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A GEOLOGIC OVERVIEW OF THE GOLD QUARRY MINE
J. Rota 4/6/88

1) Maggie Creek Mining District - Production History:

<u>Date Mine</u>	<u>Type</u>	<u>Product</u>
1983 Gold Quarry	Open pit	Gold, silver
1978 Maggie Creek	Open pit	Gold
1957 Copper King	Underground/Open pit	Copper, gold, silver
1937 Good Hope	Underground/Glory hole	Barite
1937 Maggie Canyon	Underground	Barite
1936 Maggie Claims	Underground	Gold, silver
1906 Nevada Star	Underground	Lead, silver, barite

2) Gold Quarry:

Classification-----	Sediment-hosted, epithermal, disseminated gold deposit.
Size-----	Three combined pits: Gold Quarry, Maggie Creek, Maggie Creek West. Current dimensions: 5000 feet long, 4000 feet wide, 440 feet deep.
Reserves-----	1987 Yearend Mineable Reserve: 199,207,000 short tons; average grade of ore: 0.045 ounces per ton; 8,956,700 total ounces. Production for 1983 through 1987: >700,000 ounces of gold.
Byproduct metals----	Approximate gold to silver ratio is 4:1. Roughly 20% of the silver is recovered in the CIL process.
Ore host rock-----	Siltstone, sandstone, shale and silty limestone deposited on seafloor during the Ordovician through the Devonian (505 to 360 million years ago).
Age of ore-----	Gold introduced to host rock through hydrothermal activity during the Oligocene (about 30 million years ago).
Gold occurrence-----	Disseminated throughout host rock and along quartz-filled microfractures as native particles often less than 1 micron (0.001 millimeter) wide.
Associated metals---	Gold is associated with minor amounts of arsenic, antimony, mercury; also with trace amounts of lead, copper, and zinc.
Temperature of ore formation-----	Undetermined, but indicated to be between 175 and 275 degrees Celsius.
Alteration minerals-	Quartz, alunite, kaolinite, illite, barite, iron oxides, other oxides.
Other minerals-----	Hydrocarbons, pyrite, other sulfides.
Other prospects-----	Tusc, MAC, Deep West... ?

Although the Gold Quarry pit is equidimensional in shape, the ore zones it contains can be characterized as large, structurally-controlled podiform localizations of gold near the intersection of the Gold Quarry and Good Hope faults. The allochthonous Ordovician siltstones, shales and cherts which host the deposit have been highly silicified and locally argillized, particularly along high-angle structures. Many of the faults that have served as hydrothermal conduits are characterized by zones of silica-healed breccias and high gold values.

Arsenic, antimony, copper, lead, nickel, manganese and mercury, all occur in elevated trace amounts, mirroring the geometry of gold mineralization. Geochemistry, however, was of limited use as an exploration guide at Gold Quarry because of a locally thick blanket of post-mineralization lacustrine sediments of the Tertiary Carlin Formation.

The spatial distribution of jasperoidal bodies, the wallrock alteration mineral suite, and associated geochemistry all suggest a hot-springs model for the genesis of Gold Quarry.

HISTORY

District

The Gold Quarry deposit is located just off the southern edge of the Carlin Window, in the Maggie Creek (Schroeder Mountain) mining district, approximately 11 km north of the town of Carlin, in northeastern Nevada. (Fig. #1)

The first recorded production in 1936 came from two small adits that produced 59.7 tons of ore averaging 0.42 ounces per ton of gold and 0.88 ounces per ton of silver. These workings

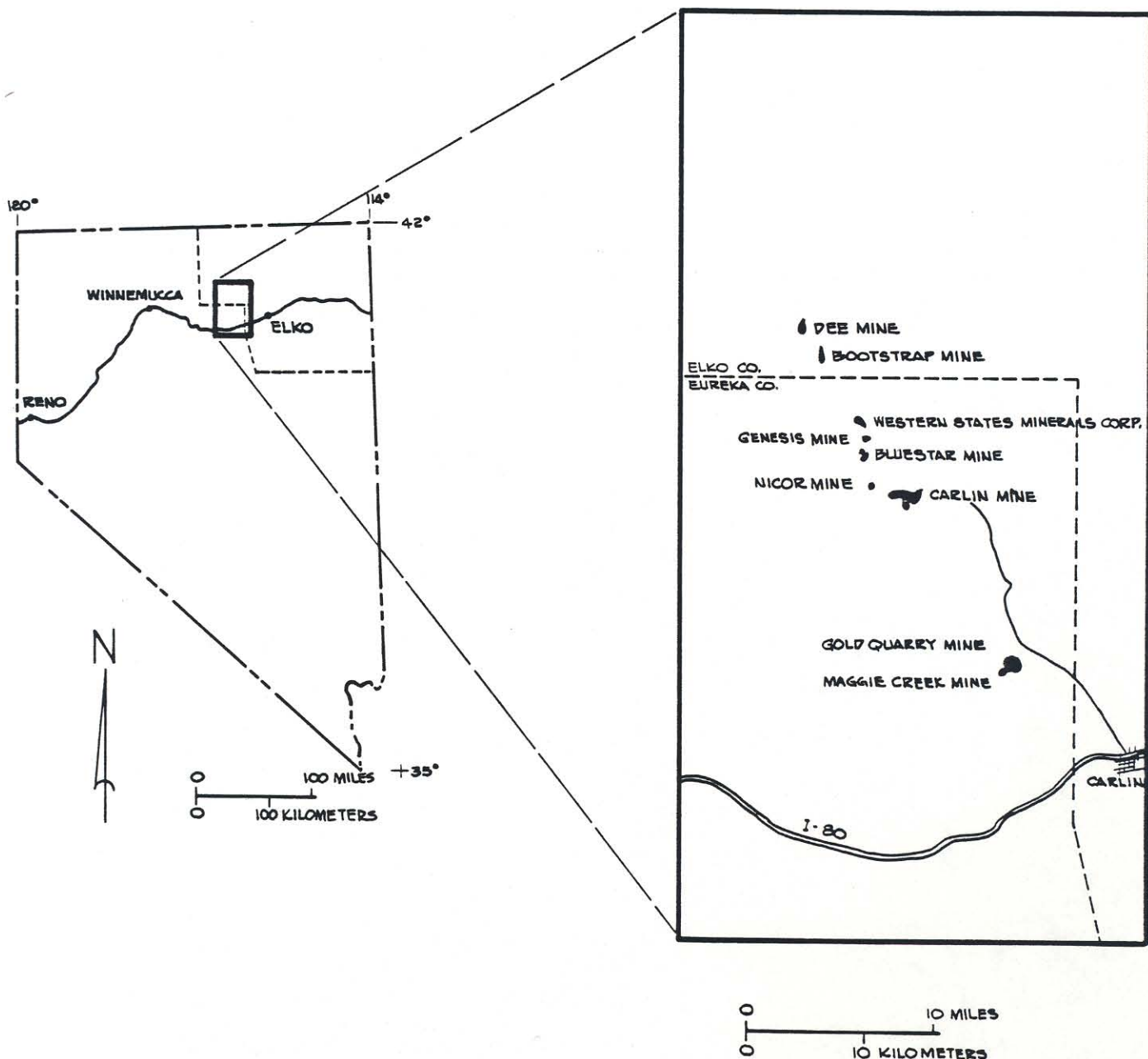


FIGURE No.1
 GENERAL LOCATION MAP
GOLD QUARRY MINE
 SITUATED IN NORTHEASTERN NEVADA

were located in a highly silicified area that is now a part of the Gold Quarry pit. The gold was reported to have come from a sheared, fractured, and iron-stained quartzite and chert (Roberts et al., 1967).

The Copper King and Good Hope properties are other mines with historic production in the Maggie Creek district. The Copper King is a small underground and surface mine 2 km northwest of the Gold Quarry orebody that worked a N60E striking copper ore zone. Between 1957 and 1958, 158 'carloads' (?) of copper ore were taken from the twin shaft development. The Copper King was listed in 1974 as the only North American occurrence of the mineral Faustite, a hydrous zinc-copper aluminum phosphate (Roberts et al., 1974).

The Good Hope mine lies roughly between the Copper King and Gold Quarry. Around 1910, a 75m. incline shaft was driven to develop a 1-1.5m wide vein of galena, silver, copper carbonates and abundant barite. No significant gold production was reported from the Good Hope mine. Total Maggie Creek district production from 1932-1958 was 858 oz. Au, 4387 oz. Ag, 656,058 lb. Cu and 27,603 lb. Pb.

Recent Development

Exploration drilling conducted by Newmont Mining Corporation in the early 1960's outlined a small, low-grade, highly siliceous orebody in and near the area of the original 1936 workings. This deposit was estimated to contain 340,000 tons of material averaging 0.120 oz./ton Au. The property was not developed by Newmont due to high grinding costs and poor metallurgical

recovery indicated by drill sample testing. Late in 1977, Carlin Gold Mining Company (now known as Newmont Gold Company) discovered the Maggie Creek orebody southwest of the original Gold Quarry workings and early Newmont drilling. The discovery of Maggie Creek prompted additional exploration drilling and investigation of the Gold Quarry area. Exploration activities were accelerated in 1979 when gold assays averaging over 0.10 oz/ton were discovered in samples from a drill hole located 600m south of the original Gold Quarry workings.

