Whole-Rock Oxygen Isotope Traverses Across Gold-Bearing and Barren Structures, Lone Tree Complex, Nevada

By
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ABSTRACT

The Lone Tree Complex includes the Lone Tree, North Peak, and Trenton Canyon deposits. These fine-grained gold deposits, hosted in Paleozoic sediments, are variations of Carlin-type deposits with ore zones being structurally controlled. Both gold-bearing and barren structures have hydrothermal alteration centered along faults that is indicated by an increase in modal percent of alteration minerals towards the structure. The alteration mineral assemblage is dominated by quartz, fine-grained white-phyllosilicates (sericite), oxidized sulfide (mainly pyrite), and locally, clays and chlorite.

Whole-rock oxygen isotope traverses across gold-bearing and barren structures record isotopic alteration resulting from deposition of alteration minerals and water-rock exchange. On a district-scale, oxygen isotopes are inconclusive at detecting ore zones. All gold-bearing traverses have depletions at the fault zone relative to background values, while barren traverses produced either an enrichment (North Peak) and a depletion (Lone Tree) at the fault zone. On a deposit-scale, correlation of oxygen isotope composition and ore zones can be made. Gold-bearing structures are associated with more oxygen isotope alteration (change relative to background values) than the barren structures. At Lone Tree, North Peak, and Trenton Canyon gold-bearing quartz was isotopically lighter than the barren quartz, respectively, by 8.8 ‰, 4.1 ‰, and 9.9 ‰.

Calculated oxygen isotope composition and fluid inclusion data indicates multiple sources of fluid for deposits of the Lone Tree Complex. A regional, barren formation water is documented by temperature and salinity measurements in inclusions and calculated oxygen isotope compositions from the three deposit areas. This formation water ranges in both salinity and oxygen isotope composition, respectively, from 3.0 to 18.0 eq.wt. % NaCl and 8.5 to 13.1 ‰, and ranges in homogenization temperature from 170 to 310°C, with the upper range resulting from mixing with a higher temperature magmatic fluid at Lone Tree.

At Lone Tree, a magmatic source for gold-bearing fluid is suggested by the range in homogenization temperatures from 280 to 400°C and salinity from 12 to 39 eq.wt. % NaCl (Kamali, 1996). Calculated oxygen isotope composition of gold-bearing fluid (6.5 ‰) supports this conclusion. Ranges in salinity and homogenization temperature for gold-bearing and barren samples suggest mixing between the gold-bearing and barren fluids. Trenton Canyon gold-bearing fluids had calculated $\delta^{18}O$ of 0.0 ‰, indicating an evolved meteoric fluid. This meteoric fluid, ranging in homogenization temperature from 210 to 350°C and salinity from 2.6 to 5.7 eq.wt. % NaCl, can be approximated by mixing the Lone Tree magmatic fluid and a local meteoric water (-6 to -9 ‰) established at Twin Creeks and Getchell deposits (Groff, 1996). Further mixing of this fluid with the barren formation water lowers salinity and homogenization temperatures from values expected by a true meteoric-magmatic mixing trend. Gold-bearing fluid at North Peak had calculated $\delta^{18}O$ value of 8.5 ‰. Mixing between meteoric water and the regional barren formation water produces the oxygen isotope composition, along with ranges in homogenization temperature (170-270°C) and salinity (3.7-14.0 eq.wt. % NaCl). As with the Lone Tree and Trenton Canyon deposits, salinity and homogenization temperatures at North Peak from gold-bearing and barren samples indicates mixing between the barren and gold-bearing fluids.

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Date

INTRODUCTION

Fine-grained sediment-hosted gold deposits, often referred to as "Carlin-type" deposits, were discovered in 1961. Since the initial finding, more than 40 such deposits have been discovered along the Carlin Trend. Variations in the type deposit are a continuum from lithologic control (Carlin) to structural control of ore zones. To date, over 25 million ounces of gold have been mined from the Carlin Trend (Lewis and Jackson, 1997). The Battle Mountain-Eureka Trend, 50 miles west of Carlin, also contains fine-grained sediment-hosted deposits, such as the Lone Tree Complex, which are classified as Carlin-type deposits. The Lone Tree Complex includes the Lone Tree deposit as well as two satellite deposits, North Peak and Trenton Canyon. The Lone Tree deposit is located in Humboldt County, Nevada, approximately 30 miles east of Winnemucca; Trenton Canyon is 12 miles south of Lone Tree and North Peak is 3 miles west of Trenton Canyon (Fig. 1). Lone Tree complex appears to be a structurally controlled variety of Carlin-type deposits.

Despite the fact that Carlin-type deposits have been the focus of much research, many aspects of the genesis of these deposits still remains unsettled. Although numerous investigators have concluded that the Carlin deposit formed in an epithermal, hot spring environment (Radtke et al., 1980; Radtke, 1985; Rye, 1985), a much deeper setting, of up to 520 to 910 meters, has been suggested by others (Hardie, 1966; Roberts et al., 1971; Roberts, 1986). An even deeper formation depth of 3.8 ± 1.9 km was suggested by Kuehn and Rose (1995) to accommodate pressure estimates from fluid inclusions.

Another uncertainty in the genetic models for this type of deposit are the number and types of fluids involved in the hydrothermal system. Meteoric, magmatic, metamorphic, and formation waters, (and combinations thereof,) have all been proposed in genetic models. Numerous studies have concluded that ore-bearing fluids were evolved meteoric water at the Carlin (Radtke et al., 1980; Rye, 1985), Cortez (Rye, 1985), Vantage (Ilchik, 1990), and the Jerritt Canyon deposits (Hofstra et al., 1991). Fluids termed "evolved" have enriched oxygen isotope compositions, which do not lie on the meteoric water line. The oxygen isotope

Fig. 1. General geology and geographic location of the Lone Tree, North Peak, and Trenton Canyon deposit areas. Modified from Doebrich and Theodore (1996) and Roberts (1964).

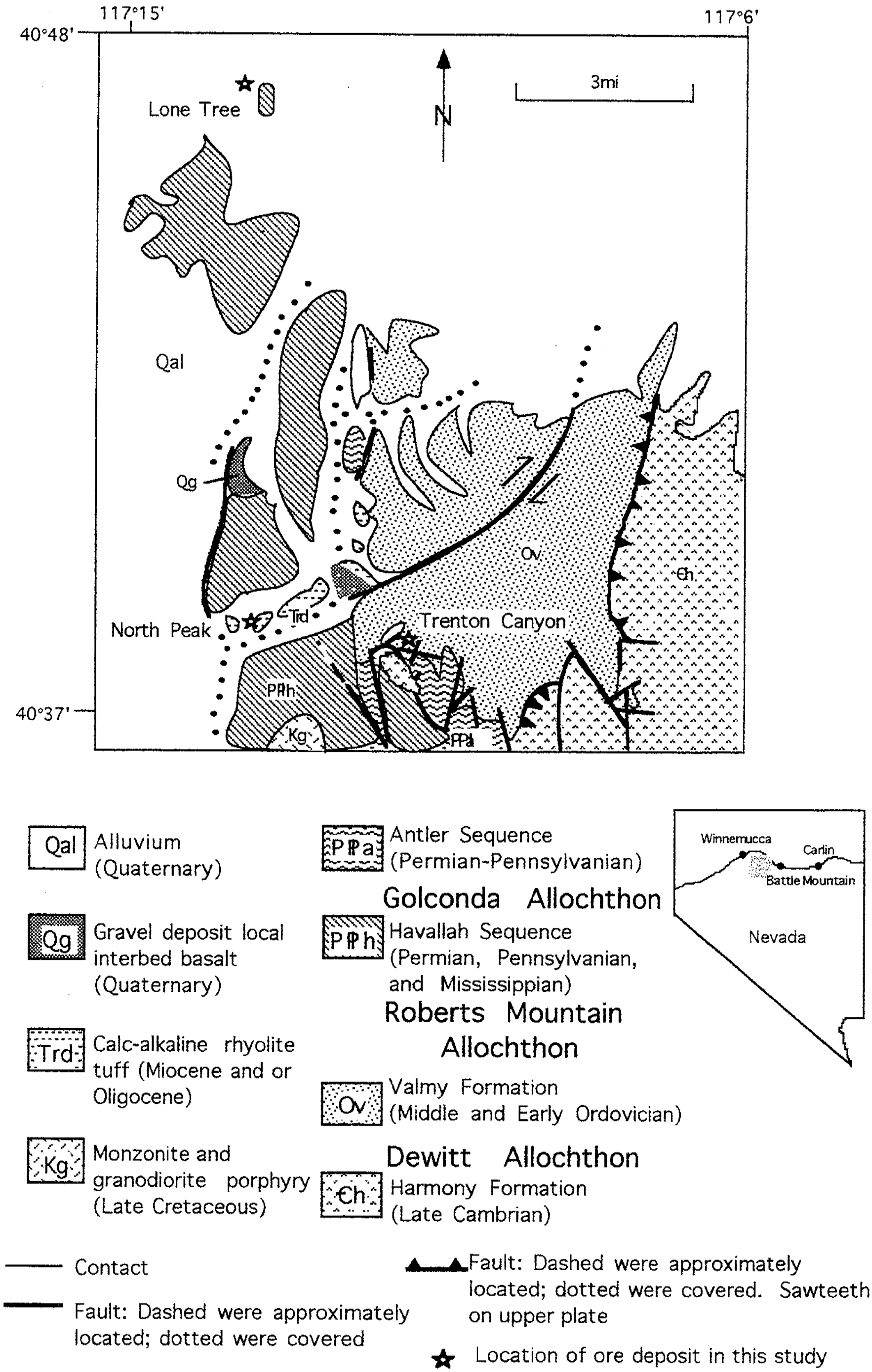

117°15'
117°6'
40°48'
40°37'
3mi
N
Lone Tree
Qal
Qg
Ov
Єh
North Peak
Trd
Trenton Canyon
PPh
Kg
PPa
Qal Alluvium (Quaternary)
Qg Gravel deposit local interbed basalt (Quaternary)
Trd Calc-alkaline rhyolite tuff (Miocene and or Oligocene)
Kg Monzonite and granodiorite porphyry (Late Cretaceous)
PPa Antler Sequence (Permian-Pennsylvanian)
Golconda Allochthon
PPh Havallah Sequence (Permian, Pennsylvanian, and Mississippian)
Roberts Mountain Allochthon
Ov Valmy Formation (Middle and Early Ordovician)
Dewitt Allochthon
Єh Harmony Formation (Late Cambrian)
Winnemucca
Carlin
Battle Mountain
Nevada
Contact
Fault: Dashed were approximately located; dotted were covered
Fault: Dashed were approximately located; dotted were covered. Sawteeth on upper plate
Location of ore deposit in this study

Fig. 1

enrichment can result from either exchange with host rocks or mixing with an (isotopically) heavier fluid. Sillitoe and Bonham (1990) suggest that the alignment of fine-grained sediment hosted gold deposits along the Carlin, Battle Mountain-Eureka, and Getchel Trends with structural windows and intrusive rocks, promotes hydrothermal circulation and contributes some component of fluid or metal, which has been proposed at the Carlin (Radtke et al., 1980; Rye, 1985), Cortez (Rye, 1985), Purísima Concepcíon, Peru (Alvarez and Noble, 1988), Getchel and Twin Creeks (Groff, 1996), and Lone Tree deposits (Kamali, 1996). Alternatively, metamorphic fluids are proposed by Seedorf (1991) for Carlin-type deposits in the Great Basin. Seedorf suggests that these fluids are derived from devolatilization of the metasedimentary host rocks. Groff (1996) and Kamali (1996) in their respective studies at Getchell-Twin Creeks and Lone Tree, concluded that a formation water was also involved in the hydrothermal systems of some Carlin-type deposits.

Deposition of ore minerals in hydrothermal systems is often accompanied by alteration of the surrounding host rock. This hydrothermal alteration often results in isotopic alteration of the host rock. As summarized by Nesbitt (1996), it appears that in many different types of deposits, whole-rock oxygen isotope mapping or distinguishing between mineralized and barren vein systems with oxygen isotope compositions can be advantageous in the search for hydrothermal ore deposits. Isotopic studies of precious-metal epithermal deposits (Taylor, 1973; O' Neil and Silberman, 1974; Criss and Taylor, 1983) established the background knowledge to investigate this exploration technique. From these early studies and others, the correlation of an isotopic depletion and the occurrence of precious-metal epithermal deposits was established. Criss et al. (1985) in the Yankee Fork District of Idaho, established a correlation of low (compared to background samples) whole-rock $\delta^{18}O$ values and steep $\delta^{18}O$ contour gradients with economic mineralization. This isotopic alteration halo (approximately 75 km^2) extended past visible hydrothermal alteration, making mapping or contouring isotope values beneficial for exploration purposes.

Isotopic variations on a smaller scale can also be detected by sampling a traverse perpendicular to ore veins/faults. At the Helen Rae gold deposit New Mexico, Douglass and Campbell (1994) documented a decrease in whole-rock $\delta^{18}O$ values extending away from the mineralized vein; $\delta^{18}O$ values decrease from 7.6 per mil near the vein to 2.6 per mil over a distance of 30 feet. Douglass and Campbell (1994) conclude that extensive propylitic alteration of andesite host rock resulted in a regional isotopic depletion and pre-dates gold mineralization. The host rock near the vein, was in turn, re-enriched (approximately 4 per mil) by ore-bearing fluids. This oxygen isotope distribution trend, visible through pre-mineralization propylitic alteration, could possibly be used an exploration tool.

A different approach attempts to distinguish between mineralized and barren vein systems by the stable isotope composition of vein material. This technique relies on the fact that ore-bearing and barren fluids in hydrothermal systems are often chemically or thermally distinct or originate from different sources. Hydrothermal minerals deposited, therefore, have unique stable isotopic composition. This approach has been examined on mesothermal Au deposits. For example, within the Contact Lake gold deposit, Fayek and Kyser (1995) were able to statistically differentiate between mineralized and barren vein systems. Ore-bearing veins had $\delta^{18}O$ values which were up to 2 per mil heavier than barren veins.

In the past, research had not focused on whether stable isotopes could be used to detect Carlin-type mineralization. Recently, Stenger et al. (1998) investigated the presence of isotope halos around ore zones at Twin Creeks mine, a Carlin-type deposit; these authors report that $\delta^{18}O$ values of Ordovician limestone are lowest in ore zones and increase outwards towards "normal" values producing an oxygen isotope halo around the ore.

The first objective of this study was to investigate an exploration technique for the Lone Tree complex using oxygen isotope values. This technique involves oxygen isotope analysis of whole-rock samples from traverses across gold-bearing and barren structures. In addition, the

$\delta^{18}O$ of gold-bearing and barren hydrothermal quartz was analyzed to possibly differentiate between the two. Both gold-bearing and barren structures have alteration minerals associated with them. Therefore, "barren" refers to structures and hydrothermal quartz found within the fault, which lacks any gold content, established by fire assays. In contrast, fault zones and hydrothermal quartz associated with the structures termed "gold-bearing" had detectable concentrations of gold. Oxygen isotope trends in whole-rock samples are dependent on numerous factors including, but not restricted to, initial whole-rock oxygen isotope composition and deposition of alteration minerals. To determine the affects of these factors on oxygen isotope trends, a petrographic study was used to establish background samples and identify types and degree of hydrothermal alteration in the host rocks.

The second objective of this study was to infer the source of gold-bearing and barren fluids for the three deposits, along with speculating on interaction between the different fluid types such as mixing. This was accomplished by conducting a fluid inclusion and oxygen isotope study on quartz associated with gold-bearing and barren structures to characterize and differentiate the fluids by their salinity, homogenization temperature, and oxygen isotope composition.

Regional Geology

Rocks in the region of the Lone Tree complex Nevada (Fig. 1) are dominated by Paleozoic sediments, which include the Valmy Formation, Antler sequence, and Havallah sequence. The Ordovician Valmy Formation, consists of quartzite, argillite, minor chert and basalt. Along with the Harmony and Scott Canyon Formation, the Valmy Formation is an allochthon of the Roberts Mountain Thrust (Theodore 1991). As described by Roberts (1964), the Roberts Mountain Thrust brought the siliceous and volcanic assemblage from the west over the eastern carbonate assemblage, sometime between late Devonian and mid-early Mississippian (Smith and Ketner 1968, 1977).

Stratigraphically above the Valmy Formation and separated from it by an unconformity lies the Antler sequence. The Pennsylvanian age Battle Formation, lowermost in the Antler sequence, consists mostly of conglomerates and sandstones, locally with shales, calcareous shales, and limestones (Roberts, 1964). Unconformably above the Battle Formation is the Permian age Edna Mountain Formation, which consists of interbedded limy shales, sandstones, limestones, and chert conglomerates (Roberts 1964).

The Golconda thrust fault, late Permian or early Triassic in age (Silberling 1975), transported the structurally complex Havallah sequence over the Antler sequence. Emplacement of the Golconda allochthon has been interpreted as obduction of basin fill by back arc basin closing (Burchfiel & Davis 1975) or as an accretionary wedge, which is under-thrust by the continental slope (Miller et al. 1982; Speed 1979). As described by Murchey (1990), the Havallah sequence consists of thrust packages of upper Paleozoic chert, argillite, sandstone, sandy limestone, conglomerate, and greenstone, which include the Havallah and Pumpernickel Formations first described by Roberts (1964).

Mesozoic and Tertiary igneous rocks are widespread in the Battle Mountain district. Oligocene and younger ash-flow tuffs, along with Pliocene to Quaternary basalts, unconformably overlie all older rocks (Roberts, 1964). Northeast trending faults, related to Late Miocene extension of the Great Basin along the Midas Trough (Rowan and Wetlaufer 1981), are common throughout the area.

Mine Geology

At Lone Tree, the Valmy Formation is dominantly quartzite with local argillite and chert units. The Edna Mountain Formation is exposed in the mine and consists of a sucrosic sandstone and siltstone, which overlies the lithic sandstone unit. The Havallah sequence is divided into two units which include: 1) chert, argillite, and a greenstone unit, and 2) sandy limestone and a pebble conglomerate unit. Alluvial cover varies greatly from two feet to over 1000 feet. Igneous rocks at the Lone Tree deposit include rhyolite dikes east striking, which are often argillically altered. Potassium-argon dating of biotite and amphibole from unaltered dikes has produced ages of 39-36 Ma (Bloomstein et al. 1993). The only other igneous rock unit in the mine area is a granodiorite dike encountered by drilling. The Lone Tree pit area is structurally complex, with most faults striking north-northwest to north-northeast, with some cross structures such as the Poplar, Piñon, and Sequoia faults.

Within the North Peak pit, only the Havallah sequence is exposed. The Havallah consists of rocks from upper thrust packages of the sequence which are not exposed in the other two deposit areas. This sequence of rocks include a rhythmically banded siltstone, massive sandstone, siltstone (wacke), and limy siltstone units. Rhyolitic tuffs that outcrop at the North Peak property are considered equivalent to the Bates Mountain tuff, which has been dated at 25 Ma (DeLong, 1996). The pit area is highly faulted, with most faults striking north-northwest to north-northeast, although some cross structures exist.

Stratigraphy at the Trenton Canyon Project includes the Valmy, Battle, and Edna Mountain Formations and the Havallah Sequence. Valmy Formation consists of siltstones, greenstones, cherts, and quartzites, while the Battle Formation is dominated by conglomerates and sandstones with minor amounts of siltstone and limestone. Edna Mountain Formation, found only at the northwest corner of the project area, consists of pebble conglomerates and siltstones. The Havallah sequence is characterized by an alternating sequence of chert, siltstone, and minor sandstone. A quartz latitic ash flow tuff, the Caetano Tuff, is exposed at the southern end of the Trenton Canyon project as an erosional surface above the Havallah sequence. North-trending, intermediate-composition, dikes and sills, dated at 34.9 ± 1.0 Ma (K-Ar; sericite) are found throughout the deposit area (DeLong, 1996). The dominant intrusive rock is the 87 Ma Trenton Canyon Stock (Theodore et al., 1973), which is a medium grained granodiorite porphyry and outcrops southwest of the project area. Faulting is extensive at the Trenton Canyon project, with most faults striking north-northwest to north-northeast.

Mineralization

Gold mineralization at Lone Tree, North Peak, and Trenton Canyon deposits is similar in many aspects including: a) the size of gold particles; b) controls on the ore bodies; and c) mineral associations. The main difference between these deposits is that of total mineralized

rock volume. Gold reserves are approximately 2.0 and 12.0 million tons at 0.029 oz Au/ton for North Peak and Trenton Canyon, respectively, and 60.8 million tons at 0.077 oz Au/ton for Lone Tree
(B. Braginton, pers. comm., 1998).

Gold grains occur as sub-micron to micron size inclusions in both pyrite and arsenopyrite for sulfide ore and in goethite and other Fe-oxides in oxidized ore (Braginton, 1996). North Peak and Trenton Canyon comprise oxidized ores, while both oxidized and sulfide ores are found at the Lone Tree deposit. In general, ore zones at the three deposits are structurally controlled, however unique structural associations have been identified at each of the deposits.

Three structurally controlled ore zones have been defined for the Lone Tree deposit: 1) Wayne Zone; 2) Sequoia Zone; 3) Antler High Zone. The Wayne Zone is developed along the Powerline fault and consists of a group of north-northwest to north-northeast trending faults, dipping on average 65 degrees to the west, that envelope blocks of fractured rock (Bloomstein et al., 1996). The Wayne zone is from 150 to 300 feet wide with a known strike length of over 9000 feet. Similar to the Wayne Zone, the Sequoia Zone is located southwest of Lone Tree Hill. This zone has a north-south trend, dips 75 degrees to the west, and has a strike length of 2000 feet but is discontinuous due to displacement by cross-structures. The Antler High Zone is located within a horst block of mostly Antler sequence rocks that lies between the Wayne Zone and Sequoia Zone. The Redwood thrust fault doubles the thickness of Edna Mountain host rocks within the Antler High.

The ore body at North peak is mostly confined to a single, large-scale structural feature, the C.O.S. Zone. This zone is bounded by two normal faults striking between N04°W and N07°E and dipping 60 to 70 degrees to the west. The fault zone is a block of highly fractured and brecciated Havallah sequence rock. Maximum fault zone width reaches up to 50 feet, with a mineralized strike length of approximately 1700 feet.

