Silver-Gold Deposits of the Yankee-Fork District
Custer County, Idaho

By

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SILVER-GOLD DEPOSITS OF THE YANKEE FORK DISTRICT
CUSTER COUNTY, IDAHO

by

ALFRED L. ANDERSON

ABSTRACT

This report deals with the geology and the silver-gold deposits of the once famous and rather highly productive Yankee Fork district in northwestern Custer County, Idaho. Until about the turn of the century the district produced about $12,000,000 in silver and gold, chiefly from the General Custer mine, the mainstay of the district until it closed in 1905. Since then there has been recurrent activity which has increased the total production by about $1,000,000, half of it during the several years just prior to the beginning of the late war.

The deposits are enclosed in the Challis volcanics (Oligocene), which rest on a basement of Paleozoic and Mesozoic rocks composed of the Wood River formation (Pennsylvania), Casto volcanics (Permian), and the Idaho batholith and its outliers (Jurassic or Cretaceous). In places the basement rocks and overlying volcanics are pierced by porphyritic dikes, chiefly dacite porphyry (lower Miocene). The Paleozoic strata have been strongly tilted and faulted and intruded by the batholith. The Tertiary volcanics above the highly deformed basement rocks have been gently warped and locally fractured.

The deposits are confined to half a dozen zones of complexly fractured and extensively altered volcanic rock, apparently localized above old lines of structural weaknesses developed in the basement rocks during the Laramide orogeny (late Cretaceous and early Tertiary) and reactivated during the mid-Tertiary crustal disturbance, which culminated with the silver-gold mineralization. The deposits comprise mostly breccia veins and lodes and to lesser extent mineralized fracture zones of the chimney and stockwork type.

The vein and lode fillings consist largely of fine-grained and coarser comb and drusy quartz, locally lamellar calcite, with minor amounts of chalcedony, adularia, and exceptionally barite and amethystine quartz. Some fillings contain considerable pseudomorphous quartz, revealed by leaching of the calcite. In most of the ore now exposed, metallic minerals are sparse and so fine-grained as to be apparent only on careful inspection. The complete list of these minerals includes pyrite, chalcopyrite, sphalerite, tetrahedrite, galena, arsenopyrite, enargite, stibnite, micargyrite, pyrrhotite, argentite, electrum, gold, and, apparently, silver selenide. The more important ore minerals are the argentile, electrum, and gold, and locally the silver sullontimine and selenides. The base metals are appreciably abundant in only a few places. Most of the ore contains 80 to 90 times as much silver as gold by weight.

The fillings show considerable bonding and crustification, particularly around fragments of the wall rock. The scaly base-metal sulfides are associated with the fine-grained quartz, making it grayish, and commonly occur as breccia fragments in a matrix of the coarser, crustified and generally drusy quartz. The precious metal minerals occur with the younger, more coarsely crystalline quartz, often, in veins on the surface of the quartz crystals. The calcite is later and replaces the quartz extensively.

Ore minerals are irregularly distributed, but much of the ore mined in the early days had a bonanza occurrence, with very rich pockets close to the surface. The ore has a shallow vertical range and nowhere has been found to extend downward for more than a few hundred feet. Rich pockets are still found, but much of the ore still unmined contains 20 or less in silver and gold, much of which is not amenable to amalgamation.
INTRODUCTION

During recent years considerable interest has been manifested in the formerly famous Yankee Fork district, which near the turn of the century was one of the most important producers of gold and silver in the State. Although many mines reached the peak of their activity in the nineties, the era of greatest productivity did not end until 1905, the year the Custer mill, which had been responsible for the larger part of the district's output, suspended operations. For several years thereafter mining operations were unimportant, but attempts were soon made to reopen some of the mines or to develop those which previously had not received so much attention. Some of the later work was rewarded, but some of it was not.

There was recurrent interest in the district during the next several decades, but work was intermittent and generally of little consequence, with small production. In the late thirties and early forties, however, the district experienced a boom and a production of nearly half a million dollars, mostly from the Lucky Boy, the mine that supplied the Custer mill during the last few years of its existence.

The late activity at the Lucky Boy and the discovery of pockets of high-grade ore in nearby properties did much to inspire the current interest in the district. Some operators have been encouraged in the belief that deeper development was justified and that the larger reserves of low-grade ore which the early operator could not afford to mine could now, because of reduced transportation costs and more economical mining and milling methods, be utilized.

In response to requests for information on the district by those interested in its economic possibilities, the Idaho Bureau of Mines and Geology undertook a comprehensive investigation of the ore deposits and their geologic environment. The findings are such as to discourage deep development but do offer some encouragement to newer development at shallower depths.

FIELDWORK AND ACKNOWLEDGMENTS

Work in the field was started on June 18, 1947, and continued until August 23. During this time, all the mines and prospects open to inspection were examined and geologic sketch maps prepared of those with accessible workings. A detailed aerial geologic map was also made of the most extensively mineralized area, and a second map of a part of another. Time, however, did not permit detailed mapping of several other mineralized areas in the district.

In addition to these special large-scale maps, an aerial geologic map was prepared to embrace much of the district, using a photographic enlargement of a part of the Custer quadrangle as a base. The southern part of this map incorporated some of the work done by Ross in his study of the Bayhorse region. On the north the map joined the one made by him of the Casto quadrangle.

Study of the mineralization was handicapped by poor exposures and by the difficulty in obtaining representative specimens of the ore such as was mined in the early days. The mineralogy of the deposits therefore could not be treated in the detail desired, but the specimens obtained and exposures accessible for study provided enough information for a fairly comprehensive understanding of the nature and conditions of mineralization.

During the field investigation the writer was ably assisted by Mr. Thor Killeggaard, Junior Geologist, Idaho Bureau of Mines and Geology, on whom fell the brunt of the underground mapping and the work on the surface with the plume table. The writer wishes to take this opportunity to express his gratitude to Mr. Killeggaard for his capable and efficient services and also to convey his thanks to those within the district for their most helpful cooperation. Special acknowledgments are particularly due Messrs. Charles E. Reamsnyder, Troy A. Becker, Frank Casto, and Lew Cruthers. The writer also wishes to offer his thanks to the U. S. Forest Service for the use of one of the buildings at the former C & C camp at Bonanza as headquarters while field work was in progress.

PREVIOUS GEOLOGIC WORK

The only previous geologic work in the district was carried on by Umpleby and by Ross. Umpleby's interest was primarily in the mineralization and he was given considerable information on the occurrence and geologic relations of the ore deposits. Ross's work has been of a reconnaissance nature and has consisted mainly of geologic mapping in the southern part of the district with few details on the mineralization not already supplied by Umpleby. His reports on the overlapping Bayhorse region and adjoining Casto quadrangle assist greatly in an understanding of the local geology. Some mineralogic details have been supplied by Shannon and some information on the district is contained in various annual reports of the State Inspector of Mines and in the annual volumes of Mineral Resources of the United States issued from 1892 to 1924 by the U. S. Geological Survey and from 1924 to 1931 by the U. S. Bureau of Mines and its successor, the Minerals Yearbook. Much data on the early day activity of the district are contained
ESTES MOUNTAIN
A. Estes Mountain is carved in the light-colored Germer tuffaceous beds. The picture shows the southwest slope and some of the mine dumps close to the summit.

JORDAN CREEK VALLEY
B. Picture shows the glaciated valley of upper Jordan Creek. The Golden Sunbeam mine lies on the valley slope on the right of the picture just above the valley bend.
Picture is taken down valley.
FOOTWALL OF CUSTER VEIN

A. The footwall of the Custer vein appears in the immediate foreground; the light-colored beds of the Germer tuffaceous member compose the mountains in the background.

LUCKY BOY MINE

B. The Lucky Boy mine is in the dark-colored flows of the andesite-latite member. Mountains in the background are carved in the Germer tuffaceous beds. The highest peak in the distance is Mount Graylock.
in a book by Strahorn. All references, except
those of the State Inspector of Mines and Min-
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GEOGRAPHY

LOCATION

The Yankee Fork district embraces all the
mineralized areas in the drainage of Yankee
Fork of Salmon River. It is in southwestern
Custer County (Fig. 1), close to the geographic
center of the State. Much of it is in unsurveyed
T. 12 N. and T. 13 N., R. 15 E., Boise meridian,
for the most part between 44° 00' and 44° 30'
north latitude and 114° 40' and 114° 50' west
longitude. The only mineralization not within
these borders is at Red Mountain near the
head of West Fork of Yankee Fork close to the
junction of unsurveyed Ts. 12 and 13 N., Rs.
12 and 14 E.

TOPOGRAPHY

The district is in the high rugged Salmon
River Mountains, a deeply dissected and in
part glacially sculptured upland drained by the
Salmon River and its tributaries. Ridges
reach accordant levels at 9,000 to 10,000 feet
above sea level. Valleys are entrenched as
much as 3,500 feet below the ridges. General
mountain at 10,325 feet is the highest point in
the district; Mount Jordan at 10,052 feet is next.
Other peaks of note are Eustis Mountain at
9,842 feet, Mount Graylock at 9,852 feet, Bachelor
Mountain at 9,503 feet, Bonanza peak at
9,507 feet and Custer Mountain at 9,742 feet.
These peaks are shown on the geologic map of
the district, Figure 2. The lowest point, where
Yankee Fork leaves the district, is 6,182 feet
above sea level. The general nature of the
topography is shown in Plates 1 and 2.

The district is drained by Yankee Fork and
its tributaries. Yankee Fork flows south-south-
west across the district and joins the eastward
flowing Salmon River about 4 miles below. Its
principal tributaries are West Fork, which flows
from the west; Jordan Creek, which flows south;
and Eight Mile Creek, which flows first north-
east and then southeast. Smaller tributaries of
importance are Fourmile of July, Adair, Slaugh-
terhouse, and Five Mile Creeks, which join
Yankee Fork from the east. Lightning Creek is
one of the larger tributaries of West Fork. Val-
leys occupied by these streams are generally
steep and narrow, but locally some of them
widen and contain comparatively broad valley
floors. Yankee Fork shows this feature below
the mouth of Jordan Creek. It is also shown by
West Fork and in part by lower Eight Mile.
Jordan Creek heads in a broad U-shaped valley
(Plate 1B), but soon enters a sharp, narrow
valley. Most of the other streams head in glacial
cirques.

CLIMATE AND VEGETATION

Because of the altitude, the district has a
rigorous climate. Winters are long and snows
are deep, lingering well into the short sum-
mer. Snow may fall during any month of the
year, but that of late spring and early autumn
remains but a short time. While the winter was
in the district, there were falls of snow on June
19 and 20 and again on August 23. The sum-
mer, though short, is pleasant. Temperatures
may drop to the freezing point on most nights,
but reach into the seventies during the day.
Normally, there is little precipitation during the
summer months.

The annual precipitation is not known, but
the amount is sufficient for heavy timber growth
on protected slopes. This growth consists largely
of lodge pole pine, spruce, and fir. Well-
drained slopes are covered by sage brush.

SETTLEMENTS

Bonanza, a half mile below the mouth of
Jordan Creek, and Custer, about 2 miles above
on Yankee Fork, are the only settlements in
the district. A few houses and cabins remain
of what were once thriving settlements with
several thousand inhabitants each. All remain-
ing cabins are occupied during the summer
months, but ordinarily no more than a family
or two remain through the winter. A gas sta-
tion operates at Bonanza during the summer,
but the nearest store and post-office is at Sun-
beam at the mouth of Yankee Fork about 6
miles below Bonanza. Because of placer opera-
tions, both above and below Bonanza during
1947, the district experienced a serious housing
shortage.

Challis, the county seat, is on the Salmon
River about 60 miles below the district.
ACCESSIBILITY

The Yankee Fork district is within easy reach of U. S. Highway 93 which lies along the Salmon River. From the mouth of Yankee Fork a graded road maintained by the Forest Service extends upstream through Bonanza and Custer and on over the divide to Challis. A branch on Jordan Creek ends at the Boyle Ranch on Loon Creek.

The district is within 85 miles of Mackay and the same distance from Ketchum, each a terminus of branch lines of the Union Pacific Railroad. During the winter months the highway to Ketchum is closed and the only outlet is down the river to Challis.

Sunbeam had tri-weekly mail service throughout the year and daily stage service during the summer months, with the trip to Challis and Salmon and to Ketchum on alternate days. At Challis there is daily stage service to Pocatello via Mackay and to Salmon.

GEOLGY

GENERAL STATEMENT

The rocks of the district consist of a thick accumulation of flows and tuffs of Tertiary age, the Challis volcanics (Oligocene), which rest on a floor of Paleozoic and Mesozoic rocks — the Wood River formation (Pennsylvanian), the Casto volcanics (Permian?), and the Idaho batholith and its outliers (Jurassic or Cretaceous). Other rocks include some small bodies of intrusive igneous rocks (lower Miocene) and minor amounts of alluvium (Quaternary).

The chief interest is in the Tertiary igneous rocks which are host to the ore deposits; the basement rocks are important for the part they have played in the deformation of the rocks above and thus in their more or less direct control on the mineralization. The basement rocks have been subjected to at least three crustal disturbances, the volcanic cover rocks to the third alone. Thus there is marked contrast in the structural complexities of the two groups.

BASEMENT ROCKS

Wood River Formation (Pennsylvanian)

As mapped by Ross the Wood River formation extends northward through the Custer quadrangle to a point a short distance south of Bonanza. From there on, isolated patches are exposed through the Challis volcanics on upper Bonanza Creek near the Sunbeam mine and at the head of Lightning Creek in the northwest corner of the district (Fig. 2). Some of the rock at the head of Lightning Creek may possibly belong to the Milligen formation (Upper Mississippian). Because of locally intense metamorphism adjacent to the Idaho batholith, there is considerable difficulty in distinguishing between rocks of the two formations, but where the metamorphism is less intense the character of the rock appears to favor the Wood River.

The Wood River formation locally seems to be essentially identical in lithologic character with the formation in its type locality. Where it has not been too much metamorphosed, it is composed of light-gray to nearly black, fairly massive quartzite with occasional thin partings of carbonaceous shale. Near the Sunbeam mine on upper Jordan Creek the small exposure consists of a considerable thickness of nearly black (graphitic) quartzite which is overlain by thick-bedded grayish quartzite and underlain by thinly bedded, light-colored quartzite. The exposure at the head of Lightning Creek just southwest of Mt. Jordan is composed largely of dark-colored quartzite like that near the Sunbeam mine, but some of the rock exposed on the ridge northeast of the peak is more thinly bedded and in part somewhat more carbonaceous and argillaceous. Much of it, however, has been so altered by igneous intrusions and has had so much feldspar added to it that it has the character of granitic rock and has been so mapped.

Ross has correlated the Wood River formation in the Bayhorse region with that in the type locality on lithology and stratigraphic relations, no fossils having been found in the type locality the formation contains fossils that definitely establish its age as Pennsylvanian.

Casto Volcanics (Permian?)

The Casto volcanics are exposed along upper Mayfield Creek in the northern part of the district (Fig. 2) and are a southerly continuation of a mass mapped by Ross in the Casto quadrangle. On the east, south, and southwest the volcanics pass under a cover of the younger Challis volcanics; on the west and northwest they terminate against the Idaho batholith.

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According to Ross the Castle volcanics are represented largely by altered flows and water-laid tuffs of chiefly andesitic and rhyolitic composition. From a distance the volcanics generally have a dull mottled-green appearance, but closer the rocks of andesitic and to lesser extent of dacitic and anditic composition show dull purplish and greenish, less commonly bluish, reddish, and yellowish hues. The rhyolitic rocks are light-colored, fine-grained, almost chestnut with little visible phenocrysts. Some, however, have a stony appearance and polished drab-gray to somewhat greenish-gray colors. All rock are distinctly altered, in contrast to the comparatively fresh Tertiary rocks above them. Phenocrysts, where present, are conspicuous, and although altered, their original character is determinable. Formerly glassy groundmasses are completely devitrified. Much petrographic detail is supplied by Ross.

The Castle volcanics exposed in the district measure more than 1,000 feet in thickness and may be much thicker. Farther north they are as much as 4,000 feet thick. Ross has pointed out that the thickness is variable because of accumulation on a topographic surface of considerable relief.

These volcanics are cut by the Idaho batholith and therefore are earlier than upper Mesozoic. As they lie unconformably above Paleozoic rocks in the Castle quadrangle they must be later than early Paleozoic. As suggested by Ross they may be stratigraphically equivalent to similarly metamorphosed volcanic rock of Permian (Phosphoria) age in western Idaho and eastern Oregon.

