

EVELYN MINE
GEOLOGIC REPORT

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SUMMARY

The Evelyn Mine is located in the west central part of Utah some 140 air miles southwest of Salt Lake City. The deposit is a narrow, high grade vein that strikes continuously for over 2 miles. Considerable high grade ore was produced from at least 4 different areas in the 1930's and 40's and much ore remains in old workings. Development and exploration by the Evelyn Partnership indicates that between 25 and 43 percent of the vein length is mineable and there is a strong geologic and theoretical basis for believing the ore will extend down and that adequate reserves can be developed. Work to date has proven that the ore can be mined at reasonable costs and that mill recovery of at least 80 percent can be expected.

LOCATION AND ACCESS

The Evelyn Mine is located in the north central part of the Deep Creek Mountains, Tooele County, Utah. The property is some seven miles due west of the community of Callao which in turn lies 90 miles northwest of Delta, Utah. Callao can be reached by traveling 75 miles south of Wendover, Utah; 100 miles west on an indifferently maintained dirt road from Vernon, Utah; or 90 miles northwest from Delta, Utah.

The mine is situated at an elevation of 8100 feet on the precipitous east slope of the range near the head of Goshute Canyon. An access road in the canyon connects the mine portal with the mill which is located at the mouth of the canyon at an elevation of 5900 feet. Living quarters are at the community of Callao. The climate is typical of the Great Basin region, summers are hot, dry and windy and the winter severe with most of the precipitation occurring in the spring.

The community of Callao was settled in the 1860's and was originally known as Willow Springs, a station on the overland stage route, and later the Pony Express during its short period of operation. It now has a population of approximately 25 people most of which are descendants of the original pioneering families.

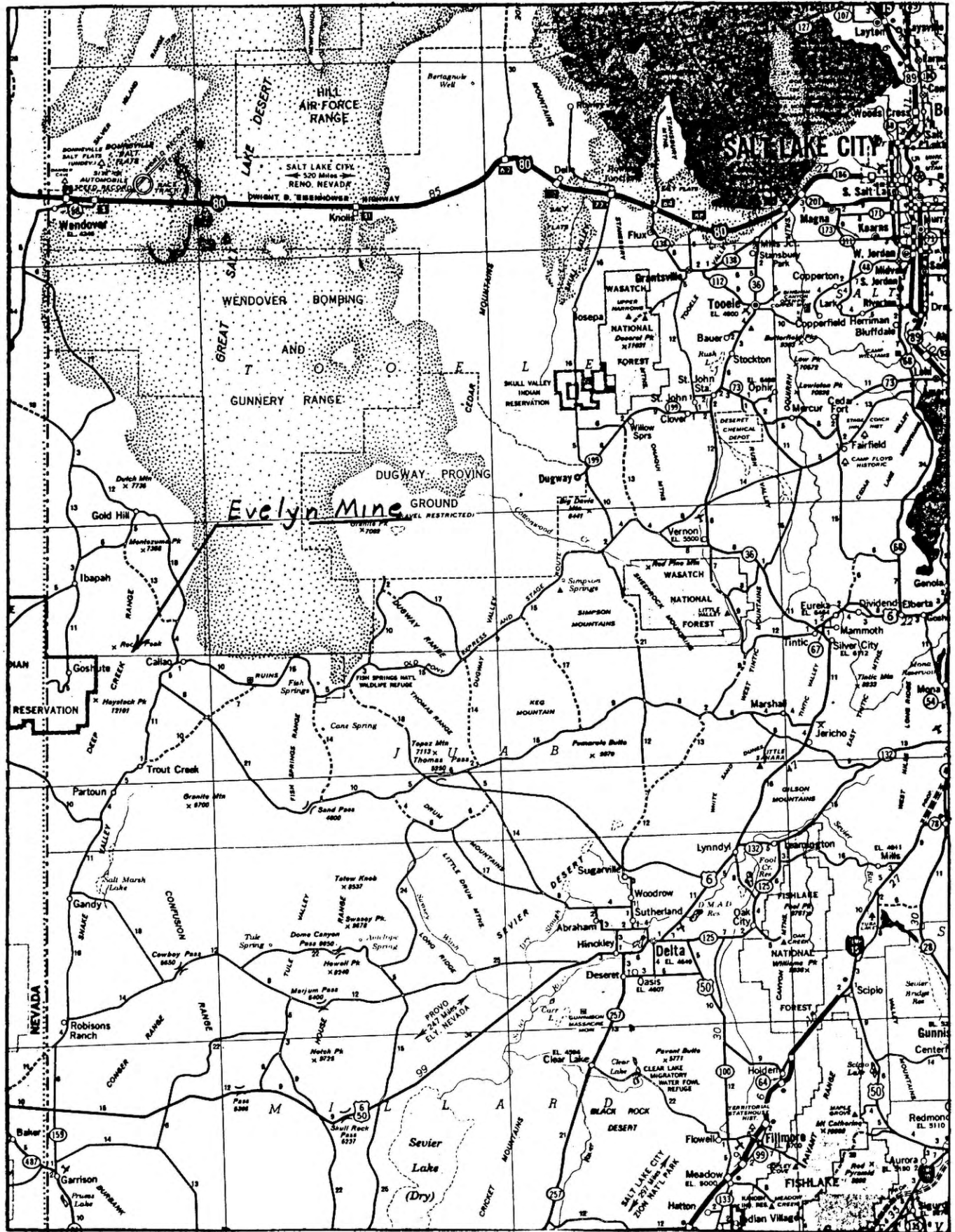


Fig. 1 Index Map Showing Location of the Evelyn Mine

LAND STATUS

The Evelyn property consists of 42 unpatented lode mining claims covering the mine area and another group of superimposed lode, placer and millsite claims covering the Evelyn millsite. The area between the two groups is a Utah State School section, the mineral rights of which are leased by the Evelyn Ltd. Partnership. In addition the partnership holds mineral leases on part of a State section adjacent and to the south of the mine group and another section two miles to the north.

The original group of claims (Fig. 2) were located by the various owners during and before the 1930's. These claims cover the main vein system and several as yet unexplored parallel veins located at the north end of the property. The Evelyn claim group was located in 1981 and 1982 to secure the southern extension of the vein and to protect the access road between the mine and mill. The State section between the mine and mill contains several prospects on two different veins that show gold values. The partial State section to the south and the non-contiguous State section to the north were acquired in 1980, but neither have been explored.

All of the claims are in good standing both with the State of Utah and the Bureau of Land Management.

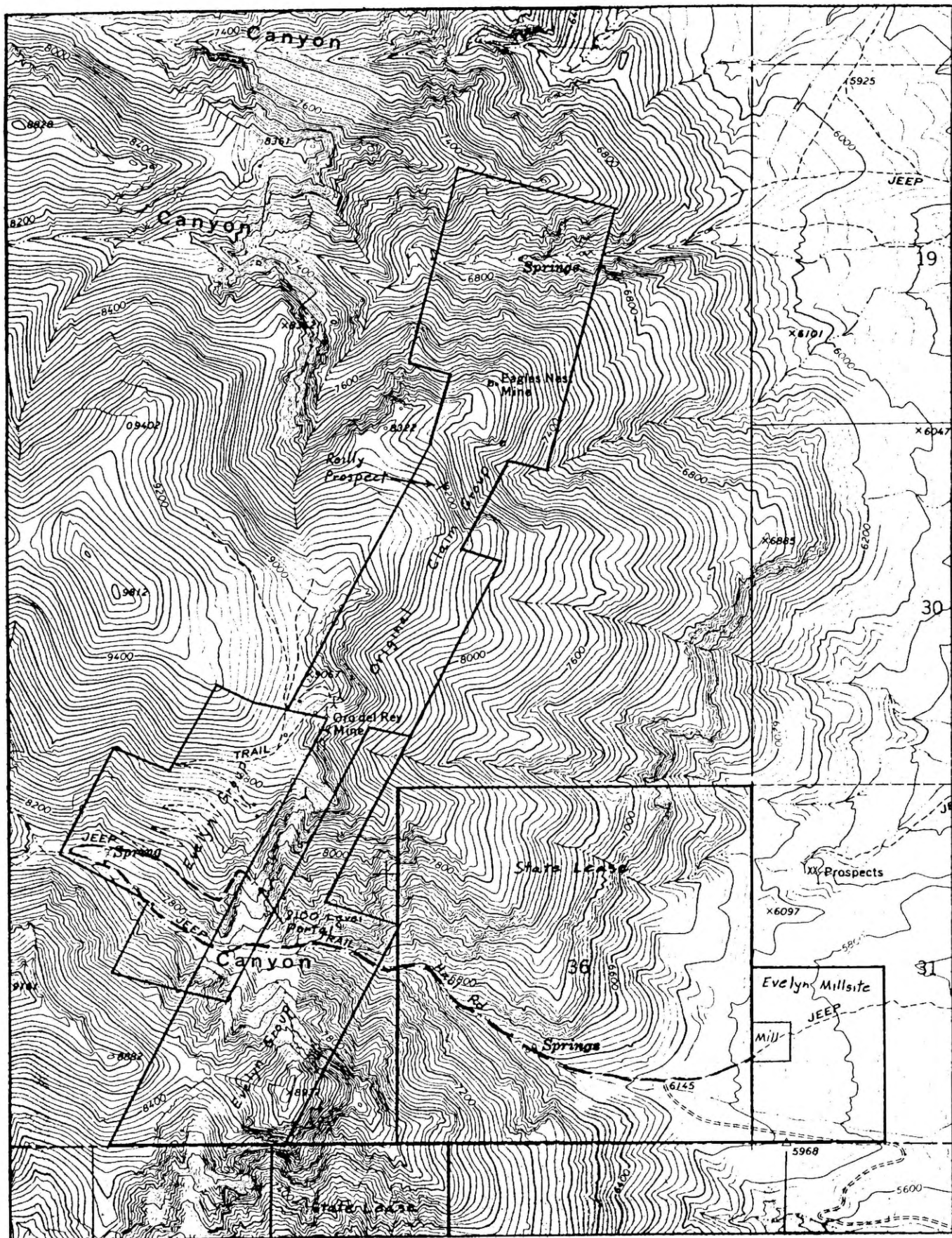


Fig. 2 Partnership Holdings at the Evelyn Mine

HISTORY OF DEVELOPMENT

The area in which the Evelyn Mine is situated is known as the Willow Springs district in older literature. This district is a southerly offshoot, or extension, of the Gold Hill district. Prospecting and small scale mining have been going on in the area since the mid 1860's and some development is thought to have taken place at the Eagles Nest in the 1890's. In the early 1930's the Eagles Nest group of claims was owned by Oliver Tripp who started mining the Eagles Nest ore shoot.

In the beginning the ore was dragged down the face at the range in "stone boats" and shipped directly to a smelter. Later a cable tram was built connecting the Eagles Nest to a road in the bottom of Reilly Canyon. During this time Oliver Tripp's brother, Alma, traced the vein south and located the Oro del Rey claim group. Most of the subsequent mining activity has been within this group and substantial production has been recorded. (Appendix III)

The Oro del Rey area is the only part of the vein that had road access prior to the work done by the partnership in 1980. The road was brought up Goshute Canyon and then, in 13 switchbacks, climbed the shale backslope west of the quartzite to a point directly above the vein which was exposed in the cliffs below. Because of its accessibility, more mining was done in the Oro del Rey area, but no systematic development was possible because of the method of operation used by Alma Tripp; he granted short term, block leases to numerous different individuals with the result that there was a continuous changing of operators in the various segments of the mine. Mining was done by open stoping and the

ore was raised to the road head on cable trams. Because of hauling costs and high royalties, ore less than .75 oz/ton could not be shipped; any ore below that grade was left in place or thrown on mine dumps. Southward from the Oro del Rey area mining was done at the Devils Pit and prospecting and limited shipping was done at the Clyde Lee and Lee Trout prospects. Other prospects showing ore are present north of the Oro del Rey but were never mined, presumably owing to poor access. Mining was halted in 1943 by the war production order and continued after the war intermittently until about 1953, when cost inflation began to outstrip the fixed gold price and the property became uneconomic.

The property was acquired by the Evelyn Limited Partnership in the summer of 1979, and preliminary road work and ore sampling was started that fall. In the spring of 1980, serious development began with the renovation of the Goshute Canyon access road, and the starting of the 8100 foot level drift by a contractor. Drifting, surface mapping and sampling, and mapping of the old workings continued until December 1980, at which time some 400 feet of drift had been completed and the South Lee Trout ore shoot had been defined. Preliminary metallurgical testing indicated that excellent recovery could be achieved by cyanide vat leaching, and plans were made for the next phase of development.

In the spring and summer of 1981, the road and mine portal were extensively reworked and the licensing and permitting process initiated. In September drifting and raising was begun again in the 8100 level. The drift was continued northward towards the Clyde Lee and Devils Pit ore shoots with breakout into the Hell Hole gulch taking place in December. Further metallurgical work had established the feasibility of vat leaching the ore and construction of the mill began in April of 1982. During the summer and fall some 3200 tons of ore was mined and

processed. The head of the 8100 level drift is presently some 1500 feet north of the South Lee Trout portal and is very near the expected position of the Devils Pit ore shoot.

RESULTS OF THE DEVELOPMENT PROJECT

The development program at the Evelyn Mine has been done in a series of phases each depending upon the success of the succeeding step. This first phase undertaken in the fall of 1979, was to do reconnaissance sampling and mapping in the old workings and on the surface to verify the pre-existing data. The reconnaissance produced favorable results. Phase II, done in the summer and fall of 1980, consisted of driving some 400 feet of drift, the 8100 foot level, under the South Lee Trout ore shoot outlined in the first phase. Exploration underground showed the ore to be better grade over longer length than surface data indicated. Preliminary metallurgical testing demonstrated that the metals could be recovered by either floatation or cyanidation, but of particular interest, that it would yield 80 percent recovery in a simple crushed ore leach. Further surface sampling indicated a 500 foot barren interval between the South Lee Trout ore shoot and the start of the South Clyde Lee ore shoot to the north. Beyond it another prospect, the North Clyde Lee, showed some good ore in place (Fig.4). The Devils Pit Mine which has very good ore in place, is situated 300 feet north and some 300 feet above the North Clyde Lee prospect, but the vein is covered between the two. In September 1981, Phase III was started with the objective to extend the 8100 level northward through the barren zone to the Clyde Lee ore shoots and to explore the vein toward the Devils Pit. In addition to the drifting, plans were made to mine the South Lee Trout ore above the drift level and to build and begin operation of the mill. During the fall of 1981, the drift was extended and broke-out into the Hell Hole gulch. This segment of the drift rather than being barren,

encountered good ore in a complex cross-fracture (described below) and produced some 200 tons of development ore. The South Clyde Lee ore shoot proved to be favorable, but it was found that the North Clyde Lee occurrence was local, small and did not extend down to the drift level. By mid summer the mill had been constructed and processing of the ore began. During its start-up phase between the first of July and the middle of October some 3200 tons of ore were processed, 2300 tons of which came from the South Lee Trout Stope. Data from this run are not complete because some 1300 tons are still in the vats and will have to await warm weather to complete the cycle; however, the mill appears to be working as planned. Some 290 oz of gold and 392 oz of silver have been sold and careful assay of the leached rock, thus far produced, show a tailings grade varying between .032 and .073 oz/ton gold, indicating very good recovery. Mining at the South Lee Trout Stope was successful and proved that the ore can be extracted by shrinkage stoping at reasonable costs. The only step remaining is to develop enough ore to bring the mine to 80 to 100 tons per day production.

GEOLOGY

Surrounding Area

The Evelyn Mine is situated on the rugged east slope of the north central part of the Deep Creek Range. The Deep Creek Range is a northerly trending range some 35 miles long and 10 miles across at its widest point. The central part of the range consists of a large granite intrusion 8 miles in diameter and reaching an elevation 12,100 feet above sea level. The ridge-like north end and south extensions are made up of a westerly dipping section of late Precambrian and early Paleozoic sedimentary rocks; the west slope is gentle while the east front is a precipitous scarp with some 5000 feet of relief in the mine area; the rugged eastern scarp is formed by the resistant Prospect Mountain quartzite.

The geology of the Deep Creek Range is complex; two periods of intense tectonic activity have influenced the area, late cretaceous overthrusting and the mid and late Tertiary intrusion and faulting. Both these episodes of structural deformation influence the distribution of mineralization at the Evelyn Mine. A more detailed description of the areal geology is included in Appendix I (Thompson 1973).

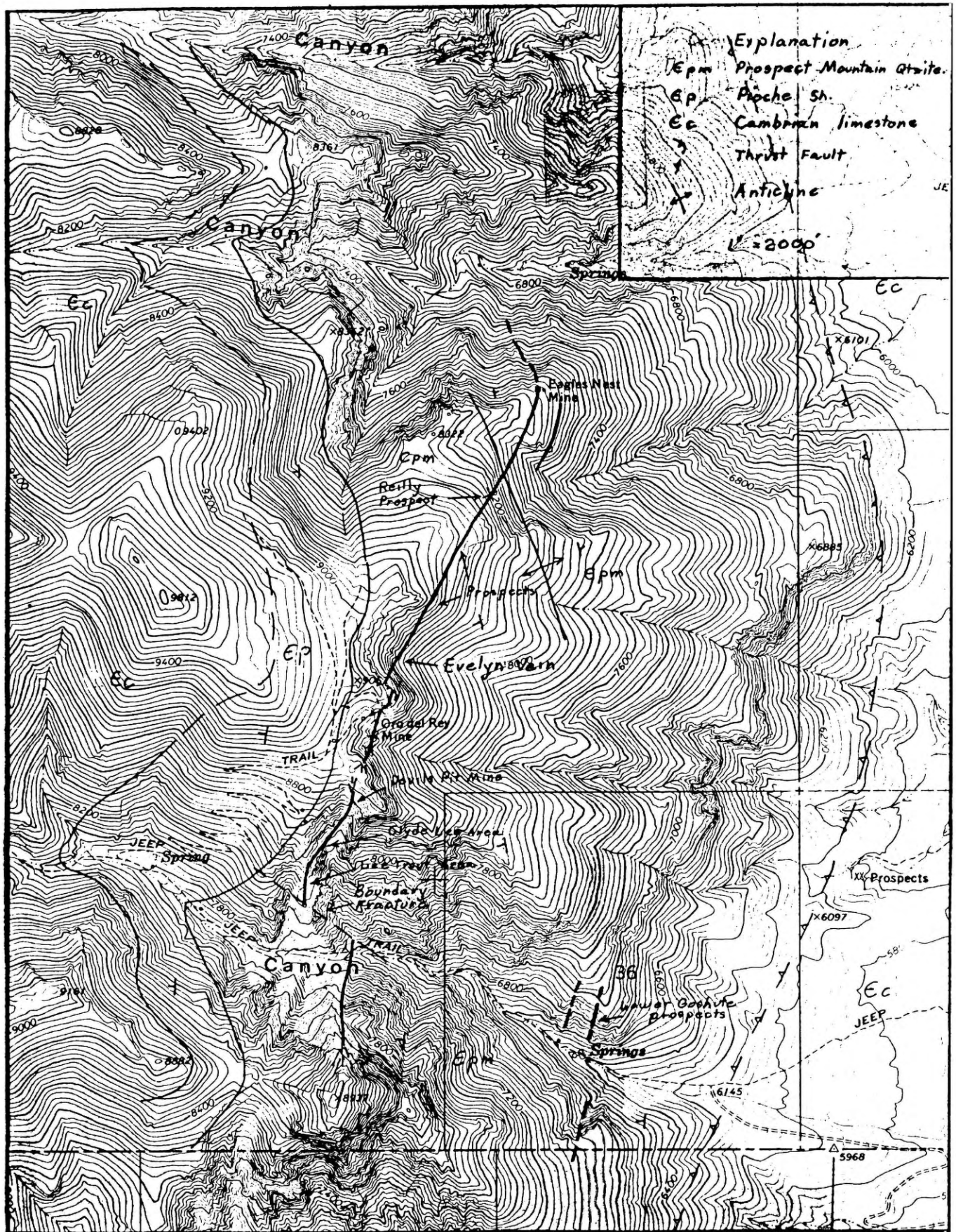


Fig. 3 Geologic Map of the Evelyn Mine Area

Mine Area

The pre-existing and present development of the Evelyn Mine occurs entirely within the outcrop band of the Prospect Mountain quartzite along the east slope of the range. The area covered by the property is a north-northeast trending zone extending from south of Goshute Canyon over a rugged drainage divide to Reilly Canyon, a distance of 2.5 miles. The ore appears to be confined to one single fracture or closely parallel set of fractures that is traceable for the entire distance. Although the general trend of the structure is north-northeast, in detail the vein is sinuous with strikes varying from the north to northeast. The vein dips at right angles to the bedding. It is broken and offset by numerous crossfaults, most of which have displacement in range of 1 to 5 feet although displacements of up to 20 feet have been seen; apparent displacement along the "boundary" fault at the south end of the developed zone is some 1000 feet. The vein is flanked by a selvage or border zone averaging about 100 feet on each side where the quartzite is lighter colored, silicified and seamed with quartz stringers, many of which contain iron oxides. Barren pyrite bearing veins, similar in appearance to the ore vein, are present both within and outside of the bleached zone, but their relationship to the mineralization is not known. Several andesite dikes are present at various localities striking parallel to the vein.

At the higher elevations, near the top of the Prospect Mountain quartzite, the vein branches into a series of white quartz bearing stringers all of which apparently die out upward. The branching or

"horsetailing" of the vein seems to start between the 8500 foot and the 8700 foot elevation; the elevation at which this splitting up of the vein takes place, appears to increase northward.

Owing to its brittle nature and the fact that the area has been subjected to several periods of tectonic stress, the Prospect Mountain quartzite has been intensely fractured and crushed. The principal types of fractures in the mine area that affect the attitude and distribution of mineralization are listed below in the order of their apparent influence on the vein.

TYPE 1. North-northeast trending faults that are the host for the vein. Numerous faults of this direction are present. In the south end of the property the ore is confined to a single fracture or closely parallel set of fractures but old data and limited field recon indicate that at least 4 different veins containing mineralization are present at the north end near the Eagles Nest. The veins dip at nearly right angles to the bedding of the quartzite. Over most of the property the dip is close to 75° east but just south of the Eagles Nest Mine it crosses a northwesterly trending anticlinal axis and the dip shifts to the west north of that point. Two more veins of this trend are present near the mouth of Goshute Canyon. Because of the lack of distinctive and traceable beds in the Prospect Mountains quartzite, it is impossible to determine the offset of these faults. Sets of shear fractures splitting off of the vein are common and their angle and direction suggest that

the vein has been emplaced in a reverse fault of small displacement. In addition to the veins, the andesite dikes also occupy these fractures. Age of these fractures is not clear, but they appear to have been present and diluent at the time both the veins and the andesite dikes were emplaced. In the part of the vein worked so far, better ore is found when the vein trends more northerly.

TYPE 2. Northwest trending, large scale throughgoing structures or structural zones. These structures affect both the position and attitude of the vein and the occurrence of mineralization within the vein. The southernmost of these structures, called the boundary structure, intersects the vein some 200 feet south of the mine portal (Fig. 3) At this intersection there are two parallel veins, both ore bearing, about 30 feet apart that trend almost due south. The ore in both of these veins terminates abruptly against this northwest structure. The altered and silicified zone turns and follows this structure some 1000 feet to the southeast near the bottom of Goshute Canyon, at which point a vein splits off and strikes south across the canyon floor and up the steep south face. The two original fractures that are ore bearing north of the boundary structure continue across it and are traceable down into and across Goshute Canyon, but these southern extensions carry neither values nor silicification. Along the 1000 feet that the altered zone

follows the boundary structure, to the point where the vein turns south again, the rock is bleached, silicified and seamed with quartz-pyrite veinlets, but no clear cut fracture is present and no values have been found. The boundary structure appears to dip to the northeast and be of small displacement although as is normally the situation in the Prospect Mountain quartzite, homogenous bedding and masking of physical evidence by silicification obscure the rock relationships.