Ore bodies at Trenton Canyon are also structurally controlled and occur at the intersection of high-angle normal faults with: 1) thrusts or litho-tectonic contacts within the Valmy and Havallah sequence; 2) stratigraphic units (i.e. Battle Formation); and an unconformity such as the Battle-Valmy Formation contact (DeLong, 1996).

SAMPLING AND ANALYTICAL PROCEDURES

Whole rock samples were collected across both gold-bearing (Lone Tree, North Peak, and Trenton Canyon) and barren (Lone Tree and North Peak) fault zones. Fist size samples were collected from approximately mid-bench level on both sides of the fault zone, at distances of 0.5, 1.0, 3.0, 5.0, 10.0, 15.0, 25.0, 50.0 feet away from the fault zone outer margins, and from within the fault zone. If another fault was encountered, the traverse distance was shortened (Trenton Canyon) or the distance was varied (North Peak). All benches which contain the traverse were mapped for lithology, structure, and alteration (Appendix 1). A tape measure extended between two surveyed points was used to determine sample location. Rock samples were split, with half used for petrographic analysis and the other half crushed and sieved for whole-rock oxygen isotope analysis. In most instances, rock units most distal from the fault along the traverse and showing no hydrothermal alteration were used as background samples. Where this could not be accomplished, samples (i.e., Battle conglomerate and Havallah siltstone) were taken from expectedly less-altered zones outside the traverse. Background samples are needed for comparison of hydrothermal alteration assemblages and whole-rock oxygen isotope composition to traverse samples along with discriminating from pervasive pre-mineralization alteration (discussion below).

Quartz from both barren and ore zones were sampled at Lone Tree, North Peak, and Trenton Canyon. Samples are referenced to a known location such as a drill hole, water monitoring station, or road cut sample location; field notes such as quartz occurrence, host lithology, and alteration were noted (Appendix 1).

Oxygen from whole-rock and quartz samples was liberated using chlorine-tri-fluoride and converted to CO_2 as established by Clayton and Mayeda (1963) and Borthwick and

Harmon (1982). Isotopic analysis was performed on a Finnigan MAT Delta E mass spectrometer. Using OZ-Tech gas standards, isotope analyses are reported as per mil deviations from V-SMOW using standard δ-notation . NBS-28 was analyzed 45 times with an average value of 9.36 per mil, and a reproducibility of ± 0.15 per mil (Appendix 2). A total of 124 samples were analyzed for oxygen isotope composition, and random duplicates of 30 samples were reproducible up to ± 0.15 per mil (Appendix 3).

A total of 47 samples from both gold-bearing and barren traverses at Lone Tree, North Peak, and Trenton Canyon deposits were prepared for thin section analysis (Appendix 4). Standard thin sections with no cover slip were prepared by Gold Hill Geological Research of Albuquerque, New Mexico. Thin sections were analyzed using a standard polarized microscope with distilled water as a cover slip for better clarity.

Seven double-polished quartz wafers from both gold-bearing and barren zones were prepared for fluid inclusion analysis. Thermometric analyses were performed on a Linkam THMS-600 heating stage using an 80 power objective. Synthetic water and CO_2 inclusions, along with vanillin, caffeine, and potassium dichromate crystals were used for calibration of the stage. The stage is accurate to within ± 0.1°C at 0.0°C and ± 3°C at 400°C. Resulting from the small size of inclusions, a "cycling" method was adopted for salinity measurements made in all samples. This method entailed freezing inclusions until a irregular boundary appeared around the vapor bubble. The inclusion, now assumed to have some form of ice, was slowly heated until the irregular boundary disappeared or the bubble abruptly moved. The inclusion was immediately frozen to try to nucleate ice, resulting in an irregular boundary around the vapor bubble. If an irregular boundary was obtained, heating continued above the previous temperature to obtain a more accurate temperature. These steps were repeated until a maximum melting temperature was obtained. Measurements were reduced with the FLINCOR program by Brown (1989).

RESULTS

Alteration

Numerous samples from both gold-bearing and barren traverses at the three deposits were petrographically analyzed to determine type (mineral assemblage), degree (modal percent of minerals relative to background levels), and extent (lateral distribution) of hydrothermal alteration (Appendix 4). Sampling occurred within the Havallah sequence at Lone Tree, upper plates of the Havallah sequence at North Peak, and Battle Formation at Trenton Canyon. Bloomstein et. al. (1996) note the presence of pre-mineralization silicification in members of the Havallah sequence and the Edna Mountain Formation along with a 2000 ft wide aureole of decalcification around the Lone Tree deposit. Field observations also indicates that both gold-bearing and barren structures have an alteration associated with them.

Hydrothermal alteration associated with all three gold-bearing areas is similar in type but differs in degree of development and volumetric extent. This alteration is typified by an assemblage of quartz, white-phyllosilicate (sericite), and oxidized sulfide (mainly pyrite), although gold-bearing samples at Lone Tree have minor amounts of chlorite and clays (Fig. 2-4). At North Peak, barite was observed in the field, but not in thin section. Hydrothermal quartz occurs as veinlets up to one centimeter in width, vuggy infilling (mainly Trenton Canyon), and breccia cementation. Oxidized sulfide grains and sericite occur as disseminated grains in clasts or matrix and locally with quartz in veins and vugs. Based on background samples (Fig. 5-7), hydrothermal alteration above baseline amounts extends up to 25 feet, 10 feet, and 5 feet from the gold-bearing faults at Lone Tree, Trenton Canyon, and North Peak deposits, respectively. Alteration is centered on these fault zones as indicated by a general increase in alteration mineral volume towards the structures (Table 1). The greatest development of alteration is seen at Lone Tree, with weaker development at North Peak and Trenton Canyon.

Hydrothermal alteration associated with barren structures has a similar mineralogy to that seen in gold-bearing structures. This assemblage includes quartz, white-phyllosilicates

Fig. 2. Typical hydrothermal alteration seen in samples across gold-bearing traverse at Lone Tree. Scale for long axis is approximately 1.5 mm. Photomicrograph shows quartz vein with center-line sericite and oxidized sulfide (pyrite) in Havallah siltstone, compare to background sample (Fig. 5).

Figure 2

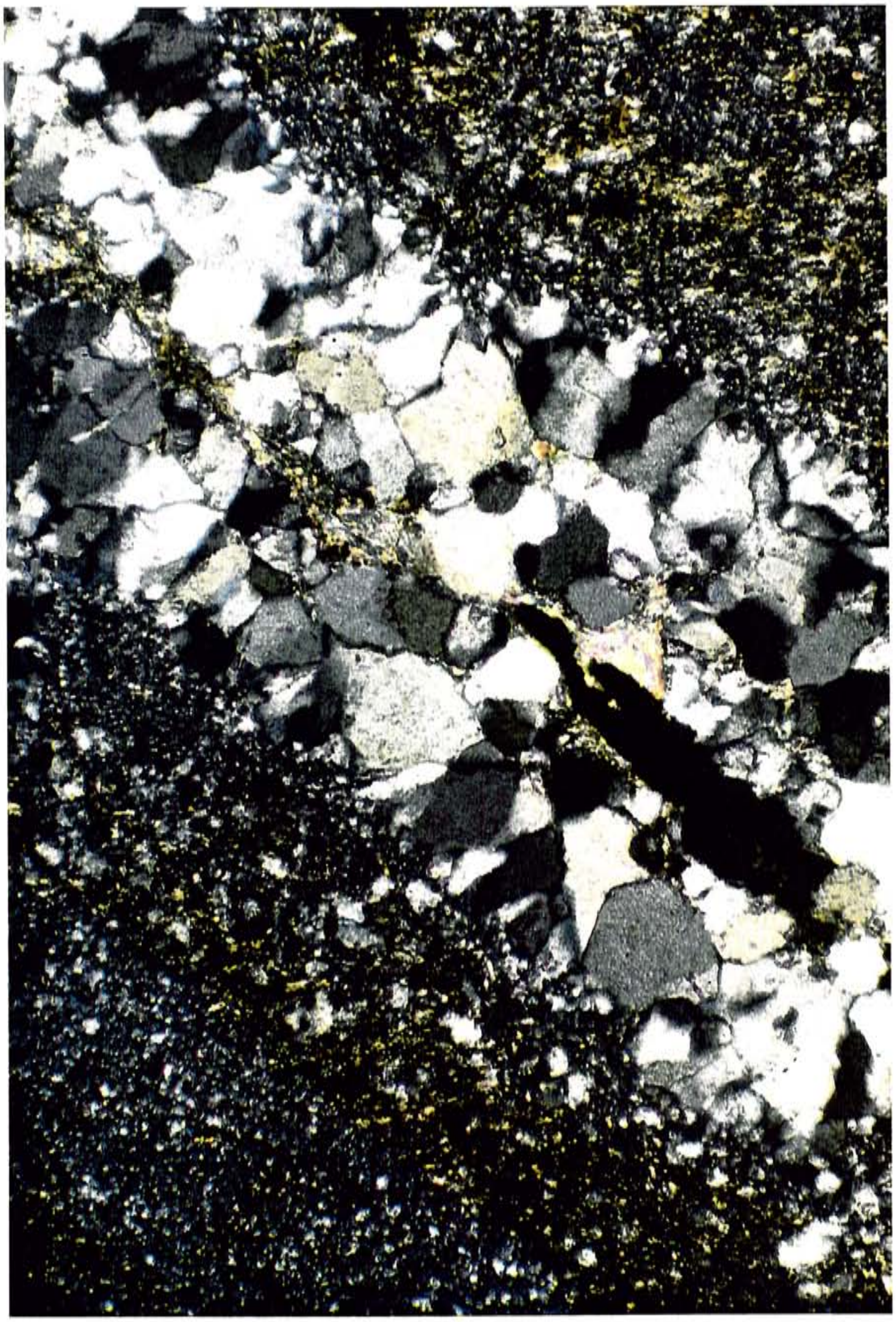


Fig. 3. Typical hydrothermal alteration seen in samples across gold-bearing traverse at North Peak. Scale for long axis is approximately 1.5 mm. Photomicrograph shows quartz in vug, along with sericite and oxidized sulfide (pyrite), in the Havallah limy siltstone. Compare to background sample (Fig. 6).

Figure 3

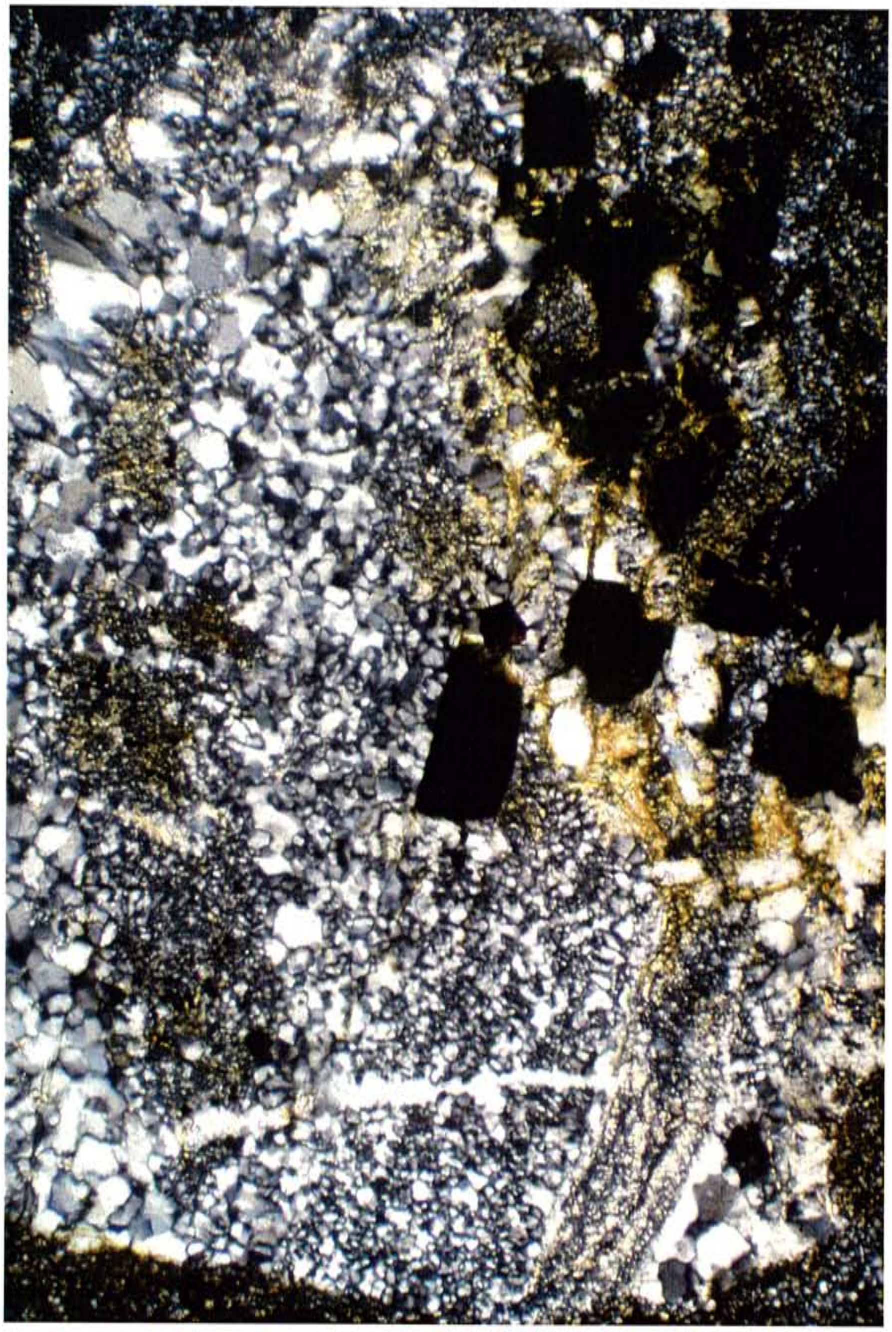


Fig. 4. Hydrothermal alteration seen in mineralized samples (Battle conglomerate) across the gold-bearing traverse at Trenton Canyon. Scale for long axis is approximately 1.5 mm. Quartz occurs as vug and matrix infilling, which is accompanied by both sericite and minor oxidized sulfide (pyrite). Compare to background sample (Fig. 7).

Figure 4

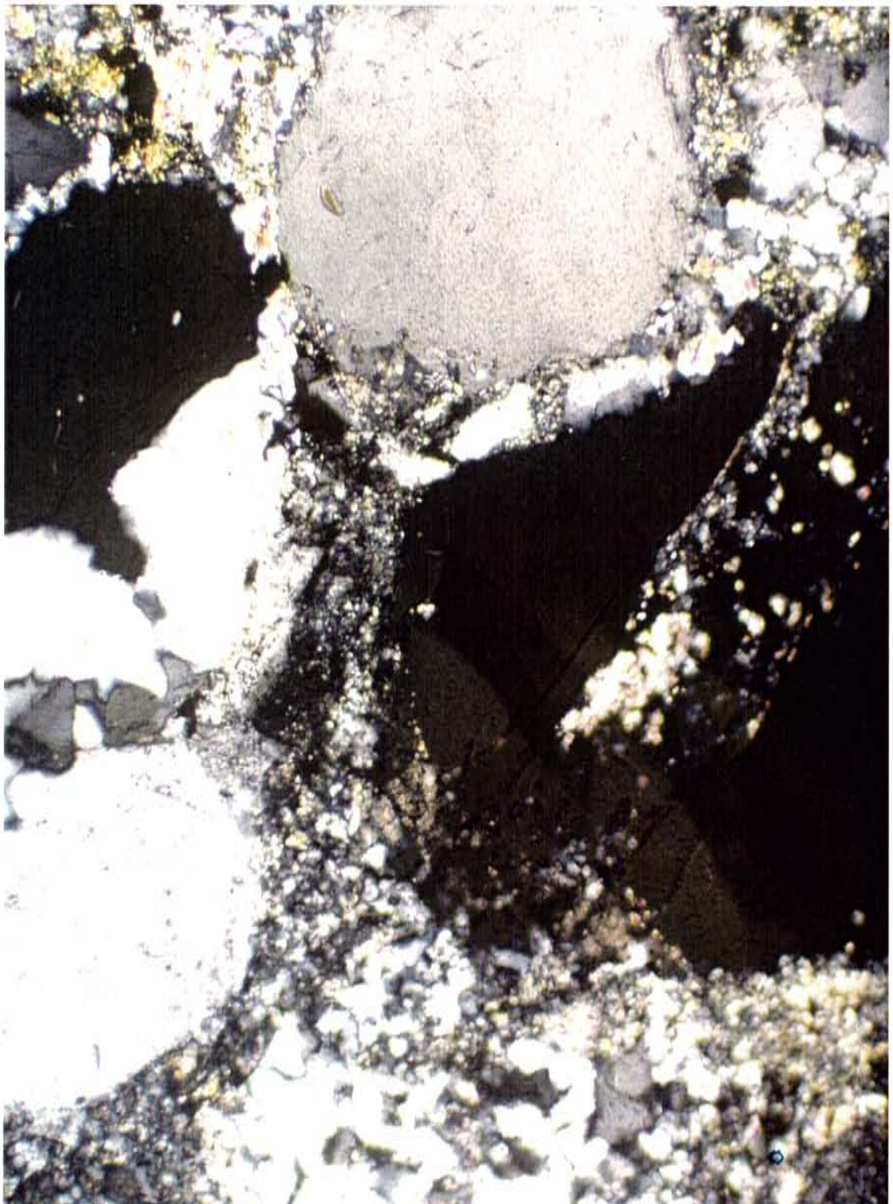


Fig. 5. Background sample for Havallah siltstone, which was sampled in both gold-bearing and barren traverses. Scale for long axis is approximately 1.5 mm. Note the lack of hydrothermal alteration.

Figure 5

Fig. 6. Background sample of Havallah limy siltstone sampled in the gold-bearing traverse at North Peak. Scale for long axis is approximately 1.5 mm. Note calcite matrix/cement, which is replaced by quartz, sericite, and oxidized pyrite in mineralized samples (Fig. 3).

Figure 6

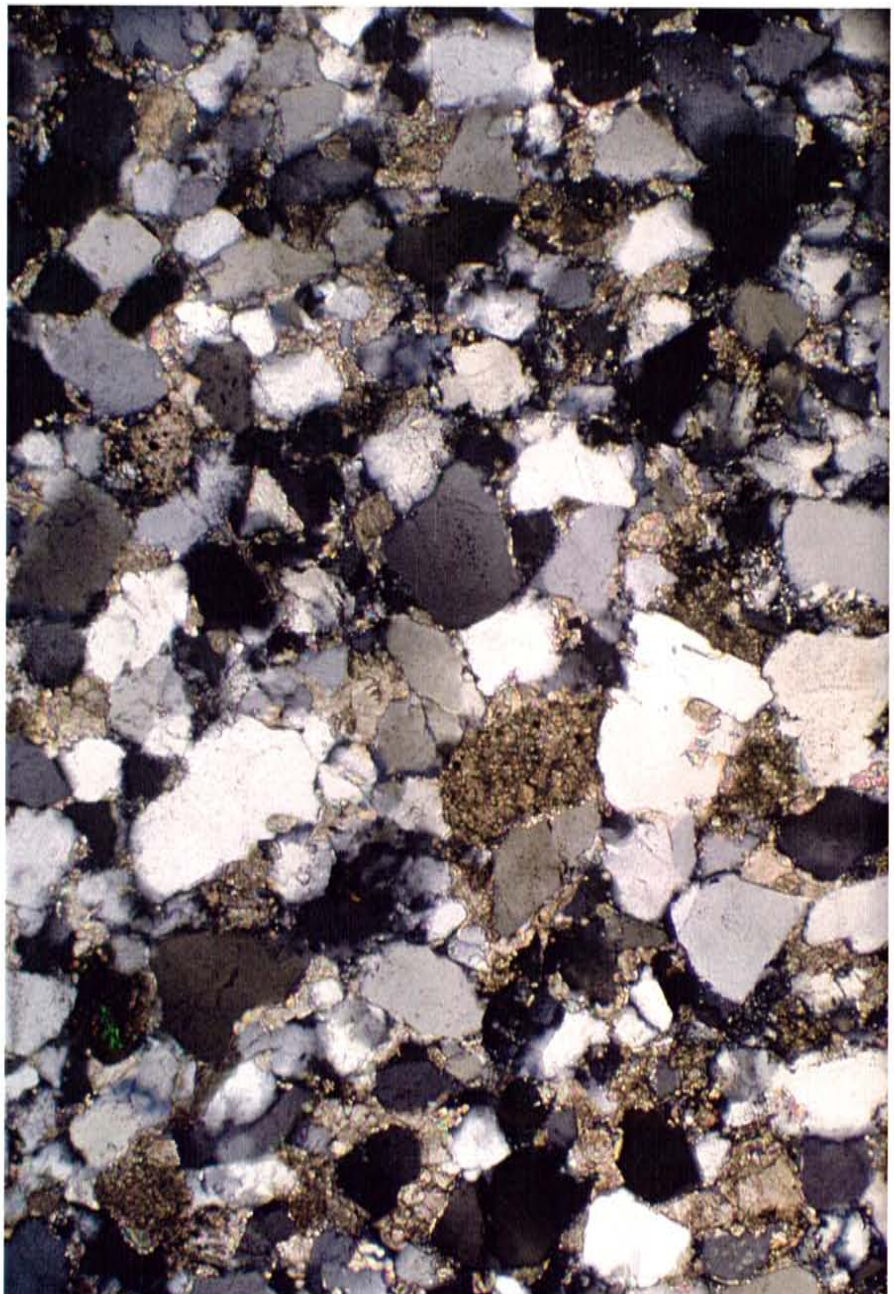


Fig. 7. Typical unaltered Battle conglomerate. Scale for long axis is approximately 1.5 mm. Note the absence of sericite and oxidized sulfide in the matrix, along with no quartz veining or vug infilling.

