RECONNAISSANCE STUDY OF THE GEOLOGY AND MINERAL DEPOSITS OF THE REVEILLE MINING DISTRICTS NYE COUNTY, NEVADA

by

Donald D. Runnels
Associate Professor
Department of Geological Sciences
University of Colorado
Boulder, Colorado

assisted by

Gary L. Grauberger
S G Associates
Boulder, Colorado

LOREN E SMITH
SILVER GOOSE #55
26 MARCH 1971

APPENDIX A

GEOCHEMICAL SURVEY OF SELECTED SITES

IN THE REVEILLE DISTRICTS,

NYE COUNTY, NEVADA

Reconnaissance Study of the Geology and Mineral Deposits of the Reveille Mining Districts, Nye County, Nevada

by

Donald D. Runnells
Associate Professor
Department of Geological Sciences
University of Colorado
Boulder, Colorado

assisted by

Gary L. Grauberger
C. Associates
Boulder, Colorado

ABSTRACT

and

SUGGESTED TARGETS

The Reveille districts are located in the northern part of the Reveille Range, about 70 miles east of Tonopah, Nevada. The rocks of the district comprise a thick section of Lower Paleozoic sediments occurring as a window in an area of rhyolite tuff, dacite flows, and basalt.

Mining in the past in the Reveille districts has concentrated largely on shallow, oxidized ores of silver and lead. The deposits that were mined occur in silicified fault zones between volcanics and sedimentary rocks. Most of the ore was present as filling of open space in the breccia zones, but some replacement is also evident.

Preliminary stratigraphic studies indicate that a thick sequence of carbonate rocks of Lower Paleozoic age occurs in the district, possibly extending to considerable depth beneath the volcanic cover. Such rocks may be the site of undiscovered replacement bodies of silver-lead sulfides, such as occur in the Eureka, Nevada and Tintic, Utah districts. Argentiferous galena and minor jasperoid have been observed in the Gila and New Reveille mines at depths of from about 100 to 150 feet below the surface. To the best of our knowledge no exploration has been conducted in the district below the deepest levels of the old mines, reported to be 460 feet for the Gila Mine and about 200 feet for the New Reveille lead mine.

Structural control of the surficial deposits is well-displayed. The most favorable locii seem to be where the Middle Ordovician Eureka quartzite has been placed in fault contact with other rocks. One obvious target for drilling is at the New Reveille lead mine, where extensive faulting has placed the Eureka quartzite adjacent to carbonate rocks. Significant tonnages of oxidized lead minerals have been mined and are still present in this area, but no modern exploration has been directed toward the discovery of replacement bodies of sulfides at depth.

Alteration of carbonate rocks and volcanic rocks is well-developed. Silicification is the most common type of alteration in the carbonates. In the volcanic rocks the alteration is locally intense, comprising chlorite, calcite, muscovite, quartz, pyrite, and clays. A large ridge of sericitized and pyritized rhyolite just east of the Gila mine offers an interesting target for the carbonates that probably lie beneath.

A small, altered instrusive of latite porphyry is present near the Kietzke mine on the west side of the Reveille districts. This intrusive should be tested for disseminated mineralization.

Reconnaissance Study of the Geology and Mineral Deposits

of the

Reveille Mining Districts, Nye County, Nevada

INTRODUCTION AND PURPOSE

This report summarizes the economic geology of the New Reveille and Old Reveille districts, Nye County, Nevada. The report and accompanying geologic map are reconnaissance in nature and are meant only to serve as an introduction to the districts. Additional work will surely refine and possibly change some of the relationships shown.

Our procedure involved preparation of a preliminary map from aerial photographs,[1] followed by approximately ten days of field mapping, the latter from 24 May through 10 June, 1971. Fifty samples of minerals and rocks and twelve petrographic thin-sections were prepared and studied by standard techniques.

OWNERSHIP

S. G. Associates holds possessory rights on 104 unpatented lode mining claims in the Reveille Districts with all location work having been completed as of June 9, 1971. S.G. Associates has leased all patented claims in the districts and 8 unpatented claims known as the Cascade group. S.G. Associates owns or controls 2300 acres which cover the area of interest in the districts.

LOCATION

The Reveille Range is shown at a scale of 1:48000 on the Reveille Quadrangle topographic map of the U.S. Geological Survey. The two districts of New and Old Reveille are located in the northern portion of the range, at approximately 38°N Latitude, 116°15' W Longitude, about 75

[1] U.S.G.S. photos GS-VBUE, 1-44 and 1-45, dated 9-1-67.

miles east of Tonopah, Nevada. The area is shown as District Number 246 on the Metal Mining Districts Map of Nevada, Second Edition (Schilling, 1969). Las Vegas is about 175 miles south on Nevada State Highway 25 and U. S. 93.

The Old Reveille district lies at the northeastern corner of the range, about 20 highway miles southeast of the road junction of Warm Springs and about five miles on a dirt road west of Highway 25 in Railroad Valley. New Reveille lies about two airline miles southwest across the range from Old Reveille. New Reveille can also be reached by driving about 25 miles south of Warm Springs on a gravel and dirt road down Reveille Valley west of the range.

TOPOGRAPHY AND CLIMATE

The highest point in the Reveille Range is Reveille Peak at an altitude of 8910 feet. In the districts proper the highest elevation is 7911 feet above sea level. The topography is rugged and typical of the desert ranges. Local relief of a few hundred feet is common (Fig. 1).

The climate is semi-arid, with hot, dry summers and cold winters. It should be possible to work year around. Running water is available in livestock troughs and tanks at the abandoned Reveille townsite on the eastern side of the range and at the abandoned Bellevue millsite in Reveille Valley west of the range.

PREVIOUS WORK

Remarkably little has been published concerning the geology of the region. Browne (1868, p. 425) summarizes the history of the discovery of the district in 1868. The name Reveille was bestowed in honor of the daily newspaper at Austin. Four mines had a production of 5559 pounds of high grade silver during the first quarter of 1867 (Browne, 1868, p. 425), the principal minerals being cerargyrite, argentite, stibnite, and "silver-copper glance". Raymond (1869, p. 107-109) gives an interesting, if somewhat quaint, account of the characteristics and origin of the silver ores of the district.

