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A RECONNAISSANCE

OF THE

JARBIDGE, CONTACT, AND ELK MOUNTAIN MINING DISTRICTS

ELKO COUNTY, NEVADA

BY

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WASHINGTON

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1912

CONTENTS.

ILLUSTRATIONS.

A RECONNAISSANCE OF THE JARBIDGE, CONTACT, AND ELK MOUNTAIN MINING DISTRICTS, ELKO COUNTY, NEVADA.

By F. C. Schrader.

INTRODUCTION.

This report is based on 27 days' field work in July and August, 1910, of which 14 days were given to the Jarbidge district, 12 to the Contact district, and about half a day to the Elk Mountain district. During this period the mines and more important prospects were hurriedly visited and located by compass and aneroid traverses.

As the districts had never been surveyed or mapped, control in the Jarbidge district was obtained by measuring with steel tape a base line about three-fourths of a mile in length, on the open ridge west of Deer Creek, about 1½ miles northwest of Jarbidge. From stations established at the ends of this base a system of triangulation, indispensable in so rugged a country, was begun and carried on throughout the work concurrently with the contour and other sketching, and tied to Government township and section corner monuments of the ninth standard parallel, found later in the southern part of the field.

Both vertical-angle and aneroid readings were employed in determining elevations, but the elevations as a whole rest on aneroid readings carried into the district from Twin Falls, Idaho, a distance of 95 miles, two days being required to make the trip.

The topographic map of the Jarbidge district (the base of Pl. II), which covers an area of almost 170 square miles, was made by R. D. Pickett, working independently, with plane-table and telescopic alidade. The topographic map of the Contact district (the base of Pl. XIV), which covers an area of about 450 square miles, was made by Nelson W. Sweetser.

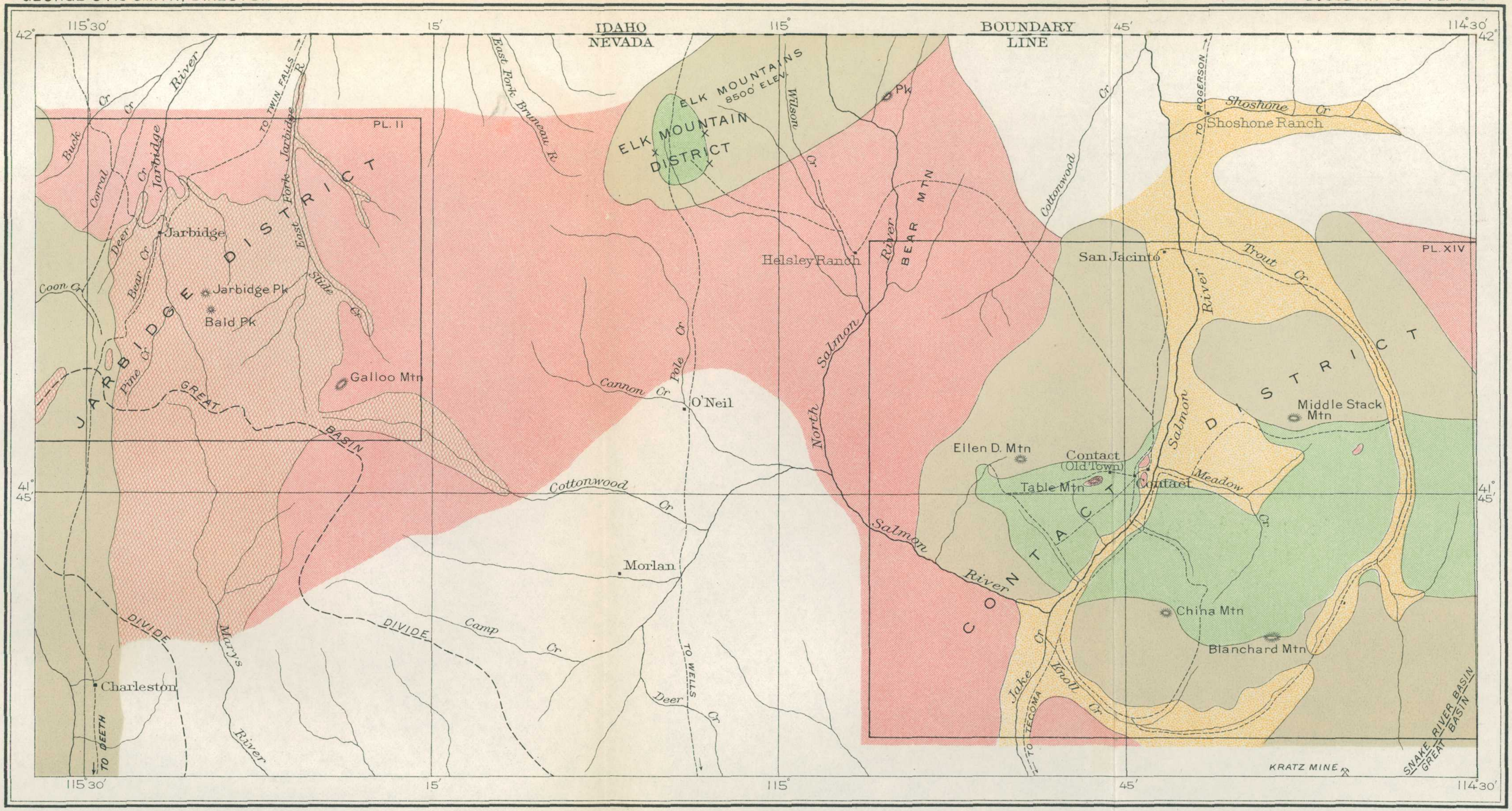
Thanks are due to the several companies, mining men, operators, the forest ranger, and prospectors for valuable information and assistance generously extended in all the districts; to Mr. Waldemar Lindgren, in charge of the metalliferous work of the Geological

Survey, and to Messrs. F. L. Ransome, J. B. Umpleby, and other members of the Survey for criticisms and petrographic assistance in the preparation of the report; and to Messrs. George Steiger and W. T. Schaller for chemical analyses and tests of the rock and ore specimens.

The area comprising the Jarbidge, Contact, and Elk Mountain districts (see index map, fig. 1, and general geologic map, Pl. I), lies in Elko County, in the northeastern part of Nevada. It is a rectangular area between 41° 37′ north latitude on the south and 42°, or the Idaho State line, on the north, and between 114° 30′ and 115° 30′ west longitude. On the east it extends within 25 miles of the Utah State line. It is about 35 miles long and 26 miles wide and covers about 1,400 square miles. The area lies in the northeastern part of the region known as the Nevada Plateau, at a general elevation of about 6,000 feet. It inclines gently to the east and is for the most part treeless.

Like the Great Basin on the south, this area is characterized by numerous broad, infilled valleys separating higher portions of the plateau and mountain ranges, which in parts are high and rugged. The main valleys lie at elevations of about 5,400 feet and above them the highest mountains rise to elevations of nearly 11,000 feet. Where watered the valleys are fertile. The area contains parts of two grand features of this western country—the Great Basin on the south and the Snake River valley on the north—and the intervening divide crosses its southern corners, as shown on Plate I. It lies mainly in the southern part of the Snake River basin, on the headwaters of Salmon and Bruneau rivers, which are among the strongest south-side tributaries of the Snake.

The area lies in a region of folded and eroded Paleozoic sedimentary rocks intruded by granitic batholithic masses and dikes, flooded by Tertiary lavas, and in part overlain by Tertiary lake sediments and Quaternary débris. The Paleozoic rocks consist principally of quartzite, limestone, shale, and slate and seem to be Carboniferous. The granitic intrusive rocks are principally granodiorite and are probably of Cretaceous age. The Tertiary lavas are principally rhyolite.



GENERAL GEOLOGIC MAP SHOWING RELATIVE POSITION OF THE JARBIDGE, CONTACT, AND ELK MOUNTAIN MINING DISTRICTS, NEVADA

By F. C. Schrader

Scale $\frac{1}{312500}$

5 0 5 10 15 Miles

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Note: Rectangles represent areas of Jarbidge and Contact districts as shown on Plates II and XIV

LEGEND

- Tertiary lake beds and Quaternary gravels and alluvium, including some volcanic tuff
- Undifferentiated Tertiary eruptive rocks, including the rhyolites elsewhere mapped with basalts and probably andesites
- Younger or rim-rock rhyolite (Pliocene?)
- Older (ore-bearing) rhyolite (Miocene?)
- Granodiorite and allied granular rocks and porphyries (Cretaceous?)
- Paleozoic sedimentary rocks
- × Prospect

THE JARBIDGE DISTRICT.

LOCATION.

The Jarbidge district lies in the northern part of Elko County, in northeastern Nevada, near the Idaho State line on the north and about 60 miles from the Utah State line on the east, as shown in figure 1 and Plate I. It is comprised within an area about 14 miles square, extending west of the main Jarbidge River and east of the East Fork. The district lies in the rugged mountains between 5,500 and 11,000 feet in elevation, on the upper north slope of the high east-west range that forms the divide between the Great Basin on the south and the Snake River valley on the north. To this range, or portions of it, particularly to the southwest of the Jarbidge district, the name Bruneau Range or Bruneau Mountains has been applied. Jarbidge, the camp (shown in Pl. III, *A*), is located near the middle of the western half of T. 46 N., R. 58 E., on Jarbidge River, at an elevation of about 6,200 feet.

The General Land Office map of Nevada shows an unsurveyed area about 20 miles square about 20 miles east of the Duck Valley Indian Reservation. This is the only large area in this part of the State that has not yet been subdivided. It extends from the Idaho State line southward across the divide, where, on the Great Basin side, it includes a considerable portion of the Marys River drainage basin, and from the west fork of Bruneau River on the west beyond the east fork on the east. The Jarbidge district lies in the heart of this area and so far as indications of mineral-bearing rocks are concerned might roughly be regarded as coextensive with it. The district is 15 miles from Mountain City, 20 miles from Edgemont, and 25 miles from Tuscarora, all three points being located west or southwest from Jarbidge, in Nevada. It is 100 miles southeast of the Silver City-De Lamar district, Idaho.

The nearest railway points in air line are Rogerson, Idaho, 50 miles to the north, on a spur of the Minidoka & Southwestern branch of the Oregon Short Line, and Deeth, Nev., 55 miles to the south, on the Southern Pacific and Western Pacific railways. Elko, the county seat, is 70 miles distant, on the Southern Pacific. At present the center of the district is near latitude 41° 50′ north and longitude 15° 25′ west.

The term "Jarbidge" is said to come from the Indian name "Ja-ha-bich," meaning the devil. Traditionally it is applied to this district from Indian association of diabolic power with the cataclysmic

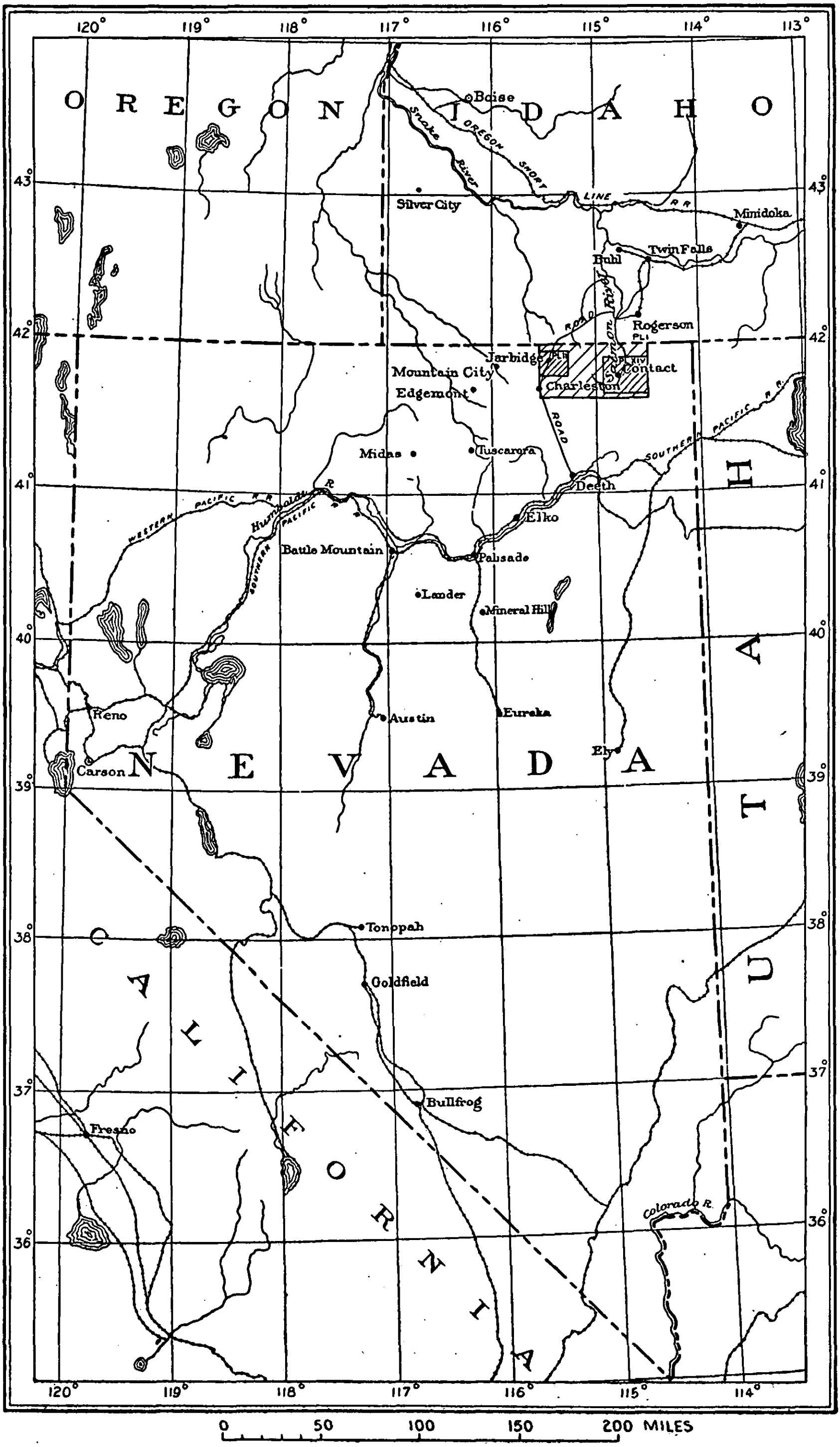
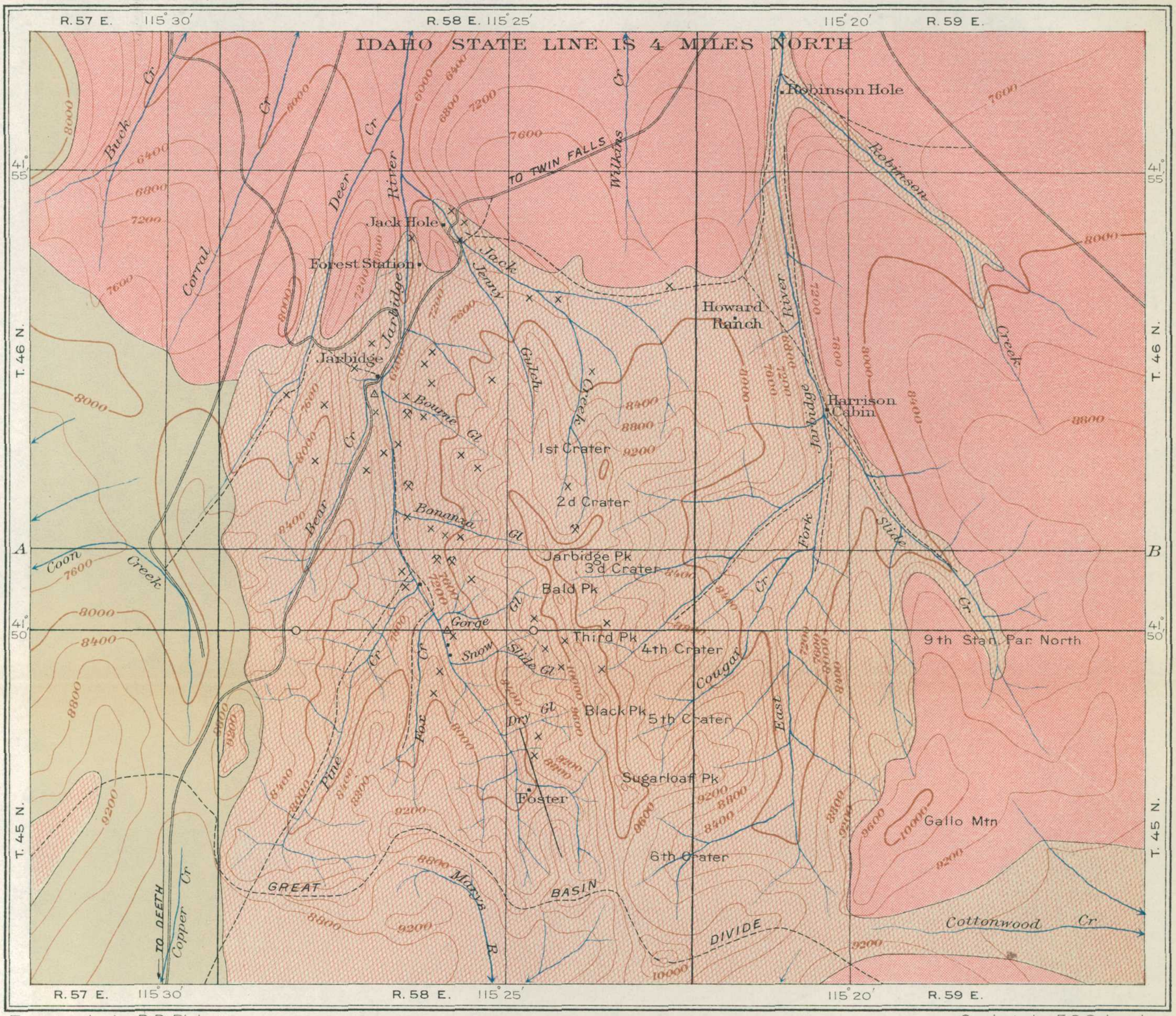
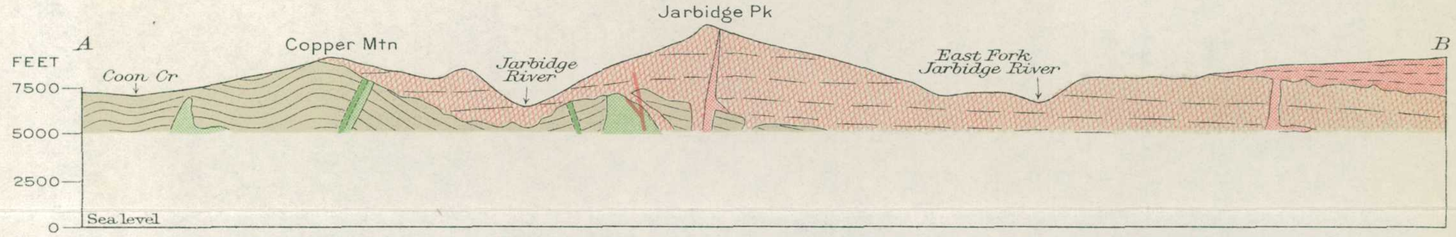


FIGURE 1.—Index map showing location of the Jarbidge district.



Topography by R.D. Pickett

Geology by F.C. Schrader



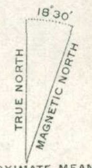
GEOLOGIC RECONNAISSANCE MAP AND SECTION OF THE JARBIDGE MINING DISTRICT, ELKO COUNTY, NEVADA

Scale $\frac{1}{125000}$

1 0 1 2 3 4 5 Miles

Contour interval 400 feet

1912



APPROXIMATE MEAN DECLINATION 1910

LEGEND

TERTIARY

Pliocene (?)

Younger or rim-rock rhyolite

Intervolcanic rhyolite dikes

Miocene (?)

Older (ore bearing) rhyolite

CRETACEOUS (?)

Granodiorite dikes and sheets, granular intrusives

Granodiorite and allied granular intrusives, principally stocks and dikes

PALEOZOIC

Principally Paleozoic sedimentary rocks quartzites, limestones, and shales, with granitic intrusives, notably granodiorite

Mine

Prospect

Section corner

Fault

U.S. Location Monument

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volcanism suggested by the rugged mountains, high peaks, deep canyons, and hot springs of the region, and probably also from local eruptions of lavas which the Indians may have witnessed in the adjoining Snake River valley within the last century, the eruptions being regarded as manifestations of the evil spirit and the lavas perhaps being correlated in origin with similar ones exposed in the Jarbidge Mountains.

PREVIOUS DESCRIPTIONS.

So far as its geology and mineral deposits are concerned the district was discovered only about a year ago, previously being practically unexplored. The literature bearing directly on the district consists of short papers appearing in current mining journals, mainly for the year 1910, describing the conditions and development of the district, the mines, the camp, the prospects, and the new discoveries. Papers by W. A. Scott and by Nelson W. Sweetser appeared in the Mining and Scientific Press of April 30 and of December 31, but a number of short articles by Winthrop W. Fiske, mining engineer, of Jarbidge, have helped more than anything else to make the district known to the mining world and the public. Most of Mr. Fiske's papers have appeared in the publications named below, under some such heading as "Jarbidge, Nevada."

Salt Lake Mining Review: January 30, February 15, 28, March 30, June 15, July 30, September 30, November 15, 30, 1910, February 15, 1911.
Mining and Scientific Press: April 30, June 18, 25, September 3, 1910.
Mining World: October 1, 8, December 24, 31, 1910.
Engineering and Mining Journal: October 15, 1910.

CLIMATE.

The district lies between the desert region of the Great Basin on the south and that of the Snake River valley on the north, so that its climate, particularly in summer, partakes in large measure of that of these regions, being modified, of course, by the greater elevations. The summers are long and dry and there is great daily range between day and night temperatures. The nights are usually cool or cold, with frosts late in spring and early in autumn, and the days are warm with abundant sunshine, but owing to the dryness of the air the heat is not oppressive. The climate is similar to that of Silver City, Idaho.

The precipitation occurs mostly in winter and falls mainly as snow, which in the higher mountains accumulates to considerable depths, lasting in places throughout the summer. Springs feed perennial streams by which the district is well supplied with wholesome water.

According to Winthrop W. Fiske,[1] in 1909 snow began to remain on the mountain tops early in October and in the valleys late in

[1] Private letters of Dec. 10, 1910, and later date.

November. In 1910 snow did not begin to remain on the mountain tops until after the middle of October, and up to December 10, although considerable snow fell at times in the valley at Jarbidge, it was usually removed in a day or two by rain. Toward the later part of December winter seemed to set in for good, and by January 2, 1911, snow lay 10 inches deep in the valley at Jarbidge and several feet deep on the mountains.

In winter the temperature rarely falls below 20° F. The coldest weather in the winter of 1909–10 was on or about January 10, when the temperature reached 12° below zero. During the winter of 1910–11 the coldest day reported up to January 9 was January 2, when the mercury fell to 8° below zero.

VEGETATION.

The area lies in the Humboldt National Forest and contains considerable timber along the larger streams and at the heads of the valleys, as is shown in Plate III, *B*. According to the Forest Service,[1] the principal commercial trees are nut pine, or limber pine (*Pinus flexilis*), alpine fir (*Abies lasiocarpa*), aspen (*Populus tremuloides*), and mountain mahogany (*Cercocarpus ledifolius*). The better stands occur on the east and north slopes. Of these trees the pine is the only one suitable for lumber. Much of the timber, however, is suitable for use in mining. The area contains many trees about 2 feet in diameter and is now supplying frame timbers for the large Pavlak mill. Along the streams there are groves of cottonwood and willow. There is also considerable small timber, much of which, however, has been fire killed by the sheepmen, who, in grazing the country for many years past, were wont to burn off the slopes to improve the range. Mountain mahogany, juniper, and aspen, mostly trees of small or stunted growth, are plentiful and widely distributed and extend high up the mountain slopes, as shown in Plate IV.

Favorable slopes from the foothills to the top of the mountains are clothed with a fair growth of good forage grass (as shown in the foreground in Pl. IV), which renders the country a summer range for stock and sheep. During the last season large bands of sheep were grazing in the vicinity of Jarbidge.

HISTORY AND PRESENT CONDITIONS.

The history of the Jarbidge mining district scarcely begins before 1909. Jack Sinclair, an old-time prospector from Silver City, is reported to have visited the region in the late sixties. Excavations that were regarded as traces of old workings were found in the eastern part of the district, on East Fork of Jarbidge River, as early as 1880, by the Wilkins brothers, whose large horse range on the Idaho side included the East Fork country. The stockmen paid little attention

[1] H. E. Fenn, acting district forester, in official letter of Dec. 28, 1910.

to mineral deposits. The first ore discovered in the district is reported to have been found on East Fork about 1904 by one Vishim, a sheep tender and former placer miner, who in looking for a sheep range came across some of these old workings, from which he brought out a piece of quartz that assayed $1,200 or more to the ton in gold. So far as learned, however, this find was not followed by any effort to exploit or work the ground. In 1907 C. M. Howard, a stockman having a ranch in the northeastern part of the district, prospected the present Bourne ledge, on Jarbidge River, but found only low-grade ores and staked no claims.

The discovery that led to the founding of the present camp and district was made by D. A. Bourne in 1909. Starting in the foothill mesa country in the vicinity of the State line, about 9 miles from the present site of Jarbidge, in 1908, he slowly ascended Jarbidge River, prospecting and panning the gravels of the river and tributaries. Having finally, late in the autumn of 1909, obtained his best prospect at the mouth of the tributary that now bears his name, he ascended this stream for about half a mile and worked for some time on the bold ledge that outcrops at this point on its north bank, obtaining by panning and sluicing the moderate return of $7 or $8 a ton. A little later, in company with friends, he discovered and located the adjoining higher ground on the south, where bolder outcrops marking the site of the present Bourne mine look down upon the scene of his former humble operations.

At about the same time the Pavlak and Buster groups, almost adjoining the Bourne and extending down to the river on the southwest, and the Pick and Shovel, high up on the mountain side to the southeast, were located and opened with good results, ore of shipping grade being found within 10 feet of the surface.

The Pick and Shovel ledge was discovered independently by John Escalon, a lone prospector, who, with pack on his back, entered the district from Charleston on the south. When, on descending the Jarbidge Valley, which he supposed to be virgin ground, he encountered Bourne, Pavlak, and other prospectors there preparing for mining operations, he hastened back to stake the Pick and Shovel ledge, whose rich float he had observed on the steep mountain side the day before.

Reports of these discoveries were soon spread abroad, and by October about 50 men had arrived in camp, most of whom spent the winter there. A meeting was called, the Jarbidge mining district was organized, and a recorder was elected. On December 10, 1909, with but 16 men present, a purse of $50 was raised to have the first mail brought in.

Early in 1910 the Bluster, Bunker Hill, Ozark, and other groups were located and prospected, with good results. In February or early March, 1910, certain newspapers published a statement that the

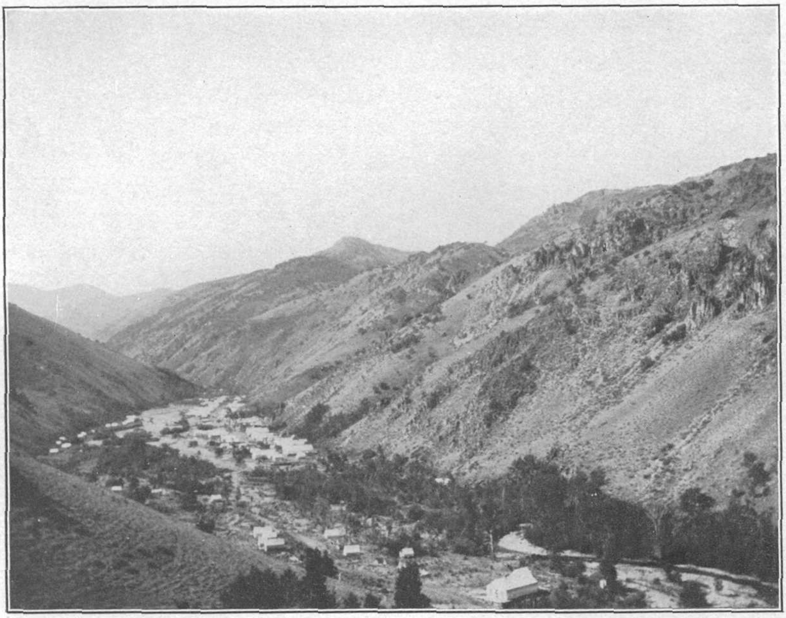
Bourne mine had over $27,000,000 worth of gold ore in sight. This announcement led to a stampede for the district, as a result of which the population of the camp was swelled to 1,500 during late March and early April. A city of 500 tents, erected on the present site of Jarbidge (Pl. III, *A*) and extending for 3 miles along the river bank, sprang up, and although the ground was heavily covered with snow—in places 15 or 20 feet deep—almost the entire country was quickly "staked" on snowshoes without being prospected. By the middle of April over 500 claims had been staked and filed for record in the district.

This movement, considering the various callings represented by its participants, the many and widely separated sections of the country from which they so quickly came, the inclemency of the season, and the conditions of travel, was remarkable, for there were no established lines of transportation and no wagon road within 12 miles of the camp, and after leaving the nearest railroad station, Twin Falls or Buhl, in southern Idaho, these men were compelled to travel a distance of 95 miles, mostly over the Snake River lava plain. The last 12 miles of this journey, from the Wilkins Hot Springs ranch (also called Rimrock), on East Fork, about a mile from the State line on the Idaho side, had to be traversed through deep mud, slush, and snow, on horseback or afoot, with baggage and freight packed on the backs of animals or men. A horse, too, was then considered a luxury and was hard to get at any price.

It is reported that a large party entering the district from the south over the snowy divide, finding it impossible to descend the icy mountain slope with pack animals in the ordinary way, lashed the horses' legs to their bodies and started them, packs and all, in bowlder style, down the rugged slope, in which fashion, it is said, they reached the foot of the mountain with only a few fatal accidents.

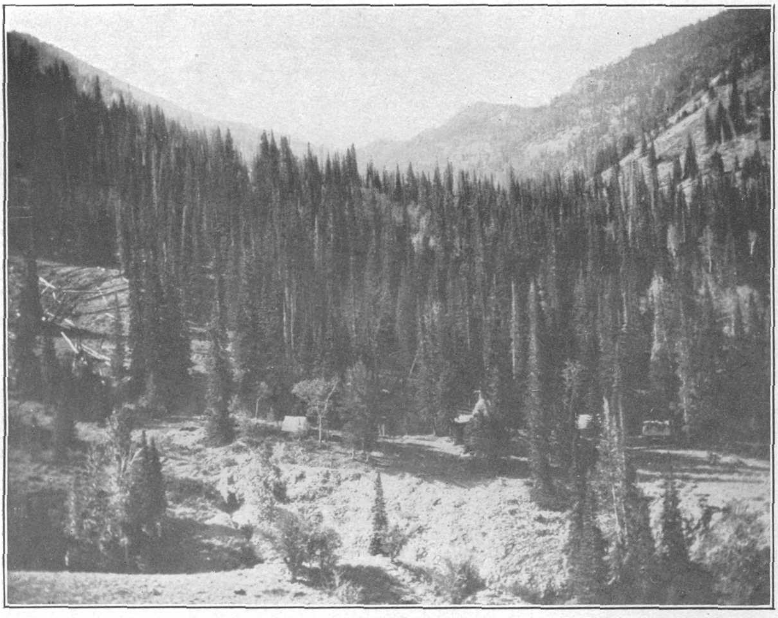
The camp was soon provided with numerous rudimentary hotels, restaurants, and the ordinary commercial and professional enterprises of a mining camp in its early development. A judge and deputy sheriff for the new town were sent in from Elko, the county seat, and until August the Jarbidge mail, sometimes amounting to several pack-horse loads a trip, was sent in gratis by the enterprise of the Elko Commercial Club. The population consisted, on the whole, of intelligent and enterprising Americans, and no disorder of any kind is reported.

A town site was soon laid out, and United States location mineral monument No. 230 was established on the ridge just above the town, between the river and Bear Creek. Town-lot rights or leases were obtained by permit from the forest officer for $10 each, and by March 15 were sold for $10 to $800 each, the price depending on the location. By that date the camp included more than 1,500 people and 300 tents.



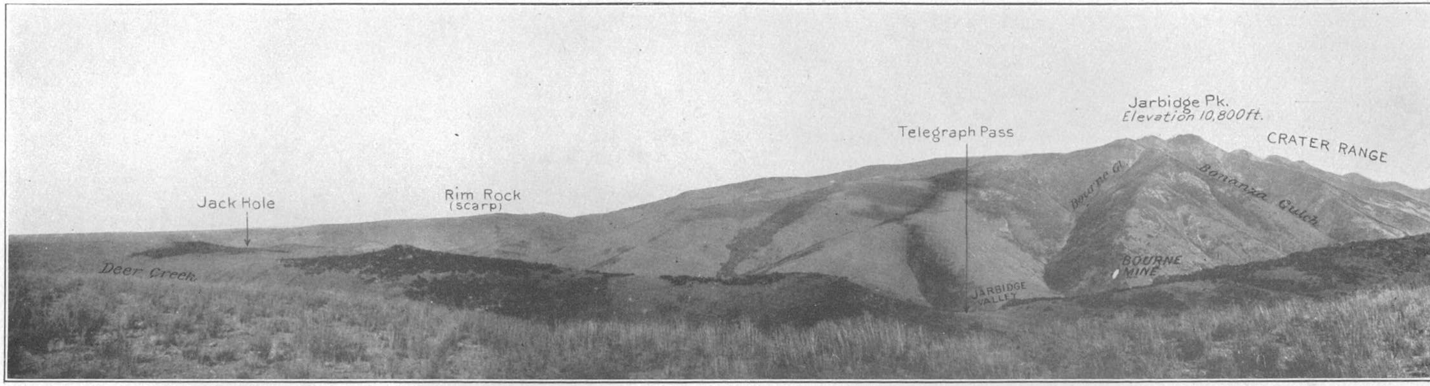
A. JARBIDGE, JARBIDGE RIVER VALLEY, AND MOUNTAINS IN OLD RHYOLITE.

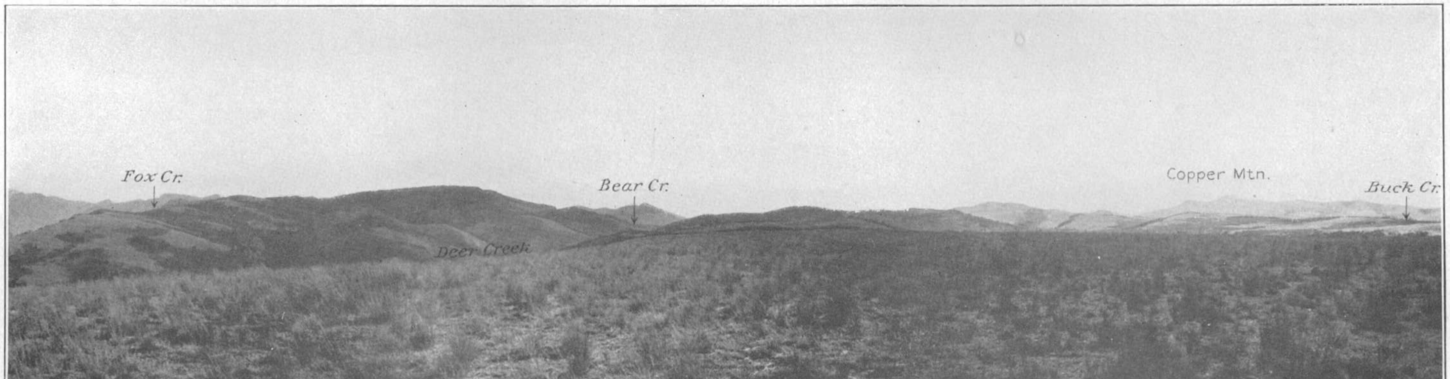
Looking S. 10° W.



B. SOUTH BRANCH VALLEY AT HEAD OF JARBIDGE RIVER.

Great Basin divide in background, Ozark lode and Foster camp on East Branch in foreground. View looking south from Ozark claim, at elevation of 7,700 feet.





JARBIDGE MOUNTAINS, LOOKING SOUTHEAST.

Panorama extending from the piedmont rim-rock plain, looking north-northeast beyond Jack Creek, south through the Crater Range to the Great Basin divide, thence west and northwest through the Copper Mountains along the western edge of the district. Taken from base-line station 1 on Deer Creek Ridge, 1½ miles northwest of Jarbidge, at an elevation of 7,500 feet.

It was soon learned that the reports of the Bourne property were grossly exaggerated, and accordingly, in May, a great exodus took place, the emigrants criticizing the country as they went out. Later, however, when the snow had melted away, many "ledges" were found, and a score or more new discoveries were made. Almost weekly up to the present time the discoveries have continued, and the developments are daily proving more promising and substantial.

With the opening of spring and the extension of the road from the Wilkins ranch, passengers and freight were delivered in the camp, and this, by materially reducing the price of merchandise and supplies, further facilitated prospecting. During the summer the trip from Twin Falls to Jarbidge is made by stage in two days and by automobile in a day, the automobile being helped up steep slopes by horses in the last 6 miles of the trip.

Early in the year several mining companies were organized and began operations. The Bourne group was financed, some machinery was brought in by sled, and with improved conditions of travel other companies sent in representatives to visit the camp. The claim holders, however, having in general exaggerated ideas of the value of their ground, held out for high prices and demanded large cash payments, causing hesitancy on the part of capitalists who would bond and develop the properties on a large scale.

Late in the summer of 1910 there were about 300 men in the district, of whom 180 voted at the November election. Although the town was quiet, considerable work was going on in the hills. Mine operators and capitalists investigated the resources of the district, and a company from Denver was examining the character of the ores with a view of installing a customs mill.

Produce and fresh meat were supplied by the neighboring ranches and fruits from the orchards on lower Bruneau and Snake rivers.

In May, 1910, the Jarbidge post office was installed, and a postmaster was appointed, and in October an official mail service (three mails a week) was started from Three Creek, Idaho, 25 miles distant, where connection is made with the mail stage from Buhl. There is also a semiweekly stage service to Rogerson to meet incoming trains on Mondays and Fridays.

Freight rates on ore and merchandise to and from the railroad are said to be \$50 a ton, or 2½ cents a pound, in either direction, making the cost of transporting lumber \$1 per thousand feet, and other things proportional.

Thus far connection with the district from the south has been made by trail only. Recently, however, the county and the business men of Deeth and Elko have started a good wagon road to connect Jarbidge with the Deeth road at Charleston, 16 miles distant. This road will give the district a direct route to the Southern Pacific Railroad and the Western Pacific Railway at Deeth (see fig. 1), bringing it into commercial relations with Deeth and Elko and giving the camp much lower freight and supply rates.

On the Idaho side, mainly through the business enterprise of the people of Twin Falls, the road to that town is being shortened and materially improved. This road will ascend the Jarbidge River canyon and flats and thus avoid the heavy Rimrock and Jack Hole grades.

The Thousand Springs Power Co., owning a water power just north of Snake River, 25 miles west of Twin Falls, is said to be considering the power needs of the camp with a view of supplying the mines with electric power at the prospective rate of $10 a horsepower a month, with a reduction to $8.25 a month when 2,000 horsepower shall be in use.

There is also assurance of early telephone connections over the line now extending from Elko and Deeth to Gold Creek, 18 miles to the southwest, and also with Hollister or Rogerson on the north.

The Buster mine has a three-stamp mill on the way. A large gang of men are at work on the Pavlak property, where a large mill, planned for both custom and private work, is being installed. According to latest accounts, eight or ten different companies are shipping ore or sacking ore of shipping grade.

For lack of title to the lots on which they desire to build, most of the inhabitants of the district are still living uncomfortably in tents, even in stormy wintry weather. They have petitioned the Government to eliminate from the national forest the most important mineral-bearing portion of the district, included in a north-south rectangular area of about 20 square miles. This area contains little or no timber, and its release would undoubtedly result in great benefit to the mining industry of the district.

Early in 1911 the camp had a population of about 1,200. The generally open character of the winter permitted practically all properties to be reached without difficulty, and work was carried on by a large number of companies, but owing to lack of funds the force was small.

At the mouth of Pine Creek, 3 miles above Jarbidge, a roadhouse and small settlement known as the Hub have been established by the progressive operators of the south end of the district to facilitate delivery of supplies to their camps. The wagon road has been extended for 2 miles above this point and includes the first bridge across the river, a substantial structure.

A plan to consolidate several of the best properties on the ridge south of Bonanza Gulch, including the Bluster, Rock Creek, Success, Sunflower, and others, and work them on a large scale through a main crosscut tunnel, for which the ground is admirably situated, is under consideration by C. J. Nelson and others with the view of enlisting Salt Lake City or Denver capital.

The district as a whole, with only meager development, is more than fulfilling the promise of its surface showings.

PHYSICAL FEATURES.

GREAT BASIN PROVINCE.

The mountain region of Jarbidge lies between two great physiographic provinces—the Great Basin on the south and the Snake River valley or Shoshone Basin on the north. The chief features of the Great Basin, comprising nearly all of Nevada and portions of Utah, Oregon, California, and Arizona,[1] consist of parallel minor ranges of mountains, trending generally in a north-northeasterly direction and separated by detritus-filled valleys.[2]

According to G. K. Gilbert, I. C. Russell, G. D. Louderback, and others, the ranges seem to owe their prominence mostly to faulting of late date, while J. E. Spurr holds that they were probably formed mainly by erosion of the separating valleys. Most of the older rocks in the ranges are folded Paleozoic and Mesozoic sediments cut by many intrusive bodies of porphyry and flooded by lavas. In northeastern Nevada the parallel ranges largely give way to irregular groups that, increasing in altitude from the foothills on the south, merge into the Jarbidge Mountains, which here form the rim of the Great Basin on the north. This portion of the basin is drained mainly by the headwaters of Marys River, which flows into the Humboldt, on the south, at Deeth.

SNAKE RIVER VALLEY PROVINCE.

Toward the north the Jarbidge Mountains slope down to the Snake River valley or Shoshone Basin,[3] which, according to Russell, consists of a vast, nearly level dissected area surrounded by deeply sculptured mountains and extends in a curved course, concave to the north, entirely across the southern portion of Idaho, with a length of about 350 miles and a width in general of 50 to 60 miles.

The master stream is Snake River, which flows in a westerly course longitudinally through the plain, here and there in box canyons, and which, at the west end of the basin, at Huntington, Oreg., enters a deep canyon.

The plain ranges in elevation from about 3,000 feet above sea level on the west to about 6,000 feet on the east. It is mainly of constructional origin and is underlain by Tertiary and Quaternary

[1] Gilbert, G. K., Lake Bonneville: Mon. U. S. Geol. Survey, vol. 1, 1890, Pl. II (opp. p. 6).

[2] The great number and distribution of the ranges in the central part of the basin is comprehensively shown in Bull. U. S. Geol. Survey No. 208, 1903, Pl. I.

[3] Russell, I. C., Geology and water resources of the Snake River Plains of Idaho: Bull. U. S. Geol. Survey No. 199, 1902.

basaltic lava flows and lake beds.[1] Certain of the lavas were poured out while the lacustrine sediments were being deposited and were interbedded with them. Some of the more recent lavas, according to Russell,[2] are probably not more than 100 years old.

A good section of the lavas is exposed in the right or north wall of the canyon just below the celebrated Shoshone Falls. The section beginning with "McKinley Rock," the flow on which the McKinley flagstaff stands, is as follows, in descending order:

Section in Snake River canyon below Shoshone Falls.

	Feet.
Black Snake River basalt, comprising many flows and exhibiting columnar structure more or less throughout	300
Unconformity.	
Reddish and yellowish volcanic breccia	100
Unconformity.	
Massive light-gray to buff rhyolite	300+

The rhyolite, according to S. F. Emmons,[3] approaches dacite in chemical composition and resembles certain modifications of the rhyolite of the Yellowstone National Park.

A good lesser section of the lavas is also well exposed on Salmon River, which joins the Snake from the south at Queens Ferry, 8 miles northwest of Buhl. The exposure is at the Salmon River dam and the crossing of the main Twin Falls and Jarbidge road, about 30 miles south of Twin Falls. Here the gorge of this stream, a steep-walled box canyon nearly 300 feet deep,[4] shows 60 feet of younger black basalt resting unconformably upon the older lavas in which the stream is now sinking its bed.

The region here described is drained mainly by the branches of Bruneau River, which from its source south of Charleston, Nev., runs nearly due north to the Nevada-Idaho boundary line and thence continues slightly west of north for about 80 miles to Snake River, which it joins about 50 miles almost due south of Boise. The next main tributary to the Snake on the east is Salmon River, which flows about parallel with the Bruneau and heads near Contact, Nev. At the State boundary line Salmon River is 50 miles east of the main Bruneau. Bruneau River splits into several branches in Idaho. The main stream flows to the west of the Jarbidge district. The East Fork heads in Nevada just south of the State line, south of Three Creek. The West Fork heads at the Nevada line near the east

[1] Lindgren, Waldemar, Mining districts of Idaho Basin and Boise Ridge, Idaho: Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1896, Pl. LXXXVII; map shows rhyolite and basalt, early Neocene. Boise folio (No. 45), Geol. Atlas U. S., U. S. Geol. Survey, 1898. The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 65. Silver City folio (No. 104) and Nampa folio (No. 103), Geol. Atlas U. S., U. S. Geol. Survey, 1904.

[2] Russell, I. C., op. cit.

[3] Report Internat. Geol. Cong., 1891, p. 373.

[4] Oral information furnished by Mr. F. C. Horn, chief engineer in charge of the Twin Falls-Salmon River Land & Water Co.'s dam now being built at this place.

line of the Duck Valley Indian Reservation. Jarbidge River lies east of the main Bruneau and joins it 40 miles north-northwest of its source, near Jarbidge, 14 miles south of the State line.

From the convex edge of the plain on the south, at an elevation of about 4,000 feet, between Salmon and Bruneau rivers, the surface rises in a long, gentle piedmont slope to the Jarbidge Mountains, as shown in the left background of Plate IV, the topography being on the whole in marked contrast with the rugged foothill slope of the Jarbidge Mountains on the Great Basin side to the south. In the vicinity of the State line the elevation in general is about 6,000 feet; 6 miles farther south, at the foot of the high divide (see Pl. III, *A*), about 7,000 feet. The highest ridges attain almost 11,000 feet. Near the headwaters and south of Jarbidge camp the forks of Jarbidge River have cut deep trenches into the elevated volcanic plateau, which reaches its highest point south and east of the town.

The high ground extending northeastward from the Jarbidge district and mountains, usually mistaken for the Great Basin divide, is in reality not the divide, but a long spur.

After a drive of 40 miles over the flat Snake River plains the Jarbidge-bound traveler on the Twin Falls route, crossing Salmon River at the dam, soon rounds on his left (southwest) the toe of a low lava-covered ridge. This ridge, with gradual increase in width and height and with gentle northwesterly slope, is on the left of the route throughout the remainder of the journey. It trends in a fairly direct southwesterly course for a distance of about 40 miles, beyond which it merges into the Jarbidge Mountains and the Great Basin divide proper. Back of the ridge from the traveler's route lie the widely branching headwaters of Salmon River, some of which reach well into the Jarbidge Mountains on the southeast.

Being without a name, the ridge may be appropriately referred to as the Elk Mountain ridge, from the so-called Elk Mountain, its most prominent landmark, in which, near the State line, 25 miles east-northeast of Jarbidge, it culminates at about 8,500 feet above the sea. (See Pl. I, p. 10.)

The ridge seems to be mainly monoclinal, with the rocks dipping gently to the northwest, but in places it may be anticlinal or domed, as at Elk Mountain. It is said to show traces of mineralization interruptedly throughout its extent, and its deposits are being prospected at Elk Mountain and other points.

JARBIDGE MOUNTAINS.

Of the mountains bounding the Snake River valley on the south the Jarbidge Mountains are among the most important and lofty. The great watershed extending irregularly through portions of Wyoming, Utah, Idaho, Nevada, and Oregon, and forming the divide between the Great Basin on the south and the Snake River valley or basin of the Columbia on the north, culminates in the Jarbidge Mountains at an elevation of nearly 11,000 feet.

The mountains are situated mainly around the head of the Bruneau River drainage basin. In the vicinity of the State line this basin has a width of about 60 miles, from a point east of Three Creek, Idaho, to Owyhee, Nev., and contains many tributary streams. It is bounded on the east, south, and west, by Salmon, Humboldt, and Owyhee River basins, respectively.

The Jarbidge Mountains are about 12 miles wide and extend in an east-west direction parallel with the axis of the divide, across Jarbidge River, a tributary to the headwaters of Bruneau, and its East Fork,[1] which drain the area in a northerly direction. The main ridges trend in the same direction, at right angles to the axis of the divide, as shown in Plate II (p. 12). This trend is not wholly due to consequent drainage on a sloping surface of lava flow, as would at first appear, but seems in general to harmonize with the trend of the Great Basin topography on the south and may owe its origin to lines of fissuring or faulting in connection with the epoch of igneous flows and uplift.

The lavas were erupted in at least two distinct and extensive epochs, separated by a considerable time interval, during which subaerial erosion scored the surface and developed a drainage system similar to that of to-day.

The lavas of the later period were more fluidal and resistant than those of the first period. For convenience they may be referred to as the younger or "rim-rock" lava. They were freely poured out, completely flooding the entire lower region and burying a large part of the older lavas, in places to depths of nearly 2,000 feet. This second period of eruption left the Jarbidge Mountain region in the form of a huge elongated east-west dome rising perhaps a thousand feet or more above the present highest peaks and having by reason of the fluidity of the later lavas a comparatively smooth surface.

From the summit of this dome the surface declined in long, gentle slopes in all directions—to the flat-lying Snake River plains, about 20 miles distant on the north, and nearly to the base of Elk Mountain, about the same distance on the east.

On this new constructional domal surface, at the close of the second period of volcanism, subaerial erosion resumed its work of destruction and denudation, and the present drainage system, with its main courses approximately parallel to the lines of the intervolcanic epoch,

[1] This stream by some is also called the East Fork of Bruneau River, but this name is preoccupied, as shown on the land-office and other maps, by the 50-mile tributary draining the large Three Creek country to the east. To avoid confusion it seems best to refer to the stream under consideration as East Fork of the Jarbidge.

was established. The higher part of the dome, where precipitation and temperature extremes were greatest and where there were lines of weakness due to volcanism and perhaps crater openings of considerable depths, was most deeply dissected.

A notable and economically important feature of this process of denudation was the stripping off of the roof or cover of the dome, the great blanket of the second or younger lavas, which are now worn back to the east side of the East Fork valley on the east and beyond the Jack Creek valley on the north. The eroded edges of these lavas, rising nearly 1,000 feet above Jack Hole and Jarbidge River, form a steep inward-facing scarp or rim rock, which rests upon and encircles the slopes of the mountains on the north and rises to the 10,000-foot contour where it crosses the divide on the east. (See Pl. II, p. 12.)