Figure 7

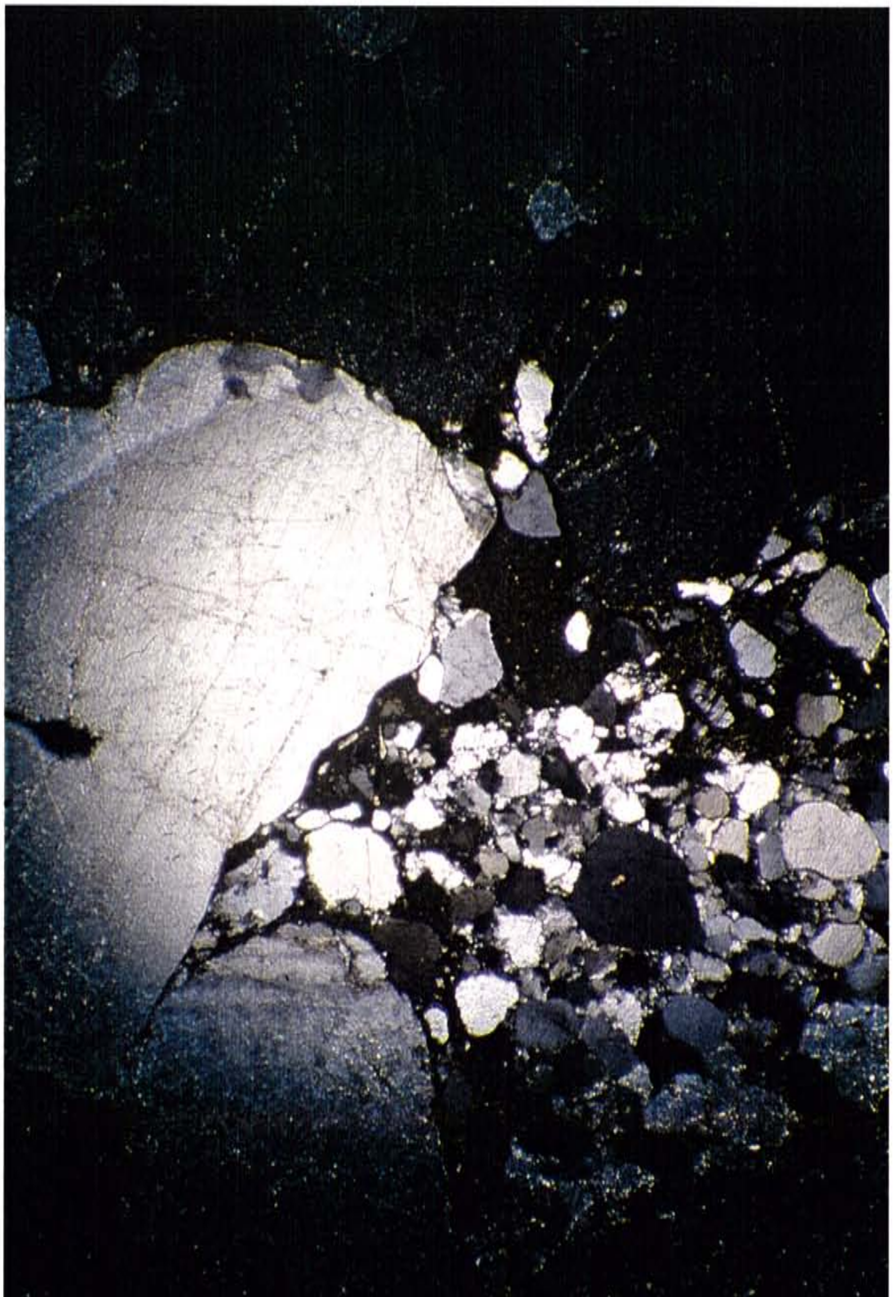


Table 1.: Correlation of alteration assemblage, degree of alteration, and whole-rock $\delta^{18}O$ in relation to distance from fault zone.

Deposit	Sample #	Distance (from fault)	Alteration Assemblage	Degree of Alteration	$\delta^{18}O$ (per mil)
Lone Tree mineralized					
	LT-1	@ Fault	qtz, white-phyllo, oxidized py, ± clays	moderate-high	9.4
	LT-12	1.0 ft west	qtz, white-phyllo, oxidized py, ± clays	minor-moderate	10.1
	LT-18	50.0 ft west	qtz, (oxidized py)	trace	12.8
unmineralized					
	LT-20	@ fault	qtz, chl, oxidized py, ± white-phyllo, (clays)	moderate	18.6
	LT-21	0.5 ft north	qtz, chl, oxidized py, ± white-phyllo, (clays	minor-moderate	20.5
North Peak mineralized					
	NP-300	@ fault	white-phyllo, oxidized py, qtz	high	13.6
	NP-317	5.0 ft east	qtz	minor	20.2
unmineralized					
	NP-90	@ fault	qtz, oxidized py	minor	20
	NP-95	5.0 ft east	none	none	16.7
Trenton Canyon mineralized					
	TC-1	@ fault	qtz, white-phyllo, oxidized py	moderate	13.4
	TC-2	0.5 ft north-east	oxidized py, (qtz)	minor	14.7

(sericite), and oxidized sulfide (mainly pyrite); barren samples from Lone Tree also have significant amounts of brown chlorite and minor amounts of clays (Fig. 8 & 9). Quartz occurs as veins and vugs, while sericite and oxidized sulfide grains occur as disseminated grains in clasts and matrix material, and locally in veins with quartz. Alteration-derived mineral abundances increase towards the fault zones (Table 1), suggesting that alteration is centered on these structures. Based on background samples (Fig. 5 & 10), hydrothermal alteration halos extend up to 25 feet, 10 feet, and 5 feet from the faults at Lone Tree, Trenton Canyon, and North Peak, respectively. As seen in the gold-bearing traverse, the greatest development of alteration is seen at Lone Tree, with weaker development at North Peak and Trenton Canyon.

Stable Isotopes

A total of 76 whole-rock samples (Table 2a) and 8 quartz separates (Table 2b) were analyzed for $\delta^{18}O$ (Appendix 5); results of whole-rock analysis are displayed in figures 11 through 13.

Up to approximately five feet from the gold-bearing fault zone at Lone Tree, oxygen isotope compositions of siltstones are fairly consistent and range from 9.4 to 13.9 per mil with an average of 12.2 per mil (Fig. 11a). This average value is close to the background value of 13.3 per mil. Greenstone units with $\delta^{18}O$ values of 7.0 per mil and 7.2 per mil fall within the accepted range of unaltered igneous rock values. However, most siltstones within five feet of the fault appear to be depleted (up to 4.2 ‰) with respect to the background value (Fig. 11a). Within the traverse, a few samples do not fit into the two general categories of unaltered or depleted. Two samples within five feet of the fault appear to retain unaltered values, which may reflect the spatial heterogeneity of the fluid flow. A siltstone 25 feet west of the gold-bearing fault produced a $\delta^{18}O$ value (9.4 ‰) which is the same as values obtained at the fault zone. Although no fault was mapped at this location, this sample had (fire assay) a gold grade that is as high as values within the gold-bearing structure, suggesting mineralizing fluids traveling through the fault also encountered this section of the outcrop. Excluding this one

Fig. 8. Typical hydrothermal alteration seen in samples (Havallah siltstone) across barren traverse at Lone Tree. Scale for long axis is approximately 1.5 mm. Quartz occurs as veinlets and oxidized sulfide as euhedral grains and open-space filling. Note large patch of brown chlorite in center of photomicrograph. Compare to background sample (Fig. 5).

Figure 8

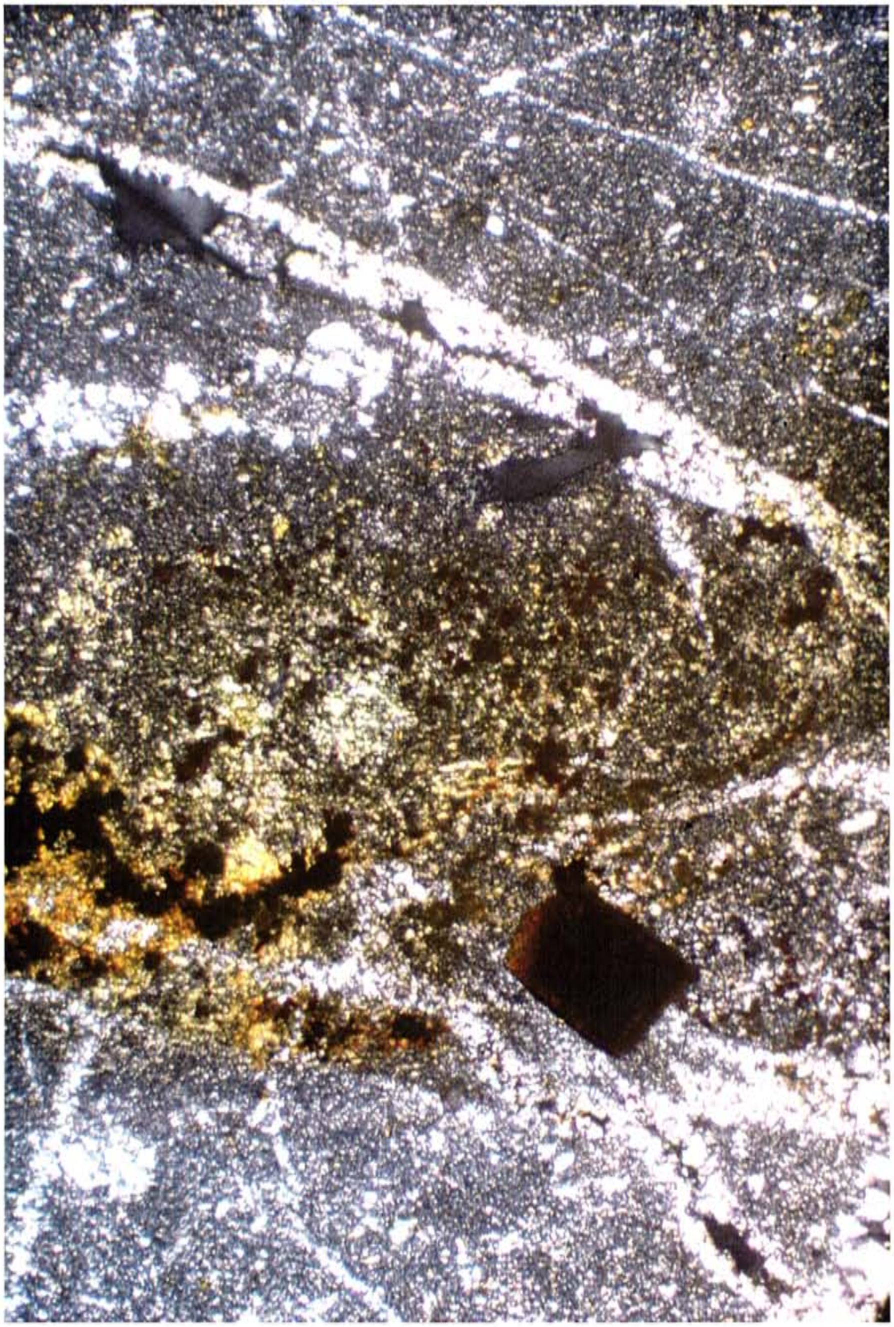


Fig. 9. Hydrothermal alteration observed in samples (Havallah rhythmically banded siltstone) across barren traverse. Scale for long axis is approximately 1.5 mm. Alteration includes much oxidized sulfide (pyrite), minor quartz veining, and trace sericite. Compare to background sample (Fig. 10).

Figure 9

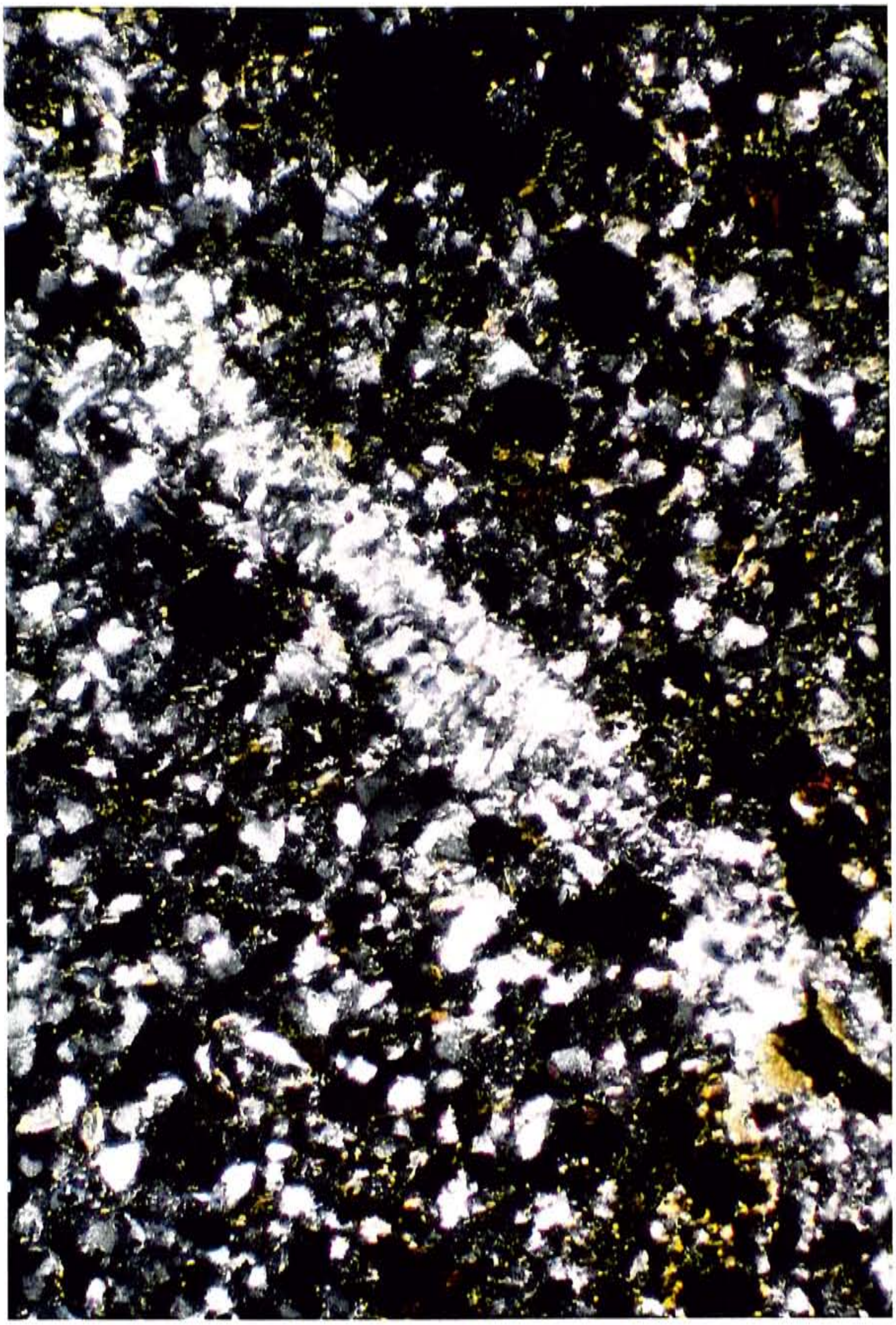
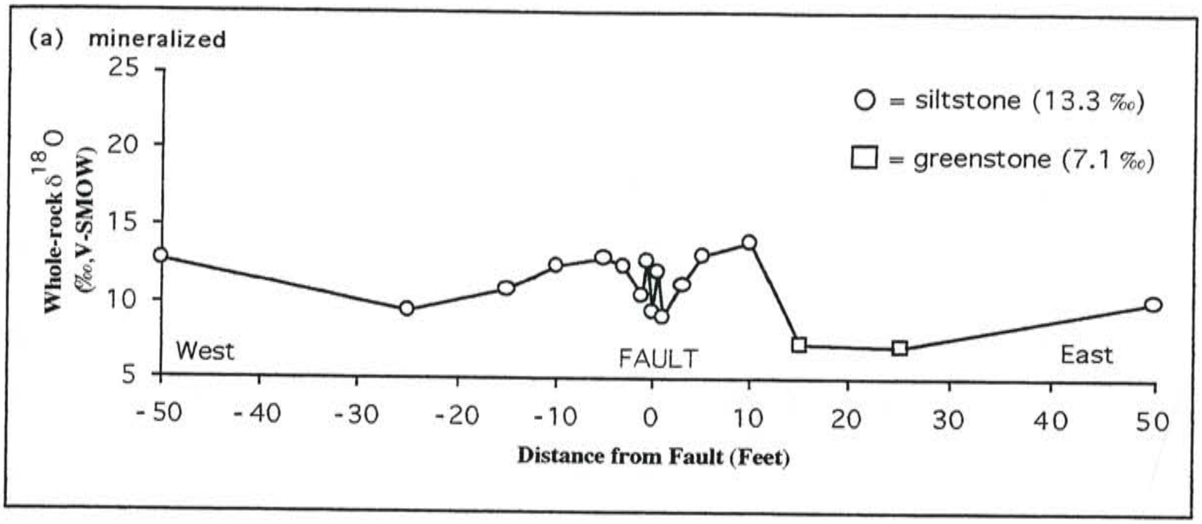


Fig. 10. Background sample of Havallah rhythmically banded siltstone. Scale for long axis is approximately 1.5 mm. Layers defined by detrital mica.

Figure 10



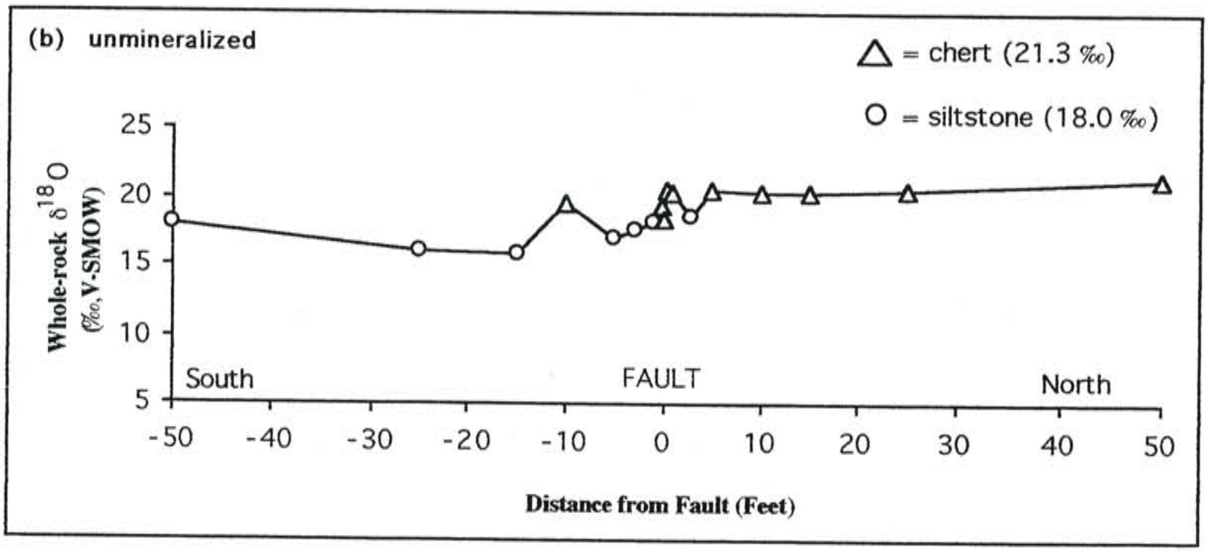


Fig. 11. Whole-rock oxygen isotope profiles for Lone Tree traverses. Vertical axis is $\delta^{18}O$ (per mil, V-SMOW) and horizontal axis is distance from fault (feet), with the fault represented as a single point at zero feet (regardless of actual width): (a) gold-bearing traverse. (b) barren traverse. Squares = greenstone unit, Circles = siltstone unit, Triangles = chert unit. Per mil values in parentheses are background values for respective rock type. Within ten feet of the gold-bearing fault, siltstones are isotopically altered compared to background values. The largest depletion (4.2 ‰) is seen at this gold-bearing fault zone. In contrast, cherts in the barren traverse are only slightly isotopically altered within one foot of the fault, with a maximum depletion of 2.7 per mil.

sample, the range (10.4 to 13.9 ‰) in $\delta^{18}O$ of siltstones outside of the isotopic alteration halo, probably reflects heterogeneity of the rock unit.

The oxygen isotope composition of cherts from the barren traverse at Lone Tree, with a range of 20.3 to 21.3 per mil, are very consistent with each other up to one foot from the fault (Fig. 11b). The average $\delta^{18}O$ of these cherts (20.5 ‰), because of the consistency, is used as the unaltered background value for this rock type. As seen in the gold-bearing traverse, rocks immediately adjacent to the fault appear to be slightly depleted with respect to the baseline value. A chert (sample 10 feet south), outside the isotopic alteration halo, appears to be anomalously depleted. This barren sample, had a $\delta^{18}O$ value slightly lighter than the baseline value (Fig. 11b), which may reflect a different depositional history than the other chert samples. Heterogeneity of siltstones outside the isotopic alteration halo appears to produce a range of $\delta^{18}O$ values from 15.7 to 18.6 per mil. This range in $\delta^{18}O$ is similar to the range seen in the gold-bearing traverse for the same rock unit, although slightly heavier in oxygen isotope composition.

At North Peak, the gold-bearing traverse reveals two isotopically distinct lithologies in conjunction with a large depletion at the fault zone (Fig. 12a). Both lithologies produced very consistent $\delta^{18}O$ values within each unit. Sandstones and limy siltstones from this traverse ranged from 16.1 to 18.4 per mil and 18.9 to 20.2 per mil, respectively. Average values of 17.2 per mil for the sandstone and 19.6 per mil for the limy siltstone are used as unaltered background values. The fault zone value (13.6 ‰) at North Peak is very depleted when compared to background wall rock values (Fig. 12a).

