GEOLOGY AND GOLD RESOURCES OF
BOISE BASIN, BOISE COUNTY, IDAHO

BY
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EDITED BY
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PREFACE.

BY FRANCIS A. THOMSON.

This report represents an endeavor to analyze the geologic and economic possibilities of production from the lode deposits which have fed one of the great gold placer fields of the old west. The author, Mr. S. M. Ballard, has lived and operated in the district for a number of years, and brings to his task an exceptionally keen familiarity with the region; the report is, of course, of greater value because of this fact.

Boise Basin is the most southerly of the gold producing districts which border the Idaho batholith, and its general characteristics are typical of such occurrences. In detail, however, the gold and silver deposits are markedly different from those at the northern end of the same batholith as described in Bulletin 7, Geology and Gold Resources of North Central Idaho. Furthermore, certain features of the relationship of the veins to areas of intrusion and to zones of fracturing within the main body of the granite, appear to be peculiar to Boise Basin and the nearby terrane. Their elucidation by Mr. Ballard in the accompanying report should prove of marked value in subsequent development.

An interesting, though somewhat incidental feature of the report is the statement that the mineral which occurs in close association with the gold in the veins of Quartzburg and vicinity, is not stibnite as has for 25 years been generally supposed but is instead a combined sulphide of bismuth and lead. It seems not unlikely that bismuth, which at current quotations is worth $1.30 per pound, may become in certain cases a valuable by-product of the gold and silver ores.

After several visits to the area, coupled with a careful study of this report, I can see no reason why, when based upon competent advice, intelligent development of many of the properties described should not result in satisfactory returns.
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MEMOIR OF A BYGONE DAY—PLACER MINER'S HANDICRAFT NEAR IDAHO CITY.
FIGURE 1.—Index map of Idaho showing location of the Boise Basin (shaded area).
EARLY DEVELOPMENT OF THE LODE DEPOSITS.

The early day placer miner, as a rule, gave little thought to the lode deposits in the surrounding hills. The development of the lodes at Quartzburg was one of the few exceptions. The main ledge in this vicinity was discovered by placer miners and quartz claims were located in 1864. A small primitive mill was built in 1866 and paid well for several years thereafter. The deposit was thought to be exhausted and operations were closed down for a few years, only to be revived and carried on intermittently to the present time. About 1867 several discoveries in the north and northeastern portions of the Basin, directed attention to that locality. Rich float and high-grade outcrops were discovered. Many claims were located and active development work was started at various places. Several small stamp-mills were built to treat local and custom ores. Amalgamation was the principal process of recovery relied upon and milling losses were considerable. Even so, most of them paid well during the life of the oxidized deposits. Attempts to treat sulphide ore with the equipment on hand resulted in failure and finally ended operations throughout the Basin. From that time work was limited principally to annual assessment requirements until 1920, during which year mining operations were begun at four different places, with very encouraging results at three of them.

GEOLOGY AND ORE DEPOSITS OF BOISE BASIN,
BOISE COUNTY, IDAHO.

BY S. M. BALLARD.

INTRODUCTION.

This report is based upon data collected during the writer's several years of residence in Boise Basin, amplified by that obtained on field trips made during the summers of 1922 and 1923 to several places which had not been visited previously. The geology of the region was mapped on a base compiled from United States Geological Survey and United States Forest Service maps. In addition, much assistance and information was given by mine owners of the district. Dr. F. B. Laney and Mr. Stanley S. Siegfus, of the University of Idaho, contributed mineralogical and petrographic studies of the ores and rocks. The results of their investigations have added materially to the discussion of ore deposits. The chemical analyses are mainly the work of the late Mr. R. M. Westover, formerly a member of the staff of the Idaho Bureau of Mines and Geology.

EARLY HISTORY.

The historical account of pioneer days is a condensation from "The History of Idaho," together with information gathered by the writer from the few survivors of the early rush of gold seekers to the Basin.

The presence of placer gold in Boise Basin was first made known to Moses Splawn by a friendly Bannock Indian. Splawn, while placer-mining near Elk City in 1861, met the Indian, who became very much interested in watching him clean the yellow metal from the sluice boxes. Later in the year, he met the Indian at Florence. Again the Indian showed an interest in Splawn's work and finally told him of a basin far to the south where he, as a boy, had found pieces of the yellow stuff in the stream beds. Splawn obtained such description of the country as the Indian could give, and decided to search for it.

1 HAILEY, JOHN: The history of Idaho, 305 pp., Boise, 1910.
In the spring of 1862, Splawn joined a party of gold-seekers headed for some lost diggings supposed to be near the point where Silver City now stands. The venture was a failure and dissatisfaction arose among the men. Splawn and seven others turned back, determined to locate the basin which the Indian had described the previous year. Shortly afterwards, Splawn met George Grimes with a like number of men, headed south to join the original party. The two parties cast their lots together and thus was formed that first group of gold-seekers to whom Boise Basin owes its discovery.

After considerable delay and difficulty in crossing Snake River, the party finally started northeastward toward the mountains. Indians who visited their camp directed them to a basin across the mountains, but informed them of hostile bands therein, who would kill them were opportunity given. The party pursued its journey across the mountains and, after several encounters with Indians, reached the Basin in August, 1862. The first camp was made at the present site of Centerville. Here one of the men discovered gold in the gravel and panned out a small amount of that metal from the first shovelful. The following day, camp was moved about four and a half miles northeastward to the present site of Pioneerville. While at work, during the several days that followed, the men were constantly subjected to a sporadic fire from Indians in the nearby foothills. Provisions were running low and the party, discouraged by their constant dangers, finally decided to cease work and abandon the Basin.

While doing some advance scouting, presumably seeking a way of retreat, George Grimes encountered an ambush of Indians on the top of a low divide. The Indians fired and fled. Grimes fell, mortally wounded, and his companions buried his body near the spot where he fell. His grave is now one of the historic landmarks of the Basin. The scene of the ambush became known as Grimes Pass and the stream nearby was named to commemorate his advent into the region.

The party then retreated down Grimes Creek, the way they had come, and finally, after many hardships and more encounters with Indians, arrived at their old camping place near the junction of Boise and Snake rivers. By chance, they met an immigrant train at this campsite and accompanied it to Walla Walla.

At Walla Walla a party of 50 men joined Splawn, and, properly armed and provisioned, they returned to the Basin and located the ground which was subsequently worked with so much profit. This party was the vanguard of the "rush" that followed in 1863. By the fall of 1863, from 15,000 to 20,000 men had arrived in the Basin and the towns of Pioneerville, Centerville, Placerville, and Idaho City had been built. These settlements became the centers of the pioneer activity in the region. During this year, tools and provisions had to be packed into the Basin from Umatilla, Oregon; Walla Walla, Washington; or Kelton, Utah. There were no wagon roads. Freight packed in on horse-back usually cost from 16 to 25 cents per pound, depending upon the season and the competition. Passenger fare from Umatilla was $50, paid in advance; it consisted of the privilege of riding horse-back for seven days and cooking one's own meals where it happened to be convenient to do so. Many walked the entire 285 miles, and packed their few needs on their backs. Oats retailed in the Basin in small quantities at 50 cents per pound and hay from 25 to 40 cents. The cost of a feed for a hungry horse often exceeded $5 in local feed-barns. The miners, however, generally cleaned up from $10 to $100 per day in their sluice boxes and were not inclined to argue over prices of necessities. During these early days, money was rather scarce among most of the miners and gold dust was used as a substitute. In making small purchases a "pinch" of dust was the recognized unit of exchange and "a pinch, a drink" was a perfectly satisfactory basis for a goodly percentage of the exchanges.

To combat the Indian menace, a military post was established in 1863 near the present site of Boise. The townsite was laid out a few months afterward. In 1864, a toll-road between Umatilla and Centerville, via Boise, was completed and business conditions throughout the region assumed a more normal aspect. Indian attacks were largely repressed and placer mining was actively carried on in the Basin until the close of 1870. The main creek beds were worked over by this time and many miners left the country that fall, never to return.

For several years after the last of the stream gravels had been exhausted, hydraulic mining of the higher bench gravels was vigorously pursued. Numerous ditches, some eight to ten miles
long, were built for the washing of the gravel banks at various places immediately above the main stream channels. This second short spurt of activity gradually slackened, and was followed by the close of the "boom" development of the region.

**GEOGRAPHY.**

**LOCATION OF THE AREA.**

Boise Basin includes approximately 300 square miles located in the south-central part of Boise County, about 20 miles northeast of Boise. It lies between parallels 43°45' and 44°05' north latitude and between meridians 115°35' and 116°35' west longitude. It is irregularly circular in outline, approximately 15 miles in diameter, and for the most part, is sharply separated from the surrounding country by a mountainous divide. The location and extent of the Basin are shown in the index map of the State of Idaho (fig. 1).

**POPULATION, INDUSTRIES, AND SETTLEMENTS.**

The population of the Boise Basin in January, 1922, was about 800 people. The seasonal variation in population is large, varying with the two important local industrial activities, mining and logging. Agriculture is negligible, and the produce therefrom, principally hay, is not sufficient to meet local needs. Stock grazing is an important summer industry.

The principal settlements of the Basin are Idaho City, Centerville, Placerville, and Quartzburg. Idaho City is the seat of Boise County. Centerville is the local headquarters for the logging operations carried on by the Boise-Payette Lumber Company; it is also a shipping point for stock during the summer months. Quartzburg is the principal industrial center, the Gold Hill & Iowa Mines Company's operations constituting the main support of the camp.

**ACCESS.**

A mail stage runs daily, except Sunday, from Boise to Quartzburg by way of Idaho City. A branch railroad line from Boise to Centerville furnishes a Wednesday and Saturday passenger train service into the Basin. Three well-travelled county roads lead westward and northwestward across the divide and out of
FIGURE 1.—Index map of Idaho showing location of the Boise Basin (shaded area).
the Basin. The main stage road runs southwesterly down Moore Creek from Idaho City, to Boise, about 45 miles distant.

Owing to the nature of the soil, mostly a decomposed granite, the roads throughout the region are in excellent condition for automobile travel during the summer months. Very few excessively long or steep grades are encountered. The building of new roads in 1921 has eliminated the high divide formerly crossed by the Boise-Idaho City road. Much of the freighting to and from Boise is handled by auto trucks at the rate of 75 cents per hundred pounds. During the summer, tourist travel through the Basin to interior points is heavy. Most of the mines of the region are accessible by automobile over roads of easy grade.

CLIMATE.

The valley plains within the Basin vary in elevation between 4,100 and 4,500 feet above sea level. Although the snowfall is considerable for such an elevation, the open season generally extends from the middle of May to the first of December. Travel keeps the main roads open throughout the winter months. The climate during the summer and fall seasons is delightful and the nights are always cool. Excessive cold does not characterize the winter months. Even though the thermometer sometimes drops to 15° or 20° F. below zero, such temperatures are exceptional, and by reason of the dry atmosphere, physical discomfort is negligible. The heaviest snowfall generally comes during the first three months of the year. Snow is often to be seen on the higher peaks as late as July. Such conditions of snowfall insure a dependable stream flow during the summer months, when the rainfall is exceedingly light.

VEGETATION AND ANIMAL LIFE.

The entire Basin was originally covered with a heavy growth of different species of pine and fir. Considerable of this has been removed to meet local and outside needs, yet ample remains to meet the demands of many years to come. Government control of most of the remaining timber insures regulation of future cutting.

Some large game yet remains in the higher country, but this is fast disappearing due to intensive grazing during the summer
months and to the advent of automobile loads of hunters during the fall season. The automobile has relegated fishing from a sport to a meagerly rewarded labor.

TOPOGRAPHY.

The elevation of Boise Basin ranges from 4,100 feet above sea level to approximately 8,300 feet at its northeastern limits. The flat bottom lands drained by Grimes and Moore creeks constitute about five per cent of the entire Basin. Low ridges and gentle foot-hill slopes form most of the terrane between the bottom lands and the mountainous region which rises rather abruptly in places to define the limits of the Basin. These general topographic features are best observed by one looking northwesterly across the Grimes Creek basin from the summit of the Centerville-Idaho City wagon road. The steep declivity defining the basin to the northwest suggests an ancient and considerably eroded fault scarp. The rise from the foothill area to the mountainous divide in the Moore Creek basin is generally more gradual and has fewer features of bold relief.

The divide between Moore and Grimes creeks, at places as high as the surrounding divide, in reality separates Boise Basin into two distinct valleys each drained by one of the creeks named. These two streams, upon leaving the Basin, enter deep canyons through which they flow for several miles before uniting to flow onward as Moore Creek. From this junction, Moore Creek flows southerly for about 10 miles and empties into the Boise River, approximately 13 miles above and east of Boise.

Nowhere in or immediately around Boise Basin, was found any high flat upland area comparable to those which characterize the mountainous portions of Idaho elsewhere. A possible exception is Summit Flat, about 8,000 feet above sea level. This area of comparatively gentle relief, about 2½ miles long from north to south and half a mile wide from east to west, is unique amid the rugged and deeply eroded surrounding country. The plateau is probably a remnant of an ancient and extensive land surface of low relief. Its present elevation could be ascribed only to crustal movement.
GENERAL GEOLOGY.

PREVIOUS GEOLOGIC WORK.

The first description of Boise Basin in technical literature was a brief popular article by Hastings in 1894. In 1898 Lindgren reported on the geology and ore deposits of the region, which he called Idaho Basin; his geologic study of the Boise quadrangle, published the same year, discusses the geology and ore deposits of the western part of the region. Nye describes the Basin briefly in a paper published in 1900. In 1916 Jones discussed in some detail the geology and mining activity of the northern part of the region.

Geologic investigations have been carried out over several nearby areas and the reports thereon have assisted the writer materially; references to these works are made elsewhere.

GENERAL CHARACTER AND SUCCESSION OF THE ROCKS.

The rocks exposed within Boise Basin include only igneous and lacustrine types. The Basin occupies a small marginal portion of the great Idaho batholith, and granitic rocks crop out over the greater part of its area. These intrusive rocks, to which Lindgren, Russell, and Umpleby have ascribed a late Cretaceous or early Eocene age, are the oldest rocks exposed. They are intruded by numerous dikes of complementary rocks which range in composition from highly acidic to highly basic types. Lacustrine sediments were deposited, probably during early Miocene time, and were subsequently covered by flows of basaltic and rhyolitic lava. During Quaternary time several series of gravels were accumulated.

No metamorphic rocks were found within the Basin. Physiographic evidence shows that erosion had removed not less than several hundred feet of granite before the accumulation of the Miocene formations. It is apparent, therefore, that the older metamorphosed rocks which originally overlay the granite were completely worn away.

Specimens of typical varieties of the most abundant and little altered igneous rocks of the Basin were selected in the field for petrographic study. Many of the rocks, apparently fresh in the hand specimen, showed considerable alteration when viewed under the microscope. Descriptions of the macroscopic character of the different varieties are given to aid field recognition, and are supplemented by microscopic analyses to secure precise identification.

**Granitic Rocks.**

The most usual type of the granitic rocks is a true biotite granite. In the hand specimen it is generally medium grained, of light gray color, with pink and light greenish-gray feldspar predominating. The gray quartz grains are variable in size and occurrence and often are not readily distinguishable from the evenly fractured orthoclase feldspar crystals, which are frequently of large size. The ferro-magnesian minerals, mainly biotite with lesser hornblende, are usually subordinate in quantity.

Plagioclase feldspar and hornblende are sometimes locally prominent, generally in the vicinity of diorite porphyry dikes. The rocks in which they are plentiful probably represent gradational phases of the granite. Some of the granitic types may be shown microscopically to be granodiorite, but for present purposes all are called granite.

As a rule the granite of the Basin weathers easily to a coarse sand and only along ridges and stream channels are natural exposures of any extent to be found. Wherever the granite is deformed by shear zones it is, as a rule, characterized by the loss of the ferro-magnesian mineral constituents.

A specimen of granite was selected for petrographic study from the face of the Diana tunnel of the Mineral Mining Co. (p. 81) at a depth of 200 feet below the surface. The petrographer's report is quoted below.
Under the microscope the altered orthoclase appears as the predominant mineral with quartz somewhat less abundant. This feldspar, as well as plagioclase, sometimes shows a banded structure with ordinary light. Under crossed nicks the altered orthoclase sometimes shows a bimineral intergrowth of both orthoclase and quartz in the feldspar. These intergrowths are less common in the altered orthoclase. Chlorite is sometimes associated with the hornblende and chlorite. There are varying concentrations of these two minerals but for the most part orthoclase is the more abundant. Chlorite, besides being an alteration around the edges of the hornblende, is found as a filling in the cracks between some of the crystals. Only a very few crystals of magnetite were found in the specimens examined. The plagioclase consists of oligoclase with a smaller amount of albite.

**DIKES.**

During and following the invasion of the Basin area by granite, dikes of many rock types were intruded. The relations of dikes at their numerous intersections indicate a recurrent igneous activity, each period being characterized to a large extent by the intrusion of a single variety of rock. Named in the order of their probable sequence the important types are pegmatite, diorite porphyry, aplite, rhyolite porphyry, and lastly the various basic differentiates. The basic rocks are very evidently a local manifestation of the general igneous activity that prevailed throughout Idaho during the Miocene period and possibly for a short time thereafter. The relative age of one late intrusion of rhyolite porphyry at Quartzburg to the basic dikes has not been definitely proven; a similar question pertains to a younger pegmatite which is frequently associated with the aplite.

The dikes of acid and intermediate types are usually confined to well defined zones or belts included within the normal granite. These zones vary in width between half a mile and two and a half miles. One extends northeasterly through Quartzburg to Grimes Pass; another lies a few miles southeast of Idaho City and follows a course which is approximately parallel thereto; a third of unknown extent strikes N. 80°-70° W. across the divide between Moore and Elk creeks in the vicinity of the Washington and Lucky Boy mines. Some few crop out on the divide between Idaho City and Centerville.

The acid dikes in the vicinity of Quartzburg are mainly rhyolite porphyry with an occasional aplite, whereas the aplite is the predominant acidic type in the Idaho City region. The individual dikes within these zones are usually between 25 and 50 feet wide; their strike is roughly parallel to that of the zone which serves as host. In one locality the outcrop of the zone may be almost entirely dike material; in another the parallel dikes may be found at intervals of 400 to 600 feet.
The diorite and quartz diorite porphyry dikes, as well as the most basic types, are not limited to zones but crop out at intervals throughout the entire Basin. Except where they have filled pre-existing fissures, the basic intrusives strike and dip irregularly in various directions.

**Pegmatite.**—The usual type of pegmatite is the common granitic variety. In the hand specimen, it shows an intergrowth of quartz and feldspar with scattered platy sheets of mica in minor quantity. It sometimes occurs as well-defined dikes a few inches wide in granite but for the most part occurs as irregular small segregations, somewhat tabular, in the aplite. This rock has not proven so far to have any economic value but is thought from field relations to be the source of some of the radio-active minerals occurring in the placers around Centerville (see p. 38).

**Quartz diorite porphyry.**—Well defined dikes of quartz diorite porphyry are quite abundant, usually in the same locality with rhyolite porphyry and aplite. The variations of the rock are so many that a detailed description of only the most important will be given. Generally it is medium to dark-gray in color, porphyritic to near-granular in texture, fine to coarse grained, and extremely hard and weather resistant. The feldspars are the prominent phenocrysts; biotite and hornblende are present in lesser amount. Quartz, usually accompanied by an increased percentage of orthoclase, is abundant in some specimens; the more granular phases of this type of rock approach a granodiorite. In some specimens, hornblende is far more abundant than biotite. Another shows augite and hornblende in approximately equal amounts; the rock is a gradation toward gabbro.

The largest diorite intrusion of the Basin and the only one worthy of description from an economic standpoint, follows the Quartzburg porphyry belt from Canyon Creek to and beyond Grimes Pass. At some places, the intrusion consists of several branching parallel dikes; at others, the several branches unite as one dike which is half a mile or more wide. The rock shows but little variation in appearance throughout the several miles of its outcrop and is easily recognized in the field wherever encountered. A peculiar spotted appearance of the smooth surfaces of boulders or of weathered outcrops is a characteristic feature which in some instances permits recognition of the rock at distances of 50 feet.
Several specimens of this rock were selected for microscopic examination from the head of Muddy Creek (on the property of the Missouri Mines Co.) and from Grimes Pass (at the Golden Age mine). The report on the samples follows:

Because the plagioclase feldspar exceeds in an appreciable extent the amount of orthoclase, this rock is classified as a quartz diorite porphyry. The difference, however, between this rock and the diorite or granodiorite is so slight that only a quantitative classification would be absolutely distinctive.

