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Geology of the Round Mountain Gold Deposit: Nye County, Nevada

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ABSTRACT

Round Mountain has recently developed into one of the largest gold mines in the United States. Annual production is in excess of 59,000 ounces of gold or 6% of the total U.S. gold production. Historically, the district produced 537,200 ounces of gold from lode and placer ores before 1960. The modern heap leaching operation has produced 240,926 ounces of gold between 1977 and 1981.

Ore reserves for the heap leaching operation were 12 million tons averaging 0.061 oz/ton Au in 1976. Recent exploration has discovered deeper disseminated ore resulting in an increase of reserves by the end of 1981 to 195 million tons of proven and probable ore averaging 0.043 oz/ton Au.

A large zoned hydrothermal alteration system in Tertiary volcanic rocks of the Jefferson caldera has localized the gold mineralization at Round Mountain. Underlying the altered volcanic rocks in the mine area are Paleozoic metasedimentary rocks and a Cretaceous granitic pluton.

Four main ore zones are developed at Round Mountain including oxidized, stockwork and vein ore in densely welded tuff, disseminated oxide and sulfide ore in poorly welded tuff, high grade vein ore in underlying metasedimentary and granitic rocks and placer ore in Quaternary gravels.

The Jefferson volcanic rocks hosting the ore at Round Mountain consist from the lowest to the highest, of a basal lithic tuff, a poorly welded tuff, a densely welded tuff and tuffaceous sedimentary rocks. A breccia pipe type structure exists in the volcanics and may represent a breccia pipe or a collapsed vent. Hydrothermal alteration appears to be concentrically zoned around the breccia structure.

The dominant alteration sequence is one of increasing hydrolitic alteration toward the central breccia involving the introduction of silica, potassium and sulfur. Quartz-pyrite-gold veins are responsible for the bulk of the vein and stockwork mineralization, while gold contained as blebs in pyrite forms the disseminated ores.

Subsequent to deposition, the ore bodies at Round Mountain have been eroded, partially oxidized, displaced by post-mineral faulting and partially buried beneath post-mineral alluvial gravel.

The Geology of the Round Mountain Gold Deposit: Nye County, Nevada

The Round Mountain Mine has recently developed into one of the largest gold mines in the United States. It is located approximately fifty miles north of Tonopah in the Round Mountain Mining District, Nye County, Nevada. The mine is on the west flank of the Toquima Range at an elevation of approximately 6,300 feet. In 1982, the property was owned and operated by a common operation involving the Louisiana Land & Exploration Company, Felmont Oil Corporation and Case-Pomeroy Corporation. In 1981, the mine produced 59,000 ounces of gold or approximately 6% of the total U.S. gold production.

HISTORY & DEVELOPMENT OF THE ROUND MOUNTAIN DISTRICT

The Round Mountain District was discovered in 1906 and remained in production from lode ores until 1935 and placer ores until 1959. During this time, 329,000 ounces of lode gold and 208,200 ounces of placer gold were produced from 690,000 tons of lode ore and 4,000,000 yards of placer gravel. The bulk of the lode production during this time came from the underground workings of the Fairview Round Mountain Mining Company's Fairview Mine and the Round Mountain Mining Company's Sunnyside Mine. The last major operation prior to the present one, was a major effort by the Morrison-Knudsen Company to evaluate and mine the placer deposits in the alluvium to the west of the lode workings. This operation ceased in 1959, and the district remained essentially dormant until 1970 when the Copper Range Company acquired the majority interest in the Round Mountain District and started a detailed evaluation of the placer and lode deposits.

An economic feasibility study by the Fluor Corporation in 1972 indicated that placer mining could not be economically undertaken at the then prevailing gold price. The Copper Range Company then turned its attention to the remaining lode deposits. Aided by a detailed underground sampling program prepared during 1936 and 1937 by the A.O. Smith Company and by limited drilling, a relatively large, low grade, heap leachable ore body of 12 million tons averaging .061 oz/t Au was blocked out by 1976.

Mine planning and development were based on this ore reserve and, with financing provided by the common operation partners, production began in 1977. Through 1981, the heap leaching operation produced 240,926 ounces of gold and 126,681 ounces of silver. In 1979, with the rapid depletion of ore reserves, the participants initiated a drilling program to develop additional reserves to extend the life of the mine. A deeper disseminated ore zone was intersected and by the end of 1981, in excess of 250,000 feet of drilling had vastly increased the proven and probable ore reserves to 195 million tons averaging .043 oz/t Au.

H. G. Ferguson (1921) of the U.S. Geological Survey made an early geological study of the Round Mountain area. Later work by the U.S. Geological Survey which included the Round Mountain area was done by H. G. Ferguson and S. H. Cathcart (1954), D. R. Shawe (1977, 1981) and J. Tingly and B. Berger (1980).

Since the start of development at the Round Mountain Mine in 1972, there has been a large amount of geologic work performed by members of the Copper Range Company. The results of some of this work have been recorded in unpublished company reports cited throughout this paper.

REGIONAL GEOLOGIC SETTING

The Round Mountain District is one of several areas of known gold and/or silver mineralization associated with Tertiary volcanism in the Toquima Range of central Nevada. Other districts of importance in this area are the Manhattan District, Gold Hill District and the Jefferson District. The Toquima Range is a typical central Nevada, north trending mountain range bounded by steep range faults on both the eastern and western sides. This faulting has resulted in the accumulation of in excess of 5,000 feet of valley fill in the Big Smoky Valley, west of Round Mountain and in the Monitor Valley to the east.

Pre-Tertiary Rocks

Paleozoic sedimentary rocks from Cambrian through Devonian age are exposed in the southern Toquima Range. These include members of both the eastern carbonate assemblage and western siliceous assemblage. Extensive thrust faulting and folding of these sediments has vastly complicated outcrop patterns, and identification of individual formations in the Round Mountain area is difficult. Relations are further obscured by extensive contact metamorphism related to the intrusion of Cretaceous plutons. Except in a few isolated areas, the dominant sedimentary rocks are extremely contorted Ordovician equivalents of the Vinini Formation.

The entire Paleozoic sedimentary sequence has been intruded by three large stocks of Cretaceous age. These stocks, the Shoshone, Belmont and Windy Creek plutons, are granitic in composition although they vary widely in texture from each other. The Shoshone pluton outcrops immediately to the east and partially underlies the Round Mountain Mine area; this coarse grained equigranular granite is characterized by a high muscovite content, occurring in distinctive large books. The Belmont pluton, in contrast, is a porphyry granite with distinctive, unusually large (0.5 - 2.0 in.) porphyry K-feldspar crystals. The Windy Creek pluton is a rather typical equigranular granite.