Exploration drilling quickly evolved into development drilling which resulted in eventual definition of the Gold Quarry orebody. Over 550, six-inch rotary percussion holes were drilled using downhole hammers to an average depth of about 600'. Drilling was conducted on a 30m square grid; despite harsh drilling conditions, costs remained low and reliable assay data was collected.

HQ wire-line core drilling was used to collect rock for geological and metallurgical testing. Four HQ wire-line holes were drilled to the respective depths of 230m, 235m, 239m and 105m. Seven PQ-size holes averaging 177m each were used to collect additional metallurgical test material.

Drilling eventually defined an orebody containing geologic reserves of over 8,000,000 oz. of gold. Proven and probable reserves, mineable by open pit, are estimated at 144,000,000 tons, averaging 0.049 oz./ton Au. This includes a high grade zone of 51,000,000 tons @ 0.077 oz./ton Au which will be used to feed the Carlin #2 Mill at an average rate of 7000 tons/day.

About 10% of this mill grade ore is carbonaceous in nature. The remaining 93,000,000 tons averaging 0.034 oz./ton Au will be treated by dump leach methods. Total 1986 production from the #2 Mill is projected at 210,000 oz.

Dimensions of the main orebody are roughly 300m wide x 300m long x 300m deep, although this is highly variable. (Fig. 5) High grade gold values are distributed along steeply dipping fracture systems. Lower grades are disseminated throughout the deposit. The proposed economic pit is 1200m wide x 1150m long x 300m deep.

Ground was first broken by mining in 1982 when 1,000,000 tons of material were removed for bulk leach and milling tests. The Carlin #2 mill was dedicated in September of 1985 and is operated by Newmont Gold Company.

DISTRICT AND REGIONAL STRUCTURE

DISTRICT

The principal geologic feature of the Gold Quarry area (Maggie Creek mining district) is the Carlin Window (Fig. 2), roughly circular in outline and about 3 km in diameter. The window exposes thin-bedded limestones of the Roberts Mountains Formation and an overlying, relatively massive Devonian limestone. These carbonates are exposed through cherts, shales, quartzites, and impure limestones in the upper plate of the Roberts Mountains thrust fault.

The Carlin Window is defined on the north by the Roberts Mountains thrust fault, on the southwest and southeast by the

LEGEND

- Qal QUATERNARY ALLUVIUM
- Tc TERTIARY CARLIN FORMATION
- LOWER PLATE —
- Dis DEVONIAN UNNAMED LIMESTONE
- Srm SILURIAN ROBERTS Mtn. Fm.
- UPPER PLATE —
- Ov ORDOVICIAN VININI FORMATION
- Ols ORDOVICIAN(?) TRANSITIONAL LIMESTONES
- ~ FORMATIONAL CONTACT (DASHED WHERE INFERRED)
- FAULT (DASHED WHERE INFERRED)
- ▲ THRUST FAULT (SAW TEETH ON UPPER PLATE)
- SHAFT
- Y ADIT

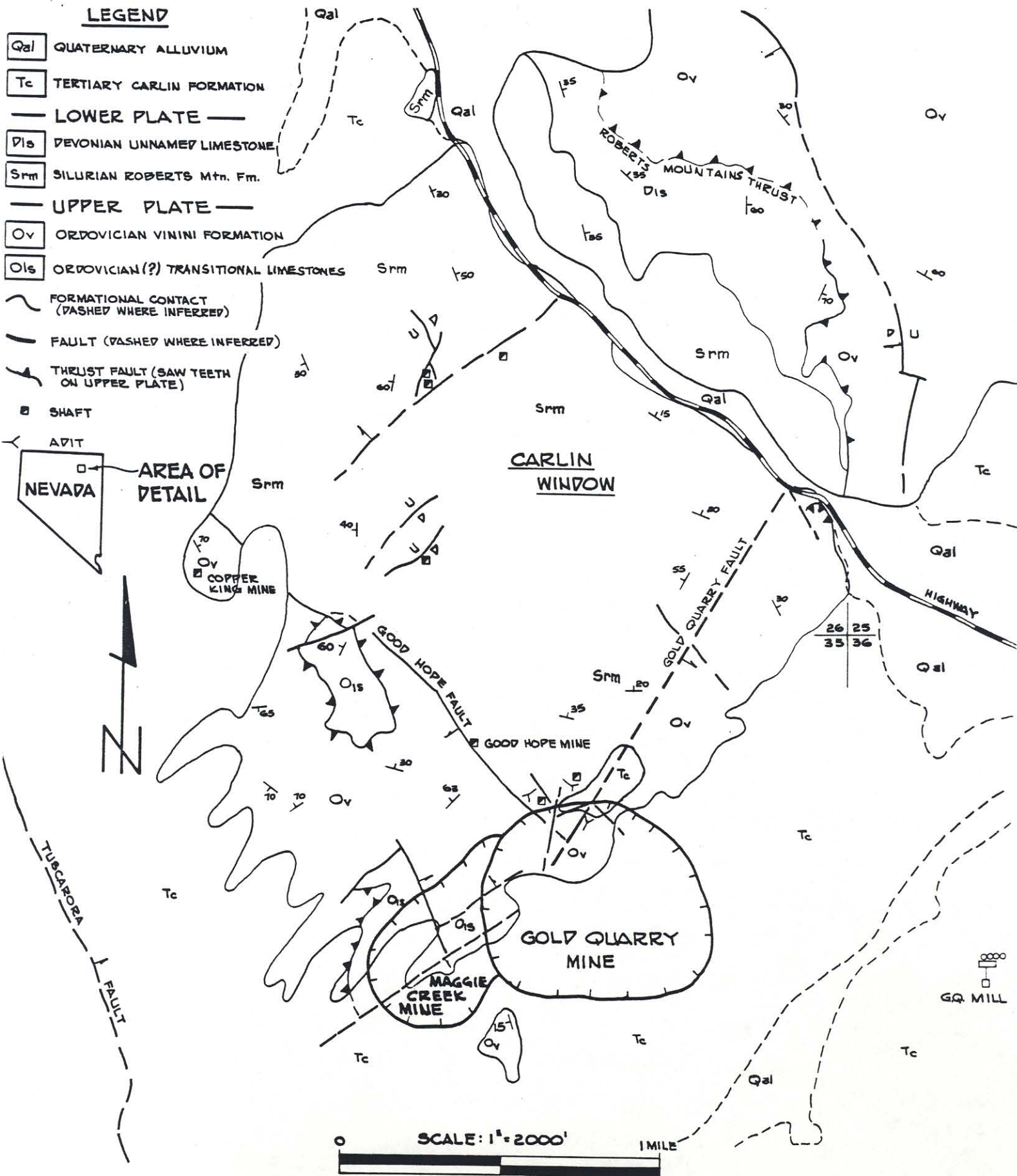


FIGURE No.2
MAGGIE CREEK MINING DISTRICT
GENERAL GEOLOGY
(AFTER EVANS AND CRESS 1971)

high angle Good Hope and Gold Quarry faults, respectively. The northwest boundary lies beneath an overlap of Quaternary alluvium and Tertiary sediments.

REGIONAL

The complex structural history of Nevada is described in great detail by Stewart (1980). Briefly, the Roberts Mountains Thrust fault is a product of the Antler orogenic event of Late Devonian (possibly earliest Triassic) time. This subduction-related highland was formed just west of the North American craton. A thick sequence of deep-water siliceous and volcanic rocks was transported eastward along the Roberts Mountains thrust for over 145 km over coeval shallow-water miogeosynclinal rocks. The upper plate of the Roberts Mountains thrust is composed of interleaved, broad, thin, thrust plates, commonly subparallel to bedding. Differential movement of these thrust slices has caused juxtapositioning of both western and transitional assemblages throughout the area. Transitional siltstones and limestones are included in the upper plate, separated from the western siliceous rocks both stratigraphically, and by smaller thrust faults and high-angle faults. Most of the upper plate lithologies are highly folded and deformed.

Doming on a northwest trend began during or shortly after thrusting, (Roberts et al., 1967). Intrusive events of the Cretaceous through the Tertiary intensified this doming and subsequent erosion exposed a N45W trending belt of carbonate windows. As tectonic regimes changed through the Paleozoic and Mesozoic, major fault trends changed from west to north, then to northwest.

Cenozoic extensional faulting in the area commenced about 17 million years ago. Displacement along these north to northeast striking high-angle faults has formed the mountains and valleys which dominate the present topography of the Basin and Range province.

STRATIGRAPHY

Western and Transitional Assemblage

The stratigraphy of the Carlin area has been described in detail by Roberts, 1967, Stewart, 1980, and West, 1974. Although some formation names and ages are disputed, a brief summary is given.

Exposed in the Tuscarora Mountains is a thick sequence of Ordovician strata assigned to the Vinini Formation, primarily composed of bedded cherts (with thin shale partings), shales, minor sandstones, impure limestones, and rare greenstones. The local portion of this 4267m+ thick formation, described as the Schroeder Mountain section, is defined as 765m of carbonaceous shale, siliceous shale, chert, siltstone, quartzite beds up to 3m thick, and minor limey siltstones intercalated throughout.

