STATE OF IDAHO
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Idaho Bureau of Mines and Geology
A. W. Fahrenwald, Director

Detailed Geology of Certain Areas in the Mineral Hill and Warm Springs Mining Districts
Blaine County, Idaho

By
A. L. Anderson, T. H. Kiilsgaard and V. C. Fryklund, Jr.

UNIVERSITY OF IDAHO
MOSCOW, IDAHO
# PART I

**GEOLOGY AND ORE DEPOSITS OF THE HAILEY-BELLEVUE MINERAL BELT**

by

A. L. ANDERSON

## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>IX</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Location</td>
<td>1</td>
</tr>
<tr>
<td>Surface features</td>
<td>1</td>
</tr>
<tr>
<td>Field work and acknowledgments</td>
<td>1</td>
</tr>
<tr>
<td>General geology</td>
<td>2</td>
</tr>
<tr>
<td>General features</td>
<td>2</td>
</tr>
<tr>
<td>Sedimentary rocks</td>
<td>2</td>
</tr>
<tr>
<td>General statement</td>
<td>2</td>
</tr>
<tr>
<td>Milliken formation (Mississippian)</td>
<td>2</td>
</tr>
<tr>
<td>Distribution</td>
<td>2</td>
</tr>
<tr>
<td>Character</td>
<td>2</td>
</tr>
<tr>
<td>Wood River formation (Pennsylvanian)</td>
<td>2</td>
</tr>
<tr>
<td>Distribution</td>
<td>2</td>
</tr>
<tr>
<td>Character</td>
<td>2</td>
</tr>
<tr>
<td>Tertiary strata</td>
<td>3</td>
</tr>
<tr>
<td>Quaternary deposits</td>
<td>3</td>
</tr>
<tr>
<td>Slope wash</td>
<td>3</td>
</tr>
<tr>
<td>Terrace gravels</td>
<td>3</td>
</tr>
<tr>
<td>Alluvium</td>
<td>4</td>
</tr>
<tr>
<td>Igneous rocks</td>
<td>4</td>
</tr>
<tr>
<td>General statement</td>
<td>4</td>
</tr>
<tr>
<td>Cretaceous intrusive rocks</td>
<td>4</td>
</tr>
<tr>
<td>Diorite</td>
<td>4</td>
</tr>
<tr>
<td>Quartz monzonite</td>
<td>4</td>
</tr>
<tr>
<td>Aplitic and pegmatite</td>
<td>5</td>
</tr>
<tr>
<td>Age</td>
<td>5</td>
</tr>
<tr>
<td>Early Tertiary intrusive rocks</td>
<td>5</td>
</tr>
<tr>
<td>Andesite and dacite</td>
<td>6</td>
</tr>
<tr>
<td>Lamprophyre</td>
<td>6</td>
</tr>
<tr>
<td>Age</td>
<td>6</td>
</tr>
<tr>
<td>Tertiary volcanic rocks</td>
<td>6</td>
</tr>
<tr>
<td>Structure</td>
<td>7</td>
</tr>
<tr>
<td>General statement</td>
<td>7</td>
</tr>
<tr>
<td>Folds</td>
<td>7</td>
</tr>
<tr>
<td>Faults</td>
<td>7</td>
</tr>
<tr>
<td>Summary of structural development</td>
<td>9</td>
</tr>
<tr>
<td>Ore deposits</td>
<td>9</td>
</tr>
<tr>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Fourth of July</td>
<td>26</td>
</tr>
<tr>
<td>Old property in Democrat Gulch</td>
<td>26</td>
</tr>
<tr>
<td>Croesus</td>
<td>26</td>
</tr>
<tr>
<td>Comet</td>
<td>27</td>
</tr>
<tr>
<td>Fair View</td>
<td>27</td>
</tr>
<tr>
<td>Keystone</td>
<td>28</td>
</tr>
<tr>
<td>Hard Times</td>
<td>28</td>
</tr>
<tr>
<td>Eclipse</td>
<td>28</td>
</tr>
<tr>
<td>Assault</td>
<td>28</td>
</tr>
<tr>
<td>Red Hornet</td>
<td>29</td>
</tr>
<tr>
<td>Babe</td>
<td>29</td>
</tr>
<tr>
<td>Westlake</td>
<td>29</td>
</tr>
<tr>
<td>Location and development</td>
<td>29</td>
</tr>
<tr>
<td>Geologic features</td>
<td>29</td>
</tr>
<tr>
<td>North workings</td>
<td>30</td>
</tr>
<tr>
<td>South workings</td>
<td>30</td>
</tr>
<tr>
<td>Pioneer</td>
<td>30</td>
</tr>
<tr>
<td>Starter</td>
<td>30</td>
</tr>
<tr>
<td>Alturas</td>
<td>30</td>
</tr>
<tr>
<td>Edres</td>
<td>31</td>
</tr>
<tr>
<td>Lark</td>
<td>31</td>
</tr>
<tr>
<td>Broken Wheelbarrow</td>
<td>31</td>
</tr>
<tr>
<td>Utah-Bellevue</td>
<td>32</td>
</tr>
<tr>
<td>South Chicago</td>
<td>32</td>
</tr>
<tr>
<td>Hillside</td>
<td>32</td>
</tr>
<tr>
<td>Chicago (Bellevue King)</td>
<td>32</td>
</tr>
<tr>
<td>Modoc Chief</td>
<td>33</td>
</tr>
<tr>
<td>Legal Tender</td>
<td>33</td>
</tr>
<tr>
<td>Other properties in Lee Gulch</td>
<td>33</td>
</tr>
<tr>
<td>Monday</td>
<td>34</td>
</tr>
<tr>
<td>Hawk</td>
<td>34</td>
</tr>
<tr>
<td>Marijory</td>
<td>34</td>
</tr>
<tr>
<td>Sunrise (Black Jack)</td>
<td>35</td>
</tr>
<tr>
<td>Memorial</td>
<td>35</td>
</tr>
<tr>
<td>Roadside</td>
<td>35</td>
</tr>
<tr>
<td>Constantin</td>
<td>35</td>
</tr>
<tr>
<td>Silver Wing</td>
<td>35</td>
</tr>
<tr>
<td>Storm Petrel</td>
<td>35</td>
</tr>
<tr>
<td>Other properties in Slaughterhouse Gulch</td>
<td>36</td>
</tr>
<tr>
<td>Betsy Jean</td>
<td>36</td>
</tr>
<tr>
<td>Clearwater and Wolverine</td>
<td>36</td>
</tr>
<tr>
<td>Quisley</td>
<td>36</td>
</tr>
</tbody>
</table>

**ILLUSTRATIONS**

<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A. Big Wood River Valley; B. Snoose mine</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Silver Star-Queens mine</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Index map showing location of the Hailey-Belleview mineral belt (1), Triumph-Parker Mine mineral belt (2), and Mayflower-Red Elephant area (3)</td>
<td>1</td>
</tr>
</tbody>
</table>
PART II
GEOLOGY AND ORE DEPOSITS OF THE TRIUMPH-PARKER MINE MINERAL BELT

by
THOR H. KIILSGAARD

CONTENTS

| Abstract | 39 |
| Introduction | 39 |
| Acknowledgments | 39 |
| Geography | 39 |
| Location and accessibility | 39 |
| Topography | 39 |
| Geology | 39 |
| Carboniferous sedimentary rocks | 40 |
| Milligen formation (Mississippian) | 40 |
| Distribution and lithology | 40 |
Wood River formation (Pennsylvanian) ........................................ 41
Lithology ................................................................................. 41
Tertiary sedimentary rocks .................................................... 41
Gravels and tuffs ..................................................................... 41
Terrace gravels and alluvium ................................................ 41
Igneous rocks .......................................................................... 42
Volcanic rocks .......................................................................... 42
Andesitic flows ........................................................................ 42
Intrusive rocks ......................................................................... 42
Dikes ......................................................................................... 42
Structure .................................................................................. 42
Folding ...................................................................................... 42
Faulting ..................................................................................... 43
Thrust faulting .......................................................................... 43
Reverse faulting ....................................................................... 43
Normal faulting ........................................................................ 43
Post-mineral normal faults .................................................... 43
Ore deposits .............................................................................. 44
Classification of the deposits ................................................ 44
Deposits in shear zones ........................................................... 44
Replacement deposits ............................................................. 45
Genesis of the ore deposits .................................................... 45
Conclusions .............................................................................. 46
Mining properties ..................................................................... 46
Triumph mine .......................................................................... 46
Introduction ............................................................................. 46
History and production .......................................................... 47
Mine workings ......................................................................... 47
Geology ..................................................................................... 47
Summary statement .................................................................. 47
Milligen formation .................................................................. 47
Geologic structure .................................................................... 48
Ore bodies ............................................................................... 49
Character of the ores .............................................................. 49
Paragenesis .............................................................................. 50
Conclusions .............................................................................. 50
Parker mine .............................................................................. 50
Location and development ..................................................... 50
History and production .......................................................... 50
Geology of the Parker Vein workings ..................................... 51
Geology of the Amicus Vein workings .................................... 51
Conclusions .............................................................................. 52
Recommendations .................................................................... 52
Baltimore mine ........................................................................ 52
Location and development ..................................................... 52
History and production .......................................................... 52
Geology ..................................................................................... 53
Conclusions .............................................................................. 54
June Day mine ........................................................................ 54
| Location and development                       | 54 |
| History and production                         | 54 |
| Geology of mine workings                       | 54 |
| Factors affecting ore deposition               | 55 |
| Suggestions for prospecting                    | 55 |
| Lucky G. I. mine                               | 56 |
| Lucky Coin mine                                | 57 |
| Bald Eagle mine                                | 57 |
| Ida Harlan mine                                | 58 |
| Quaker City mine                               | 58 |
| Jo Orla prospect                               | 58 |
| Silver Cord prospect                           | 59 |
| The Malta mine                                 | 59 |
| Elkhorn mine                                   | 59 |
| Independence mine                              | 59 |
| Mining properties outside the Triumph-Parker area | 59 |
| Sun Valley Lead-Silver Mines, Inc.             | 59 |
| Leitani mine                                   | 60 |
| Sun Valley Bartle mine                         | 60 |
| Joe Anderson property                          | 60 |
| Margret mining claims                          | 61 |
| Red Leaf property                              | 61 |
| Liberty Gem mine                               | 61 |
| Red Cloud mine                                 | 62 |

### ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Geologic map of the Triumph-Parker Mine mineral belt</td>
<td>40</td>
</tr>
<tr>
<td>17</td>
<td>Triumph mine, relations of working to surface geology and topography, also probable fissure projections</td>
<td>46</td>
</tr>
<tr>
<td>18</td>
<td>Triumph mine. Cross-section along C-C', Fig. 17, showing fissure projections. Slopes indicated by dotted lines</td>
<td>46(b)</td>
</tr>
<tr>
<td>19</td>
<td>Map showing Parker, Quaker City, and Jo Orla mine workings and relative positions of the principal geologic structures</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>Geologic map and cross-sections of the Baltimore mine</td>
<td>52</td>
</tr>
<tr>
<td>21</td>
<td>Geologic map of No. 3 level and longitudinal section A-A', June Day mine</td>
<td>54</td>
</tr>
<tr>
<td>22</td>
<td>Geologic map of the Lucky G. I. workings</td>
<td>56</td>
</tr>
</tbody>
</table>
PART III
THE ORE DEPOSITS OF THE MAYFLOWER AREA

by
V. C. FRYKLUND, JR.

CONTENTS

Introduction .................................................................................................................. 63
Scope ......................................................................................................................... 63
Acknowledgments ....................................................................................................... 63
Geology ....................................................................................................................... 63
Sedimentary rocks ..................................................................................................... 63
Wood River formation (Pennsylvanian) ...................................................................... 63
Conglomerate ........................................................................................................... 64
Massive gray-pink quartzite ...................................................................................... 64
Light gray calcareous quartzite ................................................................................. 64
Siliceous limestone .................................................................................................. 64
Interbedded argillites, and limestones ...................................................................... 64
Interbedded quartzite, sandstone, limestone, and argillite ........................................ 64
Pleistocene .................................................................................................................. 65
Metamorphism of sediments ..................................................................................... 65
Igneous rock ............................................................................................................... 65
Dikes ......................................................................................................................... 65
Larger Intrusives ....................................................................................................... 65
Flows ......................................................................................................................... 65
Structure .................................................................................................................... 65
Faults ......................................................................................................................... 65
Mayflower fault zone ............................................................................................... 66
Caledonia fault ......................................................................................................... 66
Red Elephant—O. K.—Point Lookout Vein fault ..................................................... 66
Ridge Vein fault ........................................................................................................ 66
Mud Vein fault .......................................................................................................... 66
Mountain View Vein fault ......................................................................................... 66
Wilson fault .............................................................................................................. 67
Preface

The ore deposits of the Hailey area, Blaine County, Idaho, some of the earliest found in the state, have long been of interest to mining men. These deposits, extensively worked during the latter part of the past century, were in many instances unusually rich in silver, lead, zinc, and other metals, but most were bottomed at shallow mining depths. Although many of them have been extensively explored since the days of early activity, most have remained unproductive.

It has long been believed that a more detailed geologic study of the area might be of value in determining why many of the ore bodies have apparently bottomed, and also what exploration and mine development measures might be taken to uncover possible continuations of these ore bodies or of new and hidden ones.

In the summer of 1949 the activities of the Idaho Bureau of Mines and Geology were almost entirely concentrated in the Warm Springs and Mineral Hill mining districts near Hailey, Idaho. The field work was performed by three field parties under the general supervision of Dr. A. L. Anderson. In order to expedite the work and to devote the maximum attention to the problems on hand it was decided to split the area into three limited portions, each assigned to a separate field party. The boundaries of these three areas are shown in Fig. 1 of the following report. The areas mapped were selected for the following reasons:

1. They contain most of the formerly productive mines and thus present underground workings available for examination.

2. They are localized along prominent mineralized zones and therefore offer the best opportunities toward future exploration.

3. They contain a representative variety of the ore deposits found throughout the Hailey area.

4. They expose a variety of rock types as well as geologic and structural features common to the area.

The writers of this report believe that in the case of the larger vein systems the present bottoming is the result of structural, and, in some cases, lithologic features. They believe it quite possible that favorable conditions for ore deposition may be repeated at depth.

A word of caution is suggested with respect to future exploration. Too many mining operators in the past have expended large sums of money in driving long tunnels whose purpose was to crosscut veins at lower depths, thereby gaining "backs." Inasmuch as the veins often change attitude, pinch out, or are faulted, many of these crosscut workings have completely missed their target, or failed because the operator did not recognize changes in the vein structures at the lower elevation. It is suggested that future exploration of the smaller properties be based on more technical advice than heretofore, and that the dip and/or the strike of the ore be followed for a distance sufficient to indicate an appreciable amount of ore before any exploratory "deadwork" is contemplated.

A. W. FAHRENWALD, Director
Idaho Bureau of Mines and Geology.
ILLUSTRATIONS

Plate 3. Geologic and topographic map of the Red Elephant and Mayflower areas, Blaine County, Idaho.............. 63

4. Geology and workings along Mayflower fault zone, Bullion Gulch, Blaine County, Idaho.................................................. (Rear of Book)

5. Geology and workings in the Bullion Gulch, Blaine County, Idaho ............................................................................. 67

6. Cross-sections through the Bullion portion of the Mayflower fault zone, Bullion Gulch, Blaine County, Idaho........... 67 (b)
A. Big Wood River Valley
Picture shows the town of Hailey, the county seat, on the broad floor of Big Wood River Valley. Wooded area outlines much of the present floodplain; remainder of valley floor underlain by terrace gravels. Mostly smooth slopes of the Wood River formation across the valley.

B. Snoose Mine
Picture shows the steep smooth slopes developed on the Milligen argillites with the bull-dozed road cuts providing evidence of the depth of overburden that conceals the bedrock. These smooth slopes contrast with the rocky slopes of the ridge in the background which is composed of diorite.
GENERAL GEOLOGY

GENERAL FEATURES

The Hatley-Bellevue mineral belt is underlain by a varied assemblage of sedimentary and igneous rocks, which, except for volcanics of mid-Tertiary age and some still younger unconsolidated sedimentary rocks, are all older than the ore deposits. The earlier rocks include fairly widespread exposures of the Milligen and Wood River formations—the host of so many of the ore deposits in the Wood River region—and also rather large intrusive bodies of diorite and quartz monzonitic rock which are regarded as outliers of the Idaho batholith.

There is also a younger group of intrusive rocks which are of more pertinent interest because of their close association with the mineralization.

The various rocks exhibit complex structural relationships. The Milligen and Wood River formations have been folded and greatly faulted with some of the faulting preceding and accompanying the intrusion of the different igneous rocks and some of it coming after intrusion, in part later.

Because of the small number of reliable horizon markers, it is difficult to decipher the complicated structural relationships; nevertheless, the major structural features and many of the details have been determined.

SEDIMENTARY ROCKS

General Statement

In addition to the Milligen formation (Mississippian age) and the Wood River formation (Pennsylvaniaian age), the area contains some strata in and beneath a series of Tertiary volcanics (Oligocene) and much poorly consolidated and unconsolidated slope wash, terrace gravels, and stream alluvium of Quaternary age.

The terrace gravels are herein differentiated for the first time.

Milligen Formation (Mississippian)

Distribution.—The Milligen formation is present on both sides of Big Wood River Valley; and on the southwest slope of the high ridge between Big Wood River Valley and Rock Creek (Fig. 2). In many places it shows normal contact with the younger, overlying Wood River conglomerate, but in other places it is in fault contact with the Wood River formation. Elsewhere it is bordered by intrusive igneous rock or passes beneath Tertiary volcanics, terrace gravels, and slope wash. On the southwest side of Big Wood River it is along a zone of complicated faulting and extensive mineralization.

Character.—The formation has been described in detail in U. S. Geol. Survey Bull. 814 (1926) and these details need not be repeated. It is sufficient to note that the formation consists of several thousand feet of shaly and sandy materials with some intercalated limestone. Locally the formation may be resolved into two fairly distinctive units consisting of an upper series of grayish calcareous shales with some purplish and blue shales and a thin bed or two of impure limestone. This unit is perhaps about 500 feet thick and forms much of the rock along and back of the steep escarpment bordering the southwest side of Big Wood River Valley. The purplish shales, which are not far under the Wood River conglomerate, seem especially diagnostic.

The other unit consists largely of black carbonaceous shales and argillites with several discontinuous beds of dark gray and black limestone and locally fairly thick lenses of light-colored sandstone or quartzite. This unit is some hundreds of feet thick. It is the most important part of the Milligen formation, for it has tended to localize deformation and mineralization. The unit is easily recognized by its prevailing dark color and its tendency to reduce to a black, highly carbonaceous soil (Pl. 1, B). Attempts were made to differentiate and map separately the thicker bodies of limestone and sandstone occurring in the black argillites (Fig. 2).

In and near the Minnie Moore mine west of Bellevue the Walkers (2) have subdivided the Milligen formation into the Riverview limestone (350+ feet), Chace argillite (340 feet), San Jose limestone (285 feet), Delancey argillite (1050 feet), Penasco formation (150 feet), Michigan argillite (175 feet), and Oswego limestone (550+ feet), listed in order from oldest to youngest.

Wood River Formation (Pennsylvaniaian)

Distribution.—The Wood River formation is also present on both sides of Big Wood River Valley. The exposures are most widespread northwest and east of Hatley, on the Rock Creek slope in the southwest part of the area, and on the high ridges northeast of Big Wood River Valley. The most conspicuous member of the formation is the basal conglomerate which forms fault-interrupted bands on the ridges west of Hatley and northeast of Big Wood River. Because of its usefulness as a horizon marker, the conglomerate has been mapped separately (Fig. 2).

Character.—Above the conglomerate, which measures some hundreds of feet thick, the Wood River formation consists largely of calcareous and sandy beds devoid of easily recognizable markers. A thin bed of limestone

*All references quoted are listed at the end of the paper.
Fig. 1 Index Map showing location of Hailey—Bellevue Mineral belt (1), Triumph—Parker Mine Mineral belt (2), and Mayflower—Red Elephant area (3).
lies immediately above the conglomerate but the greater part of the formation is calcareous and quartzitic sandstone, locally with intercalated beds of massive limestone and some shale. The characteristics of the formation are described in considerable detail in U.S. Geol. Survey Bull. 814. The conglomerate and the sandstones are the most conspicuous facies of the formation in the Hailey-Bellevue area.

**Tertiary Strata**

The strata between and beneath the Tertiary lava flows were not separated from the latter in mapping. Such bedded rocks are present with the volcanics west of Hailey Hot Springs and in the upper drainage of Rock Creek where erosion has disclosed considerable areas of the basal beds.

The strata are composed largely of tuffaceous materials which have been sorted by water and mixed with variable amounts of other clastic debris. In or near Democrat Gulch the deposits measure up to 200 feet thick and locally are composed largely of sandstone and shale, in part tuffaceous. Much bedded white clay and shale are exposed in the Rock Creek area; also discolored clay material that forms wide cracks on drying, and which may be made up in part of bentonitic clay from decomposition of poorly consolidated tuffaceous rocks. In general the strata have been deposited by streams, but the thin-bedded clays and shaly rocks suggest local deposition in ponded water.

**Quaternary Deposits**

Slope wash.—The material designated as slope wash is confined to the southwest part of the area (Fig. 2), and forms as caps on low broad ridges extending from the lower flanks of the high ridge between Rock Creek and Big Wood River. This material effectively conceals the identity of the underlying bedrock. It has the relations of a somewhat dissected piedmont deposit composed of debris washed from the higher slopes and accumulated as thin fans, since somewhat entrenched as a consequence of uplift, and attendant erosion.

The wash on the slopes fronting the main ridge is composed largely of granite sand with admixtures of coarse fragments or boulders of the weather-resistant aplite and pegmatite. Wash composed largely of quartzitic fragments, however, covers the surface surrounding hills of Wood River and Milligen formations on the divide between Croy and Rock Creeks.

In the extreme southwest part of the district the slope wash certainly covers granitic rock, but along the base of the main ridge the granitic wash probably covers rock of the Milligen and Wood River formations.

**Terrace gravels.**—Four different terraces have been distinguished in mapping, all of which are well developed in the broad valley of Big Wood River and the upper terraces in the broader tributary valleys (Fig. 2). Remnants of still other terraces have been observed several hundred feet above present floors of tributary valleys, but these remnants are too small to be shown on the map.

The highest terrace that was mapped (QH) rises at least a hundred feet above the margins of the valley floors, but only fragments of this terrace remain along the east side of Big Wood River Valley and in the valleys of Quigley and Slaughterhouse Creeks. This terrace is probably considerably older than the lower bordering terraces and may possibly represent outwash fill from Pleistocene glaciers in the higher mountains, since largely removed by the post-glacial streams.

The next terrace (Qm) is far more extensive than the earlier terrace and is conspicuously developed at and for a mile or two below the mouths of Quigley and Slaughterhouse Creeks. The surface of this terrace, extended upstream, forms much of the present floors of the main tributary valleys. Its appearance at Hailey and Bellevue is much like that of a fan subsequently terraced by the erosive action of Big Wood River. A short distance below each town the terrace has been effaced by the development of the next lower terrace. The terrace is also very well perfected about the north and west side of Poverty Flat at the south end of the district, forming an escarp exceptionally high and conspicuous because it descends directly to the level of the lowest terrace (Ql), which locally has wiped out the intermediate terrace (Qm).

The next or intermediate terrace (Ql) is continuous along the east side of Big Wood River and extends a short distance up Croy Creek. This terrace is not much below the level of terrace (Qm) once away from the mouths of Quigley and Slaughterhouse Creeks. The lowest terrace (Ql) forms discontinuous remnants in protected coves on the east side of Big Wood River floodplain and an extensive flat west of the river beginning about 3 miles below Bellevue, where it forms much of Poverty Flat. The terrace is only a little above the present channel of Big Wood River and is probably a fairly recent development.

The different terraces were not traced much beyond the boundaries of the mapped area but they are known to extend far upstream. They are probably a consequence of the Pleistocene glaciation of main valley heads with lower terraces formed after the glaciers had disappeared.
Alluvium.—The gravel, sand, and silt mapped as alluvium constitute the present flood plain deposits and mark the lowest bottom lands still subject to overflow. The alluvium of these flood plains forms a relatively broad band along the southwest side of Big Wood River Valley with a fairly long tapering finger reaching up the valley of Croy Creek. The sand and gravel are covered in part by a thin veneer of sandy, immature soil.

**IGNEOUS ROCKS**

**GENERAL STATEMENT**

The igneous rocks of chief interest are the intrusive rocks which are exposed over a fourth of the map-area, mainly in the southwest part. The other igneous rocks, the mid-Tertiary volcanics, blanket about one twelfth of the area, mainly along the western border. These volcanic rocks are important only because they conceal the underlying intrusive and sedimentary rocks which locally contain the principal ore deposits.

The intrusive rocks are divisible into two age groups with by far the bulk of the rock contained in the older group where members are regarded as outliers of the Idaho batholith. These intrusives are thought to be of Upper Cretaceous age. The rocks of the younger group, though much less conspicuous, are much more pertinent because of their close association with the sulphide mineralizations. They are known to be products of a Tertiary igneous activity and of the same magma which is regarded as the ultimate source of the ore-bearing solutions.

**Cretaceous Intrusive Rocks**

The older group of intrusive rocks is represented by diorite, quartz monzonite, aplite, and pegmatite, with the diorite composing about two thirds of the exposed rock and the quartz monzonite much of the remainder. The diorite was emplaced ahead of the quartz monzonite, but, although the two are not similar petrographically, they probably do not reflect separate magmatic sources. The aplite and pegmatite show a particularly close association with, and relationship to, the quartz monzonite.

**Diorite.**—The diorite forms a body about 5 miles long and 2½ miles wide elongated in a northwesterly direction and conforming closely with the structural trend of the much faulted Milligen and Wood River formations just west of Big Wood River Valley (Fig. 2). This body has a sill-like relationship and conforms roughly with the northwesterly strike and southwest-erly dip of the intruded Milligen formation, with the dip of the underside ranging from 30° SW. to 50° SW.

The diorite is composed of a remarkably uniform type of rock showing but very few variations in appearance and composition. Most of the rock is grayish, medium grained, and is particularly distinguished by rather conspicuous grains of biotite. These grains ordinarily compose about 10 per cent of the rock. When the rock weatheres, the biotite is retained in the soil in such abundance that it makes it possible to distinguish areas underlain by diorite from those underlain by quartz monzonite.

The rock may be classed as a quartz-bearing, hypersthene-augite-hornblende-biotite diorite which contains in addition to these minerals and plagioclase, minor amounts of sphene, zircon, apatite, allanite, and magnetite and small and variable amounts of various alteration products such as chlorite, epidote, and locally sericite. The most abundant mineral is the zoned plagioclase (andesine-labradorite) which comprises all but about 30 per cent of the rock. The proportion of biotite remains about constant, but the hypersthene, augite, and hornblende are present in variable amounts with the hypersthene locally more abundant in marginal parts of the body than the other dark minerals. The three minerals collectively form about 15 per cent of the rock. They show marked mantling (reaction) relationships. The quartz content is ordinarily slightly under 5 per cent, but in places increases to about 10 per cent.

In some places the rock shows transitions into somewhat lighter-colored facies, but these facies are of limited extent and rarely form bodies more than a few feet across. These lighter-colored facies range from quartz diorite to granite in composition. Biotite in reduced quantity remains as the only dark mineral and the place of the plagioclase is largely taken by microcline and quartz, in part in aplitic-like, and in part in granophytic relationships. Accessory minerals are generally more numerous than in the main diorite.

**Quartz monzonite.**—The quartz monzonite has been emplaced under and along the southwest side of the diorite body with the largest exposure measuring about 4 miles long and 1 to 1½ miles wide. Other exposures occur in the extreme southwest corner of the district separated from the larger exposure by a roof pendant of Wood River and Milligen rocks. These are continuous with a much larger area of granitic rocks to the west and may be traced almost without interruption into the granitic rocks of the Halsey gold belt G3. The granitic rocks also reappear on the other side of the volcanic blanket north of Croy Creek a short distance beyond the map border.
The quartz monzonite is more coarsely grained and much lighter colored than the dioritic rock and the contact between the two bodies is easily traced even on aerial photographs. The moderately coarse-grained quartz monzonite is generally somewhat porphyritic and in places contains conspicuous crystals of microcline measuring up to an inch or more long.

The proportions of the different minerals vary to some extent but in general the rock contains about equal amounts of andesine and microcline, 20 to 35 per cent quartz, 5 to 10 per cent biotite, in places a little hornblende, up to several per cent sphene, small amounts of the accessory minerals zircon, apatite, magnetite, ilmenite, and allanite, and variable amounts of such alteration products as epidote, chlorite, and sericite. In places the minerals are set in a more finely grained matrix of quartz grains, apparently of quartzitic character.

The quartz monzonite intrudes the diorite as well as the Milligen and Wood River formations. The contact with the diorite is sharply defined and smooth, and in the southern part of the area is nearly horizontal with inclination to the east at an angle of about 10°. In the northwestern part of the area, however, the dip becomes progressively steeper, reaching a maximum of 70°. On the other hand the contact with the sedimentary rocks is largely gradational and consists of an intervening zone of "granitized" rock in which sedimentary materials are retained and sedimentary structures in part preserved. In places the limestone shows contact metamorphic effects with recrystallization of calcite and formation of tremolite and other lime silicates. The sandstone or quartzite shows more direct transition into granite.

Aplitic and Pegmatitic.—Aplitic and pegmatitic are very closely associated and commonly form parts of the same body. They are particularly numerous in a swarm that cuts the north end of the diorite west of Scorpion Gulch with most of the bodies large enough to be shown on the geologic map (Fig. 2). Scattered but larger bodies composed largely of aplitic extend farther north into the Milligen formation and smaller bodies of aplitic and pegmatitic cut the quartz monzonite to the south. These dikes are a few feet to some tens of feet wide and up to several hundred feet long, with all of them elongated in a general north-northeast direction.

The rocks are practically devoid of dark minerals and consequently are light colored and in general more resistant to weather and erosion than the enclosing rock. The aplitic rocks are fine grained and have a distinct sugary-like appearance; the pegmatitic rocks show marked variation in grain size, from small grains as in the aplitic to coarse crystals measuring up to several inches long, the texture ranging from coarse granitic to graphic. In general, individual dikes show gradations from aplites to pegmatites.

The aplites are quite uniformly grained and is composed largely of small anhedral or subhedral grains of quartz and microcline with some sodic plagioclase and a little fine muscovite and slightly larger grains of chloritized biotite. The pegmatites on the other hand show a most variable range in grain size with the smaller grains identical in size and kind to those in the aplitic rock and with the more coarsely grained areas composed of large grains of microcline and quartz, with the microcline generally filled with remnant inclusions of aplitic minerals. The mineralogic and textural relations suggest that the pegmatite has been transformed into pegmatite by introduction of microcline and quartz, and in some places sodic plagioclase; much of the pegmatite, therefore, is a replacement of the aplitic. Locally, some perthitic albite has also been introduced into the rock mainly as veins cutting microcline.

Age.—The age of these intrusive rocks can be inferred only by comparing them with similar rocks of known age in other areas. The local rocks have been regarded as outliers of the Idaho batholith and surely the quartz monzonite is typical of much of the quartz monzonite of that well-known body. However, the diorite locally cut by the quartz monzonite is identical to the diorite that cuts the Idaho batholith in the Boise Basin (4 pp. 135-137) and Horseshoe Bend region (5). There the batholithic rock is similar to and is probably the same age as the Coast Range and Sierra Nevada batholiths (late Jurassic and early Cretaceous). The characteristics of the diorite indicate that it was intruded into quite cold rocks and consolidated rather quickly. It was thus probably intruded some time after the emplacement of the batholithic rock. The local quartz monzonite, therefore, must represent a younger emplacement, perhaps equivalent in age to the Boulder batholith of Montana, intruded in late Cretaceous time. The Idaho batholith is probably much more composite than heretofore recognized and is composed of granitic rock intruded from early to late Cretaceous time. The diorite and quartz monzonite with associated aplitic and pegmatite are probably of Upper Cretaceous age.

Early Tertiary Intrusive Rocks

The early Tertiary intrusive rocks are confined to a few dikes of andesite and diorite ex-
posed here and there on the surface cutting the diorite and quartz monzonite (Fig. 2), and to numerous dikes of lamprophyre exposed mainly underground in mine workings along and across the ore zones. The andesitic and dacitic dikes appear to be pre-ore and the lamprophyres mainly post-ore. Despite the difference in age and composition, the rocks possess some microscopic features which indicate a common magmatic ancestry.

**Andesite and Dacite.** — The andesite and dacite dikes are widely scattered and have been mapped in the swarm of aplite and pegmatite dikes in the diorite west of Scarpian Gulch, where at least one cuts bodies of aplite and pegmatite. They have also been mapped in the diorite along the divide at the head of Scarpian Gulch and in the quartz monzonite below the Estes mine near Poverty Flat. These dikes may be distinguished by their trend, for unlike the other intrusives, they invariably trend east-northeast to northeast and thus across the dominant structural grain.

Andesite is indistinguishable from dacite, except in thin section. The two are generally fine-grained, grayish, commonly much altered rocks of slight porphyritic habit with scattered phenocrysts of andesine in a matrix of small zoned andesine laths and quartz, the amount of quartz determining whether the rock should be called dacite or andesite. The plagioclase is generally dusted with alteration products but appears to have the composition of andesine. The dark minerals are largely altered to chlorite, but grain outlines and incompletely altered remnants indicate that the dark minerals were originally hornblende and less abundantly biotite. Other primary minerals include accessory grains of sphene, magnetite, apatite, and orthoclase. Secondary products include epidote and calcite.

Several of the dikes contain large widely scattered crystals of hornblende in a matrix that contains smaller rather numerous hornblende laths. This rock appears to be intermediate between the andesite-dacites and the lamprophyres described below.

**Lamprophyre.** — Because of the ease with which they weather, the lamprophyric dikes are poorly exposed on the surface and are otherwise too small to be shown on the geologic map of the area. They are, however, conspicuous features in many of the mines and particularly those in the diorite and quartz monzonite. The dikes have diverse trends, but most of them are along the same fault zones as the ore bodies and may be bordered by ore on one or both sides.

These lamprophyre dikes are composed of dark-gray to grayish-black, fine-grained, somewhat porphyritic rocks with rather inconspicuous phenocrysts of dark minerals in a matrix composed largely of dark minerals and feldspars. The rocks are generally much altered and contain an abundance of chlorite, calcite, sericite, and in some places serpentine and talc. In some rocks the dark phenocrysts consist largely of biotite with lesser olivine and hornblende in a matrix composed of plagioclase, orthoclase and hornblende, with abundant magnetite, apatite, and secondary products, including serpentine and talc (after olivine). In other rocks the dark phenocrysts are composed largely of hornblende crystals with lesser augite and olivine (in part unaltered) in a matrix composed of zoned plagioclase and dark minerals with accessory orthoclase and quartz and much apatite and magnetic plus alteration products. Thus these rocks show a range in composition from minette and kersantite to diorite lamprophyre (spessartite).

**Age.** — The andesitic and dacitic dikes show a marked independence of northwesterly structural trends and a guidance by faults of northeast to northeasterly trend. This preference is rather typical of the magma intruded in early Tertiary time which found transverse fractures produced by differential transmission of stress during late stages of the Laramide orogeny especially favorable for intrusion (6). As these dikes are in fractures that cut the diorite and quartz monzonite of probable Upper Cretaceous age and were intruded before the outpouring of lavas in mid-Tertiary (Oligocene) time, they are assigned with considerable assurance to the early Tertiary epoch of igneous activity.

**Tertiary Volcanic Rocks**

The Tertiary volcanic rocks apparently occupy an old broad valley of northeast to northeast trend of which only the southeastern part extends across the northwest corner of the map area (Fig. 2). The tuffaceous and intercalated sedimentary rocks have already been discussed; the flows that make up the greater part of the assemblage consist mainly of andesite and latite, which in U.S. Geol. Survey Bull. 814 are described as latite and augite and hornblende andesites. The augite andesite is a grayish to black rock with few, if any, feldspar pheno- cryysts, and weathers to a deep-red soil. The latite and hornblende andesite are reddish rocks, commonly have feldspar phenocrysts, and contain biotite and hornblende. In the augite andesite the matrix consists of very fine grains of andesine, augite, and magnetite; in the hornblende andesite, plagioclase, hornblende, and scant orthoclase, quartz, and bio-
lithite, and in the latite, plagioclase, orthoclase, quartz, and biotite.