Tertiary Volcanic Rocks

The Round Mountain area was subjected to extensive volcanism and caldera formation in the mid-Tertiary. Four and possibly five major caldera centers were developed in the area surrounding Round Mountain.

The two calderas exposed in the southern Toquima Range are the Jefferson caldera to the north of the Round Mountain area and the Manhattan caldera to the south. Others, exposed to the west of the Round Mountain area in the Toiyabe Range, are the Central Toiyabe caldera, the Darrough caldera and the Peavine caldera. Age dating of these volcanic rocks has placed the major eruptive events in the period from 29 mybp - 20 mybp (D. R. Shawe, 1981, D. R. Boden, 1982).

Rhyolitic ash flow tuffs derived from the Jefferson caldera are the hosts for the major gold ore bodies in the Round Mountain District. This caldera had an early stage of rhyolitic volcanism that developed a relatively thick (100-1,000 foot thick) cooling unit (coupled upper densely welded and lower poorly welded tuffs) in the area of Round Mountain, followed by a voluminous eruption of rhyodacitic ash that formed the bulk of Mount Jefferson. Ore deposits in the Round Mountain, Gold Hill and Jefferson districts are all hosted in the earlier rhyolitic tuffs, and little, if any, mineralization occurs in the Mount Jefferson rhyodacite. Details of the volcanic history of Mount Jefferson are complex and are currently being examined by D. R. Boden, PhD student at Stanford University.

Post-Tertiary Rocks

Subsequent to, and possibly partly coincident with Tertiary volcanism, basin and range faulting uplifted the Toquima Range and formed the Smoky and Monitor Valleys. These valleys have been filled with a deep accumulation of Quaternary and late-Tertiary gravels and lake sediments. Steep escarpments on the eastern sides of both the Toquima and Toiyabe Ranges indicate that this faulting may still be active. Figure 1 depicts the regional geology surrounding Round Mountain.

GEOLOGY OF THE ROUND MOUNTAIN MINE AREA

A large zoned hydrothermal alteration system in Tertiary volcanic and volcanoclastic rocks of the Jefferson caldera localized the gold mineralization in the Round Mountain District. Underlying the altered volcanic rocks in the mine area are Paleozoic metasedimentary rocks in intrusive contact with the Cretaceous Shoshone pluton. The Paleozoic rocks strike northeasterly and dip steeply to the northwest. The contact between the sediments and the granite also trends northeasterly under the mine. Tertiary volcanic rocks of the Jefferson caldera overlie the metasedimentary and granitic rocks on a gently westerly dipping erosional surface. The Tertiary volcanic rocks strike northward and dip 10° - 20° to the west. The mineralized zone has been eroded, oxidized, displaced by post-mineral faulting and partially buried beneath post-mineral alluvial gravel.

Four separate gold ore types are recognized and this has led to a designation of ore bodies as follows:

1. Densely welded ore is located in the upper densely welded zone of the Round Mountain rhyolitic ash flow tuff. Ore bodies of this type consist of oxidized structurally controlled ore zones (veins & stockworks).

2. Poorly welded ore is located in the lower poorly welded zone of the Round Mountain ash flow tuff. Ore bodies of this type consist of disseminated oxidized and sulfide ore in poorly welded tuff.

3. Deep vein ore is located in veins in the underlying lithic tuff, metasedimentary rocks and granite. Ore bodies of this type consist of high grade quartz-pyrite-gold veins.

4. Placer ore is located in Quaternary gravels to the west of the lode deposits and consist of gravels composed of weathered, densely welded ore, as well as free gold in channels in a complex alluvial fan deposit. This ore is overlain by non-mineralized Quaternary gravels largely derived from the erosion of the Shoshone pluton.

Figure 2 shows the spacial distribution of these ore zones relative to the surface in the Round Mountain District.

Metasedimentary and Granitic Rocks

Metasedimentary rocks which are in intrusive contact with the Shoshone granite, underlie the volcanic-hosted ore bodies in the Round Mountain District. The metasedimentary rocks consisting of slate, recrystallized limestone and quartzite, generally strike northeasterly parallel to the intrusive contact and dip approximately 45° to the northwest. Most of the metamorphism appears to have been developed during the intrusion of the Shoshone pluton. Very little hydrothermal alteration effects these metasedimentary rocks except where they are cut by major Tertiary veins. The Shoshone granite is also largely unaltered in the mine area except where cut by Tertiary veins.

Jefferson Volcanics

Four distinct volcanic units exist at Round Mountain. These consist, from the lowest to highest, of a basal lithic tuff unit, a poorly welded tuff, a densely welded tuff and tuffaceous sedimentary rocks. Of the volcanic rocks, only the poorly welded and densely welded units host significant ore at Round Mountain, although mineralized veins cut the entire sequence. The two central volcanic units consisting of the lower poorly welded and upper densely welded zones of the Round Mountain tuff are gradational from one to the other and are believed to represent a single cooling unit. Figure 3 is a cross section showing the relationship between the volcanics, the underlying metasedimentary rocks and the granite.

Lithic Tuff

The basal volcanic unit known as the lithic tuff directly overlies both metasedimentary rocks and granite. This unit is a clastic-rich, moderately welded tuff. Clastic content varies between forty and ninety percent, with clastic material generally being derived from the underlying metasedimentary rocks or granite. Clastics vary in size from 1-2 inches in diameter to as large as 30 feet in diameter. The unit has an average thickness of 200 feet, but pinches out updip on the east side of the mine area, and thickens to a maximum of 600 feet at the limit of drilling on the west side of the mine area. In areas of mineralization, the lithic tuff is generally strongly chloritized and contains between 1-3% disseminated pyrite.

Poorly Welded Tuff

The poorly welded tuff conformably overlies the lithic tuff and is a relatively typical rhyolitic poorly welded tuff. The unit has characteristic pyroclastic (0.25-1.0 in.) fragments of black chert that comprise up to twenty percent of the tuff at the base and grade to less than 1% at the top. In addition to chert, occasional pyroclastic fragments of granite also occur. Uncrushed 0.5 - 1.0 in. diameter pumice fragments comprise up to fifty percent of the tuff at the top, but decrease to less than twenty percent at the base. Where fresh, the tuff is generally white and forms subdued outcrops under cliffs of overlying, densely welded tuff.