The second fault of this type occurs some 500 feet north of the 8100 level portal. A set of northwest fractures in a zone some 30 feet across offsets the vein some 20 feet to the west. A considerable amount of ore is present at this intersection although north of it, the vein trends more easterly and changes to barren pyrite. Another Type 2 structure terminates the South Clyde Lee ore shoot some 120 feet north of the Clyde Lee portal. At the surface the vein is offset 2 feet to the east by this fracture, but no offset is apparent in the drift. The vein turns more easterly and changes to barren pyrite across this structure.

Another large structural zone trending northwest is present over a wide interval between the Clyde Lee prospect and the Devils Pit Mine, a distance of nearly 250 feet. On the surface and underground this zone is characterized by numerous parallel to sub-parallel northwest trending fractures, giving the rock a breccia like texture. Silicification, quartz veinlets and

pyrite in the form of veinlets and disseminated pods are present and this alteration appears to have "leaked out" into the structure for at least 200 feet southeast and possibly a like distance to the northwest. The vein does not terminate against this fracture zone but narrows and loses its identity some 20 to 40 feet into it and only random and isolated high gold values have been found within it. At the point where the 8100 foot level crosses this zone, a northeast trending andesite dike runs parallel to the drift and is apparently not offset by this structure. In outcrop, at the north edge of this structural zone, the vein reorganizes into a single fracture, turns more northerly, and starts to carry ore again; the 8100 foot level drift is just entering this transition area underground.

No more of these northwest trending structures have been observed along the north extent of the vein to date, but surface mapping scheduled for this season will probably define more of them. Present evidence suggests that these structures are one of the primary influences in localizing ore shoots. No reliable estimate can be made as yet to the relative age of these structures, but the impression is that they predate the northeast trending fractures and their main influence is that they affect the type of breaking and the permeability of the later fracture.

TYPE 3. Northwest to southwest trending faults of small displacement. Numerous faults of this type are present in the Prospect Mountain quartzite. These faults have displacements of few

inches to several feet and mostly dip northerly at angles of 65° to 75° . Most of these faults cannot be traced very far and the individual faults are part of a branching and interconnected network of fractures that distribute displacement throughout the intricately broken quartzite. Some of these fractures are quartz and sulfide bearing near the vein and occasionally carry gold values for distances of up to 4 feet away from the vein. Several of these fractures offset the vein by as much as 4 feet with 2 to 3 feet being common; these faults have also displaced the dike at several points. Others cross the structure with no effect on its position but do have marked influence on grade and thickness of ore. Several of these fractures are the host structures for barren pyrite veins.

TYPE 4. West trending tear faults. Regional east-west trending structures with varying degrees of lateral displacement are present at fairly regular intervals in the range. These faults are marked by the main drainages and it is probable that both Goshute and Reilly Canyons are situated on these structures. The structures are thought to be tear faults developed on the upthrust block that makes up the non-granitic part of the Deep Creek Range. The affect of these structures on the vein is not known at this time. The developed part of Evelyn vein system lies between Goshute and Reilly Canyon but little work has been done in the areas to the north or south of these structures. The vein is known to cross Goshute Canyon

and extend to the south but grade, width, and continuity are not known.

TYPE 5. Bedding plane faults. Bedding plane faults, or minor thrust faults, are present in the Prospect Mountain section. At the Oro del Rey workings one of these faults forms the top of the Card stope and offsets the vein some 200 feet eastward. These bedding plane faults owe their existence to the fact that the entire Deep Creek Mountain block is a slab of upthrust rock brought up by a thrust fault exposed near the base of the quartzite outcrop band.

Evidence to date suggests that most of the fault types described are older than the vein. The mineralizing solutions apparently followed fractures that were open or dilatent at the time, these being the north to northeast trending set. Underground and surface mapping indicate that the best ore can be expected in the parts of the vein that trend most northerly. The different types of structure described above interacted to channel and distribute the mineralizing solutions causing some areas to be favorable and others not. Much more data will have to be collected before these relationships can be understood, but on the basis of experience gained during the development of the Evelyn Mine so far, the following generalizations regarding structural control can be made:

1. Ore is best developed where the vein fracture is a clean, open break and where it is more northerly trending. Brecciated, or intensely cross-faulted areas do not develop ore shoots.

2. The northwest trending Type 2 structures commonly are points of inflection where the vein changes direction and ore shoots are terminated.
3. The small displacement Type 3 faults cause change in grade and thickness of the vein, and can be the locus of very high grade "chimneys".
4. Both types of cross structures dip to the north causing the rake of the ore shoots to be down to the north in the vein.

MINERALIZATION

ORE HABIT

Physical Appearance

The vein within an ore shoot characteristically is a sharp, well defined fracture with a brown iron stained boarder on either side. The entire width of the vein and stained zone, can be from two inches up to four and even five feet, but the average is close to 1.5 feet. The fracture may be a narrow seam or it can be a band of dark brown iron oxide material that can be up to six inches wide and can be either hard or soft; this filling material is generally very high grade and the best ore can be expected where it is thickest. The main seam or fracture may be centered in the vein zone or may be to either side; commonly it splits and angles across the vein to one side or the other with one of the branches dying out in a short distance. The iron oxide stained quartzite flanking the main seam varies from a few inches to several feet wide and generally carries good gold values. The outer edge of the iron stained zone can be sharp or gradational. Commonly shear fractures split away from the main fracture at about 45° and curve up or down to parallel and join bedding planes; places where several of these shears are close spaced may have ore extended out along them for up to three feet. These short extensions of ore along shear fractures can occur on both sides of the vein. Ore also can extend for short distances into the wall along the cross fractures described above as Type 3. Several localized small chimneys of very good ore have been encountered at these intersections, although they do not have very great vertical extent where observed in the present workings.

Mineralogy


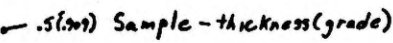
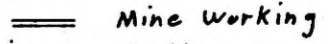
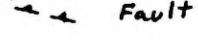
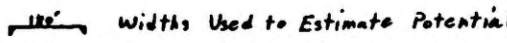
Mineralogy of the vein is simple. At several places in the drift remnant pods of unoxidized primary ore remain. Two types primary ore have been observed, a massive to disseminated pyrite type high in gold and enclosed in silicified material, and a massive galena type high in silver and lead. As yet these two types have not been found in juxtaposition thus the spatial and age relationship high gold pyritic type to the high silver-lead galena type is not known. The pyritic type is the most common and widespread while the galena is normally in clastic form in the zones where the soft iron oxide material is thickest. Galena has also been found in small veinlets paralleling the main vein and disseminated in the wall rock. Although the physical and chemical relationship of these two ore types is not clear, the appearance of remnant galena in the soft zone is a sure indication of very high gold value in the surrounding vein. In the ore zones thus far developed, it is estimated that the residual sulfide content is less than 5%. Assay of this sulfide material from within ore shoots does not show any marked variation in gold value from the oxidized parts of the vein.

In the barren segments between ore shoots the vein is generally thinner, but commonly is indistinguishable in appearance from the ore bearing parts. There appears to be slightly more unoxidized pyrite remaining in the barren segments and the barren pyrite normally is better crystallized than that seen in the ore shoots.

The only gangue minerals thus far observed in the Evelyn vein are pyrite and silica. There is no clay or carbonate minerals present and the content of mercury, arsenic, antimony, bismuth and other metals is very low.

Copper is present in small amounts, generally in the order of .1% and uranium values of 100 ppm have been observed. Black manganese oxide is common in the thicker veins at the Eagles Nest end. The selvages flanking the vein are silicified with increasing intensity inward toward the vein, but the addition of silica does not seem to be great as the quartzite was in the range of 90% silica in its unaltered form. Fresh quartzite contains interstitial iron oxide which disappears at the outer border of the alteration zone; in all likelihood, this iron was incorporated into pyrite which as the principal constituent of the primary veins and is also present in quartz stringers seaming the alteration zone. In fact, more than enough iron has been removed from this selvage to account for the pyrite content of both the mineralized and barren veins. In the parts of the mine thus far developed, the vein itself and the wall rock immediately adjacent to it is intensely silicified with very little of the original rock texture remaining. This silica occurs mainly in the form of pervasive filling and recrystallization of the quartzite with a relatively minor amount in the form of well crystallized quartz. Northward towards the Eagles Nest the amount of both crystallized quartz and massive limonite after sulfide increases and the vein appears to have filled an open fissure. Relatively large amounts of crystalline "bull" quartz are also present at the high elevations above the point where the vein splits up, and in the lower parts of the veins that occur near the mouth of Goshute Canyon.

Explanation

-  Ore in Place (+ Border of Ore Shoot where Known)
- XXX Possible Ore shoot
-  .s(.gr) Sample - thickness (grade)
-  Mine Working
-  Fault
-  Widths Used to Estimate Potential

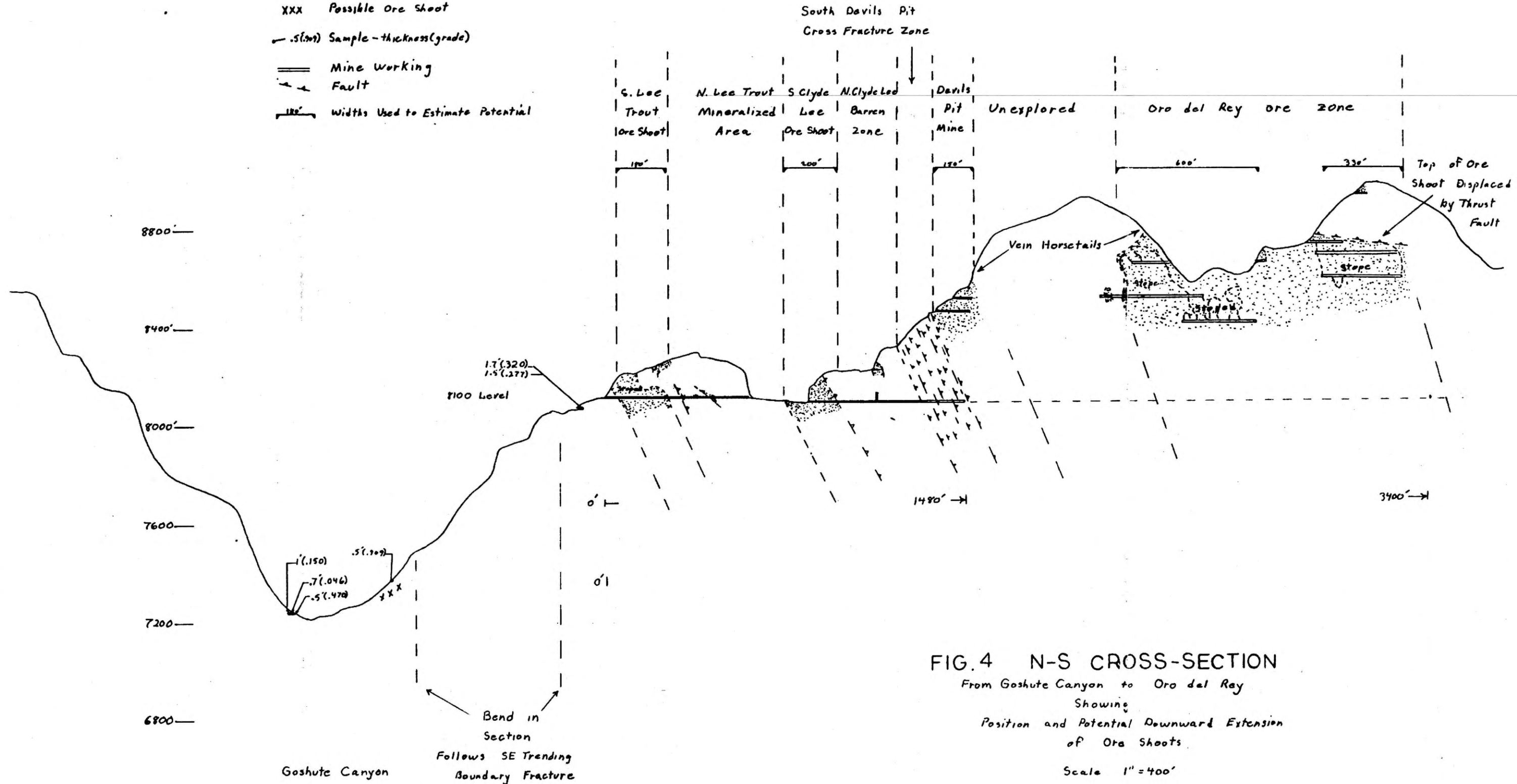


FIG. 4 N-S CROSS-SECTION
From Goshute Canyon to Oro del Rey
Showing
Position and Potential Downward Extension
of Ore Shoots
Scale 1" = 400'

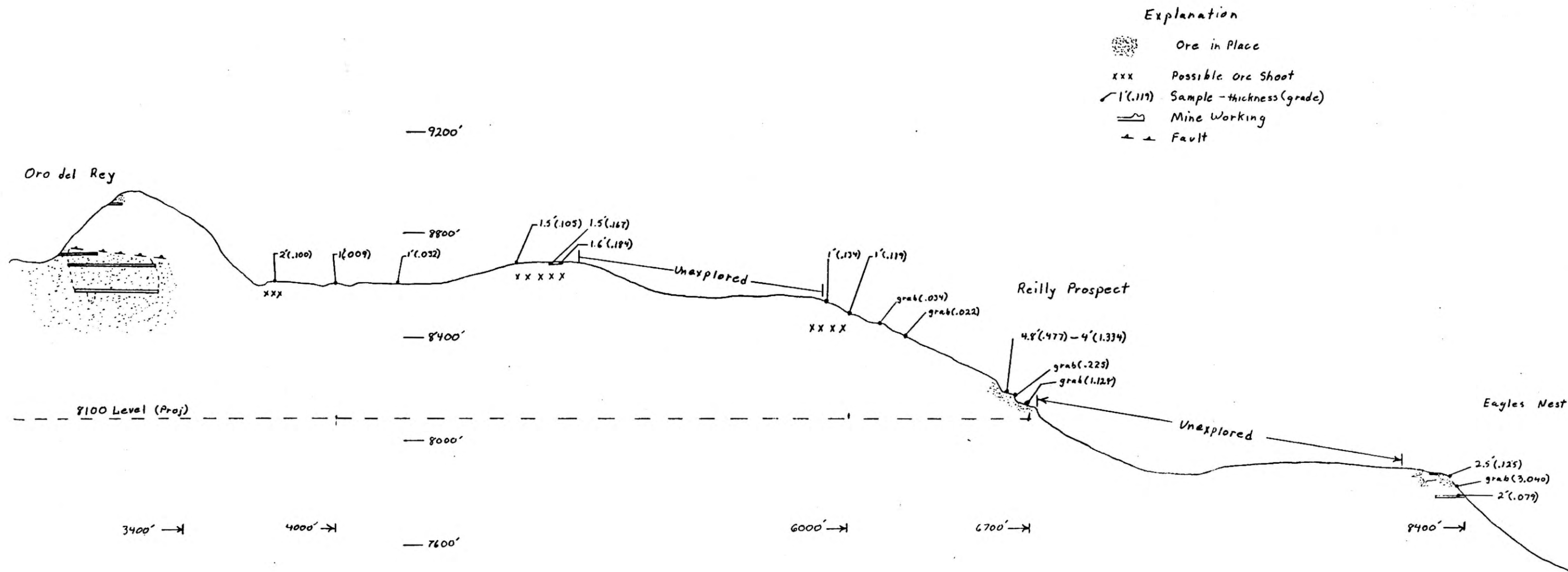


FIG. 5 N-S CROSS-SECTION

From Oro del Rey to Eagles Nest

Showing
Surface Samples and Location of Possible
Ore shoots

Scale 1" = 400'

DISTRIBUTION AND GEOMETRY OF ORE SHOOTS

The distribution of known ore shoots is shown in the cross-sections (Figs. 4 and 5). The following is a description of the vein proceeding from the 8100' level portal northward to the Eagles Nest and is keyed to these cross-sections.

1. South Lee Trout Ore Shoot.

This ore shoot was mined by a leaser named Lee Trout in the late 1940's. Early surface sampling in 1979 showed good ore to be present in two shoots separated by an approximately 100 foot barren segment. Two parallel veins are present at this locality, an easterly split which was mined by the Trouts and a west strand that to date has not been explored underground. The two strands converge northward and appear to join in an area where the outcrop is covered. The 8100' level drift was started in the stronger east vein and encountered ore about 65 feet in from the portal. The drift stayed in ore for some 180 feet at which point the vein thinned and values became erratic. When this shoot was mined in 1982 it was found that it raked sharply southward and connected with the south ore shoot on the surface. Some 2300 tons of ore were taken from this stope.

2. North Lee Trout Mineralized Area

Approximately 75 feet north of the point where the South Lee Trout ore shoot pinched to uneconomic

width, a small northwest trending fracture offset the vein about three feet to the east. Drill holes and cross-cutting show that the vein widens north of this fracture and sporadic ore lenses are present. 100 feet north of this fault the drift entered an interval of complex Type 2 cross fracturing at which point the vein was offset some 20 feet back to the west. The cross fault trended northwest and dipped north at around 50° . This cross fracture contained ore between the offset segments of the main vein and some 200 tons of development ore was taken from the area. A considerable amount of cross-cutting and sublevel drifting was done in this area to develop this ore zone, but it was found that the north and south projection of the main vein away from this cross-structure did not contain mineable grade and thickness; southward back toward the first offsetting cross fault the vein contained only scattered pods of ore, while north of it, the vein took a more easterly trend and changed to barren pyrite. Owing to physical difficulties of operating, no attempt has yet been made to trace the mineralized cross fracture up-dip back to the south. There is a possibility that this small ore shoot connects with the more northerly of the shoots present at the surface. The remaining 100 feet north of this shoot, toward the breakout in Hell Hole Gulch, was driven off of the vein in barren ground. Some 25 feet from breakout a pyrite vein was encountered striking at a small angle across the drift from east to west. Spotty values of up to .25 oz/ton gold are present in this structure.

3. South Clyde Lee Ore Shoot

At the point where the 8100' level drift broke through into the gulch, it was following the barren pyrite vein described above. Some 30 feet to the east another vein is present in outcrop striking northerly and roughly parallel. At the point of breakout, the east structure is weak and it dies out upward in the cliffs above and south of the portal. These two structures gradually converge and join some 400 feet to the north. Approximately 150 feet from the north portal of the drift, this east vein becomes ore. This ore shoot continues for some 200 feet north where it abruptly terminates against a northwesterly striking and north dipping structure. The vein continues on past the structure with no offset as barren pyrite. Three 12 foot untimbered raises were driven up from the 8100' level into this ore shoot, but no attempt has been made to mine it owing to the very limited tonnage present above the drift level.

4. North Clyde Lee Segment

Upon leaving the ore shoot the vein turns more easterly and for the next 350 feet the drift follows a progressively weakening and barren structure. At

approximately 180 feet north of the end of the South Clyde Lee ore shoot, an andesite dike enters the drift obliquely from the east. The dike turns more easterly and is followed by the drift from this point to the present head of the drift. On the surface, some 180 feet northward from the end of the South Clyde Lee ore shoot, a small prospect, the Clyde Lee Prospect, exposes good grade ore in a drift and small stope some 30 feet in length. This ore does not extend downward to the drift level nor did it extend upward to the surface above the small drift. A raise has been extended up some 50 feet from the 8100' drift to explore this occurrence but as yet has encountered no ore. The North Clyde Lee Prospect is apparently a small lens of ore in a zone that is generally unfavorable.

5. South Devils Pit Cross Fracture Zone

Some 470 feet from the Clyde Lee portal of the 8100' level drift, it entered an area of intense cross fracturing. This structural zone, described in Type 2 above, has the appearance of a tectonic breccia in places and contains a considerable amount of silica and pyrite. The pyrite is randomly distributed in pockets and stringers, but no clearly defined vein structure is present. The drift is driven in quartzite adjacent and to the west of the dike through this interval. Upon

entering this zone the dike thins and its borders become irregular although no offset is seen; the dike apparently also postdates the cross-structure and was not intruded into a clean fracture. This broken zone continues for 150 feet at which point the vein begins to reorganize and turn to the north; the dike also straightens up, thickens and becomes better lithofied at this point. At the present time the drift is some 30 feet north of the point where the vein turns and has encountered some spotty low gold values. At the surface the Devils Pit ore shoot begins some 50 to 100 feet north of the point where the vein turns.

6. North Devils Pit Ore Shoot.

Immediately north of the point where the vein turns to the north, the Devils Pit mine is situated. This working is 350 feet vertically above the present head of the 8100' level drift. Very good grade ore is exposed in those workings for 150 feet; the north headings of both the Devils Pit drifts show ore in place. On the surface the vein starts to split and die upward a short distance above the uppermost level of the working, but a strong vein and high grade are present along the length of the lower level. The dike is present a few feet east of the vein. The next 500

feet of vein between the Devils Pit and the Oro del Rey mines is unexplored. The surface above the vein in this interval is topographically high and is above the point where the vein splits up and dies. The southernmost of the Oro del Rey workings is at nearly the same elevation as the upper Devils Pit and is in a wide vein although it is not ore grade at its head.

7. Oro Del Rey Ore Zone

The Oro del Rey area constitutes the main productive area of the property. This ore shoot or series of ore shoots extends 1200 feet along strike of the vein and ore has been mined over a vertical range of 350 feet. On the south side of the Oro del Rey area the ore terminates upward where the vein starts to "horsetail" while on the north ore is found near the top of the ridge line. Northward extent of this ore zone is not known as the workings there are not accessible. The upper part of the ore shoot terminates against a thrust fault and is displaced to the east. The lower most level shows good ore in place.

8. Vein From Oro del Rey to the Eagles Nest.

The 5200 feet of vein between the Oro del Rey workings and the point where the vein enters Reilly Canyon has only been reconnaissance sampled to date. The vein is traceable although mostly poorly exposed or covered. Several prospects showing good ore are present. Starting

at a point some 500 feet north of the northernmost Oro del Rey workings, the vein appears to be wider on the average and contains much more massive iron oxide and crystallized quartz. At several locations where exposed in prospect cuts, the vein has a central massive zone from .5 to 4 feet wide that contains bands of well crystallized quartz and dense, hard iron oxide material that is interpreted to be oxidized sulfide. This same type material was mined at the Eagles Nest. At one prospect in particular, referred to below as the Reilly Prospect, some 3400 feet north of the Oro del Rey, very good grade is present in a pit (Fig. 5); 4 feet of around 1 oz/ton within a vein where total thickness is over 8 feet. In this northern part of the vein system where the ore is more massive and sulfide content of the primary ore was presumably high, there is some evidence that supergene leaching has taken place. A more detailed discussion of the probability and potential of this process follows.

ORE GENESIS

Physical Chemistry

According to the current state of thinking regarding ore forming processes, the gold ore forming solution is an aqueous solution under very high temperature and pressure with some or perhaps all the following physical and chemical parameters (Boyle 1974, 75):

1. pH nearly neutral.
2. Gold content around 1 ppm.
3. Alkalis (Na, K, etc.) as carbonates, bicarbonates and sulfates.
4. Alkaline earths (Ca, Mg, Sr, Ba) as bicarbonates.
5. Boron as borates and boric acid.
6. Silicon as colloidal silica, alkali silicate, or $\text{Si}(\text{OH})_4$.
7. Arsenic and antimony as As - Sb sulfide complexes.
8. Sulphur as H_2S , various sulfite complexes and sulphates.
9. Tellurium as telluride - sulphide complexes.
10. Fluorine as alkali fluorides.
11. Chlorine as alkali chlorides.
12. Iron and manganese as bicarbonates.
13. Base metals (Cu, Zn, Hg, etc.) as sulphide, bisulphide and polysulphide complexes.
14. Gold and silver as sulphide, bisulphide, As-Sb sulphide and tellurium - sulphide complexes.

The above model for a hypothetical precious metal forming solution is based on observation of present day geothermal systems, fluid inclusion study, and theoretical calculation. The ore is deposited (precipitated) at a point where the physical nature of the transporting solution undergoes a change that disrupts the extremely complex equilibrium relations within the solution; this change could be a chemical one that would remove or otherwise recombine one or several of the elements or complex ions in the solution or physical change such as pressure or temperature drop. In near surface vein systems in homogeneous wall rock such as the

Evelyn vein, a commonly accepted mechanism for triggering precipitation is a lowering of pressure causing the supercritical solution to boil; that is, when a solution under very high temperature and pressure moves upward through a fracture system toward the surface, the ore will be deposited in the zone where the confining pressure drops to the point where the solution will change from liquid to gas.