As soon as the young lava covering became worn through at the summit of the dome, erosion was concentrated along the contact of this covering with the underlying softer old lava formation, and it has been a controlling factor in determining the present topographic features of the district.

Simultaneously and almost coextensively with the stripping back of the young lava covering, the main streams—Jarbidge River, East Fork, and Jack Creek—in their process of down-cutting along the contact and subsequently below it, migrated or shifted their channels laterally down the slope of the dome, the Jarbidge to the west, East Fork to the east, and Jack Creek to the north. This migration of the channels has produced precipitous inward-facing cliffs bounding these streams on the outside of the dome—east of East Fork, north of Jack Creek, and west of Jarbidge River—and contrasting strongly with the long and comparatively gentle slopes on the opposite or inner sides, across which the streams have migrated. It has also resulted in the present occupation by East Fork and the Jarbidge of practically the same drainage lines that existed in the inter-volcanic epoch before the rim-rock lavas were poured out.

The denudation and dissection of the old underlying lavas that followed the removal of the young lava covering has resulted in two distinct types of topography. The one type, shown in Plate IV, generally belongs to the old lava area occupying the heart of the district, from a line west of Jarbidge River to a line east of East Fork, and is adolescent. The other type belongs to the young lava, or piedmont portion of the field, and is young. It is shown at the left in Plate IV.

The old-lava area is at once the most striking and important. It contains the dominant features of the district. These consist of the high, rugged north-south ridge between Jarbidge River and East Fork and the deep valleys of these two streams, which cut below the

6,000-foot contour, or about 5,000 feet below the tops of the neighboring mountains.

Of the culminating peaks, which, as shown on Plate II and to the left of the center in Plate IV, are seven in number and about a mile apart, the most northerly and highest is Jarbidge Peak. This and the four succeeding peaks to the south, which are nearly equal to it in height, are conspicuous to the traveler approaching the district from the Idaho side, being visible for 90 or 100 miles on a clear day. They are commonly known as the Five Peaks, also as the Crater Peaks, Jarbidge Peaks, and Jarbidge Mountains. For convenience of reference in this report they will be referred to as the Crater Peaks or Crater Range.

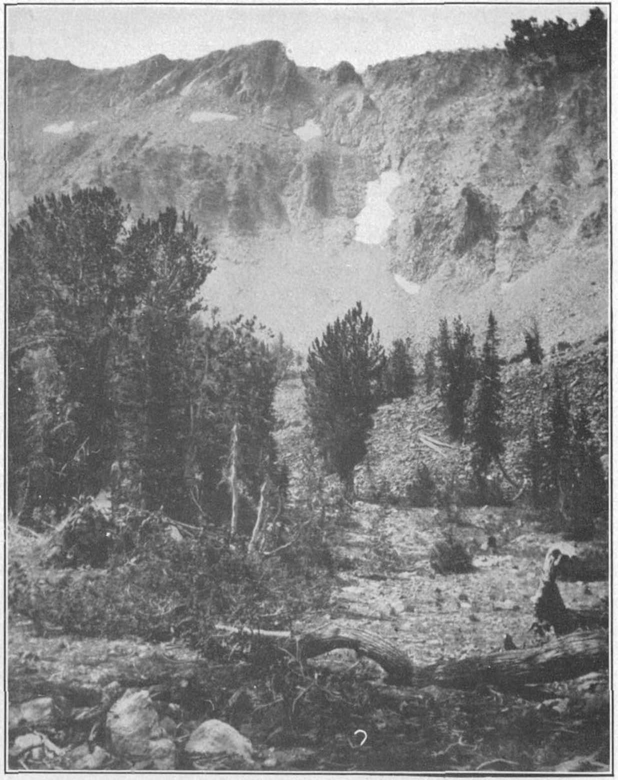
This Crater Range is the most striking feature of the district topographically, geologically, and economically. It exceeds in altitude the Great Basin Divide. It is composed of great masses of volcanic rocks and contains nearly all the mineral deposits of the district.

The topography of the old-lava area is of the type produced mainly by water erosion in an elevated country of horizontally deposited volcanic rocks. It is mainly in the adolescent stage and is characterized by long, high, and in places narrow, though not usually sharp-crested ridges, with smooth or even contours and correspondingly deep, mostly V-shaped valleys and gulches bounded by slopes rising in many places for considerable distances at average angles of nearly 45°. (See Pls. II and IV.) Near the middle of the area, from Jarbidge River to the top of the north end of the Crater Range, the surface rises about 4,300 feet in a horizontal distance of about 1½ miles, or at the rate of nearly 3,000 feet to the mile.

In portions of their courses even the main streams occupy steep-walled box canyons, and in places, as back of the lower part of Jarbidge and west of Bear Creek, the uniformity of the mountain slopes is interrupted by long stretches of vertical cliffs or scarps several hundred to a thousand feet in height, from whose base long trains of talus or rock débris extend down toward the valleys.

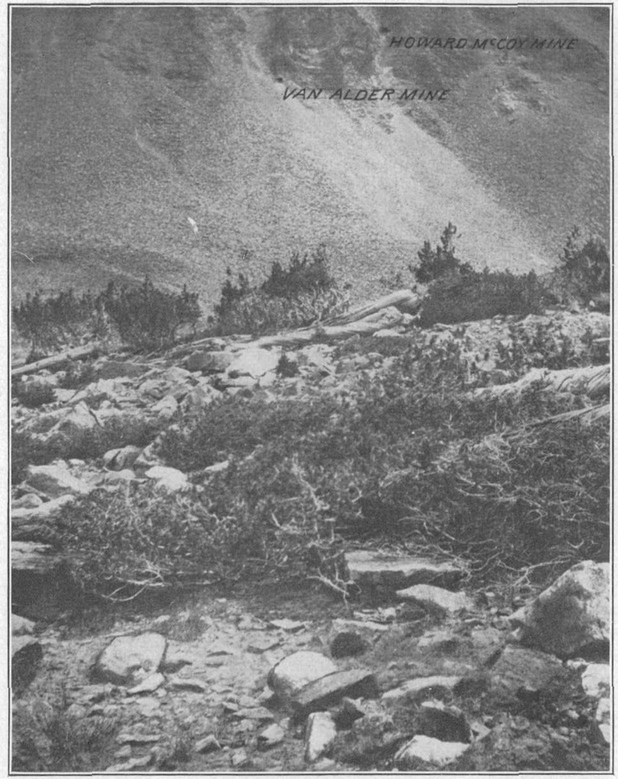
On the east the Crater Range or, more exactly, the saddles of the range, also break off abruptly into steep, high-walled ampitheaters—U-shaped cirques or basins commonly known in this region as "craters"—in which head most of the perennial tributaries of East Fork and Jack Creek.

These basins, which, like the peaks, are situated about a mile apart, and some of which are confined by walls 1,000 or 1,200 feet high on the west (Pl. V, *A*) and separated by long sloping ridges, are known in consecutive numerical order from north to south as First Crater, Second Crater, etc. It is possible, to judge from tuff, breccia, and other volcanic débris observed in the walls, that some



A. PART OF RIM OF FIRST CRATER.

From Little Jack saddle, at elevation of 9,200 feet, looking S. 30° W.

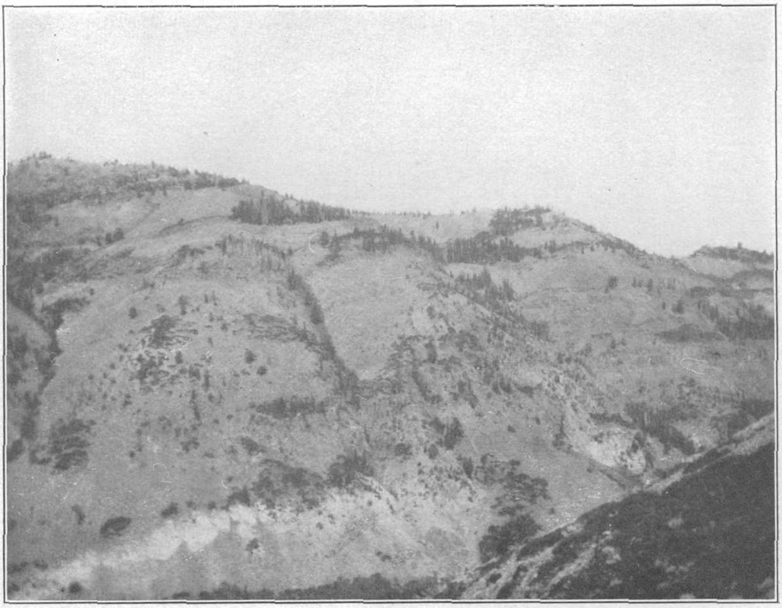


B. VAN ALDER AND HOWARD McCOY MINES, IN SECOND CRATER.

Floor of coarse glacial, snowslide, and avalanche débris in foreground, flanked by belt of steep talus 200 feet high, skirting foot of mural cliff. From floor of "crater," at elevation of 9,500 feet, looking S. 16° E.

A. PINE CREEK VALLEY IN OLD RHYOLITE.

From Pick and Shovel trail, on opposite slope, at elevation of 7,000 feet, looking southeast.



B. OLD RHYOLITES NEAR HEAD OF JARBIDGE RIVER.

Composed of heavy, ill-defined flows or beds dipping gently southwest. From the Ozark mine trail, at elevation of 7,700 feet, looking west across the river.

of the basins may really represent old craters, but time did not permit investigation of this phase of the subject.

The "craters" manifestly owe their origin and general outline to local glaciers that headed in them. They open to the east or northeast, and in this direction their floors slope gently. Since their occupancy by the glaciers their forms have been modified by subaerial erosion, including that of snowslides or avalanches. Snow and ice now remain in some of them throughout the year. They are floored by morainic and other forms of glacial drift and coarse avalanche débris, and the cliffs that confine them on all but the open side are flanked by belts of talus rising with steep slope usually about 200 feet above the floor (Pl. V, *B*). Minor features of snowslide and glacial origin also occur locally along the upper course of the Jarbidge, described later.

The old-lava area on the whole is comparatively free from the impassable precipitous barriers that usually characterize a country of this scale of topography and class of rocks. It is generally accessible to the pedestrian, and with slight detours a horse can be taken into almost any part of it.

The topography of the younger or rim-rock lava area is a young topography and contrasts strongly with that of the old-lava area. It resembles in its main features that of the adjoining Snake River plains. The area consists in general of a gently sloping, rarely benched or scarped mesa or piedmont plain dissected by more or less parallel narrow, steep-walled box or V-shaped canyons, as shown at the left in Plate IV. Its youthful character is due in some measure to the greater resistance of the rocks in which it is carved but mainly to the facts that its relatively dry climate essentially exempts it from the attacks of subaerial erosion and that the streams which rise in the moister mountain regions in crossing it erode only the bottoms of their channels, leaving the sides and upper edges of the valley walls intact.

Jarbidge River, the most important stream, heads in the southern part of the district on the upper north slope of the divide, in the angle formed by the junction of the divide with Crater Range, at an elevation of about 9,000 feet. (See Pls. II and III, *B*.) In the upper part of its course, which trends in a north-northwesterly direction and is of a more or less torrential character in a U-shaped valley, it receives contributions from numerous gulches, the most important of which is Fox Creek, entering from the south, about 3 miles in length. About half a mile below Fox Creek and the ninth standard parallel the river is joined from the southwest by Pine Creek, which is about 5 miles long and approximately equal in volume to the Jarbidge above the confluence. The valley of Pine Creek is sharply cut, with rough topography, as shown in Plate VI, *A*.

Through the remainder of the district the course of the Jarbidge is northerly and its principal tributaries are Bear Creek and Deer Creek on the west and Bonanza Gulch, Bourne Gulch, and Jack Creek on the east.

From Pine Creek nearly to Jack Creek, a distance of about 4 miles, the Jarbidge for the most part flows through a gravel-floored, locally terraced flat about 500 feet in average width (Pl. III, *A*) and has a semigraded course with a fall of about 160 feet to the mile, and is correspondingly swift. In volume of water it is said by W. A. Scott to compare with Clear Creek in Colorado. It is reported to be difficult to ford during spring and early summer. In August, 1910, at Jarbidge it was a fine clear stream about 20 feet wide and 18 inches deep.

After entering the young lava area a short distance above Jack Creek the course of the river is mostly in a box canyon, a feature which has caused the present road to enter Jarbidge over Jack Creek Mountain, the high ridge between Jack Creek and Jarbidge River. The canyon is not deep, however, and as a more or less open though somewhat rugged valley flanks it on the east this part of the course could with moderate cost be made feasible for a highway or even a railroad into Jarbidge.

Jack Creek, which heads in the First Crater and adjoining territory on the southeast, occupies in a sense a piedmont valley bounded by the old lava mountains on the south and the young lavas forming the rim rock on the north. So near do its headwaters lie to a tributary of East Fork that the triangular area to the north between these two streams and the Jarbidge, being almost completely surrounded by water, is commonly known as the island.

Bear Creek and Deer Creek are both fine streams of moderate size and are bordered by timber land in the upper parts of their courses.

East Fork, which drains the eastern part of the district, compares favorably in size with the Jarbidge. The topography of its valley, however, is more rugged, especially on the east. Its course in the young lava area, which it enters in the northern part of the district, is mainly in a narrow box canyon, whose walls have almost a sheer drop in places of nearly 1,000 feet and within the district can be crossed only by making a detour of several miles to the north over a trail by way of Robinson Hole. The Jarbidge wagon road makes a similar detour, and by means of a long "grade" on each side of the canyon crosses at the Wilkins ranch in Idaho, 6 miles below Robinson Hole, about a mile north of the State line. At the north edge of the district at the time of visit, when the water was said to be at its lowest stage, East Fork was a fine, clear stream about 25 feet in width and 9 inches deep. It flows in a semigraded or gently riffled course over a gravel bed, with an estimated velocity of about 4 miles an hour.

It is probable that in both the Jarbidge and East Fork valleys considerable water leaves the district unobserved through the subsurface gravels that constitute the valley floors. Both streams are plentiful in trout. After receiving East Fork a few miles beyond the Idaho line Jarbidge River flows to the Bruneau, about 24 miles north of the State line. From the junction Bruneau River flows a little north of west for about 50 miles across Owyhee County and joins Snake River near the corner of Ada and Elmore counties.

Bruneau River, notwithstanding the fact that in the lower part of its course its waters are largely used for irrigation, is one of the few tributaries whose waters, flowing across the Snake River plains, reach the Snake as perennial surface streams from the south. Among the tributaries of the Bruneau the Jarbidge waters are perhaps the most important.

The extreme southeastern and south-central portions of the district, which are relatively unimportant so far as present mining developments are concerned, drain, respectively, southeastward through Canyon, Cottonwood, and Camp creeks into Salmon River and southward through Marys River into the Humboldt. The extreme southwestern portion of the district drains principally into the main or Charleston fork of the Bruneau.

GEOLOGY.

Like much of the Great Basin on the south and the Snake River or Shoshone Basin on the north, the Jarbidge district lies in an area of folded and tilted, principally Paleozoic sedimentary rocks cut by granular intrusives and flooded by Tertiary lavas, as shown on the geologic map. (See Pl. II.)

The rock groups of the region, beginning with the oldest, are Paleozoic sedimentary rocks, post-Paleozoic intrusive rocks, early Tertiary lavas, late Tertiary lavas, Tertiary sedimentary rocks, and Quaternary deposits. With reference to the mineral deposits the early Tertiary lavas are the most important of these groups. The area of these lavas is approximately outlined on Plates I and II.

SEDIMENTARY ROCKS.

PALEOZOIC SEDIMENTARY ROCKS.

Rocks regarded as Paleozoic occur in the western part of the Jarbidge district and extend southward across the divide into the Great Basin. (See Pls. I and II.) In this vicinity they constitute the north-south range of hills between the Jarbidge drainage basin on the east and that of the main fork of Bruneau River on the west, locally known as the Quartzite Range and also as the Copper Mountain Range, from the prospects of copper that it contains.

These rocks, according to N. W. Sweetser,[1] who assisted the writer and who had previously devoted much time to studying the geology of the district—

> consist, in order of deposition, of quartzite, limestone, and shales. They have been considerably disturbed, faulted, tilted, and folded. They dip steeply to the north at angles of 60° and exhibit a general thickness of several thousand feet. * * * No fossils have as yet been found in them in this part of the field. They rest upon gray, coarsely crystalline hornblende granite, which seems to be intrusive, and they are locally overlain or capped by thin flows of rhyolite. The limestone is cut by dikes of granodiorite of about the same age or slightly younger than the granite.

Near the center of the district are outcrops thought to belong to these old rocks, notably on the west slope of Crater Range. Here, protruding above the surface of the surrounding rhyolite, a quartzite reef, apparently representing an upturned bed or sill, probably in the crest of a buried range, and commonly known as the "quartzite dike," is shown by more or less continuous bold croppings to extend for a distance of about 2 miles in a northeasterly direction diagonally across the mountain side above the Bourne and Buster mines and is recently reported to have been struck in the Pavlak tunnel. It is said to have an average width of about 200 feet and a maximum of about 400 feet. It agrees in trend with the Great Basin ranges on the south and probably represents the crest of one of these old mountains that was long deeply buried by the lavas through which it now protrudes, having been but recently brought to view by erosion and probably faulting. On the northeast, where it crosses Bourne Gulch at an elevation of nearly 7,000 feet, it is about 140 feet wide, dips 80° NW., and shows on the hanging wall some breccia and a little black slate or chloritic and graphitic schist containing needles and lath-shaped areas of sericite and other metamorphic minerals. Where not altered to a relatively massive quartzite by silicification, as it seems to be in most places, it consists of medium-grained whitish or light-gray, very hard quartzite. Except for a few layers of parallel sheeting it is structureless or massive. Persons who have prospected on or along the reef report that no other sedimentary rock is present in association with it.

About half a mile southeast of the quartzite reef above described, to the north of the Bluster and the Pick and Shovel mines, chiefly on the south side of Bonanza Gulch, pale-greenish siliceous shale or sericitic quartzite and conglomerate crop through the rhyolite. These rocks, though regarded as Paleozoic, appear younger than the quartzite reef, with which they are in marked unconformity and which has seemingly supplied much of the material contained in

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[1] Min. and Sci. Press, vol. 101, No. 27, Dec. 31, 1910, p. 871.

the conglomerate. The outcrops extend interruptedly from the point where the Bluster ledge crosses the gulch, at an elevation of about 7,200 feet, westward down the gulch for about a quarter of a mile, from the It claim on the east across the American Man claim and on to the Arizona Fraction on the west, at an elevation of about 6,800 feet. From Bonanza Gulch the outcrops also rise southward to the top of the ridge, at the north end of the Pick and Shovel claim.

The conglomerate, exposing a thickness of about 80 feet, occurs toward the base or lower end of the croppings. It ranges from fine grained and arkosic to coarse and bowldery. It consists mainly of bowlders and pebbles of quartzite, black massive argillaceous rock freely traversed by quartz veinlets, and some old basalt or diabase. It is overlain by impure sandstone or graywacke, which seems to grade upward into the shale. Both the conglomerate and the shale are cut by rhyolite dikes, one of which is about 30 feet wide.

The shale is more or less massive and shows some banding, apparently representing lines of stratification. It resembles some of the shales in the Cœur d'Alene district, Idaho. Though the rocks are somewhat faulted and tilted, they seem in general to dip gently southeastward into the mountain, and their deeply buried strata may be the source of crushed small masses and fragments of shale found in the veins and associated fault gouge higher up in the mountains. Their outcrops on Bonanza Gulch indicate a partial thickness of about 500 feet.

The rocks here described are referred collectively to the Paleozoic on account of their resemblance to Paleozoic rocks observed elsewhere and the well-known wide distribution of such rocks in the surrounding regions.

Some of these rocks, consisting principally of quartzite, limestone, and a considerable amount of shale and slate, are exposed in the Elk Mountains on the Nevada side of the State line, about 10 miles east of the Jarbidge district, and also in the Contact district, on Salmon River, 25 miles east of the southern part of the Jarbidge district, about 15 miles south of the State line. Both of these places were visited by the writer in 1910.

The maps of the Fortieth Parallel Survey show a wide distribution of these Paleozoic sediments on the south. Map IV, which covers an area extending north to parallel 41° 30′, or within 20 miles of the Jarbidge district, shows the Basin ranges and areas of the old eroded rocks in that region to be mostly Carboniferous, surrounded and overlain by Tertiary sediments (Humboldt formation, Pliocene) and, as in the Jarbidge district, flooded by rhyolitic lavas. To judge from reports of prospectors it is also probable that the Pliocene sediments or lake beds extend northward to the southern slope of the Jarbidge Mountains.

The region 25 miles to the west of the Jarbidge district Emmons[1] describes as an area of Paleozoic sediments cut by granodiorite and other intrusive rocks and overlain by Tertiary lake beds and lava flows, and he shows the wide distribution of these old rocks on his map.

In the light of these facts, together with the presence of eroded Paleozoic rocks in and west of the district and in Elk Mountain on the east, there seems to be no doubt that the great pile of lavas composing the Jarbidge Mountains rest upon a surface of eroded Paleozoic rocks that is continuous, beneath the lavas, with that of the Great Basin on the south, Copper Mountain on the west, and Elk Mountain on the east.

The nearest locality at which the detailed section of these Paleozoic rocks has been worked out and their succession is well known is Eureka, Nev. As inquiries concerning these rocks have been made by persons who are investigating the mineral deposits contained in them in the Copper Basin, Cornwell Basin, Gold Basin, Taylor pocket, and other areas adjoining the Jarbidge district on the west, the following Eureka section[1] is inserted as having a more or less direct bearing on these areas.

Emmons reports that in the area covered by his paper—

> none of the sedimentary or igneous rocks have suffered deep-seated dynamic metamorphism such as results in the development of gneissoid or schistose structure and none of them have been deformed in the zone of flow. Around the intrusive granular rocks there is noticeable contact metamorphism, with garnet zones, especially in limestone and in shales.

The present writer finds the same to be true of the Elk Mountain and contact districts to the east, and essentially the same seems to be true of the area bounding the Jarbidge district on the southwest and west.

Geologic section in Eureka region, Nevada.

System.	Formation.	Thickness (feet).	Character.
Carboniferous.	Upper coal measures	500	Light-colored blue and drab limestones.
	Weber conglomerate	2,000	Coarse and fine conglomerates, with angular fragments of chert; layers of reddish-yellow sandstone.
	Lower coal measures	3,800	Heavy-bedded dark-blue and gray limestone, with intercalated bands of chert; argillaceous beds near the base.
	Diamond Peak quartzite	3,000	Massive gray and brown quartzite, with brown and green shales at the summit.
	White Pine shale	2,000	Black argillaceous shales, more or less arenaceous, with intercalations of red and reddish-brown friable sandstone, changing rapidly from one locality to another; plant impressions.

[1] Emmons, W. H., A reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nevada: Bull. U. S. Geol. Survey No. 408, 1910, p. 15, Pl. V.

Geologic section in Eureka region, Nevada—Continued.

System.	Formation.	Thickness (feet).	Character.
Devonian.	Nevada limestone	6,000	Lower strata indistinctly bedded, saccharoidal texture, gray color, passing up into strata distinctly bedded, brown, reddish brown, and gray in color, in places finely striped, producing a variegated appearance; upper rocks massive, well bedded, bluish-black in color; highly fossiliferous.
Ordovician.	Lone Mountain limestone	1,800	Black, gritty beds at the base, passing into a light-gray siliceous rock, with all traces of bedding obliterated; Trenton fossils at the base; Halysites in the upper portion.
	Unconformity.		
	Eureka quartzite	500	Compact vitreous quartzite, white, blue, passing into reddish tints near the base; indistinct bedding.
	Pogonip limestone	2,700	Interstratified limestone, argillites, and arenaceous beds at the base, passing into purer, fine-grained limestone of a bluish-gray color, distinctly bedded; highly fossiliferous.
Cambrian.	Dunderberg shale [a]	350	Yellow argillaceous shale; layers of chert nodules throughout the bed, but more abundant near the top.
	Hamburg limestone	1,200	Dark-gray and granular limestone; surface weathering rough and ragged; only slight traces of bedding.
	Secret Canyon shale	1,600	Yellow and gray argillaceous shales, passing into shaly limestone; near the top interstratified layers of shale and thinly bedded limestones.
	Eldorado limestone [b]	3,050	Gray, compact limestone; lighter in color than the Hamburg limestone, traversed with thin seams of calcite; bedding planes very imperfect.
	Prospect Mountain quartzite	1,500	Bedded brownish-white quartzites, weathering dark brown; ferruginous near the base; intercalated thin layers of arenaceous shales; beds whiter near the summit.

[a] This name replaces "Hamburg" shale. See Walcott, C. D., Smithsonian Misc. Coll., vol. 53, No. 1812, 1908, p. 184.
[b] This name replaces "Prospect Mountain" limestone. Idem.

TERTIARY SEDIMENTARY ROCKS.

Rocks corresponding to Tertiary sediments are reported by prospectors to occur on the south side of the Jarbidge Mountains, but as that locality was not visited in this work, the following statement taken from Emmons's report[1] is here inserted:

Eocene.—On the northwest slope of the Elko Range, about 3 or 4 miles east of Elko, the Eocene beds are exposed, dipping 35° E. These beds consist of very thin shales, calcareous at some places and silicified at others, and they contain seams of impure coal. They are overlain unconformably by the Humboldt formation (Pliocene), which here consists of a white porous volcanic ash. * * *

Pliocene.—In Pliocene time a great lake occupied almost the whole territory between the Wasatch Range on the east and the Sierra Nevada on the west,

[1] Emmons, W. H., A reconnaissance of some mining camps in Elko, Lander, and Eureka Counties, Nevada: Bull. U. S. Geol. Survey No. 408, 1910, pp. 21–23.

extending northward far into Idaho and southward to an unknown distance. This lake Clarence King has named Shoshone Lake, and the beds laid down in it are called the Humboldt formation. These beds are composed mainly of friable gray, white, and drab sandstone and marly limestones, and at many places contain abundant volcanic material, chiefly tuff of a rhyolitic character. Some of the siliceous beds are made up largely of diatomaceous earth. In Bone Valley, just west of the Mallard Hills, which are some 30 miles north of Halleck, Pliocene fossils have been found.

The thickness of the Humboldt formation is at most places unknown, for complete sections are very rare. In the Huntington Valley, according to King, it can not be less than 600 or 800 feet, and occurrences at other places give the impression that the thickness is greater.

The Humboldt formation covers large areas in this part of Nevada. * * * At several places it lies approximately flat and rests unconformably on the upturned edges of the steeply tilted Eocene beds. * * * As a rule, however, the Humboldt formation is not so steeply tilted as earlier formations, and at several places the beds are flat-lying, resting upon the more highly tilted Eocene beds.

QUATERNARY DEPOSITS.

The Quaternary deposits so far as observed are of too small extent to be shown on the scale of the accompanying map and are relatively unimportant. They comprise glacial and snowslide deposits, talus, and alluvium.

Glacial deposits.—As noted on page 25, the series of amphitheaters, or so-called craters, into which Crater Range breaks off abruptly on the east, owe their origin to the action of ice or local glaciers that headed in them. The rock materials (Pl. V, *B*, p. 24) which these and similar neighboring glaciers eroded or transported in their downward course were deposited mainly as sheets of till, bowlder clay, ground moraine, or ridges of terminal moraine in the bottoms or lower side slopes of the upper parts of the valleys. Examples of these deposits occur on the upper course of Jarbidge River, and in the dooryard of Park's place at Jarbidge is a small esker-like gravel ridge, which seems to owe its origin to a subglacial stream. It is quite possible that on certain slopes now covered with slide and talus sheets of ground moraine of considerable local extent, not observed in this work, may occur.

Snowslide deposits.—The snowslide deposits occur mainly as crude fan-shaped accumulations at the mouths of some of the main gulches and craters, of which Snowslide Gulch is a good example. They consist of a heterogeneous mixture of talus or loose, angular rock débris, gulch scour, demolished timber, etc., gathered and mixed by the snowslide or avalanche on its way. They have a maximum extent of about one-fourth of a mile and a thickness of 30 or 40 feet. In places they are cut through to the underlying till by the present streams.

Talus deposits.—Trains or belts of talus or angular rock débris, usually coarse, extend from the foot of the cliffs down toward the valley. Good examples occur about the head of Bonanza and Gorge gulches and at the foot of the cliff in Horseshoe Crater (Pl. V, *B*, p. 24).

Alluvial deposits.—Stream-laid river gravels floor the open portions of the main valleys, especially the Jarbidge Valley, from a point near Pine Creek to the vicinity of Jack Creek, for a distance of about 4 miles, as shown in Plate II (p. 12). They consist mainly of the older lava pebbles and range from fine to coarse, but are mostly above medium size. The deposits have an average width of about 500 feet and a maximum at Jarbidge of about 1,000 feet. At the time of visit they were being exploited at the lower end of the valley, where they show a thickness of more than 14 feet, with bedrock not yet reached.

In the valleys on the south side of the divide, in the direction of Charleston, according to reports of prospectors, occur also accumulations of Quaternary gravels such as floor the valleys between the ranges more or less throughout the Great Basin region.

IGNEOUS ROCKS.

INTRUSIVE GRANITIC ROCKS (CRETACEOUS?).

The oldest igneous rocks are the post-Paleozoic intrusives. They consist of stocks and dikes of granular granitic rocks that intrude the Paleozoic sediments and are considerably older than the Tertiary volcanic rocks next described. The most important of these, according to Sweetser,[1] is a gray, coarsely crystalline hornblende granite that is extensively exposed underlying and intruded into the Paleozoic sedimentary rocks on the southwest and west of the district. This rock seems in general to agree with the prevailing intrusive found by Emmons [2] in the area farther to the west, and, like it, may be found on analysis to stand close to granodiorite.

After the intrusion of the granite both it and the Paleozoic rocks were further intruded and cut by dikes of a similarly granular rock. A small body of this rock outcropping through the sediments and their rhyolite covering occurs on the upper part of Bonanza Gulch north of the Bluster mine. It is a red medium-grained granitoid rock and contains numerous dark or dull-green, roughly equidimensional crystals of hornblende, of which the largest are nearly one-fourth inch in maximum diameter. The microscope shows the rock to be a granodiorite and to be composed essentially of soda-lime and

[1] Sweetser, N. W., Geology of the Jarbidge mining district: Min. and Sci. Press, vol. 101, No. 27, Dec. 31, 1910, p. 871.

[2] Emmons, W. H., Bull. U. S. Geol. Survey No. 408, 1910, p. 24.

alkali feldspars in about equal amount, hornblende, and quartz. Quantitatively the alkali feldspars are present in the following order: Microcline, microperthite, orthoclase. The microcline is traversed by veinlets of albite and contains inclusions of plagioclase. Optic tests show the plagioclase to be mostly andesine-labradorite. Much of it is considerably kaolinized or altered. In the weathered rock the hornblende is wholly changed by alteration to epidote, which is present in considerable amount, and to chlorite. Accessory minerals present are magnetite in considerable amount, apatite, and zircon.

In describing the occurrence of granodiorites in the area to the west Emmons[1] refers to an analysis as follows:

> An analysis[2] of the rock which constitutes the summit of Shoshone Peak was made by R. W. Woodward. This analysis gives all the iron as ferrous iron, and the norm can not be calculated; but it is sufficient to confirm the classification of the rock as granodiorite. Its composition is very near that of a granodiorite from Pyramid Peak, Eldorado County, Cal., described by Lindgren,[3] and that of other typical granodiorites in California.

Analysis of granodiorite from Shoshone Peak.

[By R. W. Woodward.]

SiO_2	70.17
Al_2O_3	14.53
FeO	4.03
CaO	2.29
MgO	.93
Na_2O	3.25
K_2O	3.35
H_2O	1.53
	100.08

The intrusive granitic rocks, on the whole, are younger than the Paleozoic rocks, which they intrude, and older than the Tertiary lavas, which they do not intrude. From a similar study of their relations to rocks of known age in various parts of the West described by Lindgren, Ransome, and others, Emmons[4] concludes that the rocks are essentially of Cretaceous age. They are very likely of the same general period of intrusion as the batholiths of California and western Nevada. They are of economic importance, for the ore deposits found in association with them in the Paleozoic sediments that are widely distributed in northern Nevada and at Cornwall and Copper basins, and elsewhere on the west and southwest of the Jarbidge district, seem to be genetically connected with their intrusion.

[1] Emmons, W. H., op. cit., p. 25.
[2] U. S. Geol. Expl. 40th Par., vol. 2, 1877, p. 621.
[3] Lindgren, Waldemar, Am. Jour. Sci., 4th ser., vol. 3, 1897, p. 306.
[4] Emmons, W. H., op. cit., pp. 28–29.

TERTIARY VOLCANIC ROCKS.

GENERAL FEATURES.

The intrusion, deformation, and erosion of the Paleozoic sediments was followed by the eruption of Tertiary volcanic lavas that more or less completely flooded the region. It was early recognized by the Fortieth Parallel and other surveys that the Great Basin shows a variety of Tertiary lavas which are identical over wide areas and were erupted in somewhat the same succession. This succession in general, according to Spurr,[1] whose studies of the lavas in a large part of the Great Basin are among the most recent, is rhyolite, andesite, and basalt.

Among these rocks the most abundant and widely distributed are the rhyolites.[2] The volcanic rocks in the Jarbidge district, as shown by a comparative study with those of the Fortieth Parallel and other surveys, plainly belong to this family. It is quite possible, however, that the rocks of the Jarbidge district may contain also other lavas than rhyolites, but they were not observed in this reconnaissance and, if present, must be in small amount.

The description of Emmons,[3] which gives the chief characteristics of the rocks of the Jarbidge district, is as follows:

> Rhyolites are glassy igneous rocks which have about the same chemical composition as granites. In color they are white, pink, purple, or dark brown. The dense, pasty groundmass may contain phenocrysts of quartz and orthoclase, with small amounts of biotite, augite, and hornblende. A little soda-rich plagioclase may also be present among the phenocrysts. They form surface flows and many of them show streaking due to flowage. Some of them are flow breccias formed of angular fragments of rhyolite in a matrix of the same. Such rocks result when a crust forms over the flow and is broken up by the movement of the still liquid portion, which, solidifying, forms the matrix for the fragments. Some rhyolites are thin, fissile bands which resemble shales. The shaly appearance is probably due to banding that developed as the rhyolite flowed and was emphasized by subsequent weathering along the parting planes. Some are vesicular. The small blebby holes in these rocks represent the places where imprisoned gases expanded when the pressure was removed from the magma at the time of eruption. In some the vesicles are filled with amygdules of amethystine quartz, deposited by water after the rock had solidified.

The rhyolites of the Jarbidge region were erupted in at least two distinct periods, separated by a considerable interval of erosion, and they will accordingly be described as the earlier or old rhyolites and the later rim-rock or young rhyolites.

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[1] Spurr, J. E., Prof. Paper U. S. Geol. Survey No. 42, 1905, p. 274; Jour. Geology, vol. 8, 1900, p. 642.

[2] U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 606.

[3] Emmons, W. H., Bull. U. S. Geol. Survey No. 408, 1910, pp. 30–31.

OLD RHYOLITES (MIOCENE?).

OCCURRENCE AND DISTRIBUTION.

The economically most important and interesting of the volcanic rocks are the old rhyolites. On the eroded surface of the Paleozoic sediments the lavas were poured out, mainly in successive broad flows, until they aggregated nearly 6,000 feet in maximum thickness, measured from the bottoms of the old valleys to the top of the neighboring mountains. They seem to have been erupted mainly along a fissure or series of inconspicuous craters or vents coinciding with the axis of Crater Range, whence they spread widely in all directions.

At or soon after the close of eruption the rocks were fissured, in part, perhaps, by contraction due to the cooling of the heated mass, but mainly by crustal movement attended by normal faulting. The fissures thus produced are now occupied by the gold-bearing quartz veins of the district and a few of them by rhyolite dikes.

The erosive processes that followed eruption and gave the region its present surface relief are described on pages 22–23.

The present exposures of these rocks in the district, as shown on Plate II (p. 12), extend from the region beyond the Great Basin divide on the south to Jack Creek, Rimrock, and Robinson Hole on the north, a distance of 12 miles or more, and from the region west of the Jarbidge to and beyond East Fork on the east, a distance of about 9 miles, thus occupying an area of about 100 square miles. Beneath the young lava covering they seem also to have a considerable extent to the southeast, where they are exposed mainly in the deeply cut valleys on the headwaters of Salmon and Marys rivers.

Measured from the summit of Crater Range to Jarbidge River, which is still sinking its bed into these lavas and so far as known has nowhere cut through them to the underlying Paleozoic rocks, the lavas, after having suffered two periods of vigorous erosion, the intervolcanic and the postvolcanic, the latter of which is yet going on, still show a thickness of nearly 5,000 feet. On the west they have been largely removed by erosion, being represented only by thin detached sheets capping the Paleozoic rocks on the summits of the Copper Mountain Range. On the east and north they pass unconformably beneath and are buried by the younger lavas described on pages 42–46.

As seen in their present weathered state in the field, the rocks exhibit a great variety of colors, of which the prevailing is pinkish or reddish ash-gray. Greenish, reddish, and purple tints are also characteristic, and practically the whole northeastern part of the Crater Range is stained a bright brick-red by iron oxide.

The rocks occur in a score or more of flows, resting unconformably one upon another and ranging from 30 or 40 to several hundred feet in thickness. Along Jarbidge River they are not well defined. (See Pl. VI, *B*, p. 24.) On East Fork, according to Sweetser,[1] 12 successive flows cut through by the stream can be counted.

In some localities, as shown in the cliffs back of Jarbidge and along Bear Creek, the flows exhibit a crude columnar structure, a feature found by the Fortieth Parallel Survey developed to a high degree of perfection at Karnak, in the Montezuma Range, Nevada.[2] Some of the flows are also more or less cavernous, examples of which are conspicuous in the high cliffs of the Bear Creek drainage basin, west of Jarbidge. Some of the openings look large enough to admit a man on horseback. At the south edge of the Jarbidge River flats, about three-fourths of a mile above the town, opposite the Buster mines and apparently on the Buster main fissure, occurs one of these features, locally called the Jarbidge Cave. It extends some 60 feet under the mountain, having a width at the floor of about 20 feet and a height of about 16 feet. These caverns were formed mainly by uneven congealment of the lava while yet in motion, and in some of them, as the Jarbidge Cave, faulting and dissolving out of the rock mass by circulating acidic solutions have been important agencies.

Similar features on a smaller scale may be observed in the hand specimen as druses, usually lined with hyalite or opaline chalcedony, examples of which are plentiful on the ridge west of Bear Creek.

The rocks are in the main nearly horizontal. They include locally intercalated sheets of black and brown obsidian or glass and also, particularly in the upper portions, the usual ejecta and coarser volcanic products, such as ash, tuffs, breccias, agglomerates, bombs, and lapilli, more or less widely distributed. On the head of Jarbidge River, to the southwest and west of the confluence of the south and east branches, the flows, as shown in Plate VI, *B* (p. 24), seem to dip to the southwest.

STRUCTURE.

The rocks show gentle folding and some smaller dislocations, particularly along the vein fissures, especially on Bear Creek. Apart from this no pronounced faulting was observed.

The faults, including the vein fissures, seem to be mostly normal. They occur roughly in two groups—the west group, mainly in the west slope of the Crater Range and along Jarbidge River, and the east or Crater group, mainly in the upper east slope of the Crater Range. Those of the west group, as shown on Plate II (p. 12), strike in the main northwestward and dip steeply to the east, into

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[1] Sweetser, N. W., Geology of the Jarbidge mining district: Min. and Sci. Press, Dec. 31, 1910, pp. 871–872.

[2] U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 644, Pl. XXI.

the range; those of the east group strike more nearly north and south, parallel with the range, and dip steeply to the west, into its axis, against the dip of the west group.

The faults probably represent in the main prevolcanic faults or deformation lines in the underlying rocks, where they reach far beyond the Jarbidge district, and they were subsequently extended upward through the lavas by widespread postvolcanic disturbances. The prevalence of the normal faulting, however, and the synclinal dips of the two fault groups or systems from opposite sides of the axis of the range indicate that some of the fissures are probably also in part due to subsidence of the axis and adjustment that followed the outpouring of the lavas. It is also probable that in places fissuring may have been aided by contraction of the heated lava mass in cooling.

The rocks are cut by rhyolite dikes, which are similar in character to the intruded rock and were probably derived from the same magma. Examples may be seen in Bonanza Gulch below the Pick and Shovel property.

MACROSCOPIC CHARACTER.

The rocks normally consist essentially of a fine-grained dense or aphanitic groundmass with equidimensional phenocrysts of quartz and feldspar ranging from very fine up to 0.2 inch in diameter and giving to the rock a porphyritic aspect. The quartz is by far the more abundant. In places the phenocrysts are so plentiful as to give to the rock the appearance of a medium-grained granite, but in general the groundmass much exceeds the phenocrysts in volume. Banding or flow structure is locally present but not usually pronounced. The rocks in general are considerably altered. In some areas, particularly in the vicinity of vein fissures, they are highly altered by metasomatic replacement, the chief changes being devitrification and silicification of the rock almost as a whole, attended with the development of certain new or secondary minerals described later.

The feldspars, which are mostly orthoclase, are usually much weathered or kaolinized and where corroded out at the surface give to the pebbles in the river gravels and to some long-exposed talus a pitted or pock-marked appearance. The quartz occurs mostly in rounded or globular grains, and though of a vitreous or glassy luster it is rarely clear or white, but ranges from pale reddish or purplish through deep wine color to dark reddish brown. Locally it is known, particularly where strongly colored, as "fish-eye" quartz.

On being mechanically isolated from the parent rock the quartz loses much of its intensity of color and the loss is still further increased by crushing or pulverizing. The finer the division the greater proportionally is the loss, and the microscope shows that the coloring is not uniform in all parts of a given piece of the crushed material. The color is strongest in areas of metasomatic alteration and here the rock, as on the Pavlak property, is also more or less impregnated with secondary pyrite and marcasite rather uniformly disseminated in small macroscopic and finer cubes and grains.

MICROSCOPIC CHARACTER.

Under the microscope the groundmass is seen to range from microcrystalline through cryptocrystalline to glassy. Much of it is felsophyric and in some places it is moderately streaked or banded with flow structure. Some unindividualized glassy base is nearly always present, forming by far the greater part of some slides, and much of it is devitrified. The groundmass is usually microlitic or contains small rods of feldspar, quartz, augitic, and other greenish dark bisilicates, presumably biotite and hornblende, with which in some sections it is heavily charged. These minerals usually lie parallel with the flow structure but in some slides are disposed in axiolitic, radial, or spherulitic arrangement, giving to the rock a spherulitic structure. Locally these spherulites constitute the principal part of the groundmass. In some slides portions of the groundmass are micrographic and micropegmatitic and portions contain lithophysæ or small vesicles lined with quartz and feldspar.

The phenocrysts are mainly quartz, orthoclase, and plagioclase, with here and there a little biotite, hornblende, and augite. The feldspars usually show crystalline outline; the quartzes are in general rounded or globular and penetrated more or less by sinuous embayments of the groundmass. In some slides, however, both the feldspar and the quartz occur also in angular fragments that have seemingly resulted from flow breccia and give the slide a clastic or brecciated appearance. The feldspar and quartz, like the other phenocrysts, are irregularly distributed throughout the slide, singly and also in groups of roughly circular or triangular outline in which the crystals and fragments aggregate 30 or 40 in number.

Both the feldspar and the quartz contain glassy inclusions which in places are so plentiful as to form netlike intergrowths with the host mineral. They also contain as small inclusions earlier feldspars, bisilicates, and the accessory minerals including magnetite. Some quartzes and feldspars exhibit frayed or corroded borders. The feldspar as a rule is mostly kaolinized or altered to a kaolinic substance and to muscovite or sericite, and some is altered beyond identification.

The feldspar is principally orthoclase, but microperthite and albite are present in some slides. The orthoclase occurs mainly in tabular and rectangular crystals and some in Carlsbad twins. Plagioclase on the whole is only sparingly present. It occurs mainly in rectangular crystals and is mostly oligoclase. Some of it, however, gives optical tests corresponding to andesine-labradorite.

The deeply colored quartz grains constituting the "fish-eye" quartz under the microscope show clear, with the coloring matter restricted to the fractures and periphery of the phenocrysts. The coloring is therefore not indigenous, nor was it incorporated in the quartz at the time of crystallization, as in smoky quartz, but is due to secondary foreign ferric oxide.

In the portions of the district containing the more highly altered rocks, where devitrification and silicification have been extensive, some feldspars and quartzes are more or less surrounded by a fringe or aureole of secondary silica and adularia, which locally as replacing minerals deeply penetrate the feldspar, particularly the plagioclase. In these rocks there is more or less pyrite and marcasite ranging from microscopic crystals down to small grains and fine dust.

The biotite occurs sparingly in small plates and foils and is mostly altered to chlorite. In a few slides biotite, magnetite, and hornblende seem to have resulted by alteration of augite. The augite, which is of rare occurrence, forms small yellowish-brown crystals. Magnetite, apatite, and zircon occur as accessory minerals.

Secondary minerals, besides the pyrite and marcasite, are sericite, chlorite, hematite, limonite, epidote, kaolinite, hyalite, opaline chalcedony, quartz, adularia, and a little calcite.

Many of the altered rocks are traversed by small macroscopic and miscrscopic veinlets of adularia, quarts, and yellowish chalcedonic or opaline silica, ranging down to less than one-eighth of an inch in width. In some veinlets the filling seems to be exclusively adularia. The veinlets are usually closed, but some are bipartite and are composed of two sets or sheets of adularia crystals, one set frozen end on to either wall, with the opposite ends abutting and interlocking with those of the other set. More generally, however, the veinlet is composed of a single set of crystals, each of which extends, usually obliquely, from wall to wall.

CHEMICAL COMPOSITION.

The determination by the microscope of these rocks as rhyolites is confirmed by the accompanying chemical analysis (A) of a relatively fresh and characteristic specimen of the normal rock obtained in the South Hilltop tunnel 75 feet from the portal. This tunnel is located at the upper end of the town of Jarbidge west of the river.

Analyses of rhyolites.

	A.	B.	C.	D.
SiO_2	76.77	76.80	75.29	71.00
Al_2O_3	12.63	11.64	....	....
Fe_2O_3	1.13	.66	....	....
FeO	.27	.50	....	....
MgO	.07	Tr.	....	....
CaO	.21	.43	.71	....
Na_2O	.30	2.53	2.90	....
K_2O	6.43	6.69	5.34	....
H_2O-	.49	....	....	....
H_2O+	1.55	....	....	....
TiO_2	.18	....	....	....
P_2O_5	.04	....	....	....
	100.07	....	....	....

A. Specimen No. 33, old rhyolite, Jarbridge district. George Steiger, analyst.
B. Specimen No. 166, Fortieth Parallel Survey, typical rhyolite, Mopung Hills, Humboldt County, Nev.
C, D. Specimens Nos. 1 and 57, young rhyolite, Jarbidge district. George Steiger, analyst.

The rock of analysis A is the old (ore-bearing) rhyolite. It is a fine-grained, purple-gray. slightly porphyritic rock with a glassy felsitic to microcrystalline spherulitic groundmass and small, irregular phenocrysts of reddish or pale wine-colored glassy quartz and dull, inconspicuous weathered kaolinized and sericitized orthoclase. It is closely banded with fluidal structure and contains sparingly small elongated macroscopic and microscopic druses and parallel veinlets or stringers of apparently secondary quartz, in association with which is developed considerable pyrite. Pyrite in small macroscopic and microscopic cubes and grains is likewise disseminated throughout the groundmass, as is also considerable fine hematite or ferritic material. Magnetite and apatite are present as accessories.

The analysis compares well with those of the typical rhyolites of the Fortieth Parallel Survey. Of the 10 analyses of rhyolites given in the report of that survey, volume 1, opposite page 652, and ranging from 68.84 to 77 per cent in silica, only two exceed this one in amount of silica, and those only by 0.23 and 0.03 per cent.

Comparison with the analyses tabulated by H. S. Washington[1] shows that it is remarkably low in sodium and belongs to an unnamed order of a perpotassic subrang, represented by only one analysis. It is evident, however, that in spite of the fresh appearance there has been much alteration which would have a tendency to increase the percentage of silica and potassium and to reduce that of sodium.

Analysis B is the most siliceous of the analyses of typical rhyolites given in the report of the Fortieth Parallel Survey and is here copied for purposes of comparison. It represents a rock specimen (No. 166) from the Mopung Hills in western Humboldt County, Nev., which, to judge from the description given, is very similar to the Jarbidge rock No. 33 (analysis A). The analyses show a very

[1] Prof. Paper U. S. Geol. Survey No. 14, 1903, p. 125.

close agreement between these two rocks in their most abundant constituents, silica, alumina, and potash.

Analyses C and D are of the rim rock or young rhyolite. C is a partial analysis of rock specimen No. 1, obtained near the wireless-telegraph station on Telegraph Ridge, 1 mile northwest of Jarbidge. It is a purple or dark reddish-brown aphanitic vesicular lithoidal rock, with small macroscopic drawn vesicles forming part of the general closely banded fluidal structure. Under the microscope it is seen to consist essentially of a brownish to greenish gray, semi-opaque felsitic glass, with spherulitic and axiolitic structure, most of which is not resolvable with the lightest-power objective. This groundmass, however, is very uniformly interrupted, to the amount of about one-third the area of the slide, by crudely circular areas of tridymite in its characteristic forms, which seems to be also plentifully present throughout the groundmass. The rock contains as small crystals, or rather fragments of crystals, a little orthoclase, a very little plagioclase which gives tests corresponding to oligoclase, a little biotite, altered hornblende seemingly derived from augite, a very little quartz, and considerable hematite, which is especially prominent about the peripheries of the tridymite areas.

Analysis D represents rock specimen No. 57, from the northeastern part of the district, about a mile southeast of Robinson Hole, where the trail in leading up out of the Robinson Creek canyon reaches the top of the rim rock and the edge of the plain on the east. This is a medium-grained black rock of vitreous luster resembling pitchstone. It consists essentially of dark-gray microlitic glass, charged with feldspathic and augitic (?) microlites, the whole showing very perfect fluidal banding, with subordinate areas of spherulitic structures. Resting in the glassy groundmass are a few small crystals or fragments of crystals of orthoclase, sanidine, a little biotite and augite, the latter mostly altered to hornblende, and a little plagioclase (oligoclase-andesine). Magnetite, hematite, and limonite are also present.

YOUNG RHYOLITES (PLIOCENE?).

OCCURRENCE AND DISTRIBUTION.