The poorly welded tuff grades upward to the densely welded tuff over an interval of between 50 to 100 feet marked by the progressive collapse of pumice lapilli. The poorly welded tuff has an average thickness of about 400 feet in the mine area, but this thins rapidly eastward and northward and thickens to in excess of 1,000 feet at the western limits of drilling.

Welded Tuff

The densely welded tuff, which forms the upper portion of the main cooling unit at Round Mountain, is a crystal-rich rhyolitic tuff in which the pumice has been crushed beyond recognition. Common broken smoky quartz crystals are a characteristic feature of the rock which led to its initial correlation with the Diamond King Formation of the Manhattan caldera. Subsequent petrographic and geologic work has led to its reassignment with the lower rhyolitic tuff units of the Jefferson caldera. The rock is tannish-grey in fresh outcrop and a strong cliff former. Eutaxitic texture is only evident in the basal 100 feet and upper 100 feet of the tuff. Biotite is the main mafic mineral in the tuff and comprises 2-5% of the total rock. The average thickness of the densely welded tuff in the mine area is estimated at 800 feet. This thickness is based on the gradation of the densely welded tuff to a thin (50 ft) poorly welded zone on the top of Round Mountain.

Tuffaceous Sedimentary Rocks

A small cap of tuffaceous sedimentary rocks is preserved on the top of Round Mountain. Exact contact relationships between these sedimentary rocks and the underlying tuff unit are imperfectly understood due to structural complexities. The tuffaceous sedimentary sequence, however, is punctuated by a thin (3 foot thick), poorly welded tuff suggesting that the sedimentary rocks have a conformable relationship with the underlying tuff unit. The unit consists of laminated tuffaceous siltstone (lacustrine deposits) and interlayered tuffaceous sandstones (fluvial deposits). These rocks are silty to sandy white tuffaceous sediments that closely resemble sedimentary deposits present locally on top and locally along the flanks of Mount Jefferson. It is believed that the later sedimentary rocks may have developed as intracaldera and moat sediments of the Jefferson caldera. However, it is unclear whether these rocks are correlative to those on the top of Round Mountain. In any event, those on top of Round Mountain have been strongly silicified and are cut by occasional mineralized quartz veins.

Breccia

An extensive breccia pipe type structure exists in the volcanic and volcaniclastic rocks on the top and north flank of Round Mountain. This breccia, consisting of small to large angular and subangular rotated blocks of tuffaceous sediments, densely welded tuff, poorly welded tuff, lithic tuff, granite and Paleozoic sedimentary rocks in a silicified, fine grained, possibly igneous matrix, may represent the surface expression of a buried intrusive or volcanic vent. Drilling has not conclusively established the origin of the breccia nor its overall spacial extent. The surface expression of this feature is almost entirely covered with alluvium. Underground exposures of the breccia exist in several drifts that were driven under Round Mountain.

Structure

Pre-mineral structures have played an important part in localizing ore zones. The dominant pre-mineral structural event was a strong, northwesterly trending, nearly vertical dipping, right lateral shearing which occurred along the southwest edge of Round Mountain. Numerous east-west dilatancy zones were developed between parallel northwest trending shears in this wide fault zone. Superimposed on the northwest trending fault is a set of radial and concentric fractures distributed around the central breccia which may have formed contemperaneously with mineralization. This radial and concentric fracture pattern is similar to that which might develop above a forcibly intruded stock or around a collapsed vent.

Post-mineral faulting has displaced ore mineralization and volcanic units up to 200 feet vertically. At least five post-mineral faults cut the entire stratigraphic sequence. These faults are northwest to northeasterly trending, dipping from 45° to the west to vertical and all motion appears to be dip-slip. It appears that the majority of the post-mineral faults were developed sympathetic with basin and range faulting. Figure 4 shows the relationship between the surface outcrops of mineralized structures, non-mineralized structures, and the breccia.

MINERALIZATION AND ALTERATION

The Round Mountain District mineralization center was formed during the Tertiary some time after the early eruptions of the Jefferson caldera. No regional structural explanation exists for the localization of the mineralization, although the center is fairly close to the proposed structural margin of the Jefferson caldera and it is possible that a lobe or resurgent intrusive of this center is responsible for the emplacement of gold mineralization.

Hydrothermally altered rocks relatable to the Round Mountain center extend in a zoned pattern over at least four square miles. In general, the northern and western portions of the alteration zone are masked by alluvial cover. The hydrothermal alteration pattern appears to be concentrically zoned around a breccia developed to the north of and on top of Round Mountain. Alteration zones overlap considerably due to changing conduits for advancing hydrothermal solutions and isolated remnants of lower temperature alteration are preserved in higher temperature zones. The dominant alteration sequence is one of increasing hydrolitic alteration toward the central breccia zone involving the introduction of silica, potassium and sulfur.

Erosion and oxidation of the upper part of the hydrothermal aureole has been extensive as evidenced by the development of the large placer ore reserve. At least one zone of later destructive alteration, probably related to the formation of a hot spring along a basin and range fault, cuts the entire ore zone.

Primary Mineralization

Quartz-pyrite-gold veins are responsible for the bulk of the vein and stockwork mineralization at Round Mountain. Disseminated ores consist of disseminated pyrite containing gold as minute blebs. In general, even in veins, the gold occurs as immiscible blebs in pyrite. Oxidation has caused some remobilization and recrystallization of gold but little or no enrichment. Where veins become rich enough, elemental gold has crystallized in intimate association with quartz and pyrite. In a strict sense, the gold mineral in the Round Mountain District is electrum consisting of 60% gold and 40% silver.

In the densely welded tuff, all of the ore grade mineralization is associated with veins and stockwork systems. This dense, non-porous rock was extensively shattered by pre- and synmineral faulting. Solutions invaded along major vein structures and permeated stockwork zones. Within ore zones, in addition to obvious veins, minute veinlets of silica and associated disseminated pyrite are ubiquitous in the welded tuff. Typically, within larger veins and vein stockworks, quartz occurs only as druses along the vein walls with vein centers filled by clay and gouge. Primary vein gangue minerals other than quartz and pyrite are occasional occurrences of the following minerals: fluorite, realgar, calcite, adularia and alunite (possibly supergene).

