Geology of the Railroad Mining District Elko County, Nevada

GEOLOGICAL SURVEY BULLETIN 1162-B

Prepared in cooperation with the Nevada Bureau of Mines

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By KEITH B. KETNER *and* J. FRED SMITH, JR.

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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CONTENTS

ILLUSTRATIONS

TABLES

CONTRIBUTIONS TO ECONOMIC GEOLOGY

GEOLOGY OF THE RAILROAD MINING DISTRICT, ELKO COUNTY, NEVADA

By Keith B. Ketner and J. Fred Smith, Jr.

ABSTRACT

The Railroad mining district, covering an area of 3 square miles in the Piñon Range in northeastern Nevada, has produced about $2 million worth of copper, lead and silver. Exposed rocks include the Pogonip Group, Eureka Quartzite, and Hanson Creek Formation of Ordovician age, Lone Mountain Dolomite of Silurian age, Nevada Formation and Devils Gate Limestone of Devonian age, and unnamed clastic units of Mississippian age. These rocks were folded into an overturned anticline and then broken by high-angle normal and reverse faults. Paleozoic rocks were intruded by a granitic stock having a rhyolite porphyry core and by rhyolite porphyry dikes. Primary pyrite, chalcopyrite, galena, and sphalerite and tetrahedrite in host rocks of marble and diopside and garnet skarn have been altered by weathering to oxide, carbonate, sulfate and silicate minerals. Some mineralized rock contains remarkably high concentrations of rare earth elements and beryllium.

INTRODUCTION

Rocks of the Piñon Range were first studied by Clarence King and Arnold Hague about the year 1870. Their observations, which included bare references to the newly discovered Railroad mining district (fig. 1), were published by Hague (1877). Hague's remarks were later supplemented with a geologic cross section of the Piñon Range in the vicinity of the Railroad district by C. D. Walcott (in Hague, 1892, p. 200); the section is virtually correct. The first geologic examination of the mineral deposits was made in 1908 when W. H. Emmons spent a few days in the district. At that time many early mines had been closed for years. Emmons (1910, p. 88–95), however, described the deposits then being worked. More recently Granger and others (1957, p. 126–132) summarized geologic data on the district, compiled production figures, and made a geologic sketch map of the district.

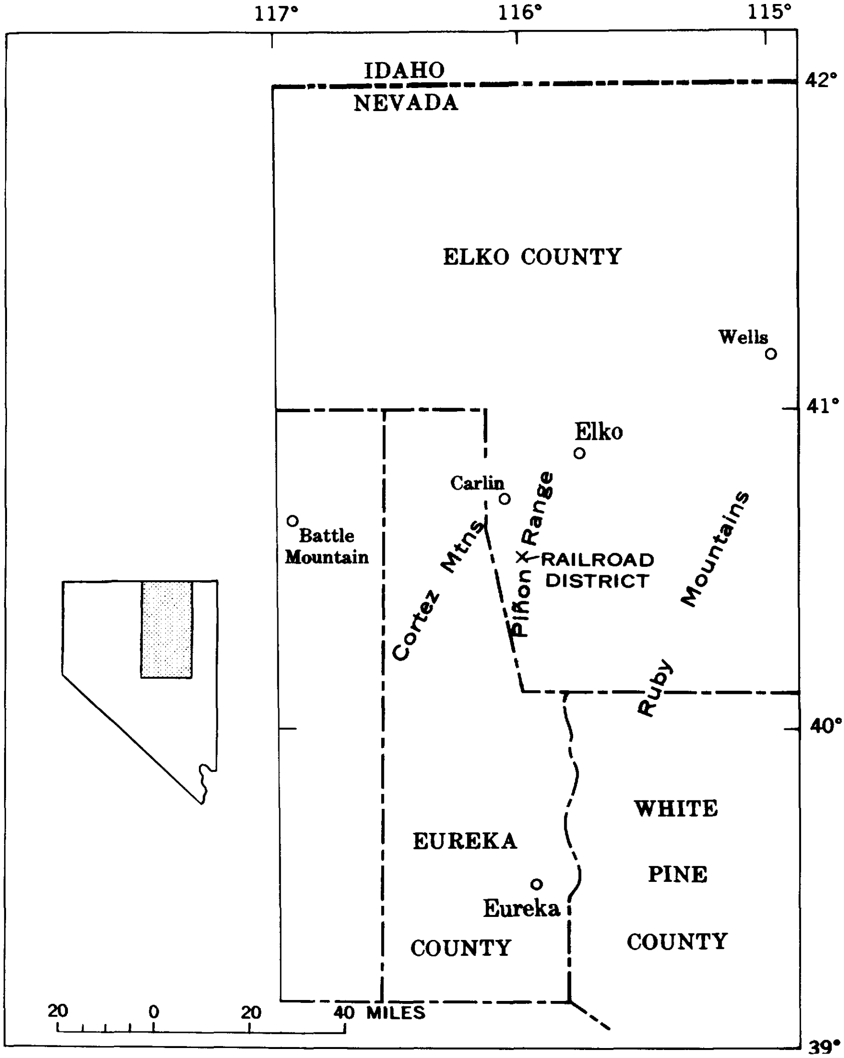

FIGURE 1.—Index map of part of northeast Nevada showing location of the Railroad mining district.

The present report is based on continuing fieldwork begun in 1955 by Smith and Ketner in the Piñon Range and adjacent areas. Results of geologic investigation of a large area surrounding the Railroad district have helped determine the stratigraphic succession and structure within the district. It is hoped that detailed studies of this and other mineral districts together with broader stratigraphic and structural studies will lead to the discovery of concealed mineral deposits.

We appreciate help in the field by Robert Crosson in 1960 and by J. A. Wolfe and P. Gelabert in 1959 and the analytical services by A. P. Marranzino and Uteana Oda.

This work was done in cooperation with the Nevada Bureau of mines.

GEOLOGIC SETTING OF THE RAILROAD MINING DISTRICT

The Railroad mining district straddles the highest ridge of the Piñon Range (fig. 2), one of the lesser mountain chains of the Great Basin. Typically, basin ranges are long and narrow; they trend northward or a little east of north and are separated from one another by broad flat valleys. Most ranges are topographically asymmetrical in cross section; however, the Piñon Range trends more northward than most neighboring ranges, is more symmetrical in cross section, and has more irregular lateral boundaries. A broad valley broken by low hills separates the Piñon Range from the Ruby Range on the east and a narrow valley separates it from the Cortez Range on the west.

The Piñon Range consists mainly of Paleozoic rocks. These can be separated into three distinct sequences on the basis of lithic composition and depositional environment:

1. Carbonate rocks and quartzite of early Paleozoic age totaling about 3,000 feet in thickness; autochthonous.
2. Chert, shale, and mudstone of early Paleozoic age carried from the west on the Roberts thrust fault.
3. Conglomerate, sandstone, shale and limestone of late Paleozoic age which overlap both sequences of lower Paleozoic rocks; autochthonous.

Paleozoic rocks of the Piñon Range are folded in an anticline nearly parallel with the northerly trend of the range. The anticline is broken by both normal and reverse faults of moderate displacement.

Certain topographically asymmetrical basin ranges seem to be the eroded upthrown edges of tilted fault blocks. The adjoining valleys seem to be underlain by the sloping downthrown parts of the fault blocks that have been built up to almost level surfaces by detritus from the ranges. Many topographically symmetrical ranges seem to be horsts with grabens on both sides. The Piñon Range, however, which is unusually symmetrical, does not seem to be faulted continuously on either side. This difference, plus the fact that the range is anticlinal, suggests that the Piñon Range is the physiographic expression of a fold rather than of a fault block.