The two lithologies sampled in the barren traverse at North Peak yield uniform $\delta^{18}O$ values up to five feet from the fault (Fig. 12b). Averages for the sandstone with siltstone interlayers and rhythmically banded siltstones are considered background values for these rock types, which are 17.3 per mil and 17.7 per mil, respectively. As sampling approaches the

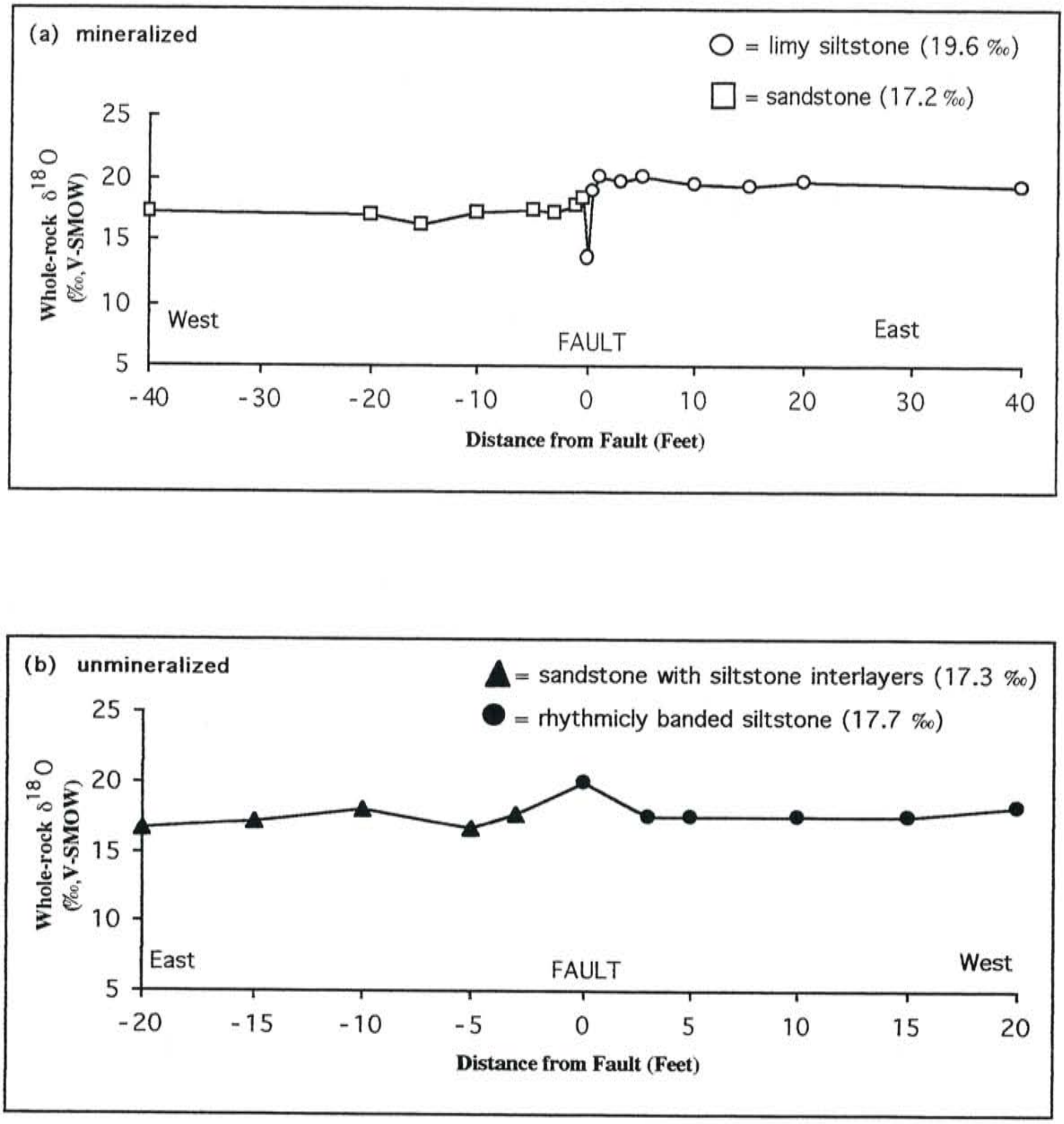


Fig. 12. Whole-rock oxygen isotope profiles for North Peak traverses. Vertical axis is $\delta^{18}O$ (per mil, V-SMOW) and horizontal axis is distance from fault (feet), with the fault represented as a single point at zero feet (regardless of actual width): (a) gold-bearing traverse. (b) barren traverse. Circles = limy siltstone unit, Circles (filled) = rhythmic siltstone unit, Triangles = sandstone with siltstone interlayers. Per mil values in parentheses are background values for respective rock type. Two distinct oxygen isotope distribution trends are seen across the gold-bearing and barren structures at North Peak deposit. Traverse across the gold-bearing structure resulted in an oxygen isotope depletion at the fault zone, whereas the traverse across the barren fault zone produced an oxygen isotope enrichment. The oxygen isotopic alteration (change of wall-rock relative to background values) of the sandstone (3.6 ‰) and limy siltstone (6.0 ‰) in the gold-bearing traverse is greater than the isotopic alteration seen in the sandstone with siltstone interlayers (2.7 ‰) and rhythmically banded siltstone (2.3 ‰) from the barren traverse.

barren structure, rocks become enriched compared to more distal samples and background values, with heaviest oxygen isotope composition (20.0 ‰) occurring at the fault zone.

Conglomerates up to ten feet from the gold-bearing traverse at Trenton Canyon are depleted with respect to a background value of 16.4 per mil (Fig. 13); the largest depletion (3.0 ‰) is seen at the fault zone. At distances greater than ten feet from the fault, conglomerates have a limited range in $\delta^{18}O$ from 14.9 to 16.7 per mil, which are attributed to different clast and matrix material of the conglomerate unit.

Quartz associated with gold-bearing and barren zones had $\delta^{18}O$ values from 8.0 to 23.6 per mil (Table 2b), with the $\delta^{18}O$ of gold-bearing quartz $\leq$ 19.8 per mil and the $\delta^{18}O$ of barren quartz $\geq$ 18.5 per mil. Lowest gold-bearing quartz values (8.0 ‰) were seen at the Trenton Canyon deposit, while highest barren values (23.6 ‰) were seen at the North Peak deposit. The range in $\delta^{18}O$ of gold-bearing samples slightly overlaps the range of barren samples. However, within the three deposits, gold-bearing samples are isotopically lighter than the barren samples.

Fluid Inclusions

To estimate temperature and salinity of these fluids and to calculate the oxygen composition of gold-bearing and barren fluids, an inclusion study was conducted on the samples gold-bearing and barren quartz (Table 3; Appendix 6) that were used for oxygen isotope analysis. Inclusions were measured in quartz that occurred as vugs (gold-bearing Trenton Canyon) and breccia matrix infilling (gold-bearing Lone Tree), with all other samples coming from veins. Temperature and salinity for the gold-bearing Lone Tree sample was taken from Kamali (1996).

Gold-bearing stage 2 quartz at Lone Tree, as established by Kamali (1996), will be referred to as LT-min. Kamali identified four types of inclusions in this gold-bearing quartz. These include: 1) one phase, vapor; 2) two phase, liquid + vapor (vapor rich); 3) two phase,

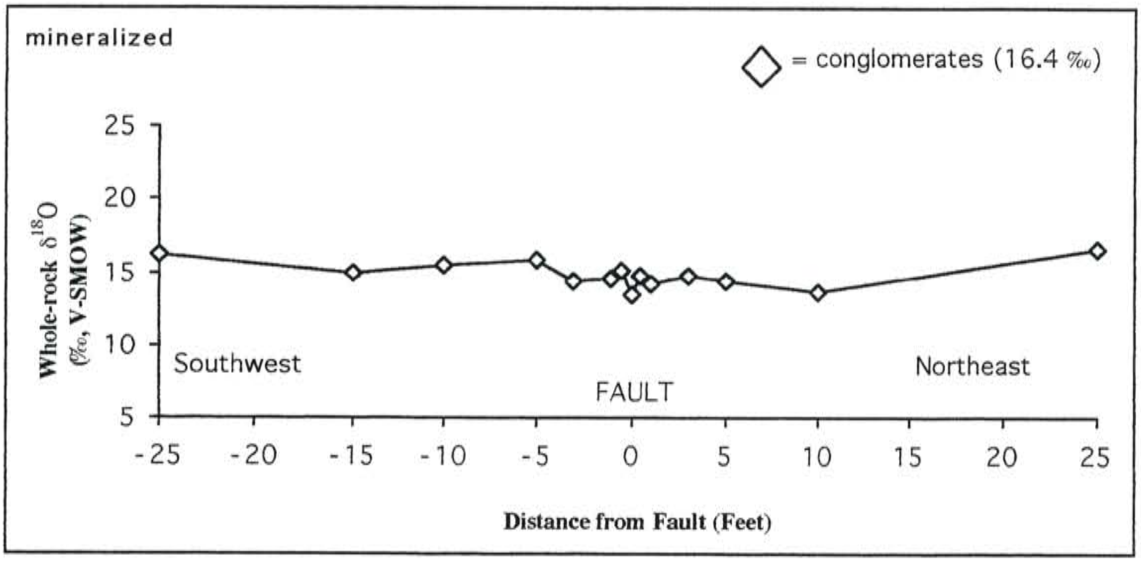


Fig. 13. Whole-rock oxygen isotope profile for Trenton Canyon gold-bearing traverse. Vertical axis is $\delta^{18}O$ (per mil, V-SMOW) and horizontal axis is distance from fault (feet), with the fault represented as a single point at zero feet (regardless of actual width): Diamonds = conglomerate unit. Per mil value in parentheses are background value for the conglomerate unit. As seen at the other two deposits, a traverse across a gold-bearing fault zone results in an oxygen isotope depletion at the fault zone. This oxygen isotope depletion extends up to five feet from the gold-bearing structure and largest depletion (3.0 ‰) from background value occurs at the fault zone.

Table 2a.: $\delta^{18}O$ of whole-rock samples from all traverses.

Distance (ft)	Lone Tree mineralized	Lone Tree unmineralized	North Peak mineralized	North Peak unmineralized	Trenton Canyon mineralized
50.0 ft	10.1‰	21.3‰	n/a	n/a	n/a
40.0 ft	n/a	n/a	19.4‰	n/a	n/a
25.0 ft	7.0‰	20.4‰	n/a	n/a	16.7‰
20.0 ft	n/a	n/a	19.8‰	18.2‰	n/a
15.0 ft	7.2‰	20.4‰	19.3‰	17.5‰	n/a
10.0 ft	13.9‰	20.4‰	19.5‰	17.5‰	13.7‰
5.0 ft	12.9‰	20.5‰	20.2‰	17.6‰	14.4‰
3.0 ft	11.1‰	18.6‰	19.7‰	17.5‰	14.8‰
1.0 ft	9.1‰	20.3‰	20.1‰	n/a	14.2‰
0.5 ft	12.0‰	20.5‰	18.9‰	n/a	14.7‰
FAULT	9.4‰	18.6‰	13.6‰	20‰	13.4‰
-0.5 ft	12.7‰	19.3‰	18.4‰	n/a	15.0‰
-1.0 ft	10.4‰	18.1‰	17.7‰	n/a	14.5‰
-3.0 ft	12.3‰	17.5‰	17.2‰	17.6‰	14.4‰
-5.0 ft	12.8‰	17‰	17.4‰	16.7‰	15.8‰
-10.0 ft	12.4‰	19.4‰	17.2‰	18.0‰	15.4‰
-15.0 ft	10.7‰	15.7‰	16.1‰	17.2‰	14.9‰
-20.0 ft	n/a	n/a	17.0‰	16.7‰	n/a
-25.0 ft	9.4‰	15.9‰	n/a	n/a	16.2‰
-40.0 ft	n/a	n/a	17.2‰	n/a	n/a
-50.0 ft	12.8‰	18.0‰	n/a	n/a	n/a

Table 2b.: $\delta^{18}O$ of mineralized and unmineralized quartz separates from all deposits.

Sample #	Deposit	Mineralized/Unmineralized	$\delta^{18}O_{QTZ}$
LT-min	Lone Tree	mineralized	12.4 ‰
LT-A	Lone Tree	unmineralized	21.2 ‰
NP-QV	North Peak	mineralized	19.8 ‰
NP-QV1	North Peak	mineralized	19.2 ‰
NP-104 (5740)	North Peak	unmineralized	23.6 ‰
TC-A	Trenton Canyon	mineralized	9.2 ‰
TC-15	Trenton Canyon	mineralized	8.0 ‰
TC-16	Trenton Canyon	unmineralized	18.5 ‰

liquid + vapor (liquid rich); and 4) three phase, liquid + vapor + halite. Inclusions for thermometric analysis were primary in origin and ranged in size from 3 to 50 μm, with most being 12 to 20 μm.

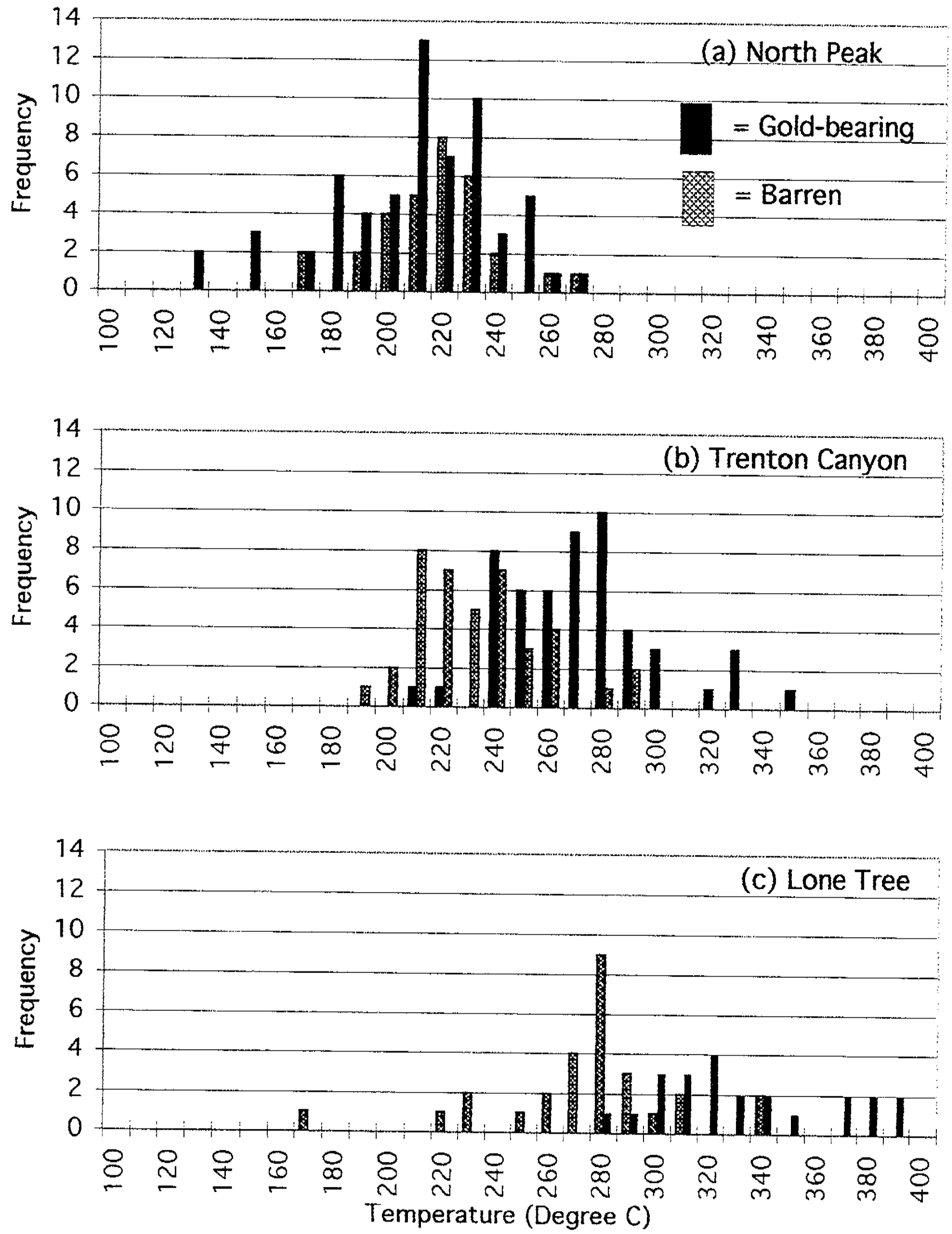
Inclusions in gold-bearing samples from North Peak and Trenton Canyon, along with those from barren samples at Lone Tree, North Peak, and Trenton Canyon were very similar. Visible inclusions that were analyzed ranged in size from 2 to 20 μm and had an average size of 6 μm. Distinguishing between primary, pseudo-secondary, and secondary inclusions was difficult because of the cloudy nature of some of the quartz and the small sample and inclusion sizes, accordingly all types of inclusions were measured. Inclusions were two phase, liquid + vapor, although degree of fill (F) ranged from liquid rich (F = 0.95) to those which contained more vapor (F = 0.70).

Combined homogenization temperatures for all gold-bearing samples ranged from 121 to 389°C. Despite the range of homogenization temperatures for all deposits, overlapping, individual populations can be discerned (Fig. 14). At Lone Tree, homogenization of the vapor bubble into the liquid phase (liquid dominated inclusions) and to the vapor phase (vapor dominated inclusions) occurred over a range from 271 to 389°C and averaged 328°C for gold-bearing samples. In contrast, homogenization of the vapor bubble to the liquid phase ranged from 181 to 347°C and 121 to 261°C, with averages of 267°C and 209°C, for gold-bearing samples at Trenton Canyon and North Peak, respectively. Two gold-bearing samples from Trenton Canyon and North Peak deposits were analyzed, which yielded similar ranges in temperatures of 194 to 347°C and 181 to 324°C for Trenton Canyon and 144 to 261°C and 121 to 251°C for North Peak.

In barren samples at all three deposits, the vapor bubble homogenized to the liquid phase. The range of homogenization temperatures for barren samples at the three deposits is more restricted than the range for gold-bearing samples. Homogenization temperatures for

Fig. 14. Histograms of homogenization temperatures for gold-bearing and barren quartz: (a) North Peak. (b) Trenton Canyon. (c) Lone Tree. Black = gold-bearing, Hatched = barren. Mineralized homogenization temperatures (T_H) at Lone Tree were obtained from Kamali (1996). Average homogenization temperatures for gold-bearing samples at Lone Tree, North Peak, and Trenton Canyon are 328°C, 209°C, and 267°C, respectively. In contrast, homogenization temperatures of 274°C, 213°C, and 223°C, respectively, were recorded in barren samples at Lone Tree, North Peak, and Trenton Canyon. At Lone Tree and Trenton Canyon overlapping ranges in T_H are higher for gold-bearing samples. In contrast, ranges in T_H for gold-bearing and barren samples at North Peak are very similar. Ranges in T_H for gold-bearing and barren samples overlap at all three of the deposits.

Figure 14


(a) North Peak
= Gold-bearing
= Barren
(b) Trenton Canyon
(c) Lone Tree
Frequency
Temperature (Degree C)
0
2
4
6
8
10
12
14
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400

barren samples ranged from 161 to 334°C and have ranges that overlap each other, however individual populations can be seen (Fig. 14). Homogenization temperatures for barren samples at Lone Tree, with a range of 169 to 334°C and an average of 274°C, overlap those seen in gold-bearing samples (Fig. 14c). This trend is seen in the other deposits as well, where an average temperature of 223°C and a range of 199 to 289°C at Trenton Canyon and an average of 213°C and a range of 161 to 268°C for North Peak overlapping their gold-bearing counterparts (Fig. 14a & 14b).

The small size of inclusions in all samples restricted the number of freezing measurements made; a total of 48 salinity measurement were conducted on all samples excluding the gold-bearing sample at Lone Tree. A total of 22 inclusions were measured by Kamali (1996) in the sample at Lone Tree. To verify that the small sample set of salinities were representative, with the exception of Lone Tree gold-bearing data, corresponding homogenization temperatures were compared to the larger homogenization temperature data sets. The homogenization temperatures for inclusions on which salinities were measured, fall within the range of values of the larger homogenization temperature data sets (Fig. 15a-15e).

Salinities for all gold-bearing samples ranged from 1.2 to 38.9 eq.wt. % NaCl (Fig. 16), which represent the range seen in samples at Lone Tree. More confined ranges of 3.7 to 14.0 eq.wt. % NaCl and 2.6 to 5.7 eq.wt. % NaCl are seen at the North Peak and Trenton Canyon deposits, respectively (Fig. 16a & 16b). Average salinity is highest at the Lone Tree deposit with a value of 18.7 eq.wt. % NaCl, followed by 8.5 and 4.0 eq.wt. % NaCl, respectively at the Trenton Canyon and North Peak deposits (Table 3). Most salinities in gold-bearing samples are based on the final melting of ice with the exception of some measurements made in samples at Lone Tree, which were based on final melting of halite daughter minerals yielding the higher temperatures seen there.

Fig. 15. Histograms of homogenization temperatures: (a) North Peak barren. (b) North Peak gold-bearing. (c) Lone Tree barren. (d) Trenton canyon gold-bearing. (e) Trenton Canyon barren. Solid = gold-bearing data, Open = barren data, Hatched = data for inclusions where salinity measurements were made. Homogenization temperatures for inclusions with salinity measurements (hatched) fall within ranges of the larger data sets, which is a good indication that the low number of salinity measurements are representative.