**Idaho Batholith (Mesozoic)**

A part of the main Idaho batholith extends across the northwest corner of the district and outliers are exposed through the Challis volcanics on upper Yankee Fork and near the southeast border of the map (Fig. 2). The granitic rock of the batholith is also exposed on lower Yankee Fork just south of the map border.

The rock is like that of the batholith elsewhere and has the composition of calcic quartz monzonite with granodiorite facies. It is a light-gray, moderately coarse-grained, granular rock with but a slight tendency for porphyritic and neusitic development. That in the northwest corner of the district shows transition to quartzite and retains within itself prominent bedding structures inherited from the quartzite and other sedimentary strata.

The rock consists essentially of quartz, clinozoisite or sodic andesine, microcline, biotite, and locally small amounts of muscovite and hornblende. The proportions of minerals are about the same as those given by Ross in the Bayhorse region where the quartz commonly comprises 20 to 40 per cent of the rock; the plagioclase, 30 to 45 per cent; microcline, 10 to 40 per cent; and biotite, 5 to 15 per cent. Hornblende is exception and sphene, apatite, zircon, epidote, and sericite are present in variable amounts. The mineral relationships are like those observed elsewhere which are discussed at some length in another report.

From the available evidence Ross has concluded that the batholith was emplaced in late Jurassic or Cretaceous time.

**CHALLIS VOLCANICS**

The Challis volcanics, the name assigned by Ross to designate the Tertiary volcanic strata in this part of Idaho, occupy the larger part of the Yankee Fork district and the surrounding region. This thick and widespread formation varies in character from place to place but is generally divisible into units whose essential features can be recognized wherever found, even though their mutual relations or thicknesses vary in different localities. The units distinguishable in the Yankee Fork district are the "lithic-andesite member," composed dominantly of flows of andesite and dacitic composition, and the "Germer tuffaceous member," composed largely of fine pyroclastic materials. In most places the Germer is interbedded with and overlies the flows and thus constitutes the major unit in the upper part of the Challis volcanics, but in the Yankee Fork district it is in part stratigraphically equivalent to the flows and in part older. The Yankee Fork tuffaceous member which occurs at the top of the Challis volcanics lies just outside the map-area on upper Yankee Fork.

From consideration of fossil and strati-
graphic evidence, Ross\textsuperscript{14} holds the opinion that the Chollis volcanics are possibly, if not probably, of Oligocene age and that they can hardly be younger than early Miocene.

**Lattie-Andesite Member**

The lattie-andesite member occupies much of the southeast half of the district, its northwest boundary lying close to Yankee Fork with a westward projection across lower Jordan Creek to Lightning Creek and thence south across West Fork (Fig. 2).

The member appears to contain more andesite and less latite than elsewhere and at and near Bonanza is composed of more than 2,000 feet of andesitic flows with some intercalated rhyolitic tuff. Lattic flows appear in the succession, however, a short distance to the northeast. The flows are dark gray to black where not weathered nor hydrothermally altered; otherwise they are mostly greenish gray. The rock is somewhat porphyritic and contains andesine, augite, and locally hypersthene phenocrysts in a matrix of tiny andesine laths, and glass. Accessory include small grains of magnetite and apatite. Little of the rock has escaped alteration and much of the andesine contains sericite and much of the augite has mantles of magnetite. Even some distance from known mineral deposits the rock is more or less extensively sericitized, chloritized, and impregnated by pyrite and calcite.

**Germn Tuffaceous Member**

The Germn tuffaceous unit of the Chollis volcanics extends from the boundary of the lattie-andesite member into the northwest corner of the district and thus occupies slightly more than half the map-area (Fig. 2). The change from the dominantly flow rock of the lattie-andesite member to the dominantly tuffaceous rock of the Germn is abrupt. The proportion of tuffaceous material in the lattie-andesite unit increases markedly near Yankee Fork, and in much of the area between Bonanza and the ridge crowned by Estee Mountain the tuff constitutes the principal rock (Pls. 1A, Pl. 2A). Some thick flows of andesitic rock are exposed along Jordan Creek from the streama mouth to the Golden Sunbeam mine, with such characteristics as to suggest the top of the lattie-andesite member as generally found elsewhere in the region. Scattered flows occur here and there throughout the Germn. Toward the northeast these flows become less basic and are mainly light-colored quartz lattes. Altogether the Germn locally consists of more than 3,000 feet of tuffaceous beds and flows.


Much of the Germn in the Yankee Fork district are fine-to-medium-grained, pale-buff to light-brown rocks composed largely of the products of explosive eruptions (Pls. 1A and Pl. 2A). A considerable part of the rock shows bedding and more or less extensive water sorting, but some accumulated directly from ash showers. Locally, there are intercalations of silt and clay, the most notable occurrence being an exposure along the road in the saddle between Jordan and Mayfield Creeks, where perhaps 50 feet of gray laminated shales have accumulated. Much of the tuff, sorted and unsorted, is composed of fragments of feldspars and other minerals, commonly less than a millimeter in diameter but, some tuffs also contain fragments of glass and some are composed largely of welded pumice.

**MIocene INTRUSIVE ROCKS**

Igneous rocks which intrude the Chollis volcanics occur in several parts of the district, but the only important mass of such rock is on the high slopes east of Custer extending from the head of Fourth of July Creek northeast across the head of Slaughterhouse Creek to Five Mile Creek (Fig. 2). In this area the intrusives are so closely spaced that it is necessary to map them as a single unit. Individuality they appear to be dikes which trend in a N. 70\textdegree E. direction, one apparently alongside the other, but some may vary stock-like characteristics. Boundaries are too ill-defined to permit mapping of separate bodies. Elsewhere, dikes were observed on upper Adair Creek south of the Lucky Boy mine and on the ridge northwest of Bonanza, but the scale of the map does not permit them to be shown. A small mass of igneous rock which may also be intrusive occurs at the Whale mine on a tributary of upper Jordan Creek, but this also was not mapped.

These intrusives are for the most part composed of dactite porphyry, but the main mass east of Custer also includes some andesite and monzonite and quartz monzonite porphyry, and a little pinkish granite. The rock at the Whale mine is a rhyolite porphyry.

The dactite porphyry which makes up the larger part of the mass in the upper basin of Fourth of July and Slaughterhouse Creeks and the ridge between is a grayish to greenish-gray, porphyritic rock with small phenocrysts of zoned andesine, hornblende, and exceptionally augite and quartz in a finely crystalline groundmass of sodic andesine or oligoclase and quartz. The proportions of phenocrysts and groundmasses vary in the different bodies and also the size of the grains in the groundmasses, but otherwise there is little difference in the rock in any part of the area. Accessory min-
erals are apatite and magnetite, and there is always much sericite, chlorite, epidote, calcite, and pyrite. In some places the original minerals have been almost entirely converted to secondary products, the hornblende particularly to chlorite. Little of the rock apparently has escaped end-stage alteration, pyrite being one of the minerals of widespread distribution.

The other rock types are subordinate and are confined to a few small bodies. The quartz monzonite porphyry is like the dacite porphyry in appearance, but its groundmass is faintly pinkish. It has phenocrysts of andesine and augite with hornblende mantles in a fine-grained groundmass of micrographic and microgranular quartz and orthoclase. The monzonite is a fine-grained, slightly porphyritic, pinkish-gray rock with about equal amounts of plagioclase and orthoclase and a little altered augite and biotite. The hornblendes are light-gray apparently granular, medium-grained rocks containing oligoclase, orthoclase, quartz, and biotite with much quartz micrographically penetrating the feldspar. The granite is coarse-grained, pinkish and contains relatively large grains of orthoclase, andesine, and quartz.

The rhyolite porphyry at the Whale mine contains abundant rounded and embayed quartz phenocrysts and sericitized plagioclase crystals in a finely granular groundmass of quartz and altered feldspar. Because of bleaching the rock is nearly white. The mass shows columnar structure where exposed on the surface, but the microscopic features suggest an intrusive rather than an extrusive rock.

As these rocks intrude the Challis volcanics and have been truncated by a Pliocene erosion surface, they were probably emplaced during lower Miocene, the time Roser has assigned the intrusion of similar rocks in the Cato quadrangle.

QUATERNARY DEPOSITS

The Quaternary deposits occupy the valleys and consist of morainal debris near valley heads and terrace (outwash) gravels and Recent alluvium in lower courses. Only the terrace and the present stream deposits (undifferentiated) are shown on the map (Fig. 2). The morainic deposits are fairly widespread above the 7,000-foot contour in upper valleys of Adams, Fourth of July, and Slaughterhouse Creeks and for some distance down the valley of Eight Mile Creek, which heads on Estes Mountain. Such deposits also occur along upper Jordan Creek, which occupies a typical U-shaped valley as far down as the Golden Sunbeam mine (P.I. 18).

The terrace deposits are extensive at and below Bonanza on Yankee Fork. They apparently were made by the debris carried by the melt waters when glaciers. Whereas the upper valleys and remain as broad terraces that have been entrenched by the present streams. In places these gravels accumulated to depths of 50 feet. At Bonanza the terraces rise steeply above the present narrow floodplain of Yankee Fork.

In addition to forming narrow strips along Yankee Fork and West Fork at and below Bonanza, the Recent alluvium also occurs farther up each stream, in both cases above landslide blockades which formed temporary dams above which the gravelly alluvium accumulated to considerable thickness, forming rather broad and long valley flats. Landslides and landslide debris are widespread through the area of Germer rocks, but were not mapped.

STRUCTURE

General Statement

The rocks of the district have been deformed by folding and faulting, but there is a vast difference in the extent to which the basement rocks and the overlying blanket of volcanics have been affected. Whereas the Paleozoic strata have been strongly folded and faulted, the cover of Challis volcanics has been much less disturbed. This marked structural differences makes it possible and desirable to separate structural features into those produced by pre-Challis deformation and those resulting from post-Challis disturbances. The pre-Challis structures are probably the product of the two most prominent orogenies of post-Paleozoic and pre-Tertiary times, the Nevada orogeny which inaugurated the emplacement of the Idaho batholith in late Jurassic or Cretaceous time and the Laramide orogeny which came at the close of the Cretaceous. The structures of the Challis volcanics are chiefly the product of a lower Miocene disturbance.

As the mineralization is confined to the Tertiary volcanic rocks, the structures in them are particularly important, but as it appears that some of the structures in the younger rocks reflect the influence of earlier zones of weakness in the basement rocks, the pre-Challis structures also are significant.

Pre-Challis Deformation

Because of the extensive covering of Challis volcanics, the precise structural relations of the basement rocks cannot be determined, but the attitude of the beds in the available exposures gives evidence of marked folding, and peculiarities in the fracture patterns in the over-
lying volcanics suggest fault controls in base-
ment rocks.

Folds—In all exposures of the Wood River
formation the beds strike northeast and dip
northwest; the attitude of the flows and tuffs
of the Casto formation was not learned. South
of Bonanza the beds strike N. 45°-50° E. and
dip 35°-45° NW. On upper Jordan Creek the
strike is more northerly (N. 20° E.) and the dip
steeper (70°-80° NW.), but at the head of Light-
ning Creek the strike is again N. 45° E. and
the dip about 20° NW. From the spacing of
these scattered exposures, it is evident that
they are not on the flanks of the same fold.
Unfortunately, they do not provide sufficient
data for reconstructing the folded structure of
the basement rocks, but they do reveal that
the folds, whatever their kind and magnitude,
trend locally in a northeasterly direction. The
preservation of the bedded structure in the
granitic rock at the head of Lightning Creek
indicates that the folding preceded the emplace-
ment of the Idaho batholith.

Faults—Faults were not observed in the ex-
posed Paleozoic rocks, but faulting surely aided
in placing these rocks in the position in which
they are now found. Folding alone can not ac-
count for the near duplication of beds in the
widely scattered exposures.

The presence of faults in the basement
rocks, however, is confirmed by the faults in
the overlying volcanics. Those in the volcanic
rocks are described in some detail in the part
of the report dealing with post-Challis deforma-
tion. As indicated in the volcanic rocks, the
faulting is more or less strictly localized and
is confined to zones of general N. 70° E. trend,
the more prominent faults striking about N. 70°
E., N. 30° E., and N. 60°-70° W. These fault zones
trend in the same direction and have the same
structural relationships as the zones of fault-
ing in the Idaho batholith and adjacent rocks,
which the writer* regards as having been pro-
duced by the differential transmission of stress
through the batholith during the Laramide ero-
sion. These zones of structural weakness
which developed in the basement rocks during
the Laramide disturbance, apparently have con-
trolled the fracturing the Challis volcanics dur-
ing the later deformation.

Post-Challis Deformation

The post-Challis deformation is marked by
gentle warping and locally by zones of com-
plicated fracturing apparently independent of
the warping.

*Anderson, A. L., Bears of the Idaho batholith during the
Laramide orogeny: Econ. Geol. vol. 43, pp. 94-95, 1948.

Folds—The blanket of Challis volcanics
forms a broad arch elongated in a northea-
sterly direction about parallel to the trend of the
strata in the basement rocks. The axis of this
broad anticlinal fold strikes about N. 40° E.
and passes just a short distance northwest of
Estes Mountain and the Golden Sunbeam mine.
On the southeast flank of the arch the flows
and tuffs dip outward at angles to 15° to 20°,
on the northwest flank the dip is about 20°.
The formation of the arch apparently was un-
accompanied by faulting.

Faults—The fracturing of the Challis vol-
ocanics is confined largely to short but rela-
tively broad belts which occur for the most part
well out on the eastern flank of the anti-
clinal arch. Most of these belts trend about
N. 70° E. and in some places one overlaps an-
other. As the fractures in these belts are more or
less extensively mineralized, the fracture belts
and mineral belts are synonymous. One of the
belts crosses Jordan Creek a short distance
above its mouth and includes in it all the min-
eralized fractures from the high ridge between
Yankee Fork and Jordan Creek southwest to
the West Fork of Yankee Fork. Another belt of
curving trend (southeast to northeast) begins
near Custer and extends into the head of Adair
Creek and thence over the ridge into the valley
of Fourth of July Creek (Fig. 3). Another
belt extends northeasterly across the top of
Estes Mountain into the head of Eight Mile Creek,
and still another stretches west-southwest from
the Sunbeam mine on Jordan Creek across the
high divide separating Jordan Creek from
Lightning Creek. The Whale mine a short dis-
tance northwest of the Golden Sunbeam mine
may be on a separate belt of much lesser
magnitude. A mineralized fracture zone not in
the map-area extends in a southeasterly direc-
tion across Red Mountain in the upper West
Fork drainage. Although most of the belts are
clamaged about N. 70° E., one at least is
aligned about N. 20° E., and two are in part
directed S. 60° E.

The fracturing in these belts is complex.
In general the most prominent fractures strike
about parallel to the long direction of the belts,
but many strike obliquely across. The fracture
pattern of each belt is much the same, except
that a set prominent in one belt may be weekly
developed in another and vice versa. The frac-
tures in each may trend N. 70° E., N. 45°
E., N. 20°-30° E., N. 50° W., and N. 60° W., and
any one, except the N. 20° W. set, may be a
dominant set in any given belt. In the one
across lower Jordan Creek the N. 70° E. con-
trols the local pattern. East of Custer the N. 60° W. and the N. 70° E. set are about equally repre-

dented but each in a different part of the belt.

On Bachelor Mountain the control is exerted by the west-northwest and the east-northeast

sets. On Estes Mountain the N. 20°-30° E. set
dominates and across Jordan Creek, the N. 30°-
40° E. set. In these belts the other fractures
tend to be subordinate, yet they are important
nevertheless in their control on mineralization.

In all belts the N. 70° E. fractures are always
conspicuous even though locally subordinated,
and generally direct the more prominent veins
and lodes and the dacite porphyry and other
dikes. Where observed, the fractures dip in
northerly directions at moderate to high angles.

The main fractures are generally well-de-

fined and are marked by gouge or breccia.

Some are of the fissure type and have lengths
up to 2,500 feet. Others are short and are lead-
ing fracture in otherwise zones of complex
fractures of diverse trend. Some zones of frac-
tures constitute stockworks. Some fractures are
split from others and diverge outward into an-
other set. Some curve and change from one set
to another.