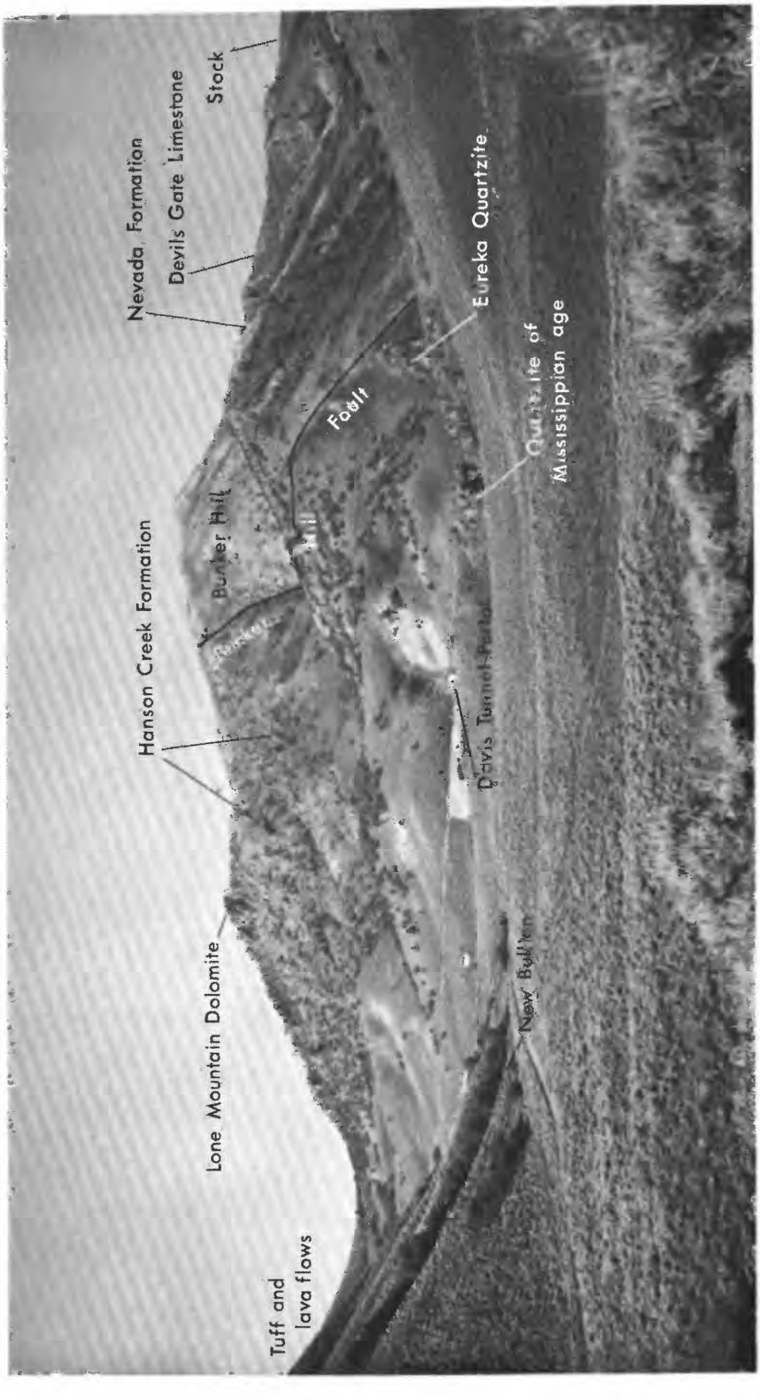

FIGURE 2.—View of the Railroad district, Nevada, from its eastern approach.

GEOLOGIC HISTORY OF THE PIÑON RANGE

During the early part of the Paleozoic Era light-colored sediments, composed of carbonate material and quartz sand, were deposited in the sea which covered the area now occupied by the Piñon Range. At the same time, many miles to the west, black siliceous mud was accumulating. In middle Paleozoic time, about the end of the Devonian Period, the ocean floor to the west was upheaved, and some of the dark siliceous rocks slid eastward and came to rest on the carbonate and quartzose sediments a few miles from the site of the Railroad district (Roberts and others, 1958, p. 2816).

Throughout the rest of the Paleozoic Era aprons of gravel, sand, and mud were spread out by streams from the uplifted western rocks and deposited at the present site of the Piñon Range. This area had remained below sea level most of the time and the detrital siliceous sediments were interbedded with carbonate sediments which continued to accumulate.

After the close of the Paleozoic Era the region was uplifted and deeply eroded. The Piñon Range anticline and associated reverse faults were formed by compressive forces probably in the Mesozoic or early Cenozoic Era.

In the Cenozoic Era new disturbances broke up earlier formed structures along myriads of high-angle normal faults. Magma intruded Paleozoic rocks, broke through to the surface in places, and poured out as sheets of lava and volcanic ash. In the Railroad district, skarn rock was formed, and metalliferous sulfide minerals were deposited deep in Paleozoic rocks penetrated by the intrusives. Erosion exposed the mineral deposits to weathering, and many early-formed sulfide minerals were altered to oxide, sulfate, and carbonate minerals which now compose most of the ore.

STRATIGRAPHY

In the following discussion, Ordovician, Silurian, and Devonian rocks belong to the autochthonous sequence, that is, rocks deposited close to their present location. Mississippian rocks are the lower part of the clastic sequence which was deposited on both the overthrust and autochthonous sequences of rocks. (See pl. 1, fig. 3.) Overthrust rocks are not exposed in the Railroad district.

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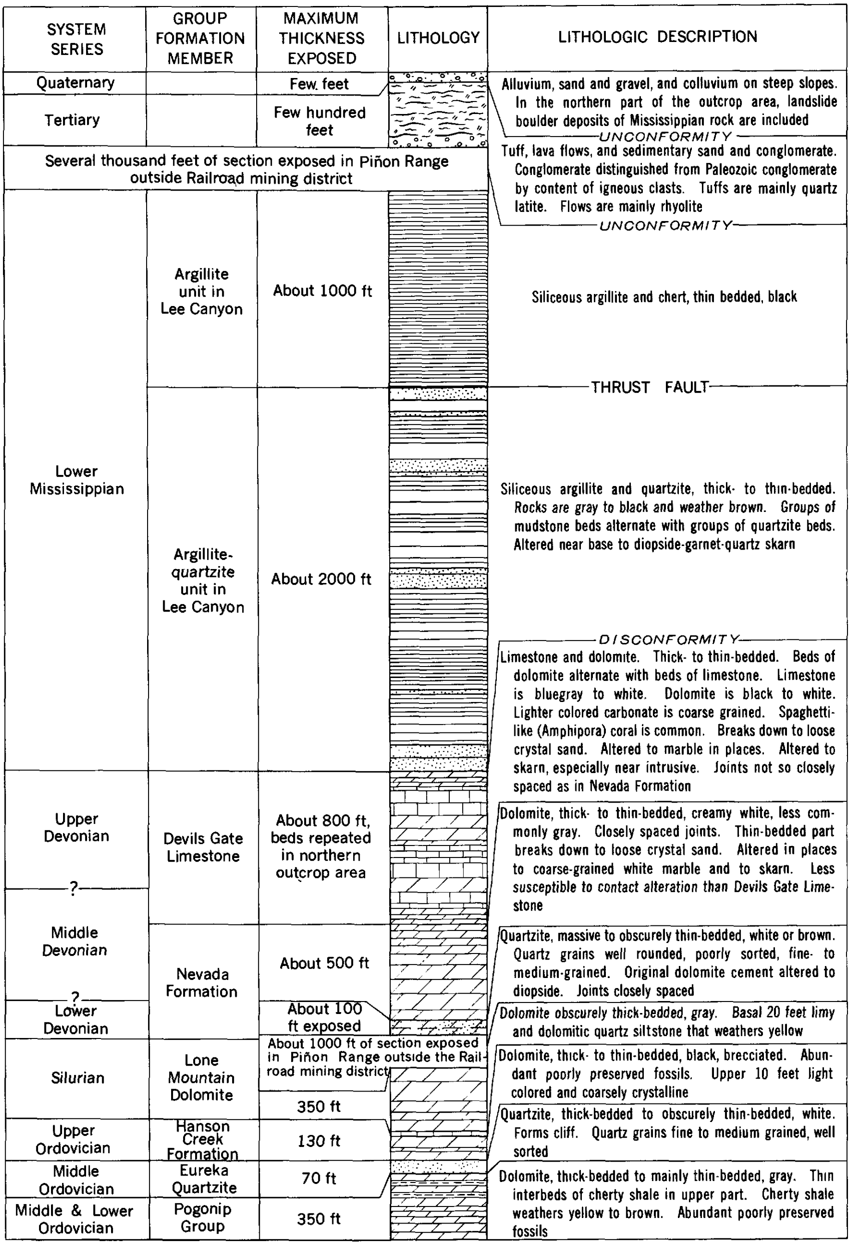

FIGURE 3.—Stratigraphic column of rocks exposed in the Railroad mining district, Nevada.