Figure 15

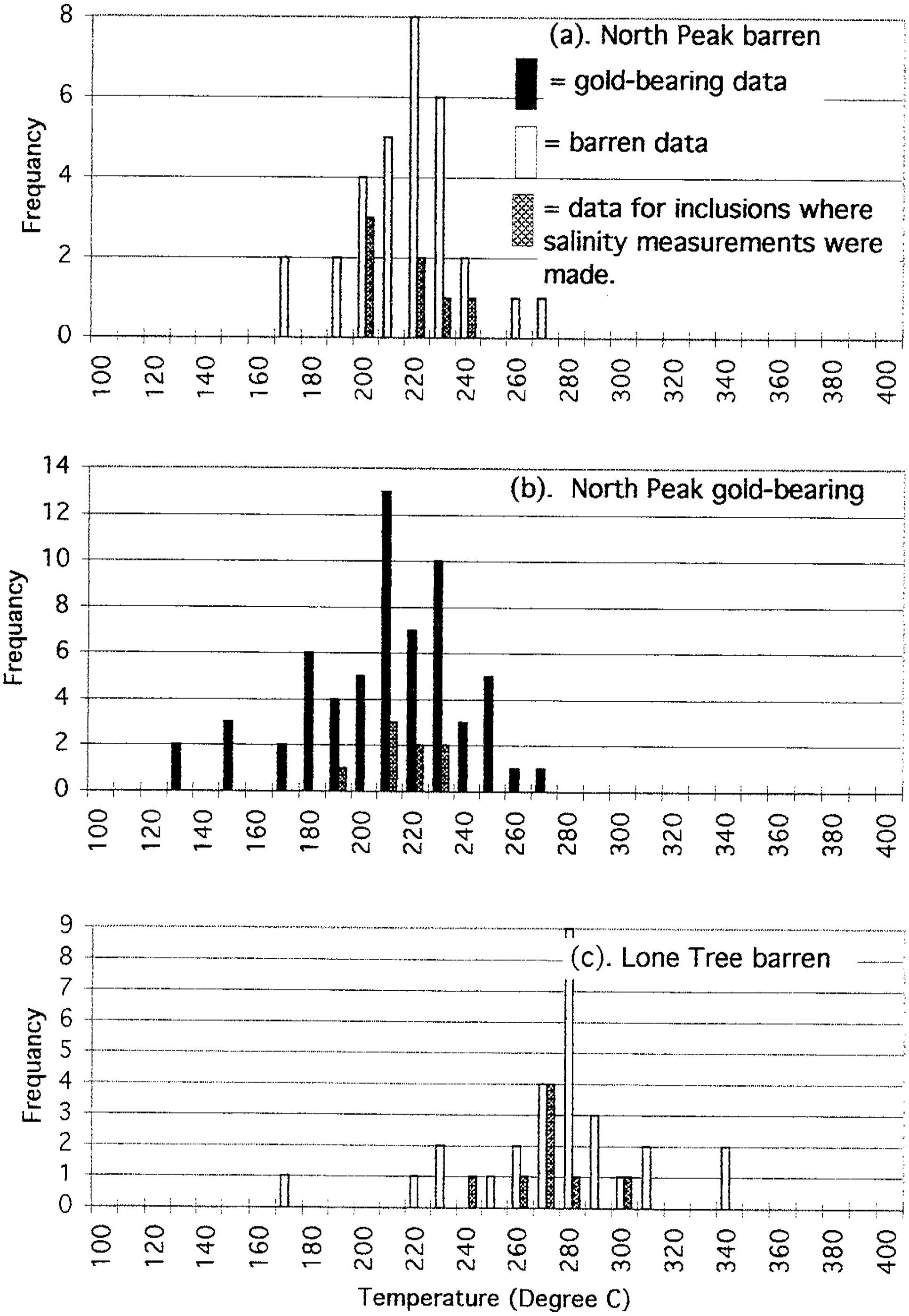
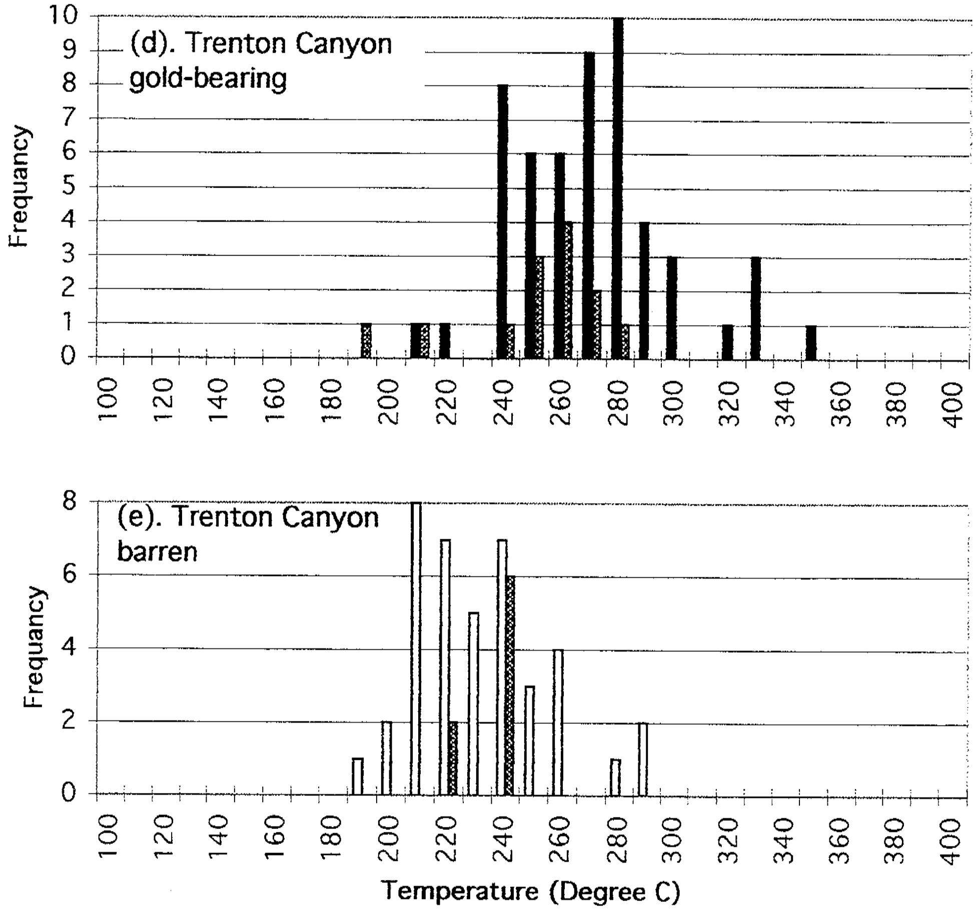

(a). North Peak barren
= gold-bearing data
= barren data
= data for inclusions where salinity measurements were made.
Frequancy
(b). North Peak gold-bearing
Frequancy
(c). Lone Tree barren
Frequancy
Temperature (Degree C)

Figure 15 (Continued)



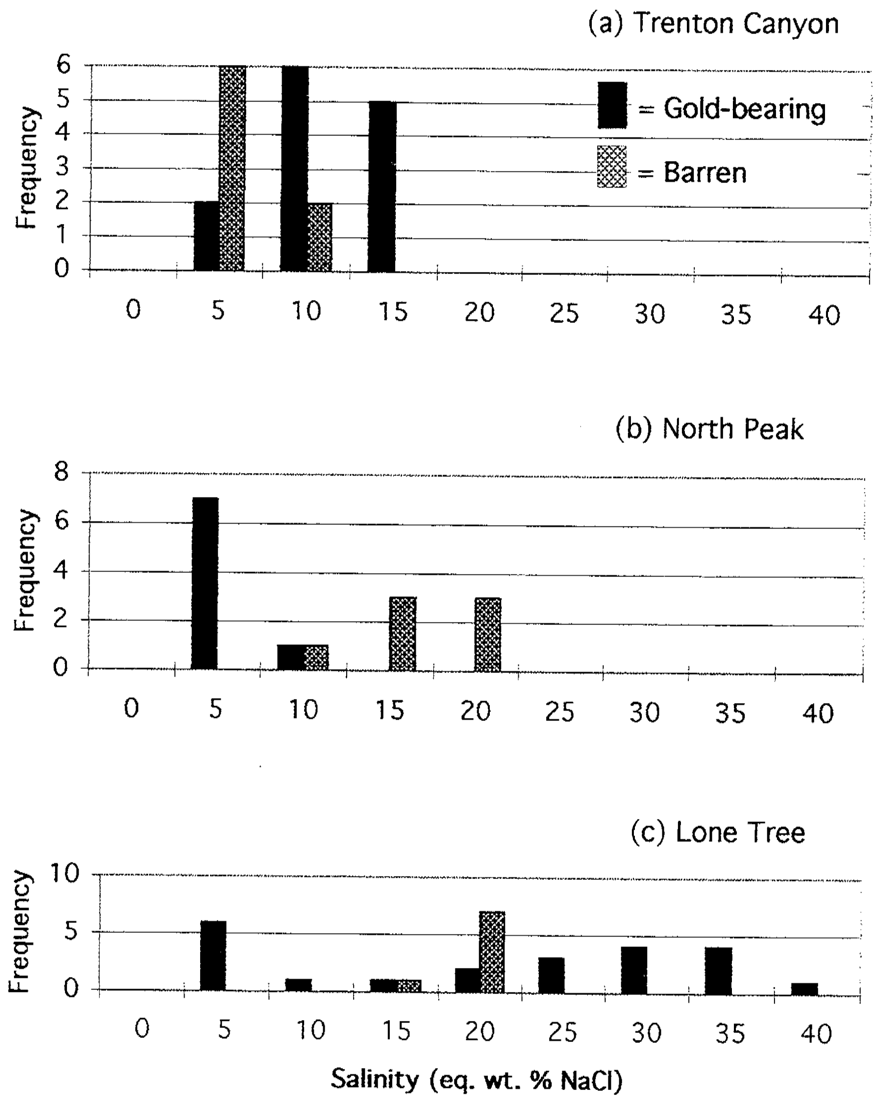


Fig. 16. Histograms of fluid salinity from gold-bearing and barren quartz: (a) Trenton Canyon. (b) North Peak. (c) Lone Tree. Black = gold-bearing, Hatched = barren. Gold-bearing salinity measurements at Lone Tree were obtained from Kamali (1996). Largest range in calculated salinity is seen in gold-bearing sample from Lone Tree; salinity estimations are based on both final melting of ice (T_m) and homogenization of halite daughter minerals. In all other cases except barren samples at Lone Tree and North Peak where salinity estimations are based on final clathrate melting above 0° C, salinity is calculated with T_m of ice crystals.

Table 3.: Summary of fluid inclusion Microthermometry for mineralized and unmineralized samples by deposit. Measurements were performed on all (primary and secondary) inclusions.

Location	Sample	Number of Measurements	T_H (°C)	Salinity (eq.wt. % NaCl)
Lone Tree				
mineralized	LT-Min	22	328	18.7
unmineralized	LT-A	35	274	15.3
North Peak				
mineralized	NP-QV	39	197	4.0
mineralized	NP-QV1	29	211	n/a
mineralized	Average	N/A	209	4.0
unmineralized	NP-104 (5740)	37	213	14.1
Trenton Canyon				
mineralized	TC-A	18	261	n/a
mineralized	TC-15	48	270	8.5
mineralized	Average	N/A	267	8.5
unmineralized	TC-16	49	223	4.5

A smaller range in salinity (2.41 to 16.1 eq.wt. % NaCl) is seen in barren samples than that which is seen in gold-bearing samples (Fig. 16). Salinity measurements in barren samples for all three deposits overlap the corresponding salinity range for gold-bearing samples (Fig. 16a-16c). At Lone Tree and Trenton Canyon, average salinities of 15.3 and 4.5 eq.wt. % NaCl, respectively, are lower than the average salinity seen in gold-bearing samples of the same deposit (Table 3). This trend is reversed at the North Peak deposit where the average salinity, 14.1 eq.wt. % NaCl, in the barren sample is higher than the salinity for the gold-bearing sample (Table 3). Final melting in barren samples at Lone Tree and North Peak occurred above 0° C, indicating the presence of clathrates; salinity was calculated using final melting of clathrates at these two locations. Salinity in barren samples at Trenton Canyon was calculated using final melting of ice.

DISCUSSION

Isotopic Traverses

The isotopic composition of altered wall rocks will be a function of: a) initial isotopic composition of the wall rock; b) the deposition and content of hydrothermal minerals; and c) exchange between fluids and original rock components. Isotopic compositions related to deposition of alteration minerals and exchange between water and rock are affected by the temperatures at which they occurred.

The effects of initial whole-rock oxygen isotope composition can be best observed in the gold-bearing traverse at North Peak. In this traverse, the fault zone separates lithologically and isotopically different rock types (Fig. 12a). The amount of oxygen isotope depletion from baseline values is different for these two units. The limy siltstones are depleted by approximately 6.1 per mil, while the sandstone with siltstone interlayer is depleted by approximately 3.5 per mil.

The deposition of alteration minerals in host rocks will effect the net oxygen isotope composition of the whole-rock. This, in turn, is a function of the oxygen isotope composition of the alteration minerals and their modal percents. Gold-bearing samples at the Lone Tree complex are associated with higher abundance of hydrothermal quartz and sericite compared to barren samples, and this is reflected in the oxygen isotope alteration. Gold-bearing traverses are associated with greater degree of isotopic alteration than the barren traverses (Table 1). Hydrothermal alteration is centered on fault zones and show an increase in modal percent of alteration minerals towards the fault (Table 1), with highest gold grades within the structures. These relationships, indicate most fluid movement occurs within these structures. However, the increase in both alteration minerals and subsequent oxygen isotope alteration towards the faults, indicates that some fluid does move laterally away from the large structures. Lateral fluid conduits are most likely fractures within brecciated rock. These brecciated zones, found immediately outside the fault zone, were associated with all structures sampled.

Oxygen isotope compositions of hydrothermal quartz and calculated $\delta^{18}O$ of white-phyllosilicates (sericite) associated with gold-bearing and barren structures are summarized in Table 4. Gold-bearing quartz from Lone Tree, North Peak, Trenton Canyon, and barren quartz from Lone Tree are lighter than the background values of the rocks that they are contained in (Table 4). Addition of this isotopically lighter component to the whole-rock would result in oxygen isotope depletion of the wall rocks relative to background values (Fig. 11, 12a, 13). In the case of the barren traverse at North Peak where an enrichment occurred at the fault zone, the quartz value (23.6 ‰) is isotopically heavier than both background (17.2 ‰ and 17.6 ‰) and fault zone (20.0 ‰) values. The addition of this isotopically heavier constituent can produce some of the oxygen isotope enrichment seen at North Peak. Along with quartz, sericite is very prominent in the altered wall rocks. The $\delta^{18}O$ of sericite, assuming equilibrium with the hydrothermal quartz, was calculated using a quartz-muscovite fractionation equation derived from Matsuhisa et al. (1979) and Friedman and O'Neil (1997), the appropriate temperatures (Table 3), and quartz oxygen isotope values (Table 2b). These calculated sericite values mimic trends that are seen for the $\delta^{18}O$ of quartz; traverses where a depletion occurred at the fault zone have calculated $\delta^{18}O$ values of sericite lower than

Table 4.: Summary of measured $\delta^{18}O$ of quartz and calculated $\delta^{18}O$ of sericite and water in relation to whole-rock $\delta^{18}O$ of mineralized and unmineralized fault zones and background rock values of rocks adjacent to fault zone.

Sample	$\delta^{18}O$Qtz	Calculated $\delta^{18}O$Sericite	Calculated $\delta^{18}OH_2O$	Fault zone $\delta^{18}O_{whole\text{-}rock}$	Background $\delta^{18}O_{whole\text{-}rock}$	Background $\delta^{18}O_{whole\text{-}rock}$
L.T. min.	12.4 ‰	10.3 ‰	6.5 ‰	9.4 ‰w	13.3 ‰ siltstone	N/A
L.T. unmin.	21.2 ‰	18.6 ‰	13.1 ‰	18.6 ‰	21.3 ‰ chert	N/A
N.P. min.	19.5 ‰	15.9 ‰	8.0 ‰	13.6 ‰	19.6 ‰ limy-siltstone	17.2 ‰ sandstone
N.P. unmin.	23.6 ‰	20.1 ‰	12.5 ‰	20 ‰	17.3 ‰ sandstone ± siltstone	17.7 ‰ rhythmic-siltstone
T.C. min.	8.6 ‰	5.9 ‰	0.0 ‰	13.4 ‰	16.4 ‰ conglomerate	N/A

background rock values (Table 4). In contrast, North Peak barren traverse with an enrichment at the fault zone, had a calculated $\delta^{18}O$ value for sericite which was heavier than the background rock value and fault zone value. Alteration minerals have oxygen isotope compositions which result in depletions, and in one case an enrichment, at the fault zones when added to the host rocks. However, with the exceptions of North Peak barren and Trenton Canyon gold-bearing traverses, the oxygen isotope composition of alteration minerals does not account for the entire depletion of the host rock. Measured and calculated $\delta^{18}O$ of alteration minerals are still heavier than fault zone values, indicating that an additional mechanism is contributing to the depletions recorded near the fault zone.

Since the isotopic composition of hydrothermal minerals cannot fully explain the trends seen at fault zones, an additional mechanism must be adopted. The simplest explanation would be exchange between water and rock components. Most traverse samples are quartz dominated sedimentary rocks, but do contain up to 15 % matrix material. The matrix material appears to be a clay, but was optically unidentifiable. Water-rock exchange is problematic because quartz grains are reluctant to exchange with water. However, the clay matrix material may be enough to exchange with fluid traveling through the rocks and affect the oxygen isotope composition.

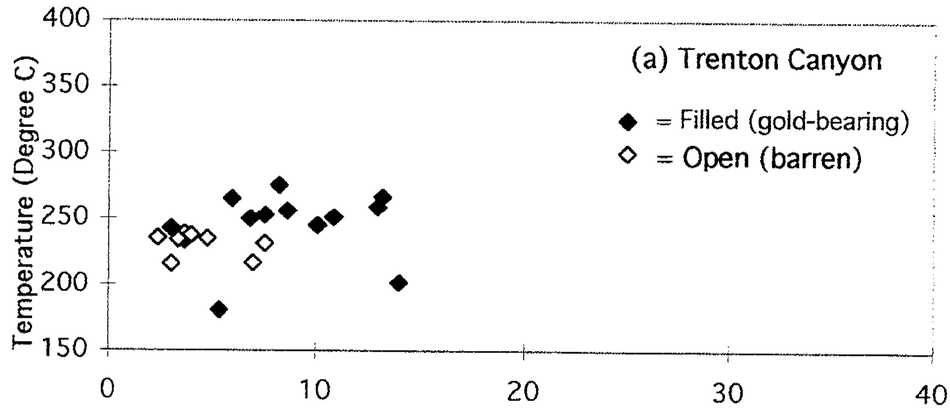
The oxygen isotope composition of fluids responsible for quartz deposition was calculated using appropriate homogenization temperatures (Table 3) for gold-bearing and barren quartz (Table 2b) from each deposit and the quartz-water fractionation equation of Matsuhisa et al. (1979). Results are summarized in Table 4. The calculated $\delta^{18}O$ of water, in all cases, would promote further depletion in all traverses if exchange occurs with the clay, at temperatures recorded in fluid inclusions. However, an enrichment was recorded across the barren structure at North Peak. A low homogenization temperatures (average 209°C) and a decreasing temperatures can promote the enrichment seen at this location. Relative isotopic fractionation (Δ_{xy}) between two phases is a function of the temperature dependent fractionation factor (α_{xy}) between those two phases. At North peak, the minerals involved in the exchanged process are assumed to be isotopically heavier than the fluid (12.5 ‰), and at these low temperatures the Δ_{xy} is large. In a water dominated system, as temperature decreases, exchange between the water and mineral would result in an isotopically heavier mineral. This scenario can produce the enrichment that is seen at the barren structure at North Peak.

Gold-bearing and Barren Fluids

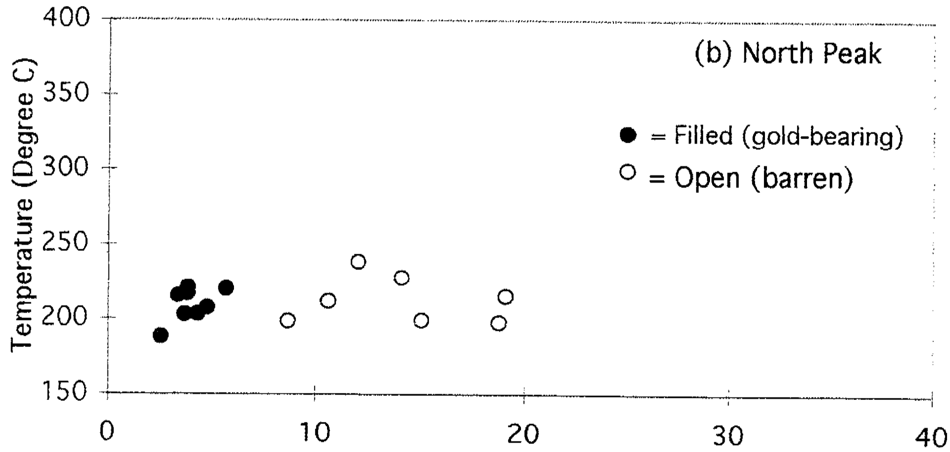
Kamali (1996), using thermometric measurements and gas analysis of fluid inclusions, postulates magmatic, crustal, and evolved meteoric water sources for the gold-bearing event at Lone Tree. Calculated oxygen composition of gold-bearing (6.5 ‰) and barren (13.1 ‰) fluids at Lone Tree fall within ranges seen for magmatic and formation waters, respectively. The quartz with a magmatic $\delta^{18}O$ signature had an average homogenization temperature (328 °C), that was higher than the average temperature (274 °C) for a fluid with oxygen isotope composition of a formation water. Salinity ranged for gold-bearing (magmatic) and barren (formation) waters, respectively, from 12 to 39 eq.wt. % NaCl and 15 to 16.1 eq.wt. % NaCl. The upper range of salinity for gold-bearing fluid could represent the initial magmatic salinity composition prior to mixing. Overlapping ranges in homogenization temperatures (Fig. 14c) and salinity (Fig. 16c) suggest mixing between gold-bearing and barren fluids. A plot of homogenization temperature versus salinity for gold-bearing and barren samples reveals a linear mixing trend, with barren samples falling within the range of gold-bearing data (Fig. 17c). These barren samples could represent a single point within a mixing trend, alternatively the barren samples may have recorded conditions of a different fluid than the high salinity, high temperature (magmatic) and a lower temperature, lower salinity (meteoric) end-members for gold-bearing fluids (Kamali, 1996). In this study, salinity in barren samples are based on final clathrate melting above 0.0°C, which was not observed by Kamali (1996). However, in some inclusions Kamali (1996) observed an irregular boundary between liquid and vapor phases

Fig. 17. Homogenization temperatures versus salinity for all deposits: (a) Trenton Canyon. (b) North Peak. (c) Lone Tree. Filled shape = gold-bearing, Open shape = barren. A linear mixing trend is revealed at all deposits and with the exception of Lone Tree, gold-bearing and barren fluids are the end-members. Gold-bearing samples from Lone Tree (Kamali, 1996) indicate mixing between a high temperature, high salinity (magmatic) fluid and a lower salinity, lower temperature (meteoric) fluid.