More substantial work began with Gilbert in 1875. He (p. 122) mentions that the Reveille Range consists chiefly of volcanic rocks with a small window of Paleozoic sediments at the northern end. It is within the window of Paleozoic sediments that both Reveille districts are located. Gilbert (1875, p. 137) correctly described some of the Paleozoic rocks as limestone and quartzite, dipping gently to the west. Ball (1907, p. 115-118) assigned a probably incorrect age of Carboniferous to the Paleozoic rocks.

Spurr (1903, p. 161-163) shows a corss-section of the Reveille Range, but an apparent error in printing resulted in the dips being reversed in his diagram. Spurr (p. 162) notes correctly that the Paleozoic rocks are surrounded by altered biotite rhyolite (now recognized to be a biotite rhyolite welded crystal tuff) and younger augite olivine basalt. Ball (1907, p. 115-118) assigned an age of Miocene to the rhyolitic rocks. The curde maps by Spurr (1903) and Ball (1907) are the only published geologic maps of which we are aware.

The most complete description of the districts is that of Kral (1951, p. 144). He gives a brief summary of the production and geology of individual mines. Although Kral adds little to the previously published information on the general geology, he does note that the occurrences of the ore deposits are in quartzite, at contacts between rhyolite and quartzite, and in limestone. He repeats an observation of Spurr (1903) that rhyolite and quartz latite dikes are common in the districts.

The chief ore minerals are reported by Lawrence (1963, p. 135) to have been cerargyrite, cerussite, galena, malachite, azurite, pyrargyrite, argentite, and stibnite. The sulfides are reported by Lawrence to increase with depth, and in the Gila mine some of the best ore in the early workings (at a depth of about 90 feet) was probably argentiferous galena (Raymond, 1875, p. 178).

There are apparently no additional published reports concerning the general geology of the districts. A few brief accounts of individual mines and data on production will be mentioned in following sections.

One additional reference which is useful for purposes of comparison is the study of the Tybo district by Ferguson (1933, 61 pgs.). Tybo lies about 30 miles north of Reveille and exhibits some of the same stratigraphic and structural features.

Miscellaneous publications not available to us include Lincoln (1923) and Gianello and Prince (1945).

The U. S. Geological Survey has recently had a mapping project in the Reveille Range.

SUMMARY OF PRODUCTION

The Reveille districts have been mined chiefly for high grade oxidized ores of silver and lead. Couch and Carpenter (1943, p. 114) give a figure of 8,261 tons for the total production of silver, lead, copper and gold ores from 1866 through 1921. The Minerals Yearbooks of the U. S. Bureau of Mines records further intermittent production of 935 tons from 1939 through 1957. The peak years in recent times were 1939, 1949, 1957, when 352 tons, 210 tons, and 150 tons were mined, respectively.

The Gila (New Hope) mine (see Fig. 2) in the Old Reveille district has been the most important producer in the area. The recorded production from 1874 through 1891 is 6,128 tons (Couch and Carpenter, 1943, p. 119). The last known work underground at the Gila mine was in 1891. The dumps were worked in 1920 and 1940-1941 (V. J. Barndt, unpublished records).

The ore from the Gila averaged $87 per ton (Kral, 1943, p. 143; price per ounce of silver used in this calculation is not given by Kral). Unpublished assay data taken in 1941 and 1944 by V. J. Barndt, present owner of the Gila, show values of from about four to 95 ounces of silver per ton.

In recent years most of the production of the districts has come from the New Reveille lead mine at the southern end of the area shown on the accompanying geologic map. The production from this deposit is included in the preceding figures for the total production in the late 1800's. From 1917 through 1949 various leasors and owners produced an additional 1,921 tons of ore (V. J. Barndt, unpublished records). Most of the 150 tons produced in the Reveille district in 1957, as described above, came from the New Reveille lead mine; at least part of this probably represents material from the dumps. The ore from the New Reveille lead mine has averaged between 10 and 30 per cent lead, with 10 to 20 ounces of silver and minor copper and gold (V. J. Barndt, unpublished records of royalty payments). A shipment of 3544 pounds of ore, shipped to the Murray plant of American Smelting and Refining in 1942, contained 12.6 ounces of silver per ton, 11.1 percent lead, 4.3 percent copper, and 1.7 percent zinc (photocopy of A. S. & R. settlement sheet to V. J. Barndt, 13 June, 1942).

The only additional property for which reliable data are available is the Antimonial mine (also called the Silvermonial and Black Hawk mine), about one-half mile northeast of the Gila mine (see map). This mine has produced 29 tons of antimony (as the metal) and minor silver from 1937 to the present (Lawrence, 1963, p. 135-137). Exploration was conducted at the Antimonial mine as recently as 1963 (Minerals Yearbook, 1963).

The Kietske mine, about one mile southwest of the Gila, was mined for many years for small amounts of high grade oxidized silver ore.

Alva Garrett of Tybo (1971, personal communication) reports that the ore averaged 10 to 40 ounces of silver per ton, with some much higher grade, mostly as the halides. Recent assays from exposures in the mine show from a trace to about 90 ounces of silver per ton (unpublished assay records of Gary L. Gramberger, present lessee of the property).

GENERAL GEOLOGY

The following discussion is based on the work we have done at Reveille, supported by brief conversations with Ruben Ross, Bart Ekren, and Gary Wilson of the U. S. Geological Survey.

Insofar as allowed by our limited number of samples, the rock names are based on determinations of textures in thin-sections and mineralogy by X-ray diffraction.

The accompanying map shows that the descriptions of the general features given by the early workers are correct. The Reveille districts occur in an island, or window, of Paleozoic sediments, surrounded on all sides by volcanics of Tertiary or younger age. Basalt overlies the rhyolite tuff and occurs at the eastern and northern fringes of the range (Fig. 3).

The Paleozoic sediments form a homoclinal sequence, striking about north-south and dipping about 20 to 30° to the west. Except for drag along some of the major faults, the rocks are essentially free of folding. Faulting is, however, extensive and complex.

The volcanics on the east side of the block of Paleozoic sediments are welded crystal tuffs, generally of rhyolitic composition but varying to quartz latite tuff. The tuffs are glassy and fresh at the fringes of the district, becoming devitrified and highly altered in the area of mineralization. A major north-south fault, passing through the abandoned townsite of Reveille on the east side of the range, marks the sharp transition from fresh to altered tuff (Fig. 3).