Movement along the principal fractures
may not be more than a few inches on a few
feet and along some of the minor fractures
there is little if any movement. Because of the
extended wall-rock alteration, markers are
poorly defined and direction and amount of
movement difficult to determine. There have
been some offsets of one fracture by another,
mostly prior to mineralization, but offsets have
not exceeded 20 feet horizontally. In such cases
the principal fissures or veins have been dis-
placed laterally. Where grooves and striations
have been preserved along the fault planes,
you are about horizontal and indicate easterly
movement of the hanging wall. These grooves
were found on only a few fractures, but on
most fractures lateral movement may have oc-
curred in any direction. In most places it was not
possible to determine whether the faults are
normal, reverse, or strike-slip; but it is probably
not a coincidence that when determination was
possible, the movement was always the strike-
slip variety.

As already pointed out the trend of the
fracture zones and the principal fractures in
them are coincident with the fracture zones and
trends believed developed in the older base-
ment rocks during the Laramide orogeny. At
that time the transmitted forces produced north-
east-trending strike-slip faults parallel to the
direction of shearing, west-northwest
normal faults in response to the tensional com-
ponent of the shearing, and thrust faults of
west-northwest trend normal to the regional
compression. Thus the fractures of north-
east trend in the overlying volcanics par-
take of the characteristics of the fractures orig-
inally produced by horizontal shearing stresses
in the basement rocks and those of northwest
trend reflect the earlier set of normal faults.

Because of the close accordance of the local
fracture patterns in the Tertiary volcanics with
the Laramide fracture patterns in the older
rocks, one may conclude that the post-Challis
structures reflect the influence of the earlier
zones of weakness in the basement rocks,
which localized later deformation. The strike-
slip movement on faults in the Challis vol-
camics suggests that horizontal shear has also
played a complicated role during the post-
Challis disturbance. In any event the post-
Challis fractures apparently are a consequence
of adjustments along the earlier zones of struc-
tural weakness in the basement rocks.

ORE DEPOSITS
HISTORY AND PRODUCTION

The first lode discovery in the district, the
Charles Dickens in 1875, came several years
after gold had been found in the gulches near
the mouth of Jordan Creek. A short time later
the Charles Wain lode was discovered on
Estes Mountain and the General Custer lode
was found on the east side of Yankee Fork
about 2 miles from the Charles Dickens. The
discovery of these lodes quickly drew atten-
tion from the prospectors and by 1877 virtually all
the lodes in the district had been located in-
cluding the famous Montana on Estes Mountain
and the Lucky Boy, Bogder, Continental, and
others near the General Custer. The ore that
was uncovered proved to be phenomenally rich,
and big profits were realized from the very
start, despite the cost of $150 to $200 a ton in
shipping the ore to the smelters at Salt Lake
and other places. Some of the ore was so rich it
was treated in hand mortars, but generally the
ore was sacked and shipped outside for treat-
ment, the shipping ore then raming from $350
to $500 a ton, with some shipments yielding
several thousand dollars to the ton. Later some
of the ore was treated locally in arrastres, but
the crude methods of treatment soon gave way
to stamp milling, and with the completion of
the General Custer mill in 1881 the district
entered its most productive stage of develop-
ment.

The district enjoyed its greatest activity
during the next 15 years but by the turn of
the century most of the Bonanza ore had been
mined and the district began its decline. Many
mines shut down in the nineties, but the General

Custer mill continued to operate until 1905, chiefly on ore from the Lucky Boy mine. After that mining operations were unimportant until 1907 when the Golden Sunbeam mine on upper Jordan Creek was opened on a large scale, a mill built, and a hydroelectric plant installed on Salmon River at the mouth of Yankee Fork. The dam and hydroelectric plant were completed in 1910 but the ore, though rich, was too low in grade and In 1911 the property passed into the hands of a receiver. Since then the district has continued to receive some attention, but activity has generally been on a greatly reduced scale. Shortly after the Golden Sunbeam mine suspended operations, the Montana mine was reopened and from 1914 to 1917 was the most important producer in the district, its ore going by aerial tram to the Sunbeam mill for treatment. After the Montana mine closed down the district was inactive until the early twenties when the Why Not mine on Estes Mountain was opened and worked more or less continuously until the early thirties. Some of the other mines also received a little attention, but the district was generally quiet until 1939 when the Custer Consolidated Mines Company took over and reequipped the mine and mill at the Lucky Boy. During the next several years the Lucky Boy enjoyed some of the activity and prosperity of the early days, but the late war put a quick end to the boom. In 1942 the mine was closed, the equipment removed, and the mine abandoned. The activity at the Lucky Boy during the late thirties and early forties served to stimulate interest elsewhere in the district and small shipments were made from the Fourth of July, Why Not, Gray Eagle, Snowdrift, and other mines.

Since the close of the war, interest in the district has been revived. In 1946 the Fourth of July Mining Company was incorporated and a mill partly equipped. The Sunbeam Mine was also incorporated and during 1947 the mill house was repaired and equipped. Late in 1947 the Yankee Mines, Inc., was organized and plans made for a large mining and milling program at the Lucky Boy mine.

During the late thirties interest in the placers was revived. A dredge was installed on Yankee Fork several miles below Bonanza and operated until forced to suspend activities in 1942. Dredging was resumed at the close of the war and the dredge was in full operation in 1947. During 1947 a second dredge began work on lower Jordan Creek.

The bulk of the Yankee Fork production came before the turn of the century, principally from the General Custer, the most important mine of the district. Of the estimated $12,000,000 production up to 1910, two-thirds is credited to the General Custer. Production of the district since has been close to $1,000,000, making a grand total of about $13,000,000. The $8,000,000 production at the General Custer is nearly four times that of its competitor, the Lucky Boy, which up to 1905 had produced about $1,750,000 and since then about $450,000, mainly from 1939 to 1942. Other important producers have been the Charles Dickens, which is credited with $600,000 from 1888 to 1903, and a considerable but unknown amount prior to 1888; the Golden Sunbeam with $400,000 from about 1907 to 1910; the Montana with more than $300,000; the McFadden with more than $200,000; and the Morrison with about $100,000. Umpleby has estimated that about 40 per cent of the total production of the district has been from gold and the remainder from silver.

**CHARACTER OF THE DEPOSITS**

The ore deposits of the Yankee Fork district are almost exclusively silver-gold veins and lodes of the shallow bonanza type, commonly referred to as epithermal. In a few deposits the gold is more abundant than the silver, as in the upper workings of the Montana mine and at the Golden Sunbeam, but in most of the veins and lodes the silver content of the ore far outweighs that of gold, the ore at the General Custer, Lucky Boy, Charles Dickens, and others having contained 80 to 90 times as much silver as gold by weight. Most of the deposits also contain some base metals, but only on Estes Mountain has there been any lead and copper production and then only as a minor by-product from the mining of the precious-metal ore. Recent exposure of a body of lead-copper ore near the southwest base of Estes Mountain suggests that modification of the classification of exclusively silver-gold deposits may be necessary.

The deposits possess the features typical of the epithermal precious-metal deposits found in Tertiary volcanic rocks: e.g., associated widespread wall-rock alteration, extensive fracturing and brecciation, fine and coarse crystallization, banding and crustification, and the presence of such minerals as arsenite and various silver sulfosalts and eislerite and selensides. In certain respects they are much like the gold-selenide veins of Republic, Washington.

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but in other respects they are like the argen-
tite gold-quartz veins of Tonopah and Virginia City (rock lode). Note, however, the silver-
gold veins of Silver City in Owyhee County, Idaho35.

DISTRIBUTION

The silver-gold deposits are grouped along
half a dozen more or less independent zones of
mineralization on both sides of the general
vicinity of Bonanza and Custer and the others
at and near Estes Mountain and upper Jordan
Creek. Still another zone is outside the map
boundaries near the head of West Fork.

Each zone of mineralization marks a zone of
fracturing in the Tertiary volcanic rocks. One
zone of deposits is along a zone extending
across lower Jordan Creek from West Fork to
Yankee Fork with the most important mineral-
ization of the Charles Dickens mine on "Dick-
ens Hill," as it was known in the early days.
Another group containing such famous mines as
the General Custer and the Lucky Boy is
along a curving zone extending southeast from
Custer to the head of Fourth of July Creek. A
short distance east of this group is a smaller
one centered on the upper north side of Jordan
Creek. Another with the Whale as its center
is close to the northwest margin of the one pass-
ing through the Golden Sunbeam. The one out-
side the mapped area extends across the top
of Red Mountain, a conspicuous and brilliantly
colored landmark on upper West Fork. For
convenience the individual zones or centers of
mineralization may be referred to as (1) the
Dickens, (2) the Custer, (3) the Bachelor Moun-
tain, (4) the Estes Mountain, (5) the Sunbeam,
(6) the Whale, and (7) the Red Mountain.

All the zones of mineralization, except those
near Bonanza and Custer and on Bachelor
Mountain, are in the German tuffaceous mem-
ber of the Challis volcanics; those excepted
are in the andesite-andesite member. Except for
minor textural and structural details, the char-
acter of the host rock has had little effect on
the nature of the mineralization.


STRUCTURAL RELATIONS

As the deposits are largely fillings, they
reflect the structural peculiarities of the frac-
tures and fracture zones that contain them. Con-
sequently those that are fissure fillings have
veinlike characteristics. Those that cement brecc-
ias form breccia veins and lodes; in fact in-
cluded fragments of the wall rock are character-
istic of all veins, fissure or breccia. Those that
are fillings of shear or complicated fracture
zones have lode characteristics, but when zones
of fractures of the stockwork type developed,
the lodes have stocklike form and the deposits
may be regarded as disseminated. In one case
the fracturing was such as to produce a chim-
ney-like type of deposit. Many of the deposits
are aggregates of small crack veins, but some
are long, individual veins with average thick-
nesses of 4 feet or more. Those in which re-
placement has played an important role may
swell into chimney-like masses, but for the
most part irregularities in thickness reflect the
size of the openings produced by movement
along the controlling fissures. Some of the fis-
sures and the veins in them are notably short.
Such short veins are commonly members of an
overlapping series.

The nature of the country rock has had
some influence on the kind and extent of frac-
turing and the structural characteristics of the
deposits contained therein. The andesitic rocks
were prone to fissure and the deposits in them
are chiefly breccia veins and lodes. The tuff-
aceous rocks, on the other hand, were less
susceptible to fissuring and had a marked
inclination to develop zones of complicated frac-
tures, in part of the stockwork type. Exceptions,
however, occur on Estes Mountain where some
prominent fissures did form in the tuff, parti-
cularly along a fault contact with andesite.

In the Dickens zone of mineralization the
structure is dominated by N. 70° E. trending
fault fissures and consequently the deposits
constitute fissure or breccia veins averaging
several feet wide and several hundred feet
long, all dipping steeply north. The deposits
along the Custer belt are much the same, but
the controlling fractures there change from
about N. 60° W. to N. 70° E., with local inter-
mingle of trends. The transition from the northwestern to the northeast is particularly
noteworthy at the Lucky Boy where the south-
eastward trending Lucky Boy vein is joined
from the footwall by veins of more easterly
trend, with all offset by a lightly mineralized
fault of northeast trend. The pattern of the belt
(Fig. 3) apparently reflects complicated adjust-
ments along the fractures in the basement rock.
The structural relations of the deposits on Bach-
elor Mountain differ from those along the Cus-
ter zone in that the controlling fissures are short and mostly arranged in echelon in a belt extending in an east-south-east to west trend up the ridges with most of the veins striking about N. 70° E. but with some striking about S. 60° E., the long direction of the belt. The mineralized belt is narrow and relatively short.

At Esis Mountain the mineralized belt crosses the peak in a northeast-southwest direction with the principal fractures striking N. 20° E. to N. 60° E., and fanning outward on the upper south and west slopes. The deposits there include fissure or breccia veins of marked persistence, chimney-lodes, and mineralized fracture zones. The Sunbeam zone of mineralization trends in a N. 70° E. or S. 70° W. direction, but the ore bodies in it are confined to stockworks or zones of complicated fracturing, excepted breccia zones, most of which are elongated N. 35° E. in the direction of the most prominent fracturing. The bodies are nearly vertical. At the nearby Whale, the zone, which is short and about as wide as long, trends somewhat southeast, but the ore bodies seem to be aggregates of small gash veins, most of which strike northeast. At Red Mountain the zone of mineralization and the more prominent fractures in it strike N. 70° E., but the deposits are mineralized fractures rather than veins.

WALL-ROCK ALTERATION

Widespread alteration of the wall rock is a conspicuous feature of the Yankee Fork mineralization, with the zone of alteration tending outward for hundreds of feet from some of the more important veins and lodes. In fact, because of the abundance of fractures and the wide dispersion of the mineralizing solutions, the zones of alteration are as broad as the belts of mineralization and the terms "alteration zones" and "mineralized zones" are synonymous for the most part, it is virtually impossible to find rock that does not show some sign of alteration.

Because the rock of the altered zone is bleached and also commonly stained by redish and brownish iron oxides from the weathering of widely disseminated grains of pyrite, it contrasts sharply with the dark, unalteredandesites and even with the less somber tuffs. Consequently, where the altered rock is not concealed, as on precipitous slopes and particularly in cirque walls, it is a conspicuous feature of the landscape, and the mineralized alteration zones may be readily traced across the country. It is the weathering along such a zone of alteration that has produced the vivid reddish coloring of Red Mountain, which is, as a result, a prominent landmark visible from afar. Shades of red and buff are also conspicuous along the Sunbeam zone where it crosses the high divide to Lightning Creek. Similar coloring is also visible in the cirque wall at the head of Fourth of July Creek and on the north-east side of Esis Mountain. The alteration zones thus stand out, and the alteration is the most easily recognizable clue to mineralization.

The minerals produced as a result of alteration by the mineralizing solutions are chiefly fine-grained quartz, sericite, chlorite, and pyrite, the reddish and brownish iron oxides being the product of the weathering or oxidation of the pyrite. The silicification is most intense next to the veins and lodes and gradually dies out with increasing distance therefrom. In some places the silicified zone is broad and produces resistant ledges 100 feet or more across. As the silicification weakens, sericite becomes proportionately more abundant and may persist far beyond the borders of the mineralized rock.

The silicification, however, is not everywhere prominent and surrounding some deposits, its effect is inconspicuous or even absent. Sericite then is the most abundant alteration product and appears not only along side the deposit but also many feet away, in some places as scattered aggregates hundreds of feet away. The sericite is an alteration product of the feldspars and of the dark minerals. The chlorite makes its appearance near the outer margins of the sericitized zones, apparently as a product of the less intense wall-rock alteration. It is generally secondary after the dark minerals of the rock and locally may be accompanied by calcite. The pyrite is generally confined to the silicified and to lesser extent the sericitized rock. Its crystals are generally so minute as to be quite inconspicuous, but the oxide staining along the alteration zones indicates a widespread, though rather scanty distribution.

MINERALOGY

The deposits have an interesting mineralogy, but unfortunately, little of the ore which was so spectacularly rich in the early days is now available for study. Nevertheless, much was learned from the few high-grade specimens that were donated and from the lower grade ore on some of the dumps and still remaining underground in some of the mines. It was possible, therefore, to work out the mineralogy with a certain degree of completion, except for certain grayish submetallic smudges, which test for selenium and gold, but which are composed of grains too minute to be resolved into recognizable minerals under the microscope.

The minerals present are those which are more or less typically characteristic of the precious-metal epithermal deposits. Among the
ever-abundant gangue minerals, fine-grained quartz predominates, but it may be accompanied by much coarse comb and drusy quartz and by smaller quantities of chalcedonic and locally amethystine varieties. Calcite and pseu-
domorphous quartz are also fairly abundant in some of the deposits, and most of them also contain a little adularia and in one deposit a little borite. The metallic minerals are generally not very abundant and therefore not very con-
spicuous. They are also usually fine-grained and are generally not easily identified as to kind without the microscope. Those recognized in the primary ore are pyrite, chalcopyrite, sphalerite, tetrachloride (Ag₂Sb₂S₅), arsen-
opyrite, enargite (Cu₅S₃As₅S₃), galena, steph-
hanite (Ag₅Sb₂S₅), microgairite (Ag₂Sb₂S₅), pyrrhotite (Ag₅Sb₂S₅), argentite (Ag₂S), aquilinite*, gold, and electrum. The propor-
tions of these minerals vary and some have a limited geographic distribution. The pyrite and chalcopyrite are generally most abundant and widespread but the argentite, electrum, and gold, though not so abundant, are also widely distributed. The secondary minerals resulting from weathering include native silver, super-
geen argentite, carargyrite, iron oxides, and locally a little malachite, azurite, chalcocite, and covellite.