The Evelyn vein could fit this theoretical model. The lack of tellurides, arsenides and antimonides in the ore suggest that these elements, as well as mercury and bismuth, were low or absent in the original solution. It is also likely that iron was low in the solution in that there appears to have been a rather large scale mobilization of iron from the wall rocks of the altered zone adjacent to the vein. The known ore shoots are within the thick, homogeneous section of Prospect Mountain quartzite which offers little potential for chemical change and, in all probability, the points where the veins begin to "horsetail" and die upward were connected to and relatively near the surface. It could be expected that during the period of time when the solutions were active, the point where boiling occurred would migrate up and down, and the vertical range would be the vertical extent of the ore zone.

Another model using a chloride solution has been suggested in a recent paper (Lewis, 1982). This model proposes that gold is precipitated from a chloride solution by pyrite. This model could fit the Evelyn vein system and explain the fact that barren veins contain mostly fresh pyrite while ore is largely oxidized. This model would call for an earlier sulfide rich stage that precipitated pyrite throughout the entire

vein followed by a later chloride gold phase that selectively oxidized pyrite and precipitated gold. It is possible that the pyrite-silica forming stage effectively sealed up the tighter parts of the vein, and these areas are now barren by virtue of their inaccessibility to the later mineralizing solution. High gold values observed in some remnant sulfide samples tends to dispute this model, but some degree of oxidation is always present, and it is possible that the values are localized in these areas.

Age

It is assumed at this time that the Evelyn vein is part of the Mid-Tertiary epoch that is the principal period of mineralization in western North America. In all probability, the vein system is contemporaneous with Gold Hill district and may be a southward extension of it. The Evelyn vein is characteristic of a type that is commonly found in the outer periphery of a large and complex mineralized center. It is the opinion of this writer that the vein is not related to and is probably older than the nearby Ibapah granite.

ORE CONTROL

The shape, extent and position of ore shoots within the Evelyn vein seem to be controlled by pre-existing structure. Based on evidence seen in the part of the mine thus far developed, the best ore occurs in the parts of the fracture that were open and had good vertical permeability at the time of mineralization. Areas where the vein is a clean, well defined fracture are favorable, and areas where the vein is "tight" or brecciated are unfavorable. Cross-fracturing seems to be the principal element influencing the favorability of the vein. Cross-fractures that intersect the vein within ore shoots create high grade pods or chimneys, other cross-fractures terminate ore shoots. The fact that almost all of these cross structures dip to the north or northeast cause a distinct "rake" of the ore down to the north. In fractures, the ore may gradually pinch out as the vein becomes narrow. In some of these "pinched" areas there is a thin seam of ore, while at others, values become erratic and decrease. It is likely that many of these pinchouts are local in nature and ore will be present again above, below, or laterally. Typically in other vein deposits, ore shoots are longer in the vertical plane by a factor of 3 to 8.

The vertical range of ore shoots is not known at this time but is vital to the success and longevity of the mine. The vertical range to be expected is dependent on the amount of vertical interconnected permeability and the vertical range over which the zone of boiling migrated. There are several lines of indirect evidence that suggest that this range will be between 1200 and 2500 feet at the Evelyn Mine. These factors are:

1. The Prospect Mountain quartzite is approximately 3000 feet thick at the property and the tops of the ore shoots, the points where the veins split up, are within a few hundred feet of the top of the formation. The entire thickness of the Prospect Mountain quartzite is exposed in Goshute Canyon and there is no evidence that the rock is any less favorable near its base. In fact, ore bearing veins are present near the mouth of the canyon and other ore occurrences can be seen about midway up the canyon near the center of the formation.
2. A review of other gold vein type deposits in the western United States shows a vertical range of between 600 and 2500 feet. Many of these deposits were already deeply eroded, thus the true vertical extent is not known; others bottomed because of changing rock type or change of the host structure. The average appears to be around 1200 feet for the western North America.
3. The two veins exposed near the mouth of Goshute Canyon are within 300 feet of the bottom of the quartzite. Both these veins contain ore where exposed in cuts and drifts

some 200 feet above the canyon floor and both lose their value and change to white "bull" quartz by the time they reach the canyon floor. It would be hazardous to assume that this change represents the bottom of the productive vein system for the whole district, but the possibility does seem attractive.

Grade, Leaching and Enrichment

Where observed to date in the south end of the vein system, gold values do not noticeably change with depth. Silver and lead are enriched from the surface down to about 20 feet in the southern end, but below the gold-silver ratio is near 1. At the south end within ore shoots, the overall grade over 3.5 feet can be expected to be in the order of .35 - .40 oz/ton gold, .5 oz/ton silver and between .4 and 1% lead. Old data indicates that grades of all three metals were higher in ore mined from the Oro del Rey area, and the average gold values in the Devils Pit workings is close to .60 oz/ton. It is difficult to estimate the original overall grade in these old workings owing to the fact that the best ore was mined and shipped and only the lower grade remains.

Some earlier examiners of the property have proposed that the Evelyn deposit is a surface enriched deposit and that it should not be expected to extend more than about 300 feet below the surface. This opinion is poorly supported by theory and experience but gold can be mobilized under weathering conditions and there is a possibility that this has happened in parts of the vein.

Gold can be enriched by weathering processes by two methods,

mechanical concentration of free gold down an open fracture as the surface is eroded and by chemical dissolution.

Mechanical concentration usually manifests itself as an enrichment of free gold in the weathered vein near the surface. There is a possibility that if the vein is relatively open, the enrichment could extend down several hundred feet under the right climatic and topographical conditions. The probability of this happening in the Evelyn vein is, in this writer's opinion, remote. The vein occurs in very rugged country, and it would be expected that weathered vein material would be washed downslope rather than winnowed down the vein itself. The vein is not deeply eroded and at several locations in the Oro del Rey and Devils Pit, high grade ore is found immediately below the point where the vein splits up and dies. Although there are places within ore shoots where the fracture is open and filled with soft material, these voids are not interconnected by large open fractures and likely represent areas where sulfide was oxidized in place. Based on these data, it is unlikely that the vein has undergone any significant enrichment by mechanical means.

Chemical dissolution and movement of gold in the surface environment is both theoretically possible and has been observed in ore deposits. The conditions under which this can take place are very restricted but there is a strong possibility that in parts of the Evelyn vein it has happened. Gold will become mobile at surface temperature and pressure in a strong acid, chloride bearing solution. Geologically, this environment can occur in a vein with an unreactive wall rock, a high primary sulfide content and a source of chloride. The only district

where this process is well documented was at the gold district of Delamar, Nevada. At Delamar, pyritic gold ore was present in the Prospect Mountain quartzite and progressive enrichment was present down to the water table at around 700 feet. Very high grade ore was mined from this deposit. It should be noted that the Delamar district is the only district appearing in the literature that is closely analogous structurally, chemically and mineralogically to the Evelyn vein.

Where the vein is exposed at the Eagles Nest and in other veins close by, it shows evidence of it being a massive sulfide bearing fissure. Widths of this central massive zone are commonly 3 to 4 feet. Recon sampling in this ore shows a different value distribution pattern from the more narrow, sulfide poor southern extension, in that these assays show a very wide variation over a short interval in identical looking rock. Values of 3.5 oz/ton have been sampled while 1 foot away identical appearing vein records no gold at all. This extreme scatter of value is compatible with leached rock. The Eagles Nest ore deposit was a small high grade pod that abruptly ended downward and laterally with no physical change in the vein. Theoretically, the Eagles Nest area is favorable for downward leaching. The host quartzite is unreactive and would not have had any chemical effect on the conditions within the vein. The sulfide content, particularly pyrite, is thought to have been high, thus the oxidizing of the vein would have led to very low pH values. Chloride in the form of wind blown dust off of the Great Salt Lake Desert would have been plentiful.

Where the gold went after it was mobilized is not certain, but it is likely that it moved vertically down the vein structure. The gold would have remained soluble until the pH of the solution was raised or

the chloride complex broken down. There is some theoretical data that suggests that contact with fresh pyrite will bring about the precipitation of gold from a chloride solution and mingling with meteoric water below the zone of active oxidization could raise the pH. Enrichment of gold in the veins near the Eagles Nest is a definite possibility.

Sampling

Obtaining unbiased sample data is very difficult in the type of deposit present at the Evelyn Mine. Gold is unevenly distributed within the vein with most of the value reporting in the fine fraction when the rock is broken; screen assay of broken ore shows that almost 70% of the gold is in the -150 mesh fraction. This concentration of gold in the fine fraction, derived from the softer parts of the vein, necessitates great care when sampling in order to obtain equal volume of material across the sample interval. Careful channel sampling underground yields accurate data provided enough are taken to provide an adequate statistical data base. Percussion drill samples driven through the vein have proven to be highly inaccurate and can be biased drastically, high or low, depending upon the nature of the vein at the point of intersection. Long hole samples while providing reliable data on the location, thickness, and relative hardness of the vein can only yield qualitative information regarding grade.

Surface samples of the weathered vein have proven to be inaccurate and imprecise and can only be regarded as qualitative. The weathered surface is physically difficult to sample because of its unevenness and the softer higher grade parts are deeply weathered and normally impossible to reach. Surface samples tend to be biased low. Near surface samples from shallow pits give better data, but are still likely to be biased; experience in sampling the vein in the south end of the property indicates that gold values will be biased low while silver and lead will be high by a factor of as much as 5. Prospect pits that expose the vein at depths greater than 5 feet below the surface will generally

provide accurate gold values, but will tend to be biased high in silver and lead.

The above observations are valid within the southern part of the vein but may not hold up in the northern parts of the property where the vein is physically different and surface leaching may have occurred.

Repeated assay of pulps from an individual sample will show a variation of 25 to 30%. This unavoidable "sample error" must be compensated for by taking large numbers of samples.

Sampling considerations may be summarized as follows:

1. Careful channel sampling in adequate numbers will provide accurate data in underground workings. Only the obviously iron stained parts of the vein should be sampled; if the vein is 1 foot wide in a drift head, the one foot interval should be sampled and the weighted grade over mining width calculated assigning a value of .01 oz/ton to the extra width. Attempting to sample the entire mining width will greatly increase the probability of low bias, will increase the sample error and drastically increase the time and labor involved in collecting the sample.
2. A sample error of 25 to 30% is unavoidable and must be compensated by taking large numbers of samples.
3. Drill cutting samples can be biased either high or low with no way to predict them and must be regarded as qualitative.
4. Surface samples of weathered vein material are inaccurate and generally biased low in gold and high in silver and lead.
5. A prospect pit that exposes the vein below a depth of 5 feet generally will yield reliable gold values, but may be biased

high in silver and lead.

6. The above observations may have to be modified when applied to the veins in the north end of the property.

Based upon experience in the developed parts of the vein the following guidelines regarding interpretation of sample data should be used:

1. Consistent high values, even where the vein is very thin indicate an ore shoot.
2. Inconsistent spotty values ranging from .02 to 1 oz/ton indicate the edge of an ore shoot regardless of vein width.
3. Spotty values of up to .10 oz/ton probably indicate the proximity of an ore shoot.
4. Consistent surface sample values greater than .10 oz/ton should be regarded as favorable.

POTENTIAL

Potential reserves of the unexplored part of the Evelyn vein are calculated by two methods. A low estimate is derived by assuming that the percent of strike length of the vein that is ore bearing in the 1480 feet of 8100 level drift, will also be the amount mineable throughout the entire distance to the Eagles Nest. A second and somewhat higher projection is made based on the percent of ore bearing vein between the 8100 portal and the north side of the Oro del Rey workings; this includes the two ore shoots in the drift, the ore exposed in the Devils Pit drift, and the widths of either ore or stope measured in the Oro del Rey workings (Figs. 4 and 5). For the Case 1 estimate, there is 380 feet of ore showing in a total 1480 feet of drift, for a percent of 25.7. In Case 2 there is 1460 feet of ore exposed over a total distance of 3400 feet, or 42.9 percent. The total vertical extent of the ore zone is assumed to be 1200 feet, 400 feet above the 8100 level and 800 feet below it. The width of the vein is 3.5 feet and the dip of the vein is set at 75° . The tonnage factor is 11.5 cubic feet per ton. Factoring of the above parameters gives a constant of .335 tons per square foot shown in the cross-section (Figs 4 and 5). Because it is topographically lower than the 8100 level, the 1700 feet between the Reilly prospect and the Eagles Nest uses a downward projection of 650 feet. Estimates for ore above the drift level are started at the present drift head 1480 feet from the portal to the point where the surface lowers below 400 feet above the projected drift level some 6000 feet from the portal,

a section length of 4520 feet.

Case I

Above 8100 level	4520 x 400 x .257 x .335 =	155,660 t
below to Reilly Prospect	6700 x 800 x .257 x .335 =	461,469 t
below from Reilly Prospect to		
Eagles Nest	1700 x 650 x .257 x .335 =	<u>95,135 t</u>
	Total below 8100 level	<u>556,604 t</u>
	Case I Total	712,264 t

Case II

Above 8100 level	4520 x 400 x .429 x .335 =	259,837 t
below to Reilly Prospect	6700 x 800 x .429 x .335 =	770,312 t
below from Reilly Prospect to		
Eagles Nest	1700 x 650 x .429 x .335 =	<u>158,805 t</u>
	Total below 8100 level	<u>929,117 t</u>
	Case II Total	1,188,954 t

The high and low estimates for the distance from the present drift head to the north edge of the Oro del Rey above the 8100 level are:

Case I	1920 x 400 x .257 x .355	66,120 t
Case II	1920 x 400 x .429 x .335	110,373 t

In addition to the direct potential tonnage, estimated above, there are several other factors that could add to it, although there is at this time no corroborating data. These factors are:

1. The other veins exposed in the Eagles Nest area and at the mouth of Goshute Canyon.

2. Possible extent of the veins north and south of the present area of consideration.
3. Possible extent of the ore deeper than 1200 feet used in the above estimate.
4. Possible enrichment in the north end at the vein.
5. Deep potential for different kinds of ore, possibly silver-lead, in the trust fault zone at the base of the Prospect Mountain quartzite.

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Thomson, K. D., 1973, Mineral deposits of the Deep Creek Mountains, Tooele and Juab Counties, Utah; Utah Geol & Min Surv, Bull. 99

APPENDIX I

Areal Geology of the Deep Creek Mountains

From Thomson, 1973

Mineral Deposits of the Deep Creek Mountains, Tooele and Juab Counties, Utah

by K. C. Thomson



UTAH GEOLOGICAL AND MINERALOGICAL SURVEY
affiliated with
THE COLLEGE OF MINES AND MINERAL INDUSTRIES
University of Utah, Salt Lake City, Utah

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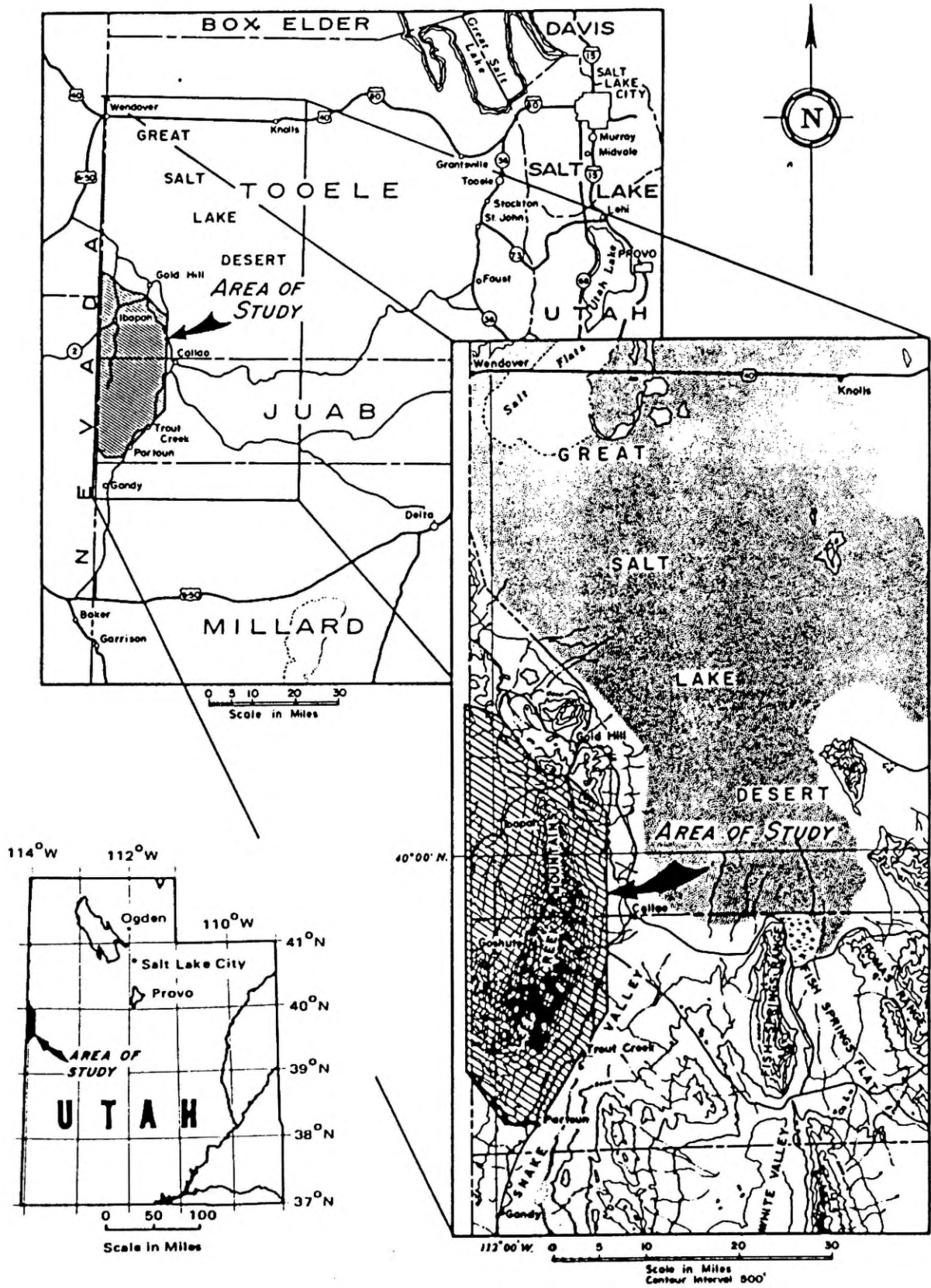


Figure 1. Index map of the location of the study area.

Quartzite formations were evaluated as potential silica deposits. Throughout the range, jasper, aquamarine, quartz, aventurine, chalcedony and petrified wood were located and mapped. Radio-quality quartz from pegmatite dikes in the southwest part of the Ibapah stock was investigated. None of the nonmetallic minerals showed promise as potential economic deposits.

Water resources and geochemistry in the range were investigated. Samples taken from 85 locations were analyzed using atomic absorption spectrophotometry for iron, copper, lead and zinc. Concentrations of these elements appeared near areas of known mineralization.

INTRODUCTION

The Deep Creek Range is a potential producer of gold, silver, lead, copper, tungsten, beryllium and mercury. The mineralization of this area is related broadly to that of the Basin and Range. The results of this study form a useful tool in examination of exploration methods and theories of ore deposition.

Previous regional geologic mapping by Nolan (1935), Bick (1958, 1966) and Nelson (1959, 1966) permitted this writer to restrict himself to detailed mapping of the mineral localities and their immediate environments. Mineral deposits in Gold Hill and vicinity are covered by Shatoury (1970).

The Deep Creek Mountains are located in western Utah between 113°45'00" and 114°05'00" west longitude and 39°35'00" and 40°15'00" north latitude, 40 miles south of Wendover by dirt road along the Utah-Nevada state line (figure 1).

Six communities in the study area, Gold Hill, Ibapah, Callao, Trout Creek, Goshute and Partoun (figure 1), supply local needs. Ibapah maintains two general supply stores with gas pumps. A hand-operated gas pump at Dorsey Sabey's ranch supplies Callao. Partoun has a cooperatively owned grocery store and gas pump. No commercial electrical power is available; power is furnished where needed by gasoline or diesel generators. Telephone service by radio-telephone became available for the first time in Ibapah in 1968. Mining supplies may be obtained from Salt Lake City, 160 miles east, or from Ely, Nevada, 120 miles southwest. The nearest rail shipping point is Wendover, Utah, 65 to 100 miles north of the mining areas.

Previous Work

Earliest accounts of the Deep Creek Mountains, in reports of the Wheeler Survey (Gilbert, 1875 and Howell, 1875), record a granite stock and sedimentary

rocks. Gilbert (1890) described the fault block nature of the Deep Creek Range. Brief articles in the *Utah Mining Review*, (Henry, 1900, McFarren, 1909, Higgins, 1917 and Reagan, 1917 and 1929), and two anonymous papers, 1889 and 1917, describe the mining activity, general geology and mineral deposits. Custer (1917) described the Clifton mining district. Butler (1920) discussed the general geology and the mineral deposits. Kerr (1946) mentioned the tungsten occurrences in the Trout Creek and Gold Hill areas. Crawford and O'Farrel (1932) worked on the mercury deposits of the Congar Hill area. Nolan (1932) worked out the geologic and stratigraphic data on the Gold Hill mining district, including the entire 15-minute quadrangle surrounding the district. Bick (1958, 1966) studied the structure and stratigraphy of the range south of the 40° parallel and Nelson (1959, 1966) determined the structure and stratigraphy south of 39°50'00" parallel. Everett (1961), in a U. S. Bureau of Mines report on tungsten properties in Utah, briefly discussed the tungsten properties. Shatoury (1970) discussed the mineralization and alteration of the Gold Hill district. Several private consultants worked on individual areas for claim owners: Spurr and Cox (1909), Burritt (1936), Robins (1938), Dunham (1959) and Flint (1962).

Physical Geography

The Deep Creek Range, the highest in western Utah, rises 7,800 feet above the Great Salt Lake Desert on the east to a maximum altitude of 12,109 feet on Ibapah Peak.

Ibapah Valley on the west side of the range is higher than the valleys to the east and south. It drains northward into the Great Salt Lake Desert. The valley ranges in altitude from 5,000 feet at the north end to 7,000 feet at the south. Snake Valley, southeast of the range, also drains northward into the Great Salt Lake Desert and ranges from 4,200 to 6,000 feet in elevation. Pleasant Valley, at the south end of the range, drains eastward into Snake Valley and ranges from 5,400 to 7,000 feet.

The surrounding valleys and lower slopes of the Deep Creek Range are arid, but with increased altitude and precipitation, the lower vegetation composed of sagebrush, greasewood and scattered grasses changes to juniper, pinyon and scrub oak on higher slopes and pines and quaking aspens in the summit area.

MAPPING AND ANALYTICAL TECHNIQUES

Aerial photographs from the U. S. Department of Agriculture were used in detailed mapping of the mining areas. Mines and prospects were mapped with tape

and Brunton compass at waist level using scales from 1 inch = 20 feet to 1 inch = 100 feet. One hundred mines and prospects were entered and mapped or sampled. Unless otherwise indicated on the map, all maps are by the author, assisted by B. Eichbauer, K. Wilson or R. C. Fox.

Chemical and fire assays were made on vein and other mineral samples by Black and Deason, assayers of Salt Lake City. Spectrographic analyses were made by the Metallurgical Laboratories of San Francisco and by the Utah Geological and Mineralogical Survey's analytical laboratory.

Rock types were studied petrographically by the writer to determine mineralogical composition and classification. Polished ore sections aided in identifying minerals and determining paragenetic sequences.

LOCATION OF MINING AREAS AND PROPERTIES

The mineral properties divide easily into three areas on the basis of geographic location and historical divisions indicated in county records. These are the southern Clifton area in the northernmost part of the range, the Willow Springs district in the central part and the Spring Creek area at the south end (plate 1).