The Gold Quarry orebody is located near the southern end of the Tuscarora Mountains where there is some question over the assignment of the allochthonous unit rocks to the Vinini Formation. Historically, mappers have assigned Gold Quarry strata to the Ordovician Vinini Formation. Recent work by Newmont geologists, in subdividing the allochthonous western assemblage, suggests that the host sequence at Gold Quarry may be

more properly assigned to the transitional assemblage. The 457m thick section of siltstone and chert in the mine area is typically thin-bedded and non-competent; some thin-bedded silty limestones are present, but are considered only a minor part of the sequence. General bedding in the present Gold Quarry pit strikes about N45W and dips between 30-80 degrees either SE or NE. Isoclinally folded bedding is common, with chaotic, discordant bedding occurring near large faults. Low-amplitude folding on a northwest trend is also present.

Eastern Carbonate Assemblage

The youngest member of the Eastern Carbonate Assemblage is an unnamed limestone unit exposed in the northern part of the Carlin Window, the upper portions of which have been cut by the Roberts Mountains thrust fault. This formation is described as a thick to massively-bedded sequence of dark grey to black fossiliferous dolomitic limestone. Silt content of this Devonian limestone increases vertically and grades upward into a sandy limestone immediately below the Roberts Mountains thrust. Devonian corals and crinoids are locally common. Estimated formation thicknesses vary from 75m in the Carlin Window to 175m for the equivalent unit at the Carlin mine to the north.

The Devonian-Silurian Roberts Mountains Formation, which makes up the bulk of the exposed rock in the Carlin Window, is described as a dark grey, platey, fine-grained, silty dolomitic limestone. The basal unit of the Roberts Mountain Formation is described as a 1.5 - 3m unit of black chert, which is overlaid by a carbonaceous silty dolomite, commonly pyritic, containing

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thin chert lenses. Higher in the section lies a grey, dolomitic, locally sandy limestone with intercalated thin, dark grey bioclastic limestone beds and lenses of chert. The formation typically weathers to a light grey slope of angular plates and is estimated to be 300 - 350m thick. General bedding of both carbonate units in the Carlin Window strikes northwest and dips about 40 degrees northeast.

Tertiary Unit

The damming of major drainages by Tertiary volcanics to the southwest of Gold Quarry developed basins for the accumulation of extensive lacustrine deposits. One of these units, the Carlin Formation, rests unconformably on or in fault contact with the Paleozoic bedrock in the Gold Quarry area. The formation consists of over 200m of tuffaceous conglomerates and siltstones, sandstones, rhyolite tuffs, diatomite, shale, and limestone. The Carlin Formation is considered to be of Pliocene age (Regnier, 1960). The basin in which it was deposited deepens to the east to include over 700m of other Tertiary units (all part of the 2200m section of Cenozoic rocks in this area of Nevada). In the mine area, the unit includes well-defined scour and fill channels, gravel bars, siliceous angular to sub-rounded gravels and bedded vitric tuffs. Adjacent to the Gold Quarry ore zones, clays and siliceous gravels of the Carlin Formation were derived from the erosion of hydrothermally altered Paleozoic units, giving the appearance of mineralized Carlin Formation (as suggested by Eklburg, 1986). The Pliocene age of the Carlin Formation postdates mineralization at Gold Quarry. Small faults

and gentle folding are common in this formation; general dip of bedding ranges from 10 to 20 degrees. The occurrence of a basal montmorillonitic - hematitic clay unit usually marks the Paleozoic bedrock contact. This lateritic layer is considered to represent a paleosol horizon.

IGNEOUS ROCKS

The only exposed igneous rocks in the immediate Gold Quarry area are found in the west pit of the Maggie Creek mine. The northwest-trending, iron stained, latite-porphyry dike has not been dated, but is assumed to be of either Cretaceous or Tertiary origin. The dike is composed of minute quartz phenocrysts in a feldspar groundmass and contains both gold mineralization and anomalously high arsenic values, and is variably argillized.

ALTERATION

Silicified and argillized rocks are the principal alteration products observed at Gold Quarry. Both rock types range from slightly altered to a near total erasure of original bedding features. Silicification is directly associated with the gold mineralizing events.

Silicification at Gold Quarry is the most pervasive style of alteration involved and has been superimposed on originally siliceous siltstone. Silica flooding of the deposit has produced rock characteristics of several types and intensities. These types range from a relatively unsilicified siltstone through three grade designations to a cherty, flint-like rock of over 96% silica. Roughly one-half of the drilled area is composed of slightly silicified to highly silicified rock. The effects of

mineralization and silicification are noted as dropping off rapidly in the footwalls of high angle faults. According to Hausen (1983), "Silicification in the form of cherty replacements appears to have been superimposed on primary siliceous siltstones ... along high angle faults, notably along the hanging walls ... [these] are commonly mineralized, locally grading up to several oz./ton Au." In general, the intensity and amount of silicified rock decreases with an increase in depth. This gives the deposit an overall characteristic of a 'silica cap' resting above moderately argillized and silicified lithologies.

Quartz veinlets containing abundant carbonaceous material ('black quartz') are noted as possibly having been the first stage in mineralization. Black quartz from the Gold Quarry 5540 bench was examined by J. Coe in 1983. She states that, "The black speckled inclusions in the quartz were very minute (about 2 to <0.5 microns) and medium to dark grey in reflected light, similar to organic carbon ... Microscopic textural evidence suggests that the organic carbon was derived from a form of asphalt bitumen that was mobilized by [hydrothermal] solutions, and became embedded in vein quartz penecontemporaneous with barite and gold mineralization." The carbonaceous material in these veins may have been derived, by earlier hydrothermal events, from the surrounding country rock on a regional basis (Kuehn, 1985). When the first pulse of silica-bearing fluids moved through, carbon became included and remobilized upward to its present position. Several stages of quartz-barite veining associated with gold mineralization came next. Following these

came a milky quartz veining stage that filled many open voids, crosscutting previous veining events.

Alunitization followed the main stages of silicification (Paragenetic Sequence graph) with alunite occurring as replacements along fractures that transect earlier quartz-barite veins. Hausen et al. (1983) noted that these replacements are more common at Gold Quarry than at other Carlin-type gold deposits. Most of the alunite occurs in the siliceous sediments and displays indications of both lithologic and structural control. Alunite at Gold Quarry occurs as 1mm to 1cm wide veins. Late argillic alteration has obscured most of these veins so that field identification is nearly impossible.

Argillically altered rock types range from a slightly soft siltstone through two local grade designations to fluffy or greasy clay. This alteration consists predominately of illitic clays (Table 1) with locally higher concentrations of kaolinitic clay occurring deeper within the deposit beneath the alunitic ore zone. Deere et al. (1966) note that illites are the dominant clay minerals in shales and mudstone (corresponding to the dominant lithologies at Gold Quarry) and other sediments such as limestone. Illites may also have a hydrothermal origin and are often found in alteration zones around hot springs and metalliferous veins. Although the somewhat stratiform distribution of illite at Gold Quarry suggests a sedimentary origin, hydrothermal activity probably accounts for the introduction of clays to the ore zones. Most of the argillic alteration at Gold Quarry is considered to be hypogene in nature.

PARAGENETIC SEQUENCE

INTERPRETATION OF ALTERATION, TEXTURAL AND
MINERALOGIC FEATURES AT GOLD QUARRY

(AFTER D. HAUSEN)

MINERALS AND TEXTURAL FEATURES	ALLOGENIC	DIAGENIC	EPIGENETIC	SUPERGENE
QUARTZ				
DETRITAL	————			
QUARTZ VEINS			————	
CHERT		————	————	—
CALCITE	————	—	—	—
ILLITE	————	—	—	—
MONTMORILLONITE		————		
KAOLINITE			—	—
PYRITE		————	—	—
CHALCOPYRITE			————	
SPHALERITE			————	
GALENA			————	
GOLD			————	—
BARITE			————	
ALUNITE			—	—
IRON OXIDES				—
MICROFRACTURING		—	—	—

TABLE #1

WALLROCK ALTERATION FEATURES

(Distribution in wt. %)

WHOLE DEPOSIT (Disseminated or area values)		LOCAL VALUES (Structural Control)
Quartz	40.0 - 60.0 %	>90.0 %
Alunite	5.0 - 20.0	30.0 - 40.0
Iron Oxides	2.0 - 6.0	10.0 - 18.0
Barite	-	1.0 - 3.0
Illite	4.0 - 5.0	10.0 - 15.0
Kaolinite	-	4.0 - 20.0

This event is definitely post-silicification as clay alteration fronts are observed to encroach upon slightly to even moderately silicified rock. Intense argillic alteration has been observed in the field to penetrate 2 to 3cm into highly silicified fragments from post-silicification fractures, leaving a core of siliceous material surrounded by clay. The resulting clay altered material is still composed of about 80% silica as original grains and partial matrix replacements. Even the most argillically altered rocks often contain 50 to 60% silica.

Decalcification, the removal of carbonate minerals from limestone through hydrothermal processes, has occurred along many faults and localized areas within the silty limestones of the Vinini Formation. A general decrease in bulk density and increase in porosity of the affected unit is usually associated with this process (Hausen and Kerr, 1968).