These rocks are regarded by the authors of U.S. Geol. Bull. 814 as probably Miocene in age, in part because of their similarity in composition and general geologic relations to lava in other parts of Idaho that has generally been considered probably of Miocene age. These volcanics may be traced with little interruption into the volcanics in the Challis area where the name Challis volcanics has been assigned them and their age since determined as probably Oligocene (7).

STRUCTURE

GENERAL STATEMENT

The folding within the area is comparatively simple and consequently faulting constitutes the outstanding structural feature. The geologic map (Fig. 2) fails to do justice to the faulting, for many faults have been omitted, chiefly because of the dearth of horizon markers needed to verify their presence. Thus faults within the larger bodies of dioritic and quartz monzonitic rock, unless occupied by dikes or mineral matter, are unmapped. Such faults are known to be numerous because of their abundance in underground workings. In the older sedimentary rocks the conglomerate at the base of the Wood River formation serves as a marker. Locally, the black argillites and their intercalated limestones and the gray shales above prove useful; in fact these rocks made it possible to recognize and map many of the faults between Big Wood River and the body of diorite (Fig. 2) in what is probably the most highly faulted part of the area. Yet the many faults observed in underground workings indicate that only a fraction of the total number of faults have been mapped.

For establishing the age of faults, the igneous rocks are most useful. Faults that directed intrusion of the diorite are the oldest, perhaps in part at least as old as the folding. Faults which facilitated emplacement of the quartz monzonite are obscure, but presumably some are younger and some older than the diorite. Faults within these intrusive masses are obviously younger than those which guided their intrusion. These younger faults range considerably in age. The oldest offered guidance to the aplites and pegmatites; those next in age directed intrusion of the andesite and dacite dikes; faults still younger served as channels for ore-bearing solutions and injection of lamprophyry dikes; and still younger faults cut the ore bodies. The age of these youngest faults is less definitely fixed. Most of them are probably older than the unconformity at the base of the Oligocene volcanics, but as faults are also known to cut the volcanics, the age may range from early Tertiary into Quaternary. The faults in sedimentary rocks are less easily dated. Faulting that affected igneous rocks also must have had a part in the deformation of the sedimentary rocks, but the only basis for dating these faults is by comparison with faults of similar characteristics in the igneous rocks. This comparison is rendered difficult and in part impractical because of the tendency of younger faults to develop along planes of weakness established by older faults and also because of the tendency for recurrent forces to act from the same direction and thus form new fractures of the same pattern as the old. Dating of many faults is obviously impossible.

Folds

The Milligen and Wood River formations have been deformed into a broad, much broken anticline with the crest closely coinciding with Big Wood River Valley. Beds on the northeast side of the anticline dip eastward at angles of 20° to 35°, exceptionally up to 70°, and beds on the southwest side dip generally westward at angles mostly between 20° and 40°. Extensive faulting on both sides of the valley has had the effect of dropping the crest of the anticlinal arch from 2,000 to 3,000 feet.

Some rather complicated folding of minor magnitude appears along the flanks of the broad anticline, particularly in the Milligen formation. Some of the beds locally are closely folded or crumpled. Such crumpling is mostly confined to the weak, thinly bedded black shales and argillites and probably reflects drag in these incompetent beds during the formation of the anticlinal arch as well as drag along some faults. More competent beds of the Wood River formation contain little of this kind of folding.

The area also shows the effect of more recent warping, which is associated with the subsidence of the nearby Snake River Plain or conversely with the uparching of rocks bordering the Snake River Plain. As a result the area is tilted toward the south with ridges at progressively lower levels from north to south and with drainages in the gulches bordering Big Wood River Valley asymmetrically disposed in streams reaching toward the north. This late warping probably took place in late Tertiary and in Quaternary time and may in part account for the broad, aggraded valley floors of Big Wood River and its large tributaries, which filled with alluvium when the lower drainage was blocked by flows of Snake River basalt.

Faults

Lack of sufficient data on the characteristics and age of most of the faults makes syste-
matic classification impractical. Some of the faults are known to be normal, others reverse, and still others dominantly strike-slip; but many offer no clues as to the direction of movement. Although something is known of the age of faulting, the time of formation of many individual faults is uncertain; thus description of the faults by geographic areas seems the most logical approach.

East of Big Wood River the faulting is not so complex as on the west side. There are some northerly trending faults of considerable length that have dropped the Wood River conglomerate against the Milligen formation. These faults are known to be normal with downthrow to the west and they have had much to do with the collapse of the crest of the anticlinal arch. There are also some faults of northwest to west trend which have caused offsets in the Wood River conglomerate and these too are probably normal or possibly strike-slip. It is not known whether these are older or younger than the more northerly trending faults or of about the same age. There is still another group of northeast faults which do cut off the others. The most prominent of the northeast faults extends along the northeast side of Slaughterhouse Gulch. Whether the fault is strike-slip or normal was not determined, but if normal it has the downthrow on the northwest. Near it is another fault, perhaps of similar kind, which is in and exactly parallel to Slaughterhouse Gulch and is concealed beneath gravels of the valley floor (not shown in Figure 2).

North of Croy Creek are many northwest-erly faults which are about parallel to Big Wood River Valley and which dip steeply northeast. These faults have also aided in the collapse of the anticlinal structure. They too are offset by northeast faults, one of which has considerable displacement and apparent downthrow to the northwest. Low-angle faults are also present in the area, but it is not known whether the upper wall has moved up or down with respect to the under wall.

South of Croy Creek the faulting is more complicated. Between the diorite body and Big Wood River, the sedimentary rocks are broken by a mosaic of faults of diverse strike and dip. Many of the faults belong to the northwesterly-trending group and like those north of Croy Creek dip northeast, bringing many slices of Wood River formation down against the Milligen. Some of the faults show considerable curvature. There are also faults of more northerly trend and a number which strike northeast. Some of the latter appear to have a very low dip, but some have a steep dip and are similar to the northeasterly-trend-
also pre-mineral faults that strike about N. 40° E. All these faults have steep dips. An area of complex faulting is also present along the south border of the map. These faults involve the Milligen and Wood River formations.

In general the faults in the area favor certain directions and can be resolved into several more or less well-defined sets which in part differ in age and reflect several crustal disturbances to which the region has been subjected.

**Summary of Structural Development**

Crustal disturbances which are known to have affected the general region include the Sierra Nevada orogeny of late Jurassic time, the Laramide orogeny of late Cretaceous and early Tertiary time, the mid-Tertiary crustal unrest, and earth movements of late Tertiary and Quaternary time.

Folding of the Paleozoic sedimentary rocks—the Milligen and Wood River formations—is probably a reflection of the late Jurassic orogeny that preceded the emplacement of the early rock of the Idaho batholith in the western part of the State. Some faulting was probably associated with the folding; but these faults cannot be differentiated from those during the early part of the next orogeny when forces acted from essentially the same (west-southwest) direction. It is likely that most of the pre-intrusion faults were formed during the early part of the Laramide disturbance. These faults would include thrusts of northwesterly trend and southwesterly dip as well as faults of other kinds with general northwesterly and perhaps in part with northeasterly strikes. In any event a zone of structural weakness was formed which facilitated igneous intrusion.

Following faulting in the early part of the Laramide orogeny (Upper Cretaceous) came the intrusion of the sill-like body of diorite, apparently along the zone of one of the thrusts. What happened immediately thereafter is not known but within a comparatively short time structural adjustments permitted upper movement of "granitizing solutions" and emplacement of quartz monzonite under and along the southwest side of the diorite body. During closing stages of the emplacement, quartz, monzonitic and dioritic rock were broken by faults of north to north-northeast trend along which were intruded aplites and pegmatites. Some faults of northerly trend, in the sedimentary rocks, may also have formed at this time.

Renewed Laramide activity in early Tertiary times created northeast faults which permitted intrusion of andesitic and dacitic magmas. Forces associated with the orogeny later induced the formation of many faults of west to northwest trend as well as a few of northwest trend. Some of these faults are nearly flat, some are thrusts, and many have pronounced strike-slip components of movement. These faults directed and controlled sulphide mineralization and intrusion of lamprophyric dikes. Some faulting may have continued after mineralization and lamprophyric intrusion, but the main post-mineral faulting is probably associated with the crustal unrest in mid-Tertiary time.

During the mid-Tertiary disturbance the rocks were broken by faults, most of which strike about N. 30° E., with a few of northeasterly strike. These ones striking northwest and locally about due north or due west. Some of the faults have relatively flat dips but most of them dip steeply; some have caused marked offsets in the earlier mineralized faults. The northeast faults have probably had a very important role in developing the northeast drainage pattern.

In late Tertiary time and continuing into the Quaternary, crustal forces created northwest-trending normal faults that may in part block out the valley occupied by Big Wood River and the high ridge southwest of Wood River. Shortly after the area was affected by the Snake River downwarp and tilted into its present position toward the south.

**ORE DEPOSITS**

**HISTORY AND PRODUCTION**

Lead-silver deposits were known along the Halley-Bellevue mineral belt back in the sixties but little attention was given them until about 10 years later. From the late seventies through the eighties the area busied with activity. Discovery of the Minnie Moore mine in 1880 marked the beginning of the most prosperous era that the area enjoyed, but the years of greatest productivity came to an end within a decade. From then until the turn of the century mining was quiet and there was virtually no production.

The discovery of more ore at the Minnie Moore in 1902 initiated another period of considerable productivity that lasted for several years. At the same time active work was carried on at the Crows and other properties and this work continued for some years after the Minnie Moore had mined the last of its known ore. From then on the story has been one of repeated attempts to find more ore at the Minnie Moore and some of the other mines. Most of the work was unrewarded and search at the Minnie Moore ceased in 1941.

With the late war came renewed interest in the mineral possibilities of the area. One of
the old mines (now known as the Snoose) was reopened and about a hundred cars of ore were shipped to Salt Lake for mill and smelter treatment. After the war the Silver Star-Queens Mines Company undertook to reopen the old Queen of the Hills mine across the gulch from the Minnie Moore and in 1949 the company rehabilitated the Rockwell shaft on the Minnie Moore property to gain access to deeper levels of the Queen mine. Much interest was manifested in other properties along the mineral belt during and after the war, but in 1949 the Snoose and Silver Star-Queens mines continued to be the most active operations.

The production of the mines along the Hatley-Bellevue mineral belt is not accurately known. During the boom in the twenties the Minnie Moore is estimated to have produced ore worth $7,316,600.12 (I, p. 222). According to the Walkers (Z) subsequent production has brought the Minnie Moore total to about $9,000,000. With the known production of other properties, including $2,500,000 from the old Queen of the Hills mine, the total of the area is above $12,000,000.

**CHARACTER OF THE DEPOSITS**

The deposits along the Hatley-Bellevue mineral belt consist of lead-silver veins and lodes and pyritic gold veins in a complex fracture and fissure zones that cut the sedimentary and metavolcanic rocks. The veins and lodes are chiefly replacements of the rock in and along the fissure and fracture zones but locally there may be more fissure filling than replacement. The lead-silver deposits have been the most productive and have, in addition to lead and silver, produced considerable amounts of gold. Some gold veins have contained a little copper.

The lead-silver and gold deposits differ somewhat in age as well as in substance. In some places ore of both have been introduced into the same fracture or fissure zones with the lead-silver as the later addition. Classed with the lead-silver deposits are several that appear to contain chiefly zinc with a little lead and silver. These differ somewhat from the normal lead-silver lodes and veins and apparently belong to a younger epoch of metasialization. Ore of commercial interest has not been found in these zinc deposits.

**GEOGRAPHIC AND GEOLOGIC DISTRIBUTION**

The veins and lodes are widely distributed along the mineral belt but show a closer spacing on the slopes southwest of Big Wood River between Hatley and Bellevue and in and along Scorpion Gulch (Fig. 21) than in other parts of the area. The most productive deposits are in the more crowded areas, with the two most important mines, the Minnie Moore and Queen of the Hills, in lower Goliath Gulch just west of Bellevue, and the third, the Croesus, in the lower end of Scorpion Gulch. In other parts of the area the deposits show a more sporadic distribution. They are fairly closely spaced east of Bellevue, especially along Slaughterhouse Gulch and also along the slope bordering Big Wood River Valley, but deposits northeast of Big Wood River have not yielded much ore. The deposits are more widely spaced north of Croy Creek and these too have not been very productive.

The deposits are mostly contained in the Milligen formation and the body of diorite rock with comparatively few in the Wood River formation and the quartz monzonite. The most productive deposits seem to favor the thinly bedded blackish shales and argillites not far from the diorite contact and to lesser extent across the contact in the diorite itself. Except for the concentration close to the diorite contact the lead-silver deposits show no particular affinity for any one kind of rock. Distribution of the deposits apparently reflects favorable structural rather than stratigraphic controls with the black argillites generally providing the most suitable structures because of their tendency to localize deformation. The gold deposits on the other hand are confined to the body of diorite and farther west to the quartz monzonite.

**STRUCTURAL RELATIONS**

All the deposits are along complex zones of fissuring and fracturing which usually show much crushing and brecciation and not too much actual fissure development. Most of the zones, however, are bounded on one or both sides by walls that have been polished and in places grooved by pre- or post-mineral movement, and if not intruded by lamprophyric dikes, may contain fractures which extend obliquely across the zone from one wall to the other. In most of the deposits the ore tends to occur along or close to the walls, in places on both sides of intruded lamprophyric dikes. In some of the broader zones of fracturing in the Milligen formation, zones which measure up to 40 feet across, with ore locally showing tendency to occur along diagonal fractures. Sharply delineated fissures therefore are rare and the usual settings for ore bodies are combined fissure-fracture zones containing several prominent slips. Some of the fissure-fracture zones split to form two fissure-fracture zones up to 100 feet or more apart which are commonly designated as "hanging wall" and "footwall" veins.

Most of the mineralized fissure zones trend
in a northwesterly direction and those which have been most productive dip southwest at moderate to steep angles. These zones roughly parallel the contact of the diorite, but show considerable variation in strike and dip. Many of them strike about N. 30° W., and thus very closely parallel the contact, but many more strike N. 60° - 70° W., and some about due west. These trends are particularly characteristic of the mineralized fissures in the diorite and the bordering Milligen formation. Farther from the diorite contact and particularly northeast of Big Wood River, the fissures show greater departures from these directions and in part are more northerly and more easterly. The characteristics of these various faults and fissure zones have been treated in some detail in the earlier part of the report dealing with structure.

The faults or fracture zones which have been mineralized probably include some of those which were formed during the major structural disturbance as well as those which accompanied and followed intrusion. Apparently, any of the older fissure and fracture zones were acceptable for mineralization provided they could be reached by the mineralizing solutions. Some of the older faults may have been reopened by structural movements prior to mineralization.

The fissure zones that have been mineralized are apparently those of minor or relatively minor displacement. The larger faults shown on the map (Fig. 2) are unmineralized, either because they contained so much gouge that the ore solutions could not enter or circulate along them, or because they are post-mineral. Thus the solutions sought out the minor, more open and permeable fractures. Crushing and brecciation of some of the ore indicated recurrent movement along the fissure zones during and after the main period of ore deposition. Some of the post-mineral faulting in and across the veins and lodes may be Mid-Tertiary in age. Offsets in northeast directions are certainly the product of Miocene faulting.

MINERALOGY

The lead-silver deposits are characterized by argentiferous galena with more or less abundant sphalerite and tetrabedrite and subordinate and variable amounts of pyrite, arsenopyrite, and chalcopyrite in a gangue of altered and crushed country rock, siderite, calcite, and quartz. Sphalerite predominates in a few deposits, especially in some of those in the diorite, but generally it is subordinate to the galena, and in some deposits very much so. Pyrite is generally conspicuous, but arsenopyrite and chalcopyrite are commonly present in very small quantities, if at all. Siderite is the most conspicuous and in part the most abundant gangue mineral, particularly in deposits in and near the body of diorite, but may be lacking in deposits some distance away. Calcite, too, is abundant locally but mostly in the fractured rock bordering the mineralized fissures. The minerals, especially the early ones, show much alteration and mineral zones are on the galena, one of the latest minerals to be deposited, shows considerable granulation and flowage resulting from movement. The minerals display the well-established sequence of deposition beginning with siderite and then proceeding with quartz, pyrite, sphalerite, tetrabedrite, chalcopyrite, and galena. Some of the deposits have been subsequently reopened and contain minor additions of marcasite, stibnite, hisingerite, calcite, and various zeolites, apparently contributed during later Miocene mineralization.

Gold deposits are characterized by pyrite and quartz and generally variable and in some places notable amounts of arsenopyrite and chalcopyrite, and exceptionally pyrhhotite. In general the sulfides are rather coarse grained and much more abundant than quartz. Some of the veins have had sphalerite and galena added to them.

The younger (Miocene) deposits contain mostly sphalerite or wurtzite, and generally considerable, somewhat globular pyrite or marcasite, and at little galena on altered rock and calcite. The mineralization is quite similar to some of that comprising the Miocene base-metal deposits in the Lava Creek district near the Craters of the Moon National Monument (8).

CHARACTER AND DISTRIBUTION OF THE ORE

Except where it has been mashed by structural movements, the ore is relatively coarse grained and is more coarsely grained in deposits in the diorite than in those contained in the Milligen and Wood River formations. In most deposits the ore is intimately associated with the crushed or fractured country rock, which locally constitutes the larger part of the gangue, but in some places the sulfides form patches and bands in massive siderite. In general a large part of the ore now exposed consists of sheared and crushed rock alternating with lenses or more or less irregular masses of nearly clean galena or of galena and other sulfides. Some areas consist dominantly of sphalerite. In a few places the ore is made up of irregular clusters, bunches, and isolated grains and granules of sulfides in the highly crushed rock.
The ore appears to be confined to more or less sharply defined shoots, most of which terminate rather abruptly along the strike, commonly with blunt ends. These shoots may be a few tens to a few hundreds of feet long, up to 1,200 feet in the case of the Minnie Moore vein, and may measure from a foot or less up to 15 feet or more wide. In general the shoots have not persisted to depths of more than a few hundred feet, but again the Minnie Moore shoot has been stopped for about 1,000 feet on the dip and may continue for a long distance beyond the zone of post-mineral faults against which the ore body has been lost.

As most of the mines in the area were not open to inspection, very little new information could be learned about the control of the ore shoots. This subject is discussed in some detail in U.S. Geol. Survey Bull. 814, pp. 101-105, but the authors of the report were not able to arrive at any satisfactory conclusions. Some of the shoots seem to be contained in parts of fissure zones in which the width of fracture rock is greater than average and the rock not very highly compressed or extensively crushed into gouge. These areas are probably determined by movement along faults of irregular strike and dip, where walls locally tend to separate and produce zones of greater permeability. In some places the ore was observed to occur where the hanging wall had steepened and had moved away from the footwall.

Where faulting is of the thrust variety, the ore tends to be localized along the flatter parts of the fault and to pinch as the fault steepens and the walls are pressed tightly together and sealed with gouge. In the normal faults the relations are reversed and the ore shoots occur in steeper parts and pinch as the dip flattens. In the strike-slip faults any variation in dip and strike may produce favorable channels for circulation of ore solutions and deposition of ore. Localization of ore shoots thus depends largely on the nature of the faulting. Apparently, fissure and fracture intersections and the character of the rocks through which the fissuring extends has had little, if anything to do with deposition of the ore and delineation of ore shoots. Until it is possible to study more of the deposits underground, little can be done to evaluate structural controls.

WALL-ROCK ALTERATION

The ore-bearing solutions have not in general had much noticeable effect on the rocks through which they have passed. The rock in and along the mineralized fissures and fracture zones in the diorite shows some bleaching with formation of sericite and addition of some carbonate and pyrite, but the effect is not widespread and may not extend for more than a few inches from fractures. In the black argillites, the rock in and along the fissure and fracture zones is not bleached, probably because the carbonaceous matter has not been removed or has merely been converted to finely crystalline graphite. Thin sections of some of the rock at the Snoose mine, however, shows that much carbonate has been introduced and that some biotite, chlorite, muscovite or coarse sericite and locally fairly coarse grains of lath-like clay mineral have also formed. The carbonaceous matter remains as streaky graphic zones.

Because of its inconspicuousness, the wall-rock alteration cannot be used as a guide to ore. In some fracture zones in the Milligen formation the sulfides appear to be in perfectly fresh rock.

ORIGIN OF THE DEPOSITS

The close association of the veins and lodes with andesitic and lamprophyric dikes implies a close genetic relationship between mineralization and dike intrusion. This relationship refutes the commonly accepted view that the mineralization is associated with the Idaho batholith or its outliers. The textural and structural relations of the dikes indicate that they were intruded long after the diorite and quartz monzonite had consolidated and probably after these bodies had been brought somewhat closer to the surface by erosion of the overlying rocks. Fractures available for dikes apparently were formed under different structural conditions than existed before the earlier bodies of diorite and quartz monzonite were emplaced.

The general concentration of veins and lodes close to the diorite contact has perhaps been used as a basis for relating the mineralization to these older intrusive bodies. This concentration of veins and lodes in the diorite and bordering Milligen formation, however, is probably a structural coincidence. The diorite was apparently emplaced along a major zone of structural weakness and instability. This zone of structural weakness then facilitated the later emplacement of the quartz monzonite in and along the southwest side of the diorite. Later deformation also tended to be localized along this old zone of structural weakness and caused profound fracturing of the diorite and bordering rock and paved the way for intrusion of the younger dike magmas and the closely associated mineral-bearing solutions. Whereas the diorite and quartz monzonite are thought to have been emplaced in Upper Cretaceous time, and andesitic and lamprophyric dikes and the mineralizing solutions are believed to be products of early Tertiary igneous activity.
Although the gold veins are somewhat older than the lead-silver deposits, there is probably no great age difference and they are probably closely related genetically. That some of the minerals introduced into the lead-silver deposits belong to the Moenee epoch of metailization is proven by the occurrence of the same minerals in the mid-Tertiary volcanic rocks.

The mineral associations indicate that deposition took place under moderate temperature conditions and that the deposits are the type which Lindgren (6) would class as meseothermal. The somewhat coarser grain size and the presence of pyrrhotite may indicate that the gold deposits formed at somewhat higher temperatures than the lead-silver deposits. The structural characteristics are those of deposits formed at moderate depths below the surface, that is, at depths of a mile or more.

OUTLOOK

It is difficult to evaluate the mineral poten.
tialities of any area in which so little is to be seen underground as along the Hatley-Selleuve mineral belt. Nevertheless, such uniformity in ore texture and mineral content throughout the range exposed in mining and such persistency of fissure systems vertically and laterally indicate that the mineralization should continue to depths greater than those yet reached in mining. As the ore is confined to shoots delimited by favorable structural conditions, there is always the possibility that more favorable conditions may again prevail at greater depths. These conditions need not necessarily be similar to those already known. In some places, as at the Minnie Moore, the ore bodies have been terminated against post-mineral faults and the extensions not yet found. Thus the search for ore is a diverse and complicated problem.

Search for ore, whether for new shoots or faulted segments, will in general require considerable capital expenditure and had best be undertaken by well-financed organizations. Search for ore should be closely supervised by competent geologic help to achieve the best results at lowest cost. Until better opportunity is afforded for study of structural controls underground, little can be said as to where best to look and what to expect.

Because the veins and lodes in the Millican formation are generally effectively concealed by surface debris, there still remains the chance of new discoveries. The area should provide ideal ground for geochemical prospecting.

The possibilities of the area are by no means exhausted. The problem is to know where to look and the best opportunities are probably afforded in and about the formerly productive mines. The lead-silver deposits show more promise of depth persistency than the gold veins. The country northeast of Wood River appears to offer less chance of important ore discovery than the area southwest of the river. The Milligen formation appears to offer the best opportunities for discovery of important deposits, followed by the diorite.

MINES AND PROSPECTS

MINNIE MOORE MINE

Introduction

The Minnie Moore, the largest and most famous mine in the district, was completely inaccessible and hence could not contribute any first hand information to the present study. Fortunately, there is an excellent description of the mine in U. S. Geol. Survey Bulletin 814, pp. 219-234, which treats the geologic setting and various features of the mineralization in some detail and discusses the mining development up to the time the report was prepared for publication in the late twenties. Exploratory work, however, has continued since the report was written and much new data have been acquired by R. T. Walker and W. J. Walker, who have incorporated these findings in a private report which they generously made available to the writer with permission to use any of the maps and text desired. The writer does not wish to repeat the contents of U. S. Geol. Survey Bull. 814, but does wish to bring the mine development to date and incorporate the later findings and conclusions of the Walkers.

The treatment that follows is largely recapsulation of the Walkers’ report and the maps that are used have been compiled or taken directly from that report.

Historical Sketch

Discovery of the Minnie Moore has been credited to a hodge which brought fragments of galena to the surface and made it possible for John M. Moore to locate the otherwise concealed ore body. Within three years after discovery of the ore, which was made in 1880, the Minnie Moore shaft had been started and some high-grade ore developed. (For a detailed story of the history of the Minnie Moore mine up to the late twenties the reader is referred to U.S. Geol. Survey Bull. 814).

In 1884 the property was sold to Deot, Palmer, and Co., an English firm, for $450,000, and the Minnie Moore shaft sunk to the 500-foot level, where a “pinch” in the ore body was interpreted to mean the bottom of the ore. By
1888 all the ore had been mined down to the "pinch" and operations were suspended. Later in the year the property was leased and work on the shaft resumed. This led to discovery of the downward extension of the ore body within 100 feet. The shaft was continued to the 500-foot level where the ore body ended against the Rockwell fault. Failing to find ore beyond the fault, and with all the ore mined above the fault, work came to an end (1899).

Ten years later the property was sold for $30,000 to I. E. Rockwell and associates. After several years of exploratory work the continuation of the ore body beyond the Rockwell fault was found (1902), and the property again began shipping ore. In 1904, while still in production, the property was sold to Chas. M. Schwab for $800,000. In the following year the ore body was found to terminate against the Minnie fault (between the 900 and 1100 levels). Search was carried out on the other side of the fault but continuation of the ore body was not found. After all the ore had been mined down to the fault the property was sold back to Rockwell and associates (1906). Some exploratory work continued until 1910 and resumed two or three years later, but after a year, work was again suspended, and the mine remained idle until 1923.

Beginning in 1923, five different operators made successive attempts to recover the ore shoot beyond the Minnie fault by exploring eastward on the 800, 900, 1,000-foot levels of the Allen shaft. The ore shoot was not found and in May, 1927, the mine was abandoned. However, two fault segments of the ore body were found, but according to R. T. Walker the operators were confused on finding four faults instead of one and failed to recognize the strike-slip movement on these faults. Hence, they had not realized that the ore body had been shifted east of the ground they had explored.

In 1932, the Federal Mining and Smelting Co. sank the Rockwell shaft near the mouth of Galena Gulch to explore the extension of the Queen of the Hills vein on Minnie Moore ground. This work was later abandoned but three years later a crosscut was started by the Minnie Moore Mines Development Company on the 450 level of the Rockwell shaft to explore the area southeast of the old workings in the hope of finding the faulted extension of the Minnie Moore ore body. Before the area was reached, the crosscut (Hershey crosscut) was stopped and work diverted southeasterly toward an area in which the existence of a large ore body was claimed on geophysical evidence. The Bergman lateral failed to find the ore body but did expose the Bergman vein, a probable extension of the Minnie Moore, east of the part known to contain the ore shoot. As funds had been exhausted in the Bergman lateral, work on the Hershey crosscut could not be resumed and in 1941 the project was abandoned, and the workings allowed to fill with water.

In 1949 the Silver Star-Queens Mines Company began to rehabilitate the Rockwell shaft in order to gain entrance to the deeper levels of the Old Queen of the Hills mine. During the summer a new headframe was raised to replace the old one which had collapsed into the shaft and by the end of the year pumps were at work unwatering the shaft and the old workings of the Minnie Moore mine.

**Property and Development**

The property consists of 20 patented and 20 unpatented claims covering the lower part of Galena Gulch and the ridge between Galena Gulch and Lee Gulch, as shown in Figure 3. This map (Fig. 3) gives the location of the shafts and underground workings as well as the aerial geology of the property and also the workings of the old Queen of the Hills mine. The underground workings and geology of the Minnie Moore, complete to 1941, are depicted on a larger scale in Figure 5.

The Minnie Moore has been developed by three inclined shafts, the Minnie Moore, Relief, and Allen; and by one vertical shaft, the Rockwell. The Minnie Moore shaft, the original working entry, has a slope length of 1,100 feet on a 30° angle. From it are 11 levels with an inclined winze, the 1012 winze, sunk from the 1,000-foot level. The Minnie Moore shaft is caved and beyond repair. The Relief shaft, about 700 feet to the west of the Minnie Moore, is a single compartment shaft inclined at 20° with a length of about 800 feet. It has five levels and is still open. The Allen shaft, which is about 800 feet west of the Relief, has three compartments and is sunk to a depth of 850 feet at an angle of 35°. This shaft also has five levels and a two-compartment winze, the Boeriches, which gives an additional depth of 325 feet. This shaft also is open. All three shafts closely parallel the Minnie Moore vein. The Rockwell shaft, about 1,700 feet east of the Minnie Moore, is a two-compartment shaft 500 feet deep with levels at 250 and 450 feet, workings on the 450 level, which include the Hershey crosscut and the Bergman lateral and drifts, and are by far the most extensive. These workings are connected with the 1,000-foot level of the Minnie Moore by a diamond drill hole which permits the old workings to be drained from the Rockwell shaft.
Geologic Features

The Minnie Moore vein is in argillitic rocks of the Milligen formation close to several limestone members a short distance under the sill-like body of diorite (Fig. 4). The Walkers have divided the Milligen locally into the Michigan argillite (100+ feet), the Penobscot formation (80 feet Upper Penobscot limestone; 40 feet Intermediate argillite; and 30 feet Lower Penobscot limestone); and the Detonance argillite (300+ feet), listed from top to bottom.

These beds strike generally northwest and dip southwest at about 30°, with two notable exceptions. One of these is between the Minnie Moore and Relief shafts, where the strike locally changes to west-southwest for 200 to 300 feet and then resumes its northwest direction. This change produces a shallow synclinal trough of southerly pitch which coincides with the middle of the Minnie Moore ore body. The other exception is near the 1,000-foot level of the Minnie Moore shaft. There the beds flatten and locally dip slightly to the northeast for some 200 to 300 feet before resuming their normal 30° southwest dip.

The diorite body conformably to the northwestly strike and southwestly dip of the Milligen beds, although the contact is quite irregular. Both the diorite and sedimentary beds are cut by a few dikes and sills.

Distribution and Characteristics of Veins and Ore

The Minnie Moore is only one of a series of roughly parallel fissure veins of northwestly strike and southwestly dip. The other veins are the Bergman and McIlvain, which are believed to be southeasterly extensions of the Minnie Moore, and the Singleterry, Gray Copper, Old Telegraph, Queen of the Hills, and Queen of the Hills Footwall vein, which are referred to as the "Footwall," because they lie beneath or in the footwall of the Minnie Moore vein (Fig. 4).

Minnie Moore vein.—The Minnie Moore vein has a west-northwest trend, except for a sharp bend on the Minnie Moore claim, where it parallels the synclinal bend in the sedimentary beds. The dip is mainly 25°-35° SW., but in places is almost horizontal. The vein apparently occupies a post-intrusion thrust fault of considerable displacement. In part the fault is conformable with the bedding, but it generally crosses the bedding at small angles on both strike and dip. In the eastern part of the mine the fault is a single structural plate made up of several prominent parallel slips 5 to 10 feet apart, but midway between the Minnie Moore and Relief shafts the fault splits into two branches—the Minnie Moore Footwall fault and the Minnie Moore Hanging Wall fault—which diverge westward until in the vicinity of the Allen shaft they are from 100 to 150 feet apart. Near the shaft the Hanging Wall branch contains two to four well-defined fissures from 5 to 15 feet apart. The Minnie Moore thus has a complex vein system rather than a single vein.

The vein system is confined to the sedimentary rocks beneath the diorite sill, in some places 200 feet from the contact, in other places within a few feet of the contact. Locality, apophyses of the diorite are cut by the vein, but in no place does the vein enter the diorite. The vein system is always closely associated with the Penobscot limestone formation. The upper part of the vein lies within or not far below the Lower Penobscot limestone; where split, the Footwall vein continues to lie in or below the Lower Penobscot whereas the Hanging Wall vein lies either in or just above the Upper Penobscot limestone. In some parts of the mine the limestone members have been faulted out by the thrusting, in other parts the limestone beds have been repeated.

The Minnie Moore ore body is a gently inclined, blanket-like body, continuous and unbroken down dip, except where offset by post-mineral faults and cut by post-mineral dikes. The ore body has varied considerably in thickness and grade from place to place and the thicker and richer parts may be deduced by referring to the stope areas (Fig. 5). The individual stopes represent flattened and somewhat irregular lenses of ore with lengths and widths up to 400 feet and thicknesses up to 18 feet. The full length of the ore zone is about 1,200 feet.

The ore consists, in order of abundance, of galena, pyrite, sphalerite, gray copper, chalco- pyrite, and arsenopyrite in a gangue of siderite, quartz, calcite, and crushed country rock. Siderite is the most abundant of the vein minerals and occurs along parts of the vein in massive extensive sheets up to 10 feet thick. Pyrite, sphalerite, chalcopyrite, and arsenopyrite are present in relatively small amounts. The ore contains an average silver-lead ratio of 1 to 2 ounces of silver to each per cent of lead.

The vein shows an interesting distribution of ore and gangue minerals. According to the Walkers, the ore body is divisible laterally into three zones with the ore in each of somewhat different character. In the western zone (Fig. 5) the ore body consists of a band of massive siderite several feet thick with not more than 2 per cent lead and 4 to 6 ounces of silver to the
Fig 4 Diagramatic cross section N 35° E. across Minnie Moore and associated "Footwall veins" (After Walker & Walker)
ton. The eastern zone consists of sulfides in a gangue of calcite and crushed country rock, with no siderite. The middle zone is intermediate in character, with a gradual change from low-grade siderite ore on the west to higher grade non-siderite ore in the east, with decreasing amounts of siderite between. The mineable ore is confined to the middle and eastern zones which have a joint width of about 800 feet. The difference in the character between the eastern and western sides of the ore body is said to persist from the outcrop to the lowest level at which ore has been mined. The Walkers use this zonal distribution in their search for the continuation of the ore body beyond the explored area.

Of the ore mined, 90 per cent is said to have been milling ore averaging 10 per cent lead and 20 ounces of silver to the ton. The remainder, direct shipping ore, contained about 60 per cent lead and 100 ounces of silver to the ton. The direct shipping ore is reported to have formed bands and lenses of solid galena a few inches to 10 feet thick either as a complete vein filling or with milling ore.

The Minnie Moore ore body has been mined for a distance of 1,400 feet down dip with no observable change in character, grade, or abundance of the ore. In this distance the ore body has been intersected by four post-mineral faults; namely, the Upper and Lower Relief faults (small with little displacement), the Rockwell flat fault (200-foot displacement), and the Minnie fault zone beyond which the ore body has not been recovered although three separate segments have been found along the fault zone. Where cut off by the Minnie fault between the 900 and 1,100 levels, the ore body occurred as three lenses. The more westerly lens was about 60 feet wide, up to 18 feet thick, and contained galena and gray copper in massive siderite. The ore averaged 8 per cent lead and 16 ounces of silver per ton. The middle lens, which was 60 tons to the east, measured 85 feet wide and up to 10 feet thick. It contained both milling and direct shipping ore in non-siderite gangue. The third lens, 60 feet beyond the second, measured 75 feet wide and contained up to 6 feet of massive galena in a non-siderite gangue.

Bergman vein. — The Bergman vein is exposed only in the Bergman lateral from the Hershey crosscut of the 450 level of the Rockwell shaft (Fig. 5). It occurs not far below the Lower Penobscot limestone. The vein is somewhat variable in width and extent in mineralization. In places it measures up to 5 feet wide and contains masses of siderite with some pyrite, sphalerite, and marcasite, and sporadic streaks and bunches of galena similar to that in the Minnie Moore vein. The sulfides are not sufficiently abundant to constitute ore.

The vein strikes about N. 30° W. and dips 45° SW. It does not accord precisely with the strike and dip with the Minnie Moore but its relation to the Lower Penobscot limestone and its structure is similar. The difference in strike reflects the local strike-like character of the diorite contact to which the vein is closely parallel. The Bergman is thus regarded as a southeasterly continuation of the Minnie Moore ore body beyond the Minnie fault zone, i.e., just ahead of the Hershey crosscut.

