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BULLETIN OF NEVADA STATE BUREAU OF MINES AND
MACKAY SCHOOL OF MINES

SPRUCE MOUNTAIN DISTRICT
ELKO COUNTY

and

CHERRY CREEK (Egan Canyon) DISTRICT
WHITE PINE COUNTY

By F. C. SCHRADER
Geologist, U. S. Geological Survey

PREPARED AND PUBLISHED BY THE NEVADA STATE BUREAU OF MINES
IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

PUBLISHED QUARTERLY BY THE UNIVERSITY OF NEVADA
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SPRUCE MOUNTAIN DISTRICT*

By F. C. SCHRADER

INTRODUCTION

A brief visit was made to the Spruce Mountain District in August, 1930. At that time only a few of the mines were being operated, but the writer received much additional information from the local companies and mining men.

LOCATION AND TOPOGRAPHY

The Spruce Mountain District covers an area about three miles square on Spruce Mountain, the southwestern peak of the Goshute Range, in the southeast part of Elko County. It has been described in the report of the Fortieth Parallel Survey[1] and by Hill[2] and Lincoln.[3] The principal supply points are Wells, on the Southern Pacific Railroad, about 45 miles north, and Currie, on the Nevada Northern Railway, 24 miles southeast. Freight is also hauled from and ore to Tobar siding, on the Western Pacific Railroad, 25 miles north, and to and from Jasper, 20 miles northeast.

Spruce Mountain is an isolated peak west of the axis of the main range, with which it is connected by comparatively low hills. It reaches an altitude of 10,400 feet, nearly 4,000 feet above the flat valleys that surround it on all but the east side, and presents a rugged topography, particularly to the south and east. Banner Hill, one and a half miles to the north, has an altitude of about 8,900 feet and is separated from Spruce Mountain by Killie Pass.

The principal settlement, at Sprucemont, on the lower west slope of the mountain, at an altitude of about 6,940 feet, has a stage service from Wells. Black Forest, on the upper east slope, receives its mail and freight from Jasper.

GEOLOGY

SEDIMENTARY ROCKS

The sedimentary rocks of the district consist chiefly of dark-blue limestone in beds from one to four feet thick, interbedded

*Published by permission of the Director, U. S. Geological Survey.

[1]U. S. Geol. Expl. 40th Par. Rept., vol. 2, pp. 502–512, 1877.

[2]Hill, J. M., Notes on Some Mining Districts in Eastern Nevada: U. S. Geol. Survey Bull. 648, pp. 67–76, 1916.

[3]Lincoln, F. C., Mining Districts and Mineral Resources of Nevada, p. 55, Reno, 1923.

with shale and quartzite. They are estimated to be about 2,500 feet in total thickness. From fossil evidence they are referred to the lower Carboniferous (Mississippian). Their structure is complicated by uptilting and faulting that accompanied the intrusion of the igneous rocks, but their prevailing dip is about 20° SE.

IGNEOUS ROCKS

Igneous rocks are only sparingly present. They consist chiefly of granite porphyry, diorite porphyry, and lamprophyre that are intrusive into the sedimentary rocks. They are in general highly altered and are not well exposed.

A dike of granite porphyry 500 feet wide extends entirely across the mountain range (Figure 1). As seen in the Porphyry tunnel, opposite the Black Forest mine, this rock is a light-gray medium-grained rock with abundant phenocrysts of quartz and orthoclase as much as 0.2 inch in diameter in a fine-grained groundmass of the same minerals. A little biotite and traces of hornblende and pyrite are also present. In places an increase in the amount of plagioclase marks a gradation toward quartz monzonite porphyry. The rock in the tunnel has been hydrothermally altered and is much weathered. The feldspar is largely kaolinized and the biotite changed to chlorite and iron oxides. There are bands of fine-grained siliceous limonite about an inch in thickness that dip about 30° SW. The rock between these bands is traversed by numerous parallel veinlets or seams of aphanitic greasy-lustered secondary quartz. These features denote that after having been closely sheeted under pressure the rock was later altered and had its fractures sealed by silica. Near the face of the tunnel the limestone has been metamorphosed and mineralized for a distance of 30 feet from the dike.

A thin section of the granite porphyry from the Spruce Standard mine, at Sprucemont, shows secondary veinlets composed of six or more depositional bands of quartz, sericite, and calcite, which in places cut through the quartz phenocrysts.

The diorite porphyry is a fine-grained dark brownish-gray rock, which occurs as small irregular bodies and dikes. It is composed mainly of plagioclase and hornblende, both largely altered to kaolin, sericite, chlorite, and epidote.

A lamprophyric dike was noted in the upper tunnel of the Black Forest mine. It is a dark greenish-gray speckled medium to fine-grained porphyritic rock, characterized by small phenocrysts of biotite, hornblende, and olivine, of which the biotite

is very abundant. Considerable orthoclase and plagioclase are also present. Much of the biotite is altered to greenish chlorite, the hornblende to actinolite and other products, and the feldspars to epidote, sericite, and kaolin.

CONTACT METAMORPHISM

The porphyry dikes have in places metamorphosed the host rocks, especially the limestone, but usually for only a few feet from their contacts. The maximum extent noted, with one exception, was 30 feet in the Porphyry tunnel of the Black Forest mine; but at the Spruce Standard mine metamorphism was observed 500 feet from any known intrusive rock.

Just east of the Spruce Standard mine is a mass of rock resembling greenstone that is about 500 feet wide and extends half a mile or more up the canyon along the Monarch road. This is locally known as diabase, but microscopic study shows it to be a lime silicate rock. It is dull or earthy to olive-green in color, minutely crystalline, and homogeneous and contains disseminated particles and veinlets or "seams" of galena. A light olive-green specimen of this rock obtained near the mine on the Carrie No. 2 claim is composed mostly of greenish garnet and fluorite, with subordinate quantities of actinolite, diopside, and other pyroxenes, and a darker olive-green specimen of the rock found a third of a mile farther east up the canyon on the Carrie No. 4 claim is composed mainly of diopside and fluorite. The metamorphism of this rock is believed to have been caused by solutions rising along the granite porphyry dike on the south.

At the southern edge of the silicate rock zone, or between the main body of the zone and the granite porphyry dike, there are two prominent iron-stained knoblike bodies of quartz breccia, commonly called blowouts, the larger one about 500 feet in diameter, which also seem to be genetically connected with the granite porphyry dike. After brecciation the quartz has been recemented by silica and iron carbonate.

HISTORY AND PRODUCTION

Lead-silver ore was discovered at the Killie (Latham) mine in 1869. Other early discoveries were the Juniper, Fourth of July, and Black Forest. In 1872–1873 the Ingot Mining Co. built a small smelter at Sprucemont to treat lead carbonate ores and for a short time smelted 35 tons of ore daily, but the plant was not a success. Just before the panic of 1907 the camp enjoyed

a brief revival of activity, and it is said that for several years prior to 1910 a considerable tonnage of ore from the Black Forest mine was smelted in the C. M. Spence 50-ton furnace, in the valley northeast of Spruce Mountain.

In 1913 about 10 men were working in the district and a small shipment of ore was made from the Keystone mine.

The total production to the end of 1930 has been about $1,731,000. No record of the production in early years is available, but the estimated early production from the eight leading mines is $700,000, and since 1901, according to available figures and probably authentic reports, the production has been about $1,031,000. According to V. C. Heikes, in the Mineral Resources of the United States, the production from 1902 to 1912 and 1916 to 1928 was as follows:

Period	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Total value
1902–1912	72.88	253,953	174,184	2,306,829	.....	$250,802
1916–1928	103.87	352,321	148,347	7,771,622	43,197	707,452

The most productive years were 1926 and 1927, with outputs valued respectively at $243,043 and $116,190; that of 1927 was all first-class lead ore. The next best year was 1924, with an output worth $113,738.

In 1929–1930 the production as given by the mining companies was about 3,200 tons of ore, of which two-thirds came from development work in the Killie mine. This figure does not include minor output made by lessees in the Bullshead and other mines.

The production by mines in 1918–1930 is about as follows:

Mine	Period	Ore (tons)
Monarch	1918–1928	21,000
Black Forest	1924–1929	9,000
Killie	1926–1930	5,000
Parker	1929–1930	300
		35,300

The chief sources of power are Diesel engines using crude fuel oil of 27° or more Baumé. Until recently only native timber was used in the mines, but now Oregon fir is imported. The average miner's wage is $5.50 a day.

As present transportation costs on the ore amount to about 50 per cent of its value, the district eagerly awaits the building of the proposed branch railroad that will connect it with the Western Pacific at a point between Jasper and Tobar. The terminus of the proposed branch is near Sprucemont, at an altitude of about 7,250 feet.

ORE DEPOSITS

The ore deposits carry chiefly lead, silver, and copper, but some contain zinc also. They occur as replacement deposits in the limestone, mainly as bedded deposits in or between certain limestone beds, as in the Killie mine, and as fissure deposits. In the limestone they also follow seams and irregular fractures. In the Porphyry tunnel they occur on the contact between the limestone and igneous rocks. The bedded deposits have been the most productive. The ores thus far mined have been mostly oxidized and consist chiefly of carbonates, of which the lead carbonates have been more profitable than those containing copper.

The lead-silver ores contain abundant limonite, together with cerusite, anglesite, wulfenite, and residual cores and kernels of galena. The copper ores contain malachite, chrysocolla, and chalcopyrite, with subordinate quantities of bornite and chalcocite.

Of the zinc minerals both smithsonite and calamine are present. Some of the brownish lead-zinc ores, as in the Killie mine, are traversed by veinlets of white smithsonite. In some of the yellowish-gray sandy carbonate ores the structure of the limestone has been preserved in great detail by the replacement ore minerals.

No sulphide ore of commercial importance has yet been found in the Monarch and Black Forest mines, and no zinc occurs in them. In general there is a marked decrease in the zinc content of the ores with nearness to the granite porphyry, as in the eastern part of the Killie mine.

MINES AND PROSPECTS

The leading property holders and operators in the Spruce Mountain District are the Missouri-Monarch Consolidated Mines Co., Sprucemont Standard Mining Co., Nevada Lead & Zinc Mining Co., Missouri-Monarch Extension Mining Co., Eastern Nevada Exploration Co., Bullshead Mining & Smelting Co., and Humbug Mining Co. The position and extent of the different properties is shown in Figure 1.