Poorly welded ore zones consist of 0.5-1.0% disseminated pyrite associated with weak to moderate silicification. Calcite is a common component of poorly welded ores and may have precipitated with the pyrite-gold mineralization. More intensely quartz-veined zones correspond with higher grade values of gold and probably represent primary solution passageways through the poorly welded tuff. Poorly welded ores generally start about 100 feet below the contact with the densely welded tuff, while densely welded ores usually do not persist down to the contact with the poorly welded tuff resulting in a barren zone 100-150 feet thick.

Below the disseminated gold ore in the poorly welded zone, drilling has intersected several very high grade (0.5-1.0 ounces/ton Au) vein zones in the basal lithic tuff and underlying Paleozoic rocks and granite. These zones typically consist of quartz veins 5-30 feet thick with free gold and pyrite. It is currently felt that these zones represent the primary feeders to the Round Mountain ore body. Figure 5 depicts the relationship between the various ore types and alteration zones developed in the Round Mountain District.

Primary Alteration

A relatively simple zoned alteration pattern has developed at Round Mountain. This zonation appears to be concentric around a central breccia zone that occurs on the north flank and top of Round Mountain. The typical pattern of alteration from the exterior to the interior of the deposit is as follows: quartz-chlorite: quartz-sericite-chlorite: quartz-sericite-secondary K-spar.

Pyrite is the primary sulfide mineral introduced throughout the explored hydrothermally altered area at Round Mountain with rare occurrences of galena, molybdenite and realgar.

Intense silicification occurred locally in the tuffaceous sedimentary rocks overlying Round Mountain. Most of these silicified sedimentary rocks have been eroded away except for one remnant exposed on the top of Round Mountain. Silicification does not appear to have been as intense laterally as it was vertically over the center of the alteration zone. Little gold or pyrite mineralization occurred during silicification; however, rare gold-bearing quartz veins cut the barren silicified zones.

The most extensive alteration zone exposed on the surface in the densely welded tuff is the quartz-chlorite zone. This zone typically results in the chloritization of some, but not all, of the biotite in the densely welded tuff, minor saussuritization of plagioclase feldspars, the introduction of up to 0.5% pyrite and weak but pervasive silicification.

Potassium feldspars are totally unaltered. In the poorly welded tuff, this zone is typified by chloritization of pumice and biotite and weak pervasive silicification. The lithic tuff is pervasively chloritized with up to 3% pyrite, except near veins where envelopes of sericite and minor secondary K-spar occur. The pyrite in the quartz-chlorite zone is slightly auriferous, even in areas where whole rock assays are below detection.

The quartz-chlorite zone gives way to a quartz-sericite-chlorite zone that is associated with the bulk of the gold mineralization at Round Mountain. In the welded tuff, this zone is most commonly present as envelopes around gold-bearing veins, stockworks, and veinlets. In areas of strong mineralization, vein envelopes coalesce resulting in pervasive quartz-sericite-chlorite alteration of the rocks. Individual mineral alteration in the quartz-sericite-chlorite zone is as follows: biotite is completely chloritized and partially sericitized, plagioclase is altered to sericite and clay, and the potassium feldspar is unaltered. Also associated with this zone are pervasive stockworks of minute quartz veinlets. The pyrite content in this zone averages between 0.5-2.0%.

In the poorly welded tuff, quartz-sericite-chlorite alteration is extensively developed showing strong sericitization and minor chloritization of the matrix, plagioclase and biotite. Local weak to moderate silicification of the tuff matrix occurs. Typically in the poorly welded tuff, mineralization and alteration extend over much wider areas than that developed in the overlying densely welded tuff.

In the poorly welded tuff, noticable disseminated carbonate (calcite) and barren carbonate veins are present in the quartz-sericite-chlorite alteration zone. Carbonate is only rarely present in the quartz-sericite-chlorite zone in the densely welded tuff.

With increasing hydrolitic alteration, all the chlorite is replaced by sericite and secondary K-spar (usually adularia) starts to develop as vein envelopes and in veins. The development of this zone usually marks the interior limits to ore grade mineralization at Round Mountain. Large veins in this zone will contain occasional pockets of crystallized gold, but the pyrite in this zone is not strongly auriferous. In the densely welded tuff, this zone is represented by the total sericitization of biotite and plagioclase, partial sericitization of original potassium feldspar, and rather extensive stockworking of quartz veins with secondary K-spar envelopes. Pyrite content is approximately 1-3%. Similarly in the poorly welded tuff, this alteration zone is expressed by intense sericitization and strong stockwork of quartz veins with secondary K-spar envelopes.

A possible additional alteration zone is sporadically developed in the upper 100 feet of the poorly welded tuff above disseminated ore. In this zone, varying from 50-150 feet thick, the poorly welded tuff has been intensely altered to clay. The clay zone, while not continuous, occurs over wide areas in the poorly welded tuff. Usually the pyrite content of this zone is quite low (less than 0.1%), and it consequently contains little or no gold values. An alternative explanation for the clay zones is their origin as local accumulations of fine grained co-ignimbrite ash cloud deposits (Sparks, et al, 1973).

Figure 5 summarizes the relationships between surface alteration, subsurface alteration and mineralization.

Destructive & Supergene Alteration

One major zone of destructive alteration 20-40 feet wide and vertically continuous through the entire section cuts the ore body at Round Mountain on a north-south trend (see Figure 4). This zone, which is intensely bleached, sericitized, manganese-oxide stained and weakly silicified, has remobilized gold mineralization and removed it from the ore zone. Both stockwork and disseminated ore have been offset across this zone of alteration suggesting that it may be a recently active basin and range fault along which hot spring activity has developed. Deeper drilling along this same trend has encountered hot water suggesting that this system may still be active.

Oxidation of ores in the Round Mountain District extends as deep as 700 feet below the surface. Typically, all of the pyrite has been altered to limonite and pseudomorphs of limonite after pyrite are common. Clay, probably derived from the supergene alteration of sericite, has infilled most of the open fractures. Veins of supergene alunite are common is some areas of the mine. Minor remobilization of gold appears to have occurred in the upper portion of the supergene zone with the rare development of recrystallized leaf gold in pockets in more intensely leached areas. No apparent enrichment of gold or silver has occurred during oxidation and supergene alteration of the ore body. A very slight capping of manganese oxide has developed on the top of Round Mountain.