The volcanic rocks which lie west of the Paleozoic backbone of the range are generally dacite flows. These are also mildly to intensely altered. Some patches of choritized dacite occur on the eastern side of the range, forming a discontinuous fringe between the rhyolite tuffs and the Paleozoic sediments (Fig. 4). Except for one large patch in the northeastern part of the mapped area, we have not attempted to map the small patches of altered dacite on the east side of the range.

The Paleozoic sediments are predominantly dolomites, contrary to the early descriptions of them as limestone. Lesser quantities of quartzite, limestone, and shale are also present. Assemblages of fossils yield ages of Ordovician and Devonian.

Intrusive bodies include plugs and dikes of rhyolite porphyry, quartz latite porphyry, and quartz diorite. One body of heterogeneous chlorite breccia, just south of the Kietzke mine, is apparently a breccia pipe.

STRATIGRAPHY

We accept the Tertiary age (Spurr, 1903: Ball, 1907) of the silicic and basaltic volcanics. The ages of the Paleozoic rocks present a difficult problem. Spurr (1903) felt that they are Cambrian, whereas Ball (1907) concluded that they are Carboniferous. Our collections of fossils yield ages of Ordovician and Devonian.

The oldest sedimentary rock exposed in the district may be a tiny outlier of dolomite in the altered volcanics about three-quarters of a mile northeast of the New Reveille lead mine (see the geologic map). Unfortunately, we could not date this small outcrop. The oldest rock which we have dated crops out at the base of the hill just a few hundred feet north of the Antimonial mine. This unit consists of thin-to-medium-bedded limestone with interbedded calcareous shale. From the calcareous shale we have collected brachiopods, crinoids, and bryozoa. Based on the presence of the brachiopod Ingria, Ruben Ross of the U. S. Geological Survey has kindly identified this formation as the Antelope Valley limestone of Middle Ordovician age. The Antelope Valley limestone is the uppermost unit in the wellknown Pogonip Group. (See Table 1 for a summary of the relevant stratigraphy of neighboring areas.) We did not measure the thickness of the outcrop of Antelope Valley, but it is less than five hundred feet. The base of the unit is not exposed, and the top is marked by a fault, so we cannot be sure of stratigraphic continuity. The Antelope Valley varies from about 500 to 1500 feet in thickness in other parts of southern Nevada (Ross, 1964, p. 6).

Overlying the Antelope Valley limestone north of the Antimonial mine is a section of about 200 feet of massive, gray, non-fossiliferous dolomite. We do not know where this unit belongs in the stratigraphic sequence of the region. We did not examine its contact with the overlying Eureka quartzite, but it is likely to be in fault contact.

The Middle Ordovician Eureka quartzite crops out in discontinuous wedges along the eastern front of the range (Figs. 2 and 4). This is the only distinctive sedimentary rock on the eastern face, and much of our structural interpretation is based on its position along the front. It is bright white to light pink in color, with a vitreous luster and rounded sand grains that are easily visible under a hand lens. The thickness appears to be about 150 feet, which is normal for this formation (see Table 1). Because of the lack of distinctive bedding the attitude of the Eureka is extremely difficult to determine. Many of the strikes and dips shown on our map for the Eureka are little more than guesses, but in general it appears to dip to the west in a fashion similar to the other sedimentary

TABLE 1

SUMMARY OF PERTINENT LOWER PALEOZOIC STRATIGRAPHY IN ADJACENT AREAS

AGE	Eureka, Nevada (Nolan and others, 1965)			Tybo, Nevada (Ferguson, 1933)		
	formation	principal lithology	thickness (feet)	formation	principal lithology	thickness (feet)
Middle and Late Devonian	Devils Gate limestone	limestone	500 ±	-	-	-
Early Devonian	Nevada formation	dolomite, sandstone, limestone	2400-2900	-	-	-
Silurian	Lone Mountain dolomite	dolomite	1500-2200	Lone Mountain dolomite	dolomite	hundreds
	Roberts Mountain fm.	limestone, dolomite	650-1900	-	-	-
Late Ordovician	Hanson Creek formation	limestone, dolomite	300-600	-	-	-
Middle Ordovician	Eureka quartzite	quartzite	150-300	Eureka quartzite	quartzite	150 ±
Early and Middle Ordovician	Pogonip Group, with Antelope Valley limestone at the top	limestone	2500	Pogonip Group	limestone, quartzite	3000 ±
Cambrian	Eight formations	shale, dolomite, quartzite, limestone	7400 +	Hales limestone	limestone	3000 ±
				Tybo shale	shale	1600 ±
				Swarbuck formation	chert, limestone	2500-3000

units. The brittleness of the Eureka quartzite has played a key role in providing open space for mineralizing solutions as will become evident in the next section.

The only other formation for which we have a relatively firm age is the Devonian limestone along the western front of the range. This is a medium-bedded, gray to blue, fossiliferous limestone. We have collected well-preserved brachiopods, bryozoa, corals, and <u>Tentaculites</u> from the unit. Based on the abundance of <u>Tentaculites</u>, Ruben Ross of the U. S. Geological Survey has concluded that the rock is Devonian. We do not know, however, where in the Devonian sequence it belongs; the Devonian in this part of Nevada can be from 3000 to 5000 feet thick (Nolan and others, 1956, p. 42). As shown in Table 1, Devonian rocks are absent in the neighboring district of Tybo.

The rock which underlies the Devonian limestone, and which forms the bulk of the mountains in the Reveille districts (see Figs. 1 and 4), is lithologically very similar to the Silurian Lone Mountain dolomite of the Eureka area (see Table 1). The description of this unknown formation at Reveille is identical to that given by Nolan and others, (1956), for the Silurian Lone Mountain dolomite at Eureka, Nevada, as follows (p. 38):

> The Lone Mountain dolomite is...characteristically a heavy-bedded to massive block-weathering saccharoidal dolomite of medium to light gray color on the weathered surface. ...produces prominent and rugged exposures. ... finely granular to coarsely saccharoidal. ...color is predominately light to very light gray... Chert is usually absent and the dolomites appear relatively pure. As a result of recrystallization organic remains ... have been obliterated, as have in many places unequivocal indications of bedding.