McLarin vein. — The McLarin vein on the Little Bone claim, some 2,000 feet southeast of the strike of the Bergman vein, is reported to be similar to the Bergman in general appearance and in relationship to the diorite. It contains little siderite and only small amounts of jasperite and stilbite. This vein is believed to be a continuation of the Bergman and hence the Minnie Moore.

Footwall veins. — The group of "Footwall veins" dip more steeply than the Minnie Moore vein, with angles mainly between 50° - 60° SW. These veins cut across the Milligen beds in strike and dip (Fig. 4). Their mineralization is more or less similar to the Minnie Moore, but the proportions of minerals differ somewhat. Only the Singletery vein has been productive on the Minnie Moore property. Most of the veins have been relatively unexplored. These veins, especially the Singletery and Gray Copper, are described in some detail in U. S. G. S. Bull. 814.

Post-Mineral Faults

The post-mineral faults of particular interest are the Relief faults, the flat faults of which the Rockwell fault is the only one of importance, and the faults of the Minnie fault zone.

Rockwell fault. — The Rockwell fault displaces the Minnie Moore vein about 200 feet at about the 900 level and also causes corresponding offsets in all the Footwall veins (Fig. 4). This fault strikes northeast and dips about 10° NW. It occurs where the Milligen beds are nearly horizontal, and it is presumed that the flattening and faulting are closely related events.

Relief faults. — The Upper and Lower Relief faults are of relatively small size and of relatively small displacement. They strike northwest and dip northeast with the main displacement in a nearly horizontal direction. Although small, these faults are of interest not only because they once caused temporary abandonment of the Minnie Moore mine but more so because they probably illustrate on a
small scale what has taken place along the Minnie fault zone on a large scale. These two faults produce a gap in the Minnie Moore ore body about 50 feet wide, with the segment between the two faults still undiscovered and unmined. The two faults appear to be compensating near the Minnie Moore shaft, for the vein below the faults has about the same position as if it were not faulted.

**Minnie faults.** — The Minnie faults are reported to be similar to the Relief faults in all respects, except for size and greater number of individual fractures. The fault zone is from 200 to 250 feet wide in plan (Fig. 3), and contains several prominent faults of which the Minnie, Allen, and South faults are the largest and most important. The Minnie forms the hanging wall of the fault zone and the South fault, the footwall. As a whole the fault zone appears to dip about 35° NE., measured from the surface and underground positions, but in the underground workings the dip of the individual fault planes range from 30° to 60° NE. Where the Minnie faults cut off the ore body, it shows about 6 inches of soft black gouge, which has striations dipping about 15° SE. The Allen and South faults are similar, but lack striations on gouge and walls.

That the Minnie fault is post-mineral is indicated not only in the lack of mineralization but also by the presence of segments of the Hanger Wall vein, and the unsplit part of the main vein. These segments are caught between the individual faults of the fault zone. One of the segments consists of a band of siderite about 2 feet thick which resembles that near the western edge of the non-commercial siderite zone. The second segment, which has been correlated with the Hanger Wall vein, consists of a layer of siderite up to 3 feet thick with bunches and streaks of Galena. The ore in this segment resembles ore near the eastern edge of the non-commercial zone. The third segment consists of a small lens of galena about a foot thick free of siderite and similar to ore in the middle ore zone. The position of the faulted segments suggests a shift southwardly on the south-western side of the fault zone. This direction of shift is corroborated by a similar offset in the diorite contact shown in the surface geology where the Minnie faults cross from the diorite into the sedimentary rocks (Fig. 3).

The apparent offset of the diorite contact is 800 to 900 feet, which corrected for topography, is actually about 1,000 feet. This distance is the aggregate movement along all members of the fault zone with perhaps about half of the displacement along the South fault. A total strike-slip of about 1,000 feet south-easterly of the Minnie fault zone would bring the center of the commercial ore zone about opposite the face of the Hershey crosscut (Fig. 5).

**Conclusions**

According to the Walker report, unmined ore may still remain in and adjacent to the old workings above the Minnie fault zone — ore that was too low grade to be worked in the early days, and ore that may have been overlooked by the early operators. It is suggested that such formerly unminable ore may occur in the siderite zone in the west end of the mine and that overlooked ore may occur near the Relief shaft. The report points out that the Relief shaft followed the Footwall ore body to the Upper Relief fault and continued in the Hanger Wall ore body below the Lower Relief fault. With stopping confined to the Footwall ore body above the Upper Relief fault and to the Hanger Wall ore body below the Lower Relief fault, there remains unexplored the Hanger Wall ore body above the faults and the Footwall body below as well as the segments of the ore bodies lost between the two faults. The possibility of ore along other unexplored fissures of the fault zone is also pointed out.

But of greater significance is the analysis of the Minnie fault zone and the conclusion that the probable location of the faulted ore body is just ahead of the Hershey crosscut. It is suggested that the Hershey crosscut be extended 150 to 200 feet from the present face until it passes through the South fault into the diorite. If the ore body is not cut in the crosscut, it may lie below the crosscut level and may be located by wire or diamond drilling. It is also suggested that a lateral be driven 900 feet westward from the present face of the crosscut to connect with the bottom of the 1012 winze. This lateral would give access to the old workings and also provide convenient points to search for segments of the Minnie Moore ore body within the Minnie fault zone.

The Walkers have presented a convincing case and make it evident that the possibilities of the Minnie Moore mine have by no means been exhausted. With reopening of the Rockwell shaft and drivages of the old workings by the Silver Star - Queens Mines Company, it should take relatively little work and money to establish the existence or non-existence of the ore body.

**SILVER STAR - QUEENS MINE**  
**Location and History**

The Silver Star - Queens mines (formerly the Queen of the Hills) is north of the mouth of Galena Gulch and covers much of the ridge and slope from the edge of Wood River Valley to the divide between Galena and Mammoth Gulches (Pl. 2).
Whether the mine was founded before or after ore was discovered at the Minnie Moore was not learned, but records show that by 1881 ore shipments were being made and that by 1884 the mine contained 3,000 feet of tunnels and drifts. By 1890 development work extended to the fifth level of an inclined shaft, which had been sunk from the Lukk tunnel level. Work was suspended in 1892 and the workings allowed to fill with water. Some work was carried on in 1903 and 1904 along the Lukk tunnel but no ore was mined. In 1907 a new mill replaced the old one below the portal of the Lukk tunnel and was used to treat the tailings dump. In 1913 the mine was reopened and two years later unwatered. After that the mine was generally idle until acquired by the Silver Star-Queens Mines Company several years ago. This company reopened and rehabilitated the Lukk tunnel level and started to reopen the inclined shaft. After sinking the shaft to a depth of 60 feet or so beyond the old face, work was suspended and attention turned to reopening the Rockwell shaft. Before the end of summer the old head frame which had collapsed into the shaft had been removed and replaced by a new headframe. Shortly thereafter a hoist and cage were installed, pumps placed, and the shaft made ready to explore the deeper levels of the old Queen of the Hills mine.

Records of production are incomplete but Blake (1, p. 237) has given figures of 11,377 tons of ore for the years 1884 to 1890 inclusive with a gross value of $1,265,608 or $916,145 net. Walker has estimated the total production at $2,500,000.

Development
Underground development at the Silver Star-Queens mine consists principally of two tunnels—the Moulton tunnel, 750 feet long and no longer accessible, and the Lukk tunnel, 2,475 feet long with an inclined shaft and drifts east and west at five levels. The shaft, which is inclined at an angle of 62° and attains a vertical depth of 354 feet, is located 738 feet from the portal. The Lukk tunnel level is shown in Fig. 6, with an insert of the longitudinal section showing levels and stopes taken from Fig. 19, of U.S. Geological Survey Bull. 814.

Geologic Features
The workings at the Silver Star-Queens mine are entirely in the Milliken formation, and, except for about the last 500 feet (black carbonaceous shales) are in black siliceous argillites. The bedding is generally well-defined. Along the Lukk tunnel the beds strike N. 40° - 50° W., and dip 25° - 35° SW. With depth the dip is reported to flatten and the beds to become horizontal below the fourth level.

The beds steepen again on level 5 and the fold occurs to correspond to the one between the 900 and 1,000-foot levels of the Minnie Moore mine (1, p. 240).

The work underground has uncovered two veins about 105 feet apart well back in the mine. One of these is the Queen vein (Hanging Wall vein) and the other is the Footwall vein (Fig. 4). These veins cut the bedding at an oblique angle. The Hanging Wall vein (followed by the long Lukk tunnel) strikes about N. 70° W., for most of its explored length, and dips 60° - 65° SW. The Footwall vein appears to be about parallel, but at the southeast end of the drift on the Lukk level it changes its direction to S. 40° - 45° E. and its dip to 42° SW. This change in strike carries it to the Hanging Wall vein close to the old inclined shaft (Fig. 6). Thus the two veins appear to be split branches that resemble the two branches of the Minnie Moore vein.

The Hanging Wall vein has a well-defined upper wall but a rather obscure footwall. The ore bodies are limited by local fractures that merge with the hanging wall. The principal shoot, the ore source of practically all the ore shipped, had a stope length of nearly 500 feet and was made up of a series of sulfide lenses 2 to 4 feet and locally up to 6 feet thick. Two smaller shoots between the main shoot and the face contained mainly argentiferous minerals with only minor amounts of sulfides. The Footwall vein on the Lukk level has lenses of ore and argentiferous minerals 2 to 4, locally 8 inches thick. According to Blake (1, p. 290) the Queen vein had, by 1900, been extensively stopped to a depth of 50 feet below the third level and lenses of ore and argentiferous minerals had been found on the lower levels. Although two veins were explored and locally stopped on level 5 it was never certain which one was the lower extension of the vein worked higher up.

Ore
The ore occurs as a filling of open fractures rather than as a replacement of the rather brittle argillite. It consists largely of dark brown sphalerite, cubic acaline, with lesser tetrahedrite, pyrite, and marcasite, the latter as a film coating the other sulfides. The associated gangue minerals are quartz, siderite, and calcite, with the quartz generally somewhat more abundant than the siderite. The calcite is most conspicuous as stringers and seams in shattered rock in the walls of the veins or in zones of fractured rock remote from the veins. The calcite and marcasite may have been introduced during the Miocene epoch of mineralization.

Apparently, the ore mined in the early days had a preponderance of sulfides, particu-
Silver Star-Queen Mine

Picture shows the surface plant on the lower slope of the ridge bordering Big Wood River Valley and some of the old workings along the ridge on the Queen of the Hills vein. In the foreground is the Rockwell shaft on the Minnie Moore ground from which the development of the Silver Star Queens mine is carried on. (Picture furnished by courtesy of Mr. Nat T. Davis).
larrily galena, and became non-commercial with increase in gangue minerals or in sphalerite. At the west borders of the stopes the filling has been reported as largely siderite and quartz, 20 to 30 inches wide. Blake reports that the lenses of ore on lower levels contained more quartz and siderite and less galena than higher up. Considerable zinc ore is reported to have been left unmined.

OVERLAND

The Overland is on the south side of Galena Gulch half a mile west of the Minnie Moore (Fig. 2). The work in the early days included a 180-foot shaft located well up the side of the ridge, apparently on the outcrop. The mine was idle from 1893 until 1922 when a long crosscut was driven from the gulch bottom to cut the Overland lode below the level of the then carved shaft. The work, however, was turned off along a weak zone of mineralization before the Overland lode was reached. Some years later work on the drift was extended and crosscuts driven beyond a faulted zone in an attempt to pick up the offset segment of the Overland lode. These workings, which are still open, are shown in Figure 7. The mine is reported to have produced from $30,000 to $125,000 worth of ore (1, p. 127).

The Overland lode is not visible but is reported by Hewett (1, p. 128) to strike N. 55° W., dips 70° SW., and measures 50 inches in width between well-defined dioritic walls. The ore composed of sphalerite, galena, chalcopyrite, and tetrahedrite, is contained in an abundant siderite gangue with some calcite. According to information given by Mr. Hall Parke, the ore shoot pitched southeast and was mined by winzes from one level to the next, with each winze offset to the east in order to remain with the ore.

The lode exposed by the long crosscut and drift (Fig. 7) strikes about N. 50° W. and dips 70° SW., to vertical. This lightly mineralized lode is lost against faults of northeast trend in the far southeast part of the drift. Although considerable work has been done beyond the first of the faults with crosscuts driven far enough to the south to intersect the Overland lode, were the lode to continue in its downward projection uninterrupted by faulting, no lode was uncovered. As the lode along the drift has been offset an unknown number of feet by these northeast Miocene faults, the Overland, too, has been cut off and offset an equal number of feet.

As a guide to future development the old shaft and the Overland lode have been projected on the plan of Figure 7. This projection shows that the Overland lode lies but a relatively short distance ahead of the face of the crosscut and becomes closer toward the far end of the drift. Assuming no change in dip, the Overland lode should be reached by a crosscut about 50 feet long just west of the first of the northeast cross-faults. At this point the Overland fissure zone need not necessarily contain ore; in fact none should be anticipated, for the downward extension of the ore body is somewhere to the southeast across the zone of cross faults. Probably the least costly plan of exploration would be to gain access to the old workings by raising from the lower workings with the shaft or the workings east of the shaft as the objective. Thus something could be learned of the location of the ore shoot and suitable plans made for its exploration.

An adit cut high on the ridge southwest of the portal of the Overland crosscut (Fig. 2) exposes a 5-foot lode with seams and stringers of oxidized siderite in sheared diorite. The lode strikes N. 60° - 70° W. and dips 84° NE. It could be a possible extension of the Overland.

LITTLE GIANT

The Little Giant is on the south side of Galena Gulch immediately east of the Overland (Fig. 2). The workings consist of cuts on the crest of a spur ridge and several old tunnels in the gulch below, one of them an open crosscut about 360 feet long.

Several fissure or fracture zones are exposed on the property, all in diorite. One exposed in the crosscut about 240 feet from the portal has been drifted on northwest and southeast, but the northwest drift is cut at the crosscut and southeast drift is blocked 30 feet from the crosscut. This fissure zone strikes N. 35° W., and dips 50° SW. It is bounded by prominent walls about 4 feet apart. A second, less prominent fissure zone, lies about 60 feet beyond. It is about parallel to the first but dips 60° SW. No ore was seen in either, but some galena and rock with siderite stringers are present in the dump. Another zone of sheared diorite exposed in one of the cuts on the ridge strikes about N. 55° W., and dips 40° SW. This zone is about 4 feet wide and contains some lenses and bunches of siderite.

HEINE (GOLDEN BELL)

The Heine, which was known in earlier years as the Golden Bell, is near the head of Galena Gulch about 3 miles due west of Bellevue (Fig. 2). The mine is one of the district's gold producers and has been worked sporadically over a number of years. The quantity of gold produced was not learned but has probably totaled some hundreds of ounces. The workings include two tunnel levels and an intermediate, which, except for the upper tunnel
level, are shown complete in Figure 8. The upper tunnel has a blocked drift, 250 feet long, driven northwest from the end of the short crosscut.

Several mineralized fracture zones are reported on the property, but all the work has been confined to the one exposed in the underground workings (Fig. 8). This fracture zone, with walls 4 to 6 feet apart, strikes N. 13° - 80° W., and dips southwesterly at angles of 35° on the upper levels and 50° - 60° on the lowest level. Some faults have caused minor offsets in the fracture zone on the upper levels, but the only fault of note is one of N. 5° E. strike and 65° W. dip that causes a 55-foot offset on the lower level (Fig. 8).

This zone of fractured and somewhat altered diorite contains a fairly well-defined sulfide vein from 3 to 10 inches, locally 20 inches thick, occurring generally next to the footwall. Above the upper tunnel level the sulfides are oxidized. The unoxidized ore below consists largely of pyrite with lesser arsenopyrite and in places some chloropyrite. The gold is reported to occur with the sulfides and to average about 0.9 ounce per ton of sulfide ore. This accords closely with the value of the ore shipped from 1911 to 1915, when 173 tons of ore yielded 156 ounces of gold, 182 ounces of silver, and 3,340 pounds of copper (I, p. 240). The gold values are reported to be spotty and in places are high. With depth, however, the tenor of the ore appears to decline and the ore in the lower tunnel level is apparently not as high grade as the ore on the upper levels.

**PETERLIN**

The Peterlin is in Galena Gulch just below the Heine (Fig. 2). The workings comprise a number of cuts and caved tunnels, extending for some distance up the north side of Galena Gulch, and one open tunnel in a dangerous state of repair, some distance down the gulch.

The Peterlin vein is exposed where it passes through the Heine vein well up the gulch. The fissure occupied by the vein strikes N. 87° E., and dips 80° N. Unlike the Heine, it is a lead vein, and although it shows nothing but oxidized material where it crosses the Heine, it is known to contain galena, pyrite, and siderite as the chief primary minerals. Where exposed, the vein is 12 to 14 inches wide. Its considerable length is indicated by the long alignment of workings down the slope on the dump of one of which is a considerable pile of pyrite. The open tunnel at the lower end of the property is along a prominent fissure zone, which locally strikes N. 85° W., and dips 55° - 65° NE.

Near the lower east end of the Peterlin is another series of cuts and caved tunnels on an adjoining property. These old workings are on both sides of Galena Gulch. Those on the north side lie just below the Peterlin and those on the south side, where the principal work has been done, extend from the gulch bottom well up the steep slope. The vein, where exposed at the portal of a caved tunnel on the south side of the gulch, strikes N. 30° W., the direction of alignment of the series of cuts and tunnels, and dips 75° SW. Only oxidized material is visible, apparently originally siderite, but galena is reported in some of the tunnels.

**SUNRISE**

The Sunrise is on the north side of Galena Gulch about midway between the Overland and Heine (Fig. 2). The work on the property consists of many cuts and several short and now inaccessible tunnels.

The two lodes exposed on the property may be readily traced along the surface by the alignment of cuts and tunnels. One of the lodes is a siderite lode, the other is a pyritic lode, like the Heine. Both strike about N. 30° W. Most of the work has been done on the siderite lode, the more westerly of the two. This lode was seen in only one cut, but its course may be readily traced by the vein material on the dumps of the other cuts. Where exposed, the lode contains about 2 feet of coarsely crystalline siderite and dips 80° SW. The more easterly lode is poorly exposed and its direction of dip could not be determined. The filling is highly pyritic and in addition contains arsenopyrite.

**PENOBSCOT**

The Penobscot is on the ridge slope just south of the mouth of Galena Gulch. The property includes the Penobscot, Penobscot Fraction, and Riverview claims. The underground workings are now not accessible but are reported to include a 285-foot tunnel on the Riverview claim with a 100-foot crosscut about 500 feet from the portal. A second tunnel more than 200 feet long is on the slope not far above. According to records the production for 1883, 1897, and 1900 totaled 15.2 tons of ore and concentrates containing 1,005.6 ounces of silver and 17,000 pounds of lead (1, pp. 126-127).

The workings are in shaly and argillitic members of the Milligen formation which, near the crosscut in the lower tunnel, are reported to strike N. 8° E., and dip 55° W. The tunnel is reported to follow a shear zone with fairly well-defined walls that strikes N. 9° W., and dips 60° W. The shear zone contains some quartz and calcite and in places a little sulfide, mainly
Fig. 7 Geologic map of accessible workings at Overland mine
Fig. 8 Geologic map of accessible workings at the Heine (Golden Bell) mine
contains massive quartz and much pyrite, in part in small globular bodies. Some of the material strewn on the upper dumps also contains brownish-red sphalerite. Ore mined is reported to have been composed of jasmanite and stibnite.

TELLURIDE

The Telluride is the most southeasterly property on the faceted front of the ridge between Galena and Lee Gulches, probably not more than a hundred yards from the mouth of Lee Gulch (Fig. 2). The workings consist of two closely spaced tunnels at about the same level, but only the one on the north, the main tunnel, is open.

The south tunnel is in black Milligen argillite, the north tunnel mostly in grayish limestone. Above the caved portal of the south tunnel is a vein with about 18 inches of quartz plus some oxidized vein stuff on the hanging wall side. The vein appears to strike about N. 70° E. and dip steeply southwest. The north tunnel, which is driven about due west, has several drifts extending about N. 25° W. along minor zones of fracturing. The individual fractures dip steeply, some to the northeast, others to the southwest. Thin seams of siderite appear along some of the fractures and very small amounts of caliche are scattered through the dump material. The more pronounced mineralization appears to be in the south tunnel, for on the dump of that tunnel is considerable reddish sphalerite and a little pyrite and galena. This ore has the compositional and textural characteristics of Miocene ore.

GROVER CROCKET (QUEEN BESS)

The Grover Crocker, formerly the Queen Bess, is at the southwest edge of the floor of Big Wood River Valley just above the mouth of Mammoth Gulch (Fig. 2). The mine was worked intermittently in the early days. Then after a long period of idleness the mine was reopened early in 1949. According to local report the mine produced about $60,000 worth of lead-silver ore during the early operations; the production since has included a small shipment trucked to a Utah smelter in the spring of 1949.

When examined by Hewett (1, p. 244) in 1913, the workings included a lower tunnel caved 60 feet from the portal and an upper 285-foot tunnel 40 feet above. These and two other newer and shorter tunnels 100 feet to the south were caved in 1949 and work was confined to an inclined shaft just above the edge of the valley floor. By September, 1949, this shaft had reached a depth of about 50 feet. Another shaft started at the level of the valley floor earlier in the year had been abandoned.
The spacing of the workings indicates at least two zones of mineralization, both within a block of moderately folded blackish beds of the Milligen formation. These beds show considerable variation in strike and dip, the strike ranging from N. 10° W. to N. 50° W., and the dip from 20° to 32° SW. According to Hewett the principal tunnel was along a well-defined hanging wall of N. 85° W. trend which overlies a succession of crushed zones. The ore along the zones was 2 to 3 feet wide and was stopped between the two levels for a distance of 60 feet. The new work apparently is on a different zone which appears to strike about N. 80° W. and to dip southwest, with reversed dips causing a succession of "rolls" with local northeast dip. The shaft started earlier in the year reached the trough of such a roll and uncovered ore up to 18 inches thick; but, because the roll carried the ore upward, the shaft was abandoned and the new shaft sunk a short distance to the south to develop the mineralized zone at greater depth on the other side of the roll. The zone containing mineralization was penetrated about 35 to 40 feet below the collar of the shaft. The zone locally is 6 to 12 inches wide and contains thin seams, small bunches, and irregular nests of siderite. Fractures in the walls also contain siderite with some brownish sphalerite, cubic and gneissic galena, and scattered crystals of arsenopyrite. Ore shipped from the shallow shaft to the north was composed almost entirely of gneissic galena and its oxidation products.

**OSWEGO**

The Oswego is in, and about three fourths of a mile above, the mouth of Mammoth Gulch with workings extending from the gulch bottom to the top of the ridge overlooking Galena Gulch (Fig. 2). The development consists of an inclined shaft 200 feet or more deep near the crest of the ridge and five or six tunnels on the slope below, two of which were partly open.

The workings are in white marbled limestone just under the diorite contact. The limestone measures several hundred feet thick, strikes about N. 40° W., and dips 40° SW. The inclined shaft is on a bedded vein with walls about 6 feet apart. No ore is visible either along the vein or on the dump. Another vein exposed at the portal of the next to the lowest tunnel strikes N. 20° -30° W., and dips 60° NE. This vein holds several feet of oxidized material and has been explored by several hundred feet of workings along and above the tunnel level.

At the head of a tributary gulch, just north-west of the Oswego, are three tunnels on what may be another property. These tunnels, the lower two of which are caved, are on a prominent lode in the Milligen argillites very close to the diorite contact. The lode is developed along a prominent zone of fissuring 8 to 10 feet wide at the portal of the upper tunnel and strikes about N. 35° W. and dips 70° SW. The lode contains conspicuous bands of iron and manganese oxides along the prominent fractures that parallel the fissuring. Layers of iron and manganese oxides are also pried on the dump and on the dump of the tunnel below.

**STAR**

The Star mine is near the head of Star Gulch about 2½ miles south of Hailey and a mile above the mouth of Star Gulch (Fig. 2). The mine was worked extensively in the early days and then intermittently until 1928-1929. The production is not known but is considerable. The property consists of three patented claims and the development includes seven tunnels at as many levels and an old shaft from which much of the early work was done. All the tunnels are caved, but the lower tunnels are known to possess lengths of over 2,000 feet. More recent exploratory work has been confined to bull-dozed cuts above and in line with the series of tunnels.

The mine is reported to have two veins about 90 feet apart of which one is known as the Hanging Wall vein and the other as the Footwall vein. These are in the diorite not far west of the contact between the diorite and the Milligen formation. Each vein is in a fissure also occupied by a light-colored 5- to 7-foot wide dike, either a bleached lamprophyric dike or a sillitic porphyry. Ore is reported to occur on either of both sides of the dikes but not within. Between the sixth and seventh levels the veins are reported to dip about 45° N., but the dip steepens above the vein exposed in the surface cuts actually dips 70° -80° NE. When exposed on the surface, the vein appears to strike about N. 70° -80° E.

The Footwall or the more southerly vein is reported to have been the most productive and to have contained ore over a maximum thickness of 6 feet on the sixth and seventh levels. The ore is reported as "clean" and to form a continuous shoot not less than 200 feet long on the seventh level. A winze has been sunk on the seventh level, but as the winze was sunk vertically it passed into the footwall of the vein and away from the ore. In the Hanging Wall vein the ore shoots are reported to have been shorter and narrower, at no place being more than 4 feet wide.

The ore is composed largely of galena with lesser amounts of sphalerite, chalcopyrite, tetrahedrite, and pyrite associated with a little siderite and quartz. Shipments to the smelter
in 1928 contained from 12 to 65 per cent lead, 0.13 to 0.65 per cent copper, 3 to 13 per cent zinc, and 44 to 140 ounces of silver per ton. In general the silver content of the ore seems to depend more on the amount of copper than on lead, which suggests that the silver is largely contained in tetrahedrite.

The ore is reported to show a small increase in zinc with depth, but otherwise there is no observable change in the character of the ore from the top to the bottom of the mine. Six feet of zinc ore is reported unmined on the sixth level.

Another vein is exposed a short distance east of the Star extending from the bottom of the gulch to the crest of the ridge in a northerly direction. In places the vein forms a ledge projecting above the surface. Whether this vein is on the Star property or not was not learned. The vein is in the black argillites of the Millien formation and may be traced for some hundreds of feet by short tunnels, cuts, and ledge exposures. Locally the vein measures 4 feet wide, dips 80° SW., and is contained between well-defined walls. The outcrop is stained by iron and manganese oxides, apparently formed by weathering of siderite.

SUNSHINE

The Sunshine straddles the high ridge separating Mammoth and Star Gulches not far east of the Star mine. The property is an old one that was relocated and reopened in 1947 and made accessible by road from the bottom of Mammoth Gulch. The workings comprise several short tunnels. The one at the end of the road has several hundred feet of workings extending through the Millien argillites into limestone. No ore was seen either in the tunnel or on the dumps of the other tunnels.

Just across on the north side of the ridge is a caved tunnel on another claim.

SNOOZE MINE

Location and Development

The Snooze mine is in, and about a mile above the mouth of Colorado Gulch or about 2 miles south-southwest of Hailey (Fig. 2). The property is one of those worked in the early days with little attention thereafter until reopened by the Snooze Mining Company in the early years of the late war. Since then the mine has been active and during the war years, and after, shipped about 100 cars of ore. The work continues mainly in two tunnels that are being extended to explore an ore body uncovered in an upper tunnel.

The development includes much old work no longer accessible as well as considerable work done during the war years which is now under water. The flooded workings are off a 225-foot vertical shaft with levels at 100 and 200 feet. Each level has several hundred feet of drifts and crosscuts. The present work is being carried on in the No. 2 and No. 3 tunnels beneath the Reed No. 1, each of which is shown in Fig. 9. Another tunnel across the creek is also open. A 500-foot tunnel is reported to lie 15 to 20 feet beneath No. 3 tunnel with its portal at creek level beneath the dump material of tunnel No. 3.

Geologic Features

The Snooze is in black argillites several hundred yards east of the contact with the diorite (Plate 2). The formation trends about N. 55° W., and dips 60° SW. Because of its dip, a fairly thick bed of dark colored limestone, exposed a short distance down the gulch, extends beneath the present workings and will be cut if the workings are carried to sufficient depth. Intercalated in the argillite locally is a thin limestone member perhaps less than 8 feet thick, which is exposed near the portal of the Reed tunnel. Aside from a host of slits and complex fracture zones that control the mineralization, the sedimentary rocks have not been much disturbed near the mine, but several hundred yards to the north the limestone is ended against a prominent transverse fault and just to the south is markedly offset by another (Fig. 2).

Three zones of mineralization are known on the property, two of which trend in a northwesterly direction. These are about 90 feet apart and are known respectively as the Footwall and Hanging Wall lodes. The third trend in a due westerly direction and is differently mineralized than the other two veins. The work during the war years was concentrated on the Footwall lode, but the present work is being confined to the Hanging Wall. Apparently little work has been done on the third vein for a long time.

The Footwall lode is partly exposed in the steep bank back of the shaft, but was not seen otherwise. It is reported to strike about N. 45° W., dip 50° NE., and to be cut 40 feet down the shaft. On the 100 level it was necessary to drive a 20-foot crosscut of the shaft to reach the vein. As the dip of the vein decreased to 30° between the 100 and 200 levels, a 190-foot crosscut was necessary to reach the vein on the 200 level. It is reported that the ore mined measured 2 to 18 feet wide, averaging 10 feet for the first 90 feet southeast of the shaft and 2 to 18 for 150 feet to the northwest. Work on the Footwall lode was stopped awaiting installation of electric power needed to operate the pumps.

The Hanging Wall lode is exposed in each
of the three tunnels (Fig. 9), the lowest of which is an adit-drift. The vein is along a marked zone of disturbance about 40 feet across, along which the rather thin-bedded, blackish argillites are broken and mashed with prominent planes of movement along the footwall and diagonally across to the hanging wall. The complicated fracturing is best displayed in the Reed tunnel where prominent fractures and fissures of the zone show curious changes in trend and dip (Fig. 9). The workings are not sufficiently extensive to reveal fully the complete structural complexities. The two tunnels below the Reed are driven along the fracture zone touching first one wall and then the other in order to explore the entire zone. Neither tunnel had reached the zone of complicated fracturing and fissuring of the Reed tunnel when the property was last visited in August, 1949. In the Reed tunnel the trend of the fracturing ranges from due west to N. 28° W., the dip of the footwall from 57° NE. to 64° NE., and the dip of the hanging wall, 65° NE. to 75° NE. In the tunnels below, the fracture zone shows little change in trend and maintains a direction of about N. 50°-35° W.

From the size of the stopes in the Reed tunnel the ore must have been distributed more or less sporadically through a zone about 40 feet long, 15 feet wide, and at least 15 to 20 feet above the level. Ore in the bin at the edge of the dump show much pyrite and sphalerite and considerable amounts of calenca. Bunches of ore were found in each of the lower tunnels while they were being driven southerly to undercut the ore body in the Reed tunnel. These bunches of ore are in part along diagonal fractures extending N. 80° W. from hanging wall to footwall. The ore is not persistent but on each of the levels bodies of sufficient size to encourage stopping have been found. The most conspicuous ore mineral is sphalerite which occurs in the crushed argillites as irregular nests and stringers. The ore in the bin at the portal of the No. 2 tunnel showed much, rather fine-grained calenca, brownish sphalerite, pyrite, and marcasite, and apparently some tetrahedrite. These were associated with trivial amounts of quartz and siderite. The ore in the bin is reported to contain 25 to 30 per cent lead, 20 per cent zinc, and 75 ounces of silver and 0.22 ounces of gold per ton. The bin at the portal of the No. 3 tunnel was filled with ore that seemed to contain more zinc than that in the bin at the No. 2 tunnel. Underneath the sphalerite is scattered sporadically as irregular bunches and discontinuous seams of irregular width.

The third vein is regarded as an easterly extension of the Croesus in Scorpion Gulch, which it resembles in trend and filling. The vein is reported to dip 60° S. and to contain an ore shoot about 360 feet long and several feet wide with values in gold and silver. The vein was not seen but is reported to skirt the edge of the back just south of the shaft. Stopping is reported at creek level. Rather than an extension of the Croesus, this is probably a separate vein, which otherwise is like the Croesus.

The workings across the creek (Fig. 9) reveal some rather complicated fissuring and fracturing but no evidence of mineralization other than a few thin seams or pods of quartz.

**MAGDALENA**

The Magdalena is at the head of Colorado Gulch about half a mile above the Snooze (Fig. 2). The property has three open tunnels, several open cuts, and two or three covered tunnels. The open tunnels and cuts are spaced at rather widely separated intervals along the gulch almost to the top of the ridge with cuts on or close to the crest and a short distance down the Croy Creek slope. The lowest tunnel consists of a crosscut and drift about 225 feet long; the second, a crosscut and short drift about 200 feet long; and the third (upper), an 80-foot crosscut which connects with a drift about 200 feet long.

These tunnels and cuts are on a vein of exceptional persistence that may be traced for several thousand feet through the fractured and fissured diorite. Its trend is about N. 58° W. in the lower tunnel and about N. 45° W. in the upper tunnel. In both places the dip is 70° NE., but in the cut near the second tunnel the dip is 75°-80° NE. The zone of fissured and fractured rock is as much as 6 feet wide but the vein itself is much smaller and its thickness appears to vary considerably from place to place. In the upper tunnel the vein in places is about a foot wide; in the lower tunnel it is 10 to 24 inches wide; and in cuts near the middle tunnel, from 2 to 4 feet wide. The middle tunnel was turned on a minor, lightly mineralized fracture of N. 68° W. strike and 55° NE. dip about 188 feet from the portal and some ten feet short of the vein exposed in the cuts and other workings.

The vein filling is chiefly white quartz with some coarsely crystalline pyrite and arsenopyrite and in places a little chalcopyrite. The main values are reported in gold.

**CLIMAX**

The Climax is on the slope southeast of Croy Creek about 2 miles southwest of Hotley (Fig. 2). Since its discovery in the early eighties the mine has produced about $80,000 from ore
EXPLANATION

- Basic dike
- Milligen formation (limestone and argillite)
- Fault
- Strike and dip of bedding
- Mineralized fracture
- Raise
- Winze

Fig. 10. Geologic map of accessible workings, Climax mine
bodies within 65 feet of the surface (1, p. 135). The mine has been developed by a series of tunnels driven at successively lower points on the hillside below the original discovery. The upper three tunnels are connected by raises and stopes, with drifts at intermediate levels. These workings are now largely inaccessible, but the lower, most recent tunnel can be entered; these with other partly accessible workings are shown in Figure 10.

The tunnels are in carbonaceous and limy shales of the Milligen formation, which has been folded and extensively faulted. Several somewhat mineralized fracture or fissure zones were observed, mostly trending in a northwest- erly direction with northeasterly dip (Fig. 10); but the main ore zone trends about due west and dips south at variable angles ranging up to 60°. This zone carried ore to a point 25 feet below the No. 2 level where the body is said to have split up into a number of bands so narrow and so low grade as to be unworkable. That the fracture zone did not bottom against a fault, as has been reported, is indicated by its presence in the lower workings at the exact place its downward projection should carry it, too. The drifts on the lower levels disclose no ore, but there are many dips and evidence of some wall-rock alteration. Open workings near the outcrop show small, nearly flat faults which cause minor vein offsets. One relatively flat fault of considerable magnitude exposed in the lower workings (Fig. 10).

The ore mined consisted largely of galena and tetrahedrite with a little sphalerite and country rock. Apparently, the mineralization has weakened materially with increasing depth.

**TOM BOY**

The Tom Boy is on the ridge north of Croy Creek about 1/4 miles west of Hailey (Fig. 2). The property straddles the ridge, but the main work is on the north side out of sight of the road along Croy Creek. The workings consist of tunnels and cuts on the north slope ending in a deep pit on the crest of the ridge, probably the top of a raise from one of the lower tunnels. Some smaller cuts continue on, and several caved tunnels unaligned with the others occur high on the south slope. Work at present is confined to a tunnel about 120 feet long driven a short distance below some older workings. About 300 feet to the north of the lower tunnel is a small inclined shaft about 12 feet deep sunk on the nose of a spur ridge. Other cuts appear across the gulch on the ridge to the north.