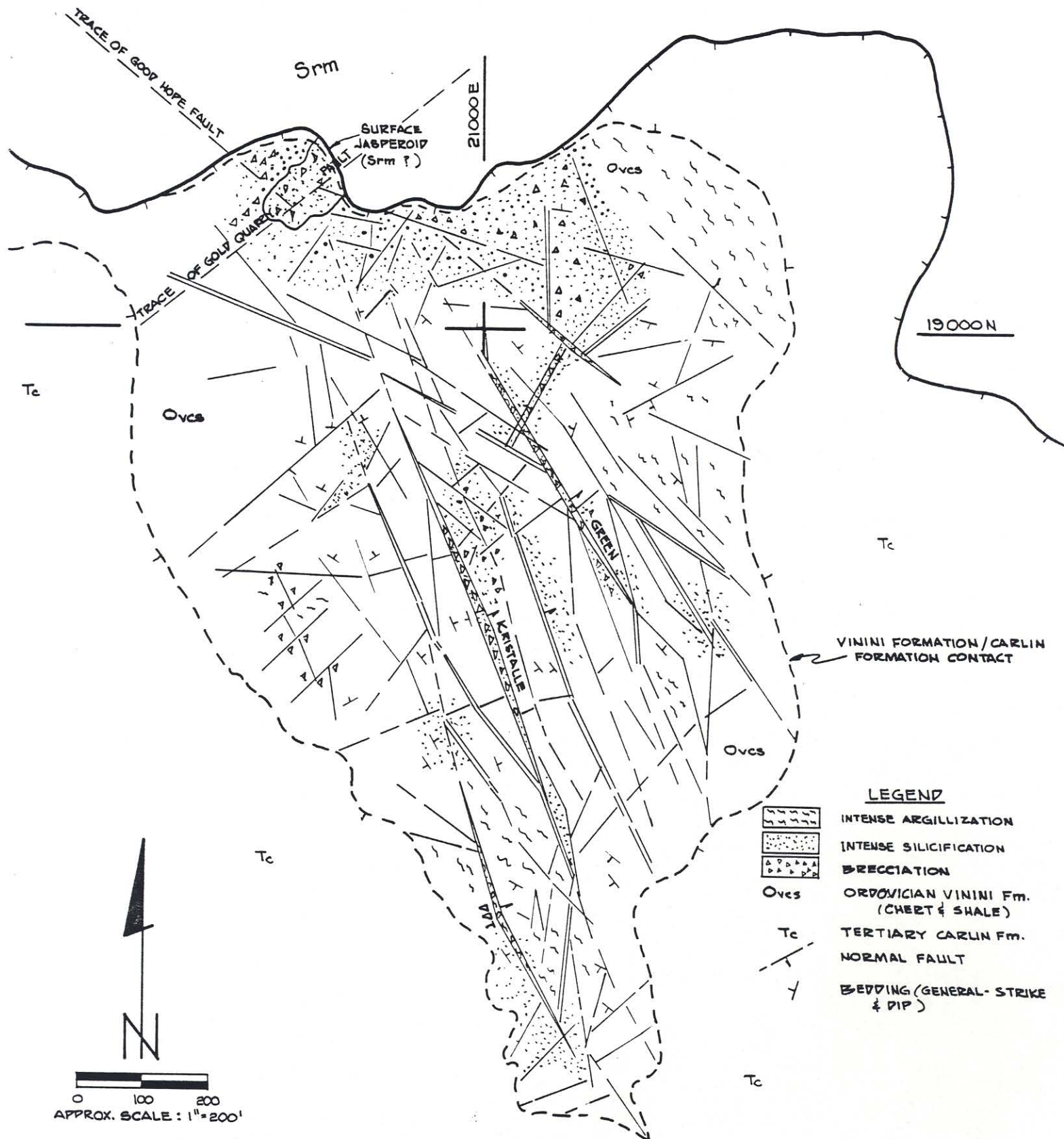
Baritization has occurred throughout Gold Quarry, especially in the vicinity of the larger faults. Bladed barite crystals up to 5cm have been taken from the highly iron-stained, open-spaced breccia of the Kristalle fault. Barite is also a common feature of the jasperoidal faults of the area and was the major constituent of some of the last hydrothermal events. While porous gossany iron within this fault contained only traces of gold, the siliceous clasts assayed up to 1.24 oz./ton Au and 0.22 oz./ton Ag.

Supergene oxidation followed formation of the Gold Quarry orebody. Drill data indicates that primary, unoxidized, pyritic carbonaceous ore begins between 120 - 200m below the

paleosurface. Deep weathering is indicated by the occurrence of pyrite molds in siliceous rocks, lateritic soil development, and the abundance of hematitic and limonitic clays found on nearly all open fractures in the near-surface areas exposed in the pit (Table 1). These iron-rich clays give the Gold Quarry pit a distinctive red hue. Supergene redistribution of some gold is indicated by Hausen (1983), "...small amounts of pyrite have been detected in Gold Quarry ores, most of which is assumed to be auriferous, analogous to Carlin, Getchell, Cortez, and other similar deposits. Small amounts of gold are therefore assumed to be liberated during this late period of supergene oxidation of sulfides." Some field evidence also exists for a downward remobilization of silica along large (permeable) faults, with silica deposited in the footwalls of these structures.

GOLD MINERALIZATION

Detailed pit mapping at Gold Quarry has shown that steeply dipping normal faults, and associated fracturing, are the major controlling features of gold mineralization. Mechanically induced permeability was important to the formation of this deposit. Highly pervasive fracture systems produced by faulting provided access to ore bearing fluids. This produced the stockwork pattern of high grade (0.05+ oz./ton Au) zones, which are concentrated along major structures, connected by overlapping (disseminated) lower grade zones. The attitudes of the northwest trending Good Hope fault and the intersecting, northeast trending Gold Quarry fault are reflected by many smaller structures within the deposit (Figs. 3 and 4). Antithetic and sympathetic



LEGEND

- INTENSE ARGILLIZATION
- INTENSE SILICIFICATION
- BRECCIATION
- Oves ORDOVICIAN VININI Fm. (CHERT & SHALE)
- Tc TERTIARY CARLIN Fm.
- NORMAL FAULT
- BEDDING (GENERAL - STRIKE & DIP)



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APPROX. SCALE : 1" = 200'

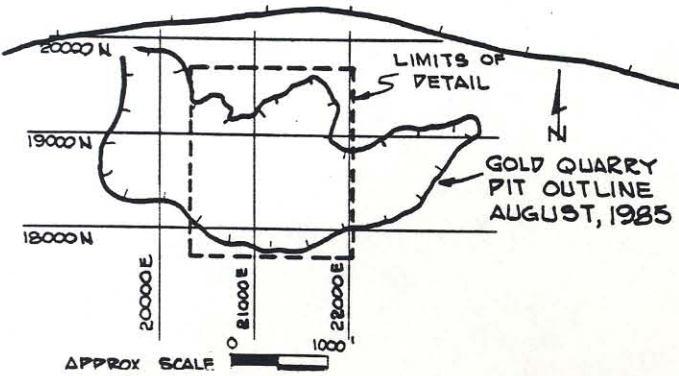
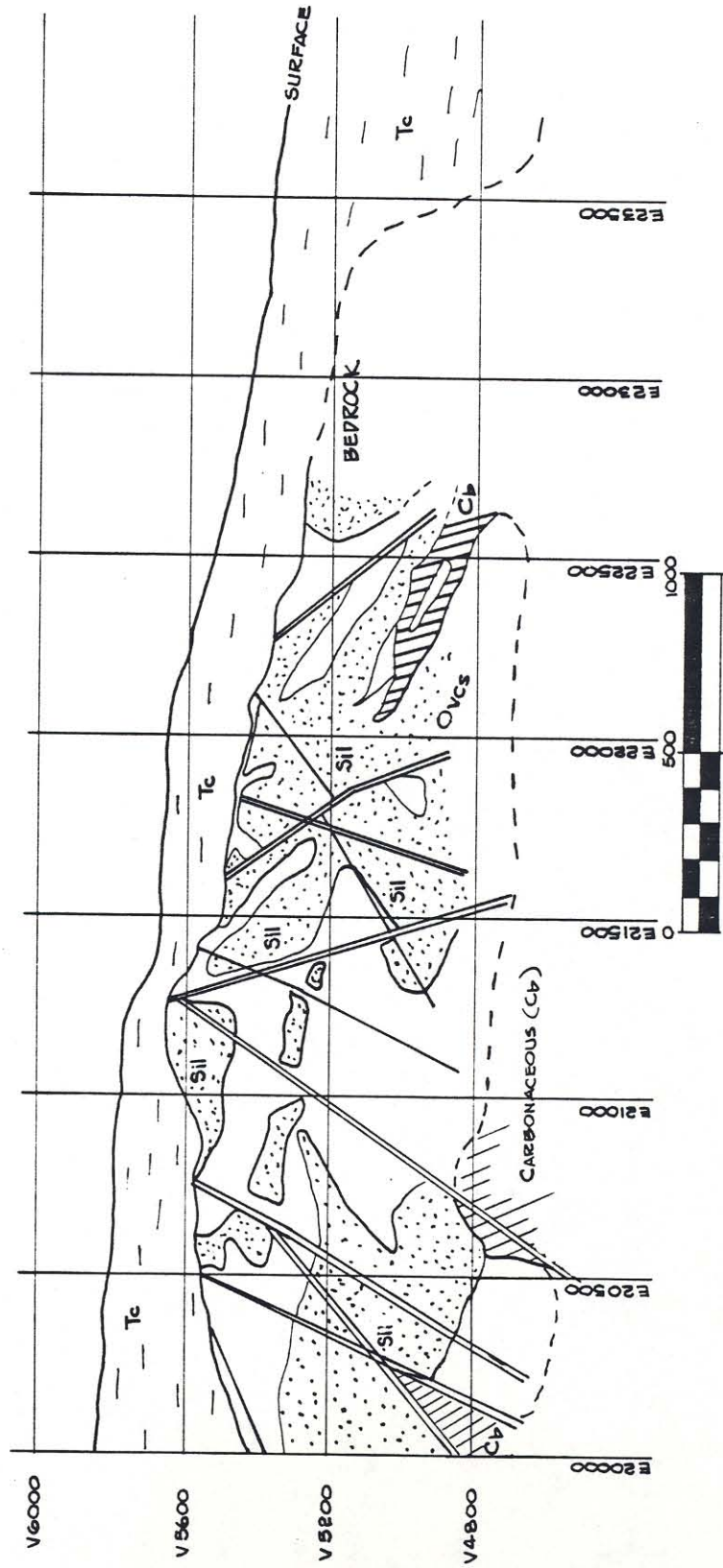