MONARCH MINE

The Monarch and Black Forest mines have been owned since 1928 by the Missouri-Monarch Consolidated Mines Co. The

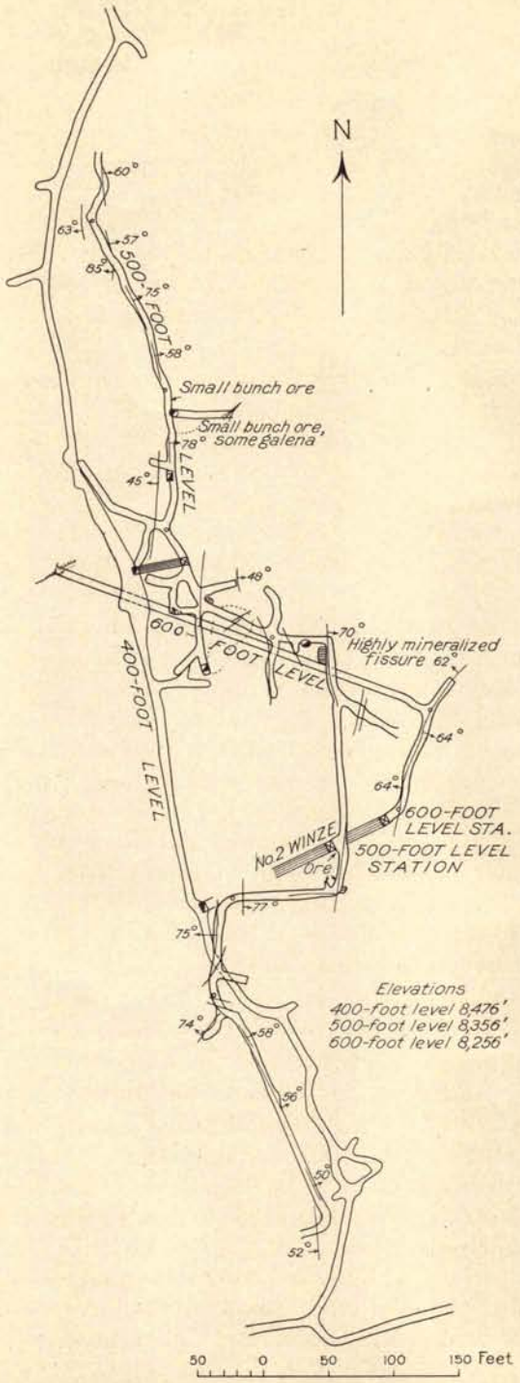

FIGURE 2—Plan of 400, 500 and 600 Levels in Monarch Mine.

Monarch mine is about one and three-quarters miles east of Sprucemont, on the middle of the steep western slope of Spruce Mountain, with the main tunnel at an altitude of 8,455 feet. It is the deepest and one of the oldest mines in the district and contains more than 3,000 feet of work along three or more veins. (See Figure 2.)

The mine was worked in the early days of the district. In 1917, after this mine had been idle since 1914, the Monarch Consolidated Mining Co. began work. The Monarch tunnel was driven to connect with the old workings, and shipments of ore began in 1919. Between 1919 and 1922 the production was about 21,000 tons of ore that contained about 17 per cent of lead and 20 ounces of silver to the ton. The bulk of this production was made in 1920. The ore was shipped to the American Smelting & Refining Co., mostly by way of Tobar, but in 1920 some was shipped also by way of Currie. The total value of the shipments, on the basis of smelter returns, was about $475,000.

In 1922 the Monarch Consolidated Mining Co. was succeeded by the Monarch Lead & Silver Co., and the mine was in that year the largest producer in the district. Some of the ore shipped contained as much as 22 per cent of lead and 24 ounces of silver to the ton. In 1926, 2,000 tons of lead-silver ore, chiefly oxidized, was shipped. In 1928 the Monarch and Black Forest mines were consolidated by the present company, which sunk the winze to the 600-foot level and did much development work. The mine continued active until February, 1930, after which the Bronco tunnel, 1,800 feet north of the Monarch tunnel and about 50 feet higher, was driven until operations practically ceased in the following June. The company is now working seven men at the two mines.

Nearly all the Monarch production came from the 300, 400, and 500-foot levels. Extensive developments on the 600-foot level have not thus far been encouraging. The work done during 1918–1928 followed the Fordna-Hardy ore shoot down to the 520-foot level. This shoot raked to the southeast and on the 400-foot level was 360 feet long. To the southeast of it three ore bodies were developed on the Monarch fissure, which here strikes N. 20° W. and dips 60° E.

In 1930 the mine was said to have good reserves, and the Thelma vein, though but little developed, was said to contain considerable ore with a high content in silver and lead; but as

the cost of transportation has always been the great drawback the company has postponed development in the hope that a railroad will soon be built into the district.

When operation is resumed it is expected to sink the winze on the Monarch fissure from the 200-foot to the 400-foot level. The Bronco tunnel, now in 1,500 feet, will, when completed, have a vertical depth of 500 feet, but indications along it so far have not been encouraging. The large dump at the Monarch tunnel contains 300 tons of low-grade brown oxidized ore said to contain 8 per cent of lead and 4 ounces of silver to the ton.

The chief veins are the Monarch, Thelma, and Big Fault, which strike nearly north and are about 800 feet apart. As the Monarch vein dips 65° E. and the Thelma 70° W., the two veins, if they continue their courses downward, should unite or intersect about 1,800 feet below the apex of the Monarch vein and 3,300 feet below that of the Big Fault vein.

BLACK FOREST MINE

The Black Forest mine is on the steep northeast slope of Spruce Mountain at an altitude of about 8,500 feet (Figure 1).

After a period of operation by lessees, the Black Forest Mining & Smelting Co. began operating the mine on its own account in the spring of 1924 and made its first shipment in June of that year. During 1926, 3,000 tons of lead-silver ore, chiefly oxidized ore, was shipped for smelting and 1,000 feet of development work was done. By 1927 the company had produced and shipped 8,800 tons of ore that contained about 20 per cent of lead and 20 ounces of silver to the ton. Most of the oxidized ore came from a series of interlacing pipes or chimneys and chambers in the white limestone above the 150-foot level. The ore was shipped by way of Jasper to the American Smelting & Refining Co. at Murray, Utah. Transportation costs amounted to 50 per cent of the value of the ore. The production included 770 tons of ore that ran 20 per cent of lead, 18 per cent of iron, and 22 ounces of silver to the ton. This ore came mostly from level A on No. 11 fissure.

The mine is opened by four tunnels, the chief of which are the upper and lower tunnels, spaced about 70 feet apart vertically. (See Figure 3.) It contains more than 7,000 feet of work. The lower tunnel trends S. 60° W. and has a length of about 3,000 feet. The most notable recent development work undertaken in the district is the driving of this tunnel and the Bronco tunnel to connect the Black Forest and Monarch mines through the heart of the mountain at an altitude of about 8,500 feet. These connecting tunnels, when completed, will have a combined length of nearly 7,000 feet and a maximum depth of 800 feet. At the time of visit 2,300 feet of ground still remained to be crossed to make the connection. Much of the ground in the Bronco tunnel is broken, soft, and wet and will require good timbering. The tunnels were designed primarily to facilitate shipment of ore from either mine on either side of the mountain and are expected to crosscut six or more fissures or mineral zones, in two of which ore has already been opened up on the Black Forest side. It will also serve as a sheltered passageway between the two mines when the surface roads over the pass are blocked by snow.

From the mine the ore is conveyed about 2,900 feet and lowered about 1,000 feet by aerial tram to the loading station at the mouth of the canyon.

The mine is near the eastern fault and, as shown in Figure 1, is surrounded except on the southeast side by the large dike of intrusive granite porphyry. Granite porphyry dikes also occur southeast of the mine, and granite porphyry, diorite, and lamprophyric dikes occur in the mine. A diorite dike cuts across the lower tunnel about 600 feet from the portal. (See Figure 4, section A–A′.) There are also a number of cross faults, and the most favorable places for ore are the junctions of the cross faults with the main fault.

The ore occurs chiefly along the northwest fault fissures, in part as large replacement ore bodies extending well out into the limestone. It also occurs as chimneys, pipes, and globular bodies three feet or more in diameter inclosed in crustified ferruginous casings or shells from one to three inches thick. A tabular body that was being mined in the lower tunnel about 2,000 feet from the portal averaged about two feet in thickness. The productive area has been developed over a horizontal distance of about 1,800 feet and through a vertical range of 400 feet (Figures 3 and 4) by eight levels spaced about 60 feet apart vertically. The mine contains about 10,000 feet of underground work.

Much stoping has been done in the vicinity of the Dutch fissure, in the Nesler and Whim stopes, on the C level (Dutch level), and in the A–3 stope, on the A level.

The ore consists chiefly of a fine-grained mixture of carbonates and oxides of lead and copper containing about 20 per cent of lead and 20 ounces of silver to the ton. In the deep part of the mine, however, the workings seem to be nearing the sulphide zone, to judge from the sulphide ore found on the C level.

KILLIE MINE

After being idle nine years the Killie (Latham) mine, in Killie Pass at an altitude of 8,900 feet (Figure 5) was reopened in May, 1926, and operated by the Spruce Consolidated Mines Co., which was succeeded at the end of the year by the Nevada Lead & Zinc Mining Co., the present owner.

During the last four years the mine has shipped about 100 tons of ore a month, or a total of 4,800 tons of $15 ore that contained 22 per cent of lead, 13 per cent of zinc, 5 per cent of iron, 6 per cent of manganese, and 4 ounces of silver and 0.005 ounces of gold to the ton. The net profit was reported to have been $3.40 a ton. No payment is made by the smelter for the zinc content, and a penalty is exacted if the zinc runs above 15 per cent. At

FIGURE 5
Killie Mine in Killie Pass, Camp, and Banner Hill. Looking Northwest.

the time of visit a small force was employed in development work.

The mine is developed to a vertical depth of 250 feet, or 450 feet on the dip of the ore zone or lode, by several thousand feet of work, mostly on the 70, 85, 120, 160, 210, and 220-foot levels, of which the most extensive are the 70 and 160-foot levels. The Killie shaft has a vertical depth of 220 feet. During the early period of operation most of the mining was done between the surface and the 70-foot level, and most of the stopes in the mine are above the 120-foot level. Ore has recently been developed on and above the 120-foot level and on the 160-foot level. The Jackson stope in 1930 had a very good showing of ore reported to contain 45 per cent of lead and 12 ounces of silver to the ton.

In October, 1930, the mine temporarily suspended operations, owing to the depressed condition of the metal market.

Besides camp buildings adequate to winter 20 men, the mine is equipped with a 25-horsepower gasoline hoist, and the compressors are run by a 65-horespower Premier oil-burning automatic engine. The ore is conveyed by aerial tram under Killie power from the Killie mine 3,900 feet to the ore bin at the Black Forest lower tunnel, and thence under Black Forest power 2,900 feet to the truck-loading station. The tram handles 50 tons of ore in eight hours. The buckets hold 750 pounds each.