ORDOVICIAN SYSTEM

POGONIP GROUP

Nolan and others (1956, p. 23) give the history of usage of the term Pogonip and assign to the Pogonip Group in ascending order the Goodwin Limestone, Ninemile Formation, and Antelope Valley Limestone. Beds in the Railroad district assigned to the Pogonip Group resemble the Antelope Valley Limestone in appearance and fauna but are mainly dolomite rather than limestone. R. J. Ross, Jr. (written communication, 1959), stated that the faunal assemblage is probably equivalent to the "Anomalorthis zone" at the top of the Antelope Valley Limestone in the Eureka area.

The lower part of the exposed Pogonip is uniformly dark-gray dolomite that contains many poorly preserved fossils. Beds range from about an inch to slightly more than a foot in thickness. In the upper part, beds of dark-gray dolomite, a few inches thick, alternate with thinner yellow or brown shale partings and beds. In places shale alone or both shale and dolomite are silicified. Fossils are commonly silicified. The dolomite is medium grained and, where partially recrystallized, is whitened. Probably the recrystallization and silicification are secondary alterations caused by the intrusive. Dolomite may be either a primary mineral or a secondary mineral due to alteration by the intrusive. No ore has been found in the Pogonip in this area.

EUREKA QUARTZITE

The Eureka Quartzite is a remarkably widespread thin quartzite unit named by Hague for exposures near Eureka, Nev. (Nolan and others, 1956, p. 29). In the Railroad mining district the Eureka generally is similar to equivalent quartzite in the type area. It consists of white medium-grained pure quartz sandstone and quartzite. It is massive to thin bedded, but bedding is obscure in most exposures. Top and bottom contacts are not clearly visible, but seem to be sharp and not gradational. Unconformities above and below the quartzite noted by Nolan and others (1956, p. 39) in the Eureka district are not evident in the Railroad district.

The Eureka is only about 70 feet thick in the Railroad district. In the type area near Eureka it is as much as 500 feet thick. The apparent northeastward thinning may be due to original thinning rather than to erosion (R. J. Ross, Jr., oral communication, 1960).

The threefold division of the Eureka recognized by Kirk (1933, p. 27–28) is not apparent in the Railroad district.

No significant alteration was observed in the Eureka and little or no ore was mined in it.

HANSON CREEK FORMATION

The Hanson Creek Formation was named by Merriam (1940, p. 10). Nolan and others (1956, p. 32) ably describe the unit in its type area and give the history of its nomenclature.

In the Railroad district the Hanson Creek consists of thick- to thin-bedded fine-grained dolomite and a few limestone beds. It is commonly dark gray to black. Bedding is distinct in some areas but is more commonly obscure. Fossil corals and brachiopods are abundant in places but are poorly preserved; they rarely weather free, but appear as white sections against a dark background.

The Hanson Creek Formation is only 130 feet thick in the Railroad mining district, less than a quarter the thickness of the type section. Like the Eureka, the Hanson Creek probably thinned out originally against the Tooele Arch.

SILURIAN SYSTEM

LONE MOUNTAIN DOLOMITE

The Lone Mountain Dolomite was named by Hague in 1883 (p. 262–263). The subsequent history of its nomenclature and its description in the type area are given by Nolan and others (1956, p. 37) and by Merriam (1940, p. 10).

In the Railroad district the lower 350 feet of the Lone Mountain Dolomite is exposed. Its contact with the Hanson Creek Formation seems to be conformable. The lower 20 feet of the Lone Mountain consists of limy and dolomitic quartz siltstone that is light olive gray and weathers yellow. This unit may be correlative with the Roberts Mountains Formation, but as no fossils were found in it a positive correlation is not possible. The rest of the exposed Lone Mountain is obscurely thick bedded gray dolomite.

The formation is mineralized locally at its fault contact with the eastern outcrop of rhyolite porphyry (pl. 1), but production from this unit was probably not great.

DEVONIAN SYSTEM

NEVADA FORMATION

History of the stratigraphic term Nevada is summarized and the formation is described near the type area by Nolan and others (1956, p. 40-48). Carlisle and others (1957, p. 2180) describe the Nevada Formation in the Piñon Range. In both papers the Nevada Formation is divided into a lower carbonate unit, a middle quartzite unit, and an upper carbonate unit. Nolan and others further subdivide the upper unit.

In the Railroad district the upper part of the quartzite unit and at least a part of the upper carbonate are recognized, but the lower carbonate is not recognized if present. The quartzite unit is named the Oxyoke Canyon Sandstone Member by Nolan and the Union Mountain member by Carlisle. In the Railroad district the exposed part of this member consists of obscurely thick bedded to obscurely thin bedded quartzite that is closely jointed and that grades in color from white to colorless to brown. Well-rounded poorly sorted quartz grains, which range from 0.1 to 0.5 mm in diameter, are set in an originally dolomitic matrix. In the quartzite north of Bunker Hill the matrix has been altered to diopside. Little or no ore is known to have been mined from the quartzite unit.

Carbonate beds of the Nevada Formation resemble the upper carbonate unit more closely than the lower carbonate, although alteration makes identification difficult. Beds range from thick near the presumed base to thin near the top. The rock is closely jointed, fine- to medium-grained, and creamy white or, less commonly, gray. The thin-bedded part weathers to loose crystal sand. This rock, formerly dolomite, has been altered in places to coarse-grained white marble and to skarn that consists principally of garnet and diopside. It seems to have been less susceptible to contact alteration than was the overlying Devils Gate Limestone.

Many of the ore deposits are in carbonate rocks of the Nevada Formation.

DEVILS GATE LIMESTONE

The Devils Gate Formation was defined on the basis of certain fossils by Merriam in 1940 (p. 16). Nolan and others (1956, p. 48) redefined it on a lithologic basis and renamed it Devils Gate Limestone. The Devils Gate, as Nolan and others describe it, is recognizable in the Railroad mining district, but here it consists in part of dolomite, perhaps of secondary origin.

In the Railroad district the Devils Gate consists of sequences of limestone beds alternating with sequences of dolomite beds. Both limestone and dolomite are thick to thin bedded; alternate light and dark thin bands are a distinctive characteristic of much of the limestone, particularly where the limestone has been recrystallized.

The limestone is blue gray to white, and original grain size is fine. The dolomite is black to white, and original grain size is fine to medium. A few chalcedony-bearing beds are yellow. Spaghetti-like coral is common in the darker-colored beds. Both limestone and dolomite have been altered in places to white marble and to skarn. On weathering the carbonate rock breaks down to loose crystal sand. Joints in the Devils Gate are more widely spaced than in the Nevada Formation.

Most of the mines in the district are in the Devils Gate, and the formation has been more extensively altered to skarn than any other unit.

MISSISSIPPIAN SYSTEM

Siliceous argillite, siltstone, and quartzite aggregating more than 1 mile in thickness overlie the Devils Gate Limestone. These beds are well exposed in Lee Canyon and in this report are designated as the argillite-quartzite and argillite units in Lee Canyon. Elsewhere the Mississippian rocks are undifferentiated.

ARGILLITE-QUARTZITE UNIT IN LEE CANYON

The argillite-quartzite unit exposed in Lee Canyon is about 2,000 feet thick. It is composed of interbedded siliceous argillite, siltstone, and lesser amounts of quartzite in beds ranging from a few inches to 2 feet in thickness. Rocks of this unit are gray or black on fresh surfaces and brown on weathered surfaces. The siliceous argillite consists mainly of very fine intergrown quartz grains, carbon, authigenic potassium feldspar, clay, and, near the base of the unit, of secondary diopside and garnet. The siltstone and quartzite are composed mainly of quartz grains and lesser amounts of chert grains.

Poorly preserved cephalopods in some of the lower beds are of probable Early Mississippian age, according to Mackenzie Gordon, Jr. (written communication, 1960). The contact between the Mississippian rocks and the Devils Gate Limestone seems to be concordant in the mining district, but relations outside the district indicate an unconformity.

ARGILLITE UNIT IN LEE CANYON

The argillite unit which has been thrust over the argillite-quartzite unit in Lee Canyon is about 1 mile thick, but only the lower part of this unit is exposed in the area shown on plate 1. Beds range from an inch to several inches in thickness. The entire unit is composed of black siliceous argillite and chert which weather black also. The contact between the two Lee Canyon units is generally concordant, but relations outside the district indicate that the contact is a thrust fault.