The fine-grained, essentially cryptocrystal-
line quartz is an important constituent of all deposits, in many the chief constituent. Much of it has a grayish color because of the pres-
ence of minute grains of metallic minerals, few of which are recognizable, except occasional larger grains of pyrite, apparently the most abundant metallic mineral. In some of the de-
posits along the Dickens belt and on Estes Mountain the sulfides are somewhat coarser and different minerals, particularly pyrite and chalcopyrite and lesser galena, sphalerite, tet-

rachloride, and locally argentite may be recog-
nized, generally with the microscope. These sulfides tend to fill in between the small quartz crystals, which in part are somewhat loosely interlocked.

The comb and drusy quartz is also pres-
ent in all deposits and in some may occupy more space than the fine-grained quartz. It in-
variably coats fragments and cements brec-
cias of the fine-grained quartz or fills fractures. In contrast with the fine-grained quartz it is white, but some at the Montana is partly ame-

thystine. The size of the crystals varies con-
siderably in the different belts, the quartz being exceptionally coarse along the Dickens and Estes Mountain belts, moderately coarse along

the Custer and Bachelor Mountain belts, and
rather finely crystalline along the Sunbeam belt. Metallic minerals also occur with the comb
and drusy quartz, generally as fairly coarse
grains between and resting on the quartz
-crystals, in fractures cutting the fine-grained
quartz, and as grains impregnating the fine-
grained quartz and its finely crystalline sulfides. This group of metallic minerals includes the argentite, gold, and electrum, and also the
various sulfosalts such as stephanite, micro-

yrite, pyrrhotite, enargite, and the more simple sulfides such as pyrite and locally arseno-
pyrite. Where abundant, such minerals con-
stitute the bonanza ore. The all deposits from
which the argentite and elec-
trum have a wide distribution, but the other
minerals are more restricted. Minor amounts of the enargite were observed along the Dick-

ens, Custer and Estes Mountain belts, the arsen-
opyrite with enargite on Estes Mountain, but the microgairite, pyrrhotite, and stephanite were observed mainly in the Custer area, the ste-
phanite in most of the veins, the microgairite at the Badger, and the pyrrhotite at the Badger,
Long View, and Enterprise. The argentite and silver sulfosalts commonly occur as grains and
massive aggregates filling the openings be-

 tween quartz crystals, but they also form well-
shaped crystals in drusy vugs.

Chalcedony is present in only small
amounts and is not observed in all deposits. It
may be either earlier or later than the fine-

grained quartz, and, though banded, seems to
be without sulfides.

The adularia is entirely microscopic, oc-
curring as grains associated with the younger,
more coarsely crystalline quartz, having been
deposited during early stages of late quartz
deposition. It was observed in all deposits from
which thin sections were made of the ore and
may be as widespread, though much less
abundant, than the quartz.

calcite is abundant in some of the deposits
along the Custer belt, but elsewhere it is spar-

ingly present, if present at all. It is particularly
abundant in the veins at the Lucky Boy and
in the adjoining Black, Fourth of July, Yellow

Bird, and Continental properties. Some of it
occurs as coarse equidimensional rhombohe-
drons but most of it is the platy or lamellar
variety. The calcite is younger than the quartz
and the lamellar variety replaces the quartz
extensively, assuming its own platy form dur-
ing the replacement. On weathering the calcite
is leached out, leaving the quartz as pseudomor-
phous coats, thus giving rise to typical "pseu-
domorphous" quartz, which disappears in the
unleached fillings below. The calcite is evident-
ly a late addition to the ore. It failed to replace
the metallic minerals, as it did the quartz, and

*Presence of aquilinite—Ag₅Sb₅S₅—is the ore is reported by
Thor Killionard, written communication.
hence contains the ore minerals as inherited inclusions.

Barite was noted only at the Long View mine, occurring there as small crystals in fractures cutting the ore. Certain other minerals have been listed as present in the deposits, specifically calcite and opal, but these were not seen by the writer.

The grains of gold and electrum are generally so fine as to be difficult to detect without a lens, but some of the gold along the Dickens belt was notably coarse, yielding nuggets weighing up to 2 pounds. Much of the gold is confined to the outcrops or upper parts of the deposits where original electrum has been leached of its silver, but in some parts of the district, as at the Sunbeam mine and in the upper part of the Montana lode, the gold is primary. The electrum is in general more abundant and apparently more widespread than the gold.

The various mineral relationships indicate two and at the most three general stages of deposition. During the first the minerals deposited were the fine-grained quartz and sulfo-silicates and perhaps gold and silver selenides; during the second, the coarse comb and drusy quartz and the argentite, electrum, gold, and the various sulfo-silicates; and during the third, calcite.

TEXTURAL AND STRUCTURAL CHARACTERISTICS OF THE ORE

Except along the Sunbeam belt where much of the ore consists of bodies of mineralized tuff, the ore is sharply defined and is enclosed between well-defined walls. The fillings, however, commonly contain numerous angular inclusions of the wall rock, in part as sharply defined fragments, which are sericitized, scantly pyritized, and generally somewhat silicified, and in part as phantom fragments, almost completely replaced by quartz. Because the fine-grained quartz, which cements the wall fragments, has itself been brecciated and has in turn been cemented by the more coarsely crystalline quartz, the filling in general has the appearance of an ore breccia with abundant openings lined with drusy quartz and in the bonanza pockets also with ore minerals. Crystallization is conspicuous throughout most of the deposits, either in bands broadly parallel to the walls or in concentric layers about breccia fragments. Generally the early fine-grained quartz and the later coarse-grained quartz stand out in sharp contrast, but in some deposits there is little difference, except in color. The calcite in part cements breccias of the earlier fillings, but more generally it has been directed along prominent fractures parallel to the walls and has penetrated and replaced the quartz unevenly. At the Lucky Boy the calcite comprises about a fifth of the filling, locally even half, and contains mainly remnants of the quartz. Elsewhere the calcite is likely to be along or close to one of the walls. With loss of the calcite at and near the surface the deposit is left with streaks or zones of porous, pseudomorphous quartz.

The metallic minerals are irregularly distributed through the quartz and to lesser extent through the calcite. In many places they are arranged in broken layers parallel to the bedding of the gangue or conform roughly with the crystallization. Locally crystals of metallic minerals occur on quartz druses. The sulfides associated with the early fine-grained quartz are coarse enough to be seen and the individual minerals recognized without a lens only on Estes Mountain and along the Dickens zone of mineralization. Otherwise the early sulfides are so fine as to merely darken the quartz.

Textures and structures show considerable variation in the different belts. The filling along the Dickens belt is exceptionally coarse and contains an abundance of coarse comb and drusy quartz commonly in crystals as much as an inch and even up to two or three inches long. This quartz comprises the most conspicuous feature of the filling, although there are numerous wall-rock inclusions and also much early fine-grained quartz. Some of the early quartz contains easily recognizable grains of pyrite, chalcopyrite, and galena. The late metallic minerals also tend to be coarse-grained, the gold being the coarsest in the district and in part of nugget size. Some calcite is present, but there is little, if any, pseudomorphous quartz.

The ore in the Custer area shows some local textural variations, but in general it is considerably finer-grained than the ore at the Dickens. Comb and drusy structures are generally present, but the crystals composing them are rather small (less than half an inch) and hence the comb and drusy structures are not so conspicuous. Except near the outcrop, the Custer vein seems to have relatively minor amounts of the comb and drusy quartz, and the ore appears more massive than elsewhere. The ore at the Lucky Boy is more or less completely dominated by calcite and fragments of the altered wall rock and shows less of the crystal quartz than the others. Metallic minerals are relatively coarse and are scattered irregularly and rather sparsely through the filling. Pseudomorphous quartz is conspicuous in the near-surface ore. This type of quartz is also con-
spicuous and locally characterizes the vein fillings at the Continental, Black, Yellow Bird, and one of the veins at the Fourth. The ore on Bachelor Mountain is much like that in the Custer area, except that there is generally little calcite and the pseudomorphic structures resulting from its leaching are not conspicuous.

On Estes Mountain the textural and structural characteristics of the ore are much like those of the ore along the Dickens belt. Precipitation is conspicuous and the quartz and its contained sulfides are relatively coarse. In the Contact (McFadden) vein much of the ore is roughly crutified parallel to the walls of concentrically banded about included fragments of wall rock. The metallic minerals are in easily discernable grains, readily recognizable as pyrite, chalcopyrite, and galena, and locally as argentite. Coarse comb and drusy quartz are conspicuous and abundant.

The ore along the nearby Sunbeam belt is altogether different from that on Estes Mountain. The minerals are very fine-grained, even the second-generation quartz, and breccia structures are exceptional, being confined to a few of the more prominent fractures. Much of the ore is in narrow strings of fine-grained quartz in the fractured tuff. Drusy surfaces are relatively inconspicuous, being composed of tiny quartz crystals. The ore bodies may be described most aptly as bodies of mineralized (largely silicified) tuff.

The Whale ore is much the same as the Sunbeam. It has some wall-rock inclusions, but much of the ore is finely crystalline, delicately banded, crystalline quartz. Combs and druses are composed of tiny quartz crystals.

The ore on Red Mountain is not much different from that in the Custer area. Comb and drusy quartz are common, but the crystals are not as large as those on Estes Mountain or along the Dickens belt. Individual veins are small and breccia structures are not conspicuous.

**DISTRIBUTION OF THE ORE**

The ore minerals are largely confined to definite parts of the veins—the ore shoots—which alone have been mined at a profit. The ore shoots are rarely more than a few hundred feet long (the Custer shoot had a slope length of 500 feet) and in each the ore may have a very erratic distribution and consist of scattered pockets of high-grade ore (the bonanzas) and intervening stretches of much lower-grade material. The pockets may measure up to 10 to 20 feet long and a few inches to a foot or two wide or may form small irregular masses. In these pockets the ore minerals are notably abundant and the presence of permeability as is apparent without assay. In the ore between, the ore minerals are so sparse or fine-grained as to escape easy detection.

With increasing depth the ore minerals become less abundant and the ore less rich. Ore shoots also become shorter and at depths of a hundred feet become too lean to be worked. Ore at the Montana mine ceased at a depth of about 500 feet and at the Charles Dickens at a depth of 250 feet. The Golden Sunbeam was disappointing on lower levels, and the ore at the Custer had a vertical range of only 600 feet. Though the Lucky Boy, the deepest mine in the district, was worked to the 900-foot level, most of the production came from much nearer the surface. The ore thus appears to have a limited vertical as well as horizontal distribution.

As the ore solutions operated mostly in open channels, as shown by the general crystallization of vein material and the numerous cavities lined with druses of quartz crystals, the shoots must mark those zones along the veins and lodes of greatest permeability. As the Fourth of July the pockets of high-grade ore were exposed are in part near or along cross fractures of northeasterly trend which cut the main vein. The main ore shoots of the Lucky Boy also lie on either side of the ABC fault, suggesting that the pre-mineral movement along the northeasterly trending cross fault helped to separate the walls of the Lucky Boy fissure and thus facilitated the movement of the ore solutions and the deposition of ore. Cross faults are visible in the footwall of the General Custer vein, but with the ore zone, it cannot be determined what effect these faults had, if any, on ore localization. At the Golden Sunbeam the N. 30° E. fractures, to lesser extent the northwest set, appear to have had the greatest control on the localization of ore shoots, at least they control their trend, but localization of many fractures may have been the chief factor. As workings in most mines were inaccessible, it was not possible to get much information on ore shoot controls. The evidence of horizontal movement along many of the fractures suggests, however, that changes in strike and dip of fracture plane and fracture zones may have been largely instrumental in creating the openings and localizing the ore.

The fading of the ore with depth, however, cannot be attributed to lack of favorable openings, for at the relatively shallow depths at which the mining ceased, breccia structures and open spaces still abound and the filling still contains as much quartz and calcite as on
higher levels. Ore values, however, have dropped and that fact suggests that thermal factors were in control of the vertical distribution of the ore, that with depth the temperatures were too high to permit deposition of ore minerals, and that the ore, therefore, remained in solution until dumped in the abundant openings close to the surface.

**TENOR OF THE ORE**

The ore that was mined in the early days was notably rich, some of the high-grade pockets yielding as much as $7,000 a ton in gold and silver. To bear the shipping costs of $150 to $200 a ton the ore had to be rich and much of that shipped was worth from $350 to $500 per ton, with some shipments yielding several thousand dollars to the ton. These shipments constituted hand-sorted ore from the high-grade pockets. With the erection of mills ore of lower tenor was mined. Ore from the General Custer before the mill was installed averaged about $500 to the ton. Early mill runs averaged $150 to $300 to the ton in gold and silver, but during the late stages of mining, the tenor fell to $10 and lower.

Ore mined since the turn of the century has been of much lower grade, but pockets of high-grade have been mined. Some ore shipped from the Montana in 1915 contained 8 to 23 ounces of gold and 53 to 1,000 ounces of silver per ton, and some 20 tons of ore shipped from the Fourth of July in 1942 contained 9 ounces of gold per ton. In 1946 a small shipment of ore from the Long View was worth a dollar a pound, mostly in silver.

Much of the ore now in sight in the district will probably average less than $20 a ton, but there may be exceptions. Sampling of the veins shows a spotty distribution of gold and silver. An assay at one spot may reveal the presence of more than an ounce of gold per ton, but another assay three feet away may disclose little or no gold. Ore mined at the Lucky Boy from 1939 to 1942 averaged about 0.4 ounce of gold per ton; sampling showed a spotty distribution. Occasional high-grade pockets may still be found in some of the deposits, but the average tenor of remaining ore is probably less than 0.25 ounce of gold per ton, with enough silver to bring the values up to $15 or $20 a ton. Some deposits, however, may run somewhat higher and some on the other hand may run very much less. Because of the erratic distribution of the gold and silver, it is difficult to make reliable estimates of the average or possible tenor of the ore yet remaining.

**OXIDATION AND ENRICHMENT**

Some of the ore mined in the early days was probably enriched by supergene agencies, but the presence of pyrite and other sulfides in surface exposures indicates incomplete oxidation and enrichment. The rich ore mined in the early days was due only partly to the presence of native silver, cerargyrite, and secondary argentite. Such high-grade ore as remained in the Fourth of July was literally shrouded in evidence of oxidation and supergene enrichment, and most of the ore studied microscopically, even the high-grade specimens that were donated, showed little or no evidence of secondary enrichment.

Oxidation and supergene enrichment have apparently been of minor importance and consequently the high-grade pockets that have been mined have represented in large part the primary ore.

**GENESIS OF THE DEPOSITS**

The ore unquestionably was introduced into the fractured rocks by hydrothermal solutions which had their source deep in the earth, probably in the same magma body as that which supplied the materials for the great accumulation of tuffs and flows that enclose the deposits and which provided the substance for the porphyritic dikes and the rocks intruded of the same some of the fracture zones prior to mineralization. These solutions, which apparently escaped during the closing stages of igneous activity, were directed toward the surface along the reactivated zones of structural weakness which had been initiated during the earlier Laramide orogeny.

Chilled on spreading through the abundant fractures in the cold rock near the surface, the solutions dumped their load of metals within a vertical range of a few hundred feet. The flow of solutions, however, was not continuous from the start to the end, nor was the unloading of minerals an uninterrupted process. After filling the fractures in the volcanic rocks with quartz and other trivial amounts of metallic minerals, principally pyrite and possibly selenides and locally cerargyrite and some amounts of other sulfides, all of them generally very fine grain because of the rapid cooling and crystallization, the solutions apparently ceased to flow, possibly because of plugged channels. Structural movements, however, soon reopened the channels, brecciating much of the filling in the process, and permitting the mineralization to continue. Deposition apparently was resumed at a more leisurely pace and partly filled the breccia openings with comb and drusy quartz, minor amounts of adularia, and, along the main
channels, variable amounts of the precious metals, which also penetrated the earlier fill- ing. Mineralization stopped at most places with the deposition of the valuable ore minerals, which here and there made rich shoots or pockets of bonanza ore, but in some places, particularly along the east end of the Custer belt, the deposits were restructured and the solutions that were introduced left variable amounts of lamellar calcite, which replaced earlier fillings rather extensively.