The Killie mine and camp pipe a rather scanty water supply from the Spartan tunnel, in the porphyry dike on the adjoining west slope of the mountain.

The Killie mine is chiefly in limestone about 800 feet northwest of the granite porphyry dike, and the ore bodies now being developed extend from the glory hole northeastward down the dip of the lode for a known distance of 450 feet. The lode seems to be on or just east of a north-south fault or zone of disturbance, because immediately on the west and northwest the rocks dip west, while in the mine they have an average dip of about 40° ENE. The section in part, so far as made out, is as follows, in descending order:

	Feet
Grayish-blue limestone, ore-bearing	60
White limestone	50
Quartzite or silicified limestone	40

The Killie lode or ore zone, beginning at the glory hole, has a known extent of 450 feet down a 28° dip, a width of 100 feet along the strike, and a thickness of 40 feet or more measured at right angles to the dip. It is estimated to contain about 50,000 tons of mill-grade ore with a probable tenor of 10 per cent of lead, 10 per cent of zinc, 3 ounces of silver to the ton, and a little gold.

The ore is in part localized by the intersections of the lode and many fissures or slips, which strike and dip in various directions, some being curved in both strike and dip, so that it is very difficult to follow any given ore body. The largest of these is the "big fissure," which strikes about N. 70° E., parallel with the dip of the lode, and dips steeply north northwest.

The Killie glory hole is about 80 feet east and west by 60 feet wide and 60 feet deep and has been worked underground to a vertical depth of 80 feet, or 120 feet on the dip, below which mineralization ceased. It has produced much good ore, some of

it very high in lead and zinc. The ore has replaced limestone and contains streaks of residual galena.

The Latham tunnel is on the 70-foot level and extends 700 feet east to the Killie shaft. The western part of the tunnel passes through the white barren limestone which, about 350 feet from the portal, is succeeded by the overlying blue limestone. Both formations dip very gently east. The rocks are crushed and shattered. The white limestone is marmarized, and the blue limestone, which is in part ore bearing, is stained brown with lead and iron carbonates or oxides. Ore has been stoped in places for a distance of 100 feet south from the tunnel.

Ore from part of the Jackson lode is roughly banded and consists mainly of brownish-gray cerusite and perhaps other oxidized lead minerals replacing limestone in part stained with malachite. Minute specks of dark copper oxide (melaconite) are also present. The silver seems to be associated with the cerusite and other oxidized lead minerals.

Lead-silver sand-carbonate ore from the footwall side of the Killie lode consists of brownish-green fine-grained cerusite, very closely banded and preserving in detail the structure of the limestone which it has replaced. This ore is friable and is said to contain about 40 per cent of lead and 20 ounces of silver to the ton. The upper part of the ore body, which is completely oxidized, is capped by half an inch or more of a yellowish and yellowish-green mineral, possibly lead oxychloride.

The brown ore that occurs generally throughout the mine is composed of a mixture of partly oxidized sphalerite and cerusite and traversed by seams and veinlets of smithsonite. It contains about 30 per cent of lead and an equal amount of zinc.

A lighter-brown and more compact variety of the ore, which also is general throughout the mine, contains considerable cerusite and is said to average 25 per cent of lead and 10 per cent of zinc.

In the oxidized ore are sporadic residual nodules of coarsely crystalline galena a few inches or less in diameter, said to contain about 65 per cent of lead and a little silver.

From the relatively small quantity of silver found in the sulphide ore it is inferred that the silver in oxidized ore has been considerably concentrated by leaching.

Good indications of ore occur also in the vicinity of the Killie mine in the low ridge extending from the glory hole northward. Here the limestone dips 30° W. Lessees mined five tons of copper

ore during the winter of 1929–1930 from the adjoining Bingo claim.

BULLSHEAD MINE

The Bullshead mine of the Bullshead Mining & Smelting Co. is on the northeast slope of Spruce Mountain about half a mile south of Black Forest Canyon, at an altitude of about 7,900 feet. (See Figure 6.) It has been a large producer and contains about 6,000 feet of underground work, mostly drifts, on both sides of the canyon.

A 50-ton smelter was built in 1917 and a trial run made with ore from the Bullshead and Black Forest mines. The plant has since been idle. The Bullshead was one of the two principal pro-

FIGURE 6
Bullshead Mine in East Slope of Spruce Mountain, with Quartzite Reef in Left Mid-Ground and Top of Goshute Range in Background. Looking East down the Canyon.

ducers in 1918, when the total value of the district's output was nearly $24,000. It was also a large contributor to the district's output of $53,428 in 1922, and was then said to have in reserve 10,000 tons of ore averaging 3 per cent of lead and 10 ounces of silver to the ton. In 1926, 150 tons of lead ore was shipped from the mine by lessees.

At the time of visit two small leasing parties were working in the so-called upper tunnel about 800 feet from the portal and taking out brown oxidized ore said to average 30 per cent of lead and 20 ounces of silver to the ton, some of it containing considerable residual galena.

The main vein, which reaches four feet in width, strikes N. 30°

E. and dips 30° ESE. in blue limestone. It seems to be downfaulted 15 to 20 feet on the west.

About 1,000 feet down the canyon east of the mine the country rock, which is mostly bluish-gray limestone with a little shale or slate, contains a bed of leaden to brownish-gray medium-grained impervious quartzite about 100 feet thick. This bed dips about 40° E. and seems to overlie the ore-bearing limestone that contains the Bullshead and other neighboring deposits. Its quartz grains are subangular and corroded along the edges and show slightly parallel arrangement which is evidently due to sedimentation pressure. Considerable sericite has also been developed. The quartzite is in part heavily iron stained or mineralized and contains a zone of mineralization along its base or footwall. This zone suggests that the quartzite in its former westward extent was probably an important factor in ore deposition by serving as a barrier that checked or dammed back the ascending solutions that deposited the Bullshead and neighboring ores.

SPENCE MINE

In 1917–1918 sinking was done in the Spence copper mine, which is said to have disclosed 15 feet of low-grade copper ore on the south contact of the granite porphyry dike and limestone and small stringers of good-grade ore in the dike, but work was discontinued in the fall of 1918.

PARKER MINE

The Parker or Humbug mine, a new property owned by Mr. Parker and associates, is in the northeastern part of the district below the Spence mine, in a low flat-topped foothill at an altitude of about 6,950 feet. The claims are known as the Humbug group. In 1929 and 1930, 250 tons of ore with a tenor of 22 per cent of lead and 9 ounces of silver to the ton was shipped.

The principal vein is in limestone. It is three feet or more wide, with vertical dip, and strikes N. 10° W. It has several branch veins.

The ore is mostly gray lead carbonate replacing altered limestone, much of which is stained reddish and yellowish brown with iron oxides, and in places contains disseminated cubes and grains of pyrite. The ore occurs chiefly along the lode and as replacement deposits in the limestone. Some ore is also found as replacement bodies in a fine-grained gray calcareous rock that is locally called porphyry but is shown by microscopic

study to be an impure lime silicate rock composed mainly of quartz and calcite with a little diopside and other silicates. This rock contains remains of crinoid stems, which are probably of Mississippian age.

Besides the ore of the main lode it is reported that good ore occurs in a fissure east of the main shaft.

The mine is opened by shafts to a depth of 80 feet. Owing to the flatness of the topography the mine can now be worked by shaft only, but it has been suggested that as other lodes occur southeast of this property it would probably pay to drive a 400 or 500-foot tunnel from the foot of the hill and thus gain considerable depth on the lodes.

BANNER HILL MINE

About 1925 the Banner Hill crosscut tunnel, driven on the Banner Hill group of claims, in the western part of Banner Hill, was advanced from about the 500-foot point to a total length of 800 feet, when work ceased after the death of the owners. The tunnel was to prospect copper deposits.

SPRUCE STANDARD MINE

The Spruce Standard mine is at Sprucemont, in the lower west slope of the mountain, at an altitude of about 7,000 feet, and is easy of access. It was formerly a part of the Ada H. property.

The mine is credited with an early-day production of more than $100,000 in lead-silver-copper ore, in part very rich. It is opened by a shaft inclined at 65° (Figure 7), from which levels have been driven at depths of 165 and 265 feet. In 1926 several hundred tons of oxidized lead ore containing silver was shipped from it by way of Tobar by the Paramount Consolidated Mining Co., and 100 tons of old slag from the Spruce Standard dump. In September, 1928, the mine was taken over by the Sprucemont Standard Mining Co., of Elko, which has since reconditioned it and sunk the shaft from the 165-foot to the 265-foot level, on which it has done extensive development work and mined a little ore; but no shipment has yet been made. At the time of visit six men were employed. The mine makes about 40 gallons of water a day. The surface equipment includes a Gardner-Denver portable 220-horsepower compressor engine and a 10-horsepower Fairbanks-Morse sharpener and hoist engine.

The main lode strikes N. 35° E. and dips 60° SE. in limestone. It ranges from a few feet to five or six feet in width. It is

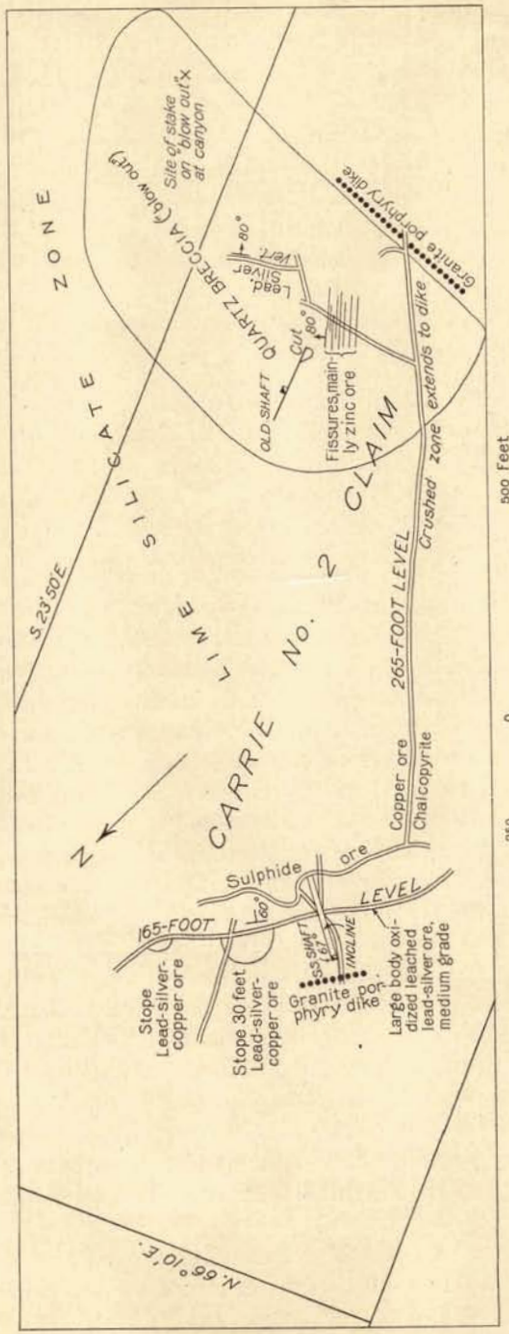

FIGURE 7

Plan of Workings in the Spruce Standard Mine.

opened for about 700 feet on the 165-foot level and 300 feet on the 265-foot level.