No fossils were found in this unit in Lee Canyon, but rocks with which the unit can be reasonably correlated contain Early Mississippian conodonts identified by W. H. Hass. The argillite unit in Lee Canyon outside the map area is overlain by shale, sandstone, and conglomerate of Early Mississippian age.

TERTIARY SYSTEM

Several hundred feet of quartz latite tuff and black vitrophyre are exposed in the eastern part of the map area. A small exposure of conglomerate containing igneous clasts near the portal of the Davis tunnel is assigned to the Tertiary System.

Tertiary rocks lie on Paleozoic units with profound unconformity.

QUATERNARY SYSTEM

Stream-laid sand and gravel, landslide debris, and colluvium compose the material of the Quaternary System. This material is estimated to be a few feet to a few hundred feet thick. Large quartzite boulders apparently derived from Bald Mountain form a landslide in the northeast corner of the map area.

INTRUSIVE ROCKS

Mississippian and Devonian rocks in the Railroad district are penetrated by a silicic stock about one quarter of a square mile in outcrop area. The stock consists of an outer shell of medium-grained granite, monzonite, and quartz diorite and a core and marginal bodies of rhyolite porphyry. A large dike of rhyolite porphyry, named the Bunker Hill dike, extends from the rhyolite core eastward through the outer shell of the stock and into the country rock on Bunker Hill. Although the Bunker Hill dike does not crop out continuously, a high concentration of halloysite, an alteration product of porphyry, in excavations and on dumps on the north side of Bunker Hill indicates that the dike is continuous under a cover of Quaternary colluvium.

Typically, the granite, monzonite, and quartz diorite in the outer shell of the stock is hypautomorphic granular to porphyritic and fine to medium grained. Many of the larger plagioclase grains are zoned progressively outward but also show uncommon reversals. Biotite is the only mafic mineral. Two specimens of granitic rock analyzed spectrographically (table 1, samples 660 and 654) contain more than average amounts of titanium, barium, strontium, zirconium, and molybdenum (Turekian and Wedepohl, 1961). In addition, sample 654 contains more than average amounts of copper and tungsten, and sample 660, of cobalt.

The rhyolite composing the core, the northeast margin of the stock, and a faulted body on the east side of the district typically is porphyritic and consists of euhedral phenocrysts of quartz, sanidine, and, less commonly, plagioclase, 1 to 6 mm in diameter. The matrix consists mainly of potassium feldspar and quartz grains 0.01 to 0.1 mm in diameter. Iron- and magnesium-bearing minerals are scarce. The rhyolite is interpreted as intrusive because of its sharp contact with the granitic shell.

TABLE 1—*Spectrographic analyses of selected metals, in parts per million, of intrusive rocks, Railroad district, Nevada*

[Analyst, Uteana Oda]

Sample (pl. 1)	Ti	Zn	Ba	Sr	Mn	Zr	La	V	Cu	Ni	Pb	Cr	B	Y	Co	Sc	Mo	Ag	Bi	Sn	Ga	Be	W	Sb	As
660 [1]	2,000	<100	1,500	700	300	300	70	70	10	5	15	5	<10	30	10	10	5	<1	<5	<10	15	2	<20	<50	<500
654 [1]	3,000	<100	2,000	500	300	500	70	70	50	5	20	10	<10	30	<10	10	70	<1	<5	<10	15	2	70	<50	<500
659 [2]	700	<100	1,000	150	100	150	70	10	100	5	30	<5	<10	70	<10	<10	10	<1	<5	<10	15	3	<20	<50	<500
666 [2]	1,500	<100	1,000	200	30	200	70	10	100	5	20	<5	10	20	<10	<10	150	7	<5	<10	15	2	<20	<50	<500
657 [3]	3,000	200	>20,000	200	100	200	70	100	150	5	300	<50	<10	15	<10	<10	150	7	<5	15	15	1	70	<50	<500
674 [3]	500	<100	>20,000	300	200	150	<50	10	30	5	10	5	<10	30	<10	-----	<2	1	<5	<10	15	2	<20	<50	<500
Average [4]	1,200	39	840	100	390	175	55	44	10	4.5	19	4.1	10	40	1	7	1.3	.037	.01	3	17	3	2.2	.2	1.5

[1] Granitic outer shell.
[2] Rhyolite porphyry core.
[3] Bunker Hill dike, rhyolite porphyry.
[4] Low calcium igneous rock (Turekian and Wedepohl, 1961, table 2).

Sulfide minerals occur in the core as minute crystals, mainly in quartz phenocrysts, not in veinlets. Pyrite, chalcopyrite, sphalerite, pyrrhotite, ruby silver, and galena were observed microscopically in polished sections. The small size of crystals made identification of all but pyrite and chalcopyrite uncertain. Sericite is present in small amounts throughout the porphyry. Two specimens of the rhyolite core of the stock analyzed spectrographically (table 1, samples 659 and 666) contain more than average amounts of copper and molybdenum; in addition, sample 659 contains more than average amounts of yttrium and sample 666 more than an average amount of silver.

The Bunker Hill dike is generally similar petrographically to the porphyry core. It seems to contain more barite and sulfide minerals than any part of the stock, however. Two specimens analyzed spectrographically (table 1, samples 657 and 674) contain more than average amounts of barium and strontium. In addition, sample 657 contains more than average amounts of titanium, copper, lead, molybdenum, silver, tin, and tungsten, and sample 674, of copper and silver.

The structural relations indicate the following episodes in the development of the stock:

1. Intrusion of stock having granite to quartz diorite composition.
2. Solidification of the outer parts.
3. Displacement of the still-molten interior by magma of more silicic composition.
4. Fracturing of the outer shell of the stock and country rocks.
5. Filling of some fractures by porphyry from the still-molten core of the stock.

CONTACT ALTERATION

When magma comes in contact with carbonate rock, elements in the magma combine with calcium and magnesium in the carbonate to form skarn or contact metamorphic rock. Associated metal deposits are contact or pyrometasomatic deposits. In his text book on mineral deposits Lindgren (1933, p. 695) illustrated his discussion of pyrometasomatic deposits with a sketch map of part of the Railroad district originally drawn by W. H. Emmons.

Contact alteration in the Railroad district has resulted in the formation of skarn which consists mainly of andradite garnet and diopside and contains smaller amounts of penninite, phlogopite, magnetite, pyrite, pyrrhotite, and chalcopyrite. The country rock must have received material from the intrusive body during contact metamorphism, because none of the host rocks contain enough iron and aluminum to form such large amounts of garnet and diopside merely by recrystallization.

By far the largest body of skarn in the district is near the contact between the Devils Gate Limestone and the granitic part of the stock. Lesser amounts of skarn occur at the contact between the Nevada Formation and porphyritic parts of the stock and in the Nevada Formation and Devils Gate Limestone as much as half a mile from exposed parts of the stock. Some skarn also occurs along the contact between Mississippian clastic rocks and the Devils Gate Limestone where much of it seems to have been formed in the clastic rocks rather than in the limestone. The Bunker Hill dike does not seem to have generated much skarn rock.

The Devils Gate Limestone contains more dolomite in the Railroad district than elsewhere in the Piñon Range. Probably much of this dolomite is secondary having been formed by solutions from the intrusive mass. Both limestone and dolomite have been marbleized in places as much as half a mile from exposed parts of the stock. Within the district marbleization seems to have been a general effect of the intrusive activity rather than a concentrated effect correlative with nearness to igneous rocks.

STRUCTURE

The major structural feature in the Railroad mining district is the Piñon Range anticline. Generally, beds on the western side of the district dip west, whereas those on the east dip east. East dipping beds along the western contact between the Nevada Formation and the Devils Gate Limestone on the west side of Bunker Hill indicate that the anticline is sharply overturned to the west (section *B–B′*, pl. 1). In detail the structural complexity increases from south to north. Beds in the Devils Gate Limestone north of Bunker Hill and east of the stock are vertical or dip steeply west or east. Here the east limb of the anticline is almost vertical, and beds must be repeated in folds or by unrecognized faults that are parallel to the bedding; a normal sequence across the strike would require several hundred feet more of Devils Gate than are exposed elsewhere. In comparison with bed attitudes farther south, the steepening of dips reflects an eastward tilting; this increased tilt of the beds along with the possible tight folding may reflect eastward pushing and deformation by injection of the stock. The Piñon Range anticline is dated post-Permian because Upper Permian beds outside the Railroad mining district are folded.