The southern Clifton area includes all mineralized ground in the northern part of the Deep Creek Mountains including part of the Gold Hill or Clifton mining district, between 40°04'00" and 40°06'15" north latitude and 113°48'00" and 113°56'00" west longitude. The Monocco property lies in the northeast part of the area, the Complex area and vicinity in the west and the Overland Canyon mines in the southeast.

The Willow Springs district, an unorganized mining district, lies between the south boundary of the southern Clifton mining area and the north contact of the Ibapah granite stock, a large intrusive occupying the central portion of the mountain range. Included in this district is the Dewey property in the northwest portion, the Congar Hill property in the southwest part, the North Pass area in the northeast, the Willow Springs area in the east central part, and the Reilly-Goshute canyons area in the southeast part. In the Reilly-Goshute canyons area are the Prosperity mine in Reilly Canyon, the Devils Pit-Oro del Rey-Eagles Nest area between Reilly and Goshute canyons, lower Goshute area mines in lower Goshute Canyon, and the Silver Queen in the foothills between Reilly and Goshute canyons.

The Spring Creek area includes all properties from the Ibapah stock south to Pleasant Valley and

from Snake Valley on the east to the Utah-Nevada border on the west. It includes the Gold Bond mineralization in the northeast part of the area; Trout Creek, 2 miles south of Granite Creek; Singleton Canyon; and the Heavenly Hills about 3 miles southwest of the community of Partoun. Water Canyon, near the Utah-Nevada border about 6 miles north of Pleasant Valley, Johnson Canyon at the south end of Ibapah Valley along the Utah-Nevada border, and the Queen of Sheba property about 5 miles southeast of the community of Goshute on the west side of the mountain range are also part of this area. The Spring Creek area includes the unorganized mining districts recorded in the county and state records as follows: Trout Creek, Johnson Canyon and Spring Creek districts.

GENERAL GEOLOGY

The Deep Creek Range is a horst bounded on the east and west by long normal faults along which the range was raised above the adjacent valleys and tilted to the west. In the center is the Ibapah granite stock (plate 2). Precambrian to Recent formations in the north end of the range occur as a series of parallel bands striking approximately north-south and dipping from 30° west to vertical. In the south end, metamorphosed rocks of Precambrian age and some Paleozoic sedimentary beds dip to the west and have a north-south strike (plate 2). Figures 2, 3 and 4 show the stratigraphic sections in the three parts of the range.

Nolan's (1935) geologic map was used as a base to map the alteration and mineralization in the north end of the range south to 40°00'00" north latitude. The studies by Bick (1966) and Nelson (1966) were used as references for the general geology of the area and the names used for the many rock units were taken from their reports.

Stratigraphy

Precambrian Rocks

Trout Creek Sequence. The metamorphic rocks of the Trout Creek sequence in the south part of the area (plate 2) were divided into seven successive units labeled A to G by Nelson (1966, p. 926). Unit A, the oldest, is a 200-foot thick biotite-bearing muscovite schist and schistose quartzite. Unit A is overlain by unit B, a strongly foliated, blue-black and white dolomitic schist 1,100 feet thick, is overlain by unit D, a 600-foot quartzite unit, unit E, a 1,300-foot fine-grained garnetiferous muscovite-biotite schist, unit F, a 3,500-foot dark colored mica schist with light colored quartzitic interbeds, and unit G, a 1,500-foot massive reddish quartzite with interbedded schist. The entire sequence is 8,800 feet thick.

SYSTEM	SERIES	LITHOLOGY	FORMATION	THICKNESS
QUAT.	Recent		Alluvium UNCONFORMITY	Variable
DEVONIAN	Middle		Guilmette Formation	888-1400
			Simonsen Dolomite	963-1030
DEVONIAN	Lower		Sevy Dolomite UNCONFORMITY	450-670
			Laketown Dolomite	659-970
ORD. SIL.	Middle		Fish Haven Dolomite	250
			Chokecherry Dolomite	850-1000
C A M B R I A N	Upper		Hicks Formation	1160-1200
			Lamb Dolomite	1020-1162
			Trippe Limestone	660-795
			Young Peak Dolomite	338-600
	Middle		Abercrombie Formation	1765-2708
			Busby Quartzite	412-519
			Pioche Shale	360-530
	Lower		Prospect Mountain Quartzite	2950
			Goshute Canyon Formation UNCONFORMITY	2706
	CAMBRIAN and/or PRECAMB.			Goshute Canyon Formation

Figure 2. Stratigraphic section in the southern Clifton Hills (after Nolan, 1935, and Bick, 1958, 1966).

Johnson Pass Sequence. A metamorphic unit, the Johnson Pass Sequence is approximately 10,000 feet thick, and is composed of schist, quartzite and minor interbeds of both quartzose marble and amphibolite. Both the marble and amphibolite weather brown or gray. Characteristically, the rocks near the southern border of the Ibapah stock are deep brick red.

Water Canyon Sequence. This 5,000-foot section in the vicinity of Water Canyon (plate 2) consists of argillite, quartzite and purple or green shale.

Cambrian and Precambrian Rocks

Goshute Canyon Formation. The Goshute Canyon Formation is exposed typically in Goshute Canyon (plate 2) and has been divided by Bick (1966, p. 20, 21) into four successive members labeled a, b, c and d. Member a, the lowermost, is 200 feet thick and is composed of light gray quartzite. Member b, an

SYSTEM	SERIES	LITHOLOGY	FORMATION	THICKNESS			
QUAT.	Recent		Younger Alluvium	Variable			
	Platycene		Older Alluvium UNCONFORMITY	Variable			
PENNSYLVANIAN	Member to Wolfcamp Undivided		Quirrh Formation	5300+			
			Manning Canyon Formation	450'			
			Ochre Mountain Formation	4500+			
			Herald Shale Member				
			Woodman Formation	800'			
			Guilmette Formation UNCONFORMITY	800-1000'			
			MISSISSIPPIAN	Upper		Herat Shale Member	
						Woodman Formation	800'
						Ochre Mountain Formation	4500+
						Manning Canyon Formation	450'
Quirrh Formation	5300+						
Older Alluvium	Variable						
Younger Alluvium	Variable						
DEV.	Middle					Guilmette Formation	800-1000'
						UNCONFORMITY	

Figure 3. Stratigraphic section in the Willow Springs area (after Nolan, 1935, and Bick, 1966).

alternating sequence of light gray quartzite and shale beds, is 1,506 feet thick. Member c, 734 feet thick, is a massive quartzite overlain by member d, a sandstone and shale section 265 feet thick.

Lower Cambrian Rocks

Prospect Mountain Quartzite. A light pink to gray quartzite with interbedded lenses of conglomerate weathers yellow-brown and comprises the bulk of the Prospect Mountain Quartzite. Schist and quartzite make up the pebble fraction of the conglomerate lenses. Massive brown outcrops of Prospect Mountain Quartzite are conspicuous in the north part of the east side of the range. The formation is about 2,950 feet thick in this area and from 2,500 to 3,000 feet thick in the southwest part of the range.

Pioche Shale. The Pioche Shale (Cabin Shale of Nolan, 1935, p. 6, 7), ranging from 360 to 530 feet thick, is a micaceous, dark gray-green shale which weathers reddish brown. It contains some limy, medium gray shale which becomes sandy toward the top of the formation.

Busby Quartzite. The Busby Quartzite, a fine- to medium-grained gray-brown to dark yellow-brown quartzite with an argillaceous and micaceous matrix,

SYSTEM	SERIES	LITHOLOGY	FORMATION	THICKNESS
QUATERNARY	Recent		Alluvium	Variable
PERMIAN	Lower		Arturus Formation	1,000 ft
PENNSYLVANIAN	Lower and Middle		Ely Formation	1,500'
MISSISSIPPIAN	Upper		Chenman Shale	1,000'
DEVONIAN	Middle		Sevy Dolomite	400'
SILURIAN	Middle		Lakstown Dolomite	850'-1,050'
ORDOVICIAN	Upper		Fish Haven Dolomite	250'-275'
	Middle		Lurets Quartzite	150'-320'
			Lehman Limestone	700'
	Lower		Kanosh Shale	1,000'
			Unit B	1,000'
			Unit A	1,000'
			Young Peak Dolomite	200'
CAMBRIAN	Middle		Abercrombie Formation	2,700'
			Busy Quartzite	500'
	Lower		Pioche Shale	500'
			Prospect Mountain Quartzite	3,000'
			Water Canyon Sequence	3,000'
PRECAMBRIAN			Johnson Pass Sequence	10,000'
		Treat Creek Formation	Unit G	1,500'
			Unit F	3,500'
			Unit E	1,300'
			Unit D	400'
			Unit C	1,100'
			Unit B	400'
			Unit A	200 ft

Figure 4. Stratigraphic section in the Spring Creek area (after Nelson, 1959 and 1966).

weathers to a reddish brown. Massive resistant quartzite 412 to 500 feet thick forms cliffs above the readily eroded Pioche Shale.

Middle Cambrian Rocks

Abercrombie Formation. The limestone beds of the Abercrombie Formation are thin-bedded to massive with interbedded shale and sandy shale partings. Blue-gray rocks weather light gray with reddish or yellowish tints at the shale partings in the limestone. The formation is from 1,765 to 2,708 feet thick.

Young Peak Dolomite. Typical of the Young Peak Dolomite is a dark gray to black dolomite containing short, white dolomitic rods and several varieties of limestone, most of which are similar to the underlying Abercrombie Limestone. The remaining limestone is medium gray and very dense. The limestone and dolomite intertongue, with dolomite composing most of the formation in the north and limestone predominating in the south. The formation ranges in thickness from 200 to 600 feet.

Trippe Limestone. The Trippe Limestone is composed of thin- to medium-bedded, light gray limestone beds with yellow-brown and red shale partings. A 64-foot dolomite section occurs 300 feet below the top of the formation. The Trippe Limestone is from 660 to 795 feet thick.

Lamb Dolomite. Coarse-grained, light gray dolomite, making the bulk of the Lamb Dolomite, is overlain by 85 feet of thin-bedded limestone and 22 feet of sandstone. Total thickness of the Lamb Dolomite is from 1,035 to 1,160 feet.

Hicks Formation. The Hicks Formation is mostly a light gray, thin-bedded to massive dolomite. It is oolitic in some parts of the section and sandy in others. The thickness ranges from 753 feet to 1,160 feet.

Upper Cambrian and Lower Ordovician Rocks

Chokecherry Dolomite. The Chokecherry Dolomite is mostly coarse-grained, massive, light gray dolomite. The formation is characterized by abundant chert nodules and sand between layers of dolomite. The thickness is from 850 to 1,100 feet.

Lower Ordovician Rocks

Pogonip Group. The Pogonip Group was divided into four units by Nelson (1966, p. 930-934): an upper unit, the Lehman Limestone, a 700-foot thick, dark gray argillaceous, fossiliferous limestone; the Kanosh Shale, a 1,000-foot thick sequence of greenish gray fissile shale, with interbedded siltstone; Unit B, a light brown, brown-weathering argillaceous limestone containing chert nodules 1,000 feet thick, and a lower unit A, a 1,000-foot thick, medium- to thick-bedded, massive gray limestone. The Pogonip is restricted to the southwest part of the range.

Middle Ordovician Rocks

Eureka Quartzite. The vitreous, white to light gray quartzite and sandstone of the Eureka Quartzite form a 150- to 320-foot thick unit in the cliffs west of Johnson Canyon in the southwest part of the range.

Upper Ordovician Rocks

Fish Haven Dolomite. A dark gray, light gray-weathering, fine-grained dolomite, from 250 to 270 feet thick, makes up the Fish Haven Dolomite.

Middle Silurian Rocks

Laketown Dolomite. The Laketown Dolomite is composed of dark- to medium-gray, medium- to thick-bedded dolomite. Chert nodules and stringers are common throughout the formation. Thicknesses range from 659 to 1,050 feet.

Lower Devonian Rocks

Sevy Dolomite. The Sevy Dolomite consists of evenly bedded, fine-grained, light gray homogeneous dolomite, 450 to 670 feet thick.

Middle Devonian Rocks

Simonson Dolomite. The Simonson Dolomite, 963 to 984 feet thick, is a dark to medium gray, medium-grained dolomite that weathers to a medium gray.

Guilmette Formation. The limestone and dolomite which form the Guilmette Formation in this range are massively bedded, light bluish to dark gray rocks which weather to tan. Sandstone is interbedded with the limestone and dolomite. The Guilmette Formation is from 800 to 1,000 feet thick.

Upper Mississippian Rocks

Woodman Formation. Two main units comprise the Woodman Formation, a lower calcareous sandstone and an upper sandy limestone. The sandstone is purplish to reddish brown and fine-grained. The limestone is dark gray to almost black on fresh fracture and weathers to a light brown or pink. All units are thin-bedded. The thickness of the formation in Sevy Canyon (north part of the range) is 1,027 feet.

Ochre Mountain Limestone. The Ochre Mountain Limestone is composed of fine-grained, brownish gray to light bluish gray limestone with beds from 1 to 10 feet thick. The upper part of the formation measures 4,500 feet in thickness; the base is not exposed.

Chainman Shale. Predominately olive green to dark brown fissile shale, the Chainman Shale weathers to pink, yellow, greenish brown, brown and black, and commonly contains lenses of limestone, sandstone and quartzite. Outcropping only in the south part of the range, it is approximately 1,000 feet thick.

Upper Mississippian and Lower Pennsylvanian Rocks

Manning Canyon Formation. The Manning Canyon Formation, composed of gray to black quartzite with interbedded black shale, is approximately 450 feet thick northeast of Overland Canyon (Nolan, 1935, p. 32). The formation outcrops only in the north part of the range.

Lower and Middle Pennsylvanian Rocks

Ely Formation. The Ely Formation occurs as a medium-grained, gray limestone with several interbedded shale and quartzite units. The formation changes southward to a lower dark gray to bluish gray limestone member and an upper shale, limestone and sandstone member. The formation is approximately 1,500 feet thick. It outcrops only in the south part of the range.

Pennsylvanian and Permian Rocks

Oquirrh Formation. The Oquirrh Formation is composed of dark gray to reddish brown, somewhat nonresistant sandstone, and fine-grained, dark bluish gray to light gray sandy limestone beds containing some chert nodules, many of them jasper. In some areas the limestone is platy and darker in color. The formation outcrops only in the north part of the range (plate 2) and is probably correlative in part with the Ely Formation. Its thickness as determined by Nolan (1935, p. 35) is 5,300 feet.

Lower Permian Rocks

Arcturus Formation. The Arcturus Formation outcrops in the south end of the mountain range (plate 2) as a yellowish to gray sandstone and dolomite unit with minor interbedded limestone and quartzite. Thickness of the formation has not been measured, but is estimated to be 1,000 feet or more (Nelson, 1959, p. 76-78).

Tertiary Rocks

Salt Lake Group. Outcropping in the south part of the mountain range and northwest of Ibapah (plate 2), the Salt Lake Group contains three units: (1) the lowermost unit, a red to yellowish brown calcareous

Table 1. Composition of igneous rocks in the Deep Creek Mountains, Juab and Tooele counties, Utah.

Rock Type	Mineral Content in Percent									
	Plagioclase	K-Feldspar	Quartz	Magnetite	Biotite	Zircon	Apatite	Sphene	Glass	Other
Intrusive Rocks										
Quartz monzonite	10-60	10-50	10-20	A	A	A	A	A		
Granite	25-35	25	28-38	A	10-15	A	A			Muscovite
Alaskite		20-30	30		A-3	A	A			Muscovite
Dike rocks										
Quartz-monzonite porphyry	10-60	10-50	10-20	A	A	A	A	A		
Rhyolite	10-15	35-40	20-40	A	A	A				
Aplite		50	20-30	A			A			Muscovite
Andesite	30-35		0-5	A	A				50	
Basalt	60-70			5-10	A	A	A	A		Olivine
Extrusive rocks										
Welded tuff	10		15		A				60-70	Hornblende
Crystal-vitric tuff	30	25		A	A				35	
Andesite	40-50	5-10	5	A	A	A	A		A	Olivine
Rhyolite	35-40	20	15-20	A	A	A		A		
Tuff	A		A	A					85	Muscovite

A=accessory amounts.

sandstone and arenaceous limestone, overlain by (2) a 2,000-foot sequence of crystal and lithic tuff and vitrophyre of ignimbrite origin, with some rhyolite and andesite flows, and (3) the upper unit, a 400-foot sequence of greenish brown and light brown bentonitic claystone with periodic thin, lignite laminae. The formation is probably Miocene to Pliocene in age (Heylman, 1965, p. 20, 21).

Quaternary Sediments

Older Alluvium. Outcrops of older alluvium occur in the northeast part of the range. These alluvial deposits contain pebbles and boulders which are all rounded, poorly sorted and sufficiently cemented with calcium carbonate to be considered conglomerate. Composition of the pebbles and boulders ranges from limestone to quartzite, but does not include quartz monzonite or volcanic rocks. Thickness of this unit was not determined.

Alluvium. Alluvium includes all unconsolidated sand and gravel which occur in stream channels, bajadas, alluvial fans and other features. Nearly every lithology in the range is represented in the rounded to subrounded and good to poorly sorted gravels. Thickness of the formation is extremely variable and was not measured.

Igneous Rocks (table 1)

Intrusive Rocks

Gold Hill Stock. Quartz monzonite of the Gold Hill stock covers approximately 40 square miles between Overland Canyon and Gold Hill (plate 1) and intrudes Cambrian to Pennsylvanian sediments in the northeast part of the Deep Creek Mountains. The stock has been dated by Nolan (1935, p. 43) as Late Eocene to Early Oligocene, approximately 40 million years (my) old. Lead-alpha age determinations by Odekirk (Whelan, 1969) give the stock ages of 471 and 499 my, but these ages are anomalous because the stock intrudes rocks as young as Pennsylvanian (250 to 270 my).

Ibapah Stock. The Ibapah granite stock, approximately 64 square miles in area, transects the full width of the range (plate 1). Bick (1966, p. 52) describes the contacts on the north and south sides of the Ibapah stock as smooth and planar, strike N. 70° W. and dip from 40° to 70° S.

Contact metamorphism in the Willow Springs area produced minor recrystallization of the quartzite of the Goshute Canyon Formation and the Prospect

Mountain Quartzite, some recrystallization of the Abercrombie Formation at the contact with the stock and metamorphism of shale to hornfels.

Alaskite Intrusives. Three alaskite intrusives occur in the Spring Creek area where they are associated with mineralized areas: Trout Creek, Queen of Sheba and Johnson Canyon. They are similar in composition.

Of the three areas, only the alaskite at Trout Creek is exposed at the surface; the other two were found in underground workings of the Queen of Sheba mine and in the Bismark mine in the Johnson Canyon area.

Dike Rocks

Porphyry Dikes. Five quartz monzonite porphyry dikes in the Overland Canyon area (plate 3), striking northeasterly within the Gold Hill quartz monzonite, range from 400 to 1,800 feet in length and from 1 to 4 feet in width. Two occur in Hopkins Gulch, one in Barney Reevey Gulch and two outcrop between the two gulches.

The dikes are holocrystalline and porphyritic. Phenocrysts are 1 to 2 cm long. In hand specimen, the dike rocks are light brown to orange, fine-grained, soft and highly altered.

Rhyolite Dikes. Two rhyolite dikes between Barney Reevey Gulch and Hopkins Gulch in Overland Canyon (plate 3), striking nearly east-west, range from 2 to 30 feet wide and from 400 to 600 feet long.

The light gray rock is porphyritic with phenocrysts ranging in size from 0.05 to 0.1 inches in length in a very fine-grained groundmass.

Rhyolite dikes (called aplite dikes by Bick, 1966, p. 54, 55), common within the Ibapah stock and in the adjacent sediments on the north side, range from ½ inch to 1 foot wide. Two large dikes 50 to 100 feet wide, approximately ¼ mile apart, strike N. 20° E. and extend for 2 to 3 miles in quartzite and shale in the southeast part of the Willow Springs area.

Aplite Dikes. White to pink, granular aplite dikes, common in the quartz monzonite intrusive, are exposed in the area of Overland Canyon near the edges of the intrusive (plate 3). One dike is completely within the intrusive, three dikes are on the contact between the intrusive and sedimentary rock, and another is completely surrounded by limestone. The aplite dikes, diverse in their strike, are from 50 to 75 feet wide and from 500 to 800 feet long.

Andesite Dikes. Andesite dikes outcrop in the northeast part of the range in Blood Canyon, a southern branch of Overland Canyon (plate 3). The dark gray porphyritic outcrops reveal quartz and feldspar in hand specimen.

Basalt Dikes. Basalt dikes, none more than 300 feet long and too small to map, outcrop near the mouth of Hopkins Gulch and on the north side of Blood Canyon near Overland Canyon in the north Deep Creek Mountains. In the south end of the range, basalt dikes are exposed north of Granite Canyon, near Singleton Canyon and east of Lime Mountain.

The dark gray, porphyritic rock with obvious flow orientation of laths, is vesicular with some of the vesicles filled with carbonate.

The southern basalt dikes are dark brown to black, fine- to medium-grained.

Pegmatite Dikes. Pegmatite dikes intimately associated with the granite stock occur just north of Granite Canyon, in the south Deep Creek Mountains, in the Gold Hill Stock and in the southwest part of the Ibapah stock.

Extrusive Rocks

Ignimbrite Sequence. In the south part of the range in the Heavenly Hills area (plate 1), a sequence of welded tuff and vitrophyre comprise part of the middle member of the Salt Lake Formation. The welded tuff layers are of two generations with interbedded black vitrophyres. The uppermost welded tuff, red to pink, is a vitric-crystal tuff.

Andesite. A dark greenish gray porphyritic andesite flow, overlying the upper tuff of the ignimbrite sequence, covers the west side of the Heavenly Hills.

Rhyolite. A younger flow rock occurring above the andesite is a light gray, dense, fine-grained, porphyritic rhyolite.

Tuff. White and red tuffs occur in a 2,400-foot square area in the northeast part of the range just east of Blood Canyon Spring. The light gray to white tuff is the more abundant of the two types. The red tuff, although not found in outcrop, occurs in abundance within the white tuff weathered area.

Other Extrusive Rocks. Several varieties of latite and trachyte, discussed by Nolan (1935, p. 50-53), occur in the north part of the range.

Structure

In common with many of the mountain ranges within the Great Basin, the internal structure of the Deep Creek Mountains is extremely complex. In the course of mapping the Gold Hill quadrangle, which in the author's opinion includes the north end of the Deep Creek Mountains, Nolan (1935) made one of the most remarkable analyses of deformation structure ever attempted. He related the structural development of the Gold Hill area to five cycles and eight stages followed by the late normal faulting, which in concert with erosion, has determined the present configuration of the range. Most of the complex structural development, marked by transverse faults accompanied by or transformed into thrusts with associated complex folding, occurred prior to the intrusion of the Gold Hill stock (Late Eocene or Early Oligocene) and subsequent to a deposition of Triassic sediments which are conformable with the underlying Paleozoic beds. A Cretaceous and Eocene age is assigned to the development. Normal faulting was subsequent to the Gold Hill intrusion and has continued nearly to the present time.

Bick (1958, 1966), in mapping the remainder of the range south of the 40th parallel, provided a structural analysis and divided the structural modifications into six episodes, the earliest of which is not repeated in the Gold Hill area. He emphasized the significance of the more or less east-west transverse faults. The Ibapah granite stock, 8 miles wide, lies between two of these transverse faults which it presumably, for the most part, postdates. Nelson (1959, 1966) mapped the part of the Deep Creek Mountains south of the Ibapah stock as well as the Kern Mountains south of Pleasant Valley and the north end of the Snake Range. His interpretations differ slightly from those of Bick.

This writer examined structural features in the mineralized areas to determine what, if any, relationships exist between structure and mineralization. The most obvious conclusion is that the Deep Creek Mountains are divided by more or less east-west structures (plate 4) into the Gold Hill area north of the Blood Canyon fault, the narrow westward-tilted block 5 to 6 miles wide and 10 miles long between the Blood Canyon fault and the Ibapah stock 8 miles wide in a north-south direction, and the Trout Creek-Johnson Pass area 9 miles long in a north-south direction at the south end of the range. Each of these areas possesses unique structural features.