On the 165-foot level south of the shaft there is a large body of medium-grade oxidized and leached lead-silver ore, and north of the shaft there are two good stopes of lead-silver-copper ore. The oxidized ore, much of which is friable, in general is stained reddish or yellowish brown with iron oxides and is sparingly speckled with copper carbonates, particularly malachite. The silver content seems to be associated with the lead and copper minerals.

On the 265-foot level the ore is mainly sulphide ore containing lead, silver, and copper and may represent the top of the sulphide zone.

The ore occurs chiefly as replacement deposits in the limestone and the granite porphyry and along the contact of these two rocks in a quartz-pyrite gangue and is mostly crudely banded and speckled. The ore minerals are chiefly galena, which is probably argentiferous, chalcopyrite, pyrite, and a little arsenopyrite. Some of the ore, however, is relatively pure fine-grained or dense chalcopyrite, and some is stained black with manganese oxide. The lead-silver ore contains 12 per cent or more of lead and is high in iron. A polished section of the dark-purplish bronzy fine-grained chalcopyrite ore shows it to consist predominantly of chalcopyrite and pyrite, intimately mixed with a subordinate quartz and carbonate gangue.

From a point near the south end of the drift on the 265-foot level a 1,400-foot crosscut has been driven southeastward to a granite porphyry dike. It is reported that geophysical prospecting showed favorable indications in this region. The rock in the crosscut is highly crushed and in part mineralized. In places a little copper ore, mostly chalcopyrite, has been found. The dike, which strikes easterly, is about 200 feet wide and seems to be a branch of the main dike, as shown in Figure 1. The rock is the normal granite porphyry of the district and contains sparingly disseminated fine-grained pyrite, which also coats the joint planes.

In this area there is a metamorphic zone 500 feet or more wide in which the limestone has been completely changed to a grayish olive-green rock that has been locally called a diabase dike. Study of it in thin section, however, shows that it is composed chiefly of diopside, greenish garnet, and fluorite. The diopside may be accompanied by other pyroxenes and more or less tremolite and actinolite. In places the rock contains

also a little secondary calcite and quartz. This metamorphic zone also contains, north of the spur dike, the larger of the two quartz blowouts mentioned on page 9, which likewise seem to be genetically connected with the dike.

A dike of the granite porphyry occurs also at about 200 feet northwest of the Spruce Standard mine. It strikes N. 40° E., about parallel with the Spruce Standard vein, and is probably connected with the ore deposits in that vicinity.

At 150 feet to the north of the dike a 250-foot branch turns off from the crosscut and runs east nearly parallel with the dike. At about the 100-foot point it cuts a zone of closely spaced, parallel mineralized fissures 20 feet in width and dipping 80° NE. Sphalerite is the principal ore mineral in this fissure zone. After making a 70-foot offset to the southeast beyond this fissure zone the branch crosscut resumes its northeasterly course for about 150 feet and follows a fissure of vertical to steep southerly dip that contains some lead and silver. The crosscut ends beneath the center of the big quartz breccia mass or "blowout."

The ore deposits in and near the Spruce Standard mine are believed to be genetically associated with the granite porphyry dikes and to have been formed by thermal solutions that circulated soon after their intrusion.

The Ada H. mine, half a mile east of Sprucemont, has been similarly prepared for active mining by the Sprucemont Co. Here two series of closely spaced mineralized fissures intersecting northeast and northwest form a stockwork 1,800 feet or more in extent.

OUTLYING ZONE

On the west the foothill belt of limestone for a distance of eight miles north and two miles south of Sprucemont and for a width of one and a half miles contains many prospects and outcrops of veins. Of this total width about 3,000 feet is fairly heavily mineralized. Some of the properties in this zone—for example, the Chicago, Ohio, Paramount, and Cedar groups—are opened to depths of more than 100 feet. Some made small outputs in the early days of the district and seem to give promise of future production. The old Paramount shaft, on Paramount claim No. 7, about one mile northwest of Sprucemont, has a depth of 200 feet and has produced considerable ore that is said to have run about 40 per cent of lead, 15 ounces of silver and $5 in gold to the ton, and a little copper. It is sunk at the intersection of two veins, one of which dips 60° N. and the other 80° NW.

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CHERRY CREEK (EGAN CANYON) DISTRICT*

By F. C. SCHRADER White Pine County

INTRODUCTION

The present report is based mainly on a brief visit made to the Cherry Creek District in August, 1930. The writer desires to acknowledge the aid and valuable information obtained from several mining engineering reports, which were kindly furnished by mining men of the district, especially members of the New Nevada Standard Mining Co.

The district has been described by Emmons,[1] Spurr,[2] Hill[3] and Lincoln,[4] on whose reports the present sketch down to the year 1923 is largely based.

LOCATION

The Cherry Creek District is in the Egan Range, four miles west of the Northern Nevada Railroad, with which it has mail-stage connections. (See Figure 1.) It is 90 miles south of Cobre, on the Southern Pacific Railroad, 70 miles south of Shafter, on the Western Pacific Railroad, and 50 miles north of Ely, the seat of White Pine County. Cherry Creek, in the early days a populous town, now has only about 40 inhabitants but is still the distributing point to much of the surrounding mining country.

TOPOGRAPHY

The Egan Range in the Cherry Creek District is a high, narrow ridge that separates Steptoe Valley on the east from Butte Valley on the west. The town of Cherry Creek is at an altitude of about 6,000 feet. It is situated at the mouth of Cherry Canyon at the upper edge of a long, gentle slope that rises about 600 feet in the four miles west from the railroad station. North and west of the town the mountains rise by steep slopes and cliffs

*Published by permission of the Director, U. S. Geological Survey.

[1]Emmons, S. F., Egan Canyon District: U. S. Geol. Expl. 40th Par. Rept., vol. 3, pp. 445–449, 1870.

[2]Spurr, J. E., Descriptive Geology of Nevada South of the Fortieth Parallel and Adjacent Portions of California: U. S. Geol. Survey Bull. 208, pp. 47–52, 1903.

[3]Hill, J. M., Notes on Some Mining Districts in Eastern Nevada: U. S. Geol. Survey Bull. 648, pp. 161–172, 1916.

[4]Lincoln, F. C., Mining Districts and Mineral Resources of Nevada, pp. 242–244, Reno, 1923. (Contains full bibliography.)

to an altitude of more than 8,000 feet in less than three miles. From Cherry Canyon for five miles southward to Egan Canyon, which is a narrow notch cut through the range, the topography is less rugged.

GEOLOGY

SEDIMENTARY ROCKS

The rocks of the district consist of sediments of supposed

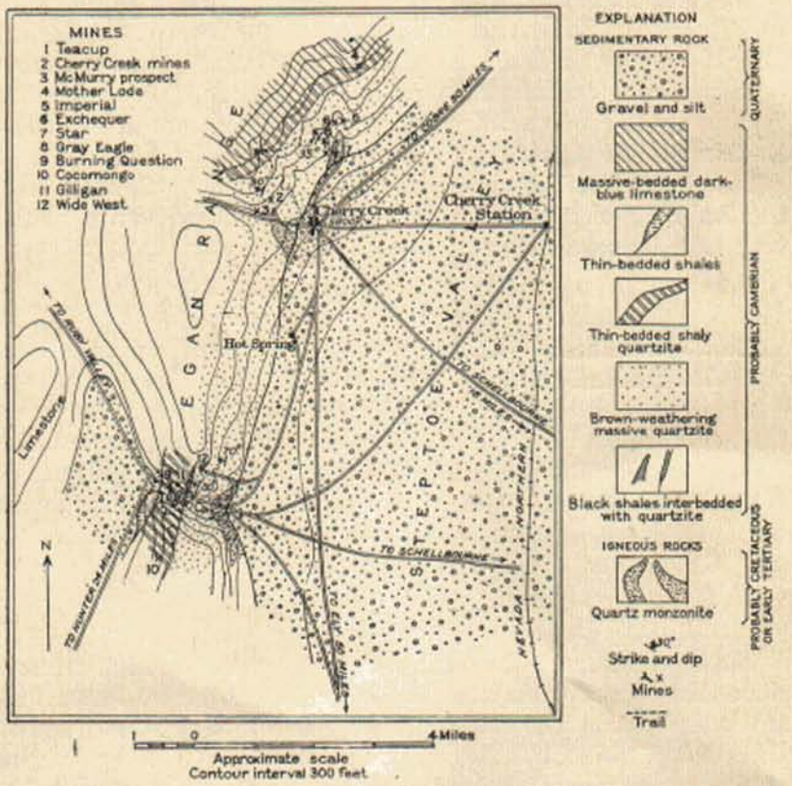

FIGURE 1

Sketch Map of the Cherry Creek (Egan Canyon) District, White Pine County, Nevada. (Hill, U. S. G. S. Bull. No. 648.)

Cambrian age. Their distribution and sequence are shown in Figure 1.

In the east slope of the range the rocks in general dip west-northwest at angles of about 40°, but in the west slope they dip east, according to Spurr, who regards the range as having been carved from a shallow syncline. Accordingly, in the east slope the older rocks are exposed along the base of the range. Here

they are chiefly thick-bedded brownish quartzites, with some interbedded dark arenaceous, micaceous, and argillaceous shales; near the top of the series the quartzite becomes thin bedded and nearly white. The quartzites and shaly quartzites are at least 3,000 feet thick and are thought to be the equivalent of the Cambrian Prospect Mountain quartzite of the Eureka section.[5] They are overlain by blue-gray limestone and intruded by small dikes and masses of quartz monzonite and diabase. Hill[6] suggests that the limestone and the dark shale near its base, which overlies the quartzite northwest of Cherry Creek are probably to be correlated with the Cambrian Eldorado limestone of the Eureka section.

At the Star mine, just below the assay office and mill, in the lowest part of the section exposed, there is a bed of hard siliceous conglomerate about 50 feet thick, composed mainly of white quartz and dark slate pebbles averaging less than half an inch in diameter. The persistence of this bed is not known, but the horizon of the exposure suggests that it may mark an unconformity.