These workings disclose several veins, each in thinly bedded grayish shales of the upper Milligen formation. The deep pit on the crest of the ridge reveals a complex fractured zone about 10 feet wide which strikes about due north and dips 65° E. In it is a quartz vein 1 to 2 feet thick partly stained by brownish iron oxides and by greenish scordite. The lower tunnel is apparently on a different vein, for the last 40 feet of the tunnel is along a highly disturbed zone of N. 55° W. strike and 30° NE. dip, with about 2 feet of white quartz. The workings above disclose recurrent quartz lenses with rather flat dip, occurring in the midst of highly contorted shale. The quartz shows a marked tendency to pinch and swell and in one place on the ridge forms a body about 12 feet thick. Apparently another vein occurs in the incline on the spur ridge to the north. This one strikes N. 10° E. and dips 30° E. It is aligned with exposures in cuts some distance to the north. Some quartz deeply weathered and oxidized material is piled on the dump of the incline. Greenish patches of scordite suggest that the primary minerals include arsenopyrite.

The vein exposures are so spaced as to suggest that all are along the same general zone of mineralization, with discrepancies in strike and dip the result of local structural variations. Bunches of oxidized lead-silver ore are reported at grass roots for over a thousand feet. The ore is said to be associated with small bunches and pockets of quartz.

**LITTLE HILMAN**

The Little Hilman, formerly the Dewey, is on the steep slope north and just above the mouth of Democrat Gulch about 2 miles west-southwest of Hailey and half a mile from Hailey Hot Spring. The work on the property consists of a number of tunnels, all caved but one, and some open stopes and cuts.

A number of veins containing white massive quartz and one vein with coarse-grained calcite and granules of galena are exposed on the property. The vein with calcite is in limestone near the top of the Milligen formation; those with quartz are mostly in or near the overlying Wood River conglomerate, which locally has a northeasterly strike and a rather flat northwesterly dip.

Most of the work is along the calcite vein which averages up to 10 feet wide. The grains and granules of galena are rather scattered and in part changed to carbonate. One of the quartz veins has been explored by a tunnel, but the tunnel is now caved. This vein is more than 12 feet wide, but is probably less than 100 feet long.
CHIEF OF THE HILLS

The Chief of the Hills is on the crest and upper south slope of the escarpment overlying Big Wood River Valley about a mile north-west of Hailey (Fig. 2). This old patented claim has a number of caved tunnels and old cuts and a small chimney, one on the crest of the escarpment open at the surface.

The workings are apparently in the Milligen formation but may possibly extend into the Wood River conglomerate. There are a number of quartz veins on the property, but the open cuts disclosed a fracture zone 4 to 5 feet wide with some iron-stained seams but not quartz. The fracture zone strikes N. 5° W., dips 35° SW., and is in line with an exposure of “bull” quartz about 1/2 mile to the south.

FOURTH OF JULY

The Fourth of July and the adjoining Glory and Cynthia patented claims are at the head of the first long tributary gulch of Cray Creek about 2 miles by air northwest of Hailey (Fig. 2). The property is one that was located and received some work in the early days and then reopened and equipped with an ore bin and chute several years ago. The development comprises three tunnels as shown in Figure 2 plus a caved tunnel about 30 feet above the No. 2 tunnel, and two other caved tunnels in the next gulch to the north. Except for short raises in the lower and middle tunnels, practically all the mining has been carried on in the upper tunnel with stopes above and below the tunnel level.

The workings are in sandstone of the Wood River formation, which locally has been rather extensively faulted, with indications of mineralization along some of the faults. The fault patterns are basically different in each of the tunnels, but it is likely that the fault followed in the middle shaft is the one that is also exposed in the upper tunnel. The faults in the lower tunnel apparently have no relation to those in the tunnels above.

The upper tunnel was started along a prominent fault of N. 40° 13' W. strike and 58° 30' SW. dip, but where the fault was offset by cross faults the tunnel was directed in a more westerly direction, and into a prominent fault zone of northerly trend which apparently contained ore that was stopped above and below the level (Fig. 2). The fault on which the tunnel started apparently ended against the ore containing fault at about 70° W. dip, and the zone of disturbed rock measures up to 6 feet wide. The length of the mineralized fault could not be determined as an open space from below prevented passage to the end of the drift.

The middle tunnel is along a fault of N. 40° 50' W. trend and 55° 60° SW. dip for its entire length, with one chute serving as the only clue to possible mineralization above. The footwall of the fault is remarkably persistent and shows little variation in strike and dip, but the hanging wall has numerous bulges accompanied by reversal of dip with the greatest breadth where the dip is reversed to northeast. The most interesting feature of the structure, however, is the large number of northerly trending faults with low easterly dip (20°-25°) that enter the hanging wall of the main north-west fault, but do not cross to the other side (Fig. 2). These faults are probably associated fractures and may indicate prominent horizontal movement along the northwest fault with the footwall side displaced southeast with respect to the hanging wall side.

The lower tunnel exposes a northeasterly trending fracture zone at the portal, but the fracturing apparently dies out in less than 40 feet and the tunnel thereafter passes through fault and after fault of mostly N. 20° E. strike and 20°-30° SE. dip (probably the same system of hanging-wall faults exposed in the middle tunnel). About 90 feet from the face, however, the tunnel picks up and follows a fault that strikes N. 50° W. and then curves to a more northerly direction. This fault dips 50°-60° SW., is joined by northeasterly trending faults, and thus resembles the fault exposed along the middle tunnel.

OLD PROPERTY IN DEMOCRAT GULCH

An old property in a tributary of Democrat Gulch lies about 31/4 miles due west of Hailey (Fig. 2). The workings comprise several open cuts and four or five caved tunnels with one raise or stope reaching the surface.

The work is in the black argillites of the Milligen formation. The portals of some of the caved tunnels and cuts reveal a prominent fracture zone of N. 15° W. trend and 30° SW. dip, with the zone of disturbance measuring up to 12 feet or more across. The fractured rock is heavily iron-stained, but the iron oxides afford no easy clue to the nature of the primary mineralization.

CROESUS

The Croesus is in lower Scorpion Gulch about 31/4 miles airline southwest of Hailey or 5 miles by road (Fig. 2). Ore was discovered in 1881 but little work was done until 1895, and thereafter was carried on intermittently until about 1940. The mine is the deepest in the
Fig. 11. Geologic map of open workings at Fourth of July mine.
The mine is of more than ordinary interest, because for the first 600 feet it was a gold mine and for the remaining 200 feet a lead-silver mine. This was possible because of the presence of two mineralogically different veins, one of the gold type and the other of the lead-silver type. These veins are apparently similar in trend but they dip in opposite directions. As a consequence, the lead-silver vein passes through the gold vein between the 500 and 600 levels. These veins and another parallel vein, the Hope, which lies a short distance to the south, are along east-west fracture zones in the diorite. The gold (Crosesus) vein dips steeply north near the surface but reverses dip with depth and below the 200 level dips rather uniformly about 70° S. The lead-silver vein, which was first uncovered on the 600 level, dips about 65° N., and has been traced upward to the point where it intersects the gold vein. The Hope vein also dips north to the 200-foot level, where it apparently fades away or loses its identity. The walls of the fracture zones are 6 to 8 feet apart, exceptionally 40 feet apart, with rock between very badly crushed and intruded by lamprophyric dikes younger than the ore.

The ore bodies along the Crosesus vein are reported to occur as lenses of varied size and shape with long axes generally inclined steeply to the east. The largest bodies were on the second and third levels where the main ore shoot ranged from 100 to 187 feet long and from 4 to 5 feet wide. The gold ore consisted of quartz, pyrite, chalcopyrite, arsenopyrite, and pyrrhotite with a little siderite and galena. The direct shipping ore is said to have averaged $40 to $50 to the ton and the milling ore $10 to $12 to the ton. The Hope is similar to the Crosesus, but the ore is of lower grade.

The lead-silver vein is typical of the lead-silver veins of the area. It contains galena, a little sphalerite, quartz, pyrite, chalcopyrite, and tetrahedrite in a siderite gangue. The ore is reported to have contained 5 to 20 per cent lead, with one ounce of silver for each per cent of lead and from 0.25 to 0.35 ounce of gold per ton.

**COMET**

The Comet is on the west side of Scorpion Gulch about a mile above the Crosesus (Fig. 2). The mine has been worked intermittently since the discovery of ore in the early days, and, according to available data, produced from 1883 to 1918, 281.3 tons of ore containing 29.13 ounces of gold, 11,912.20 ounces of silver, 270.560 pounds of lead, and 1,234 pounds of copper (1, p. 133). The workings comprise three main and several shorter tunnels; those accessible in 1949 are shown in Fig. 12. The No. 4 or the middle of the three main tunnels is the longest (750 feet), but is blocked about 140 feet beyond the end of the crosscut.

The work in the Comet is along a prominent fracture zone in diorite. This zone measures up to 10 feet wide and is occupied by a lamprophyric dike which apparently was intruded after mineralization and locally divides the ore into foot and hanging wall bodies. The fracture zone shows marked variation in strike and dip, with the strike N. 50° - 60° W., and the dip 30° - 40° NE. The footwall shows a more variation in dip. Local pinches and swells of the fracture zone are apparently associated with changes in the dip of the hanging wall. The flattening of dip denoting an increase in the width of the fracture zone, and a steepening of dip, a decrease. In places fractures show nearly horizontal grooves which indicate a marked horizontal component of movement. The ore bodies are rather thin and short. The distribution of ore and other pertinent geologic data are shown in Fig. 12.

In the No. 3 or the uppermost of the three main tunnels 6 to 8 inches of ore occurs along the footwall of the fracture zone below a 2 to 4-foot lamprophyric dike, and 12 to 18 inches of oxidized quartz-carbonate-sulfide fillings occur along the hanging wall. Several lamprophyric dikes cross the fracture zone at the portal of the tunnel.

Several small stopes extend above the No. 4 or middle tunnel (Fig. 12). Up in the largest stope about 8 inches of galena remains along the hanging wall of the fracture zone, and 6 to 8 inches along the footwall, which is 4 to 10 feet below the hanging wall. The hanging wall vein dips about 60° NE., and the footwall vein 55° NE. As the walls come closer together the ore bodies tend to pinch, both on the strike and dip. These same tendencies also prevail in the tunnel below, the No. 4 tunnel.

The ore consists chiefly of galena with lesser sphalerite, pyrite, and chalcopyrite in a quartz gangue that also contains some siderite. The ore is intricately fractured and in large part consists of a cemented breccia of ore minerals.

**FAIR VIEW**

The Fair View is in Scorpion Gulch just above the Comet, perhaps on the same vein or on a closely overlapping vein. The work-
ings comprise three tunnels and several cuts but only the lower tunnel in the gulch bottom was open. This tunnel consists of a 42-foot crosscut with a drift to the northwest, carved at 95 feet and another drift to the southeast blocked at 49 feet. The southeast drift has a small water-filled stope about 24 feet from the crosscut.

The drift is along a weak zone of fracturing which trends N. 30°-50° W., and dips 55°-70° NE. In a surface cut the fracture zone is about five feet wide but appears to be somewhat less in the tunnel below. Where exposed in the drifts, the fracturing is in diorite but passes into quartz monzonite at the cave-in in the northwest drift. A caved tunnel above is entirely in quartz monzonite.

The drifts show as much as 6 inches of quartz or vein matter, but the ore mined in the stope and in the old work nearer the surface was probably from a lens about 12 inches thick. Considerable siderite is piled on the dump. This siderite contains a little quartz, some coarse cubic galena, and a little pyrite.

**KEYSTONE**

The Keystone is on the east side of Scorpion Gulch almost directly across from the Comet (Fig. 2). This mine like the Comet was located and worked in the early days. The recorded production from 1883 to 1908 is given as 108.9 tons of ore containing 2.64 ounces of gold, 5.115 ounces of silver, 48.701 pounds of lead, and 12,768 pounds of copper (1, p. 135). The workings are now inaccessible but formerly consisted of three rather lengthy tunnels connected by raises, with the main stopes above the upper tunnel level. The plan and longitudinal section of these workings are published in Bull. No. 814, p. 134.

The tunnels were driven about S. 70° E. along the vein, which is reported to strike N. 69° W., to dip 70° NE., and to range from a few inches to 4 feet wide. The ore is reported to have occurred in pockets which decreased in size and number from the upper workings down to the lowest tunnel. The ore closely resembles that of the Comet.

**HARD TIMES**

The Hard Times is in upper Scorpion Gulch up the slope southeast of the Keystone (Fig. 2). The workings consist of four tunnels and several surface cuts, all carved except the lower tunnel. The lower tunnel is a crosscut about 200 feet long driven northeastward with a short drift to the west and a longer but blocked drift to the east.

The only rock visible on the property is diorite. As shown in the crosscut the diorite has been broken by a relatively flat fault that strikes N. 10° E., dips 27° NW., and is accentuated by 6 to 8 inches of gouge. Just beyond the flat fault is a steeply dipping fissure that contains a quartz vein about 8 inches wide. The crosscut, however, was driven to reach a siderite vein exposed in the drifts ahead and in the upper workings. The siderite vein strikes about N. 80° E., dips 60° N., and is contained in a fracture zone 4 to 5 feet wide. All that was seen of the vein were siderite stringers extending from the ends of the stope, which probably once reached the surface.

The ore consists of siderite, quartz, and galena, fragments of which were found both on the dump of a small tunnel beneath the outcrop and on the dump of the lower tunnel. One of the other dumps, however, has quartz and pyrite, apparently from a quartz-pyrite vein.

**ECLIPSE**

The Eclipse is across the gulch west of the Crosses. It has a two-compartment shaft just above the gulch bottom, and, to the side of the shaft, a short drift with several short branches. The depth of the shaft and whether there are workings from it was not learned.

The shaft is in the footwall of a vein or fracture zone which is exposed at the portal of the short tunnel. The vein trends in an easterly direction toward the Crosses shaft. The vein, which dips about 70° N., had not been drilled on for more than 40 feet before it was lost against a fault of N. 40° E. trend and 60° SE. dip. The work in the tunnel was abandoned a short distance beyond the fault. There is no indication of ore along the vein fracture.

**ASSAULT**

The Assault is along the north boundary of the Eclipse in Scorpion Gulch and covers a series of short caved tunnels which are aligned up the ridge in a northwesterly direction. The vein is exposed near the crest of the ridge where it is composed of 4 feet of white quartz with some partly oxidized pyrite. The vein appears to strike about N. 80° W. and to dip about 70° NE.

Another vein of unknown name and ownership lies just north of, and parallel to, the Assault. It has two tunnels, one in the gulch bottom, open but difficult to enter, and the other on the ridge just above, but caved. The upper tunnel is along a vein which strikes about N. 80° W. and dips 60° N. This vein, where exposed in the tunnel portal, contains 7 feet of quartz, some of which is crusted with iron oxides. Above the portal of the lower tunnel is about 2 feet of fractured diorite. The
Fig 12. Geologic sketch map of accessible workings at the Comet mine.
zone of fracturing trends N. 70° - 80° W. and dips 80° N. The dump shows very little quartz.

Still another quartz vein with gossan about parallel to the other vein is exposed a little lower in the gulch. A tunnel farther down the gulch apparently failed to reach the vein.

RED HORNET

The Red Hornet embodies several veins on both sides of the high ridge between Scorpion Gulch and the Rock Creek slope west of the Creuson (Fig. 2). The most extensive work is on the Scorpion Gulch side just under the crest of the ridge. This work includes a cut or caved stope almost on the crest, and three tunnels below, all caved but the second. The opening above the tunnel reveals a fracture zone 4 to 5 feet wide which strikes N. 60° W., and dips 65° NE. The fracture zone contains a lamprophyric dike and some quartz seams, the main one less than 8 inches thick. In the tunnel portal below, the vein has flattened and increased in thickness. On the dump of the second tunnel are several small piles of ore consisting of galena with quartz and siderite, in part in chunks up to 10 inches thick. In addition to the main ore seam there are other smaller seams in the fractured rock. The dump of the lower tunnel shows altered rock but no sulfides.

On the west side of the ridge a short distance below the crest are two small groups of workings separated by a broad shallow gulch. The more easterly of the workings (Red Hornet No. 2) consists of two short tunnels driven easterly into the ridge. These workings reveal a fracture-zone about 4 feet wide in quartz monzonite with a quartz vein up to 8 inches wide bordered by smaller parallel seams. This mineralized fracture-zone strikes about N. 60° E., and dips 50° SE. The quartz is the coarse comb variety with intervening siderite crystals. The more westerly group of workings (Red Hornet No. 1) appears to be an extension of the same vein. These workings include a short tunnel in diorite driven just under two old cuts. The fracture zone is about 4 feet wide and contains a quartz vein less than 12 inches thick which contains some siderite, pyrite, and a little galena. A southwesterly dipping fault with a foot of gougy material is exposed in the tunnel several feet short of the vein.

There is also some old work close to the ridge crest a short distance north or northeast of the Red Hornet. This work includes two cuts on the Rock Creek side and a caved tunnel, perhaps about 200 feet long, on the Scorpion Gulch side. The cuts expose a basic dike and a quartz vein less than 8 inches wide with a little pyrite and galena. The vein strikes N. 75° W. and dips 65° NE.; to the west the vein is cut off by the dike. The tunnel on the other side of the ridge apparently does not cut the vein.

BABE

The Babe is just over the low divide between a tributary of Rock Creek and the broad basin of Croy Creek. It lies in the gulch bottom a short distance above the turn of the road that leads to the Westlake property (Fig. 2). The workings comprise a vertical shaft about 40 feet deep near the bottom of the gulch and a short tunnel into the slope behind the shaft.

The property is at the southwest edge of the main pegmatite-aplite swarm, and the fracture-fissure zone containing the vein body of pegmatite-aplite intruded into diorite. The fracture zone strikes N. 30° W., dips almost vertically, measures about 6 feet wide, and contains up to 10 inches of quartz on one wall and 4 inches on the other. Quartz on the dump has scattered grains and granules of coarse galena, occasional grains of tetrachalcite, some scattered crystals of pyrite, and a very little chalcopyrite. The sulfides are partly oxidized and the quartz is in part coated by scattered patches and thin crusts of chrysocolla and lesser malachite and azurite, apparently formed by oxidation of the tetrachalcite.

WESTLAKE

Location and Development

The Westlake is near the head of several westward-flowing tributaries of Rock Creek on the slope of the high ridge about opposite the head of Lee Gulch (Fig. 2). The property is about 7 miles by road from Hailey at the end of a branch that leaves the Rock Creek road across from the mouth of Bullion Gulch.

The property consists of 10 unpatented claims and two mill sites, and covers about a mile-long strip of land along the southwest side of the ridge. The first claims were located in 1907. Since then much exploratory work has been carried on in numerous cuts, shallow shafts and short tunnels. The only workings now open are a 785-foot tunnel, caved 245 feet from the portal, and two shorter tunnels, which are inset on the map showing the distribution of the various workings (Fig. 13).

Geologic Features

The scattered workings disclose a number of more or less extensively mineralized fracture zones or veins, most of which, though locally prominent, appear to lack continuity of strike and dip. They appear to be associated with a complicated zone of deformation within the black argillites of the Milligen formation very close to the contact of the large body of quartz monzonite. The more prominent fractures and
fracture zones trend N. 20° - 30° W., about parallel to the quartz monzonite contact, but there are some fractures almost as prominent and as well mineralized but of a different trend; which, however, are much less persistent in strike and dip after a few tens of feet.

North workings.—The most prominent mineralized zone at the north end of the property is exposed in the face of a cut at the top of a 36-foot inclined shaft on the north side of a shallow gulch, and partly exposed in the side of a caved vertical shaft on the south side of the same gulch. This fracture zone strikes N. 25° W. and dips 45° NE. Several caved tunnels aligned with these shafts on the north side of the ridge suggest that the fracture zone controlling the mineralization is quite long. The long 765-foot tunnel was driven toward this fracture zone but apparently failed to reach it.

The tunnel is reported to pass through a body of low-grade milling ore, about 15 feet wide, several hundred feet from the portal. Where exposed at the top of the inclined shaft, the fracture zone is about 12 feet wide and contains about 2 feet of partly oxidized lead ore along the footwall. The Milligan beds, in and along the mineralized fracture zone are very much disturbed, but the bedding along the hanging wall is not destroyed and the beds strike N. 25° W. and dip 67° NE. In almost the center of the fracture zone is a dark-colored basic dike which appears to be younger than the mineralization.

Just over the ridge south of the two shafts is a recently driven tunnel (Fig. 13), some cuts, and several caved tunnels. The cuts reveal one mineralized zone 4 to 5 feet wide with 10 inches of oxidized lead ore and a second fracture zone 5 to 6 feet wide with some quartz stained by scorodite and limonite. The first zone strikes N. 40° E. and dips 70° SE. The other strikes N. 50° W., dips 68° NE, and passes through the first. The tunnel driven to explore these fracture zones at depth (Fig. 13) passes through many fractures but zone that can be identified as belonging to those in the cuts. Apparently, a marked change in structural conditions has occurred within the very short vertical distance between the outcrop and the tunnel level.

Another zone of fracturing is poorly exposed on the ridge farther to the south. This one strikes about N. 70° W. and dips steeply northeast. A series of cuts continue down the crest of the ridge to old workings in the gulch bottom a short distance south of the recently driven tunnel, but these cuts and others in the vicinity provide little information.

South workings.—More workings at the southeast end of the property, which include one accessible and several caved tunnels on the north side of a steep ridge, and an inaccessible shaft and some cuts near the top on the south side, reveal two parallel veins, each striking N. 20° - 25° W. The more easterly one is exposed in the shaft. This mineralized fracture zone is 8 to 10 feet wide with the most intense deformation confined to a zone 2 to 3 feet wide. The dip is about 85° NE. The other mineralized fracture zone is reached by crosscuts on the north side of the ridge. This zone and other mineralized fractures are shown in Figure 13. The main fracture zone apparently splits and the easterly branch measures up to 8 feet wide and contains considerable partly oxidized ore. Toward the face of the draft the fracturing tends to break up or is interrupted by fractures of more westerly trend. Just before this happens, the fracture zone is cut by a mineralized cross fracture of N. 70° E. strike and 45° NW. dip, which has been explored by a maze of holes above the level to a height of about 25 feet, apparently on small bodies of ore. Ore has been stopped below as well as above the level.

Except in the one mineralized zone near the north end of the property, where quartz apparently occurs with pyrite and arsenopyrite (gold- pyrite type of mineralization), the unoxi- dized ore consists of galena, probably with sphalerite and tetradetrite but unaccompanied by siderite.

**PIONEER**

The Pioneer is on the low broad ridge a few hundred yards below the Westlake (Fig. 2). The workings include one small hole on a large boulder of iron-stained silicified quartz-monzonite rock and a 15-foot shaft in altered quartz monzonite. The work in the granitic rock is on a zone of fractured, mineralized rock that strikes N. 60° W. and dips steeply northeast. The shaft exposes 1 to 1½ feet of rusty rock that is said to contain gold and to have provided ore for some early day shipments.

**STARTER**

The Starter is about half a mile southeast of, and in line with the Pioneer, its supposed extension (Fig. 2). The work on the property consists of a 40-foot shaft, a 25-foot caved tunnel, and a 75-foot open cut. The cut is along a quartz vein reported to contain some galena but with values principally in gold and copper. The vein is steeply dipping, measures up to 6 feet wide, and is in the Wood River formation.

**ALTURAS**

The Alturas is along the sides and bottom of a gulch near the head of a tributary of Rock Creek at the very southwest edge of the map.
Fig. 13 Geologic maps of surface and accessible underground workings (A and B) at the Westlake mine.
ped area (Fig. 2). The property comprises 5 claims on which there are several tunnels and an inclined shaft, the latter being about 60 feet long on a 35 degree slope. The main tunnel is just above the shaft and has been driven into the slope about 300 feet.

The various tunnels and the shaft explore at least four separate bodies of gossan. These are in limestone of the Wood River formation close to a body of quartz monzonite, the contact of which lies along the crest of the ridge a short distance above and west of the gossan bodies.

The main body of gossan seems to trend in a general northerly direction and to dip easterly at about 25°, conforming to the surface slope. The 300-foot tunnel is driven into the slope under the gossan and exposes only unmineralized footwall. The inclined shaft is started at the portal of the tunnel and extends down under the gulfch. As the incline has a steeper angle than the gossan body, it passes into the footwall. The gossan body is exposed for at least 100 feet on the strike and an equal distance down the slope. This body is several feet thick. The other bodies are much smaller. Short tunnels beneath two of them disclose nothing of geologic significance. The bodies in general appear to be rather flat, perhaps pipe-like, but fracture controls are not apparent.

The gossans are composed of yellowish, reddish, and bluish iron oxides, which carry no more than 2 or 3 ounces of silver nor more than 0.02 to 0.03 ounce of gold per ton.

EDRES

The Edres is high on the slope above Poverty Flat and not far west of Rattler Mountain (Fig. 2). Some recent work has been done on this old property. The development comprises an open tunnel with several hundred feet of crosscuts and drills (Fig. 14) and a caved tunnel a short distance above. Ore shipments have been small.

The workings disclose a thrust zone up to 6 feet wide in quartz monzonite not far below its contact with the diorite. The thrust zone, which strikes about due East and dips 30°-38° N., contains a komatophyric dike 3 to 4 feet wide, and, on either side of the dike, lenses of ore measuring up to 8 inches thick. The dike is somewhat bleached along the ore zone but is little fractured and contains no ore. As shown in Figure 14, the ore has been stopped both above and below the level. The ore appears to be confined to the flatter parts of the fault zone, particularly on the under side of the dike. The ore consists largely of argilliferous galena with much lesser pyrite, sphalerite, chalcopyrite, and tetrahedrite, in a scant quartz gangue.

Before reaching the mineralized thrust zone exploration work picked up and was directed along a weak fault of N. 32° W. trend and 80° NE. dip. A small body of basic igneous rock occurs along the fault, not far from its junction with the thrust fault.

LARK

The Lark mine borders Poverty Flat about 2½ miles southwest of Bellevue (Fig. 2). This property has been worked intermittently since the early days, but so far as known there has been no production since 1923. Except for a shallow, recently sunk, inclined shaft at the west end of the property, the workings are inaccessible and consist of a long series of caved shafts and cuts extending in an east-west direction for several hundreds of yards. Most of the underground work apparently has been carried on from just one of the shafts, which is reported, in 1913, to have had a depth of 80 feet with levels at 30, 36, 65, and 80 feet (1, p. 244). The new shaft does not expose the vein.

Where exposed in the upper part of the main shaft, the vein strikes about N. 55° W. and dips 80° SW., the dip decreasing somewhat with depth. The vein is in diorite and its walls, which are 3 to 5 feet apart, enclose slices of little altered diorite and seams and small irregular masses of partly oxidized siderite. According to Bull. 814, the vein was narrower near the ends of the drifts, which extend 20 to 60 feet from the shaft, and was composed partly of lenses of the diorite and partly of lenses of sulfides and quartz, with the sulfdre lenses ranging from a few inches to as much as 20 inches thick and 15 to 25 feet in stope length. Altogether these formed an ore shoot about 50 feet in strike length.

Some partly oxidized siderite and galena remain in small piles on the dump at the main shaft and at several other places. The galena is associated with quartz rather than with siderite. According to Hewett the ore contained some sphalerite and tetrahedrite in addition to the galena and lead carbonate. Selected ore is reported to have carried 2 ounces of silver for each cent of lead.

The ore shoot is said to have pinched with depth and the pinching apparently has discouraged any attempt at deeper mining.

BROKEN WHEELBARROW

The Broken Wheelbarrow is near the summit of Rattler Mountain a little less than 3 miles airline southwest of Bellevue (Fig. 2). The property, an old one, was relocated May 1, 1949. The development comprises a number of
cuts and short tunnels, all caved, aligned along the north slope of the mountain.

The cuts and tunnels are along a fissure or fracture zone of west-northwest trend and steep southwest dip. The zone is several feet wide and is contained wholly in diorite. In places the fractures contain siderite. At the location noted is a small pile of ore containing galena and pyrite with siderite and little quartz.

**UTAH-BELLEVUE**

The Utah-Bellevue is in upper Townsend Gulch about 3 miles airline west-southwest of Bellevue (Fig. 2). Work was carried on as late as 1922 but apparently little, if anything, has been done since, and workings are all inaccessible. Shipments made in 1915, 1918, 1921, and 1922 totalled 267 tons of ore which contained 21.28 ounces of gold, 9,984 ounces of silver, 37,109 pounds of lead, and 998 pounds of copper (1, p. 120).

A sketch of the underground workings is contained in Bull. 814, p. 125. This sketch shows that the principal development is a crosscut about 240 feet long connecting with a 1,200-foot drift. A 50-foot winze extends below the drift at a 45-degree angle with short drifts and another short winze at the bottom. There are also several raises above the main drift inclined at angles of 30 to 40 degrees, one of which reached the surface, and part way up connected with a drift about 258 feet long.

According to Bull. 814, the workings explore a broad and poorly defined shear zone in quartz monzonite and lamprophyre. The lode fissure aligned along the zone of shearing strikes about N. 70° W. and dips northeast at a moderate angle. Many of the slips of the shear zone are lined with chloritic material. Both the quartz monzonite and lamprophyre are altered and in places contain calcite, quartz, galena, sphalerite, and pyrite. Much of the ore is reported in the lamprophyre or in association with chloritic layers in the quartz monzonite. Most of the ore shipped came from the main winze, but some was stopped above the crosscut 50 feet southwest of the winze and in the raise that reaches the surface with some ore in the drift connecting to this raise. Ore shipped in 1922 is reported to have assayed 9.9 per cent lead, 0.13 ounce of gold and 66.82 ounces of silver per ton, 17.7 per cent zinc and 1.0 per cent arsenic. Fragments of ore on the dump show some arsenopyrite.

**SOUTH CHICAGO**

The South Chicago is on the north side of Townsend Gulch well up toward the crest of the ridge separating Townsend Gulch from Lee Gulch (Fig. 2). The property apparently was explored in the early days and then left idle until relocated in April, 1943. The workings comprise a caved tunnel and a 50-foot cut along the strike of the lode.

The lode is in little altered diorite and where exposed in the cut, strikes about N. 70° W., and dips 70° - 80° SW. As it extends beyond the cut it may swing in a more northerly direction. The lode consists of up to 6 feet of prominently fissured diorite with seams of siderite up to a foot wide. The dump at both the cut and caved tunnel below hold piles of blackened, very coarsely crystalline siderite containing here and there a little chalcopyrite. The siderite apparently contains appreciable amounts of manganese, for the outcrop, where stripped, is conspicuously black.

Across the gulch southeast of the South Chicago are two groups of workings on separate lodes. The more westerly lode is exposed in cuts along the outcrop but is not revealed in the tunnel, which apparently is short of its goal. The lode has the same trend and dip as the South Chicago and may be a possible extension. It contains up to 5 feet of sheared diorite with thin seams of siderite.

The more easterly lode has been explored by a tunnel several hundred feet long. The lode strikes N. 20° W., dips 68° SW., and comprises a zone of sheared and fissured rock up to 8 feet wide with scattered seams and stringers of siderite.

**HILLSIDE**

The Hillside is near the crest of the low ridge separating Lee Gulch from Townsend Gulch a short distance from Big Wood River Valley (Fig. 2). The property has had some work in recent years but the underground workings, which include several tunnels from creek level to well up the slope, and two inclined shafts on the outcrop near the top of the ridge, are inaccessible.

Where exposed at the top of the more easterly shaft, the vein, which is about a foot wide, strikes about N. 60° W. and dips 60° SW. The vein consists of siderite seams in weakly leached siderite seams in weakly fractured diorite. Considerable amounts of siderite, iron oxide, and small masses of galena, tetrahedrite, pyrite, and sphalerite.

**CHICAGO (BELLEVUE KING)**

The Chicago, formerly the Bellevue King, is on the south side of Lee Gulch about 2 miles west-southwest of Bellevue (Fig. 2). The property apparently has been idle for a long time and little of the underground work is now open. The development comprises a number of tunnels, one open and another partly open. The
Fig. 14 Geologic map of underground workings at Edres mine
partly open tunnel has the principal work on the property. This, the lower tunnel, now blocked 210 feet from the portal, is shown in U.S.G.S. Bull. 814 as Figure 20. From the tunnel a winze has been sunk 40 feet and a raise with some stopes has been extended to the surface 80 feet above.

The workings are in diorite and all that can be seen underground is a prominent fault zone trending about N. 30° E. This fault is one of several northeast faults shown in U.S. Geol. Survey Bull. 814, as striking N. 42° E. and dipping 75° to 85° NW. A fault of northeast trend also recurs in the open tunnel above this level. Some of the caved tunnels are aligned in a northeast direction, presumably along zones of northeast shearing. These faults cut off the veins and thus apparently belong to the Miocene group of northeast faults.

According to the map, two veins or lodes are exposed underground but most, if not all the material shipped, has come from the one explored by the 40-foot winze. This lode strikes about N. 45° W., dips 40° SW., and in a 5-foot zone contains at the most five veins of siderite that range from 1 to 3 inches thick. Some veins contain irregular patches of tetraedrite and chalcopyrite, and some of the siderite on the dump also contains pyrite and a little arsenopyrite. The other vein strikes in a more westerly direction and dips 75° N. It is from 1 to 4 inches wide and is reported to have contained siderite and disseminated pyrite, arsenopyrite and chalcopyrite. These lodes and the fractures that control them are not persist nor well marked by walls, but as pointed out in U.S. Geol. Survey Bull. 814, p. 234, are distinctly minor fractures that are limited in strike by much more impressive faults of northeast trend.

Although the northeast faults are post-mineral insofar as the main ore mineralization is concerned, they do in places contain the zeolite, laumontite (a hydrous silicate of calcium and aluminum), a product of Miocene mineralization. The Miocene mineralization has also in part affected the older veins causing development of the mineral hisingerite (a hydrous iron silicate) in and about fragments of siderite. Associated with laumontite is some calcite; and with the hisingerite, both calcite and quartz.

Across the gulch some distance northwest of the Chicago are a number of old caved tunnels along a wooded gulch bottom. The vein where exposed is about a foot wide and appears to be striking N. 70° W. and dipping 65° SW. Some fragments of siderite are present on several of the dumps.

MODOC CHIEF

The Modoc Chief is at the end of a branch road on the upper north slope of Lee Gulch (Figs. 2 and 3). The workings comprise several blocked tunnels.

Where exposed on the surface the lode consists of a zone of fractured diorite about 6 feet wide striking N. 70° W. and dipping 62° SW., with 1 to 8-inch seams and stringers of siderite mainly parallel to the walls but in part oblique thereto. At the portal of the lower tunnel the diorite is cut by a 40-foot fault zone of easterly strike, which the Walkers regard as the surface exposure of the Minnie fault.

LEGAL TENDER

The Legal Tender is on the north side of Lee Gulch several hundred yards east of the Modoc Chief (Figs. 2 and 3). The development comprises several open cuts and not less than five caved tunnels, apparently on three different fracture zones. The size of some of the dump is indicate considerable underground work.

Two of the veins, one of which is exposed at the portal of the lowest tunnel and in the open cut above, strike N. 30° E. and dip almost vertically. The other is a short distance southeast and it too has been explored by a short tunnel and open cut. These veins are in sheared diorite and each contains a little pyrite, scant sphalerite and galena, and locally a little arsenopyrite in a gangue of fine-grained quartz. The sphalerite is light colored and the ore has the compositional and textural characteristics of mid-Tertiary mineralization. The mineralized fractures explored by the other tunnels were not seen, but dump material also indicates Miocene mineralization, possibly along zones of northeast shearing.

OTHER PROPERTIES IN LEE GULCH

The names of several old properties in Lee Gulch were not learned. One of these is a short distance east of the Modoc Chief on the north side of Lee Gulch. The property has a considerable number of short tunnels and cuts, mostly in two groups, one on each side of a gulch that drains into Lee Gulch proper. The workings on the east side of the gulch consist of seven short tunnels driven as crosscuts into the slope; each is blocked, except the lowest, which is several hundred feet long. These are driven beneath a long open cut, now partly filled with surface debris. The other group lies across the gulch to the northwest and consists of three tunnels, driven from the gulch bottom, and several open cuts. A loading platform indicates that some ore has been shipped.

The alignment of the long opencut and the
tunnels indicates a vein or lode trend of about N. 45° W., and probably steep northeast dip in sheared diorite. Considerable iron oxide is scattered around, probably from the oxidation of siderite. The vein or lode is apparently longer than most, but there was no opportunity to see the vein or lode and learn its size and more precise structural relation.