In considering the mineral deposits, this writer has designated that portion of the Gold Hill area between the Blood Canyon fault and the Clifton Flat, the southern Clifton block; the narrow tilted block

south of the Blood Canyon fault, the Willow Springs block; and the area south of the Ibapah stock, the Spring Creek block.

Southern Clifton Block

Sedimentary formations in the southern Clifton block strike northeast-northwest and dip 10° to 50° E. Six north-south trending anticlines occur north of Pony Express Canyon in the west part of the area.

Four normal faults north of Blood Canyon striking N. 25° to 70° E. terminate in the quartz monzonite intrusive. South of Ochre Mountain normal faults have a northerly strike and dip east and west. West of Montezuma Peak, normal faults are older than the intrusive and terminate at its contact.

Four lateral faults occur in this area (plate 4):

1. The Overland Canyon fault, a right lateral fault at the south boundary of the Gold Hill stock;
2. A right lateral southeast striking fault in the mouth of Hopkins Gulch;
3. Blood Canyon fault, a left lateral fault trending completely across the range, and
4. South Ochre Mountain fault, a right lateral fault trending from lower Pony Express Canyon to the east side of Clifton Flat.

Two thrust faults occur in Pony Express Canyon. The first, west of Clifton Flat, strikes north and terminates against the south Ochre Mountain fault. The second, the North Pass thrust fault, is exposed twice in Pony Express Canyon and once in the northwest corner of Clifton Flat.

Willow Springs Block

The Willow Springs block is tilted to the west 20° to 45° and is bordered on the east and west sides by normal faults.

The Deep Creek anticline, an asymmetric anticline along the east side of the range (plate 4), shows a nearly north-south axial strike. Beds on its west flank dip 20° to 46° W. and on its east flank dip about 10° to 25° E.

The north-south striking East Flank and West Flank normal faults occur along both sides of the range. Throw of these faults may be as much as 9,000 feet. The faults dip away from the range on both sides.

Other minor normal faults occur on both sides of the range with displacements to 2,000 feet.

A number of east-west striking, right and left lateral faults such as the North Pass fault, Sevy Canyon fault, Dry Canyon fault and Hardscrabble fault occur throughout the block. Displacement ranges from 600 to 2,000 feet.

Two areas of thrusting in the Willow Springs area are (plate 4):

1. Rocky Springs thrust, in the southwest part of the area, carrying Cambrian sediments over Silurian and Devonian strata, and
2. North Pass thrust, in the north end of the range.

Both thrusts showing east and southeast movement are separated and cut apart by younger lateral faults.

Spring Creek Block

Sedimentary formations in the Spring Creek block dip steeply to the west at angles ranging from 80° to 90°. Cutting these sediments on both the east and west sides are N. 5° E. striking normal faults that lifted this part of the range into its present position. The mountain block is terminated on the south end by the Pleasant Valley fault.

The Trout Creek Dome, an anticline just north of Trout Creek, probably was caused by the intrusion of the Trout Creek alaskite stock. At the south end of the range near the Pleasant Valley fault, several small anticlines of varying axial bearings near N. 60° W. occur in the vicinity of Lime Mountain and the Heavenly Hills. A broad anticline strikes N. 5° to 10° E. in Johnson Canyon and a large east-west striking overturned anticline, the Water Canyon anticline, occurs in the south part of Water Canyon.

The Gorgon Ridge syncline, a major overturned syncline, has a north-south axial strike along Gorgon Ridge in the center of the range. A broad syncline strikes N. 5° to 10° E. in Johnson Canyon and many minor synclines are associated with the anticlines in the Heavenly Hills and Lime Mountain.

Two normal fault trends, N. 70° to 80° W. and N. 5° to 10° E., occur in the Spring Creek block. The northwest faults are younger and offset the northeast faults.

A thrust fault on the east side of the range mapped by Nelson (1966, p. 944) carried rocks eastward over the range, leaving younger Cambrian rocks

on the east flanks. Several thrust faults occur on the west side of the range, one east of Johnson Canyon and the remainder west of the canyon. They are cut apart by northwest-striking normal faults.

Ibapah Stock

Six sets of joints confined to the Ibapah stock occur as three conjugate sets (Bick, 1966, p. 85-86):

<u>System I</u>	<u>System II</u>	<u>System III</u>
N. 20° E., 75° E. N. 20° E., 70° W.	N. 70° E., 65° N. N. 70° E., 70° S.	N. 40° W., 80° E. N. 40° W., 75° W.

These joints, entirely confined to the stock, are related to the emplacement or cooling of the stock rather than to later deformation.

Alteration

Inasmuch as widespread and intense alteration of country rock is commonly regarded as one of the more favorable indicators of possible hidden ore bodies, the writer gave special attention to this feature in his field examination of the Deep Creek Mountains. Nolan (1935, p. 91-97) described alteration in the Gold Hill area and Shatoury (1970) recently compiled a further study of the same area. The masses of intrusive rock especially were examined for possible areas of propylitic and argillic alteration which, according to Creasey (1966, p. 59-61) and others, accompanies the formation of disseminated copper deposits. In spite of the deep dissection and favorable exposure of these rocks, no significant occurrences of these types of alteration were found. Some altered igneous rocks show formation of sericite with accompanying quartz and pyrite and some chlorite, kaolinite and carbonate. Impure limestone adjacent to igneous contacts was variably replaced by silicate minerals and masses of jasperoid or dense chalcedonic silica is associated with fracture zones in limestone with no obvious relationship to intrusive rock. Variable hematitization, indicated by red color, occurred in some of the limestone, especially in Blood Canyon just south of Overland Canyon. Areas of altered rock associated with mineralization were mapped in Overland Canyon (plate 3), Monocco mine, Pony Express Canyon-Clifton Flat (plate 5), Dewey property, Trout Creek and the Queen of Sheba mine area. Samples from these areas were examined by means of petrographic examination and infrared and X-ray diffraction analyses and the results are given in the description of the individual mines.

Silicification

Silicified rocks in which the original rock, mainly limestone, is replaced by silica occur in several areas.

The masses of silicified rock, jasperoids or siliceous reefs stand out topographically as prominent ridge lines and knobs above the less resistant unaltered rock. All are related to faults and fractures where migrating silica replaced the surrounding limestone, dolomite or igneous rocks for distances of a few inches to several hundred feet from the fracture. Volcanic rocks in the hills just west of White Sage Flat are replaced in two large fault zones in which the fault breccia is both cemented and replaced by cryptocrystalline silica or chalcedony. This silicified zone is 1 to 5 feet in width and a half mile long. Small parts of latite in White Sage Flat are replaced in several areas by chalcedony.

Silica replacements of limestone or dolomite in the vicinity of fractures occurred in the north part of the range in the Ochre Mountain and Oquirrh formations and in the Laketown Dolomite, and large jasperoid areas were observed just north of the Yellow Hammer mine road in the northeast corner of Clifton Flat. These replacements guided by a northeast-trending fault have nearly obliterated the evidence of faulting.

A second area consisting of minor patches of silicification in the Ochre Mountain and Oquirrh formations occurs along the 2-mile east-west striking south Ochre Mountain fault zone in Pony Express Canyon (plate 5). These patches are probably fracture related.

A large east-west trending area of silicified limestone in Overland Canyon occurs along the Overland Canyon fault and its eastward extension.

In one area, silicified Ochre Mountain Formation limestone is capped by Manning Canyon Formation quartzites. Nolan (1935, p. 93) says that silicified limestones "... have, in general, the appearance of cemented siliceous breccias, owing to the presence of several generations of quartz." Quartz grains in the silicified quartz groundmass are sand grains in the original limestone.

Silicified rocks occur south of Pony Express Canyon and Clifton Flat in the Silurian Laketown Dolomite and in northeast-trending fault zones in Sevy and Cold Springs canyons. These zones are in a formation which prior to silicification had a high silica content as indicated by the abundance of chert nodules in the dolomite.

Sericitization

Sericitization is confined to igneous rocks, especially the Gold Hill and Ibapah stocks and south alaskite intrusives.

Sericite, pyrite and quartz are the principal minerals in this type alteration, with small amounts of kaolinite, chlorite and carbonate. These minerals occur as fine, highly birefringent aggregates near or within the feldspars, the mineral most commonly attacked. The pyrite in the altered rock oxidized near the surface and released sulfuric acid, which bleached the rocks white and stained them brown with limonite and jarosite. The formation of jarosite $[KFe_3(OH)_6(SO_4)_2]$ is doubtless correlated with the availability of potassium, iron and sulfate. Kaolinite, chlorite and carbonate probably were derived from the plagioclase (andesine).

Fracture zones tend to localize the areas of sericitic alteration. In the Monocco area, the quartz monzonite is highly altered to sericite along the N. 35° to 40° E. striking fractures and veins. Sericitic areas occur in Overland Canyon in the quartz monzonite along the Overland Canyon fault and its projected extension (plate 3). These areas, large near the fractures, become sparse with distance from the fault. The Queen of Sheba alaskite intrusive is highly altered in places to sericite in the lower workings of the mine where it is associated with the Martin vein.

Only small amounts of sericite occur in other intrusives in this area.

Silication

Silicate minerals were formed in the Ochre Mountain Formation limestone, Oquirrh Formation limestone and the Trout Creek Formation.

Two types of silication are illustrated in Overland Canyon. Wollastonite is the major mineral in the first, the second contains garnet and diopside. The wollastonite reaction, $CaCO_3 + SiO_2 = CaSiO_3 + CO_2$, was incomplete or did not reach equilibrium because of the presence of quartz and carbonate remnants in the rock. This phenomenon was observed near the Midas mine in the northeast part of the Overland Canyon area (plate 3).

The second silication type, alteration of impure limestone and dolomite to andradite and diopside with small amounts of calcite and scheelite, appears along the quartz monzonite-limestone contact in Barney Reevey Gulch and near the mouth of Overland Canyon (plate 3). In the Trout Creek area silication occurs in the contacts with alaskite intrusive (plate 6). Quartz, scheelite, siderite, limonite, sphalerite and other contact minerals were observed in the Trout Creek mine and in prospects around the southwest periphery of the intrusive.

ORE DEPOSITS

General Character and Classification of Deposits

Mines in the Deep Creek Mountains produced ores of gold, silver, lead, copper, zinc, arsenic, tungsten and mercury intermittently since the late 1800's. Most of the ore bodies are located in fractures as veins or as bedding replacements in limestone. Surficial alteration has occurred in nearly all deposits, but very little enrichment has taken place.

These metals occur in ore bodies of four genetic types described below: pegmatite dikes, hydrothermal veins, hydrothermal replacements and contact metasomatic deposits.

Pegmatite Dikes

An outer zone of graphic granite (quartz, feldspar and mica) surrounds an intermediate zone of orthoclase, muscovite and quartz. Quartz crystals have been the only mineral mined from the dikes. These are simple, roughly zoned pegmatite dikes occurring only in the granite of the Ibapah stock and in the metamorphic units of the Trout Creek series, with cores of vuggy gray and white quartz containing crystals of quartz and beryl.

Hydrothermal Veins

Most of the mineral deposits in the range are hydrothermal veins. All three of Lindgren's (1936) basic types of hydrothermal veins, hypothermal, mesothermal and epithermal, occur.

Hypothermal Veins. These occur in two areas, both closely related to intrusives—Overland Canyon and Trout Creek Canyon. Hypothermal arsenic-silver-lead-gold veins occur along quartz monzonite porphyry dikes in quartz monzonite in the Cyclone, Monte del Rey, Bonanza, Midnight and Fortuna mines in Overland Canyon. Ore minerals observed are arsenopyrite, chalcopyrite, aikenite, pyrite and sphalerite with quartz and limonite gangue.

Beryl-scheelite-quartz veins occur in the schist and dolomite of the Trout Creek Formation just north of the Trout Creek alaskite intrusive on the Apex Tungsten property.

Mesothermal Veins. These veins contain minerals characteristic of both hypothermal veins and epithermal veins. Mesothermal veins in the range occur in the sedimentary and metamorphic rocks and contain chalcopyrite, galena, sphalerite and tetrahedrite, with

quartz, limonite, hematite and calcite as gangue minerals. The veins are generally simple and regular in their strike and dip and show no accompanying brecciation.

Epithermal Veins. Minerals characteristic of epithermal veins occur at the Congar Hill mine. Cinnabar, metacinnabar and stibnite occur with barite, quartz, calcite and dolomite as the gangue minerals in a breccia of dolomite. The cinnabar is dispersed in barite as patches and blebs with stibnite centers. Walls of the brecciated veins are irregular with open spaces.

Bedding Replacement Bodies

Gold-silver-copper-lead replacement bodies of the mesothermal type occur in the Monocco area. These bodies are in selected beds of the Oquirrh Formation limestone adjacent to the mesothermal veins discussed above. Minerals found in replacement bodies are chrysocolla, copper pitch and malachite oxidized from the original chalcopyrite, and hematite. Gangue minerals are quartz, calcite and dolomite. These ore bodies are not large and Nolan (1935, p. 103) states that the ore is "rarely found more than 15 or 20 feet away from the mineralizing fracture . . ."

Replacement bodies near Granite Canyon occur in the Trout Creek Formation. Here quartz containing gold and silver replaces carbonate beds in schist.

Contact Metasomatic Deposits

Contact metasomatic deposits containing native gold associated with various sulfides occur in limestone on the contact between quartz monzonite and limestone. This limestone is recrystallized, replaced by quartz or highly silicated. Intensity of alteration can vary from area to area. Metallic minerals common in this type of deposit are native gold, pyrite, chalcopyrite, bornite, scheelite and magnetite. Gangue minerals are wollastonite, andradite, tremolite, diopside and quartz. Mineralization on the Midas and Gold Star properties is in contact metasomatic zones.

A second type of contact metasomatic deposit occurs at the contact between Trout Creek alaskite intrusive and dolomite of the Trout Creek Formation. Ore minerals are sphalerite and scheelite with a gangue of fluorite, quartz, limonite, actinolite, tremolite, pyro-lusite, muscovite and biotite.

Controls of Mineralization

Mineral deposits in the Deep Creek Mountains are related to fractures, stratigraphy and igneous rocks. Analysis of these features shows no consistent mineral control in the area.

Fracture Systems

Most mineral deposits occur in fractures of Cretaceous and Tertiary age. Nolan (1935, p. 55 to 63) and Bick (1966, p. 86-95) outline the structural history of the area.

Most fracturing in the range took place prior to the intrusion of the Ibadah and Gold Hill stocks. The later intrusion of the Trout Creek alaskite is postdated by the mineralized fractures in the Trout Creek area. Normal faults striking nearly north-south, and bounding the range on east and west are the youngest structural features.

Contacts between vein and country rock are generally sharp. Exceptions to this occur in replacement deposits in the Monocco and Gold Bond areas. The Queen of Sheba mine exhibited areas in the country rock where gold and silver pervade it along the Martin vein to form a protore.

Minor ore shoots were observed where younger fractures offset the Martin vein in the Queen of Sheba mine. Change of strike and dip in fractures in other areas, particularly at the Oro del Rey, tended to localize ore.

Mineral deposits in the range exhibit an affinity for a particular fracture direction. Figure 5 shows graphically the mineralized fracture directions in each structural block in the range and their relationships to all fractures in the area.

Stratigraphic Controls

Ore bodies occur in relatively few stratigraphic horizons ranging from Precambrian to Permian in age. Of the formations acting as host rocks for ore bodies, only three, Oquirrh, Abercrombie and Trout Creek, apparently controlled mineralization. In all other formations, veins are clean walled and mineralization is restricted to fracture filling.

Oquirrh Formation limestones have favorable horizons for replacement by copper and lead mineralization. Bedding replacement deposits associated with mesothermal veins in the Oquirrh Formation occur in the Monocco mine. The contact metasomatic deposits of the Midas mine also occur in these limestones. The Oquirrh Formation has been a favorable rock for mineralization in other districts and forms the host rock for Bingham Canyon's lead-zinc mines near Salt Lake City.

The Abercrombie Formation appears to have a horizon favorable to mineralization, a limestone bed 1,116 to 1,260 feet above the base of the formation.

In the Willow Springs, North Pass and Prosperity areas, fractures cutting the Abercrombie Formation are mineralized when they encounter this bed.

The Trout Creek Formation contains mineral-susceptible carbonate members near Trout Creek and Granite Canyon. Scheelite and sphalerite in contact metasomatic deposits and veins comprise mineralization in Trout Creek and Apex mines. Limestone beds have been replaced by silver and gold mineralization near Granite Canyon.

Igneous Relationships

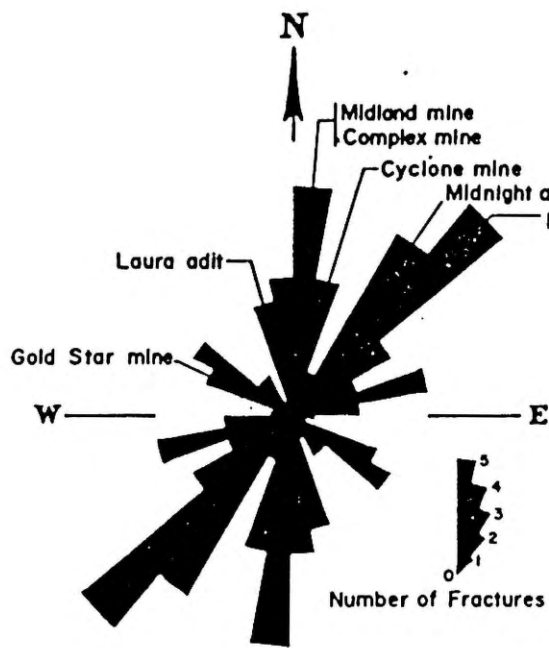
Most ore deposits in the Deep Creek Mountains are related to intrusive igneous rocks. Six intrusive bodies occur in the range (from north to south): Gold Hill quartz monzonite stock, rhyolite dikes, Ibadah granite stock, Trout Creek alaskite intrusive, Queen of Sheba alaskite intrusive and the Johnson Canyon alaskite intrusive.

Within the Gold Hill stock, several ore deposits occur in or adjacent to quartz monzonite porphyry dikes. Mineralization in these ore deposits is related to fluids from the porphyry magma. Those showing contact metasomatic action along the periphery of the quartz monzonite intrusive were caused by fluids directly attributable to or associated with the quartz monzonite stock.

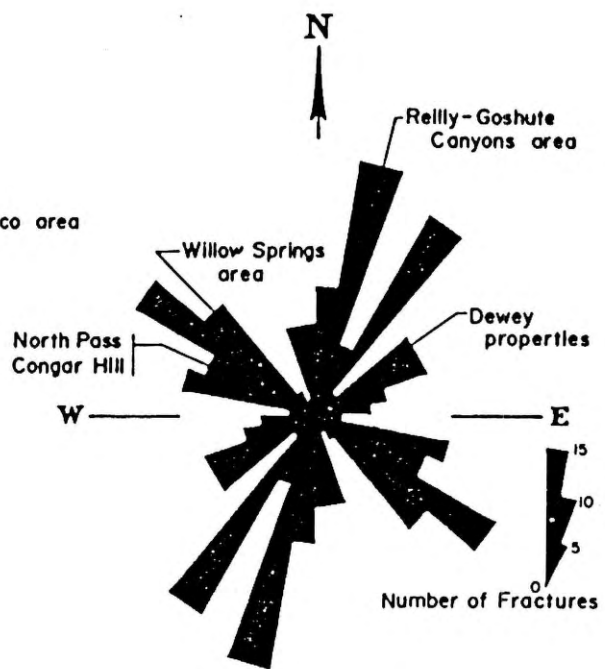
Relationships between mineralization and intrusives in mineralized areas not directly related to intrusives, such as the Dewey mine, North Pass mines, Willow Springs mines, Congar Hill mine and Reilly-Goshute canyons mines, are probably related to the Gold Hill stock.

Beryllium-bearing pegmatite dikes comprise the only mineralization in the Ibadah stock.

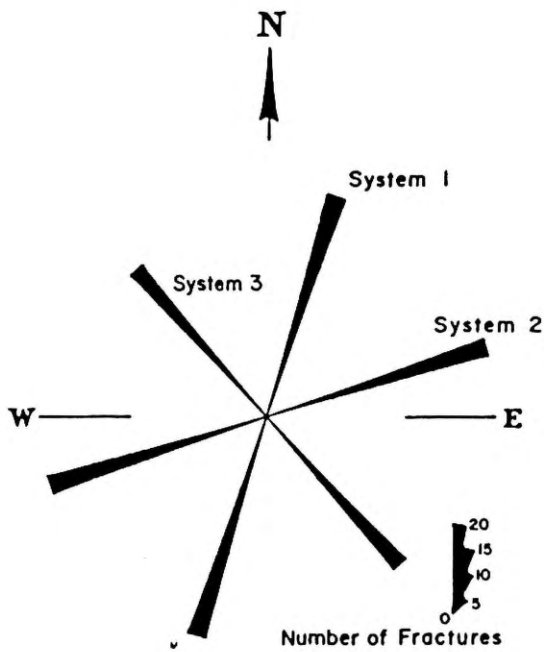
Mineral deposits occur at the peripheries of three alaskite intrusives in the south part of the range. Trout Creek area mineralization surrounds the Trout Creek alaskite and occurs as contact deposits and veins. The alaskite in the Johnson Canyon area does not outcrop and was found in workings of the Bismark mine. The intrusive at the Queen of Sheba mine area likewise does not outcrop, but the relationships between mineralization and intrusive were made in the Queen of Sheba mine. Here alaskite grades into pegmatite dikes which in turn become rich in quartz and lead to quartz veins. These quartz veins contain the gold mineralization. Nowhere was the silica enrichment traced directly from the alaskite to the quartz veins.



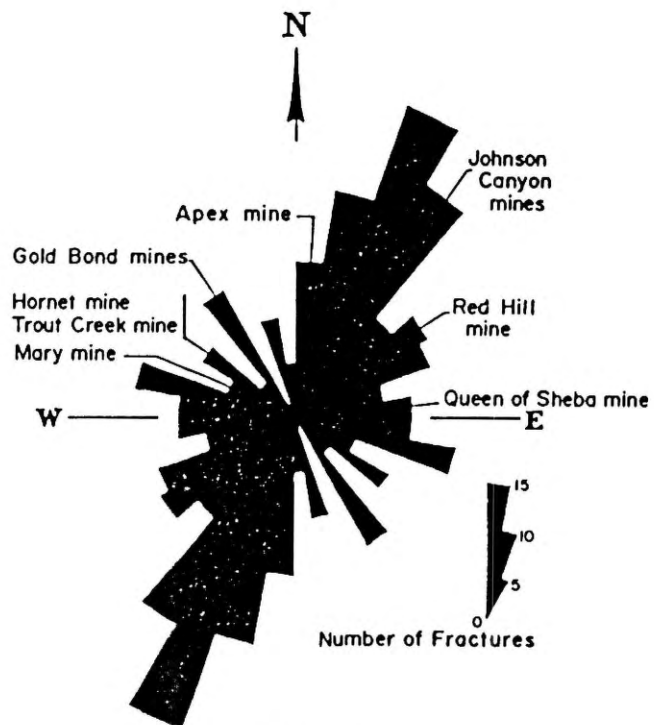
A. Southern Clifton area.



B. Willow Springs area.



C. Ibapah stock.



D. Spring Creek area.

Figure 5. Fracture roses for the southern Clifton, Willow Springs, Ibapah stock and Spring Creek areas showing relations of mineral deposits to fracture trends. The length of the wedge is proportional to the number of fractures.

Table 2. Age relationships of intrusives in the Deep Creek Mountains.

Rock Type	Age (10^6 years)	Reference
Quartz monzonite	499	Odekirk in Whelan (1969) lead-alpha
	471	Odekirk in Whelan (1969) lead-alpha
	40	Nolan (1953) stratigraphic relations
Granite	71	Armstrong (1963) lead-alpha
	22	Armstrong (1963) potassium-argon
Quartz-beryl-muscovite veins related to alaskite intrusive	17.7±0.9	Geochron Laboratories (Park, 1968)

quartz monzonite stock, where ore bodies were affiliated with quartz monzonite porphyry dikes. These associations were observed at the Midland incline shaft, Midnight adit, Cyclone mine, Bonanza mine, Monte del Rey mine and the Fortuna mine in Overland Canyon. Beryllium-bearing pegmatite dikes occur in the Ibapah stock.