IGNEOUS ROCKS

The only igneous rocks found in the district are quartz monzonite and diabase, which are intrusive into the older sediments.

Quartz Monzonite

Quartz monzonite porphyry occurs as small masses and dikes within a north-south belt about six miles long and more than a mile wide. The most prominent masses are at the mouth of Egan Canyon and at the Cherry mines in Cherry Canyon; the principal dikes are west of the Star mine. In the Star mine a persistent dike was noted in the west drifts on the sixth and seventh levels and on the tunnel level at the end of the Star vein in the Walker drift. It also occurs in the Imperial and Exchequer mines.

The rock that forms small masses, as typically seen in the Mary Ann mine of the Cherry Creek group, where it is associated with the veins, is gray, medium grained, granitoid, and porphyritic with pink orthoclase phenocrysts as much as half an inch in length. It is composed of orthoclase and oligoclase-andesine in about equal amounts, quartz, greenish-brown biotite, and a little hornblende, with apatite, magnetite, and titanite as accessories. The rock that forms dikes, however, is finer grained

[5] Hague, Arnold, Geology of the Eureka District, Nevada: U. S. Geol. Survey Mon. 20, pp. 34–36, 1892.
[6] Hill, J. M., op. cit., p. 163.

and more basic where fresh, but in the mines it is in general highly altered, the feldspars being changed chiefly to sericite and the biotite to chlorite and iron oxide. Gradations showing the close relation of these different varieties are observable in thin sections studied under the microscope. Probably most of the ore deposits are genetically connected with the quartz monzonite, which is mapped by Hill as of probable Cretaceous or early Tertiary age.

The dike associated with the Exchequer vein in the Imperial mine is a dull-gray fine-grained rather dense rock, which contains little or no visible quartz and corresponds closely to monzonite. In the neighboring Exchequer mine the dike along the same vein is a darker-gray medium-grained quartz monzonite porphyry and has a microgranitic structure. It is distinctly siliceous and is speckled with feldspar phenocrysts 0.2 inch or less in diameter. It contains more ferromagnesian minerals than the dike in the Imperial mine.

In the Walker drift of the Star mine the rock is greenish gray and appears to be intermediate between the two varieties just described, but the microscope shows it to be an altered quartz monzonite porphyry. It contains finely disseminated pyrite and shows a parallel arrangement of the minerals that in places resembles flow structure. Much chlorite derived from biotite gives it the greenish tinge.

Diabase

The diabase is nearly black, with fine-grained ophitic or diabase texture. It occurs as a dike on the tunnel level of the Star mine and probably also on the deeper levels, for fragments are found on the Star shaft dump. It is composed chiefly of basic plagioclase, augite and biotite. The rock on the Star dump has been hydrothermally altered. It is sparingly pyritic and contains much magnetite, much green hornblende, derived from augite, and chlorite and iron oxide derived from biotite. The rock is believed not to be genetically connected with the ore deposits, though it seems to be older than the veins in the Star mine.

ORE DEPOSITS

HISTORY AND PRODUCTION

Ore was first discovered in the district in 1861 in Egan Canyon, on the Gilligan vein, and, by 1866, $60,000 worth of ore had been produced there. Estimates of production prior to 1902 range from $6,000,000 to $20,000,000.

The production for which figures are available, based chiefly

on reports by V. C. Heikes in "Mineral Resources of the United States," is as follows:

Period	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Total value
1902–1904	.....	6,201.57	52,975	.....	.....	$152,735
1905–1922	23,758	*$246,154	334,720	96,053	645,788	566,670

*Value.

Mining in the district was most active from 1872 to 1883, and during that period the population of Cherry Creek is said to have reached 6,000. But decline followed, and production practically ceased in 1893, with the demonetization of silver. Later, however, the camp revived, and since 1895 work has been done at several properties, notably the Star, Exchequer and Teacup mines, which have been worked more or less steadily on a small scale down to the present time.

In 1905 to 1908 the Teacup mine was active and shipped ore. Up to about 1906 the Exchequer, which by some is credited with an early production of $3,000,000, is known to have produced $2,500,000 while it was worked by the Jones-Hand-Prior Co. In 1906 to 1910 the Star mine produced ore and later kept the water pumped out until 1913, when it, together with the Nevada-British, Chief of the Hills, and Mascot was acquired by the Nevada Standard Co. From 1917 until the drop in silver in 1923 the Mary Ann mine, a member of the Cherry Creek group then being worked by the Cherry Creek Silver Dividend Mining Co., produced $35,000 worth of silver ore, which contained also about $1 in gold to the ton. Prior to 1893 this mine is reported to have produced $65,000. The mine is opened chiefly by an upper and a lower tunnel, each 1,000 feet long. The veins and ore dip east in limestone and quartz monzonite.

In 1920 to 1923 the Exchequer mine, reopened by the Silver Dividend Mining Co., of Pioche, produced 5,350 tons of silver ore that ran $16 to the ton, a total value of $85,600. Since 1924, when the Star mine was taken over by the Nevada Standard Mining Co., it and the Exchequer have been worked on a moderate scale and the Star has produced about $27,000. The North Mountain mine, in Egan Canyon, was worked in the fall of 1929 and produced several hundred tons of ore.

TYPES OF DEPOSITS AS DESCRIBED BY HILL[1]

"There are two somewhat overlapping types of veins in the Cherry Creek (Egan Canyon) District. One type, represented by the Wide West, Cocomongo, and possibly the McMurry prospect, has its principal value in gold carried in a white quartz gangue

[1]Hill, J. M., op. cit., p. 165.

that shows a minor amount of pyrite and less galena. The other and by far the most important in the district is represented by the Exchequer, Star, Biscuit, Cherry Creek, and Gilligan veins, which carry galena, sphalerite, pyrite, and rich secondary silver minerals. That there may be a transition between these two types is strongly suggested by the Exchequer New Century (Imperial) vein, in Exchequer Canyon, north of Cherry Creek. West of the canyon, on the Exchequer ground, the quartz carries the base-metal sulphides and contains more silver than gold; and east of the canyon, on the New Century (Imperial) ground, what appears to be the same vein is not strongly mineralized but carries pyrite, gold, and silver. It may be that the gold- and silver-bearing portions of the veins are those parts which have not been strongly mineralized and that the ore shoots will all prove to be of the lead-zinc type, carrying more silver than gold. In both types the veins are strong in the quartzites but tend to finger out where the fissure enters argillaceous shales. This is particularly well shown on the Gilligan and Star veins.

"At the upper tunnel on the Cherry Creek Co.'s property the ore body is a mineralized quartz monzonite dike carrying galena, sphalerite, and pyrite. It is evident that the dike was metallized after its consolidation, and it is believed that most of the veins of the district were formed shortly after the intrusion of the quartz monzonite.

"The lead-zinc veins have been crushed since the deposition of the original ores and have been enriched by descending waters which have deposited rich silver minerals such as argentite, proustite, and an antimonial silver-lead-copper mineral of uncertain composition. The enrichment of the Star vein, as indicated by the largest stopes, was greatest between the third and seventh levels but extended to a depth of 600 feet vertically below the croppings. At the Biscuit mine argentite and copper carbonates are said to have been found to a depth of 1,100 feet on the dip of the vein."

In nearly all the mines oxidation extends to depths of 200 to 300 feet.

MINES AND PROSPECTS

Only a few of the mines were accessible at the time of visit. Their general distribution is shown in Figure 1.

STAR GROUP OF MINES

The Star group of mines is about two miles north of Cherry Creek, in the east slope of the range. (See Figures 1 and 2.)

It comprises the mines or properties and claim groups formerly known as the Star, Gray Eagle, Exchequer, Imperial, and Nevada British, aggregating about 500 acres, which were consolidated under one ownership in 1929.

STAR MINE

History and Production

The Star mine is about one and one-half miles north of Cherry Creek in the southern part of the Star group at an altitude of about 6,700 feet. (See Figure 1.) It was worked chiefly in 1872 to 1883 and has produced more than $6,000,000. After striking a heavy flow of water at the depth of 350 feet in 1880, the Star crosscut tunnel was started for drainage, and a little later mining was resumed and continued until the decline in the price of silver in 1893. Up to that time the mine had produced $5,000,000 in gold-silver bullion, in which gold was the predominant metal by value.

The Glasgow & Western Exploration Co. worked the mine between 1895 and 1910 and advanced the Star tunnel to a point 800 feet beyond the shaft, but the vein disappeared about 400 feet west of the shaft, and as crosscutting to the north failed to find it, it was supposed to have pinched out. An adequate water supply, however, was obtained from the tunnel, and before operations ceased in 1910 three unsuccessful attempts were made to mill the ore locally. The mine was kept pumped out, and in 1913 the Nevada Star Mining Co. began operations. As this company was operated with British capital, the outbreak of the World War forced a withdrawal of financial support, and the mine was again closed in 1914.

The mine was later worked by lessees until 1924, when it was taken over by the Nevada Standard Mining Corporation, under whose operation, directed by J. W. Walker, it has produced about $27,000, more than half of which was in gold.

In 1927 Mr. Walker recovered the Star vein by crosscutting to the south on the tunnel level, and in 1927–1929 he drove the Walker drift 800 feet westward on the vein. During the fall of 1929, until the stock-market crash, the mine and mill employed more than 100 men, and 35 men were kept at work until the midsummer of 1930.