After a considerable time interval of volcanic quiescence and vigorous subaerial erosion, the young rhyolitic lavas were poured out from essentially the same vents as the old lavas. They covered the deeply eroded surface of the old rhyolites, and the marked unconformity between the two formations is plainly seen in the northern and western parts of the district. (See Pl. II.) Here they form a gently outward-sloping piedmont plain which, extending beyond the district, merges into the flat-lying Snake River plain on the north and reaches the foot of Elk Mountain, 10 miles distant, on the east.

Other vents were probably situated in this latter direction. The rhyolitic lavas seem also to have a wide extent to the southeast and south, on the headwaters of Salmon and Marys rivers, respectively.

These lavas were poured out at greater elevations than the old lavas; they were also more liquid and, being erupted in successive homogeneous flows that lay conformably one upon another, they spread widely and reflooded the entire district more extensively than the old lavas, though not so deeply, and gave to the Jarbidge Mountains roughly the form of a huge east-west dome. On the outskirts of the district they rest in places upon the old eroded floor of Paleozoic rocks, as in the northwestern part of the district and adjoining territory. Within the district they are best exposed on the north and east, where the eroded edges of their flows that terminate the surrounding plain form the inward-facing scarp or rim rock, bounding Jack Creek valley on the north and East Fork on the east.

In the valleys and low places the lavas attained a considerable thickness, probably almost 2,000 feet, as may be inferred in the vicinity of the junction of Jack Creek with Jarbidge River, where they still show a section of more than a thousand feet. At the summit of the dome and the rim of the crater, however, by reason of their fluidity and the steeper slopes, their thickness probably did not much exceed a few hundred feet.

Owing to the unevenness of the floor on which the lavas rest and to later erosion, their contact with the underlying old lavas is very irregular, as shown on the map (Pl. II, p. 12), in the northern part of the district, particularly from Jack Hole westward. After crossing Jack Mountain near the wagon road, the line descends westward into Jarbidge Valley to a point near the forest station and about 400 feet above the river; this figure approximately expresses the depth to which the river has at this point sunk its channel into the old underlying lavas during the present period of erosion. Here the contact line is sharply deflected to the north and crosses the river at a sharp angle about a mile farther downstream, near the 5,800-foot contour, whence it bends back on the opposite side and crosses Telegraph Ridge 2 miles to the southwest, at an elevation of about 7,500 feet, between the Elko wagon-road pass and the wireless-telegraph station, which stands upon this rock north of the contact.

The young rhyolites occur mainly in homogeneous fine-grained flows conformably superimposed one upon another and dipping gently away from the mountains in quaquaversal manner. They are as a rule closely though in places dimly banded by fluxion structure parallel with the flows and are practically free from volcanic ejecta. In color they are prevailingly dull reddish purple and reddish brown, but they contain also locally intercalated sheets of finely tuffaceous and vesicular phase which are drab, dull greenish, and glassy black.

In places they are very gently folded and slightly faulted, but compared with the old underlying lavas they have been on the whole not much disturbed or deformed. So far as observed none of the dikes, veins, or fissures so freely traversing the old lavas occur in these rocks.

MACROSCOPIC CHARACTER.

These rocks are lithoidal. They contrast strongly with the old rhyolites above described, having a much more basic appearance. To the local prospectors and mining engineers they are known as basalt. In a few places they are medium grained or moderately porphyritic. They consist almost wholly of a dark-reddish or brownish-purple aphanitic groundmass, which usually is more or less closely banded by flow structure and grained and streaked by drawn vesicles, some of them minute. Macroscopic minerals are usually absent and if present are so few and small as to form a negligible percentage of the rock. They occur as mostly glassy laths or needles and short prisms of plagioclase and a little orthoclase, ranging from mere specks to scarcely 0.1 inch in maximum diameter. Visible quartz is usually lacking. In the glassy pitchstone tuffaceous phase, however, which seems to occur mainly in the upper part of the section, the rock has a medium-grained appearance and may contain feldspar phenocrysts 0.2 inch in maximum diameter. The rock has a more or less conchoidal fracture and weathers to a purplish or dark reddish-brown color due mainly to oxidation of its iron content.

MICROSCOPIC CHARACTER.

Under the microscope the rock is seen to consist mainly of a pale greenish-gray to brownish semiopaque groundmass ranging from vitreous to felsitic or, in exceptional cases, microcrystalline. The groundmass contains, besides microlites of feldspar, quartz, and augite, dark and more or less opaque cuneiform and variously shaped grains and dust of ferritic minerals. It is generally characterized by closely banded and woody-grained flow structure, in places developed to a high degree of perfection, the flow lines curving beautifully around phenocrysts that dam their courses.

The continuity of the groundmass is interrupted by more or less equally spaced small, crudely circular or elongated, axiolitic, nearly transparent areas occupied by tridymite. In some slides these areas are perfect spherulites; here and there the macroscopic structure becomes spherulitic with visible tridymite. The tridymite occurs mainly in crudely fan-shaped crystalline aggregates of tilelike, feebly polarizing forms. Tridymite probably constitutes the greater portion of the rock; this conclusion is confirmed by partial chemical analysis

(C, p. 41) of a characteristic specimen of the rock from Telegraph Ridge 1 mile west of Jarbidge.

According to Rosenbusch[1] tridymite is a common constituent of rhyolite. Zirkel,[2] however, states that in the rhyolites of the Fortieth Parallel Survey tridymite is of rare occurrence, and adds that—

> This may in some way be consequent upon the great quantity of quartz present in most of these varieties; for it has been stated, as a result of observations of European rocks, that an abundant secretion of quartz is unfavorable to the formation of tridymite in the same rock.

With these observations the rhyolites of the Jarbidge district seem to be in full accord, for in the old rhyolites, which, as has been shown, are rich in normal quartz, no tridymite was found, while in the young rhyolites, which contain little or no quartz, tridymite seems to be the chief constituent of the rock.

Associated with the tridymite, usually toward the periphery of each area, is considerable hematite, which seems to be primary. It occurs in deep-red plates and in the groundmass in irregular smaller forms, grains, and dust, and seems to be the ingredient which imparts to the rocks their reddish or purplish color. Associated with the hematite as an alteration product and clouding the groundmass in places is also much brownish limonite.

Resting in the groundmass, from 6 to 12 millimeters apart, occur a few small incomplete phenocrysts or more commonly fragments of crystals of feldspar and quartz and rarely biotite, hornblende, or augite. The quartz tends to be rounded in outline; the feldspar, which is mainly plagioclase, with a less amount of orthoclase, is mostly in angular broken fragments.

Small feldspars of an earlier generation and some magnetite occur as inclusions in both the feldspar and the quartz phenocrysts, but the more common inclusions are those of the greenish and brownish glassy groundmass, which also penetrates the phenocrysts as tongues and embayments. A crystal of augite partly inclosed by orthoclase shows the former mineral to have been formed before the latter.

The plagioclase is mostly oligoclase-andesine. Magnetite is present as large and small grains, mostly in association with hornblende and augite. Other accessory minerals observed are apatite and zircon.

Some of these rocks contain a little pyrite, which is probably secondary, but they show practically none of the metasomatic or propylitic alteration occurring in the old rhyolite.

In the table on page 41 the partial chemical analysis (C) of a characteristic specimen of these young rhyolites, collected from Tele-

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[1] Rosenbusch, H., Microscopical physiography of the rock-making minerals (tr. by J. P. Iddings), 3d ed., p. 177.

[2] Zirkel, F., U. S. Geol. Expl. 40th Par., vol. 6, 1876, p. 202.

graph Ridge, about a mile southwest of Jarbidge, and containing very little quartz, shows a remarkably high percentage of silica for a rock of so basic an appearance—less than 1.5 per cent lower than that in the analysis (A) of the old rhyolite, which is shown to be rich in quartz. Analysis C also shows that the silica must be contained almost entirely in the groundmass, either as tridymite or in some other form. In lime, soda, and potash content it stands close to analyses A and B and shows that in composition the rock on the whole is normal rhyolite.

The partial analysis (D) of a specimen of the glassy pitchstone black rock from the top of the piedmont rim rock in the northeastern part of the district, which is the most basic rock encountered in the region and which, carrying considerable augite, under the microscope presents the appearance of quartz-bearing andesite, shows this basic phase of the rock to contain 71 per cent of silica, which is more than 2 per cent above the lowest and only a few per cent below the average of the rhyolites of the Fortieth Parallel Survey.

AGE OF THE VOLCANIC ROCKS.

Formations of known age fixing closely the age of the Tertiary rocks above described do not occur in the Jarbidge district. According to King,[1] the rhyolites of the Fortieth Parallel Survey in Nevada are post-Miocene and their earliest eruption is contemporaneous with the first Pliocene beds. King says:

> The extravasation of rhyolites was a feature of the orographical disturbance which followed the dislocation of the Miocene rocks, and the earliest accumulations of Pliocene contain products of the first rhyolitic eruption. In many places, however, notably northeastern Nevada, the outpourings of rhyolite continued well into the Pliocene period, and a vast amount of the Humboldt Pliocene of that region is made of the acidic ejecta of the rhyolitic period laid down in the fresh-water lakes as local tuff beds. * * * Rhyolitic eruptives were characteristic of the opening of the Pliocene and extended over perhaps the first third of the Pliocene epoch.

From similar evidence—rhyolitic ejecta, etc., contained in lake beds—furnished by later and more detailed work in the area to the southwest, Emmons[2] concludes that the rhyolitic eruptions probably began in early Miocene time and continued through the Pliocene. The rhyolites that deeply flooded the Owyhee Mountains in the region about Silver City, Idaho, are referred by Lindgren[3] to the Miocene epoch and regarded as being erupted simultaneously with the great flows of the Columbia River basalt. Their deformational features, faulting, fissures, and ore deposits are similar to those of the older lavas in the Jarbidge district.

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[1] King, Clarence, U. S. Geol. Expl. 40th Par., vol. 1, 1878, p. 606.
[2] Emmons, W. H., Bull. U. S. Geol. Survey No. 408, 1910, p. 35.
[3] Lindgren, Waldemar, Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 116.

As the Mount Bennett rhyolite of Russell[1] in the region near Mountain Home, Idaho, bears similar relations to the lavas of Snake River to those borne by the rhyolites of the Silver City region, and as it resembles and is correlated by Russell with the rhyolite underlying the Snake River plains, as exposed at Shoshone Falls, which King,[2] under the name of trachyte, refers to the Miocene, it seems probable that the rhyolites of Mount Bennett and Shoshone Falls are of the same age as those of the Silver City region and are probably Miocene. Therefore, to judge from the rhyolites in the surrounding regions, it seems probable that the rhyolites of the Jarbidge district range from Miocene well into the Pliocene. The older rhyolites are regarded as late Miocene and the younger ryholites as near middle Pliocene and possibly later.

It is very likely that field work extended either to the lake beds of the Snake River plains on the north or to the Humboldt formation in the Great Basin on the south will determine definitely the age of these lavas, especially of the younger series.

MINERAL DEPOSITS.

The Jarbidge district shows at least two distinct periods of mineralization. The deposits here described occur in two sharply contrasted groups that differ considerably in age—the early, occurring in or associated with the sedimentary and early granular intrusive rocks, and the late, occurring in the rhyolite. The former are probably Cretaceous and the latter are regarded as post-Miocene.

EARLY DEPOSITS (CRETACEOUS ?).

The older deposits occur in the sedimentary Paleozoic rocks and their associated early granular intrusives, granodiorite, etc., in the western part of the district and the adjoining region. They could not be reached by the writer in this work and are known mainly from oral accounts of mining men and prospectors. They are said to occur chiefly as tabular fissure veins containing gold, silver, copper, and lead in quartz gangue, but they probably include also contact-metamorphic and replacement deposits in the limestone, such as were observed in the Elk Mountain and Contact districts on the east and were also found by Emmons[3] in the area on the west, where they have associated with them a great variety of minerals, which are mostly metamorphic.

The deposits occur mostly near the contact between the Paleozoic sediments, especially quartzite and limestone, and the granular in-

[1] Russell, I. C., Bull. U. S. Geol. Survey No. 199, 1902, p. 42.
[2] King, Clarence, U. S. Geol. Expl. 40th Par., vol. 1, pp. 192–193.
[3] Emmons, W. H., Bull. U. S. Geol. Survey No. 408, 1910, pp. 40–41.

trusives, and both classes of these rocks are cut by the veins. They seem to have been formed by thermal solutions after the intrusion of the granite and granodiorite, which, as shown under "Geology," are regarded as of Cretaceous age. According to Sweetser[1] the veins are numerous and small. They strike northeast and southwest and have produced some placers.

These deposits, in part at least, have been known for sometime. They have received attention at the Cornwall, Copper, and Gold basins, mainly on the southwest, and at the Taylor pocket on the northwest, and some of them are said to be promising, but owing to the high cost of transportation and increase in baseness of the ore with depth, extensive developments have not yet been undertaken. At the Cornwall Basin and Taylor pocket they occur chiefly in quartzite and limestone.

LATE DEPOSITS (POST-MIOCENE).

OCCURRENCE AND DISTRIBUTION.

The later and more important deposits, which led to the recent discovery of the Jarbidge district and are now attracting so much attion, occur chiefly as tabular, gold-bearing quartz fissure veins or lodes in the old rhyolite, with which, so far as this district is concerned, they are roughly coextensive. They are in general well defined, being more or less sharply separated from the country rock, and contain angular inclusions of rhyolite, sedimentary rocks, and seams of clay. Many of them have 1 to 8 inches of gouge on either wall. They seem very obviously to belong to the—

> important division of the propylitic veins, which were formed, in most cases, since the Miocene period. Among their characteristics is a peculiar alteration of the adjoining wall rock and a tendency to contain both gold and silver, the value of the latter being usually greater than that of the former. The most prominent representative of this propylitic group is the Comstock lode, which is credited [1878] with a production of $368,000,000.[2]

The veins are about 40 in number. They are associated with the Crater Range or seat of volcanic eruption. They lie mainly between Jarbidge River and East Fork and are mostly comprised in a belt about 4 miles wide extending from Jack Creek on the north to the divide and the head of Jarbidge River, 7 miles distant, on the south. Most of them are on the lower slope and upper east slope of the Crater Range and in general they have a north-northwesterly strike, in places gently curved, and a nearly vertical dip, as shown in figure 2.

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[1] Sweetser, N. W., Min. and Sci. Press, vol. 101, No. 27, p. 872.

[2] Trans. Am. Inst. Min. Eng., vol. 33, 1902, p. 830.

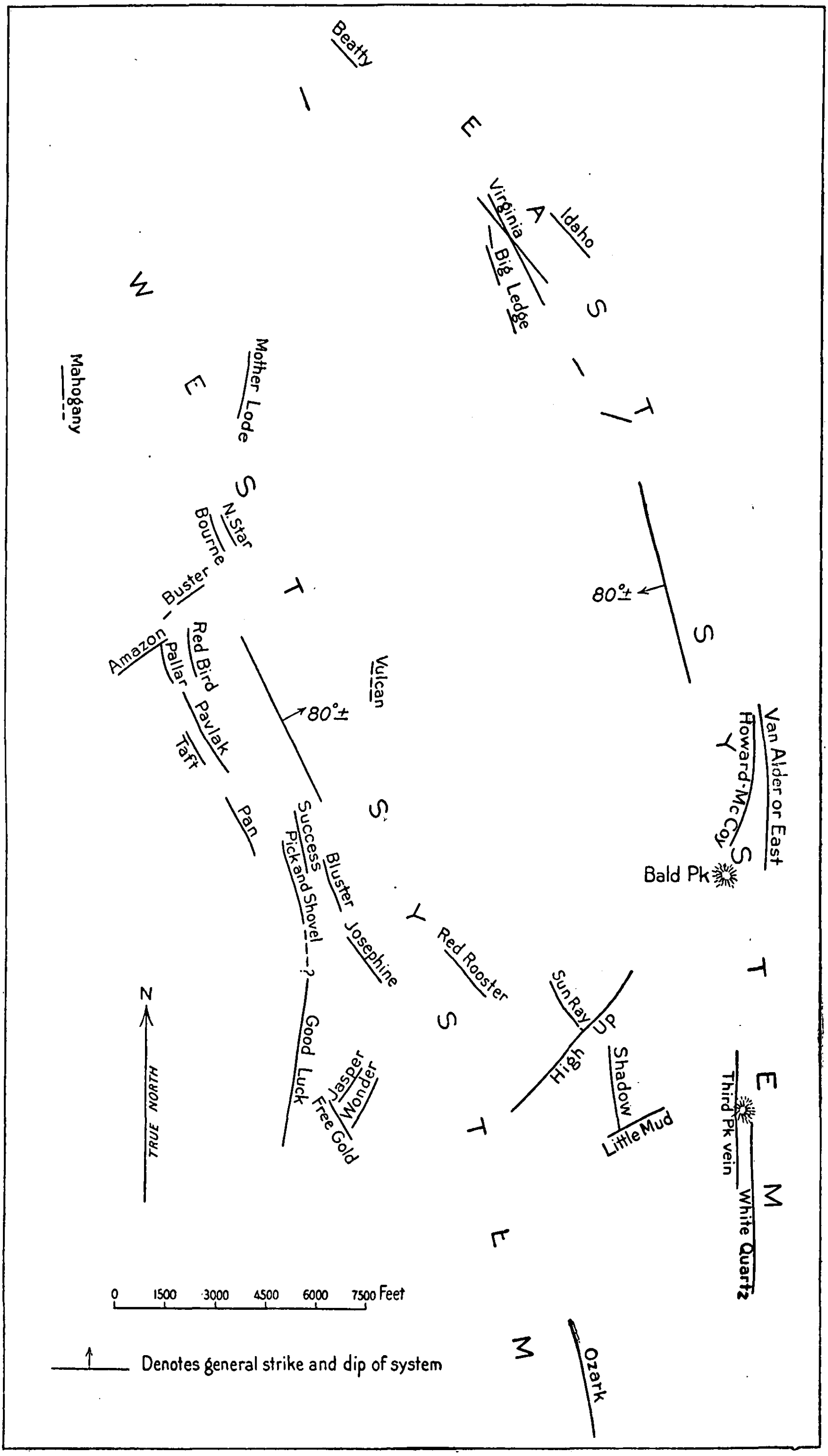


FIGURE 2.—Diagram showing trend and relative position of the principal veins in the Jarbidge district.

They range from 1 to 20 feet or more in width and from less than 1,000 feet to several miles in length. Their outcrops, many of which are bold, prominent reefs, rising in places 60 feet or more above the surface (see Pl. VII), extend interruptedly from 6,000 to 10,800 feet in elevation and show a vertical range in some individual veins of nearly 2,000 feet. Deep shafts have not been sunk on these veins, but it seems very probable that most of them penetrate the underlying sedimentary and granitic rocks, like the veins in the Silver City-De Lamar district, Idaho, to which the Jarbidge district is geologically and mineralogically very similar.[1]

The veins in general consist of two main systems or groups which, starting at the head of Jarbidge River and the junction of the Crater Range with the Great Basin Divide on the south, gradually diverge northward into the western or Jarbidge River group and the eastern or Crater group; these groups, however, are not everywhere sharply differentiated.

The veins of both groups occupy chiefly normal fault fissures, which seem to have been produced mainly by regional disturbances and in part by a sinking or parallel down-faulting of the axial portion of the range that followed the first period of eruption, in consequence of which the fissures on either side dip steeply in opposite directions into the range, the east group to the west and the west group to the east. The two groups converge downward, and it is probable that some of them meet or intersect in the deeply buried axial portion of the range. It seems also probable that in some places fissuring may have been aided by lateral contraction due to cooling of the heated lava mass.

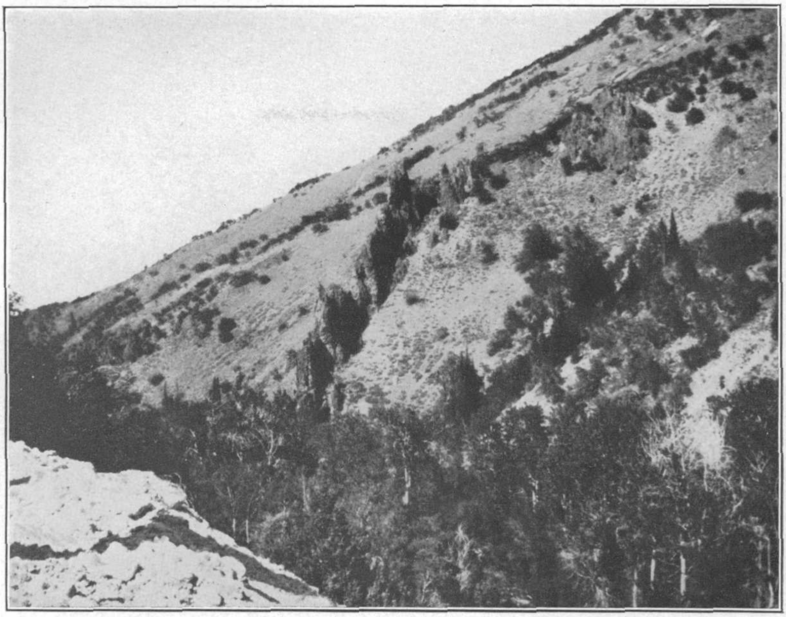
In the fissures produced by extensive regional faulting more or less regularity in strike, dip, and vein content is to be expected, but in those due to local postvolcanic sinking and adjustment of the range there should naturally be more variations, including probably in most cases change in dip at the contact of the lavas with the underlying older rocks.

WEST SYSTEM.

The western edge of the mineral belt, comprising the veins of the west system, crosses Jarbidge River obliquely near the mouth of Bonanza Gulch and the Pavlak mine, whence it continues north-northwestward across the lower part of Bear Creek near the elbow nearly to Telegraph Ridge Pass. Half a mile northwest of Jarbidge it includes the Mahogany vein and to the south of this the ridge between the lower part of Bear Creek and the river.

This system of veins comprises the wider and more important deposits, such as the Pavlak, Bourne, Buster, Pick and Shovel, and

[1] Lindgren, Waldemar, The veins of Silver City and De Lamar, Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, 107–189.



A. BUSTER VEIN OUTCROP.

Shown as bold, dark, dikelike wall ascending slope of mineralized belt. From Park lease, at elevation of 6,400 feet, looking N. 30° E. across Jarbidge Valley.

B. PICK AND SHOVEL MINE AND OUTCROP OF PICK AND SHOVEL VEIN.

From the west (normal) slope of the Crater Range, at elevation of 7,400 feet, looking N. 8° W.

Bluster, on which the most extensive development work in the district has been done. These veins lie mostly between elevations of 6,000 and 8,000 feet, at a considerably lower geologic horizon than the veins of the Crater group. They also contain the most prominent croppings in the district. They are nearly all easily reached by wagon road or trail from the Jarbidge River valley. As shown in figure 2, they strike in general north-northwest and dip east into the mountains at angles of about 80°. They contain more brecciated material and their walls are more irregular, less sharply defined, and show more extensive propylitic alteration than the veins of the east system.

The most important of these deposits are concentrated in a belt about a mile wide and 3 miles long, bounded on the west by Jarbidge River and extending from Bourne Gulch on the north to Gorge Gulch on the south.

EAST SYSTEM.

The east or Crater group of veins, represented at the time of visit mainly by the Van Alder and Howard-McCoy veins, occur on the upper east slope of the Crater Range, mostly between elevations of 9,000 and 10,800 feet (the crest of the range). They extend from Jack Creek on the north more or less throughout the series of "craters" or glacial cirques and their intervening ridges, nearly to the Great Basin divide on the south, a distance of about 7 miles. They are best reached by way of the Jack Creek and East Fork valleys or by going across the divide from the head of Jarbidge River.

These veins in most respects contrast strongly with those of the west system. As shown in figure 2, they have a more nearly north-south strike than the western veins, and they dip about 80° W., into the mountain, in opposite direction to the dip of the veins of the west system. Their outcrops, which are usually inconspicuous, show a vertical range of more than 4,000 feet. So far as their present exposures are concerned they mostly occur at geologic horizons nearly 2,000 feet higher than the western veins. They are narrower, being usually from 1 to 4 feet in width, and are more persistent horizontally, some being said to have a length of 3 miles and to extend interruptedly for 6 or 7 miles. They are more sharply defined, with clean-cut walls, and they are closely, definitely, and in places beautifully banded.

These veins occupy mainly normal fissures produced seemingly in part by subsidence or down-faulting of the axial mass of the range, with which they are nearly parallel. The walls are free, and the footwall generally carries from 1 to 8 inches of clayey "talcose" gouge. The bands within many of the veins are separated by thin seams of gouge, which appears to be of shale or slate origin.

CROSS SYSTEM.

Besides the two main systems above described there is also a subordinate system whose veins strike northeasterly, almost at right angles to the two main systems. This third system, which for convenience may be referred to as the Buster or cross system, is represented along Jarbidge River by the Buster and Amazon veins, on the north by the so-called cross veins of Jack Creek, and on the south, toward the head of Jarbidge River, by the Jasper, Wonder, High Up, and Little Mud veins. (See fig. 2.)

STRUCTURE AND COMPOSITION OF THE VEINS.

The minerals of these deposits are adularia, apatite, argentite, calcite, chalcedony, chlorite, epidote (?), fluorite, gold, gold-silver alloy, hematite, hyalite, kaolin, limonite, manganese oxide, marcasite, muscovite, opaline silica, orthoclase, pyrite, quartz, sericite, silver, silver gold alloy, and talc.

The veins are composed mainly of a characteristically laminated pseudomorphic milk-white quartz-adularia gangue, which in the croppings and surface workings is usually stained reddish brown to blackish and yellowish by iron and manganese oxidation products. Some of them, as the Pavlak and the Pick and Shovel, also contain considerable fault breccia or fragments of silicified rhyolite country rock, fragments and seams of the underlying shale, slate, or quartzite, and seams or stringers of talc, from all of which it is inferred that more or less faulting or movement accompanied and followed the fissuring and subsequent veining. Some veins also contain small or minute parallel dikelets that were injected after the veins were formed, as shown in the Van Alder mine of the Crater or east system. These dikelets are probably contemporaneous in age with the dikes of the first period described under "Geology" (p. 33), whose age, however, relatively to the veins, has not yet been determined. In the quartz-adularia gangue quartz is on the whole the dominant mineral, but it is seemingly in all the veins more or less profusely intergrown with adularia, and in some veins the adularia, although not macroscopically prominent, greatly exceeds the quartz and constitutes the bulk of the vein. Specimens examined from the west group of veins show from 10 to 60 per cent of adularia, and from the Crater group as high as 90 per cent.

Adularia is a variety of orthoclase free from sodium, semitranslucent, and with characteristic crystal form. It was first discovered in the western United States by Lindgren in the veins of Silver City and De Lamar, Idaho, in 1897, since when it has been recognized at several other places, notably at Tonopah by J. E. Spurr, in southeastern Nevada at the Gold Springs district, and in adjoining parts of Utah by B. S. Butler, and in the Black Mountains of Mohave County, Ariz., by the present writer. Its abundance in some of the Jarbidge veins is of unusual interest, especially as quartz is looked upon as the ordinary if not universal gangue mineral of auriferous veins. As explained on page 54, the amount of adularia present and the manner of its occurrence are best shown under the microscope.

The following is an analysis of a general sample of the ore from the Bourne mine:

Analysis of ore from Bourne mine.

[George Steiger, analyst.]

SiO_2	72.28
Na_2O	.20
K_2O	11.84

From this analysis and from the composition of adularia as given in Dana's "System of mineralogy" it is calculated that the amount of adularia present in the Bourne ore is 70.65 per cent. The rest of the ore consists of 13.67 per cent of free silica and 15.68 per cent of undetermined constituents, presumably for the most part alumina and other impurities. Except that it shows about twice the amount of potash the analysis is markedly similar to that of the country-rock rhyolite given on page 41 (analysis C).

Comparison of the microscopic sections of this ore with sections from the Crater veins indicates that much of the Crater ore probably contains more than 90 per cent of adularia and about 15 per cent of potash and will compare favorably with the two following analyses of selected specimens of adularia:

Analysis of adularia from the Black Jack mine, Silver City, Idaho.[1]

[W. F. Hillebrand, analyst.]

Silica (SiO_2)	66.28
Alumina (Al_2O_3)	17.93
Potassa (K_2O)	15.12
Soda (Na_2O)	.25
Undetermined	.42
	100.00
Specific gravity	2.54

Determination of alkalies in adularia from the Trade Dollar mine, Silver City, Idaho.[1]

[George Steiger, analyst.]

K_2O	14.95
Na_2O	.20

[1] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 167.

A striking feature of the Jarbidge gangue is its characteristically laminated or platy and bladed structure, in which innumerable contiguous or connecting laminæ or plates are variously arranged. This material is aptly termed by the miner "fish-scale quartz," from the adjacent plates partly overlapping one another. (See Plate VIII.)

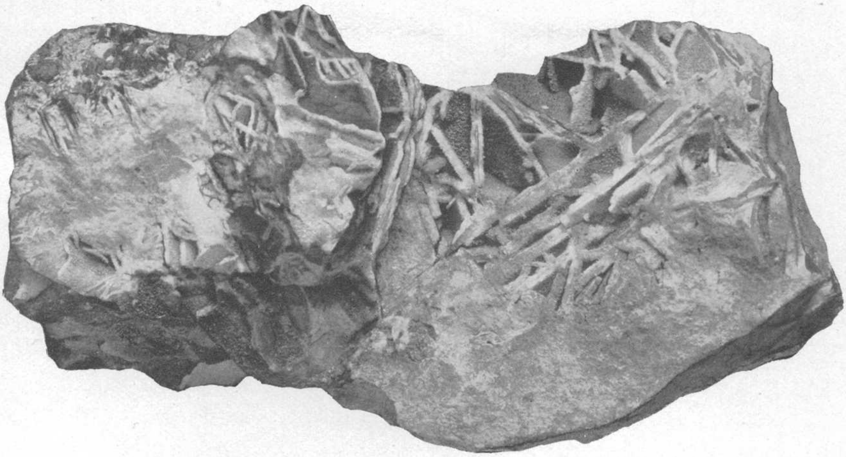
Much of the pseudomorphic platy and cellular structure seems to be due to silicification and replacement of calcite. This replacement begins along the cleavage planes of the primary calcite.

The plates range from minute size up to nearly an inch in diameter and from the thickness of a knife blade to that of ordinary pasteboard. They are mostly triangular in outline and form tetrahedral or polyhedral cavities (Pl. VIII). They are composed of fine-grained quartz and adularia. Usually each plate is bipartite or composed of two dissimilar-sided halves smoothly placed back to back against each other along a very fine median seam, from which as a starting plane the formation or mineral growth of each half proceeded outward. Each half shows one or more, usually several, layers of mineral growth, and the outer or last growth incrusts or faces the plate with a sheet of small comby quartz and adularia crystals. The seams along which the growth and development of the plates began appear to represent the cleavage planes of some former mineral, probably calcite, which the present gangue has replaced. In the honeycombed or cellular structure these plates, meeting one another at different angles, form small variously shaped polyhedral druses.

Depending on their form and mode of arrangement the plates give rise to solid angles and polyhedrons of many shapes and radial or fan-shaped and other pseudomorphic forms. The structures range from porous and cellular on a large scale to fine, closed, and filled or solid. The plates are marginally cemented together by material like that of which they are composed. In the closed forms this material constitutes a matrix in which the structures rest, and in places it passes laterally into fine or medium grained seemingly solid quartz-adularia gangue, in which only dim traces of the obliterated plates or structures remain.

Associated with the quartz and adularia in the gangue, notable in the veins of the west system, is also considerable fluorite, which seems to occur as a later filling. There is also some sericite, which, however, is mostly microscopic.

Only under the microscope does the proportion of quartz to adularia become apparent. Here the adularia may be differentiated from the quartz in subdued light and by its lower index of refraction. It occurs in individual crystals and grains intergrown with the quartz and only rarely shows cleavage.



PSEUDOMORPHIC QUARTZ AND ADULARIA AFTER CALCITE.

From Bourne mine. Characteristic of the veins and ores of the Jarbidge district.

The crystals occur in several forms, of which the most plentiful and characteristic seem to be small, thin tabular rhombic plates. Cuneiform and elongated or acicular crystals are also present, variously intergrown with the quartz. In one specimen from the Bourne mine the adularia is so fine grained that it seems to be amorphous or massive, being analogous to vein quartz or glass. Some crystals occur in Carlsbad twins. Some show zonal structure and some show the wavy extinction characteristic of vein quartz.

The pseudomorphic replacement structures of the quartz-adularia gangue are on the whole very interesting and complicated, and some of them are microscopically reproduced in Plate IX. The quartz and adularia are intimately intergrown with each other; the crystals and grains are arranged in various patterns, mosaic fashion, and show in places three generations of mineral growth, ranging from material with crystals one-fourth inch in maximum diameter to microcrystalline or even cryptocrystalline material. Some of the larger crystals, particularly those of adularia, seem to lie almost as phenocrysts in a groundmass of much finer microcrystalline to cryptocrystalline quartz and adularia. Some large crystals of adularia are replaced by the granular intergrowths of later adularia and quartz, the adularia being in small rhombic plates, prisms, and grains.

As seen in thin section the dominant structure is the general disposition of the minerals in sectors or long fan-shaped areas, each area being composed of a number of similar subareas, with the minerals in general arranged leaflike at right angles to the radii or stems and in places forming well-defined comb structure. Some thin sections of the ore show also microscopic, mostly elongated druses which are wholly or in part filled with a much finer growth of adularia than that forming the periphery, the fineness of grain commonly increasing from the periphery inward. Some druses are surrounded by as many as six more or less distinct bands of alternating coarse and fine gangue, with the crystals of the bands in part interlocking. Some druses are in part lined with the very fine grained material of the gangue; in others relatively coarse crystals, particularly of adularia, project irregularly into the druse cavities and produce a very jagged, saw-toothed lining.

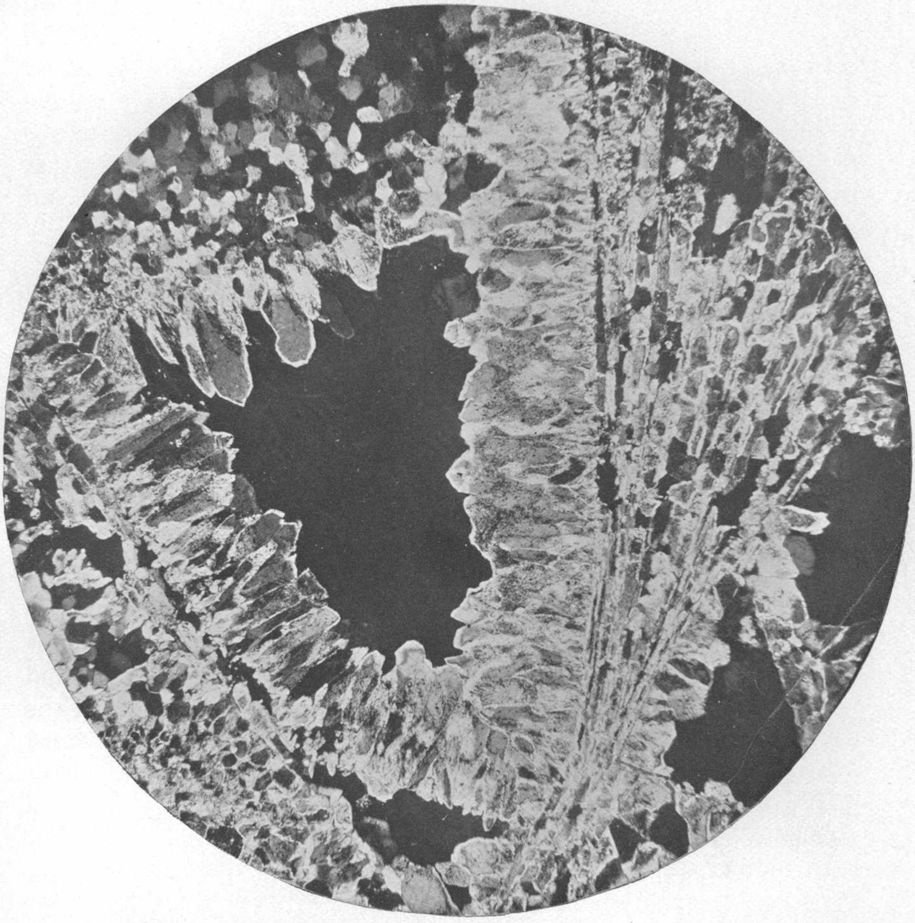
Considerable sericite, occurring mostly in aggregates and here and there in rosettes, is finely disseminated throughout some thin sections and occurs in some of the druses. Thin sections from the veins of the west system contain also considerable fluorite, which occurs mostly in the form of a late filling occupying the interstices, some of them large, between the principal gangue minerals. The persistent and plentiful association of sericite with the fluorite wherever the latter mineral is present is remarkable and not satisfactorily accounted for at present.

Disseminated generally throughout the thin sections, particularly in ores from the oxidized zones, occurs also considerable hematite as grains and dust probably derived from the oxidation of pyrite. Owing to the generally porous character of the gangue and plentiful supply of the percolating surface waters, this oxidation probably extends to considerable depths. The gangue contains also, mainly as filling, considerable gold and silver, the metals of the camp, described in detail further on. The gangue ranges from fine to coarse and from soft and friable to hard and siliceous, but owing to the prevalence of the pseudomorphic cellular structures the ore of the district on the whole is fragile and can be easily crushed and milled. It is of coarser texture and harder in the veins of the west system, where silicification has been more extensive. Here the veins are as a rule coarsely and crudely banded or massive, and the laminated gangue occurs largely in bowldery bunches up to several feet in diameter, which, however, are easily crushed. These veins also contain in places considerable fault breccia or fragments of silicified rhyolite country rock, from which it is inferred that more or less faulting accompanied the fissuring and subsequent vein formation. From the association of this silicified rhyolite the veins are often called "dikes."

Some veins, of which the Pick and Shovel is a good example, also contain fragments and seams of siliceous pale-greenish and blackish shale or slate derived from the underlying sedimentary rocks, and some contain minute parallel dikelets of rhyolite scarcely larger than a seam.

In places the walls of the western veins are irregular and ragged, or less sharply defined than in the veins of the east system, and show the most extensive propylitic alteration of the wall rock to be found in the district. Here also occur the bold croppings. Many of the outcrops are prominent reefs of the characteristically laminated quartz and adularia gangue and silicified rhyolite. They are commonly stained yellowish to reddish brown and blackish by iron and manganese.

In the eastern veins the gangue is composed of the same minerals (laminated quartz and adularia) as in the western veins, but in reverse proportions, the adularia here being the dominant mineral and constituting in the specimens examined 80 to 90 per cent of the vein. Though the same pseudomorphic structures are present in these veins as in those of the west group, they are less pronounced and the textures are relatively fine grained. The veins are closely and definitely ribboned and comby, the bands being in places separated by thin dikelets of rhyolite and by slate-colored partings.



PHOTOMICROGRAPH OF PSEUDOMORPHIC QUARTZ AND ADULARIA AFTER CALCITE.

From Pick and Shovel mine, 100-foot level. Example of the cellular, drusy, radial, and bladed structures characteristic of the Jarbidge veins. Magnified 25 diameters.

OCCURRENCE OF THE GOLD.

Both the croppings and the gangue in the veins show macroscopic free gold, the principal metal of the camp, which may be obtained by panning the crudely crushed material, the first means employed by the prospector in testing the ground. Good ground usually yields a long string of fine bright colors of gold in the pan, and rock in which the metal occurs in workable amount constitutes ore.

With the gold in the veins is associated also silver, which occurs chiefly as argentite (silver sulphide, Ag_2S; see Pl. X), as an alloy with the gold, and probably also in other forms. The quantity of silver is usually small, amounting to only 2 ounces or so to the ton of ore, but in some ore as much as 90 ounces is reported. A few operators also report tellurides, such as petzite, with the richer ore, but the presence of these minerals is not known to have been verified.

In its widest distribution the gold shows as small bodies or specks, but parallel areas or slabs of the gangue, some of them larger than a man's hand, are continuously coated or plated with gold as thick as a knife blade. In other places large areas are incrusted with blebs of iron-stained quartz, freely sprinkled with specks of gold. (See Pl. XI, *A*.)

Most of the gold, however, is finely divided and not macroscopically visible. It ranges from particles the size of a pinhead down to minute specks, in which form, usually associated with dark patches or specks of argentite and hematite and probably some other silver-bearing mineral (Pl. X), it constitutes ore more or less throughout the vein. In most of the veins, however, it is concentrated in streaks or pay shoots associated with fine dark streaks of silver sulphide and iron. The values range from low to very high, the shipping ore of some veins being worth $600 to $1,000 a ton. The Bluster vein, 5 feet in width at the point reached at the time of visit, was sampled by several persons independently and said by each to average $60 a ton all the way across.

Another common form of occurrence of the gold, as shown on the Pavlak property, is in nodules or reniform lumps formed by more or less finely banded concretionary growths of the gangue, usually round an inclosed fragment of rhyolite which is generally corroded and metasomatically altered, or around a fragment of slate, as illustrated in part in Plate XI, *B*. In these kidney-shaped forms, which usually constitute very rich ore, the gold occurs mostly along the dark lines associated with the circular banding before described.

Though the gold probably on the whole favors the quartz portion of the gangue where quartz is plentiful, in many places it seems to occur independently in both quartz and adularia. Where these two gangue minerals are present in about equal amounts, as in the ores from the Bourne and the Pick and Shovel mines, the gold seems to occur in one mineral about as much as in the other, and in some of the veins of the Crater group composed almost entirely of adularia it occurs, of course, almost exclusively in the adularia. According to B. S. Butler,[1] in the Deer Lodge district, in southeastern Nevada, the yellowish adularia is regarded as the richest portion of the deposits.

With development work scarcely begun, it is too early to form an estimate of the average value of the ore for the district or even for individual veins. From the excellent surface showings, however, it seems certain that the values will compare favorably with those of similar ores in other districts—for instance, that of the De Lamar mine, Idaho, which averages $14 in gold and 4 ounces in silver to the ton.[2] This mine has been a more or less steady producer since the early sixties and by 1900 had produced about $10,000,000.

The gold in the western veins is mostly of high grade; that of the Bluster mine, which has a deep yellow color, seems to be among the best and is said to run about $20 or more to the ounce. In the eastern veins, however, the gold is mostly light colored, contains much silver alloy, and runs only about $12 to the ounce.

ORIGIN OF THE VEINS.

From the omnipresence of the characteristically laminated and other pseudomorphic structures of quartz and adularia practically composing all the veins, and even the branches and veinlets in the wall rock down to 0.1 inch in width, it seems certain that in the fissures occupied by the present veins there have been at least two distinct periods of mineralization.

After the eruption and fissuring of the early rhyolites there followed a period of mineralization which filled the present fissures with material totally different from that which now occupies them. Just what minerals composed this first filling or what metals it may have contained are not definitely known, for so far as present developments in the district extend, no trace or clue to them remains save the casts and forms shown in the pseudomorphic quartz-adularia gangue above described. From a study of these forms in connection with cabinet specimens of calcite and barite and similar deposits in other fields, notably the Silver City and De Lamar, Idaho,[2] and the

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[1] Oral communication.

[2] Lindgren, Waldemar, The gold and silver veins of Silver City and De Lamar, Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 115.

PLATE X.

PLATE X.

Photomicrograph of gold ore.

From Bourne mine. Shows character and manner of distribution of the gold (yellow) in the quartz-adularia gangue (gray) and its association with argentite (black), characteristic of the Jarbidge district. The white area represents a hole in the thin section. Magnified 105 diameters.

A. Hoen & Co. Baltimore.

PHOTOMICROGRAPH OF GOLD ORE

PLATE XI.

PLATE XI.

GOLD ORES.

A. "Blistery" phase, from Bluster mine.

B. Nodular or kidney phase, from Pick and Shovel mine. Characteristic of certain ores in the veins of the west system, especially the Pavlak and others. The gold occurs mostly along the dark lines and seams crudely encircling the nodular nuclei of rhyolite or other rock. The nodule marked *a* is old rhyolite that has been so corroded and metasomatically altered around the periphery by the gangue solutions that the sharp contact line has been obliterated or resolved into an ill-defined zone of transition between the vein gangue and the rhyolite.

A.

B.

A. Hoen & Co. Baltimore.

A. GOLD ORE, "BLISTERY" PHASE

B. GOLD ORE, NODULAR OR KIDNEY PHASE

Gold Road and other districts in the Black Mountains, Arizona,[1] and with microscopic sections of ores from the Deer Lodge district and surrounding region in southeastern Nevada recently shown to the writer by B. S. Butler, it seems certain that the first minerals in the Jarbidge veins must have been calcite or barite, or possibly both, and pretty certainly not quartz. In the Black Mountain field proportionally large amounts of calcite still remain in partly replaced veins, and some large veins are still composed almost or entirely of seemingly original calcite. The sections from Deer Lodge likewise show considerable calcite, which appears to be primary. The only trace, if such it be, of these primary minerals, found in the Jarbidge district is a very little calcite which occurs here and there, seemingly as secondary filling, in some thin sections of the altered rhyolite.

The replacement of the primary minerals by the present gangue minerals, deposited first on the faces and cleavage planes of crystals and subsequently in cavities or druses, seems undoubtedly to have been accomplished through the agency of ascending hydrothermal solutions, as was first pointed out by Lindgren [2] for the deposits in the Silver City-De Lamar district, Idaho. Of the hydrothermal character of the deposition the Jarbidge veins afford plentiful evidences, among which may be mentioned the dikelets of the old lava magma, one-fourth inch or so in maximum width, filling parallel seams in the veins. The dikelets seemingly contribute nothing of value to the veins in which they occur nor do they in any wise affect them. Their manner of occurrence, however, in extremely attenuated tabular forms, together with their position at the very crest of the range, where the covering, when the veins were formed and the dikes injected, could not at most have much exceeded 2,000 feet in thickness, is regarded as significant in shedding light on the temperature that prevailed in the region at that time, for the injected magma that formed the dikelets must have been in an extremely fluidal, molten condition and possessed of great power of penetration, and this fluidity must have depended on high temperature, supplied from the plutonic seat of waning volcanism. Had the rock mass as a whole, the veins included, not been at a relatively high temperature, the progress of the magma between almost contiguous cool walls would have been quickly arrested by stiffening and congealment.

From these facts it is inferred that for a considerable period after the eruption of the old lavas, the period in which the veins were deposited the Jarbidge region maintained a relatively high though perhaps gradually descreasing temperature and the veins must therefore have been formed by ascending thermal solutions. These solutions

[1] Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona: Bull. U. S. Geol. Survey No. 397, 1909.

[2] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, pp. 165–166.

brought in the metal values and probably contained several other minerals, but they were particularly charged with silica, potassium, and aluminum, and as they dissolved out the calcite of the original gangue, silica was precipitated and quartz intergrown with adularia was secreted in its place, largely as pseudomorphic quartz and adularia after the crystalline forms or casts of the preexisting calcite, thus forming the present gangue.

In connection with the hydrothermal origin of the veins, it may be also noted that, so far as learned, the nearest hot spring to the district at present is the Wilkins Hot Spring on the Wilkins ranch, in Idaho, where the Twin Falls and Jarbidge road crosses East Fork, about 10 miles northeast of Jarbidge and a mile north of the State line.

The presence of dikes of rhyolite, particularly in the veins of the west group, suggests that some of the fissures now occupied by the veins may formerly have been occupied by dikes that have since been replaced, or that the fissures may have been reopened and vein material deposited on one or both sides of the dike, as indicated by some veins on the Pavlak property. Evidence in this direction, however, in the present stage of the field's development is not conclusive. A similar occurrence in the Eureka district, Nevada, is described by Curtis.[1]

The erroneous view that gold veins invariably become poorer with increase in depth is regarded by Lindgren as a misconception of the data involved. In describing the Ophir veins of California [2] he says:

> The veins may on the whole have been richer near the original surface, * * * but the occurrence of rich ore bodies at a depth of several thousand feet below the original surface certainly appears to indicate that the limit where gold was no longer deposited from its solutions has not by any means been reached in our present mines.

Below the water level the ore may be expected to become richer in sulphides, with probably a very material increase in silver and with the gold content mainly in the sulphides, but little if any of it being free.

The exact depth at which the Jarbidge veins were formed is difficult to say. It seems probable, however, that the veins now exposed in the upper part of the Jarbidge Mountains were formed at a depth of not more than 2,000 feet below the surface and the other deposits at perhaps a correspondingly greater depth.

ALTERATION OF WALL ROCK.

The country rock, particularly in the walls adjacent to the veins and extending for a hundred or more feet away from them, has suffered more or less extensive and characteristic alteration, in which

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[1] Curtis, J. S., The silver-lead deposits of Eureka, Nevada: Mon. U. S. Geol. Survey, vol. 7, 1884, pp. 90–106.

[2] Fourteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1894, pp. 279–280.

the chief results have been devitrification and silicification of the normal rhyolite and in places the development of sericite in the feldspars as well as of much pyrite throughout the rock. This process of alteration has left the texture and constituent minerals in an almost perfect state of preservation and given to the silicified rock a fresh and unaltered appearance. Elsewhere the rock is completely replaced or changed into massize quartz or vein gangue in which all trace of the feldspars and other rock minerals has disappeared except the quartz phenocrysts, which by their wine color and other characteristics can be distinctly traced from the relatively little-altered rock over into the gangue, where they occupy the same relative position to one another which they held in the original rock.

Whether some of this rock alteration may not be due to solutions of the early or primary mineralization has not yet been determined. Indications that the alteration on the whole was probably accomplished by the same solutions that replaced the veins are the absence of any sharp contact line between the present veins and the wall rock or between the vein and the inclusions of wall rock it may contain, as shown, for instance, in the specimen illustrated in Plate XI, *B*, where the passage from the vein gangue to the rhyolite is merely an ill-defined transition zone of corrosion in which the rhyolite gradually shades into the gangue, or vice versa. The rhyolite contains veinlets of quartz and adularia, which seem to be of the same age and to have been formed by the same solutions as the replacing gangue of the veins.

Furthermore, in the east-group veins that are composed chiefly of adularia, denoting that the solutions that formed them were poor in silica, there is little, if any, alteration of the wall rock. On the whole, the degree of alteration of the wall rock seems in general to bear a more or less direct ratio to the acidity of the neighboring veins.

Although, as already noted, most of the veins probably penetrate the underlying sedimentary and granitic rocks, it is also probable, to judge from the nature of the veins and the character of the rhyolites and of the fissures in which they occur, that some of the harder of these underlying rocks, such as quartzite reefs, may, like the "iron dike" in the De Lamar district, Idaho, prove to be the downward limit of certain of the veins and, by acting as a barrier and damming back their metals, greatly concentrate their values on the upper sides, a feature which should be looked into by managers planning for extensive operations. It seems also likely, as shown by Lindgren in the De Lamar district, Idaho, and already demonstrated to some extent in the Pavlak tunnel, that strong outcrops may dwindle in depth and that blind or new veins may be struck in underground work.