Steeply dipping normal and reverse faults trend both parallel to and at angles to the trend of the anticline. A high-angle reverse fault, designated the Bunker Hill fault on plate 1, extends from southwest of Ravens Nest northward to a point about 1,000 feet north of the Davis Tunnel mouth where it ends or becomes impossible to trace in poorly exposed rocks. This fault brings older beds on the east into contact with younger beds about 1,000 feet higher stratigraphically on the west. The position of this compressional fault parallel to the Piñon Range anticline suggests that it resulted from the same forces which made the anticline.

Another reverse fault designated the Bald Mountain fault trends generally eastward, dips southward, and separates older rocks on the south from younger ones on the north. In addition to several hundred feet of stratigraphic throw, this fault may have had considerable right lateral strike-slip movement as indicated by the nonalinement of fold axes across the fault. South of the fault the axis of the Piñon Range anticline, by extension, passes through the east side of the stock. The meager data available indicate that the fold axis north of the fault is offset at least 1,000 feet to the east.

Other faults either are high-angle normal faults or cannot be classified owing to poor exposure.

Apparently the Bunker Hill fault pre-dates the porphyry because a porphyry dike is intruded along it, whereas the Bald Mountain fault postdates the porphyry or, at least, postdates the granite because it cuts the granite. Normal and unclassifiied faults both antedate and postdate the porphyry. Evidently igneous intrusion accompanied an episode of normal and reverse faulting.

The effects of probable post-Permian deformation are more apparent in the Railroad district than elsewhere in the Piñon Range. Only in the Railroad district is there an overturned anticline and only here are autochthonous beds as old as Ordovician exposed.

ORE DEPOSITS

HISTORY AND PRODUCTION

After the discovery of silver at Virginia City in 1859 and at Austin in 1862, prospectors discovered precious and base metals in all parts of Nevada. Deposits at Cortez were discovered in 1863, at Eureka in 1864, and at Mineral Hill in 1868. The Railroad mining district was established in June 1869, according to Raymond (1870, p. 186). Raymond's remarks suggest that the district may have been named as a result of the miners' elation at being only a few miles from a railroad. As the Eureka and Palisade railroad line in Pine Valley was not constructed until 1875, reference must have been to the Central (now Southern) Pacific Railroad about 12 miles distant.

Ore was at first shipped to Chicago and San Francisco for smelting, but in 1872 a smelter was designed and erected by O. H. Hahn of Freiberg at the town of Bullion (Raymond, 1873, p. 158). Charcoal fuel was obtained from the pines growing on nearby slopes and coke was shipped from Pennsylvania. Since 1905 newly mined ore, dump waste, and old slag have been shipped to Salt Lake City for reduction.

The production of gold, silver, copper, lead, and zinc in the Railroad district cannot be estimated accurately. Reliable figures for the years 1869 to 1905 are not available, but certain evidence suggests that the district was not very productive in those years. Production estimates (table 2) given by Couch and Carpenter (1943, p. 43) for the years 1871–73 and 1883–87 are not very high except for 1885 and 1886. Raymond (1873, p. 158) gave the capacity of an early smelter as only 20 tons of ore per day. A second small smelter was constructed later. Whitehill (1879, p. 22), the State Mineralogist, remarked that few mines were being worked in 1877 and 1878 and that good mines could be bought for a few hundred dollars each. Emmons (1910, p. 89) stated that in 1906 some of the mines were reopened after being worked in the 1870's and 1880's. We estimate the total value of production for the years 1869 to 1956 at about $2 million (table 2).

GENERAL FEATURES

The faults and the major fold that are prominent features of the district do not seem to have controlled ore deposition. Emmons' (1910, p. 91) remarks, together with our observations of presently accessible parts of mines, indicate that ore was found mainly along dikes and as vertical chimneys along intersections of joints in carbonate rock of the Nevada Formation and Devils Gate Limestone. Lesser amounts of ore were found in skarn of the Devils Gate.

Brown gossans indicate where mineralized zones intersect the present surface (pl. 1). Gossans stand out as dark rocky outcrops in places, but more commonly, because they are composed of soft earthy material, they form slight inconspicuous depressions. Most adits have been driven in on gossan zones, but, as Emmons (1910, p. 91) remarked, parts of the gossans do not seem to have been explored.

More than 100 adits scattered over an area of about 3 square miles indicate widespread exploration. The concentration of adits and sizes of dumps, the observations of Emmons, and the spectrographic analyses of dumps (table 3), however, indicate that mineralization was concentrated in two areas. A central area, within a radius of 2,000 feet centering on the intersection of the Bunker Hill dike and the Nevada Formation, was probably more intensively mineralized than the peripheral areas. Both the Standing Elk and Delmas mines in the central area were large early producers, and the Standing Elk (now Aladdin) was the last mine in the district to be closed. The workings of the Standing Elk are more extensive than those of any other mine. Emmons (1910, p. 94) stated that the Copper Bell mine in the northern part of the district produced half a million dollars worth of ore. The high concentration of adits and large sizes of dumps confirm that this area was moderately mineralized. The western edge of the district northwest of the stock and the extreme southern and eastern mineralized areas were not productive.

Spectrographic analyses of random samples of fine-grained material in the mine dumps (table 3) also indicate the uneven mineralization in the district. Zinc, lead, silver, molybdenum, bismuth, beryllium, yttrium, and lanthanum seem to be more concentrated in the central part of the district than in the peripheral areas.

TABLE 2.—*Recorded production of the Railroad mining district, Nevada, 1871–1956*

[Sources of data for the years 1871–1905 from Couch and Carpenter (1943); for 1907–23 from U.S. Geological Survey (1908–27); for 1925–56 from U.S. Bureau of Mines (1928–58)]

Year	Number of mines producing	Ore (tons)	Gold (fine ounces)	Silver (fine ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Total value (dollars)
1871	-----	380	-----	-----	-----	-----	-----	15,561
1872	-----	468	-----	-----	-----	-----	-----	25,136
1873	-----	613	-----	-----	-----	-----	-----	17,470
1883	-----	891	-----	-----	-----	-----	-----	25,200
1884	-----	331	-----	-----	-----	-----	-----	26,741
1885	-----	2,103	-----	-----	-----	-----	-----	99,349
1886	-----	3,953	-----	-----	-----	-----	-----	101,475
1887	-----	680	-----	-----	-----	-----	-----	17,600
1905	-----	210	-----	-----	-----	-----	-----	2,387
1907	2	440±	-----	8,800±	44,000±	88,000±	-----	20,000±
1908	4	649	47	8,000±	44,000±	59,000±	-----	18,298
1909	-----	-----	40	2,061	5,116	38,535	-----	4,227
1910	4	162	4	3,682	8,992	61,769	-----	5,923
1912	4	179	-----	-----	-----	-----	-----	9,369
1913	6	593	15	19,202	54,645	187,219	-----	28,608
1914	5	2,942	59	61,296	234,018	767,394	-----	96,159
1915	24	2,210	15	31,190	359,247	233,659	-----	89,966
1916	13	5,640	61	66,917	1,012,535	706,419	-----	343,117
1917	11	3,324	12	39,252	595,931	165,078	-----	209,478
1918	6	613	9	12,605	72,165	128,250	-----	39,732
1919	4	254	9	4,380	30,288	79,096	-----	14,927
1920	7	197	5	2,183	31,026	12,398	-----	9,184
1921	2	76	-----	-----	-----	-----	-----	3,571
1923	6	123	150	2,093	5,411	21,593	-----	7,106
1925	-----	[1] 3,941	-----	-----	-----	-----	-----	-----
1927	5	small	-----	-----	-----	-----	-----	2,182
1928	-----	none	-----	-----	-----	-----	-----	-----
1929	1	238	-----	-----	-----	-----	-----	-----
1934	4	15	7	562	50	3,250	-----	735
1937	1	107	3	1,071	16,000	-----	-----	2,869
1939	1	195	2	1,463	23,800	1,800	-----	3,623
1940	1	48	1	606	7,700	400	-----	1,356
1942	2	1,371	10	4,843	15,000	217,800	1,900	20,379
1943	4	1,030	3	2,080	10,900	147,300	3,000	14,373
1944	3	596	1	1,367	15,400	50,800	-----	7,150
1945	1	46	1	284	6,000	-----	-----	1,047
1946	1	63	-----	307	2,100	100	2,500	904
1947	2	201	-----	2,812	4,900	27,500	4,000	8,018
1948	4	234	1	1,929	16,700	21,500	-----	9,254
1949	1	140	1	1,435	3,100	18,900	19,400	7,337
1950	3	1,353	7	11,924	74,600	211,700	52,400	62,575
1951	1	1,883	2	18,952	43,000	292,700	65,100	90,114
1952	1	2,271	14	33,046	47,200	377,400	11,800	104,541
1953	1	756	4	12,945	20,000	166,100	90,200	49,728
1954	1	568	3	7,493	15,700	85,500	5,800	23,858
1955	1	484	2	3,076	9,900	44,100	34,000	17,299
1956	1	1,368	7	13,920	20,300	124,300	82,100	52,234
Total (rounded)	-----	43,940	495	382,000	2,850,000	4,340,000	372,000	1,710,000

[1] Slag.