Placer Mineralization

Erosion of ore in the densely welded tuff has resulted in the development of a rather unusual placer accumulation to the west of Round Mountain. Due to the close proximity of the placer to its source, almost half of the gold values in the placer occur as gold contained in rock derived from the weathering of the lode ore bodies as well as gravity accumulations of gold in channels. The placer ore body consists of a complex alluvial fan that has developed from the interfingering of eroded ore gravels, barren granitic gravels and free gold accumulations in channels. The placer varies in thickness from a few feet of pay gravels high on the west slope of Round Mountain, to in excess of 200 feet of pay gravels at the western limits of drilling. As much as 200 feet of barren gravel overburden cover the placer on the western side. Figure 2 shows the known extent of this ore.

GEOLOGIC SEQUENCE OF EVENTS

Lower Paleozoic strata in Nevada were deposited in the Cordilleran Geosyncline. In the eastern part of the geosyncline, the lower Paleozoic strata are dominantly shelf and slope sediments consisting largely of limestones and dolomites with minor shales and quartzites. These miogeosynclinal rocks have a measured thickness in excess of 15,000 feet and are commonly referred to collectively as the carbonate (or eastern) assemblage. The southern part of the Toquima Range probably occupied a position in the mid- to outer continental shelf during the accumulation of these carbonate rocks.

In the western part of the geosyncline, lower Paleozoic strata consisting of abyssal, deep water cherts, clastic sedimentary rocks and intercalated volcanic and pyroclastic rocks were deposited. This sequence has a total thickness in excess of 50,000 feet and is commonly referred to as the siliceous (or western) assemblage.

During late Devonian and early Mississippian time, the lower Paleozoic strata were folded and faulted in central Nevada along the Antler orogenic belt. This orogeny gave rise to the development of numerous thrust faults, the best known of which is the Roberts Mountains thrust. Along this series of thrusts, rock of the siliceous (western) assemblage were moved eastward, possibly as much as 90 miles, over carbonate (eastern) assemblage rock (Stewart, et al, 1977).

Following the emergence of the Antler orogenic belt, a period of structural quiescence and renewed sedimentation occurred during Mississippian, Pennsylvanian and Permian time. No sediments of this age are preserved in the southern Toquima Range and were either never deposited or were stripped off by rapid erosion in mid- to late Tertiary time following the commencement of basin and range faulting.

Structural activity was renewed in the late Permian and early Triassic with the development of the Golconda orogenic belt. During this time, thrust faulting moved previously thrusted carbonate and siliceous assemblage rocks eastward over both the upper and lower plates of the Roberts Mountains thrust belt. Evidence of both Roberts Mountains and Golconda thrusting are preserved locally in the Paleozoic sediments of the southern Toquima Range.

During the Mesozoic Era, erosion appears to have been the dominant sedimentary activity in the Toquima Range. Limestones of the Triassic Luning Formation were deposited in a shallow sea to the west of the Toquima Range but no sediments of that age are preserved near Round Mountain. In the Jurassic and Cretaceous, probably following the development of a subduction zone to the west, large igneous intrusives were emplaced over widely scattered areas throughout central Nevada. Extensive thermal contact aureales developed in the intruded sediments surrounding the stocks. The Shoshone, Belmont and Windy Creek plutons record this igneous event in the southern Toquima Range.

Rapid erosion followed Cretaceous igneous activity and continued into the Cenozoic in the Toquima Range. Several small stocks and rhyolitic dike swarms of early to mid-Tertiary age are preserved in the area surrounding Round Mountain. By the mid-Tertiary, erosion had deeply unroofed the Shoshone and Belmont plutons and locally exposed the thrust contact between the siliceous and carbonate assemblages. Renewed strong igneous activity commenced in the mid-Tertiary in central Nevada probably starting around 35 mybp and ending about 20 mybp (Stewart and Carlson, 1976). During this period, numerous ash flows were erupted and deposited in and around calderas in the southern Toquima Range.

The Jefferson caldera, whose early erupted ash flow tuffs host the mineralization at Round Mountain, was probably active commencing around 26 mybp and ending around 20 mybp. Initial eruptions of the Jefferson caldera resulted in deposition of tuff-charged landslide debris on the gently dipping slopes of the west, northwest and northeasterly sides of Mount Shoshone. This unit forms the lithic tuff unit at the base of the Round Mountain gold deposit. Following deposition of this clastic-rich basal unit, continuing eruptive activity produced the thick cooling unit of coupled poorly welded and densely welded tuff that forms the bulk of Round Mountain. These tuffs filled a shallow basin to the west of Round Mountain and onlapped up the western slopes of Mount Shoshone.

Continued voluminous eruptions, becoming less silicic with time, developed a thick accumulation of densely welded, rhyodacitic tuff within the collapsing center of the Jefferson caldera. This and subsequent tuffs were largely ponded within the collapsing center of the Jefferson caldera and have little or no aerial extent outside the caldera margins. Following this initial period of voluminous eruptive activity, post collapse intracaldera lake sediments and minor tuffs were deposited. Regional faulting dominated by right lateral shearing also occurred during this hiatus in volcanic activity. This tectonic activity was responsible for a substantial amount of the structural ground preparation for the Round Mountain ore deposits.

Following this brief period of quiescence, igneous activity resumed with the intrusion of small rhyolitic domes and plugs along the structural margins of the Jefferson caldera. It was probably during this igneous activity that the ore deposits at Round Mountain were developed.

Erosion and basin and range faulting dominated events in the late Tertiary and Quaternary following the development of the Round Mountain ore body. Minor recent hot spring activity along basin and range faults cutting the ore body locally remobilized and destroyed primary mineralization. Uplift resulted in the erosion of approximately the upper third of the Round Mountain alteration-mineralization zone and developed the alluvial fan placer deposits to the west of, and partly covering, the lode ore bodies.