At the time of visit in August, 1930, the Star mine was being worked with a force of 20 men under a cooperative leasing system that was said to be very successful and to yield about $60 net a day. The company was also milling ore from the old Star

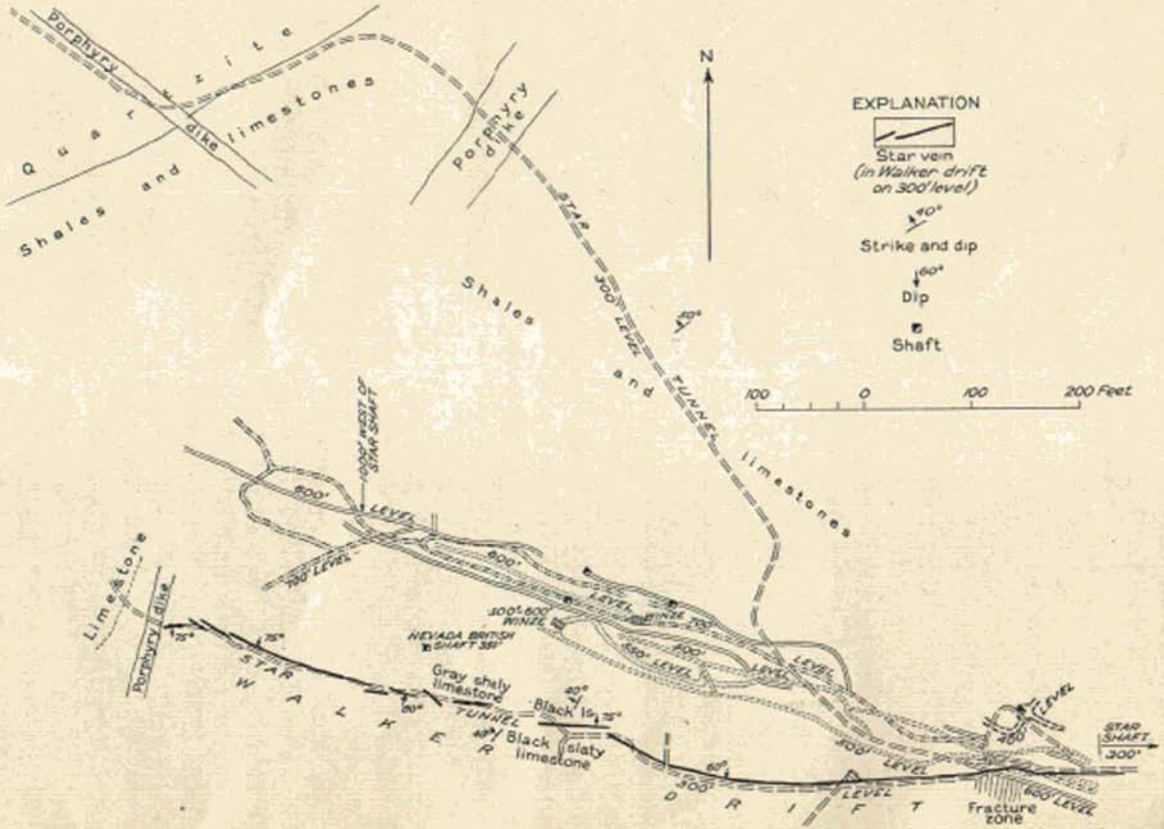

FIGURE 3—Map Showing Part of Workings in Star Mine of the New Nevada Standard Mining Co., Cherry Creek, Nevada. (Diagrammatic.)

shaft dumps which were estimated to contain 10,000 tons, with a tenor of about $6 to the ton in gold and silver, about equal in value, 7 per cent of lead, and 3 per cent of zinc. The concentrates produced contained 288 ounces of silver to the ton, considerable lead, and a small amount of gold, and were hauled by truck to one of the smelters near Salt Lake City. The extraction obtained in the mill was about 92 per cent. The company produced its own electric power and light. The miner's wage was about $5.50 a day and that of the engineer $6.

In March, 1931, the company was treating chiefly ore from these dumps in its flotation mill. The funds thus obtained were being used to drive the new Lower Star drainage tunnel, which was to have a total length of 2,000 feet and had then attained a length of 500 feet.[8]

Development and Equipment

The mine is developed by a three compartment vertical shaft 750 feet deep, with nine levels aggregating more than 15,000 feet of work. (See Figures 2 and 3.) Underground work is conducted through the Star tunnel, or third level, which drains the upper part of the mine. The tunnel, advanced from the 2,000-foot point since 1913, is now 4,200 feet long and intersects the shaft 1,400 feet from the portal at a depth of 340 feet. The lower levels (Figure 3) were under water at the time of the visit, and the old workings above the tunnel level were mostly caved and mined out.

A 20-stamp mill and cyanide plant has recently been remodeled to treat the ore by flotation, and the stamps have been replaced by a ball mill. The plant includes also a small ball mill, a tube mill, a 250-horsepower gasoline engine, an 8-horsepower Diesel engine burning 27° gravity oil, and an emergency Koler-Koler generator.

The Star tunnel discharges 15 cubic feet of potable water a minute, more than enough to supply the camp and a 100-ton mill, and this quantity will probably be considerably increased when the projected Star workings cut the water-bearing strata of the Exchequer mine. If much ore is found in depth in the Exchequer and Imperial mines below the Star tunnel level the company contemplates extending the lower tunnel, which will drain all the mines to a much lower level.

Deposits

The ore occurs in two nearly parallel quartz veins about 30 feet apart which cut across quartzite and shale. They are

[8]Nevada Min. Press, vol. 13, p. 1, 1931.

known as the Star or South vein and the North vein. They are best developed in the quartzite and finger out and become barren in the shale. In a few places they are associated with dikes of the quartz monzonite. The Star vein ends at a quartz monzonite dike near the face of the Walker drift on the Star tunnel level, and both veins are said to cut the same dike near the west ends of the sixth and seventh levels.

The veins have a known horizontal extent of about 2,200 feet and a vertical range of about 900 feet, with good indications in the deepest workings of continuing to greater depths. The winze extending from the seventh to the ninth level, the bottom of the mine, is said to be on the vein and mostly in good ore. In this horizontal extent, however, the deposits include a barren zone extending 250 feet westward from a point a little beyond the shaft. The Star or South vein strikes N. 72° W. and the North vein N. 78° W. Both dip steeply south for the most part, but in places they stand vertical or dip steeply north. Their intersection on the sixth and seventh levels is about 1,000 feet west of the shaft. They have well-defined walls, but little or no gouge. The Star vein is the larger and more productive. It ranges from 1½ to 7 feet in thickness, with an average of 2 feet; one ore shoot mined had a maximum horizontal extent of 1,000 feet and ranged from 1 to 6 feet in thickness, averaging 2½ feet. The North vein, which is about 1 foot wide on the average, has received comparatively little attention.

The veins in places are associated with quartz monzonite and are cut by small vertical normal faults that strike north-northeast, about parallel with the strike of the country rock. The part of the vein west of the fault is generally displaced to the south, as in the Star tunnel east of the shaft. (See Figure 2.)

In the Walker drift the vein ranges from 1.2 to 3 feet in width and carries good ore through almost the entire extent of the drift, near the end of which it ends against a quartz monzonite dike.

In the upper levels the ores are highly siliceous and oxidized, but they become base in depth, where the ore minerals consist mainly of galena, sphalerite, and pyrite in a roughly banded white quartz gangue. These sulphides, however, have been in part replaced by tetrahedrite, proustite, stephanite, pyrargyrite, polybasite, argentite, and chalcopyrite, largely as pseudomorphs after the primary minerals, especially galena and sphalerite. These secondary minerals occur also as veinlets filling fractures in the vein and in the wall rock. Enrichment has extended even

to the eighth and ninth levels, although here the ore is base, carrying about 8 per cent of lead and an equal amount of zinc.[9] Ruby silver and tetrahedrite are present in the richest ore, and silver chloride and bromide were also noted in the oxidized ore.

The ore of the Star mine is said to average about a quarter of an ounce in gold and 20 ounces in silver to the ton, and about 8 per cent each in lead and zinc. It is not amenable to cyanidation. Some of the ore, however, is very rich in both gold and silver and is said to run as high as 800 ounces in silver to the ton. Yellowish-brown scheelite was noted in one specimen. A specimen of the rich gold-silver ore collected by the writer from the vein near the face of the Walker drift consists of vein quartz crudely banded with galena, sphalerite, pyrite, and ruby silver. The gold in the ore is mostly associated with the pyrite and sphalerite. Tetrahedrite, which is rich in silver, is also associated with the sphalerite.

A polished section of the rich ore from the Star tunnel level shows the metallic minerals in order of relative abundance to be pyrite, sphalerite, and galena. The sphalerite contains tiny elongated blebs of chalcopyrite showing a tendency toward parallel orientation. The rough sides of the specimen show wire silver, which has formed along minute seams in the quartz in sufficient quantity, it is believed, to account for most of the silver present. The wire silver is probably of hypogene origin.

A thin section of this ore shows a considerable quantity of a dark silver mineral which may be argentite and also contains small specks of what is probably gold associated with calcite.

According to Hall, who examined the mine in 1928, the reserves at that time amounted to 34,450 tons of ore but this figure did not include the ore in the vein above the Walker drift, which was a later discovery. As the vein carries ore throughout the length of the Walker drift, which is 800 feet long and 650 feet below the surface, it is regarded as containing a large volume of possible stoping ground between the drift and the surface.

Other engineers credit the Star mine with a proved reserve of 15,222 tons of ore containing about 30 ounces of silver to the ton and a possible additional reserve equivalent to 4,000,000 ounces of silver.

GRAY EAGLE VEIN

The Gray Eagle shaft lies about 900 feet northwest of the Star vertical shaft. It is 210 feet deep, and the collar is at

[9]Hall, Clarence, unpublished report on the properties of the Nevada Standard Mining Corporation, 1928.

an altitude of about 7,400 feet, or 650 feet above the Star tunnel level, through which the vein will be worked. (See Figure 2.) The vein strikes N. 60° E. and dips 45° NNW., cutting shale, limestone, and quartzite. It is about 3 feet in width and has a known length of about 1,600 feet. It crosses the Gray Eagle and Chief of the Hills claims. On the latter it has been called the Mascot vein and is said to crop out at a height of 1,175 feet above the Star tunnel level. The ore is said to run about 0.3 ounces of gold and 8 ounces of silver to the ton.

EXCHEQUER AND IMPERIAL MINES

The Exchequer and Imperial (New Century) mines, on the west and east side of Exchequer Canyon, constitute the northern part of the Star group (Figure 2) and are about 3,800 feet north-northwest of the Star mine, at an altitude of about 7,100 feet or 400 feet higher than the Star tunnel, by which they will eventually be drained. They were among the first mines to be worked in the district. They are on two approximately parallel veins, about 60 feet apart, the Exchequer or North vein and the Blue vein, which strike about N. 80° E., stand about vertical, and have a length of about 3,000 feet on the property but are said to be known from outcrops to have a total extent of more than 4,000 feet.

The veins lie in the series of argillite, limestone, shale, and quartzite, which here has been much disturbed, and are associated with one or more dikes of the quartz monzonite porphyry. The ore is reported to run 22 ounces of silver and 0.05 ounce of gold to the ton, and much of the quartzite and quartz monzonite porphyry between the two veins is supposed to be sufficiently mineralized to form ore of milling grade.[10]

IMPERIAL MINE

The Imperial mine is opened by an adit 600 feet in length and a 320-foot shaft. The adit is driven westward on the Exchequer vein and intersects the shaft about 70 feet below the surface. At the time of visit the shaft was accessible only to the 150-foot level. The vein here consists mainly of a mineralized quartzite breccia in a fault zone about 11 feet wide and is associated with a fine-grained quartz monzonite dike which forms a considerable portion of its south wall and extends southward to the Blue vein. The ore-bearing portion of the vein, however, is from 2 to 6 feet wide and averages about 4 feet.