FIGURE No.3
GOLD QUARRY
COMPOSITE PIT GEOLOGY
8/24/85



SCALE: 1" = 500'
FIGURE No. 4

GOLD QUARRY SECTION 18,100N COMPOSITE GEOLOGY SHOWING SILICIFIED AREAS AND CARBONACEOUS ZONES

fracturing along these trends can be traced from faults 3m wide down to fractures only a few centimeters apart. Microfracturing is pervasive and is usually filled with minute quartz veinlets.

Nearly all faults show signs of repeated movement, especially the larger northwest trending faults now exposed. The northwest trend of the Good Hope fault dominates the current Gold Quarry pit geology and ore distribution, with northeasterly trending structures in a subordinate role. The presence of large siliceous faults within the Gold Quarry ore zones appears to have been enhanced by hydrothermal solutioning and brecciation as the faults are much less noticeable when away from centers of ore deposition. Seismic, or mechanical, brecciation appears to have provided fluids an open access through these structures, allowing additional hydrothermal brecciation and microbrecciation to occur.

Many ore zones within the deposit display silica cemented hydrothermal breccias as veins and pod-like bodies ranging from 2cm to 20cm in width. Angular to rounded clasts are locked within a quartz or quartz-barite matrix and may have been repeatedly brecciated. Clasts range from 1mm to 5cm. Evidence for mechanical brecciation is lacking at these small occurrences.

The combination of large, open space, siliceous to moderately argillic breccias, barite crystals, abundant manganese oxides and iron oxides appears to define possible hydrothermal "vent" areas. Small gypsum crystals have also been noted to occur in these open breccias, near the paleosurface. According to Berger (1985), areas of this type may have been formed by

predominantly gaseous discharges. Aqueous fluids were prevented from flooding these areas because of their probable formation during a late-stage period of steam dominance in the hydrothermal system. These areas are often isolated (at northeast/northwest structural intersections) and are not highly mineralized.

Secondary ore controls are provided by the host rock lithologies. Relatively porous siltstone and silty limestone are noted to localize small ore pods away from controlling structures. The dense primary cherts that occur within the Vinini Formation are mineralized on fracture surfaces only and, therefore, tend to be of lower grade than the more permeable lithologies.

According to Hausen (1983), gold mineralization began immediately following initial silicification, and continued up until the latest silicification events. Through petrographic examinations conducted while studying a large mass of highly silicified rock, Hausen states, "Gold mineralization appears to have occurred over an extended period of time, beginning with the early introduction of barite-quartz veins and continuing during the waning stages of late cherty silicification. The most intense period of gold mineralization appears to be associated with this late stage of silicification, related to low temperature hot springs activity." The gold particles occur mostly as fine, native granules between 10.0 and <1.0 micron in size, associated with microfractures or a microcrystalline cherty matrix.

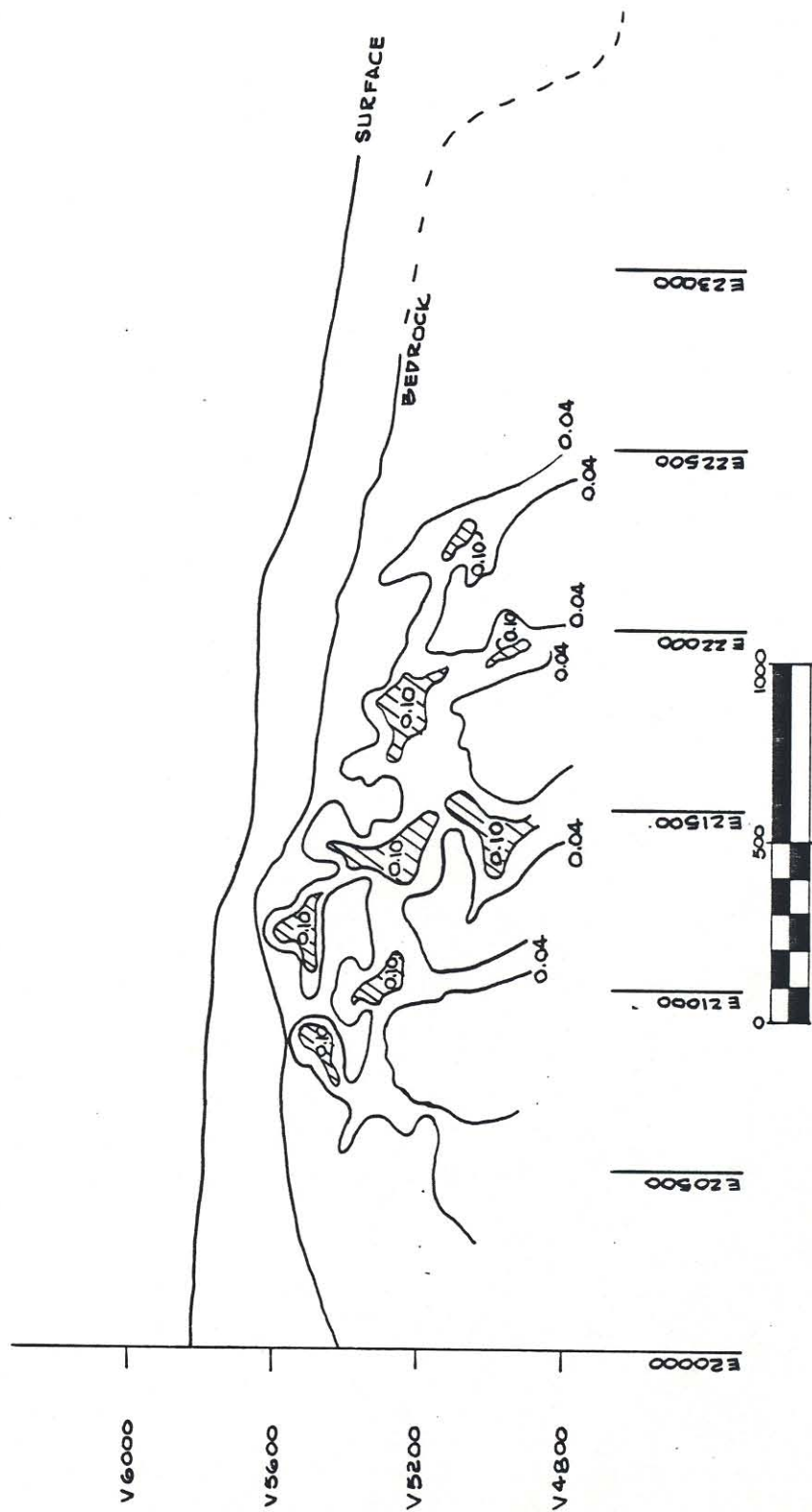
Commenting on the highly fractured nature of Gold Quarry,

Hausen also states, "Several periods of microfracturing relevant to gold mineralization are evidenced from microscopic examination of thin sections. At least three periods are recognizable, the first of which was noted as pattern fracturing, occurring in over half of the samples of siliceous chert. This close-spaced pattern fracturing ... (contains) much of the gold, and (has) been recemented to a major degree, resulting in a refractory lockup of a portion of this gold. A later period of fracturing occurred during later stages of epigenesis, transgressing earlier pattern fractures and retaining a more vuggy open structure. Small amounts of gold have also been observed along these partially open fractures ... A final period of fracturing is post-mineral in nature, related possibly to post-mineral faulting at Gold Quarry. These latest fractures are generally open and may contain varying amounts of iron oxides, clays, and alunite." Open fracture density usually ranges from 3cm to 10cm in argillized rock and from 10cm to 1m in the silicified rock at Gold Quarry, quartz-filled microfracture density ranges down to a spacing of about 50 microns.