Weathering since has transformed some of the minerals into secondary products, but erosion has been permitted to result in extensive enrichment. Thus most of the ore found near the surface represents the primary ore. Deposits were more or less deeply eroded, but in view of the small placer production the larger part of the gold must have been left in the veins and lodes, until removed by mining operations.

As the mineralizing solutions spread through the broad zones of fractured rock near the surface, they caused extensive alteration of the country rock, with the most intense effects on the principal fractures. The alteration of the intrusive porphyries, however, is not the result of the action of the mineralizing solutions, but of their own end-stage solutions, an effect which tends to link closely the mineralization with the igneous intrusion.

As weathering later attacked the deposits and leached the calcite from the upper parts of the veins and lodes, the pseudomorphous quartz, which preserves the form or cast of the lamellar calcite that replaced it, came into existence.

As the deposits are contained in the Challis volcanics of Oligocene age and are truncated by a Pliocene erosion surface, they belong to the younger period of mineralization recognized in Idaho, that of mid-Tertiary (Miocene) age.

CONCLUSIONS

These deposits are quite typical representatives of the well-known group of epithermal deposits prized for their precious metal content and like such deposits show all the features indicative of formation at shallow depths and at relatively low temperature. Like such deposits they also show the pockety or bonanza development and the shallow vertical range for which the type is notoriously famous.

Because the ore shoots in these deposits have such a limited vertical range, perhaps a thousand feet at the most, less erosion, the driving of long crosscuts with the expectation of finding ore at levels lower than those reached during the early days is to be discouraged. The records indicate that the mining stopped where it did because, with increasing depth, the ore became lower and lower in grade and finally too low grade to be mined profitably. In evaluating the deposits today, however, one must take into consideration the fact that the early mining had a lower order of efficiency and a relatively higher cost as compared with today's mining practices, that the mill recovery then was much lower than is obtainable now by cyanidation and flotation, and that the transportation costs then were far above those of today. All of which means that it should be possible to mine and treat ore now which was not profitable to treat then.

If deep development is not likely to be rewarded, there still remains possible discovery of ore along vein extensions on higher levels and utilization of the lower grade ore that the earlier operator was unable to treat. As demonstrated at the Fourth of July, occasional pockets of bonanza ore still exist and others may await discovery, particularly along the veins and lodes that have not been extensively explored. Most of the ore still unmined, however, contains $20 or less in gold and silver, much of which is not amenable to amalgamation.

Small shipments of high-grade ore of not less than $50 value may be expected in the future, as in the past, but any appreciable production must come from the lower grade milling ore. No mill should be planned or equipped until at least enough ore has been blocked out to pay for the installation out of earnings or production.

Mines and Prospects

General Statement

For convenience the mines and prospects are grouped according to the zone of mineralization along which each is located. These zones are considered as geographic areas and are referred to as the Custer, Bachelor Mountain, Estes Mountain, Sunbeam, Whale, Dickens, and Red Mountain areas.

Custer Area

General Custer

The General Custer, the largest and most famous mine of the district, is on the high, rugged slope above Yankee Fork, a short distance southeast of the town of Custer (Fig. 3). It comprises several claims, principally the General Custer, the Unknown, and the White Bird (Fig. 4), which in the early days were regarded as separate mines. These claims extend along the Custer lode from an elevation of about 7,000 feet to the summit of the ridge.
at 8,500 feet. The vein was discovered about 1876 and was worked actively most of the
time from then until 1905, when the mine was
closed. During that time the Custer is said to have produced about $9,000,000, some from
early shipments to Salt Lake and San Francisco,
but mostly from the mill at Custer, which was
completed and in operation early in 1881.

The development at the General Custer mine
has consisted of surprisingly little under-
ground work. Practically all the development
was performed by nature before man arrived,
for erosion had stripped the hanging wall from
much of the vein, as a result of which the ore
lay as a great slab against the side of a narrow
gulp, tributary to the main canyon at Custer
(P1. 2A). All that was necessary in the early
days was to break the ore from the side of the
gulp. This has left the footwall exposed, which
resembles a dip slope pitching toward the bot-
tom of the gulch (P1. 2A). Several tunnels have
been driven into the gulch below the exposed
part of the vein, two of which were partly open
in 1947 and were mapped (Fig. 5). Other tun-
nels east of the open exposure developed a
part of the vein on the Unknown claim, but
these workings are now completely inacces-
sible. The Summit, a parallel vein directly
above and east of the General Custer, was
opened to a depth of 150 feet by tunnel and
shafts, but only the open cuts and the tops of
the carved stopes are now open to inspection.
A crosscut still open on the White Bird claim is
about 270 feet long; it is driven from the south
side of the ridge to the vein.

The upper part of the General Custer vein
is in the andesite, but the lower part enters
bedded tuff. The rock bordering has been exten-
sively altered and in places the silicified anden-
site stands out on the slope in bold relief, as
ledges tens of feet across. The vein itself is a
fissure filling and strikes N. 60° W. and dips
about 35° NE. It measures from a few inches
up to 12 feet, locally up to 18 feet wide, but
averages about 6 feet. One of the partly acces-
sible drifts (Fig. 5) shows two veins, one reported
to be a split part of the other, but the mapping
suggests a parallel, closely spaced, overlapping
vein. The vein on the summit above the Custer
is about parallel but the dip is 72° NE. Appar-
ently several veins of variable magnitude occur
along the broad mineralized zone constituting the
General Custer lode.

The ore shoot of the Custer, most of which
was contained in the exposed portion in the
side of the gulch, had a stope-length of about
500 feet. This shoot was mined from an altitude
of about 8,000 to 8,400 feet. The pitch of the
ore shoot apparently corresponded closely with
the grade of the gulch, and the shoot terminated
as the vein neared or penetrated the tuff. As
the vein entered the tuff it is reported to have
widened by 30 feet and values dropped from $150 to $900 per
ton, but only during the later stages of mining the
tenor dropped to $30 and less.

Lucky Boy

The Lucky Boy, the most recently produc-
tive mine in the district, is in the Adair Creek
drainage, about a mile east-southeast of the
General Custer at an altitude of 8,300 feet (Fig.
3). The vein was discovered in 1878 but it was
not extensively opened until the late nineties
when the General Custer or body began to show
signs of exhaustion. It was worked actively from
then until 1904, the ore being carried by aerial
tram to the General Custer mill on Yankee
Fork. The mine closed in 1905 but was reopened
in 1938 and two years later was the district’s
big producer. Mining continued until May 1942
when the war put an end to further work. The
property was then abandoned by the Custer
Consolidated Mines, Inc., and all equipment
removed. The property was later leased to
others and in November 1947, the Yankee
Mines, Inc., was organized with the expectation
of installing a 50-ton jig and flotation mill,
reopening the mine, and operating it on a fairly
large scale. The Lucky Boy is said to have pro-
duced about $1,750,000 in the early days and
additional $450,000 during the recent activ-
ity. From 1939 to 1942 the production is reported
to 10,000 ounces of gold and 142,000 ounces of
silver.
In addition to a complete surface plant (P1. 28), the Lucky Boy mine has more than 10,500 feet of underground workings on nine levels connected by two inclined shafts, one of which is caved to the 600 level. The 400 and 600 levels also have connection with the surface by adits, but in 1947 only the 400 adit was open and only the 400 and 600 levels were accessible, those below the 600 being flooded and those above the 400 blocked by caved. The plan of the underground workings, with the geology on the 400 and 600 levels, is shown in Figure 6. Other data on the underground workings are given in the longitudinal sections (Figs. 7 and 8) and in a cross section (Fig. 9). Mining has extended from the surface at 3,300 feet to an altitude of 7,584 feet on the 900 level.

There are four veins exposed underground, the Lucky Boy, the A vein, the Calcite vein, and the McGuire, but the bulk of the early production has come from the Lucky Boy and much of the recent production from the Calcite vein (once known as the Turkey Foot). These veins are part of a branching system, the A, Calcite, and McGuire veins being offshoots or branches of the Lucky Boy. The latter strikes about N. 70° W. and dips 70° NE. The other veins have a more easterly bearing and a steeper dip. The A and Calcite veins lie in the footwall of the Lucky Boy, the McGuirie in the hanging wall. Striking N. 80° W. and dipping 80° N., the A vein joins the Lucky Boy between the two shafts (Fig. 6) and between the 600 and 400 levels (Fig. 9). The Calcite vein strikes N. 80° E., dips 80° N., and intersects the Lucky Boy vein about 420 feet southeast of the main shaft (Fig. 6). The McGuire, which has about the same strike and dip as the Calcite vein splits from, and enters the hanging wall of the Lucky Boy about 500 feet east of the shaft. None of these veins extends across the Lucky Boy, but the so-called ABC fault does extend across and displaces the Lucky Boy and the Calcite veins about 30 feet. This fault strikes N. 45° E. and dips 50°-65° NW. The ABC fault is mineralized and much of the movement, largely horizontal, took place prior to mineralization. The movement along the fault produced much gouge, which explains why the mineralizing solutions entered with difficulty and left little ore. There are also many other seams and stringers parallel and cutting across the principal veins, but these are composed mostly of barren calcite and have no commercial worth. The relations of the different veins and mineralized fractures are shown in the plan map (Fig. 6).

The veins are much alike in their structural and compositional characteristics. All of them may be classed as breccia veins with well-defined walls and abundant wall-rock inclusions in a matrix of quartz and calcite. The Lucky Boy vein averages about 5 feet wide, but in places it narrows to a stringer and in other places widens to 18 feet. The A vein ranges from 2 to 6 feet wide; the Calcite vein, 3 to 4 feet wide; and the McGuire, up to 1 foot wide. In some places the veins contain more fragment of the altered rock than quartz and calcite.

The Lucky Boy vein has been more persistently mineralized than the others, but the rich ore has had a spotty distribution and ore, shoots are irregular. As shown in the longitudinal section (Fig. 7), stoping was almost continuous for about 1,000 feet on the strike above the 300 level; but below, much of the ore was found close to the ABC fault, where cross movement apparently provided more permeable openings in the Lucky Boy fracture for the circulation of the mineralizing solutions. With increasing depth the ore shoots became smaller (Fig. 7) and the ore lower grade, reflecting perhaps higher and less favorable temperature conditions. The A vein has been stoped from the 600 level to a height of about 40 feet for a distance less than 100 feet. The distribution of the ore along the Calcite vein is shown in Figure 8. Below the 600 level the values diminished to a point where no stoping was attempted.

As already indicated the vein fillings consist of fragments of sillified and somewhat pyritized andesitic wall rock, cemented by quartz and calcite. The calcite here is more abundant than elsewhere in the district and forms up to half the filling. It is apparently only slightly less abundant in the Lucky Boy than in the Calcite Boy and locally is the chief filling in the A vein. The quartz, however, is the more important mineral. It is older than and is in part replaced by the calcite, some of which is lamellar and when leached makes the quartz appear as the pseudomorphous variety. Otherwise the quartz is like that throughout the district, and is represented by the early fine-grained grayish variety, more or less thoroughly permeated by the lighter-colored, somewhat more coarsely crystalline kind and by microscopic grains of adularia. The values are restricted to the sprinkling of metallic minerals which occur in narrow irregular bands and veinlets, commonly parallel to the wall of the veins. The veins and stringers are discontinuous and rather sparsely distributed. Commonly the metallic minerals occur as small irregular spots in the ore, principally in the quartz but also as incrustations within the calcite. Apparently the calcite that invaded the veins was less successful in replacing the metallic minerals than in replacing the quartz. Although fine-grained,
the metallic minerals may be readily identified in polished sections. Those recognized are pyrite, chalcocyprite, sphalerite, galena, tetrahedrite, and locally a little pyrrhotite. Some of the pyrite forms crystals large enough to be recognized without a lens, and in one specimen gold also was visible, but otherwise the various minerals cannot be distinguished individually by the unaided eye. The ore is reported to have contained gold and silver in about the same proportions as at the General Custer. The ore last mined averaged about 0.4 ounce of gold per ton.

**Badger**

The Badger, one of the early productive mines, adjoins the Lucky Boy on the east (Fig. 4). By 1890 the mine had been opened by two tunnels, the lower at a depth of 220 feet below the surface. Later the mine was developed by shaft, but by the late nineties mining had ceased and today, except for the dumps, there is little to mark the position of either the tunnels or shaft. Neither the total development nor the production was learned.

The Badger is reported to parallel the Lucky Boy, and is regarded by some as an offset and localized by a later, shifted fault along what has been postulated as the Badger fault. Such relations, however, cannot be demonstrated by anything seen on the surface. According to early reports, the vein was 2 to 12 feet wide.

Such ore as was found in and on the dumps is much like that at the Lucky Boy and contains both fine and coarse-grained quartz and calcite, and appreciable amounts of metallic minerals, some relatively coarse and massive. Ore mined in the early days is reported to have yielded $150 to $350 per ton, a report apparently substantiated by the richness of some of the ore fragments in the dump. Minerals identified in polished sections of high-grade ore include the abundant micromyrite and pyrrhotite, considerable amounts of tetrahedrite and argentite, and some enargite, galena, sphalerite, steinheite, electrum, and gold.

**Vishneo**

The Vishneo is on the upper slope south of Adair Creek a few hundred feet east of the General Custer (Figs. 3 and 4). It is developed by two tunnels and an old shaft, the tunnels being just below the road to the Lucky Boy. The upper tunnel, which passes a few feet below the road bed, is about 95 feet long; the other, 65 feet vertically below, is more than 250 feet long. The shaft was sunk and some of the tunnel work was done in the early days. The lower tunnel was extended during 1947.

The Vishneo lode, which may be traced on the surface for about 1,500 feet, strikes about N. 70° E. and dips steeply northwest. It appears to lack the simplicity of the fissure-controlled veins and consists of a zone of complex fractures which in the face of the upper tunnel strikes N. 60° E. and dips 70°-85° NW. The fracturing plays out a few tens of feet west of the tunnel, for the lode does not appear in the lower tunnel driven about 100 feet to the west.

A small pocket of rich ore was reported in the shaft and fair values are said to show in the upper tunnel where stringers and a 16-inch vein of grayish quartz is exposed. The lower tunnel is started in and passes through the Mullan vein. Some distance in, this tunnel passes through some minor slips of N. 70° E. strike and steep southeast dip, two of which are slightly mineralized.

**Mullan**

The Mullan lies between the General Custer and the Lucky Boy (Fig. 3) The workings consist of several short tunnels at the west end of the property and a shaft and some cuts on the lode and a 550-foot crosscut, which fails to reach the shaft, at the east end. Some ore may have been mined at the shaft, now caved, but there is nothing elsewhere to indicate any production.

The Mullan lode is one of the longest in the district and may be traced by outcrop exposures and cuts and tunnels for fully 2,500 feet. It strikes in a general east-southeasterly direction, starting a short distance southeast of the end of the Custer lode; but, although it has some of the characteristics of the Custer, it is not a continuation or offset segment of that lode. Although persistent, it is not uniformly thick, but ranges from several feet up to 40 feet or more, consisting of breccias of silicified andesite and fine-grained grayish quartz with extremely minute sulfides cemented and coated by white, somewhat more coarsely crystalline, in part comb and dumpy quartzes. The vein is well-exposed at the portal of the lower Vishneo adit and in another short open tunnel nearby. It is also exposed in several cuts near the shaft near the east end of the property.

The Mullan crosscut (Fig. 10) exposes a number of minor fractures, some of which are lightly mineralized. Some strike about due east, some slightly north of east, and others south-east. Most of them dip steeply north. One of the

*Reported by Thor Kilhammar, written communication.*
Black

The Black lies on both sides of the ridge between Adair and Fourth of July Creeks a short distance south of the Lucky Boy (Fig. 2). The mine was known and worked in the early days, but its production, though considerable, was not learned. By the turn of the century the development, except in one tunnel, was not as extensive as today and consisted of about 6,700 feet of workings in five adit tunnels. In 1906 the mine was acquired by the Omaha Gold Mining Co., Ltd., and work was begun on a 1,300-foot adit drift from mill level on Adair Creek to explore the ore bodies at an additional depth of 300 feet. The development continued for several years and then the mine suspended operations. In 1934 the mine was taken over by the American Dollar Mining and Milling Co. (incorporated Dec. 15, 1936), and work was started at reopening the lower tunnel. Rehabilitation continued until 1942, when work was suspended. The development now consists of more than 7,000 feet of workings in six tunnels, which are either caved at the portals or within 50 to 140 feet of the portals.