Although this is a perfect description of the rock at Reveille, it could still be an error to identify it as the Lone Mountain dolomite. This is an important question that must be resolved early in any further investigation of the area. If it is Silurian, then the limestone on the western face of the ridge must be Early Devonian and close to the bottom of the Devonian sequence.

From the accompanying map, it is seen that the maximum true stratigraphic thickness of the massive dolomite between the top of the Eureka on the east and the bottom of the Devonian limestone on the west is about 2000 feet. Table 1 shows that the Eureka is overlain by several hundred feet of Upper Ordovician Hanson Creek formation in the Eureka area. Closer to Reveille in southern Nevada the Eureka quartzite is overlain by 300 to 1000 feet of Upper Ordovician Ely Springs dolomite (Ross, 1964, plate 1), but similar rocks are absent at Tybo (Ferguson, 1933, p. 21). Therefore, we cannot be certain how much of the section at Reveille between the Eureka and the Devonian rocks is Ordovician in age and how much is Silurian or earlier Devonian. These are critical points in trying to estimate the displacement on the main bounding faults on the eastern face of the range. The fact that the Eureka is in fault contact (Fig. 4) with the dolomite, not in a conformable sedimentary relationship, leads us to believe that the Upper Ordovician carbonates may be faulted out or stripped away at Reveille.

Intriguing and possibly important economic questions are raised by the lack of outcrop of the approximately 10,000 feet of Cambrian and lower Ordovician carbonates, shales, and quartzites that might be expected in this part of Nevada (Table 1). Lower Paleozoic carbonates and quartzites are the hostrocks for many of the great replacement ore bodies in such districts as Eureka and Pioche, Nevada, and Ophir, Rush Valley, Tintic, and East Tintic, Utah. As far as we know, Reveille has never been tested for the presence of these rocks at depth, not to mention any mineralization that might be contained therein. The deepest mine in the district is the Gila, which is reported to extend to a depth of 460 feet (Kral, 1951, p. 143); from an underground inspection one of us (G.L.C.) feels that the Gila is much shallower than this. We have discovered the remains of two apparently shallow churn drill-holes in the district, one at the base of the dump at the New Reveille lead mine and the other near the southern bounding fault in the large east-west valley that cuts through the range at the northern end of the district. We have no information on these holes, but Madison Locke of Ely may have some knowledge of them. We suspect they were drilled at the same time that the geologist deCarbonel (unknown to us) mapped the New Reveille mine in 1958 (Unpublished maps, supplied by Madison Locke).

STRUCTURE

As noted above, the main structure of the district is homoclinal, with Paleozoic sediments striking northerly and dipping gently to the west (Fig. 1). Folds are minor, but an extensive system of faults is present.

Referring to the accompanying geologic map, it is evident that there are several dominant directions of faulting. Prominent faults strike north-south, northwesterly, northeasterly, and approximately east-west. A prominent set of joints that strike northwesterly is also well displayed in the field but not shown on the map.

Of particular interest are the several northeasterly trending faults that offset and cut out the Eureka quartzite along the eastern front of the range. The Gila and the New Reveille mines each occur along this zone, where it is intersected by faults that trend other directions. Most segments of this fault zone dip steeply to the east. We recognize normal displacement on some of the individual faults in the zone and reverse displacement along others. The fact that the Eureka quartzite is in contact with younger sediments to the west indicates that the Eureka has been uplifted along a reverse fault in that section of the zone (Fig. 4). The amount of reverse displacement that can be estimated depends on the age that is chosen for the massive dolomite. Using the thicknesses listed in Table 1, if the beds against which the Eureka has been placed are Upper Ordovician or Lower Silurian in age, the total displacement should be only a few hundred feet. If, however, the Devonian limestone on the west is Late Devonian, then the Eureka may be resting against Early Devonian rocks and the total displacement could be several thousand feet. The importance of this question is obvious.

Ferguson (1933, p. 31) states that more than one episode of faulting has affected the Tybo district. The net effect at Tybo has been to leave the central part of the district as a horst of older formations bounded on the east and west by relatively depressed younger rocks (Ferguson, 1933, p. 31). We believe that much the same thing has happened at Reveille. We interpret the main ridge of Paleozoic strata to be a horst, flanked on the east by a graben of altered volcanics (Fig. 3). We assume that the fault zone on the west has some component of normal displacement, as is typical for the Basin and Range province

We cannot say what proportion of the present exposure and elevation of the ridge at Reveille is due to uplift, in contrast to erosion. However, the fact that the northern and southern extensions of the range are still buried by volcanics at elevations not much greater than in the Reveille districts suggests that relative uplift has been important.

There are five main zones of east-west faults, each cutting completely through the range. Each is mineralized and altered to some extent. The Gila, Kietzke, and New Reveille mines are each on a different east-west zone, at intersections with faults that trend northerly. The strong structural control exerted on the flow of mineralizing solutions in the district is self-evident.

Two major east-west grabens are well-developed, as shown on the map. The altered volcanics which now fill these grabens are pre-faulting in age, showing that some of the volcanics have been dropped down from higher elevations. It is almost a certainty that the entire area was at one time covered by volcanic flows and tuffs.

Two particularly intriguing features are the intrusive bodies of altered quartz latite porphyry and chorite breccia which occur at the intersection of several faults near the Kietzke mine. (Note: From our brief inspection we could not be absolutely certain that these bodies are intrusive in nature. However, we understand that geologists of the U. S. Geological Survey have mapped both bodies as intrusives). It should also be noted that the main fault zone along the western side of the range changes strike to the east, north of this point. We are tempted to draw two faults along the western front, intersecting near the Kietzke property.

Most of the faults in the dolomites are marked by silicification. An example is shown in Figure 5. This is particularly well displayed on the aerial photographs.

INTRUSIVE IGNEOUS ROCKS

The geologic map shows several intrusives. The rhyolite and quartz latite porphyry dikes consist of phenocrysts of quartz and either potassic feldspar or plagioclase in a fine-grained groundmass of quartz and feldspar.

Kaolinite, sericite, granular quartz, iron oxides, and manganese oxides are present as alteration products. The dike at the northern end of the range contains beautiful water-clear sanidine phenocrysts up to about an inch and a half in length. This dike is also cut by northerly trending fractures, outward from which dark red hematite has replaced the dike rock.

The dike or plug at the southern margin of the district is cut by numerous northerly trending fractures that are rich in manganese oxyhydroxides.