The hand specimen is a gray porphyritic rock with the usual occurrence of white feldspar, phenocrysts, averaging about a quarter of an inch in diameter. The groundmass consists chiefly of reddish orthoclase with minor amounts of quartz, hornblende, and magnetite. The biotite and hornblende are slightly pleochroic. Biotite is somewhat in excess of the hornblende occurrence.

Under the microscope the typical feldspar, which had a rather cloudy appearance, proved to be orthoclase. Most of the plagioclase consists chiefly of oligoclase with small amounts of andesine, periclite, and aplitite. Some of the crystals show zonal structure and a few porphyrite twins. Magnetite (1), which is very sparingly distributed throughout the rock, is found with the biotite and hornblende. Quite commonly the biotite and hornblende are altered to chlorite in a very raggered border. Under crossed nids and at high magnification the orthoclase is seen to be extensively altered to sericite and kaolinite. These individual minerals are so small, however, that they are almost indistinguishable.

Aplite.—Dikes of aplite varying in width from a few inches to 200 feet occur with great frequency. Several specimens were collected from mine dumps and shallow cuts in the vicinity of the Washington and Lucky Boy mines northeast of Idaho City. The rock is easily fractured and is somewhat decomposed in its outcrops. Its permeability has played an important part in ore deposition, especially where secondary enrichment occurred. The aplite resembles a very fine grained granite of uniform texture, cream to light gray color, composed mainly of orthoclase, lesser quartz, and occasional muscovite. It is generally, however, of lighter color than the enclosing granite. Some was found containing a small amount of biotite. Small irregular segregations of medium to coarse-grained pegmatite are very frequently scattered through the aplite. The segregations are indicative of intrusion under conditions of high temperature, conditions which may point to an older age for the aplite than for the rhyolite. This age relationship is rather definitely proven by the few dike intersections found. Microscopic studies served to confirm the field classification given.

Rhyolite porphyry.—The dikes of rhyolite porphyry are easily recognized in the field by the characteristic light color of the rock and by the rounded quartz grains which are scattered throughout the fine-grained groundmass. Occasionally, outcrops are locally stained to a light gray or red color, or the rock shows gradational changes. It is exceedingly weather resistant and its float usually
consists of coarse angular fragments which require a sharp blow
of the hammer to break. The enclosing rocks, with the exception
of some of the diorites, are generally friable. Some weathered
outcrops of the finer grained quartz diorite porphyry closely re-
semble the rhyolite, but comparison of fresh specimens of the two
rocks generally shows a decided difference. The presence in the
unaltered diorite of biotite and frequently of hornblende, in con-
junction with its more granular texture and darker color, gener-
ally serve for field distinction.

In the vicinity of the prominent shear zones the dike rocks
are quite frequently so highly altered that field identification is
uncertain. At a few such places the rhyolite is rather chalky
and at others so intensely silicified that under the pocket lens it
resembles a dull white quartz.

Some of the less usual types of the rock will bear mention.
It occurs at a few places as a typical felsite with the character-
istic color of the rhyolite as the only feature aiding field recogni-
tion. Some evidence of an extrusive rhyolite is found near one
felsite dike northeast of Placerville. Another phase is occasion-
ally encountered in a zone of blending between a wide rhyolite
porphyry dike and the enclosing granite. Within this zone, be-
tween 10 and 20 feet wide, all gradations between the normal
rhyolite and the granite may be found, although the transition is
so gradual that it almost escapes notice.

Specimens collected for microscopic examination showed so
much alteration that in most cases no information of value was
obtained from them. However, the results of a study of the late
phase of the rhyolite porphyry which is associated with bismuth
at Quartzburg (see p. 53) is worthy of mention. The rock occurs
as a prominent dike cutting diagonally across older intrusions of
rhyolite porphyry in the vicinity of the Pioneer shaft of the Gold
Hill and Iowa Mines Co. The specimen described was obtained in
the Sunshine tunnel of the Gold Hill property about 350 feet from
the portal at a depth of about 100 feet beneath the surface. No
veins or shearing were evident in the vicinity. The intrusive is
known locally as the “lab.” (labradorite) dike.

In appearance the rock is coarser grained than the typical rhyolite porphyry
and is of slightly darker color. It is distinguishable by the larger orthoclase
tabulars generally between half an inch and one inch in length. These show
Carlsbad twinning very prominently. The microscope shows that the rock is
composed of phenocrysts of orthoclase and an to intermediate plagioclase, of
quartz showing resorption embayments in an altered felsitic groundmass of
cryptocrystalline quartz and abundant sericitized feldspar, of shreds of sericite or muscovite, and of irregular patches of calcite. There is also present a small amount of pyrite. The presence of pyrite, together with the abundant sericite and calcite, is proof of the intense hydrothermal alteration which the rock has suffered.

Diabase.—Most of the basic dike rocks of the Basin are conveniently classed as diabase; typical lamprophyres are comparatively rare. Some few gradational phases of the diabase of small extent were found. In some, easily recognizable lath-like phenocrysts of plagioclase are comparatively prominent. Such a rock may be classed more properly as a diabase porphyrite. Elsewhere, abundant hornblende phenocrysts in the diabasic groundmass class the rock as a hornblende porphyrite. The widest deviation from the typical are rocks shown microscopically to be basalt. These may sometimes be recognized in the field by the apparent absence of feldspars and by the dense fine-grained to almost glassy character of the black groundmass, but microscopic determination alone is conclusive. As by far the greater number of the dikes are typical diabase, only a general description will be given to aid field recognition.

The typical unaltered diabase is a very hard, fine-grained, even-granular rock of dark gray to black color which usually occurs in dikes from five to ten feet wide. Recognition of the fresh rock is not difficult but the same can not always be said for the altered phases. Outcrops of the slightly or moderately altered rock invariably show a gray or green surface-staining, but the true character is revealed by breaking open a fragment. Near prominent fissures, outcrops of the extremely altered rock are frequently marked by a coarse, light gray or greenish compact sand, which may be shoveled without difficulty to depths of three or four feet. Where the rock has suffered intense hydrothermal alteration, as at many intersections of the dikes with vein, it is often nearly white and requires close scrutiny to distinguish it from the acid felsites. Usually, however, such alteration results in a greenish coloration due to the development of chlorite. Much of the dark colored gouge which is found in fissures is the crushed and altered basic rock; in some cases, however, similar gouge is colored by finely crushed sulphides. The diabase has nowhere proven to be an ore though cases are known of the rock containing small amounts of subsequently deposited galena, and of fractures filled with pyrite which carries small amounts of gold.
OLDER LACUSTRIAN SEDIMENTS.

The lowland areas of Boise Basin are underlain to a great extent by fine sediments of undoubted lacustrine deposition. The beds consist largely of partially consolidated clay and fine sand, and include occasional seams of carbonaceous material and even fragments of petrified wood. About the margins of these deposits may be found some gravel composed of rounded pebbles of granite, quartz, and the various dike rocks. The extreme fineness of these sediments indicates deposition in a country of comparatively low relief. These lacustrine sediments, known to the placer miners as “false bedrock,” are proven by the results of drilling to exceed 600 feet in thickness at Idaho City. They are not known to carry appreciable quantities of placer gold. The area of the sediments is estimated as five per cent of the area of the Basin.

The lacustrine sediments of the Boise Basin have a very close lithologic similarity to the Fayette formation of the Snake River plains which lie several miles to the west and south. Buwald’s has assigned the Fayette formation to the middle or upper part of the Miocene series on the basis of mammalian fossils and of the interbedding of the Fayette with Columbia River basalts, which are generally accepted as Miocene in age. It is the writer’s belief that the lacustrine beds of Boise Basin are of the same age as the Fayette of the Snake River plains and, therefore, are of middle or upper Miocene age.

RHYOLITE.

A few miles northeast of Placerville boulders and fragments of rhyolite lava occur in the stream beds although the rock was not found in place. A dense cover of vegetation and of deep soil masks the rocks of the locality, and it is very probable that rhyolite flows exist beneath cover. At Silver City 9 and near Weiser 10 the relation of rhyolite flows and intrusives to the lacustrine beds of known age infers a Miocene age for the rhyolite. There is some evidence that a similar age should be assigned to the late rhyolite dike which occurs in the Basin near Quartzburg (p. 52).

BASALT.

Near Idaho City, Placerville, and Pioneerville and northwest of Quartzburg basalt lavas cover the older lacustrine rocks at several places. Usually this rock covers only a few acres in any one exposure, but on the main divide northwest of Quartzburg it crops out extensively and attains its maximum thickness of 200 feet. The lava is for the most part a very dense black fine-grained olivine basalt with ferro-magnesian minerals sometimes abundant as very small crystals. Feldspar was not apparent in any of the hand specimens collected. The rock is very much finer grained than the diabase dikes, and is at places almost glassy. The top of the flow is frequently vesicular. Near Idaho City some of the basalt contains cavities filled with calcite and aragonite, the latter crystallised as within a geode. A typical specimen was selected for microscopic examination from the summit northwest of Quartzburg. The petrographer’s report follows:

The rock is black, dense, and has lath-shaped feldspar microlites present in rough parallelism. Throughout the rock there are scattered very small specks of magnetite associated with kaolin. Feldspar comprises most of the groundmass, magnetite and kaolin in about equal amounts constitute the groundmass. Olivine phenocrysts are only very sparingly distributed.

GRAVEL.

After the outpouring of the basalt the Boise Basin region suffered a pronounced and comparatively sudden uplift. The streams were rejuvenated to a remarkable degree and large quantities of big boulders and coarse gravel were carried down from the highlands and discharged upon the flat lake-bed areas. At some places, the boulder deposits attain a thickness of from 30 to 50 feet. These gravels, in which the largest boulders exceed three feet and are frequently one or one and a half feet in diameter, afford a striking contrast to the underlying lacustrine sediments where the two are exposed in some of the placer diggings. At a few places, the gravels rest upon the basalt which was poured out at the close of the first period of lacustrine sedimentation.

YOUNGER LACUSTRINE DEPOSITS.

Upon the coarse gravel were deposited various grades of finer material ranging in depth from 50 or 75 feet about the margins of the areas of deposition to a few feet near the central portions. The deposit is clearly lacustrine. The distribution of the prominent banks around the ancient shore-line, at the mouths of tribu-
tary streams, fairly well outlines the submerged areas (Grimes Creek and Moore Creek basins), which were larger than the older lakes. Although the younger beds lie unconformably upon the earlier lacustrine sediments, the unconformity is erosional rather than angular.

STRUCTURAL GEOLOGY.

The earliest period of structural deformation of the rocks of Boise Basin is now marked by several broad extensive shear zones which strike roughly parallel to the dike zones. The most extensive occur along the northern and western boundaries of the Basin. Each zone usually consists of several approximately parallel major fissures a few hundred feet apart. All the rocks within the zone are often deformed by complex and irregular faulting, the intensity of deformation being most pronounced adjacent to the main fissures. At places, less extensive zones of shearing intersect the main fissures at an acute angle, and extend across the faulted area with little displacement. These zones of secondary shearing, evidently later than the main fissures, are sometimes important sources of ore, as at Quartzburg. The accompanying sketches (figs. 2 and 3) illustrate the complexity of the shear

**FIGURE 2**—Generalized sketch showing faulting within intrusive zone and ore bodies along the main fissures, near Quartzburg.

zone structure. Lateral displacement along the main fissures occasionally exists but seldom exceeds a few feet; in a few places,
however, the longitudinal displacement is considerable and even exceeds 500 feet.

The age relation of the regional shearing to the Miocene gravel is well shown at the Mayflower mine near Quartzburg. At this place one of the main fissures strikes under a thick deposit of the coarse gravel. A rhyolite dike has been displaced along the fissure but the gravel bank extends unbrokenly across it. The regional shearing is also definitely later than most of the basic intrusions, although a few of the basic intrusions are younger than the fissures. These facts all point to the contemporaneity of the shearing and the Miocene igneous activity.

Northwest of Quartzburg on top of the main divide, deposits of typical Basin gravel are to be found at an elevation of nearly 7,000 feet above sea-level and fully 2,000 feet above any similar gravel in the Basin below. These gravels—composed of rounded pebbles of quartz, granite, and various dike rocks—are deposited upon a tilted basalt flow which may possibly be correlated with that in the Payette Valley to the north about 4,000 feet lower. This crustal disturbance undoubtedly followed the accumulation of the Tertiary gravels and is, therefore, later than the regional shearing. There is some doubtful evidence that the Summit Flat
region at the head of Grimes Creek was similarly elevated during this same disturbance.

The final stage of structural deformation within the Basin area was characterized by irregular block faulting throughout the lowland areas. The deformation was evidently one of gradual re-adjustment inasmuch as no rapid accumulation of gravel followed. Blocks of early lacustrine sediments, some 25 to 50 acres in extent, may be seen dipping as much as 20° in some of the many abandoned placer pits near Idaho City (fig. 3). The Basin lakes were evidently at a very low stage, or were perhaps even drained when this deformation took place, for no deposits lie unconformably upon the tilted gravel banks. Evidence of block faulting was also found at several places in the foothill ridges and to a minor extent in the vicinity of the main shear zones close to the Basin divides.

GEOLOGIC HISTORY.

Speaking of the geologic history of the Boise Basin Lindgren\(^2\) says:

> The succession of geological events to which the existence of the basin and of the gold-bearing gravels is due, is neither simple nor easy to decipher. In a large degree this is owing to the very monotonous structure of the bedrock series, which gives few clues, except those indicated by the topography, to the

character of the movements that have taken place, for it soon becomes apparent during a study of the district that erosion alone, unaided by structural movements, cannot have produced the depression situated on the divide between two main rivers.

Jones states further that:

The oldest rock is the granite, which is of late Cretaceans or early Tertiary age. Next the granite dike rocks were intruded, and still later the basic deposits were formed. Before the uplift that differentiated the mountainous area from the more level plains from the mountains area to the east the granite was extensively eroded, and the higher summits are thought to be a part of the old surface thus produced. The structure of the basin is due to faulting, by which a block of granite was sunk far below the surrounding upland surface. At this time the wall of the basin was initiated, and the streams within the basin eroded the upland surface. Later, during Tertiary time, Snake River was dammed by the upper crustal movements, and the plains area was occupied by a lake whose high-level mark, as indicated on the mountains near Boise, was 4,500 feet. This lake extended along the present course of the main tributary Moore Creek and occupied much of the basin. Beds of clay and sand and coarse granite sands were deposited in the lake, and gravel deposits were laid down at the mouths of tributary streams. Basalt flows were intercalated with the lake beds. Further crustal movements caused the draining of the Tertiary lake and the streams within the basin resumed their erosion. Large parts of the gravel and lake beds within the basin were removed, but the general level of the lake was kept about 4,000 feet above sea level. This depression of the lake and streams was maintained during the later basaltic flows of Tertiary time. Some of the basalt flowed into the lake and covered its surface in a sheet not more than 50 feet thick. The close contemporaneity between rhyolite porphyry and basic dike intrusions, shearing, and ore deposition, together with the evidence afforded by the various lava flows, indicate that the duration of erosion subsequent to the ore deposition has been very much less than that which preceded it. This distinction should be made to avoid over-estimating the depths to which present ore deposits have been eroded. One feature of the drainage of the later lake is worthy of mention—the streams which cut through the marginal gravel banks effected a re-concentration of those gravels and formed the rich gold placer deposits which attracted the pioneer prospector.

A. Lava flow on Boise River near mouth of Moore Creek.

B. Remnant of auriferous gravel on top of false bedrock (clay) near Idaho City (see p. 20).
A. DREDGE OF THE BOSTON AND IDAHO GOLD DREDGING CO. AT WORK NEAR IDAHO CITY.

B.HYDRAULIC MINING OPERATIONS AT IDAHO CITY.
GOLD PLACER MINING OPERATIONS.

HISTORY.

Dredging operations were started on Wolf Creek near Placerville in 1896, and at two different places on Grimes Creek near Centerville in 1899. Owing to faulty construction of the first dredge and expensive operation of the other two, all were closed down after short runs and were later dismantled.

Boston and Idaho Gold Dredging Company.—About 1897, the Boston and Idaho Gold Dredging Company acquired a considerable tract of placer ground near Idaho City along Moore Creek. A 2½ cubic foot open-connected steam-operated Risdon dredge was built near Warm Springs about two miles below Idaho City. This dredge was operated continuously until it sank in 1905. During this period the company also built a large steam-shovel dredge, but this did not prove to be an economical method of handling the ground and was abandoned.

In 1908, Mr. F. W. Estabrook of Boston assumed the controlling interest in the company and constructed a hydro-electric plant of 1,400 horsepower on the Payette River about three miles north of Grimes Pass; transmission lines were built to Idaho City, Centerville, and Quartzburg. A 4-foot open-connected Risdon dredge was erected on Cold Spring Flat, six miles below Idaho City. This dredge commenced digging in the summer of 1909 and continued operation until the spring of 1914, handling from 40,000 to 100,000 cubic yards of gravel per month. The gravel was rather tight. The bedrock was granite, usually soft but with occasional rough reefs and hard spots. The gold recovered had an average fineness of 780 based upon mint returns.

In 1910, a 16-foot close-connected bucket dredge was built for this company by the Yuba Construction Co., on Elk Creek about one mile above its junction with Moore Creek. The dredge was later equipped with new buckets of 18-foot capacity, and as finally operated had a reach of 36 feet below the water line. It is pictured in Plate VI. It was started in May, 1911, and, with the exception of one year’s shutdown during 1916-17, operated continuously until August, 1918, in the channels of Elk and Moore creeks near Idaho City. The maximum capacity attained in any one month was 461,000 cubic yards, and for one year was 4,800,000 cubic yards. From May, 1911, to September, 1916, the aver-
age cost of operation, exclusive of depreciation, was 2.91 cents per cubic yard. Under normal working conditions, four men constituted the crew for each eight hour shift. The gravel, for the most part, was loose and free from large boulders. The usual bedrock was clay but some hard lava and decomposed granite were encountered. The gold recovered averaged 800 fine. This dredge was dismantled a few years ago and the bucket line shipped to the scene of the company's present operations in California.

Boise Basin Placer Co.—Hydraulic mining is being carried on at the present time by the Boise Basin Placer Co. in one of the extensive gravel bars about one mile northeast of Idaho City. The company's holdings consist of 150 acres near the junction of Moore and Elk creeks; about 20 per cent of this area has been mined up to the present time, and a ten years' life for the operations seems assured. The average depth of the gravel is reported as 60 feet and the value per cubic yard as 2.79 cents. The total production during the period from 1900 to 1918 inclusive, based upon bullion returns, has been $477,478. The company has a small hydro-electric plant for lighting purposes and a sawmill for its lumber supply. A small air compressor supplies power to jackhammers for plugging boulders. The sluice boxes are set on a grade of 11 inches per rod or 5.6 per cent and are lined throughout with 35-pound rails placed parallel to the direction of flow. During the peak of the spring flood season, 45 second-feet of water can be taken from Elk Creek under a head of 140 feet and 30 second-feet from Moore Creek under about 115 feet head, to the present site of operations. The working season varies from three to four months and usually opens in March or April. The maximum yardage attained with favorable conditions is said to be 3,000 each 24 hours. The ratio of the gold to silver in the bullion is reported as averaging about 8 to 1.

Moline Mining Co.—Dredging operations were conducted by the Moline Mining Co. on Fall Creek about two miles southwest of Placerville from 1902 to 1911. About one mile of the Fall Creek channel was worked with a total production slightly exceeding $444,000. The company used a steam shovel dredge from 1902 until 1905, then abandoned it as inadequate. A 5-foot Risdon dredge of the alternate bucket and link type with a maximum reach of 30 feet below water line was then operated until 1911.
Operations ceased with the increase of mechanical difficulties as the dredge approached the Fall Creek canyon. Steam power was used with a consumption of six cords of wood per day. The dredge had a capacity of 50,000 cubic yards per month. The ratio of gold to silver in the bullion is reported as 5.9 to 1. The source of the gold is definitely traceable to a prominent system of veins which cross Fall Creek about one mile up stream from the point at which the dredge had to cease operations.

**PRODUCTION.**

The total placer gold production from the Boise Basin in the past is an unknown quantity. Estimates varying between $50,000,000 and $60,000,000 are given by those who have investigated the fragmental records that exist. In all such estimates, however, a considerable element of guess work is invariably interwoven with that which is authentic. The estimates are comparable in accuracy with a figure which, although it purports to be the exact distance between two points, is nevertheless obtained by accurately measuring a portion of the distance and guessing at the rest. Whatever the true amount may have been, the opportune discovery of gold in the State came during a critical period in national affairs. The output of Boise Basin with that from Pierce City, Florence, and Elk City, camps which had been discovered but a short time previously, went a long way toward stabilizing national currency for the North at a time when the need was greatest.