GEOCHEMISTRY

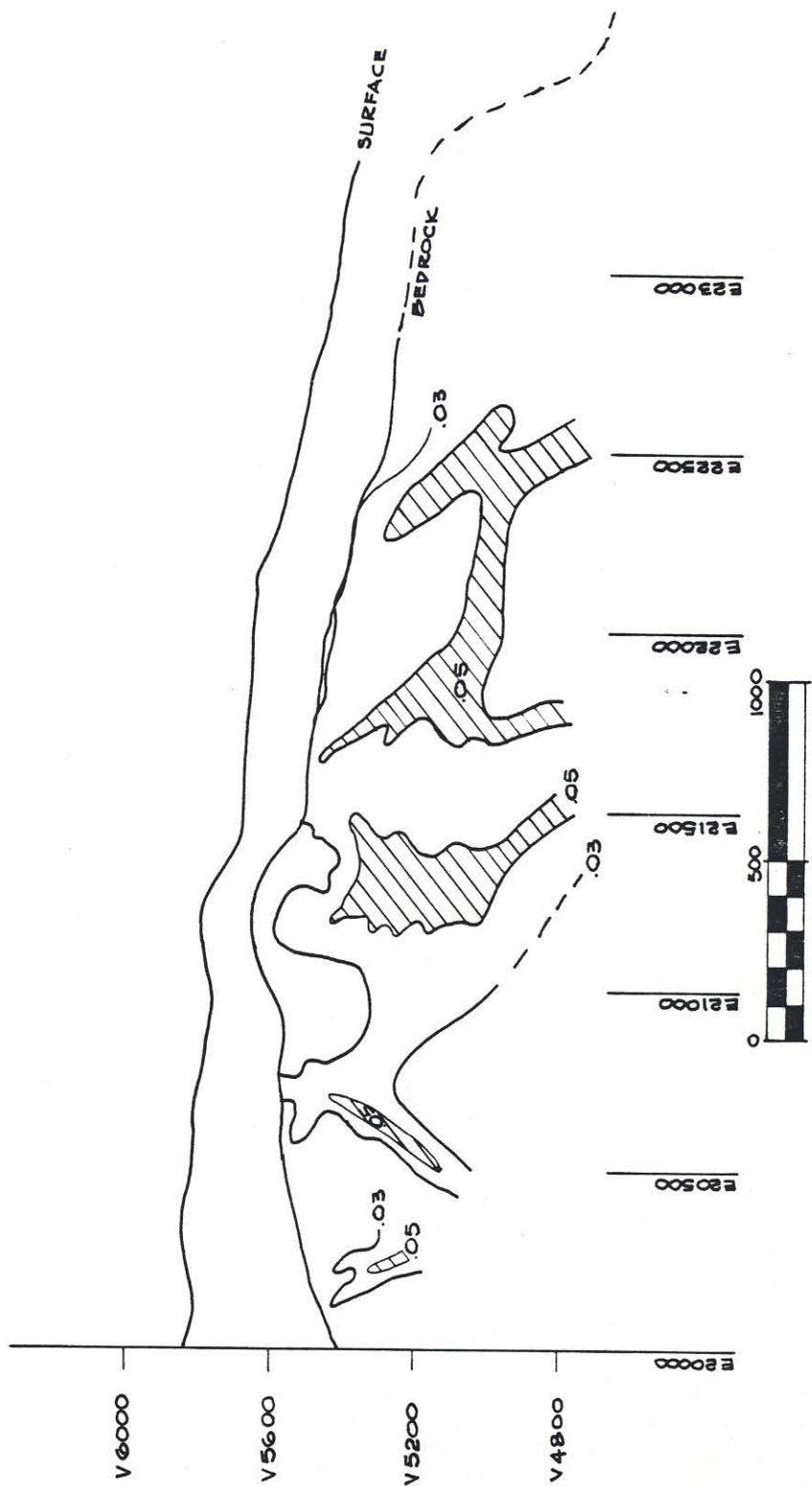
The best geochemical pathfinder to the Gold Quarry deposit was found to be gold (Fig. 5 and Table 2). Sampling of soils, rock chips, and stream sediments provided surface indications of the orebody's existence. As mentioned before, surface sampling was limited due to the extensive Tertiary cover.

The second best indicator of gold mineralization was arsenic (Fig. 6 and Table 2). High geochemical arsenic values are found



SCALE: 1" = 500'
FIGURE No. 5

GOLD QUARRY SECTION 18,100N
MAIN GOLD QUARRY ORE BODY
GOLD VALUES IN OUNCE/TON



SCALE : 1" = 500'
FIGURE No. 6

GOLD QUARRY SECTION 18,100N
MAIN GOLD QUARRY ORE BODY
ARSENIC VALUES POSTED IN WEIGHT %

TABLE #2

GOLD QUARRY GEOCHEMICAL VALUES

(Distribution in parts per million)

WHOLE DEPOSIT (Disseminated or area values)		LOCAL VALUES (Structural Control)
Au	0.3 - 1.6 ppm	>6.9 ppm
Ag*	0.1 - 1.6	>6.9
As	200.0 - 300.0	>500.0
Mn	<400.0	500.0 - 1000.0
Pb	<100.0 - 200.0	500.0 - 3000.0
Ni	<100.0	300.0 - 1000.0
Sb	<50.0	200.0 - 2000.0
Cu	<50.0	200.0 - 1500.0
Hg	<1.0	3.0 - 12.0

*Limited data.

directly associated with mineralized zones. This arsenical overprint is common at other disseminated gold deposits, including the Carlin Main, Maggie Creek, and Bluestar mines. The arsenic geochemistry appears to be controlled by the same structures and lithologies that control gold mineralization. Arsenic is more mobile than gold and produces a slightly larger geochemical anomaly.

Silver is present in highly anomalous amounts at Gold Quarry. Limited testing has shown silver occurring at about 2:1 Au/Ag ratio in mill grade ores, ranging up to 1:3 in leach grade ores. This is high when compared with the Au/Ag ratios normally associated with Carlin type deposits. Grab samples that assay up to 2.5 oz./ton silver have been taken from large structures. Silver mineralization appears to predate gold; a generally disseminated background of silver values, overprinted by gold mineralization, is indicated in limited drill sample studies. Both silver and gold seem to be controlled by the same major structures.

Geochemically anomalous antimony, copper, lead, nickel, and zinc occur in the Gold Quarry deposit (Table 2). Numerous green montmorillonitic clay seams containing anomalous iron and nickel are found in the surficial areas of the deposit. Small specimens of acicular, fibrous, bright green malachite crystals have been collected from the lower levels of the current pit. Most of the anomalous geochemistry is restricted to fault-controlled ore zones. Mercury is also present, but occurs only in trace amounts.

GENETIC MODEL

Several factors point directly to an eroded epithermal hot springs model for the Gold Quarry deposit. The spatial relationships between gold mineralization, jasperoids, silicified wallrock, various zones of argillized rock and seismic and hydrothermal brecciation are summarized in this section.

The concept of a silica cap and the occurrence of large jasperoidal faults at Gold Quarry are consistent with the model of Hedenquist and Henley (1985). In defining pre-existing conditions to a hot springs eruptive event, Hedenquist and Henley show a schematic figure (Fig. 7A) dealing with a "fracture network within a silicified zone as that at Waiotapu, and the pressure distribution in this upper boiling or two-phase zone of the system (Fig. 7B). Curve 1 is the hot water hydrostatic pressure gradient and curve 2 is the approximate hydrodynamic gradient indicated from measurements in active geothermal systems ... As fluid ascends, its temperature is constrained by the boiling point for a given pressure (i.e. depth). The liquid cools by vapor loss as it approaches the surface resulting in silica deposition (usually as quartz at depths below 100m or so and as chalcedonic silica above). Boiling also causes gases to fractionate preferentially into the vapor phase ... resulting in deposition of calcite and other minerals, including ore minerals. Deposition serves to decrease the permeability in the upper portion of the system. However, flow paths to the surface become sealed at different rates depending on, among other factors, temperature and the ratio of flow rate to fracture width; thus, all available channels do not seal simultaneously. Furthermore, tectonism in these systems continually provides new channels."