In veins having so-called talc seams and ore bodies in association, this material should be examined for values, for "much of the high-grade ore developed by the De Lamar mine, Idaho, was of a soft clayey character and gave little evidence to the eye of its richness."[1]

It is held by some that all the Jarbidge deposits of promise are restricted to the small belt in which the outcrops or traces of sedimentary rocks occur east of the river, and some mining men hold that the principal deposits are in association with or near the quartzite reef or "dike" on either side. These views are not warranted, however, for persons who have prospected the reef or "dike" report with small exception no values found in it or in the quartz immediately associated with it, whereas in localities remote from the sedimentary belt both on the north and on the south promising deposits are being opened.

That the sedimentary rocks, so far as they contain carbonaceous matter and have come into contact with the gold-bearing solutions, may have influenced the deposits is not to be doubted. The favorable effect of organic and carbonaceous material contained in shale, slate, schists, and allied rocks on the precipitation of gold is generally well known, and examples of it in the Ballarat mines have been described by Rickard[2] and in Victoria by Smyth.[3] But this influence in the Jarbidge district, so far as present developments extend, was slight, and where the shale partings or seams were introduced subsequently to the formation of the veins they could have had no influence on the precipitation of the gold.

DESCRIPTION OF PROPERTIES.

The mining properties of the Jarbidge district, several hundred in number, consist as a rule of claim groups located on the veins that have been described, and on most of them work has been begun. A description of the more important ones must suffice to convey a more or less general idea of the district as a whole. Owing to the newness of the camp and the consequent incipient stage of development, and in some cases to lack of information owing to absence of the owners, the descriptions will be necessarily brief. The properties described are mainly among the surveyed claims, most of which, up to August, 1910, are shown on the claim map (Pl. XII) kindly furnished by Messrs. Fairbanks & O'Byrne. Plate XIII, showing about 800 claims or groups, includes also unsurveyed claims and also the principal claims on the veins of the east system.

PROPERTIES ON THE WEST SYSTEM OF VEINS.

The properties on which the most development work has been done are on the veins of the west system. They comprise the Pavlak,

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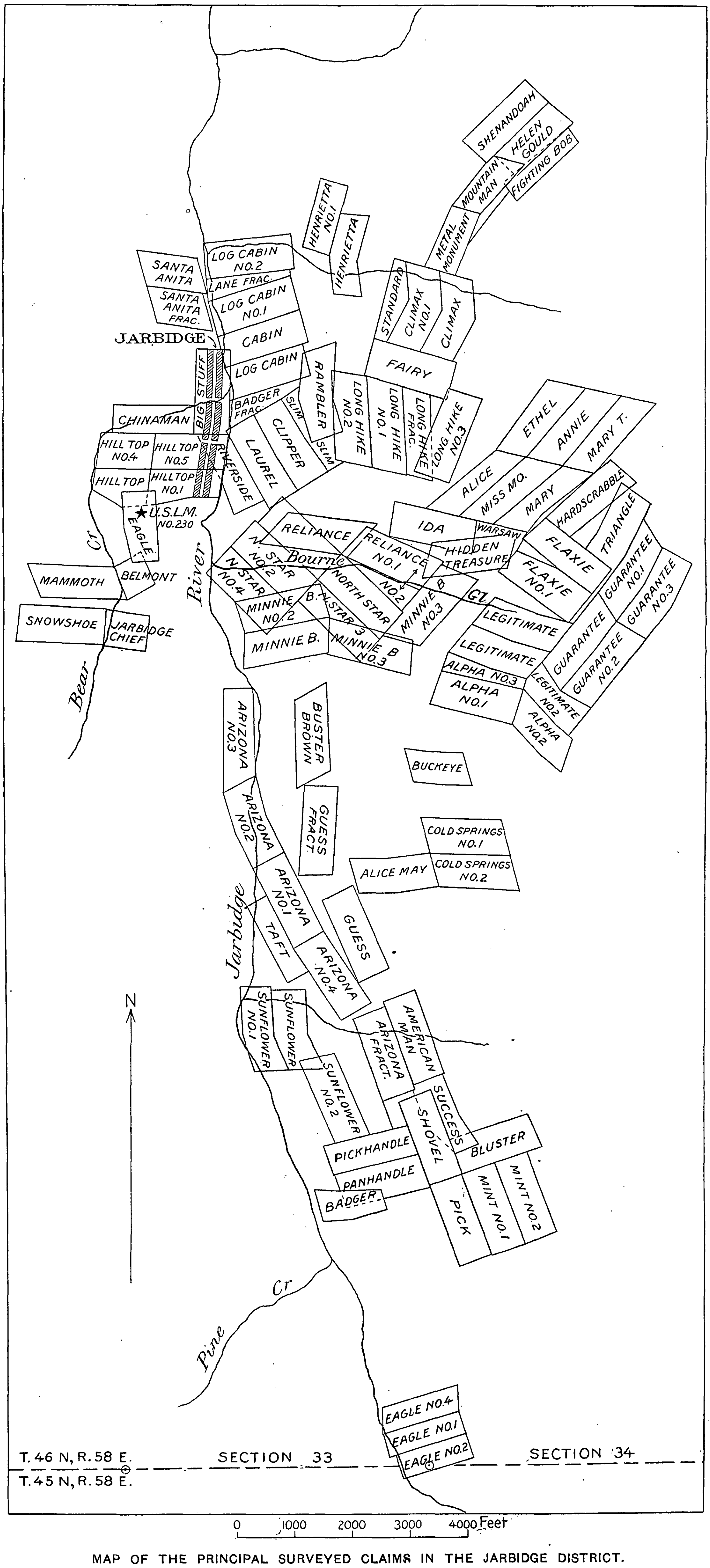
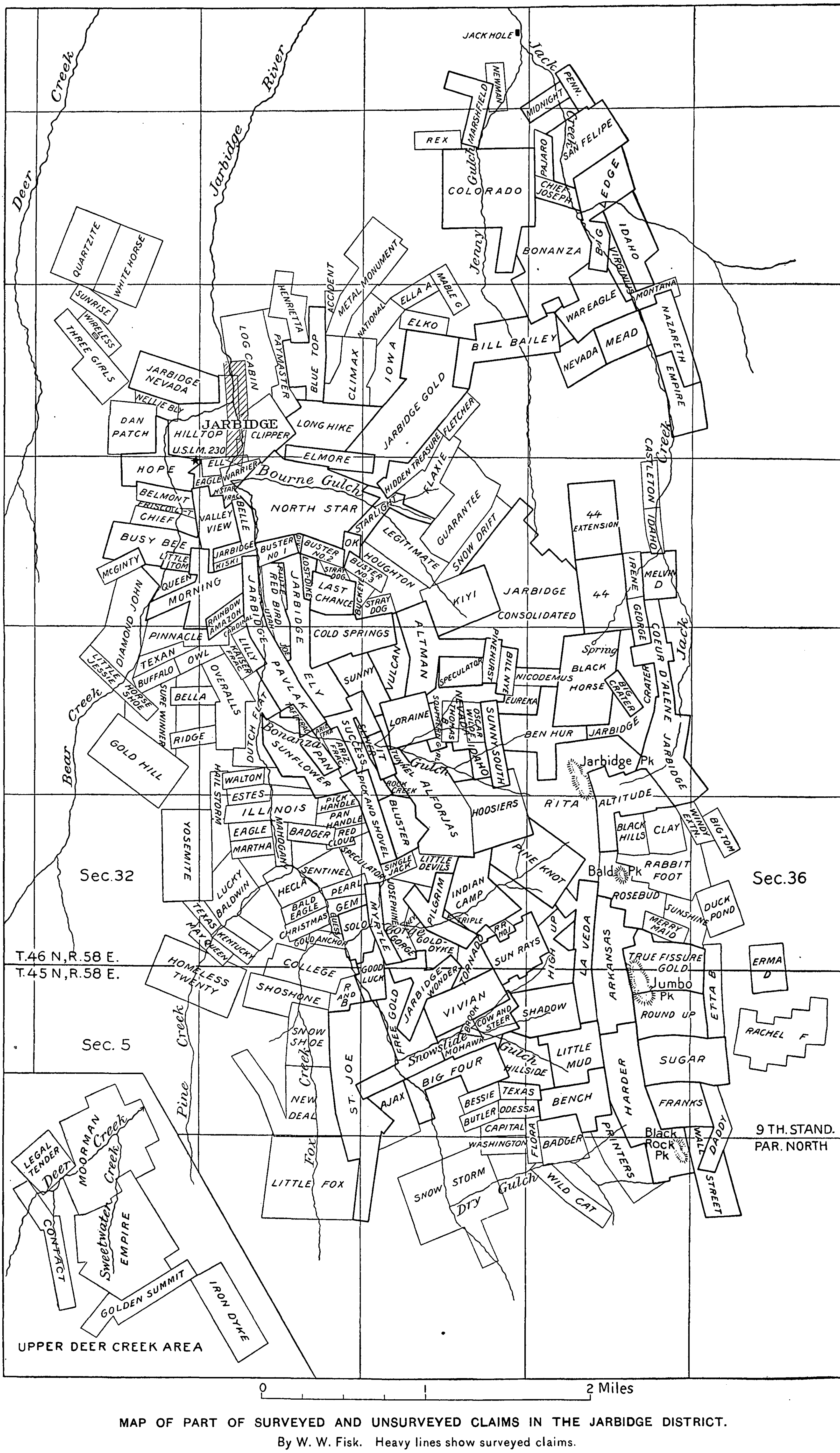
[1] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 122.

[2] Rickard, T. A., Certain dissimilar occurrences of gold-bearing quartz: Proc. Colorado Sci. Soc., vol. 4, 1893, pp. 323–329.

[3] Smyth, E. B., The gold fields and mineral districts of Victoria, London, 1869, pp. 74, 240, 246.



MAP OF THE PRINCIPAL SURVEYED CLAIMS IN THE JARBIDGE DISTRICT.



MAP OF PART OF SURVEYED AND UNSURVEYED CLAIMS IN THE JARBIDGE DISTRICT.

By W. W. Fisk. Heavy lines show surveyed claims.

Bourne, Buster, Pick and Shovel, Bluster, and others. On but a few of them has more than 200 feet of work been done. They are mostly located east of Jarbidge River, on the west slope of the Crater Range, in a belt about 1½ miles wide and 5 miles long, extending from the town of Jarbidge southward to the head of the river.

PAVLAK MINE.

LOCATION.

The Pavlak property, one of the earliest discoveries, is centrally situated and easy of access, on Jarbidge River about a mile above the town, between elevations of approximately 6,400 and 7,000 feet. It was located by Michael Pavlak, a leading pioneer of the camp and one of the present proprietors, late in 1909. It is owned by the Jarbidge-Pavlak Mining Co. and is operated principally by lessees. It consists of a group of about seven claims commonly known as the Arizona group, comprising the Arizona Nos. 1, 2, 3, and 4, the Amazon, the Taft, and the Rainbow Fraction. As shown in Plate XII, the claims extend for more than 6,000 feet, mainly along the Pavlak vein, in a northwest-southeast direction diagonally across the Jarbidge Valley, and outcrops occur interruptedly more or less throughout this distance. The vein seems to be in general alignment with the Pick and Shovel vein to the southeast. The principal portion of the property is on the east side of the river. Here, diagonally ascending the steep rough mountain slope, it rises 500 or 600 feet above the river, extends nearly to Bonanza Gulch on the southeast, and affords favorable ground for tunneling and mill sites.

GEOLOGY.

The country rock consists of flows belonging to the old lavas and is normal porphyritic rhyolite, except that on the Pavlak lease it includes the most altered phase encountered in the district. Much of the altered rock is purplish or bluish gray, with the feldspar kaolinized, and it is rich in macroscopic phenocrysts of wine-colored or reddish-brown "fish-eye" quartz and contains disseminated throughout considerable secondary pyrite and marcasite, both macroscopic and microscopic. It shows much secondary silicification.

The Paleozoic quartzite is reported to have been encountered recently in the Pavlak tunnel several hundred feet below the surface. The rocks as a whole are reported to show a westerly dip.

VEINS AND ORE.

There are four or more veins on the property. The most important are the Pavlak and Taft veins. They have a northwesterly strike, which is concave to the east and a steep or nearly vertical easterly dip.

The outcrops form bold reefs of silicified quartz and light-colored rhyolite stained by iron and manganese, in places as much as 60 feet wide, and rise to a height of 75 feet above the surface. The Pavlak vein is supposed to extend throughout the length of the claim group, a distance of nearly 1¼ miles. Nearly all the development work has been done on this vein. From the presence of the silicified rhyolite some portions of the vein are frequently referred to as dikes.

The Taft vein, exposed for a considerable distance along the property, principally on the Taft claim, nearly parallels the Pavlak vein on the southwest. In places it is said to show a width of 15 to 20 feet. Little development work has been done on it, but the Pavlak tunnel shows small quartz-adularia stringers which contain fair values and which are supposed to be feeders of this vein.

The veins and ore consist mainly of the gold and silver bearing quartz-adularia type of rock, which contains also much sericite widely distributed, considerable fluorite, some iron, and in places associated seams of talc from 1 inch to several inches in thickness.

The ore occurs in a great variety of forms and ranges in texture from coarse to fine and in structure from the characteristically laminated honeycombed or cellular variety rich in free gold, with gold frostings in the cavities, some yielding several thousand dollars a ton, to hard semitranslucent massive forms in which the values are usually small. A fine-grained siliceous phase showing deep-yellow free gold associated with blackish specks and streaks of a dark mineral, seemingly argentite, is reported to range as high as $4,000 to the ton. Some values occur also in the associated seams of "talc," but in a few places, if anywhere, in the wall rock.

DEVELOPMENTS AND PRODUCTION.

The development work, which was done mainly during the year 1910, consists of crosscut tunnels and drifts aggregating about 1,000 feet. They are mostly near the river at 20 feet or more above water level, on the lower west or footwall side of the veins. The work is distributed in three areas known in order from north to south as the Riddle, 4-M, and Pavlak leases, with about 100 feet on each of the two first named and the rest on the Pavlak.

4-M LEASE.

The 4-M lease, on Arizona claim No. 1, has made the best showing in the Jarbidge district so far as production and high-grade ore are concerned. On this lease, held and operated by Moffit, McCarty, Morris & Son, the principal opening at the time of visit was a 70-foot drift on the Pavlak vein, where its bold outcrops are cut by Cold Springs Gulch at an elevation of about 6,500 feet, or nearly 100 feet above the river. The drift runs S. 25° E. and has a depth or back of 120 feet at the face. The country rock is nearly normal rhyolite. It contains here and there a little pyrite, some in seams or veinlets one-eighth of an inch wide and some also disseminated through the rock, as at the Pavlak tunnel later described, but none was observed in the vein. The vein dips about 80° W.

Some of the outcrops are said to have assayed about $800 to the ton. On removal of the surface strippings on the hill slope above the drift, the vein showed a small streak of high-grade ore extending continuously for a distance of nearly 200 feet, which panned well and assayed from $300 to $850 to the ton. In the drift that was being run to open this rich ore shoot in depth the vein showed a width of 1½ to 3 feet. It consisted of iron-stained quartz and some associated rhyolitic breccia, and was practically all good milling ore worth $60 to the ton, or better. It contained also streaks, bunches, and pockets of high-grade shipping ore in which much of the gangue or matrix was sugary quartz running high in values, the highest being on the footwall side, where assays are reported to have yielded as high as $18,036 to the ton, of which 36 ounces was silver and the remainder gold. A more or less persistent streak about half an inch in width, which was being broken down on canvas and sacked for shipment, was said to range from $5,000 to $10,000 to the ton.

In some of the high-grade ore the nodular or concretionary kidney-shaped phase already described is also well developed, the streaked or banded ore being deposited concentrically around inclosed fragments of silicified rhyolite as nuclei. The encircling black streaks associated with the bands are in places rich and show free gold. The specimen shown in Plate XI, *B* (p. 62) is an example of ore of this class.

From the ore mined about 100 sacks had been hand sorted for shipment, effort being made to keep the grade up to $1,000 a ton. Late in November, 1910, it was authentically reported that from the bottom of a winze sunk to the 50-foot level drifts were being extended both to the north and to the south. A carload of shipping ore averaging $1,000 to the ton had been sacked and a large amount of high-grade milling ore was being accumulated on the dump for the new mill.

On the 4–M lease the Taft vein lies 150 feet southwest of the Pavlak vein. It varies from 8 inches to 3 feet in width and pans about $15 in free gold to the ton, but probably contains values that will average several times this amount.

A recently discovered vein on this lease, opened by a short tunnel about 40 feet below the surface, is said to show a width of about 7 feet of mainly good ore, of which about 4 feet is a fine-grained white quartz that pans well in gold and is mostly of shipping value.

RIDDLE LEASE.

The development work on the Riddle lease, held and operated by Riddle & Corrigan, on Arizona claim No. 2, includes several openings, but consists mainly of a tunnel or drift a hundred feet in length.

This tunnel starts about 20 feet above the river flats and is driven eastward, mostly in normal gray rhyolite and in part on what seems to be a spurlike vein to crosscut the main Pavlak vein, 150 feet beyond the face, beneath a shaft and bold outcrops that stud the steep slope 200 feet above the river. This work, it is said, was started on an outcrop of mostly barren quartz with which was associated an 8-inch streak of ore showing values of only about $1.60 to the ton.

The spur vein consists of the usual quartz-adularia rock and contains inclusions of metasomatically altered gray rhyolite, like the specimen shown in Plate XI, *B*. It also contains much fluorite and sericite and shows in places 5 to 8 feet of ore that averages about $15 to the ton. Here and there it carries bodies of rich ore sprinkled with visible free gold. Recent reports state that the vein has also been opened by a tunnel on a higher level, where it shows considerable quantities of $12 to $16 ore.

PAVLAK LEASE.

The Pavlak lease, also called the Pavlak-Thorout lease, is located south of the 4–M lease on the Taft and Arizona No. 1 claims and is operated by the Pavlak-Jarbidge Mining Co. It comprises some of the highest ground, strongest outcrops, and most extensive development work on the Pavlak property. The work consists principally of the Pavlak tunnel, which, starting at about 20 feet above the river flats, is driven about N. 75° E. for a distance of nearly 700 feet to crosscut the Pavlak vein at a depth of 600 feet beneath the surface. In its course the tunnel seems to have cut almost the entire Pavlak vein system. It is said to cross several stringers and two veins besides the Taft and Pavlak veins. The veins range from 2 to 8 feet in width. In the last 200 feet or more of its course the tunnel also penetrates the Paleozoic quartzite, which is said to have been encountered to the west of a vertical line beneath the shaft and the outcrops and which probably expands into the core of the mountains and perhaps widely underlies the lavas in this vicinity. In the tunnel this rock seems to deflect or pinch the veins, but near the present face of the tunnel it contains quartz stringers regarded as promising. Also in the north drift from the tunnel a large amount of good-looking quartz has been encountered on the Taft vein. Each of the four veins has been drifted on for 50 to 70 feet to the right and the left of the crosscut tunnel, with only moderate success. The best showing seems to be on the Taft vein, which, at about 80 feet in from the portal of the tunnel, shows several feet of low-grade ore.

At the east contact of the rhyolite with the quartzite there is, it is said, a large, ill-defined vein with a seam of talc and a copious flow of water, and this is thought to be the main or Pavlak vein. About 100 feet beyond this contact the tunnel crosses what seems to be a 2 to 3 foot fissure containing bowlders of hard quartz and likewise yielding a large flow of water.

The Pavlak shaft is located on the Pavlak vein on the course of the tunnel at about 600 feet above its level. It is 40 feet deep and shows the vein here to be from 10 to 12 feet wide. It was started on 2 feet of low-grade ore, but at a depth of 18 feet it shows 7 feet of ore ranging from $2 to several hundred dollars to the ton. The lower part of the shaft, 10 feet in width, is said to be wholly in good-grade milling ore, which, taken in connection with the neighboring outcrops, indicates a considerable body of good ore at this place. The entire dump from the shaft is said to pan well in gold.

About midway between the Pavlak and Taft veins a new vein has recently been opened on the surface which is probably one of those that were crosscut in the tunnel below. It is said to be 3½ feet wide and shows fair gold values. At last accounts a large body of rich ore had been opened in the crosscut from the north drift in the tunnel at a depth of about 300 feet.

The country rock on the Pavlak lease, as shown in the tunnel several hundred feet underground, is the typical porphyritic rhyolite. Though it looks relatively fresh, in reality it has undergone more alteration and silicification than any other rocks seen in the district, especially between and along the veins. In places it carries fair values. The groundmass is purple or bluish ash-gray. It is finely holocrystalline, with a tendency to be poikilitic, and it is at least partly altered by secondary silicification. Plentifully scattered throughout it are secondary pyrite, hematite, marcasite, and a little magnetite and sericite, and in places it contains much finely divided chlorite.

The rock contains abundant phenocrysts of the deep reddish-brown "fish-eye" quartz, whose cracks are filled with infiltrated hematite. Some of the phenocrysts are surrounded by aureoles of secondary silica. The orthoclase phenocrysts are in part kaolinized or suffused with secondary silica. Some contain epidote, chlorite, pyrite, and a little sericite. The principal processes of alteration in this rock are silicification, epidotization, chloritization, and pyritization.

On the bank of the river at the mouth of the tunnel the company is installing an improved cyanide plant and mill with classifiers. In November, 1910, most of the lumber and part of the machinery was on the ground. Besides treating the output of this property, the mill is planned to handle custom ore for other mines.

HAM-AND OR CURLEY LEASE.

To the south of the Pavlak lease, but on the Pavlak ground and on the extension of the Pavlak and Taft veins, is the Ham-And or Curley lease, operated by McCoy, Andrews & Murray, on which each vein is about 5 feet in width and shows milling ore that pans well. One vein is opened by a 155-foot drift and a shaft. The drift is said to show ore all the way that pans from $14 to $60 to the ton.

The shaft extends 25 feet below the level of the drift, and its bottom part is all in vein material, of which nearly 2 feet is high-grade ore and most of the rest milling ore.

PAN PROPERTY.

Joining the Pavlak property on the southeast is the Pan claim. (See Pl. XIII.) It lies mostly on the south side of Bonanza Gulch, between elevations of 6,700 and 6,900 feet. It is operated by J. P. Duncan, and is opened mainly by a tunnel or drift at an elevation of about 6,730 feet on Bonanza Gulch, which is here a canyon.

The country rock is greenish or purplish-gray hard rhyolite, and it is porphyritic mainly, with more or less conspicuous phenocrysts of the "fish-eye" quartz.

The tunnel runs S. 35° W. for about 100 feet, to a point where it obliquely strikes the vein, which trends in a southeasterly direction, like the western veins in general. The dip of the vein is about vertical, and it seems to be on the trend of the Taft vein. The vein is 3½ feet wide. It is composed chiefly of medium-textured quartz-adularia rock, some of which is sugary or fine, but inclosed in it are small fragments of completely altered and silicified rhyolite, and it presents in part a brecciated appearance. The vein is also split by a horse or lens of country-rock rhyolite about a foot in width, the extent of which was not shown at the time of visit.

The vein is oxidized and looks well, but is of low grade. The ore, which includes most of the vein, at the time of visit ran from $3 to $4 to the ton. Recent developments, however, are said to show ore of better grade in the drift about 225 feet in from the portal of the tunnel, at a depth of about 150 feet.

SUNFLOWER GROUP.

Joining the Pan property on the west and extending down Bonanza Gulch to the river flats is the Sunflower group (see Pl. XII), consisting of four or more claims owned by F. W. Riddle, which are said to comprise two veins showing workable ore of fair grade.

RED BIRD AND DUFFY CLAIMS.

On the Red Bird and Duffy claims (see Pl. XIII), joining the Pavlak property on the northeast and the Buster on the north, three veins lying about parallel with the Pavlak veins and probably belonging to the same subsystem have been opened at several points by W. W. Williams, of Butte, Mont. They are from 4 to 6 feet in width and from the outcrops seem to extend more or less continuously across the property. One of these veins for about 600 feet is said to carry nearly 5 feet of good ore that shows considerable free gold in the pan. This vein has been traced southeastward across the Guess and other groups into Bonanza Gulch.

BOURNE MINE.

LOCATION.

The Bourne property is situated about a mile north of the Pavlak mine and about three-fourths of a mile south-southeast of Jarbidge, east of Jarbidge River, on Bourne Gulch. It comprises 17 claims, known as the North Star or Bourne group, which, as shown on Plate XII (p. 66), extend more than 1½ miles eastward from the river up the steep but not generally rugged mountain slope to the 9,000-foot contour. The mine proper is situated in the western part of the group on the North Star No. 3 claim, at an elevation of about 6,950 feet, or 650 feet above the river.

The property was discovered and located August 19, 1909, by D. A. Bourne, the pioneer discoverer of the district. Soon afterward the North Star Mining & Milling Co., of Boise, Idaho, the present owner, was organized to develop the property. Development work is mostly carried on by lessees.

DEVELOPMENTS.

The developments, which consist of 100 feet or more of underground work, are mostly at the Bourne mine or Fletcher lease and at the Buys-Riddle lease.

At the Fletcher lease, held and operated by Clark & Fletcher, of Ely, Nev., the development consists principally of two tunnels or drifts driven on or in association with the lode known as the Bourne vein (see fig. 2, p. 49) and spaced 105 feet apart vertically and about 20 feet horizontally. Of these the upper or main tunnel, which runs in general in a southeasterly direction, is 212 feet long and contains about 300 feet of crosscuts and laterals, a 45-foot upraise to the surface, and a 30-foot winze. The lower tunnel, in which work is now going on, has a length of about 200 feet. It also contains a crosscut, from which an upraise is being driven on the vein to connect with the winze of the upper tunnel. This connection will give the mine good ventilation and will open considerable stoping ground. According to recent accounts this lease has been sold to a Salt Lake company by which a mill is soon to be installed.

In the Buys-Riddle lease, on the adjoining North Star claim and North Star vein, to the east, about 200 feet lower than the Fletcher lease, the developments consist of two short tunnels or drifts. The upper and more important runs S. 22° E. and is in 40 feet on the vein, which in places is about 7 feet in width, and has an 18-foot winze sunk about 15 feet in from the portal. At the time of visit a new and shorter tunnel was also being driven lower down the slope.

GEOLOGY.

The country rock consists mainly of the old rhyolite, much of which, owing to the steepness of the slope, is covered by slides and talus. The reef or "dike" of Paleozoic quartzite, about 200 feet wide, best exposed where it crosses Bourne Gulch, extends diagonally across the property in a northeast-southwest direction. No values to speak of have yet been found in association with this rock.

VEINS AND ORES.

The deposits on the Bourne group, so far as observed, seem in large part to be more in the nature of composite veins or lodes than of well-defined individual veins. They are marked by strong outcrops trending in the usual northwest-southeast direction, which, however, occur only interruptedly in isolated knobs, bunches, or masses a few hundred feet or less in extent. Though some of them are in alignment, the continuity or discontinuity of the deposits from one outcrop to another is masked by the heavy sheet of slide and talus that in most places blankets the slope.

At the Bourne mine, on the Fletcher lease, the outcrops, which are 40 feet or more wide, extend for about 200 feet, and rise boldly about 20 feet above the surface, consist mainly of silicified rhyolite and some associated vein material and contain in places very high values. Beneath the outcrops the deposit, which seems to be a lode or mineralized shear zone in highly altered rhyolite, dips eastward, into the range, at angles of 80° to 85°. The lode has an average width of 16 to 20 feet and a known maximum width of 113 feet. It is composed of the usual laminated quartz-adularia rock shown in Plate VIII (p. 54) and is said to run about $12 in gold to the ton. It shows considerable free gold in places, and free gold may usually be obtained in panning. The entire mass is deeply oxidized or stained by iron and manganese and contains seams of "talc."

Under the microscope the thin sections show that the lode material contains more than 60 per cent of adularia and is on the whole much finer grained than any seen elsewhere in the district. At least two generations of crystals seem to be present, the medium or coarse and the very fine grained. In the latter, almost as in a groundmass, the coarser crystals seem to rest, the whole forming a faintly and imperfectly banded structure, as shown in Plate IX (p. 56). In this rock the gold occurs mostly in association with argentite and in the form of free gold, as shown in Plates X (p. 60) and XI, *B* (p. 62), and described more in detail on page 57.

The gold and especially the associated argentite occur in irregular ragged-edged areas and in small bodies and grains, and the argentite also in still smaller grains ranging down to dust in the adularia interstices. Where the gold occurs in areas or specks of any considerable size it is for the most part surrounded by argentite, with which its main contact is usually irregular, as shown in Plate X.

Argentite and apparently some gold fill certain of the cracks that cross the large crystals. Some crystals or grains of adularia penetrate the periphery of the gold-bearing part of the ore and show that the gold occurs as filling and was probably deposited later than the adularia. In places the gold tends to occur in or close to the druses that are more or less surrounded by coarse adularia crystals, and some of it is associated with iron.

In the early stages of the mine's development a number of assays made by F. V. Bodfish,[1] who sampled the lode, showed that the ore averaged about 0.44 ounce of gold and 1.4 ounces of silver to the ton. Later developments show the ore in general to contain more nearly an ounce of gold and half an ounce of silver to the ton. The silver seems to occur principally as argentite.

The values favor the footwall. Here, at about 6 feet from the side of the lode, a band of ore 16 to 24 inches wide, starting about 12 feet in from the portal of the tunnel and having a known extent of 16 feet, contains more than $100 to the ton, with portions ranging as high as $10,000. The values in the winze are said to range from $16.50 to $482 to the ton. The highest-grade ore is usually associated with dark longitudinal streaks and specks of silver sulphide or argentite.

At about 112 feet in from the portal the tunnel is crossed by a northwestward-dipping fault which disturbs the constancy in values, locally terminates the bold surface outcrops overhead, and suggests that the exploited portion of the lode may be faulted down from the rich outcrops occurring considerably higher up the mountains, some 500 or 600 feet to the southeast. The adjoining open test cuts, however, are too shallow to show the dip. In the bottom of the winze is a so-called cross bar of rhyolite, which, however, may be only a horse.

According to advices received in April, 1911, the ore chute had just been opened with good results at three points 60, 100, and 140 feet below the surface, and the vein was found to vary from 8 to 13 feet in width. It showed much easy-milling $17 ore, sufficient, it is said, to run a 10-stamp mill for a year. The workings were all in the laminated quartz, said to carry the best values.

In July, 1911, it was reported that the mine had $150,000 worth of ore blocked out, and that the mill being installed on the ground was nearly completed. In this mill, it is said, the crushing will be done by rollers and the pulp passed over plates and then cyanided.

The crude alignment of the Bourne mine deposits here described with the prominently outcropping lode or reef of reddish altered mineralized rhyolite about one-eighth of a mile to the north-northwest, in the north cliff of Bourne Gulch, suggests that beneath the

[1] Scott, W. A., Jarbidge, Nevada: Min. and Sci. Press, Apr. 30, 1910, p. 614.

surface covering the deposits may be continuous between these two outcrops. At the latter locality, which is an earlier discovery, some development work has been done. The outcrops are traversed by a prominent sheetlike structure with a N. 60° W. strike and a dip of 80° S.

On the Buys-Riddle lease the vein is in places about 7 feet wide. It is said to pan well in free gold and the ore runs about $10 to the ton, with a little high-grade ore in spots. Considerable free-milling ore containing $17 to the ton was taken out of the winze, mostly in a sugary quartz gangue.

MISSMO GROUP.

To the northeast of the Bourne property, above the quartzite reef, much of the surface dirt pans well in free gold and here a considerable area covered by the Missmo group of claims (see Pl. XII, p. 66) is being opened by a crosscut tunnel driven by E. Fletcher and others, of Boise.

BUSTER MINE.

The Buster mine is situated between the Pavlak and Bourne mines, at the foot of the mountain on the east side of Jarbidge River, about three-fourths of a mile above Jarbidge, at an elevation of about 6,360 feet, and is opened at about 20 feet above the river. It was located late in 1909 and is owned and operated by the Buster Mining Co., of Jarbidge. The property comprises several claims and a fraction (Pl. XIII, p. 66) situated on the steep hillside slope shown in Plate VII, *A* (p. 50). The country rock is the old rhyolite. Much of it is considerably altered and locally silicified along the veins and in places contains finely disseminated pyrite.

The mine is on the cross-vein system, which trends in a northeast-southwest direction, nearly across the general trend of the neighboring veins of the west system.

The deposits comprise several short parallel veins or lodes, all dipping steeply to the southeast. They are composed chiefly of the usual laminated quartz and adularia and contain in places considerable associated altered rhyolite. Of these veins the most important is a vein about 12 feet in width, with casing and slickensiding on either wall, contained in a lode 30 feet wide, whose outcrops, consisting of silicified gangue and altered rhyolite rising boldly 30 feet or more above the surface, extend for about 600 feet up the slope, as shown in Plate VII, *A*, and assay fair values in gold.

The property is opened by a 125-foot crosscut tunnel which runs southeast and crosses three veins. The first vein, located 25 feet in from the portal, is about 9 feet in width, including considerable altered rhyolite, and is said to average about $16 in gold to the ton.

The second vein, which occurs about 50 feet in from the portal, has a width of about 2 feet and is reported to carry good values. Here small bodies of the wall rock contain disseminated fine-grained secondary pyrite.

The third or main vein, the one marked by the strong outcrops and but recently reached underground, lies near the face of the tunnel, about 125 feet in from the portal, at a depth of 140 feet. It is said to be 12 feet wide and to average $12 in gold to the ton.

The continuation of this vein, or its fault fissure, is represented on the opposite or west side of the Jarbidge Valley by the Jarbidge Cave, described on page 37, which is on the strike of this vein and is roofed or capped by outcrops similar to those at the Buster mine. Within the cave are good slickensided walls on the northwest. It contains rhyolite fault breccia and associated mineralized rock or vein material and in places has yielded the prospector as high as $17 to the ton.

It seems also probable that the Amazon vein, situated to the south of the cave, formerly belonged to the main Buster vein, which it parallels and from which it seems to have been displaced by a transverse fault with a lateral throw of about 500 feet.

A 3-stamp mill being installed at the Buster mine is expected to be soon in operation. Recently a good opening has been made on the Buckeye ground, adjoining the east end of the Buster on the south and lying in the trend of the Bourne and Buster mines.

PICK AND SHOVEL MINE.

The Pick and Shovel mine, also known as the Escalon mine, is located 2¼ miles south-southeast of Jarbidge, on the middle west slope of the Crater Range, near the head of Pick and Shovel Gulch, at an elevation of about 7,600 feet, or 900 feet above the river. The camp is on the opposite or east side of the gulch, about 300 feet below the mine. The mine was discovered September 15, 1909, by John Escalon, of Elko, Nev., soon after the famous Pavlak and Bourne properties were discovered.

At the time of the writer's visit the property was developed by a 100-foot shaft sunk on the vein with a 20-foot crosscut and a 40-foot drift on the 50-foot level, a 16-foot crosscut on the 100-foot level, and 50 feet of main adit tunnel started in the hillside on a level 200 feet below the collar of the shaft. Hoisting machinery and boiler were soon to be installed. The mine is said to be bonded since March, 1910, for $100,000 to the Twin Falls-Jarbidge Development Co., with headquarters at Twin Falls, Idaho, by which it is operated.

The property consists mainly of the Pick and Shovel and the Shovel Fraction claims, shown on Plate XII (p. 66). It trends northwest and southeast, about parallel with the veins of the west system, and lies mainly between elevations of 7,300 and 7,700 feet. The slope is steep, about 30°, but the topography is not rugged. The mine is now reached by trail, but a good wagon road could readily be constructed.

The country rock is mainly the old rhyolite, which in places, especially on the north, is worn through by erosion to the underlying sedimentary rocks, notably siliceous shale and sandstone or quartzite, and some of which occurs in the mine associated with the vein. The rhyolite is normal, but is finer grained than the relatively coarse porphyritic phase occurring at the Pavlak tunnel. The bedrock is mostly covered, however, by a surface sheet of slide and talus that lies upon the slope, as shown in Plate VII, *B* (p. 50).

The deposits occur in a fissure vein or lode known as the Pick and Shovel vein. The course of the vein obliquely along the mountain side is marked in places by bold outcrops rising 30 feet or more above the surface, both north and south of the mine. The outcrops consist of the usual quartz-adularia gangue and rhyolite.

The general alignment of the vein with the Pavlak vein on the northwest has been noted in the description of the Pavlak mine. Openings on the south, near Gorge Gulch, on the Good Luck claim, and on the Free Gold No. 4 claim, are also in alignment and thought to be on the extension of the Pick and Shovel vein.

According to latest reports the vein on the 100-foot level shows a width of about 30 feet, most of which carries good average values and contains some high-grade ore, samples containing $45 in gold to the ton being reported. The high-grade ore occurs largely in dark-colored bands, streaks, or lines which, in the deeper part of the mine, traverse a relatively fresh-looking milky-white to semitranslucent rock. The dark color in these streaks and lines is due in part to argentite associated with the gold, and in part to the gangue itself, which is of dull-grayish luster and darker and later than the surrounding rock whose fractures it fills. Considerable portions of this earlier rock are almost completely replaced rhyolite.

The walls of open or loosely filled portions of fissures in the lode are faced with a reddish to brownish-gray incrustation of argentite and hematite from 0.05 to 0.1 inch in thickness, throughout which visible free gold is finely disseminated.

The ore also contains nodular concretionary forms in which fragments of altered silicified rhyolite or of the sedimentary rock are the nuclei around which deposition and ore concentration have taken place. Plate XI, *B* (p. 62), is a reproduction of a sample of the ore with rhyolite nucleus from the 100-foot level.

The ore on the whole consists of the usual gold and silver bearing quartz-adularia rock. It is for the most part crudely banded or massive and contains fragments of rhyolite and siliceous greenish-gray and black massive shale or slate ranging up to 2 inches or more in diameter, the latter being traversed by numerous quartz-adularia veinlets. Some pieces show pronounced contact metamorphism and some have been so suffused, silicified, and changed by the gangue solutions that they are altered into a kind of hard, dense aphanitic hornstone or flint. These hard flints or hornstones and the metamorphic fragments alike show finely disseminated specks of free gold.

Under the microscope thin sections of the ore, notably from the 70-foot level, show the rock to be composed of about 50 per cent of adularia variously intergrown with the quartz, all showing very complicated replacement structures, bladed, fan-shaped, and drusy, some of which are reproduced in Plate IX (p. 56). The quartz and adularia seem to be of several generations, small crystals of the older being contained as inclusions in crystals of the younger.

Disseminated throughout the ore is also considerable sericite, which occurs mostly in aggregates, locally in the druses. Fluorite as a late filling is present in considerable amount, notably in sections from the 70-foot level, and the ore contains also considerable disseminated hematite or ferric oxide in grains and dust.

Toward Bonanza Gulch on the north end of the property, at an elevation of about 7,550 feet, a 10-foot open cut shows what seems to be a lode or vein, striking N. 35° W. with nearly vertical but variant dip, which is thought to be the Pick and Shovel vein. The northeast side of this vein is composed of quartz and adularia and the remaining 8 or 10 feet is in the main partly altered silicified rhyolite, in part replaced by the same gangue minerals. The northeast wall is well frozen to the country rock. The vein is good looking so far as exposed. The outcrops are massive iron-stained quartz and silicified rock.

A short distance to the north of this opening, down the south slope of Bonanza Gulch, are exposures of the younger Paleozoic sedimentary rocks, to which the fragments contained in and associated with the Pick and Shovel vein are very similar and from which they have doubtless been derived. To judge from the amount and size of the fragments and the angular character of many of them, the parent beds probably lie at no great depth below the bottom of the Pick and Shovel mine.

From these conditions it is inferred that this mine, as well as the Pavlak crosscut tunnel, promises to disclose at an early date very interesting and significant results concerning the continuity and behavior of the veins in the sedimentary formations that underlie the rhyolite lavas, in which alone, up to the present time, the veins are known to occur. The sedimentary rocks of the Pick and Shovel mine appear different from and younger than the hard quartzite encountered in the Pavlak tunnel.

BLUSTER MINE.

The Bluster mine, also known as the Winkler mine, is situated about 2½ miles south-southeast of Jarbidge, on the middle west slope of the Crater Range at the head of Pick and Shovel Gulch (Pl. VII, *B*, p. 50), about one-fifth of a mile east of and up the slope from the Pick and Shovel mine. (See Pls. XII and XIII, p. 66.) It lies at an elevation of about 8,050 feet, or about 1,300 feet above the river.

The property consists principally of the Bluster and Scenic claims. It was discovered and located January 11, 1910, by George Winkler, T. B. Beadle, and Edward Benane, the present owners and operators, and received its name from the atmospheric conditions of the day on which it was located. Its promising character and rich ore, however, were not recognized until early in July, since when excellent results have been shown, considering the moderate amount of development. It was worked on a small scale until August 4, 1910, but from then until about the end of the year operations were temporarily suspended owing to litigation.

The developments at the time of visit consisted mainly of a 5 by 7 foot shaft 16 feet deep sunk on the footwall of the vein; later this shaft was deepened to 52 feet. The mine is now reached by trail. The topography is similar to that of the Pick and Shovel ground shown in Plate VII, *B*, except that being higher up the slope the surface is steeper and in places strewn with heavy talus and rock débris.

The country rock is the old rhyolite and is the medium or fine grained phase. It is mostly light gray and is silicified and traversed by quartz-adularia seams and veinlets, but ranges in color to dark purple or blackish.

There are no strong outcrops of the Bluster vein at the mine. Along its strike, however, about 1,000 feet to the north, in the south slope of Bonanza Gulch, outcrops occur, and farther down the slope, crossing Bonanza Gulch at an elevation of about 6,200 feet, about 2,000 feet distant from the mine, is a boldly outcropping reef or dike about 100 feet wide, commonly known as the Bluster dike. This dike is composed mainly of silicified rhyolite similar to that forming the footwall at the mine, and it is commonly regarded as representing the continuation of the Bluster vein or at least of its fissures. Several cuts or openings whose material pans well in gold have been made on or near this reef between the mine and Bonanza Gulch. The vein is also opened at a point several hundred feet to the south of the mine, on the opposite side of Pick and Shovel Gulch.

The Bluster vein as seen in the mine strikes N. 28° W. and dips 75° E., into the mountain. It showed at the time of visit a width of 4½ feet in the shaft, with both walls composed of silicified rhyolite and locally containing values.

The vein is crudely banded with five or six longitudinal bands. It is composed of the usual milky-white or vitreous quartz-adularia rock and contains some fault breccia of rhyolite and dark siliceous slate or slaty quartzite. Fragments of each of these varieties of rock form the nuclei in the nodular phase of the ore, as in the 4-M lease on the Pavlak mine and in the Pick and Shovel mine. On the whole the color of the vein is light. Much of the ore glistens with the many bright glassy faces of the small pseudomorphic plates of the gangue lying at all conceivable angles. Owing to the delicacy of these plates much of the ore is friable and is easily pulverized by rubbing between the hands or fingers. The texture is medium to fine; the coarse-textured gangue or ore such as is shown in Plate VIII (p. 54) seems to be absent.

The vein contains gold almost from the surface down. This is readily shown by panning. The values favor the footwall, and the occurrence of the metals is in most respects similar to that in the Bourne and Pavlak mines.

At the time of visit the vein in the 16-foot shaft had been carefully sampled by several persons independently, each of whom reported it to average $60 to the ton in gold and silver, including everything from wall to wall. Except about 30 sacks of shipping ore the entire dump excavated from the shaft, it is said, will average about this amount and is to be milled. In the sampling the values were found to vary in different parts of the vein. The lowest assay obtained was $10 and the highest $1,200 to the ton. The richer ore occurs in certain portions of the crude bands, mostly near the middle, on tabular slabs of quartz, where the metal incrusts areas that may reach a foot or more in diameter. A sample of this ore is shown in Plate XI, *A* (p. 62). These incrustations are richly coated or sprinkled with patches or relatively coarse specks of gold, many being from one-half to three-fourths of a millimeter in diameter. The gold seems to be coarser than that in the mines down near the river, already described.

Some of these rich bands extend continuously across the shaft and others about halfway. A 1-inch band next to the footwall is said to run $800 to the ton, and a 5 or 6 inch band next to it about $200 to the ton. In each of these bands occur thin discontinuous pay streaks running as high as several thousand dollars to the ton.

With the gold is nearly always associated considerable argentite, the quantity of which stands in direct proportion to that of the gold. The highest silver value reported from the mine is 90 ounces to the ton, which is somewhat exceptional for this district.

Since the property was released from litigation the shaft has been sunk to a depth of 52 feet, where the vein, it is said, is about 5 feet wide and is richer than at any other point at which it has been opened from the surface down.

SUCCESS GROUP.

Adjoining the Pick and Shovel and Bluster mines on the north, in the south slope of Bonanza Gulch, as shown on Plate XII (p. 66), is the Success property, owned and developed by Nelson Bros., of Nevada. It is crossed by several veins, among which that supposed to be the Pick and Shovel vein is the most important. This vein is here 5 to 6 feet in width and shows ore considerable portions of which are said to average $100 to the ton.

ROCK CREEK FRACTION AND IT CLAIMS.

Northeast of the Bluster mine and the Success group are the Rock Creek Fraction and It claims (see Pl. XIII, p. 66), traversed by a 2-foot vein composed mostly of good ore. Before the vein was opened a one-third interest in the Rock Creek Fraction, it is said, exchanged hands for $1,500.

JOSEPHINE GROUP.

On the Josephine group (see Pl. XIII), in the north side of Gorge Gulch, about half a mile south of the Bluster mine and approximately on the trend of the Bluster vein, occur two veins. The quartz in the more easterly one, which is opened by a 40-foot tunnel, is said to resemble closely that of the Bluster vein and to pan well in gold. Farther up Gorge Gulch to the northeast, on the Stray Dog, Indian Camp, and Red Rooster claims, occur two veins said to show good values and to extend southeastward across the ridge into Snowslide Gulch.

GOOD LUCK PROPERTY.

The Good Luck property is about 3 miles south-southeast of Jarbidge and about a mile south of the Pick and Shovel and Bluster mines. (See Pl. XIII, p. 66.) It is situated in the more or less steep basal slope of the mountains, mainly east of Jarbidge River, a short distance above Gorge Gulch, and lies mostly between elevations of 6,750 and 7,000 feet. It is being developed by Park & Coburn, and is opened mainly by a 100-foot drift at an elevation of about 6,900 feet, or 150 feet above the river. The country rock is the old rhyolite, for the most part considerably altered or stained reddish brown.

The deposits occur in a tabular fissure vein or lode commonly known as the Good Luck vein. It strikes about N. 10° E., with approximately vertical dip, and is from 10 to 30 feet in width. It crosses Jarbidge River obliquely just below the Scott-Power place and here shows a width of about 20 feet. Its course in general is marked by well-stained and prominent outcrops which show at the Good Luck mine, across the river in the bluff back of the Scott-Power place, on the south, and beyond Gorge Gulch, on the north. The outcrops are said to show as a rule some free gold in the pan.

The Good Luck drift follows the footwall of the vein for about 100 feet, and from its end, at about 60 feet below the surface, a lateral is turned off across the vein, which here has a width of about 25 feet. Both the drift and the crosscut show the vein to be thoroughly mineralized with finely disseminated pyrite and to contain values of $1 to $20 in gold to the ton, with some high-grade ore in places. From present indications it seems that this vein may prove to be an extensive body of low-grade ore.

ST. JOE GROUP.

The St. Joe group comprises the western part of the Free Gold group. The claims are shown on Plate XIII, but the location has been amended to conform to the trend of the vein. The property is located 3½ miles south-southeast of Jarbidge, on the extension of the Good Luck vein southward across Jarbidge River, where the vein seems to be nearly a mile long and to extend across the high interstream ridge into the head of the Fox Creek valley. It lies mainly between elevations of 6,800 and 8,000 feet in the high, narrow ridge between Jarbidge River on the east and Fox Creek on the west.

The vein has about the same course, a little east of north, that it has on the Good Luck ground. The property is owned by the St. Joe Co., of Jarbidge, and is being developed by the C. A. McMaster party. It is opened by a tunnel or drift just south of the Good Luck ground, in the base of the mountain west of the river. The tunnel has been driven for 60 feet, and, it is said, can be carried along the vein for nearly a mile, the entire length of the property, attaining a depth of 1,000 feet. It could also be used to mine the Solo vein, situated about 400 feet west of the Good Luck vein. The vein material is rhyolitic breccia and is pyritic, but in the present face of the tunnel the gangue is mainly quartz.

FREE GOLD GROUP.

The Free Gold group, comprising half a dozen or more claims, joins the Good Luck and St. Joe groups on the southeast. (See Pl. XIII.) It is owned by the Twin Falls Free Gold Mining & Milling Co., and is said to be crossed by a belt or lode 100 feet wide, the same that occurs on the Jarbidge Wonder ground near by, which is reported to pan gold at the surface throughout the extent of the property.

OZARK GROUP.

LOCATION.

The Ozark property is situated 5 miles southeast of Jarbidge, on the headwaters of Jarbidge River, where, as shown on Plate XIII, it extends in a northwesterly direction across the east branch of the river to and beyond Dry Gulch. The camp, commonly called the Foster camp, is located on the south side of the east branch, as shown in Plate III, *B* (p. 16). The property ranges in elevation from about 7,500 feet at the river to nearly 8,100 feet on the mountain slope to the north, where it crosses the ridge between Dry Gulch and the east branch.

It was located in February, 1910, by Foster & Anderson, who are the principal owners, and it is developed mainly by a few hundred feet of drifts and crosscuts.

The property lies on the rough mountain side sloping steeply to the river on the southwest, and is deeply strewn with coarse, heavy talus and slide rock.

GEOLOGY.

The country rock is the old rhyolite. It is mostly coarse, and includes flows and beds of agglomerate and breccia at a higher horizon than any of the other properties so far described.

The normal rock is more or less porphyritic, with wine-colored "fish-eye" quartz predominating over the much kaolinized feldspars. Some of its phenocrysts are nearly one-fourth inch in diameter, and the entire rock is as a rule heavily charged with reddish ferric oxide and in places contains disseminated pyrite.

The rock is cut by a N. 60° E. sheeting which dips steeply to the southeast and by a similar structure, pronounced in places, which dips in the opposite direction, at angles of about 50° NW., and in some localities seems to be or to merge with the platy flow structure of the mountain.

ORE DEPOSITS.

The deposits are contained in a fault-breccia shear zone or lode about 100 feet in width traversing the rhyolite country rock. This lode strikes about N. 17° W. It has a known extent of about a mile, and probably extends much farther. It passes beyond the limits of the Ozark property on both the north and the south, and in the latter direction it probably crosses the Great Basin divide. It is locally regarded as the southwesterly extension of the Pick and Shovel vein and is commonly referred to as the Pick and Shovel "quartzite dike." As a matter of fact, the lode shows no association or traces of quartzite or any similar rocks.

The lode stands about vertical or may dip steeply in one direction or the other. At the Foster camp, where it is crosscut to a depth of

30 feet by the river, the lode dips about 80° W. The walls are only locally well defined.