TABLE 3.—*Spectrographic analyses of selected metals, in parts per million, of fine-grained dump material*

[Analyst, Uteana Oda]

Sample (pl. 1)	Ti	Zn	Ba	Sr	Mn	Zr	La	V	Cu	Ni	Pb	Cr	B	Y	Co	Mo	Ag	Bi	Sn	Ga	Be	W	Sb	As
Northern area																								
34	500	5,000	20,000	200	7,000	50	50	50	10,000	200	100	20	10	100	30	15	5	<5	<10	5	5	<20	<50	<500
24	500	7,000	7,000	150	5,000	30	50	15	10,000	200	20	10	20	100	20	10	1	<5	<10	5	5	<20	<50	<500
35	700	2,000	10,000	150	5,000	30	50	50	10,000	200	20	20	15	100	70	10	1	<5	<10	5	5	<20	<50	<500
Central area																								
30	700	1,500	1,000	20	2,000	50	<50	15	7,000	15	70	10	10	20	20	70	5	20	200	15	5	150	<50	500
46	1,500	150	1,000	30	2,000	70	<50	30	3,000	10	15	10	10	15	20	70	2	10	500	15	2	50	<50	500
28	300	5,000	7,000	100	20,000	20	100	20	10,000	30	100	<5	<10	300	<10	500	30	<5	<10	5	15	<20	<50	<500
27	500	50,000	10,000	100	15,000	30	50	20	20,000	50	50,000	5	<10	200	50	2,000	100	200	200	5	10	<20	700	2,000
21	500	15,000	7,000	100	7,000	30	500	20	20,000	50	200	5	<10	700	50	10	2	5	<10	5	50	<20	<50	500
22	1,000	50,000	15,000	200	3,000	100	<50	70	20,000	20	2,000	50	10	70	30	200	30	150	200	20	10	150	700	1,000
13	1,000	15,000	15,000	100	5,000	100	500	70	5,000	200	1,500	30	15	1,500	20	20	10	100	200	10	15	100	<50	700
9	1,000	7,000	2,000	50	3,000	70	200	30	7,000	20	2,000	20	15	70	50	150	30	200	200	10	2	150	200	1,500
14	300	10,000	1,500	20	3,000	20	100	10	7,000	20	7,000	5	10	150	20	150	20	100	30	5	7	<20	300	1,000
10	300	50,000	10,000	70	10,000	50	500	10	7,000	300	100	10	15	500	15	2	7	10	15	5	70	<20	<50	<500
12	500	50,000	10,000	70	15,000	50	500	20	10,000	500	1,500	10	10	700	20	150	20	200	30	<5	70	30	<50	<500
45	300	20,000	5,000	50	20,000	70	50	10	5,000	15	10,000	<5	<10	150	50	70	20	100	50	<5	7	<20	<50	500
8	700	7,000	1,000	50	5,000	50	<50	20	7,000	15	15,000	20	10	<10	20	100	30	500	150	<5	5	100	<50	<500
33	2,000	2,000	1,500	50	3,000	100	<50	50	2,000	10	1,000	15	20	10	15	50	15	30	100	10	2	50	<50	500
16	700	50,000	1,000	20	2,000	150	<50	30	1,500	5	20,000	10	10	10	10	200	300	2,000	200	15	1	50	50	5,000
15	700	50,000	3,000	30	3,000	70	<50	15	2,000	5	15,000	5	10	20	15	100	50	200	150	7	1	30	100	3,000
17	700	100,000	5,000	20	2,000	20	1,000	15	50,000	30	1,000	15	10	500	15	5	30	5	<10	<5	20	<20	50	1,500
Southern area																								
626	700	>10,000	>10,000	700	3.000	50	<50	70	10,000	50	1,000	30	10	10	30	10	20	200	200	50	3	<100	<100	<500
Eastern area																								
42	1,000	1,500	1,000	30	3,000	100	<50	20	2,000	5	100	10	<10	20	10	50	7	20	30	10	1	<20	100	1,000
41	700	3,000	5,000	100	10,000	70	<50	15	5,000	7	500	5	<10	150	50	20	7	7	20	5	2	<20	50	1,000

Areal and textural relations suggest that mineralization took place in three stages. Stage 1 was the contact-metamorphic stage consequent on intrusion of the stock, mainly the granitic part. Stage 2 was a hydrothermal stage which took place soon after intrusion into the country rock of the Bunker Hill dike which emanated from the core of the stock. The minerals deposited at this time are common in mesothermal base-metal deposits of the region. Stage 3 took place much later when earlier formed minerals were exposed to oxidation. The brown gossan zones were formed during this stage. Minerals which are assigned to these three stages are listed in the following table.

Stage 1	Stage 2	Stage 3	
Formed early mainly at time of intrusion of stock	Formed mainly after intrusion of dike	Formed last as a result of alteration of earlier minerals	
Diopside	Barite	Anglesite	Kaolinite
Garnet	Calcite	Azurite	Malachite
		Calamine	
Magnetite	Chalcopyrite	Cerussite	Manganese oxide minerals
Phlogopite	Galena	Chrysocolla	Marcasite
Penninite	Pyrite	Copper pitch	Montmorillonite
Pyrrhotite	Quartz	Covellite	Opal
	Sphalerite	Duftite	
	Tetrahedrite	Halloysite	
		Iron oxide minerals (except magnetite)	Willemite

Other minerals which cannot be confidently assigned a position in one of these stages are listed as follows.

MINERALS OF THE RAILROAD DISTRICT

Andalusite (Al_2SiO_5). This aluminum silicate was reported by Emmons (1910, p. 90), but was not identified by us.

Anglesite ($PbSO_4$). Lead sulfate is an uncommon oxidation product of galena. It replaces galena along cleavage joints.

Andradite. See garnet.

Aragonite ($CaCO_3$). This fibrous form of calcium carbonate is an uncommon vein material.

Azurite ($2CuCO_3 \cdot Cu(OH)_2$). Basic copper carbonate is a common ore of copper in the area. It is easily identified by its brilliant blue color. Azurite commonly forms from oxidized copper sulfides.

Barite ($BaSO_4$). Barium sulfate is a common mineral of the ore deposits. The heavy, clear or white, soft mineral found on the dumps in the northern part of the district is most likely to be barite. It is probably a primary mineral rather than an alteration product of some other mineral.

Beryllonite ($NaBePO_4$). Sodium beryllium phosphate was identified by X-ray in association with duftite by Shirley K. Mosburg.

Bornite (Cu_5FeS). This copper iron sulfide is a scarce ore of copper, as indicated by its occurrences on dumps. It seems to replace galena in one specimen.

Calamine ($H_2Zn_2SiO_5$). Hydrous zinc silicate forms crusts of radiating crystals on oxidized rock.

Calcite ($CaCO_3$). Calcium carbonate is a ubiquitous mineral in the district. It constitutes much of the Devils Gate Limestone and is a very common vein mineral. Some crystals are several inches long. These commonly are banded with brown manganiferous impurities.

Cerargyrite (AgCl). Silver chloride, also called horn silver, was reported in the Railroad district by Emmons (1910, p. 91). It is alteration product of silver-bearing sulfides. We did not see any cerargyrite.

Cerussite ($PbCO_3$). Lead carbonate is a common alteration product of galena. It commonly replaces galena along cleavage fractures.

Chalcocite (Cu_2S). This copper sulfide, also known as copper glance, is a scarce ore mineral in the district as indicated by its scarcity on the dumps. It seems to alter to copper pitch.