**FUTURE POSSIBILITIES.**

The placer gold deposits of Boise Basin have by no means been exhausted. Several bank deposits yet remain. Such data as are obtainable show these to contain about the same gold content as the deposits formerly worked, but great depth to bedrock and lack of dumping space are problems involved in their exploitation. The economic value of the thorium and other radio-active minerals found in the sands near Centerville is not sufficient to warrant treatment at the present time. It is reported that early day placer miners experienced considerable difficulty, in certain localities, from the choking of sluice boxes with several complex bismuth-lead-silver sulphides. The high silver content of the bismuth mineral may warrant the recovery of concentrates from some of these localities.
ECONOMIC GEOLOGY.
MINERALOGY.
METALLIC MINERALS.

Pyrite.—Auriferous pyrite is the predominant sulphide of the Boise Basin. As a rule the gold content is low, generally between 50c and $2 per ton, but the oxidized portions of deposits of this mineral have been important sources of gold. The gold content of the pyrite is materially greater when the mineral is associated with quartz. Under the microscope, specimens of this pyrite are seen to be traversed by minute quartz-filled fractures.

Marcasite.—Marcasite is found at many places in association with pyrite. It usually carries very little gold.

Pyrrhotite.—Pyrrhotite has been found at the Belshazzar mine west of Quartzburg and at a few other places. It is finely crystalline, is about the color of pyrite but lacks the lustre of that mineral, and is slightly magnetic. Specimens usually show considerable arsenopyrite associated with the pyrrhotite.

Arsenopyrite.—Arsenopyrite is found at various places throughout the Basin but usually in small amounts. Its gold content is generally much higher than that of pyrite—selected specimens taken from the lower tunnel of the Mountain Chief mine, about 250 feet below the surface, assayed 0.55 ounce gold per ton.

Galena.—Galena occurs very frequently in the region about Grimes Pass. With it are generally associated sphalerite and subordinate amounts of copper sulphides. The galena of the primary zone generally carries slightly less than an ounce of silver for each per cent of lead but the gold content is low. Galena also occurs at several places along the Quartzburg porphyry belt. It is the principal ore mineral in the region northwest of Quartzburg, and also occurs in intimate association with the gold-bismuth deposits of that camp. A polished section of a specimen from the Coon Dog property on Grimes Creek shows the galena replacing pyrite. Another specimen from the property of the Mineral Mining Co. in Charlotte Gulch shows sphalerite which formed later than the galena; still other specimens show galena subsequent to sphalerite.
Sphalerite.—Sphalerite is a minor ore constituent at most of the mines, but occurs more frequently in those localities where galena is prominent. It is present in the Gold Hill, Mountain Chief, Buckskin, Hiatt, and in practically all the other mines in the Grimes Pass region. At a few places the sphalerite carries considerable gold; in most instances of this kind field relations point strongly to surface enrichment, as specimens taken at depth generally carry between 0.02 and 0.10 ounce per ton.

Tetrahedrite.—Tetrahedrite carrying a high silver content occurs at many of the mines in the Grimes Pass locality and at the Silver Hill property about two miles northwest of Quartzburg. Examination of several specimens under the microscope points conclusively in each case to the primary character of this mineral.

Chalcopryrite.—Chalcopryrite is not found as frequently as the minerals previously described, the largest deposit being at the Coon Dog property on Grimes Creek. At this place the chalcopryrite is closely associated with sphalerite, and is replaced in many instances by covellite and chalcocite. Chalcocite as an alteration product of chalcopryrite was noticed in one specimen of Golden Age ore. A specimen from the Mohawk vein of the Mineral Mining Co. shows chalcopryrite contemporaneous with galena and sphalerite. Minor amounts of copper sulphides occur elsewhere in the same region but as a rule do not form workable ores.

Cerussite and anglesite.—Minor amounts of cerussite are found in the upper portions of many of the galena deposits in the region about Grimes Pass. Some anglesite is found closely associated with the cerussite.

Limonite.—As an alteration product of pyrite, limonite is prevalent throughout much of the Basin in the oxidized portions of the veins.

Magnetite.—Large quantities of “black sand” or magnetite occur in many of the creek channels and gravel bars. Much of the material however, is the titaniferous variety, ilmenite. Boulders of magnetite several inches in diameter occur along stream beds. Several small segregation deposits occur in place about two miles from Placerville in California Gulch.

Bismuth minerals.—Several sulphide minerals of bismuth, bismuthinite, beegerite, cosalite, lillianite and other unidentified combinations with lead and silver occur at many places in the
Quartzburg mineral zone. In appearance they have about the same color as freshly broken galena. Aside from its needle-like crystallization in vugs and open crevices, the bismuthinite is finely granular and has no distinctive crystallization apparent to the eye. A freshly broken surface has the hackly texture of cast iron. It occurs in seams with or without quartz gangue; none has been observed with calcite.

An analysis of an 8.5-gram sample of the bismuth mineral, segregated as cleanly as possible under the binocular microscope, shows the following:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bismuth</td>
<td>18.2 %</td>
</tr>
<tr>
<td>Lead</td>
<td>10.0 %</td>
</tr>
<tr>
<td>Gold</td>
<td>Trace</td>
</tr>
<tr>
<td>Copper</td>
<td>2.8 %</td>
</tr>
<tr>
<td>Iron</td>
<td>13.0 %</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Antimony</td>
<td>1.4 %</td>
</tr>
<tr>
<td>Arsenic</td>
<td>None</td>
</tr>
<tr>
<td>Sulfur</td>
<td>19.5 %</td>
</tr>
<tr>
<td>Insoluble</td>
<td>3.8 %</td>
</tr>
</tbody>
</table>

Considerable coarse metallic gold was removed from the sample together with the other foreign material. The iron content represents pyrite, which occurs with the bismuthinite in a fine crystal intergrowth and could not be separated. Iron is not a constituent of the pure bismuth mineral.

These bismuth-lead-silver sulphides had long been classed at one mine as "antimony" and had been sent to waste for many years past. The error in classification was discovered by the Idaho Bureau of Mines and Geology. The mineral will undoubtedly form an important by-product in future operations at several places along this particular zone.

It is shown microscopically that the gold and bismuthinite were deposited at essentially the same time. Particles of gold are usually enclosed by the bismuth mineral, but a few cracks in the gold are filled by the other. The second relation is rather exceptional but indicates the contemporaneity of the two minerals (Plate VIII A). Gold is invariably associated with the bismuth, but the amount is not constant. The silver content is generally high. Bismuth ores from Canyon Creek and from the Mineral Hill mine, at opposite ends of the same deposit, show abundant coarse gold. The Buckskin deposit on the other hand is characterized by its high silver content.

Stibnite.—The antimony sulphide, stibnite, may be found at a few places in the Idaho City region. In one specimen a seam
Specimen from Gold Hill Mine. Gold (light gray) at one place fills crack in the bismuth mineral, mostly flirtinite (dark gray), and at other places is enclosed by the bismuth mineral. Magnification 150 diameters.

Specimen from Gold Hill Mine. Gold (light colored areas in center of field) enclosed by and at one place cut by (bismuth mineral). In the center of the field, near the margin, show (by the various shades of gray) the different bismuth-lead minerals. Note the quartz veinlet (dull gray) cutting through the field near the margin. Magnification 150 diameters.
Etched section of specimen from the Buckskin mine. Two nearly parallel rosettes of chalcopyrite (light gray) strike diagonally across the field of galena (dark gray). The other light-colored irregular patches are an unidentified bismuth mineral enclosed in galena. The bismuth mineral, partly beegearite, is interbedded in ore between galena and chalcopyrite. Magnification 150 diameters.

Specimen of bismuth mineral from Gold Hill mine. After etching with HCl fumes, shows intergrowth of several bismuth-sulphide minerals not visible in the unetched section. Magnification 150 diameters.
of this mineral an inch and a half wide bisects a 4-inch quartz vein. The stibnite carries no gold and only a very small amount of silver. Stibnite occurs also as a minor constituent of some of the ore along the Quartzburg porphyry belt, and in association with the several bismuthinite deposits. The most prominent occurrence observed was that at the Buckskin mine.

Gold.—Native gold occurs in the oxidized portions of quartz and fissure veins, and as a primary deposit associated with bismuth. Primary gold also occurs with pyrite in the sulphide zone of the veins but invariably as a dissemination of minute particles. Polished sections of auriferous pyrite do not show the gold except at a magnification of 200 diameters or greater. A specimen of quartz-pyrite ore was taken in the Belshazzar mine 600 feet below the surface, clearly below the zone of oxidation; the specimen was more than half quartz. An assay of the crushed specimen ran 7.45 ounces in gold, although panning the unused portion of the sample failed to show any colors. A variable amount of silver is associated with the gold. Some of the bullion recovered from primary sulphide ores is reported to run as low as $14 per ounce. That now being recovered at the Gold Hill mine ranges close to $18 per ounce, but it is from a bismuth-bearing deposit. The placer gold is reported to have averaged nearly $17 per ounce, but $20 bullion was not uncommon in certain localities.

An average recovery of 60 per cent of the gold can be made on most of the oxidized ores by means of amalgamation. At some places this has been exceeded. With an increase of the sulphide content of the ore, the recovery drops decidedly. Some bright and apparently clean yellow gold is sometimes encountered which will not amalgamate even after crushing the ore through rolls and a tube mill. Some of this metal was collected and scoured vigorously in a mortar; after this treatment amalgamation was quickly effected.

Silver minerals.—Native silver occurs at several places near vein outcrops and at shallow depths. Some exists near Grimes Pass and in the vicinity of the Washington mine northeast of Idaho City. The upper levels of the Silver vein at this place were inaccessible when visited by the writer; galena is prominent in the sulphide zone. Some specimens of native silver were seen
A. Specimen from Golden Age mine. Fluoresce in sphalerite (Sp) filled with hexahedrite (T) and quartz (Q). Magnification 100 diameters.

B. Specimen from Golden Age mine. Tetrahedrite (T) occurring as a peripheral fringe around siderite (Ch). and filling cracks in chalcopyrite. The dark back ground (Q) is quartz. Magnification 100 diameters.

C. Specimen from Golden Age mine. Intergrowth of contemporaneous galena (G) and sphalerite (Sp) crossed by remelt of later tetra-
hedrite (T), filling a fissure. Magnification 50 diameters.

D. Specimen from a cove. Filled fissure on the property of the Mineral Mining Co. Kidney of galena (dark gray areas marked G) de- posited subsequent to (T) and replacing that material. A small, rounded area of quartz (Q) is included by the gal-
ena. Magnification 75 diameters.

PHOTOMICROGRAPHS OF BOISE BASIN ORES.
quartz, it has been observed filling fractures in many of the ore minerals. Some calcite veinlets between half an inch and an inch in width were observed cutting through pyrite as well as containing it. Assays of the segregated pyrite showed a negligible gold content. Replacement of calcite was an important factor in the genesis of many of the galena deposits; some occurrences, which show almost complete replacement, indicate a comparative abundance of calcite during the initial stage. The microscope shows the presence of secondary calcite in several of the ore specimens collected from the lead-silver deposits.

Sericite.—Sericite is the principal alteration product of the rock minerals and is found filling fissures in the main shear zones of the Basin. Where the walls of the shear zones are granite or quartz diorite, they often show sericitization many feet from the fissures. Disseminated through the sericite occur deposits of all the various sulphides diminishing rapidly in amount with added distance from the fissures.

Kaolin.—Kaolin occurs more abundantly in the outcrops of veins than at considerable depths below the surface. It is most abundant in those places where acid solutions have acted on the rocks. Often, where deeply iron stained along fractures, the kaolin carries a high gold content. A silicate resembling kaolin occurs closely allied with sericite as an alteration product in some of the fissures of the Grimes Pass region. This silicate, as viewed under the microscope, is seen to have been a precipitant for galena. Fairly pure beds of kaolin are to be found at places near Idaho City in the older lacustrine sediments.

Plates VIII, IX, and X show typical mineral associations as revealed by photomicrography.

VEIN SYSTEM.

The quartz veins of the Boise Basin may be divided into three classes on the basis of mode of origin, relative age, and economic importance. These three are, as a rule, easily distinguished in the field.

QUARTZ VEINS NOT ADJACENT TO PORPHYRY ZONES.

The veins of the first class, which are also probably the oldest veins of the district, are the "bull" quartz veins which occur in
the granite at some distance from dike rocks of acid or intermediate type; occasionally one will be found within a porphyry belt. The veins of this class form prominent outcrops in several localities and may sometimes be traced for several thousand feet. They attain a maximum width of 20 feet or more, though 2 or 3 feet is an approximate average. They usually occur in sets of several roughly parallel veins a few hundred feet apart, and strike approximately east and west. They are older than the diabase with no apparent strike relation to the nearest porphyry belts. They are for the most part neither adjacent nor parallel to any acidic dike; this fact, coupled with the rough parallelism and extent of their outcrops, suggests that the position of these dikes has been determined by an extensive regional fracturing which is older than the shearing of Miocene time. Isolated occurrences of pegmatite are quite common in many of these veins, a fact which is indicative of formation at great depth.

The deposition of veins of the first class was accompanied by an insignificant amount of mineralization. Numerous prospect holes were sunk on them in early days and very definitely proved their unproductive character. Neither were they accompanied by hydrothermal alteration of the enclosing wall rocks to any significant degree.

The few ore deposits which have been found in veins of the first class occur in the immediate vicinity of subsequent basic dikes in or across the quartz. The ore minerals consist of galena, tetrahedrite, sphalerite, and pyrite. There is in each case considerable evidence of a later phase of quartz deposition accompanied by sericitization of wall rocks. A rather abundant pyrite mineralization was noted in a few of these veins in the vicinity of a prominent shear zone which cut across them at an acute angle. The quartz was considerably shattered and the mineralization, very evidently subsequent, was confined to the vicinity of the intersection.

QUARTZ VEINS ASSOCIATED WITH ACIDIC DIKES.

The veins of the second class are frequently of the same general appearance as the first but are usually distinguished by the absence of pegmatite and by the presence of an appreciable pyrite mineralization. They are believed to be genetically related to the
acid dikes, usually aplite, on the basis of approximate parallelism of strike and dip and proximity of the two. As a usual thing, the wall rocks enclosing veins of this class have not been hydrothermally altered to any pronounced degree.

The pyrite which occurs with veins of this class is auriferous although assays of concentrates reveal the fact that it is usually of low grade. The oxidized zone of these veins has, in the past, however, furnished large quantities of high-grade free-milling gold ore, especially from those places where the quartz is extensively fractured. At two places near Grimes Pass, a vein of the second class includes a deposit of galena, chalcopyrite, and sphalerite associated with quartz and pyrite. In each case however these sulphides are later than the vein and are probably related to adjacent mineralized fissures of the third and last type of vein.

**Fissure Veins Related to the Miocene Regional Shearing.**

The third and by far the most important class are the fissure veins related to the regional shearing and subsidence which occurred during Miocene time. In veins of this type occur the principal ore deposits of the region. They occur as irregular chimneys and lenses of quartz at the intersections of the fissures with acidic dikes. These lenticular veins seldom exceed 500 or 600 feet in length; generally they are between 100 and 200 feet. They vary in width from a few inches to several feet, four to five feet being an average. Irregular tabular bunches of calcite are found widely scattered along the fissures. The crushed wallrocks comprising the fissure filling have been intensely altered to sericite and subordinate quantities of other metamorphic minerals by hydrothermal agencies. The alteration at places extends for many feet into either wall of the fissure, especially where the wall rock is granite; this rock is sometimes so extremely altered that the walls are indefinite.

Pyrite is quite generally distributed along the main fissures and often constitutes a prominent part of the vein material. Although it generally occurs as irregular streaks throughout the soft gouge of the shear zone, it is sometimes 2½ or 3 feet wide and makes up the entire vein. Other sulphides, generally those of lead and zinc, occur irregularly and disseminated in tabular shoots extending at times as much as 300 or 400 feet along the fissure.
A second characteristic phase of the quartz veins of the third class, is associated with the branching fissures or, rather, zones of fracturing. These fissures, usually well defined in the granite, where they pass through acid dikes often resolve themselves into countless seams or planes of fracturing with but minor crushing of the dike rock. The fractured zones in the dikes have afforded avenues for solutions evidently more favorable than those in surrounding rocks, for, at such places often occurs a filling of quartz and the various sulphides throughout the fractures. Such deposits, probably best described as a stock-work, seldom extend beyond the dike as such; the extension of the quartz beyond the dike is invariably confined to the first 50 or 100 feet of the main fissure in the intruded rock. Such deposits are frequently important sources of ore, as in the recent work at the Gold Hill mine.

The principal production of the Basin has come from veins of the third class which accompany two of the main shear zones, the one extending through Quartzburg to Grimes Pass and the other striking about N. 70° W. through the region north of Idaho City. Considerable shearing is also evident along the main divide between Centerville and Idaho City, and good ore has been found at several places in the oxidized zone of the fissures. Although shearing and dikes are prominent southeast of Idaho City, no important production other than placer gold has yet resulted from the limited exploratory work done there.

**Ore Deposits.**

The ore deposits of Boise Basin generally occur in veins of the third class and are probably genetically related to certain of the dike rocks. Primary mineralization during several epochs has formed ores of gold and silver with subordinate amounts of lead, zinc, and copper. Variable small quantities of bismuth and vanadium are associated with lead in several deposits in the western part of the Basin. The quantity of lead, zinc, and copper minerals in the ores, decreases in the order stated; the copper content rarely exceeds three per cent.

**Relation to Dike Rocks.**

At most places in Idaho where ore deposits are associated with dike rocks there is a very evident genetic relationship between
the two. Although the same relationship is thought to exist in the Boise Basin it is mainly an indirect one. The principal productive veins are directly related to the extensive regional shearing and are subsequent to most of the dike intrusions. This shearing as a rule has a strike which differs between 10° and 30° from that of the dikes and dips away from the dikes more often than toward them. The main ore deposits are found at or near the intersections between fissure and dike. Dikes which are not accompanied by subsequent shearing are as a rule negligible sources of ore.

An indirect genetic relationship exists between the acid dikes and gold-bearing quartz-pyrite ore shoots in veins of the third class as well as between the basic dikes and galena, sphalerite, and copper sulphides. The first is well proven at many mines; the second, although very obvious at some places, is not so conclusively proven at others. The principal deposits of the lead, zinc, and copper ores invariably occur in the vicinity of prominent basic intrusions though all basic intrusions are not accompanied by similar ore deposits.

As the mineralized fissures are younger than all the acid and most of the basic dikes, any assumption of genetic relationship between intrusion and deposition must be based upon the postulation of shear-zone fractures communicating with deep-seated portions of the intrusives, the fractures affording an avenue of ascent for the mineralizing solutions. Why the mineralization did not accompany the intrusion of the various dikes rather than the subsequent fissuring can not be explained satisfactorily by the writer. Only a few instances were found showing an apparently direct relationship between intrusion and ore deposition.

PERIODS OF PRIMARY MINERALIZATION.

If one excepts the pyritization of the veins of the first and second classes, there have been two periods of primary ore deposition in the Boise Basin. The first period is characterized by a very general distribution of auriferous pyrite throughout the main fissures. Except for the pronounced gold content where quartz vein and acid dike intersect, there is no feature of the occurrence that suggests a relationship with any of the various
dike intrusions. Associated with the pyrite are small amounts of marcasite and, occasionally, pyrrhotite. The gold content is variable and usually low, but sufficient at many places to justify cyanidation. The precious metal exists in a very fine state of division, so that high-grade pyrite, even after extremely fine grinding, seldom shows colors upon panning. The coarseness of the gold in the oxidized portions of the veins, however, is often pronounced.

The second period of mineralization is characterized by the deposition of galena, sphalerite, tetrahedrite, and the complex lead-bismuth sulphide. Coarse gold is commonly associated with the bismuth as a closely subsequent phase of deposition. The study of ore paragenesis shows that the above minerals were deposited in successive stages but not always in the same order even in the same neighborhood, permitting the general statement that the different minerals were closely contemporaneous.

REPLACEMENT DEPOSITS.