[10]Hand, C. T., unpublished report on the Exchequer and Imperial mines, September 27, 1919.

There is said to be ore in the bottom of the shaft, but no large body of sulphide ore has been found. According to Prior,[11] the strongest showing is on the 250-foot level, where the ore shoot for a length of 110 feet averages 6 feet in width.

The ore minerals are pyrite, galena, tetrahedrite(?), cerargyrite, stromeyerite, and argentite(?). A considerable portion of the ore is said to run about 30 ounces in silver and $1 or more in gold to the ton.

The ores are not as complex as those of the Star mine and can be cyanided. Cerargyrite, said to have been abundant in the surface ores first mined, was not seen in the present workings, although the ore now exposed is more or less oxidized.

The minerals are finely disseminated in the gangue and in part follow fractures and seams, along which they form irregular replacement bodies extending laterally into the quartzite and quartz.

The principal ore mineral occurring along fracture planes in the quartz is a black mineral which a polished section of the ore shows to be stromeyerite $(Cu,Ag)_2S$. In places this is partly oxidized to malachite and black copper oxide (melaconite). Limonite is also present in places. All these minerals are regarded as of supergene origin.

According to reports by several engineers the total proved and possible reserves of the mine amount to 132,125 tons of ore with a tenor of 25 to 35 ounces of silver to the ton.

EXCHEQUER MINE

The Exchequer mine, on the west side of the canyon, is opened by a 1,200-foot tunnel and a 220-foot shaft, mainly on the Exchequer vein, which has produced more than $3,000,000 in silver, much of it from ore of shipping grade.

For the first 600 feet of the drift westward from the portal the Exchequer vein is separated from the Blue vein by a 30-foot dike of quartz monzonite porphyry. Throughout this part of the mine the vein is 12 feet thick and contained an average width of 10 feet of low-grade ore, which occurred in shoots 2 to 8 feet thick that raked steeply north. There was also high-grade ore in streaks, mainly in a zone 4 feet wide along each wall.

The oxidized ore is very siliceous and resembles that in the Imperial mine. A considerable shipment made by J. W. Walker ran 92 per cent silica.

[11]Prior, C. E., unpublished report on Exchequer and Imperial mines.

The average of ore reserves with which several engineers credit the Exchequer mine is as follows:

Proved—31,000 tons of ore containing about 30 ounces of silver to the ton.

Partly proved—34,000 tons of ore containing about 25 ounces of silver to the ton.

In 1919 it was estimated that the ore of the Exchequer and Imperial could be mined and milled at a cost of about $6.50 a ton.

BLUE VEIN

Although the Blue vein has been but little developed, it is said to be nearly as promising as the Exchequer vein. Much of it for a width of 8 to 11 feet is said to average 16 ounces in silver and 80 cents in gold to the ton.

TEACUP MINE

The Teacup (Biscuit) mine (No. 1, Figure 1) is 2½ miles northwest of Cherry Creek, near the top of the range, at an altitude of about 7,800 feet. It is probably on the continuation of the Mother Lode zone, described below. It was worked in the early days and also in 1907 and 1912 and is said to have produced about $3,000,000 in silver. It is developed to a depth of 1,100 feet through a shaft that inclines westward at an angle of about 40° and has many short levels and drifts. The deposit follows a tabular sheet of fault gouge beneath a 25-foot bed of greenish shale interbedded with limestone. The ore occurs in lenticular bodies of white quartz which have replaced the footwall limestone beneath the gouge. According to Hill, the valuable ore mineral is either argentite or stromeyerite. Copper carbonate stains fracture faces in the ore. A width of 9 feet of good-grade mill ore is reported to be exposed in the bottom of the shaft.

A specimen of dark-gray to blackish ore collected from the dump consists chiefly of replacement quartz of two or more stages of deposition, with veinlets filling fractures. It weathers brown, owing to its iron and manganese content, and is more or less calcareous. Most of its dark mineral content seems to be manganese oxide.

MOTHER LODE

The so-called "Mother Lode," known also as the Upper or Teacup lode, is an extensive mineralized zone near the top of the mountain and relatively inaccessible. It follows the "final" contact between the quartzite-shale series on the east and the

overlying blue massive limestone on the west. For the most part it has a limestone footwall and green shale hanging wall, but in a few places two or three feet of limestone occurs on the hanging-wall side. It is said to average about 20 feet in width and to be traceable from a point south of the Teacup mine 12 miles north-northeastward, to the foot of the mountain, where it passes beneath the detritus of Steptoe Valley. Its outcrop is said to be almost continuous throughout this distance. The lode is geologically and mineralogically very similar to that of the Teacup mine, which seems to be a part of it. Like the Teacup lode, it dips westward at medium angles.

The lode is not known to have made much production other than the $3,000,000 in silver produced by the Teacup mine. In 1919 and 1920 J. W. Walker and associates working on a part of it owned by the Mother Lode Co. crosscut the lode by a 2,000-foot tunnel at a vertical depth of 600 feet. The lode here was found to be 16 feet in width, with an average tenor of $10 a ton. Several shipments of selected ore carried 57 ounces of silver to the ton and 10 per cent of lead, with a high content of silica and iron.

About one and a half miles (five claim lengths) on the southern part of the lode, extending from the ridge north of the Exchequer mine northward, is owned by the Mother Lode Mining Co., of Philadelphia, Pa., and is being operated under lease by the Liberty Mining Co., of White Plains, N. Y.

Adjoining the Mother Lode property on the north is the Good Chance lead-silver prospect, a group of three claims seven miles north of Cherry Creek, which is being worked with encouraging results by S. T. Stafford and associates. Beyond the Good Chance property some of the remaining six miles of the lode has not been staked, and much of the lode as a whole has been but little prospected.

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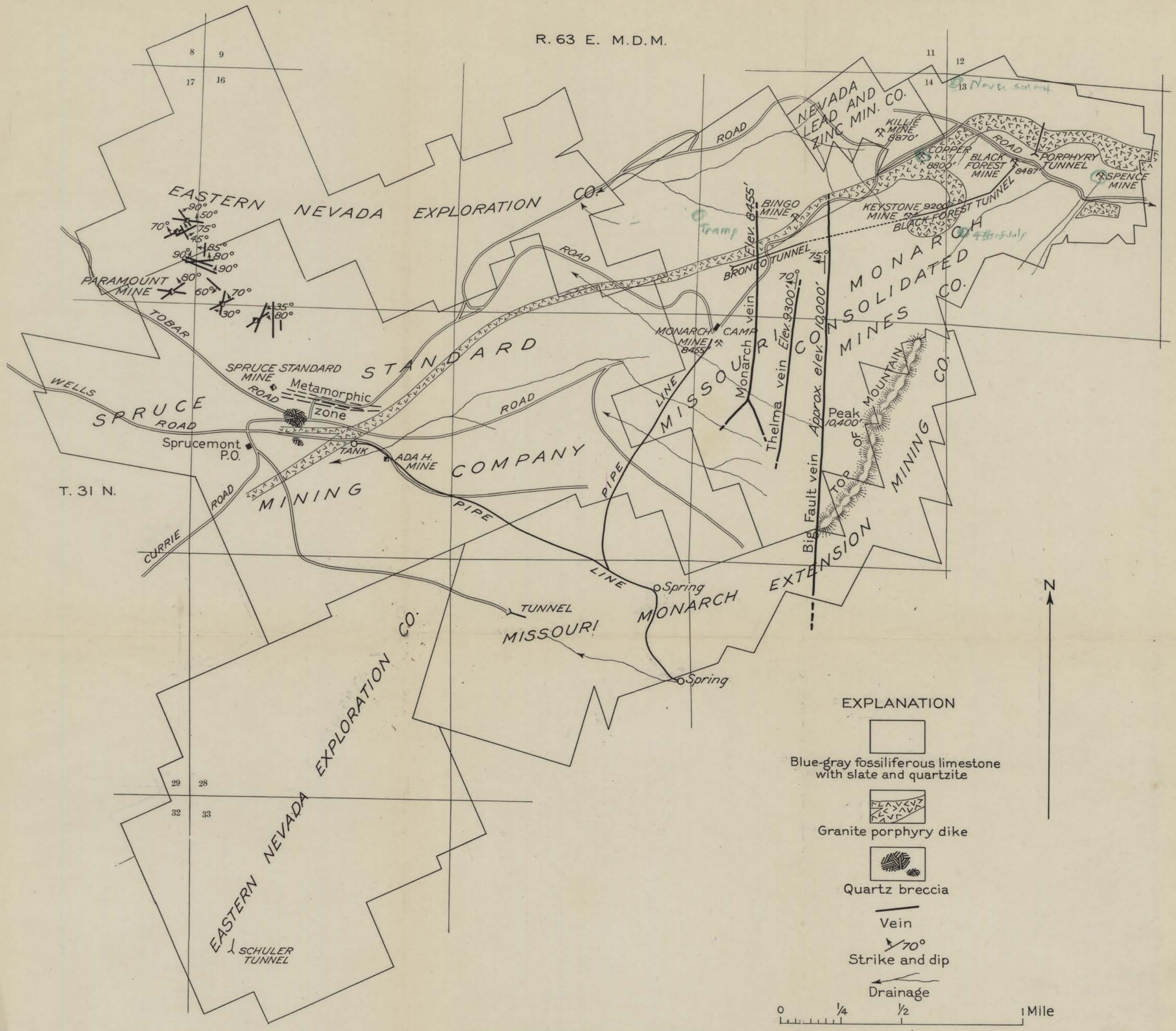

FIGURE 1—Geologic Map of Spruce Mountain District.