The plug or sill of quartz diorite at the northwestern corner of the range is distinctive. The grains average about two millimeters in diameter, and it is obvious with a hand-lens that all of the ferromagnesian minerals have been replaced by a dark purple hematite. The hematite lends a distinctive violet hue to the whole body of rock. It is tempting to postulate a genetic relationship between the intrusive quartz diorite in this area and the dacite flows in the same area.

We interpret the breccia near the Kietzke mine to be of intrusive origin. The rock consists of subangular to well-rounded fragments up to a foot or more in diameter, comprising an amazing mixture of rock types. We have observed pebbles, cobbles, and boulders of limestone, quartzite, volcanics, granite, and felsic metamorphics. We know of no other occurrences of either granite or metamorphics in the area. The matrix of the breccia consists of nearly monomineralic chlorite, speckled with fragments of minerals and rocks. We have considered very seriously the possibility that this is a sedimentary deposit, localized in the narrow valley in which the Kietzke mine occurs, but it is just as difficult to imagine how such a sediment would develop as it is to picture it as a breccia pipe. A bulldozer cut exposes one of the margins of the body, and it does seem to have a vertical attitude. In addition, the Survey geologists who have spent much more time in the area have mapped this as an intrusive.

Possibly the most exciting intrusive body is the altered quartz latite porphyry near the Kietzke mine. This mass occurs as two prominent peaks at the front of the range, marking the intersection of the several faults described above. We have examined four specimens of the rock in detail, and each is slightly different than the others. In its freshest aspect the rock consists of a very fine-grained groundmass of quartz, plagioclase, and K-spar, with tabular fresh phenocrysts of plagioclase up to about three millimeters in length. A few plates of black biotite up to about two millimeters in diameter also occur. Other samples of the rock collected nearby seem to show a progressive loss of potassium feldspar and variable gains of kaolinite, chlorite, and sericite. Fine-grained aggregates of quartz also seem to develop during the alteration. In the advanced stages of alteration the rock is a mass of granular quartz, fine-grained muscovite, and minor plagioclase. In thin-section the altered rock exhibits a texture of interlocking grains of quartz and minor feldspar, with a mean diameter of about 0.2 millimeters, pervaded and felted by fine-grained muscovite. The ferromagnesian minerals, some of which were probably originally hornblende, are also replaced by a felted mass of sericite. We have not observed any obvious mineralization in the rock, but we do feel that the body deserves a very careful examination.

VOLCANICS

Within the area of interest the two principal types of volcanic rocks are welded rhyolite crystal tuff and porphyritic dacite flow rock. Both are locally intensely altered.

The fresh welded rhyolite tuff occurs on all sides of the window of Paleozoics. It exhibits good megascopic and microscopic flow textures, including vesicles, shards, and stretched pumice. The freshest material occurs on the fringes of the district, becoming highly altered over a very short distance as the down-faulted block east of the range is encountered (see Fig. 3). The tuffs on the fringes of the district are still glassy, but the glass has been lost in the altered area. Embayed and shattered quartz phenocrysts up to about five millimeters in diameter characterize the rock and provide a guide for recognizing the highly altered equivalents.

Some phenocrysts of plagioclase (an_{30}) up to about one millimeter in length occur, and the fresh rock contains shiney pseudo-hexagonal books of black biotite up to about two millimeters across. Some portions of the rock contain enough plagioclase to approach a quartz latite in composition. The color of the biotite is a good guide to the degree of alteration. The biotite changes to brown or tan as mixed-layer vermiculite-montmorillonite develops and to white as muscovite (sericite) becomes dominant (see Fig. 3).

The freshest dacite is usually present on the west side of the range, although patches are also seen on the east side. From the present elevations of the outcrops of dacite and welded tuff at the northwestern corner of the mapped area, we feel that the dacite is the older of the two rocks. The freshest material is dark-gray to black, with phenocrysts of white or transparent plagioclase (variable from an_{30} to an_{45}). Embayed phenocrysts of quartz up to about 1.5 millimeters across also occur. The groundmass consists of microcrystalline quartz with scattered microlites of plagioclase. The microlites of plagioclase exhibit a poorly-developed parallelism. Chloritized phenocrysts of probable hornblende up to about one millimeter in length are also observed in thin-section. Much of the rock has suffered at least propylitic alteration.

We did not examine the basaltic rocks that overlie the rhyolite tuffs east and north of the district (Fig. 3).

ALTERATION

The alteration of the various types of rocks is extensive. From our brief study we recognize the following:

1. in the dolomites:

   a) staining by hematite contemporaneously with minor silicification

   b) extensive silicification to crystalline quartz or jasperoid

2. in the dacites:

   a) propylitization

   b) development of chlorite, calcite, traces of hematite, incipient muscovite and pyrite

   c) sericitization and pyritization

3. in the rhyolite and quartz latite tuffs:

   a) kaolinization and development of mixed-layer clays

   b) sericitization, silicification, and pyritization

4. in the silicic intrusives:

   a) Kaolinization

   b) sericitization and silicification

   c) replacement by hematite and manganese oxyhydroxides

5. in the quartz diorite:

   a) replacement of ferromagnesian minerals by hematite.

The following discussion follows the numbering of the preceding items.

1. In the dolomite nearly all of the faults and zones of brecciation are silicified and Stained with hematite (Fig. 5). The earliest stage is marked by a slight pink color developing outward from the traces of silica. The pink color must be due to the expulsion and oxidation

of ferrous iron from the dolomite lattice. As silicification proceeds the pink color is lost and the quartz becomes gray or white in color, and massive, crystalline, or vuggy in texture. Textures that indicate successive brecciation and silicification also occur. The remarkable consistency of the silicification allows one to map the faults in the field with relative ease.

We have observed the presence of dark-red jasper in the middle levels of the New Reveille mine and in an old adit in the east-west valley at the northern end of the district.

2. Even the freshest dacites have suffered some low-grade alteration. Calcite and chlorite are the earliest minerals to develop that we can recognize. We consider this to be a mild type of propylitization; it is nearly ubiquitous in the dacites.