The local ore bodies are, for the most part, replacement deposits along fault fissures in which veins of the third class have been formed. Quartz, calcite, and sericite are the principal gangue minerals. All the deposits are decidedly tabular in form, but frequently an irregular dissemination of the ore minerals extends for a short distance into the more highly altered wall rocks. In ore bodies of this type there is no evidence that the enclosing wall rocks have influenced the character of the ores formed. Replacement of some of the common alteration products—sericite, kaolin, and another hydrous magnesium silicate—in the filling of the fissures and to a slight extent in the adjacent walls, seems to have been the principal feature of the deposition. A single exception to the foregoing statement lies in the effect of basic dike rocks on ore deposition. Wherever shearing and alteration of these rocks has been produced by an intersecting fissure, the intersection is usually lean or barren of ore. Fractured zones in the basic rocks frequently show small amounts of pyrite and occasionally of galena, but nowhere in sufficient quantity to constitute an ore.
A few of the ore deposits are clearly fissure fillings, occupying the cores of narrow quartz veins of the third class and fractures in the rhyolite and other porphyritic rocks. Of such a nature are the gold-bearing quartz-pyrite shoots found at the intersections between major fissure and acid dike. These shoots are tabular or vertically elongated lenses sometimes attaining a width of four or five feet and a stop length of 50 to 200 feet.

Quite frequently a major fissure, near its intersection with a porphyry dike, resolves itself into a zone of fracturing 30 feet or more in width, which persists across the dike and then compounds itself once more. Such an occurrence resembles a stockwork with the veins consisting of numerous approximately parallel stringers following the fractures of the dike rock. The longitudinal extinction of the quartz veinlets a short distance either way from the dike is a very characteristic feature of this type of deposit. Scattered throughout the quartz veinlets, though generally as a central filling, occur the various sulphide minerals and, in certain localities, coarse gold. The veinlets are sometimes seams of knife-blade width which hold considerable gold plastered over the rock surface; at other places native silver, thought to be secondary, is the most abundant metal. The greatest width observed for any of the stockwork seams was approximately four inches; the quartz was invariably drusy where the seam approached such widths. Although the ore minerals are generally confined to the more central portions of these veinlets, some transparent quartz crystals were found at Quartzburg which contained needle-like bismuthinite. In some of the smaller seams, quartz is absent and the metallic minerals constitute the fissure or fracture filling, very sharply defined from the enclosing rock. Sphalerite, associated with less galena and chalcocite, forms such a recementation of considerably shattered rhyolite in the vicinity of prominent fault fissures, in No. 9 tunnel of the Coon Dog mine near Grimes Pass.

Rhyolite porphyry in the vicinity of the fissure filling ore deposits is usually considerably altered and invariably contains a scattered dissemination of small pyrite or marcasite crystals for a considerable distance from the shoots. It does not, however, disintegrate as does the granite under like conditions. The alter-
ed porphyry is often chalky and can be cut with a knife; again in the same vicinity it may be highly silicified and present the appearance of the unaltered rock.

In fractured diabase dikes which show little or no alteration to the eye, the small irregular fractures have considerable pyrite mineralization. This mineralization is very definitely confined to open spaces in rock of the less basic phases. In one instance some quartz occurred with the pyrite. Several assays of the clean pyrite concentrate obtained by grinding and panning ranged between 0.2 oz. and 1.8 oz. per ton in gold, but even in the favorable instance the mineralization was not sufficient to constitute an ore. The general statement is warranted that nowhere have the basic rocks proven to be ore-bearing.

GEOGRAPHIC DISTRIBUTION AND CHARACTERISTICS.

Gold.—Gold-bearing pyrite ore is of general distribution throughout the veins of the entire Basin. Except where the veins intersect acid dikes and throughout the zone of enrichment, the gold content is usually low. Exceptions to this statement were found at a few mines where the pyrite carries sufficient of the precious metal to warrant mining. The ores from the oxidized portions of the veins are free-milling—50 to 60 per cent of the precious metal content may be recovered by amalgamation; the bullion recovered runs between 10 and 20 per cent silver. The auriferous pyrite ores are amenable to cyanidation, 90 per cent of their gold content being recovered. The extraction of the associated silver is much lower, but the added expense of effecting a more complete recovery would probably be greater than the gain.

The high-grade gold ore from the oxidized zone of the lead-silver veins of the Grimes Pass region is largely secondary, and is very evidently derived from gold-bearing pyrite which is abundantly associated with the galena of the primary zone. These quartz-pyrite ore shoots, with primary gold content ranging between 0.5 oz. and 1.0 oz. per ton, have been disclosed more than 300 feet beneath the surface and in sufficient quantity to constitute an important part of the ore, which is mainly silver-bearing galena.
Gold is also found in the unoxidized zone of the lead-bismuth ore shoots, and as a dissemination of minute particles with all other sulphide minerals. No tellurides are known to exist in the Boise Basin although some have been reported.

_Argetiferous galena._—The primary silver-bearing galena ores are confined mainly to the Quartzburg-Grimes Pass mineral zone, and are most numerous near Grimes Pass. Lesser amounts of sphalerite, chalcopyrite, and tetrahedrite are associated with the galena. Ore of this character has not been found in any noteworthy amount in the Moore Creek basin—the most prominent showing known to the writer occurs in the Silver vein of the Washington mine. Ruby silver is reported in some of the region to the east beyond the Basin. At no mine was there noted any pronounced tendency of the galena to give way to sphalerite with depth. Ore shipments from the lead-silver deposits show a lead to zinc ratio varying between 4 to 1 and 2 to 1, with the zinc seldom exceeding 10 per cent of the total.

_Copper._—Copper is not found in sufficient amounts to warrant mining or concentrating for this metal alone. The most prominent deposits occur at and in the vicinity of the Coon Dog property near Grimes Pass. The copper content of the Coon Dog ore averages close to five per cent and occurs principally as chalcopyrite and to a lesser extent as tetrahedrite. At the Silver Hill mine, two miles northwest of Quartzburg, the ore is essentially tetrahedrite with high silver content. Disseminated chalcopyrite in altered granite occurs at the Fred Garrecht claims about two miles southeast of the hot springs below Idaho City.

The copper ores are mainly primary. Chalcopyrite, however, often shows a coating or recementation by chalcocite, covellite, or bornite. The silver-bearing tetrahedrite, in all cases noted, is primary. This is the important ore at a few places.

_Lead-bismuth._—Deposits of lead-bismuth sulphides occur at intervals along the Quartzburg mineral zone from Canyon Creek on the southwest as far as the Mineral Hill and Buckskin mines on the northeast; none have been found in the lead ores of the Grimes Pass region. This ore has been most extensively developed at Quartzburg in the vicinity of a late intrusion of the rhyolite which strikes across the country from Canyon Creek to California Gulch. Some float containing bismuth minerals was
found in Alder Creek northwest of the Mineral Hill mine. The lead-bismuth sulphides bismuthinite, lillianite, beegerite, and cosalite have been identified in the ores but several unidentified mineral combinations remain. The ores are quite distinct from the typical galena and sphalerite ores common to the Grimes Pass deposits. Associated with the bismuth, generally as a subsequent phase of deposition, is a variable though generally high content of metallic gold. The gold is coarse, and usually averages about $18 per ounce or 870 fine. The silver content of the concentrate segregated from several selected specimens of bismuth minerals ranges between 2.1 and 2.6 per cent. The gold-bismuth deposits are primary and may be expected to extend to considerable depth. The workings at the Gold Hill mine show no change in the tenor of the ore to a depth of 700 feet, although the zone of secondary enrichment extends but little below the 250 level in the vicinity of the Pioneer shaft or 200 feet below the level of the creek nearby. None of the other mines has explored the deposits so deeply.

Vanadium.—The vanadium-bearing ore has been very recently discovered and has not been fully investigated. It occurs in small amount in the oxidized zone of the lead-bismuth deposit of the Buckskin mine as vanadinite together with pyromorphite, the lead phosphate. Up to the present time, none of the ores has been worked for its vanadium content.

SECONDARY ENRICHMENT.

The term secondary enrichment is used to designate the enrichment of ore deposits through the agency of descending solutions. Both the chemical and mechanical phases of the process are locally evident in the concentration of gold and silver in the upper portions of the fissure veins. Within the Basin, the enrichment of auriferous pyrite so far outweighs in importance that of other ores that it alone will be considered.

The most important enriched deposits of auriferous pyrite have been found at acid dike and fissure intersections. To a lesser extent secondary gold occurs in the upper portions of the older quartz veins and also along the main fissures where pyrite was an abundant primary mineral. Surface solutions have carried the dissolved or liberated gold down through the fissured rocks to
depths ranging from a few to 400 feet, and deposited it in gradually diminishing amounts as added depth was gained. The depth to which enrichment extends, although dependent directly upon local fissures, is largely influenced by the relief of the region, and is greater in the higher rugged country than in the low-lying areas along trunk streams. Erosion has been a factor at a few places in determining the depth.

Good illustrations of secondary enrichment were noted at two places. At the Gold Hill mine a crosscut intersects a prominent fissure 250 feet below the surface. No oxidation was evident in the vein at the time it was first intersected. Subsequently a red sludge of iron oxides formed along the roof and walls of the cross-cut for several feet each way from the fissure. Two samples of this sludge assayed 0.12 oz. per ton in gold. A similar deposit on mine timbers at about 100 feet depth at the Belshazzar mine assayed 0.10 oz. per ton in gold. Panning of these sludges failed to reveal any gold even after they had been vigorously scoured.

Coarse gold occurs in the oxidized portion of many veins in which auriferous pyrite constitutes the primary ore. Accompanying such deposits are abundant stains of manganese oxides in the outcrops and throughout fissures for depths of 250 feet or more. The gold of the strictly primary ore occurs with the pyrite in an extremely fine state of division. Many workings have proven these relations of enrichment to underlying sulphide ore.

Gold nuggets weighing between one and five ounces have been found in the placer deposits derived from such zones of enrichment. Some of the placer gold had a fineness as high as 950 parts in 1,000, but the greater part of it was between 730 and 800 fine; the remaining parts of the bullion were composed of silver. Many authorities agree that the process of nugget formation is probably closely related to the reprecipitation of gold from its chloride solution in the progress of secondary enrichment. They do not, however, explain the process to its completion, neither do they explain how nuggets precipitated from chloride solution may contain silver, whose chloride is insoluble.
EARLY DEVELOPMENT OF THE LODE DEPOSITS.

The early day placer miner, as a rule, gave little thought to the lode deposits in the surrounding hills. The development of the lodes at Quartzburg was one of the few exceptions. The main ledge in this vicinity was discovered by placer miners and quartz claims were located in 1864. A small primitive mill was built in 1866 and paid well for several years thereafter. The deposit was thought to be exhausted and operations were closed down for a few years, only to be revived and carried on intermittently to the present time. About 1867 several discoveries in the north and northeastern portions of the Basin, directed attention to that locality. Rich float and high-grade outcrops were discovered. Many claims were located and active development work was started at various places. Several small stamp-mills were built to treat local and custom ores. Amalgamation was the principal process of recovery relied upon and milling losses were considerable. Even so, most of them paid well during the life of the oxidized deposits. Attempts to treat sulphide ore with the equipment on hand resulted in failure and finally ended operations throughout the Basin. From that time work was limited principally to annual assessment requirements until 1920, during which year mining operations were begun at four different places, with very encouraging results at three of them.
GOLD HILL & IOWA MINES CO.'S SURFACE PLANT AT QUARTZBURG, IDAHO.

MAIN STREET, QUARTZBURG.
MINES AND PROSPECTS.

In the following description of the mines and prospects of Boise Basin it is not intended to convey the idea that those described are the only ones worthy of mention. Many could not be visited. Some are of considerable merit but present no features other than those which are described; the description of all would amount to useless duplication. E. L. Jones, jr., describes eleven of the mines in the Basin. Many of these are now inaccessible and only such as have been re-opened with a noteworthy amount of development are mentioned here, together with whatever new discoveries have been made since 1916.

GOLD HILL & IOWA MINES CO.

The property of the Gold Hill & Iowa Mines Co. consists of 18 patented and 28 unpatented claims centrally grouped about Quartzburg. This village of about 250 population is situated well toward the head of Granite Creek, in the northwestern part of the Basin, and is the terminus of the mail stage route from Boise into the Basin. It has local and long-distance telephone service, electric power, and a general store and post office.

The mine was originally located in 1864 by placer miners who uncovered what is now known as the Gold Hill vein. Subsequent work for several years was confined to the oxidized zone of this vein for about 1,000 feet each way from the discovery point. Later the vein was explored to a depth of 400 feet with less satisfactory results. At this depth several rich seams were discovered leading off into the hanging wall. These were followed and at several places they opened into shoots of considerable size which were stoped to the surface at two places. These old stopes were long since caved or filled, but sufficient access was to be had to afford some data. The ore shoots were in each case found at or near the intersection of the seams with several granite or rhyolite porphyry dikes of the locality.

In recent years, attention has been directed toward the intersection of fissures with a dike of rhyolite porphyry which previously had been but slightly prospected. An ore shoot was found

which followed a fissured zone in the highly altered and complexly faulted rhyolite porphyry and terminated abruptly against an intersecting dike of later rhyolite. Subsequently a crosscut was driven through the later dike and another ore shoot similar to the first was disclosed in the extension of the older porphyry. Further development in the vicinity of the dike intersection disclosed several other ore shoots and the production of the mine for the past six years has come exclusively from them. They have been stoped from the 600-foot level, which is over 700 feet beneath their outcrop. The character of the ore is apparently the same throughout the full vertical range of development and, allowing for irregularities in occurrence, shows no indications of being bottomed.

FIGURE 5.—Sketch map of dike system at Gold Hill property.

A description of general geologic conditions may aid in an understanding of the ore deposit. Numerous rhyolite porphyry dikes crop out across the country, as shown in fig. 5, for a zone width of about one mile; several older diorite porphyry intrusives occur approximately parallel to the rhyolite dike, but are not shown by the figure. A younger dike, also of rhyolite porphyry, strikes across the older intrusives at an acute angle; it is known to extend a few miles each way from the outcropping portion indicated by the sketch. Basic dikes are fairly numerous in the
region, but more accurate mapping was impracticable. The Gold Hill vein in the vicinity of the workings strikes N. 60°-70° E. diagonally across the dikes and dips 70°-90° S. Several other prominent fissure veins, approximately parallel to the Gold Hill and between 200 and 600 feet apart, define a shear zone half a mile or more in width. Most of the other veins dip southward as does the Gold Hill. The strike of the later porphyry suggests that other dike intersections may occur in the neighborhood. The significance of these intersections with respect to ore bodies is discussed in subsequent paragraphs.

No development work of importance has been done on the Gold Hill property during the past 15 years except in the vicinity of the Pioneer shaft. Former operators obtained considerable free-milling gold ore at three other points along the Gold Hill vein but these workings are now largely inaccessible. Surface indications seem to warrant more extensive exploration.

The original work along the Gold Hill vein proved the lower limit of enrichment to be near the 250-foot level. This means a depth of about 200 feet below the level of the nearby creek. Subsequent drifting on the 400-foot level developed some ore; exploratory work along the main fissure on the 500-foot level was less successful. At one place on the level, however, the vein cut diagonally across a wide rhyolite porphyry dike, and seams leading into the porphyry contained considerable gold. A 60-foot winze was sunk and the porphyry stoped to the 500 level over an area approximately 40 by 150 feet. Above the 500 level the porphyry caved and instead of being stoped was drawn off from the level as it broke down. This furnished ore for several months.

Although it is reported that gold-bismuth ore was found in the Gold Hill fissure, it was not as abundant there as in the porphyry. It was found as isolated, irregularly scattered lenses or bunches three or four inches thick or as seams through the soft gouge which filled the fissure and along the walls. The highest gold content was found with the bismuth, though the pyrite is reported to have carried noteworthy amounts. As nearly as could be learned, quartz was frequently associated with the better grade of pyrite. The ore shoots were confined to the fissure in the vi-
cinity of its intersection with the several dikes of older rhyolite porphyry.

The present workings are confined mainly to the older rhyolite in the vicinity of its intersection with the subsequent intrusion previously mentioned. The rocks are faulted in a very complex manner; most of the faulting, however, is older than the shearing to which the ore deposits are related. It has not interposed any great difficulty in mining. The ore is found in shear zones which constitute a definite system of fractures striking about S. 40° W. diagonally across the porphyry dikes and dipping 70°-90° SE. The system is made up of numerous parallel planes of faulting extending across widths of 30 to 40 feet. These shattered zones define the stopes, within which the gold is confined to the seams. The dikes as a rule vary in width between 50 and 75 feet and several of the stopes exceed 100 feet in length. Longitudinal displacements of 5 or 10 feet occur along the more prominent seams of the fracture zones, which are, at least in part, subsequent to the later rhyolite. Crushed sulphides at a few places show movement subsequent to deposition. In the granite country rock the fracture system is replaced by a single fault fissure.

Hydrothermal alteration of the country-rock is prominent along the course of the shearing. Some of the older rhyolite porphyry has been silicified to such an extent that it resembles the unaltered rock; at other places it is chalky and can be cut with a pocket knife. Much of the altered porphyry shows throughout a mineralization by small scattered cubes of pyrite; at one place, near the surface, was found a similar mineralization by galena carrying a small percentage of bismuth.

Although the characteristic gold-bismuth ore is confined mainly to the older rhyolite, it often follows the main fissure for various short distances into the enclosing granite but in a gradually diminishing amount. Some has been thus followed for more than 100 feet.

The ore seldom effects more than a slight penetration into the younger rhyolite dike, rarely more than a few feet. It has nowhere been found as yet to extend completely across. A given seam will often show a fairly abundant uninterrupted pyrite mineralization across both dikes and into the granite beyond. Uncrushed seams of gold-bismuth ore, which enter the late rhyo-
lite are definitely of later age than the intrusive. That the dike is elsewhere barren has been definitely proven throughout the mine.

The fact that the main ore bodies are confined to the older dike rock, although the shearing to which they are related extends unbrokenly across both ages of intrusives, is perhaps explained by a difference of temperature prevailing between the two dike rocks at the time of ore deposition. Bismuth ore has also been found in quartz-diorite porphyry, a more basic rock than the rhyolites; this fact seems to indicate that difference in rock composition is not a controlling factor in the deposition.

The possible relationship of the gold-bismuth deposits to a particular variety of dike rock is a matter of considerable local importance, inasmuch as the deposits occur here and there for several miles along this late rhyolite porphyry intrusive. At the Gold Hill workings the deposits are confined in a general way to the late rhyolite. The proximity of wide basic dikes to the four known deposits on this property introduces an element of uncertainty in the question of genetic relationship. The relative age of the basic intrusions to the late rhyolite has not been determined. At a neighboring mine, over a mile distant from the late rhyolite, the bismuth ore is found in the vein at a point where it is cut by six basic dikes. The ore shoot had a stope length of more than 400 feet and pinched out decidedly at short distances from the basic dikes.

Quartz is the predominant gangue mineral of the bismuth bearing ore. Neither calcite nor siderite occurs in the gangue. The quartz is invariably the first to be deposited in the fissures; the bismuth minerals and gold, in the order named, are a subsequent filling of the more central and open portion of the seams. These seams vary in width from that of a knife blade to three or four inches, but for the most part average close to half an inch. By reason of the dependably high gold content of these seams, the presence of but one in the breast of the stope is often deemed sufficient to warrant mining the particular set of ground. Subsequent sorting eliminates the waste thus broken down.

At a few places around the marginal portions of the ore shoots a small amount of galena seems to occur as a continuation of the more centrally located bismuth ore. The gold content of the
galena is negligible but several assays of clean concentrates show silver ranging from 30 to 40 ounces.

The lead-bismuth minerals range from bismuthinite to galena with various intermediate combinations of the two. In some specimens lillianite (3PbS.Bi₂S₃) is abundant. Beegerite (6PbS. Bi₃S₅), and cosalite (2PbS.Bi₂S₃) have also been identified. Assays of clean concentrates generally show a lead to bismuth ratio of about 2 to 1. The fairly high silver content of the minerals is thought to occur as matildite (Ag₅S.Bi₂S₅). The bismuth is easily separated from pyrite by concentration but slimes freely during the ordinary processes of milling.

Sphalerite assaying between 0.07 oz. and 0.10 oz. per ton in gold and little or no silver, occurs quite generally throughout the stopes as separate seams. Some of this mineral from near the surface quite consistently runs about 0.5 oz. in gold; surrounding conditions, however, suggest that this high gold content is due to surface enrichment. At one place shortly above the 250 level a 16-inch vein of clean sphalerite was found that assayed less than 0.10 oz. per ton in gold. One specimen from the 600 level showed coarse wire gold protruding from sphalerite; in this instance, however, the gold was very evidently subsequent to the sphalerite. It has been consistently noted in exploratory work that sphalerite is a fair indicator of the proximity of a shoot of bismuth ore.