Another property is almost at the head of Lee Gulch and straddles a high ridge that descends southeastward from the Rock Creek divide to the uppermost fork of the gulch (Fig. 2). The development comprises three short tunnels on the southwest side of the ridge, just below and almost on the crest; a bull-dozed trench just over the crest with a 15-foot tunnel a short distance below; and two caved tunnels on the northeast slope several hundred yards to the southeast. Two of the tunnels on the southwest side are connected by a drift and one is apparently connected by a raise from the tunnel on the other side of the ridge.

The workings are in diorite which locally contains many lamprophyric dikes. The tunnels on the southwest side expose a prominent shear zone up to 8 feet wide with gouge along the more conspicuous slips. The shear zone strikes about N. 70° W., dips 45° - 65° NE., and contains a lamprophyric dike and seams and lenses of quartz, locally with sulfides, up to 12 inches thick. The zone cannot be traced more than 100 feet. The trench just over the crest exposes altered, weathered material, but no distinct fissure or fracture zone. The tunnel below shows no signs of mineralization. The ore on the dumps on the southwest side of the ridge contains some pyrite, sphalerite, and galena in quartz. Some quartz, galena, and sphalerite also occur on the dump of the upper caved tunnel off to the southeast, possibly on the same or a parallel lode.

A third property is located a few hundred yards up a tributary that enters Lee Gulch about half way to its source (Fig. 2). The property is an old one and apparently has not been worked for a long time. Development consists of a series of cuts and caved tunnels along and close to the creek bottom.

Spacing of the cuts and pits suggests the presence of several veins, but only one was seen. This vein, exposed in one of the cuts, is along a fissure zone in diorite and strikes N. 50° W. and dips 60° NE. Where exposed, it contains about 12 inches of oxidized siderite. Some siderite also occurs on the dump at the bottom of the gulch just west of the exposure.

Near the crest of the ridge is another series of cuts and short caved tunnels on a vein that strikes N. 45° W. and dips 60° SW. This vein also contains some oxidized siderite. The vein is probably on another property.

**MONDAY**

The Monday is about a mile east-southeast of Bellevue on the steep slope bordering the valley just east of Bellevue (Fig. 2). The mine has been inactive for many years. It was developed by several tunnels, but those which exposed the ore are caved and the only one not caved is barren of ore.

The workings are in black shales of the Milligen formation some hundreds of feet below the Wood River conglomerate. The beds exposed in the open tunnel are somewhat fractured and locally displaced by faults, but the low-angle fault which is said to contain the ore body was not observed. The ore body was small but exceptionally rich in silver. According to records the 15.3 tons of ore marketed in 1883, 1886, and 1889 contained 1,203.3 ounces of silver and 6,640 pounds of lead.

**HAWK**

The Hawk is on the lower slope east of Big Wood River about midway between Bellevue and Hailey (Fig. 2). Some six or seven tunnels, all blocked but two, extend into the slope beginning a short distance above the edge of the valley.

The tunnels were driven to explore a relatively flat vein which strikes about N. 30° W. and dips about 30° SW. Small amounts of ore occur on two of the upper dumps. This ore consists of small seams and nests of galena, in one place forming a boulder about 10 inches in diameter.

Two other tunnels higher on the slope are on another vein. This one strikes N. 30° W. and dips 60° SW. No ore is exposed on the dump.

**MARBOY**

The Marbo is on the low ridge at the edge of Big Wood River Valley about 1½ miles southeast of Bellevue (Fig. 2). The workings consist of a deep cut on the crest of the ridge and three caved tunnels, one on the northeast side of the ridge and two others on the southwest side. The tunnel on the northeast side appears to be connected with the cut by a raise, now caved.

The property is near a downfaulted block of Wood River conglomerate, but rock exposed in the cut is a limy shale. The cut discloses a pronounced fault zone which strikes about due north and dips vertically to steeply west. This zone is up to 6 feet wide and is made up of complexity fractured rock above a basic dike that lies along the faultwall. The rock along
the fracture zone contains some tremolite and the fractures within, some seams of limonitic iron oxides.

**SUNRISE (BLACK JACK)**
The Sunrise, formerly the Black Jack, re-located and renamed early in 1949, is at the edge of Big Wood River Valley about 2 miles southeast of Bellevue (Fig. 2). The workings include four rather long tunnels, all blocked but one. The tunnel is between 500 and 600 feet long.

All tunnels are in the Milligen formation and the dump material is as black as coal. The open tunnel passes through an anticlinal fold into black argillites dipping 50° E. These argillites contain sporadically distributed bunched, podes, and irregular vein-like bodies of white, barren quartz. A much disturbed zone, striking northwest and dipping 30° NE, on the slope above, contains a quartz vein a foot or more wide in which there is some pyrite and arsenopyrite.

Some old workings on a property to the north—several short tunnels of which one is open—are in steeply, easterly-dipping shales. The open tunnel discloses that the shales are cut by a flat, 2 to 4-inch quartz vein which dips 10° E. Farther in the tunnel is a steeply dipping fault occupied by an altered basic dike.

**MEMORIAL**
The Memorial is on the slope bordering Big Wood River about 1/2 mile southeast of Hailey (Fig. 2). The property was active some years ago and again in 1947. The workings consist of a number of tunnels, inclines, and cuts. The one open tunnel contains about 350 feet of work. Development has been confined to two rather closely spaced veins, both in limestones and sandstones of the Wood River formation.

The lower vein strikes about N. 30° W. and dips 30°-40° NE. It appears to be more extensively explored than the other and may be traced along the slope for several hundred feet by the long line of inclines, cuts, and short tunnels, some of which pass through the vein into the hanging wall. The vein is confined between well-defined walls, and where exposed, contains a band of limonitic oxides from 2 to 10 inches wide. The open tunnel, one of several below the outcrop and second from the lowest, may pass through the vein but if so the vein is unmineralized. The tunnel extends through one fault, which strikes N. 30° W. and dips 45° NE, and then a second fault which strikes N. 60° W. and dips 45° NE.

The second vein appears to have a more northerly trend than the other and dips 45° NE. This vein also has good walls and as much as 2 to 10 inches of limonitic material.

**ROADSIDE**
The Roadside is along the road in Slaughterhouse Gulch about 21/2 miles above Bellevue (Fig. 2). The development consists of two tunnels, both inaccessible. Nothing was learned of the tunnel lengths nor of the history of the property. It was relocated in July, 1947.

The tunnels are driven in black Milligen formation, apparently to explore a 24-foot zone of shearing exposed in a small cut above the upper tunnel. This zone strikes about N. 80° E., dips 35° W., and contains some limonitic stains. The black argillite exposed on the dump of the lower tunnel contains some scattered thin seams of quartz with pyrite, but otherwise there is little evidence of mineralization.

**CONSTANTINE**
The Constantine is in upper Constantine Gulch, a tributary of Slaughterhouse Gulch about 11/2 miles northeast of Bellevue (Fig. 2). Development consists of two caved tunnels on the south side of Constantine Gulch and two or three smaller ones on the north side. They are in the blackish Milligen argillites. Some quartz float was noted in the gulch but no quartz was seen in place. The tunnels are reported to have been driven to explore a gold-quartz vein.

**SILVER WING**
The Silver Wing is on the southeast side of Slaughterhouse Gulch about 1 mile from Bellevue (Fig. 2). The workings include several tunnels, one near the floor of the gulch and the others on the slope 100 feet above. About $50,000 worth of ore has been reported shipped from the mine.

The deposit is in the Milligen formation and is along a fissure or fracture zone which strikes about N. 80° W. and dips 50° SW. Ore was not seen in place, but some partly oxidized galena with quartz remains on the dump of one of the cuts.

**STORM PETREL**
The Storm Petrel lies in Slaughterhouse Gulch just east of the Silver Wing. The property comprises two claims, each on a separate vein and each with several caved tunnels and cuts.

On one of the claims the vein or fracture zone strikes N. 80° W. and dips 20°-50° SW. The disturbed zone is up to 6 feet wide and consists of sheared grayish shales of the Milligen formation, locally unmineralized. Some gossan, however, is present on one of the dumps.
On the second claim, which lies east of the first, the vein is not exposed, but appears to parallel the one on the other claim.

OTHER PROPERTIES IN SLAUGHTERHOUSE GULCH

The names of several old properties in Slaughterhouse Gulch were not learned. One of these is just west of and above the Petrel. The lower tunnel is caved but the upper one is open for a distance. The fracture explored by the tunnel apparently strikes N. 80° E. and dips 37° SW. The disturbed zone, which is as much as 5 feet wide, cuts the bedding of the Milligen shales at a small angle. Some of the fractures contain thin seams of limonitic material.

Another property is on the north side of Slaughterhouse Gulch about 3 miles northeast of Bellevue. The workings consist of half a dozen caved tunnels on the northeast side of a ridge along and just under the crest, and one tunnel on the northwest side, all about 200 feet above the bottom of Slaughterhouse Gulch.

The tunnels are along a rather flat fracture zone which strikes about N. 8° W. and dips 35° W., apparently about parallel to the strike and dip of the grayish Milligen shales. Where exposed, the fracture zone is about 3 feet wide and contains minor amounts of oxidized material, including some greenish scorodite. The scorodite indicates the presence of some primary arsenic mineral, probably arsenopyrite.

Still another property is on the north side of Slaughterhouse Gulch about a mile northeast of Bellevue. The development consists of two tunnels, one at road level, the other about 100 feet above. There are also a number of cuts above and beyond the upper tunnel. Only the lower tunnel is open.

The upper tunnel started along a fissure zone 2 to 3 feet wide, which, in the cuts above, strikes about N. 30° E. and dips 45° - 50° NW. In one of the cuts the fissure zone appears to be joined by a branch which has a 50° - 70° SE. dip. The lower tunnel is along a weak zone of fracturing that strikes N. 8° - 15° W. and dips 25° W. It reveals 6 to 8 feet of laminated rock. The fracture zone exposed in the tunnel and in the cuts contains scattered bunches of quartz but little limonitic material.

BETTY JEAN

The Betty Jean is about 3 miles northeast of Hatley on a tributary of Quigley Creek just off the edge of the map. The property received some attention in the past, but little serious attempt was made to develop the property until the late war, when a short switchback road was built-down to the mine about 200 feet above the gulch bottom, an ore bin was installed, and some of the numerous cuts and short, closely spaced tunnels were partly re-equipped.

These shallow workings are along a zone of considerably fractured rock in the Wood River formation, which locally has been brought against the Milligen formation by faulting. This zone is about 20 feet wide and strikes about N. 30° - 40° E. and dips about 30° NW., with some fractures dipping as steeply as 75° NW. Some of the more prominent fractures contain thin seams of galena; otherwise there is not much evidence of movement along the fracture zone. Much of the mineralization appears to be concentrated in a band about 3 feet wide, with the ore consisting mostly of limonitic material, locally with scattered small residual grains of fine-grained galena.

CLEARWATER AND WOLVERINE

The Clearwater and Wolverine is on the southeast side of Quigley Creek about 6 miles from Hatley and outside the boundary of the map. The principal work is about 200 feet above the creek and consists of a 110-foot tunnel. Some ore is piled near the portal and in the bin, but little, if any ore has been shipped.

The tunnel follows along a zone of complexly fractured and brecciated sandstone belonging to the Wood River formation. The zone, which trends about N. 55° W., has a pronounced footwall, which dips about 30° SW., but the hanging wall is not sharply defined. The fracture zone may be traced for several hundred yards with exposures high on the ridge to the southeast and apparently also on the ridge slope northwest of Quigley Creek. The fracture zone appears to be quite continuous but is offset a few inches by a fault of N. 65° NE. strike and 65° NW. dip, exposed in the face of the tunnel.

The fracture zone is more or less persistent and locally mineralized and locally the mineralization extends out as much as 10 feet from the footwall, mostly as seams and stringers of quartz along fractures and locally as massive and drusy fillings of breccias. Here and there the quartz is accompanied by small bunches and thin discontinuous seams and irregular veinslets of galena.

QUIGLEY

The Quigley is along Quigley Creek a little over 6 miles from Hatley and just short of the Clearwater and Wolverine. The property has four or five tunnels, two northwest of the creek (both open) and the rest on the southeast side, the lowest of which is mapped (Fig. 13). The other tunnels are caved.

The Quigley deposit is much like the one
Fig. 15 Geologic sketch map of the open tunnel at the Quigley mine
on the adjoining property in its structural relations and filling. The two lodes are parallel and about 150 yards apart. The Quitley is marked by an outcrop of massive quartz more than 10 feet and perhaps as much as 20 feet wide, including horses of country rock, of Wood River sandstone.

The lode, however, has a lenticular habit, but is as much as 10 feet wide in the lower tunnel (Fig. 15). Much of the quartz is in the hanging wall of the fracture zone, but some stringers extend locally into the footwall. Quartz is plentiful but sulfides are hard to find. Small patches of iron oxides and a little residual galena appear in the big cropping. Structural and other characteristics of the deposit are shown in Figure 15.

The tunnel rather high on the slope across the creek passes through what may be the extension of the Clearwater and Wolverine vein, which locally forms a dip slope along a tributary gulch of Quitley Creek. Most of the work in the tunnel is in the footwall of the vein, in part some distance from the vein. The tunnel was driven N. 25° W. for 60 feet but at 42 feet a drift was carried S. 60° E. for about 108 feet. This drift has exposed widely scattered stringers of quartz in somewhat fractured rock.

The other tunnel on the northwest side of the creek immediately behind the cabin is about 60 feet long and uncovers a little quartz in the tunnel face.
The Geology and Ore Deposits of the
Triumph-Parker Mine Mineral Belt

by

THOR H. KILSGAARD

ABSTRACT

The Triumph-Parker mine mineral belt is
underlain primarily by the Milligen formation
of Mississippian age. This formation consists of
argillites, limestones, and quartzites, and
their various gradational facies. Thrust rem-
nants of Wood River formation (Pennsylvanian)
cap some of the higher ridges and hilltops in
the area. Along the western border, the Milli-
gen formation is overlain by a series of vol-
canics, and interbedded sands, tuffs, and grav-
els. Intrusive dikes, chiefly andesitic, crop out
throughout the district, and are particularly evi-
dent in some of the major shear zones.

A series of major shear zones, most of
which strike west-northwest and dip at mod-
erate angles to the southwest, occur through-
out the area. Many of these have been in-
vaded by mineralizing solutions which have
created ore bodies. The ore bodies are of two
types: (1) fissure fillings; and (2) replacement
bodies originating from replacement of suscep-
tible limestones. The ores are of value pri-
marily because of their lead, zinc, and silver
content, although some gold and copper is also
present.

The district has been intermittently produc-
tive since the eighteen eighties with the Tri-
umph, North Star, Independence, and Parker
mines being the chief contributors.

Although past mining operations have bot-
tomed many of the ore shoots at comparatively
shallow depths, there is reason to believe that
ore should continue below the present lower
mining levels.

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conducting the writer through the Deer Creek
area.

LOCATION AND ACCESSIBILITY

The Triumph-Parker mine mineral belt is
in the Warm Springs Mining District, Blaine
County, Idaho. It is roughly five miles east of
U.S. Highway 93, between Hailey and Ketch-
um, and extends from the East Fork of the
Wood River about three and one-half miles
northwest to Parker Gulch (Fig. 1). The Tri-
umph mine is located in the southeastern part
of the area, twelve and one-half miles north of
Hailey. A secondary road leads from the Tri-
umph northwest to the Independence mine and
then down Independence Gulch to its junction
with Elkhorn Gulch. The road continues to the
west and intersects U.S. Highway 93 one mile
south of Ketchum. This road, or branches there-
from, leads to most of the mining properties in
the district. It is accessible only during the
summer months and even then steep grades
make passage difficult.

TOPOGRAPHY

The Triumph-Parker mine region is typical
of the semi-arid and mountainous topography
in that section of Idaho. Elevations range from
5800 feet to 8000 feet above sea level. The more
prominent valleys have a graded floors, some
with distinct alluvial terraces. Many of the
tributary valleys are occupied by intermittent
streams and are to be viewed more as gullies
than valleys. For the most part, they are wall-
ed by steep slopes which rise rapidly to narrow
inter-stream ridges. The similarity in the south-
west trend of some of the gullies suggests their
control by a major fault pattern, however, such
cannot be substantiated by field studies.

GEOLOGY

The sedimentary rocks of the region have
been classified by U.S.G.S. Bulletin 814 as
being members of the Milligen and Wood Riv-
er formations, of Mississippian and Pennsyl-
vanian age, respectively (1, pp. 25-34). There
are also gravels and interbedded sandy tuffs
of early Tertiary age, terrace gravels, and re-
cent stream alluvium. Igneous rocks include
extensive andesitic flows and several varieties
of dikes.

CARBONIFEROUS SEDIMENTARY ROCKS

Milligen Formation (Mississippian)

Distribution and lithology.—The dark, fine-
grained, argillaceous rocks that crop out in a
broad northwest-trending belt across the east-
ern part of the area are members of the Milli-
gen formation (Fig. 18). They take their name
from the type section exposed along Milligen
Creek, which empties into the East Fork of the
Wood River about one-half mile east of the
Triumph mine. This formation, which is the
host rock for all the ore deposits in the Tri-
umph-Parker mine area, has a regional north-
west strike and southwest dip.

The absence of horizon markers, and the
abundance of local crumbling and faulting,
makes it difficult to measure the formation
thickness. A measured section in Parker Gulch
showed a thickness greater than 7500 feet; how-
ever, this measurement may be in error,
because of the possible repetition of beds. Cer-
tainly, the formation thickness is more than
5,500 feet.

The Milligen formation is composed main-
lly of black carbonaceous argillite, the product
of mild regional metamorphism. Perhaps the
most noticeable feature of the formation is the
abundance of carbonaceous material, particu-
larly the graphitic films on cleavage and frac-
ture surfaces. Often, where mine workings
have penetrated rocks rich in graphite, the
mine dumps resemble piles of coal. Other dis-
tinguishable lithologic units present are quartz-
tic beds, limy members, and at the base, a
series of brown sandy shales. Gradations from
one rock type to another are present through-
out the formation.

In certain areas metamorphism of the Milli-
gen formation is more pronounced. Tactite,
formed by contact metamorphism of limestone
beds, is present near the mouth of Parker
Gulch. On the western side of Independence
hill, on Telephone Peak, and at other points,
some limestone and limy argillites have been
altered to a whitish lime-silicate rock composed
of accicular tremolite crystals and other lime-
silicate minerals. A spotted argillite member,
the product of incipient metamorphism, crops
out in a road-cut between Chicago Gulch and
the Independence Mine.

Although there are no dependable horizon
markers in the Milligen formation, two lime-
stone beds are recognized in the Triumph mine
area and are thought to continue northwest be-
yond Parker Gulch. There are other less read-
ily recognizable limestones between Independ-
ence Gulch and the area northwest of Parker
Gulch. These limestones, while persistent in
attitude, are locally concealed by surface mant-
tle and elsewhere appear to lens out or to be
faulted. Inasmuch as the intersection of min-
eralized structures and limy members often
controls the location of replaced ore bodies in
the Triumph-Parker mine area, an attempt was
made to map the limestones and to observe
their condition where cut by faults. (Fig. 18)

The Upper limestone crops out on the ridge
about 400 feet west of the portal of the Lucky
Coin mine. The bed is about 75 feet thick
strikes N. 64° W. and dips 55° SW. To the
northwest, across Independence Gulch, and t.
the southeast near Chicago Gulch, it passes be-
neath andesite. It is a dark blue, fine-grained
rock that weather light gray. The more weather-
ered surfaces are covered with blades and
sheath-like aggregates of amphibole crystals,
probably tremolite. The member is penetrated
by the Lucky Coin tunnel.

The Middle limestone member is best ex-
posed in Independence Gulch northwest of the
Lucky Coin portal. It is a rather massive blue-
gray limestone with a rough appearance on the
more weathered surfaces. It tends to be a
bluff-maker, as evidenced in Chicago Gulch.
In Keystone Gulch this member is 55 feet thick
but appears thicker in Independence Gulch,
owing to a dip slope. The Middle limestone
may be traced to the ridge northwest of Parker
Gulch where it is overturned and appears to
lens out. To the southeast, it passes beneath
hillwash from Independence hill. This lime-
stone is believed to continue beneath the hill-
wash and andesite cap and reappear near the
head of Triumph Gulch from where it continues
to the southeast across the Triumph hold-
ings. It is described in the section on the Tri-
umph mine as the Upper tremolite limestone.

The Lower limestone is separated from the
Middle limestone by 150-200 feet of argillite.
It crops out in the road cut between the Tri-
umph and Independence mine, and at the
mouth of Chicago Gulch where it strikes N. 50°
W. and dips 44° SW. About 150 feet above
the Triumph-Independence road the limestone
terminates abruptly against what may be a
fault, but which cannot be confirmed because
of heavy surface mantle. Further to the south-
east, in Rose Gulch, a limestone with similar
characteristics reappears. This limestone is be-
lieved to be the southeast continuation of the
Lower limestone and is discussed in the section on the Triumph mine under the title of Lower tremolite limestone. The Lower limestone may be traced northwest with the dip gradually becoming steeper. On Elkorn ridge the beds are vertical and in Parker Gulch the dip is overturned to the northeast. The Lower limestones are exposed in the June Day area, where an appreciable ore body is formed at its intersection with the June Day fault. The rock is described in the section on the June Day mine.

The Elkorn limestones underlie the Lower limestone, separated by several hundred feet of argillite. They crop out across the ridge near the old Elkorn diggings, but appear to lens out to the southeast on Baltimore ridge. To the northwest, in the Bald Eagle area, the Elkorn limestones have been strongly affected by fault action.

These portions of Fig. 16, mapped as underunmetamorphosed Milligen, are argillites, gradations of limy and siliceous argillites, and quartzites, with boundaries too indefinite for accurate field mapping. By far the most abundant of these rock types are the argillites, which, where relatively unmetamorphosed, grade imperceptibly into shales. The attitude of the argillite members is often strongly contorted, particularly where they are interbedded between more competent members such as limestones and quartzites. North Star Peak in particular, the argillites are easily deformed by stress they are usually the sites of strongly contorted areas and of the larger faults or shear zones, particularly those which have resulted from compressive stress.

Wood River Formation (Pennsylvanian)

The Wood River formation is described in U.S. Geol. Survey Bulletin 814, p. 34, as being Pennsylvanian in age. A large block of the formation occurs in the southern part of the Triumph-Parker mine area, but the described outcrops are thrust remnants that cap North Star Peak, Grouse Peak, and the ridge above the Baltimore mine. Wood River outciders are separated from the underlying Milligen formation by a low angle thrust fault that is inclined to the southwest. The thrust fault is characterized by a brecciated and re-cemented zone, which, owing to its resistance to erosion, often stands out in relief.

Lithology.—The most recognizable lithologic units of the Wood River formation includes blue-gray sandy limestones, gray quartzites, and fine-grained siliceous limestones. In general, the formation members are lighter colored, more calcareous and more massive and bluff-forming than the underlying Milligen members; however, there are exceptions. No identifiable fossils were found in the formation, but Merriman (10), in describing the Wood River exposed on North Star Peak, points to fossils of an indeterminate character occurring in a medium to coarse-grained crinoidal limestone. These include products, stony bryozoans, tabulate corals, and probable fusulinds.

There is no evidence of sulphide mineralization in any of the Wood River formation outciders in the Triumph-Parker area. On North Star Peak a blue-gray limestone is cut by numerous quartz and calcite stringers, but there appears to be no evidence of accompanying sulphide mineralization.

TERTIARY SEDIMENTARY ROCKS

Gravels and Tuffs

A northwest-southeast trending belt of pebbly gravels, sands, and interbedded tuffs occurs east of the mouth of Keystone Gulch. These sediments underlie the large exposure of andesitic lava that crops out south of Independence Gulch. (Fig. 16.) To the northwest, beyond the mapped limit, the pebbly gravels overlie a lava flow. The sediments are composed chiefly of surrounding lava and quartzite pebbles, although fragments of argillite, sandstone, and siliceous limestone are common. Pebbles range in size from three-eighths of an inch to two and one-half inches, in the long dimension. They are water sorted and locally interbedded with more sandy layers. Some light-brown, banded, tuffaceous deposits occur in the southern part of the area. The laminae vary in thickness, with an average of about one-tenth of an inch. The tuffs are probably products of volcanic explosions and the fact that they are now contaminate with more sandy aggregates is indicative of fluvial deposition.

Inasmuch as these sediments are interbedded with lava flows, they are thought to be of the same age as those flows. This age is probably Miocene (?), pp. 53-56.

Terrace Gravels and Alluvium

The Terrace gravels along the East Fork of the Wood River, and the alluvial debris along all of the streams are the products of relatively recent erosion. The alluvial matter is derived from all of the rocks in the vicinity and ranges in size from silt to boulders several feet in diameter. It is probable that some of the higher terraces, composed of boulders, coarse cobbles, and gravel, have originated from outwash of alpine glaciers present in the higher mountains during Pleistocene time.
IGNEOUS ROCKS

Volcanic Rocks

Andesitic Flows.—Andesitic flows cover much of the central portion of the area, especially south of Independence Gulch. The major part of these flows is hornblende andesite. Other varieties of lava were recognized but no attempt was made to differentiate them into mappable units. The andesite rock has a dark greenish-gray color on fresh fractured surfaces, and plainly discernible plagioclase phenocrysts. The greenish color of the rock matrix results from an abundance of chlorite. The rock weathers to a rusty-brown color.

The flow capping Porphyry Peak, east of Independence Gulch, is a greenish-black, porphyritic augite andesite. Similar remnants cap ridges and peaks, at nearly the same altitudes, to the northwest and northeast.

The irregular eastern contact of the andesitic flows resting unconformably on the underlying Milligen formation, suggests that the lava was poured over an uneven surface, probably a low-lying area or valley with its attending foothills. The long spur-ridge of Milligen that penetrates the lava adjacent to Elkhorn Gulch, indicates that the old land surface, in that area, had a gentle dip to the southwest.

Intrusive Rocks

Dikes.—All intrusives noted in the area are described as dikes, although many are more like sills, lying almost in the bedding of the enclosing host rock. For the most part they are andesitic in composition, although a hornblende-granite dike crops out on the Bald Eagle property, and basic lamprophyre dikes are common throughout. The dikes vary in thickness from a few inches to over 15 feet, and have short strike lengths, lensing out at the ends. The general strike is northwest and the dip is to the southwest at varying angles; there are several exceptions. They are chiefly confined to thin-bedded argillaceous members of the Milligen formation, although andesitic dikes crop out in the more competent Wood River rocks above the Baltimore mine. At the outcrop, the more acidic porphyritic dikes usually weather to shades of greenish gray in which the light gray outlines of the plagioclase phenocrysts are plainly visible. These plagioclase phenocrysts commonly measure up to three-eighths of an inch in length. The black, aphanitic, lamprophyre dikes are usually fresher and less affected by alteration.

Underground, light colored andesite porphyry dikes are common in the larger shear zones, although occasionally they wander off into the walls in relatively unfractured rocks, as in the Bonanza tunnel of the Baltimore mine.

In the shear zones dikes are often crushed and hydrothermally altered to a whitish gouge-like material, much the same as some types of fault gouge. It is evident that during intrusion the magmatic material followed shear zones and was transformed by subsequent fault adjustment. In their crushed condition they were more easily altered by migrating solutions. Those dikes away from the shear zones are less altered.

Inasmuch as the dikes are common in shear zones they are often contiguous to ore bodies, and have even been found partially replaced by sulphides, as in the Bald Eagle mine and in parts of the Triumph mine. For this reason early mine operators commonly drilled on the dikes, thinking they were responsible for the mineralized deposits. The fact is, however, that in those exposures accessible to observation, the dikes are pre-mineral, and are associated with ore bodies only in that both have favored the more permeable pre-dike and pre-mineral shear zones as sites of deposition. In this respect the dikes are comparable with those occurring in the Milligen formation in other areas (11, p. 12).

STRUCTURE

Folding

The Milligen formation is strongly folded and faulted in the Triumph-Parker mine area, but generally strikes to the northwest and dips to the southwest. At the mouth of Parker Gulch the dip has been overturned to the northeast. Throughout the area the formation appears to be the limb segment of a broad, regional, open fold; in many respects it resembles a southwest-tilted homoclinal block. An interesting feature of the formation is that only the more competent rocks, limestones, quartizes, and some limy argillites are persistent in attitude. The pliant, incompetent argillites interbedded between have been intensely crumpled and distorted by differential movement, having yielded more readily to deformational stress. In places stress has deformed the argillites beyond their elastic limit, resulting in rupture. This action has emplaced most of the shear zones so common in the argillitic members, particularly those striking northwest and dipping southwest. Such shear zones commonly grade into regions of tight folding and crumpling, both on the strike and dip, with no apparent fracturing. A structure passing into such a crumpled area is difficult to follow in underground exploration, and, on occasion, has been lost completely.

The folded Wood River formation remnants, separated from the Milligen by a thrust fault, indicate that major folding was post-Pennsylvanian. It is probable that folding preceded thrust faulting, though both actions
could have occurred somewhat simultaneously. In the U. S. Geol. Survey Bull. 814, it is suggested that the major period of deformation be correlated with the Laramide orogeny which came near the end of the Mesozoic era.

Faulting

**Thrust faulting.** — On North Star and Grouse Peaks, and on the ridge above the Baltimore mine, a major pre-mineral thrust fault separates the Wood River from the Milligen formation. On Baltimore ridge, the fault is marked by a brecciated and re-cemented zone which is at least 15 feet thick near the portal of the No. 2 tunnel. The fault plane is tilted about 9 degrees to the southwest. On North Star Peak, Merritt (10) describes the tilt as about 17 degrees to the west. Breccia fragments comprising the zone range in size from microscopic to those an inch in length. They consist of black chert, quartzite, and siliceous limestone, embedded in a siliceous groundmass. The breccia fragments show a distinct orientation with the long dimension roughly aligned in the plane of thrusting. The thrust zone of the above mentioned fault outliers is comparable in all respects with the one existing near the mouth of Decker Gulch, as described in Bull. 814, and is probably closely related, if not the same.

The tilt of the thrust plane suggests that movement was from southwest to northeast. Thrusting probably originated from compressive stresses from the southwest, active during late folding of the carboniferous sediments.

**Reverse faulting.** — Reverse faulting, though analogous to thrusting, is herein confined in description to shear zones of a somewhat steeper dip and less regional in extent. Those of chief importance include the Triumph, North Star, Independence, Baltimore, Amicus, Quaker City, and the Parker shear zones. Locally, minor wisps of drag folding in the walls adjacent to the shear zones are indicative of normal fault action; however, this is probably the result of gravitational adjustment at some period after formation of the fault. A major period of oblique, reverse fault movement is suggested by larger drag folds, fault attitudes, and the almost universal existence of a well defined slicken- sided hanging wall, commonly with pronounced mullion structure. Hershey (1, p. 178) describes the Independence lode as being on a reverse fault, and bases his conclusions on local stratigraphy. Merritt (10) advances the theory that the principal component of movement along the North Star and Triumph fissures has been of a reverse dip-slip nature. The major reverse faults, for the most part, strike in a west-northwest direction and dip moderately to the southwest, usually at angles less than the southwest dipping bedding of the host rock. They are pre-mineral faults that probably originated from the same compressive stress that gave rise to the above-mentioned thrust fault. They favor the incompetent argillites as host rocks and frequently merge into zones of tight and crumpled folding. Ore found within these zones of shearing is often broken and intermingled with fault gouge, although nowhere is there evidence of major post-mineral displacement within the plane of reverse faulting. It is believed that where post-mineral fracturing does occur, in the plane of shearing, that it is only a minor structural readjustment.

In addition to those reverse faults mentioned above there are others that are more properly described as flat faults. These are observed in many mine workings but not in enough detail for accurate description. In the Triumph mine a set of pre-mineral flat faults are tilted in a westerly direction, which would suggest that they too are allied with a compressive stress acting from the southwest.

**Normal faulting.** — There appears to be several patterns of normal faults in the area. Both pre- and post-mineral, some of which cannot be described from the data on hand.

A pattern of pre-mineral normal faults, striking northeast and dipping steeply southeast occurs in upper Parker Gulch. (Fig. 16.) Maximum displacement measured in this fault pattern was about 350 feet, apparently with the hanging wall being displaced to the southwest. Whether this fault pattern had any effect upon the mineralized Parker and Amicus veins is not known.

The June Day fault, Fig. 21, strikes northwest and dips northeast. It appears to be a pre-mineral normal fault, but its displacement was not determined.

There are other faults, most of which strike in a northerly or northeasterly direction, about which little is known. They commonly offset lithologic members but are either concealed by debris or too indefinite to map. It is believed that pre-mineral normal faults are associated in some way with stress that emplaced the thrust and reverse faults, though such a postulation cannot be proved. One possibility is that they have resulted from lateral stress developed during thrusting movement. This could account for their near-normal strikes to the strikes of the major reverse faults.

**Post-Mineral Normal faults.** — Throughout the area there is a pattern of post-mineral normal faults striking to the north and northeast, and dipping northwest and north. Some of
these faults offset mineralized structures. The best example of this type of faulting occurs in the western portion of the 700-level of the Triumph mine. Another example is the North fault which exposed in the Bonanza tunnel in the Baltimore mine. (Fig. 20.)

There are undoubtedly many faults in the Triumph-Parker mine area that have not been recognized. The absence of reliable horizon markers and occurrence of heavy surface mantle interferes with interpretation, not only of folded structure, but of faulting as well. For this reason no attempt was made to map faults inferred by topography or by drainage patterns.

The existence of many of the inferred normal faults, postulated in Bull. 814, p. 70, is doubted. An example of such an inferred fault is the normal fault a few hundred feet west of the Lucky Coin portal, which reputedly separates the Milligen formation from endoskeletal flows. Recent mining exploration has failed to confirm this fault. The Lucky Coin tunnel penetrates the Milligen-endoskeletal contact, but shows no evidence of fault separation. Furthermore, at the tunnel contact, limestone fragments from the Milligen formation have a weathered appearance, similar to those now existing at the contacts. Such an underground rock condition suggests an ancient land surface that was later covered with lava. The 700-level of the Triumph mine also penetrates endoskeletal flows with no indication of a fault contact.

ORE DEPOSITS

Classification of the Deposits

The ore deposits of the Triumph-Parker mineral belt fall into two groups: (1) mineralized fissures or shear zones, most of which strike in a west-northwest direction and dip to the southwest at moderate angles usually 30-35 degrees; (2) replacement deposits occurring at the intersection of mineralized shear zones and susceptible limestone members. Both types are found only in the Milligen formation.

Included in the first group are the deposits worked in the Triumph, North Star, Independence, Baltimore, Parker, Lucky G. L., and possibly Elkhorn mines. The second group includes the bedded siliciclastic and "complex" ore of the Triumph and North Star, and deposits in the June Day, and part of the Bald Eagle. In addition to these, part of the ore mined in the mineralized shear zones occurs as a replacement of scattered calcareous material, and not as fissure filling.

In general, ore throughout the district has similar characteristics. It is of value primarily because of its lead, zinc, and silver content, although there are exceptions. Fissure ore in the Triumph mine is higher in gold values than are the replacement deposits. The "complex" ore at the Triumph consists of galena and sphalerite in a pyritic gangue; there is little quartz or siderite present. The replaced ore at the June Day is largely gold, with little galena or sphalerite present.

Deposits in Shear Zones

The mineralized shear zones form the most common ore deposits in the district. For the most part, they are west-northwest striking, southwest dipping, pre-mineral reverse faults, some of which may be traced at the outcrop by vegetation markings. They favor the more incompetent argillitic members, probably because these rocks yielded more readily to stress than the more competent quartzites and limestones. The shear zones range in thickness from a few inches to over 40 feet. In places they consist of a few scours or graphitic-faced fractures, elsewhere they broaden into heavy shear zones composed of a multitude of close-spaced slickensided slips. Such zones occasionally grade into highly crumpled and fractured areas in which trace of the shear zone is difficult to follow, and may even be lost. Ore and gangue minerals are unequally distributed along the zones of shearing. They commonly occur as pods and lens-like agglomerates or as streaks and stringers intermingled with fault gouge. Occasionally the ore is massive, but is more likely to be somewhat granulated, possibly owing to post-mineral movement in the fissure. Ore is often contiguous to igneous dikes in the shear zones, and, on occasion, has replaced dike material.

The shear zones are not simple planes but show sinuous surfaces and many irregularities. It is evident that during the time of mineralization the greater part of the individual shear zones, being heavy with gouge and sheared material, were too tightly compressed and impermeable to permit entry of the mineralizing solutions. Only in the more open areas, or those irregular sections reopened by recurrent fault action, were there sites available for mineral deposition. Such fault action has accounted for a large part of the stringers and discontinuous lens-like ore shoots commonly found. In some calcareous sections of the shear zones mineralizing solutions replaced the limy substance thus forming deposits in part fissure filling and in part replacement.