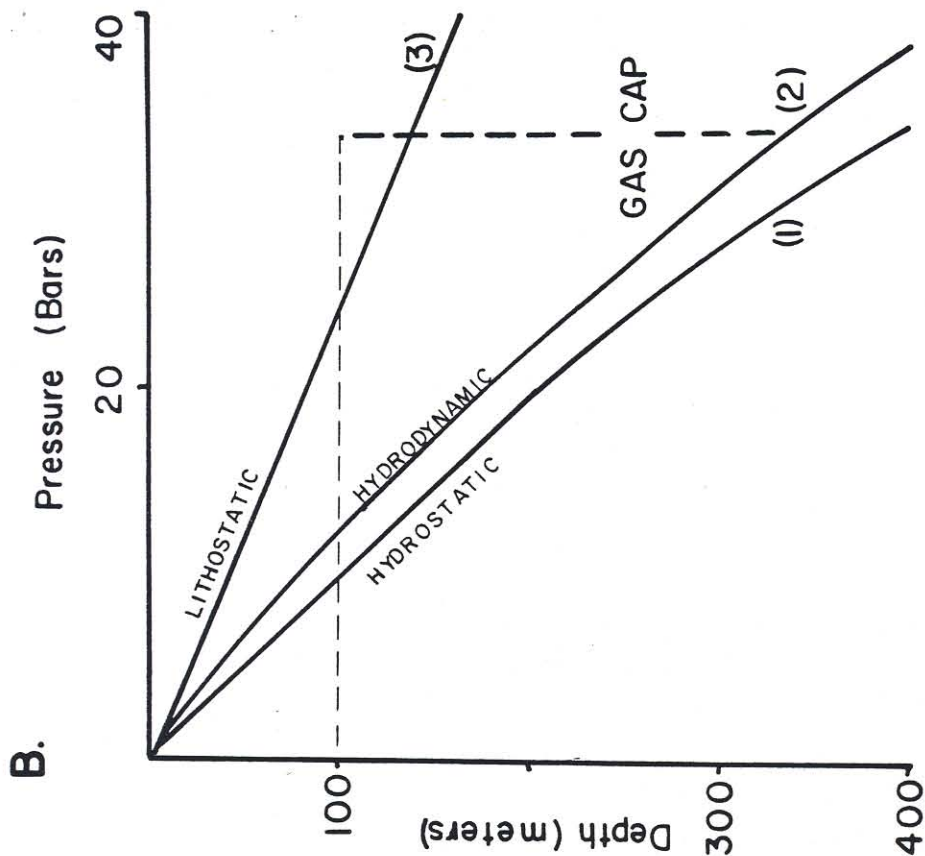
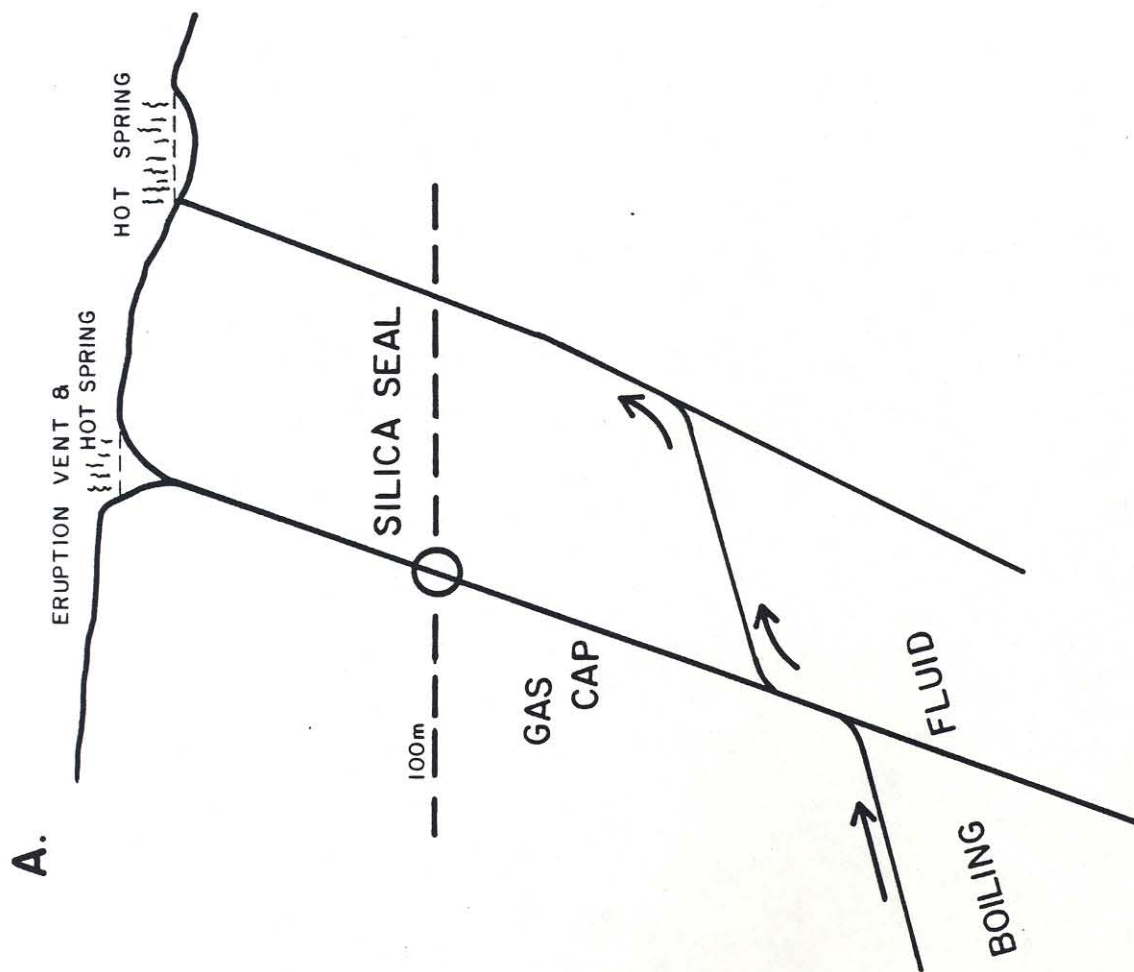


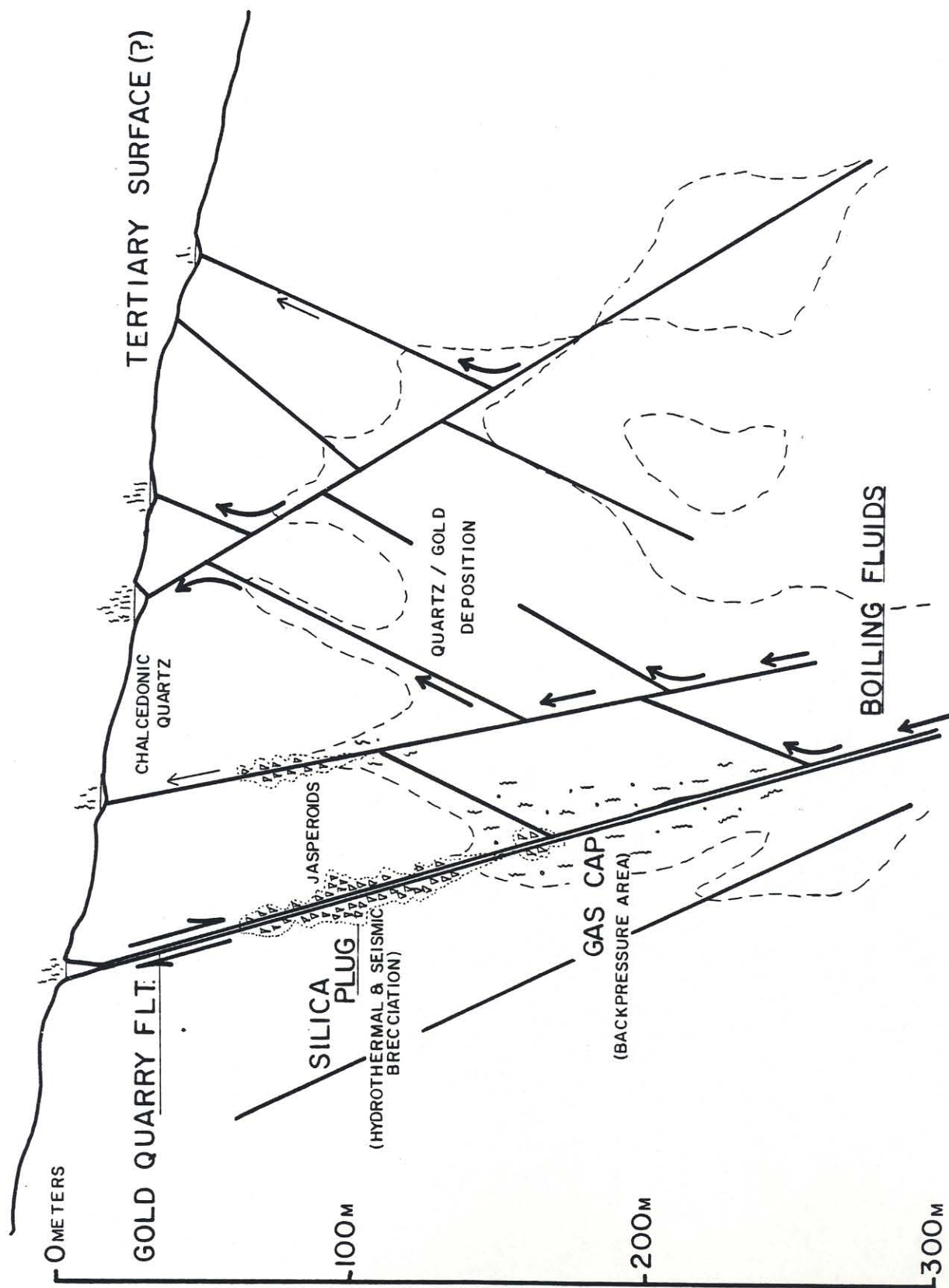
FIGURE 7.
(AFTER HEDENQUIST & HENLEY)
(1985)

A local interpretation of this concept for Gold Quarry is sketched in Figure 8. A highly fractured hanging wall provides accessible channels when the main feeder conduit (in this case, the Gold Quarry fault) becomes plugged with silica. Repeated tectonic movement and/or hydraulic fracturing brecciates and opens the silica plug, releasing the backpressure from below. Silicification and mineralization in the hanging wall rock decreases as the main conduit vents to the surface. Resealing begins again, possibly lower in the conduit due to a decrease in lithostatic pressures since the first sealing event. The jasperoids we now observe at the surface are developing at this point.