Although the gold is with few exceptions later than the bismuth, the exceptions serve to indicate that its deposition closely followed the bismuth. Pyrite is notably absent in most specimens of the typical ore from the more central portions of the deposits but becomes more abundant as the margins are approached. Segregated pyrite from the stopes is shown under the microscope to contain minute quartz seams; it has a decidedly higher gold content than that obtained at a distance therefrom.

The following miscellaneous data pertain to the character of the ore now being mined between the 500-foot and 600-foot levels. A shipment of bullion to the United States Assay Office, Boise, in November, 1923, assayed 863 fine in gold and 116 fine in silver; the bullion had been recovered by amalgamation. Previous shipments for the same year show the gold ranging between 860 and 881 fine and the silver between 116 and 110 fine.
During 1924 the high-grade concentrate is being selected in the mill for separate treatment, and the second grade is being sent to the cyanide department. A smelter assay of a representative sample of the first-grade concentrate, which includes the bismuth, follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Assay</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>79.03</td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>112.7</td>
<td></td>
</tr>
<tr>
<td>Bismuth</td>
<td>5.93</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>0.6</td>
<td>6.26%</td>
</tr>
<tr>
<td>Copper</td>
<td>0.31</td>
<td>4.39%</td>
</tr>
<tr>
<td>Iron</td>
<td>25.5</td>
<td>25.5%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>20.5</td>
<td></td>
</tr>
<tr>
<td>Insoluble</td>
<td>3.2</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Smelter returns on a 1923 shipment of the undivided concentrate following amalgamation, are as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Assay</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>5.55</td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>3.4</td>
<td>3.4%</td>
</tr>
<tr>
<td>Iron</td>
<td>45.4</td>
<td>45.4%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>47.34</td>
<td>47.34%</td>
</tr>
<tr>
<td>Insoluble</td>
<td>2.55</td>
<td>2.55%</td>
</tr>
</tbody>
</table>

A shipment of cyanide precipitates returned 698.5 ounces gold and 386 ounces silver.

An assay of the clean sphalerite obtained on the 600 level showed 0.14 oz. gold and a trace of silver. Another assay of a sample across the same seam, but taken at a place where a small streak of bismuth occurred with considerable pyrite, assayed 4.96 oz. gold. The concentrate, omitting the bismuth, showed values ranging from 0.40 oz. to 0.60 oz. per ton in gold.

The recovery of valuable metals from 1919 to 1923 inclusive, from amalgamation, followed by cyanidation of the concentrates, according to company records, ranges from 90 to 92 per cent of their total value in the mill feed; the 92 per cent recovery was effected in 1923.

The gross production of the Gold Hill prior to 1911 is reported as approximately $5,500,000. Between 1911 and October, 1923, slightly more than $1,949,300 was recovered from 230,100 tons of ore, a recovery which indicates an average mill-head of slightly less than $8.50 per ton. An approximate total production of $7,500,000 has thus been made at the property.

Square-set stoping is the method of mining used. Owing to the character of the ground, back-filling is necessary in the stopes and timbers cannot be recovered for further use. Hand sorting is necessary with most of the material broken down. The rejected material at times affords sufficient waste for back-filling,
though short waste-drives are often necessary to supplement this. They are driven on an incline to avoid shoveling and are located to prospect likely ground.

One feature of the ore deposit is unusual—it cannot be satisfactorily sampled according to usual methods. Such erratic results are obtained near the high-grade seams that they are valueless. Mine samples carefully taken, discarding erratic results, usually show values ranging between $2 and $5 per ton. The corresponding mill heads, due to sorting, usually range between $8 and $9 per ton.

During 1924 the mill was running at approximately 100 tons capacity. The hand-sorted ore, including all the fine material from the stopes, was passed over a bar grizzly; the oversize went to a Blake crusher. The crushed ore passed to rolls, thence to a 4 by 5-foot ball mill, and finally to an 8-foot Hardinge mill with a Hardinge amalgamator at the discharge. “Quick” was fed at regular intervals into the intake end of the Hardinge mill. The amalgam which formed in protected places on the lifter bars within the mill was cleaned about once a month. From the Hardinge mill the feed passed over amalgamating plates, thence without classification to tables of the Overstrom and Willsey type. The table concentrates were elevated to a storage bin above the cyanide department. The concentrates were reground in cyanide solution in a 4 by 22-foot tube mill and alternately agitated and settled in two Pachuca tanks. Zinc shavings are used with good results to precipitate the gold and silver. An extraction exceeding 90 per cent of the gold is obtained, with a variable and smaller recovery of the silver content. Shipping concentrates to Salt Lake smelters was carried on for two years, but cyanide treatment at the mine has proven far more profitable.

IDAHO DEVELOPMENT CO. (BELSHAZZAR).

About two miles southwest of Quartzburg and on the same general zone of shearing as that at the Gold Hill property is the Idawa Development Co.’s group of 14 claims, better known locally as the Belshazzar group. Three prominent fissure veins strike approximately west across the property and dip 45°-50° S. Development has been confined mainly to the centrally located Belshazzar vein, though shallow work has been done on the Cen-
tennial vein 300 feet farther south. None worthy of mention has
been done on the third vein, some 600 feet north of the Belshazzar.
Several wide steeply dipping rhyolite and diorite porphyry dikes
strike N. 60°-70° W. across the western portion of the group.
They are intersected and displaced laterally from 10 to 20 feet
by the three vein fissures. Four small basic dikes, striking ap-
approximately northward, occur at 200 to 400-foot intervals in the
same locality with little or no displacement at vein intersections.
The only ore of any importance so far discovered has come from
about these various intrusives. Former owners placer-mined the
surface over an area of about 30 acres and recovered $60,000;
the gold was evidently derived from erosion of the vein outcrops.

The original workings on the Belshazzar vein consist of three
drifts extending westerly into the hill at 60 foot intervals; they
have developed the ground for a maximum distance of about 800
feet and a maximum depth of about 200 feet. Sulphides show up
rather plentifully on the lowest or No. 3 level, though stains of
iron and manganese oxides are fairly abundant at many places.
The ore obtained from these workings was treated locally in a
10-stamp mill. A recovery of $10.50 per ton was made by amal-
gamation, with a total production of $25,000. The concentrates
obtained were piled on the dump for future treatment.

The present owners have driven a shallow crosscut tunnel
to the Belshazzar vein at a point about 300 feet east of and 135
feet below No. 3 tunnel. Drifting along the vein for about 200
feet revealed some high-grade gold ore. This exploratory work
attained a maximum depth of about 50 feet. Later a crosscut
was started several hundred feet east of No. 3 tunnel and about
535 feet below it to explore the vein at depth. This crosscut
encountered the vein about 1,000 feet from the portal, and a drift
followed it westward for 1,700 feet. Two small ore shoots were
encountered in the last 700 feet, and work is now being confined
to raising on the second one of these near the face of the main
drift. The vein at this point has an average dip of 52° and the
raise has been driven approximately 300 feet toward a known
ore shoot in the old workings above. A drift to the west from the
top of the raise encountered sulphide ore at 25 feet and followed
it 45 feet further to a narrow barren rhyolite porphyry dike. The
average value shown by sampling this 45-foot ore body is report-
ed as 0.45 oz. in gold across an average width of 2½ feet. Ore was again encountered in the drift on the opposite side of the dike and was followed for the next 110 feet. Samples taken every 5 feet along this 110 feet of drift for widths of 2½ to 3 feet are reported to show a gold content ranging from 0.50 oz. to 0.90 oz. per ton. There is yet about 360 feet of stoping ground above the drift before the old workings will be encountered.

![Sketch showing geologic features of the Belshazzar ore deposit.](image)

The Belshazzar vein is a typical gouge-filled fault fissure, with abundant pyrite and occasional sphalerite mineralization, varying in width from a few inches in the discovery tunnel, to three and four feet toward the west end of the lowest drift (No. 5). The two shoots of quartz-pyrite ore occur as small kidneys and lenses extending along the fissure in the vicinity of the several dikes. The quartz ore is as a rule considerably fractured and frequently shows mineralization by sphalerite subsequent to the pyrite. Only very small amounts of galena are present. One specimen collected in the raise, showing some galena and considerable sphalerite, contained a small amount of bismuth. Whereas the pyrite elsewhere along the vein seldom assays more than 0.10 oz. to 0.20 oz. per ton in gold, that which occurs with the quartz very consistently assays 0.50 oz. or more. A sample of material composed of quartz and pyrite in about equal amounts
which was selected from the vein near its intersection with a rhyolite dike on the No. 5 level assayed 7.45 oz. gold per ton. The place sampled is fully 700 feet beneath the surface and the ore showed no evidence of supergene enrichment, the lower limits of which are evidently 200 or 300 feet above. A portion of this same material was thoroughly ground and panned, but no gold was revealed.

There are several unexplored vein-like intersections on this property in the vicinity of the present workings. The company intends the exploration of these, especially throughout the zone of enrichment. The work of the past year has already met with encouraging results, sufficient to warrant the erection of a small mill, construction of which is now well under way.

MOUNTAIN CHIEF.

The Mountain Chief property, consisting of 11 unpatented claims, lies at the head of Canyon Creek immediately west of the Belshazzar group. It is the most westerly property that has been developed on the Quartzburg shear zone. It was located in 1870 and worked almost continuously from that date until 1915. The exhaustion of the known bodies of oxidized ore and the inadequacy of the mill to handle sulphide ore, necessitated closing down pending further development.

Until 1915 work was confined mainly to the Mountain Chief vein, which is the westward continuation of the Belshazzar vein, near the eastern end of the group of claims. Four adit drifts were extended eastward into the divide which crosses the property in the vicinity of the common endline which separates the Mountain Chief from the Belshazzar group. The lowest drift (No. 4), over 1,000 feet long, attained a maximum depth of about 380 feet; the last half, with the exception of the 80 feet nearest the face, was in ore. This ore has been stopped to the surface and carried by aerial tram to the mill 3,000 feet south. At the time the property was visited by the writer No. 4 drift was accessible, though the stopes above were not. On account of the timbering and of the deep sediment which covered the floor of the drift, satisfactory ore specimens could not be obtained.

Pyrite characterized the vein throughout its length, but in the shoot which has been described, the gold and silver occurred
closely associated with bismuth minerals. Qualitative tests of selected specimens taken from the ore bin and the dumps show bismuth rather abundantly. The ore of this metal occurred as scattered bunches and streaks throughout the gouge and was often accompanied by quartz. Sphalerite was abundant but its quantity or relation to the deposit could not be learned. Two unusual features characterize this deposit: (1) the six basic dikes cutting diagonally across the vein at intervals of 50 to 75 feet, and (2) the localization of the ore in that portion of the vein intersected by these dikes. Two rhyolite dikes were cut elsewhere on the property by the same vein, but the bismuth was apparently not related to that intrusion. On account of timbering the age relations between the basic intrusives and the fissure could not be determined underground. Little if any displacement of the basic intrusives is evident whereas the rhyolite has been displaced several feet. The later rhyolite intrusion mentioned under the description of the Gold Hill property is about one mile to the south.

Recent work on this property has been confined to a mill-level drift, 200 feet below No. 4 tunnel, also on the Mountain Chief vein. This drift as yet lacks a few hundred feet of being beneath the original ore shoot, the downward extension of which is the
objective. Ore was encountered near the present face at an intersection with a rhyolite porphyry dike; a small basic dike also occurs in the vicinity of the intersection. The ore is a sulphide, shows no oxidation, and consists mainly of pyrite, sphalerite, and some arsenopyrite. The vein is slightly over three feet wide and consists of the usual gouge filling of crushed, altered, and mineralized country rock with occasional streaks of mineralized quartz. A specimen of apparently clean arsenopyrite, selected near the face of this lower drift, assayed as follows:

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Ounces or Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>1.24 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>0.79 oz.</td>
</tr>
<tr>
<td>Bismuth</td>
<td>0.6 %</td>
</tr>
<tr>
<td>Lead</td>
<td>6.3 %</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Copper</td>
<td>0.6 %</td>
</tr>
<tr>
<td>Antimony</td>
<td></td>
</tr>
</tbody>
</table>

Arsenopyrite is not the most abundant sulphide at the place the specimen was selected but it is fairly common in the vicinity. Pyrite predominates, and sphalerite is next in order of abundance. Quartz and occasionally calcite occur as small bunches or lenses. The ore is reported to assay 0.53 oz. in gold across the 3-foot fissure.

The 30-ton amalgamation plant which was originally built on the Mountain Chief property to treat the ore, sufficed until the zone of oxidation was bottomed in the mine. Concentrates were then made and shipped for a short time but freight costs were prohibitive. Later an all-slime cyanide addition was made, but it was not suitable to the complex bismuth-bearing sulphide ore which was encountered at greater depth. The mill treated ores from the intermediate sulphide-oxide zone and normally recovered between 75 and 80 per cent of the precious metals.

The Mountain Chief mine has a recorded production slightly over $240,000 and an additional estimated production close to $70,000 under a former management whose records are not available.

BOISE BASIN IMPROVEMENT CO.

The property of the Boise Basin Improvement Co. lies near Quartsburg, immediately northeast of that belonging to the Gold Hill and Iowa Mines Co., and covers the easterly extension of the Gold Hill rhyolite porphyry belt. The group is composed of 33 unpatented quartz claims. Considerable development work has
been done, most of which lies north of the porphyry belt. One small shoot of high grade sulphide ore was encountered in a drift 90 feet beneath some old workings from which a considerable amount of free-milling gold ore had been taken in former years by the original owners.

The late intrusion of rhyolite porphyry, which occurs at the Gold Hill, strikes to the south and below the past exploration in the Boise Basin Improvement Co.'s ground. The company has recently started a crosscut tunnel to the south of the porphyry belt and is driving northwesterly with the intention of exploring it and the particular dike above mentioned.

Early-day work on this property was confined to the oxidized ore zone, which is about 65 feet deep. Manganese oxides are not in evidence to any appreciable extent. It is evident that within this zone decomposition of the auriferous pyrite followed by downward infiltration of gold bearing solutions was the principal process of enrichment. At one place, along one wall of a fault fissure, was found a rich seam of iron-stained gouge about two inches thick which, upon panning, apparently yielded nothing. Vigorous scouring of the dark colored concentrate disclosed the fact that it consisted of rusty gold. This seam was cut at a depth of 180 feet in a vicinity characterized elsewhere by iron sulphides.

The one small ore shoot found in the old workings bears description because of its relation to a dike intersection in the sulphide zone and also because of its high gold content. The following sketch of typical conditions simplifies description. The ore is found in a prominent fissure vein at a depth of about 160 feet beneath the surface. Both granite walls show shearing and are seen in crosscuts to be hydrothermally altered for several feet from the fissure. The fissure filling at the intersection consists of lenses and kidneys of quartz in sericite which contains small fragments of quartz and of altered wall rock. The quartz and the precious metals diminish at short distances along the fissure either way from the dike intersection. The only sulphide evident to the eye is pyrite, which occurs as scattered patches throughout the quartz. A 5-pound average channel-sample taken from the vein assayed 11.20 oz. per ton in gold. Panning disclosed considerable bright-yellow gold. The sampling was done at a depth of about 155 feet and apparently below the limits of oxi-
oration. This example of deposition is of interest as it discloses the conditions which presumably exist beneath many of the more important oxidized deposits of the Basin.

![Diagram of vein-dike intersection.](image)

FIGURE 8.—Typical vein-dike intersection. Heavy black indicates gold-bearing quartz-pyrite lenses.

The Boise Basin Improvement Co.'s property has produced $36,000 from the oxidized portions of two veins. In addition approximately $27,000 was recovered by placer mining in California Gulch within the property limits and below the vein outcrops.

**LAST CHANCE.**

The Last Chance property, which consists of two patented claims and covers the larger portion of the townsite of Quartzburg, lies parallel to and immediately north of the Gold Hill vein. A prominent fissure vein, known as the Last Chance, crosses the claims about 100 feet north of the Gold Hill and dips 70° N. The Last Chance vein splits in the western half of the property and one branch has a steep dip to the south. Both branches are reported to be apparently equally mineralized. Numerous workings may be seen along the Last Chance vein, the main production of which was derived from the upper 250 feet of its western half. The ore was treated on the ground, principally by amalgamation.

The ore of the sulphide zone is essentially auriferous pyrite, with occasional irregular occurrences of sphalerite, galena, and bismuth sulphides. The latter three were found as irregular streaks or kidneys in the soft gouge material or associated with
narrow quartz-pyrite lenses which were scattered throughout the fissure or, more frequently, along the walls. The highest gold content was found in the bismuth sulphides though the quartz-pyrite bodies were usually high grade.

The Last Chance vein very definitely marks the northern limits of any known important gold deposition near Quartzburg. Rhyolite porphyry has not been found to the north of this vein so far as is known. Wide quartz veins occur to the north of the Last Chance, but these carry principally lead, silver, zinc, and copper.

One feature of interest in connection with the deposit is the occurrence of pyromorphite (?) in an altered and considerably fractured diorite porphyry at two places on the property. Concentrates obtained by panning the outcropping dike-rock contain considerable bismuth with a rather high silver value; the lead phosphate is associated.

The gross production of the Last Chance property, as revealed by bullion receipts, is slightly less than $55,000.

JAMES HAWLEY GROUP.

Five patented and twelve unpatented claims constitute the James Hawley group, which lies along the main divide three miles due north of Placerville. The main rhyolite porphyry belt of the Basin strikes northeasterly across the property. But little development work, other than some surface cuts and a few short tunnels, has as yet been done. A small prospect shaft about 18 feet deep which was sunk during 1922 on a rhyolite porphyry outcrop, disclosed a 3-foot fissure filled with gouge and crushed quartz that assayed 0.83 oz. per ton in gold. This shaft was started late in the season and winter suspended further development for the time. There are several quartz veins on this property which as yet have not been explored. The surface soil over a considerable region round about generally yields a few colors of gold upon panning. Dense forest growth obscures the surface over most of this property, though dike outcrops are numerous on the ridges.

BUCKSKIN.

The Buckskin group of 12 unpatented claims lies about four miles northeast of Placerville along the ridge between Ophir and Grimes creeks at an elevation of about 5,000 feet. It is located
along the southern margin of the main Quartzburg-Grimes Pass belt of rhyolite porphyry. Three prominent and several minor fissures strike N. 30°-35° E. lengthwise of the group and cut the several dikes at an angle of about 20°. The development work consists of a 700-foot adit drift on the Lost Cabin vein, and numerous short tunnels and shallow shafts at different places. The deepest shaft (100 feet), was inaccessible. Present work is being confined to annual assessment requirements.

The Lost Cabin vein is a typical steeply dipping fault fissure which generally varies between one and five feet in width. Pyrite predominates and sphalerite is abundant. Arsenopyrite and stibnite occur occasionally. Galena is disclosed at several places as a replacement of the altered country rock; to a slight extent it is subsequent to sphalerite in quartz. Intimately associated with the galena are frequently found bismuth and silver. Samples collected showed closer relationship of silver to bismuth, than to lead. A typical specimen of the clean galena selected from the main tunnel at a point approximately 100 feet deep carried 0.02 oz. in gold and 15.8 oz. in silver. Plate IXA (p. 37) is a photomicrograph of the specimen. The clean lead-bismuth segregate from this specimen was analyzed with the results which are tabulated below; the iron and insoluble represent material which could not be eliminated.

<table>
<thead>
<tr>
<th>Element</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver</td>
<td>3.14</td>
</tr>
<tr>
<td>Bismuth</td>
<td>14.8</td>
</tr>
<tr>
<td>Lead</td>
<td>46.5</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.1</td>
</tr>
<tr>
<td>Copper</td>
<td>Trace</td>
</tr>
<tr>
<td>Antimony</td>
<td>2.8</td>
</tr>
<tr>
<td>Iron</td>
<td>4.8</td>
</tr>
<tr>
<td>Sulphur</td>
<td>12.38</td>
</tr>
<tr>
<td>Insoluble</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Micro-chemical tests made on several specimens of Buckskin galena show bismuth sulphide filling cracks, a structure which is apparent only after etching. In one specimen chalcopyrite is the last sulphide deposited. Gold does not occur with the bismuth at the Buckskin property as it does at other places along the porphyry belt. The only gold so far found occurs with the oxidized ores, which are frequently stained with manganese.

Some local mill tests made a few years ago on oxidized ore yielded an abundant concentrate which resembled pyromorphite but was mainly the oxides of the complex lead-bismuth ore. Quali-
tative tests show a large content of phosphorous. One sample showed 0.7 per cent vanadium.