Some ore shoots occur where shear zones truncate the bedding of thinly-laminated argillites. In these areas slippage along the shear zone apparently produced torsional stress which parted the adjacent bedding planes, thus
creating sites for mineral deposition. In such areas ore appears to leave the fissure and curve into the bedding as wisps and irregular veinlets, extending only a few inches or feet. Such ore formed chiefly as void-fillings; there is little evidence of replacement of the more impermeable argillite. Ore shoots of this general type are mentioned by Merriam (10) as occurring in the Triumph mine. This type also occurs in the Amicus vein, in the Quaker City workings, and probably in the ore shoot near the face of the No. 6 level of the Baltimore mine and extending upward.

The principal gangue minerals of the shear-zone deposits are altered wall rock, quartz, calcite, and siderite. In some cases pyrite is an important gangue mineral. Important metallic minerals include galena, sphalerite, tetrahedrite, and ruby silver. The Triumph vein also contains appreciable gold. Quartz and calcite appear to have been the first minerals deposited, followed by sphalerite, galena, and tetrahedrite in that order. Ruby silver ores have been among the latest deposited. Judging from the brecciated and cross-cutting relationships, ore deposition was not continuous but was recurrent. In some instances younger sulphides appear to have replaced older sulphides. Illustrative examples are lenses and pods of lead ore that thin out on the ends to zinc ore. Such lenses were probably originally filled with sphalerite, only to be brecciated by recurrent faulting and replaced by later galena.

There is no evidence of mineral zoning in the shear-zone deposits, nor can any ratio be fixed on the lead-zinc-silver values. At some spots the ore shoots may be high in zinc values, elsewhere they run more to lead and silver.

Replacement Deposits

Replacement deposits occur in limestone members that have been intersected by certain shear zones. The shear zones have provided avenues of approach for invading mineralizers, which, upon encountering susceptible limy members, have diffused into the rocks, deposited their mineral load and carried the replaced limestone away in solution. This type of mineral deposition has locally built up large irregular deposits with ore values gradually fading away from the shear zone. An example is the stope deposit in the June Day fault hangingwall on the No. 3 level of the June Day mine. Recognition of the replaced deposit is often aided by preservation of textures and structures of the original limestone. This is particularly true of the bedded siliceous deposits in the Triumph mine where host-rock bedding is plainly evident.

The bedded siliceous and "complex" ores of the Triumph and North Star mines form the largest of the known replacement deposits. In the past "complex" ore accounted for the bulk of Triumph production. One ore shoot of "complex" is described by Merriam (10) as: "... on an area roughly 700 feet wide by 170 feet long with a thickness varying from six feet in the upper part to fifty feet below."

The "complex" developed as a replacement of the Lower tremolite limestone of the Milligen formation. (See Triumph mine description.) "Complex" ores are rich in sphalerite and carry appreciable amounts of galena and tetrahedrite. They are notable for the minimum amounts of quartz and siderite in the gangue and the abundance of pyrite.

In U.S. Geol. Survey Bull. 814, the ore deposits of the June Day and Bald Eagle mines are described as contact-metamorphic in origin. However, in the light of recent work it appears more probable that the ore minerals in these deposits were introduced after metamorphism of the host rock, and that they are replacement deposits in which metamorphism and ore deposition were in no way connected. In all probability, the late sillimanite-gneisses have undergone contact metamorphism of the original limestone and argillitic members; however, the ore deposits show a later fault control. In those cases studied, faulting has offset the metamorphic contact, and in some cases faulted ore bodies appear to be truncated. (Figs. 21-25.) It is believed that in the June Day mine, the June Day fault provided access to mineralizers which entered into the hangingwall and replaced the metamorphosed limy members thus creating irregular ore bodies gradually decreasing in content away from the fault.

In Bald Eagle mine a younger hornblende-granite dike cuts the metamorphosed limy members. In places the dike has been replaced by sulphides, chiefly chalcopyrite, suggesting that mineralization is appreciably younger than metamorphism of the host rock.

The important metallic minerals in replacement deposits include sphalerite, galena, tetrahedrite, and chalcopyrite. The latter mineral is of greatest importance at the Bald Eagle mine. At the June Day mine free gold is the more important mineral, though sphalerite is dominant in the upper levels.

Genesis of the Ore Deposits

The origin of the ores in this area is somewhat debatable. Former writers (1, pp. 101 and 10) who have studied the district, note that major mineralization is related to the Idaho batholith and its satellites, and to orogenic distur-
ances that accompanied its replacement, probably in late Jurassic or Cretaceous time. They point to crossings of granitic rocks in nearby areas and call attention to the partially metamorphosed condition of the Milligen formation, suggesting that it is underlain at no great depth by plutonics. On the other hand, there are those who recognize the oreogenic disturbances that accompanied intrusion of the batholith but who believe the area to be genetically related to younger period of Tertiary igneous activity (6). Perhaps a closer appraisal as to the origin of the ores may be found in a study of the amesitic dikes so common in mineralized shear zones. The altered and occasionally replaced condition of these dikes implies that many of them are pre-mineral in age. Furthermore, the fact that similar amesitic dikes are found cutting the granitic rocks west of Bellevue, presumably related to the Idaho batholith, implies a younger age for dike intrusion. Although no dike and volcanic flow contacts were found, U. S. Geol. Survey Bull. 814, p. 61, mentions occurrences of volcanic flows covering truncated porphyritic dikes, which leads one to believe that the dikes and accompanying or subsequent mineralization are pre-volcanic in age. This would place their age as post-batholithic and pre-volcanic, or early Tertiary.

Groundwork for mineralization apparently was laid during the oreogenic disturbance that folded and faulted the carboniferous sediments, probably in Jurassic or Cretaceous time. The major fault patterns were formed at this time. At a later date these shear zones were invaded by igneous dikes, which offers evidence that these shear zones are of major extent and had access to magmatic masses below. Recurrent faulting in the shear zones followed, and may have been concurrent with dike invasion, as testified by the sheared and granulated condition of so many of the dikes.

It is probable that mineralizing solutions, ascending from underlying metamorphic bodies, found a means of access along the shear zones during this later stage of fault adjustment. As these solutions ascended and found favorable sites for deposition, they deposited their mineral load as fissure filling and as replacement of certain susceptible limestones encountered both within and adjacent to the shear zone. Textures and mineral associations suggest that the zone of deposition was only moderately deep. Fault adjustment was probably continuous throughout the period of mineralization, inasmuch as a static faulting condition would have become choked and impervious to mineral deposition. The brecciated and granulat ed condition of the earlier deposited minerals, i.e., quartz, pyrite, sphalerite, and galena, tends to confirm this observation. It is believed that the inter- and post-mineral fault adjustments in the major shear zones have been minor, and have not displaced the ore bodies to any great extent.

There is no appreciable oxidation zone in the Triumph-Parker mine area. Occasional traces of secondary lead ores are found in mine workings near the surface; however, there are no instances of ore deposits being enriched by descending secondary mineralization. Absence of an extensive oxidized zone suggests that erosion of the overlying rock has been rapid enough to keep abreast of oxidation.

CONCLUSIONS

It is believed that the ore bodies of the Triumph-Parker mine mineral belt should continue below the lowest depths yet reached by mining. The deposits are of a moderately deep seated character and would be expected to continue on to greater depths. Ore bodies should occur in the mineralized shear zones in those areas that were accessible to mineralizers during the period of sulphide mineralization. These depositional zones will be found only by continued exploration. There is no evidence of a major fault pattern which might cut off the deposits with depth.

It is suggested that in any future exploration of the mineralized shear zones, that they be closely followed. Too many past exploration programs have attempted to gain "backs" by driving lower crosscut workings. Often, in doing so, they have completely lost the sought-after structure. In disturbed and contorted rocks, such as the Milligen formation, projection of mineralized structure through several hundred feet of unexplored ground is hazardous and is to be avoided whenever possible. Furthermore, to adequately explore these shear zones demands mine workings within the zones of shearing. The scattered and pod-like occurrence of the ore bodies makes it easy to intersect a barren zone with a crosscut, which often tends to discourage further exploration of the sheared area. For the same reason, diamond drilling has often proved valueless not only in that core recovery is difficult in the crumpled Milligen formation, but in that intersected barren parts of the shear zone are uninformative.

MINING PROPERTIES

TRIUMPH MINE

Introduction

The Triumph mine is six and one-half miles northeast of Gimlet siding, on the north side of the East Fork of the Wood River Valley. The mine, which is the principal producer in the Hailey district, is operated by several com-
Fig. 18. Triumph mine. Cross section along C–C', Fig. 17, showing fissure projections. Stopes indicated by dotted lines.

(After Merriam & Bozian, unpublished USGS report, 1942)
bined independent organizations. Its holdings include not only the old Triumph mine, but also the North Star and the Independence, as well as several lesser properties.

Inasmuch as the geology of the Triumph holdings is competently mapped by company personnel, and because the workings are extensive and the geology complex, no attempt was made by the writer to make a detailed geologic study. The surface geology was mapped and some underground workings visited; however, in the following generalized description, the writer leans heavily upon an unpublished U. S. Geological Survey report prepared in Nov., 1942, by C. W. Merriam and C. N. Boston (10). To them goes full recognition for their contributions. Appreciation is also extended to members of the Triumph Mining Company staff for their courteous and helpful advice.

History and Production

The Triumph was worked in the eighties, but hardly advanced beyond the prospect stage. It did not become a producer until it was reopened in 1927. The production records for the period 1927-1935 are not available, but the following statement by the company gives the production from 1936-1948.

Production from the Triumph Mine

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<th>Dry Tons</th>
<th>Value Per Ton</th>
<th>Net Smelter Return</th>
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<td>107,658</td>
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<td>105,916</td>
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<td>$809,280.13</td>
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<td><strong>$8,10</strong></td>
<td><strong>$3,315,976.31</strong></td>
</tr>
</tbody>
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*Average.

Tonnage and Assay Values from the Triumph Mine

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<th>Ag. oz.</th>
<th>Pb. %</th>
<th>Zn. %</th>
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<td>1943</td>
<td>108,751</td>
<td>0.10</td>
<td>7.49</td>
<td>4.00</td>
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<tr>
<td>1944</td>
<td>108,465</td>
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<td>3.55</td>
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<td>1945</td>
<td>92,067</td>
<td>0.11</td>
<td>6.12</td>
<td>3.04</td>
<td>4.34</td>
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<td>1946</td>
<td>64,211</td>
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<tr>
<td>1947</td>
<td>52,093</td>
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<td>4.08</td>
<td>6.10</td>
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<tr>
<td>1948</td>
<td>35,552</td>
<td>0.10</td>
<td>9.02</td>
<td>4.15</td>
<td>5.60</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>655,935</strong></td>
<td><strong>0.071</strong></td>
<td><strong>7.80</strong></td>
<td><strong>4.02</strong></td>
<td><strong>6.57</strong></td>
</tr>
</tbody>
</table>

Grand Total 1,065,383 dry tons production.

During the early years most of the ore was shipped to the Combined Reduction Company mill at Baker, Utah. In 1942 a 300-ton flotation mill was installed only to be destroyed by fire during the winter of 1947. Since 1947 the ore has been shipped crude to Utah.

Mine Workings

The mine was formerly worked through the Triumph shaft which reached to the 700-foot level. The shaft was a bottleneck to production, and in the early forties a lower-level haulage tunnel was driven some 6500 feet from a point near the North Star mill to intersect the 700-foot level. An inside shaft extends from the 700-foot level to the deeper workings. Recent development work has been more or less concentrated on the Triumph fissure vein in the lower northwestern levels with excellent exposures of high-grade silver-lead ore occurring in an intermediate level below the 900. This is the deepest level in the mine.

Geology

Summary statement. — The Triumph mine is entirely in the Milligen formation. Intrusive, pre-mineral, porphyritic dikes are present both in the mine workings and on the surface. To the northwestern, extrusive andesite has been encountered by a lower exploration tunnel. Several hilltops above the mine are capped by thrust remnants of the Wood River formation.

Milligen formation. — The Milligen formation in this area differs little from that exposed elsewhere. Merriam lists a thickness of roughly 2,000 feet with neither the top nor bottom exposed. He sub-divides the formation as follows:

- Upper argillite .......... 1000 feet
- Upper tremolite limestone 45 feet
- Middle argillite .......... 150 feet
- Lower tremolite limestone 95 feet
- Quartzite member .......... 730 feet (plus)

Total 2020 feet

This correlation of members is difficult to follow in some phases of field mapping and most certainly would be interpreted differently by each successive study. For one thing there are limestone members in the upper argillite, some of which may be mapped separately. Then too, the lower quartzite member is very indefinite. It is often argillite, even limy; in fact, over the whole, it more closely approaches an argillite than a quartzite. Of the members quoted, the Upper and Lower tremolite limestones are the only ones which may, in any sense of the word, be used as marker beds; even these are indefinite.

The Upper tremolite limestone, designated Middle limestone in Fig. 16, is best exposed on the ridge northwest of the Triumph shaft, where it strikes N. 80° W. and dips 31° SW. On the western side of this ridge the outcrop broadens, owing to a dip slope. (Fig. 17.) When traced to the northwest, the member passes beneath
the extrusive andesite. Further to the northwest, near Chicago Gulch, a limestone reappears which has similar attitudes and characteristics. In all probability it is a continuation of the Upper tremolite member. The limestone may be traced southeast from the shaft, passing beneath the North Star Peak Wood River cap, and beyond to a point near the Courier Gulch Schoolhouse where it is overlain by alluvium. It is a dense, fine-grained, bluish-gray limestone with beds varying from an inch to a foot or more in thickness. Tremolite blades and crystals are locally abundant on the more weathered surfaces, but are difficult to recognize underground. Stratigraphically, the Upper tremolite limestone lies well above the Triumph vein. For this reason it is often referred to as the Hanging Wall limestone at the Triumph mine. At the North Star mine, it locally forms the hanging wall of the North Star vein and is thought to have been replaced forming one of the mine's larger bodies of "complex" ore.

The Lower tremolite limestone, designated Lower limestone at the Triumph, is well exposed in the Triumph No. 3 tunnel, and on the ridge point just east of the Triumph shaft. It is a fine-grained, bluish-gray, massive limestone with beds approaching several feet in thickness. It tends to be impure in the upper and lower parts, often containing thin, interbedded argillaceous and siliceous layers. Large well-formed blades of tremolite are conspicuous on more weathered surfaces. The member may be traced southeast from Rose Gulch, immediately east of the Triumph shaft, through Telephone Peak, where it has been altered to an amphibolitic rock, and beyond to where it passes beneath the alluvium east of Courier Gulch Schoolhouse. The limestone does not extend northwest beyond Rose Gulch. Further to the northwest, on the western side of Independence Hill, a limestone stops abruptly against what appears to be a fault. Close examination of the faulted area cannot be made because of mantle. (Fig. 16.) This limestone is 70 feet thick, similar in attitude, and occupies about the same position the Lower tremolite member would if projected along the strike to this area.

The sudden termination of the limestone in Rose Gulch has long puzzled those who have studied it. The difficulty has been explained as a result of faulting, as a lensing out of the limestone, and as a result of folding coupled with erosion. The problem is further complicated by the manner in which the Upper tremolite limestone, lying only 150 feet stratigraphically above, continues on to the northwest with neither thinning nor abrupt termination. (Fig. 17.) The most logical explanation seems to be the result of faulting, as the limestone stops too abruptly to be lensed, and as there is no evidence of major folding either stratigraphically above or below. No fault is visible in Rose Gulch, but on the 750-foot level of the mine, the Footwall fault, thought to be the Triumph fissure, changes in strike more to the northwest, flattens in dip, and cuts the Lower tremolite limestone at an acute angle. Although the Triumph fissure has been drilled on further to the northwest on the 750-foot level, and, on lower levels, the Lower tremolite limestone has not been found in these areas.

Any explanation for the disappearance of the Lower tremolite limestone both below the 750-foot level and northwest of Rose Gulch is speculative and needs more confirming evidence before it can be accepted. It is possible that the footwall fault, having a sinuous course and being evidently reverse, has displaced the limestone leaving the unfaulted segment somewhere to the north and in the footwall of that structure. Such a postulation would need further exploration in the footwall of the fault before it could be confirmed.

The Lower tremolite limestone member is of interest in that at its intersection with the Triumph fissure it has been replaced, giving rise to large bodies of replacement ore ("complex" ore).

There are several types of dike rock present in the mine workings. They are usually light colored, porphyritic, and highly altered. Scattered remnants of dike rock are common in some of the fault zones where they are often so crushed and hydrothermally altered that they resemble fault gouge. The dikes are pre-mineral. In places they have been found replaced by ore minerals, elsewhere they lie adjacent to ore bodies.

Geologic structure.—Fault attitudes, drag folding, warped bedding, and other criteria indicate that most geologic structure in the Triumph area is associated in some way with the compressive stress that thrust the Wood River formation over the Milligen. Such stresses have created the following pre-mineral structures:

1. Vein faults, striking northwesterly and dipping moderately to the southwest. Examples are the North Star and the Triumph fissures.

2. A pattern of flat faults that dip at low angles to the west and northwest.

3. A set of reverse faults which roughly parallel the northwesterly strike of the
bedding and which dip to the south-
east.

In addition to those mentioned above, the usual pattern of minor faults, some of which are well displayed in the west-
ern portion of the 700-foot level. These have a
northeastern strike and dip to the north. In
these cases examined, the displacement is to
the right as the fault is faced, with an average
throw in the neighborhood of 50 to 60 feet.

Although the Triumph and North Star fis-
sures were formerly regarded as parts of the
182). Merrim suggests that these are prob-
ably distinct and separate fissures, differing in
attitude and position, but probably intersecting in
one or more places as above the 800 and
850-foot levels of the Triumph mine. (Fig. 18,
cross section C–C') The Triumph fissure zone
varies in width up to as much as 40 feet. The
North Star fissure, while prominent, is general-
ly believed to be narrower than the Triumph.
Crushing in both fissures is intense with much
fractured argillite and clay-like gouge. In de-
scribing their fault action, Merrim states:

"The principal component of movement
along the shear zone is thought to be reverse
dipslip (reverse faulting) though there is local
evidence of movement in various directions;
some of this movement is clearly post-mineral
and perhaps in part gravitational adjustment."

Mineralization in the pre-mineral flat faults
indicates that they have locally guided ore-
bearing solutions off into the wall rock, thus
confusing the appearance of the Triumph fis-
sure at their junction with that structure. The
occurrence of ore in these fractures and in the
adjacent rock bedding gives the appearance of
a more scattered ore being everywhere but not in
enough quantity to mine profitably.

Merrim notes that minor slips with strike
dip roughly concordant with bedding of the
southwestern dipping Milligen are com-
mon; they often show a thin gouge of calcite
filling.

Ore bodies. — There are two general types
of ore bodies in the Triumph mine: (1) fissure,
and (2) replacement bodies (bedded siliceous
and "complex").

The fissure ores are localized along the
major fissures, which are essentially large
shear zones, or areas where intense crushing
and brecciation has taken place. As such, the
ore is only in part actual fissure filling, but
more a replacement of rock within the sheared
zone. Fissure ores extend throughout the mine
from the surface to the intermediate level below
the 900.

The replacement bodies occur where more
calcareous or soluble rocks have been re-
placed by mineralizing solutions.

Galena, sphalerite, tetrahedrite, polybasite,
and other silver-sulphide ore minerals are com-
mon ore minerals. Other primary sulphide
minerals include arsenopyrite, pyrite, and pyrr-
hotite. Among the more prominent gangue
minerals may be listed quartz, siderite, calcite,
argillitic wall rock, a hydrous manganese ox-
ide (probably a variety of wad), and, accord-
ing to Merrim, certain iron-bearing carbonates
of calcium, iron, and manganese. Pyrite and
sphalerite are the most prominent gangue min-
erals that have been reported are boulangerite, stib-
nite, kermesite, and tinst.

Character of the ores. — (The following de-
scriptions are from Merrim (10):

"Three general types of ores may be rec-
onized in the Triumph-North Star group:

(1) Fissure ores
(2) Bedded siliceous ores
(3) "Complex" bedded ores (high in zinc)

The fissure ores consist of galena, sphaler-
rite, arsenopyrite, and sulphantimonides (tetra-
hedrite, boulangerite) in a gangue of siderite
(with ankeritic phases) and quartz. Some py-
rite is present. Large amounts of gouge and
partly replaced crushed argillitic rock are
removed with the ore. Fissure ores are spotty,
occuring in pods and lenses varying in size
from a few inches to many feet across. . . .
The principal values are gold and silver but with
appreciable amounts of lead and zinc. (An
average assay of fissure ore is 0.16 ounce per
ton in gold, 9.28 ounces per ton in silver, 4.12
per cent lead, and 4.94 per cent zinc.) The
fissure ore is intimately associated with bedded
ores which represent replacement of suscep-
tible lime beds in the fissure.

Bedded siliceous ores consist mainly of
galena and sphalerite in a gangue of siderite
and other carbonates with quartz, unmineral-
ized argillite and limestone. . . . The gold, sil-
ver, and lead values are below average for
the mine with zinc near the average. (An
average assay of siliceous ore is 0.01 ounce of
gold per ton, 3.48 ounces of silver per ton, 3.18
per cent lead, and 6.35 per cent zinc.) These
siliceous bedded ores may, in part, be regard-
ed as marginal ores, . . . in part they represent
replacement of susceptible limy beds with ac-
companying introduction of quartz and siderite.

The "complex" bedded ores usually occur
in the hanging wall of the fissure. They con-
sist largely of sphalerite and galena in a py-
rilite gangue. The term "complex" was origi-
nally applied at the Triumph because of metal-
lurgical complications previous to perfection of
zinc concentration. These ores are not, as a
rule, accompanied by quartz or siderite and
locally represent almost complete replacement
of limestone beds by sulphides. The "com-
pless" may show a fine lamination or banding
parallel to original bedding planes. Dark car-
bonaceous or graphitic debris is associated
with the "complex" ore and some of the
gangue is partly or little replaced limestone or
limy argillite. The "complex" ore carries a
high percentage of sphalerite with appreciable
lead and silver and has in the past constituted
the "heart" of the Triumph production. The
largest Triumph ore shoot, ...... is "complex"
bedded ore, in places 50 feet thick, occupying
an area roughly 700 feet wide by 170 feet long
and with thickness varying from six feet in the
upper part to fifty feet below. This body ......
lies between the 700 and 750 levels, apparently
terminating rather abruptly below. There is
apparently no evidence of post-mineral faulting
off, as the associated normal fissure ore
continues downward to the lowest workings."

(An average assay of "complex" ore is,
0.02 ounces per ton in gold, 6.50 ounces per ton
in silver, 5.90 per cent lead, and 13.00 per cent
zinc.)

**Paragenesis**

There is no evidence of mineral zoning in
the Triumph mine. The ores do not present a
uniform ratio of lead to silver or of lead to zinc,
and the assay values vary. One notable dif-
ference in the mine ore is the presence of gold
in the fissure ore, and its comparative absence
in the bedded siliceous and "complex" ore.
This suggests a broken sequence in mineral de-
position with gold being introduced along the
fissure at a later date, following solidification of
the ore in the bedded siliceous and "complex"
areas.

The bedded siliceous ore apparently form-
ed when the limy beds were brecciated by
fault action, which was followed by the intro-
duction of silica that filled voids and replaced
much of the host rock. This was followed by
the introduction of mineralizing solutions that
deposited sphalerite, tetrahedrite, and galena
in that order.

The "complex" ores appear to have result-
ed from a later period of brecciation and min-
eralization during which time there was no
quartz being deposited.

The brecciated and recemented character
of the fissure ore suggests several periods of
mineralization. Quartz appears to have been
among the first minerals deposited, where as
gold and ruby silver ores appear to have been
among the last.

**Conclusions**

It is not known how far to the northwest
the Triumph fissure can be followed on the
present working levels. The northwestern end
of the 700 level penetrated andesitic flows of a
much younger age than the fissure. Inasmuch
as the andesite covers an old land surface its
basal contact is probably uneven and at a
questionable depth. Lower levels will prob-
ably pass beneath these flows.

In 1949 the Triumph Mining Company was
conducting an active exploration program to
develop future ore reserves. A large part of
the work was being centered on exploration of
the Triumph fissure. Other ports of the mine
that might prove favorable to exploration are
the North Star fissure in the area southeast of
the portal of the Triumph shaft, and possible
replacement ore bodies in the Lower limestone
(Bryon limestone) below the 750 level. The lat-
ter area might be explored by diamond drill-
ing in the footwall of the Triumph fissure.

The Triumph fissure has been mined for
some 800 feet, measured down the dip of the
fissure. The lowest working level is about 250
feet below the Triumph tunnel or slightly below
the level of the nearby East Fork of Wood Riv-
er. Thus, it is readily apparent that it cannot
be classed as a deep mine. The mineralization
is of a character that should be expected to
continue well below the present lower working
levels.

**PARKER MINE**

**Location and Development**

The Parker mine is 6.7 miles east of Ketch-
um, in Parker Gulch. It comprises 7 patented
and 8 unpatented mining claims covering por-
tions of Sect. 10 and 11, T. 4 N., R. 18 E., Boise
Meridian. The property is held by the Amicus
Trust Company, currently under the manage-
ment of Mr. Heber Comer of Ketchum, Idaho.

There are four tunnels on the property that
explore the Parker vein. These include the
Western Reserve, Blacksmith, Montgomery,
and the St. Louis. (Fig. 19.) Other mine work-
ings include the lower Parker tunnel, and the
Amicus and Gondolier. The latter two explore
the Amicus vein. Several smaller diggings are
scattered throughout the property. All work-
ings are in the Milligen formation.

**History and Production**

According to Bull, 814 the Parker deposit
was discovered in 1883 by Eugene Gillenwater.
During the next 15 years the property produced
1,552 tons of ore carrying 1,108,463 pounds of
Fig. 19. Map showing Parker, Quaker City, and Jo Orla mine workings and relative positions of the Principle Geologic Structures.
lead and 300,236 ounces of silver; the bulk of which was taken from one ore shoot about 75 feet long, extending from the Blacksmith level to some distance. Bulletin 814 quotes the manager of the mine at the time of its production, who stated that the ore shoot was followed by a winze driven on the 30 degree dip of the vein for about 500 feet. At that point the vein terminated against a steeply dipping fault and no ore was found beyond.

At a later date the Montgomery tunnel was driven at a lower level to intersect the downward continuation of the Parker vein but this long tunnel and its accompanying crosscuts failed in their efforts.

The property has been worked intermittently since 1938 with the lower Parker tunnel, the Amicus tunnel, and the raise near the face of the Montgomery tunnel receiving most of the attention. It was idle during the summer of 1949.

**Geology of the Parker Vein Workings**

The Parker vein crops out across a small ridge between the Blacksmith and Western Reserve tunnels. It strikes N. 72° E. and dips 35° SE. The vein has been explored by numerous pits which expose it as a rust-colored quartz-bearing shear zone whose average width approaches four feet. The vein wall rock is dark carbonaceous argillite. Although the vein is oxidized on the outcrop, the quartz when broken often presents fresh sulphides. An assay taken on the outcrop went .03 ounce in gold per ton, 17.5 ounces in silver per ton, and 30 per cent lead (120). The vein may be traced up the hill beyond the Western Reserve tunnel but is soon lost beneath surface mantle.

The Western Reserve tunnel is caved 75 feet from the portal, and, in the area accessible, presents nothing but an 18-inch barren quartz vein.

During recent years the Blacksmith tunnel has been reopened for a distance of 350 feet; however, much of the tunnel is tightly logged, making geologic observations difficult. The innermost 150 feet of tunnel follows the Parker vein, a pronounced shear zone striking almost east-west and dipping about 30° S. A 30-inch quartz and calcite vein, containing some sulphides, occupies most of the shear zone at the caved face. The country rock adjacent to the footwall of the vein is a shiny, graphitic material with abundant slickenside surfaces. It has a greasy feel when touched and readily soils the hands. The graphitic substrate is probably the result of metamorphism of bituminous material that was deposited with the argillitic country rock. According to an old mine map, 110 feet beyond the caved area a 500-foot winze was driven from the Blacksmith level. Several sub-levels and stopes led to this winze, all long since caved and now inaccessible.

The Montgomery tunnel, driven during the early 1900's, was reopened by Mr. Comer, who advanced a raise at the tunnel end to intersect the lower workings driven from the winze extending from the Blacksmith level. The tunnel and raise contain "bad air," and unless the air compressor is operating, forcing compressed air back to the raise, entry is hazardous and even then is restricted to the main tunnel. For this reason the tunnel was not mapped in detail, but a tracing of the tunnel workings was obtained from a previous map. (Fig. 13.) A small dike of andesite composition is followed by the main tunnel, and by one short crosscut, and while it is reported to contain some gold values there is no evidence of lead-silver mineralization.

The St. Louis tunnel intersects and drifts on a flat dipping shear zone, which locally contains quartz lenses and stringers, and often good showings of sulphide ore. Where thickest, the vein dips from six to twelve degrees, elsewhere in areas of steeper dip the vein pinches. Near the winze the vein is four feet thick and contains abundant exposures of galena, sphalerite, tetrahedrite, and some ruby silver. Assays from this area run as high as 114 ounces of silver per ton, and 49.8 per cent lead. The ore is somewhat oxidized in the footwall areas of the shear zone. Crushed and dislocated quartz fragments suggest post-mineral shearing in the plane of the vein. Intricate drag folding of the thin-bedded argillite indicates the shear zone is a reverse fault, with perhaps minor normal fault adjustment.

Across the draw from the St. Louis portal, a 60-foot adit follows a major fault, striking N. 73° E. and dipping 48° SE. This, the St. Louis fault, displaces a 90-foot quartzite member 350 feet to the right, as the fault plane is faced. (Fig. 19.) Although it cannot be proved, lithology of the faulted area suggests that the fault is normal.

**Geology of the Amicus Vein Workings**

The Amicus vein crops out 1500 feet north of the Parker vein, and lower down the hillside near the bottom of the gulch. In many respects it is similar to the Parker. It roughly strikes east-west, and dips from 24° to 40° S. The vein is predominantly a shear zone and in places the small slips and crumpled areas have an aggregate width up to 20 feet. The shear zone is readily visible in the road cut behind and above the Amicus dump. From here
it may be traced to and beyond the Condolier workings. Down the gulch, below the Amicus dump, the outcrop is lost beneath alluvium.

Neither the Amicus or the Condolier workings have a record of production, although the Amicus has produced some ore. Rich silver-lead ore, some running several hundred ounces in silver per ton, has been taken from the Amicus workings, but it has occurred only as small pockets and bunches scattered throughout the shear zone. When found, it has required hard sorting to compile any amount. Polished-surface studies show the ore to consist of galena, sphalerite, tetrahedrite, pybaterite, and chalcopyrite. Dull white quartz, often filling fractures in sulphides, is a common gangue mineral, although calcite and siderite are present. The most common gangue is "gouged" wall rock.

The Amicus tunnel starts in black thinly-bedded argillite, which generally strikes northwest and dips southwest. Eighty feet from the portal it encounters the Amicus shear zone where lenticular masses of quartz and calcite contain small bunches of ore. These quartz and calcite bodies are of short strike length and quickly pinch out. There are some small stopes in the shear zone but their production is not known. A winze has been driven in the shear zone to a drainage level 20 feet below, which was partially flooded at the time of the visit.

The Condolier is a short tunnel that intersects the Amicus shear zone 60 feet from the portal. At this point it turns and drifts east on the shear zone. Aside from exposing several iron-stained quartz stringers it has been unsuccessful in its development. It has been idle for many years.

The lower Parker tunnel was driven in an attempt to intersect the Parker vein at an elevation 274 feet below the Montgomery tunnel level. Unfortunately, it is incorrectly located for such an attempt and was more or less doomed from the start. It has been idle for many years.

Conclusions

A study of the surface area, coupled with observations of vein structure in the Blacksmith and St. Louis tunnels, leads one to believe that the Parker and St. Louis veins, as shown in Fig. 19, are the same structure. This conclusion is supported by cross sections drawn through the various workings. If such is the case, the Montgomery workings were of little value in the exploration of the Parker vein because they were too far in the footwall, a conclusion supported by their negative findings.

The Parker vein is said to be cut off by a steeply dipping strike fault somewhere near the bottom of the winze driven from the Blacksmith level. Inasmuch as this area is now caved, nothing could be learned of the nature of the fault. A projection of the St. Louis fault, as exposed in the short adit across the gulch from the St. Louis tunnel, would intersect the Parker vein somewhere near the base of the winze and could possibly be tested and the definition of the vein in that area. Such a postulation would, of course, have to be investigated by further exploration.

Recommendations

The St. Louis tunnel area should be given priority in any future exploration program. The vein in this area is quite probably the continuation of the Parker structure, and, as such, represents an unexplored and promising part of that structure.

Continued advancement of the raise near the face of the Montgomery tunnel is likely to prove unsuccessful. The fact that it will intersect old mine workings comprised of several hundred feet of drifts, raises, and stopes, now flooded and caved, will not only be dangerous to mining operations but will likely be valueless because these areas have been previously explored.

Baltimore Mine

Location and Development

The Baltimore mine is on the ridge between Independence Gulch and the South Fork of Keystone Gulch, about 1500 feet north of the Independence mine. It is slightly over 4 miles east of Ketchum, and is accessible by a secondary road leading up Independence Gulch. The Bonanza tunnel, the lower and most exploratory working level, is at an altitude of 7262 feet. The property comprises 4 patented and 6 unpatented claims, owned by the Baltimore Silver-Lead Company.

The Baltimore vein has been explored by five tunnels, three of which were caved at the portal at the time of the visit. (Fig. 20.) There are a number of old workings, stopes, raises, etc., between the tunnel levels, but they were inaccessible. The lower Bonanza tunnel was driven from the south side of the ridge to crosscut the vein at a lower level. This tunnel was being advanced at the time of the visit.

History and Production

The Baltimore was one of the early discoveries in the Hailey district, and it was during the years immediately following the discovery that most of the mine development was advanced. Although there are no records of production, a dump of hand-dugged tailings in
Keystone Gulch, left by the old timers, indicates that a fair tonnage of ore was extracted from the mine workings. In 1896 mining operations ceased with three carloads of ore, assaying 10 percent lead, 14 percent zinc, and 12 ounces in silver per ton, being left on the dumps (13).

In 1922 the Federal Mining and Smelting Company had an option on the property and did some exploration work in the Bonanza tunnel, but failed to find any ore bodies and consequently abandoned the mine.

In 1942 the Baltimore Trust Company was organized to reopen the mine workings but it was not until 1947 when the company was reorganized to the Baltimore Silver-Lead Company that any progress was achieved. Since that time, roads have been built from the Independence mine road to the Bonanza tunnel dump and beyond to the No. 4 and 6 tunnel dumps. Ore lying on the upper dumps has been shipped and the No. 6 and Bonanza tunnels have been reopened.

Reconditioning work concentrated on the No. 6 level which crossties and drifted on the vein for about 350 feet to the east. Samples taken from the vein showed ore to occur throughout most of this distance, not as pronounced ore bodies, but as scattered irregular bunches, often lens-like in shape. Two hundred and seventy-five feet from where the tunnel cut the vein a channel sample assayed 3 percent lead, 19 percent zinc, and 12 ounces in silver per ton. Near this spot a winze was started on the vein, but was abandoned after a few rounds, owing to a heavy flow of water. At that time it was decided to transfer development work to the Bonanza tunnel in hopes of crosstying the vein at a lower level.

Geology

The Baltimore vein crops out along the north side of the ridge as a shattered, transtained quartz vein occupying a well-defined shear zone. Further down the side of the ridge to the west the outcrop disappears beneath mantle, but the position of the vein is prominently displayed by a line of vegetation.

The mine workings are in the Milligen formation, although as can be seen in Fig. 20, cross section A-A’, a thrust remnant of the Wood River formation caps the ridge. The thrust remnant consists of gray quartzite, and fine-grained siliceous limestone resting upon a brecciated shear zone that is at least 15 feet thick near the portal of the No. 2 tunnel.

The Milligen rocks are chiefly black carbonaceous argillites, although limy and quartzitic members are not uncommon. Throughout the Baltimore ridge area they have a regional strike of N. 40° - 75° W., and dip at varying angles to the southwest. Locally, the beds have divergent attitudes especially the more pliant argillities. In many exposures the beds of argillites are so contorted that it is impossible to determine their structure or their stratigraphic position. This is particularly true in the southwestern portion of the Bonanza tunnel.