The intrusive rocks apparently represent a part of an igneous rock series, becoming more siliceous with decrease in age (table 2 and figure 6).

The Kern Mountain granite, just south of Pleasant Valley, was included in the diagram to show its relationship to the series. It is probably younger than the quartz monzonite and the Ibapah granite.

In all areas investigated, where mineralization was found within an intrusive, it was directly associated with a post-intrusive porphyry dike. The only mineralization observed directly connected with granitoid intrusives is in areas of contact metamorphism. Dike-associated mineralization occurred in the Gold Hill

In large porphyry copper deposits, Stringham (1966, p. 39) found that:

1. Intrusives should not be more basic than andesite-diorite, although there seems to be a preference for quartz monzonite-quartz latite associations.
2. Intrusive porphyry is absolutely a necessary feature existing with or without associated granitoid types.
3. Passive intrusive emplacement is the most desired structural condition.
4. Where granitoid and porphyritic-textured intrusives coexist, the porphyry should be late in its development.
5. Sharp boundaries between granitoid and porphyritic types are more favorable, although some gradation is not entirely unfavorable.
6. Wall or country rock may be of all lithologic types, thicknesses and ages, except perhaps Pleistocene.
7. For disseminated deposits, intrusive or highly siliceous metamorphic and sedimentary rocks are the most favorable host rocks.

He also stated (1958, p. 821) that "... an intrusive aphanite porphyry of intermediate to acid composition with or without granite should be present in the district within a distance of 2 miles of the deposit if one expects to find a large mineralized body, at least for 86 percent of the localities." Porphyry intrusives with the above qualifications occur only in the Gold Hill area. They are small and most mineral deposits connected with them are small.

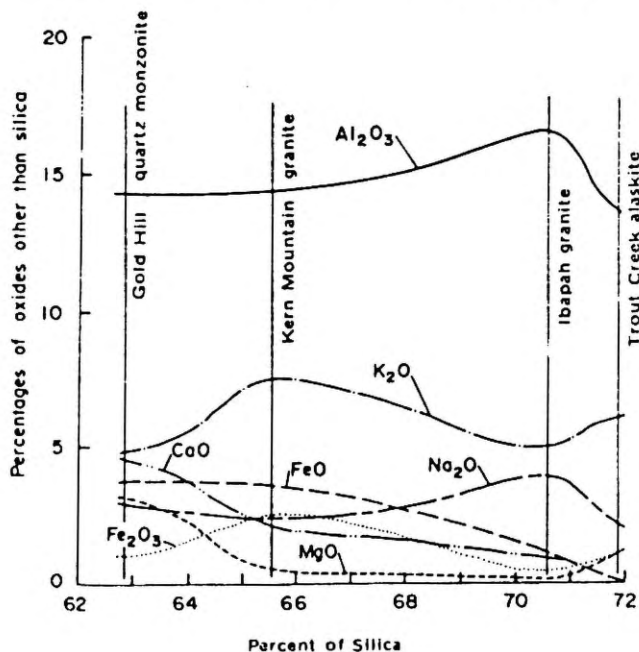


Figure 6. Silica-oxide variation diagram for the Gold Hill quartz monzonite, Kern Mountain granite, Ibapah granite and Trout Creek alaskite.

Extrusive Relationships

Although extrusive igneous rocks cover many areas throughout the range, mineralization occurs only in the Heavenly Hills where welded tuffs, rhyolites and andesites are in contact with Mississippian and Pennsylvanian limestones. Small iron oxide zones with little metallic mineral other than iron oxide and a little copper carbonate are developed.

Ore Body Zoning

Nolan (1935, p. 107-108) and Shatory (1967, p. 113-117) discussed the zonal arrangement of ore deposits in the Gold Hill area. Nolan based his zonal arrangement on temperature of deposition. He identified only one zone which had other lower temperature zones superposed on it, the result of recurrent fracturing and further deposition in a time zonal sequence. Shatory found zoning based on metal content in the Gold Hill area and extending into the Overland Canyon area.

Zoning throughout the range can be based on the hydrothermal vein type of deposition, with two zonal centers, the Gold Hill stock and the Trout Creek alaskite intrusive. Hypothermal veins and contact metasomatic deposits occur in and immediately surrounding these two intrusives. In the Gold Hill stock, lower temperature deposits are superposed on the hypothermal veins. Surrounding the hypothermal zone to the west and southwest are deposits of the mesothermal type. Included here are parts of the Overland Canyon properties, Monocco mines, Complex mine, Willow Springs mines, North Pass mines and the Reilly-Goshute canyons mines. West and southwest of this zone is the epithermal mercury-antimony-silver zone represented by mines in the Congar Hill and Dewey properties.

In the south part of the area, the Trout Creek alaskite is the center of the zonation. Contact zones and hypothermal veins surround the alaskite. These deposits, exhibited in the Trout Creek, Apex, Mary and Hornet mines, show tungsten, beryllium and zinc mineralization. Mesothermal veins containing gold-silver and lead-zinc-silver lie west and north of the alaskite intrusive at Granite Creek (Gold Bond property), Queen of Sheba property and Johnson Canyon. The Singleton mine, Water Canyon mine and the Heavenly Hills prospect pits could be epithermal deposits, but no diagnostic low-temperature minerals occur. The zoned nature of the area is shown in figure 7.

Alteration of Mineral Deposits

Alteration resulting from oxygen-charged surface waters acting on the sulfide minerals in ore bodies near

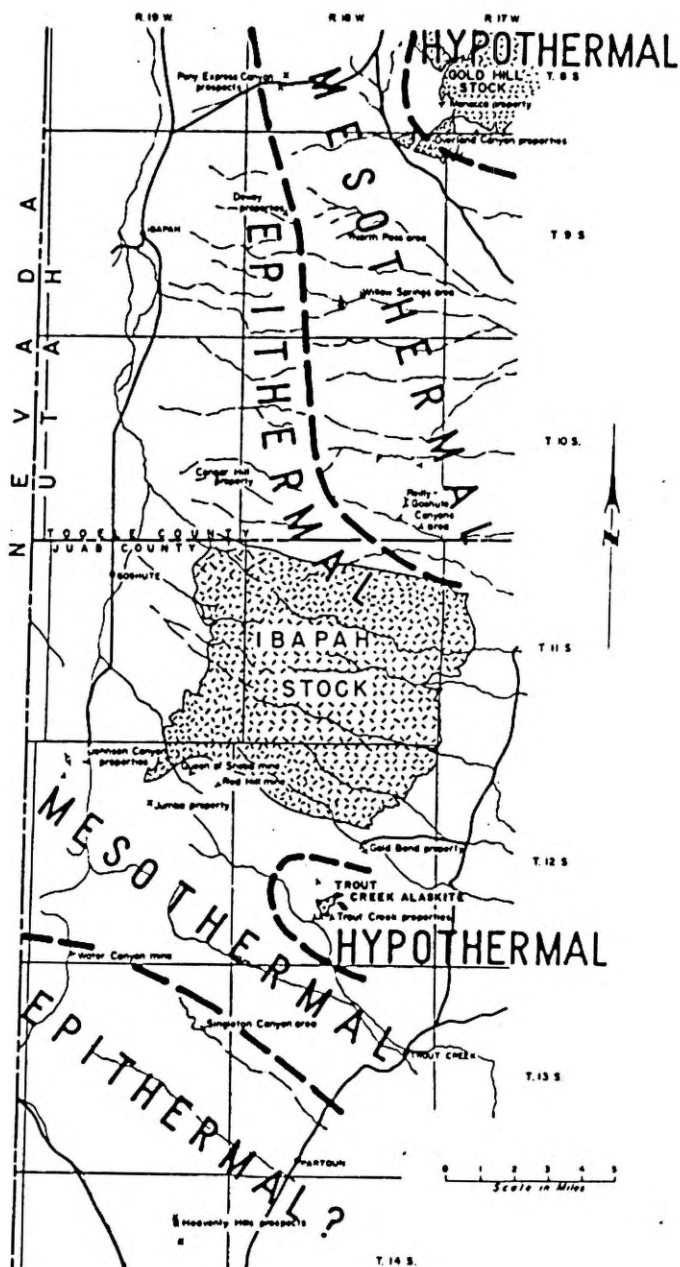


Figure 7. Hydrothermal mineral zones in the Deep Creek Mountains.

the surface is evident in many of the deposits in the range. This alteration may result from weathering only or from oxidation and leaching by meteoric waters. Each deposit type is discussed.

Alteration of Pegmatite Dikes

Alteration of pegmatite dikes results in the breakdown of plagioclase and orthoclase to form quartz, kaolinite, sericite and carbonate. Weathering

was the alteration agent in the pegmatite dikes. The contained feldspars are partially altered to sericite and kaolinite. Chlorite is the alteration product of biotite and muscovite.

Alteration of Hydrothermal Veins

Hypothermal Veins. Minerals in lead-silver-zinc-arsenic veins in the Overland Canyon area are oxidized to limonite, scorodite, jarosite and cerussite. Sulfides show little supergene enrichment. Nolan (1935, p. 105) reports that in the Cyclone mine "copper content of the unoxidized ore is low in this mine, ranging from 0.5 to 1.7 percent and is apparently balanced by a sufficient quantity of carbonate in the vein to prevent any downward transportation of copper. There is certainly no accumulation of secondary copper sulphides at the present water table in this mine." The tungsten-zinc-beryllium-quartz veins in the Trout Creek area show limonite and jarosite caused by oxidation of pyrite.

Mesothermal Veins. Limonite, jarosite, copper carbonates, conichalcite and cerussite were produced by oxidation of bornite, chalcopyrite, sphalerite, tetrahedrite, galena and pyrite in mesothermal veins in the range.

Epithermal Veins. Minerals in epithermal veins at Congar Hill were oxidized near the surface by weathering. Mercury minerals, cinnabar and metacinnabar, are unaltered. Stibnite is oxidized to valentinite, senarmonite and stibiconite. Small amounts of pyrite have been oxidized to limonite. Other epithermal deposits, particularly iron oxide zones associated with volcanic rocks, show only limonite with no sulfide minerals present.

Alteration of Bedding Replacement Deposits

Bedding replacement deposits occurring in limestone are almost completely oxidized. Fractures at the Monocco mine contain dark brown to black copper pitch with remnants of chalcopyrite and veins of malachite, azurite and chrysocolla. These oxidized materials spread into the limestone beds where they and limonite-hematite form the bulk of the mineralization. Lead ores formerly containing small amounts of galena are now composed of cerussite, anglesite, jarosite and plumbojarosite. In some parts of the Monocco area, plumbojarosite is the only lead mineral present. Some secondary chalcedony and opal occur, but rarely.

Limonite and some kaolinite and chalcantite were the alteration products in the gold-silver replacement zones on the Gold Bond property near Granite Creek.

Alteration of Contact Metasomatic Deposits

Contact metasomatic deposit minerals are only slightly altered. Pyrite oxidized to limonite occurs in some deposits.

Genesis of Original Ore Deposits

The ore deposits in the Deep Creek Mountains are closely related to intrusive rocks in the area. Nolan (1935, p. 108-109) discussed the genesis of the ore deposits in the Gold Hill quadrangle. He stated that contact metasomatic deposits were directly related to the Gold Hill quartz monzonite intrusion. This intrusion was followed by four periods of mineral deposition. The first took place during the final state of igneous activity and "...resulted in the formation of anhydrous silicate minerals with, locally, tungstates in the form of scheelite." The second stage was the formation of rock-forming elements, iron oxides and volatile constituents. The "...third period is marked by the appearance of quartz and the metallic sulphides." The final period is "...characterized by the almost complete absence of silicate minerals and metallic sulphides." Nolan further stated that "The abrupt changes in mineralogy shown by the deposits of the four periods appear to have been the result of a constantly decreasing temperature, by which new mineral groups become the stable phase in place of the older minerals that they replaced." The chief modifying factor in the progress of mineral deposit formation was recurrent fracturing. This provided new "plumbing" and tended to cause abandonment of old fractures. Hence, there are many small deposits and no large single deposits.

The above four stages of mineralization are post-quartz monzonite porphyry intrusion and may be related to such dikes within the quartz monzonite Gold Hill stock. These fluids initially formed hypothermal deposits of the above four generations. As the fluids migrated out from the stock in the Willow Springs area, they cooled and formed the mesothermal deposits. Numerous fractures in this part of the range provided pathways for the fluids. Still later, and farther from the source, these fluids probably left the epithermal deposits of the Congar Hill and Dewey properties.

The intrusion of the Ibapah granitic stock, later than most fracturing and later than the formation of the Gold Hill stock, was accompanied by little contact metasomatism. Pneumatolytic activity or metamorphic differentiation formed beryllium-bearing pegmatite dikes in the southwest part of the stock.

Three alaskite intrusives, formed later than the Ibapah stock, cut metamorphic rocks of the Trout Creek series, the Johnson Pass sequence and lower Paleozoic rocks in the south part of the range. It is not known whether these represent one or more intrusions. In the Trout Creek area contact metasomatic zones surround the alaskite. Fluids emanating from the alaskite formed hypothermal veins which fill post-alaskite fractures in the schist and dolomite. As the fluids migrated away from the alaskite area, they cooled and formed mesothermal deposits in the Gold Bond area.

Veins in the Johnson Pass sequence at the Queen of Sheba mine appear to be the result of a differentiation series. Pegmatites can be traced from the alaskite and quartz veins can be followed from the pegmatite dikes. They apparently form a complete series. Gold accompanies the quartz and pervades the quartzite country rock. Spurr (1906, p. 122) described a similar situation in Crystal Peak, Nevada, which he ascribed to a similar differentiation sequence.

Small mineral occurrences at Water Canyon, Singleton Canyon and Heavenly Hills are probably the result of late appearing fluids and are considered by the author to be epithermal because of the preponderance of vugs, breccia, carbonate minerals and very narrowly confined alteration zones.

Supergene weathering processes influenced all deposits and altered their hypogene character; little supergene enrichment occurred.

Summary, Practical Applications and Future of the Area

Ore deposits in the Deep Creek Range are related to fractures and intrusive bodies. Some control was affected by lithologic units.

Most ore deposits occur as quartz vein fillings in fractures. These fractures in the Willow Springs, southern Clifton and Trout Creek areas formed prior to the Gold Hill, Ibapah and alaskite intrusions. The Trout Creek fractures formed earlier than or contemporary with the Trout Creek intrusion, but later than the Gold Hill or Ibapah stock. Mineralization had little preference for any particular fracture direction, least of all those directions as described by Stokes (1968), statistically most favorable to mineralization in the eastern Great Basin. Most of the veins are clean walled; the host rock generally had little to do with localization of mineral deposits in most areas. The Oquirrh, Abercrombie and some members of the Trout Creek formations are favorable to replacement and mineralization.

It appears that most of the mineralization in the range is related to Gold Hill stock and alaskite intru-

sives. Probably only pegmatitic mineralization can be directly related to the Ibapah granite. Intrusives in the range form part of an igneous rock series characterized by increasing silica content with decreasing age. Mineralization appears to have occurred both early and late in two stages, first associated with the quartz monzonite intrusion and last with the alaskite intrusion. The quartz monzonite-connected mineralization in the Gold Hill stock occurs in quartz monzonite porphyry dikes within the stock. No mineralized porphyry dikes were found within the Ibapah stock although there are some small barren porphyry dikes within the stock. The alaskite stock mineralization occurs in veins adjacent to the stock and in contact metasomatic deposits at its periphery.

Very little mineralization was associated with or is attributable to the influence of extrusive rocks.

Statistically unfavorable fracture directions, few favorable stratigraphic horizons and the paucity of porphyry intrusives make the area an unfavorable environment for large ore bodies. Even so, each of the three Deep Creek Mountain mining areas has produced mineral values, and five areas are potential mineral producers.

In Overland Canyon in the southern Clifton mining area, geophysical (magnetic), geochemical and geological data indicate a potential mineral deposit. This area lies near Barney Reevey Gulch not far from the Cyclone mine, a former gold, silver, lead and zinc producing mine. Drilling in this area should determine the extent of mineralization.

In the Willow Springs mining area, Reilly-Goshute canyons and Congar Hill areas are potential mineral producers. Cinnabar remains in the upper workings of the Congar Hill mine. Further delineation of the deposit by use of the mercury halo method of geochemical prospecting might determine its extent and potential value. The Goshute-Reilly canyons area, with a mineral-related fracture system extending for about 3½ miles, has the greatest potential in the area. Samples taken along the known area of mineralization range in value from a trace of gold and silver to 4.5 ounces of gold and 30 ounces of silver per ton. Systematic sampling of the fractures (N. 5° to 10° E. system) is needed to determine the extent of mineralization and minable areas.

Of the seven areas in the Spring Creek mining area, the Trout Creek and the Queen of Sheba areas stand out as potential mineral producers. Trout Creek, a former tungsten-producing area, still contains areas with scheelite exposed.

Pegmatitic beryl in the Apex area requires delineation through further drilling and geochemical sampling.

Early in the 1900's, the Queen of Sheba mine produced several thousand ounces of gold. The workings are now caved and inaccessible but could be reopened with little difficulty. Reconnaissance geochemical sampling across the veins shows concentrations of gold and silver. Further detailed grid sampling could show the potential of this area.

MINES AND PROSPECTS

Southern Clifton Area

Monocco Property

The Monocco property lies 5½ miles south of Gold Hill and 10 miles northeast of Ibapah on the west slope of Montezuma Peak. It can be reached from the southeast side of Clifton Flat on a dirt road which winds its way east up the slopes of the Clifton Hills (plate 1).

Twelve claims comprise the Monocco property (figure 8). Dandy, Pad No. 1, Monocco No. 2 and Julian, patent No. 6998, were patented in 1928, and Silver King, Hercules and Lion, patent No. 7002, in 1929. The Sheba, Fortune, Jemine and Centuary claimed about 1929 were not patented. The Monocco mineral lot No. 58 was patented prior to 1917. These patents and claims, issued to the Monocco Mining Co. and A. J. Young, are owned by Floyd Myers of Gold Hill, Utah.

Two types of ore deposits occur on the Monocco property—veins and bedding replacement deposits. The veins, striking N. 45° E. and dipping 60° to 90° NW or SE, range from 1 to 6 feet wide and are exposed along distances of 100 to 1,200 feet (figure 9). These veins contain quartz, limonite and small amounts of chalcopyrite, galena, plumbojarosite and chrysocolla. Samples of these veins assay as follows:

Location	Width of vein (feet)	Ounces/ton		Percent	
		Gold	Silver	Copper	Lead
Vein north of Monocco incline	1.0	0.01	0.80	0.40	2.50
Incline 600 feet east of Monocco mine	grab	trace	3.0	3.90	Not reported
Monocco mine sample 8	1.5	0.02	4.6	2.0	0.70

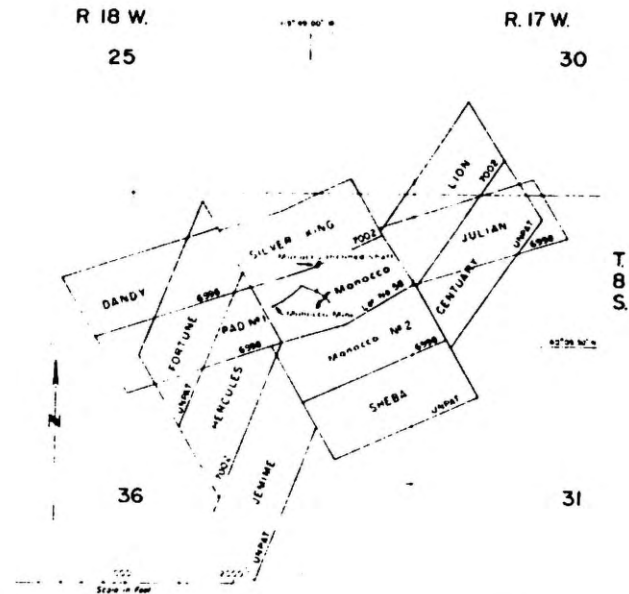


Figure 8. Claim map, Monocco property, southern Clifton area.

The country rock, dark to light gray limestone of the Oquirrh Formation, was bleached white to light cream in an irregular pattern as a result of baking by an underlying intrusive quartz monzonite. The original feldspars in the quartz monzonite were hydrothermally altered to sericite and kaolinite, and the biotite to chlorite.

Bedding replacement bodies in limestone associated with quartz veins contain limonite, hematite, malachite, azurite, copper pitch and chrysocolla.

Development consists of the Monocco mine, the Monocco inclined shaft, several small adits and a number of prospect pits. The mine follows a quartz vein for about 300 feet, then cuts across several other stope veins. The stopes in the mine are on bedding replacements. Assay results are shown in figure 10. The Monocco inclined shaft opened a bedding replacement zone 40 feet wide and 0.5 to 1 foot thick which dips 15° NE, then followed it for 175 feet. Several stopes developed in the zone west of the incline are shown in figure 11. East of the incline a small adit was driven along a vein for about 60 feet. About 200 feet south of this adit, a 15° to 28° inclined adit follows another vein for about 195 feet. Thirteen prospect pits and seven shafts from 20 to 25 feet deep, all on veins, are scattered around the property (figure 9).

APPENDIX II

Published Evaluation of the Evelyn Mine Area.

From Thomson, 1973

Table 3. Workings in the Willow Springs area.

Location No. (Figure 24)	Name	Type of opening	Length or depth (feet)	Figure No.	Country rock	Status
1	Roy mine	adit		10	Abercrombie Fm.	open
		incline		10	Abercrombie Fm.	open
2		adit		11	Abercrombie Fm.	open
		shaft	6	11	Abercrombie Fm.	open
3		adit		12	Abercrombie Fm.	open
4		adit	120	13	Abercrombie Fm.	open
5		incline	33		Abercrombie Fm.	open
6		adit	unknown		Abercrombie Fm.	closed
7		adit	50	14	Abercrombie Fm.	open
8		incline	30		Abercrombie Fm.	open
9		adit	15		Busby Quartzite	open
10		adit	unknown		Busby Quartzite	closed
11		adit	unknown		Pioche Shale	closed
12		adit	unknown		Pioche Shale	closed
13		adit	unknown		Pioche Shale	closed
14		shaft	10		Prospect Mtn.	open

58° northwest to a depth of 112 feet. Here a drift extends southwest for 40 feet, intersecting four fractures, the first of which contains sulfides. The drift continues southwest as a winze in barren limestone for another 30 feet (figure 25). At a 40-foot depth, the inclined shaft of the Roy mine is intersected by a 110-foot access adit driven from the south.

About 600 feet north northeast of the Roy mine and on the Roy No. 1 claim is a 10-foot shaft and a 30-foot prospect adit on an iron oxide-stained fracture (figures 24 and 26a). North of the shaft by 150 feet is an 80-foot adit which bears roughly south following an iron oxide-stained fracture (figures 24 and 26b). In the northwest corner of the Roy No. 3 claim 1,600 feet north northeast of the Roy mine is a 140-foot adit driven N. 30° E. on a series of limonite-stained fractures (figures 24 and 26c). About 600 feet east of this adit on the Roy No. 5 claim is a 33-foot inclined shaft also sunk on an iron-stained fracture zone. An adit, 1,200 feet east of the shaft, was driven N. 5° W. along an iron oxide-stained fracture zone for 45 feet (figures 24 and 26d). On the north side of Dry Canyon on the southeast side of the Sleuth lode mineral lot, a 30-foot inclined shaft to the west follows an iron oxide-stained limestone bed (figure 24). On the south side of the canyon, 1,500 feet southeast of the 30-foot inclined shaft is a 15-foot adit driven south along an iron oxide-stained fracture in Busby Quartzite (figure 24). On the east side of the area, in the mouth of Dry Canyon on its south side, is a 10-foot shaft sunk on an

iron oxide-stained fracture in Prospect Mountain quartzite (figure 24).