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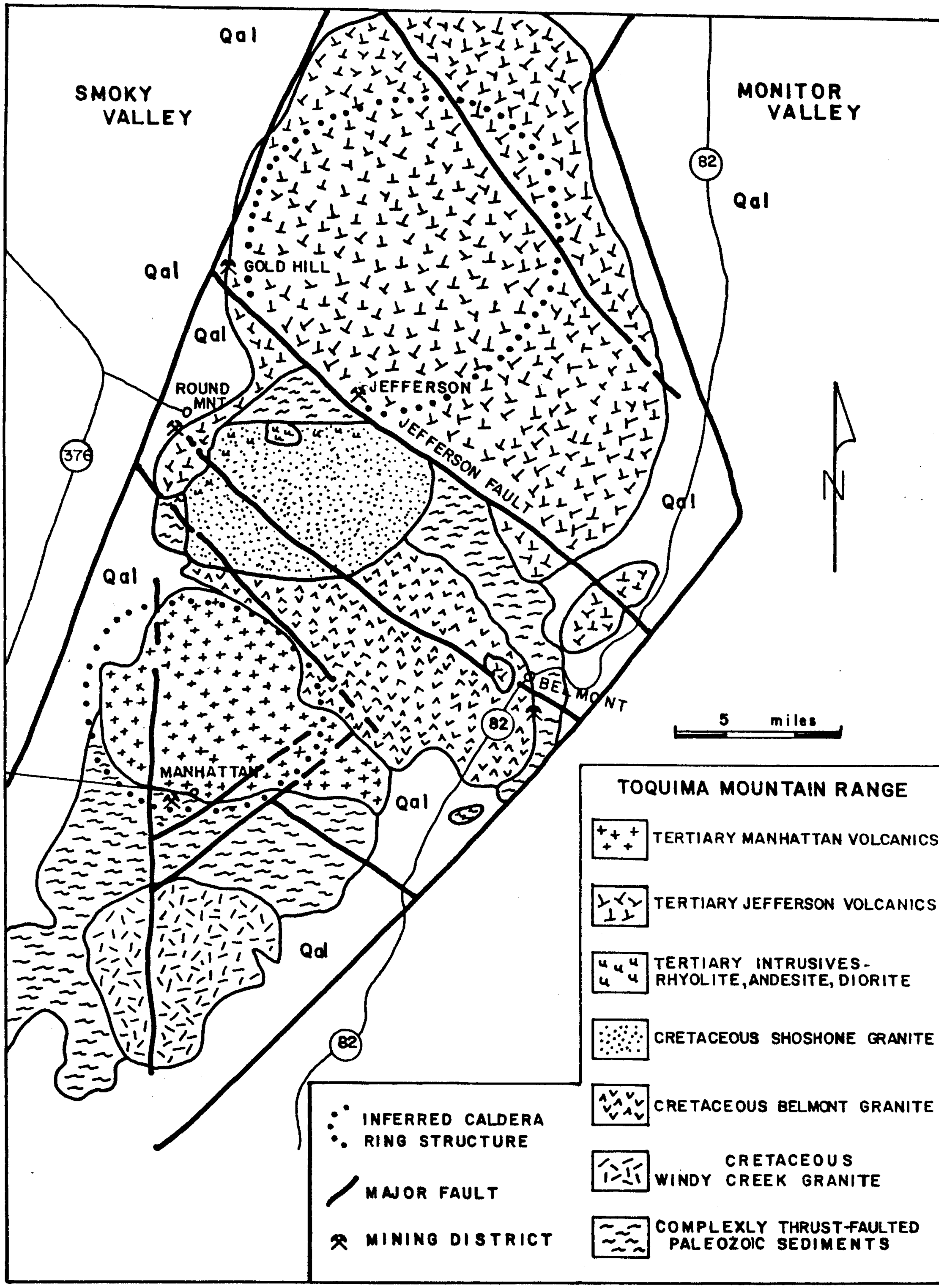

FIG. I. Regional geology of the Toquima Range, Nye County, Nevada

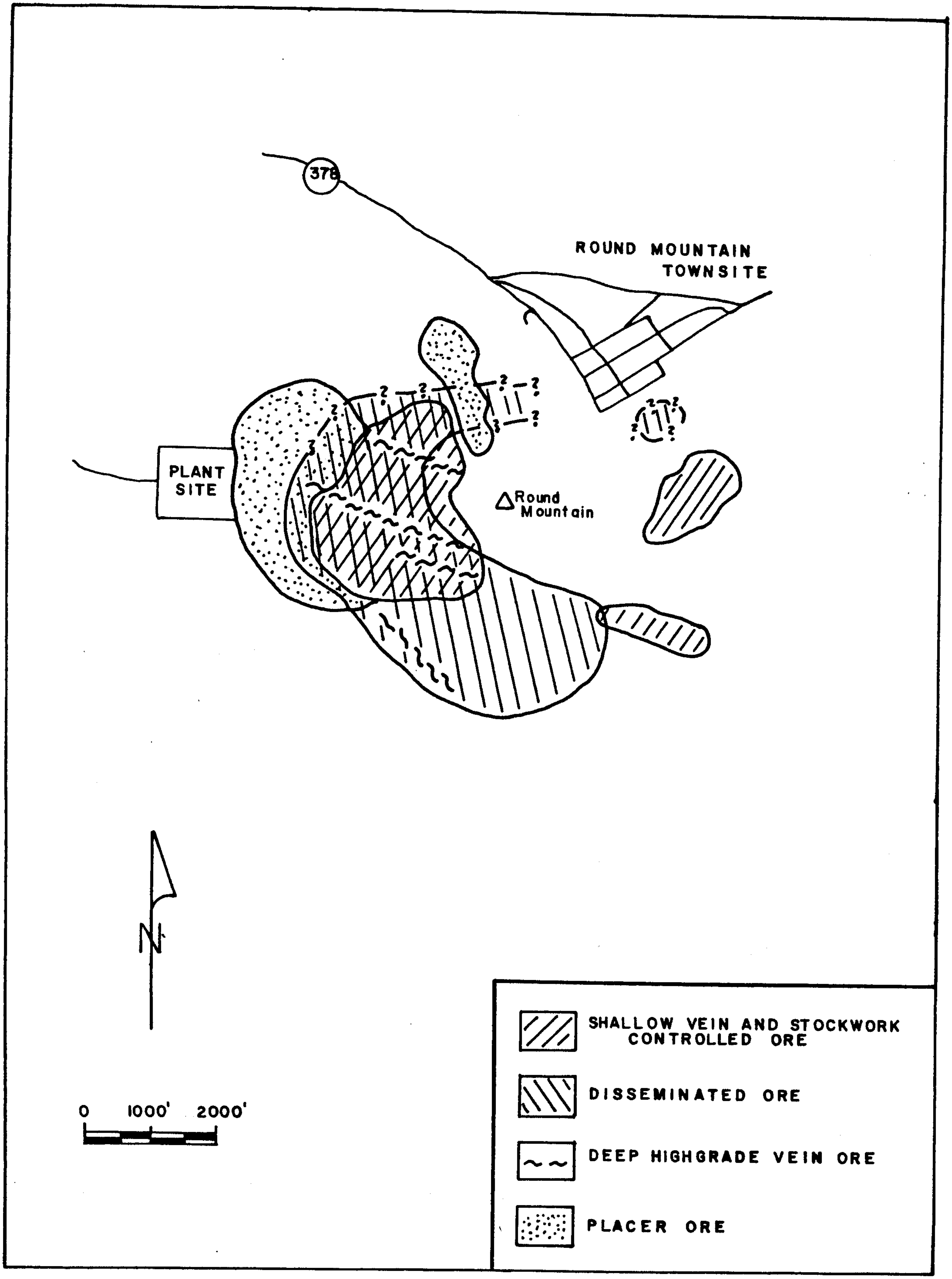

FIG. 2. Spacial relationships between stockwork ore, disseminated ore, deep vein ore, and placer ore