More similarities to a hot spring model for Gold Quarry come from Hedenquist and Henley's description of the active geothermal system at Waiotapu: "If local silica sealing occurs in the system, the pressure will rise slightly, with fluids diverting to other hot springs. The sealed fracture, however, accumulates vapor which has separated from the underlying boiling hot water flow. Steam condenses in the fracture and drains back leaving relatively insoluble gases below the seal. The compressed gas transmits the pressure of the flowing fluid to the seal ... As gas exsolution proceeds, the depth of the gas column increases, and with it, the pressure on the sealed point moves toward lithostatic." (dashed line to curve 3, figure 7B).

The final event in this cycle is described by Hedenquist and Henley: "If the geometry of the fracture network permits, the pressure on the seal may exceed lithostatic pressure sufficiently

FIGURE 8. SKETCH SECTION OF GQ AREA
(Showing mineralization, silicification and jasperoid formation)



(i.e. by the tensile strength of the rock) to induce hydraulic fracturing and trigger a hydrothermal eruption."

Using this model, jasperoid formation within the large, high angle normal faults that border the Roberts Mountains Formation can be directly linked to repeated silicification of the host lithologies. These faults were part of the plumbing system that provided access for the ascending hydrothermal fluids. Brecciation and silicification are noted to have occurred periodically within these structures. This indicates a repeated history of seismic and hydrothermal events. Periodically, these conduits became plugged or sealed off near the surface by silica deposited within them. The silica plug and resultant backpressures forced fluids out into the hanging wall fracture-permeable rock units. Repetition of the cycle during epigenesis would tie the overlapping zones of hypogene silicification observed in the deposit to the multiply brecciated and silicified jasperoids. Jasperoid bodies at Gold Quarry are noted to die out at depth (existing over a vertical range of about 75m), indicating some fluctuation in depth of formation of the silica seal. Areas of 'spongy' (porous - vuggy) silicification are often found associated with the large jasperoid bodies, and may be indications of a near-surface environment (Berger, 1985).

The spatial distribution of argillic alterations at Gold Quarry also lend itself to the hot springs model. Deere et. al. (1966) note that, in laboratory experiments and at low temperatures and pressures, acidic conditions favor the formation of kaolinite. These are the conditions that could be expected in

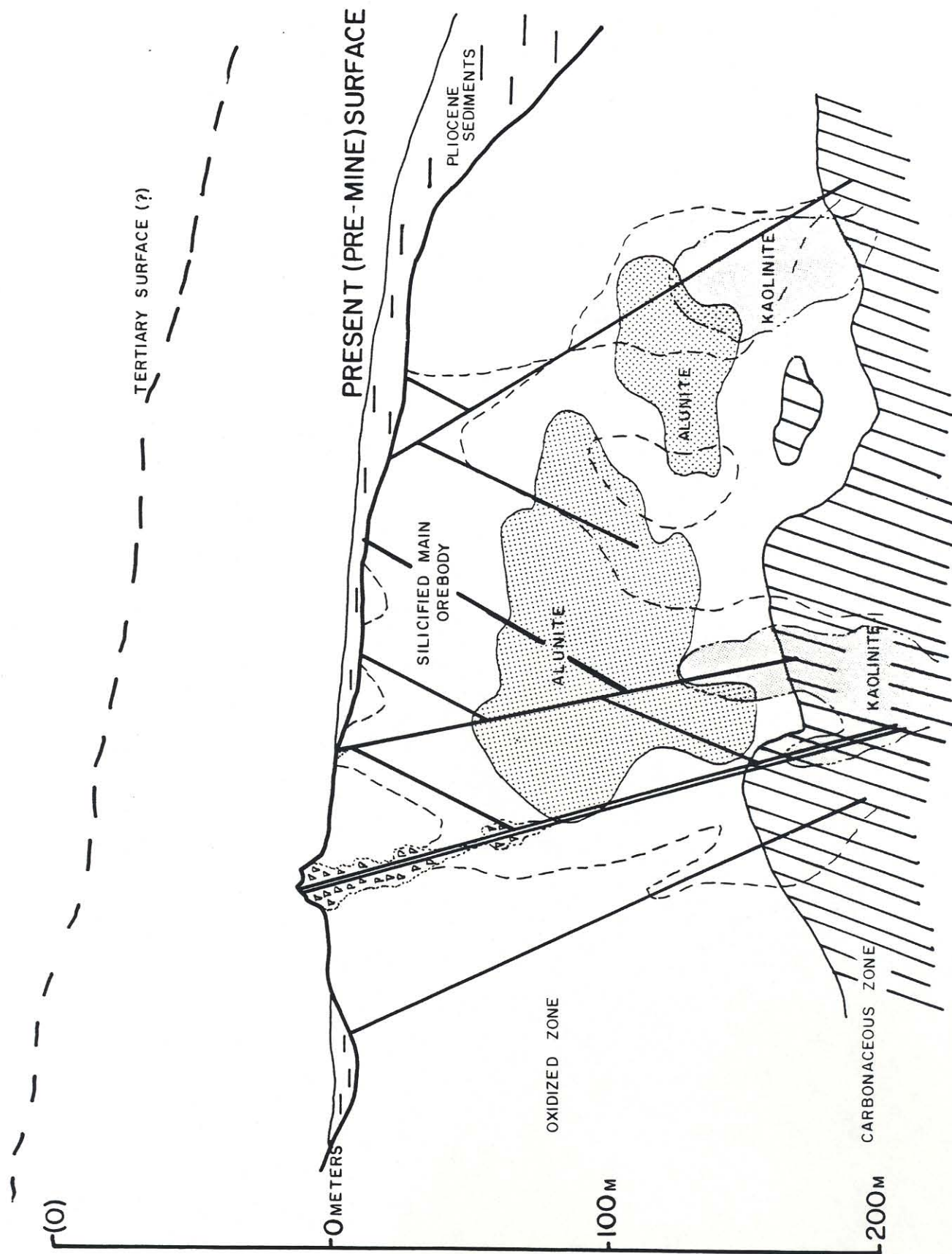
a hot springs environment. Solfateric alteration typical of hot springs is noted in the present pit and in XRD-XRF studies by Hausen et al.(1983).

The nature of the hypogene argillic alteration at Gold Quarry was probably intensified by other 'acid leaching' processes. It is highly likely that descending argillization by acidic waters (Schoen et al. 1974) has occurred at Gold Quarry. Schoen states that, "Features diagnostic of a surficial alteration are the relict rock structures of a siliceous residue and a kaolin-alunite zone immediately beneath." Quarry's silica 'cap' and concentrations of kaolinite beneath an alunitic zone seem to fit this model (Fig. 9).

Finally, support for a hot springs environment can be indirectly gathered from the pathfinder elements present at Gold Quarry. The elemental association of Au, Ag, As, Pb, Mn, Cu, Ni, Sb, and Hg at Gold Quarry is similar to the group reported from the active hot springs at Waiotapu (Hedenquist and Henley, 1985), although the concentrations vary somewhat. The report of an elevated Au/Ag ratio (1:100) taken from a 1" quartz vein at a depth of 150m below the surface at Waiotapu can be related to the relatively high (2:1 to 1:3) overall Au/Ag ratios reported at Gold Quarry, possibly suggesting a similar depth of formation.

The age of mineralization at Gold Quarry is still in question; the following is offered as a relative dating only. The precursor to the Humboldt drainage system was dammed by Tertiary volcanic flows between 6 and 17 Ma. This led to sedimentation in the Pliocene (1.6 -5.3 Ma) and the deposition of

FIGURE 9. SKETCH SECTION OF GQ AREA
(Showing present argillization and oxidation patterns)



the Carlin Formation. Siliceous mineralized material from Gold Quarry is incorporated in this unit as basal gravels lying immediately above the unconformable bedrock contact and as gravel bars throughout the unit. Erosion of the deposit may have occurred concurrent with mainstage mineralizing events and, as evidenced by the Tertiary gravels, definitely after. This places the age of mineralization as older than 6 Ma. Stewart, 1980, shows that Cenozoic igneous activity in Northeastern Nevada was at its peak between 43 and 34 Ma. Mineralization is probably related to the high heat flow and crustal extension that began in this area at that time. This dating (between 43-6 Ma.) is tenuous at best, and is meant to show a possible mid-to-late Tertiary age of mineralization.

ACKNOWLEDGEMENTS

The geological evaluation of the Gold Quarry deposit has extended over many years, occupied the time and efforts of many people and is still far from complete. This paper draws heavily upon the extensive works of Dr. Don Hausen and would be lacking in detail if not for his many years of research. The author extends special thanks to Mr. Charles Ekborg for his geological input and editing of this paper. Thanks are also extended to Dr. Odin Christensen, Gale Knutsen, Deb McFarlane, Tyler Shepherd, and Chuck Zimmerman for their review and comments on this paper. The extensive efforts of Walt Smith for drafting and Lisa Hanson for wordprocessing are also acknowledged. The author also extends thanks to Mr. Don Hammer, Dr. Robert Miller, and Newmont Mining Corporation for allowing the publication of this work.

NOTE:

As of May 5, 1986, Carlin Gold Mining Company was re-named Newmont Gold Company, a public corporation.

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