Chalcopyrite ($CuFeS_2$). This copper iron sulfide is the commonest copper-bearing sulfide observed on dumps. It is commonly associated with sphalerite. It can be recognized by its bright greenish-gold color.

Chrysocolla ($CuSiO_2 \cdot 2H_2O$). Hydrous copper silicate is a common ore in the district. It is formed by alteration of copper sulfides. It can be recognized by its light-blue color and layered appearance.

Copper (Cu). Native copper is a scarce mineral seen only microscopically as minute grains.

Copper pitch. The commonest copper-bearing secondary mineral in the district is copper pitch, a mixture of copper, manganese and iron oxides with silica. The more dense varieties tend to be black, lustrous, and smoothed as if by the action of running water. The porous varieties are brown, dull, and rough. Copper pitch is one of the end products of the complete oxidation of copper sulfides.

Copper glance. See chalcocite.

Covellite (CuS). This copper sulfide is common in sulfide ores of the district, but occurs as such tiny grains that it can be seen only with the aid of a microscope. It is generally associated with chalcopyrite and galena and appears to replace those minerals.

Cuprite (Cu_2O). This copper oxide was reported by Emmons (1910, p. 91). Specimens resembling cuprite in color tested by us turned out to be iron oxide.

Diopside ($CaMgSi_2O_6$). Calcium magnesium silicate is one of the most abundant minerals in the district. It is most abundant where igneous rock has come in contact with limestone and dolomite but occurs in small patches, especially in carbonate rocks, throughout the district.

Dolomite ($CaCO_3 \cdot MgCO_3$). Calcium magnesium carbonate constitutes much of the Nevada Formation and Devils Gate Limestone in which the ore occurs. Some of the dolomite in the Devils Gate Limestone may have been formed by the effect of the igneous intrusive on limestone.

Duftite ($PbCu(AsO_4)(OH)$). Lead copper arsenate is a common mineral in the district. The mineral Emmons reported (1910, p. 91) as pyromorphite may have been duftite. The color ranges from bright yellowish green to brown to transparent. It encrusts the surface of veins and cavities and occurs within a matrix of other secondary minerals.

Fluorite (CaF_2). Calcium fluoride was observed in microscopic amounts in only one specimen.

Galena (PbS). Lead sulfide is one of the most common sulfides probably following pyrite and chalcopyrite in order of abundance. It alters to cerussite, anglesite, and probably duftite.

Garnet ($Ca_3Fe_3(SiO_4)_3$). This calcium iron silicate is one of the more abundant minerals of the district especially near the granitic intrusive. It is commonly green or brown and is formed in equidimensional grains a few millimeters in diameter. Specific gravity of this garnet ranges between 3.6 and 3.9, and refractive index is about 1.87. This indicates the garnet is of the variety called andradite which has the composition just given or contains a small proportion of aluminum substituting for some of the iron.

Goethite. (See iron oxides.)

Halloysite ($Al_2O_3 \cdot 2SiO_2$). This clay mineral is an abundant constituent of many of the mine dumps in the district. It is a white soft chalky substance apparently derived from the alteration of quartz porphyry dikes. Quartz grains imbedded in lumps of halloysite have the angular appearance of the quartz phenocrysts in unaltered dike rock.

Hematite. See iron oxides.

Horn silver. See Cerargyrite.

Iron oxides. The common red to yellow color of the soil and dumps and many outcrops in the district is due to iron oxide. Microscopic examination of specimens containing sulfides indicates that much iron oxide is formed by alteration of pyrite. Surrounding corroded grains of pyrite is an inner layer of dense iron oxide and an outer layer or matrix of porous yellower iron oxides. Hematite, goethite, and lepidocrocite were uncertainly identified.

Kaolinite ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$). This aluminum silicate, like halloysite, may have been formed by alteration of dike rock.

Lepidocrocite. See iron oxides.

Limonite. See iron oxides.

Magnetite (Fe_3O_4). This iron oxide occurring as black octahedra disseminated in silicate rocks is not an alteration product of sulfides but a primary mineral formed with the garnet and diopside. It is intergrown with blades of hematite in places.

Malachite ($CuCO_3 \cdot Cu(OH)_2$). This copper carbonate is the common green mineral of the district. It was probably formed by the alteration of copper-bearing sulfides. It can be distinguished from green duftite by its bluish rather than yellowish cast and the radiating habit of the crystals.

Manganese oxide. The dull black soft earthy mineral commonly occurring with white halloysite is amorphous manganese oxide. It also occurs with copper oxide and silica in copper pitch, as dark bands in calcite crystals, and black blotches on copper carbonates. It is not present in sufficient concentration to be commercially valuable.

Marcasite (FeS_2). This iron sulfide has the same composition as pyrite but does not have the same crystal form. It is an uncommon mineral in the district.

Montmorillonite. This hydrous calcium, magnesium, and aluminum silicate is present in altered rock. Like halloysite, it may have formed by alteration of dike rock.

Opal ($SiO_2 \cdot nH_2O$). Hydrous amorphous silica is a common mineral of the district. It encrusts cavities in oxidized ores. It was one of the latest minerals to be deposited.

Penninite. This magnesium silicate is a member of the chlorite group of minerals. It is a green micaceous mineral occurring in aggregates associated with magnetite.

Pentlandite. Iron nickel sulfide is associated in small amounts with pyrrhotite.

Phlogopite ($H_4K_2Mg_6Al_2Si_6O_{24}$). This potassium, magnesium silicate is a member of the mica group of minerals. It occurs with diopside and is undoubtedly formed in the same way by contact alteration of carbonate.

Pyrite (FeS_2). This iron sulfide is the most abundant sulfide in the district. It alters to iron oxides and may be the source of most iron oxide in the district.

Pyrrhotite. This ferrous sulfide has an indefinite ratio of iron to sulfur. It is a rather abundant sulfide widely disseminated in sedimentary rocks of the district.

Pyromorphite. See duftite.

Quartz (SiO_2). Quartz is a common constituent of sedimentary rocks in the district and also occurs commonly with ore minerals.

Silver (Ag). Native silver probably forms minute blebs in galena in one specimen observed.

Sphalerite (ZnS). Zinc sulfide is a common sulfide in the district but considerably less abundant than galena. Chalcopyrite is almost invariably associated with sphalerite. Sphalerite probably alters to calamine and willemite and other secondary zinc-bearing minerals.

Stibnite (Sb_2S_3). Antimony sulfide is an uncommon mineral in the district. It was observed in one specimen from the southwest side of the district.

Tetrahedrite. This complex copper, iron, zinc, silver, antimony sulfide is a scarce associate of galena in the district.

Willemite (Zn_2SiO_4). Zinc silicate is an uncommon mineral formed as perfect crystals with and on duftite. It is probably formed by alteration of sphalerite.

Zoisite ($HC_2Al_3Si_3O_{13}$). This uncommon calcium aluminum silicate was uncertainly identified in association with garnet and diopside.

GUIDES TO PROSPECTING

In many base-metal deposits copper and other elements are carried downward by percolating water from the oxidation zone near the surface and redeposited in the primary ore zone just below the zone of oxidation. It seems certain from examination of dumps and mines and from the remarks of early observers that all ore mined in the district was at least partially oxidized. Since a distinct zone of secondary enrichment has not been reached, one should be sought in the central part of the district where mineralization was concentrated. Probably the Davis Tunnel is below the zone of secondary enrichment, as the only sulfide minerals seen by us in the tunnel are the primary ones, pyrite and chalcopyrite.

Spectrographic analyses (table 3) indicate that some of the dumps contain remarkable concentrations of beryllium and the rare earth elements, lanthanum and yttrium. A more intensive geochemical search of the dumps and gossans might reveal concentrations of minable grade.

A logical method of exploration would be to drill to a depth below the zone of oxidation in parts of gosans determined to be favorable by systematic sampling and analysis.

MINE DESCRIPTIONS

Descriptions of individual mines are reprinted from Emmons (1910, p. 93–95) who was able to investigate the workings of several mines while mining was in progress. The approximate positions of some of the mines and claims mentioned by Emmons are shown on plate 1 and figure 4. The locations of others are unknown except as vaguely indicated by Emmons.

Standing Elk mine.—The Nevada Bunker Hill Mining Company controls the Standing Elk, Tripoli, Red Bird, and other mines, and is driving a crosscut tunnel to intersect the several lodes in depth. This tunnel in July, 1908, was 1,500 feet long but was still several hundred feet from the nearest lode. The Standing Elk, the most important mine of this group, is opened on seven levels, mainly adits, having altogether a vertical range of 600 feet. There are several thousand feet of workings on this claim, the principal level being adit No. 5. When the camp was visited the workings above this level were not accessible.