In areas of more intense alteration, as near veins, the rock takes on the distinctive green color of chlorites. In this more advanced stage the plagioclase phenocrysts are replaced by an aggregate of calcite and muscovite; chlorite also develops at the expense of the ferromagnesian minerals and in the groundmass. Small grains of pyrite are locally abundant in this type of rock. In hand-specimens the calcite is marked by tiny specks of pink hematite. This stage of alteration is nicely displayed at the bend in the road about 1200 feet northeast of the Antimonial mine (Fig. 3) and on the knob in which the open-cuts of the Gila are located.

In the most advanced stage of alteration the dacite is converted to a rock consisting of granular quartz and sericite. A probable example occurs along the ~~wester~~ western side of gulley that runs south from the Gila mine (Fig. 2). A good example of the transition from chloritic alteration to sericitic alteration can also be seen adjacent to thin veinlets of pyrite in a stripped area at the bend in the road just northeast of the Antimonial mine (Fig. 3). Pyrite becomes more abundant in the sericitized material.

3. Early alteration of the tuffs seems to be marked by the replacement of the plagioclase phenocrysts either by fine-grained kaolinite, by a mixture of kaolinite and muscovite, by a mixture of muscovite and carbonate, by mixed-layer vermiculite-montmorillonite swelling clays, or by epidote. The biotite phenocrysts are early replaced by chlorite or mixed-layer clays, and chlorite may also be found in the plagioclase.

We have found only a few examples of this early alteration. It can probably be recognized by the presence of chalky pseudomorphs of white or brownish clay after the plagioclase phenocrysts and by the dull brown or tan color of the biotite. We have also found minor veinlets of stilbite in one specimen. More study is needed to really characterize and recognize this material.

Sericitization of the silicic volcanics is widespread, especially in the graben area east of the main ridge of Paleozoics (Fig. 3). In this stage of alteration the former sites of the plagioclase are filled with a pseudomorphic, waxey aggregate of sericite. The sparkle is just visible with a hand-lens. Sericite also begins to develop in the groundmass, in the form of finely-felted aggregates. Some granular quartz is precipitated in tiny cavities and in the groundmass. In advanced cases the entire rock is converted to a mass of fine-grained muscovite and granular quartz. Fine-grained pyrite is locally very abundant. In such rocks the relict tuffaceous textures may still be visible. Fine examples of this advanced alteration are present in patches on the high hill just east of the Gila mine (Fig. 4) (some dacites may also be involved at this location).

4. Much the same sequence of alteration as occurs in the tuffs seems to take place in the silicic intrusives, but we have devoted only a little

study to the latter. Good kaolinization is exhibited in the dike or plug south of the New Reveille mine, and the intrusive near the Kietzke mine shows some kaolinization and excellent sericitization.

Fringes of manganese and iron oxides occur as replacement features adjacent to fractures that cut some of the silicic dikes. The best examples are found in the two dikes that occur at the northern and southern extremities of the portion of the range shown on the map.

5. All of the amphibole and other ferromagnisian minerals in the quartz diorite have been converted to hematite. A few sheeted zones of fracturing also cut the quartz diorite intrusive, and chlorite and iron oxide have developed along the margins of these fractures.

From the preceding summary it is apparent that we have only touched on the nature of the alteration in the district. A great deal more work should be done in order to develop criteria for recognizing the various types of alteration and for using this information in delineating targets for exploration.

MINERALOGY OF THE ORES

The ores mined at Reveille have come chiefly from the oxidized zone. Minerals which have been reported by others as being in the ore include cerussite, cerargyrite, oxides of antimony, malachite, azurite, argentite, stibnite, pyrite, molybdenite, arsenopyrite, chalcopyrite, galena, quartz, calcite, gypsum, and "silver-copper glance".

We have collected samples from most of the dumps and accessible workings in the area and have identified (by X-ray diffraction in most cases) the following minerals.

name	formula	local characteristics
smithsonite	$ZnCO_3$	black, massive, dense
hemimorphite	$Zn_4(OH)_2Si_2O_7 \cdot H_2O$	baby blue, fine needles, brittle
beaverite	$Pb(Ca,Fe,Al)_3SO_4(OH)$	canary yellow, earthy, heavy
jarosite	$KFe(SO_4)_2(OH)_6$	brown, translucent, glassy
sphalerite	ZnS	dark brown
argentiferous galena	(Pb,Ag)S	
fluorite	CaF	white, coarsely bladed
rosasite	$(Cu,Zn)_2CO_3(OH)_2$	finely fibrous to earthy, light bluish green to malachite green
arsenopyrite	FeAsS	massive, silvery in color, in thin veinlets
manganosite	MnO	black, earthy, in mixtures
hausmannite	Mn_3O_4	black, earthy, in mixtures
Unidentified mixtures of manganese and iron oxyhydroxides	shown by emission spectrography to sometimes be very rich in Cu, Pb, Zn	black, earthy
hetaerolite	$ZnMn_2O_4$	black, earthy
chrysocolla	copper silicate, hydrous	blue-green, glassy
cerussite	$PbCO_3$	bladed, vitreous luster, stained brown, small clusters
goethite	FeOOH	brown, earthy
plumbojarosite	$PbFe_6(SO_4)_4(OH)_{12}$	dull faded yellow, soft, earthy
pyrargyrite-proustite	$Ag_3(Sb,As)S$	small masses, meatllic, red streaks, soft

stibnite	Sb_2S_3	coarse, bladed, silvery crystals
pyrite	FeS_2	typically fine-grained
tennantite	$Cu_{12}As_4S_{13}$	Gray, metallic, structureless
conichalcite	$CaCuAsO_4(OH)$	shamrock green, compact, brittle films
anglesite	$PbSO_4$	yellow-brown, massive
barite	$BaSO_4$	perfect rhombohedrons, clear

Be means of X-ray diffraction we have verified in the altered volcanics the presence of kaolinite, muscovite, chlorite, and mixed-layer swelling vermiculite-montmorillonite. We used glycolation and heat treatment to identify the swelling clays. One specimen of slightly altered tuff contained thin veinlets of pink stilbite.

One of us (G.L.G.) collected the sample of argentiferous galena from a pod, apparently several feet across, in the middle levels of the New Reveille lead mine. The sphalerite was found as residual blebs in oxidized specimens from three dumps in the district, including the Gila. One small grain of galena was also found on the Gila dump.

INDIVIDUAL MINES

We have inspected all of the accessible and reasonably safe underground workings, including the Gila, New Reveille, Antimonial, and Kietzke mines. V. J. Barndt has supplied unpublished maps of the Gila mine and Gary L. Grauberger has provided similar data for the Kietzke mine.