There are two parallel veins on the property but most of the work has been confined to the Black, on the west side of the ridge. The Black strikes N. 50°-55° E. and dips 65° N.W., but on the other side of the ridge the strike changes to about N. 70° E. The vein has been explored underground for about 2,000 feet, but nothing was learned of the size or characteristics of the ore bodies. In the uppermost workings the vein is 4 to 5 feet wide.

The mineralization appears to be much like that at the Lucky Boy, for dump material shows considerable calcite and pseudomorphic quartz and some fine-grained metallic minerals.

Fourth of July

The Fourth of July extends across the high ridge between Adair and Fourth of July Creeks a short distance southeast of the Lucky Boy (Figs. 3 and 4) and a few hundred feet south of the Black. The mine was one of those worked in the early days, but little information is available concerning its early history and production. In the late thirties it became one of the better known mines in the district, largely because of small shipments of very rich ore, one shipment of 20 tons in 1942 averaging 9 ounces of gold per ton.

The development consists of 7 adits, 5 on the east side of the ridge and 2 on the west side. The workings on each side being on a different vein. The lowest tunnel on the Fourth of July Creek side was caved but the others
wire open. The one next above (Fig. 11) is about 270 feet long, the others, 98, 75, and 30 feet respectively. On the north side of the ridge only the lower adit (Fig. 11) with about 115 feet of workings is open.

The two veins overlap on the crest of the ridge but neither extends very far down on the opposite side. They lie within a broad zone of completely fractured and locally silicified rock which trends about N. 70° E. across the ridge. The vein on the east side strikes a little north of east. Near the portal of the lower open tunnel the mineralized zone is about 40 feet wide; the vein is perhaps 3 or 4 feet wide. The zone has several rib of silicified rock, one of which is reported to carry about 0.25 ounce of gold across 10 feet. In the tunnel near the crest of the ridge the vein is narrower and much better defined, being 14 to 18 inches wide and bordered by less intensively altered rock. The vein shows local curvature and some changes of dip, but for the most part the dip is 80°-90° N. As shown on the map of the lower open tunnel (Fig. II) the vein is cut by numerous fractures of general northeast, exceptionally northwest strike and steep northerly dip, but offsets are generally negligible. The vein is reported to consist of coarse aggregates of quartz with graystone matrix which form the ore with glass and there small pockets of bismuth ore. There is some suggestion that the high-grade pockets are localized by cross fractures and by undulations on strike and dip. Considerable stoping has been done above and below the level. In the short adit on the west side of the ridge a pocket of high-grade ore was uncovered along the footwall of a N. 45° E. cross fault and stopped to a depth of 10 feet for a horizontal distance of 15 feet.

The filling of both veins contains appreciable amounts of the fine-grained grayish quartz rather highly impregnated with small crystals of pyrite, considerable fairly coarse comb and drusy quartz, and locally much pseudomorphous quartz and calcite, particularly along one or the other of the walls. In places there are also minor amounts of chalcedony and microscopic grains of adularia, which is associated with the more coarsely crystalline quartz. Polished sections of some of the high-grade ore from the vein on the west side of the ridge shows much pyrite and free gold, with the gold in part replacing the pyrite, which is included within the quartz, and in part filling the interstices between and covering the quartz crystals. Other minerals noted included a little sphalerite closely associated with the pyrite and some argentite filling between the quartz crystals. The quartz filling near the face of the lower tunnel on the east side of the ridge also contains high gold values and fairly conspicuous grains of grayish metallic minerals. Some of the metallic minerals form small crystalline aggregates on the surface of quartz crystals in druses. Minerals recognized included crystals of argentite and small striated crystals of stephanite.

**Wire Silver**

The Wire Silver is on the same ridge as the Fourth of July and crosses the ridge about the 9,000-foot contour. The development consists of surface cuts and a shallow tunnel with a slope or cave to the surface.

The cuts and tunnels are aligned across the ridge in a N. 55° E. direction, which appears to be the general trend of the vein. Where the vein is exposed at the caved portal, it is about 4 feet wide and strikes N. 70° E. and dips 80° NW., occurring within a broad zone of sericitized and locally silicified andesite. The vein shows considerable variation in its textural and mineralogic characteristics along its more than 150 feet of exposed length. At the portal the vein is mostly massive crystalline quartz but along the strike it shows a preponderance of drusy and pseudomorphous quartz and locally minor amounts of metallic minerals, identified as small grains and crystals of pyrrhotite and pyrite. Microscopic grains of adularia also occur in the quartz.

**Continental**

The Continental is about due east and just over the ridge from the Lucky Boy, on the steep slope that descends to Fourth of July Creek (Figs. 3 and 4). The mine was worked as early as 1878 and is reported to have been highly productive. All but the highest of its five tunnels, which have been driven at intervals beginning near creek level, are now caved. The one that is open, an adit drift, is about 200 feet long.

The vein strikes about N. 60° W. and dips 60° NE. It is relatively short and swells into a huge chimney-like mass composed largely of silicified rock about 100 feet across. This large bulge makes a conspicuous outcrop. The open adit is driven into the lower end of the bulge along the main ore zone, which in places forms the walls on both sides of the tunnel and in other places a 1 to 3 feet band on one wall or along the roof. About 150 feet from the portal the vein appears to split. The branch that continues ahead is about 5 feet thick, the other, which curves to due west, is even thicker. Here and there strings extend into the bordering fractured and silicified andesite.

The vein contains an exceptionally large amount of pseudomorphous quartz, considerable calcite, and much white quartz with spots
of finely crystalline metallic minerals of which pyrite and gold are megascopically visible. Such material occurs on each of the dumps and in the uppermost part of the lower tunnel, where the pseudomorphous quartz is particularly abundant. The metallic minerals appear to be older than the quartz, which contains them in the form of inclusions. In polished sections, these grayish spots were found to contain in addition to the pyrite such minerals as sphalerite, tetrahedrite, galena, chalcopyrite, pyrrhotite, argentite, electrum, and gold.

McClure

The McClure property is on the west side of Fourth of July Creek just over the ridge from the Lucky Boy and a few hundred feet west of the Continental (Figs. 3 and 4). The development comprises half a dozen tunnels, half of them well up the slope at about the level of the saddle between Adair and Fourth of July Creeks and the others well down toward the creek 400 or 500 feet below. Three of the tunnels could be entered, the uppermost being about 300 feet long, the lowest about 185 feet long.

The upper tunnel, driven in a southerly direction, enters a mass of boulder and clay about 35 feet from the face, first exposing two lightly mineralized faults in altered andesite, the first striking N. 80° E. and dipping 65° NW., the second striking N. 74° E. and dipping 60° NW. The first consists of 4 feet of fractured rock with some quartz stringers; the second, of 30 inches of fractured rock and 8 inches of gouge. An intermediate tunnel carved at 40 feet exposes a 6-inch quartz vein which strikes N. 70° E. and dips 45° NW. The lower workings are on another vein, but the lower tunnel is carved at the point where the vein is cut and nothing could be learned of its characteristics. In old workings just above, the vein appears to strike N. 70° E. and dip 45° NW. Considerable calcite with some quartz is piled on the lower dump.

About 100 feet south of the lower tunnel is a broad zone of highly silicified and ledge-forming rock with small stringers of quartz. The zone is controlled by fracturing of N. 25° E. trend and steep northwest dip. It has been explored by a large cut and short tunnel.

Idaho (Enterprise)

The Idaho, formerly the Enterprise, is a few hundred yards east of the General Custer on the north side of the ridge (Figs. 3 and 4). The development consists of an 850-foot crosscut with a 25-foot drift at the far end and a number of cuts and short tunnels along the cut-crop several hundred feet above. All working, except some of the cuts and a large glory hole, are inaccessible. No information was obtained on past production.

The vein strikes about N. 70° E. and dips 65° NW. It may be traced by a series of cuts from the saddle near the General Custer east-erly for about 2,000 feet. The vein is not conspicuous except where the main work was done on the slope above the long crosscut. There it consists of a brecciated zone 25 to 30 feet wide, heavily imbricated and cemented by vein quartz. The mineralized zone pinches abruptly on strike and dip and is reported to be no more than 2 feet wide in the short drift at the end of the long crosscut.

Some ore from the drift and the 7 to 10 foot stope above still remains on the dump of the long crosscut. This ore consists of a breccia of fine-grained grayish quartz in which occasional small crystals of pyrite may be recognized in a matrix of more normally crystalline white quartz, in part drusy. Some of the latter quartz is sprinkled with small sulfide grains and crystals which prove on microscopic examination to consist of small crystals of arsenopyrite, pyrite, enargite, pyrrhotite, and more rarely gold (electrum) and tetrahedrite. Considerable of the arsenopyrite occurs as a mantle of small crystals extending out from and into lath-shaped crystals and small bodies of enargite. Electrum was observed alone and in association with pyrite. The enargite and arsenopyrite were deposited with and ore enclosed within the quartz, but the pyrrhotite is along fractures in the quartz and a filling between quartz crystals.

Long View

The Long View is about half way up the road leading to the General Custer and extends across the crest of a sharp spur ridge about a quarter of a mile north of the General Custer mine (Fig. 3). The road crosses and recrosses the property which is at an altitude of about 7,500 feet. Some ore was mined in the early days. The workings are shallow and consist of an old abandoned shaft and cut on the crest of the ridge, a caved tunnel on the south side, and two open tunnels on the north side. The upper tunnel on the north connects with the bottom of the shaft. The two open tunnels, 48 feet apart vertically, are shown in Fig. 12.

The Long View is along a broad complex zone of fracturing in extensively sericitized and scantily pyritized andesite with the mineralization confined to a prominent fissure which strikes about N. 77° W. and dips 60°-70° NE. in the lower workings and then curves so that its strike is S. 77° W. and its dip 74° NW. in the upper tunnel. The fissure contains considerable gouge, bordering by slickensided surfaces with horizontal striations. The filling is the breccia type with small fragments of the altered andesite and early quartz in a matrix.
of younger quartz. The filling lacks continuity but locally swells into a lenticular body 4 to 5 feet wide and 45 feet long. Some quartz seams possess closely spaced and occasional lenticular veins up to 2 feet thick occur in more distant fractures. Many fractures exposed underground are mineralized and contain thin seams of gouge.

The ore is spotty in distribution and most of that so far uncovered is confined to a high-grade pocket at the shaft or raise from the upper tunnel to the surface. The ore body locally is rich in silver, containing perhaps 100 ounces of silver to each ounce of gold, and shows a generous sprinkling of small grains and short irregular veins of pyrrhotite and rarely small grains of gold associated with and occurring between crystals and in vugs in the young quartz. Associated with the pyrrhotite is a minor amount of tetrahedrite, locally sphalerite, and pyrite. Much of the late quartz is fine-grained and in part chalcedonic. It generally contains numerous inclusions of the sericitized andesite and dark gray, almost black, fine-grained quartz in which tiny crystals of pyrite may be recognized. In some places the dark gray quartz is scaly and lacking and the filling is entirely the young generation of quartz. In some of the grayish and other seams, crystals of exceedingly minute size are developed in lithiclike aggregates by replacement of some unknown leucoxene mineral. Stringers of calcite occur in bordering fractures, but the ore apparently is without calcite. Some fractures in the ore, however, are cored by coarse flat barite crystals measuring up to ½ inch long.

**BACHELOR MOUNTAIN**

Gray Eagle

The Gray Eagle is high on the ridge that extends up the northwest side of Bachelor Mountain, mostly above 9,000 feet. A road, at present usable, ends at the old mill site on Slaughterhouse Creek about 500 feet vertically below the mine. The mine was worked in the early days and was active in 1917, 1934, 1937, and 1938. The workings are fairly extensive and consist of more than a dozen tunnels of various lengths driven along or just under the crest of the ridge and many cuts and shallow slabs, mostly near the top of the mountain. Some but not all of the tunnels are shown in Fig. 3.

The tunnels and cuts expose about as many veins, most of which are short and arranged, in part, in parallel, overlapping series along or close to the crest of the ridge. Some of the veins strike in a northeasterly direction but many strike N. 50°-70° E., somewhat obliquely across the ridge. Individual veins are from 2 to 8 feet wide but apparently no more than a few hundred feet long. Most of them dip steeply north. The visible parts of all of them are in the andesitic flows a short distance above the mass of dacite porphyry.

The mineralization differs little from that in the rest of the Yankee Fork district. The early fine-grained grayish quartz with occasional recognizable tiny crystals of pyrite, chalcopyrite, and galena is fairly conspicuous in the ore, commonly as breccia fragments cemented by white more coarsely crystalline quartz. The latter also contains scattered sulfide grains, and some of that which is finely drusy also has occasional small grains of ruby silver, pyrite, and gold. Minerals identified in polished sections include pyrite, sphalerite, chalcopyrite, galena, and electrom. The metallic minerals have an irregular, spotty distribution: pyrite and chalcopyrite, though scaly, are apparently the most abundant. Unlike elsewhere, the younger white quartz is rather fine-grained and crystals in drusy are also tiny. There are also widely scattered thin seams and stringers of a third-stage comb and druse quartz and occasional thin seams of calcite.

The lowest tunnel on the ridge is caved and the dump material is composed of sericitized and silicified andesite. A 15-foot tunnel a short distance above exposes a 20-inch vein striking N. 85° E. and dipping 65° NW., probably not the one reached by the lower tunnel. The filling is chiefly very fine-grained quartz, in part finely drusy. In the face of the tunnel the vein is cut by a fault which strikes N. 45° E. and dips 80° NW. The offset is not revealed.

The next tunnel above, which is about 25 feet long, is an iron which strikes N. 65° E. and dips 55° NW. The vein is more than 5 feet wide, with the face entirely in quartz. A fourth tunnel, caved but showing more than 10 feet of quartz at the portal, is apparently on another vein. The quartz is white, massive, and considerably iron-stained. A short distance away from the portal, the face is exposed at the end of a 10-foot crosscut and along a 10-foot drift.

The sixth tunnel up the ridge is one of the most extensive. A blacksmith shop on the dump identifies the tunnel. The track has been removed, evidence that there has been no work in the tunnel for a long time. The tunnel is partly blocked, but the size of the dump indicates several hundred feet of workings. The tunnel is on a broad mineralized zone and is driven N. 35° E. A fault exposed at the portal strikes N. 20° and dips 85° NE. Just above the
tunnel is another which connects with a stope, apparently from the tunnel below. A drift driven southeast exposes an alteration zone about 30 feet wide, and near the face, a N. 45° E. fault, with steep northwest dip.

The eighth tunnel has several hundred feet of work and a track. The tunnel is very crooked as it zigzags back and forth along a 2 to 3 foot quartz vein, which strikes N. 45° E. and dips steeply northeast. The quartz is massive and heavily stained by iron oxides.

The ninth tunnel is about 95 feet long and has a stope 50 feet long beginning about 35 feet from the portal. This vein strikes about N. 55° W., and dips 50° NE. and is as much as 7 feet wide. The stope has been carried to the surface about 30 feet above. The bottom of the stope is in quartz. The vein is also exposed in a tunnel just above.

Numerous cuts and short tunnels continue on up the ridge, particularly on the southwest side. Some expose veins which trend northwest, others which trend about N. 70° E. In the most distant tunnel the exposed vein is about 5 feet wide and strikes N. 85° E. and dips 70° NW. A vein a short distance on strikes N. 50° W. and dips 60° NE. From there almost to the summit of Bachelor Mountain the veins strike about N. 70° W. One caved tunnel of considerable length has been driven from near the head of a gulch on the northeast side of the ridge, apparently to explore one of the veins about midway up the ridge.

Dorothy

The Dorothy is on the slope south of the Gray Eagle. The 70-foot tunnel is driven along a 10 to 14-inch vein which strikes N. 65° E. and dips 80° NW. The vein, filled largely with calcite, is in the dacite porphyry.

ESTES MOUNTAIN

Montana

The Montani is on the south slope of Estes Mountain a few hundred feet below the summit. The mine, the most productive on the mountain, was discovered in 1877 and in the next few years produced $337,000, mostly in gold, from ore that assayed up to several thousand dollars per ton. Mining ceased before the turn of the century, but the mine was reopened in 1905 and operations carried on for several years, mainly in the 2,000-foot Cutick crosscut which was to develop the mine at depth. The mine was mostly idle after 1907, but discovery of rich ore about 1913 soon made it the most productive in the district. At that time an aerial tram was built to carry the ore from the mine to the Sunbeam mill on Jordan Creek. In 1918 the mine closed and has remained closed to the present. Altogether the mine has produced about $356,000. The workings are now inaccessible but are reported to include 6 tunnels and levels about 50 feet apart to a depth of 565 feet.