The ore bodies are irregular replacement veins in limestone, which intersect to form chimneys of ore, the largest being about 50 feet in diameter. The country rock varies from a hard gray limestone to a massive marble which locally is very coarsely crystalline. The limestone is sheeted, brecciated, and filled with white calcite. In a few places garnet rock is developed in the mine, but none of the Standing Elk deposits consist of the typical garnet ore. The intruding quartz porphyry is much decomposed and is locally silicified, and a considerable mass of it carries copper. Nearly everywhere the ore is highly oxidized. The principal ore minerals are lead and copper carbonates, copper and iron oxides, bornite, pyrite, chalcopyrite, and a copper-antimony sulphide, which is probably gray copper. Calcite and quartz are the important gangue minerals; a little fluorite is present in microscopic crystals, intergrown with quartz.

Tripoli mine.—The Tripoli mine, about 800 feet northeast of the Standing Elk, is owned also by the Nevada Bunker Hill Mining Company. A tunnel is driven into the mountain for 100 feet to an engine station, where a winze is sunk to a depth of 175 feet. Levels are turned at vertical intervals of about 50 feet and a second winze is sunk from the lowest level, giving a maximum depth of 300 feet below the surface. The country rock is marbleized gray limestone which on the surface strikes N. 20° W. and dips from 85° SW. to 90°. The limestone is intruded by an acidic phase of granodiorite. The incline and drift are driven on a fissured zone, which strikes about N. 25° W. and is approximately vertical. The zone of crushed limestone is crossed by two fissures, approximately at right angles, and these dip steeply toward the northwest. Chimneys of rich silver-lead ore are formed at or near the intersections. Lead carbonate and pyromorphite are mixed with galena and copper carbonates, and the ore is highly oxidized as deep as development goes. In the bottom of the winze, 300 feet below the surface, garnet and tremolite are extensively developed. At this place the metamorphosed rock is crushed and greatly altered, and it is said to carry about $25 in lead and silver.

At the surface to the east of the Tripoli claim the limestone is medium-grained marble containing reefs and patches of garnet rock, with which are intergrown small masses of pyrite and chalcopyrite, stained here and there with copper carbonates.

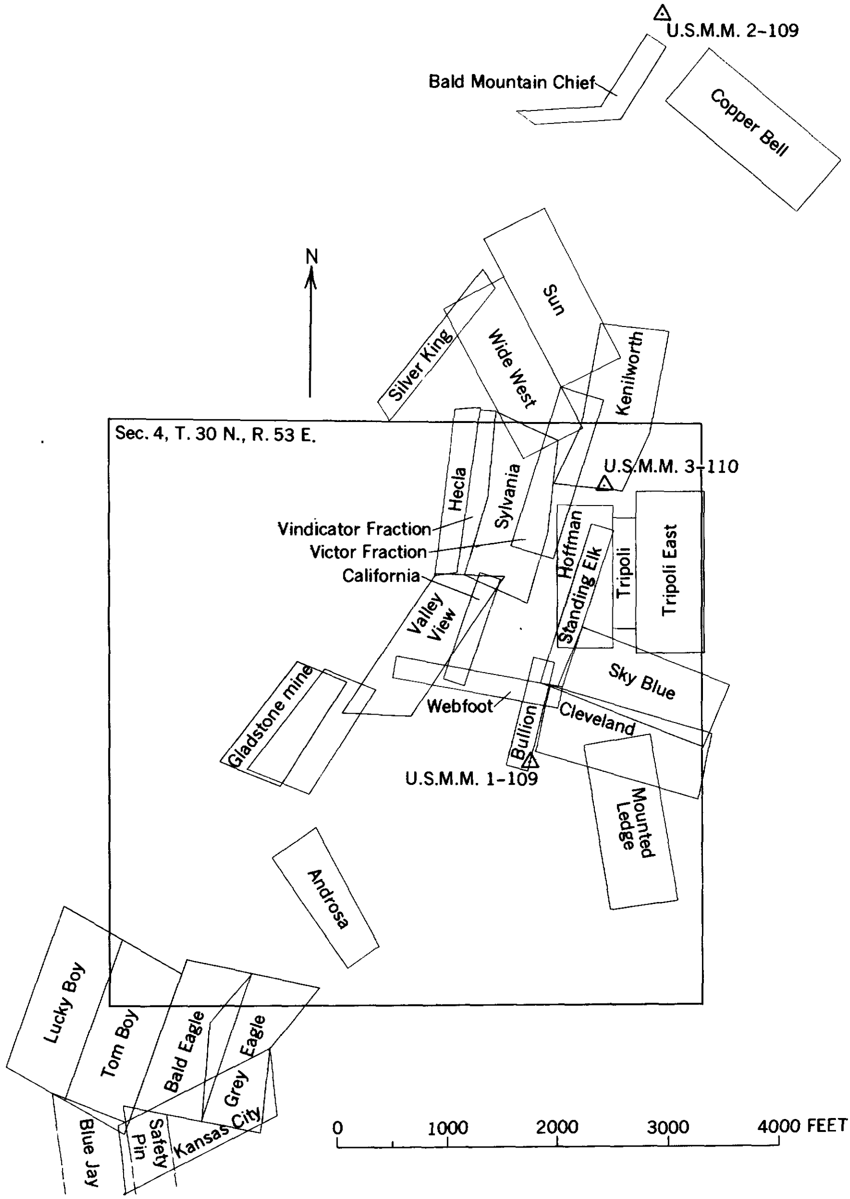

FIGURE 4.—Map of patented mining claims in the Railroad mining district, Nevada.

Red Bird mine.—The Red Bird mine, of the Bunker Hill group, is about half a mile northeast of the Standing Elk and nearest the portal of the low-level adit. A tunnel is driven for 250 feet on a steeply dipping lode, and 80 feet below this a second tunnel is driven for 200 feet. About 150 feet from the portal of the lower tunnel a raise connects the two levels. The lode, which at some places is 4 feet wide, carries good values in lead and silver.

Copper Belle mine.—The Trimetal Mining Company controls a large acreage which joins the Nevada Bunker Hill holdings on the northwest. This group includes the Copper Belle, Copper King, and Philippine claims, on each of which considerable development work has been done. The Copper Belle mine is about half a mile northeast of the Standing Elk. The principal tunnel is driven for 325 feet S. 60° E. to the ore body, which is a large irregular mass of oxidized ore carrying lead, silver, and copper. It is said to have produced about half a million dollars' worth of ore, which was smelted in the copper smelter at Bullion. The ore body, which is nearly everywhere inaccessible, resembles the deposits of the Standing Elk in that it is a replacement of marbleized limestone. On the surface above the ore body and at several other places near by the rock is stained with iron oxides and copper carbonates.

Delmas mine.—The Delmas Copper Company owns several claims which are located near the crest of the mountain range and extend southwestward from it.

On the Sweepstakes claim, which is the most extensively explored, are the copper deposits of contact-metamorphic origin which have been mentioned above. These deposits, as already stated, are composed of garnet, tremolite, and other contact-metamorphic minerals, which at some places are intergrown with pyrite, chalcopyrite, bornite, galena, and zinc blende. Locally the copper-iron sulphides, which are unquestionably primary, are coated over with secondary copper glance. Here and there the copper sulphides have oxidized to copper carbonates and iron oxides, but the oxidation is not complete, even at the surface, and at some places less than 10 feet below the surface the sulphides are much more abundant than the carbonates and oxides. Shipments of 210 tons of ore from this claim averaged 70 ounces of silver to the ton, 10.4 per cent of copper, and 2.8 per cent of lead. There is a considerable tonnage of low-grade ore partly developed. It will probably be found that the high-grade ore is restricted to that which carries chalcocite-coated sulphides, or to that which has resulted from the oxidation of such ore.

Other claims.—The Kenilworth claim, north of the Standing Elk; the Sylvania claim, west of the Standing Elk; and the Blue Belle, northwest of the Sylvania, have each produced considerable ore from workings which were inaccessible when the camp was visited by the writer. The principal deposits of these mines appear to resemble those of the Standing Elk rather than the contact-metamorphic deposits of the Delmas group.

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