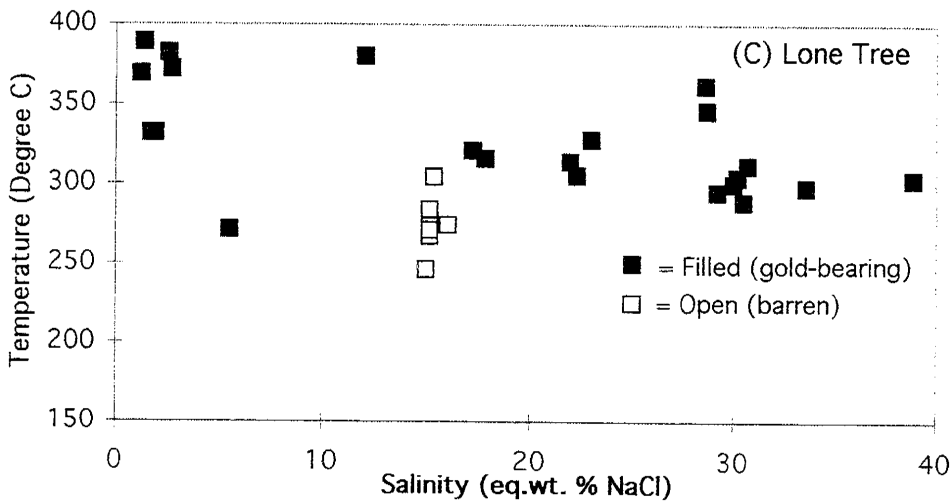
Figure 17



(a) Trenton Canyon
= Filled (gold-bearing)
= Open (barren)
Temperature (Degree C)
400
350
300
250
200
150
0
10
20
30
40



(b) North Peak
= Filled (gold-bearing)
= Open (barren)
Temperature (Degree C)
400
350
300
250
200
150
0
10
20
30
40



(C) Lone Tree
= Filled (gold-bearing)
= Open (barren)
Temperature (Degree C)
400
350
300
250
200
150
0
10
20
30
40
Salinity (eq.wt. % NaCl)

upon freezing to temperatures of -95°C, which disappeared on heating to -56.6 °C, indicating the presence of CO_2. Clathrate melting curves reach temperatures as low as -8°C (Shepherd, 1985; Collins, 1979). Due to optical limitations in viewing clathrates, low melting temperatures in the gold-bearing sample interpreted as melting of ice by Kamali (1996) could be final melting of clathrates below 0.0°C. Re-calculation of the low salinity measurements, based on clathrate melting, brings salinity values up to those which are seen in barren samples, which establishes a mixing trend between barren formation water and a gold-bearing magmatic fluid (Fig. 18). The mixing of ore-bearing magmatic fluid and barren formation water appears to account for the lower range of salinity of magmatic fluids and the upper range of homogenization temperatures for barren formation waters (Fig. 18).

Calculated oxygen isotope composition of gold-bearing fluids (0.0 ‰) at Trenton Canyon suggests some component of meteoric water. Meteoric fluids at Getchell and Twin Creeks deposits, 35 miles northeast of Lone Tree, had $\delta^{18}O$ values from -6 to -9 per mil (Groff, 1996). These values are assumed to represent oxygen isotope composition of meteoric water at the Lone Tree Complex. A mixing trend (Fig. 19) between a meteoric water and magmatic fluid can approximate the measured salinity and oxygen isotope composition of gold-bearing fluid at Trenton Canyon. Mixing with a magmatic fluid can also account for the upper range of homogenization temperatures measured in this meteoric water. Gold-bearing fluids are skewed towards less salty conditions expected by a pure meteoric-magmatic mixing trend (Fig. 19). This can be explained by mixing with the barren formation water, which is suggested by the linear trend in the salinity-homogenization temperature plot (Fig. 17a). Evolution of $\delta^{18}O$ by exchange with the country rock could also produce the isotopic values calculated, and cannot be ruled out. However, the mixing theory seems more plausible because of salinity and homogenization temperature trends. Calculated $\delta^{18}O$ value for Trenton Canyon barren fluid (8.5 ‰) lies within values for magmatic fluids, however a heavier oxygen

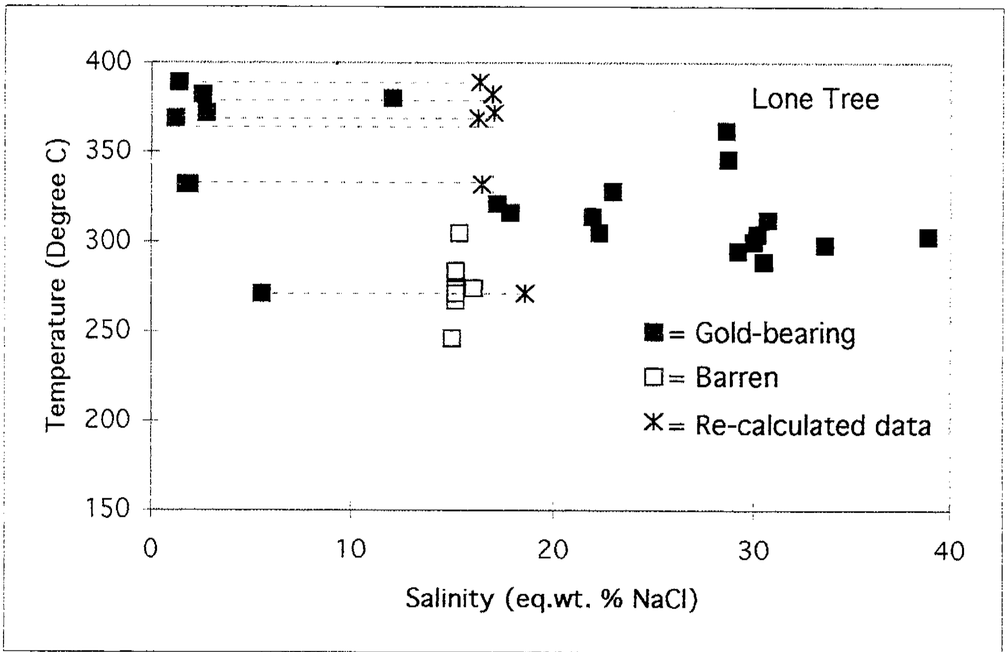
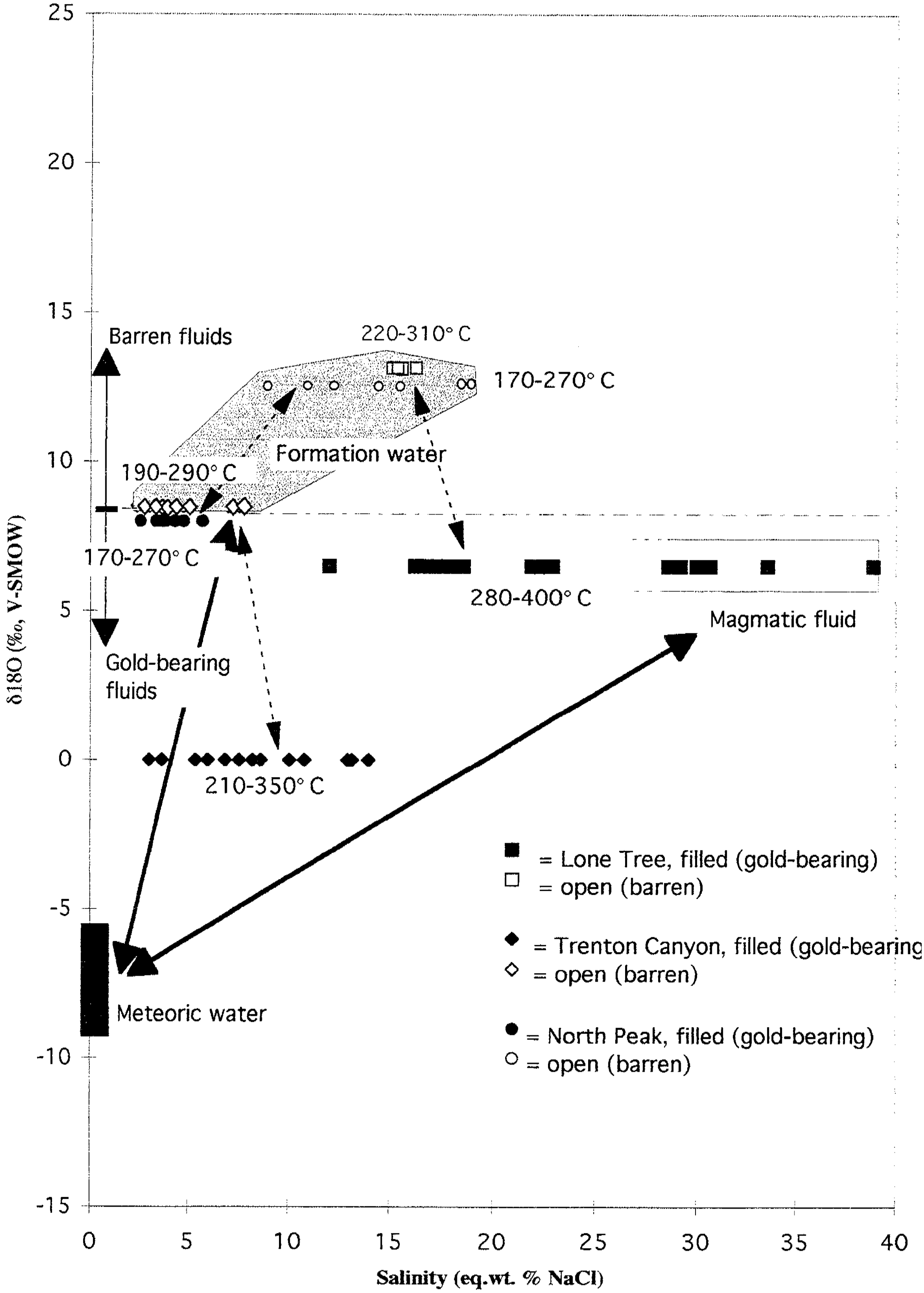


Fig. 18. Homogenization temperatures versus salinity for samples at Lone Tree: Filled square = gold-bearing samples (Kamali, 1996), Open square = barren samples (this study), Asterisks = re-calculated data from Kamali (1996) using final melting of clathrate as opposed to final melting of ice (see discussion in text). Re-calculation of data brings low salinity inclusions of gold-bearing samples up to ranges of salinity measured in barren samples. It appears a mixing trend is established between both barren sample measurements and re-calculated data with the high temperature, high salinity (magmatic) measurements from gold-bearing samples.

Fig. 19. Calculated oxygen isotope composition of gold-bearing and barren fluids versus corresponding ranges of salinity estimates: Square = Lone Tree, Diamond = Trenton Canyon, Circles = North Peak, Filled shape = gold-bearing fluid, Open shape = barren fluid. Major fluid sources for the Lone Tree complex include magmatic, meteoric, and formation waters. Gold-bearing fluids have oxygen isotope composition lighter than 8.5 per mil, while barren fluids (formation water) have oxygen isotope composition heavier than 8.5 per mil. Shaded field represents the regional formation water with ranges of oxygen isotope composition and salinity determined by barren samples from the Lone Tree, North Peak, and Trenton Canyon deposits. Oxygen isotope composition of meteoric fluid at the Getchel and Twin Creeks mines (35 mi. northeast), as established by Groff (1996), is used as oxygen isotope composition of meteoric fluids at the Lone Tree Complex. The magmatic fluid is represented by upper ranges in salinity for mineralized sample at Lone Tree along with an oxygen isotope composition of 6.5 per mil. Solid arrows represent proposed mixing trends to account for fluids not represented by the three major fluid sources. Trenton Canyon gold-bearing fluids can be produced by mixing between the magmatic and meteoric fluids. Mixing between meteoric fluids and formation water can also result in a fluid with this composition, however a magmatic end-member for mixing is preferred to do the upper range of homogenization temperatures for Trenton Canyon. The gold-bearing fluid is skewed off the ideal mixing line to lower salinity by mixing with the barren formation water (dashed arrow). Although the gold-bearing fluid at North Peak has an oxygen isotope composition within the magmatic range, perhaps it is more plausible to produce it by mixing between the meteoric and formation waters (solid arrow). This composite fluid accounts for lower ranges of salinity and homogenization temperatures measured for the North Peak gold-bearing fluid.

Figure 19



Barren fluids
220-310° C
170-270° C
Formation water
190-290° C
170-270° C
280-400° C
Magmatic fluid
Gold-bearing fluids
210-350° C
Meteoric water
= Lone Tree, filled (gold-bearing)
= open (barren)
= Trenton Canyon, filled (gold-bearing
= open (barren)
= North Peak, filled (gold-bearing)
= open (barren)
δ18O (‰, V-SMOW)
Salinity (eq.wt. % NaCl)
25
20
15
10
5
0
-5
-10
-15
0
5
10
15
20
25
30
35
40

isotope value (formation water) for the initial fluid is expected if this is the fluid that mixed with the gold-bearing meteoric water.

Based on oxygen isotope composition (12.5 ‰), salinity (14.1 eq.wt. % NaCl), and homogenization temperature (213°C) the barren fluid at North Peak appears to be a formation water. Gold-bearing fluid at North Peak had a calculated oxygen isotope composition of 8.0 per mil; this value lies within the range of magmatic fluid values, although the homogenization temperature is problematic in regards to this interpretation. The average homogenization temperature of 209°C for inclusions in gold-bearing quartz would be a very low end-member temperature for a magmatic fluid. A fluid with this salinity, temperature, and $\delta^{18}O$ values could result from mixing between a meteoric water and the formation water (Fig. 19). Further mixing is suggested by the homogenization temperature-salinity plot for North Peak gold-bearing and barren samples (Fig. 17b). Alternatively, this average homogenization temperature may result from a magmatic fluid which is very distal to its heat source or towards the end of the magmatic history.

In the Battle Mountain-Winnemucca area, calling upon a magmatic and meteoric (mixed) source for gold-bearing fluids for these Carlin-type deposits (Lone Tree, North Peak, and Trenton Canyon) is not without precedent, nor is a basinal / formation water for deposition of barren stages. Research on deposits in close proximity to the Lone Tree complex have resulted in similar fluid sources. The Getchel and Twin Creeks mines are approximately 35 mi. northeast of the Lone Tree deposit along the eastern flank of the Osgood Mountains. Through the use of fluid inclusions, stable isotopes (H-O), and gas analysis, economic gold stages 3 & 5 at the Getchell and Twin Creeks mines were determined to be of magmatic origin; barren stage 5 at these deposits was postulated to have formed from a basinal fluid or an evolved meteoric fluid (Groff, 1996).

The types of fluids presented in this study are not restricted to deposits in the Battle Mountain-Winnemucca area. A magmatic fluid or some component of magmatic fluid, as seen at the Lone Tree and Trenton Canyon deposits, respectively, has been documented at other locations. Sillitoe and Bonham (1990) suggest the alignment of Carlin-type deposits in Carlin, Battle Mountain-Eureka, and Getchel trends with structural windows and intrusive rocks, promotes hydrothermal circulation and contributes some component of fluid or metal, which has been proposed at the Carlin (Radtke et al., 1980; Rye, 1985), Cortez (Rye, 1985), Purísima Concepcíon deposits (Alvarez and Noble, 1988).

An oxygen enriched meteoric water, as seen during the gold-bearing event at Trenton Canyon, has been suggested by others as the source of ore-bearing fluids. The movement of fluid in a magmatic driven hydrothermal systems often results in these evolved (exchanged or mixed) meteoric waters, such as those seen at Carlin (Radtke et al., 1980; Rye, 1985) and Cortez (Rye, 1985) and Vantage, Alligator Ridge-Bald Mountain mining district (Ilchik, 1990) and Jerritt Canyon district (Hofstra et al., 1991).

CONCLUSIONS

An Exploration Tool

Oxygen isotope distribution trends produced from sampling across structures result from the deposition of alteration minerals, water-rock exchange, and initial rock composition. Within all traverses, modal percent of alteration minerals and degree of isotopic alteration reach maximums at the structures. These trends suggest that fluid flow is mostly confined to the large-scale structures, with limited fluid flow perpendicular to the fault. The lateral extent of fluid flow and subsequent isotopic alteration halo outside the fault zone, appears to be controlled by the brecciated zone immediately adjacent to the structure. The spatial occurrence of ore bodies also indicates that fluids are structurally confined. The presence of gold, because of its low concentration in fluid, also suggests that more fluid has traveled through gold-bearing structures compared to barren structures. As a consequence of more fluid flow, ore-bearing fault zones are associated with higher degrees of isotopic alteration; this is a product of more hydrothermal alteration minerals, specifically quartz and sericite.

Net effects on whole-rock oxygen isotope values, enrichment or depletion, are governed by the $\delta^{18}O$ and temperature of fluids from which the alteration minerals (i.e., quartz and sericite) deposited from. Measured $\delta^{18}O_{quartz}$ and calculated $\delta^{18}O_{sericite}$ have values that can account for some of the oxygen isotope alteration in whole-rocks across fault zones; that is, $\delta^{18}O$ values of alteration minerals are lighter and heavier than baseline whole-rock oxygen isotope values, respectively, where depletion and an enrichment occurred. Direct evidence that other mechanisms are contributing to the oxygen isotope alteration is seen where $\delta^{18}O$ of alteration minerals is heavier than the depleted fault zone values.

Water-rock exchange should account for some of the oxygen isotope alteration, but most rocks encountered in the traverses contained dominantly quartz clasts. As a hypothesis, water could have exchanged with the unidentifiable clay matrix material, common and in many cases abundant in these host rocks. This assumes that fractionation between water and unknown mineral is such that final composition of the mineral has a value that can be a cumulative affect on the oxygen isotope alteration. For example, if the indistinguishable clay matrix material was kaolinite and exchanged with the water at temperatures recorded in the fluid inclusions, an equilibrium value of the kaolinite would be isotopically lower than both background and fault zone values. This would result in more depletion of the host rock and account for some of the alteration that the deposition of hydrothermal minerals does not account for.

Given the oxygen isotope composition of alteration minerals and affects of water-rock exchange, net depletion and enrichments seen in the traverses are directly related to the initial $\delta^{18}O$ of the host rocks. Many different lithologies are interleaved throughout the deposit areas. Despite the heterogeneity from primary rock components, effects of fluid flow are evident at all fault zones.

The district-scale use of oxygen isotopes as an exploration technique for the Lone Tree complex is somewhat inconclusive. All gold-bearing traverses produced a depletion at the fault zone, while barren traverses produced both an enrichment and a depletion at the fault zone. Oxygen isotope composition of gold-bearing and barren quartz overlap each other, with $\delta^{18}O$ of gold-bearing quartz $\leq$ 19.8 per mil and $\delta^{18}O$ of barren quartz $\geq$ 18.5 per mil. Neither trends in whole-rock oxygen isotopes across faults or oxygen isotope composition of gold-bearing and barren quartz can discriminate between gold-bearing and barren zones. Stenger et al. (1998) report that variations in the Ordovician Sequence and Etchart Formations distal to the Twin Creeks mine are such that a district-scale exploration technique using carbon and oxygen isotopes is unlikely. Others have seen similar results in mesothermal gold deposits where on a district-scale, stable isotopes are unable discern between mineralized and barren vein systems (Ansdell and Kyser, 1992; Nesbitt et al., 1989).

Despite problems of overlap in $\delta^{18}O$ values and distribution trends on a district-scale at the Lone Tree Complex, correlation between oxygen isotopes and ore-zones can be made on the deposit-scale. At the Lone Tree deposit, gold-bearing zones are associated with higher amounts of oxygen isotope alteration. In conjunction with the amount of oxygen isotope alteration, gold-bearing quartz samples at Lone Tree (12.4 ‰) are isotopically lighter than the barren quartz (21.2 ‰).

Along with the correlation of more oxygen isotope alteration, gold-bearing fault zones at North Peak are associated with a depletion, while barren fault zone produced an enrichment. At North Peak, once again, $\delta^{18}O$ of gold-bearing quartz (19.5 ‰) is isotopically lighter than the $\delta^{18}O$ of barren quartz (23.6 ‰).

Although a barren traverse was not sampled, the trend of an oxygen isotope depletion across a gold-bearing structure continues at Trenton Canyon. At Trenton Canyon, the $\delta^{18}O$ of gold-bearing quartz (8.6 ‰) is lighter than the barren quartz (18.5 ‰), which is the largest difference (9.9 ‰) in oxygen isotope composition between gold-bearing and barren quartz at all the deposits.

Despite the fact that the hydrothermal alteration assemblage centered on both gold-bearing and barren structures is similar, gold-bearing zones are associated with much greater abundance of alteration minerals. Larger amounts of isotopic alteration is associated with gold-bearing structures compared to barren structures, however the extent of this isotopic alteration halo is very limited. Due to the fact that hydrothermal alteration extends further away from ore zones than the isotopic alteration, it may be beneficial to use an alteration study in conjunction with the oxygen isotopes when searching for ore zones.

Ore Genesis and Genetic Links

Most fine-grained disseminated gold deposits in Nevada are confined to linear trends defined by different types of deposits and their alignment with structural windows and intrusive rocks (Roberts et al., 1971). Doebrich and Theodore (1996) in the Battle Mountain mining district, delineated northwest and north striking fault zones; the authors suggest that the intersection of these zones influenced where magmatic systems and there associated hydrothermal systems developed, which resulted in the formation of ore deposits. In conjunction with these large-scale structural association, close spatial relationship of the Lone Tree, North Peak, and Trenton Canyon deposits, along with similar ore-mineral relationships (gold in geothite and other Fe-oxides), size of gold grains (micron to sub-micron), controls of ore zones (structure), and hydrothermal alteration assemblage (quartz and sericite) suggests some type of genetic link. However, the temporal relationship of these three deposits has not been established. Oxygen isotopes and fluid inclusion measurements (Table 5) suggest local variations in the types of fluids involved in the formation of the deposits or different stages of hydrothermal development, and precludes a general genetic model accounting for the formation of all three deposits. A general schematic diagram depicting the development of individual deposits from results presented here is provided in Figure 20.

Table 5.: Summary of ore-bearing and barren fluid chemistry by deposit.