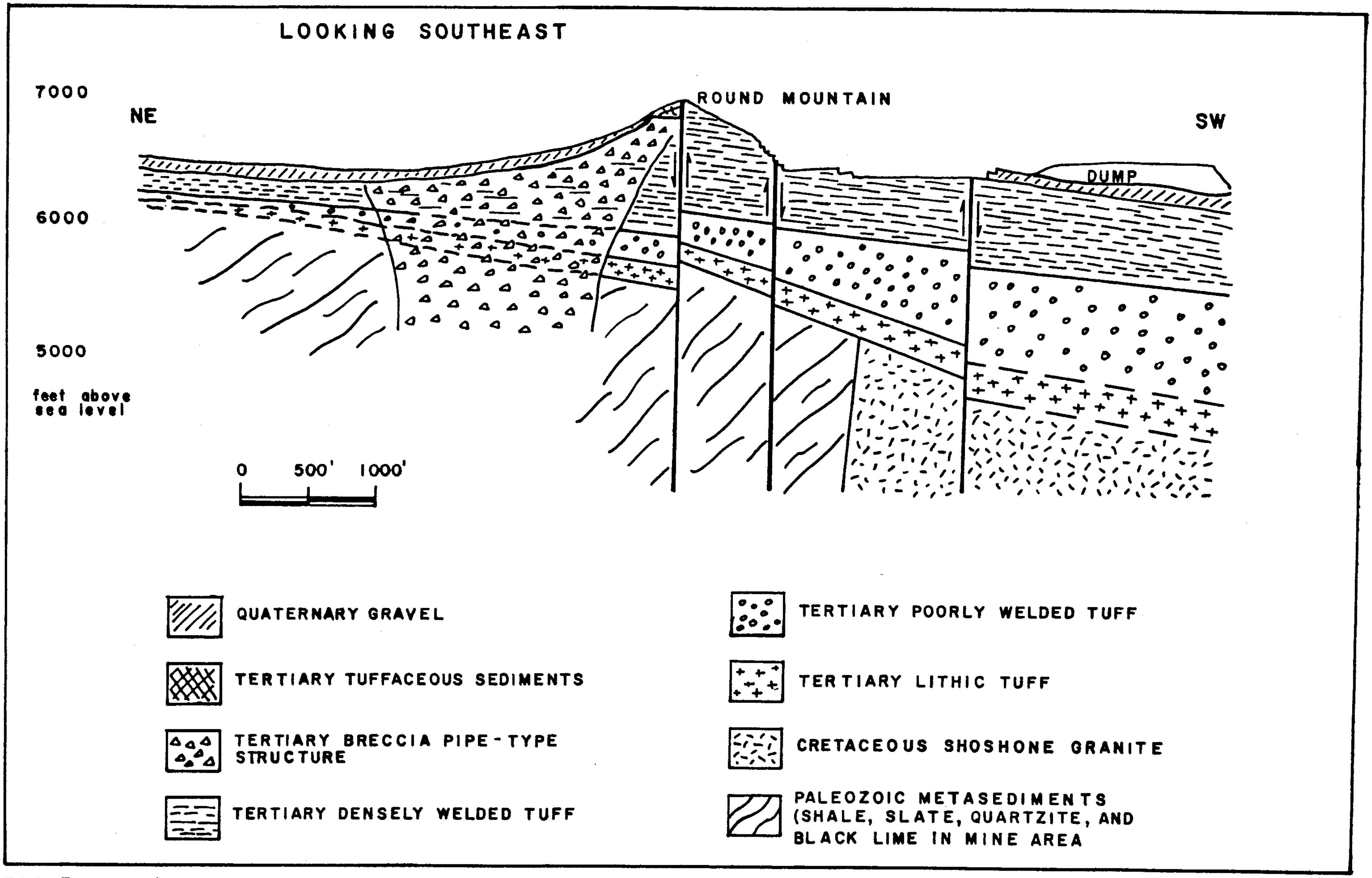

FIG. 3. Northeast-southwest cross-section through Round Mountain depicting relationships between volcanics and underlying Cretaceous and Paleozoic rocks