The Montana is on a fissure of northeasterly trend, but the ore was confined to a chimney-like shoot 5 to 17 feet wide and 20 to 60 feet long, which extended to a depth of 530 feet. In the upper 250 feet the shoot dipped about 80° SW., flattening below to 45°. Near the shoot the tuff was extensively silicified.

The vein and ore material now available on and about the dumps and about the old ore bin at the Sunbeam mill shows some fine-grained grayish quartz with fine-grained sulfides, mostly pyrite, as breccia fragments in a matrix of coarse comb and druzy quartz, some of which is partly amethystine. Locally some of the early quartz has fairly coarse-grained sulfides, recognizable in polished sections as chalcopyrite, sphalerite, galena, and pyrite. Grains of gold and crystals of argentite were noted on some of the quartz combs and druses. Locally some chalcedony, as bands, crusts the quartz crystals.

Above the 250 level the chief value was in gold; blow the ore became rich in silver. None of the bonanza ore was available for study, but according to Strohorn the ore contained much wire and sheet gold and often small nuggets. Some ore was so rich that it was worked in a mortar at the mine. Some of the best of the early ore is reported to have assayed $2,000 to 3,500 to the ton. Ore mined in 1915 rivalled that of the early days, with some shipments containing 8 to 23 ounces of gold and 23 to 1000 ounces of silver per ton.

McFadden

The McFadden mine is in the cirque at the head of Eight Mile Creek on the northeast side of Estes Mountain at an altitude of 9,100 feet. The mine was located in 1878 and has been worked at intervals since, producing in all more than $200,000, considerable of it in silver. One car of rich ore was shipped in 1923, but whether any ore was shipped in 1936 when the last work was done was not learned.

The workings were not accessible in 1947 but were reported to consist of three tunnels totalling about 2,000 feet and an inclined shaft about 500 feet long sunk from the lower tunnel level and increasing the mine depth by about 350 feet. One formerly was treated in a 10-stamp mill on Eight Mile Creek about 3 miles below the mine. The buildings at the mine are still in a fair state of repair.
The McFadden is on the "Contact" vein which lies between a fine-grained tuffaceous hanging wall and an andesitic or latitic footwall, both walls being intensely altered. The vein strikes about N. 20° E. and dips 37° NW. It is reported to average 3 to 4 feet wide and to be composed primarily of clear crystalline comb and drusy quartz arranged as crystals roughly parallel to the walls and as concentric bands about included fragments of the altered country rock. The ore is confined to tilled and poorly defined shoots about 100 feet long on the upper levels but much less on lower levels. The ore body is reported to pitch 30°-40° N., and, because the incline has been sunk at a steeper angle, 100-foot drift was needed to reach the shot on the lowest level.

The ore scattered about the bin near the portal of the lower tunnel contains considerable pyrite, chalcopyrite, sphalerite, galena, and argentite. These sulfides form rather coarse grains associated with fairly coarse granular quartz and occur as fragmental inclusions in an abundant matrix of white, coarse-grained quartz of comb and drusy habit. The encrusting quartz contains occasional crystals of pyrite and argentite on the surface of the quartz crystalline, but most of the argentite apparently has entered and replaced the included sulfides, particularly the galena. The argentite appears exceptionally abundant in the ore. A specimen of high-grade ore given the writer is composed almost entirely of chalcopyrite and grayish sulfides. A polished section reveals that a breccia of the chalcopyrite, pyrite, sphalerite, tetrahedrite, and galena is cemented and veined by arsenopyrite, enargite, tetrahedrite, argentite, gold, and electrum. The silver-gold ratio of the sulfide ore is about 100 to 1. Oxidation is reported to have been well advanced in the upper workings, the proportion of gold there being relatively greater than in the unoxidized ore. Below the tunnel level the primary minerals predominated and the ore at the bottom of the incline is reported to be composed largely of base metals.

**Golden Gate**

The Golden Gate is another property on Estes Mountain on which there has been considerable work. It is on the same vein as the McFadden and lies in the gulch just north of the McFadden mine. The work consists of a tunnel about 1,000 feet long which is reported to tap the bottom of the McFadden shaft. Some ore is reported to have been mined from the new blocked tunnel, but the production, which is less than the McFadden, is not known.

The vein was not seen at or below the surface but is said to maintain the same characteristics as on the McFadden ground. One ore shoot is reported but nothing was learned of its size or tenor. The ore still remaining on the dump is identical to that at the McFadden. It shows the earlier quartz with coarse grains of chalcopyrite, galena, argentite, and pyrite, and the younger white, coarse comb and drusy quartz, the earlier as breccia fragments in the latter.

**Tonto**

The Tonto is on the slope north of the Golden Gate. The workings consist of a 65-foot shaft on the outcrop and a tunnel about 200 feet long on the slope below. The two are not connected. During the early summer of 1947 the outcrop, which shows considerable free gold, was being hydraulicled.

The Tonto is on a mineralized zone in the tuffaceous volcanics but the ore appears to be confined to a small chimney-like body of mineralized fractures. These fractures contain thin seams of quartz in which gold is visible or is revealed by crushing and panning. In a specimen given the writer by Mr. Frank Costa, the gold is conspicuous as small grains filling between and wrapping around tiny quartz crystals in veins.
Charles Wain

The Charles Wain, the first discovery on Estes Mountain, is high on the cirque wall at the head of Eight Mile and reaches across the very top of Estes Mountain. It was discovered shortly after the Charles Dickens in 1875 and soon produced small amounts of very rich ore. Several tunnels were driven just under the top of Estes Mountain and some very rich pockets of unexposed, but the mine never rivaled the Montana.

There are two veins extending across the top of the mountain. The one which is apparently the main Charles Wain vein strikes N. 40° E. across the crest and dips 45° NW, but lower in the cirque wall, the strike at the portals of the upper and lower tunnels is about N. 50° E. and the dip 55° NW. The stope which comes to the surface at the top of the mountain reveals that the vein is about 18 inches wide. The other vein strikes N. 32° E. and dips 50°-60° NW. It is 2 to 2½ feet wide at the surface.

The veins contain much comb and drusy quartz, considerably iron-stained at the surface, and the mineralization appears to be little different from that in the other veins in the area. Some of the quartz in the second vein is accompanied by a little ruby silver.

Gold Star

The Gold Star is on the southwest side of Estes Mountain a short distance northwest of the Montana. It covers the southwest extension of the Charles Wain vein and has been developed by two tunnels, each with about 500 feet of workings. The vein and its mineralization is reported to be unlike that at the Wain but the ore, most of which is oxidized, is said to be rather low grade. Some sulfitides appear in the lower workings.

Arcade

The Arcade, which is also on Estes Mountain, lies between the Gold Star and the Charles Wain and covers the mid-part of the Wain vein. The property has three tunnels totalling about a thousand feet of workings. Actually there are two veins about 150 feet apart. One of them is said to have values chiefly in silver, the other in gold. The ore apparently is not of shipping grade.

Snowdrift

The Snowdrift is on the north side of Estes Mountain about 200 feet from the top. The mine, which is beneath snow a considerable part of the year, has been worked off and on since 1924 and has produced some small shipments of very rich ore. The property has four claims in all and workings in three tunnels. The two upper tunnels, one of which has 700 feet of drifts and crosscuts, are on the east side of the ridge, the lowest tunnel, which has been driven 300 feet, is on the west side of the ridge.

The several workings expose fractures of diverse trend and dip which cut the bedded tufts whose strike locally is N. 75° E. and dip 18° NW. At least three mineralized fissure zones are exposed in the main upper tunnel. Most of the production has come from one of the zones which strikes N. 10° W. to N. 5° E. and dips 74° W. The ore shoot is about 40 feet long and is a gouge-filled fissure several inches wide in which there are thin seams of gold-bearing quartz. Another fissure or fracture zone strikes N. 20°-30° W. and dips 80° SW. The lower tunnel driven to cut the main deposit at greater depth exposes a gold-bearing slip which strikes N. 25° W. and dips 70° SW. This slip intersects another which strikes N. 70° E. and dips 48° NW. This second slip has been drifted on for about 40 feet, the fracture increasing in prominence along the drift.

The ore apparently is confined to the thin quartzose seams in the altered tuff and occurs in largest quantity along the more prominent gouge-filled fractures.

Mountain Chief

The Mountain Chief is on the west side of the ridge a short distance north of the Snowdrift. The work comprises several partly filled cuts on the steep mountain slope, made apparently during the early days. These cuts are along a prominent fissure which strikes N. 20° E. and dips 70° SE. This fissure may be traced for several hundred yards. It is about a foot wide and in places is iron stained. Considerable drusy quartz surrounding breccia fragments of the altered tuff is exposed on the dump of one of the cuts.

Kwajalein

The Kwajalein, the only strictly base-metal property in the district, is on the lower southwest slope of Estes Mountain directly across from the Golden Sunbeam mine and about 300 feet above Jordan Creek. The property, a recent location, has little work on it, and the only tangible evidence of mineralization was several piles of partly oxidized boulders and chunks of ore exposed below a largely concealed, iron-stained cropping.

The deposit apparently is in the altered tuffaceous beds a few tens of feet above the basement of Wood River rocks. The shape and extent of the deposit could not be determined, but the iron-stained ledge just above suggests a N. 70° E. trend, and the size of the ore chunks, a vein or lode more than a foot wide.
The chunks of ore are composed largely of massive, coarsely crystalline chlorite with subordinate galena and trivial amounts of pyrite and sphalerite. The ore is partly banded, with the bands composed of alternating coarser and finer grained chlorite and pyrite and galena. The sulfides appear to fill between crystals of quartz, apparently an unusually coarse development of the ordinarily finely crystalline early stage pyritization. The sulfide masses are cut by some thin seams of comb quartz, locally by seams up to 1½ inches thick. Polished sections of the ore show the presence of a little secondary covellite and chalcocite.

**SUNBEAM AREA**

**Golden Sunbeam**

The Golden Sunbeam is on the steep slope bordering the west side of Jordan Creek (Fig. 2). The camp is along the road on the east side of the creek; the mill and portal of the lower adit are several hundred feet up the opposite slope with the other workings higher still at altitudes of 7,400 to 8,000 feet (Fig. 13). The mine was located in the late eighties, but didn't have much activity until about 1900, with the most extensive development beginning about 1905, coincident with the discovery of a large new ore body. The mines were operated sporadically for several years, was increased to 100 tons. In 1909 work was begun on a new 50-ton mill and a 150-h.p. hydromaltite plant on the Salmon River at the mouth of Yankee Fork. The power project was completed in 1910, but the deposit proved to be too low grade to be worked at a profit and in June 1911, the mine was closed, the company passing into the hands of a receiver. The production during the period is given as about $400,000 in gold and silver. During the next three years leasers operated the mill on tolling; later the mill treated ore from the Montana. In 1946 plans were made to reopen the mine, and during 1947 a new jig flotation plant was installed and the main tunnels reopened. Late in the summer the mill was run on ore from the Whale mine, which the company had under lease.

The holdings of the present company, the Sunbeam Mines, Inc., includes 4 patented and 3 unpatented claims covering the original Golden Sunbeam and Bismarck groups but not the North Sunbeam. The development on the Golden Sunbeam consists of five tunnels, two intermediate levels between the two lowest tunnels, and several glory holes, one on the outcrop of the main ore body. All the workings, except the Daisy No. 3 and No. 4 tunnels (Fig. 14), 800 and 1,000 feet long respectively, and some short tunnels high on the slope, were closed, but work was underway at reopening the 1,200-foot No. 5 tunnel at mill level. The development at the Bismarck, a short distance to the south of the Golden Sunbeam, consists of two caved tunnels and a small glory hole. The Golden Sunbeam (Daisy) and the Bismarck groups contain more than 6,000 feet of workings. The North Sunbeam, a short distance north of the Daisy, has about 2,000 feet of work.

The ore bodies at the Golden Sunbeam comprise stockworks and zones of mineralized tuff, exceptionally breccia lodes. These bodies owe their existence to innumerable, more or less closely spaced fractures, grouped into zones and irregular masses. The most important ore body, a mineralized stockwork on the Daisy, known locally as the "Big Stope", was an irregular mass which appears today as an open stope about 120 feet long and 75 feet wide extending 85 feet above and 115 feet below the No. 4 level (Fig. 13). The rock surrounding the open stope is rather extensively fractured, with the principal fractures trending about N. 30° W. and N. 30° E., the latter being the more prominent and controlling the general strike of the ore body. Although the fractures of north-west trend seem more numerous throughout the mine than those or northeast trend, the latter apparently had a more effective control in directing the mineralization.

The complicated fracturing on the No. 4 level is shown in Fig. 13. The rock surrounding the "Big Stope" and bordering the fractures is extensively sericitized, but, except locally, is not much silicified. Toward the face of the largest crosscut, however, the rock is silicified, but, although generally impregnated with small crystals of pyrite, it has little gold or silver. The complicated fracturing on the No. 5 level is also shown in Fig. 13. The character of the fracturing is little different from that on the level below. The "Big Stope" projected upward would reach the No. 3 level near its portal.

The mineralized zones and stockworks and their controlling structural features are best shown in the glory holes. In one of these, about 70 feet long and 50 feet wide about 100 feet above the No. 3 portal, the fractures of N. 30° W. trend and 55° NE. dip border the west face and appear on other sides, but the more prominent fractures strike about N. 70° E. and dip 55°-75° NW., as many as six of them appearing in a single face. The fractures apparently have no great length and gradually fade out across the mineralized zone. The northeast set cuts the northwest, but there is little displacement, apparently the two were formed contemporaneously. The northeast
fractures are relatively straight, but the other set shows considerable local curvature.

Up about another hundred feet are the No. 2 workings with several hundred feet of branching tunnels (not mapped). The prominent fractures there strike N. 70° E. and dip 70° NW. Less prominent fractures strike N. 30° E. and dip 60° NW. There are also numerous fractures of diverse strike and dip. These intersect the others and give very blocky ground.

The top glory hole, about 60 feet above and connected to the tunnels below by raises, is about 75 feet long, 50 feet wide, and 50 feet deep (at the far southwest face). The rock surrounding the glory hole is extensively fractured, the most prominent fractures striking N. 30° E., N. 70° E., N. 30° W., and N. 60° W. There are also less prominent and less persistent fractures of diverse trend, crossing from one major fracture to another. The N. 30° E. set apparently dominates and controls the direction of the stocklike ore body.

The body at the Bismarck, outlined by covered stopes and a glory hole on the outcrop shows control by N. 30° E. fracturing, but N. 30° W. fractures also are present. Although the fracture zone tends to form a stockwork about 40 feet across, part of it is a breccia zone and the body is more like a breccia lode.

As the tunnels of the North Sunbeam were not open, the structural relations are not known. It is reported that considerable work was expended in search of possible extensions of the "Big Stope" ore body.

At the margin of the "Big Stope" the ore is a grayish sericitized bedded tellu sparsely impregnated with small pyrite crystals and containing occasional very thin, generally inconspicuous seams of quartz. These seams and bands are more conspicuous in the higher workings and constitute the main ore bodies. They are composed of the very fine-grained grayish quartz and the slightly coarser-grained, in part drusy kind, but the quartz in the druses is very minute. Minor amounts of adularia may be observed with the younger quartz in thin section. Occasionally minute crystals of pyrite may be recognized in some of the grayish quartz, but other metallic minerals are in grains too small to be identified in polished sections.

According to old reports some of the ore in the "Big Stope" was high grade with one 10-foot zone assaying $30 to 100 per ton. The ore was in thin lenses and coatings of grayish quartz and in occasional small vugs and spots containing silver sulfides and other metallic minerals. Some of the ore also is reported to have been sprinkled with native gold. The ore in the "Big Stope," however, averaged only $2 to $4 to the ton at the then prevailing price of gold.

There apparently was no production from the No. 5 level, which appears to be below the bottom of the ore body, but much ore was mined from the intermediate levels on which more work was done than on either the No. 3 or 4 levels.

Some of the ore at the Bismarck is a fairly coarse breccia with the fragments of altered tuff cemented by the fine-grained, rather dark-gray quartz, which is penetrated by almost white, finely crystalline quartz, in places forming minute druses in vugs. The grayish minerals are too minute for identification.