So far as shown by outcrops and openings the lode is composed mainly of crushed country-rock rhyolite or breccia, most of which is deeply oxidized and otherwise altered and in part silicified and pyritic, with the local development of laminated quartz-adularia vein material. The lode is not continuously brecciated, however, but in places contains coarse, angular blocks or masses of normal country-rock rhyolite, some of which extend nearly or quite across its width, and probably have even greater longitudinal and vertical dimensions.

In this brecciated shear zone or lode the deposits occur in bands or streaks, composed usually of altered and silicified material that is more completely brecciated than that of the lode in general, with a greater amount of quartz-adularia gangue. These bands seem to occupy fissured zones produced by differential movement of portions of the mass within the lode. In composition they differ from the lode only in showing greater concentration of mineralization. In general they lie roughly parallel with the lode, but many of them are oblique to it in both strike and dip, as shown in the Ozark mine, where some of the bands strike N. 40° W. and the lode strikes N. 17° W. They vary from 1 to 20 feet in width and usually show surface values ranging from a few dollars up to $9 or $10 to the ton. Like the main lode, they have well-defined walls in places only. They apparently favor the footwall of the lode but are not confined to it.

The property is opened at three points, which may be referred to as the south, middle, and north openings. At the south opening, where the deposits are crosscut by the river at the Foster camp, there were at the time of visit two parallel cuts, one on either side of the stream, on the footwall side of the lode. These showed moderate values. Later developments are said to show the vein or ore-bearing belt to have a width of 25 feet, to average $4 to the ton, and for several feet, in a drift now being opened, to yield $9 a ton.

The middle opening, which is the location opening on Ozark claim No. 1, is a 25-foot open cut in the hanging-wall side of the lode near the top of the ridge at an elevation of about 8,050 feet. It shows considerable mineralization and moderate values.

The north or main opening, called the Ozark mine, is toward the north end of the property at an elevation of about 7,950 feet, in the south bluff of a perennial stream gulch of steep gradient. Here the country rock is the medium to coarse grained porphyritic purple rhyolite, and the ground is opened principally by a 60-foot drift in the hanging-wall part of the lode. The drift runs 40° S. on what seems to be a contact between thoroughly oxidized normal porphyritic rhyolite on the footwall side and dark slate-colored fine-grained pyritic rhyolite that seems to be a dike on the hanging-wall side. The drift lies mainly in the footwall rock. The walls are mostly good. The hanging-wall rock is the more mineralized and contains more quartz gangue, which is said to average $7 in gold and silver to the ton. The footwall rock also contains fair values.

The ore varies in color from that of yellowish limonite to dark or blackish and though much oxidized it is more or less pyritic throughout, with the pyrite finely disseminated.

At 75 feet east of the 60-foot drift and about 35 feet higher, in the footwall side of the lode, a 25-foot drift is run on a steep eastward-dipping similar vein or band of oxidized and mineralized rock with some quartz gangue; it is 4 feet thick and is said to contain $3.50 to the ton in gold and also some silver. In fact, the Ozark ore in general is said to contain about $2 in silver to the ton.

The cross section of the lode at this place shows also three other but less important veins or mineralized bands similar to the two above described. To judge from the showing made at this place, where the lode is crosscut by the gulch, and at the Foster camp, where it is crosscut by the river, the only two places affording good exposures, it seems quite possible that the lode may be found to contain other workable deposits of low grade.

MAMMOTH CLAIM.

The Mammoth claim is said to be about a mile south of the Ozark property and to contain a 15-foot vein which seems to be similar to the Ozark and at the surface shows ore assaying from $4 to $9 to the ton.

GUESS GROUP.

The Guess property, comprising the Guess, Guess Again, Guess Fraction, Buster Brown, and other claims (see Pls. XII and XIII, p. 66), is located about 1¾ miles south-southeast of Jarbridge, higher on the mountain slope, east of the Arizona group of the Pavlak property. The topography is in part rugged and the country rock is the old rhyolite. The property is approximately on the trend of the Pick and Shovel, Bluster, Success, Rock Creek, and other veins to the southeast and is said to present good surface showings. It is being opened by a tunnel, starting on the Guess claim on the west. The tunnel is said to be in about 70 feet and to have encountered a slate formation, supposed to be the wall rock of the vein. On the Guess Fraction the company is opening a vein in the quartzite reef or "dike" (p. 66), which shows good gold colors. This vein is thought to belong to the post-Miocene deposits and is of interest in being the first of its kind reported from the sedimentary rocks in the Jarbidge district.

VULCAN GROUP.

East of the Guess group and about 1,000 feet higher on the mountain side is the Vulcan group (Pl. XIII), on which a strong vein yielding good values is said to be opened by the Jarbidge-Vulcan Mining Co.

MAHOGANY MINE.

The Mahogany mine, also known as the Tacoma group and formerly as the Blake group, comprising the Golden Eagle, Golden Queen, and fractions of each (Pl. XIII), is about half a mile west of Jarbidge, at an elevation of about 6,700 feet, or 650 feet above the river. It is in the so-called Mahogany Flats (see Pl. II, p. 12), a sort of bench in the mountain slope at the head of a short, steep gulch that trends south to Bear Creek and is traversed by the Elko mail trail. It may be reached by this trail, by a similarly steep trail from the lower part of town, or by the Elko wagon road, which begins the ascent a short distance farther down the river. The mine is owned by the Jarbidge-Tacoma Mining Co.

The topography is not rugged. The country rock is the old rhyolite, stained reddish to reddish brown. It shows considerable alteration and contains some black obsidian or glass. There are also present bands of dense white and red rocks which are probably dikes of later intrusion.

The deposits are contained in a mineralized zone, or perhaps, more correctly, a compound fault zone, several hundred feet in width. This zone contains two belts of white outcrops, each belt representing a subzone of movement, deposition, and silicification. The zone as a whole has a north-south trend. It is in alignment with and may represent the northwesterly extension of the Pavlak subvein system or its fissures, with which it seems to connect through the veins on the Valley View, Ely, and other neighboring properties. The outcrops are principally quartz and silicified white rhyolite. They dip steeply to the west and are exposed for a distance of 600 feet or more. Both belts are more or less mineralized, particularly the easterly or lower one, which is said to show values of $1 to $5 in gold for a width of 150 feet.

The deposits at the time of visit were opened by a 50-foot shaft in the slope a little below the lower belt. The shaft and dump showed mainly reddish-brown stained altered and mineralized rhyolite and associated quartz gangue or vein material. It is said to have yielded $3.50 to the ton in gold and some silver near the surface and to contain values only slightly less all the way down.

AMAZON-RAINBOW GROUP.

The Amazon-Rainbow property lies 1¼ miles south of Jarbidge, on the west side of the river. (See Pl. XIII.) The deposits are said to occur in a vein 4 feet or more in width, which seems to intersect the northwesterly extension of the Pavlak vein. Both the claims and the vein trend N. 50° E., parallel with the Buster vein on the opposite side of the river and about at right angles to those of the Pavlak property.

The property is opened by a drift on the Amazon vein. This drift in the recent part of the work is said to show about 12 feet of more or less pyritic good-looking quartz, of which 2 feet pans well in gold. In November, 1910, the drift was said to be in 90 feet, and at 100 feet farther it would strike the intersection of this vein with the Pavlak vein at 140 feet below the surface. Recent accounts state that the developments continue in good-looking quartz with the values improving and that considerable ore is being blocked out.

PROPERTIES OF THE EAST OR CRATER GROUP.

LOCATION AND GENERAL CHARACTER.

The properties of the east or Crater group are located on the veins of the east system, which have been described as occurring mostly in the upper east slope of the Crater Range. (See Pl. II, p. 12.) They are comprised in a north-south belt about 1½ miles wide and 7 miles long extending from Jack Creek on the north nearly throughout the series of "craters" to the head of Jarbidge River and the Great Basin divide on the south. They were discovered and located later than the properties of the west group, mostly late in the spring and summer after the snow disappeared from the mountains.

The veins of this group contrast more or less strongly with those of the west group in several important respects. They occupy a geologic horizon nearly 2,000 feet higher. They strike more nearly north and south and dip steeply to the west instead of to the east. They are more regular, with sharply defined, clean-cut, and usually free walls. They are more persistent and narrower, from 1 to 4 feet being a fair average width. They are closely and definitely ribboned or banded and are finer and more uniform in texture. They contain very little quartz, being so far as observed composed chiefly of adularia, and for this reason the bold silicified outcrops characteristic of the western veins are mostly lacking. There is also little of the alteration of the wall rock found to be so pronounced in the veins of the west system. The gold of the eastern veins is of a lighter color and contains much more alloy of silver.

Some of the individual veins are said to extend almost throughout the length of the belt, but lack of time precluded any attempt to follow them in this work. That some of them have an extent of 2 or 3 miles, however, seems probable.

The properties are best reached by way of Jack Creek and East Fork from the north, or by crossing the divide from the head of

Jarbidge River on the south. By a climb of nearly 5,000 feet many of the properties can be reached from Jarbidge direct, but there seems to be no record of anyone trying this route a second time.

Recently it has been reported that the True Fissure Co. and others are building a wagon road into this part of the district. This road leaves the Twin Falls road at Three Creek, follows the high lava plateau to the rim rock at a point about a mile above Robinson Hole, descends into the canyon down Robinson Creek to Robinson Hole on East Fork, and ascends East Fork and its tributaries to the several properties.

Owing to their later discovery and comparative difficulty of access they are less extensively developed than the properties of the west group, but they have been opened at many places, mostly with promising results.

The properties lie mostly in the middle 4 miles of the belt, extending from the second to the fifth "crater," inclusive, but a great deal of ground has also been staked in the northeastern part of the belt on Jack Creek.

SECOND CRATER.

In the Second, Horseshoe, or Big Crater, which is the largest of all the "craters," situated 3 miles southeast of Jarbidge at the northeast base of Jarbidge Peak, at the head of the East Fork of Jack Creek (see Pl. II, p. 12), the properties comprise the Howard-McCoy, Altitude, Van Alder, Windy, Clay, and Victoria claims or groups, among which seemingly the most important openings at the time of visit were the Howard-McCoy and the Van Elder, on adjoining claims. (See Pl. V, *B*, p. 24.) Here the first strike of high-grade ore was made in the "crater section" of the district, and in July this strike caused a rush to relocate claims.

The veins on which the Howard-McCoy and Van Alder openings are made are reported to extend from the Second to the Fifth Crater, inclusive, a distance of 4 miles, through all of which these or similar veins are opened or developed. The Howard-McCoy vein is also held by some to extend southwestward into Snowslide Gulch, opposite the Fifth Crater.

The veins lie from 120 to 150 feet apart and show fair values wherever they have been opened. At the Howard-McCoy and Van Alder mines the rock in the footwalls appears to be somewhat different from that in the hanging walls.

VAN ALDER MINE.

The Van Alder or Windy property (Pl. XIII, p. 66), owned and located by Mr. Van Alder, of Jarbidge, and operated by the Cœur d'Alene-Jarbidge Co., is located in the lower slope of the steep south rim of the "crater," about 160 feet above its floor, at an elevation of 9,900 feet (Pl. V, *B*, p. 24), and is being developed chiefly by drifting. It is on or a trifle below the contact level of a considerable body of underlying vertically jointed rhyolite with overlying horizontal massive flows.

Disseminated throughout the rock are minute crystals and grains of pyrite, to which the bright brick-red to deep reddish-brown hematite stain of the weathered surface of the rock is due.

The footwall on the east is a greenish to purplish ash gray, nearly aphanitic rhyolite with glassy base. The fault that produced the vein fissure appears to be normal, to judge from the drag or upward curving of the platy structure in the hanging wall as it nears the vein, as shown in Plate V, *B*, and figure 3.

The vein strikes N. 14° W. and dips 70° W. Where exposed at the time of visit it is 18 to 20 inches in width and is well banded, being composed of 10 or 12 distinct but not persistent bands of adularia and quartz, and some included crushed and altered rhyolite. Later reports state that in the face of the drift, which has been extended to a length of 65 feet, the vein shows a width of 4 feet and is all good ore.

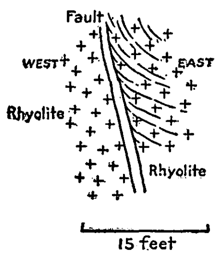


FIGURE 3.—Sketch of normal fault structure at Van Alder mine.

The vein shows a sort of comb structure, with the combs, however, usually closed up solid. Some of the crystals are nearly half an inch in length.

The west or hanging wall is the purple porphyritic to agglomeratic phase of the old rhyolite, with a glassy base having flow structure, but so closely packed with phenocrysts of altered feldspar, some nearly one-fourth of an inch in diameter, as to present the aspect of a medium-grained rock. The quartz, which is but sparingly present and occurs only in minute crystals scarcely noticeable to the unaided eye, is of the "fish-eye" type.

The vein is sharply defined, and though in sharp contact with the hanging wall it is free and has no gouge. The footwall, on the contrary, carries from 1 to 6 or 8 inches of dull-greenish gouge.

The gangue in the pure state is of light color, but owing to the abundance of hydrated iron it is deeply stained.

The vein contains a few small parallel dikelets, about one-fourth inch in maximum width, of nearly aphanitic rhyolite, one set of which is very dark purple or black and the other light purplish gray. The lighter dikelets are younger and more abundant. They cut the dark dikelets in places and inclose numerous angular fragments derived from them. These dikelets obviously belong to the magma of the old and not the young lavas and, as shown on page 63, seem to indicate that the rock mass of the region was maintained at a relatively high temperature from the first period of eruption till after the dikelets were injected, a conclusion which favors the view of the hydrothermal origin of the veins.

The vein contains also what seems to be a little dark modified slate or shale gouge, principally in parallel seams that may have been dragged up between the bands by subsequent faulting, or perhaps deposited by ascending solutions. At the time of field examination these seams were regarded as of sedimentary origin, but it is possible that closer work may show them to belong to the dikelets above described.

The vein is said to average about $30 to the ton in gold from wall to wall. According to recent reports a fair body of ore has been encountered, from which some of high grade is being sacked for shipment.

Much of the gold is finely disseminated throughout the gangue, associated with argentite and iron. Some of it also occurs as plating, but this phase is better shown in the Howard-McCoy mine, next to be described.

The microscope shows the vein to be composed of about 80 to 90 per cent of adularia, which exhibits the characteristic pseudomorphic laminated structure (Pl. IX, p. 56) more or less throughout. The adularia occurs mostly in small tabular rhombic crystals and acicular forms. Some crystals show good terminal zonal structure, and some of the larger crystals seem to be completely replaced by fine-grained granular intergrowths of secondary adularia and a little quartz. The fracture cracks traversing the thin section are filled with brown grains of limonite.

HOWARD-McCOY MINE.

The Howard-McCoy mine, located on the Altitude claim (Pl. XIII, p. 66), joins the Van Alder mine on the west, its opening being situated about 40 feet higher on the steep rim of the crater, or about 200 feet above the floor shown in Plate V, *B* (p. 24). Like the Van Alder it is developed mainly by a drift. It is owned and operated by William Connors, C. B. Howard, and J. A. McCoy.

The country rock is rhyolite, which on the hanging wall is nearly normal but conspicuously porphyritic, with " fish-eye " quartz phenocrysts. Though much iron stained, as on the hanging wall of the Van Alder vein, the rock is relatively firm and fresh. The foot-wall rock is purple or greenish gray and finer, and resembles the foot-wall of the Van Alder mine.

The vein lies 120 feet west of the Van Alder vein, which it nearly parallels. It strikes N. 22° W. and dips from 85° W. to vertical. It is regular and sharply defined, with free, clean-cut walls, and is from 1 to 3 feet in width. The vein is banded like the Van Alder vein, but not so closely, and is composed of essentially the same materials as that vein. It is iron stained, with the ferruginous material being particularly concentrated in the seams along the junctions of the banding. The vein on the whole looks well and shows much free gold, especially as sheets or plating on the faces of jaspery iron-stained bands and along the ferruginous seams. Much gold, however, is finely disseminated throughout the gangue. Argentite is also present.

VICTORIA GROUP.

The Victoria group (Pl. XIII, p. 66) is situated to the north of the Howard-McCoy and Van Alder properties, in the bottom of the "crater," at an elevation of about 9,700 feet. Here several openings have been made, principally on the Howard-McCoy vein, all showing fair values and some of them high-grade ore. The vein here is said to maintain its usual strike and dip, and has a width of 2 to 3 feet. On the Victoria No. 5 considerable ore is reported as being sacked for shipment.

CŒUR D'ALENE-JARBIDGE PROPERTY.

Another apparently promising property is that of the Cœur d'Alene-Jarbidge Gold Mining Co., on which considerable development work has been done with good results. Two ore shoots showing considerable free gold have been opened, and work by a party of 8 or 10 men, for which equipments and supplies were installed in the autumn of 1910, was carried on throughout the winter. Plans were made for soon installing a mill and cyanide plant. The principal part of the deposits is in a 4-foot quartz vein, said to carry promising values.

THIRD CRATER.

The Third Crater is located south of the Second Crater and at approximately the same elevation, with its floor at about 9,600 feet. (See Pl. II, p. 12.) It drains eastward into East Fork. In this "crater" several new veins are reported to have been discovered recently, some of which extend southwestward across the crest of the range into Snowslide Gulch, where they are marked by prominent outcrops.

The principal properties opened in or adjacent to this "crater" are the Arkansas, Rosebud, Third Peak, Rabbit Foot, and True Fissure.

ARKANSAS PROPERTY.

The Arkansas or Harder vein, on the Arkansas claim, owned and operated by R. J. Harder and Bishop Norman, is said to be opened by a 70-foot tunnel and shows several feet of ore, some of which averages about $40 to the ton. This vein is said to extend southwestward across the Arkansas, De Witt, Panorama, Laveda, High Up, Vista, and Little Mud claims into Snowslide Gulch. Where it has been opened on the Panorama the vein is said to have a width of nearly 6 feet and to consist mainly of altered rhyolitic material, with 2 feet of quartz on the footwall side.

TRUE FISSURE GROUP.

The True Fissure group, comprising five claims (Pl. XIII, p. 66), is said to extend from the upper rim of the "crater" southwestward along the crest of the range to the Third or Jumbo Peak, on whose north and east slopes it mainly lies. It is owned and operated by the True Fissure-Jarbidge Gold Mining Co. and is developed by several tunnels, drifts, and open cuts on the main or Third Peak vein, shown in figure 2 (p. 49). This vein is said to consist mainly of 2 to 7 feet of granular soft white sugary quartz between well-defined hard bluish "porphyry" walls. At the time of visit the lower drift was in more than 155 feet and was said to show good ore all the way which pans well in gold and shows some macroscopic free gold. The company has done considerable prospecting and development work on several other veins.

At last accounts this property seems to be taking rank among the best in the district. The drift has been extended to a length of 185 feet, throughout which the ore body is continuous in extent and from 2 to 6 feet in width, and the main outcrops, toward which the drift is being carried, still lie 200 feet ahead and several hundred feet above its present face. A mill is to be installed near Fall Creek below the mine, where there is a good supply of saw timber and water power, and the mine and mill are to be connected with the East Fork wagon road.

SNOWSLIDE GULCH.

On the Snowslide Gulch extension of the Arkansas and Third Peak veins from Third Crater, on the High Up, Vista, and Panorama group (Pl. XIII), Middleton & Eichert are said to have recently opened several good ore shoots. In fact, recent recognition of the fact that the projected courses of several of the Crater veins, as well as a number from the Bonanza Gulch field of the west system, trend in the direction of Snowslide Gulch, whose head is a great gash in the steep mountain side, has led to considerable staking and development work in this vicinity.

FOURTH CRATER.

The Fourth Crater lies next south of the Third Crater, at an elevation about the same or slightly lower, the upper part of its floor being crossed by the 9,200-foot contour. (See Pl. II, p. 12.) It drains northeastward into East Fork. The country rock is the old rhyolite. The principal properties near this "crater" seem to be the Sugar group and the Round Up.

SUGAR GROUP.

The Sugar group, said to consist of nine claims, is owned by Mr. McCormick and partners. The vein, which has some prominent outcrops, has been opened at several points with good results and shows free coarse gold.

ROUND UP GROUP.

The Round Up group (Pl. XIII, p. 66), on which but little work has yet been done, is said to show chiefly good milling ore.

WHITE QUARTZ VEIN.

On or near the crest of the divide, at the head of the "crater," and striking nearly north and south, parallel with the axis of the range, is the White Quartz vein. It is said to be the smallest, most perfect, and most sharply defined vein in the district. It is but 15 inches in width and is reported to extend for 2 miles or more.

FIFTH CRATER.

The Fifth Crater lies next to the Fourth Crater, on the south, at a slightly lower elevation, approximately on the 9,200-foot contour. (See Pl. II, p. 12.) It is just across the narrow divide to the east from the East Fork of Jarbidge River and is best reached by the Jarbidge River route. It drains northeastward, through Cougar Creek, into East Fork. The country rock is the old rhyolite. The veins are said to be essentially the same that occur in the Third and Fourth craters to the north. The principal property seems to be the Wall Street group, consisting of four claims. It has two openings on the vein, which is said to contain about 4 feet of mineral-bearing quartz.

Two other properties, owned by Buys & Franklin and Harder & Norman, are said to contain some high-grade ore. A good-looking vein that is said to occur in the crest of the divide at the head of the "crater" is probably the southerly extension of the White Quartz vein described above.

FIRST OR JACK CRATER.

The First or Jack Crater lies at the head of Jack Creek, north of the Second Crater, from which it is separated by a northeast-southwest ridge that is in part low and narrow. (See Pl. II, p. 12.) It is about 2 miles east-southeast of Jarbidge and is easy of access by way of Jack Creek. It has about the same elevation as the Second Crater, its floor being crossed by the 9,200-foot contour. It drains northward into Jack Creek. The country rock is the old rhyolite. The principal veins reported here are the Comet and Camp Bird, on both of which development work is being carried on with good results. The Comet property consists of a group of claims owned by Pontaine & Cameron Bros., of Jarbidge. The vein is composed chiefly of the characteristic quartz-adularia replacement gangue and shows free gold.

JACK CREEK AREA.

The Jack Creek area joins the First Crater on the north. It is a mile or more wide and extends northwestward down the curved course of Jack Creek and its East Fork for a distance of about 3½ miles to Jack Hole. The area has a vertical range of 3,000 feet, mainly between the 6,000 and 9,000 foot contours. In its upper part the topography is rugged and the main streams in part flow in canyons.

The country rock is the old rhyolite, heavily iron stained.

The deposits occur in about a dozen veins or lodes, some of which are shown in figure 2 (p. 49). They include the Big Ledge, Fissure, Idaho, Wandolee, Virginia, War Eagle, Georgian, San Felipe, Beatty, and others. They mostly strike about northwest and dip 70° SW. to 90°. They agree in dip with and are regarded as belonging to the east vein system, though they strike more nearly parallel with the west system. Some of them have a known length of nearly a mile. A number of these deposits are among the most recent discoveries of the camp. The existence of some of the veins had been known for some time, but they were not thought to contain values.

Among the properties of the area one of the most important and most developed seems to be the Big Ledge group. It comprises five claims and is located mainly on the Big Ledge vein, 2½ miles northeast of Jarbidge and about 1¼ miles up the creek in a southeasterly direction from Jack Hole, above the junction of Jack Creek and its East Fork, at an elevation of about 7,500 feet. It is owned chiefly by A. E. Bettles, of Jarbidge, by whom the deposits were discovered late in 1910, and it is developed mainly by a 40-foot tunnel or drift and terminal crosscuts.

The country rock is the old rhyolite. The vein, as shown in figure 2 (p. 49), strikes northwesterly and dips 60° to 85° SW. It has a known extent of about half a mile. It outcrops more or less prominently on the Big Ledge property for about 100 feet, and from outcrops and float found interruptedly along the projection of its course it seems to extend into the First or Jack Crater, about 2 miles to the southeast, and to connect there with the veins of the east system.

The vein is composed mainly of the laminated quartz characteristic of the district; some of it is hard and glassy. The material is said to pan well and to show some free gold.

In the principal opening on the property the vein has a reported width of 9 feet and contains several shoots of ore averaging about $30 to the ton in gold. In an open cut about 700 feet south of the main opening the vein shows a width of 7 feet and is said to average $6.50 in gold and 4 ounces in silver to the ton.

Paralleling the Big Ledge vein on the east, at a distance of 200 feet, is another vein about 6 feet in width from which samples are said to have indicated values of $9 in gold to the ton. At about 400 feet west of the Big Ledge vein the country rock is traversed by a parallel, mineralized, brecciated fault or shear zone from 10 to 20 feet in width, which is said to be very persistent and to have been traced southward into the First and Second "craters." It is composed principally of finely-crushed "conglomeratic" material or breccia, surface assays of which show values of $1 to $2 a ton. This "ledge" has not yet been opened.

Associated with the veins here described are said to be also a couple of "cross" veins, seemingly somewhat similar in occurrence to the Buster, Amazon, and others of this class on the Pavlak and Bourne properties, already described, and forming in a rough way a branching or linked system.

The ores of the Big Ledge group, as a whole, are said to be less free milling than any other ores of the Crater system.

OTHER AREAS AND PROSPECTS.

Besides the deposits which have been described there are several outlying areas in which indications of mineral are reported to be good and in which, though they are for the most part situated farther from the seat of volcanic eruption, values may reasonably be expected to occur.

On East Fork, to the east of the Crater group of veins, is a belt of country some 2 or 3 miles in width in which the indications of mineral are reported to be favorable but in which no discoveries or openings to speak of have yet been made.

This vicinity includes the eastern foothills of the Crater Range, East Fork, and the east side of its valley, in which the tributary canyons show the old rhyolites extending eastward beneath the covering of young lava.

Reports essentially similar to those on the East Fork area are also made with regard to a considerable portion of the upper south slope of the Great Basin divide, on the headwaters of Marys and Salmon rivers. (See Pl. I, p. 10.) This area, it should be noted, contains the projected course of the Crater Range, along which the ground seems particularly to commend itself for prospecting, for there is good reason to believe that the faulting or crustal deformation that permitted the outpouring of the lavas of the Crater Range extended far south of the Great Basin divide.

Values are also reported as being found at the head of Deer Creek, in the western part of the district.

A new strike was recently made on the west side of Jarbidge River just south of Pine Creek, where about 2 feet of well-mineralized quartz, contained in an 8-foot vein, is said to pan well and show free gold.

Recently several promising discoveries have been reported from the head of Bear Creek and seem to be important in confirming the extension of the deposits into the southwestern part of the district. Among the new strikes are the Mohawk vein, which is said to be a well-defined vein, about 5 feet in width, and much of which assays about $7 to the ton, mostly in gold.

In January, 1911, a strike of silver and copper ore made 8 miles southwest of Jarbidge, on Coon Creek, which drains westward into Bruneau River, was reported to be attracting considerable attention. The deposits of this strike seem obviously to belong to the early or Cretaceous group, associated with the older rocks and their granitic intrusions.

PLACER DEPOSITS.

No workable placers have yet been found in the Jarbidge district. Their apparent absence is remarkable, considering the plentifulness of the lode gold and the great depths to which the valleys are worn down into the gold-bearing veins and rocks.

Fine gold is, of course, sparingly present in practically all the recent stream gravels, but thus far the gravels have received little attention. At the time of visit the gravels were being prospected on a moderate scale on Jarbidge River, mainly at a point about 1½ miles below the town, or half a mile below the forest station, by the Park City (Utah) Placer Co. The deposits here, measured from rim rock to rim rock, have a width of about 600 feet and, as shown in the bottom of the workings, a thickness of more than 14 feet, including a 5-foot terrace on the east. They are the normal old rhyolite stream gravels described as alluvial deposits on page 33 and are opened by about 50 feet of trenches and a pit. A pan of the gravels taken from the bottom of the trench and washed by the writer gave considerable fine black sand and three colors of fine gold. The operators report that colors are found in nearly all the gravels and that the deeper strata frequently yield ten or a dozen colors to the pan, but the colors are all fine. This is encouraging, however, and leads to the hope that on bedrock the gold may be coarser and may occur in such quantities as to render the ground workable. Sinking to bedrock at this place is rendered difficult and had at the time of visit been delayed by the water of the river percolating through the gravel. The same difficulty, it is said, led to the abandonment of an attempt to prospect the gravel some years ago.

The company reports that there is an increase in the amount of gold and particularly the number of colors downstream from this place. At the mouth of Buck Creek, in the piedmont plain, some 8 or 10 miles below Jarbidge, similar gravels worked by this company often yield from 60 to 70 fine colors to the pan.

Some of the ice-laid deposits of till, or ground moraine, described under "Geology" (p. 32), may likewise be auriferous, though as yet they have received no consideration. The deposits which most commend themselves to prospectors' attention are those which have accumulated on the downstream sides of areas containing promising ore-bearing veins or lodes, of which Snowslide Gulch is an example.

To judge from the geologic history of the district, it is also quite possible that on the outskirts, particularly on the north, buried stream placers may exist beneath the young or rim-rock lava covering. Such placers were formed during the intervolcanic period of erosion and are of early Pliocene age. Except in places where they were derived from the richer portions of the surface on which the veins were first exposed, the deposits are probably similar in character and grade to the present stream deposits and were laid down on slopes of gentle gradient favorable to their accumulation.

THE CONTACT DISTRICT.

GEOGRAPHY.

LOCATION.

The Contact mining district[1] (Pls. I, p. 10; XIV) is in the northeastern part of Elko County, Nev. (see fig. 1, p. 12), about 35 miles east of the Jarbidge district. The town of Contact, the principal settlement, is near the center of the district, about 15 miles south of the Idaho State line and 40 miles west of the Utah boundary. It is 35 miles from Rogerson, the nearest railway station on the Oregon Short Line, to the north; about 50 miles from Wells, on the Southern Pacific Railroad and Western Pacific Railway, to the south; and 80 miles northeast of Elko, the county seat.

The district lies on the headwaters of Salmon River, which, taking its rise in the mountainous belt that divides the Great Basin from the Snake River plain, after doubling back on the first 20 miles of its course (see Pl. I, p. 10), flows in a northerly direction and joins the Snake at Lewis Ferry, about 50 miles north of the Idaho State line and 20 miles below Shoshone Falls.

TOPOGRAPHY AND DRAINAGE.

The district lies in the Nevada Plateau and, broadly characterized, is an elongated quaquaversal produced by the updoming of Paleozoic sedimentary rocks by an underlying intrusive granitic mass from whose intracontact area all the sedimentary rocks have been removed. The floor of the basin has been lowered by erosion to a considerable depth into the granodiorite.

The mountains are of the rounded massive type. Of these the principal landmarks are Ellen D., China, and Middle Stack mountains, situated about 8 miles apart, in the western, southern, and northeastern parts of the district, respectively, at the apices of an equilateral triangle (Pls. XIV, XV). Important secondary points

[1] Legally Contact is in the Salmon River mining district, which was organized in 1909 and extends from the eighth standard parallel, 25 miles south of Contact, range corners 62, 63, 67, and 68, 42 miles northward to the Idaho State line, having a width of 30 miles. Up to that time the country to the southeast of Salmon River was in the Kit Carson and Portis districts; for example, the Hanks-Boston property, in the northern or Middle Stack Mountain part of the Contact area, was patented and recorded in the Kit Carson district, and the southern or China Mountain portion of the Contact area lay in the Portis district; about 18 miles to the southeast of Contact began the Delano district.

are Blanchard Mountain, toward the southeast, and Toano John Peak,[1] on the east. The latter occupies a commanding position and is visible from the vicinity of Rogerson and other points 50 miles distant.

These mountains are all on the Contact zone (Pl. XIV) and owe their existence to uplift and induration of the rocks by metamorphism and silicification. Other subordinate but conspicuous features are inlying flat-topped lava-capped buttes, of which Table Mountain, near Old Contact, one like it west of San Jacinto, and similar ones on Meadow and Trout creeks are examples.

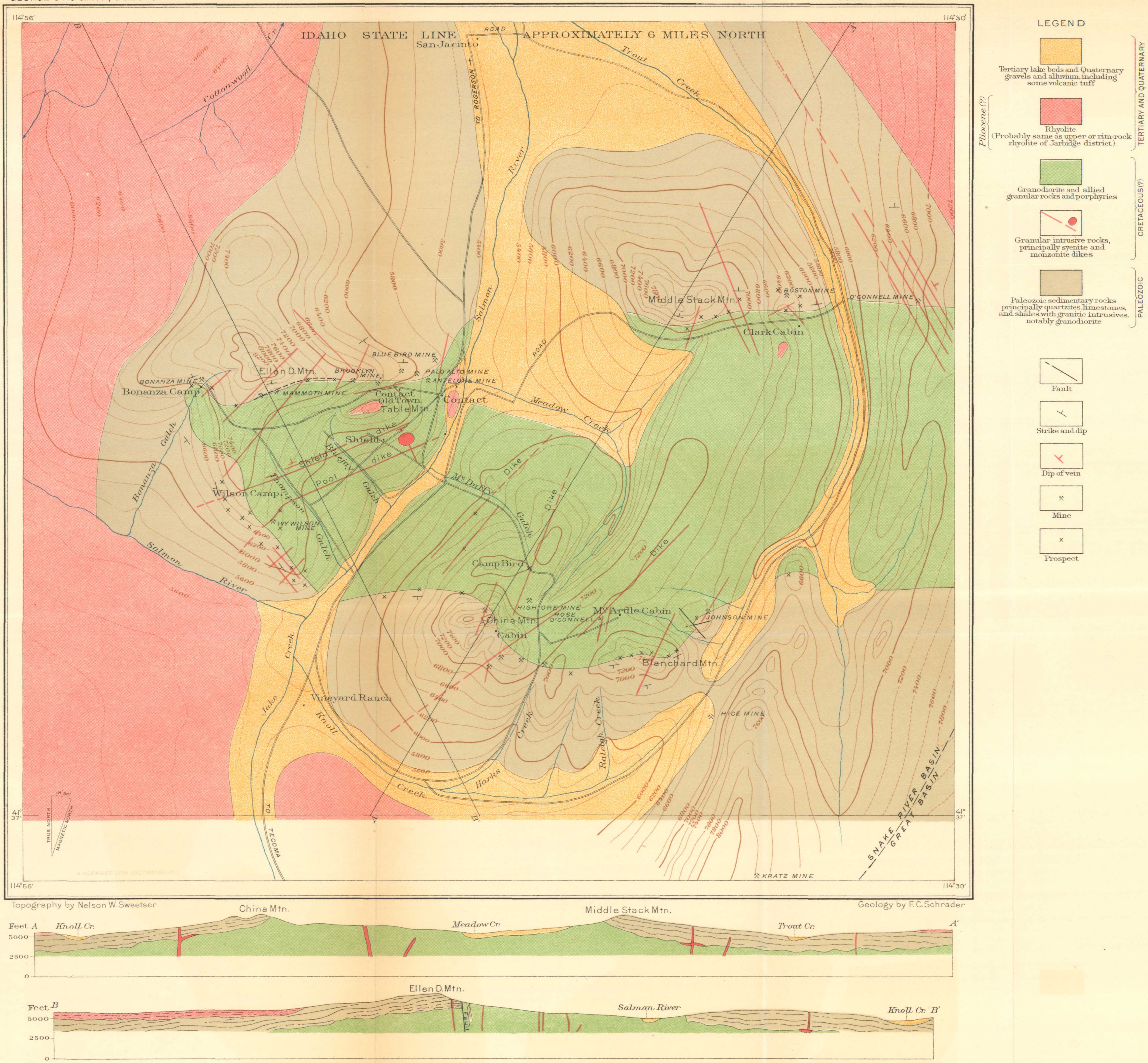
Salmon River, the master stream of the area, flows through it in a northerly direction in a narrow but generally open valley floored with lake beds and gravel. This valley is from half a mile to a mile or more in width, and its sides rise in furrowed, more or less débris-covered slopes which in Ellen D., China, and Middle Stack mountains culminate, respectively, at 8,500, 8,100, and 7,900 feet above the sea, or a maximum of 3,150 feet above the valley. The rise from the river westward to the top of Ellen D. Mountain is made in a horizontal distance of 4½ miles, or 700 feet to the mile. The grade to the top of China Mountain is about 917 feet to the mile and to the top of Middle Stack Mountain about 670 feet to the mile.

The central east-west granitic belt of the area, shown on Plate XIV, has a width of about 6 miles and a known length of 25 miles. It presents, as is shown in the foreground in Plate XV, *B*, a rough though not generally rugged adolescent topography as developed in an arid climate.

This belt seems to represent an elongated dome-shaped mass, now truncated and deeply eroded, so that in general it is below the level of the surrounding rocks. For convenience it may be referred to in this report as the basin. In fact, the rocks along the peripheral contact of the granodiorite form a more or less continuous ridge, the peaks of which constitute the highest features of the district, overlooking on the one hand the low interior basin and on the other, with gentler slope, a more elevated lava plateau. The roughest topography of the granitic area is in the southwest, between the headwaters of Meadow and Trout creeks. Here the broad ridge extending northeastward from China Mountain bristles with sharp peaks and pinnacles which are commonly known as the White Peaks and are so designated on the General Land Office map.

Nearly encircling the basin or central belt of granitic rocks is a zone from 1 mile to several miles wide, of hilly but gentler topography (Pl. XVI, *A*) in a quaquaversal belt of Paleozoic sediments that dip away from the basin. In places the inward-facing edges of these upturned rocks form scarps, as at China and Ellen D. moun-

[1] Said to be so named after an Indian chief.



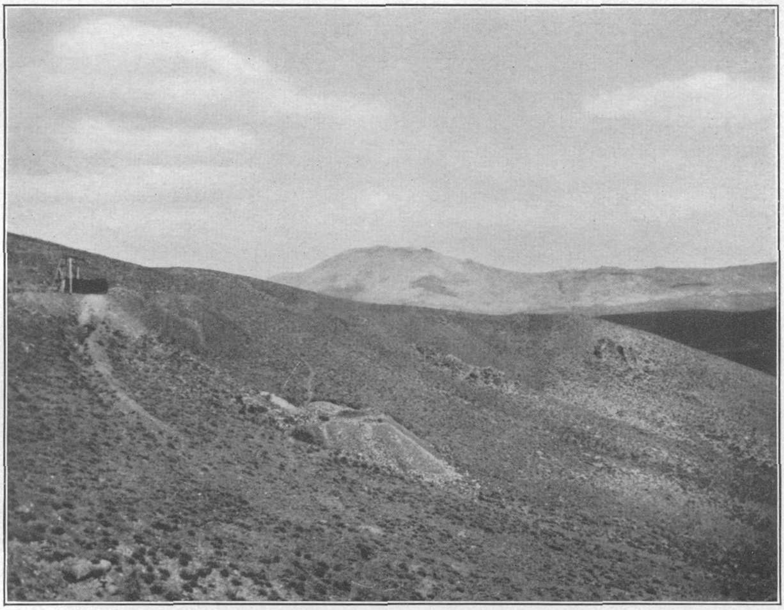
GEOLOGIC RECONNAISSANCE MAP AND SECTIONS OF CONTACT DISTRICT, NEVADA

Scale $\frac{1}{125000}$

1 0 1 2 3 4 5 Miles

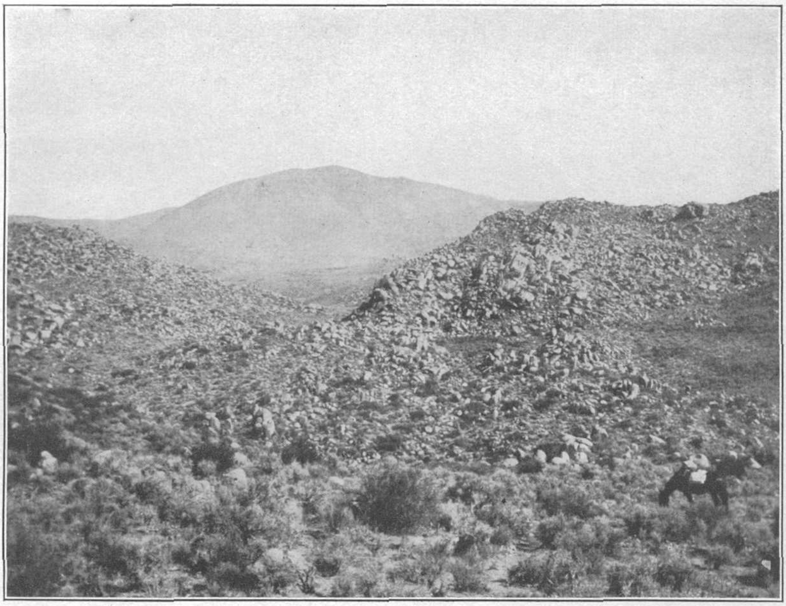
Contour interval 200 feet

1912



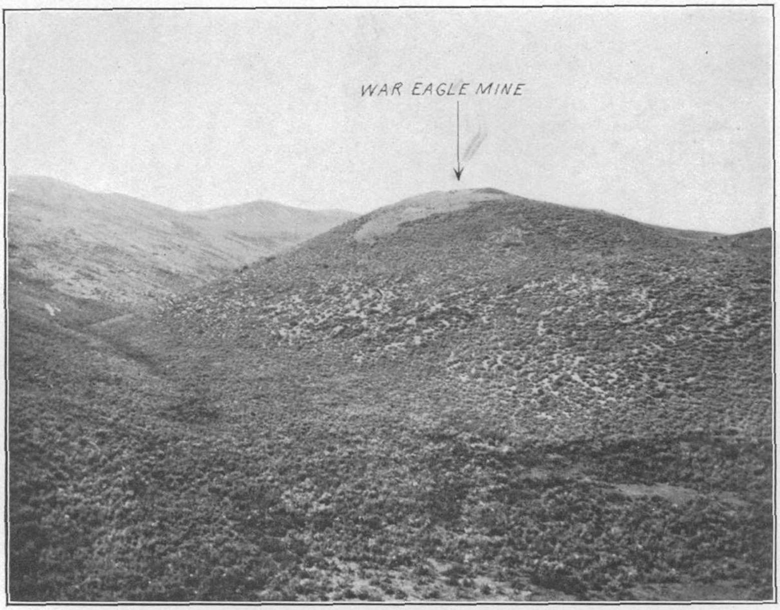
A. PALO ALTO MINE AND MIDDLE STACK MOUNTAIN.

The mine is in the left foreground with basal quartzite croppings extending to right of center; Middle Stack Mountain, 7,900 feet in elevation, is in the far center beyond Salmon River valley, with its whitish limestone contact between intrabasin granodiorite area on right and Paleozoic sedimentary rocks, forming main and higher mass of mountains, on left. View from Delano Hill.



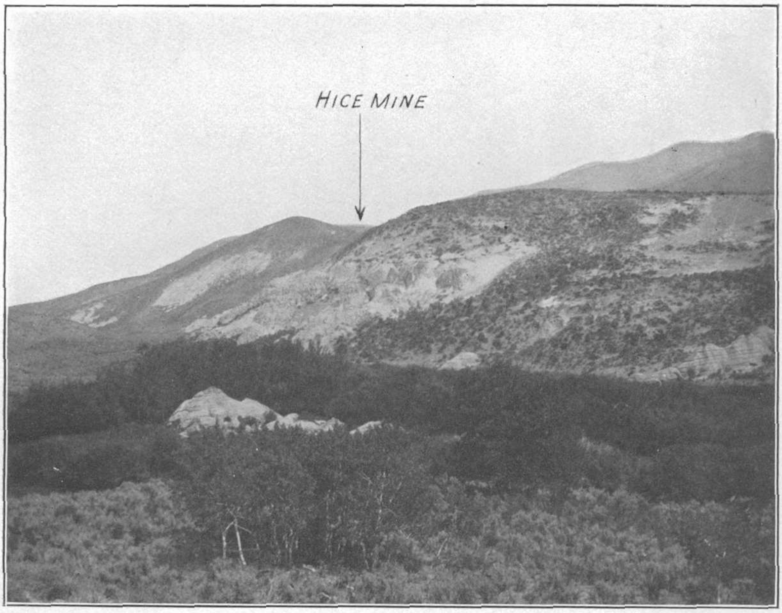
B. VIEW SHOWING TOPOGRAPHY OF GRANODIORITE BOWLDERY SURFACE AREA (IN FOREGROUND) AND ELLEN D. MOUNTAIN, 8,500 FEET IN ELEVATION (IN BACKGROUND).

From point northwest of Ivy Wilson camp, looking N. 10° W. up Thompson Gulch. The mountain is composed chiefly of Paleozoic sedimentary rocks.



A. TOPOGRAPHY IN ERODED PALEOZOIC SEDIMENTARY ROCK BELT, CHIEFLY LIMESTONE, IN CHINA MOUNTAIN AREA ON THE WAR EAGLE MINE.

Looking N. 55° W.



B. LAKE BEDS OF TUFFACEOUS SANDSTONE (HUMBOLDT FORMATION, PLIOCENE), KNOLL CREEK VALLEY.

Looking north-northeast nearly up the valley; H. D. Range, chiefly Paleozoic sedimentary rocks, in right background.

tains, but more commonly they outcrop as long, sloping ridges. In some places, as at China Mountain, the scarps are compound, their several members being surmounted by narrow dip-plane benches.

Surrounding the sedimentary zone is an area of brown rhyolitic lavas which is continuous with the Jarbidge and Elk Mountain lava field on the west and with the Snake River lava plains on the north.

The prevailing topographic forms in these lavas are benched mesas, scarps, box canyons, and sharp V-shaped gulches, depending on the local character and attitude of the flows, which are nearly horizontal or gently tilted. Inliers of these lavas also cap isolated flat-topped buttes, as at Table Mountain, just southwest of the old town of Contact.

Other subordinate features occurring in certain of the valleys are miniature badland forms carved in horizontal lake beds of whitish or light-colored soft friable "sandstone" or water-laid volcanic tuff, as on Knoll Creek, in the southeastern part of the district (Pl. XVI, *B*). The creek takes its name from the many knolls carved from this formation, some of which resemble the snow huts of an Eskimo village.

Salmon River is formed by many small tributaries whose sources lie chiefly in the southeast slope of the Elk Mountain ridge and in adjacent parts of the Jarbidge Mountains on the west. Of these the most important, beginning on the northeast, are Wilson, Lime, Pole, Cottonwood, Canyon, Camp, and Deer creeks.

At Contact the river has a nearly graded course. It flows in a shallow channel sunk only a few feet below the general surface of the valley and is said to carry 5,000 miner's inches of water at its lowest stage. In the southwestern part of the district the river is joined by Jake Creek, which, with its tributary, Knoll Creek, drains the south-central part of the district. In its course through the middle part of the district the river receives the drainage of several gulches, most of which are dry during the summer. They are Thompson, Bluejay, and Town[1] gulches on the west and McDuffy Gulch and Meadow Creek on the east. They all lie in the granitic area, which is liberally dotted with excellent small springs of water.

About a mile north of San Jacinto the river is joined by Trout Creek, an important tributary, which, rising on the southwest near the crest of the Great Basin divide, drains the eastern part of the area.

CLIMATE.

The climate is broadly similar to that of other upland districts in the Great Basin region near the Snake River valley. Although more arid it otherwise differs but little from that of the Jarbidge district.

[1] As this gulch seems to be unnamed, it is here called Town Gulch, from the fact that the old, the new, and the lower towns of Contact are located on it.

It is nearly rainless, with only a moderate snowfall in winter, much less than occurs in the Jarbidge district. The summers are long but not hot, though there is a great daily temperature range during the midsummer months. In the mountains frost may occur on almost any night in the year.

VEGETATION.

The region, as shown in Plates XVI, *A*, and XVII, is for the most part a treeless desert covered with a scattered growth of sagebrush, scrub oak, mahogany, and other shrubs. Fair growths of willow and cottonwood flourish along Salmon River and the larger creeks and forage grass grows in the valleys and on favorable slopes, especially in the granitic belt. The river flats are utilized for grazing and the raising of hay.

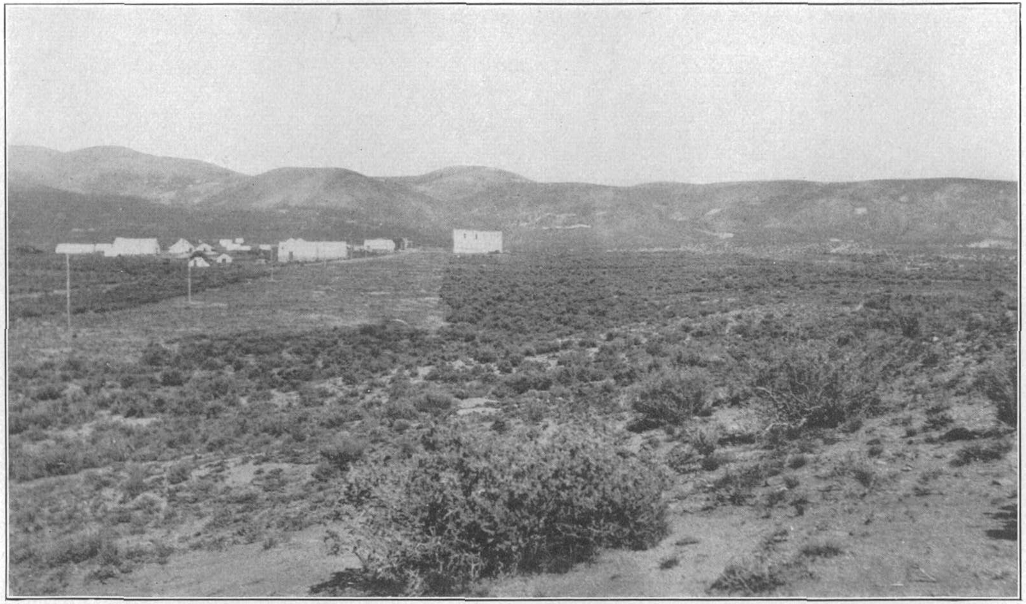
HISTORY AND PRESENT CONDITIONS.

Complete records of the district are not available. In 1897 an old claim notice dated 1870 and signed James Moran was found by W. T. McArdle inscribed on a monument on the north contact belt east of the river, from which it is probable that indications of ore were found prior to that date. The early prospecting up to the middle seventies was solely for gold.

In 1876 the China Mountain deposits were located by an official of the Southern Pacific Co., who enlisted the services of three parties of Chinamen on commission and sunk several 50-foot shafts in search of copper, with encouraging results.