Fluid	Calculated $\delta^{18}O_{H2O}$ (per mil)	Temperature (Degree celcius)	Salinity (eq. wt. % NaCl)
Lone Tree mineralized	6.5	*328	*23.3
Lone Tree barren	13.1	274	15.3
North Peak mineralized	8.0	209	4.0
North Peak barren	12.5	213	14.1
Trenton Canyon mineralized	0.0	267	8.5
Trenton Canyon barren	8.5	223	4.5

* Kamali 1996

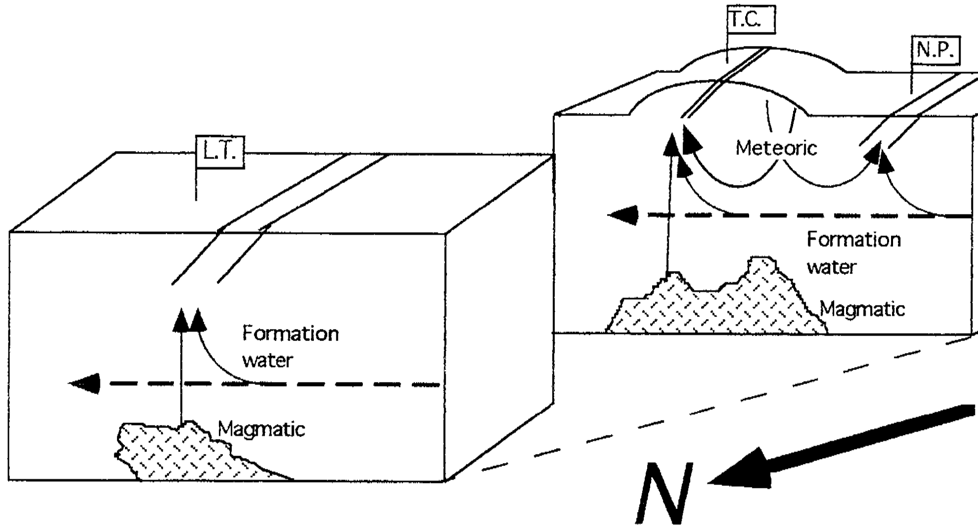


Fig. 20. Schematic cross-section through Lone Tree, North Peak, and Trenton Canyon showing proposed genetic model for the formation of ore and the different fluids involved in the hydrothermal systems.

A regional, barren formation water, responsible for hydrothermal alteration associated with barren structures, is documented by temperature and salinity measurements in inclusions and calculated oxygen isotope composition from the three deposit areas. This formation water ranges in both salinity and oxygen isotope composition, respectively, from 3.0 to 18.0 eq.wt. % NaCl and 8.5 to 13.1 per mil (Fig. 21). The upper range of homogenization temperatures (Lone Tree sample) for this formation water results from mixing with a higher temperature magmatic fluid (Fig. 18).

Kamali (1996) suggests that ore-bearing fluids at Lone Tree had a strong component of magmatic fluid, which is supported by calculated oxygen isotope values of gold-bearing fluids in this study. Re-interpretation of some salinity measurements in Kamali (1996) along with salinity, temperature, and $\delta^{18}O$ of barren quartz signifies a formation water for barren fluids at Lone Tree. Mixing between magmatic, ore-bearing fluids and the barren formation water is indicated in Figure 18.

Trenton Canyon gold-bearing fluids have calculated $\delta^{18}O$ values of an oxygen-enriched meteoric water. Due to lack of knowledge of δD values, it is uncertain whether exchange with host rock or mixing with an isotopically heavier fluid resulted in the values measured. Salinity, temperature, and $\delta^{18}O$ for Trenton Canyon gold-bearing fluids can be obtained through mixing between a magmatic fluid and meteoric water (Fig. 20), and suggest a magmatic source for gold. Further mixing between gold-bearing and the barren formation water (Fig. 17a) pulls gold-bearing fluids towards lower salinity conditions off the true magmatic-meteoric water mixing trend (Fig. 19).

Oxygen isotope composition, salinity, and temperatures for gold-bearing fluids at North Peak can be achieved by mixing of a meteoric water and the regional formation water (Fig. 19). A homogenization temperature-salinity plot (Fig. 17b) of inclusion measurements

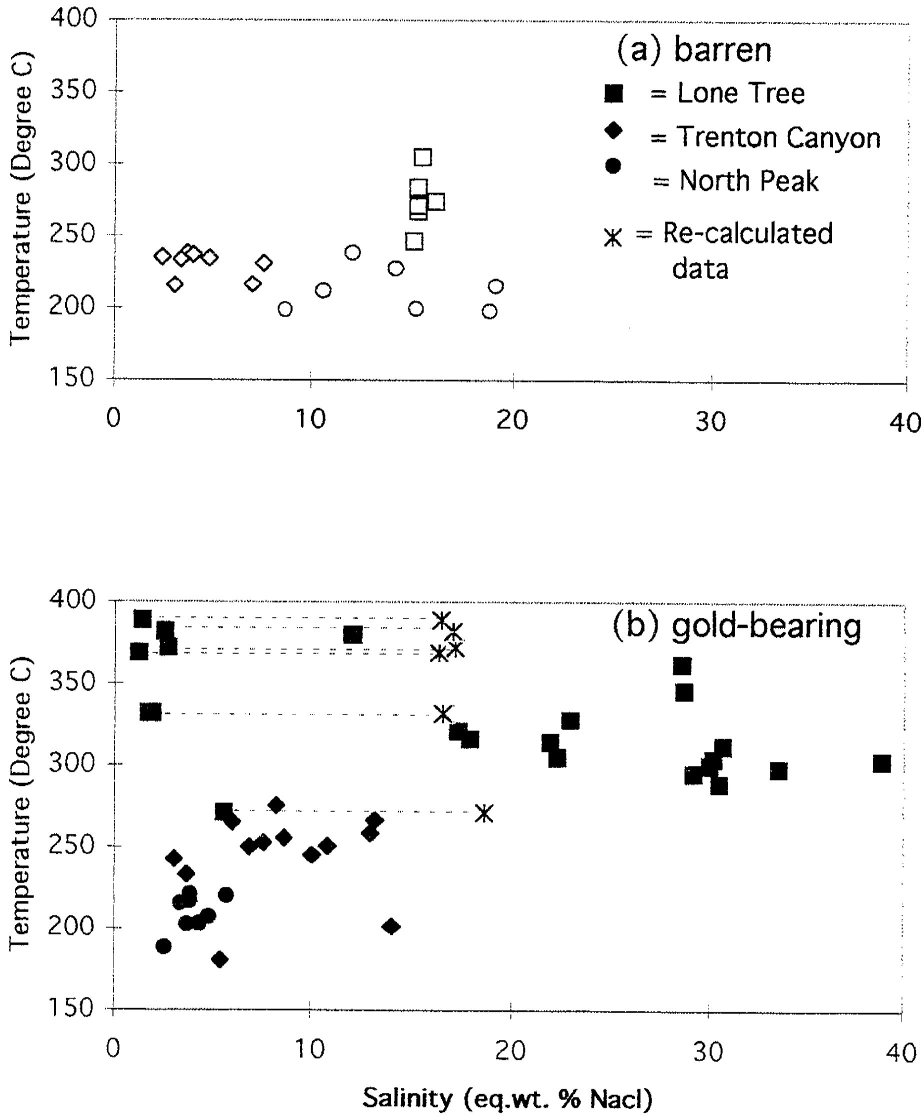


Fig. 21. Homogenization temperatures versus salinity for all deposits: (a) barren samples. (b) gold-bearing samples. Squares = Lone Tree sample, Diamond = Trenton Canyon sample, Circle = North peak, Asterisks = re-calculated data from Kamali (1996). Barren sample plot indicates a range of salinity for the barren formation water. Homogenization temperatures for this barren formation water are generally restricted, although Lone Tree samples are slightly elevated in temperature due to mixing with a magmatic fluid. Gold-bearing samples indicate a hydrothermal system with a broad range of salinity and homogenization temperatures, distinct fluid sources can be identified by different oxygen isotope compositions (discussion in text).

in gold-bearing and barren quartz samples suggest further mixing between the composite gold-bearing fluid and barren formation water.

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LIST OF APPENDICES

Appendix 1
Sample Location and Field Notes

Samples were collected from high-walls and locations were determined by noting the distance in feet on a tape measure drawn between two surveyed (northern, eastern, elevation) points or are referenced to a known location.

Lone Tree: Gold-bearing Traverse   Survey points A: N28009, E82932, 4440 ft
B: N28008, E83044, 4440 ft

Sample Identification	Location (distance from flt)	Field Notes
LT-1	53 ft (w/ in flt zone)	Flt zone, g.g., clay, and brecciated.
LT-2	59 ft (w/ in flt zone)	Same as LT-1
LT-3	49.5 ft (0.5 ft east)	Fault breccia, clay g.g., Havallah siltstone clasts(qtz dom.), and oxidized (red).
LT-4	49 ft (1.0 ft east)	Same as LT-3
LT-5	47 ft (3.0 ft east)	Decrease the amount of oxidation, more purple color. Rock same as LT-3.
LT-6	45 ft (5.0 ft east)	Same as LT-5
LT-7	40 ft (10 ft east)	Same as LT-5
LT-8	35 ft (15.0 ft east)	Volcanically derived (Havallah greenstone) sediments displaying mylonitic texture, purple in color.
LT-9	25 ft (25.0 ft east)	Same as LT-8, but tan-red rock.
LT-10	0 ft (50.0 ft east)	Green chert, Havallah.
LT-11	61.5 ft (0.5 ft west)	Qtz dominate s.t. w/ orange clay coating.
LT-12	62 ft (1.0 ft west)	Same as LT-11
LT-13	64 ft (3.0 ft west)	Same as LT-11
LT-14	66 ft (5.0 ft west)	Same as LT-11, but w/ qtz veinlets.
LT-15	71 ft (10.0 ft west)	Qtz dom. siltstone w/ Fe-ox coating/stain.
LT-16	76 ft (15 ft west)	Same as LT-15
LT-17	86 ft (25.0 ft west)	Same as LT-15
LT-18	111 ft (50.0 ft west)	Greenish chert w/ Fe-ox stain and veinlets, also small qtz veinlets.

Lone Tree: Barren Traverse (Fault located on southwest wall, near ramp, at the 4460 ft elevation). Mining prevented surveying points.

Sample Identification	Location (distance from flt)	Field Notes
LT-20	71.5 ft (w/ in fault zone)	Fault breccia w/ g.g.
LT-21	0.5 ft north	Rhythmic sltstone, highly brecciated, and appears hydrothermally altered.

Sample Identification	Location (distance from flt)	Field Notes
LT-22	1.0 ft north	Same as LT-21
LT-23	3.0 ft north	Same as LT-21, but less alteration/brecciation.
LT-24	5.0 ft north	Same as LT-23
LT-25	10.0 ft north	Rhythmic siltstone unit, more brecciation, and dull brown color in outcrop.
LT-26	15.0 ft north	Siltstone(?), brecciated, and rx bleached.
LT-27	25.0 ft north	Slightly brecciated/altered cherty unit.
LT-28	50.0 ft north	Unaltered, brecciated, and greenish to reddish chert unit.
LT-29	0.5 ft south	Highly fractured w/ Fe-ox veinlets, re-xtalized(?), and silicified(?) cherty/siltstone unit.
LT-30	1.0 ft south	Same as LT-29
LT-31	3.0 ft south	Same as LT-29
LT-32	5.0 ft south	Drk gray to light red to green siltstone unit, still brecciated, but not as altered.
LT-33	10.0 ft south	Siltstone(?) or cherty(?) unit, still brecciated, and slightly altered.
LT-34	15.0 ft south	Drk gray to red-brown to green mudstone or siltstone, and out of brecciated zone.
LT-35	25.0 ft south	Slightly brecciated/altered (on fractures) drk gray to red-brown to green siltstone.
LT-36	50.0 ft south	Drk gray to red-brown to green siltstone, little to no brecciation, Fe-ox on fractures, silicified.

North Peak: Gold-bearing Traverse Survey points A: N764673, E579028, 5700 ft
B: N764641, E578738, 5700 ft

Sample Identification	Location (distance from flt)	Field Notes
NP-300	300 ft (in fault zone)	White, highly bleached, and fractured fine to med. qtz dom. sandstone.
NP-0.5W	266.5 ft (0.5 ft west)	Massive gray sandstone, highly fractured, w/ barite vugs, veins, and coatings.
NP-1.0W	267 ft (1.0 ft west)	Same as NP-0.5W
NP-269	269 ft (3.0 ft west)	Massive gray sandstone, no siltstone units, fine to med.

		grained, > 95% qtz.
Sample Identification	Location (distance from flt)	Field Notes
NP-267	267 ft (5.0 ft west)	Same as NP-269
NP-262	262 ft (10.0 ft west)	Same as NP-269
NP-257	257 ft (15.0 ft west)	Same as NP-269
NP-252	252 ft (20.0 ft west)	Same as NP-269
NP-40W	272 ft (40.0 ft west)	Massive and highly fractured, gray sandstone w/ moderate barite coatings or veins.
NP-0.5E	311.5 ft (0.5 ft east)	Drk brown, highly friable, w/ clay alteration, fine grained sandstone or siltstone.
NP-1.0E	312 ft (1.0 ft east)	Same as NP-0.5E
NP-314	314 ft (3.0 ft east)	Drk brown, qtz dom., limy siltstone w/ secondary calcite.
NP-317	317 ft (5.0 ft east)	Same as NP-314
NP-322	322 ft 10.0 ft (east)	Drk brown, qtz dom., limy siltstone.
NP-327	327 ft (15.0 ft east)	Similar to NP-314, but w/ calcite veins.
NP-337	337 ft (25.0 ft east)	Similar to NP-314, but w/ more clay.
NP-40E	352 ft (40.0 ft east)	Drk brown siltstone to sandstone w/ red clay coating and secondary calcite.

North Peak: Barren Traverse Survey points A: N764673, E579028, 5700 ft
B: N764641, E578738, 5700 ft

Sample Identification	Location (distance from flt)	Field Notes
NP-90	(W/ in flt zone)	Fault breccia, qtz dom., sandstone w/ lots of clays.
NP-93	93 ft (3.0 ft east)	Massive gray sandstone w/ siltstone interlayers.
NP-95	95 ft (5.0 ft east)	Same as NP-93
NP-100	100 ft (10.0 ft east)	Same as NP-93
NP-105	105 ft (15.0 ft east)	Same as NP-93
NP-110	110 ft (20.0 ft east)	Same as NP-93
NP-87	87 ft (3.0 ft west)	Thin bedded (4-6”), qtz dom., rhythmic siltstone unit w/ hematite stain.
NP-85	85 ft (5.0 ft west)	Similar to NP-87
NP-80	80 ft (10.0 ft west)	Similar to NP-87
NP-75	75 ft (15.0 ft west)	Similar to NP-87
NP-70	70 ft (20.0 ft west)	Similar to NP-87

Trenton Canyon: Gold-bearing Traverse (Mineralized fault located along road cut near drill hole DNT-49. Sample locations are referenced to road cut sample RNT14-1637).

Sample Identification	Location (distance from flt)	Field Notes
TC-1	(W/ in flt zone)	Fault breccia, Battle conglomerate w/ vuggy qtz, and maj. Fe-ox.
TC-2	37.5 ft (0.5 ft northeast)	Battle conglomerate w/ vuggy qtz and maj. Fe-ox.
TC-3	38 ft (1.0 ft northeast)	Battle conglomerate w/ vuggy qtz and maj. Fe-ox.
TC-4	40 ft (3.0 ft northeast)	Battle conglomerate w/ vuggy qtz and maj. Fe-ox.
TC-5	42 ft (5.0 ft northeast)	Battle conglomerate w/ vuggy qtz and maj. Fe-ox.
TC-6	47 ft (10.0 ft northeast)	Battle conglomerate w/ vuggy qtz and maj. Fe-ox.
TC-7	62 ft (25.0 ft northeast)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-8	25.5 ft (0.5 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-9	26 ft (1.0 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-10	28 ft (3.0 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-11	30 ft (5.0 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-12	35 ft (10.0 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-13	40 ft (15.0 ft southwest)	Battle conglomerate w/ vuggy qtz and mod. Fe-ox.
TC-14	50 ft (25.0 ft southwest)	Battle conglomerate w/ vuggy qtz and min. Fe-ox.

Locations for individual quartz samples from the three deposits are referenced from a known location such as a drill hole or other surveyed point.

Deposit	Sample Identification	Location	Field Notes
North Peak	NP-QV	5700 level 0.5 ft west of flt (see survey pts for min. traverse)	Massive sandstone w/ siltstone interlayers w/ 0.25 inch qtz vein.
North Peak	NP-QV1	w/ min. fault zone 5680 level.	Massive light gray sandstone w/ 0.25 inch thick qtz vein.
North Peak	NP-QV2	N765747, E579279, 5600 level	Decalcified limy sandstone w/ qtz veins.
North Peak	NP-104 (5600)	104 ft south of N765747,	Botryoidal qtz and vugs in shear zone.

		E579279, 5600 level.	
Deposit	Sample Identification	Location	Field Notes
North Peak	NP-104 (5740)	N764580, E578867, 5740 level.	Re-xtalized fine to med. qtz dom. sandstone w/ qtz veinlets and vugs.
Lone Tree	LT-MIN	Within Power line flt	N/A
Lone Tree	LT-A	Section 13, 4380 level, 20.0 ft S65°W of N24324, E84217.	Qtz seam w/in fault (.05-1.0 ft wide w/g.g.) and cuts Havallah chert.
Lone Tree	LT-B	N25383, E84063, 4260 level	Qtz seam in Golconda thrust.
Lone Tree	LT-C	12 ft east of N26072, E84207, 4270 level.	Large (5-7 inch) qtz vein in Edna mtn. sucrosic unit.
Trenton Canyon	TC-A	10.0 ft south of CNT-102, in the "Saddle".	Hematite stained vuggy qtz on battle conglomerate.
Trenton Canyon	TC-15	15.0 ft south of RNT14-1637.	Similar to TC-A
Trenton Canyon	TC-16	133 ft northeast of RNT14-1637.	Valmy qtzite w/ 0.25 inch thick qtz vein.

Samples collected from reverse circulation drill hole chips (composite over five ft).

Deposit	Drill Hole	Depth (ft)	Notes
Lone Tree	PLT-1164	530	Chert (+ fine s.s.),minor oxidation, and qtz veinlets.
Lone Tree	PLT-1164	535	Same as PLT-1164 (530).
Lone Tree	PLT-1164	540	Siltstone (+chert)w/ calcite veins.
Lone Tree	PLT-1164	545	Same as PLT-1164 (540), but w/ calcite veins.
Lone Tree	PLT-1164	550	Same as PLT-1164 (540), but w/ calcite veins.
Lone Tree	PLT-1164	555	Same as PLT-1164 (540), but w/ calcite veins. Ore zone.
Lone Tree	PLT-1164	560	Similar to PLT-1164 (540), w/ more qtz veining

			and some calcite veining. Ore zone.
Lone Tree	PLT-1164	565	Same as PLT-1164 (560). Ore zone.
Deposit	Drill Hole	Depth (ft)	Notes
Lone Tree	PLT-1164	585	Siltstone w/ minor oxidation and qtz veining.
Lone Tree	PLT-1164	590	Same as PLT-1164 (585)
Lone Tree	PLT-1164	595	Same as PLT-1164 (585)
Lone Tree	PLT-1164	600	Same as PLT-1164 (585)
Lone Tree	PLT-1164	605	Same as PLT-1164 (585)
Trenton Canyon	DNT-36	420	Quartzite w/ mod. oxidation and min. qtz veining , py.
Trenton Canyon	DNT-36	425	Quartzite w/ mod. oxidation and min. qtz veining , py.
Trenton Canyon	DNT-36	430	Quartzite w/ min. oxidation and min. qtz veining , py.
Trenton Canyon	DNT-36	435	Quartzite w/ min. oxidation and min. qtz veining , py.
Trenton Canyon	DNT-36	440	Quartzite w/ min. oxidation and min. qtz veining , py. More brecciated.
Trenton Canyon	DNT-36	455	Quartzite w/ mod. oxidation and mod. qtz veining , py. More brecciated. Ore zone.
Trenton Canyon	DNT-36	460	Quartzite w/ min. oxidation and mod. qtz veining , py. Brecciated. Ore zone.
Trenton Canyon	DNT-36	465	Quartzite w/ min. oxidation and min. qtz veining , py. More brecciated. Ore zone.
Trenton Canyon	DNT-36	470	Quartzite w/ min. oxidation and min.

			qtz veining , py. More brecciated. Ore zone.
Trenton Canyon	DNT-36	485	Quartzite w/ min. oxidation and min. qtz veining , py.
Deposit	Drill Hole	Depth (ft)	Notes
Trenton Canyon	DNT-36	490	Quartzite w/ min. qtz veining , py. Ore zone.
Trenton Canyon	DNT-36	495	Quartzite w/ min. qtz veining , py. Ore zone.
Trenton Canyon	DNT-36	515	Quartzite w/ minor brecciation.
Trenton Canyon	DNT-36	520	Quartzite w/ some siltstone, minor oxidation.
Trenton Canyon	DNT-36	525	Quartzite w/ some siltstone, minor oxidation.