MINERAL HILL

The claims which comprise the Mineral Hill group, seven patented and six unpatented, lie along the main divide between the heads of Alder and Ophir creeks about five miles northeast of Placerville. The property is about centrally located in the mile-wide belt of rhyolite porphyry that extends between Quartzburg and Grimes Pass. The property has lain idle for several years and the workings are now inaccessible. A 50-ton amalgamation mill was built and run intermittently for two seasons. Slightly over $32,000 was produced under the present management, most of it from one stope encountered 165 feet beneath the surface. The additional production by former owners is reported as $53,000, principally by amalgamation in a small 5-stamp mill which is dismantled.

The main workings as shown by maps consisted of a mill-level crosscut over 400 feet in length. Two parallel fissure veins were encountered striking northeasterly, one at 250 feet and the other at 300 feet from the portal. Ore was encountered at the second vein and stope both ways for a total length exceeding 400 feet. A diagonal crosscut driven southwesterly from the face of the left hand drift encountered a dike deposit from which the production of the mine has been largely derived. The ore body is reported by the manager to have been stope over a width of 30 feet and a length of 160 feet from the tunnel level to the surface, a distance of 165 feet. The ores of both the fissure veins and of the dike deposit are reported to have been mixed iron sulphides and oxides together with considerable bismuth; its average tenor was 0.70 oz. gold per ton. A 5-pound specimen of the ore was found on the dump near the outcrop of the stope; in it the bismuth and iron sulphides were about equally abundant. The sulphides which were panned from the gangue with a concentration ratio of 7.4 to 1, assayed 7.60 oz. gold and 0.8 oz. silver. The gold formerly obtained by amalgamation averaged nearly 935 fine.

The last development work of importance at this property consisted of a 120-foot vertical shaft, sunk near the portal of the main tunnel to tap the downward extension of proven ore bodies.
A 2-foot vein striking about N. 25° E. was cut; it followed the shaft for 23 feet farther. The mine closed down before any work was done from the bottom of the shaft to cut this vein, which should be found within a few feet. The vein was thoroughly sampled in the shaft and is reported to assay from 0.14 oz. to 1.11 oz. per ton in gold. The shaft is now filled with water and no samples could be obtained. In the early days placer miners exposed three other veins in the main gulch below the workings. No exploratory work was done on these.

The typical porphyry dikes of the Basin are numerous about the mine. To judge from the oral reports of those familiar with the underground workings and from observations made at various shallow surface cuts, there are two systems of fissures at this place, one striking northeast and the other approximately north. Ore is reported to be more abundant in the northeast system but occurs also along the other; the largest ore bodies are to be found near junctions of the two systems.

**MAYFLOWER GROUP.**

The Mayflower group consists of three patented claims and one unpatented, and adjoins the Gold Hill group to the southwest. It lies wholly in the basin of the West Fork of Granite Creek. The vein was discovered and located in the early eighties by placer miners working the West Fork channel. These first locators worked the vein from creek level up to the surface over a distance of 500 feet, and ran the ore through an arrastre. The tailings from the arrastre went to waste. Later owners sank two winzes, one 50 and the other 30 feet deep, and stoped the oxidized ore, which they worked in a similar manner. Pyrite ore was also found in the winzes. The total production from the vein has been slightly in excess of $15,000. The Mayflower vein varies between six inches and five feet in width, strikes about N. 40° E., and dips about 70° NW.; in the winzes the vein shows signs of changing to the opposite dip. It is supposed to be the southwestward continuation of the Confederate vein on the Gold Hill property which has produced considerable ore from the oxidized zone.

An interesting feature of the geology at the Mayflower property is the occurrence of Tertiary gravel in the tunnel, as is shown in the following plan and section. The gravel is later
than the vein—there is no break in it where it extends across the outcrop. This gravel and neighboring banks are a part of the marginal deposit of the Miocene lake shore; they very definitely establish the age relations between the lake deposits and the Mayflower fissure.

No work is being done at the present time on the property. The extension of the vein beyond the gravel remains to be found; what is supposed to be this extension, and very probably is, crops out several hundred feet to the northeast. It was extensively worked in former years with good returns. No rhyolite porphyry was found upstream (northward) from this property.

Another large vein approximately parallel to the Mayflower crops out on the Homeward Bound claim of this group about 600 feet to the south. About 200 feet of the outcrop of this vein was worked in early days to a depth of 30 to 50 feet and the high grade ore sorted and worked on the ground in a large mortar.

**SILVER STAR.**

South of the Mayflower are three unpatented claims comprising the Silver Star group. These cover a third prominent fissure vein which is about 600 feet south of and parallel to the
Homeward Bound vein. Whereas the other two are auriferous pyrite deposits, galena is almost the only sulphide in the Silver Star vein.

The vein crops out as numerous small stringers in the decomposed granite. As disclosed in a 60-foot shaft these stringers merge about 45 feet below the surface into a body of ore three feet wide with well defined walls. About two thirds of the width of the vein is clean ore throughout the lowest 15 feet of the shaft. A sample across this clean ore is reported to assay 0.12 oz. in gold and 508.0 oz. silver per ton. Another sample across the ore at the bottom of the shaft is reported as 0.10 oz. in gold, 46.6 oz. silver, and 50.7 per cent lead.

Former locators worked this vein westward from the shaft for a distance of a few hundred feet and to a depth of about 45 feet. No data are available regarding the returns gained. No shipments have yet been made from this property by the present owners. Work is being confined to annual assessment requirements at another point on the vein to prove the extent of the deposit.

HARTFORD GROUP.

Three unpatented claims located along the main porphyry belt about one a half miles northeast of Quartzburg comprise the Hartford group. Work is as yet in the oxidized zone at a maximum depth of about 60 feet. A good grade of free-milling ore has been encountered in a fissure which at one place attains a width of 16 feet; the average width elsewhere varies between three and four feet for the better grade of ore. The ore body was but recently encountered and no attempt has yet been made to treat it. Bright yellow gold is revealed upon panning.

The strike of the vein is somewhat irregular, due to faulting, but the general strike is that of the main fissures of the vicinity. A noteworthy feature of the deposit is the abundance of tremolite found with the sericite and kaolin; at places the tremolite constitutes a major portion of the fissure filling.

BLUM AND EKEN GROUP.

The Blum and Eken group of 12 unpatented quartz claims lies three miles north of Placerville near the point at which the main county road crosses the Garden Valley summit. Prominent out-
crops of quartz veins occur on the north slope of the divide and
the main portion of the porphyry belt extends northeasterly along
the summit and immediately south of it. An 1,100-foot tunnel
has been driven from the north side of the divide but as yet lacks
a few hundred feet of reaching the ground where the quartz veins
and rhyolite dikes intersect.

HIATT GROUP.

The Hiatt property is located near the southern margin of
the main porphyry belt about two miles north of Placerville. The
group comprises an area of about 200 acres, a large portion of
which is patented. Considerable surface work has been done
along one prominent vein that strikes northeasterly across the
property. An 100-foot shaft has been sunk and drifts therefrom
show a 4-foot vein which contains considerable sphalerite and
some galena. A short crosscut which was driven northward from
the bottom of the shaft discloses a second equally wide fissure par-

allel to the first; the second of the two has not been explored.
Several tons of high grade lead-silver were obtained near the
shaft within 35 feet of the surface. This ore was not shipped
and its average value is unknown. Assays of selected specimens
of partly oxidized galena show a high silver content.

Several hundred feet northeast of the shaft the vein crosses
a small gulch in which former-day placer miners obtained con-
siderable bismuth in their sluice boxes together with coarse gold.
The few short prospecting tunnels in the vicinity have not re-
vealed the veins which supplied these placers.

SILVER HILL AND BLUE ROCK.

About one and a half miles northwest of Quartzburg on the
ridge between Granite Creek and Confederate Gulch are located
the Silver Hill and Blue Rock mines. They are adjoining claim
groups on two parallel quartz veins about 600 feet apart and have
several features in common. The veins strike N. 70° W. and dip
steeply to the south; they vary in width between six inches and
four feet. The outcrops of both have been traced for several
hundred feet each way from the mines. Their westerly exten-
sions beyond the two properties, are concealed by basalt; their
easterly extensions were not traced beyond the limits of the
claims. Some few diorite porphyry dikes occur in the locality but they bear no evident relationship to the veins. Of several basic dikes which strike approximately eastward across the groups, one forms the footwall of the Blue Rock vein and another apparently intersects the Silver Hill vein to the north at an angle of about 20°. These basic dikes strike toward the area of basalt lava to the west and are thought to mark fissure vents for a local extrusion which long since has been removed by erosion.

The vein-filling is quartz, largely the massive white variety; at some places in the mines, however, is found a type built up of densely interlocking crystals and the later phases of "vein" quartz formed from solutions. These veins, with several others to the north and south, are thought to be members of the first and oldest class which antedates the regional subsidence. Elsewhere in Boise Basin the old "bull" quartz veins have not been found productive in spite of the considerable prospecting that has been done on them. Field relations point definitely to a later age for the basic dikes, to which the mineralization of the veins is thought to be related. The relationship remains to be proven by future prospecting.

Silver Hill.—The Silver Hill group of four unpatented claims is located along the strike of the Silver Hill vein which crops out here and there for several hundred feet. The exploratory work consists of a 200-foot adit driven westerly from a point near the top of the local divide. The drift strikes the vein, which is between one and four feet wide, about 30 feet from the portal and follows it for the next 60 feet; at this point the vein is displaced laterally and is exposed in the face of a 13-foot crosscut to the south. The drift deflects slightly at the crosscut and in the same direction, picks up the vein, and follows it to the face. In the crosscut and last half of the drift, several small quartz veins a few feet apart are seen to run parallel to the main vein and to the north of it. These veinlets are apparently mineralized as abundantly as the main vein; the highly altered and sheared granite which intervenes is also mineralized but less intensely. No crosscut has been driven north in the first half of the tunnel to ascertain whether or not the veinlets are repeated there.

Near the portal of the adit silver-bearing tetrahedrite is the most abundant mineral of the ore. It is reported that the gold
content is comparatively low and seldom exceeds 0.15 oz. per ton. Pyrite and sphalerite are fairly abundant and chalcopyrite and galena much less so. The sulphides occur scattered throughout the shattered quartz as small bunches of prominent crystals; tetrahedrite was observed at one place filling a vug in quartz. In the portion of the drift between the crosscut and the face tetrahedrite is disseminated throughout the altered granite between the veinlets, but in the main vein is less plentiful than sphalerite. The vein in the face of the drift is reported to assay 0.12 oz. in gold, 30 oz. in silver, and 3 per cent copper, for a width of two and a half feet. A 10-pound sample of the mineralized altered granite was taken to ascertain whether valuable metals occur therein. This was crushed in a mortar and concentrated by panning in the approximate ratio of 5½ to 1. The concentrate assayed 0.50 oz. in gold, 154.5 oz. in silver, 5.8 per cent copper, and 0.1 per cent lead.

A representative piece of ore which was taken from the dump showed considerable tetrahedrite scattered through a quartz gangue and smaller amounts of chalcopyrite, sphalerite, and pyrite. Tetrahedrite and sphalerite are generally found together in the polished sections examined under the microscope, but there was nothing which would show conclusively that they were contemporaneous, although such is believed to be the case. Chalcopyrite is found both as fine specks and inclusions in the sphalerite with which it is contemporaneous, and also filling cracks in older sphalerite and tetrahedrite. The younger chalcopyrite is a little more abundant in the tetrahedrite than in the sphalerite.

No attempt has been made to treat the ore at the mine nor has any been shipped.

Blue Rock.—Three unpatented claims comprise the Blue Rock group, which is located along a wide quartz vein of the same name. The claims extend diagonally across a rather steep mountain slope with the principal workings about 400 feet below those of the Silver Hill group to the north. The Blue Rock vein crops out for several hundred feet in the vicinity of the workings and has a maximum width of six feet. It strikes N. 75° W. and dips 75° S. and is quite similar to the Silver Hill except that galena is the predominant ore mineral and tetrahedrite is subordinate; sphalerite and pyrite are associated with the galena. Silver is the
most valuable constituent of the ore. No shipments have been made nor has there been any attempt at local treatment.

Development work consists of an 100-foot crosscut at creek level extending northerly to the vein and drifts along the vein for 70 feet to the west and 175 feet to the east. The vein in the vicinity of the crosscut varies between 2 and 3½ feet in width but pinches to narrow gouge seams at the faces of the drifts. The walls are well defined and are separated from the vein by gouge; a basic dike forms the footwall and granite the hanging wall. The ore shoot was encountered in the west drift about 10 feet from the crosscut and was followed for 40 feet. No data are available as to the average value of this ore though a fair silver content is known to occur.

Along the hanging wall side of the west drift occurs a flat dipping quartz vein over two feet wide with a strike at right angles to the vein. It is apparently mineralized as abundantly as the ore shoot from which it is separated by the hanging wall gouge. Sufficient work has not been done to prove whether this represents a separate vein or a faulted block broken from the Blue Rock.

**GOLDEN AGE**

The Golden Age mine is situated in the extreme northern part of Boise Basin on Grimes Creek, about half a mile east of Grimes Pass, and at an elevation about 4,800 feet above sea level. The group consists of 8 patented and 18 unpatented lode claims with a small unknown area held by placer location; the group extends northeasterly from Grimes Pass and has a total length of approximately 1½ miles. The mine is near the northeastern end of the group and is reached by a private road branching from the main county road, which crosses the southern end of the property.

The Golden Age deposit was discovered about 1895 and was worked intermittently until 1920; a 250-foot two-compartment shaft was completed in 1921 and subsequent development work has been carried on through it beneath the old workings. The upper workings, consisting of about 2,000 feet of crosscuts and drifts, were mainly in the oxidized zone. The ore was free-milling and the principal recovery was made by amalgamation. The total production by this process was approximately $200,000, princl-
pally in gold. When the sulphides—pyrite, galena, and sphalerite, with some chalcopyrite and tetrahedrite—were first encountered, cyanidation of concentrates was attempted on a small scale. This method of treatment was soon abandoned and the property was closed down until re-opened by the present management.

A rather detailed description of features exposed in the lower drift is justified in that the development here has attained a greater depth than at any other accessible working in the locality. The Gold Dollar vein to which all work has been confined, was formerly worked from a level about 30 feet below the collar of the present shaft. Exploratory work from this level disclosed the fact that, as depth was gained, the intensity of oxidation became rapidly less though streaks of oxidized ore continued through the sulphides and carried considerable free gold. In short north and south drifts from the bottom of a 65-foot winze the ore minerals consisted largely of galena, sphalerite, and pyrite, with some chalcopyrite and tetrahedrite. As amalgamation was the principal process of recovery, operations ceased. The present company sank the 250-foot shaft in the vicinity of the old workings and drove a 380-foot crosscut eastward cutting the Gold Dollar vein at 300 feet from the shaft, and at a vertical depth of about 375 feet or, as measured on the dip of the vein, about 425 feet beneath the outcrop. The shaft bottom is 160 feet beneath the old winze level and about 125 feet beneath Grimes Creek, a few hundred feet to the west of the shaft.

The Gold Dollar vein, as disclosed in several hundred feet of drifting thereon, has an average strike of N. 10° E. and a dip of 60°-80° W.; the last 60 feet of the north drift, however, shows a reversal of the dip to 70° E. The Gold Dollar vein is younger than the major fault fissures of the locality which strike N. 40°-60° E. and dip steeply to the southeast.

Ore was disclosed in the south drift about 30 feet from the crosscut and followed for the next 70 feet, decreasing thereafter in value to a barren condition at the face, 45 feet distant. Oxidation, while in evidence at a few places, is practically negligible in the main shoot. Signs of oxidation exist at one place near the face of the north drift in a seam about 1½ inches wide which
is filled with iron-stained crushed sulphides and gouge. A sample of this filling assayed as follows:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Assay Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>2.58 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>0.1 oz.</td>
</tr>
<tr>
<td>Bismuth</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Lead</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.1 %</td>
</tr>
<tr>
<td>Iron</td>
<td>17.0 %</td>
</tr>
</tbody>
</table>

The Gold Dollar vein is a well defined gouge-filled fault fissure from one to five feet wide. Sericite and subordinate kaolin constitute the gouge material, throughout which occur bunches of calcite and small lenses of quartz which is generally shattered. These bunches and lenses are more numerous along the walls than in the center of the fissure. Pyrite is found disseminated throughout all of the vein material and abundantly in well defined streaks; when found in or near quartz it is generally auriferous. The

**FIGURE 16.** Sketch showing vertical section of the face of the north drift on the Gold Dollar vein, Golden Age mine. Width of vein about four feet.

Explanation: 1. highly altered quartz diorite showing an occasional reed in the walls of the drift; 2. altered phase of the quartz diorite, exceedingly hard; 3. disseminated pyrite, sericite, and calcite; 4. highly altered, gossan, and small irregular kidneys of calcite; 5. disseminated galena and chalcopyrite in the highly altered portion of the wall rocks; 6. streak of crushed sulphides which are oxidized in places and usually have a high gold content; 7. disseminated pyrite, sericite, and calcite.
other sulphides occur mostly as irregular replacements of the gangue minerals and sometimes as tabular bunches several inches thick. Chalcopyrite and tetrahedrite occur sparingly at a few places, most plentifully in the south drift. Galena and sphalerite are usually found only in the ore shoots. Where sheared and highly altered, the wall rocks often show an abundant mineralization of galena and sphalerite which sometimes extends two or three feet from the vein. In some of these mineralized seams in and along the walls the sulphides are considerably crushed, a fact which plainly indicates subsequent shearing. These crushed sulphides very often have a higher gold content than the uncrushed minerals.

The wall rocks are mainly quartz diorite with occasional reefs of granite. Both rocks are considerably altered in the vicinity of the ore shoots. One phase of the alteration is manifested in a fine grained rock that composes the walls at a few places; it contains abundant hornblende phenocrysts and blends into the quartz diorite within a range of a few feet. It has much the appearance of a distinct dike rock. Rhyolite porphyry dikes are numerous in the vicinity of the mine; they are found in the upper but not in the lower workings. Basic dikes are numerous over the property and one 10 feet wide was exposed in the old workings in the vicinity of the main ore shoot. The property is located near the northwest margin of a quartz diorite porphyry dike which strikes northeasterly and has a width of more than half a mile.

A study of the bedrock exposed over quite an area in this vicinity by placer miners definitely proves the existence of two sets of shearing, evidence of which has also been disclosed in the lower workings of the mine. The two sets, one striking northerly and the other northeasterly, are apparently equally important as the loci of the ore deposition. However, some of the younger faulting of northerly strike, as disclosed in neighboring mines, is post-mineral.

The Golden Age ore deposits, as well as those nearby, have been proven to occur in fairly well defined shoots along the vein and without any evident relationship to the enclosing rocks; quartz diorite and granite seem to be equally favorable toward deposition. Microscopic examination of specimens points to the
precipitation of sulphide minerals having been effected by some of the common alteration products rather than by any of the normal rock constituents. The relationship of the ore shoots to any particular variety of dike rock is not as evident at this mine as elsewhere, but the proximity of the main ore shoot to the basic dike mentioned is at least very suggestive.

Three samples were taken in the lower workings to show the relation of the gold content to the various sulphide minerals. Sample No. 1 was composed of several small representative pieces taken in the south drift from a quartz-pyrite deposit along the footwall. The quartz lens was about four inches wide, considerably shattered, and showed some oxidation. An assay is tabulated below.