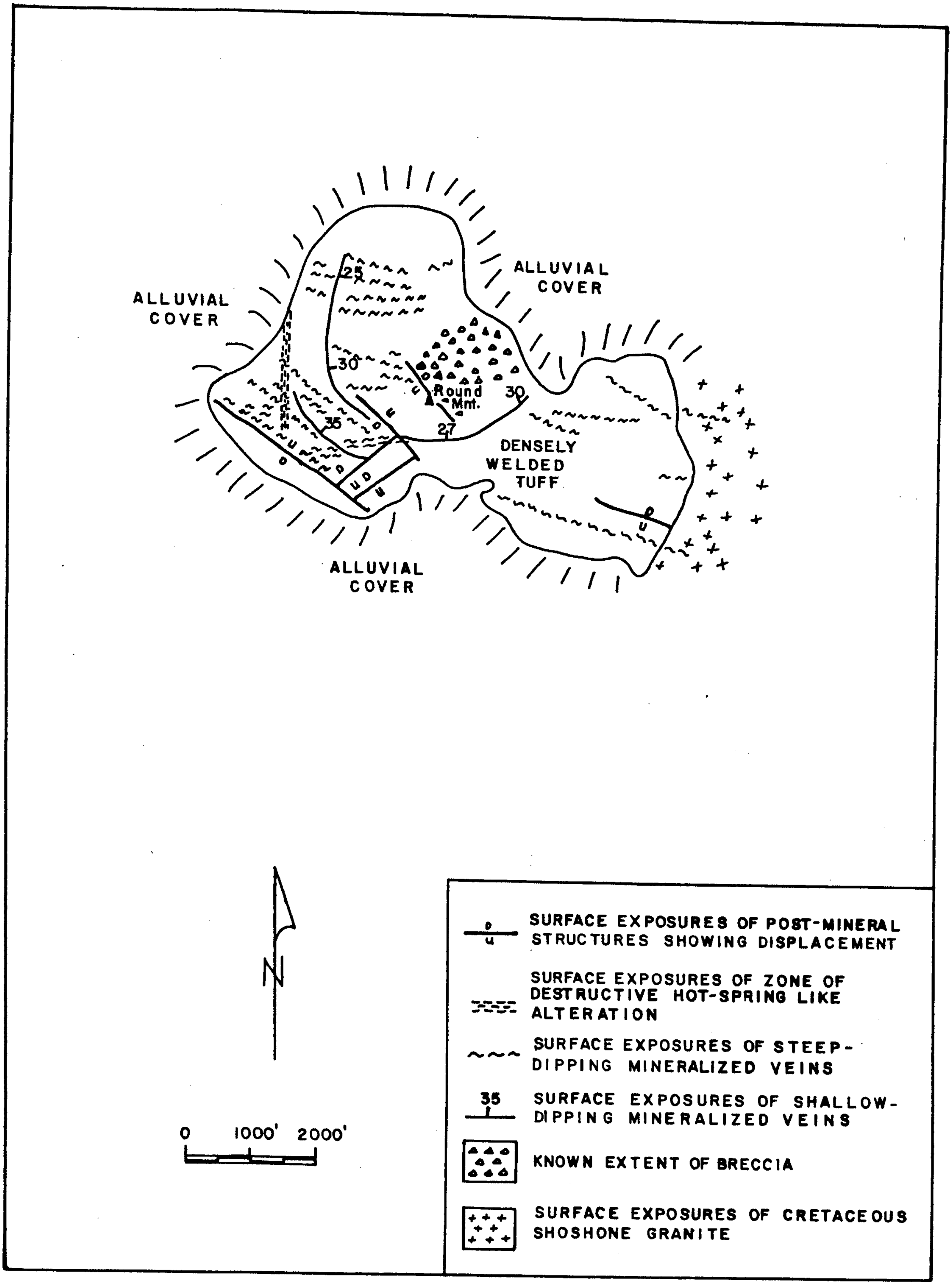

FIG. 4 Surface exposures of major structural features at Round Mountain

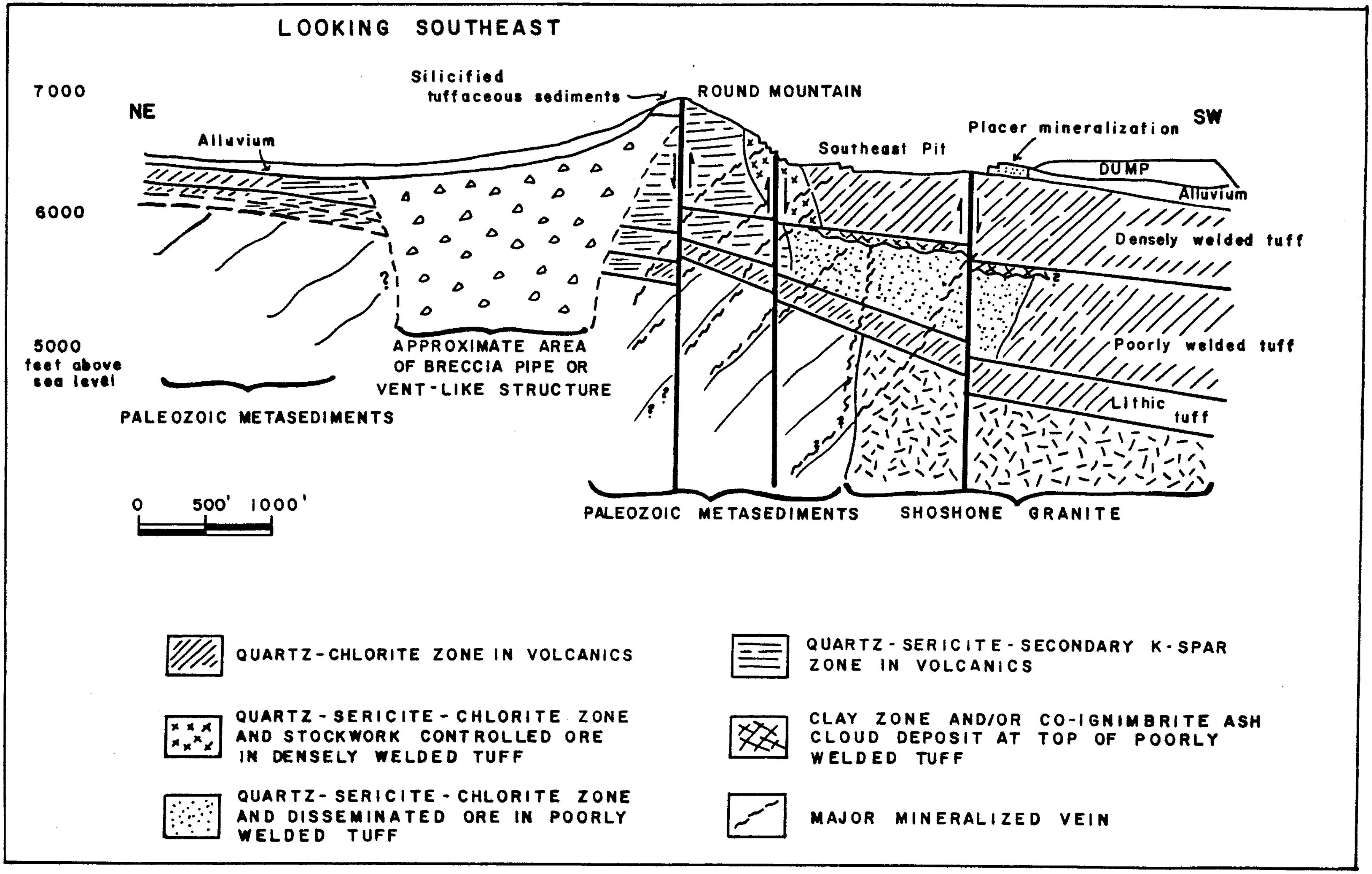

FIG. 5. Northeast – southwest cross-section through Round Mountain depicting alteration and mineralization