Mineral deposits are localized in younger fractures between 1,116 and 1,260 feet above the base of the Cambrian Abercrombie Formation. Fractures striking N. 40° to 50° E. cut the formation with minor displacement. Some iron staining occurs in fractures of N. 50° E. to N. 10° W. strike in the Busby and Prospect Mountain quartzites. Oxidized lead, copper and iron minerals occur near the surface. On the second level of the Roy mine, a 2-foot oxidized vein sample (figure 25) carries 36 ounces of silver per ton. On the third level, galena and tetrahedrite in a 3-inch vein carry 44.4 ounces of silver per ton.

Nolan (1935, p. 169) reports that an 8-ton shipment from the claims in 1917 contained 18 ounces of silver per ton and 37 percent lead. Small ore shipments have been made since then but no production records are available.

Reilly-Goshute Canyons Area

The Devils Pit-Oro del Rey-Eagles Nest, Lower Goshute Canyon area, Prosperity claim and the Silver Queen claims (plate 1) are on the east side of the Deep Creek Mountains between Reilly and Goshute canyons. Access is by means of a rough road leading 6 to 8 miles west from Callao into the Silver Queen and Lower Goshute Canyon workings. Continuing up Goshute

Canyon to Devils Pit-Oro del Rey-Eagles Nest area, the road is steep and difficult to traverse. The Prosperity claim is accessible only on foot or horse back from the Oro del Rey area.

The east wall of the Deep Creek Mountain block between Reilly and Goshute canyons is a line of precipitous quartzite cliffs cut by the steep-walled, easterly trending Goshute and Reilly canyons. These cliffs are capped by shale which forms a rounded upland area. The Devils Pit-Oro del Rey-Eagles Nest group lies in quartzite along the tops of these cliffs between the north wall of Goshute Canyon and the south wall of Reilly Canyon. The Prosperity property, stratigraphically higher and in the rounded upland area on the south side of Reilly Canyon, is about 8,000 feet west of the north end of the Devils Pit-Oro del Rey-Eagles Nest property. The Lower Goshute Canyon property is located in the quartzite cliffs 300 feet above the canyon floor on the north side of Goshute Canyon, a half mile from the mouth of the canyon. The Silver Queen property is in the Goshute Canyon Formation, 7,000 feet east of the Oro del Rey area (plate 7).

One patented and approximately 54 unpatented lode claims covering most of the Devils Pit-Oro del Rey-Eagles Nest area are owned by Alma Tripp of Salt Lake City, who maintains the annual assessment work. The Silver Queen claims are owned by the original claimant, Eugene Timms, Callao. The Prosperity claims, last staked by F. Wilson, S. R. Wilson and C. H. Wilson in 1940, have not been maintained and their present ownership is unknown.

Country rock consists of Precambrian to Cambrian quartzite, shale and limestone. Bick (1966, p. 103-105) measured the following formation thicknesses in Goshute Canyon:

Series	Formation	Feet
Cambrian	Abercrombie Fm.	1,765
	Busby Quartzite	412
	Pioche Shale	360
	Prospect Mountain Quartzite	2,950
Precambrian and/or Cambrian	Goshute Canyon Fm.	2,706

The mineral deposits occur in the Goshute Canyon Formation members A and C, the Prospect Mountain quartzite and the Abercrombie Formation (figure 27). These formations dip westerly and are cut by northerly and by westerly to northwesterly trending normal faults. A N. 10° to 15° E. striking system of discontinuous bifurcating fractures, healed erratically by gold-bearing quartz, acts as mineralization control

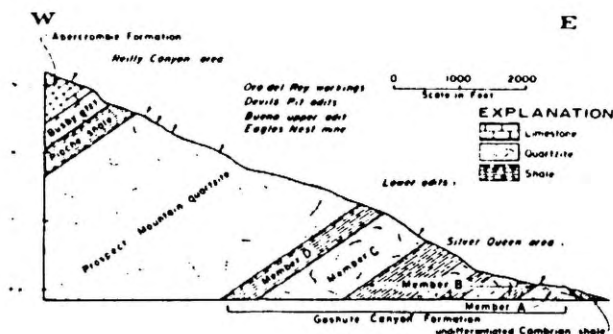


Figure 27. Diagrammatic geologic section showing stratigraphic relations of mine workings in the Reilly-Goshute canyons area.

in the Oro del Rey area (plate 7). Younger nonmineralized fractures striking about N. 65° to 70° W. offset the mineralized fracture system.

Granite and rhyolite are the only igneous rocks. The Ibapah granite stock outcrops about 1 mile south of the Devils Pit-Oro del Rey-Eagles Nest area (plate 7). A half mile west of the Oro del Rey property, two rhyolite dikes, 50 to 100 feet wide and ½ to ¾ mile long, strike N. 10° to 15° E. from the granite.

Prosperity Property. C. H. Wilson, W. F. Wilson and F. L. Wilson located the property about 1895 and worked it until 1914. No records of dates or quantities of ore shipments are available (S. R. Wilson, personal communication).

Malachite, azurite and copper pitch associated with calcite, aragonite and quartz occur in N. 5° to 10° E. striking fractures in the Abercrombie Formation. Assays are shown on top of page 38

The fractures bifurcate and are cut by younger N. 45° E. to west-east fractures. Caverns and cave formations have been developed along nonmineralized sections of the fractures.

Workings consist of several prospects, a winze and two adits. The upper "101" adit is 97 feet long. It follows veins on two levels, the "50" and "70" which are connected by winzes. The lower "102" adit is 240 feet long (figure 28).

Devils Pit-Oro del Rey-Eagles Nest Area. This property consists of the Eagles Nest mines on the north, on top of the cliffs and overlooking Reilly Canyon, the Devils Pit mines on the south in a steep side canyon north of Goshute Canyon, and the Oro del Rey mines just south of the center. The mines are all

Number	Location	Width (inches)	Ounces/ton		Percent		
			Gold	Silver	Copper	Lead	Zinc
1	Vein in upper adit	4	trace	3.8	11.6	10.0	0
2	Ore dump sample	—	trace	trace	11.5	15.8	0
3	Screened ore pile	—	trace	0.8	8.5	16.8	0.3

on an 8,000-foot long fracture system in the tops of the Prospect Mountain Quartzite cliffs. Samples 2, 3 and 5, tabulated in plate 7, taken from the same vein, illustrate its erratic mineral content. The veins split vertically and horizontally.

Examination of polished sections indicate that the vein minerals were emplaced during two depositional periods. Silicification accompanied by minute inclusions of specularite was followed by a reopening of the vein system. This was accompanied by a second period of quartz deposition with attendant pyrite and galena, disseminated chalcopryrite, specularite, chalcocite, sphalerite, and sparse grains of metallic gold. Silver was not recognized by assay and might be present in the galena. Plumbojarosite, kaolinite, limonite, goethite, malachite and azurite are present as secondary minerals. Assays are shown in plate 7.

Workings on the Eagles Nest property from north to south consist of a shallow prospect pit, the Eagles Nest inclined shaft, a water-filled shaft, a prospect trench and a small westerly trending adit. The 110-foot Eagles Nest inclined shaft bears west and dips from 35° to 50° W. Stopes extend from it along the vein 20 to 40 feet both north and south (figure 29). An abandoned aerial tram once carried ore from an ore bin at the north end of the property to a second ore bin in the bottom of Reilly Canyon 1,000 feet lower. A road leading up Reilly Canyon reached the lower ore bin.

The Oro del Rey mine was developed from adits driven into cliff faces at an elevation of 8,700 feet. Eight adits and one shaft develop the Oro del Rey mine for 1,200 feet horizontally and 300 feet vertically. These are the largest underground workings in the area (figures 30, 31 and 32). Ore, lifted by three aerial trams, was transported down a switchback road to Goshute Canyon and thence out to the range front.

The Devils Pit mine, on a southward extension of the Oro del Rey veins, lies at the head of Hells Hole, a nearly inaccessible steep-walled canyon just south of the Oro del Rey property. Workings at an altitude of

about 8,000 feet consist of a 120-foot adit, and 55 feet above it a 60-foot adit; a shaft was sunk at the mouth of the 120-foot adit (figure 33). Ore lifted by an aerial tram was hauled out through Goshute Canyon. Four hundred feet southwest of the Devils Pit is the 20-foot deep Imp No. 1 shaft. Imp No. 2, a small adit bearing N. 5° to 10° E., is 1,200 feet south southwest of Imp No. 1. The 150-foot Bueno mine, 2,400 feet south of the Devils Pit, bears N. 5° W. on the north side of the bottom of Goshute Canyon on the same vein as the Devils Pit (figure 34), but 1,000 feet lower in altitude. A 20-foot prospect adit bears due south on the south side of the canyon.

Lower Goshute Canyon Property. Three N. 5° W. bearing adits, the lower 80 feet long, the middle 90 feet long, and the upper 10 feet long, were driven into the quartzite cliffs 300 feet above the canyon floor in lower Goshute Canyon and 5,000 feet southeast of the Oro del Rey mine (figure 35). The adits follow a quartz vein in the C member of the Goshute Canyon Formation.

Silver Queen Property. The Silver Queen property, about 7,000 feet east of the Devils Pit, lies in the foothills north of Goshute Canyon. It is developed by a 34-foot adit, a 50-foot inclined adit and three prospect shafts 15, 10 and 17 feet deep. Several smaller prospect pits are scattered throughout the area (figure 36). Limonite and jarosite stain the quartzite yellow to black on or near the contact between A and B members of the Goshute Canyon Formation. Chalcopryrite, argentiferous galena and pyrite occur with secondary malachite, azurite, limonite and jarosite in a quartz gangue in prospect pits along the contact. The following shows representative assays:

Sample No.	Width (feet)	Ounces/ton		Percent		
		Gold	Silver	Copper	Lead	
12	North adit	1.0	0.06	12.6	1.10	—
30	North adit	1.5	trace	22.0	0.80	—
95	Dump sample	—	trace	2.0	0	0

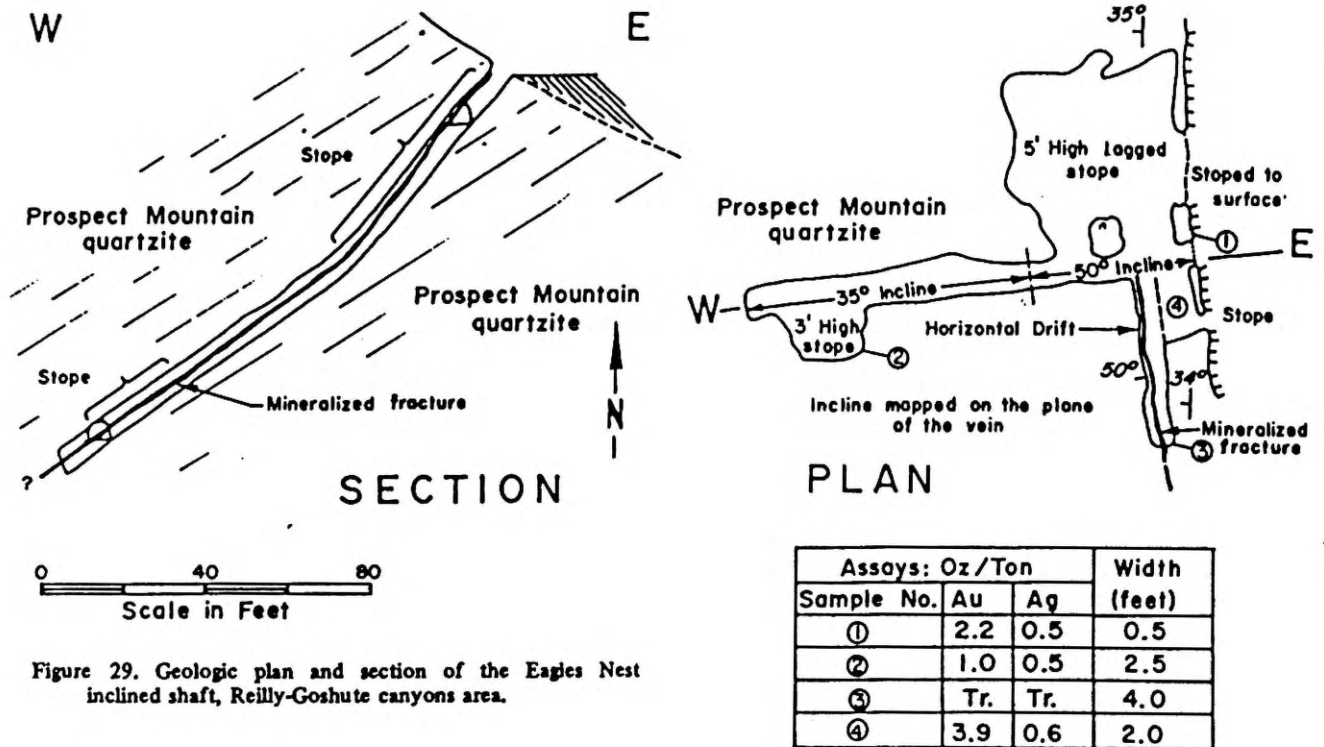


Figure 29. Geologic plan and section of the Eagles Nest inclined shaft, Reilly-Goshute canyons area.

Production. Most of the \$699,605 produced in the Willow Springs district from 1934 to 1954 came from the mines in the Reilly-Goshute Canyons area. No production has been reported since.

Spring Creek Area

Gold Bond Property

The Gold Bond property in sec. 5, T. 12 S., R. 18 W. (plate 1) lies on the east side of the Deep Creek Mountains in the mouth of Granite Canyon. Graded roads leading 18 miles south from Callao or 4 miles from Trout Creek provide access.

The property consists of ten unpatented claims (Gold Bond Nos. 1-10), staked in 1931 by S. F. Falkenburg. The claims form a solid block extending 3,000 feet along the bed of the canyon and 3,600 feet along the south wall of the canyon and the east flank of the range (figure 37). Although surveyed for patent, action was never completed. Falkenburg maintained the assessment work until his death in 1967. The property belongs to Falkenburg's estate.

The Gold Bond claims lie on the Trout Creek Formation, a dark brown series of fine-grained quartzite and interbedded biotite-sericite schist and limestone as described in the Geology section. Units C and D

(figure 37) of this formation strike N. 10° to 15° W. and dip west 20° to 38°. On the north wall of the canyon about a half mile north of the claims, Ibapah granite stock intrudes the Trout Creek Formation. Near the granite, iron-stained pegmatite dikes occur in the quartzites and schists of unit C.

Two types of mineralization occur—gold-bearing quartz veins cutting the schist, and gold-silver-bearing limonite replacements of limestone. The quartz veins, 2 to 3 feet wide, irregular and difficult to follow, are mineralized with malachite, azurite, limonite and pyrolusite.

Six adits, one shaft, one inclined shaft and several prospect pits comprise the development of the Gold Bond claims:

A 180-foot, 20° inclined shaft (figure 38) sunk to the west on a replacement zone.

A 1,185-foot adit (figure 39d) driven under the 180-foot inclined shaft, with a raise at the face, collapsed and inaccessible, cut to intersect replacement zones 96 feet above.

A 50-foot adit (figure 39b) driven northward into a replacement zone 700 feet northeast of the Gold Bond incline.

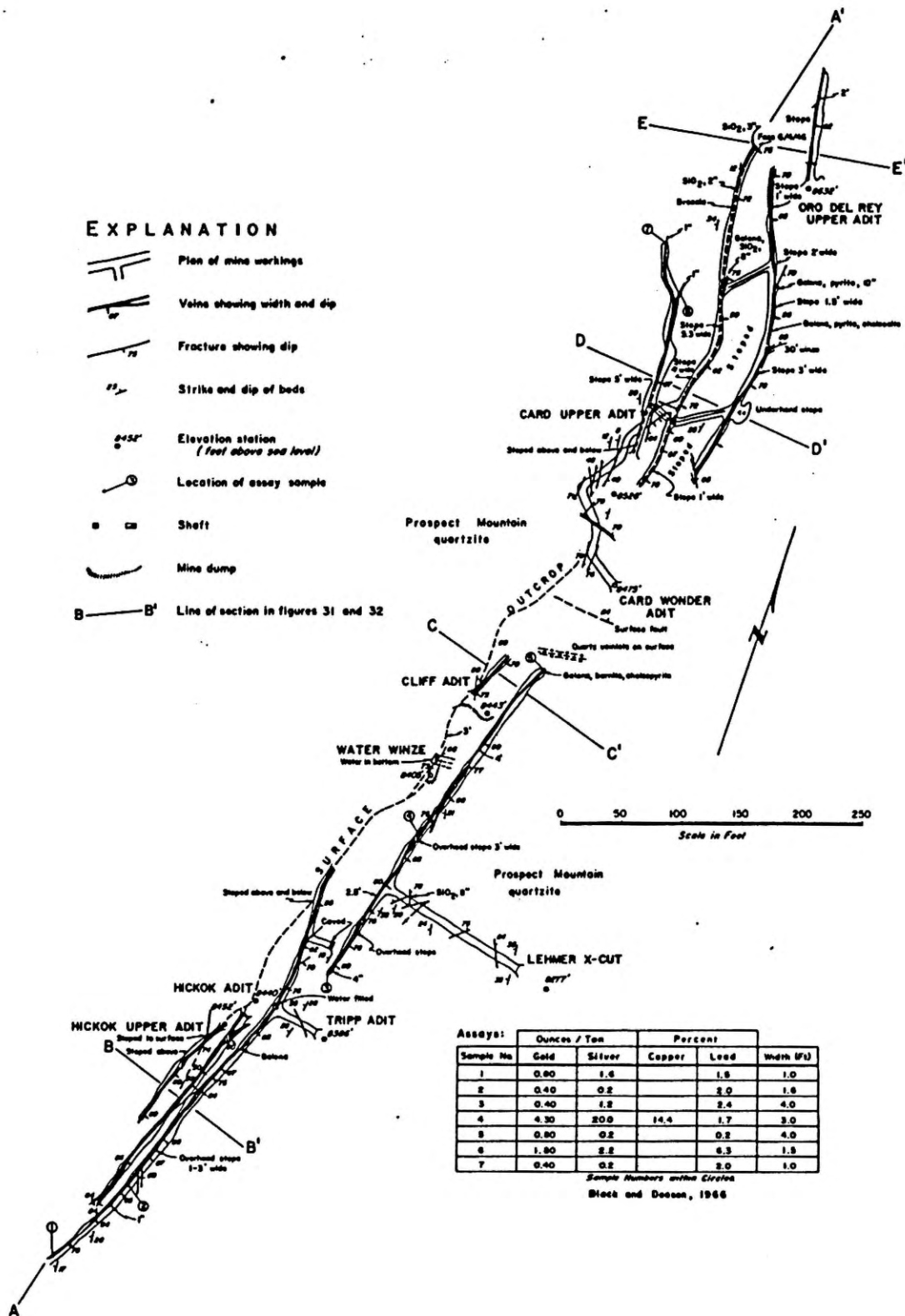


Figure 30. Geologic map and sample data of the Oro del Rey mine, Reilly-Goshute canyons area.

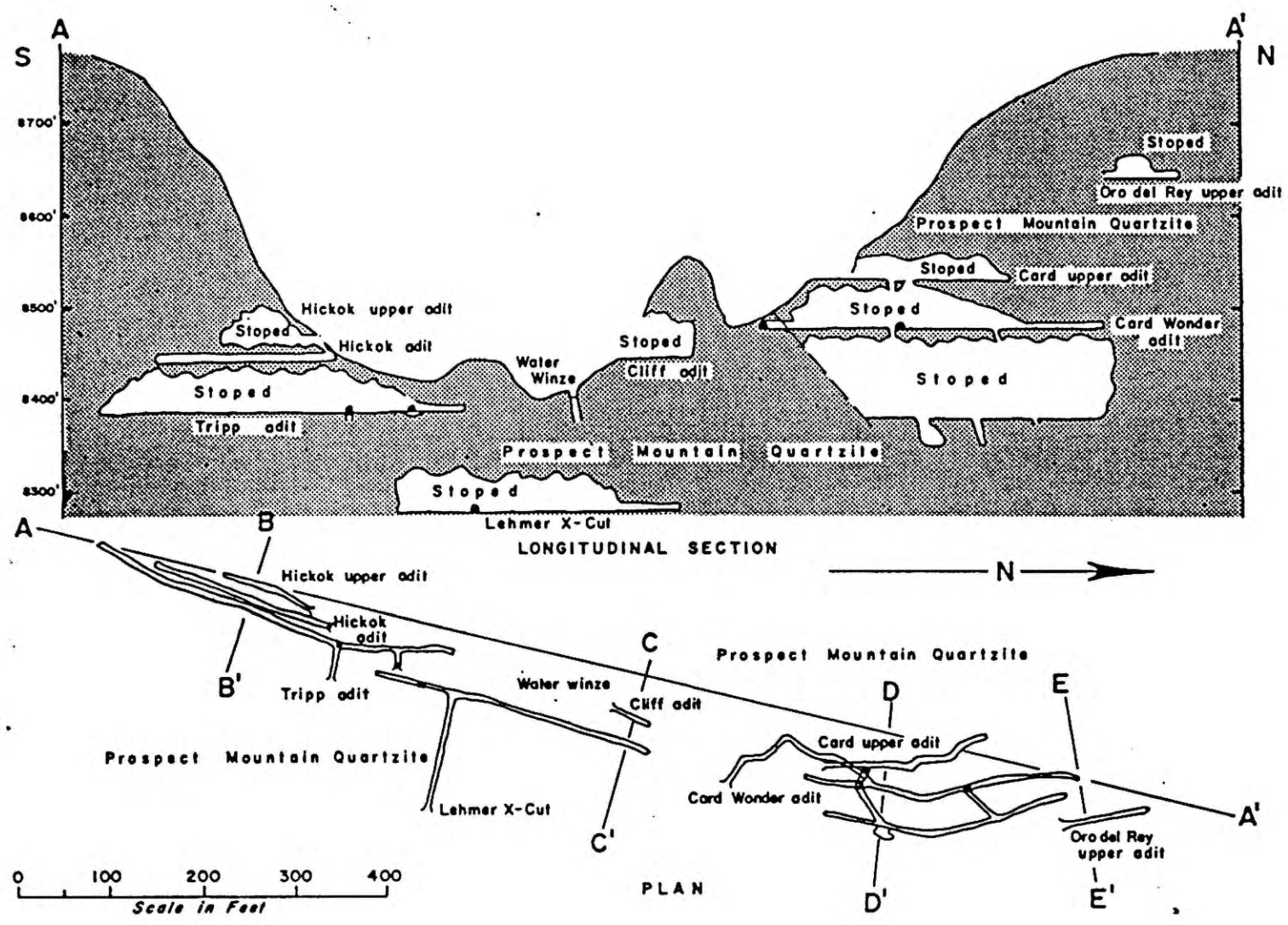


Figure 31. Plan and section of the Oro del Rey mine, Reilly-Goshute canyons area.