<table>
<thead>
<tr>
<th></th>
<th>2.54 oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>6.4 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>0.0%</td>
</tr>
<tr>
<td>Biureth</td>
<td>0.9%</td>
</tr>
<tr>
<td>Lead</td>
<td>0.8%</td>
</tr>
<tr>
<td>Zinc</td>
<td>8.1%</td>
</tr>
<tr>
<td>Copper</td>
<td>20.6%</td>
</tr>
<tr>
<td>Iron</td>
<td>46.4%</td>
</tr>
<tr>
<td>Insoluble</td>
<td></td>
</tr>
</tbody>
</table>

Sample No. 2 is a general sample taken across the vein in the face of the south drift as it existed at the time of the writer's visit. The vein is a 2½-foot gouge filling showing considerable pyrite, with some galena and sphalerite. The following assay discloses a lower precious metal content than does sample No. 1:

<table>
<thead>
<tr>
<th></th>
<th>0.54 oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>3.8 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>0.5%</td>
</tr>
<tr>
<td>Biureth</td>
<td>1.5%</td>
</tr>
<tr>
<td>Lead</td>
<td>5.1%</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.7%</td>
</tr>
<tr>
<td>Copper</td>
<td>8.8%</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
</tr>
</tbody>
</table>

Sample No. 3 includes five pounds of small selected pieces of sulphide ore taken from the winze 65 feet below the old workings. The vein at the point sampled shows some oxidation but has been exposed several years. The sample contains pyrite, galena, tetrahedrite, sphalerite, and chalcopyrite; quartz and decomposed calcite are the gangue minerals. The assay is characterized by the parallel increase in the silver and copper content over samples Nos. 1 and 2, an increase which is possibly due to the presence of argentiferous tetrahedrite.
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>1.74 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>15.5 oz.</td>
</tr>
<tr>
<td>Blende</td>
<td>0.03 oz.</td>
</tr>
<tr>
<td>Lead</td>
<td>0.9 oz.</td>
</tr>
<tr>
<td>Zinc</td>
<td>1.9%</td>
</tr>
<tr>
<td>Copper</td>
<td>2.3%</td>
</tr>
<tr>
<td>Antimony</td>
<td>23%</td>
</tr>
<tr>
<td>Iron</td>
<td>18.6%</td>
</tr>
</tbody>
</table>

Some of the specimens collected at point No. 3 were selected for microscopic examination; the microscopist’s report is quoted below:

The pyrite is undoubtedly earlier than all the other sulphides. The galena and sphalerite were next deposited contemporaneously. Chalcopyrite and tetra-
headrite fill cracks in both galena and sphalerite; in the sphalerite, they some-
times fill stylolites on the outside and are accompanied, with the tetrahedrite predominating. They are often found in the same section, but under varying conditions either one may be later than the other. At places all the sulphides are cut by quartz and calcite veins; in the same section, at places all the sulphides are cut by quartz and calcite veins; in the same section, quartz and calcite fill cracks in all the sulphides and quite often the chalcopyrite and tetrahedrite minerals appear to be contemporaneous. The only positive evidence of secondary alteration was a slight staining of some of the chalcopyrite.

The long exposure of this ore, though most of the time under water, may explain this trace of oxidation. Plate X (A, B, and C) shows the characteristics of some of the Golden Age ores. (p. 38.)

The age relations between dikes are plainly evident at the Golden Age mine. The quartz diorite is the most extensive and also the oldest intrusive. Rhyolite is younger than the quartz diorite and the basic dikes are last in order of age. The shearing is very clearly later than the first two dike intrusions but its relation to the basic dikes could not be determined underground. Elsewhere in the vicinity the shearing is largely later than the basic rocks but that it is wholly so is not known.

The regional subsidence, although not as evident in the northern part of the Grimes Creek basin as farther south, is, by reason of the continuity of the major shear zones, thought to have been the cause of the fissuring about the Golden Age mine. The same dike and vein age relations prevail about the Golden Age as elsewhere.

The company has completed a 100-ton concentrator which will probably be in operation sometime during the latter part of 1924. Electric power will be used. Adequate quarters have been provided for employees and the camp, in general, is one of the most attractively arranged in the Boise Basin.

MINERAL MINING CO. (DIANA).

The property of the Mineral Mining Co., formerly known as the Diana, comprises 10 unpatented and 11 patented lode claims.
GOLDEN AGE SURFACE PLANT, GRIMES CREEK BASIN, LOOKING EAST.
in Charlotte Gulch, east of the Golden Age mine, and one placer claim of about 160 acres at the junction of the gulch with Grimes Creek. It was originally worked for the rich gold ore of the oxidized zone. Upon the exhaustion of the free-milling oxidized ores, the plant was closed down and has remained idle for several years. These old workings show that the deposit does not differ in type from others in the same locality.

The present company acquired possession of the property during 1919 and started a prospect tunnel near the western and lower end of the claim group to tap the old workings at depth. Since that year, development work has been confined mainly to this tunnel which has cut one of the principal veins, the Blackbird, with encouraging results. Drifting easterly on the Blackbird is now in progress and has opened about 750 feet of the vein on a level 110 feet beneath the old workings. It is intended to carry this drift to the east end line of the property, approximately 2,000 feet distant, and thereby attain a maximum depth of 650 feet. Three other parallel veins are known to exist north of the Blackbird at intervals of 200 to 600 feet.

The present workings are mainly in granite near the southeast contact of a wide quartz diorite porphyry dike which strikes about N. 35° E. The Golden Age mine, which has been described, lies about half a mile northwest and near the opposite edge of this intrusive. The present lower Blackbird adit, if carried easterly half a mile, will encounter two more approximately parallel dikes of the same type; the first is 400 feet wide and will be reached within about 1,000 feet, and the other, which is over a quarter of a mile wide, after about 1,800 feet. The granite in the vicinity of the workings is intruded by several large rhyolite porphyry and aplite dikes which strike about N. 45° E. and dip steeply southeastward. These acidic dikes vary in width from 100 to 150 feet. The rhyolite is younger than the nearby quartz diorite. In the same area were found several basic dikes, five to ten feet wide, which have no apparent uniformity of strike. Both rhyolite porphyry and basic dikes were encountered in the Blackbird workings. The acid dikes have suffered considerable longitudinal displacement along the fissures whereas the basic types have suffered little or none.
As disclosed in the lower Blackbird level, the typical sulphides are pyrite, galena, sphalerite, chalcopyrite, and occasionally tetrahedrite. No bismuth was found in any of the samples collected. The accompanying sketch (fig. 10) shows the ore in the main shoot encountered in the lower workings on the Blackbird vein, at a depth of 250 to 300 feet as measured on the dip of the vein. Some oxidation was evident at places where the shoot was first entered but none was evident in the later portion of the drift about 200 feet further east. The ore which has been taken out represents material obtained in drifting along the vein; little stoping has been done.

The ore which was removed during the development work was hand-sorted and the reject was concentrated in a 15-ton ex-
perimential plant, which included a two-stamp mill and an improvised two-compartment water-driven Harza jig. The following tabulation of smelter returns on shipments of sorted and concentrated material serves to show the approximate character of the ore.

**Smelter returns on shipments of sorted and concentrated ore from Blackbird vein, Mineral Mining Co.**

<table>
<thead>
<tr>
<th>No.</th>
<th>Tons Net</th>
<th>Gold Oz</th>
<th>Silver Oz</th>
<th>Lead %</th>
<th>Zinc %</th>
<th>Copper %</th>
<th>Iron %</th>
<th>Sulphur %</th>
<th>Insoluble %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23.346</td>
<td>1.41</td>
<td>15.1</td>
<td>18.2</td>
<td>6.9</td>
<td>24.0</td>
<td>23.2</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>19.139</td>
<td>2.12</td>
<td>13.5</td>
<td>10.0</td>
<td>5.0</td>
<td>0.65</td>
<td>17.4</td>
<td>24.0</td>
<td>27.4</td>
</tr>
<tr>
<td>3</td>
<td>12.101</td>
<td>0.85</td>
<td>13.4</td>
<td>18.8</td>
<td>10.4</td>
<td>77.4</td>
<td>21.4</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>15.182</td>
<td>1.42</td>
<td>11.5</td>
<td>16.0</td>
<td>8.4</td>
<td>0.65</td>
<td>26.7</td>
<td>23.3</td>
<td>32.6</td>
</tr>
<tr>
<td>5</td>
<td>22.887</td>
<td>2.10</td>
<td>14.6</td>
<td>12.3</td>
<td>4.8</td>
<td>24.4</td>
<td>35.6</td>
<td>18.2</td>
<td></td>
</tr>
</tbody>
</table>

At one place about 100 feet above the present lowest level was encountered an ore shoot of galena and sphalerite at an intersection of the fissure with a prominent granite porphyry dike. The ore is confined mainly to prominent seams which cross the sheared porphyry but has also replaced to a minor extent the wall rock. The ore shoot pitches easterly with increasing depth. Along the upper part of this lead-zinc ore shoot, was disclosed another one of the quartz-pyrite occurrences previously described as typical of those shoots occurring at fissure and acid dike intersections. At places the two shoots overlap with a considerable replacement of the quartz by galena and sphalerite. A 2-pound sample composed of small representative pieces of the quartz-pyrite ore assayed 0.43 oz. in gold. Several samples of the clean galena and sphalerite failed to show above 0.03 oz. in gold. This quartz-pyrite ore shoot was highly productive of free-milling gold throughout the zone of oxidation immediately above. Iron and manganese stains are at many places prominent along the outcrop of the vein and in the upper workings. It is thought that the auriferous pyrite from such shoots was the source of much of the gold obtained from the upper portions of the lead-silver deposits.

A specimen of sphalerite was selected for assay from the lowest tunnel approximately 430 feet from the portal. It showed no galena and very little pyrite; it assayed 0.04 oz. gold, 3.75 oz. silver, 3.3% lead, and 46.2% zinc. From report these figures con-
form very closely to the average tenor of the sphalerite. A sample of nearly clean pyrite taken from a 2-foot vein about ten feet from the previous sample, contained a very small amount of lead and zinc and assayed as follows: 0.72 oz. gold, 4.70 oz. silver, 51% lead. A sample composed of several selected pieces of apparently clean galena from the same vicinity assayed 0.66 oz. gold, 33.0 oz. silver, and 49.6% lead.

Two samples taken from the first compartment of the jigger were composed of fairly clean pyrite and galena. The first was from the side discharge and was plus $\frac{3}{4}$-inch in diameter. The second was from the hutch discharge and was minus $\frac{3}{4}$-inch in diameter. The bed was composed of galena fragments. The sample from the side discharge assayed 1.04 oz. gold, 13.2 oz. silver, and 17.0% lead; that from the hutch carried 2.02 oz. gold, 19.6 oz. silver, and 21.1% lead.

One typical ore specimen from the Smuggler vein showing pyrite, sphalerite, galena, and quartz was selected for a segregation test. The different constituents were assayed separately and disclosed the following relations:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Gold (oz)</th>
<th>Silver (oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyrite</td>
<td>0.34</td>
<td>0.40</td>
</tr>
<tr>
<td>Sphalerite</td>
<td>0.06</td>
<td>4.40</td>
</tr>
<tr>
<td>Galena</td>
<td>0.04</td>
<td>78.10</td>
</tr>
<tr>
<td>Quartz</td>
<td>0.66</td>
<td>2.40</td>
</tr>
</tbody>
</table>

A few ore specimens representing as nearly as possible the typical ore were selected for microscopic examination, inasmuch as ore from this property is as a rule freer from oxidation than that to be gotten elsewhere in the locality. A specimen of galena was taken from the Smuggler vein, which shows considerable quartz, chalcopyrite, galena, sphalerite, tetrahedrite, and pyrite. The quartz of the vein is at places well crystallized. The findings of the microscopist are quoted below:

Paragenesis.—Pyrite is the oldest mineral present and at numerous places cracks therein are filled with chalcopyrite. Galena and sphalerite were probably deposited contemporaneously after the pyrite, although the relationship of the galena is not very well shown. Cracks in sphalerite, however, are filled at numerous places by chalcopyrite. Chalcopyrite is next in occurrence and in this sample is generally speckled through the sphalerite. Arsenopyrites tetrahedrite is present as the latest hypogene mineral. It is well crystallized along with the quartz on a surface which appears to be the inside of a vein or opening. Caravellite, chalcocite, and bornite in small amounts are present as clearly defined supergene minerals filling cracks in the chalcopyrite. It was also observed in the hand specimens that slight scratches on the secondary copper revealed the presence of chalcopyrite underneath.

A second specimen of nearly clean sulphide ore was selected from the Blackbird vein at the deepest part of the workings. No
quartz veinlets occur in the place of selection, which was from a kidney in the soft gouge fissure filling. The sample contains galena, pyrite, sphalerite, and quartz; the galena was most abundant. The following quotation presents the microscopist's conclusions:

Paragenesis—Pyrite was first to form; galena closely followed and filled cracks in the pyrite. In these two minerals there is practically no quartz. Quite clearly intruded into them is sphalerite with another occurrence of quartz which indicates that there have been two periods of quartz deposition.

At one place in the Blackbird tunnel an alteration and replacement of the wall rock (quartz diorite porphyry) was noted. The alteration extended eight to ten inches into the wall; embedded in the altered rock near its contact with the vein were very noticeable amounts of galena and pyrite which diminished with distance from the fissure. One specimen of the wall rock at the contact and a second less altered one about six inches from it were selected for microscopic examination. The description of the unaltered quartz diorite, which has previously been given under the caption "Dikes," will serve as a basis with which the petrographer's reports may be compared. The specimen of wall rock taken at the contact shows the following conditions under the microscope.

The feldspar constituting the greater part of the rock is almost completely altered to crystallized talc (?), sericite, and kaolin. This crystallized talc is for the most part a hydrous magnesium silicate; it is soft and fits the requirements for this mineral. It was found impossible to positively identify this talc under the microscope because of the thinness of the section and the dirtiness of the rock. The talc which was not altered was probably formed from the feldspar contemporaneously with the intrusion of the metallic sulphides. Sillimanite is in evidence only at a few places, at the contact of the metallic sulphides. Quartz is present only in small amounts.

The second specimen, taken six inches from the contact, is described by the petrographer as follows:

Very evidently the ferro-magnesian minerals were the first to be replaced, next the feldspar, then the quartz. Biotite is scarce and the hornblende and chlorite present in the original rock (quartz diorite porphyry) are absent. The feldspar, generally altered to sericite, kaolin, and small amounts of crystallized talc (?), predominates; quartz is present in small amounts. The metallic minerals are pyrite, galena, and sphalerite, the latter being the most abundant; the pyrite was evidently first, with the galena and sphalerite, closely associated, coming later.

From these studies of the rocks and the fact that sphalerite is more abundant in the second specimen and galena more abundant in the first, it seems likely, if these conditions are typical, that the sphalerite was taken from solution before the galena. The silicate minerals were probably formed first.
Ore has been disclosed in three other veins on the property in noteworthy amounts: in the Mohawk about 850 feet northerly, in the Smuggler about 500 feet westerly, and in the Baby about 1,500 feet northeasterly, from the present workings. The Baby vein is thought to be an eastward continuation of the Blackbird but this supposition has not been definitely proved.

In the Mohawk vein occurs a quartz lens about 55 feet long and 3½ feet wide in maximum dimensions. Overhead stoping has partly exposed the lenticular shape, the quartz pinching out around the slope margin. The sulphide minerals are tetrahedrite, chalcopyrite, and pyrite. The average value of six samples across the quartz for widths varying between 2 and 3½ feet are reported as follows: 0.47 oz. gold, 12.0 oz. silver, 1.8% lead, and 3.71% copper.

Two shoots of ore with galena as the predominant sulphide were developed in the few hundred feet of drifting along the Smuggler vein. The first shoot, 120 feet long and three feet wide, was cut at a depth of 65 feet and has a reported average value of $18 per ton in gold, silver, and lead. The second shoot, 70 feet long by two feet wide, was encountered 100 feet deep and has a reported value of $15 per ton in the above metals. A 20-ton shipment of sorted ore from this shoot gave a gross return slightly over $70 per ton. A few tons of galena ore from these two shoots still remain piled on the dump near the portal of the lower adit drift. Two specimens of clean galena were selected which weighed about five pounds each. Pyrite and sphalerite were present in small amounts. These pieces assayed as follows:

- Gold 0.78 oz., silver 49.3 oz., lead 44.8%.
- Gold 0.14 oz., silver 55.1 oz., lead 47.5%.

At the Baby workings near the highest point on the property, former operators sank a 125-foot shaft. Galena is reported to occur at the bottom. Drifts from the shaft near the bottom developed a shoot of oxidized ore 110 feet long by three feet wide. The workings were inaccessible when visited. Sampling of the ore in this shoot is reported to have shown an average of slightly over five ounces per ton in gold.

At one place, well up on the mountain side, along the outcrop of the Blackbird vein and immediately below it, placer miners had worked over about one acre of ground. Charlotte Gulch, the main
drainage across the property, was formerly placered from this property to Grimes Creek, about two miles distant.

The company contemplates the erection of a 60-ton concentrating plant in the near future. Electric power will be used. Mill tests are now in progress but the flow sheet was not available. No unusual departures are contemplated from the ordinary methods of treatment for lead-silver ores.

ADER GROUP.

Adjoining the Mineral Mining Co.'s ground to the south are five unpatented claims belonging to D. Adèr. On this property can be seen the conditions which are typical of the oxidized ore zones in the locality, and a rather exceptional type of quartz vein. The quartz veins in the main workings occur in a zone of parallel fracturing, and are accompanied by comparatively little hydrothermal alteration and shearing of the wall rocks. They strike N. 40° E. and dip 50° NW. parallel to a nearby rhyolite porphyry dike to which there is thought to be a genetic relationship. The veins are not related to the regional shearing and should probably be grouped with those of the second class.

The development consists of several hundred feet of adit-tunnels with short crosscuts, which extend into opposite hillsides about ten feet above the creek which cuts across the outcrop. Two short crosscuts from the southwest adit, each way therefrom, show the fractured zone to be about 45 feet wide at this point. At intervals of 3 to 5 feet occur twelve parallel quartz veins which vary in width from 4 to 25 inches. Stains of iron and manganese oxides are prevalent throughout the wall rocks and also in the shattered quartz. Free gold in varying amounts occurs in the fractures and to a lesser extent in the quartz itself. The gold obtained by panning is bright yellow and that from some of the seams is fairly coarse. This adit has not attained sufficient depth to reveal the character of the sulphide ore; some pyrite was observed in a few of the specimens that were panned.

The adit on the opposite side of the creek, extending north-easterly, attains greater depth and exposes the sulphide ore in the face of the drift. At this point pyrite occurs with some galena and sphalerite. Recent stains of copper coat the walls at one place nearby. As proved elsewhere the galena and sphalerite
were deposited later than the pyrite. Prominent fissure veins containing these sulphides occur nearby and the local mineralization, by reason of its exceptional occurrence, is thought to be related thereto.

**MISSOURI MINING CO., LTD.**

The property of the Missouri Mining Co., Ltd., includes about 525 acres and is located on the head of Muddy Creek, a tributary of Grimes Creek. It was originally located as placer ground and has been extensively worked for placer gold. Numerous veins crop out in the bedrock and the local source of the placer gold is very evident. Much of the gold was coarse, some nuggets weighing between one and two ounces each.

The property lies a few hundred feet within the northwestern boundary of the main quartz diorite intrusion which locally strikes northeasterly. The veins are shear zones with characteristic gouge filling and occasional quartz lenses in the more prominent fissures. It is shown in the exposed bedrock and in the various workings over the property, that the same two systems of shearing exist at the property of the Missouri Mining Co., Ltd., as at the Golden Age mine, which lies about two miles to the northeast. The main system strikes about N. 50° E. and the other and later one N. 20°-25° E. Both seem to be equally mineralized. In the region to the southwest, along the same porphyry belt, auriferous pyrite is found, principally in the veins which trend N. 50°-60° E., and the system of faults which strike more northerly is generally regarded as post-mineral with respect to that ore.

During 1923, development was being carried on through two shafts a few hundred feet apart near the center of the group; one is on a vein of the system which strikes N. 25° E. and the other is on a vein that trends N. 60° E. The shafts are down about 50 feet, and a few hundred feet of drifts have been extended from the bottom of each. Recent workings in the property show the characteristic lead-zinc-silver mineralization in the sulphide zone similar to that in the Golden Age mine and the Mineral Mining Co.'s property. The gold content of the local ore is decidedly less but the lead and silver tenor are much the same.
A shipment of 20 tons of ore from the shaft on the vein which strikes N. 60° E. was made in 1922; the smelter returns were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Gold</th>
<th>Silver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31.1 oz.</td>
<td>53.4 oz.</td>
</tr>
<tr>
<td>Lead</td>
<td>13.8%</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>1.9%</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>11.9%</td>
<td></td>
</tr>
<tr>
<td>Sulphur</td>
<td>3.4%</td>
<td></td>
</tr>
<tr>
<td>Insoluble</td>
<td>5.1%</td>
<td></td>
</tr>
</tbody>
</table>

The ore was from the oxidized portion of the vein and from a depth of 25 feet or less. Several samples were taken by the owners across the vein in the lower 25 feet of the shaft; the widths sampled varied between 2 and 3½ feet and comparatively little oxidation was in evidence. The ore occurred as streaks of nearly clean galena from one to four inches wide and to some extent disseminated throughout the soft gouge filling. Pyrite is equally abundant with galena at places, and sphalerite is present in small amounts. The precious metal contents of the six samples are tabulated below:

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Gold</th>
<th>Silver</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0 oz.</td>
<td>20.0 oz.</td>
</tr>
<tr>
<td>2</td>
<td>0.0 oz.</td>
<td>20.0 oz.</td>
</tr>
<tr>
<td>3</td>
<td>0.3 oz.</td>
<td>62.5 oz.</td>
</tr>
<tr>
<td>4</td>
<td>Trace</td>
<td>51.0 oz.</td>
</tr>
<tr>
<td>5</td>
<td>0.05 oz.</td>
<td>46.6 oz.</td>
</tr>
</tbody>
</table>

In the Muddy Creek channel at the southern and lower end of the property is an extensive deposit of the early lake sediment or "false bedrock," at places 40 or 50 feet deep. The true bedrock is quartz diorite porphyry. At one place a 6-inch gravel streak on the true bedrock panned considerable coarse gold. This is the only instance of its kind in the Boise Basin known to the writer, wherein coarse gold, in appreciable amounts, has been found beneath the early sediment.