Dikes occur throughout the Baltimore area, often conforming so nearly to the enclosing bedding that they could be nearly described as sills. Those observed were chiefly andesitic in composition, striking in a general northwesterly direction and dipping to the southwest. Several highly altered dike segments are exposed in the Baltimore shear zone on the No. 6 level. Some of these segments have been crushed and decomposed to white, gossy masses that are readily distinguishable from the black gouge of the shear zone. By contrast, a dike intersected by the Bonanza tunnel, in the hanging wall of the North fault, in an unfaulted area, is much fresher and less decomposed.

The Baltimore vein, as exposed in the No. 6 level, strikes roughly parallel to the strike of the enclosing rocks, but dips at flatter angles to the southwest. It is essentially a shear zone, in places as much as 15 feet thick. Ore occurs irregularly throughout the vein, often as scattered lens-like masses and elsewhere as discontinuous stringers. Some ore appears to have resulted from replacement of limy material in the shear zone. The ore has been shattered and brecciated by post-mineral fault adjustment and often ore is found as “drag” in the fault gouge; however, there is no indication of major displacement. Primary ore minerals include sphalerite, talc, pyrite, and tetrahedrite in order of decreasing abundance. Other minerals include pyrite, chalcopyrite, and calcite. The usual gangue is crushed wall rock, calcite, and some quartzite. On the No. 6 level, the rocks in the footwall are black quartzitic argillites, whereas those in the hanging wall are thinly laminated argillites. Drag folding in the hanging wall suggests that the Baltimore structure is a reverse fault.

In 1922 the Federal Mining and Smelting Company, in advancing the Bonanza tunnel, intersected and drifted on a strong fault striking N. 10° E. and dipping 45° to 60° NW. Nine hundred and ten feet from the portal the tunnel encountered a quartz and calcite vein, containing some traces of sulphides, that abutted the fault footwall. The vein strikes N. 70° E. and dips 34° SW., and is comparable in most respects to the Bonanza vein on the No. 6 level. The Federal people drifted 274 feet to
the northeast on this vein and drove raises but failed to find an ore body.

In 1948 the Baltimore people turned a heading from the Bonanza tunnel to the northwest, passed through the North fault, and explored the hanging wall area beyond. If the quartz and calcite vein, drifted on by the Federal people, had extended through the North fault they should have intersected it; but they failed to do so, which suggests that the North fault is post-mineral and has displaced the vein. A rolling andesite dike was intersected and drifted on the northwest. (Fig. 20.) After turning southwest and leaving the dike, the tunnel advanced beyond the area where the vein should have projected from the No. 6 level, but with negative results. Several small faults near the southward bend in the tunnel conformed in attitude with the projected vein but were valueless.

Conclusions

The failure at intersecting the Baltimore vein with the southwesterly advancing Bonanza tunnel could depend on several factors. A flattening of dip could project the vein beyond the tunnel face. On the other hand it is possible that the stress that created the shear zone in the upper levels could have been locally resolved into the highly contorted and folded argillite found in the southwesterly end of the tunnel. It is not believed that the North fault would have any effect on the location of the projected vein in the northwestern part of the Bonanza level inasmuch as the upper workings as well as the northwestern extension of the Bonanza tunnel are in the hanging wall of that structure.

In regards to further exploration, continuation of the winze from the No. 6 level would have been more informative; however, a raise driven to the southwest at an angle of 60 degrees from the northern bend in the Bonanza tunnel, 90 feet west of coordinates 1200 N and 600 E, (Fig. 20) might intersect the vein at less cost to the mine operators.

JUNE DAY MINE

Location and Development

The June Day (commonly called Noon Day) mine is about 5.5 miles east of Ketchum, by road. It is near the mouth of Parker Gulch, with the mine dump about 30 feet above creek level. The property is comprised of the June Day and Gem claims and one-half interest in the patented Noonday claim. It is developed by two shafts, the Noonday and Starlight, and by several thousand feet of tunnel on six levels. (Fig. 21, longitudinal section A-A') Figure 21 shows only the map of the third or main level. A map of the other levels has been purposely deleted because their superposed position, coupled with the map scale, obliterates map reading.

History and Production

The main tunnel, or No. 3 level, was started in search of the downward continuation of the Elkhorn vein (1, p. 199), which crops out about 1000 feet to the southeast. After a considerable amount of tunnel work had failed to reveal the Elkhorn vein it was discovered that much of the rock being penetrated contained gold. The gold did not occur in a vein, but was disseminated throughout the wall rock, particularly in some metamorphosed limestones. During the early nineteen hundreds mining operations produced several hundred tons of ore from these gold-bearing areas, but activity ceased in 1915. In 1940 production was resumed, the high silica content of the ore making it in demand as a smelter flux. Mining operations terminated in 1947. Available data on production are given in the table below.

Production from the June Day Mine

(From A. S. & R. smelter returns)

<table>
<thead>
<tr>
<th>Year</th>
<th>Dry Tons</th>
<th>Of Gold</th>
<th>Net Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>51.68</td>
<td>$702.44</td>
<td></td>
</tr>
<tr>
<td>1941</td>
<td>1997.67</td>
<td>13,204.81</td>
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</tr>
<tr>
<td>1942</td>
<td>437.77</td>
<td>4,351.49</td>
<td></td>
</tr>
<tr>
<td>1943</td>
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<td>1944</td>
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<tr>
<td>1945</td>
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<td></td>
</tr>
<tr>
<td>1947</td>
<td>50.10</td>
<td>380.27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3,884.72</td>
<td>$27,407.16</td>
<td></td>
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</table>

June Day and Starlight

<table>
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<th>Of Gold</th>
</tr>
</thead>
<tbody>
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<tr>
<td>1915</td>
<td>1073</td>
<td>261.42</td>
</tr>
<tr>
<td>Total</td>
<td>1312</td>
<td>615.32</td>
</tr>
</tbody>
</table>

Geology of Mine Workings

The No. 3 tunnel starts in the Lower limestone member of the Million formation. (Fig. 21.) Near the portal, the member strikes N. 20° W. and varies in dip from 33° NE. to vertical. It is composed of limestone beds varying from a few inches to two or more feet in thickness, often separated by thin, one-inch to four-inch beds of argillite. These rocks have been intensely metamorphosed with the limestone being far more affected. The resultant metamor-
PLAN VIEW, NO 3 LEVEL

A-A', LONGITUDINAL SECTION, JUNE DAY MINE

- Crosscut away
- Crosscut towards

Fig 21. Geologic Map of No 3 Level & Longitudinal Section, June Day Mine
phosed rock is a tactile, containing among other minerals, diopside, garnet, wollastonite, scapolite, clinzoisite, zoisite, and vesuvianite. The tactile is fine-grained, and presents through lineation of the darker silicate minerals sub-parallel to the bedding. In places the lineation gives the rock a gneissoid appearance.

The No. 3 tunnel follows tactile beds to the southeast, and about 150 feet from the portal widens into a stope extending both above and below the tunnel level. Immediately north of the stope the tunnel passes through the June Day fault, a major shear zone of crushed and brecciated limy material striking N. 59° W. and dipping 65° NE. Continuing to the south, the tunnel branches into several headings. One of these, the Buckhorn crosscut, explores the upper part of the tactile member, and, in the raise at the crosscut face, penetrates an overlying argillite member. Another heading, the SE. crosscut, intersects the June Day fault in two places and finally ends in an underlying slaty quartzite member well to the southeast. The final 35 feet of this crosscut is of interest in that the quartzite wall rock assays $6 in gold to the ton (13). The main tunnel continues to drift more or less on the strike of the enclosing wall rock, and, at a point about 50 feet north of the base of the Noonday raise, the rock grades from a tactile into what appears to be a fine-grained, thin-bedded quartzite. Thin section study reveals that this rock is not a quartzite, but an extremely fine-grained siliceous limestone. The change in rock type is not due to faulting, but appears to have resulted from gradation in the intensity of metamorphism. The silicified limestone rocks have been explored by several short crosscuts and drifts but no ore bodies have been found.

The Noonday raise extends from the No. 3 level to the upper sub-level near the bottom of the Noonday shaft. (Fig. 21, longitudinal section A-A′) Three short levels have been driven from this raise. The southern extension of the lower, or No. 2 level, intersects the No. 2 level fault, a strong four foot shear zone striking N. 75° E. and dipping 83° SE. This fault has been drifted on to the southwest for about 60 feet and the final 30 feet of the drift has been stopped up for about 20 feet. The northern extensions of both the No. 1 level and the upper sub-level penetrate the June Day fault, and both levels show ore in the fault hanging wall. The upper sub-level is unusual for the mine in that it exposes an appreciable amount of sphalerite.

Two levels have been driven from the Starlight shaft. The upper or drainage level was accessible, but the workings beneath were flooded in 1949. The drainage level, driven to come beneath the undercut stope on the No. 3 level, intersects and drifts 120 feet on a prominent fault striking N. 23° W. and dipping 60°-65° SW. This fault is mineralized throughout its exposed length. It passes into the wall before intersecting the June Day fault, however, inasmuch as it does not show in the No. 3 level SE. crosscut, it is believed to be cut off or to merge with the June Day fault somewhere near the "A" raise on the No. 3 level. The area in and about the "A" raise is highly contorted and contains more exposures of sulphide mineralization than anywhere else on the No. 3 level.

Factors affecting ore deposition.—The metamorphic mineral assemblage of rocks indicates that they have resulted from contact metamorphism. It is not believed that ore minerals, primarily gold, were introduced during metamorphism, but that they were deposited at a later date. The location of ore bodies in the hanging wall of the June Day fault, and the mineralized condition of the Drainage level fault, suggest that mineralizers entered the region by way of these structures. Gold is disseminated throughout the tactile in the June Day fault hanging wall on the No. 3 level; however, it steadily increases in quantity as the fault is approached. Inasmuch as the June Day fault appears to be normal, it is possible that during fault movement the hanging wall was disturbed and fractured, thereby creating access for the invading mineralizing solutions; such may well be the case in the Drainage level fault. It may be that the near vertical bedding abutting the fault hanging wall offered an escape for the solutions migrating along the fault. In any event the June Day fault has exerted a control on the mineralizing solutions, which have favored the hanging wall, and, where conditions were suitable, they have diffused into and replaced the host rock giving rise to the silico-rich disseminated deposit. This holds not only for the more easily replaceable tactile containing the big stope above and below the No. 3 level, but also for the ore near the "A" raise and for the low grade gold deposit near the face of the southeast crosscut, all of which are in the June Day fault hanging wall.

Suggestions for Prospecting

In the event of future mine exploration, attention should be given to the hanging wall area of the June Day fault, inasmuch as it holds promise of undeveloped ore bodies. This is particularly true of the junction area of the Drainage level and June Day faults. The presence of ore minerals in the No. 2 level fault suggests that ore bodies may be found in other
parts of the mine, but the collected data on these areas is insufficient to warrant a planned exploration program.

LUCKY G. I. MINE

The Lucky G. I. mine, formerly known as the Duquette prospect, is at the mouth of Milligen Creek, about 6 miles up the East Fork of Wood River from Gimlet Siding. The property is owned by John Plummer of Hatley, Idaho, but in 1949 was under lease to A. L. Patterson, E. R. Rice, and N. L. Patterson. The property comprises three unpatented claims held by Plummer, and three additional claims filed on by the present lessees. It is developed by three short adits, which explore the Plummer vein, an abandoned tunnel, and a lower G. I. tunnel that was being advanced at the time of the visit. The total extent of workings is about 1700 feet.

The country rock is composed of various members of the Milligen formation. Throughout most of the region explored by the adits, and near the portals of the lower tunnels, the rock is a strongly contorted, brown sandy shale. In the G. I. tunnel, underlying the shale and separated by a strong shear zone, there is a 60-foot bed of black quartzite, which, in turn overlies a succession of argillites, calcareous argillites, and quartzitic beds.

At the apex, the Plummer vein consists of white quartz veins in a strong shear zone. It strikes west, dips 70° S., and averages about 16 inches in thickness. It contains some sulphides, primarily galena, all of which have been more or less oxidized. The vein may be traced down the hillside where it has been explored by three adits, the lower being 300 feet below the apex. In the upper and middle adits, the vein has been stopped for short distances, but for the most part the ore bodies have been too small and discontinuous to warrant mining.

An interesting feature of the vein is the gradual increase in dip, going from 70° S. at the outcrop, to 85° S. in the middle adit, and finally overturning to 85° N. in the lower adit. The change in dip is accompanied by a slight change in strike. There has not been enough development work to determine what effect, if any, this change in structure might have on possible sites of ore deposition.

The lower adit drifts on the vein and near the face it encounters a lens-like massive quartz body containing abundant pyrite with intermingled particles of galena, sphalerite, chalcopyrite, and tetrachalcite.

Advancement of the lower or G. I. tunnel was resumed in 1948 by the present lessees after it had been abandoned for many years. Its purpose was to intersect the downward extension of the Plummer vein, which, if accomplished, would give about 440 feet of "backs." On June 20, 1949, at the time the tunnel was mapped, a projection of the Plummer vein, using a mean dip as exposed at the outcrop and in the upper adit, indicated that the vein might be reached by advancing the tunnel 140 feet in a due north direction. This figure was rather dubious because in a projection of that distance, a minimum of 300 feet, a variation of a few degrees in dip could distort the picture. Moreover, the reversal in dip as exposed in the lower adit further complicated the projection. On Aug. 25, when last visited, the tunnel had been advanced N. 30° E. for 155 feet, but the vein had not been intersected. (Fig. 22.) The last 100 feet of tunnel were driven through dark, massive quartzite, in which were occasional bedding-plane veinlets of quartz and calcite that contained some galena and sphalerite. At the face, the tunnel penetrated a shattered area in which quartz and calcite-filled fractures cut the wall rock in several directions. Many fractures contained galena and sphalerite but none gave evidence of being associated with the sought-after vein.

Previous to the writer's visit, the lessees drove through a large shear zone, the Patterson fault. It is about 700 feet from the portal, strikes in a westerly direction, dips about 35° S., and approaches 7 feet in thickness. Assays taken across its width gave faint traces of lead and silver. In as much as this shear zone has characteristics similar to other veins in the district, it was thought that it might be the downward extension of the Plummer vein. However, such a hypothesis is doubtful. The character of the fault differs markedly from that exposed at the Plummer vein outcrop and it is only by a reversal of dip coupled with a decided flattening of dip, or by large scale faulting, that the Plummer vein could have reached this position.

It is suggested that future development continue advancement of the G. I. tunnel for at least 50 feet in its present direction in order to completely explore the possibility of the Plummer vein projecting to the above mentioned target area. The vein's reversal of dip to north, while unusual in this district, could project it beyond the present face. (Fig. 23.) If the vein is not intersected in this distance drifting on the Patterson fault might prove informative.

There is no record of production of the property, but judging from the size of the stopes it has been very slight. E. R. Rice reports that
Fig. 22. Geologic Map of the Lucky G.I. Workings
in 1948 he and John Plummer shipped about three tons from the upper adit that grossed about $200 a ton in lead and silver values.

LUCKY COIN MINE

The Lucky Coin mine is in Independence Gulch, about three-quarters of a mile west of the Independence mine, and at an altitude of 6386 feet. It is reached by the road leading to the Independence and Baltimore mines. The property comprises 7 unpatented claims owned jointly by the Baltimore Silver-Lead Mines, Inc., and the Triumph Mining Co. (13). Mine workings consist of a meandering tunnel, Fig. 24, driven in search of the western continuation of the Independence vein.

Following many years of idleness, advancement of the Lucky Coin tunnel was resumed in 1959 and continued until 1961 when exploration work was abandoned. During this time the tunnel passed through a series of limestones and andesitic dikes, and finally encountered the volcanic andesites that cover so much of the western part of the Triumph-Parker area. According to Frank Plughoff, the tunnel drifted 120 feet to the southwest on the limestone-andesite contact before it was abandoned. This part of the tunnel is now caved. Mr. Plughoff further states that for a distance of 80 feet before intersecting the andesite the tunnel followed a flat-dipping shear zone through brecciated and heavily pyritized limestone. Assays taken in this part of the tunnel went from a trace up to $8 per ton in gold. No lead, silver, or zinc values were obtained.

There is no evidence in the tunnel of a fault contact between the brecciated limestone and the andesite extrusives. Specimens of limestone taken from the contact area present weathered surfaces, suggesting that they were part of an ancient land surface which was covered by flows.

It is believed that any continuation of the Lucky Coin workings, in search of the western extension of the Independence vein, is unwarranted. The Lucky Coin holdings, located across the projected path of the westward striking Independence vein, are almost 1000 feet lower in elevation than the Independence workings on the No. 4 level. For this reason, if the vein is projected along the strike and dip as exposed in the Independence and Idaho Harlan workings, it would lie well to the south of the Lucky Coin mine. Incidentally as this area is covered by post-mineral andesitic flows, it follows that the vein not only would be overlain and concealed by these volcanics, but may have been largely removed to an unknown depth by pre-volcanic erosion.

BALD EAGLE MINE

The Bald Eagle mine is on the north side of Parker Gulch, about one-half mile northeast of the June Day mine. It is reported to have been active during the early nineteen hundreds but is now idle and has been for many years.

The property has been explored by several small dippings near the hill top, all now caved, and by two lower tunnels, 150 feet apart vertically. The upper tunnel is caved at the portal, but the lower tunnel is open. It starts in a 10-foot andesitic dike and then proceeds to pass through a series of argillites and argillaceous limestones of the Milligen formation, whose attitudes are locally contorted, but which generally trend northwest and dip both to the northeast and southwest. (Fig. 25) About 375 feet from the portal the tunnel passes through a hornblende-granite dike. Small veinlets and disseminated blebs of pyrite, pyrrhotite, and chloropyrite are scattered throughout the dike but not in sufficient quantities to constitute ore bodies. The dike outcrops on top the hill above the tunnel portal, where it is explored by some small open-cuts. In a more northern continuation, a crosscut from the tunnel re-enters and passes through the hornblende-granite dike and then encounters an ill-defined 75-foot thick zone where dike minerals are present, but where there is no definite contact between dike and country rock. Instead, there is a gradual change of one rock type to another. The limestone host rock, where not replaced by dike minerals is metamorphosed, containing diopsidite, garnet, epidote, and other contact meta-morphic minerals. Copper ore is scattered throughout the zone, chiefly as chloropyrite. In addition there are occasional disseminated blebs of sphalerite and galena. No assays were taken from the area, but a previous sample (1, p. 188) taken along a 25-foot section of the main tunnel averaged 2 per cent copper, 0.002 ounces of gold, and 1.2 ounces of silver to the ton. The mineralized zone strikes N. 30° - 40° W. and has been drifted on in that direction for about 135 feet. Several raises and crosscuts also explore the area but none reveal appreciable ore bodies. To the west, the zone is bounded by a fault that strikes N. 30° - 40° W. and dips 40° to 50° SW. Continuing to the westward, the tunnel encounters and drifts on a second faulted and diked area, but evidence of ore minerals is negligible.

It is believed that the country rock in the Bald Eagle area was metamorphosed prior to mineralization. Furthermore, the mineral assemblage in these metamorphosed rocks indicate that igneous intrusives, possibly at depths not too great, were responsible for the metamorphism. At a later date the hornblende-granite dike intruded the area to be followed
still later by faulting, in and continuous to, the dike area. The faulting provided access for the mineralizing solutions, which invaded the area and deposited minerals not only in fractures in the dike, but by replacement of the dike-rock and the nearby limestone.

**IDA HARLAN**

The Ida Harlan patented claim is on the south side of Independence Gulch slightly west of the Independence dumps. The claim is part of the Baltimore Silver-Lead holdings, but is located along the western extension of the Independence vein outcrop. The vein is intersected by a 280-foot tunnel that starts 1000 feet southwest of the old Independence mill. This tunnel was driven in the early eighties, but was abandoned after crosscutting the vein. In 1947 the Baltimore people drifted on the vein to the southwest for 145 feet and to the southeast for 170 feet; they also put up two short raises, but their explorations failed to find ore bodies and they stopped mining operations.

In the footwall area, the tunnel crosscuts a succession of limy argillites and limestones that strike northeast and east, and dip at varying angles to the south. The rock in the vein hanging wall is argillite, which, in the East drift, strikes N. 57° W. and dips 40° SW.

The West drift follows an 8-foot white quartz vein, which, at the face, increases to 12 feet in thickness. It strikes N. 73° E. and dips 30° SE. The walls of the quartz vein are comparatively free of gouge, but the quartz is broken by innumerable tiny fractures that more or less conform in attitude to that of the vein. Locally, these fractures contain sulphides that, for the most part, are iron-stained and partially oxidized. A sample taken across the vein went 1.5 per cent lead, 3 per cent zinc, and 3 ounces in silver per ton 11.9.

In the East drift the quartz vein quickly flattens in dip, and the gouge on the footwall thickens to 18 inches. The strike of the vein swings abruptly to the south and it quickly pinches to a small 2-inch stringer, as does the footwall gouge. Drifting continued for about 80 feet to the east, but although the stringer changes attitude several times, developing a sinuous trend, it does not widen into either a quartz vein or an ore body.

The large relatively barren quartz vein and its sudden lens-like termination is characteristic of other instances in the Independence and Triumph veins. In the Independence mine a similar quartz occurrence is reported to have opened into a large ore body.

**QUAKER CITY MINE**

Little is known about the Quaker City mine, located northwest across the gulch from the Parker mine. Records from the old Ketchum smelter (1, p. 188) show that the property was worked from 1884 to 1895, and that during that time it produced 170 tons of ore that yielded 41,239 ounces of silver and 108,438 pounds of lead. The total production is said to have been about $50,000. The mine is owned by Mrs. Alice Moser of Huntington Park, California. It was last worked in 1950 when the lower east tunnel was extended; however, no ore was found and operations soon ceased.

The property has been explored by nine tunnels; six of the tunnel dumps form an almost continuous dump down the hillside. Most of the ore is said to have come from the 3rd level above the creek bed, occurring as small discontinuous pockets of high-grade lead-silver ore. All workings are now caved except the two lower tunnels. (Fig. 13.) These two are almost at the same elevation and both intersect and drift on a major shear zone, which, in places, aggregates a thickness of 18 feet. The strike of the shear zone varies from N. 72° W. to N. 84° W. and the dip is gentle, varying from 20° to 26° SW. Irregular masses and stringers of quartz and calcite are scattered throughout the shear zone, some heavily pyritized. High-grade ore picked from the dump is rich in galena and tetrachloride. Examination of the mine workings is impeded by the heavy coating of malachite and other iron oxides. Moreover, the workings have been idle so long that they are badly caved, making entry hazardous.

**JO ORLA PROSPECT**

The Jo Orla prospect consists of one short tunnel west of, and adjacent to, the Quaker City diggings. It is held by H. F. Cassidy and M. B. Oberhansley of Hailey, Idaho. The tunnel extends through highly contorted argillite of the Millen formation, and was evidently driven to intersect the western continuation of the Quaker City shear zone. It seems to have accomplished its purpose, for near the tunnel face a faulted zone was encountered which occupies the projected position of the Quaker City shear zone. An exploratory raise was started in the fault zone, but, other than exposing some iron-stained quartz and calcite stringers, it appears to have been unsuccessful. Fifty-eight feet from the portal, the tunnel cuts a small two-inch to six-inch quartz vein containing some lead-silver sulphides. The vein strikes due north, and dips 20° E. Some undercutting was done in the tunnel but the vein quickly pinched out and exploration ceased.
Fig. 23. Profile View and Cross Section along A—A', Lucky G.I. Mine
Fig. 24. Geologic Map of the Lucky Coin Mine
Fig. 25. Geologic Map of the lower level, Bald Eagle Mine
SILVER CORD PROSPECT

The Silver Cord prospect is adjacent to, and east of the June Day shaft. It is slightly higher in elevation than the collar of the June Day shaft. The property is developed by two tunnels, both driven in the nineteen twenties, and both now inaccessible.

It is reported (13) that a geophysical survey of the property indicated the possibility of an ore deposit, and, acting on this advice, the tunnels were driven to explore the deposit. However, when they reached their objective, they found only a pyritized zone, and at this point exploratory work was abandoned. It has never been resumed.

THE MALTA MINE

The Malta group of claims are at the head of Independence Gulch, a few hundred yards east of the Independence mine. The property is developed by several rather short tunnels, judging by the size of the dumps. The tunnels are now caved at the portal. Some traces of badly oxidized lead-zinc ore was found on the dumps, but there is no record of production.

It is reported that during its early years, the Malta property was involved in litigation that halted mine exploration (13). At a later date the Malta holdings came under control of the company owning the Independence mine, but no attempt was ever made toward exploration.

Plate 21, of U.S. Geol. Survey Bull. 814 shows the Independence vein outcrop passing through the Malta No. 1 claim. However, the Malta No. 2 and 3 that contain the mine workings, appear to have been filled in or structure, that, in all probability is the southeast extension of the Baltimore vein.

The mine has been idle for many years.

ELKHORN MINE

The Elkhorn mine is about 5.5 miles east of Ketchum, by road. It is atop the ridge immediately southeast of the June Day mine. According to Bull. 814, pp. 190-191, the mine was discovered about 1879 and was an active producer until 1885. The vein was worked continuously from the outcrop to a vertical depth of about 300 feet, where it gave out. It is credited with a production of about $1,300,000 in silver, lead, and gold values. Continued exploration work on lower levels failed to expose any ore.

The mine workings are now in a state of disrepair and inaccessible. They have been idle for many years. There is little to see except at the outcrop where some open pit diggings expose a structure, presumably the Elkhorn vein, which strikes about N. 60° W. and dips rather steeply SW.

INDEPENDENCE MINE

The Independence mine is near the head of Independence Gulch, directly south and across the gulch from the Bonanza tunnel of the Baltimore mine. It was formerly one of the leading producers in the Hailey district, being worked intermittently from 1883 until the early nineteen twenties. In 1940 the Independence holdings came under control of the Triumph Mining Co.

The mine workings comprise several levels, four of which were entered from the surface. With a few exceptions, the workings were inaccessible at the time of the visit. For this reason no attempt was made to record the geology. For a more detailed description of the mine, the reader is referred to U.S. Geol. Survey Bull. 814, pp. 174-178.

MINING PROPERTIES OUTSIDE THE TRIUMPH-PARKER MINE AREA

SUN VALLEY LEAD-SILVER MINES, INC.

The Sun Valley Lead-Silver Mines property is 1.8 miles west of Ketchum on the south side of Warm Springs Creek. The property comprises the old New Hope group of claims plus a more recently filed-on group, making a total of 12 unpatented claims.

In 1947 the present operators are reported (14) to have shipped from the old New Hope mine two shipments of ore of 52 and 47 tons respectively, which netted $48 and $39.50 per ton in lead and silver values. The ore is chiefly very fine-grained galena; no silver-bearing minerals are visible in the hand specimen.

Exposures of good ore occur in the New Hope workings, but owing to the mine's inaccessible location it was decided to move development work several hundred feet down the mountain side and come under the vein with a crosscut tunnel. Since 1947 development work has advanced this tunnel 975 feet in a N. 85° E. direction. Three hundred and twelve feet from the portal the tunnel intersected a 12-foot vein that strikes N. 5° E. and dips 42° NW. It assays one ounce of silver per ton and one per cent lead. At 560 feet, the tunnel passed through a 10-foot vein that strikes N. 45° W. and dips 47° NW. The vein is strong and has given assays up to 6.5 ounces of silver per ton, and 6 per cent lead. An iron-stained quartz and calcite vein ranging from 4 inches to 4 feet in thickness was intersected 875 feet from the
portal. It strikes N. 5° W. and dips 77° E.
This vein is thought, by the mine operators, to be the downward continuation of the New Hope vein. Drifts were driven on the vein, the north drift extending 126 feet and the south drift 170 feet at the time of the visit. In the north drift the vein is a 2 to 4-foot shear zone, which, near the drift face, has assayed as high as 7 ounces in silver per ton and 7 per cent lead. Mullion structure on the hanging wall rakes south at 23 degrees, and suggests oblique normal faulting. Rock in the vein hanging wall is quartzite, striking N. 40° W. and dipping 40° SW., whereas the footwall rocks are predominantly limestones striking N. 70° W. and dipping 80° NE. These sedimentary rocks are members of the Wood River formation.

**LEILANI MINE**

The Leilani prospect is about one-quarter mile up Federal Gulch from the mouth, and one-eighth mile up the hillside to the south. The property was formerly prospected by a series of small open cuts; however, during the summer of 1949 a new outcrop was discovered, and for a few weeks the property was the scene of considerable activity. A tunnel was driven to come under the outcrop, and 35 feet from the portal a 17-foot quartz lens was encountered which was drifted on for about 40 feet and then abandoned. Innumerable quartz veins of a second and younger period of quartz mineralization cut the quartz lens and these locally contain lead-silver ore, though not in sufficient quantity to warrant shipping. The lens conform in attitude to the enclosing rock bedding, and is one of a series, the others lying above it.

The country rock in the Leilani area is black carbonaceous argillite of the Milligen formation, striking N. 50° W. and dipping 70° SW. A few hundred feet above the prospect, the Milligen formation is capped by a small remnant of a hornblende andesite flow.

**SUN VALLEY BARITE MINE**

The Sun Valley Barite mine comprises the Bonnie group of mining claims, located on the ridge between Ajax Creek and the North Fork of Deer Creek. It is owned by the Bunker Hill and Sullivan mining company, but currently is under lease to the J. R. Simplot Fertilizer Co. of Pocatello, Idaho. The barite mine has been worked intermittently during recent years. In 1946 a road was built from the North Fork of Deer Creek to the Ajax ridge summit where a large barite deposit was developed by a sidehill cut. In 1947 the Simplot Company obtained control of the property together with 2500 tons of barite already mined and stockpiled. The company mined an additional 4120 tons during the summer of that year. Mining operations then tapered until 1949 when 6700 tons of barite were produced. All mined ore is trucked to a railroad siding about 3 miles north of Hailey where it is crushed to one-inch size and shipped to Pocatello, Idaho. There it is stockpiled and further crushed and bagged for shipment as the demand arises. To date, the entire market has been in the oil well drilling industry.

The barite deposits are described in U. S. Geol. Survey Bull. 814, p. 150, as a series of lenticular masses enclosed in the Wood River formation, which, in general, strikes N. 50° W. and dips 50° SW., with many variations. At the pit face the deposit is irregularly iron-stained and appears to be contaminated by oxidized matter; however, sample analyses frequently show the iron-stained barite to have a higher specific gravity than the white more pure-appearing variety. Close analysis reveals the presence of siliceous zones throughout the working face that are largely responsible for contamination of the barite. These silicified areas fade away from fractures that probably admitted silica-bearing solutions into the deposit. The siliceous areas are avoided, when possible, by selective mining; all barite that does not have a specific gravity of 4.0 is cast out as waste.

With regards to chemical analysis, the ore has varied from 84 per cent to 88 per cent BaSO₄, however, inasmuch as the product is used solely in the oil well drilling industry, the more pressing problem is the specific gravity of the barite. Samples of barite with a specific gravity of 4.2 are found, but the over-all average is somewhat less, owing to impurities. By selective mining, a specific gravity of 4.0 to 4.1 can be obtained. Present market conditions do not warrant the increased mining costs that would be necessary to raise the specific gravity above that figure.

In the event that the market demand should improve to an extent that would warrant the cost of installing the necessary equipment, the specific gravity of the barite could be raised by flotation. However, the film formed on the barite particles during flotation makes the product water repellent. This film would have to be destroyed by calcination before the barite could be used as a drilling mud (113).

**JOE ANDERSON PROPERTY**

The Joe Anderson property is at the end of the automobile road up Hyndman Creek. It comprises 4 unpatented mining claims that are explored by two short tunnels. High-grade ore has been found in the workings, some assaying 1060 ounces in silver and 42 per cent
lead, but the amount produced has been negligible.

The country rock is Milligen formation, composed of brownish shales and some interbedded one to eighteen-inch limestones. The rocks strike N. 60°-75° W. and dip 50°-70° SW. The lower tunnel, immediately behind the cabin, was driven along the hanging wall of a fault striking N. 78° W. and dipping 54° SW. The fault has been silicified by hydrothermal quartz to a thickness ranging from 6 to 18 feet. At some time following silicification the zone has been cut by a series of tensional fractures striking almost due north and dipping steeply to the east. They abut the main northwest fault on the north and quickly die out in the shale to the south. These fractures have been filled with a second stage of quartz mineralization, which occasionally contains minor traces of ore.

The upper tunnel, 600 feet above the lower one, follows a 16-inch quartz vein, striking N. 33° E. and dipping 64° NW. Eighteen feet from the portal the vein abuts a fault striking N. 80° W. and dipping 40° SW.; no vein is exposed in the 42 feet of tunnel beyond this fault. Twenty-five feet above the upper tunnel, and 50 feet northeast of the portal, a small open cut, driven on the N. 33° E. vein, is supposed to have yielded some ore.

MARGRET MINING CLAIMS

The Margret mining claims are near the head of War Dance Gulch in Sec. 28, T. 3 N., R. 17 E., Boise Meridian. The property is directly north of, and across the gulch from the old War Dance mine. It comprises 4 unpatented claims held by Victor Anderson and L. B. Miller, the latter of Halley, Idaho.

Old development consists of some surface diggings and one short tunnel; however, during the past four years development has been centered in a lower tunnel near the bottom of the gulch. This tunnel strikes N. 4° W. for 463 feet, then turns more to the northwest for 248 additional feet. A crosscut 130 feet from the portal turns to the northeast and follows a fault for 100 feet but did not encounter an ore body. All of the tunnel workings are in quartz monzonite.

During the summer of 1949 a raise was being driven from the lower tunnel. It is located 25 feet from the tunnel face, and strikes N. 35° W., extending up at a 45 degree angle for 103 feet. The target of the raise is the quartz monzonite contact with the overlying Wood River formation, thought, by Mr. Miller, to be not too far beyond the face of the raise.

Some minor traces of lead and silver are reported to occur in some small fractures cut by the tunnel; but, on the whole, the property offers little encouragement to continued development.

RED LEAF PROPERTY

The Red Leaf property is about one mile north of Clarendon Hot springs. It is reached by the Deer Creek road. The property comprises 6 unpatented claims held by E. H. Sawyers and Stan Johnson but currently (1949) under lease to the Beauregard brothers. Previous mine development consists of three short tunnels from which some oxidized lead-silver ore has been taken.

In 1948 a bulldozed cut exposed a mineralized shear zone striking N. 61° W. and dipping 60° NE., which had been untouched by previous exploration. To explore this newly discovered vein a crosscut tunnel was started 258 feet below and 420 feet northeast of the vein outcrop. At the time of the writer's visit the tunnel had been advanced 231 feet in a S. 45° W. direction, but was at least 40 feet short of reaching its objective. A second vein crops out 260 feet east of, and 51 feet lower than the previously mentioned vein. It strikes N. 43° W. and dips 82° NE. On the outcrop it is an iron-stained quartz vein from one to two feet thick. This vein has been cut by the lower crosscut tunnel 220 feet from the portal. At the tunnel intersection it is a 14-inch fault of gouge and sheared material with no indication of quartz or ore.

The three, short, older tunnels are northwest of, and 145 feet higher in elevation than the crosscut tunnel. They have badly iron-stained walls that are open only a few feet in from the portal. Little can be learned from the vein structure in these workings; however, they appear to have been driven on a sheared structure which could be the northwest continuation of the mineralized shear zone exposed in the bulldozed cut.

The country rock in the Red Leaf area is mostly black shaly beds of the Wood River formation with some interbedded members being more calcareous. The rocks strike about N. 50° W. and dip from 40°-60° NE.

LIBERTY GEM MINE

The Liberty Gem mine is 8.5 miles southwest of Hailey, and about one-half a mile northeast of the junction of Kelly Gulch and Croy Creek. The property comprises 22 unpatented claims, owned by the National Milling and Mining Corporation. There are several exploration workings on the property, but development has been principally by two shafts; the Bernie, 230 feet deep; and the Main shaft, 210
feet deep. Both shafts are now caved at the surface. The deposits were discovered in 1927 by Newton Matthews and have been worked intermittently since that time.

Three veins are reported to occur on the property, although only one was examined. This vein is exposed in an open pit a few feet from the Main shaft. It is 30 inches thick, strikes N. 15° W., and dips 48° SW. The vein is essentially a shear zone containing irregular masses of lead ore distributed throughout the fault gouge.