- 76 -

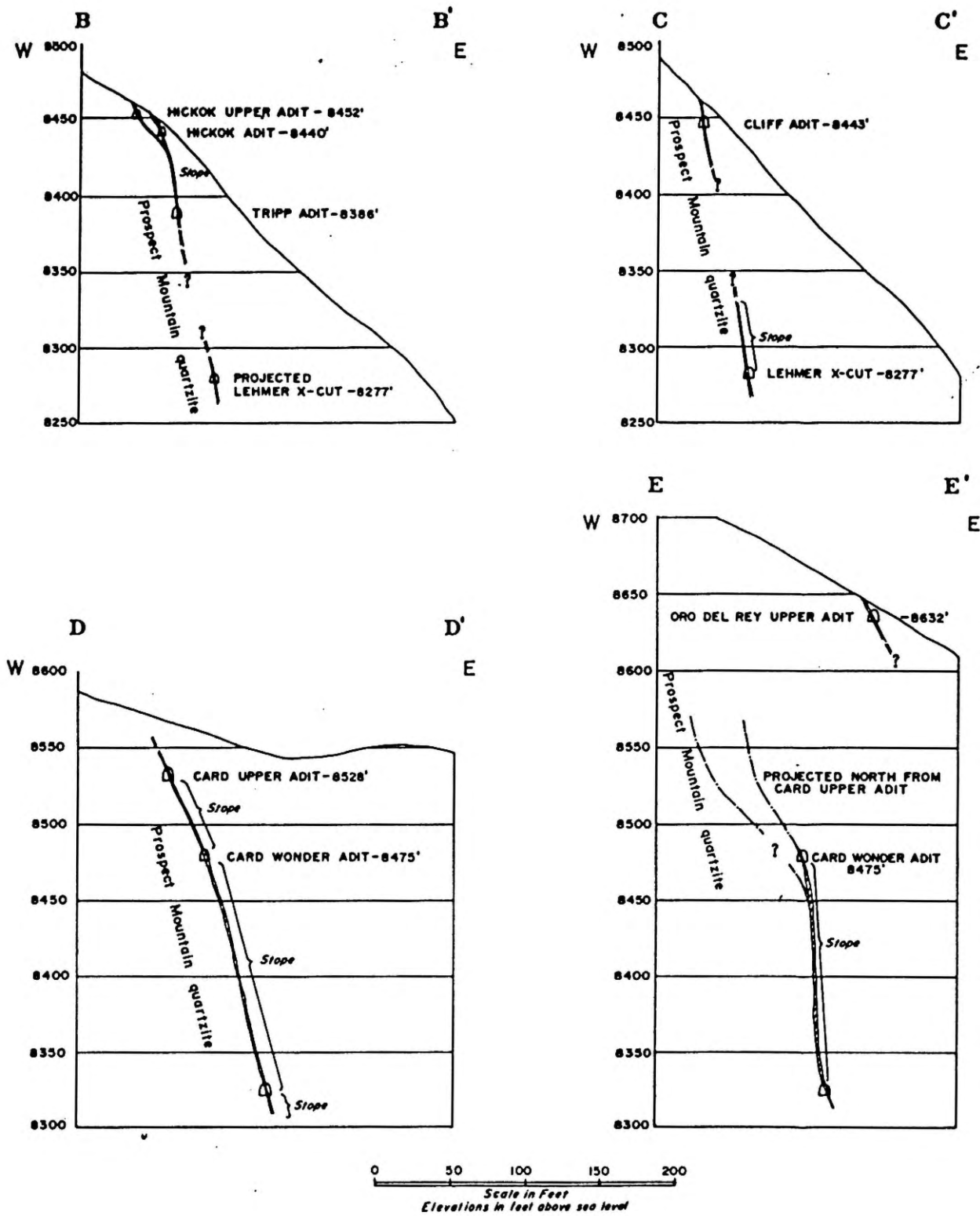


Figure 32. West-east geologic sections facing north of the Oro del Rey mine vein system. See figure 31 for location of sections.

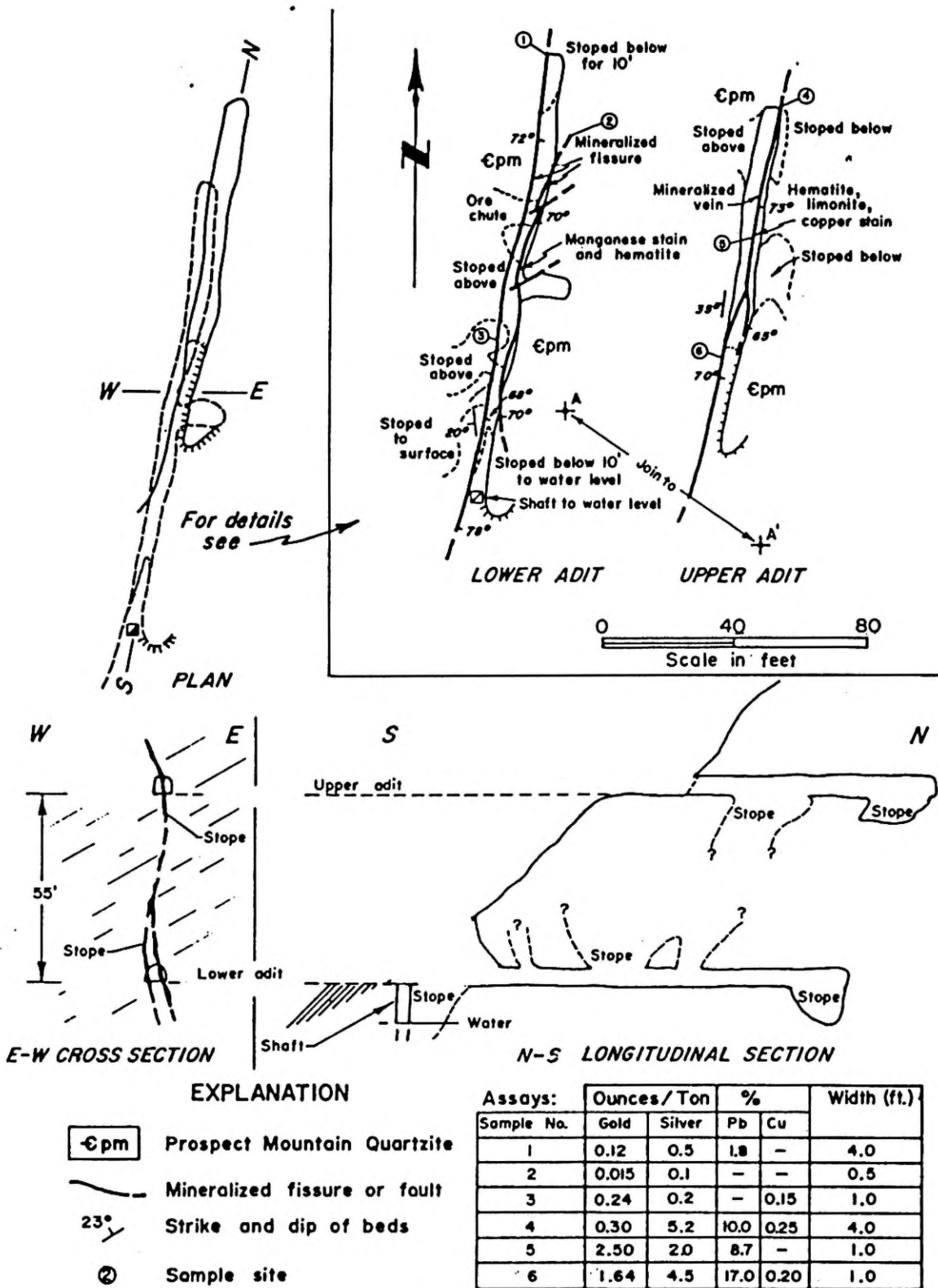


Figure 33. Geology and workings in plan and section of the Devils Pit mines, Reilly-Goshute canyons area.

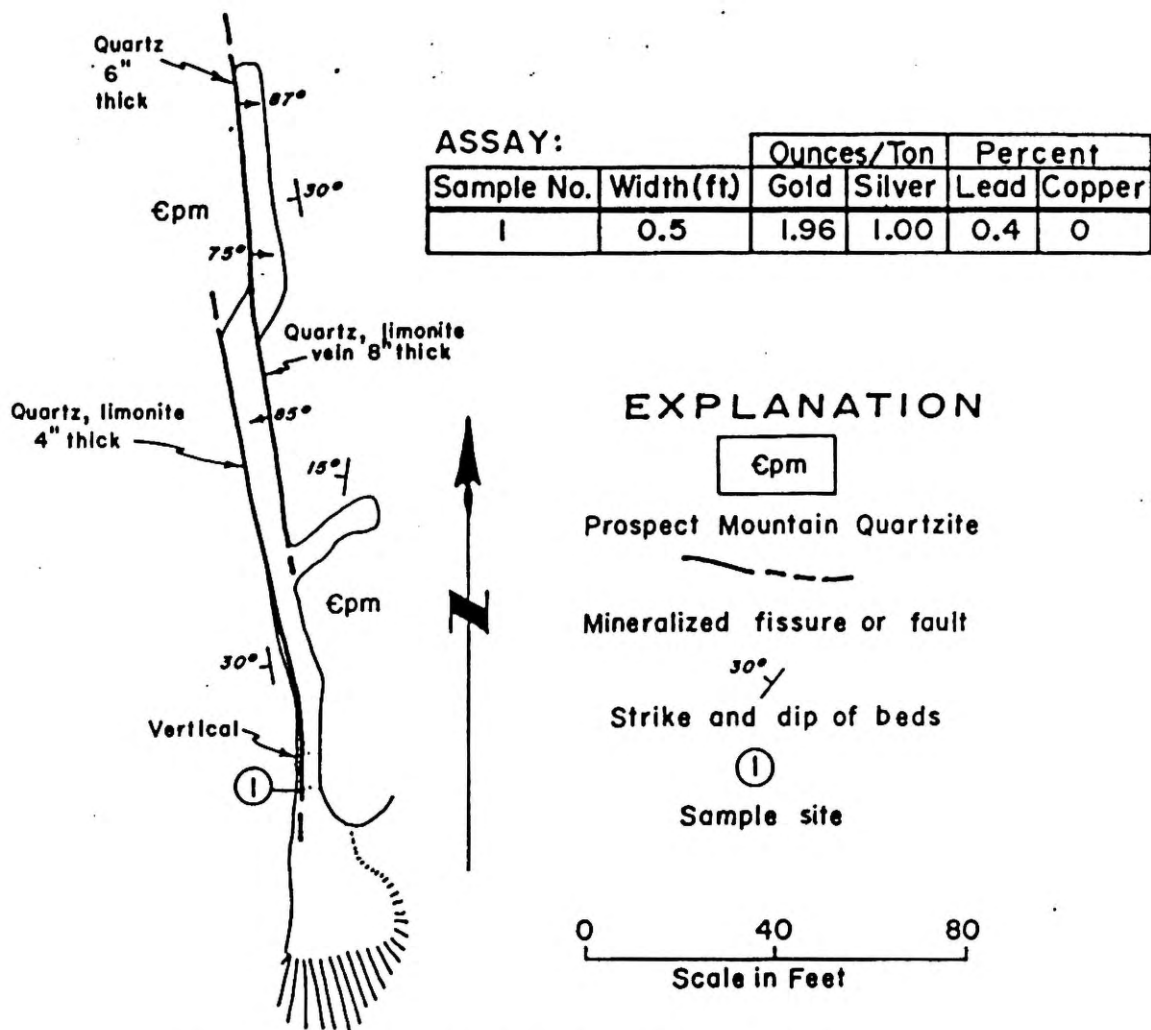


Figure 34. Geology and workings of the Bueno mine, Reilly-Goshute canyons area.

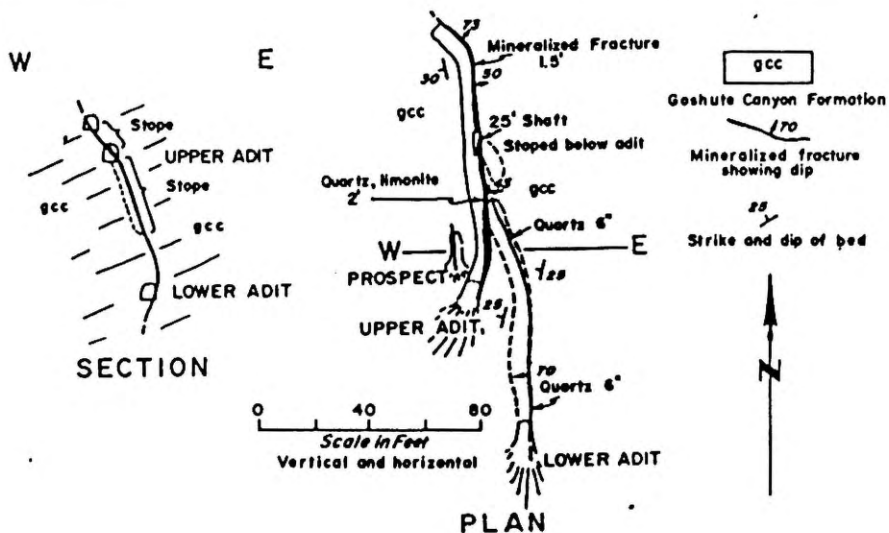


Figure 35. Geology and workings in plan and section of the lower Goshute Canyon mines, Reilly-Goshute canyons area.

APPENDIX III

Partial Tabulations of Production from the Evelyn Vein

From Company Files

CALCULATION SHEET

CLIENT ORO Del Rio Mine (Settlement Sheets)

PROJECT Tooele County
Deep Creek Range

	Milk	W.U	DW	Gold oz	Silver oz	Lead 90	
1	3 11 50	A S R	15720	14934*	1.54	3.82	695
2	4 7 50	U S R	19180	9.7 Tons.	1.88	6.20	2165
3	4 26 50	U S R	19600	9.8 "	2.57	4.43	1930
4	5 2 50	U S R	23388	11.69 "	1.98	6.45	775
5	6 17 50	A S R	19620	9.50 "	1.72	3.95	605
6	6 12 50	A S R	16980	16148*	2.30	3.87	525
7	6 20 50	U S R	19278	9.63 Tons.	2.01	4.68	1890
8	8 21 50	A S R	24960	24112*	2.02	3.65	385
9	8 7 50	A S R	22120	21162*	1.83	4.11	2.55
10	7 31 50	U S R	- - -	9.47 Tons.	2.00	4.50	13.70
11	2 27 50	U S R	- - -	10.40 "	1.35	4.95	17.75
12	4 18 50	U S R	- - -	15.50 "	2.08	3.50	6.55
13	5 2 50	U S R	- - -	19.72 "	1.74	5.00	13.85
14	7 10 50	U S R	- - -	16.96 "	2.75	3.90	17.00
15	6 29 50	U S R	Moisture	8.49 "	1.50	4.05	8.10
16	3 6 50	U S R	2.7	17660*	1.73	6.70	19.45
17	2 9 50	U S R	9.3	784 Tons.	1.28	4.10	11.05
18	2 15 50	U S R	5.8	16640*	2.13	3.68	7.45
19	1 26 50	U S R	6.0	765 Tons.	1.44	5.35	18.90
20	1 13 50	U S R	6.2	474 "	2.00	19.00	16.30
21	12 16 49	U S R	6.6	997 "	2.00	4.86	18.20
22	11 15 49	U S R	5.8	887 "	1.77	19.30	21.00
23	10 20 49	U S R	5.6	1124 "	2.13	10.47	24.95
24	9 29 49	U S R	3.2	1090 "	1.46	11.03	21.20
25	9 27 49	U S R	4.4	1420 "	1.14	9.70	23.00
26	9 2 49	U S R	2.4	1200 "	1.23	4.20	19.95
27	11 30 49	U S R	1.2	1197 "	1.32	8.42	4.30
28	9 23 49	U S R	0.6	676 "	.98	7.95	6.40
29	8 30 49	U S R	2.1	672 "	1.81	31.60	31.20
30	10 17 49	A S R	1.4	1362 "	1.14	6.60	4.10
31					3		
32							
33							
34							
35							
36							

Form EC-2-4 (Rev. 10-66)

CALCULATION SHEET

Form EC-2-4 (Rev. 10-66)

	Milk	DRY Ton	Moisture	Gold oz	Silver oz	Lead oz	
1	102249	215 R	12.0	33	210	475	890
2	72249	A S R	12.2	45	96	142	430
3	82649	A S R	12.7	27	183	312	295
4	101949	A S R	12.1	30	210	320	335
5	61049	A S R	9.8	45	264	315	645
6	1349	A S R	17.8	99	139	540	2312
7	11349	A S R	11.1	108	238	420	3160
8	8949	I S R	-	-	177	552	1170
9	122448	U S R	220	60	215	285	660
10	12748	A S R	83	137	232	750	2230
11	12148	A S R	96	72	207	510	2450
12	102148	A S R	224	63	367	352	500
13	101548	I S R	-	-	220	634	2095
14	9848	A S R	97	40	410	612	2470
15	9748	A S R	113	38	276	485	1250
16	10448	A S R	167	204	246	292	450
17	8248	A S R	79	61	317	830	2950
18	71648	A S R	7.0	24	291	330	410
19	52548	A S R	329	74	159	595	2860
20	61648	A S R	173	72	283	915	3337
21	41648	A S R	187	109	254	792	3660
22	33148	A S R	165	75	266	940	2010
23	31848	A S R	313	95	151	510	2775
24	3448	A S R	187	74	264	550	1490
25	22048	A S R	185	84	239	497	2275
26	123147	A S R	102	81	220	570	1940
27	112647	A S R	132	98	245	795	2890
28	123147	A S R	132	87	266	907	2580
29	82947	A S R	162	19	111	181	405
30	82347	A S R	279	64	98	747	3662
31							
32							
33							
34							
35							
36							

REF-CHEM ENGINEERING & CONSTRUCTION CO.
CALCULATION SHEET

PROJECT NO. _____

BY _____ CHK _____

DATE _____

SHEET 3 OF _____

CLIENT _____

PROJECT _____

	Mill	Gr nd wt	Moisture	Gordon	Silver	oz	Lead	oz
1	8147	A S R	10.2	5.6	96	610	2800	
2	61447	A S R	11.9	8.5	123	510	2027	
3	6247	A S R	22.1	8.5	58	1070	4215	
4	5847	A S R	19.6	8.3	52	1090	4305	
5	5147	A S R	27.8	7.9	56	1140	5090	
6	11747	A S R	37.7	9.9	62	845	4750	
7	102247	A S R	12.5	2.9	153	147	100	
8	101746	A S R	24.2	8.5	76	632	3795	
9	101246	I S R	-	-	365	505	1710	
10	92046	I S R	-	-	60	732	3930	
11	82946	I S R	-	-	161	882	3870	
12	81946	I S R	-	-	207	332	1190	
13	8546	I S R	-	-	136	884	4310	
14	52746	I S R	-	-	238	422	1690	
15	122145	I S R	-	-	178	346	1360	
16	112345	A S R	6.3	-	50	122	32	
17	11945	A S R	12.4	-	153	460	1315	
18	102045	A S R	5.3	-	64	230	267	
19	10445	A S R	3.0	-	129	866	2430	
20	92245	A S R	5.4	-	81	247	155	
21	9345	A S R	(382 lbs)		1206	990	135	
22	82245	A S R	22.2	3.0	142	900	2590	
23	81045	A S R	19.3	2.3	160	1402	3095	
24	73145	A S R	12.6	2.5	173	227	290	
25	52245	A S R	14.9	5.0	122	825	2945	
26	31445	A S R	26.6	9.2	103	685	2290	
27	11045	I S R	-	-	223	402	1730	
28	112944	A S R	27.8	5.9	138	770	2550	
29	91344	I S R	-	-	229	450	1975	
30	82544	A S R	37.4	2.3	148	710	2385	
31								
32								
33								
34								
35								
36								

Form EC-2-4 (Rev. 10-66)

REF-CHEM ENGINEERING & CONSTRUCTION CO.
CALCULATION SHEET

PROJECT NO. _____

BY _____ CHK _____

CLIENT _____

DATE _____

PROJECT _____

SHEET 4 OF _____

	Mill	moisture	Dry wt	Gold oz	Silver oz	Lead oz	
1	8344	ASR	43	284	204	717	1955
2	7844	ASR	34	182	96	577	1805
3	63044	ISR	-	-	251	558	2270
4	61744	ASR	54	451	58	650	2205
5	11444	ASR	58	208	84	580	1860
6	121743	ASR	43	184	67	790	2635
7	102848	ASR	58	92	118	665	2485
8	101243	ISR	-	-	277	473	2510
9	9343	ASR	25	90	77	805	2870
10	8543	ASR	28	124	225	700	2690
11	72043	ASR	1.8	122	225	850	3305
12	71643	ASR	1.7	25.0	179	780	2580
13	6843	ASR	45	96	162	1410	4470
14	6743	ISR	-	-	204	593	2725
15	6543	ASR	29	64	146	830	3035
16	6543	ASR	57	52	276	440	1085
17	121442	ASR	85	10.0	196	455	1495
18	111242	ASR	71	222	129	600	1385
19	111242	ASR	78	18.0	219	370	1055
20	11442	ISR	-	-	298	442	1430
21	102642	ASR	68	95	242	415	1090
22	101342	ASR	38	128	95	620	2550
23	102042	ASR	33	70	232	620	2460
24	92342	ASR	12	87	170	372	920
25	92642	ASR	34	65	260	1195	3685
26	92542	ASR	31	54	86	555	2100
27	92542	ASR	31	84	276	375	1200
28	92142	ISR	-	-	338	496	890
29	91542	ASR	32	92	299	445	2180
30	9942	ASR	3.8	11.0	120	665	2235
31							
32							
33							
34							
35							
36							

Form EC-24 (Rev. 10-66)

CALCULATION SHEET

PROJECT NO. _____

BY _____ CHK _____

DATE _____

SHEET 5 OF _____

CLIENT _____

PROJECT _____

	Milk	Moisture %	Dry Tons	Gold oz	Silver oz	Lead oz	
1	9142	A S R	3.7	75	360	390	2370
2	8542	A S R	2.8	130	193	760	2900
3	8542	A S R	1.7	324	181	760	1950
4	8442	A S R	2.8	12.7	319	740	2770
5	71342	A S R	2.9	15.3	190	1415	3636
6	7642	A S R	3.2	30.4	150	330	1075
7	7342	I S R	-	-	269	413	1090
8	61842	A S R	3.3	13.2	262	970	2695
9	61842	A S R	4.2	12.5	163	1460	4175
10	61742	I S R	-	-	239	481	1210
11	61042	I S R	-	-	138	111	90
12	6842	I S R	-	-	306	524	1190
13	6442	A S R	4.3	17.3	148	1392	5045
14	51742	A S R	5.1	12.9	249	615	1695
15	52542	A S R	7.1	19.4	226	1160	2610
16	52542	A S R	2.3	7.8	183	1640	2670
17	5242	A S R	9.7	12.2	185	1090	2800
18	5242	A S R	5.3	12.2	223	985	2235
19	31042	A S R	-	-	265	872	2110
20	22742	I S R	-	-	326	956	2510
21	22642	I S R	-	-	254	621	2120
22	21142	I S R	-	-	187	1038	2450
23	21042	U S R	5.8	9.9	238	765	2930
24	2542	I S R	-	-	205	1097	3410
25	2542	I S R	-	-	158	1537	4870
26	12742	I S R	-	-	241	1934	5390
27	11642	U S R	9.4	12.2	180	1360	4550
28	11042	I S R	-	-	284	2166	3100
29	123141	I S R	-	-	274	1085	2350
30	121941	I S R	-	-	138	1502	5170
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REF-CHEM-ENGINEERING & CONSTRUCTION CO.
CALCULATION SHEET

PROJECT NO. _____

BY _____ CHK _____

CLIENT _____

DATE _____

PROJECT _____

SHEET 6 OF _____

	Mill	Moisture %	Dry Tons	Gold oz	Silver oz	Lead lb	
1	121741	1.5 R	-	-	143	2641	5630
2	121541	4.5 R	33	86	283	111	2800
3	121541	4.5 R	79	126	119	2165	6040
4	121541	1.5 R	-	-	364	916	3090
5	121041	1.5 R	-	-	319	803	1480
6	12641	1.5 R	-	-	131	2556	6470
7	112541	1.5 R	-	-	281	1917	4690
8	111941	4.5 R	67	91	352	2085	4620
9	103141	1.5 R	-	-	250	2774	4830
10	102241	1.5 R	-	-	155	319	280
11	93041	1.5 R	-	-	289	511	1210
12	92641	4.5 R	3.4	7.0	347	870	3250
13	82641	1.5 R	-	-	239	321	1520
14	81541	1.5 R	-	-	148	286	200
15	8541	1.5 R	-	-	235	404	2550
16	71441	4.5 R	22	10.9	196	2080	3520
17	71541	1.5 R	-	-	149	241	150
18	71241	1.5 R	-	-	264	1643	3035
19	61641	4.5 R	51	18.9	210	1510	2850
20	52241	1.5 R	-	-	209	295	680
21	42441	1.5 R	-	-	168	532	1530
22	32741	1.5 R	-	-	324	375	460
23	31841	1.5 R	-	-	411	389	500
24	31541	1.5 R	-	-	145	535	1380
25	31141	1.5 R	-	-	490	474	490
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