Gila Mine:

The Gila mine consists of one patented claim owned by V. J. Barndt of Tybo. The claim was patented by the Gila Silver Mining Company as the New Hope Lode in 1890. Because of the age of the mine, geologic information is extremely sparse. It has been the largest producer in the district, with a recorded production of over half a million dollars (Couch and Carpenter, 1943, p. 119)

The mine is developed on a brecciated and silicified fault zone at the contact between altered volcanics and the Eureka quartzite and associated dolomite (see Fig. 2). The workings are open and accessible to shallow depth. It is obvious from inspection that the brecciated zone dips in some complicated fashion to the east and south. We measured strikes on the vein that vary from nearly north-south to east-west over short horizontal distances in the mine. The ore shoots were horizontal in the upper workings, steepening rapidly to the east and south (Raymond, 1875, p. 177-179); the steepening to the east is easily visible in the present openings. From the description of the early workings (Raymond, p. 177-179) it is possible to estimate the various dips of the lode as being near horizontal in the upper workings, changing with depth to near-vertical to the south and 70° to the east. These changes may be due to cross-faulting, as shown on the accompanying geologic map.

In 1875 the workings, consisting of three levels, extended to a depth of about 100 feet below the top of the ridge on which the surface cuts are located. The shaft that was being sunk at that time was intended to intersect the lode at a depth of about 380 feet below the uppermost open cuts on the ridge (Fig. 2), or 286 feet below the level of the adjacent gulley in which the shaft is collared (Raymond, p. 178). We do not know what the present depth of the mine is, but from limited inspection (by G.L.G.) we suspect that it is less than the 460 feet reported by Kral (1951, p. 143).

The patches of ore that remain in the upper levels consist of highly oxidized material, with an appearance generally like that of mixed earthy iron and manganese oxides. The silver-bearing minerals, if present, cannot be identified by eye. The dump shows much oxidized material, including stains of copper. Brecciation and silicification are ubiquitous. Raymond (1875) reports that the ore shoots were tabular, relatively continuous in the shallow workings at that time, and up to about six feet thick. The ore must have occurred chiefly as a filling of the open space in the silicified breccias.

Sulfide ore became increasingly abundant below the second level of the mine, at a depth of 93 feet below the surface of the ridge (Raymond, 1875, p. 178). He reports the occurrence of pyrite, chalcopyrite, arsenopyrite, and galena. We have found specks of pyrite, galena, and sphalerite on the dumps.

It seems clear that the brittle nature of the Eureka quartzite must have aided in creating favorable open space in the complicated intersection of faults at the Gila (Figs. 2 and 4).

New Reveille Lead Mine

Four patented claims comprise the mine area. The major owner is Madison Locke of Ely. The claims were patented in 1913.

An unpublished map of the underground workings (deCarbonel, 1958) shows four main levels at the New Reveille mine. The deepest level is at a depth of 200 feet below the collar of the shaft. The largest slope in the mine, on the top level, is about 160 feet long by 60 feet wide.

Maps of the surface geology and of the underground workings (both unpublished, by deCarbonel, 1958) show a complicated pattern of intersecting faults involving the Eureka quartzite, adjacent dolomite, and slivers of altered volcanic tuff. The main intersecting faults strike east-west and northeast. Dips are steep to the south and east. Normal displacement is apparent on the northeasterly faults. A comment of unknown origin in the records of V. J. Barndt states that there is a displacement of 2000 feet on the fault at the shaft; we cannot confirm this.

As at the Gila mine, it is obvious that the New Reveille mine is localized at a structurally favorable locus formed by the intersection of faults in the presence of the Eureka quartzite. Unlike the Gila, however, there is good evidence of replacement of the dolomitic wallrock by the ore mineralization. This apparent replacement occurs between the first and second levels at a depth of about 100 feet below the collar of the shaft. One of us (G.L.G.) observed a pod of galena several feet across, with jasperoid occurring as a fringing replacement of the dolomite wallrock.

One of the two churn drill holes that we have found in the district is located on the road at the base of the dumps at the New Reveille mine.

Only oxidized lead and iron minerals were observed at the dumps. A few grains of sphalerite, surrounded by rosasite, were found in the prospect on top of the quartzite ridge northeast of the New Reveille mine. Unpublished records owned by V. J. Barndt list 3400 tons of material ranging from five to eleven percent lead on the dumps, and 4500 tons of nine percent lead "in sight" in the mine. Numerous assays of various portions of the mine taken in 1942 show values of from about three to ten ounces of silver, about five to twelve percent lead, and from a trace to 0.03 ounces of gold per ton. Selected specimens of galena(?) and cerussite contain from 37 to 58 percent lead and from 31 to 58 ounces of silver per ton.

Kietzke Mine

The Kietzke property consists of eight unpatented claims owned by Florence Reppert, Helene Neal, and Phyllis Frank of Shasta and Redding, California. These are the daughters of Frank Kietzke, for whom the property is named. Frank Kietzke mined small amounts of high grade oxidized silver ore from the property for many years.

The mine consists of an upper and lower tunnel, probably connected through one or more winzes. The upper tunnel is driven on a brecciated and silicified fault zone for a distance of about sixty feet. Three winzes were sunk on high grade stringers The fault places dolomite in the footwall in contact with altered volcanics in the hanging wall. The dip of the vein is about 50 degrees to the southwest. The lower tunnel is 2200 feet long, also driven on a fault zone between dolomite and altered volcanics. In one crosscut the dolomite is locally well-sanded. Steeply pitching stringers of high grade silver halides occur in shear zones of brecciated and crustified quartz.

Numerous unpublished assays of samples collected by Gary L. Grauberger, leasee of the property, show from a trace to 88 ounces of silver and a trace to 0.70 ounces of gold per ton.

Antimonial Mine

The Antimonial mine is described by Lawrence (1963, p. 135-137). The property consists of one patented claim, owned in 1961 by Magnus Peterson, E. M. Booth, and Lee Hand. The mine consists of several shafts, open pits, and about 520 feet of adit.

The main vein strikes north 80° west and dips 20-25° to the north, bringing altered volcanics on the hanging wall against quartzite on the footwall. The vein consists of quartz and gouge, with pods of stibnite. Two assays by Lawrence (1963, p. 137) show 27% and 37% Sb, a trace of gold, and 0.58 and 33.5 ounces of silver per ton.