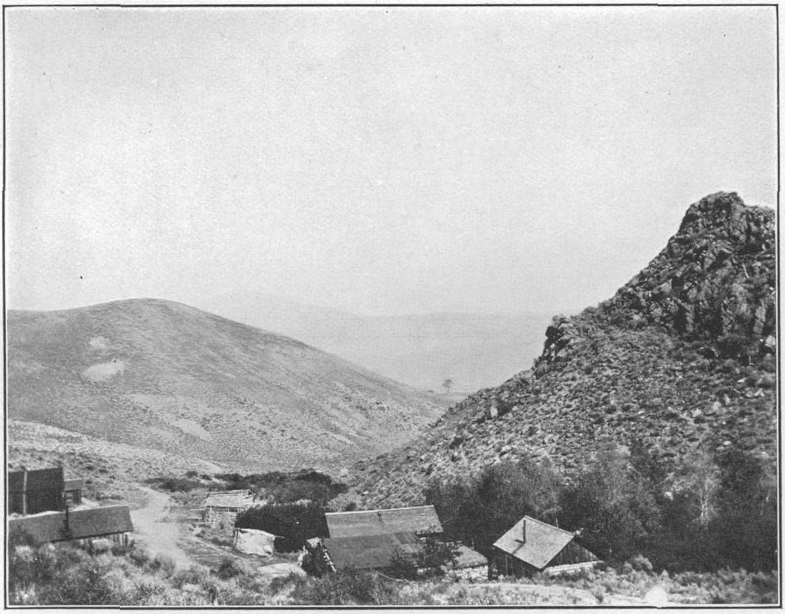
About 1880 copper ore was shipped from the Boston mine, on the north or Middle Stack contact, to Swansea, Wales, and to Boston.

During the decade that followed the country lay dormant until about 1887, when the Jules Verne and Midnight claims produced and shipped to Swansea, Wales, a carload of copper ore, and the Hanks property was located and bonded to an English syndicate by a German. In 1888 the present Delano group was located by Messrs. Hickey, Delano, Ayres, and Hechathin; in 1889 or 1890 the Brooklyn property by Messrs. Warwick, English, and two others; and about 1891 the Empire mine, which turned out well, by Mr. Dewith, and soon after the Copper Queen by Mr. Susettie, all being located for copper. It is also reported that about 1888 the Boston Copper Co. did about $20,000 worth of development work in the district, concerning which, however, nothing definite was learned. This was the extent of the camp until about 1895, when its activity was revived by the immigration of 60 or 70 men, making a total of more than 100 men working in various parts of the district. The present Ivy Wilson and Zetta Blanchard groups were located by W. T. McArdle, who in the following year mined and shipped from the Hanks



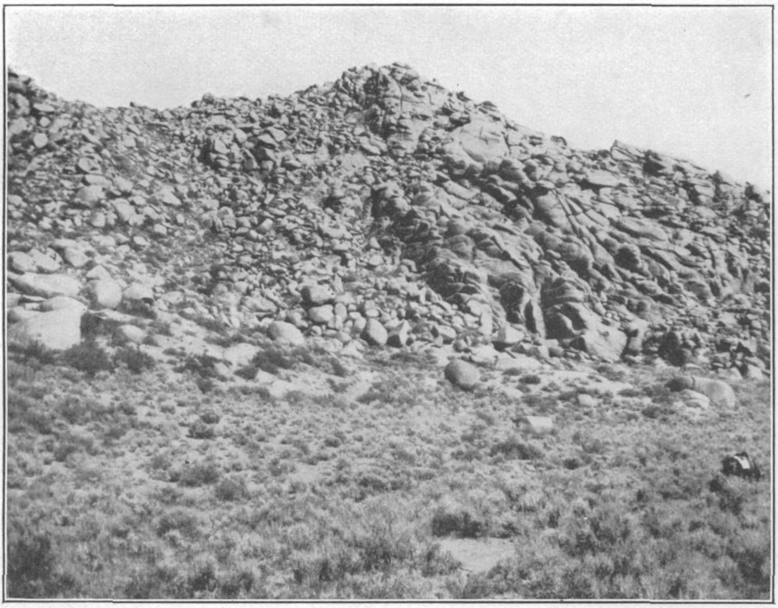
VIEW OF CONTACT (NEW TOWN).

Gently sloping intrabasin floor of eroded granodiorite in foreground, bounded by Ellen D. Range of outward-dipping Paleozoic sedimentary rocks forming rim of basin in background, with mines in face of range. Looking west-northwest.



A. VIEW OF OLD CONTACT.

In Town Gulch, with sheeted granodiorite butte on right and Delano openings in hill of Paleozoic sedimentary rocks on left. Looking N. 75° E.



B. CHARACTERISTIC SEDENTARY BOWLDERS PRODUCED BY WEATHERING OF THE GRANODIORITE IN THE CONTACT DISTRICT.

Looking southeast on Thompson Gulch and Bonanza road above White's camp.

property 8 carloads of ore that assayed 24 per cent of copper and 14 ounces of silver to the ton. In 1896 Mr. Bourne, of Wells, father of the well-known Jarbidge Bourne, located the Mammoth and adjoining claims on the east, and almost simultaneously the present Bonanza property, under the name Dolly B., was located by Messrs. Coleman, Moore, and Thompson, of whom the first named located the Father de Smet property of Hearst fame in the Black Hills. In the same year the Lucky Boy group, later known as the Emerald and now also as the Winnemucca group, was located by Mr. Armstrong. In 1896–97, with local aid in which 20 men contributed $100 each, a 50-ton smelter of the water-jacket type was installed about a mile south of the present new town, near the river, by the Salmon River Mining Co., of which S. P. Kemper, of Butte, Mont., was president, but the plant did not prove a success, and after a trial of three different runs, starting April 1, and a production of 14 tons of 98 per cent copper, from ore obtained principally from the Bluebird mine, was closed and has remained so to the present.

Soon after the trial of the smelter Mr. Kemper formed a company of the prospectors and miners in camp, with the view of mining the Brooklyn, Empire, and other properties and making a success of the smelter, but as the project was not successful and the members of the company could not keep up their assessments, Mr. Kemper, it is said, became sole owner of both mines and smelter. After failing to acquire also the Delano group, he closed the Brooklyn mine, which at that time was making one of the best showings in the camp. After this suspension of operations the population by 1898 fell to but 20 or 25 men, and the district slumbered until 1905, when, with only five men in camp and no companies working, there began a gradual revival of activity. By 1908 there were about 300 people in the camp, owing chiefly to the starting of operations on the Ivy Wilson group by the United States Mining Co. and on the Bonanza group by its owner. At present the camp has a population of about 100 people.

The principal settlement is the new town of Contact, of about two years' growth (Pl. XVII), favorably situated on a gentle slope about half a mile west of and 200 feet above the river. The place known as Old Contact or Old Town (Pl. XVIII, *A*) is now nearly deserted.

Railroad facilities seem likely to be soon supplied by the extension of the Oregon Short Line branch now in operation from Twin Falls to Rogerson, Idaho. The line has been surveyed southward up the Salmon River valley to Valley Pass, Nev., a point on the Southern Pacific Railroad between Cobre and Wells. The route is said to be feasible, and when completed the line will pass directly through the Contact district. At present, owing to the occupancy of the valley flats, under range fence, by the Vineyard Land & Stock Co., to the exclusion of small ranches, all supplies and ordinary ranch produce have to be freighted by wagon from the railroads.

The Twin Falls Power Co. has a branch plant at the Salmon River dam 30 miles north of Contact, and offers to supply the camp with power at reasonable rates. The Contact Power & Milling Co. contemplates the development of home power by the installation of a dam and plant on the river in the box canyon of the lava area a few miles west of Ellen D. Mountain.

GEOLOGY.

Like much of the Great Basin on the south, the Shoshone or Snake River basin on the north, and the Jarbidge district on the west, the Contact district lies in an area of folded and tilted sedimentary rocks, mostly Paleozoic, cut by granular intrusives and flooded by Tertiary lavas. (See Pl. XIV, p. 100.)

The rock groups of the district, beginning with the oldest, are Paleozoic sedimentary rocks, post-Paleozoic granitic intrusive rocks, Tertiary lavas, Tertiary lake beds, and Quaternary deposits. Of these the most important, with reference to the mineral deposits, are the post-Paleozoic granitic intrusive rocks and the Paleozoic sediments. Except that the old rhyolite of the Jarbidge district is absent and that lake beds are present, the geologic section at Contact is similar to that of the Jarbidge district.

SEDIMENTARY ROCKS.

PALEOZOIC ROCKS.

The Paleozoic sedimentary rocks which formerly covered the entire district now form merely an outward quaquaversally dipping belt encircling the granitic basin, as shown on Plate XIV. The belt ranges from a mile to several miles in width, the sedimentary rocks being in part underlain and intruded by the granitic rocks on the inner side and overlain by the Tertiary lavas on the outer side.

The rocks as exposed do not appear to be over 1,600 feet thick, as shown in the sections of Ellen D. Mountain and on the Ivy Wilson ground on the west. It is possible, however, that further field work may show a greater thickness between Old Contact and the northern edge of the area mapped.

The rocks exposed, however, do not necessarily constitute the entire section of the Paleozoic in this district, for if the granitic mass, as has been suggested by Purington[1] and Bailey,[2] represents a laccolith, the basal part of the sedimentary section must be deeply buried under the granitic intrusive. From the areal extent of the granodiorite,

[1] Purington, C. W., Proc. Colorado Sci. Soc., vol. 7, 1903, p. 130; also Eng. and Min. Jour., vol. 76, 1903, p. 426.

[2] Bailey, J. T., Eng. and Min. Jour., vol. 76, 1903, p. 612.

which occupies a belt 25 miles or more in length and 6 miles in width, and from its exposure through a vertical range of more than 3,000 feet without revealing any trace of sedimentary beds, it appears probable that the granodiorite may be a stock or batholith. The absence from the surrounding region of any section of the Paleozoic rocks of much greater thickness than that exposed in the district is also unfavorable to the laccolithic view. At Elk Mountain, 12 miles to the northwest (see Pl. I, p. 10), the Paleozoic section is about the same as in the Contact district. Further light will probably be shed on this subject when study is made of the H. D. Range, to the east, where the Paleozoic rocks appear to be displayed on a grander scale, with perhaps a much thicker section.

In Ellen D. Mountain the rocks dip north at angles near 20° or lie nearly horizontal. On the Ivy Wilson and Bryan claims they are mostly on edge or highly tilted. Elsewhere they are variously deformed, distorted, folded, faulted, and brecciated. Some apparently detached portions of the strata, with steep inward dip, appear to be inclosed in the granitic mass, as indicated in the left part of section B–B′, on Plate XIV.

In some places the contact is therefore compound and comprises a zone several hundred feet wide in which bands of limestone or other sedimentary beds alternate with bands of granodiorite. This is particularly true of much of the contact on the northwest, extending from a point near the river 6 miles westward to Bonanza Gulch.

The contact, like some of the sedimentary beds, in places also dips inward toward the granodiorite, but wherever it has been followed for a few hundred feet in depth it straightens or assumes the normal outward dip, as at the Brooklyn mine.

No detailed examination of the Paleozoic rocks could be made in the time allotted to this work. So far as observed the exposed portion of the section consists principally of alternating beds of blue and white limestones, quartzites, and slate or dark slaty and shaly quartzite. In descending order the members are essentially as follows:

Section of Paleozoic rocks in Contact district.[1]

	Feet.
Granodiorite.	
8. Limestone	1,100
7. White limestone	
6. Bluish limestone	
5. Heavy quartzite	
4. Black limestone	
3. Reddish limestone shale	
2. Slate or dark slaty to shaly quartzite	300
1. Quartzite, basal (?)	200

[1] Nos. 3 to 8 principally from information supplied by J. V. Marshall.

The basal quartzite, as shown on the Bryan ground, has a thickness of about 200 feet and, as shown both here and on Strawberry Hill, on the Ivy Wilson ground, is a thick-bedded hard pinkish-gray rock, which weathers reddish brown.

The limestone varies from thin to thick bedded and, where in contact with the intrusive granodiorite, is usually silicified, garnetized, and in places chloritic or almost completely changed to diopside, with which are associated scapolite, calcite, and other metamorphic minerals.

In some places, however, the limestone near the granodiorite is but slightly altered; elsewhere it is highly metamorphosed for a distance of 1,600 feet or more from the contact. Most of the indications of ore occur in the altered and replaced limestone. The sedimentary rocks are cut also by dikes of syenite, monzonite, aplite, and rhyolite or felsite. (See pp. 109–112.)

No fossil remains were found in these Paleozoic rocks, but from their lithologic character and general resemblance to the nearest Paleozoic rocks of ascertained age,[1] which occur 10 miles south of the district, the rocks appear to belong to the upper Carboniferous portion of the Eureka region section.

TERTIARY LAKE BEDS.

In the valleys of the district, as well exposed in its southeastern part on Knoll Creek (Pl. XVI, *B*), occur water-laid deposits of whitish to dull-gray sandstone. This formation rests unconformably upon the eroded surface of the Paleozoic sediments, the granodiorite, and the Tertiary volcanic rocks and in large part underlies the late Quaternary deposits on Salmon River, in the large, gently sloping quadrangular embayment between Meadow Creek and Middle Stack Mountain (Pl. XIV, p. 100) and seemingly also between Meadow Creek and McDuffy Gulch. In the undulating hilly country north of Middle Stack Mountain the formation occupies the widening valley of Trout Creek and, as on Knoll Creek, it appears to extend almost to the headwaters of the stream, reaching an elevation of about 6,600 feet.

The thickness of the formation, which depends on the underlying topography and on the extent of later erosion, varies in places from less than a foot to a known maximum of about 400 feet on Knoll Creek, although it may locally be much greater.

The formation for the most part lies nearly horizontal but in places is tilted, flexed, and gently folded. It tends to weather in bluffs and miniature badland forms, as shown in Plate XVI, *B*.

The beds are of various thicknesses and the layers are not sharply defined. They are composed of light, friable, almost pumiceous vol-

[1] U. S. Geol. Expl. 40th Par., Atlas, Map IV.

canic tuff deposited as ash showers in a Tertiary lake. Under the microscope the tuff is seen to consist of minute elongated particles of glass which along their edges show feeble polarization. There are also present a little biotite and hornblende.

It is possible that some deposits of coarser angular volcanic tuff, 100 feet or more thick, that occur in the vicinity of Contact and elsewhere, may represent shore or delta deposits associated with the finer lake beds, but such connection was not investigated in this work.

At Contact tuffaceous sandstone of medium grain is penetrated by a 72-foot well, with its bottom still in this rock, and at Lower Town a 90-foot well is almost wholly in this light tuffaceous sandstone, with some argillaceous material, although its bottom is in granodiorite, 60 feet below the level of the river. Water was finally obtained here by drilling laterally on a moist seam 20 feet above the bottom of the well.

No fossil remains were found in the lake beds, but from their lithologic character and their relation to the other rocks of the district they appear to be of Pliocene age and to belong to the Humboldt formation, which occurs extensively in northern Nevada, as described on pages 31–32. According to the Fortieth Parallel Survey,[1] it covers large areas in northern Nevada, and it is known to extend within 8 or 10 miles of the Contact district on the south.

IGNEOUS ROCKS.

The igneous rocks of the district comprise several types of granitic intrusive and Tertiary volcanic rocks. Of these the oldest and most important are the intrusives.

INTRUSIVE GRANITIC ROCKS (CRETACEOUS?).

The oldest of the granitic rocks is the granodiorite. Economically it is also the most important, for the discoveries, prospects, and developments are mainly near the contact between the granodiorite and the Paleozoic sedimentary rocks, especially limestone. The granodiorite area has a width from north to south of 6 miles and a length of over 25 miles. Its outline, defined by the surrounding Paleozoic sedimentary rocks, is well marked by Ellen D., Middle Stack, China, and other prominent mountains. At nearly all these places the granodiorite is plainly intrusive into the sediments, which it has uplifted with quaquaversal outward dip along the contact. From this and other phenomena observed at Ellen D. Mountain, on the west, it is evident that the Paleozoic sedimentary rocks formerly extended entirely over the granodiorite as a huge elongated anticlinal dome, practically coextensive in area with the present basin.

[1] U. S. Geol. Expl. 40th Par., Atlas, Map IV.

The granodiorite therefore intrudes and in part underlies the surrounding sedimentary rocks. It is locally overlain by Tertiary volcanic rocks, Tertiary lake beds, and Quaternary alluvium, and is cut by syenite, monzonite, aplite, and felsite dikes. It is much younger than the Paleozoic sediments, and like the granodiorite of the Jarbidge district, which it resembles, is probably of Cretaceous or near Cretaceous age.

Since its intrusion the granodiorite has suffered considerable disturbance. It is faulted, fissured, and generally sheeted. Locally, as at Ellen D. Mountain and in the Johnson tunnel on Trout Creek, it is sheared and laminated. For instance, in the western part of the basin, on Thompson Gulch, about midway between the Bonanza, Brooklyn, and Ivy Wilson mines, it is cut by a pronounced dominant N. 70° E. sheeting with a dip of 80° S. and by a second sheeting that dips steeply to the west. Owing to these structures the rock weathers concentrically into huge heaps of sedentary bowlders, as shown in Plate XVIII, *B* (p. 102). Examples of shearing and lamination occur about a mile east of Old Contact, on the Palo Alto and Bryan ground.

The granodiorite, as well shown at the Brooklyn mine and elsewhere, is a gray, coarsely speckled rock, of medium to moderately coarse grain. It contains feldspars two-tenths of an inch in maximum diameter, quartz in moderate amount only, biotite, and hornblende crystals one-tenth of an inch in maximum length. Under the microscope the rock is seen to have a eugranitic, hypidiomorphic granular texture and to be composed essentially of plagioclase, orthoclase (including microcline), quartz, pale-brown biotite, and hornblende. The feldspars show zonal structure. Some are kaolinized or altered. The hornblende is partially altered to chlorite and has associated with it considerable magnetite. In certain specimens the minerals are bent by dynamic action. The plagioclase is principally oligoclase and stands close to oligoclase-andesine.

TERTIARY VOLCANIC ROCKS.

The Tertiary volcanic rocks occur as flows, with local beds of associated ash or tuff and allied volcanic ejecta, resting unconformably upon the Paleozoic sediments and extending outward in all directions over the surrounding plateau. They also occur as local inliers within the granodiorite area, where they form bluffs along the streams, as on Meadow Creek and Salmon River at Lower Contact, or cap flat-topped buttes, of which Table Mountain, near Old Contact, the similar butte near San Jacinto, and others on Trout Creek near Clark Cabin are conspicuous examples. The presence and general accordance in elevation of these inliers indicate that these lava flows formerly extended continuously over the entire region.

The lavas nowhere appear to attain a great thickness. Their thickest section is probably at Ellen D. Mountain, where, according to Purington,[1] they have a thickness of about 500 feet. The lavas occur in thin to moderately thick flows superimposed one upon another and in places showing fine fluxion laminations, from which it may be inferred that in the molten state they were very fluid. They are mostly dense or aphanitic rocks. On fresh surfaces they are bluish gray, and they weather brown.

These lavas, like the young or rim-rock lavas of the Jarbidge district, have hitherto been commonly known as basalt. Examination, however, shows them to be rhyolite very similar to or identical with the rim-rock rhyolite of the Jarbidge district, with which, to judge from a rapid traverse made between the districts, they appear to be practically continuous. Like the rhyolites at Jarbidge, they consist essentially of a glassy felsitic groundmass and contain considerable tridymite. In fact, so closely does the description of the rhyolites of the Jarbidge district apply to these lavas that it would be superfluous to repeat it here. (See pp. 42–47.) To judge from the overlying eroded sediments and associated deposits, the rhyolites of the Contact district probably contain more ejecta than those at Jarbidge.

DIKE ROCKS.

CLASSES AND GENERAL FEATURES.

The dike rocks observed in the Contact district may be roughly grouped into two main classes—(1) syenitic or siliceous and (2) lamprophyric or basic. Both are younger than the granodiorite, which they cut, as they do also the Paleozoic sedimentary rocks. The basic dikes, according to W. T. McArdle[2] and J. T. Bailey,[3] are younger than the siliceous dikes. As seen on the Bryan ground and elsewhere the basic dikes weather down evenly with the inclosing rocks, but the siliceous dikes outcrop in places 10 feet or more above the surface.

According to Lindgren[4]—

> It is well known that large intrusive areas usually contain a series of dikes filled with molten magmas shortly after the consolidation of the main mass. The composition of these dike rocks is very apt to bear a certain relation to that of the main intrusive mass, and it is held by some that the dikes represent products of differentiation derived from the principal magma. In case of certain rocks like nepheline syenite, the dike rocks are especially characteristic.

[1] Purington, C. W., The Contact, Nevada, quaquaversal: Proc. Colorado Sci. Soc., vol. 7, 1903, p. 131.

[2] Oral communication.

[3] Eng. and Min. Jour., vol. 76, 1903, p. 612, map.

[4] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3, 1900, p. 85.

This statement is characteristically true of the Contact district, in which the principal dikes are syenite and syenitic rocks composed essentially of orthoclase feldspar, one of the principal mineral constituents of the granodiorite. The dikes include also, however, monzonitic and aplitic rocks.

SYENITIC OR SILICEOUS DIKES.

The syenitic dikes are widely distributed and cut both the granodiorite and the Paleozoic sedimentary rocks. They are more plentiful or at least are more conspicuous and have been more frequently observed in the granodiorite, in which they are usually associated with ore deposits. The more feldspathic varieties weather evenly with the country rocks (Pl. XXIII, *A*, p. 118). They strike as a rule a little north of east. They are mostly from 1 to 3 or 4 feet in width, but locally they attain a width of 200 feet or more as shown on the Salt Lake ground near Contact and on the Camp Bird claim, 2 miles east of the river.

The rock is generally pale pink or flesh-colored, especially in the weathered state, but some varieties are light to iron-gray. It is granitic in texture and somewhat closer grained than the granodiorite. In the weathered state it appears somewhat porphyritic, with tabular feldspar phenocrysts, whence it is commonly known as porphyry. It is moderately miarolitic, with small cavities some of which contain chalcedonic or hyaline silica. The dikes represented on the map (Pl. XIV, p. 100) are nearly all of this class, particularly in the granodiorite area. They are of economic significance from the fact that they are usually associated with ore or indications of ore, especially in the granodiorite area; the Shield, Pool, and Camp Bird dikes described later are examples.

The rock is predominantly feldspathic and is composed essentially of orthoclase, with usually a smaller quantity of plagioclase, albite, etc., very little hornblende or other bisilicates, and, in its typical form, little or no quartz. Apatite, octahedrite, magnetite, and rutile are present as accessories. A specimen (No. 84) from White Elephant No. 3 of the Ivy Wilson ground shows the accessory octahedrite or titanium dioxide, TiO_2, very plentifully present in pleochroic, strongly double-refracting striated octahedra and modified forms.

From true syenite the rock in different localities or dikes ranges to monzonitic and to siliceous or aplitic varieties. For instance, a specimen from the Pool dike, which cuts the granodiorite near Contact, shows this dike to be composed of orthoclase (perthitic) and plagioclase in about equal proportion, a very little quartz, and a moderate amount of bisilicate, now represented chiefly by pale-green chlorite. The plagioclase corresponds mostly to oligoclase-andesine and the rock seems to stand close to monzonite. It contains considerable sericite, some being in rosettes.

Near Clark Cabin, on Trout Creek, the granodiorite is intruded by numerous dikes and by a small stock of a light flesh-colored fine-grained rock composed of orthoclase, plagioclase, and quartz in about equal proportions, with a little disseminated hornblende and a very little biotite. It appears to stand between quartz syenite and quartz monzonite.

On the Camp Bird ground, at the head of McDuffy Gulch, the granodiorite is cut by a persistent 200-foot dike of a similar but coarser-grained porphyritic rock composed of about 40 per cent each of orthoclase and plagioclase, both considerably sericitized, about 20 per cent of quartz, and but a small amount of bisilicate. This rock is apparently a quartz monzonite.

At the Chinaman mine, in China Mountain, the limestone and the granodiorite, which is here comparatively basic, are cut by a fine-grained dike that is macroscopically similar to that near Clark Cabin, but is composed principally of orthoclase and quartz, with a very little plagioclase and apatite, and stands close to aplite.

LAMPROPHYRIC OR BASIC DIKES.

The lamprophyric or basic dikes appear to be less plentiful and smaller than the syenite dikes. They were observed chiefly in the western and northern parts of the district, where they are intrusive into both the granodiorite and the sedimentary Paleozoic rocks and are said to cut the syenite dikes also. They trend for the most part north-northwestward nearly at right angles to the general trend of the syenite dikes. They were observed at several points. On the Bryan ground, near Contact, in the gulch to the southeast of the shaft, a dike nearly 8 feet wide cuts the quartzite. In the southeast base of Ellen D. Mountain a dike of this class is intruded into both the granodiorite and the Paleozoic sedimentary rocks; and at the top of the mountain, according to a specimen collected by Sweetser, the sedimentary series is cut by a similar dike, possibly the same one.

The dikes of this class are dark. They range from iron-gray to nearly black and are moderately porphyritic, with small phenocrysts of pinkish feldspars and dark-brown hornblende in an aphanitic or microcrystalline groundmass of plagioclase, hornblende, biotite, and usually a moderate amount of quartz, although the dike in the top of Ellen D. Mountain shows little if any quartz. The groundmass is holocrystalline, is nearly equigranular, and shows fluxion structure. The plagioclase ranges from oligoclase-andesine to andesine-labradorite. The hornblende is in long prisms and much of it is changed to chlorite and epidote. The rock of these dikes is essentially a hornblende basalt and stands close to camptonite.

These dikes are locally called porphyry or bird's-eye porphyry and seem to be the dikes described by Purington[1] as felsite and by Bailey[2] as felsitic dikes.

SUMMARY OF GEOLOGIC HISTORY.

During Paleozoic time in the area now corresponding to the Contact district sediments were deposited on the floor of the ocean as mud, silt, carbonate of lime, sand, etc. Later these deposits were elevated above the sea as shales, limestones, and quartzites, their elevation presumably being accompanied by deformation, folding, and faulting. Of early Mesozoic changes, which, as indicated in neighboring regions, were probably extensive, no records remain in the district. Apparently, near the end of the Cretaceous period, the granodiorite batholith was intruded into the Paleozoic rocks, the intrusion being accompanied by an anticlinal uplift, particularly through the east-west central belt of the district, and by folding, faulting, and other deformation. A little later the rocks were intruded by the syenitic and lamprophyric dikes, which traverse both the granodiorite and the Paleozoic sediments. The ore deposition appears to have been associated with the intrusion of the granodiorite and these dikes and was probably effected by thermal solutions and gases that followed the intrusion.

The intrusion of the granodiorite batholith, which probably fractured the overlying Paleozoic rocks, was followed by a long period of erosion in which the entire arch of the anticline was removed and its limbs truncated to the form of the rim of the granodiorite basin.

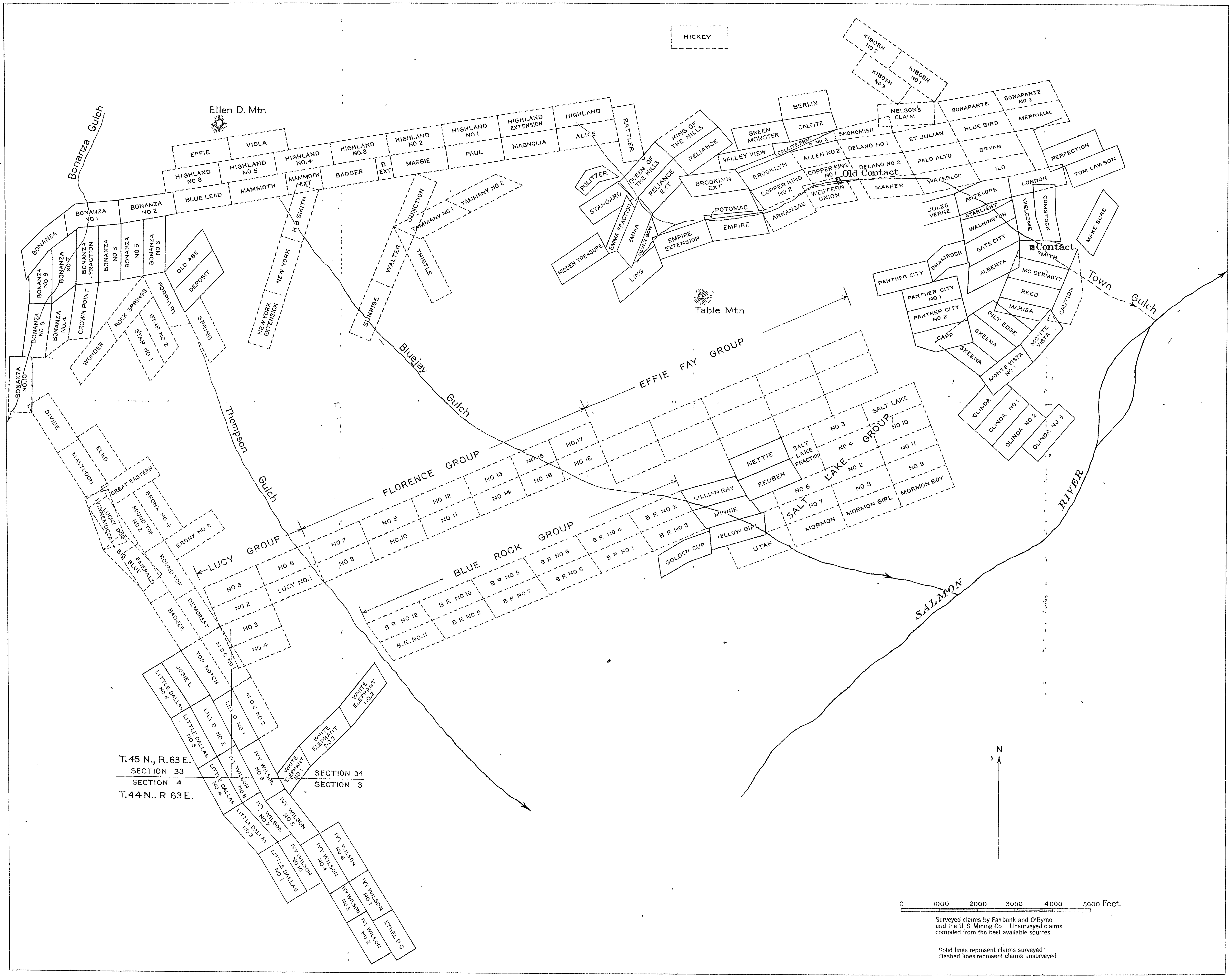
In Tertiary time an outpouring of rhyolitic lavas flooded the entire district and during the later part of this volcanic epoch the low places of the district were occupied by lakes in which, among other sediments, beds of tuffaceous sandstone, etc., constituting the Humboldt formation (Pliocene), were deposited. These beds have since been largely removed by erosion, which has continued to the present time and which, in connection with local transportation of material, in places has buried what remains of the lake beds under Quaternary débris derived from the surrounding slopes and mountains.

MINERAL DEPOSITS.

LOCATION AND GENERAL CHARACTER.

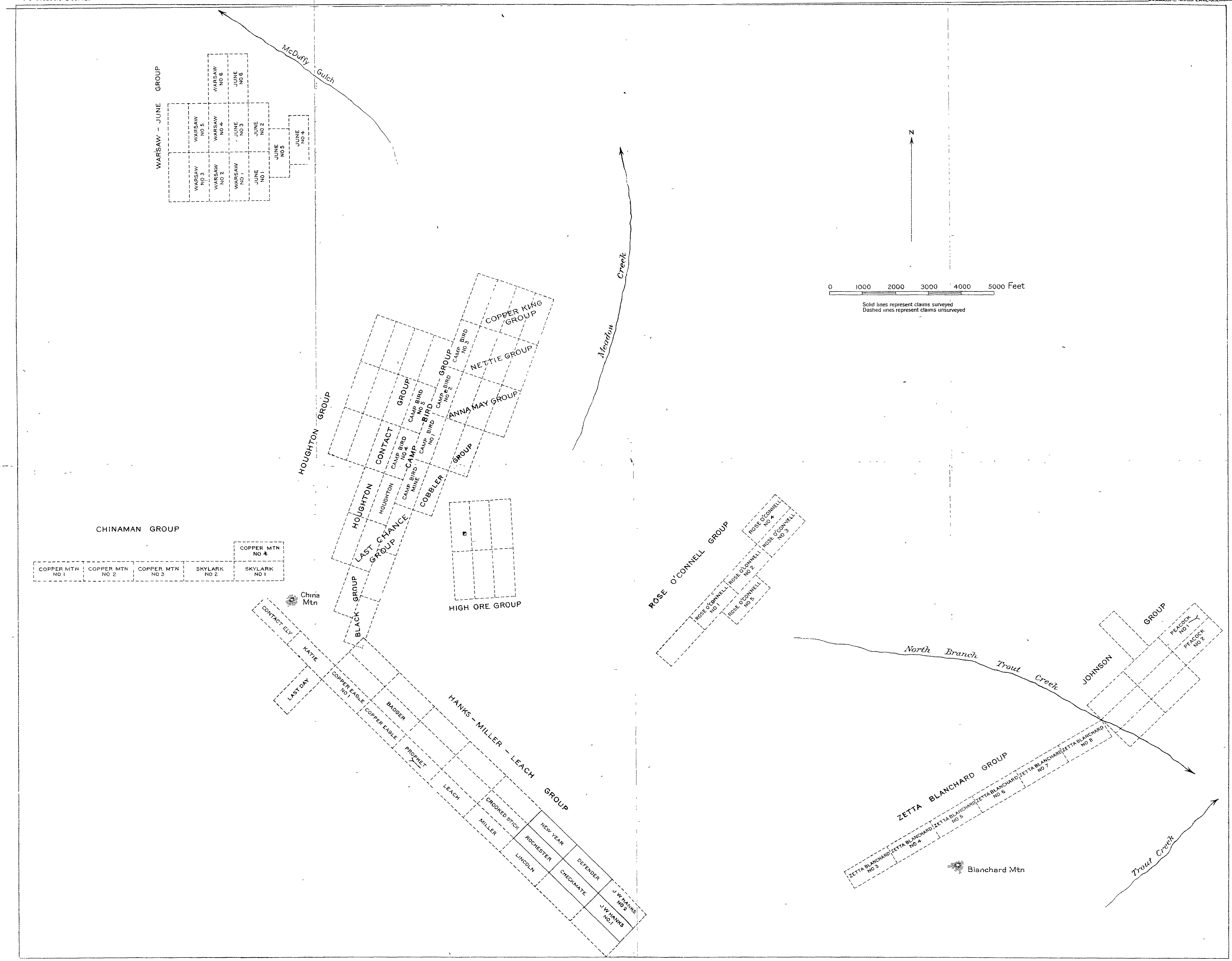
The mineral deposits of the Contact district occur principally in the contact zone of the granodiorite and within the granodiorite area in connection with the dikes. They lie on a curve nearly 50 miles

[1] Purington, C. W., Eng. and Min. Jour., vol. 76, 1903, p. 427.
[2] Bailey, J. T., idem, p. 612.



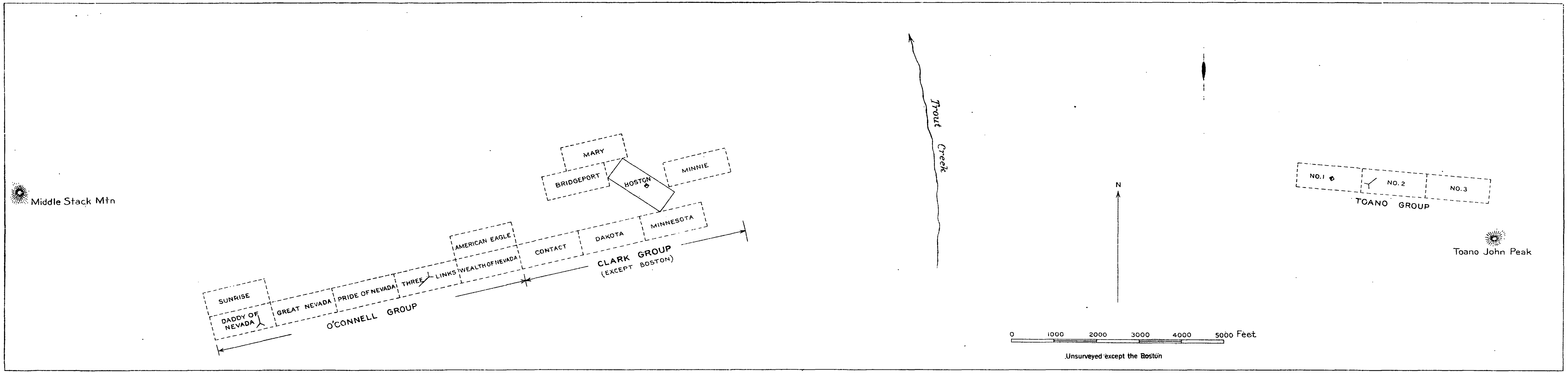
MAP SHOWING DISTRIBUTION OF PRINCIPAL MINERAL CLAIMS IN THE WESTERN PART OF THE CONTACT MINING DISTRICT, NEVADA

THE NORRIS PETERS CO WASHINGTON D C



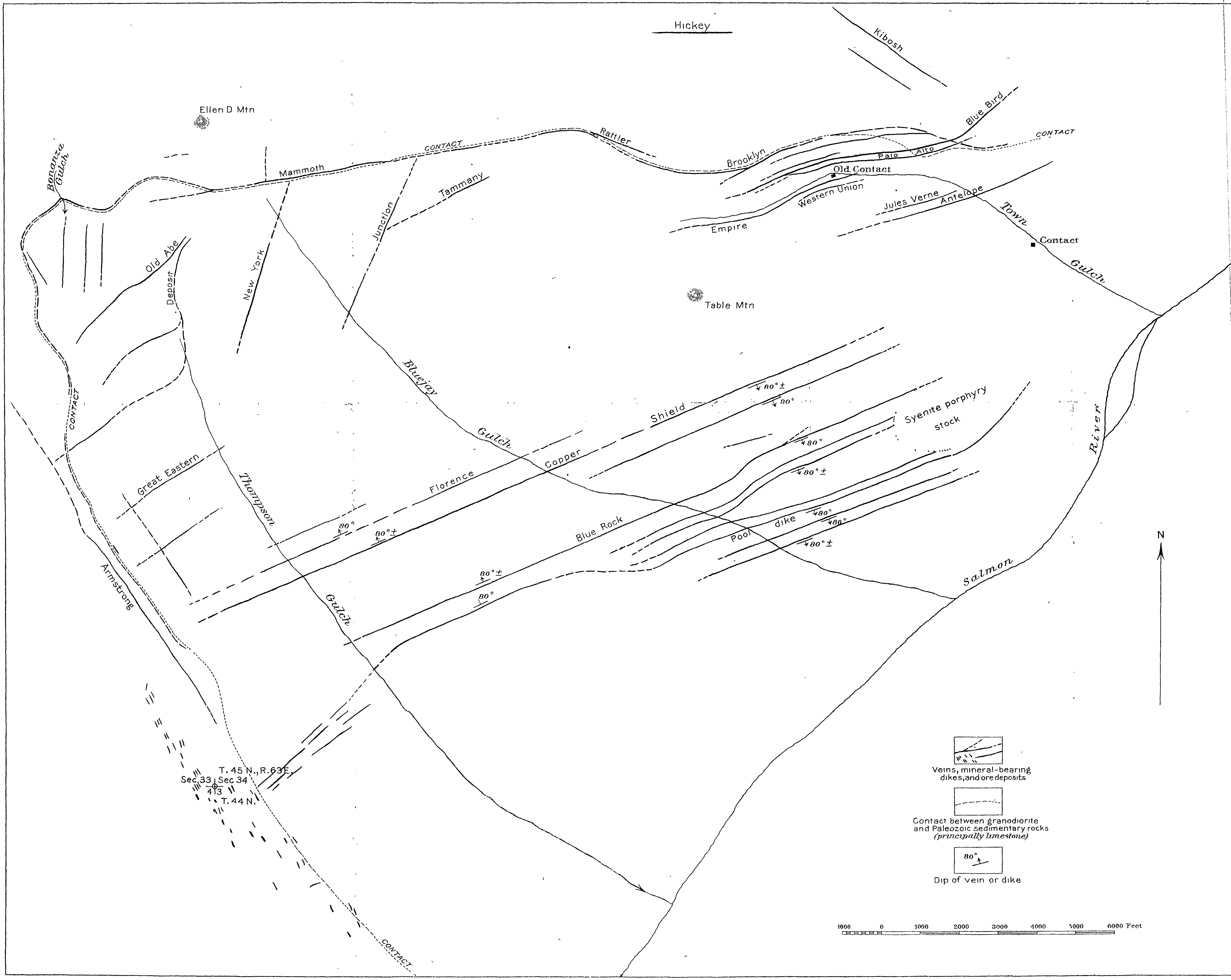
MAP SHOWING PRINCIPAL CLAIMS IN THE SOUTHEASTERN OR CHINA MOUNTAIN PORTION OF THE CONTACT MINING DISTRICT, NEVADA

THE NORRIS PETERS CO WASHINGTON D C



MAP SHOWING APPROXIMATE RELATIVE LOCATION OF PRINCIPAL CLAIMS IN NORTHEAST OR MIDDLE STACK MOUNTAIN PORTION OF THE CONTACT MINING DISTRICT, NEVADA

THE NORRIS PETERS CO., WASHINGTON, D. C.



MAP SHOWING APPROXIMATE DISTRIBUTION OF THE PRINCIPAL VEINS, MINERAL-BEARING DIKES, AND DEPOSITS IN THE WESTERN PART OF THE CONTACT MINING DISTRICT, NEVADA long, which from its shape is locally called "the horseshoe." Most of them, however, are in the toe of the shoe, on the west or town side of the river. (See Pl. XIV, p. 100.) Their general distribution is shown in Plates XIX to XXII.

In the contact zone the deposits occur principally in the limestone at or near the contact. They appear to owe their origin to the intrusion of the deep-seated granular rocks, especially to the pneumatolytic gases and thermal solutions that accompanied and followed the intrusion. They are therefore probably of Cretaceous age.

The region is not characterized by a great variety of minerals. The following list gives those that have been observed:

Actinolite.	Chrysocolla.	Octahedrite.
Allanite.	Cuprite.	Orthoclase.
Apatite.	Diopside.	Plagioclase.
Aragonite.	Epidote.	Pyrite.
Argentite.	Galena.	Pyrolusite.
Asbestos (?).	Garnet.	Quartz.
Augite.	Gold.	Quartz (secondary).
Axinite.	Hematite.	Rutile (?).
Azurite.	Hornblende.	Scapolite.
Biotite.	Hyalite.	Sericite.
Bornite.	Ilvaite.	Specularite.
Calcite.	Kaolin.	Spinel (?).
Cerusite.	Limonite.	Titanite.
Chalcedony.	Malachite.	Tourmaline.
Chalcocite.	Microcline.	Vesuvianite.
Chalcopyrite.	Molybdenite.	
Chloropal.	Muscovite.	

The ores of the district are almost wholly copper ores, but they contain also small amounts of silver and gold. Some of the ore—for instance, that at the Bryan mine—is said to contain as high as 8 ounces of silver and from $10 to $12 in gold to the ton. The Blue Bird ore carries 20 ounces in silver and $2 in gold. In only a few places do lead, manganese, and zinc ores occur.

The ore minerals are malachite, argentite, azurite, chalcopyrite, bornite, chrysocolla, chalcocite, cuprite, galena, gold, cerusite, hematite, and pyrolusite. Of the copper minerals probably chalcopyrite alone is primary, the others being derived from it.

According to their mode of occurrence, the deposits may be roughly grouped into three classes—contact-metamorphic deposits, fissure veins, and replacement deposits. It is obvious that some deposits can not be assigned to any single class. In some openings deposits of two or more of the classes may be present and so intermingled or blended as not to be easily separated. A brief description, with examples of the different classes, follows.

CONTACT-METAMORPHIC DEPOSITS.

The contact-metamorphic deposits, as shown at the Queen of the Hills, Mammoth, Johnson, Zetta Blanchard, and other openings, consist essentially of a mixture of carbonates, massive garnet, axinite, epidote, calcite, quartz, actinolite, diopside, malachite, azurite, pyrite, chalcopyrite, bornite, copper oxides, specularite, hematite, limonite, chloropal, molybdenite, muscovite, etc. The minerals are all more or less intergrown and, except the oxides, were apparently all formed at the same time, probably by the contact metamorphism of the limestone by the intrusive granodiorite. The metals are copper and silver, with a little gold. The deposits occur on or near the contact of the two rocks, usually in the limestone, where they form irregular bodies 40 feet or more in width.

Garnet is generally present as a gangue mineral, but it is not so plentiful as at first appears. Much of the massive grayish-brown gangue mineral throughout the district that has hitherto been taken for garnet, even by the trained eye, is found on examination to be axinite. The garnet is almost wholly massive. Its occurrence in crystalline form is extremely rare; about the only example observed is in the Zetta Blanchard No. 5 shaft, where a few fairly well-formed, very impure crystals half an inch in maximum diameter were seen in a dark-brown or blackish ferruginous gangue. Portions of smaller crystals were noted in the axinite-chloropal gangue of the same opening.

An unusual and interesting feature of the deposits is the occurrence of axinite, a rather rare boron-bearing grayish-brown hydrous silicate of aluminum and calcium with iron and manganese. It is generally present as a gangue mineral throughout the contact zone. It shows plentifully in microscopic slides of the Brooklyn, Alice, and Zetta Blanchard ores, and specimens from a dozen or more different localities, covering all parts of the contact zone, examined chemically by W. T. Schaller, gave strong tests for boron, denoting the presence of axinite in considerable amount. It forms about 50 per cent of a thin section from the yellowish gray-brown gangue portion of the deposits in the Alice shaft and about 80 per cent of ore from the Zetta Blanchard No. 5 shaft.

The distinctive features of axinite are the presence of boron, which colors the flame green, its acute-edged crystal form, the combination of high refractive indices with low double refraction, and its good cleavage. In a thin section of ore from the Brooklyn mine the refraction of the axinite was found by J. B. Umpleby and Waldemar Lindgren to be higher than 1.650 and lower than 1.700, which agrees closely with published data.

Axinite is known to occur here and there on the borders of intrusive granitic and diabase areas, and has been noted by Ransome in the contact zone at Coppereid, Nev.[1] Hoerner[2] regards axinite as essentially a pneumatolytic mineral produced by the gases of a granitic magma in contact with a highly calcareous rock. If this view is correct it would seem that there must have been considerable pneumatolytic action in the Contact district, and probably the copper with the other ore constituents was introduced at the time of the intrusion.

Chloropal, plentiful in places as a gangue mineral, is a yellowish-green or finch-green hydrous silicate of iron and aluminum. It is not an ore of copper, and whatever copper it may contain has probably been mechanically introduced.

A typical specimen of the ore from the Alice shaft in places suggests crude banding, but as a whole is nearly massive. It is medium grained and consists principally of a mixture of malachite and azurite with a little chalcopyrite and bornite in a dark iron-stained garnetiferous axinite-quartz gangue. These constituents are intergrown with leaf-like veinlets of molybdenite, which form a sort of mesh. The latter feature is still better shown under the microscope, which also discloses the presence of much microcrystalline chalcedonic quartz, pyroxene, mostly altered to epidote and chlorite, and veinlets of epidote.

The contact-metamorphic deposits were the first to be formed, and their highly-colored outcrops, stained with copper carbonates, tend to convey a strong impression of the mineralization of the district. They are seemingly best developed around Ellen D. Mountain and China Mountain, but good showings also occur in the Middle Stack Mountain, Trout Creek, and Zetta Blanchard areas.

FISSURE-VEIN DEPOSITS.

Though less conspicuous than the contact-metamorphic deposits the veins appear to be the more promising. They are more regular and persistent.

After the intrusion of the Paleozoic rocks by the granodiorite the rocks were fissured and were subsequently intruded by the dikes already described. In the fissures circulating thermal solutions, in some cases after the intrusion of the dikes, deposited quartz veins containing ore minerals. Some veins follow or parallel the main contact, others cut across it nearly at right angles, and others occur chiefly in the granodiorite, in association with the dikes.

The veins appear to be best displayed along the portion of the contact zone that extends from a point north of Contact westward to

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[1] Ransome, F. L., Notes on some mining districts in Humboldt County, Nev.: Bull. U. S. Geol. Survey No. 414, 1909, p. 64.

[2] Hoerner, Thomas, Über die Axinitvorkommnisse von Thum in Sachsen und die Bedingungen der Axinitbildung überhaupt: Zeitschr. Deutsch. geol. Gesell., vol. 62, pt. 1, 1910, pp. 17–20.

the Bonanza mine. Most of them are from 1 to 4 feet wide and outcrop boldly from 1 to 8 feet above the surface. They contain little or no gouge. Examples are the Antelope vein, about midway between the new and old towns, and the veins on the Delano No. 2 and Copper King No. 1 claims, just north of Old Contact, all for the most part in the granodiorite.

The filling is glassy quartz, with a little chalcedony, and it contains the usual copper-ore minerals chalcopyrite, bornite, malachite, azurite, chalcocite, cuprite, and chrysocolla, all of which were probably deposited originally as chalcopyrite. Silver and gold are also present in small amount, and there is in many places some associated molybdenite.[1]

It is probable that further work may show that some of the veins now within the dikes, instead of having been deposited within a single dike, were formed alongside of one dike, and that a later dike was then intruded between the vein and the granodiorite.

REPLACEMENT DEPOSITS.

In some localities veins normally but a foot or two in width widen by replacement of the country rock. This feature was pointed out by C. W. Purington [2] in describing a set of narrow veins at Ellen D. Mountain which cross the granodiorite contact and in the limestone contain ore bodies nearly 50 feet wide. Essentially the same feature occurs at Middle Stack Mountain, and in the Delano veins near Old Contact J. T. Bailey [3] observed the replacement of quartz by a siliceous hematite intimately associated with secondary chalcocite, cuprite, and chalcopyrite. Chrysocolla, azurite, and malachite are also present. The replacement is sporadic and is developed best near the impervious slate belt where the circulation was arrested.

Bailey [4] also describes a vein which is only 1½ feet wide on the Delano No. 2 claim, but which on the Alto claim, the circulation having been arrested or turned back by the impervious slate, has been enlarged by replacement of the granodiorite to a maximum width of 7 feet.

It is probable that some of the bodies now regarded as contact-metamorphic deposits may belong to the replacement class and are connected in origin with veins or dikes not yet observed. As noted by Purington, it is the under side of the limestone bed that is usually the most mineralized or replaced by ore. This is natural and is especially to be expected where the deposits are of pneumatolytic origin, as appears to be the case in the Contact district, the under side

[1] A more detailed description of the vein ore appears in the section on the Brooklyn mine (pp. 117–119).

[2] Eng. and Min. Jour., vol. 76, 1903, p. 427.

[3] Idem, p. 613.

[4] Idem, p. 612.

of the beds being the side most exposed to the action of the ascending mineral-bearing pneumatolytic gases.

Further details on the deposits are given in the descriptions of the different mines and prospects that follow, but as exploitation thus far, with a few exceptions, has been only in the oxidized zone, which, especially in the granodiorite, seems to extend to about 200 feet in depth, most of the openings expose chiefly oxidized ores.

DETAILED DESCRIPTIONS OF MINES AND PROSPECTS.

ELLEN D. MOUNTAIN AREA.