**Jesse James**

The Jesse James is on the upper west slope of the same ridge as the Golden Sunbeam at an altitude of 8,200 to 8,500 feet. The workings consist of two long and several short tunnels driven north and east into the ridge. The longest and lowest tunnel is reported to contain 1,700 feet of workings and the one next in length perhaps 400 or 500 feet. Much of the work apparently was done between 1907 and 1910 and all, except some of the shorter tunnels near the outcrop, are inaccessible. Some work was carried on in 1947 by C. C. Pierce, who was preparing the outcrop and the surface debris for hydraulicting.

The zone of mineralization extends across the property in a N. 70° E. direction, but the more prominent mineralized fractures are oblique to the zone and trend about N. 30° E. and dip 45° NW. A number of the fractures, which, because of local silicification are ledge-forming, are distributed along the 500-foot wide alteration zone. The most productive ledge, however, is the one at the head of the steep gullies, and that has been explored by the second longest tunnel and several shorter ones above. The ledge is broad but the ore appears to be localized along a relatively narrow, 15-foot zone of extensively brecciated, silicified rock in which many of the fragments have been rounded. Other ledges with smaller and less impressive outcrops appear along the ridge to the southeast. These also have been explored by cuts and short tunnels.

In the cut and tunnel of the outcrop of the main ledge the ore appears a breccia of white, finely crystalline quartz and silicified tuff in a cement of finely crystalline grayish white quartz with darker grayish smudges, locally with small unfülld openings lined with fine quartz druses. Pseudomorphic quartz and banded chalcedony are also present but are not con-
spicuous. Tiny grains of gold are visible in some of the iron-stained quartz, particularly in fractures which cut the quartz. Some of the gold appears to be a product of residual enrichment.

**WHALE AREA**

**Whale**

The Whale is on the first tributary of Jordan Creek above the Golden Sunbeam mine and lies at an altitude of just under 8,000 feet, a few hundred yards northwest of the Jesse James. It is reached by a steep but relatively short road that leaves the Loon Creek road about a half mile above the Golden Sunbeam mine. The workings on the property are not extensive but include a shallow tunnel or cut about 225 feet long, mainly open to the surface, and several small cuts and trenches on the slope above. Some rich ore was mined in the slope from the tunnel level to the surface 40 feet above, but the production was not learned. In 1947 the mine was optioned to the Sunbeam, Inc., and during the late summer ore was trucked to the Sunbeam mill.

The Whale zone of mineralization is about 100 yards wide and several hundred yards long, apparently trending about N. 70° W. This zone cuts the tuffs and a small body of rhyolite or rhyolite porphyry, which has in part a columnar structure. The lower tunnel is in northwesterly dipping silicified tuff, the cuts on the slope above appear to be in the silicified rhyolite or rhyolite porphyry. The tunnel is driven southwesterly on what appears to have been a zone of fissuring or fracturing, which curves inward to due west and then northwest. However, the only visible fractures are those in the sides of the tunnel and these trend N. 10° E. to N. 60° E., less commonly north to northwest. Some of the fractures have as much as 12 to 18 inches of gouge. In some of the cuts, in the silicified rhyolitic rock, the more prominent fractures trend about N. 60° E.

The ore exposed on the dump and along the sides of the tunnel and cut is very fine-grained and includes the finely crystalline variety with grayish spots in which tiny grains of pyrite may be detected with a lens, and also some banded chalcedony and fine quartz veins in small vugs in the grayish quartz. The ore is in part the breccia type and contains small fragments of the silicified and pyritized wall rock. In places the ore is delicately banded and possesses a conspicuous botryoidal structure. These small globular bodies are composed of the very fine-grained grayish quartz and are coated by minute quartz crystals. A specimen of high-grade ore donated for study purposes contains a thin seam of massive argentite, which cuts the fine-grained grayish quartz.

**DICKENS AREA**

**Charles Dickens**

The Charles Dickens is near the summit of the bold ridge that separates Jordan Creek from Yankee Fork about a mile north of Bonanza, with the main workings on the steep Jordan Creek slope at an altitude of 7,250 or 7,300. Discovered in 1875, its very rich ore and early profitable production soon made it one of the most famous mines in the country. Within a month after its discovery, $12,000 is reported to have been pounded out by two men using hand mortars. Ore sacked and shipped to Salt Lake and Swansea and totalizing a few tons netted $15,000, and a 20-ton shipment the next year is reported to have netted $17,000. Later the ore was treated in an arrastra. By 1880 the mine had been opened by two tunnels connected by a 120-foot winze, and crosscuts driven south had exposed a second vein almost as large and rich as the Charles Dickens. This early work disclosed all the ore subsequently mined. The mine continued in operation until 1902, with little work since. The total production is not known, but Umpleby reports that the property produced about 860,000 in gold and silver bullion from 1888 to 1902. Apparently the ore bottomed on the lower tunnel level, for several winzes sunk below that level exposed no ore of consequence. Most of the production apparently came from above the upper tunnel level. A plan and longitudinal section of the mine workings is reproduced in Fig. 15. The workings were only partly accessible in 1947.

The upper parts of the veins are in tuff, but the lower parts are probably in andesite. Both rocks have been extensively sericitized and next to the veins somewhat altered. The veins strike N. 70°-80° E. and dip 75° NW. They are about 30 feet apart, the Charles Dickens being north of the other. The latter was not seen underground but is reported to be as much as 4 feet wide. The Charles Dickens, which has been stope to the surface for nearly 200 feet, averaged 4 to 5 feet wide, the width ranging from 2 to 6 feet, exceptionally up to 12 feet wide. The distribution of the ore within the veins is shown in the longitudinal section (Fig. 15). The ore had a notably shallow vertical range, being confined within 200 feet of the surface.

None of the early-day bonanza ore could be found underground or on the surface, but

there remains much quartz, some of it finely crystalline with small scattered grains and crystals of pyrite, galena, sphalerite, and chalcopyrite, and some of it coarsely crystalline and occurring as comb and drusy quartz, in part about inclusions of the fine-grained and associated sulphides. A specimen of high-grade open cut ore of the writer by Mr. C. E. Rewed contains considerable native silver as microscopic grains replacing intimate intergrowths of galena and chalcopyrite. Shamrock87 reports encrinite as a primary constituent in some of the ore, and Umpleby88 reports free gold, wire silver, cecaryrite and argentite in the oxidized ore. Except for the native silver, the precious metals apparently are associated with the younger, coarsely crystalline quartz. The writer was informed of one specimen of the ore in which coarse silver gold was intricately entwined about drusy quartz crystals and saw for himself a specimen with a small grain of gold in coarsely crystalline quartz. The ore mined in the early days was apparently very rich. Strahorn reports that the best ore then assayed from $1,000 to 2,500 to the ton, even up to $3,500 per ton.

Morrison

The Morrison property is on the first tributary of Jordan Creek just across from the Charles Dickens. The property was one that was worked in the early days, with a production of about $100,000, but, except for some open cut ore, all the workings are closed. The size of the dumps indicates a considerable amount of underground work, mainly on one vein. Apparently all work was carried on from tunnels at about creek level.

Two veins a short distance apart are exposed on the property, each revealed in open cuts. These are contained in a thick flow of massive anodesite, which forms a bold, dark outcrop on the slope above. The veins strike about 70° E. The one on the south, which appears to be the main vein and has been exposed in cuts for nearly 500 feet, dips about 50° NW., the other dips 75° SE.

The north vein, which is exposed at the side of a caved tunnel portal, is about 10 inches wide and is bordered by a narrow zone of altered rock. The vein is fairly compact and is composed of exceptionally coarse comb and drusy quartz crystals measuring more than an inch in length, and enclosing breccias of altered wall rock.

The south vein as exposed in one of the

cuts is about 2 feet wide and is bordered by a broad zone of silicified and sericitized rock, with the silicification next to the vein. Like the other vein, the filling is chiefly coarse comb and drusy quartz, in part deposited about fragments of the altered country rock.

The comb quartz is the chief but not the only filling of these veins. Material on the main dump also contains fine-grained greyish quartz with small grains of pyrite and chalcopyrite, occurring in part as breccia fragments in the coarse drusy quartz. Locally small pyritohedral crystals of pyrite occur on the faces of quartz crystals of calcite. Small patches of malachite and azurite were observed in some of the ore, but no gold or silver minerals were visible. Coarse nuggets were found on the creek below the Morrison, one near the outcrop weighing 32 ounces, and several others in the same vicinity weighing 8 to 10 ounces. It is likely that the ore worked in the early days contained much coarse gold, associated with the coarse comb and drusy quartz.

Red Rock

The Red Rock is along the same general zone of shearing or fissuring as the Charles Dickens and Morrison and is at the edge of a small meadow in the saddle back of the lookout hill just north of Bonanza. The work on the property consists entirely of cuts and pits.

Two veins about 30 feet apart are exposed in a series of cuts for about 200 feet. These veins strike about N. 60° E. and dip 70° NW. They are less than 2 feet wide and consist of coarse comb and drusy quartz in fractured volcanics.

Whether the fissuring controlling these veins continues southwest across the ridge to the West Fork slope, where dumps of considerable size appear at caved portals high on the valley side, was not learned.

Bonanza

The Bonanza lies several hundred yards south of the Charles Dickens high on the slope above Yankee Fork. Some work apparently was done in the early days, but the discovery of new ore in 1922 by the Bonanza Gold Mining Company led to renewed activity but apparently little production. The development consists of about 700 feet of workings in four tunnels, all but one of which was blocked in 1947. These tunnels are spaced at intervals along the side of the ridge. A stopa from one of the workings reached the surface.

The vein strikes N. 70° E and, where stoped through to the surface from the lower tunnel,

dips 30° NW. Where the vein is exposed in the pillars and wall of the open stope, it is 12 to 18 inches thick. It is composed in considerable part of rather coarse comb and drusy quartz deposited around fragments of the altered wall rock and relatively fine-grained quartz containing scattered crystals and grains of pyrite, chalcopyrite, and galena.

Other Properties

A number of old properties whose names and ownerships were not learned were visited in the vicinity of the Charles Dickens and Morrison mines and in a few other places. These were examined insofar as the available workings would permit and for what information the dumps might contribute. Some on lower Jordan Creek apparently had an appreciable production in the early days.

Some old workings lie south of the Morrison. These were not examined, but they may be the old Fairplay and Passover claims mentioned by Umpleby44, each of which produced $20,000 to $25,000.

Several hundred yards above the Morrison on the west side of Jordan Creek is an open adit about 140 feet long. The portal is about 100 feet above the creek. The adit was driven about S. 62° W. for 70 feet along a minor fracture zone and then turned N. 78° W. for 33 feet on a branch vein which dips 68° NE. The adit then turns S. 70° W. along a fairly prominent vein which dips 84° NW. Horizontal grooves along the vein indicate strike-slip movement. This vein is 12 to 15 inches wide in complexity fractured andesite. Many fractures are oblique to the vein. Both veins contain small bunches and thin seams of quartz, in places covered by crystals of coarse calcite. The rock bordering the main vein is considerably altered, but that along the other is little changed.

About a fourth of a mile above the Morrison on the west side of the creek are two caved tunnels at creek level. These tunnels have been driven into a broad zone of bleached, highly sericitized rock more than a hundred feet wide. No ore was on the dump.

Just across Jordan Creek from the Morrison is an adit about 100 feet above creek level. In extensively sericitized and somewhat pyritized andesite. The adit is driven N. 77° E. for 68 feet where it branches, one branch extending north for about 43 feet exposing a fracture zone with small bunches and lenses of quartz striking N. 70° W. and dipping 60° NE. The other branch continues in an easterly direction (N. 83° E.) for 63 feet, exposing occa-


sional small quartz seams, and then turns sharply S. 12° E. and ends against a fault zone with much black gouge which strikes N. 50° E. and dips 28° NW. All the rock underground is sericitized and impregnated with small crystals of pyrite. The intensely altered zone is about 100 feet wide with outward fading limiting values of coarse comb and drusy quartz are on the dump.

About 100 yards up the stream is another caved adit close to creek level. This tunnel is also in bleached andesite, which locally is intensely sericitized and in part silicified. It appears to be in the same general alteration zone as the other adit, which would make the zone of more or less intensely altered rock about 100 yards wide.

There is another caved adit farther up the creek and still another with a large dump high on the hill and about the same level as the Charles Dickens. Umpleby mentions the Juliette and Leitha claims on this side of the creek, the Leitha with a production of $60,000, but which of the workings on the east side of Jordan Creek are on these claims could not be learned.

Some old work a short distance above the old Custard mill on Yunka Fork was also examined. The workings consist of three short tunnels and a cut. The upper workings disclose a 16-inch quartz vein along a prominent fissure which strikes N. 85° W. and dips 75° NE. The bordering walls are silicified and locally weak impregnated with pyrite. Much of the quartz is massive. In places it is cut by narrow seams of relatively coarse pyrite. In the lower tunnel the vein or another strikes N. 75° E. It has 5 feet of quartz above a prominent footwall on which the grooves 17° E. The quartz is fine- to medium-grained.

There are other old, long-abandoned workings on the slope west of Custer and along the upper Fourth of July Creek. These were not examined at close range.

Red Mountain Area

Red Mountain, about which mineralization is centered on upper West Fork beyond the map border, has a number of mining locations, but only one on the high ridge west of Red Mountain was visited. This property consisting of the Hyndman and Jumbo claims (seven in all) is apparently near the western end of the mineralized zone which extends across and contributes so vividly to the coloring of Red Mountain. These claims have two main groups of workings and a number of cuts and other open-
ings. The main workings consist of tunnels driven northeast from the southwest side of the ridge and comprise in each about 2,000 feet of crosscuts and drifts. These workings extend almost through the ridge.

The mineralized zone cuts the Challis volcanics close to the exposed border of the Idaho batholith, which is a few hundred yards to the north. The zone of mineralization appears to be about 800 feet wide and not less than 2 miles long. It trends in a N. 55° E. direction across Red Mountain and is confined to a broad zone of complexly fractured rock. Extending diagonally across the mineralized zone are small, light colored dikes, but the most conspicuous features are the many mineralized fractures and the highly sericitized and stilclized rock that borders them. The most prominent mineralized fractures are faults that strike about N. 70° and N. 40° E., the former with 60°-75° NW dips, the latter with 60°-80° SE. dips. Some of the N. 70° E. set are well exposed in the underground workings, where they usually show much gossan. Both sets show prominent horizontal grooves and striaions along fracture surfaces.

Mineral deposition has been confined to narrow seams and stringers and rarely has produced veins more than a few inches wide. The filling consists chiefly of fine-grained grayish quartz and white, rather coarse comb and drusy quartz, locally also pseudomorphous quartz and coarse adularia. Some of the grayish quartz contains recognizable crystals of pyrite, and some of the younger comb quartz, small grains of gold.

The quartzose fillings are reported to give good assays, principally in gold, but individual seams and veins provide little tonnage. Samples across the entire mineralized zone are reported to show that as a whole the mineralized zone is a very large, low-grade ore body with values of two to four dollars a ton in gold and silver. Gold is said to form the predominant value near the west end of the mineralized zone and silver the main substance on Red Mountain.

Much mineralized rock is contained in landslide debris on the northeast side of the ridge.
Figure 1. Index map showing location of Yankee Fork area.
Figure 2. Topographic and Geologic map of the Yankee Fork district.
Figure 4. Claim map of Custer area.
Figure 5. Map of accessible workings on the General Custer vein (vein shown by dots; faults, by heavy lines)
Figure 6. Plan map of Lucky Boy Mine with geology on 400 and 600 levels.
Figure 7 Longitudinal section along the Lucky Boy vein showing stopes. (Diagonal lines)
Figure 8. Longitudinal section along the Calcite vein at the Lucky Boy Mine showing stopes. (diagonal lines)
Figure 9. Cross section through Lucky Boy Mine along line A B showing attitude of veins.
Figure 10. Geologic map of the Mullan tunnel level (faults, heavy black lines with arrows showing direction of dip)
Figure 11. Geologic map of two adits on Fourth of July veins (ore dotted; heavy black lines are faults)
Figure 12. Geologic map of underground workings of Long View mine. (dots indicate mineralization, black lines show faults)
Figure 13. Geologic and topographic map showing location of workings at or near Golden Sunbeam mine and exposure of Wood River formation (ruled area)
Figure 15. Plan and longitudinal section of the workings at the Charles Dickens mine.