Other Mines

Numerous other open pits and adits are scattered across the districts.

SUMMARY

The preceding discussion attempts to provide an outline and a guide for further work in the district. It is clear that the Reveille area offers interesting possibilities for exploration for ore bodies that are more meaningful than those mined in the past. The districts show evidence of the passage of solutions, possibly through rocks that may have been replaced by sulfide mineralization at depths not yet tested. The intriguing possibility exists of a thick section of favorable carbonate rocks at depth, similar to historically more important districts in which large replacement ore bodies have been mined. The obvious structural control and the well-developed alteration provide immediate targets for exploration. Longer range possibilities are offered by the intrusive rocks at the structural locus near the Kietzke mine.

RECOMMENDATIONS

Based on our work in the district we can offer the following suggestions for a program of exploration:

1. determination of the stratigraphic sequence and nature of movement along the major faults,
2. detailed mapping of the volcanics and study of the associated alteration,
3. projection of structural features to favorable locii,
4. detailed geochemical survey,
5. reconnaissance geophysics, with the objectives of:
   a) determining the depth to the sediments below the volcanics in the graben east of the range,
   b) detecting massive sulfides in carbonate rocks and along veins,
   c) investigating the Kietzke intrusive for disseminated sulfides,
   d) investigating the covered flats adjacent to the range,
6. churn drilling to verify or establish stratigraphic and structural relationships,
7. churn or diamond drilling to the most promising stratigraphic and structural targets,
8. drilling in the intrusive if warranted by geochemistry and geophysics.

The most promising targets are:

1. extension and enlargement of the mineralization at the New Reveille lead mine, including replacement deposits,
2. mineralization beneath the intensely altered ridge just east of the Gila mine (Fig. 4),
3. the Kietzke intrusive and the adjacent flats.

REFERENCES

Ball, S. H., 1907, A geologic reconnaissance in southwestern Nevada and eastern California: U. S. Geological Survey Bull. 308, 218 pp.

Browne, J. R., 1868, Mineral resources of the states and territories west of the Rocky Mountains: U. S. Govt. Printing Office, Washington, D. C., [illegible] pp.

Couch, B. F. and [illegible], J. A., 1943, Nevada's metal and Mineral product[illegible] [illegible]940 inclusive): Univ. of Nevada Bull: v. VI[illegible] [illegible]ol. and Mining Series No. 33, 159 pp.

Ferguson [illegible] [illegible]933, Geology of the Tybo district, Nevada, Univ [illegible]vada Bull: no. 3, 61 pp.

Gianel[illegible], and Prince, R. W., 1945, Bibliography of geol[illegible] [illegible] of Nevada and bibliography of geologic maps of N[illegible]as: Nevada State Bur. Mines Bull., v. 39, no. 6

Gilbe[illegible], 1875, Geology, part I in Wheeler, G. M., Explo[illegible] [illegible]s west of 100th meridian, vol. III: Army Engin[illegible] [illegible], 681 pp.

Kral, [illegible]951, Mineral resources of [illegible] County, Nevada: [illegible] Nevada Bull: v. XLV, Geol. [illegible] Mining S[illegible] 50, Ne[illegible] Bur. Mines, Reno, 223 pp.

Lawre[illegible] [illegible]6[illegible], Antimony deposits of Nevada: Nev. Bur. Mines, Bu[illegible], Mackay School of mines, Reno, 248 pp.

Lincoln, F. C., 1923, Mining districts and mineral resources of Nevada: Nevada Newsletter Publ. Co., distributed by Nev. State Bur. Mi[illegible]

Minerals Ye[illegible] [illegible] Mines, U. S. Dept. Interior, Washington, D. C.

Nolan, T. B., Merriam, [illegible] [illegible]iams, J. S., 1956, The stratigraphic se[illegible] [illegible] of Eureka, Nevada: U. S. Geol. Survey Prof[illegible] [illegible] pp.

Raymond, R. W., 1869, Mineral resources of the states and territories west of the Rocky Mountains: House Exec. Doc. 59, Govt. Printing Office, Washington, 172 [illegible]

_______, 1875, Mineral resources of the states and territories west of the Rocky Mountains: Govt. Printing Office, Washington, p. 177-179 (seen only in photo[illegible]).

Ross, R. J., 1964, Middle and Lower Ordovician formations in southern Nevada and adjacent California: U. S. Geol. Survey Bull. 1180-C, 101 pp.

Schilling, J. H., 1969, Metal Mining districts of Nevada, Nev. Bur. Mines Map 37, Mackay School of Mines, Reno.

Spurr, J. E., 1903, Nevada south of the fortieth parallel and adjacent portions of California, U. S. Geol. Survey Bull. 208, 229 pp.

York, Bernhard and [illegible]son, H. G., 1944, The geology of Nevada ore deposits and [illegible] ning districts of Nevada: Univ. Nev. Bull., v. XXXVIII, [illegible], Geol. and Mining Series No. 40.

FIGURE 1

View to the northwest from a high point in the center of the area of the geologic map. Volcanics in lower portion of photo, with ridge of massive dolomite in middle ground. Open-cuts at left center mark a major east-west fault that extends through the Gila mine off the photo to the right.

FIGURE 2

Gila dumps. Bold outcrops directly above dumps are altered and silicified dacite. Open cuts of the Gila, described in the text, can be seen at the top of the trail extending up to the right from the dump. The Eureka quartzite forms the sharp outcrops in the right distance. The major east-west fault shown in Figure 1 lies in the valley (not obvious in photo) between the Eureka quartzite in the background and the ridge of altered volcanics in the foreground. View to the northwest. Gila shaft just off the photo to the right.

FIGURE 3

View to the northeast from a high ridge above the Antimonial mine. The Antimonial mine is located at the near end of the road, in the dark, low ridge at the lower left of the photo. Basaltic cappings on top of fresh rhyolite tuff can be seen in middle distance. The fault shown here is the one that passes through the abandoned townsite of Reveille shown on the geologic map. The rhyolite tuffs to the right (east) of the fault are fresh, whereas [illegible] large patch of white phyllic alteration is visible immediately [illegible] of the fault in the center of the photo. The low area is thought to represent part of the eastern graben.