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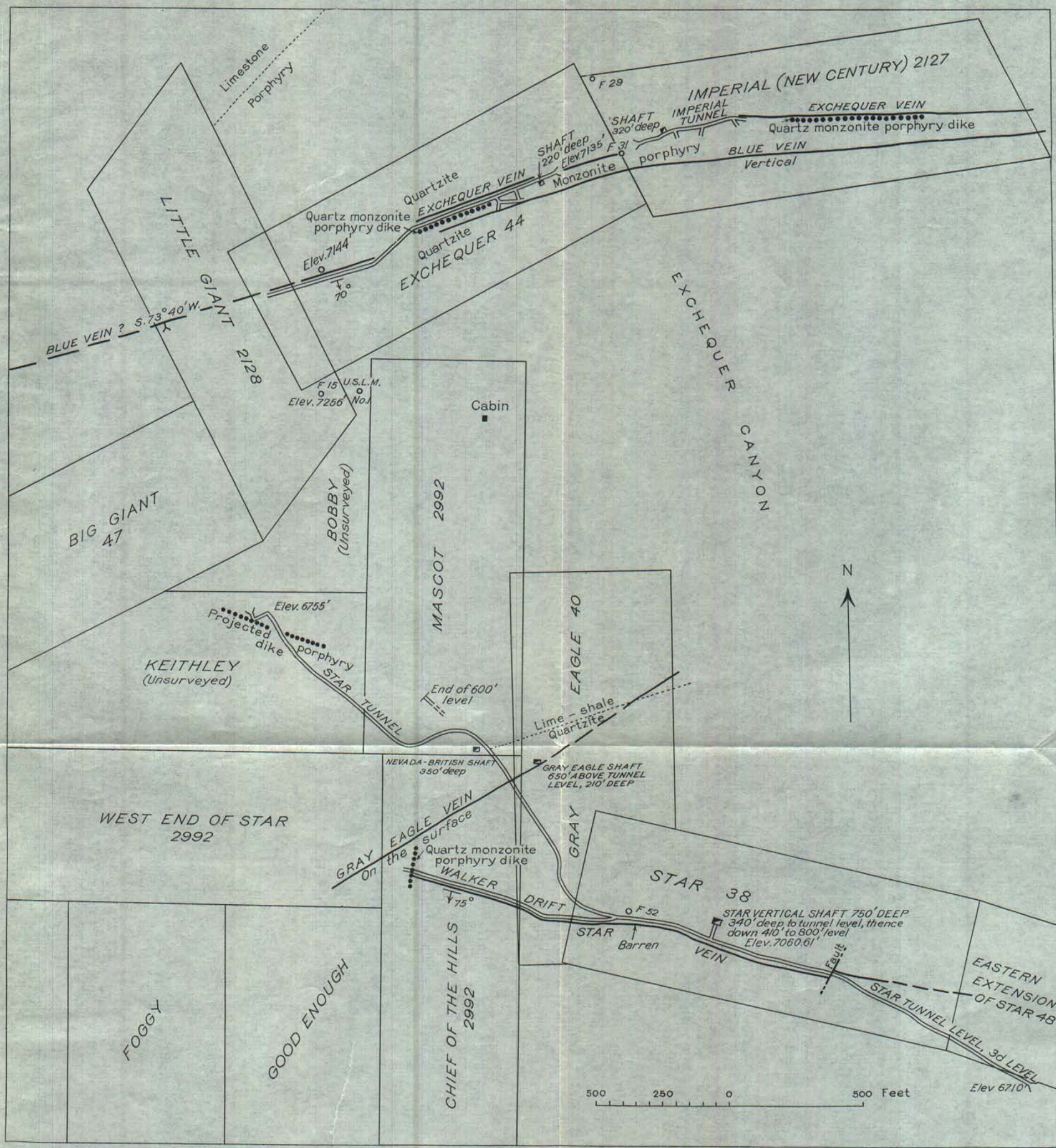

FIGURE 2—Claim and Vein Map of Star Group of Mines.

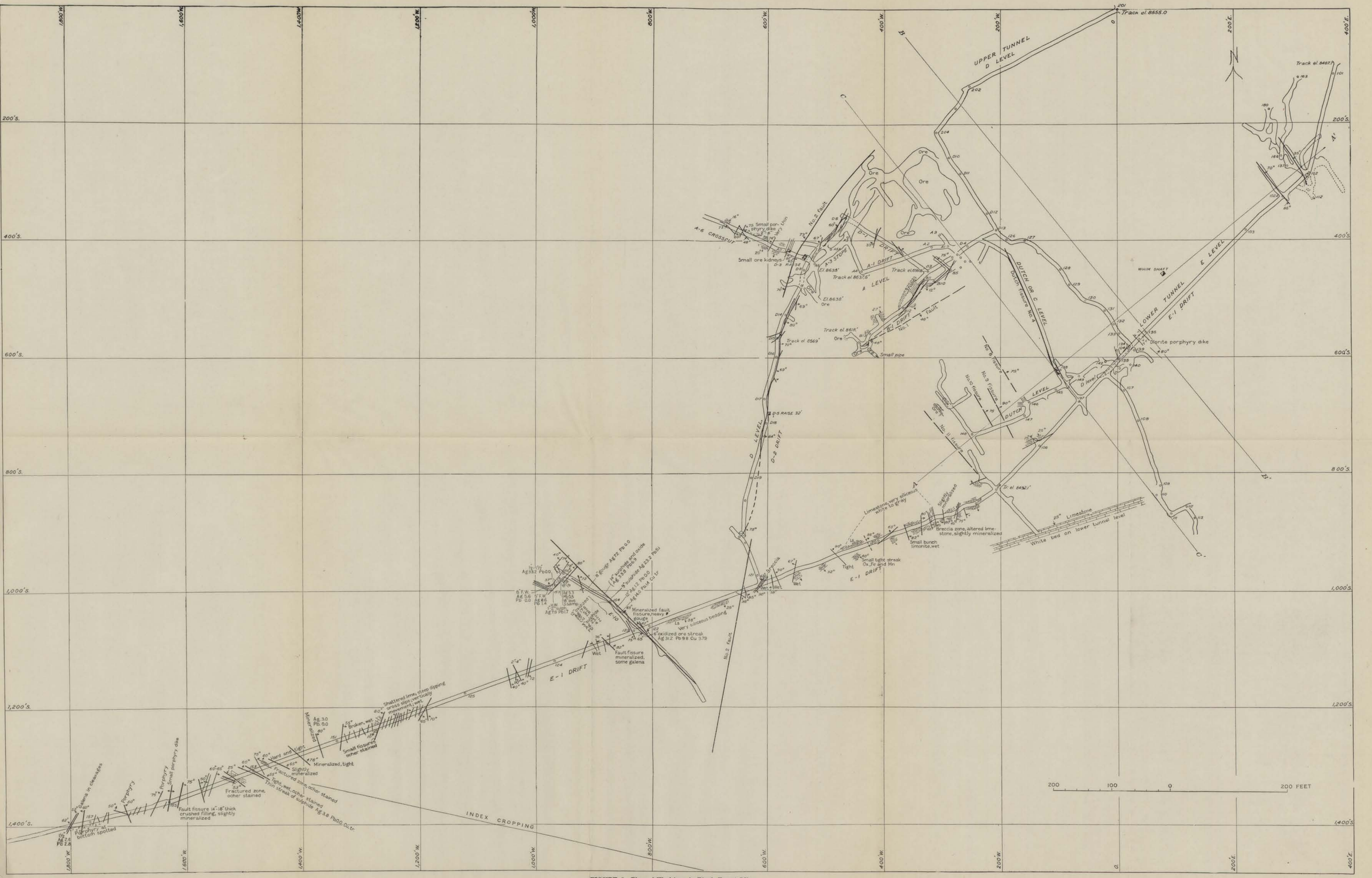

FIGURE 3—Plan of Workings in Black Forest Mine.

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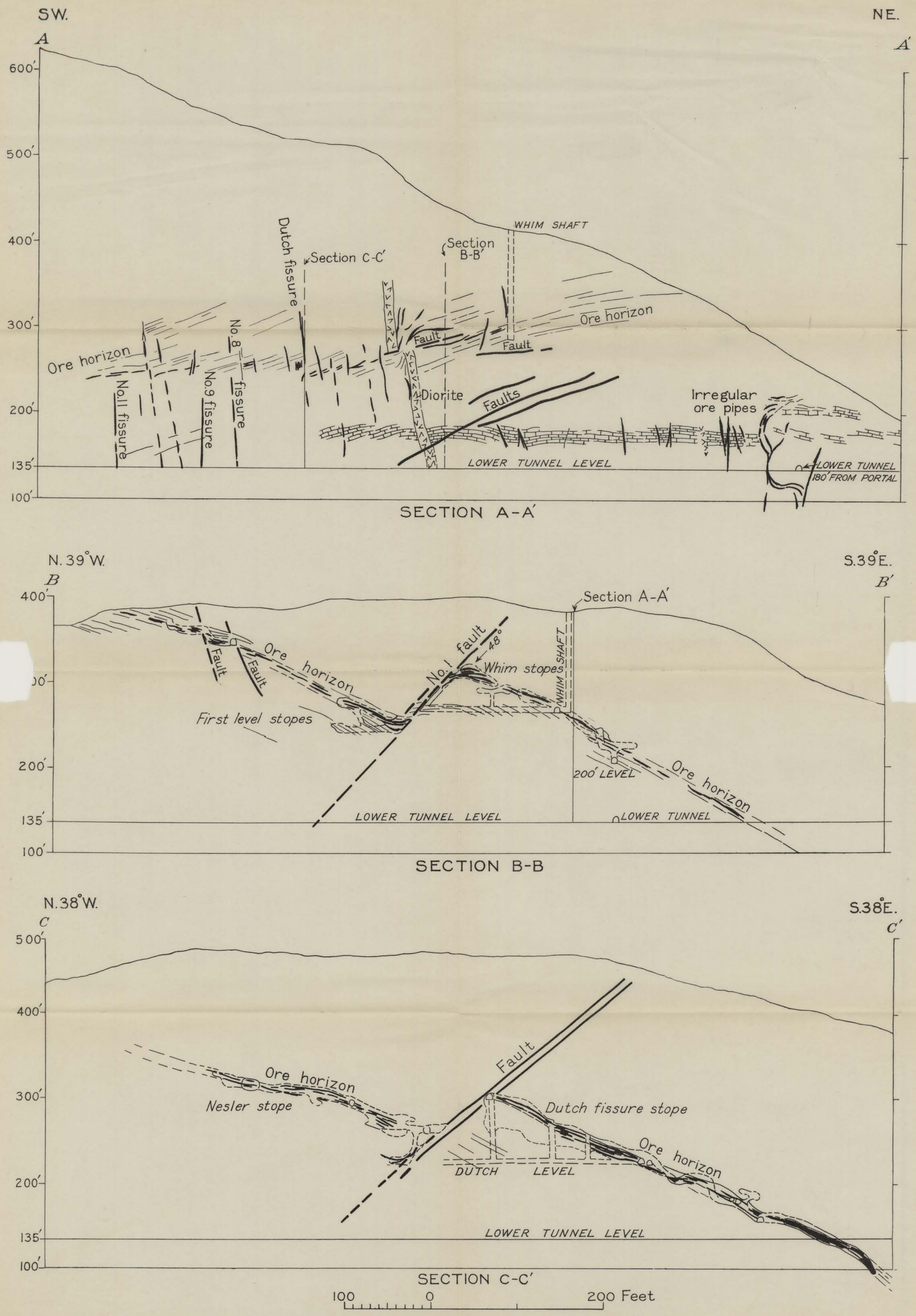

FIGURE 4—Section on Line A–A′, B–B′ and C–C′ in Figure 3, Showing Relations of Fissures and Ore Deposits. Looking Northwest.

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