The country rock is part of the Wood River formation, although it is reported (13) that on the 100-foot level from the Main shaft the vein passed into granitic rock, presumably a part of the large granitic mass outcropping nearby to the southwest in the Halley Gold Belt area.

In 1939 a shipment of crude ore from the property assayed 0.15 ounce of gold per ton, 18.4 ounces of silver per ton, 18.9 per cent lead, and 3.3 per cent zinc. The production record of the mine was not obtained but it is believed to be small.

**RED CLOUD MINE**

The Red Cloud mine is one and one-half miles northwest of the Red Elephant mine, but is most accessible by way of the Deer Creek and Wolltone Gulch road further to the north. The mine has been more or less idle since the early nineteen hundreds and most workings are now inaccessible. In 1949 only the No. 5 and No. 13 levels and some of the ridge-vein levels were open. Owing to the inaccessibility of the mine workings most of the following description is taken from Turner (16), Lindgren (17), and Cramer (18).

The Red Cloud mine was active between 1880 and 1902 and during that time produced lead, silver, and gold ore with a gross value of $815,802 (16). Some tailings from the old mill were jigged and shipped during the early twenties, and in 1941-42 some 179 tons of tailings from the upper levels were shipped to the smelter. (Fig. 28.) During the early forties some RFC funds were expended in opening the caved mine portals, otherwise mining activity has been negligible since the period of early operation.

The property has been developed on 11 levels. The lowest, or 13th level, at an altitude of 7030 feet, is 1,065 feet below the outcrop. Most of the ore came from above the No. 9 level, or 705 feet below the surface as measured from the No. 1 level.

The country rock is dark limy argillite of the Wood River formation. There are three prominent veins on the property—the Ridge vein, the Red Cloud vein, and the Hanging Wall vein. (Fig. 26.) Of these, the Red Cloud and the Hanging Wall veins have produced practically all of the ore. The Red Cloud vein strikes N. 23° W. and dips at a high angle to the west. The Hanging Wall vein branches off the Red Cloud vein to the northwest, striking N. 50° W. and dipping southwest at about 60 degrees. The Ridge vein, which is explored by several short tunnels, strikes N. 45° W. and dips 70° - 90° SW. It appears to be cut off at depth by the Ridge fault. (Fig. 27, cross section C-B.)

In the Red Cloud workings the Red Cloud vein and the Hanging Wall vein have been affected by faulting at several points, but only two fault movements are described by Turner as being of any consequence. The fault with the greatest displacement occurs between levels 5 and 6 where an ore body has been displaced N. 25° W. for 240 feet along a fault that dips 9° NW. A lower fault cuts the Hanging Wall vein at a point 15 feet above the No. 9 level. A crosscut driven southwest from the No. 9 level encountered the vein at a point that showed it had been displaced 90 feet to the southwest along a fault dipping about 15° NW. Another fault, encountered a few feet below the No. 9 level, displaced the Hanging Wall vein, and ore bodies were not found below it in the No. 10 and 13 levels.

Three strong faults with some evidence of mineralization were found in the No. 13 level—these are the Yellow Dog, Kelly, and Vindicator. A few tons of ore were taken from the Kelly fault, but no significant ore bodies were found in any of these faults.

Turner thinks the Yellow Dog may be a major fault, upon which the upper productive area has been moved to the southwest. He also considers that the Kelly vein might be a continuation of the Hanging Wall vein. Furthermore, he reasons that the large mineralized outcrop east of the upper Red Cloud workings might be the upward projection of one of the faults found on the No. 13 level.
Fig. 27. Cross Section C—D, Red Cloud Mine
black color of the beds. Banding is common in both the quartzite and limestone.

Many of the quartzite beds are medium-grained and gray in color but a number are fine-grained and black. The individual grains of the black quartzite are readily visible and the rocks were, therefore, classified as quartzite rather than argillite.

There is a tendency toward a dominance of dark limestone toward the ridge crest and probably a gradation into the overlying argillite and black limestone. There are no distinctive beds other than a light gray, banded calcareous sandstone which lies at the level of Bullion Gulch opposite the wye in the road. Unfortunately, this sandstone dips well beneath the mine workings. Float, grass cover, minor faulting, and lensing makes the tracing of any particular bed impossible.

Pleistocene

Remnants of old terraces are present in Red Elephant Gulch, and a small area was mapped just west of the Lipman tunnel portal. The terrace is composed of well-rounded boulders, cobbles and gravel-sized material, dominantly quartzite and argillite.

These terrace remnants should probably be correlated with the uppermost terrace in Croy Creek Valley just west of the Wood River.

Metamorphism of Sediments

The sediments, particularly those in the north portion of the mapped area, show the effects of mild metamorphism. The limestones in the north portion of the area contain silicates, probably amphiboles, as do the calcareous argillites.

The use of the term argillite rather than shale is in part due to the development of silicate minerals. "Argillite" has had a number of definitions (See Pettijohn, Sedimentary Rocks, Harper Bros., 1949, p. 269 f.l.) but in this report it will refer to slightly metamorphosed shales and mudstones.

It is probable that the metamorphism was produced by the stock one-half mile north of the mapped area.

IGNEOUS ROCK

Dikes

Dikes of two different ages are probably present. The oldest dikes reach 40 feet in width, are buff colored, and so altered that of the primary constituents only quartz is still present. These dikes were apparently intruded along faults (Plate 3). Thoroughly altered fragments of these dikes have been recognized in the workings of the Bullion claim. They are probably related to the stock which lies about one-half mile north.

A 23-foot segment of a fresh, one-foot wide lamprophyre dike is in the Rough and Ready claim. Because of its apparent lack of alteration it is considered to be much younger than the major period of igneous intrusion.

Larger Intrusives

One-half mile north of the mapped area is the south contact of a stock considered by Umpleby (Bulletin 814, p. 91) as quartz monzonite. The granitic dikes are probably related to this mass but there is no definite proof.

Flows

A small remnant of a porphyritic olivine basalt flows lies at the head of the Red Elephant Gulch. The basalt was considered to be of Miocene (?) age by Umpleby (Bulletin 814, p. 55).

STRUCTURE

Faults

The most obvious and significant structural features of the area are the major faults or fault zones which divide the area into a number of distinct blocks. If a comparison is made with Plate 15 of U.S. Geol. Survey Bull. 814, the reader will see that there has been some rearrangement of the toponography with respect to the faults (Plate 3). Also the offset segments of the "Red Elephant lode" are given distinctive names in keeping with local custom.

Most of the major faults strike roughly northwest and are so nearly parallel that age relationships cannot be determined. The following relationships are reasonably certain:

1. Mayflower fault zone is older than Cal- edonia fault.
2. Red Elephant — O.K. Vein — Point Lookout Vein are all segments of the same fault and are older than the Caledonia fault.
3. Goose Egg fault is probably older than the Wilson fault.
4. Mud Vein fault is probably older than the Red Elephant fault (as now defined).

The Goose Egg, Caledonia, and Wilson faults dip to the north, while the others dip south, so these may have the same origin.

The age of the oldest faults are to be placed as pre-intrusive and possibly all the major faulting is pre-intrusive. The Mayflower fault zone contains acid dike material altered during mineralization. The Mud Vein fault is paralleled by a dike in the Belmont and Red Elephant claims, as is the Wilson fault in the Wilson claim. The Indian Queen fault in the Indian Queen claim is also paralleled by a
dike in several places. All of the major faults are probably pre-mineral as well as pre-intrusive.

In general, these faults appear to flatten at depth; however, criteria for determining whether they are normal or reverse faults is uncertain. First, there are no key beds by which relative movement might be determined. Second, even though there appears to be flattening at depth for several of the faults, slickensides indicate the last movement to be either normal or horizontal. Many of the slickensides rake to the southeast. While there was apparently some local thickening of the ore shoots where the Mayflower fault and the East Caledonia fault intersect, cross-sections show that the large stopes between the No. 4 and No. 5 levels in the Bullion workings is actually in a steeper than average position of the fault zone. This would indicate normal movement.

The generally low dip of the Red Elephant — O.K. — Point Lookout fault (50-65 degrees at the surface) and the 22 degree dip of the Ridge Vein fault certainly hint at thrust faulting, as do lower dips of the Mayflower fault zone at depth. Similar low angle faults in the Parker—Triumph area where there has been much more underground exploration, have been interpreted by competent geologists as reverse faults. However, much more must be known of the regional geology before a decision can be made in this area.

Mayflower Fault Zone

The Mayflower fault zone strikes approximately N. 50° W., roughly paralleling the strike of the bedding through which it passes, dips at the surface vary from 70-85 degrees to the southeast. Maximum dips underground are much flatter and average perhaps 30 degrees with some dips as low as 30 degrees.

On the surface the fault zone may be traced as a discontinuous iron gossan which varies from 5-75 feet in width. The discontinuous outcrop in the Bullion claim, and the underground structure sections show that there are parallel and overlapping fault planes which constitute the Mayflower fault zone.

On the east, the fault zone cannot be traced on the surface from the Bullion Claim to the Durango Shaft, nor can it be traced westward beyond the central portion of the Jay Gould claim although there are prospect pits in the Jay Gould Extension Claim which possibly are on the Mayflower lode.

Caledonia Fault

The Caledonia fault offsets the O.K. Vein fault and apparently the Mayflower fault. Its eastern and western ends have been sufficient-ly mineralized to produce an iron gossan upon weathering. The gossan on the east end is 2-3 feet wide and has been prospected by 3 caved shafts. The gossan on the west end reaches 5 feet in width and is underlain by ore mined through the Red Elephant No. 2 portal.

The Caledonia inclined shaft was sunk about 60 feet in the footwall from the fault, but judging by dump material this portion of the fault was barren.

Red Elephant — O.K. — Point Lookout Vein Fault

The fault has a sinuous outcrop striking roughly N. 50° E., with dips varying from 50-65 degrees south. Mining has been active in the three segments of the vein, and as indicated by the size of the dumps there are quite extensive underground workings. Much of the vein outcrop is an iron gossan which reaches 10 feet in width. The westernmost portion of the O.K. segment is mainly a fracture zone until it reaches the Caledonia vein. The outcrop of the Red Elephant segment is gossan 20-feet wide.

Ridge Vein Fault

The Ridge Vein outcrops in the O.K. Claim. It is a low angle fault with a dip of about 8-2 degrees to the southwest. The fault contains 20-30 inches of stained quartz which assayed 7 per cent lead, 6 oz. of silver and no zinc. On either side of the quartz vein is a zone of black gossage and crushed rock.

There has been no underground prospecting of this fault.

Mud Vein Fault

The Mud Vein fault is probably the major fault structure of the area. It is a high angle fault which dips steeply southwest. Its western continuation beyond the mapped area is unknown and it can be traced with certainty only to the southeast end of the Point Lookout claim.

Mountain View Vein Fault

The Mountain View vein is a continuation of either the Point Lookout or Mud Vein faults, more likely the latter. The Mountain View Vein fault outcrops as a gossan 20-foot wide on the ridge crest in the Mountain View claim. The outcrop strike is almost due north, with a southward dip of 85 degrees, but it bends westward and its continuation may be traced by means of caved tunnels in the south end of the Rough and Ready claim. Several tons of oxide ore are piled at these portals.

The fault is cut in the Jennie Drifts of the Durango level and, also, in the writer's opinion, in the Durango cross-cut. The fault at depth.
has flattened to about 35-40 degrees and contains slightly mineralized gray clay gouge.

Wilson Fault
The Wilson fault is best exposed in a road cut in the Wilson Lode claim, but it can be traced northwest and southeast by lithologic discontinuities. The fault dips approximately 60 degrees north and is probably genetically related to the Caledonia fault.

New York Fault
The offset segments of this fault outcrop as iron gossans. The fault strikes northwest and dips approximately 60 degrees south. U.S. Geol. Survey Bull. 814 shows the projection of the Red Elephant Consolidated fault as lying near this mapped fault. The projected and actual fault should not be confused, as sections show that the New York fault is well in the hanging wall of the Red Elephant Consolidated vein.

Red Elephant Consolidated Vein Fault
The Red Elephant Consolidated vein fault does not outcrop, or if so it is not yet correlated with any of the major faults to the north. The fault is cut by the Lipman Tunnel about 2000 feet from the portal.

Goose Egg Fault
The Goose Egg fault can be traced across the Goose Egg, Manhattan, and New York claims. In the New York claim the strike is almost due north dipping east. The fault is a strong structure where it is cut in the Lipman Tunnel.

Indian Queen Fault
The Indian Queen cuts across the west end of the Indian Queen claim. The strike is N. 10°-15° W. and, where observed, dipped 80° W. Gossan outcrops on the north and middle of the fault, reach 6 feet in width. About 100 feet of the fault is filled by a quartz dike. Intermittent breccia zones outline the remainder of the fault length.

The portions of this fault with gossan outcrops should be thoroughly tested.

Minor Faulting
There are a number of minor faults of varying magnitudes, the most important of which strike northeast with dips both to the north and south. These appear to be mainly normal faults. There are also many small reverse faults visible underground, some almost flat, others of a high angle of dip.

Folding
The lack of key beds within the major fault blocks prevents positive determination of the fold structure. Lack of stratigraphic knowledge which would permit correlation of the lithology of the major fault blocks also prevents determination of major pre-fault fold structures with any certainty. However, there is apparently a broken syncline lying south of the Mud Vein fault and an anticline north of the Mud Vein fault. This picture is complicated by a zone of small overturned folds in the overlap area of the Indian Queen and Emma claims. It appears probable that there are also large overturned folds in the same area.

UNDERGROUND STRUCTURE ON MAYFLOWER LODE
The underground structure can most easily be understood and described if the subject is considered with respect to three distinct areas. These areas are:
1. The Jay Gould workings.
2. Workings in the Mayflower claim.
3. Workings starting in the Bullion and Ophir claims.

As the greatest amount of mapping was done on the various levels in the Bullion claim that area will be described first.

Bullion No. 3 level.—The Bullion No. 3 level is the uppermost of the mapped levels, and can be reached from a short raise in the Brown level. The level and its stope were mined from portals and shafts, now inaccessible, in the western part of the Bullion claim. The major structure, as exposed at the caved end of the drift, is a single fault which was followed by the drift. In the western end of the drift the fault contains mill ore up to 6 feet in thickness extending to the south crosscut. From the crosscut the fault pinches until at the face, in the east end of the drift, there is only an inch of gouge. The transition from mill ore to waste is a sampling problem, but as shown by iron stained breccia and gouge a small amount of sulphides was present along the length of the fissure. As shown in Section BB' (Plate 4) the Bullion No. 3 fault pinches out near the head of the winze to the Bullion No. 4 level. The pinched out ends of the faults from Bullion No. 3 and Bullion No. 4 overlap with a vertical separation of three to four feet.

Striations and slickensides show that at least the last fault movement was normal.

Brown level.—The Brown level is 17 feet lower in elevation than the Bullion No. 3 level, and there is direct access through a partially caved portal to the surface. A short crosscut connects this level with the winze to the Bullion No. 4 level.

There is no strong structure in the west end of the Brown level, and moreover the drift lies in the footwall of the Bullion No. 3 fault. East
of the portal crosect a small stope was opened on an expansion of a modest structure cut just at the drift end. While there is a higher angle fault forming the south wall of the stope there is evidence of stope filling so it may have continued below the level. No ore is now in sight.

At the east end of the drift a winze gives access to the Brown stope which was opened on a second vein, which will be referred to as the Brown stope vein, lying only a few feet below the level. High grade galena ore is exposed in all parts of this stope with thicknesses varying from 6-18 inches up-dip to 3-4 feet down-dip. This is probably the most interesting part of the mine at the moment.

According to old maps a short drift was driven northeast from the southeast end of the Brown stope, possibly following the limit of ore. At the bottom of the stope a winze connects with the Boggs level. The dip of the vein in the Brown stope is such as to place the winze in the footwall of the vein, thus leaving what appears to be a large area of favorable ground completely unexplored. If, as seems possible, the large fault exposed in the Boggs level at coordinates 7,050 E. and 7,550 N. is the same, there is about 200 feet down the dip of the vein between the Boggs and Brown levels to explore.

**Bullion No. 4 level.**—The Bullion No. 4 level is actually two interconnected levels. The uppermost is about 30 feet below the Brown level and may be reached by a winze from the Brown level. The lower Bullion No. 4 is 20 feet below the uppermost Bullion No. 4, and in the western end may be reached through a half-filled stope; this end of the lower drift was not mapped. The main connection between the two levels is near the east end of the upper level through an open stope. The upper level continues west through a series of minor workings which, because of the lack of time, were not mapped.

The vein exposed on the Bullion No. 4 level pinches up dip as noted above, and there is no connection with the vein on the Bullion No. 3 level. On the east end of the Bullion No. 4 level the vein is less than one-half inch wide where it passes into the wall of the drift. As shown by the map, the vein has been stoped down to the Bullion No. 5 level with the stope having a rake (angle from the strike or horizontal direction of the ore shoot in the plane of the fault) of about 45 degrees to the southeast. As shown in cross section (Plate 4) the stope are in the steepest part of the vein.

The general outline of the stope is shown on Plate 3, but the stopes were not mapped in detail.

As shown in a gopher hole in the side of the winze to the Bullion No. 5 level the vein, while still containing up to 2 feet of mill ore, is rapidly pinching to the southeast.

**Bullion No. 5 level.**—The Bullion No. 5 level marks the bottom of the largest stope on the Mayflower lode. At the level there are a number of places where considerable thicknesses of mill ore are visible. Old maps show stopping continued 15-15 feet below the level but the stopes were back filled. The dip of the vein averages 55 degrees except in the southeast end of the level where the dip flattens to 30 degrees. In that area there is one to two feet of ore up dip but with only a gray clay gouge on the level itself.

At the northwest end of the level the vein has been cut by a strong fault. At first glance it appears as if this fault is simply a gouge-filled continuation of the main vein fault. However, it is believed that the vein fault is cut by a second fault of nearly the same strike and dip and perhaps of roughly the same age. While the fault appears strong there is no important displacement except possibly in a strike slip direction.

Although local flattennings of the vein between Bullion No. 5 and Bullion No. 4 appear to have formed rich ore shoots, over-all the ore zone is in a steep portion of the vein.

**Boggs level.—**The short winze from the No. 5 level to the Boggs level begins in the vein, and passes into the vein footwall. Continuation of the vein from the No. 5 level can be located with certainty only in a short length of drift 15 feet southwest of the winze. The vein dips 30 degrees southwest, has a maximum width of two and one-half feet and is filled with iron-stained gouge and breccia. It pinches rapidly southeastward. To the northwest the vein can be traced into logged ground where it is cut off by the N. 15-20° E. striking No. 1 Boggs fault. This is a low angle fault with a gouge thickness of up to 6 feet.

The offset segment of the Bullion No. 5 vein has not been discovered on the Boggs level. According to Bulletin 814, p. 143, Bunker Hill and Sullivan Mining Company geologists considered that there was a southwest slip of the footwall of the No. 1 Boggs fault (or parallel slips) on the order of 200 feet. The level, in its continuation into the Mayflower workings, follows a zone of minor slips but cross-cutting to the north would undoubtedly intersect other fault planes, and possibly the slightly offset segment of the Bullion No. 5 vein.

The continuation of the level into the May-
flower workings is more likely to be on a group of slips related to the No. 2 Boggs fault which is exposed in the south portion of the Boggs level loop (Plate 3). The No. 2 Boggs fault contains altered dike material mixed with gray clay gouge. The great thickness of gouge in the fault is probably due to its passing through more argillaceous rock. Attitudes of the foot and hanging wall show that the fault probably pinches southeastward and down dip. The Boggs No. 2 fault is undoubtedly part of the Mayflower fault zone but it represents a plane of movement different from the Bullion No. 5 vein.

The southeast extension of the Boggs level east of the Boggs level loop (see Plate 3) follows a fault zone, which, at coordinates 7,050 E. and 7,330 N., has a 45-foot slip filled with iron-stained siderite and breccia. As noted above this fault may be the same as the Brown stope fault. The fault is cut by a northeast-striking high angle fault, and the faulted-off segment probably lies in the north wall of the drift. Minor slips parallel the drift eastward and culminate in a strong fault which can be followed past the caved foot of the Durango shaft. The up dip portions of this entire fault zone should be explored.

Durango level.—The Durango Tunnel is about 180 feet below the Boggs level. The tunnel and Durango drifts were the work of early miners, the remainder by the Bunker Hill and Sullivan Mining Company in the years 1921-24. This company drove the meandering drifts and some minor crosscuts that were run immediately after the Boggs and Bullion workings. The Durango tunnel was also continued to the southwest, the Jennie drifts were run, and also the Durango crosscuts. The Durango crosscuts were driven under the assumption of a major displacement of the Mayflower fault zone by a parallel striking flat fault.

As noted in Bulletin 814, p. 146, the simplest explanation of the geology which also fits the observed facts does not require any major crosscutting offsets of the Mayflower fault zone. The single major structure in the western Durango drift and the complexity faulted area in the east portion of the Durango drift is probably the Mayflower fault zone at that level. It is possible that the shear zone, cut 100 feet (Plate 3) southwest from the beginning of the Durango crosscut, is also the Mayflower fault zone. However, as shown by Plate 4, this fault appears to lie in the footwall of the fault zone followed by the Boggs levels.

The major fault exposed in the Jennie drift and in the Durango crosscut is probably the fault explored by the Mountain View mine (Mountain View Fault). As the dip of the fault in the Jennie drift is 35°, and the dip 500 feet above the surface is roughly 85°, they might be assumed to be two different faults. However, the Mayflower fault zone shows the same flattening of dip at depth. To summarize, two major faults or fault zones are exposed on the surface; two major faults or fault zones are cut at depth.

It might be added that the Mountain View fault is either a continuation of the Mud Vein fault or the Red Elephant—O.K.—Point Lookout vein fault. In either case there is no point in continuing a search for the "Red Elephant vein" in Durango workings. Continuation of the left hand Durango crosscut will, of course, reach the Red Elephant Consolidated vein.

UNDERGROUND GEOLOGY OF MAYFLOWER COUNTRY

Ore has come from several levels in the Mayflower area; however, these levels were not accessible in the summer of 1949.

The Mayflower tunnel is 970 feet long and cuts major fault structures at 558 and 732 feet. The strongest structures have been explored by the Mayflower level which connects to the east with the Boggs level.

The major structure is a black clay gouge with fracture zones on hanging and foot wall, the foot wall being more fractured. The dip of the gouge-filled fracture is extremely variable going from 10 to 75 degrees within 100 feet along the drift. Eastward, the probable continuation of the fault goes into the wall where the drift takes a jog to the south, just past the raise to the intermediate levels. This jog undoubtedly is the junction between the Boggs and Mayflower levels. It is quite evident that the zone of faults followed by the Boggs level lies in the hanging wall of the fault followed in the Mayflower level.

The two small intermediate levels above the Mayflower level are connected by a maze of corkscrew raises which are shown in a simplified manner in Plate 2. The dip of the faults on these two levels show that they coincide with structures on the Boggs portion rather than the Mayflower portion of the level which lies directly below. An inaccessible raise goes from the intermediate levels to ore-bearing levels above. The lack of alteration of the fault gouge indicates little prospect of ore, in depth, in this section of the fault zone. Northward, the major structure on the Mayflower level pinches and passes into the wall as a very insignificant looking fault containing about 3 inches of gouge.
WAR EAGLE WORKINGS

Location of the War Eagle portal, as shown on Plate 16 of Bull. 814, could not be verified. In accordance with Lindgren (17) the War Eagle portal must be the portal on the east edge of the small gulf in the west end of the Mayflower claim. According to Lindgren (op. cit. p. 201), in 1898 work in the Jay Gould was being carried on by way of the War Eagle portal. The portal of the upper Jay Gould level is caved but its approximate position, based on old maps, would place it near what is believed to be the War Eagle portal. While the name of the workings may have to be changed they lie on a continuation of the Mayflower lode rather than on a separate fault zone. In the summer of 1949 the portal was caved but because old maps indicated possible connections with the upper Mayflower levels an entire day was spent by the writer and his assistant in reopening the portal. The condition of the reopened workings, however, prevented mapping. A short tunnel about 40 feet long led to a large southeast striking stope, which, on the east end, broke through to the surface. This stope is a continuation of the open stopes of the upper Mayflower workings (see Plate 2). A drift to the northwest in the direction of the Jay Gould workings was caved and back-filled as was a southwest-bearing crosscut leading from the west end of the stope.

JAY GOULD UNDERGROUND

Two lower levels of the Jay Gould mine were open in the summer of 1949. Two levels above the "upper" level as described in this report were visible in a raise, but could not be reached. The two accessible levels are connected by a series of raises and small stopes which lie about 300 feet west of the tunnel.

Upper level. — The portal and the first hundred feet or so of the upper tunnel is now caved. The first 300 feet was driven in the hanging wall of the fault which was followed by the remainder of the level. While it is probable that the level followed a single major structure, the vein is now visible over a distance of only about 70 feet in the eastern part of the level. The walls on about 300 feet of the level are covered with one-fourth of an inch of soil, and the walls are so rotten that no attempt was made to trace the vein. To the west, past the sooty area the fault is less than an inch wide and contains only clay gouge. The fault quickly widens and continues as a strong feature almost to the west end of the level. The westmost 30 feet of the level passes into the footwall of the fault. The vein was stopped above and below the level with the main stopes lying below. The dip of the fault ranges from 50 to 70 degrees Southwest, but averages about 55 degrees; striations on slickensides show the last movement was normal. The country rock is mainly quartzite which strikes northwest and dips between 10° and 40° N. This attitude is completely opposite to the dip in the lower level.

This is the only level in the entire Mayflower group which contained ore and in which there was adequate crosscutting.

Lower level. — The lower level is reached by way of a 790-foot tunnel driven late in the life of the mine. A number of small, high, angle stopes were cut in the tunnel but the most interesting geologic features are the very flat, slightly undulating but almost horizontal faults. Small horses lie in the fault but the displacement is not known. In addition the bedding, while parallel in strike to the surface bedding, is dipping at low angles to the south rather than to the north as at the surface.

The only strong fault cut by the tunnel has been driven on along the level. At the intersection of the tunnel and the drift, the fault is filled with about one and one-half feet of black gouge. A channel sample of the black clay gouge assayed 0.5 per cent lead and 0.8 per cent zinc, silver was nil. There is minor shattering on the foot wall. The fault was followed to the east with the drift for about 180 feet. The last 60 feet is filled with siderite and a small amount of galena and tetrahedrite. The fault pinched rapidly east of the stoped area and the drift went into the hanging wall. A second low angle fault was intersected 50 feet further east, and, as shown on the map (Plate 4), it may be an offset segment of the main fault. The drift was driven into the hanging wall of this fault for about 60 feet and then stopped.

The drift west of the tunnel intersection was apparently driven to reach the large stope on that level as it follows a series of minor low angle faults, turning north and ignoring each as these faults began to strike to the south. As shown in the raises and small stopes which connect the two levels, there is probably no single fault plane in the lower level of this portion of the mine that can be correlated with the main fault of the upper level.

Forty feet east of the caved portion of the lower level a raise gives access to a stope between the levels. This stope exposes a strong northwest striking vein which dips about 35 degrees north. The vein is about six feet wide and contains galena ore of shipping grade. Down dip this vein is cut off by a high angle fault dipping 70 degrees to the south. As shown in cross-section (inset of Plate 3) it appears that
the offsetting fault is not the fault of the upper level; however, as the survey was carried by Brunton and tape it is probable that the faults are identical.

As the vein dips north and is of some magnitude it is probable that this is the Caledonia fault. On the surface the Caledonia fault dips 75 degrees north but as flattening at depth is characteristic of the major faults of the area the approximately 40 degree dip in this stope is not a good reason for assuming two different faults.

Although there is no appearance of an ore shoot formed by intersecting veins in this stope the larger stopes between the inaccessible portion of the lower level and the upper level may have been on a vein intersection with the Caledonia fault.

In any case there is a long segment of the Caledonia fault which should be carefully explored up dip.

ORES

Polished surfaces of the ores of the mines have not as yet been examined, but it is hoped that a separate paper describing the ores will be published in the near future.

The following list of minerals are known to occur in the ores of the area. Most have been identified in hand specimens. Others have been reported in U.S. Geol. Survey Bull. 814 but have not been recognized in the recent examination.

Argentite—reported in Bull. 814
Anglesite
Azurite
Cerussite
Chalcopyrite
Galena
Hissingerite—from Jay Gould
Limonite
Malachite
Minimum—down to 40 feet in Jay Gould. Reported in Bull. 814
Molybdenite—one specimen from Bullion mine—reported in Bull. 814
Lead—in upper 40 feet of Jay Gould according to Bull. 814
Silver—reported in Bull. 814
Quartz
Ruby Silver—specimen from Jay Gould dump
Pyrolusite
Siderite
Sphalerite
Tetrahedrite—more in Jay Gould than Bullion workings

Galena, sphalerite and tetrahedrite are the most common ore minerals in that order. Sphalerite is perhaps more abundant in the Red Elephant workings. Tetrahedrite seems more abundant in the Jay Gould workings, although considerable silver has been present in all the ores mined.

The most common metallic gangue minerals are pyrite and chalcopyrite; chalcopyrite being much more abundant in the Red Elephant workings. The dominant non-metallic gangue minerals are siderite, calcite and quartz. Siderite is most abundant and is clearly closely associated with the ore mineralization. The time of quartz introduction is uncertain; the calcite is definitely post-ore.

The zone of oxidation was little over 40 feet in depth (See Umpleby Bull. 814, p. 117 for details) and most of the oxidized ore has long since been removed. The ore in the Brown level stope of the Bullion mine is partially oxidized; there malachite and azurite film breccia particles and galena, but the galena has been only slightly replaced.

Ore solutions were undoubtedly introduced into the faults along the more permeable channels occupied by breccia rather than gouge zones. Specimens from ore bodies and from mineralized fault zones adjacent to ore bodies show that the ore solutions have replaced quartzite, silicious argillite and limestone fragments. No limestone fragments were recognized in shipping grade ore from the Jay Gould intermediate level stope; nor in low grade milling ore east of the large Bullion stope on either the Bullion No. 4 or No. 5 levels. Scattered limestone fragments are present in the ore of the Brown level stope. From the evidence along the margin of mined out ore bodies it appears that the more permeable channels were largely filled with harder quartzite and argillite fragments which were replaced by ore and gangue minerals.

It seems possible that gouge-filled portions of the faults were formed by crushing the much softer argillaceous limestone and calcareous argillite. Bleached clay gouge and altered dike fragments along sections of the Mayflower fault zone show that some gouge sections were permeable.

There are good examples of black clay gouges which have not been altered in the Mayflower fault zone, with the exception of the Jay Gould tunnels. If bleached clay gouge in the various portions of the Mayflower fault zone was formed by ore solutions, then portions of the fault containing black clay gouge either cannot directly overlie ore solutions
channels or less likely represent impermeable dama. In either case several areas of the mine become only of secondary interest to further exploration. The mapped portions of the Jay Gould lower level east of the main stopes, and entire Mayflower level and most of its continuation, as the Bogus level, show little promise for the occurrence of ore at depth.

On the other hand the faults in the Bogus and Durango levels under the big Bullion stope are thoroughly altered and indicate the general direction from which the ore solutions came, and if followed in depth might prove ore-bearing.

The influence of lithology and rock attitudes, if any, in the formation of ore shoots is a matter for conjecture. Bedding in the Jay Gould mine strikes and dips in radically different directions with no apparent influence on ore deposition. With only minor rolls, the bedding in the lower portions of the Mayflower and Bullion mines has on almost uniform northwest strike and northeast dip. As the drifts on the ore-bearing levels followed faults, and there was no crosscutting, bedding determinations were rare and there is no possibility of comparing bedding attitudes with the lower portions of the mines.

The wall rock in the stopes and along the upper levels is mainly quartzite. There is more argillite and calcareous material exposed in the lower barren levels but quartzite is still dominant. There is a possibility then that ore deposition occurred in those parts of the Mayflower fault zone in which a dominance of quartzite fragments produced permeable fault breccias. If such is the case ore may be present at depth if the fault zone has cut another thick quartzite sequence.

The age of these ore deposits is uncertain. Umpleby (op. cit. p. 90) says:

“All the different masses of granitic rock have points of petrographic similarity, and all are believed to have been intruded during the same period of igneous activity.” On the same page Umpleby points out that “they (the ore deposits) occur in rocks of a number of different types, but each of the groups except the small one on Lake Creek is near a mass of granitic rock.”

The hydrothermally altered granitic dike material in the faults of the Mayflower fault zone does not imply anything with respect to the age of the mineralization other than that the mineralization followed a period of granitic intrusion which is considered to be Cretaceous.

CONCLUSIONS

As to be expected, the major problem as to why these ore shoots do not continue to depth, has not been solved. The writer believes, and the most recent exploration attempt (1921-24) has shown, that there has been no offsetting of the Mayflower fault zone. Further, the writer believes that the Mayflower fault zone is cut in the Durango drifts of the Durango level and that the strong fault followed by the Jenny drifts is the Mountain View fault. Surface mapping shows that the Mountain View fault is probably a continuation of either the Mud Vein or the Red Elephant fault. There is no continuous outcrop and as the two faults converge no distinction is possible.

The two faults on the Durango level are filled with gray clay gouge. The gray color of the clay is probably due to hydrothermal alteration of black clay similar to the gouge in the Mayflower and lower Jay Gould levels. The Mountain View faults also contain visible pyrite. It is probable that the ore solutions passed through the gray clay gouge zones but only sinking will tell if ore lies at depth.

There appears to be no criteria which would indicate that the absolute bottom of the ore mineralization had been reached. Even though a thousand feet of the fault zone may have been removed by erosion, the last 200 feet which has been mined showed no evidence of zoning or reduction in values such as to indicate a bottoming of the lead-silver mineralization and a change to zinc or copper mineralization.

The present bottoming, therefore, should be considered as structural or lithologic with the possibility of the proper structural or lithologic conditions being repeated at depth.

SUGGESTIONS FOR EXPLORATION AND PROSPECTING

The suggestions for exploration and prospecting have been divided into two groups. The first group is of a general nature, the second deals with specific features of the various mines.

General Suggestions

Most of the outcrops of the major veins have been adequately prospected but all gossan outcrops other than veins known to have been worked at depth should be examined by test pits. Barren iron and manganese gossans may run into ore fairly near the surface. Ten-foot deep pits followed by long-steel drill holes should be adequate. The Ridge Vein in particular should be examined.

There has not been adequate crosscutting in any of the mines along the Mayflower fault
zone except in those levels below the main ore occurrences. As the ore lies in overlapping fault fissures, not in a single fissure, crosscutting in the upper levels may discover more ore. In addition it appears possible that the walls in the stopes may be false walls and that not all of the ore has been removed. The hanging and foot walls of the large Bullion stopes should be probed with long steel.

Detailed Suggestions

Some of the suggestions have been mentioned in the description of the underground geology but will be repeated here.

**Bullion Country**

1. Ore remains in the Brown level stope, both up and down dip. Raising from the Boggs level, beginning at coordinates 7,440 N., 10,650 E., along the fault may reach the bottom of this ore.

2. Reopen and continue the raise in the west Durango drift at coordinates 7,380 N. and 10,500 W. This is probably on the continuation of the Mayflower fault zone. Iron oxide drip in the Durango shaft immediately west indicates sulphide above.

3. The iron-stained fault in the Boggs level at coordinates 8,300 N. and 7,930 W. should be raised on.

4. There should be crosscutting to the north near the above point or further east on the Boggs level. There is no assurance that the entire width of the Mayflower fault zone has been cut, and crosscutting north would be most likely to intersect any structures.

5. While no great amount of ore has come from the Mountain View vein, raising on the Mountain View fault from the Jennis drifts, particularly the west drift, may be productive.

**REFERENCES**


GEOLaY AND WORKINGS IN THE BULLION PORTION OF THE MAYFLOWER FAULT ZONE, BULLION GULCH, BLAINE COUNTY, IDAHO

EXPLANATION

- Low grade ore, showing dip
- Faults, showing dip
- Vertical fault
- Probable fault
- Direction and plunge of strike and dip of bedding
- Bullion No. 3 Level
- Bullion No. 5 Level
- Bell Level
- Nearby Level
- Intrusive Level
- Cross-cutting with probable continuation outside of mine
- Head of mine or raise
- Foot of mine or raise
- Inclined mine
- Shafting
- Logging

Scale: 1/2 inch = 100 feet

Fig 5 Map of the underground workings of the Minnie More mine (Geology by R.T. Walker and W.J. Walker)