The Ellen D. Mountain or western area comprises the western portion of the granodiorite batholith and the part of the contact zone lying west of the river. It is nearly an equilateral triangle, with each side about 5 miles in extent. Some of the more important properties in this area are the Brooklyn, Delano, Empire, Blue Bird, Antelope, Bonanza, Ivy Wilson, Florence, Copper Shield, Yellow Girl, and Hickey.

The principal feature of the geology, as shown on Plate XIV (p. 100), is the curved contact zone with its scarp of Paleozoic rocks overlooking the granodiorite. Along the north side of the area the Paleozoic rocks are tilted and irregularly disturbed, and on the west, as shown on the Ivy Wilson ground, they are steeply upturned or on edge, but in the higher part of Ellen D. Mountain they lie for the most part nearly horizontal or dip gently northwest.

The area contains deposits of all three classes and the most extensive and deepest developments of the district. The general distribution of the deposits is shown on the vein and claim maps, Plates XIX and XXII. They occur mainly in association with the contact zone and with dikes principally in the granodiorite.

BROOKLYN MINE.

Among the deeper openings is the Brooklyn mine, situated on the open, gently eastward sloping ridge of Ellen D. Mountain, about a mile west of Old Contact, at an elevation of about 6,300 feet. (See Pls. XIV, p. 100; XXIII, *B*.) The property was located in 1889 or 1890 for copper by Messrs. Warwick, English, and two other partners. It is owned by the Brooklyn Mining Co. It is developed principally by a 210-foot shaft, a 300-foot crosscut tunnel driven from the bottom of the shaft northeastward into the mountain, with a depth of 300 feet at the face, and a 300-foot "tunnel" or drift which starts to the northeast about 90 feet above the shaft and is driven N. 65° W. on the contact and vein. The principal equipment is a 15-horsepower gasolene hoist, which is housed. The shaft is well timbered, is in good condition, and was unwatered in 1909. The water level stands at about 90 feet below the surface. The mine could not be entered at the time of visit.

The production, which is not large, was not learned. Some ore was produced when the Contact smelter was in operation. The mine is on the so-called Brooklyn vein or main granodiorite and Paleozoic rock contact, which is here compound. The principal Paleozoic member at this point is the white limestone, but an inlier or detached band of blue limestone is also included in the granodiorite. The blue band, according to Bailey,[1] is metamorphosed, silicified, and chloritic, and where encountered in the 300-foot crosscut its junction with the granodiorite shows secondary quartz with bornite.

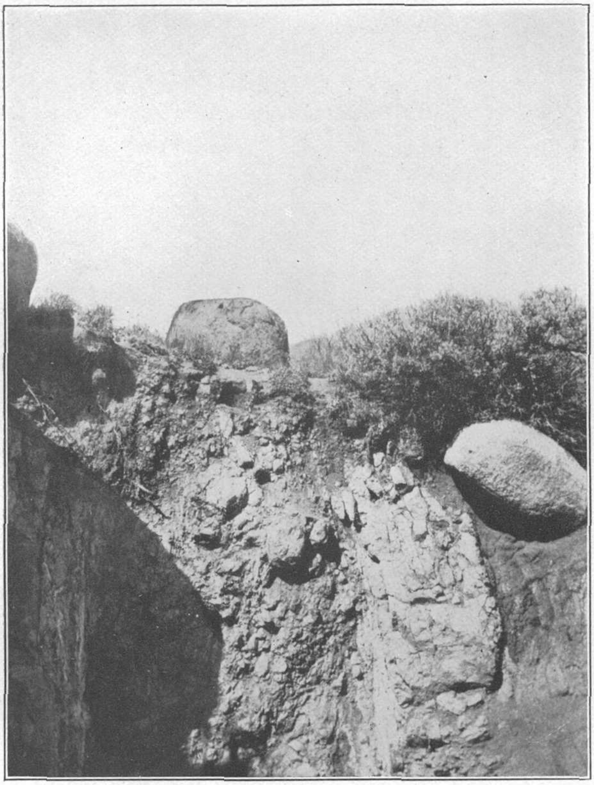
The shaft was sunk in the granodiorite, then supposed to be the hanging wall, at a point several hundred feet from the contact, with the expectation of striking the vein in depth, as at the surface the vein dips inward or south toward the granodiorite. The dip, however, seems to steepen rapidly below the surface, for, after sinking 210 feet and crosscutting 300 feet from the bottom of the shaft, the vein was encountered on the contact, with granodiorite forming the footwall and limestone the hanging wall. The mineralization or ore was mostly in the limestone and in the 25-foot winze in the bottom of the mine. At the end of the crosscut the vein, it is said, stands about vertical, has a width of about 8 feet, and contains a shoot or streak of rich bornite-chalcopyrite ore 10 to 25 inches wide, which is variously reported to range from 3½ to 25 per cent in copper, with moderate values in gold and silver. These reports are borne out by the ore seen on the dump, most of which would by estimate run about 15 per cent. There are said to be two veins, one on the granodiorite side of the contact and one on the limestone side.

It seems very probable, also, from the amount of garnetiferous axinite-epidote gangue material on the dump, the width of the lode, and the reports of much ore in the limestone and of two veins—one on each side of the contact—that the deposits are contact-metamorphic as well as fissure-vein deposits.

The principal part of the ore as seen on the dump is a mixture of fine-grained or massive chalcopyrite and bornite with a nearly glassy vein quartz and is in part crudely streaked or banded. Honeycombed masses composed of skeletal casts show that the quartz has here and there replaced bunches of finely crystalline calcite.

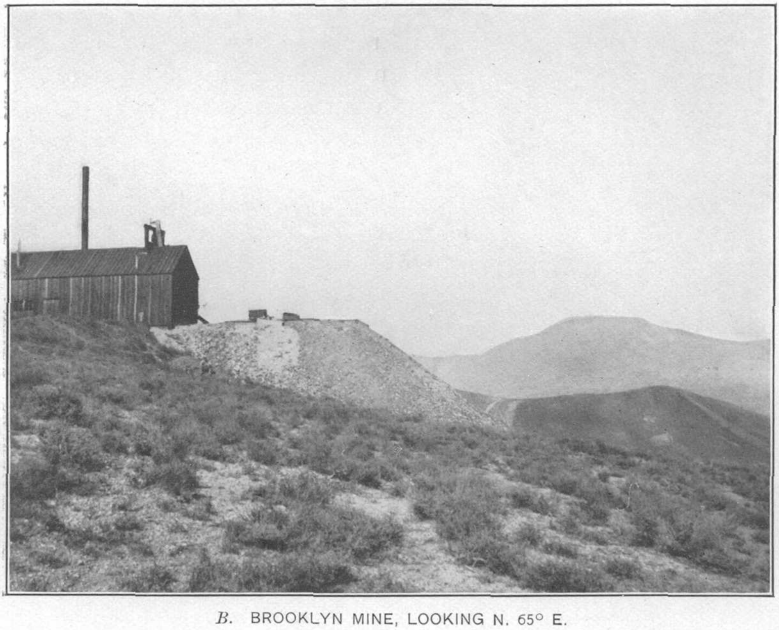
A microscopic section shows most of the gangue to be characteristic vein quartz in which the chalcopyrite occurs irregularly or connectedly as filling, both massive and in cuboidal crystals and grains. The bornite occurs mainly as irregular inclusions or filling within and as veinlets traversing the chalcopyrite and seems to be secondary. With

[1] Bailey, J. T., The ore deposits of Contact, Nev.: Eng. and Min. Jour., vol. 76, 1903, p. 612.



A. ORE-BEARING SYENITE DIKE CUTTING COUNTRY-ROCK GRANODIORITE ON PORTLAND GROUND.

Looking west.



B. BROOKLYN MINE, LOOKING N. 65° E.

it occurs also considerable axinite and some impure massive garnet. Minute chalcedonic veinlets are sparingly present.

At the mouth of the tunnel the ledge shows a mineralized width of about 8 feet and contains carbonates and oxide of copper in sheeted granodiorite, apparently with associated syenite dikes. This mineralization, however, does not seem to continue more than 40 or 50 feet beyond the portal. Near the vein in the bottom of the mine thin seams and plates of native copper occur in the granodiorite.

ALLEN AND DELANO CLAIMS.

In its easterly extension from the Brooklyn ground the Brooklyn vein, or the contact representing it, traverses successively the Allen No. 2 and Delano No. 1 claims of the Delano group; thence, curving southeastward, it is regarded as the same vein on which the Bryan shaft is located, to the east of the Palo Alto ground.

In the Allen No. 2 claim a 40-foot crosscut tunnel shows the lode to have a mineralized width of about 100 feet and to consist of alternating bands of altered and mineralized granitic rock and thin layers of limestone, all capped with gossan, as on the Brooklyn claim. To the east of this tunnel a 10-foot shaft shows considerable 8 per cent carbonate of copper ore, with no wall yet reached.

On the Allen No. 2 and Delano No. 1 claims this lode is paralleled by a similar vein or lode which lies about 200 feet distant on the south, and on the Delano No. 1, where the country rock is chiefly whitish limestone, both lodes are opened by shafts 50 feet or more deep and make a fair showing of ore containing red and black oxides with carbonates. The ore is said to average about 50 per cent in copper and to be some of the best in the district.

EMPIRE MINE.

The Empire mine is about half a mile southwest of Old Contact, on open patented ground. It was located by Mr. Dewith in 1891 and is now owned by the Salmon River Mining Co. It is developed by a 360-foot shaft, reported to be the deepest opening in the district. The shaft is sunk in the granodiorite about one-fourth mile from the limestone contact, which occurs on the Brooklyn ground, on the north. It is on a "fissure vein" which dips steeply to the south, into the granodiorite, and is said to continue strong throughout the depth of the shaft. The mine was worked at the time the smelter was operated and contributed ore to it in 1886, but since then, after a breakdown of the pump and some caving in at the bottom of the shaft, the property has been idle.

To the northeast the vein seems to traverse the Arkansas and Western Union claims of the Delano group, and to the southwest the Empire extension and other ground.

PALO ALTO MINE.

The Palo Alto mine is about half a mile east of Old Contact and the same distance northwest of the new town, at an elevation of 5,900 feet, on the inner slope of the basin rim. (See Pls. XIV and XV, *A*, p. 100.) It was discovered in 1894 and 1895, and is now owned by the Nevada Copper Mining, Milling & Power Co.

It is developed by a 292-foot shaft, a 150-foot crosscut tunnel, 300 feet of drift, and 100 feet or more of crosscuts and stopes distributed on four levels, the whole being said to have cost more than $8,000. The 50-foot level contains the crosscut tunnel, 150 feet of drift, and 50 feet of crosscut; the 100-foot level, 30 feet of drift and 50 feet of crosscut; the 290-foot level, 125 feet of drift and 25 feet of crosscut; and the 250-foot level has 30 feet of stope.

The mine has produced about 300 tons of ore, most of which averaged about 32 per cent in copper, with $3 in gold and 8 ounces of silver to the ton. The ore was shipped to Selby and elsewhere, and considerable ore now lies on the dump.

The mine is in the contact zone, within a few hundred feet of the main granodiorite body. The contact here is more or less irregular and compound. The country rock is chiefly dark coarse Paleozoic slate with some associated pinkish quartzite. The crosscut tunnel starts in the quartzite, which is the same as that at the Bryan mine and is shown in the two outcrops proceeding from center to right about on a level with the lower dump in Plate XV, *A* (p. 100). The slate is blocky and seamed with calcite. The rocks are upturned and dip toward the contact or granodiorite at angles of about 75°. They are intruded by radial dikes, tongues, or sheets of granodiorite which seem to be offshoots from the main mass and which, following the nearly vertical bedding or cleavage planes of the slate, thin out as they recede from the main contact.

The deposits are contained in a small fissure vein in one of the 40-foot dikes or sheets of the granodiorite in the upper part of the mine and the shaft is sunk on the vein, which dips steeply to the south, about parallel with the sedimentary rocks and the dike. In depth, however, the dike seems to thin out, as does also the fissure, which ends at the lower contact of the dike with the impervious slate, with the result that the lower 200 feet of the shaft and other workings are in barren slate, approximately as shown in a diagram by Bailey.[1] The best prospect for ore on this property would seem to be to follow the vein westward into the granodiorite, away from which and from other dikes the slate seems to be barren.

This vein is thought to be the same vein as that on which the Blue Bird, Copper King No. 2, and other openings on the Delano group are located.

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[1] Eng. and Min. Jour., vol. 76, 1903, p. 613.

BLUE BIRD MINE.

The Blue Bird mine is two-thirds of a mile northwest of Contact and about one-fourth mile northeast of the Palo Alto mine. It is on open ground, on the outer slope of the contact-zone ridge, at an elevation of about 5,800 feet. The property comprises a group of 12 claims and, like the Palo Alto, is owned by the Nevada Copper Mining, Milling & Power Co., of Contact, with headquarters in Tacoma, Wash.

This mine was discovered in 1884 and located by A. J. and Isaac Reed and William Southard. It is developed mainly by a southwesterly 70° incline with chambers and crosscuts.

The total production was not learned. From an ore heap, of which 300 tons of principally 8 to 10 per cent carbonate ore still lies on the dump, 100 tons of ore shipped to the Selby and Contact smelters is said to have averaged respectively 32 per cent and 17 per cent of copper and about 20 ounces of silver and $2 in gold to the ton.

The deposit is located about 1,200 feet out from the main contact, seemingly in a northeast-southwest fissure in whitish limestone, in which it seems largely to be a replacement; perhaps it is also in part a replacement of a dike. On the north the limestone is bounded by a band of quartzite which, toward the north side of the claim, is in turn succeeded by limestone.

The limestone at the mine is in part silicified or associated with quartzite. The deposit dips about 60° SE. toward the contact. The ore body in general has a width of 1 to 3 feet, but in places it exceeds the width of the shaft.

On the 60-foot level the ledge seems to be cut off by a cross fault or "watercourse," but crosscuts extended to the southeast may show ore. In the watercourse extensive deposition of quartz and calcite has silicified the adjoining limestone.

The ore contains principally malachite, red and black copper oxides, and some chalcocite or glance. A brown banded phase of it locally known as "copper silicate" is said to run high in copper values. The deposit seems to contain several thousand tons of ore that can be shipped as soon as railway facilities become available.

DELANO AND COPPER KING CLAIMS.

The Delano group, comprising eight claims and trending for three claim lengths in an east-west direction, centers a little northwest of Old Contact. It was mostly discovered and located late in the eighties by Messrs. Hickey, Delano, Ayers, and Hechatin, and since 1905 has been owned by the Seattle-Contact Copper Co., with headquarters at Seattle and Contact. The deposits on the north tier of claims have been described under the heading "Allen and Delano claims" (p. 119). Those on the middle tier, the Delano No. 2 and Copper King Nos. 1

and 2 claims, contain two veins regarded as the westerly extensions of the Palo Alto and Blue Bird veins. These veins, situated about 150 feet apart and nearly parallel, after traversing the Delano No. 2 and Copper King No. 1 in a westerly direction, seem to unite finally on Copper King No. 2, whence the deposits continue westward across the Bell claim as a single vein. This vein, taken in connection with the Palo Alto or southern of the two veins east of the junction, is said to be continuously and plainly traceable by the copper carbonate color of the quartz croppings for a distance of about 8,000 feet. On the Delano No. 2 ground, however, the veins seem to be materially interrupted or pinched by the impervious slate. On the Copper King claims they lie in the granodiorite and make a considerable showing.

The vein filling is the glassy quartz; and the mineralization, which is sporadic, as suggested by Bailey,[1] seems to be a replacement of the quartz by siliceous reddish-brown hematite intimately associated with the secondary copper minerals, chalcocite, copper oxides, chalcopyrite, and chrysocolla; the carbonates azurite and malachite are also present.

On Copper King No. 2 the Palo Alto vein dips about 70° S., is from about 1 to 3 feet in width, and contains considerable 5 per cent copper ore, with small values in gold and silver. The ore contains brown and black copper oxides, chrysocolla, and chalcocite or glance in kidneys and lenses, some ranging as high as 60 per cent in copper. Here the principal opening is a 200-foot crosscut tunnel, all in westward-dipping sheeted granodiorite intruded by parallel medium-grained pinkish syenitic dikes. The tunnel lacks but 40 feet to reach the Palo Alto vein, and at about 30 feet from the face it cuts a 14-inch blind quartz vein containing a little copper. The tunnel is in part old work, but it is in good shape.

On the east end of the Copper King No. 1, at an elevation of about 6,000 feet, at the upper " tunnel," the Palo Alto vein dips 60° S., and it is opened by a 200-foot drift run toward the west. Here the vein is about 6 feet wide, has a quartz gangue filling, and carries about 2 feet of copper ore which is best on the hanging-wall side.

At the lower tunnel, which is about 70 feet lower on the slope, the vein is opened by a 260-foot drift, in which the ore, said to be more than 3,000 tons, is left blocked out in the mine, except about 50 tons, which has fallen down. Here also the vein is about 6 feet wide and is confined by fairly good granodiorite walls which have locally almost 2 feet of kaolinized gouge on either side.

ANTELOPE MINE.

The Antelope mine is about one-third of a mile northwest of Contact, on open ground. It is on the Worth claim, formerly the

[1] Eng. and Min. Jour., vol. 76, 1903, p. 613.

Starlight. The property was discovered about 1898 and was recently sold by Ludnow Kroof to the present owner, the Antelope Mining Co., of Contact, said to be incorporated. It is developed by 200 feet of tunnel and about 100 feet of shaft, the deepest shaft being about 60 feet deep. The company is planning for continuous and more extensive developments.

The mine is now working on a small scale near the middle of the property, mainly through an 80-foot tunnel that opens on Town Gulch. In July, 1910, a carload of high-grade ore that averaged $101 to the ton was shipped from this mine to Salt Lake. A carload of ore was shipped some years ago from a 125-foot tunnel on the northeast end of the claim, with good returns.

The country rock is the granodiorite. The mine is about 600 feet from the nearest contact, at which the intruded rocks are the Paleozoic pulplish-pink quartzite and dark slate, the same as on the Bryan ground to the north. This mine is of special interest in being a type of the producing and promising deposits occurring in the granodiorite and seemingly not associated with the contact zone. The granodiorite is sheeted in a northeast-southwest direction about parallel with the vein.

The main workings are on the Antelope vein, which has also been called the Jules Verne vein. The vein dips south, away from the contact at angles of about 80°. Its outcrop or those of the silicified granodiorite, particularly on the south or hanging wall, rise in places 8 feet above the surface, or about 70 feet above the portal of the tunnel. It has a width of about 2 feet. The filling or gangue is glassy quartz in which, mostly in a pay streak or ore shoot from 6 inches to 2 feet in width, are contained the usual copper carbonates and red and black oxides. Besides the copper the ore contains about 6 ounces of silver to the ton and some gold. The bottom of the shaft seems to be entering the sulphide zone.

To the northeast, on the London claim, the Antelope vein is opened by a 30-foot shaft with a reported fair showing, and on the southwest it traverses the Jules Verne ground, where in 1887, together with the Midnight claim, it produced and shipped to Swansea, Wales, a carload of copper ore.

About 75 feet north of the Antelope vein and paralleling it in strike, but with about vertical dip, is a similar vein, from 1 foot to several feet in width, which, where opened by a shaft on the Antelope ground, is said to yield assays of 47 per cent of copper, with 6 ounces of silver and $11.60 in gold to the ton.

QUEEN OF THE HILLS PROSPECT.

The Queen of the Hills prospect is about a mile west of Old Contact and about half a mile west of the Brooklyn mine, on open ground in a low hill at an elevation of 6,500 feet. It is owned by the Nevada Copper Mining, Milling & Power Co. and is located on the westward extension of the same main contact between granodiorite and white silicified limestone or quartzite as the Brooklyn mine. The prospect is opened by a 60-foot drift extending eastward on the contact in the upper slope of the hill, and a winze 20 feet in length sunk to a depth of 6 feet below the floor of the drift. Including an open cut to the right or south, the openings show the deposit to have a width of at least 10 feet. It consists mostly of reddish, brownish, and greenish stained gossan-like garnetiferous calcitic gangue, containing considerable iron and copper oxides, malachite, chalcopyrite, bornite, etc., and seems to be of the contact-metamorphic type. By reason of the coloration, the opening presents an impressive showing.

RATTLER PROSPECT.

About 200 feet north of the Queen of the Hills opening is a lode or mineralized belt 120 feet wide known as the Rattler "vein," which seems to be an easterly spur or offshoot from the main contact. It follows approximately the strike of the limestone in which it occurs and which the contact traverses obliquely. The limestone, which here consists of heavy-bedded white and thin-layered blue rock, stands about vertical or dips steeply to the south-southeast, toward the granodiorite. The lode is exposed in a gulch which cuts across it. It is similarly exposed in a gulch about one-eighth of a mile to the west, but in the intervening ridge it disappears beneath the limestone, in whose beds at greater depth its mineralization occurs. Its exposure in the gulches therefore seems to mark approximately the upward limit to which the contact mineralization due to the granodiorite penetrated in the limestone at this place. The extent of this mineralization above the granodiorite will probably be disclosed in future underground work.

Toward its west end, at about 100 feet in from the contact, the Rattler property is opened by a 40-foot cut and winze, and shows considerable copper carbonate and oxide in garnetized granodiorite with associated syenitic dikes.

MAMMOTH AND NEIGHBORING PROSPECTS.

From the Queen of the Hills and the Rattler prospects the mineralization continues interruptedly westward along the contact in the south slope of Ellen D. Mountain for a distance of about 2½ miles to the Bonanza mine. The zone varies from 100 to several hundred feet in width and contains two or more contacts; in other words, the contact in places is compound, with outlying or detached vertical bands of limestone contained in the granodiorite and with here and there associated parallel and transverse dikes and veins. The ground is mostly owned by the Nevada Mining, Milling & Power Co. and is in the prospect stage.

Among the openings on the east are the Alice and Magnolia. On the Alice ground, which is opened by a shaft, the lode for about 400 feet parallels the Rattler lode on the north and dips 75° S. toward the granodiorite. The ore, which is said to average well in copper and silver, contains some molybdenite and epidote and occurs mostly in streaks or bands in a siliceous gangue of axinite, epidote, hematite, and garnet, of which axinite and the brown acicular epidote seem to constitute about 50 per cent, garnet being only sparingly present.

Farther west, on the Magnolia ground, which contains two parallel lodes at the contact of granodiorite and white limestone, separated by 150 feet of granodiorite and dipping steeply to the south, the principal opening is a 40-foot crosscut tunnel on the south lode, mostly in the limestone. The north or main contact lode, regarded as the extension of the Rattler lode, has a width of about 25 feet and consists mostly of a brownish to greenish gangue of axinite, garnet, and chloropal, with a good carbonate and copper oxide ore.

One of the most important showings on this part of the contact zone seems to be that of the Mammoth. It is about 3 miles west of Old Contact, at the head of Bluejay Gulch, on the open, steep slope of Ellen D. Mountain, at an elevation of about 7,200 feet. This claim, with several others to the east, was located about 1896 by Mr. Bourne, father of D. A. Bourne, of Jarbidge. The principal opening is a 60-foot shaft on the south contact, or lode, which has a width of about 20 feet and dips normally outward to the north. The shaft inclines 60° N. It starts in the hanging-wall side of the lode and strikes the granodiorite footwall at a depth of about 60 feet, whence downward there seems to be a decrease in angle of dip, which apparently tends to conform with the gentler dip of the rocks to the north in the mountain.

The deposit consists principally of a brownish and greenish oxidized massive axinite-garnet-quartz-chloropal gangue thoroughly penetrated by bornite, chalcopyrite, chalcocite, copper carbonates, chrysocolla, and some associated molybdenite. The ore favors the inner, footwall, or more massive granodiorite side of the lode, and here later developments are said to show that the deposit in depth becomes more permeated with bornite. The outcrop or capping to the depth of 3 feet is particularly garnetized. About 75 tons of 7 per cent copper ore lies on the dump.

Higher on the slope, to the northwest, about 400 feet from the main contact on which the 60-foot shaft above described is sunk, is another deposit exposed by a cut-short tunnel-winze opening (Pl. XXV, *B*, p. 152) showing a lode width of 20 feet. The structure dips normally

25° N. and the lode carries the usual ore minerals, especially the copper carbonates and oxides, contained in a massive garnetiferous gangue in darkish or blue country-rock limestone.

Adjoining the Mammoth ground on the west, on the main contact, is the Blue Lode claim containing a lode 20 feet wide on the contact of granodiorite and hard limestone, with associated siliceous syenitic dikes. It is opened by a 40-foot crosscut tunnel and a 20-foot shaft. The deposit consists principally of garnetiferous-looking gangue containing the usual ore minerals, which, however, do not seem to be strong in copper, 20 tons on the dump being reported to average about 5 per cent.

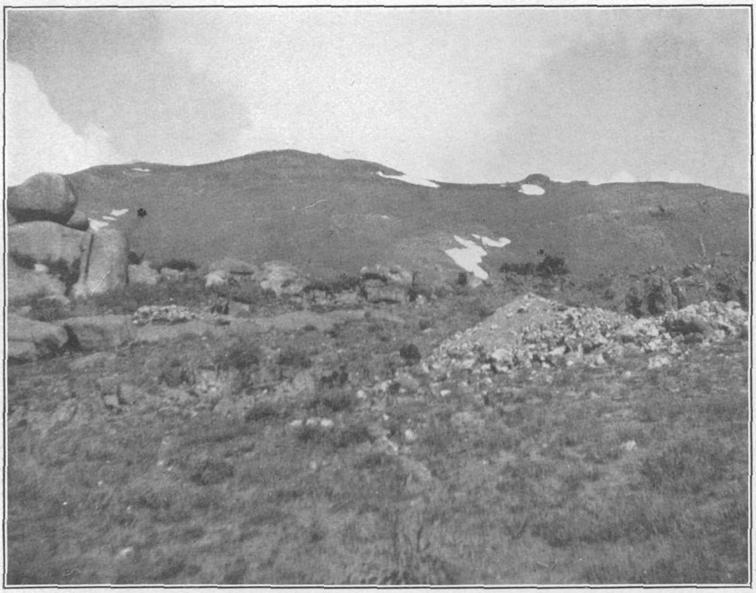
Of the transverse deposits, usually veinlike or dikelike in character, which are more or less indirectly associated with the contact zone in this part of the field, those of the Junction and New York groups, which lie in the granodiorite, may be mentioned. The so-called Junction vein, as shown on Plates XIX and XXII, starts on or near the main line of contact on the Maggie ground, and extends in a southwesterly direction continuously, it is said, for more than 2 miles to the west-side contact at the north end of the Ivy Wilson group. It is from 2 to 4 feet in width, is usually well banded, dips about 65° SE., and is associated with siliceous syenitic dikes. It is said to carry considerable good ore, much of it averaging about 25 per cent in copper.

Some outcrops and an opening on the New York vein, which is said to be similar to the Junction vein, are shown in Plate XXIV, *A*.

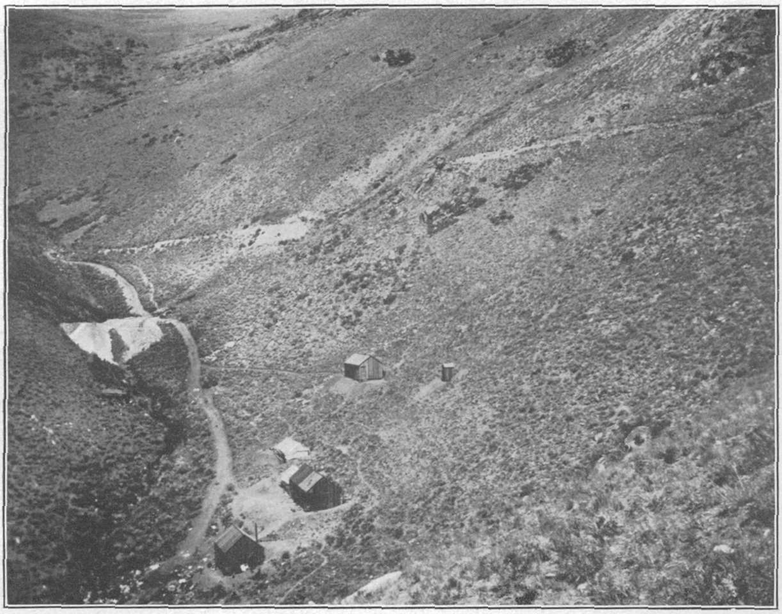
BONANZA MINE.

The Bonanza mine is situated about 4 miles west of Old Contact, in Bonanza Canyon, which drains the southwestern slope of Ellen D. Mountain into Salmon River. (See Pls. XIV, p. 100; XXIV, *B*.) Although the canyon has a depth of several hundred feet, it is generally V-shaped and the topography is not rugged. The mine and camp are reached by a wagon road of easy grade. The mine is among the early discoveries of the district. It was located in 1896 as the Dolly B. by Messrs. Coleman (locator of the Father de Smet mine in the Black Hills), Moore, and Thompson. The property comprises a group of 14 claims and several fractions, all surveyed, as shown on Plate XIX. It is owned by Samuel J. Sneider, of Minneapolis, Minn., by whom most of the development work was recently done. A small force of men was at work in the summer of 1910. The developments comprise about 500 feet of tunnel or drift, two shafts 60 and 45 feet deep, a 50-foot and an 80-foot winze, a 100-foot and a 45-foot crosscut, and a 50-foot upraise.

Owing to the location of the mine in the canyon, a valuable feature in obtaining depth on the deposits by tunnels or drifts, instead of



A. NEW YORK VEIN OUTCROP AND OPENINGS, LOOKING NORTH.



B. BONANZA MINE AND CAMP IN BONANZA GULCH, LOOKING N. 20° E.

the more expensive method of sinking shafts, the work is distributed through a vertical range of about 350 feet, from an elevation of about 7,100 feet in the bottom of the canyon to 7,450 feet on the ridge to the east.

The property is mainly on the contact of granodiorite and Paleozoic rock at the western extremity of the granodiorite batholith, which at this point, by reason of the gentle northerly dip of the contact and the depth of the canyon that cuts across it, forms an upstream embayment of the granodiorite in the sedimentary rocks.

Except about 400 feet of limestone next to the granodiorite at the base of the section, the sedimentary rocks seem to be mainly dark quartzite or siliceous slate. The principal openings are near the apex of the embayment or arc in the bottom of the canyon near camp (Pl. XXIV, *B*). Here the two lower tunnels are driven, one to the northeast and one to the northwest, both chiefly in the granodiorite. The east tunnel has a length of about 225 feet, the last 30 feet lying beyond the contact in dark limestone, which is timbered. At the face the tunnel contains a 50-foot winze, from the bottom of which extends a 100-foot crosscut in a northerly direction, with a 10-foot lode of 2 per cent copper ore, consisting chiefly of bornite and chalcopyrite in a dull greenish and brownish gray siliceous and garnetiferous hard massive gangue. Some ore, consisting mostly of malachite and bornite in 6 to 8 inch bodies, occurs also in the winze just beyond the contact, which is slickensided and barren.

On the opposite side of the canyon the west tunnel, which is 202 feet long, strikes the contact at about 114 feet from the portal. At this point there is an 80-foot winze with carbonate and oxide ore and a 40-foot crosscut driven farther into the limestone with a body of sulphide ore dipping 20° N. At the face of the tunnel there is a 50-foot upraise with an 8-foot bed of carbonate and sulphide ore in a hard gangue composed of siliceous dendritic hematite, massive garnet, quartz, calcite, and chloropal, which in places is profusely and finely seamed or veined with secondary calcite.

From the exposures in these two tunnels there seem therefore to be at least two separate lodes or ore bodies in the mine, and these lodes seem to occur also, in part, at least, in the upper workings.

In the upper west workings an inclined winze shows about a 10-foot lode or bed of low-grade ore dipping gently to the northwest, which by replacement seems to have penetrated the medium or heavy bedded limestone. It consists mostly of copper carbonates, oxides, and sulphides, with associated molybdenite, in a garnetiferous gangue. The footwall or underlying limestone is irregularly crushed, crudely bedded, and highly stained yellowish, greenish, and black by iron, manganese, chloropal, garnet, and associated green and blue copper carbonates.

The upper east tunnel, which is about 75 feet above the lower tunnel and just above the road, extends northeastward for 60 feet, chiefly in whitish limestone which dips 30° to 40° W. At the portal this tunnel shows the 20-foot mineralized "lead" or lode, which is reported to average about 4 per cent in copper. A carload of the ore, presumably sorted, shipped to Salt Lake, yielded 24 per cent of copper. The lode at this point is traversed diagonally by a dark, medium-grained, moderately porphyritic dike 4 to 8 feet wide which seems to stand near monzonite and which also, as a result of replacement, contains good ore. This dike in general is said to accompany the contact zone in a similar manner across the Bonanza group, particularly west of the canyon, where it shows a darker phase.

At the top of the ridge east of the mine, about 350 feet above the lower workings, on claim No. 2, the contact croppings, opened by a series of shallow en échelon open cuts, show a mineralized zone about 40 feet in width, or 60 feet across the surface, composed of nine or ten members, including several porphyritic dikes. The gangue is in general siliceous and garnetiferous and in certain members, notably in those favoring the granodiorite side, it is sparingly ore bearing, the usual copper carbonate and sulphide minerals being conspicuously present.

In the southwestern part of the property, on claim No. 4, in the contact zone, a 60-foot shaft is said to show a "vein" containing about 5 feet of sulphide ore in a mixed siliceous garnetiferous gangue, with well-defined walls. The dip is outward or normal, to the west, and is steep, as the contact steepens after leaving the mine, as it curves and goes south.

Striking about north and south through the Bonanza Fraction claim, in the granodiorite, is a reported fissure vein 30 inches wide with a quartz gangue, dipping steeply to the west and carrying considerable copper ore, mostly in the carbonate form and averaging about 25 per cent in copper. It is in line with the mine, where it has apparently not yet been observed and may lie buried in the bottom of the canyon. Claims Nos. 3, 5, and 6, to the east, are said to be located on similar fissure veins, all in granodiorite and trending northward, at about right angles to the contact. Claim No. 7 is said to contain a similar 30-inch fissure vein dipping southwestward in a large lode and is opened by a 15-foot shaft.

About one-fifth of a mile southwest of the Bonanza mine and camp, south of the point where the wagon road crosses the ridge, the granodiorite is intruded by a stock of the whitish siliceous syenite or aplitic rock that appears to form the prominent butte or knob studding the ridge at that point, and it seems probable that the fissure veins above described, whether associated with dikes or not, may be genetically connected with this siliceous intrusive rock, as are probably the Poole, Shield, and other dikes and veins on the Salt Lake and neighboring ground southwest of the town.

IVY WILSON GROUP.

The Ivy Wilson group is located on the western contact zone, 5 miles southwest of Contact, in the western part of the area. It is chiefly on the southern part of the long, sloping ridge that extends from Ellen D. Mountain southward to the river, between Salmon River on the southwest and Thompson Gulch on the northeast.

The property is about one-third of a mile wide, trends in a northwest-southeast direction for a distance of nearly 2 miles, and ranges from about 5,500 to 6,700 feet in elevation. The camp, commonly known as the United States camp, is located three-fourths of a mile to the east, at a spring, on a line of claims known as the White Elephant claims, which follow mineral-bearing syenite dikes in the granodiorite. These dikes dip northwest. Associated with them in places are veins or other mineral deposits. For instance, on the White Elephant No. 1 claim is a small vein composed chiefly of copper carbonate.

The topography is rough but not rugged. The ground is easy of access. It was discovered and partly staked about 1880, and was located by W. T. McArdle, of Contact, the present owner, in 1895, about which time it supplied some ore to the Contact smelter. Very little substantial work was done, however, until recently, when the property was taken over by the United States Mining Co., of Salt Lake, which has steadily prosecuted development work and at the time of visit was operating with a party of 15 men. The company expects to continue operations for some time to come.

The property comprises a group of 22 surveyed claims (Pl. XIX, p. 112), the openings or prospects on which are commonly referred to collectively as the McArdle mines. It is developed principally by four tunnels aggregating 1,100 feet, of which the longest is 400 feet and the shortest 160 feet long. The production, which was not learned, can not have been large.

The property is located principally on the west or outer side of the contact zone of the granodiorite intruded into the Paleozoic limestone and other Paleozoic sedimentary rocks. These limestones, next to the contact, form a north-south belt having a known width of about three-fourths of a mile, and for the first 1,200 or 1,500 feet the beds are on edge or steeply upturned and in general highly altered by contact metamorphism, being in some places completely marmarized and in others almost wholly changed to diopside and other minerals. Locally, the beds are crushed and slickensided and show considerable disturbance. They are generally, in places profusely, intruded by granodiorite and syenite sheets, dikes, and masses. These intrusions are particularly plentiful on the Ivy Wilson claims Nos. 3 and 4, where the limestone in the top of the hill is intercalated or ribbed with them.

The contact approximately follows the ridge, which is relatively steep faced on the east or inner side, but slopes more gently toward Salmon River on the west or outer side.

The deposits are principally of the contact-metamorphic and replacement types and occur mainly on the sedimentary side of the contact zone, but they are less closely confined to the contact than the deposits heretofore described, being more widely and sporadically distributed in the limestone in a belt 1,200 feet or more wide. The greater width of this belt and the greater degree of metamorphism may be due in some measure to the fact that the zone here lies about 1,000 feet lower than it does on the north and was probably about this amount more deeply buried at the time of the intrusion.

Ivy Wilson claim No. 9, situated on the contact near the middle of the group, is opened principally by what is known as the granite tunnel and a shaft. The tunnel has a length of 260 feet and a maximum depth of several hundred feet at the axis of the ridge it undercuts. The first 200 feet lie in the granodiorite and the remainder in limestone. The limestone is more or less crystalline, silicified, and slightly garnetized, and most of it is so completely crushed that the structure of the beds is not determinable. The contact, however, dips about 80° abnormally, in toward the basin, and its crushed and slickensided condition shows it to be much disturbed and more or less faulted. At about 150 feet in from the portal the limestone is cut by a 1-foot dike of the fine-grained phase of the syenite dipping 25° E. into the basin.

At and in the shaft, which is several hundred feet above the tunnel, the limestone dips 65° outward, to the west-southwest, and exposes a partly mineralized lode (?) 8 feet wide, containing several 4-inch stringers of copper carbonate alternating with 6 to 8 inch bands of garnetiferous rock or gangue, but the lode does not seem to connect with the garnetiferous band in the crest of the ridge over the tunnel. The limestone here is more or less crystalline, silicified, and otherwise altered by metamorphism to very fine grained or dense light-colored aphanitic silicate rock resembling quartzite, flint, or chert.

The old-time shaft on Ivy Wilson claim No. 5, which contributed ore to the Contact smelter some years ago, has a depth of 60 feet, of which 40 feet is in a mineralized brecciated zone of dark country-rock granodiorite, with which is associated a 15-inch dike of partly mineralized syenite porphyry.

On Ivy Wilson claim No. 1, among other openings, is a 40-foot shaft and below it a 400-foot tunnel showing a 40-foot lens or bed of low-grade ore. The shaft shows also iron-capped carbonates on a 4-foot vein (?) or mineral band containing also other copper-ore minerals. The tunnel is mostly in limestone and beneath the shaft shows the 40-foot lens of low-grade copper ore with a little asbestos in a blackish garnetiferous gangue.

A 15-foot shaft on Ivy Wilson claim No. 4 opens a good-looking cross-fissure vein which has been traced westward for more than 200 feet and seems to be among the best showings of the group.

On Ivy Wilson claim No. 8, in metamorphosed limestone at about 500 feet from the contact, occurs a peculiar deposit of copper-pitch ore or impure chrysocolla consisting apparently of a breccia of dark-brown or blackish siliceous copper-bearing hematite of vitreous luster, the fragments of which are firmly cemented, principally with impure chrysocolla, and which contains, besides disseminated chalcopyrite, copper in chemical combination with the hematite. The deposit is massive and contains angular druses nearly an inch in maximum diameter lined with finely crystalline silica. A 30-foot shaft sunk on the deposit is reported to be all in good ore, which is said to be very hard to drill. There are no outcrops or surface features to indicate the lateral extent of the deposit, but, although it appears chimney-like, it probably follows a fault plane or the bedding of the limestone for some distance.

An interesting and seemingly important feature of the group is the so-called sulphide zone, which is about 400 feet wide and extends through the western tier of claims for about 6,000 feet. It lies about 1,200 feet west of the contact, with which it is about parallel, and it follows the strike of the rocks, which are mostly on edge or highly tilted. The rocks consist chiefly of limestone altered by contact metamorphism, are moderately garnetiferous, silicified, silicated, hard, and mostly massive, and seem to contain the other usual minerals—axinite, epidote, chloropal, diopside, limonite. In this zone the principal ore mineral is chalcopyrite, usually with some associated molybdenite and bornite. It is more or less widely disseminated throughout the rock but with some degree of concentration in certain bands or areas, examples of which are described below.

A 15-foot "sulphide" shaft on the north end of the Dallas claim No. 3 shows about 6 feet of solid massive greenish-gray mineralized limestone in a single bed which dips steeply in or stands vertical and is thoroughly disseminated with chalcopyrite.

The 50-foot crosscut "sulphide" tunnel on Dallas claim No. 4, which is in slate-colored slaty limestone, at about 25 feet from the portal cuts a 1-foot band of soft mineralized rock containing, among other minerals, copper carbonates, some chalcopyrite, and a little bornite; also lenses or portions of the harder rock contain some disseminated copper sulphides.

About 200 yards north of the "sulphide" tunnel occurs a bed of bluish-gray quartzite (?) 1 to 3 feet thick, which is more or less garnetiferous and contains disseminated molybdenite. The rocks on either side of this bed contain disseminated chalcopyrite and bornite.

COPPER SHIELD AND NEIGHBORING GROUPS.

Extending from the Ivy Wilson group in an east-northeast direction across Thompson and Bluejay gulches through the granodiorite to a point within a mile or two of Contact and the river are 10 or more fissures containing chiefly syenitic and quartz monzonite porphyry dikes which are locally mineral bearing and on which, as shown on the claim map (Pl. XIX, p. 112), are located the Copper Shield or Effie Fay, Florence, Salt Lake, Blue Rock, and other groups. Though the surface is locally rough or bowldery, the area as a whole is easy of access.

At about the middle part of their courses the dikes are crossed by Bluejay Gulch, to the west of which they are said to dip steeply northward toward the contact, while to the east of the gulch they dip steeply southward, a fact which suggests that the gulch here probably lies on a fault line.

The mineral in some places is contained in quartz veins associated with the dikes (see Pl. XXIII, *A*, p. 118) but elsewhere occurs as replacement or segregation deposits in the dikes themselves. A few examples of these deposits are described below. The croppings of the larger fissures are usually the quartz syenite porphyry; those of many of the smaller fissures are cappings of oxidized ore and vein material.

FLORENCE GROUP.

The Florence group is composed of a dozen or more claims owned by the Maine Contact Copper Co. On claim No. 7, opened by a shaft, a 3 to 5 foot light-colored medium-grained syenite dike lying between sharply defined granodiorite walls contains copper carbonates, oxides, and some sulphides distributed or scattered in stringers or stringer-like lenses of quartz, mostly toward the sides or walls. At about 150 feet to the east a 60-foot shaft shows some good ore in place and some on the dump, and a streak of this ore is said to extend all the way down in the shaft. Here the dike has a width of about 8 feet.

On the adjoining Portland claim, to the north, owned by Hickey, Klitz & McShane, of Contact, a similar parallel dike or vein, 4 feet or more in width, with sharply defined walls, consists mostly of copper-bearing cobbly quartz fragments and bowlders contained in a seemingly decomposed granitic matrix (Pl. XXIII, *A*).

To the east, on Florence claim No. 16, one-eighth of a mile west of Bluejay Gulch, the dike, which is opened by a 20-foot shaft, contains carbonates, oxides, chrysocolla, and also the sulphides of copper in a gangue of glassy quartz and dark-brownish siliceous hematite, with considerable associated flaky molybdenite in the more hematitic portion.

To the east of Bluejay Gulch Florence claim No. 13, opened by a 30-foot shaft for 20 feet or more down, shows a 1½-foot vein of good-looking ore similar to that just described. This vein is confined by the dike rock a foot or more in thickness on either side, outside of which, on the south or hanging-wall side, the granodiorite rock is considerably crushed. A large "bowlder" of the ore from this opening is said to have attracted considerable attention at the Alaska-Yukon-Pacific Exposition.

COPPER SHIELD GROUP.

Northeast of the Florence group is the Copper Shield or Effie Fay group, consisting of 11 claims owned by the Copper Shield Copper Co. It contains a large dike which, where observed on the western part of the ground in a crosscut tunnel, shows a width of more than 50 feet with the south wall not exposed and contains a small amount of copper carbonates. The dike to the east of this point is reported to be 200 feet in width and in places carries copper ore, including bornite, all the way across.

In the southern part of the group, at the Shield house, in a 30-foot shaft and well, a 3½ to 4 foot dike contains ore nearly all the way across, and a large bowlder like part of the ledge outcrops 5 feet high in an adjoining pit. The ore has a good-looking siliceous hematite and quartz gangue, is crudely banded, and somewhat crushed. The ore minerals are principally the copper carbonates and oxides, with the sulphides, bornite and chalcopyrite. With the ore are associated some specularite and molybdenite.

SALT LAKE GROUP.

Joining the Copper Shield group on the south is the Salt Lake group of 16 claims, owned by J. H. Raleigh, of Salt Lake. The claims are all located on mineralized dikes or veins and show ore. On claim No. 5, a 50-foot tunnel shows 18 inches of ore in the face. On claim No. 7, on a syenite dike 60 feet wide, a 15-foot shaft shows about 3 feet of ore said to average about 6 per cent in copper.

In the southern part of the group the ore in places is said to be of considerably better grade, much of it going about 20 per cent, with the porphyry in general well stained with copper. Here on claim No. 9, on the Poole dike, which is syenite porphyry and which has a width of more than 100 feet, a 10-foot shaft shows a well-banded 6-inch vein of copper oxide and carbonate ore with a siliceous hematite and quartz gangue. This vein or dike is said to extend southwestward for more than 3 miles to the Ivy Wilson ground.

YELLOW GIRL MINE.

The Yellow Girl claim adjoins the Salt Lake group on the southwest. It is patented and said to be held at $100,000. Where the Poole dike is opened by a 200-foot shaft, it rapidly widens from the 60-foot level downward, and on the 200-foot level, where it has been crosscut for 38 feet with no wall yet reached, it is said to carry 6 feet of 12 per cent copper ore, similar to that on Salt Lake claim No. 9, described above, and about 32 feet of low-grade ore.

HICKEY PROSPECT.[1]

Among the outlying prospects of the Ellen D. Mountain area should be mentioned the Hickey prospect, owned by M. F. Hickey, of Contact. This is commonly known as the Lead-Silver mine. It is located about a mile northwest of Old Contact, in the second gulch, a locality which seems to be mineralogically an interesting part of the district.

The country rock is said to be the dark or blue limestone. The developments consist principally of a short tunnel and an upraise from which relatively considerable lead-silver ore of fair grade has been taken out.

The deposits are contained in two or more veins which trend in an east-west direction with nearly vertical dip and seem to be more or less associated with porphyry dikes or other intrusions, near which there is a reported improvement in the quality and increase in quantity of the ore.

The mineralization, to judge from the ore specimens examined, seems to have resulted from a process of replacement in a finely comminuted fault breccia. The ore minerals are those of silver, copper, lead, and gold, and the ore seems to consist of two principal types, known as cerusite ore, which is a yellowish lead carbonate, and "binoxide" ore, which is brownish red and seems to consist principally of the oxides of iron, lead, and copper.

The principal vein is about 3 feet in width and contains chiefly cerusite ore. The other vein consists chiefly of binoxide ore. Silver, seemingly as argentite, is present in both veins, but it occurs chiefly in the cerusite ore, where it amounts to as much as 92 ounces to the ton. The gold, on the other hand, occurs chiefly in the binoxide ore of the smaller vein, where it averages about $4 to the ton.

CHINA MOUNTAIN AREA.

LOCATION AND GENERAL FEATURES.

The China Mountain area almost joins the Ellen D. area on the southeast, lying on the other side of Salmon River. It centers near

[1] For information on this property and for specimens, the writer is indebted to Messrs. D. C. McIntyre and M. F. Hickey.

China Mountain, about 5 miles south-southeast of Contact. (See Pl. XIV, p. 100.) It is contained in an area 4 miles wide and 5 miles long, extending from the head of Meadow Creek and McDuffy Gulch southward toward Knoll Creek. From an elevation of less than 5,400 feet at the river the surface, which is generally rough, rises above 8,000 feet in China Mountain, whence it declines in all directions to the borders of the area.

Both the granodiorite and the Paleozoic sedimentary rock types of topography are present. The latter, which comprises the dominant features and especially characterizes the southern part of the area, including the large rounding mass culminating in China Mountain, is illustrated in Plate XVI (p. 100). The area, however, is generally accessible. It is nearly encircled by a wagon road, and by means of certain gulches on the northwest can be penetrated by wagon to points within a mile of the top of the mountain.

The country rock is the granodiorite on the north and the Paleozoic sedimentary rocks on the south. The two are separated by the usual well-defined east-west contact, which, as shown on Plate XIV, crosses China Mountain and the highest near-by peaks almost at their summits, but these summits, as at Ellen D. Mountain and elsewhere, are all situated to the sedimentary side of the contact. The sedimentary beds, though variously deformed, in general dip toward the south, or away from the contact, along which their upturned edges form a hogback-like scarp overlooking the lower-lying granodiorite area within the basin.

At China Mountain in 1876 apparently the earliest substantial work in the district was done by a group of Chinamen employed by an official of the Southern Pacific Co. Seized with superstition by the illness and death of one of its members, the party abandoned the work in the midwinter and traveled on foot to Wells, after which the ground lay idle till late in the eighties.

The deposits are similar to most of those in the Ellen D. Mountain area, described above. Their general distribution is indicated by the mine and prospect symbols on Plate XIV (p. 100) and by the location of the claims as given on Plate XX (p. 112). They occur mostly in association with the granodiorite and Paleozoic rock contact zone, which in places has a width of nearly 2,000 feet. The Hanks-Miller-Leach group[1] of claims and the Chinaman group, trending respectively northeasterly and easterly, are in this zone, but the inlying groups to the north of this and trending more nearly north and south, at about right angles to the contact, are in the granodiorite and comprise deposits of the dike-vein class.

[1] This term is here used for convenience of reference and does not necessarily imply ownership in common.

The principal openings are the so-called Chinaman, War Eagle, Hanks, Turo-Sheckles, and High Ore mines, which, however, are for the most part still in the prospect stage.

CHINAMAN MINE.