VAN METER GROUP.

About two miles south of the Golden Age mine and one mile east of the Missouri lies the Van Meter group of quartz claims. The exploratory work on the property, directed toward one of the principal shear zones, has not as yet reached its goal, but the surface indications are very promising. Both sets of shearing are in evidence on the property. The prevailing rock exposed is quartz diorite porphyry containing numerous later intrusions.
of rhyolite porphyry with here and there a basic dike. It is thought from surface indication that the same character of lead-silver ore will be found with depth as has been found elsewhere in the locality. Several prominent fissures cross the western portion of the property.

MITCHELL-JANOT GROUP.

Another interesting bit of evidence as to the character of the oxidized ores of the Basin was observed at the Janot group of quartz claims, which lies midway between the Missouri and Golden Age groups on the ridge between Grimes and Muddy creeks. At several shallow cuts and holes on this property decomposed gold ore was being mined from the vein outcrops. The ore is hauled by wagon to Grimes Creek and put through a small three-stamp mill. Inside and plate amalgamation are relied upon for recovery and very satisfactory returns are effected. From 3 to 3½ tons of ore are treated per day. No figures on recovery are available.

COON DOG.

The Coon Dog group of ten unpatented claims lies principally on the slopes of Grimes Creek; the main workings are south of this stream, about 1½ miles northeast of the main camp of the Golden Age mine. As disclosed in various old workings and surface cuts there are several veins extending lengthwise across the property; they strike N. 60°-70° E. and dip 50°-60° S. Several large rhyolite porphyry dikes crop out in the granite in the vicinity of the veins and have about the same general strike. The large quartz diorite dike that strikes northeasterly at the Golden Age property crops out a short distance south of this claim group. Several prominent basic dikes occur in the vicinity of the main workings.

At the time of the writer's visit the main development work was being done on Coon Dog No. 9 tunnel. This consisted of 650 feet of tunneling northeasterly along a prominent series of quartz veins in a wide rhyolite porphyry dike which extends along the hillside a short distance south of and about 300 feet above Grimes Creek. Several short crosscuts each way from the main tunnel disclosed conditions along the course of the veins. The drift had reached a point beneath a prominent outcrop from
which some exceedingly high silver and subordinate gold assays have been obtained in several shallow surface cuts. Inasmuch as the ore shoots of the Basin pitch eastward with depth, a short advancement of the tunnel is expected to encounter the ore shoot at an estimated depth of 200 feet.

The quartz veins have been traced to the next ridge, about a third of a mile to the northeast. No. 9 tunnel encountered these a short distance from the portal and followed them northeasterly for 250 feet or more in ore. From this point the tunnel was driven the remaining distance of approximately 400 feet in the footwall to secure better location, and an occasional crosscut was driven to the veins. One of these crosscuts affords an excellent section of the vein structure, which is shown in the following sketch. The quartz veins are centrally located in a 200-foot rhyolite porphyry dike of approximately the same strike and dip. A basalt dike follows the quartz veins closely throughout the length of the workings but no clear-cut evidence of the relative ages of dike and veins could be found. Shearing along the dikes in the vicinity of the veins subsequent to the basic intrusion is clearly revealed. Hydrothermal alteration is pronounced near
the main fissures and the quartz veins are considerably shattered throughout. The principal ore deposits are very evidently subsequent and related to the shearing. Although the principal ore minerals are found in the quartz, shattering of this gangue mineral was evidently a prerequisite to any appreciable deposition therein.

The ore minerals are essentially pyrite, sphalerite, galena, chalcopyrite, and occasionally tetrahedrite, named in decreasing order of abundance. Although these sulphides generally occur in the quartz veins, they also occur in the enclosing rocks as fissure fillings. This second mode of occurrence points strongly to a genetic relationship of the ores to the shearing rather than to the quartz veins. The rhyolite for several feet in the vicinity of the quartz veins and the basic dike shows considerable shattering which at places amounts to brecciation. The recementation of the shattered rhyolite by sphalerite, galena, and chalcopyrite, with or without quartz, is a feature of the deposit. These minerals are very sharply differentiated from the angular fragments of the rock throughout the deposit.

Specimens were collected of the shattered rhyolite porphyry which showed the typical mineralization in the fractures. Under the microscope the fractures are seen to be sharply defined, and filled with sphalerite containing minute specks of chalcopyrite, galena, and pyrite decreasing in amount in the order named. All four minerals are contemporaneous. Where the seams are wider, galena is more plentiful than sphalerite. In another specimen angular rhyolite fragments, about half an inch in diameter, were recemented by sphalerite with lesser galena and pyrite, associated with quartz which was about as abundant as the sulphides. One sample from the first ore shoot encountered in Coon Dog No. 9 tunnel in a quartz vein near the first crosscut south, assayed as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>0.18 oz.</td>
</tr>
<tr>
<td>Silver</td>
<td>19.6 oz.</td>
</tr>
<tr>
<td>Lead</td>
<td>19.0 %</td>
</tr>
<tr>
<td>Zinc</td>
<td>19.8 %</td>
</tr>
<tr>
<td>Copper</td>
<td>25.4 %</td>
</tr>
<tr>
<td>Sulfur</td>
<td></td>
</tr>
</tbody>
</table>

A specimen of quartz ore was selected from the same place for microscopic examination. The sulphide minerals were chalcopyrite (generally coated with secondary copper minerals), tetra-
hedrite, sphalerite, galena, and pyrite; quartz (at some places druzy) was the principal gangue mineral. The microscopist's report follows:

Paragenesis—Only a little pyrite is present and it is not often associated with the other sulphide minerals. It was probably deposited first. At places the sphalerite, galena, and chalcopyrite appear to be closely related in time of deposition. Cross sections show the chalcopyrite filling cracks in the sphalerite, and the sphalerite and galena closely associated. There is a small amount of tennantite present, some of which is contemporaneous and some of which fills cracks in chalcopyrite. Chalcopyrite is the most abundant sulphide and shows numerous thin cracks filled with bornite, chalcocite, and covellite, named in the order of their abundance. These latter minerals are closely associated and are not plentiful. Quartz fill fractures in many of the sulphides and probably is of two periods, the first being associated with galena and the later filling cracks in the sulphides after they had been deposited.

Several specimens from the outcrop of the vein vertically above the face of No. 9 tunnel were selected because of the reported silver content, thought possibly to occur as cerargyrite. Subsequent tests failed to reveal silver in this form. An assay of the sample revealed the following precious metal content: gold 0.04 oz. and silver 26.0 oz. per ton.

A two-carload shipment of ore from Coon Dog No. 1, a vein which is adjacent and parallel to Coon Dog No. 9, appeared similar to the ore from No. 9 and assayed as follows:

<table>
<thead>
<tr>
<th></th>
<th>Gold</th>
<th>Silver</th>
<th>Lead</th>
<th>Zinc</th>
<th>Copper</th>
<th>Iron</th>
<th>Sulphur</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot No. 1</td>
<td>0.15</td>
<td>13.4</td>
<td>0.85</td>
<td>7.1</td>
<td>4.95</td>
<td>15.2</td>
<td>18.9</td>
<td>44.4</td>
</tr>
<tr>
<td>Lot No. 2</td>
<td>0.10</td>
<td>14.6</td>
<td></td>
<td>7.2</td>
<td>5.96</td>
<td>15.9</td>
<td>19.9</td>
<td>44.4</td>
</tr>
</tbody>
</table>

INDEPENDENCE GROUP.

Immediately northeast of the Coon Dog on the opposite slope of Grimes Creek is the Independence group of seven unpatented quartz claims. Two prominent fissures extend northeasterly across the group, about 300 feet apart, with the same general strike and dip which prevail with the fissures elsewhere in the vicinity. The predominant rock is granite. This rock has been intruded by several dikes of rhyolite porphyry and a few basic dikes. The fissuring is clearly subsequent to the rhyolite.

The workings have attained comparatively shallow depth, though the last work done has just entered the sulphide zone and disclosed the typical lead and zinc ores of the locality. Samples of the ore are reported by the owners to run high in silver; an appreciable gold content is found in that which shows partial
oxidation. Considerable free-milling high-grade gold ore was formerly obtained along the two vein outcrops mentioned and for shallow depths therein. This was treated locally in an arrastre with good results. The gold, however, was rather unevenly distributed and the future of the property very evidently depends upon the development of the sulphide ore such as was recently disclosed.

MAMMOTH.

About seven miles due east of Grimes Pass on Summit Flat is the Mammoth group of eight unpatented quartz claims. These are located on the headwaters of Grimes Creek at an elevation about 8,000 feet above sea level. The country is comparatively flat, well timbered, and abundantly watered. There are several other mines in the vicinity but, from report, none of the deposits differ materially from that of the Mammoth, which was the only one at which work was in progress when the area was visited by the writer.

Two prominent quartz veins have been opened on this property; they are about 600 feet apart, strike N. 10°-20° E., and dip steeply to the west. Work is being confined at present to the eastern one of the two, and ore is being stoped from it at one point about 100 feet beneath the surface. The ore is a hard white quartz, considerably fractured at places, which shows a scattered mineralization of pyrite, and occasionally galena and sphalerite. Many of the fractures show iron stains. The occasional stains of manganese oxide indicate that the ore now being mined is near the lower limits of oxidation. The unfractured ore shows the sulphides in an apparently fresh state. The lower workings, 200 feet deeper, and now under water, are reported to have reached the primary sulphide zone.

A typical piece of the high-grade sulphide ore from the shoot now being worked was selected for microscopic examination. The specimen, principally quartz, contained sphalerite, galena, and pyrite. Gold was visible to the unaided eye at a few spots. The pyrite is shown to be the oldest mineral and has at places been partly or almost wholly replaced by sphalerite and the sphalerite has, in turn, been replaced by gold. The galena is closely associated with the sphalerite and is probably contemporaneous with
it. Although the gold occurs most abundantly where the sulphides are most plentiful, it replaces the various sulphides in part and is in part not associated with them.

About 50 tons of ore have been piled near the portal of the mill-level tunnel. A 15-pound grab sample of the surface of the pile assayed 8.05 oz. gold and 3.3 oz. silver. The owners intend recovering the precious metal content of this ore by amalgamation in a 5-stamp mill on the property.

The Mammoth was worked in former years and has a recorded production of $472,000. Mining was confined to the oxidized free-milling ore and amalgamation was the sole process of recovery. Considerable specimen ore came from the upper levels at a depth of 50 to 75 feet. Some ore of this character has been encountered in the stope now being opened.

JOE BRANSON GROUP

Work on several other claims along Grimes Creek is confined to the limited annual assessment requirements. On the Joe Branson claims some high grade gold ore was encountered in a shallow open-cut near the top of the Grimes Creek-Payette River divide about three miles east of Grimes Pass. The work has not yet attained sufficient depth to warrant any statement regarding the size of the deposit. Two samples showed gold contents which warrant further development.

MONETARY METALS CO. (WASHINGTON)

The Washington mine is located near the head of Gambrinus Gulch about seven miles northeast of Idaho City. The claim group covers a portion of the shear zone to which most of the early day quartz mining of this part of the Basin was confined. The mine is the only one in the Gambrinus district at which any noteworthy amount of development is being carried on in 1924.

The Washington mine was worked in former years through a vertical two-compartment shaft, which is located near the northern and higher portion of the property, to a depth of 560 feet. Two veins, about 100 feet apart, were exposed in the vicinity of the shaft. The northern one, known as the Silver vein, strikes about N. 70° W. and dips 75'-90° S.; the southern, known as the Washington or Gold vein, strikes E. and dips almost 90° S.
The two veins merge a few hundred feet east of the shaft and the principal ore shoot formerly developed was near this junction. The shear zone which strikes eastward across the property consists of several well defined fault fissures 50 to 200 feet or more apart. These fissures are clearly later in age than the aplite intrusions of the locality, several of which are cut diagonally by the fissures.

The Washington, or Gold vein, was worked by former operators to the 400 level through the vertical shaft. From a drift to the east on the 400 level, and 180 feet from the shaft, a 165-foot winze was sunk on the vein. Some drifting was done at the 500-foot and 565-foot levels. A short crosscut to the south on the 500 level intercepted what was called the Silver vein; no crosscut was driven from the bottom of the winze. From assay records it is apparent that the better grade of gold ore will be found above the 400 level whereas the tenor of the lead-silver ores seems to persist with depth. The crosscut to the Silver vein discloses silver ore whose tenor is the same as that encountered above.

It is reported that a recovery of $92,000 was effected by amalgamation of the ore removed between the 400 level and the surface from the two shoots which were encountered east of the shaft in the Washington vein. No data are available as to tonnage. The ore was crushed in two 5-stamp batteries and plated. No attempt was made to mine or treat the silver ore; this yet remains as a future asset for the company. No information is available regarding its average value. That from the oxidized zone contained considerable native silver. Specimens from the upper levels of the Subrosa claim show wire silver much resembling in miniature the fleece of a sheep.

Recently the mine has been reopened by the Monetary Metals Co. A good road has been built to connect with the main county road which ascends Moore Creek. A suitable camp has been built, a sawmill has been placed in operation to supply timber needs, and steps have been taken to secure the installation of electric power. The erection of a concentrating plant is contemplated for 1925. The underground work being carried on by the Monetary Metals Co. consists of an adit driven northerly from a point about 1,300 feet south of the old shaft, which it taps 420 feet below the collar. At the time of the writer's visit the adit had
been extended about 125 feet beyond the shaft and drifting both to the east and west was in progress along one of several fissure veins which were encountered a short distance beyond the shaft. Two of these fissure veins attain a width of several feet. Workable ore was not disclosed in any of them until the vicinity of the old workings was reached. One specimen, taken from the vein exposed in the east drift and not far below the former workings, carries considerable native silver scattered throughout the fractured and slightly oxidized quartz ore. The main adit penetrates several large aplite dikes and near its connection with the vertical shaft, at a depth of 420 feet, exposes the only basic dike encountered in the recent workings. The rock is shown under the microscope to be a minette. At the point of exposure underground the dike is about 30 feet wide, strikes about N. 40° E., and dips 60° SE.; its age with relation to the fissures could not be determined. There is elsewhere in the same neighborhood, notably on the Subrosa claim, this same persistent suggestion of a genetic relationship between the basic dikes and ore deposition, a relationship not fully proven, but not to be ignored by those in search of ore.

BOULDER GROUP.

The Boulder group, consisting of eleven quartz claims and one mill site, lies along what is thought to be the westward continuation of the Washington and Subrosa veins. This property definitely proves the persistence of the shear zones from Moore Creek to Elk Creek basin. There are three prominent veins which strike lengthwise across the group N. 70° W. and dip 60° S. They are the usual type of gouge and quartz filled shear zones in a country rock of granite. The granite has been intruded by several wide aplite dikes that strike easterly and have about the same dip as the veins. Considerable faulting, for the most part older than the main shear zones, is in evidence. The fissure veins are of later age than the aplite dikes—at places they cross them at an acute angle with displacement of the dikes and at others they follow the contact between granite and dike for considerable distances.

The deposits on the ridge at the east end of the property, according to reliable information, were principally free-milling
gold with some silver; the precious metal content was highest in
the zone of oxidation and enrichment. Iron and manganese stains
are prominent along lines of fracture in the vicinity of the veins.

At the present time the principal work is being done near the
western end of the group and consists of several hundred feet of
crosscut and drifts which extend easterly from an elevation
slightly above Elk Creek. There is one drift along which some
overhead stoping was being done on a vein whose average width
was about four feet; the vein filling was highly altered and crush-
ed country rock and broken quartz between fairly well defined
walls. A sample taken across the vein at a point immediately
above the main drift and about 50 feet beneath the surface as-
sayed 0.55 oz. gold and 8.5 oz. silver.

A well equipped stamp mill of about 20 tons capacity is used
to treat the ore. Amalgamation is followed by table concentra-
tion; the concentrates are being stored on the ground for future
treatment. The mill was run intermittently during the summer
months a few years ago, to treat ores encountered in development
work. During the spring and early summer Elk Creek furnished
ample power to run the mill.

**Mattie Group.**

About three miles northwest of Idaho City on the divide
between Grimes and Moore creeks is the Mattie group of three
claims. Work now being done on the property along the Mattie
vein discloses conditions which are characteristic for the locality
and warrant description. Considerable prospecting of the vein
outcrops has been done elsewhere along the local dike belt but the
workings are for the most part now inaccessible. Numerous
aplite dikes crop out in the granite in the vicinity of this property
and old workings show the existence of prominent shear zones.
The prevailing strike of the aplite dikes is about N. 50° W. with
a variable southwest dip. Two veins have been developed—the
Mattie, striking N. 55° W. and dipping 35° SW., and the Boise,
which strikes N. 10° W. and dips 45° W. The present work is
being done through a 60-foot shaft on the Mattie a few hundred
feet southeast of the probable intersection of the two.

The Mattie vein is exposed near the bottom of the 60-foot
shaft and drifts follow it southeastward. A short distance from
the shaft, in the crushed material that comprises the greater part of the fissure filling, an ore shoot was encountered. Drifting disclosed that this shoot extended 40 feet farther. A composite sample taken at intervals of five feet across the vein, which was between 2½ and 3 feet wide, assayed 1.40 oz. gold and 0.9 oz. silver. An inclined winze is being sunk on the vein to prove the depth of the ore shoot. The sulphides of the locality are mainly pyrite, but the winze is still in the oxidized zone and has not yet disclosed the character of the ore at depth. Some specimens of quartz from the fissure containing partly oxidized pyrite, revealed considerable yellow gold when panned. Some of the iron-stained gouge filling likewise carries considerable gold. The precious metal appears to occur usually in streaks near the vein walls. Iron and manganese oxide stains are abundant along fractures in the enclosing rock. The deepest work shows that ore persists at least to a depth of about 100 feet, measured along the dip of the vein, with pay still showing in the bottom of the incline winze.

HAY FORK AND GARRECHT PROPERTIES.

There are several prospects along the ridge southeast of Moore Creek which warrant further development. The Hay Fork mine, at which some high grade gold ore has been found, was not visited. The Garrech claims about three miles south of Idaho City show favorable structural conditions in a region of numerous acid and some basic dikes. A crosscut tunnel is being run on these claims to cut a prominent fissure which crops out on the hillside above. The face of the tunnel is approaching the calculated position and several samples of the crushed iron-stained material show gold assays ranging from 0.1 oz. to 0.45 oz. per ton. A wide basic dike, in the fractures of which small amounts of galena are scattered, crops out near the portal of the tunnel.
CONCLUSION.

Mining in Boise Basin is passing through that transition stage between the decline of placer-mining and the revival of interest in lode mining. Many of the mines have, in years past, been considered as "worked out" yet at least six of these are now being reopened, with good results in several cases. A concentrating mill has been completed at one property and construction is under way at another to treat the ore which has been discovered. The Gold Hill is the only mine producing at present; for several years prior to 1923 it held the State record for gold production. Quite a few prospects in the Basin present interesting possibilities but as a rule these have not yet passed the development stage; upon the success of these and of those to follow depend the future prosperity of the region. The bismuth deposits, besides indicating persistence of the associated gold and silver content to depths, may become profitable as a by-product. Up to the present time no serious attempt has been made to prove this possibility. Although superficial enrichment has been an important factor of deposition in the case of the gold-bearing pyrite veins, an initial recognition of this condition should permit profitable exploitation where it is undertaken on a scale commensurate with the size of the deposit. Although the lead-silver deposits are not as extensive as those found at other places in the State, the grade of ore is generally equal to or higher than that now profitably treated elsewhere; especially is this true of the associated gold and silver content. Concentration is essential to the economic handling of these deposits, but ample electric power is at hand. The heavy stand of timber in the Basin renders surface prospecting rather difficult at many places. Sufficient work has already been done however to define fairly accurately the main mineral zones. It has been the purpose of this report to outline these mineral zones and the principal characteristics of the ore deposits. Variations present their own problems but it is believed that a general understanding of the main features will facilitate the solution of such as arise.
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