The Chinaman mine is in the upper northwesterly slope of China Mountain, at an elevation of about 7,700 feet. It is on the Skylark claim No. 1, one of a group of six claims (the Chinaman group, Pl. XX, p. 112) located by W. T. McArdle in 1895, about 20 years after the ground had been prospected and deserted by the Chinese party, as above described. The group is owned by Messrs. Lumm, Morling, Pritchard, and McArdle. It extends from a point above the mine down along the contact zone for about 1½ miles, nearly to the base of the mountain and the river on the west. The topography in the upper part of the group is rugged and the mine is not easy of access. It is reached by trail only, for which reason operations have recently been begun on the lower end of the group on Copper Mountain Claim No. 1, nearly 2,000 feet lower, where the deposits are more accessible, and a tunnel, now in 50 feet, is being driven.

The mine is located near the head of a gulch, on the limestone side of the contact. Sheets or dikes of granodiorite, the thinnest 3 feet in width, are intercalated in the limestone, and quartz syenite porphyry dikes of the aplitic phase, described on page 111, are associated with the deposits.

The deposits are opened principally by a short tunnel or drift, a crosscut, and a 50-foot winze. They are contained in a lode or mineralized band about 22 feet in width, with some ore distributed nearly all the way across. The dip is about 75° away from the contact, and at about 12 feet in from the portal of the tunnel the ledge is cross faulted at nearly right angles by a southward-dipping fault plane showing slickensides, etc.

A partial section of the lode, beginning with the granodiorite country-rock footwall on the north, is as follows:

Partial section of lode in Chinaman mine.

	Feet.
Granodiorite.	
Aplitic dike	3
Limestone, light and in part siliceous	1½
Banded copper ore in the usual siliceous chloropal-garnet gangue	5

The ore consists mostly of carbonates. About 80 tons of 14 per cent ore, remaining from a heap of which a test was made at the Contact smelter, lies on the dump.

WAR EAGLE MINE.

The Hanks-Miller-Leach group comprises 27 or more claims extending, three deep, from the summit of China Mountain southeastward on the contact zone down the slope for a distance of nearly 3 miles. The contact approximately follows the median line of the northeast tier of claims, the Defender, New Years, and others. Of this group the nine end claims on the southeast, owned by J. W. Hanks, are known as the Hanks group. They were located in 1887 for copper by a German who bonded the property to an English company. Later the ground was several times relocated by others, among whom W. T. McArdle, in 1895–96, mined and shipped 8 carloads of copper ore that averaged about 24 per cent of copper, 14 ounces of silver to the ton, and about 7 per cent of silica; one of these carloads is said to have averaged $33\frac{1}{3}$ per cent of copper.

Five of the claims indicated on Plate XX (p. 112) are surveyed and patented ground, and the principal openings on them, notably the War Eagle, Turo-Sheckles, and Turo, are known as the Hanks mines. They seem to be among the most important in the area. The topography is rough but not rugged. Its character is shown in Plate XVI, *A* (p. 100).

The War Eagle mine is located about $2\frac{1}{2}$ miles southwest of the summit of China Mountain, on Hanks claim No. 1, at an elevation of about 7,300 feet. The mine is about 500 feet outside of the contact, on a parallel streaked or banded lode or bed 8 feet wide, carrying copper ore in a gangue of chloropal, jaspery quartz, axinite, and garnet in dark limestone country rock with 40 feet of silicified limestone or quartzite on the inner or hanging-wall side. Siliceous syenitic dikes occur near by—for instance, in the saddle at the location stake about 200 feet to the northwest. The lode is open mainly by an inclined shaft 120 feet deep, and a 75-foot drift to the northwest on the 25-foot level with a 40-foot upraise at the end.

The work was nearly all done in 1895 and 1896 by W. T. McArdle. To a depth of 100 feet the lode is said to dip 70° in toward the contact, but from this point downward it gradually straightens and is thought to turn over and dip normally outward, like the Brooklyn vein. The mine was last worked in 1899. About 100 tons of the ore now on the dump is said to average 7 per cent of copper and about 4 ounces in silver to the ton. It consists chiefly of copper carbonates and oxide, with a little copper sulphide.

TURO-SHECKLES MINE.

The Turo-Sheckles mine is about half a mile northwest (up the slope) from the War Eagle mine, on the Rochester claim, at an elevation of about 7,600 feet. It is located at about 900 feet outside of the contact, on a parallel ledge or ore bed in whitish limestone. Both the ledge and the limestone have a steep normal dip outward toward the south. Dikes of quartz syenite porphyry are intruded within 30 feet of the ledge on the north. The ledge is opened by a

120-foot shaft which shows neither wall but in which no crosscutting has yet been done.

The ore is mostly carbonate and oxide of copper, with some sulphide in depth. Three carloads of the ore were shipped. They contained 18, 24, and 32 per cent of copper, and averaged 7 ounces in silver to the ton. About 75 tons of 12 per cent copper ore and 450 tons of 6 per cent ore lie on the dump.

TURO MINE.

The Turo mine is about 200 yards southwest of the opening last described, at an elevation of about 7,600 feet, on the Lincoln claim, which joins the Rochester on the southwest. It is on what is known as the Hanks vein, which lies conformably in vertical dark country-rock limestone, is 12 feet wide, and contains principally carbonate and oxide copper ore in a bowldery-like garnetiferous gangue with some included limestone. It is opened by an 80-foot shaft, which is now considerably caved. About 60 tons of 12 per cent copper ore is on the dump.

HIGH ORE MINE.

Of the vein or "dike-vein" deposits in this area, all in the granodiorite, the most important are those of the High Ore mine and Camp Bird prospect. Practically all the veins or dikes observed trend northeastward, roughly parallel with those in the Ellen D. Mountain area west of the river, and seem to belong to the same fissure system.

The High Ore mine is about a mile northeast of China Mountain and the contact, at the head of Meadow Creek, at an elevation of about 6,800 feet, in open country, and is easy of access. It was exploited in the middle seventies by the same persons who then worked the Chinamen mine. The property comprises a group of six claims. It is opened chiefly by an old 65-foot inclined shaft sunk on a vein which dips 45° W., and sems to be contained in a quartz monzonite porphyry dike similar to that of the Camp Bird prospect next to be described. Owing to a cave-in, the shaft could not be entered, but to judge from blocks of ore seen on the ground the vein has a width of at least a foot and consists of about 9 inches of ore with 1 or 2 inches of quartz gangue on either side. The ore consists of red copper oxides, carbonates, and sulphides in a siliceous gangue. The run-of-mine ore is said to average about 16 per cent of copper and the high grade 40 per cent. The ground in the vicinity of the property seems to be all staked.

CAMP BIRD PROSPECT.

The Camp Bird prospect is about a mile north of the High Ore mine, 5 miles southeast of Contact and about 1½ miles northeast of

China Mountain, at the head of McDuffy Gulch, on open ground, at an elevation of about 6,800 feet. The property comprises a group of six or more claims on or near the low divide which it nearly parallels between McDuffy Gulch on the west and Meadow Creek on the east. It was located about 1907. The country rock is the granodiorite. The principal opening is a 40-foot shaft on claim No. 2 in a quartz monzonite porphyry dike which is more than 200 feet in maximum width and is said to extend on the southwest to China Mountain and the contact. It seems to fill a compound fissure or sort of shear zone and locally contains horses, lenses, vertical sheets, or bands of the country-rock granodiorite, as shown in prospect pits to the south on claim No. 3 and other ground.

In the 40-foot shaft the dike rock seems to be oxidized all the way down, and in the lower part to be generally impregnated with disseminated pyrite and chalcopyrite.

The ore consists of malachite, azurite, chrysocolla, chalcopyrite, and bornite. It occurs to some extent sporadically in the body of the dike rock itself, but more generally in and associated with parallel bands and stringers or lenses of quartz traversing the dike, some of which are 3 to 4 inches in width and alternate with bands of the dike rock. Many of the smaller stringers are comby. Associated with the ore in places as gangue is also considerable siliceous hematite.

The dike is shown by microscopic examination to consist of about 40 per cent each of orthoclase and plagioclase and 20 per cent of quartz, almost no bisilicates being present. Both feldspars are considerably sericitized, and considerable rutile and apatite are present as accessories.

The deposits on the half dozen or more neighboring groups of claims are said to be similar to those of the Camp Bird. The deposit on the Haskney-Shoun property, about 1½ miles to the west, is opened by a 25-foot 60° W. inclined shaft and shows some malachite and sulphide ore. The Warsaw-June group, to the northwest, on Warsaw claim No. 2, is said to be traversed by a vein several feet wide containing three 2-inch bands or shoots of rich ore, spaced about a foot apart. From samples furnished to the writer, this ore seems to be chiefly chalcocite, with some carbonate.

BLANCHARD MOUNTAIN AREA.

LOCATION AND GENERAL FEATURES.

The Blanchard Mountain area joins the China Mountain area on the east. It is about 4 miles in diameter and centers at Blanchard Mountain, which rises to an elevation of about 8,800 feet. From the summit the surface, which is usually not rough, declines, for the most part gently in all directions—to Trout Creek, at about 6,000 feet, on the north and east, and to Knoll Creek, at about the same elevation, on the south. On the northeast, however, is a prominent hill a few hundred feet in height, which, from the name of the property located on it, may be called Johnson Hill.

The geology is similar to that in the China Mountain area already described. The country rock is the intrusive granodiorite on the northwest, and it is embayed by an open crescent of the Paleozoic sedimentary rocks on the southeast. The general course of the contact is northeastward, in the form of a curve open to the northwest. As usual, it crosses the peaks, Blanchard Mountain and Johnson Hill, near their summits, on the upper, granodiorite, or basin side. On the upper southwest slope of Johnson Hill the contact swings or is offset to the south, seemingly by a fault of about 500 feet lateral throw, as indicated on the map.

In the Blanchard Mountain portion of the area the formations and the deposits are traversed by the usual dikes of syenite porphyry, local masses of which seem to occur in a prominent twin-peaked spur of Blanchard Mountain on the north, known as Twin Buttes. This spur appears to contain an inlier of Paleozoic quartzite.

The general distribution of the deposits is indicated on Plates XIV (p. 100) and XX (p. 112). They lie principally in the contact zone and the most important showing is on the Zetta Blanchard group.

ZETTA BLANCHARD GROUP.

The Zetta Blanchard group consists of a linear group of eight or more claims covering an extent of nearly 2 miles in the contact zone on the northerly slope of Blanchard Mountain. From claim No. 8, at an elevation of about 6,800 feet on the east slope, to No. 4, on the upper north slope, it has a vertical range of nearly 1,000 feet. It was mostly discovered and located by W. T. McArdle in 1895. The deposits so far as exploited seem to be of the contact-metamorphic type and they occur in a mineralized band or lode about 25 feet or more in maximum width on the granodiorite-limestone contact, where they have been opened at several places by shafts, tunnels, drifts, and cuts aggregating about 400 feet of work. The dip is at a steep angle conformable with the limestone and is normal, being outward.

The ore in general consists of carbonates, oxides, and the common sulphides of copper and a little chrysocolla contained in a garnetiferous gangue of chloropal, siliceous hematite, limonite, and axinite, with glassy quartz present in places. Axinite is particularly plentiful in the Zetta Blanchard gangue. The microscope shows a section from shaft No. 5 to contain about 80 per cent of axinite.

On claim No. 8, in the east slope of the mountain, at an elevation of about 6,950 feet, the lode is opened by a 60-foot "tunnel," or drift, run westward in the garnetiferous chloropal-axinite zone, or lode, which contains some disseminated copper ore and shows some garnetized granodiorite on the footwall and partly metamorphosed garnetized gray crushed limestone on the hanging wall.

To the west, up the slope, on claim No. 6, at an elevation of about 7,000 feet, the principal opening is a 150-foot crosscut tunnel containing about 70 feet of so-called crosscut or drift. This opening shows a 7 to 8 foot lode that contains good oxide-carbonate-sulphide copper ore, with some chrysocolla in the usual gangue, but seems to have in association considerable iron. Siliceous syenite dikes appear to be associated with the deposit.

On claim No. 5, at an elevation of about 7,670 feet, where the lode shows a width of 25 feet with dark-blue country-rock limestone on the hanging wall, the opening is a 52-foot inclined shaft in the outer or hanging-wall side of the lode, sunk in 1897, it is said, at a cost of $5,000. Copper ore, including chalcopyrite and bornite, impregnating a brownish-gray siliceous axinite gangue, appears all the way across the shaft. A thin section of the ore shows about 80 per cent of axinite.

Higher on the slope, at an elevation of about 7,850 feet, on claim No. 4, a similarly located 20-foot inclined shaft shows the westward and upward continuation of the same geologic and mineralogical conditions, but there is less display of ore, specularite is associated with the copper carbonate, and the mineral zone in general is considerably crushed by crustal disturbance. Farther west, on claims Nos. 3 to 1, where the openings are only a few feet in depth, the lode, or mineralized band, seems to narrow. On No. 3 it shows a width of about 2 feet, stands about vertical, and is confined between walls of the pressed granodiorite on the north and crushed dark limestone on the south.

JOHNSON GROUP.

The Johnson group, comprising nine or more claims, covers a considerable portion of Johnson Hill, in the northwestern part of the area, where, with the claims three deep, it extends along the contact for nearly a mile. The geologic and mineralogical conditions are essentially the northeastward continuation of those on the Zetta Blanchard group, except that a short distance back from the contact, to the south or outer side, the hill, to judge from the débris covering the surface, is mainly quartzite, much of it closely banded, and contains intrusive sheets or parallel dikes of quartz syenite porphyry and bedlike ledges of iron ore, apparently hematite, on which the two southeastern tiers of claims seem to be principally located. The property is owned by the Montilla Mining Co., of Montilla, Nev.

The principal openings are a 400-foot tunnel and a 100-foot shaft. The tunnel is located in the east base of the hill on claim No. 1, at an elevation of about 6,630 feet, and is driven westward on the granodiorite and limestone contact, which dips steeply out to the south or is vertical. The granodiorite, which in places forms a good firm footwall, is unusually dark, with far more than the ordinary amount of green hornblende, and is crushed, pressed, sheared, and schistose. The limestone is white, metamorphosed, crystalline, and banded. Both formations are cut by dikes of coarse quartz syenite porphyry younger than the shearing.

In much of its course the tunnel shows from 6 inches to 1½ feet of banded and crushed, partly mineralized rock or vein material, which, however, shows only sporadically a slight stain of copper carbonate and no trace of ore. It is said that no ore was expected in this part of the tunnel for the first 1,000 feet, or until the ground beneath the shaft or vicinity should be reached, a fact which, together with the transverse claim projecting at right angles down the northwest slope of the hill, suggests the probable presence of a transverse lode or vein in this locality, not observed by the writer.

The shaft, which is also located on the contact on the limestone side, is farther west, at an elevation of about 6,880 feet, or 250 feet above the level of the tunnel. It has a reported depth of 100 feet and, to judge from the material on the dump, is still in the oxidized zone. This material consists mostly of brownish and greenish garnetiferous gangue containing a little malachite and much yellowish-green to finch-green chloropal.

At a point on the contact about midway between the tunnel and the shaft, at an elevation of 6,780 feet, an open cut shows a 1½-foot band of crushed, partly mineralized material in the banded limestone, containing on the outer or hanging-wall side a 3-inch vein of malachite ore in a silicified garnetiferous axinite gangue.

On the upper north slope of the hill, at an elevation of 6,900 feet, an open cut shows the garnet-chloropal gangue zone or lode having a width of more than 10 feet, with the contact between the limestone and the crushed gangue sharply defined and vertical.

From the Johnson ground eastward the contact zone is said to be staked for several miles beyond Trout Creek, nearly to the crest of the H. D. Range. The most important claims in this vicinity seem to be the Leach group, which joins the Johnson group on the west and is said to show fair prospects in copper, but on which only the necessary work is done.

R. O. C. PROSPECT.

The R. O. C. prospect lies wholly within the basin and granodiorite area, about 1½ miles northwest of Blanchard Mountain, at an elevation of about 7,400 feet. It is in open country and easily accessible. It was discovered and located in 1908 by W. T. McArdle and is owned by Mr. O'Connell and others. The property comprises a group of six or more claims trending in a northeasterly direction for more than a mile. It is opened principally by several shafts, of which the deepest is 45 feet deep.

The deposits are of the dike-vein class. They are apparently replacement deposits in association with a medium or fine grained quartz syenite porphyry or aplitic dike which dips about 65° NW., and is about 6 feet in maximum width. In places the silicified dike and vein croppings stand boldly from 1 to 8 feet above the surface.

On claim No. 1 two shafts, 10 and 45 feet deep, show on the footwall side of the dike a banded vein from 6 inches to 2 feet wide, averaging about a foot, composed mostly of copper carbonates, oxides, and chalcopyrite with some gray copper mixed with iron, all contained in a quartz gangue. The ore is said to contain also considerable silver, some assays reporting as high as 38 ounces to the ton. The vein is tightly frozen to the granodiorite footwall and especially so to the dike hanging wall. To the northeast of the shaft the quartz vein is barren, is 6 inches wide, and gradually passes to the hanging-wall side of the dike, which varies down to a foot in width.

To the northeast on claim No. 2, where it is opened by an 8-foot shaft, the dike is softer and altered and contains quartz stringers and in places 3 to 4 inches of banded or streaked malachite-stained material or low-grade ore.

On claim No. 5 an inclined cut or shaft shows another copper-bearing dike, or probably a spur, to the southeast of the main dike. It is 8 feet wide, dips 60° W., and contains also considerable iron oxide.

On claim No. 3, opened by a 25-foot shaft, the showing is said to be in a cut similar to that on claim No. 1.

HICE MINE.

In connection with the Blanchard Mountain area two outlying properties, the Hice and Kratz mines, merit passing notice.

The Hice mine (see Pl. XIV, p. 100) is located 2 miles southeast of Blanchard Mountain, on the head of Knoll Creek, at an elevation of about 6,700 feet. It is among the early discoveries of the district and is developed by a 300-foot crosscut tunnel and a 30-foot shaft. The mine is in the crest of a prominent ridge (Pl. XVI, *B*, p. 100) of the Tertiary lake beds, which dip 20° to 30° NW. and strike nearly parallel with the trend of the ridge. These beds show faulting and slickensiding.

The deposits, which seem to consist principally of outcrops, occur in the upstream portion of the ridge, from the head of which the outcrops, from 10 to 30 feet or more wide, extend southwestward for nearly one-fourth of a mile, their trend diverging slightly from the axis of the ridge, so that while on the northeast they occupy the crest of the ridge, on the southwest they lap upon its southwest flank. In places they rise 8 or 10 feet above the adjacent surface underlain by the lake-bed sandstone. They appear to be portions of the crest of a reef of Paleozoic rocks that forms the core of the ridge, and protrudes through the surrounding younger sandstone at the surface.

These deposits are brown, yellowish, greenish, and blackish, or variously mottled with these colors. They are heavy and are said to contain on an average 60 per cent in lead, with 2 to 3 ounces in gold and as high as 240 ounces in silver to the ton. The lead seems to be all in the carbonate or so-called "sand carbonate" and oxide forms. No trace of galena is present.

The outcrops consist principally of mineralized faulted and brecciated material derived from the Paleozoic sedimentary rocks of the region, silicified and silicated dark and white limestone, quartzite, slate, quartz, jasper, barite, etc. The material is mostly fine, of the arenaceous type, though much of it ranges to medium or coarse. It is heterogeneously mixed, and much of it is firmly cemented. Underground, however, it seems to be in part but loosely coherent and in places to be crudely stratified or coarsely banded.

Owing to the high value of its mineral content and the amount of ore in sight in the croppings, the deposit has attracted considerable local attention, and recently the 300-foot crosscut tunnel was driven in a northwesterly direction to crosscut the ledge about 100 feet below the surface croppings. The tunnel, however, in passing beneath the outcrops and considerably beyond their zone continued uninterruptedly from the portal to the breast in the young soft sandstone only, encountering no trace of a ledge. The 30-foot shaft and other openings sunk on the croppings also seem to show no trace of the old rock formation or even solid ledge matter or sandstone, but have cut through only incoherent, partly cemented old fault breccia or partly rounded talus-like material, some dipping unconformably against the sandstone and some gently with it. These facts and the manner in which the sandstone rises on all sides of the ridge within 40 or 50 feet of the top make it seem certain that the outcrops and the underlying material in the sandstone are not in place, but are merely a cap resting upon the sandstone and have been brought there by a thrust fault or landslide, perhaps in the nature of an earthquake disturbance, which for lack of time could not be worked out on this visit.

So far as geologic and mineralogical composition is concerned the deposit gives no indication of any connection with the granodiorite and Paleozoic rock contact, whose nearest exposure on the opposite slope of Blanchard Mountain is 2 miles distant.

It is asserted by some that the parent ledge from which the outcrops have been derived is located far up the slope of Blanchard Mountain, which seems possible. Except that the H. D. Range is somewhat farther away, the deposit may equally well have come from the slope of that range on the southeast, a view which is favored by the fact that the sandstones in which it occurs are tilted up to an angle of 30° or more toward the northwest. Unless there is such a deposit on Blanchard Mountain, a remarkable feature is the absence of any such deposit anywhere else in this part of the district. The nearest known similar deposits are those of the Hickey mine, already described, 14 miles to the northwest, near Old Contact.

An alternative to the thrust-fault or landslide view is the view that the ledge or old rock core of the ridge, if such it be, of which the outcrops may represent the crest, may have been undermined, hollowed out, corroded, or eroded through after the manner of a cave or natural bridge and the opening subsequently become filled with the sediments that formed the young sandstone where the course of the tunnel now passes beneath the outcrops, which therefore at this point form a natural arch or bridge in the ridge of Paleozoic rocks.

The advisability of further prospecting the ledge by crosscuts and of sinking to determine its downward extent at various points before installing expensive machinery is obviously shown by the results obtained in the present tunnel.

KRATZ MINE.

The Kratz mine, better known as the "old Kratz" mine and the "old silver" mine, is, as shown on Plates I (p. 10) and XIV (p. 100), about 14 miles southeast of Contact and 3 miles south-southeast of the Hice mine, on the northwest slope of the H. D. Range, at an elevation of about 7,800 feet. The topography is mountainous but not rugged. The deposit was discovered and located about 1885, by Mr. Turo and his partner, who sunk an 80-foot shaft and took out some ore.

The country rock consists of the Paleozoic sedimentary rocks, and apparently a sandstone-like formation is dominant at the mine.

The deposit is said to be contained principally in a 10-foot lode of white quartz, which is traceable for 3,000 feet and is opened at several points, but on which not sufficient development work has been done to determine its value. The ore minerals are contained in an 18-inch vein or ore shoot crossing the lode. They consist chiefly of silver sulphide, and average about 40 ounces in silver to the ton, manganese, copper, lead, and zinc also being present. In the bottom of the shaft the ore carries about 4 per cent of copper, which leads to the hope that at greater depth it may be workable for copper. From portions of the vein J. F. O'Byrne reports assays running as follows: Manganese, 40 per cent; copper, 2 per cent; lead, 20 per cent; silver, 4 ounces to the ton; zinc, one-half ounce to the ton; gold, a trace.

MIDDLE STACK MOUNTAIN AND TROUT CREEK AREA.

LOCATION AND GENERAL FEATURES.

The Middle Stack Mountain and Trout Creek area lies in the northeastern part of the district, on the north contact zone. It begins at Middle Stack Mountain, 6 miles northeast of Contact, whence it extends eastward across Trout Creek for a distance of about 6 miles. The topography is mountainous and much of it rough, but it is generally not rugged. The area is reached from Contact by wagon road or trail, passing to the south of the mountain, and also by ascending Trout Creek from San Jacinto on the north. Mineral seems to have been discovered here in the sixties. The country rock is the usual intrusive granodiorite and Paleozoic sedimentary rocks, principally limestone and slate, which in general dip to the north away from the contact and with the granodiorite are intruded by syenite and monzonite dikes. The granodiorite in places shows pronounced sheeting, and at about 2 miles southeast of Middle Stack Mountain and also a few miles northeast of this point, on the contact near Clark Cabin, it is intruded by quartz syenite or quartz monzonite stocks accompanied by radial dikes.

The mineralized zone has a maximum width of about half a mile. The general distribution of the more important deposits is indicated on Plate XXI (p. 112). The deposits, except those to the west of Trout Creek, are similar to those on the contact zone described in the preceding sections, except that they are more generally associated with dikes. The usual metamorphic minerals, particularly massive garnet, chloropal, and axinite, are characteristically present in the gangue. A specimen from the Dakota shaft on the Clark group gives strong tests for boron, indicating the presence of axinite in considerable amount.

The principal properties are the Boston mine and the O'Connell, Clark, and Toano claim groups.

O'CONNELL GROUP.

The O'Connell group comprises seven or more claims, beginning on the southeast slope of Middle Stack Mountain and extending eastward along the contact for about 1½ miles. The location of these claims is indicated on Plate XXI (p. 112).

On the west, on the Daddy of Nevada claim, at an elevation of about 7,100 feet, the deposit is opened by a tunnel several hundred feet long driven in a northerly direction through sheeted granodiorite and the contact where the granodiorite is garnetized contains molybdenite, and is succeeded by garnetiferous limestone or quartzite. Both the granodiorite and the sedimentary rocks are intruded by the medium to fine grained light-colored siliceous syenite or aplitic dikes and the dump contains a small amount of good copper ore. A cut to the west of the tunnel shows 8 feet of banded greenish chloropal-garnet vein or lode material containing some mineral and with the contact between granodiorite and decayed limestone sharply defined and dipping normally 70° N., or outward.

About one-fourth mile farther west, on the Great Nevada claim, at an elevation of about 6,970 feet, a 40-foot inclined shaft is sunk in the white-limestone hanging wall of the garnetiferous lode, here 30 feet wide, granodiorite forming the footwall. The dump shows siliceous and garnetiferous banded ore.

Half a mile farther west, on the Three Links claim, at an elevation of about 6,740 feet, a tunnel starting on the sedimentary side of the contact runs S. 60° W., mainly in the garnetiferous banded gangue material, which dips abnormally 80° S. At the contact this tunnel exposes copper carbonate ore in the granodiorite. Here and in an adjoining cut to the southwest copper ore also occurs in the joint planes in the granodiorite, and in both tunnel and cut the granodiorite is traversed by dikes of medium-grained quartz syenite porphyry or aplitic rock.

About a quarter of a mile to the northeast, on the American Eagle claim, on the east end of the group, at an elevation of about 6,500 feet, one-fourth mile distant from the contact on its outer side, a dike of medium-grained pinkish monzonite porphyry cuts across the dark country-rock limestone and contains in association some malachite ore. One-eighth mile south of this point, up the hill, a 50-foot inclined shaft, seemingly in the same dike and formation, shows the mineralization much better developed. About 20 tons of siliceous copper ore, which is said to carry also considerable values in silver, is on the dump. The limestone dips normally about 45° N. The dike has been considerably shattered and is traversed by quartz veins and stringers 8 inches in maximum width.

CLARK GROUP.

The Clark group consists of six or more claims owned by George Clark, a pioneer of the district. As shown on Plate XXI (p. 112), these claims center about the Boston mine, to be described. The group joins the O'Connell group on the east, whence it extends eastward for nearly a mile, with the mineralized zone half a mile or more in width.

The contact here lies at the southern edge of the zone and follows for the most part the crest of an isolated elongated hill or ridge

(Clark Hill) several hundred feet high, rising to an elevation of about 6,550 feet. The contact zone is compound, being 150 feet or more wide, with inlying, upturned, apparently detached bands of limestone, as at Ellen D. Mountain (p. 105), and it contains the siliceous syenitic or aplitic dikes; in fact, on the southeast slope of the hill the granodiorite is intruded by a stock of a rock standing close to quartz monzonite, with which the dikes are probably connected.

The west end of the hill exposes a peculiar anticlinal structure where the upturned edges of silicified limestone or fine-grained quartzite beds, aggregating 40 feet in thickness and dipping steeply outward to the north, are met by equally steep and pronounced sheeting structures in the granodiorite and dikes dipping in the opposite direction.

The three southerly claims, the Contact, Dakota, and Minnesota, are on the contact, mostly on the hill portion. On the southwest corner of the Minnesota, at about 150 feet in from the granodiorite contact, a cut shows a parallel garnetiferous belt or lode 16 feet wide, which it is difficult to differentiate from garnetized granodiorite and altered limestone, but which, to judge from its alignment in strike with less altered beds of white limestone near by, seems to represent completely metamorphosed and mineralized limestone. Near its middle the lode contains two more completely mineralized bands, 1 or 2 feet wide, containing some malachite and a little chalcopyrite, and a short distance to the northwest of the cut the limestone is banded with parallel veinlets and stringers of quartz ranging up to 1½ inches in width.

On the Dakota claim, at an elevation of about 6,430 feet, the northwesterly side of a 12-foot shaft sunk in the granodiorite within 5 feet of the contact shows a fairly regular mineralized vein, 3½ feet wide at the top and 1½ feet wide at the bottom of the shaft, with stained garnetiferous quartz gangue containing some copper carbonates. The dip is about vertical, with granodiorite on both walls and silicified limestone or quartzite dipping 70° outward only 5 feet distant. To the northeast both the granodiorite and the sedimentary rocks are much crushed and blocky. At the northeast corner of the claim, about 200 feet northwest of the contact, is a short tunnel, which, however, shows little more than the crushed brown limestone, with coarse calcite.

About 1,500 feet outside of the contact, on the south slope of the hill to the north, on the Bridgeport claim, at an elevation of about 6,370 feet, an 8-foot inclined shaft shows a 3-foot mineralized bed in which massive garnet with considerable quartz forms the gangue in apparently alternating dark and light layers of silicated limestone. The bed contains copper carbonate, some oxide, and a little bornite.

On the Mary T. claim, joining the Bridgeport on the north, at an elevation of about 6,440 feet, a 16-foot cut exposes a 4-foot ledge which seems to be an altered dike or sheet of igneous rock that dips 70° NNW., conformably with the bedding of the dark-limestone country rock, and contains sporadically distributed malachite. About 50 feet farther down the slope another cut shows about 4 feet of good, low-grade ore with the dip of both vein and formation straightened to about vertical. Near by, on the eastern part of the southern slope of the hill, at an elevation of about 6,330 feet, to the north of the Boston mine, next to be described, occurs plentiful good-looking float, similar to the sulphide ore in the Boston mine. The float seems to be derived from outcrops not yet discovered, farther up the slope to the northwest.

BOSTON MINE.

The Boston mine, as shown on Plate XXI (p. 112), lies in the midst of the Clark group at an elevation of 6,140 feet. The claim trends to the northwest, diagonally across the gulch which separates Clark Hill on the south from higher ground on the north. Access is easiest from the southeast around the foot of Clark Hill, where there is an old wagon road over which the ore produced was hauled out.

The date of discovery was not learned, but the property was probably discovered in the early seventies, about the time the China Mountain deposits received attention. The mine was worked in the late seventies, and about 1880 it made shipments of copper ore which were hauled by ox team and wagon to Ogden, Utah, and to Tecoma, Nev., whence the ore was shipped to Swansea, Wales, and to Boston. The ground was patented in 1900 and is developed principally by a tunnel, a winze, and a shaft. The production was not learned, but probably was not large. About 40 tons of low-grade ore lies on the dump.

The mine is located about 700 feet to the north of the granodiorite contact. The country rock is the light-colored, mostly heavy-bedded Paleozoic limestone. It is uptilted and folded and at the mine dips steeply out to the northeast. No dike rocks were observed in association with it at the mine. Dike float, however, is present, and the deposit is approximately in alignment with the opening on the Mary T. claim, to the northwest, already described as being on a dike or intrusive sheet.

The deposit consists mainly of a 4-foot vein or ore bed composed principally of a crudely banded limy, garnetiferous, more or less silicified or silicated gangue. It trends northwestward, nearly along the strike of the limestone, and it dips steeply to the northeast, about conformably with the limestone, or stands about vertical. Its principal opening is a tunnel which, starting in the gulch, runs southwestward for about 30 feet, to a point where a 30-foot winze is sunk to the northeast. This winze contains some drift and gouging, and beyond the winze is a 9-foot chamber from which also considerable ore was probably taken out.

The opening as a whole shows the ore minerals to be principally the copper carbonates and the sulphides, chalcopyrite and bornite. They are contained in the vein or ore bed and also sporadically distributed and disseminated in the wall-rock limestone, particularly along the bedding and joint planes. In places they deeply penetrate the limestone itself, which is locally more or less garnetiferous, silicified or silicated, and seems to contain as much ore as the vein. A near-by cut shows similar though more finely banded or parallel streaked and veined occurrences of the ore in the silicified limestone.

TOANO GROUP.[1]

The Toano group, also called the O'Connell mine, from the name of the owner, is located on the granodiorite-limestone contact zone to the northwest of Toano John Peak, about 2 miles west of Trout Creek, at an elevation of about 6,400 feet. The topography is rough but not rugged. A wagon road leads up Trout Creek to the property.

The country rock is principally the light-colored limestone. It dips northward, away from the contact. The deposits are on the north or sedimentary side of the contact and occur chiefly in a parallel east-west ridge of the limestone. They are contained in four veins or lodes which, as shown on Plate XIV (p. 100), strike northwestward, approximately parallel with one another, and dip steeply to the northeast, into the mountain. These veins seem to represent replacements of porphyry dikes, which are more or less completely altered, replaced, and mineralized in the vicinity of the workings, but which plainly show their true porphyry-dike character in the limestone to the northwest and in the granodiorite to the southeast. Beginning on the west, No. 1 is a good 4-foot vein containing copper ore; No. 2, the most important of the group, is a lode 75 feet wide, composed principally of 40 per cent siliceous iron ore and containing at about the middle, as shown in the crosscut tunnel, a 20-inch vein that consists principally of copper oxide and carbonates averaging about 7 per cent in copper; Nos. 3 and 4, which have received but little exploitation, have a siliceous or quartz gangue.

[1] The information here given on this group, which was seen only from the region west of Trout Creek, was obtained chiefly from Mr. W. T. McArdle.

THE ELK MOUNTAIN DISTRICT.

GEOGRAPHY.

LOCATION.

The Elk Mountain district comprises a small area a few miles south of the Idaho State line. As shown on Plate I (p. 10), it is about midway between the northern boundaries of the Jarbidge and Contact districts, from each of which it is distant about 10 miles. It is about 25 miles southwest of Rogerson, Idaho, the nearest railway station on the Oregon Short Line. The nearest post office is Three Creek, Idaho, 9 miles distant on the northwest. With both of these places there are good wagon road connections. By trail the district is 30 miles from Contact and about the same distance from Jarbidge. From Contact, however, a wagon road extends to the Helsley ranch, a good stopping place within 8 miles of the district on the southeast.

TOPOGRAPHY.

The long, gently sloping, lava-covered ridge already described as extending from the Jarbidge district northeastward to the dam on Salmon River, near the middle part of its course, near the point where it crosses the State line at the 115° meridian, culminates in an elliptical group of mountains or elongated dome-shaped mass studded with low peaks that trend northeast and southwest for about 7 miles, with a maximum height of about 8,500 feet southwest of the State line. From the rounded, unit-like appearance of the mass on the north, the group is locally known as Elk Mountain, but from its dissected and composite character on the south it is more frequently called the Elk Mountains. According to J. F. O'Byrne, the State line crosses the northeast shoulder of the group.

On the southeast the mountains meet the surrounding lava plateau or plain of the Salmon River valley at an elevation of about 6,700 feet, above which their summit rises 1,800 feet. The mountains as a whole probably represent up-doming by a granodiorite stock, batholith or laccolith, similar to that in the Contact district. The granodiorite is exposed only in the southwestern part of the mountains, where they are most deeply dissected.

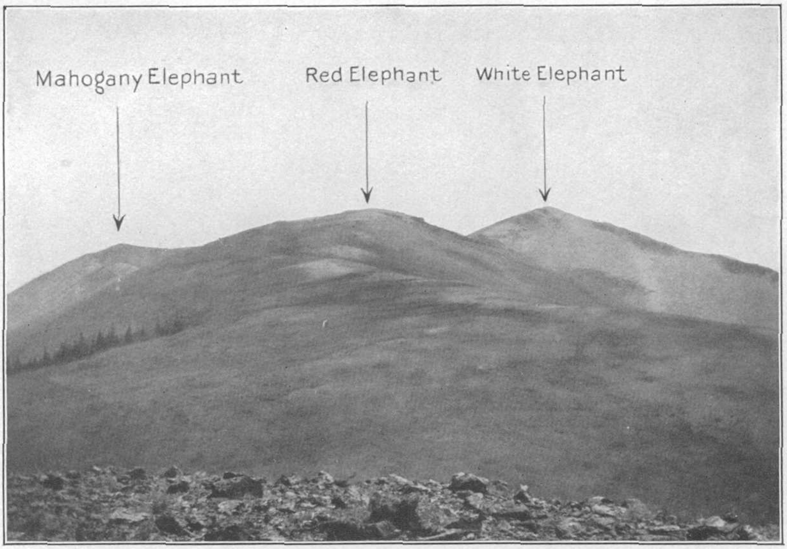
The Elk Mountain district here described is located at the southwest end of the group, on the headwaters of Salmon River, on the upper south slope of the divide that separates these waters on the southeast from the drainage of the East Fork of Bruneau River on the northwest, between elevations of 7,000 and 8,000 feet. The topography is mountainous and rough (Pl. XXVI), being of the same type as that of the Contact district, and is produced by deep erosion in the folded Paleozoic sedimentary rocks, which have been uplifted and tilted by plutonic masses covered by lava and subsequently denuded. The topography is mostly of the ridge and gulch type and trends south-southeasterly, at right angles to the axis of the mountains. The district is drained chiefly by Fall, Lime, and Willow creeks, small streams that flow eastward into Wilson Creek, which joins Salmon River below the Helsley ranch. Pole Creek, a larger stream, flows near by on the southwest.

GEOLOGY.

Geologically and mineralogically the Elk Mountain district, as indicated on Plate I (p. 10), is a replica of the Contact district, already described. It consists of a central intrusive granodiorite core, surrounded by a zone of Paleozoic sedimentary rocks, and an outer field of Tertiary lavas underlying the surface of the surrounding plateau.

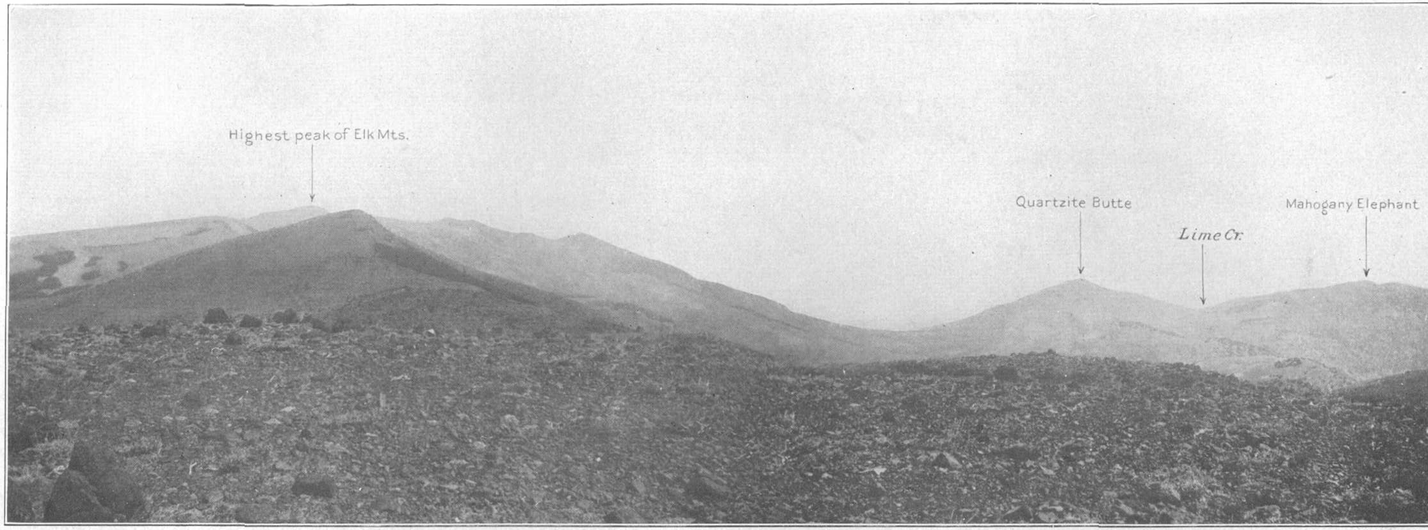
It lies in the Nevada Plateau, which is underlain by the Tertiary lavas and lake beds resting upon the folded and eroded Paleozoic sedimentary rocks. The Paleozoic rocks seem to consist of the same formations that appear in the Contact district, namely, limestone, quartzite, shale, slate, etc. They have been similarly domed up by a stock or mass of intrusive granodiorite, which apparently so shattered the beds in the crown of the dome that it soon became the seat of active erosion, which stripped back the quaquaversally dipping beds down the sides of the dome to the points where their upturned truncated edges now form a rim overlooking the still more deeply eroded granodiorite of the central area. The dip, which is fairly uniform, varies from 40° to 70°, the maximum observed being on the north. On the east it is about 50°, with decrease toward the south end. On the southeast the rim has been removed by erosion, which seems to be also the cause of the elongation of the central granodiorite area to a length of 1½ miles, against three-fourths of a mile in width.

The granodiorite is similar to that of the Contact batholith, except that it seems on the average to contain more bisilicates, notably hornblende, as at the Johnson mine. It consists essentially of plagioclase, orthoclase, quartz, hornblende, and biotite, with the accessories titanite or sphene, magnetite, and apatite. In the slide examined, which was obtained not far from the contact, calcite, pyrite, and much garnet are also present. The plagioclase seems to be oligoclase, about the same as that in the Contact batholith, but



A. EAST PRONG OF ELK MOUNTAIN MINERAL-BEARING HORSESHOE, LOOKING SOUTHEAST.

B. MAMMOTH VEIN IN CUT AND ORE, LOOKING NORTH.



VIEW OF ELK MOUNTAINS, CHIEFLY PALEOZOIC SEDIMENTARY ROCKS.

Left half is looking along crest of range, which extends 7 miles north-northeast to the Idaho State line.

owing to its altered condition the determination was not wholly satisfactory. The rock is regarded as of the same age (Cretaceous or near Cretaceous) as the Contact batholith. It is deeply oxidized, with the hornblende and feldspars much altered and sericitized, and, like the Contact rock, it is intruded by quartz syenite and quartz monzonite dikes, of which a dike of the aplitic phase occurs in the northwest slope of White Elephant Mountain.

The limestone in association with the deposits is chiefly the whitish or light-gray, finely crystalline, closely banded or straticulate rock, well shown in the west spur of Red Elephant Mountain along the road between the Austeon camp and tunnels.

About the middle of the east side of the granodiorite area is a low peak of white limestone known as the White Elephant, which reaches an elevation of about 8,070 feet, and of which the upper part is shown at the right in Plate XXV, *A*. About one-third of a mile to the northwest is a similar but less prominent swell known as Red Elephant Mountain, shown in the center of the same plate. Half a mile east of Red Elephant and separated from it by a narrow valley or gulch nearly 1,000 feet deep is a prominent outlying parallel short ridge or peak, shown at the left in Plate XXV, *A*, and at the right in Plate XXVI, which from its color and the scrub trees upon it is known as Mahogany Elephant. It seems to consist mostly of dark slate-colored thin-bedded blue limestone, slate, and shale, which dip outward (east) at angles of about 40°. In a similar but longer and larger mountain mass about a mile farther east, beyond Lime Creek, whose valley here seems to occupy a syncline, the dip is at about the same angle in the opposite direction, or west. In a similarly prominent mountainous outlier known from the rocks composing it as Quartzite Butte, which culminates in a sharp-crested ridge or peak (Pl. XXVI, at right of center), about a mile to the north of the one last described, the beds seem to dip 40° NW. toward the axis of the mountains.

If the dip of the rocks continues the same in the intervening valley as in Red Elephant and Mahogany Elephant, which seems probable, these two mountains, including the valley, expose a section about 1,300 feet in thickness; and in case the quartzite of Quartzite Butte, on the trend of whose strike the section is located, occurs at the base of the section, as seems likely, the total thickness of the Paleozoic rocks must be considerably greater than 1,300 feet, probably 1,600 feet or more.

On the west side of the area, which lies largely in the Fall Creek valley, the geologic section seems to be in descending order as follows: Rhyolite; light-colored limestone, 600 feet; quartzite (?), 300 feet; granodiorite.

The lava encircling the limestone zone and underlying the plateau on the outer side seems to be the young rim-rock lava of the Jarbidge district, with which it is apparently continuous, though in places débris or small exposures of rock resembling the old rhyolite of the Jarbidge district were also observed. It does not appear to exceed a few hundred feet in maximum thickness. It caps in scarp fashion the limestone to the west of the district, and with gentle dip it laps upon the west and northwest slopes of the mountains, reaching for the most part to the crest. Commencing at their north base it underlies the expansive plain, declining in long, gentle slopes toward Snake River on the north, as described in the section on the Jarbidge district. At a mile or more to the northwest of the Elk Mountain district the piedmont tributary valley of the East Fork of Bruneau River, several hundred feet deep, is seemingly cut through the lava into the underlying limestone. From the base of the mountains and limits of the Paleozoic rocks on the southeast the lava underlies a benched valley plain or mesa, several miles in width, which slopes southward or downstream, with the valley of North Salmon River, and seems to be continuous with the similar lava mesa in the southwestern part of the Contact district. From the base of the mountains the lava also inclines at a low angle laterally toward the river and the Helsley ranch, near which it breaks off abruptly in steep scarps or bluffs 100 feet or more in height overlooking the younger portion of the valley now occupied by the river. As a result of these conditions the tributary streams, which near the mountains flow almost upon the surface of the plain, emerge at the foot of the scarp through narrow, deeply cut notches or passes, affording in most places the only means of access to the plains from the valley side.

MINERAL DEPOSITS.

GENERAL FEATURES.

Mineral was known in the Elk Mountain district at least as early as 1890, since which date W. H. Austeon, a pioneer of Silver City, Idaho, as well as of this district, has annually carried on work here. His cabin and buildings, located in the northwestern part of the district at an elevation of about 7,600 feet on the head of Fall Creek, seem to be about the only permanent camp. The district, however, as a whole is still in the prospect stage, its most extensive openings not exceeding 200 feet in depth. At present ground is held and assessment work is being done on it by a dozen or more persons.

As in the Contact district, the deposits occur principally in association with the contact zone of the intrusive granodiorite and the Paleozoic limestone and are regarded as of Cretaceous or near Cretaceous age. They seem to be mostly of the contact-metamorphic type, with more or less massive garnetiferous chloropal and siliceous ferruginous matter in the gangue.

The metal of the district is chiefly copper, with which, however, is associated also gold and silver. A tin can placed in the creek at the foot of the mountains, it is said, soon becomes copper plated. The gangue here is not so ferruginous as in the Contact district, nor is the garnet so massive. Some of it shows well-developed crystal forms of garnet. The minerals observed in association with the deposits are as follows:

Aragonite.	Flint.	Molybdenite(?).
Argentite(?).	Garnet.	Pyrite.
Axinite(?)	Gold.	Quartz.
Calcite.	Hematite.	Silver(?).
Chert.	Limonite.	Stibnite.
Chloropal.	Manganese.	

The ore minerals are malachite, azurite, chalcopyrite, bornite, chrysocolla, gold, and silver.

The deposits are mostly on the arms of a horseshoe-shaped belt along the east and west sides of the granodiorite area, the toe portion on the north being apparently more deeply buried or less favorable for the occurrence of mineral and its exploitation.

The outcrops or " copper cap rock " as shown on the Austeon property, on the west spur ridge of Red Elephant Mountain near the west arm of the horseshoe, seems to consist mainly of reddish-brown, greenish, and blackish iron, copper, and manganese stained, altered, and in part mineralized granodiorite and limestone. Locally they are seemingly brecciated and here and there they constitute fair-grade ore.

AUSTEON TUNNELS PROSPECT.

A little farther down the slope from the outcrops just referred to, the Austeon tunnels ground is opened principally by a 130-foot tunnel and a 200-foot tunnel, spaced about 200 feet apart vertically, and both driven northward in the granodiorite to strike the Austeon 6-foot transverse vein, which is said to average about 3 per cent in copper and $7 in gold to the ton and to contain some beads or small nuggets of native copper. The granodiorite is mostly altered and barren or only slightly mineralized. At about 190 feet in from the portal of the lower tunnel, however, which is at an elevation of about 7,150 feet, firm, hard granodiorite is encountered, which is darker, with more green hornblende, than the average of this rock and contains also pyrite and calcite.

O'NEIL PROSPECT.

Near the south end of the west arm of the horseshoe is the O'Neil property, owned by O'Neil Bros. It seems to be one of the best showings in the district, and is said to be located on a good-looking persistent ledge, much of which carries about 16 per cent of copper.

RED ELEPHANT INCLINE.

The Red Elephant incline is located on ground owned by W. H. Austeon at the east contact, on the upper southwest slope of Red Elephant Mountain, at an elevation of about 8,180 feet. Following the granodiorite contact, which dips 30° to 40°, it extends N 30° E. for 155 feet in massive white fine to medium grained crystalline limestone and exposes the following section, which seems not only to be coextensive with the incline, but to continue beyond it in depth.

Section in Red Elephant incline.

	Feet.
Crushed and partly silicated and mineralized brownish and mottled limestone, containing flint or chert and manganese oxide and running from 1 to 2 per cent of copper, mostly in malachite, oxide, and chrysocolla	8
Garnetiferous, finely banded reddish, brownish, greenish, and bluish mottled altered limestone and garnetiferous chloropal gangue with malachite, azurite, chalcopyrite, and bornite, averaging as a whole about 3 per cent in copper and small values in gold and silver	6½
Bedrock granodiorite.	

There seems to be here a 14½-foot bed or body of low-grade ore which, if it continues in extent and depth, as appears to be the case, will probably be some day profitably worked.

GOLD PROSPECT.

A few hundred yards southeasterly of the incline opening just described and somewhat higher up the slope, on the same Austeon ground and in the same limestone country rock, occurs a parallel 2-foot impure quartz ledge or bed said to carry fair values in antimonial gold. The ledge, which is opened by a small pit or cut and shows portions resembling breccia, seems to be a replacement in the limestone along a fault plane. The outcrops are mostly reddish and dark-brown iron-stained siliceous material. The antimony is present as stibnite in the massive form, in impure dark-gray or blackish submetallic-looking small sheets or veinlets, films, and irregular bodies. Associated with the deposit is also considerable iron oxide and some yellowish material, apparently lead, and dark argentite.

ESTES PROSPECT.

The Estes prospect lies on the upper northerly slope of White Elephant Mountain, at an elevation of about 8,050 feet, on the contact between silicified garnetiferous limestone and granodiorite, with well-developed crystalline garnet in the gangue. The principal deposit consists of a bed 1 foot wide containing numerous pockets of good-grade copper ore.

OTHER PROSPECTS.

At the south end of the east contact, at the base of White Elephant Mountain, is the Robinette prospect, said to present a good showing.

On the northeast or outer side of the contact zone are also a number of outlying prospects in the limestone and quartzite, which were not visited in the course of this investigation.

INDEX.