Key of abbreviations:

flt = fault
g.g. = fault gouge
qtz = quartz
py = pyrite
Fe-ox = hematite and/or limonite
rx = rock
drk = dark (in color)
dom. = dominantly
w/ = with
maj. = major
mod. = moderate
min. = minor

Appendix 2
Oxygen Isotope Analysis of National Bureau of Standards NBS-28

Reported value for NBS-28 is $\delta^{18}O$ = 9.64 ‰ vs. V-SMOW

DATE	VESSEL #	$\delta^{18}O$ (per mil)	YIELD (%)	STANDARD DEVIATION
4/3/97	1	9.499	88.2	0.157
4/3/97	2	9.720	92.4	0.093
4/3/97	3	9.396	88.4	0.087
4/3/97	5	9.561	87.9	0.112
4/3/97	6	9.485	90.8	0.110
4/3/97	7	9.413	80	0.084
4/3/97	8	9.512	88.8	0.045
4/3/97	10	9.478	93.8	0.071
4/3/97	11	9.468	91.9	0.059
12/11/97	1	8.863	93	0.083
12/11/97	2	9.405	95	0.074
12/11/97	3	9.478	96	0.049
12/11/97	4	9.321	95	0.069
12/11/97	5	9.520	86	0.056
12/11/97	6	9.461	94	0.08
12/11/97	7	9.195	97	0.077
12/11/97	9	8.362	96	0.093
12/12/97	1	9.495	93	0.073
12/12/97	2	9.665	83	0.060
12/12/97	3	9.786	96	0.047
12/12/97	4	9.782	93	0.061
12/12/97	5	9.763	95	0.046
12/12/97	6	9.753	99	0.043
12/12/97	7	9.598	94	0.089
12/12/97	9	9.617	94	0.105
12/12/97	10	9.630	96	0.032
12/12/97	11	9.358	95	0.052
12/12/97	12	9.313	94	0.054
12/16/97	1	9.412	91	0.064
12/16/97	2	9.029	89	0.111
12/16/97	3	9.504	89	0.060
12/16/97	4	9.124	94	0.122
12/16/97	5	9.387	95	0.138
12/16/97	6	9.354	94	0.059
12/16/97	7	9.214	92	0.120
12/16/97	9	9.164	93	0.185
12/16/97	10	9.301	93	0.147
12/16/97	11	9.112	93	0.103
7/23/98	5	9.043	93.7	0.074
7/23/98	6	9.105	95.1	0.055
7/23/98	7	9.083	95	0.044
7/23/98	9	9.228	95.4	0.068

DATE	VESSEL #	$\delta^{18}O$ (permil)	YIELD (%)	STANDARD DEVIATION
7/23/98	10	9.213	91.8	0.072
7/23/98	11	9.031	91.4	0.038
7/23/98	12	9.115	93.8	0.109

Average $\delta^{18}O$ for NBS-28 = 9.36 per mil ± 0.3 per mil

Appendix 3
Duplicate Oxygen Isotope Analysis

SAMPLE#	$\delta^{18}O$ (per mil)	YIELD (%)	DUPLICATE	$\delta^{18}O$ (per mil)	YIELD(%)
LT-6	13.84	92.4	LT-6	12.864	73.6
LT-12	10.6	91.5	LT-12	10.4	87.0
LT-17	9.4	89.4	LT-17	9.8	90.8
LT-20	18.4	91.4	LT-20	18.9	92.1
LT-1	9.4	91.1	LT-1	9.5	97.0
LT-20	18.9	91.6	LT-20	18.4, 18.9	91.4, 92.1
NP-90	17.2	88.7	NP-90	20.0	78.7
NP-100	18.0	90.5	NP-100	17.1	96.1
NP-95	16.7	95.8	NP-95	16.7	91.0
NP-300	13.7	89.2	NP-300	13.7	89.2
NP-317	20.2	92.2	NP-317	19.9	84.9
NP-332	19.7	87.5	NP-332	19.8	88.5
TC-1	13.4	89.7	TC-1	14.0	89.0
TC-6	13.7	93.9	TC-6	13.7	92.2
TC-12	15.4	92.7	TC-12	15.4	89.1
DNT-36 420	15.9	88.6	DNT-36 420	16.2	91.1
DNT-36 490	17.0	94.5	DNT-36 490	17.0	92.4
DNT-36 455	15.3	93.1	DNT-36 455	15.2	92.0
NP-QV1	19.0	80.7	NP-QV1	19.4	87.2
TC-A	9.0	89.8	TC-A	9.3	89.5
TC-16	18.8	86.2	TC-16	18.2	90.9
NP-104 5600	13.4	82.6	NP-104 5600	13.5	78.0
NP-QV	19.7	90.7	NP-QV	20.0	90.2
NP-104 5740	23.4	90.9	NP-104 5740	23.9	89.6
LT-C	17.4	93.0	LT-C	17.7	93.8
LT-A	20.9	100.2	LT-A	21.5	93.5
TC-15	7.9	96.3	TC-15	8.1	91.3
NP-QV2	18.3	77.3	NP-QV2	18.8	90.0
LT-B	20.4	96.5	LT-B	20.6	91.0
LT-min	12.4	92.6	LT-min	12.4	89.5

Appendix 4
Petrographic Descriptions

All petrographic observations made from standard thickness (30 µm) thin sections lacking cover slips.

Deposit: Lone Tree
Sample I.D.: LT-10

Location: 50.0 ft east of flt.
Gold-bearing traverse

Grain size: 20 µm (med. silt)
Sorting: good

Roundness: subangular to subrounded

Rock name: Chert (in field)/ Wacke

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Opaques	< 2%

Matrix: very grundgy approx. 30-40%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	minor (5%)	Qtz	Silicified clasts.
Sulfide/oxidized	minor (5%)	Sulfide (diagenetic?), (py?) oxidized euhedral cubes.	Disseminated grains.

Deposit: Lone Tree
Sample I.D.: LT-9

Location: 25.0 ft east of flt.
Gold-bearing traverse

Grain size: porphyritic
Sorting: N/A

Roundness: N/A

Rock name: "Greenstone" breccia (flow)

Grains/Clasts	Percentage (%) (of grains)
K-fsp .75 mm	50%
Qtz .5 mm	30%
Plag	20%

Matrix: very grundgy fine grained micas, fsps, and qtz.

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Phyllo-silic.	trace (<5%)	White phyllo (sericite).	Altering K-fsp, and as veins and vugs.
Clays	mod-high (10-15%)	Clays	Grundgy appearance in matrix.
Silica	trace (<5%)	Qtz	In vugs.
Chlorite	high (≥20%)	Light brown chlorite.	Replacing matrix, and as infillings.

Other: flow banding

Deposit: Lone Tree
Sample I.D.: LT-4

Location: 1.0 ft east of flt.
Gold-bearing traverse

Grain size: 20 μm (med. slt) to 8 μm (v. fine slt)
Sorting: poor to moderate

Roundness: angular to subangular

Rock name: Siltstone wacke

Grains/Clasts	Percentage (%) (of grains)
Qtz	85%
Micas	7-10%
Opaques	5%

Matrix: very little; 5-7%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	minor (5%)	2 generations of qtz grains 10-30 μm.	Veinlets 0.5 mm in width.
Phyllo-silic.	minor (5%)	Fine grain accicular sericite.	Lrg vug filling, and center line in veins.
Clays	mod to high (10-15%)	Clays	Pervasive throughout rock.
Oxidation	minor (5%)	Hem. after opaques.	Rims on opaques.

Deposit: Lone Tree
Sample I.D.: LT-3

Location: 0.5 ft east of flt.
Gold-bearing traverse

Grain size: 20 μm (med. slt) to 8 μm (v. fine slt)
Sorting: Moderate to poor

Roundness: angular to subangular

Rock name: Siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	83%
Micas	7%
Opaques	10%

Matrix: clays(?) >15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	minor to mod. (5-10%)	Multiple generations of qtz.	Veinlets 0.1 mm in width, and locally as vugs.
Phyllo-silic.	mod. to high (10-15%)	Fine grain accicular white phyllo (sericite).	In veinlets and disseminated patches.
Clays	moderate (10%)	Clays	Overall, rx very grundgy.

Deposit: Lone Tree
Sample I.D.: LT-1

Location: w/ in flt zone
Gold-bearing traverse

Grain size: mm's to cm's
Sorting: poor

Roundness: very angular to subangular

Rock name: Matrix supported breccia

Grains/Clasts	Percentage (%) (of grains)
Siltstone clasts	40%
Chert clasts	40%
Argillite clasts	20%

Matrix: 20-30 μm hydrothermal qtz (65% of rx)

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (15-20%)	Qtz	Veining and silicification of matrix and rx frags.
Phyllo-silic.	trace (<5%)	Fine grain accicular white phyllo (sericite).	Disseminated
Clays	moderate (10%)	Clays	Overall, rx very grundgy.
Sulfide/oxidized	minor to mod. (5-10%)	Hem. after py(?)	Rims on rx fragments and indiv. grains in matrix.

Deposit: Lone Tree
Sample I.D.: LT-11

Location: 0.5 ft west of flt
Gold-bearing traverse

Grain size: 18 μm (medium slt)
Sorting: good

Roundness: subangular

Rock name: Siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Opaques	5%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	v.high (≥20%)	Grains up to .25 mm and as small as 30 μm, and w/ semi to opaque mineral + sericite.	Veinlets 2.5 mm to 40 μm in width.
Phyllo-silic.	min. to mod. (5-10%)	Bladed and accicular fine grained white	Disseminated patches and as

		phyllo (sericite).	veinlets.
Type:	Degree:	Minerals:	Occurrence:
Opaque to semi - opaque, later oxidized	mod.(10%)	Bladed material, mar(?) or asp(?) later to hem.	Veinlets and disseminated euhedral grains.

Deposit: Lone Tree
Sample I.D.: LT-12

Location: 1.0 ft west of flt
Gold-bearing traverse

Grain size: 12 μm (fine slt) to 125 μm (v. fine sand)
Sorting: moderate

Roundness: angular to subangular

Rock name: Siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	60%
Micas	40%

Matrix: grundgy stuff <5%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	v. high (≥20%)	Qtz grains (6 μm to 250 μm).	Veinlets 1 mm to 50 μm in widtht.
Phyllo-silic.	mod. to high (10-15%)	White phyllo-silic. (sericite).	Halos around qtz grains, in veins, and disseminated.
Sulfide later oxidation	low to mod. (5-10%)	Asp(?) or mar(?) later hem.	As veinlets and disseminated.

Deposit: Lone Tree
Sample I.D.: LT-15

Location: 10.0 ft west of flt
Gold-bearing traverse

Grain size: 12 μm (silt) to 100 μm (sand)
Sorting: poor

Roundness: angular

Rock name: Siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	85-90%
Mica	10-15%
Opaques	<5%

Matrix: approx. 10%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains 12-125 μm w/ opaques and white phyllo.	As veinlets 2.5 mm to 12 μm in width, multiple

			generations, and patches replacing grndmass.
Type:	Degree:	Minerals:	Occurrence:
Phyllo-silic.	high (≥20%)	12 μm long accicular grains.	As veinlets, disseminated patches, and centerline w/ qtz.
Sulfide later oxidized	minor (5%)	Oxidized sulfide.	Small grains and veinlets
Clays	mod. (10%)	Clays	Pervasive.

Deposit: Lone Tree
Sample I.D.: LT-17

Location: 25.0 ft west of flt
Gold-bearing traverse

Grain size: 6-20 μm (fine to med. slt)
Sorting: moderate

Roundness: subangular

Rock name: Siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	80%
Mica	20%

Matrix: grundgy <5%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica/sulfide	minor (5%)	Oxidized opaque (py?) in center of vein followed by qtz 250 μm or less w/ halos of opaques and qtz.	2 mm wide veinlets w/ cm's halo.
Phyllo-silic.	trace to minor (1-5%)	Fine grain white phyllo (sericite).	Disseminated

Deposit: Lone Tree
Sample I.D.: LT-18

Location: 50.0 ft west of flt
Gold-bearing traverse

Grain size: 10 μm (fine slt)
Sorting: moderate

Roundness: subangular to subrounded

Rock name: Chert (in field)/wacke

Grains/Clasts	Percentage (%) (of grains)
Qtz	60%
Mica	30%
Opaques	10%

Matrix: grundgy 15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	minor (5%)	Qtz (10-250 µm) grains, multiple generations, and w/ center line opaques and white phyllo.	Veinlets 50-500 µm wide.

Deposit: Lone Tree
Sample I.D.: LT-35

Location: 25.0 ft south of flt
Barren traverse

Grain size: 40 µm (med. to coarse silt)
Sorting: moderate

Roundness: subangular to subrounded

Rock name: Wacke (siltstone)

Grains/Clasts	Percentage (%) (of grains)
Qtz	80%
Mica	15%
Opaques	5%

Matrix: . >15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. (10%)	Qtz (250-25 µm) grains.	Mainly as veinlets 250 to mostly 75 µm in width), and locally as vugs.
Chlorite	mod. to high (10-15%)	Green, accicular chlorite.	Veinlets, but mostly patches.
Phyllo-silic.	minor (5%)	White phyllo (sericite).	As center line w/ qtz or as veinlets.
Oxidation	mod. to high (10-15%)	Hematite	Oxidation of some sulfides, but mostly of chlorite.

Other: mylonitic texture w/ "eyes" of qtz and wacke clasts with flow texture of chlorite, but in places chlorite post-dates mylonitic event.

Deposit: Lone Tree
Sample I.D.: LT-33

Location: 10.0 ft south of flt
Barren traverse

Grain size: 20 µm or smaller (fine slt)
Sorting: moderate

Roundness: subangular

Rock name: Siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)

Qtz	90%
Mica	5%
Opaques	3%

Matrix: 15% grundgy

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains (250-25 μm).	Multiple (3) generations of veinlets (10 μm to 2 mm), also as vug fillings.
Phyllo-silic.	low to mod. (5-10%)	White phyllo (sericite).	As veinlets, (2) generations, also w/ qtz center lines.
Chlorite	mod. to high (10-15%)	Chlorite	Veinlets and patches.
Sulfide/oxidation	mod. (10%)	Py(?)/ hem.	Oxid.of sulf.& chl.

Deposit: Lone Tree
Sample I.D.: LT-31

Location: 3.0 ft south of flt
Barren traverse

Grain size: 40 μm (coarse slt)
Sorting: moderate

Roundness: subangular to angular

Rock name: Siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	90%
Mica	5%
Opaques	5%

Matrix: 15%, grundgy

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	high (15-20%)	Multiple generations of qtz grains (10-250 μm).	As veinlets (1 mm to 25 μm), and as replacement of rock and infilling of vugs.
Phyllo-silic.	mod. (10%)	White phyllo (sericite).	Mostly disseminated, also in vugs and as center line w/ qtz.
Chlorite	minor (5%)	Chlorite	Patchy areas
Sulfide/oxidation	min. to mod. (5-10%)	Py(?)/ hem.	Oxidation of sulfides and chlorite.
Carbonate (?)	trace(<5%)	Calcite	Veins

Deposit: Lone Tree
Sample I.D.: LT-29

Location: 0.5 ft south of flt
Barren traverse

Grain size: N/A
Sorting: N/A

Roundness: N/A

Rock name: Chert

Grains/Clasts	Percentage (%) (of grains)

Matrix:

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	high (20%)	Qtz grains (350-10 µm).	As veinlets (500-25 µm), also as replacement and/or infilling.
Phyllo-silic.	min. (5%)	White-phyllo (sericite).	In qtz veins and disseminated.
Chlorite	min. (5%)	Chlorite	Small patches
Sulfide/oxidation	min. to mod (5-10%)	Py(?)/hem.	Oxidation of sulfides and chlorite.

Deposit: Lone Tree
Sample I.D.: LT-20

Location: w/ in flt zone
Barren traverse

Grain size: N/A
Sorting: N/A

Roundness: N/A

Rock name: Chert

Grains/Clasts	Percentage (%) (of grains)

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains (10-100 µm).	Veinlets (100-20 µm) wide.
Phyllo -silic.	min. (5%)	White phyllo (sericite).	Center line w/ qtz, and some disseminated.
Chlorite	min. (5%)	Chlorite	Disseminated patches.
Oxidation	mod (10%)	Hematite	Many oxidized veinlets (50 µm) wide.

Deposit: Lone Tree
Sample I.D.: LT-21

Location: 0.5 ft north of flt
Barren traverse

Grain size: N/A
Sorting: N/A

Roundness: N/A

Rock name: Chert

Grains/Clasts	Percentage (%) (of grains)

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains (1 mm to 10 μm).	Multiple generations of veinlets (10 μm to 5 mm) wide.
Phyllo-silic.	trace (<5%)	White phyllo (sericite).	Disseminated
Chlorite	trace (<5%)	Chlorite	Small patches
Sulfide/oxidation	minor (5%)	Py(?)/ hem.	Sulfides as disseminated grains and veinlets, and oxid. of sulfide and chl.

Deposit: Lone Tree
Sample I.D.: LT-23

Location: 3.0 ft north of flt
Barren traverse

Grain size: 30 μm (coarse silt)
Sorting: moderate to good

Roundness: subangular to subrounded

Rock name: Siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	60%
Oxidized opaques	40%

Matrix: 10-15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	min. (5%)	Qtz grains (25-10 μm).	As veinlets (125 μm) wide and vug infillings, and locally groundmass replacement.
Phyllo-silic.	min. (5%)	White phyllo (sericite).	Disseminated.

Sulfide/oxidized	min. (5%)	Sulfide(?)/ hem.	Oxidation of veinlet material.

Deposit: Lone Tree
Sample I.D.: LT-27

Location: 25.0 ft north of flt
Barren traverse

Grain size: 50-20 μm (v. coarse to med. slt.)
Sorting: poor to moderate

Roundness: subrounded to subangular

Rock name: Chert (in field)/Wacke

Grains/Clasts	Percentage (%) (of grains)
Qtz	85%
Mica	10%
Opaques	5%

Matrix: 15% grundgy

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	moderate (10%)	Qtz grains (5-100 μm) granular and fibrous habit.	At least 3 generations as veinlets (25-100 μm), and locally replacement of layer/horizon.
Phyllo-silic.	moderate (10%)	White phyllo (sericite).	Patches in veinlets w/ qtz, also disseminated.
Sulfide/oxidation	minor (5%)	Py(?)/ hem.	Disseminated grains and as veinlets.

Deposit: North Peak
Sample I.D.: NP-40W

Location: 40.0 ft west of flt
Gold-bearing traverse

Grain size: 25 to mostly 250 μm (coarse slt to med. sand)
Sorting: moderate to good

Roundness: subangular

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	95%
Opaques	<2%

Matrix: N/A

Cement: qtz (clay, calcite(?))

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-257

Location: 15.0 ft west of flt
Gold-bearing traverse

Grain size: 25 to mostly 250 µm (coarse slt to med. sand)
Sorting: moderate to good

Roundness: subangular

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	95%
Opaques	<3%

Matrix: N/A

Cement: qtz (clay, calcite(?))

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-267

Location: 5.0 ft west of flt
Gold-bearing traverse

Grain size: 250 µm (med. sand)
Sorting: good

Roundness: angular to subangular

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	95%
Opaques	<5%

Matrix: N/A

Cement: qtz (minor calcite(?))

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-1.0W

Location: 1.0 ft west of flt
Gold-bearing traverse

Grain size: 20 to mostly 500 µm (med. slt to med. sand)
Sorting: moderate

Roundness: subrounded

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	85%
Opaques	15%

Matrix: N/A

Cement: qtz (minor calcite?)

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-300

Location: w/ in flt zone
Gold-bearing traverse

Grain size: 18-100 μm (fine slt to fine sand)
Sorting: moderate

Roundness: subangular

Rock name: Flt breccia

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Lithics	5%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Euhedral qtz grains (50 μm) and accicular (50 μm).	As veinlets 1 mm wide.
Sulfide/oxidation	high (20%)	Euhedral sulfide (?) grains that have been oxidized, and zones of pervasive hem.	Sulfides disseminated, and hematite pervasive.
Phyllo-silic.	mod. to high (10-15%)	White phyllo (sericite).	Disseminated

Deposit: North Peak
Sample I.D.: NP-1.0E

Location: 1.0 ft east of flt
Gold-bearing traverse

Grain size: 12-50 μm (fine to coarse slt)
Sorting: moderate

Roundness: subangular

Rock name: Decalcified, Limy siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	60% (normalized)
Opaques	40% (normalized)

Matrix: qtz, clays 15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Phyllo-silic.	high (20%)	White phyllo (sericite).	Disseminated and as veinlets.
Sulfides/oxidized	high (20%)	Py(?)/ hem.	Euhedral grains (12-

			75 µm) that are oxidized.

Deposit: North Peak
Sample I.D.: NP-317

Location: 5.0 ft east of flt
Gold-bearing traverse

Grain size: 6-125 µm (fine slt to fine sand)
Sorting: moderate

Roundness: subangular

Rock name: Decalcified, limy siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Opaques	5%
Lithics	5%

Matrix: fine grain qtz grains >15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	trace (<5%)	Qtz grains (50 µm).	Veinlets (100 µm) in width.

Deposit: North Peak
Sample I.D.: NP-332

Location: 20.0 ft east of flt
Gold-bearing traverse

Grain size: 24-90 µm (fine to coarse slt)
Sorting: moderate to good

Roundness: subangular

Rock name: Limy siltstone (arenite)

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Opaques	5%
Lithics	5%

Matrix: grundgy calcite

Cement: see matrix

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Carbonate	mod. to high (10-15%)	Calcite	Veinlets (1 mm to 10 µm) and disseminated masses.

Deposit: North Peak
Sample I.D.: NP-40E

Location: 40.0 ft east of flt
Gold-bearing traverse

Grain size: 12-60 μm (fine to coarse slt)
Sorting: moderate
Roundness: subangular to subrounded

Rock name: Limy siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	90-95%
Opaques	5%
Lithics	5%

Matrix: grundgy calcite, clays >15%
Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Carbonate	moderate (10%)	Calcite	Veinlets (1 mm to 25 μm) wide.

Deposit: North Peak
Sample I.D.: NP-75
Location: 15.0 ft west of flt
Barren traverse

Grain size: 50-60 μm (coarse slt)
Sorting: moderate
Roundness: subangular

Rock name: Siltstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	63%
Mica	30%
Opaques	7%

Matrix: N/A
Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	trace (<5%)	Qtz grains (50-250 μm).	Veinlet 250 μm wide.

Deposit: North Peak
Sample I.D.: NP-85
Location: 5.0 ft west of flt
Barren traverse

Grain size: 50 μm (coarse slt)
Sorting: good w/ in layers
Roundness: subangular to subrounded

Rock name: Rhythmic siltstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	63%
Micas	30%
Opaques	7%

Matrix: N/A
Cement: N/A

Alteration: No visible alteration

Other: Oxidation of mica rich layers give the rock its rhythmic look.

Deposit: North peak
Sample I.D.: NP-87

Location: 3.0 ft west of flt
Barren traverse

Grain size: 20-80 μm (medium slt to fine sand)
Sorting: moderate

Roundness: subangular

Rock name: : Rhythmic siltstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	90%
Mica	10%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Sulfide/oxidation	high (20%)	Oxidized (hem?) sulfide grains (40 μm).	Pervasive throughout and w/ qtz in veinlets.
Silica/phyllo-silic.	minor (5%)	Qtz grains (10-40 μm) w/ fine grain (<10 μm) white phyllo (sericite).	Veinlets 150-30 μm wide.

Deposit: North Peak
Sample I.D.: NP-90

Location: w/ in flt zone
Barren traverse

Grain size: 30-50 μm (med. slt to fine sand)
Sorting: moderate to good

Roundness: subangular to subrounded

Rock name: Siltstone flt breccia

Grains/Clasts	Percentage (%) (of grains)
Qtz	75%
Mica	20%
Opaques	5%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Oxidation	mod. (10%)	Hem. after sulfides/micas.	Pervasive throughout layers.
Silica	minor (5%)	Qtz grains (30 μm).	Veinlets 50 μm wide.

Deposit: North Peak

Location: 3.0 ft east of flt

Sample I.D.: NP-93

Barren traverse

Grain size: 10-80 μm (fine slt to med. sand)
Sorting: good

Roundness: angular to subangular

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	100%

Matrix: N/A

Cement: N/A

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-95

Location: 5.0 ft east of flt
Barren traverse

Grain size: 25 to mostly 125 μm (fine slt to med. sand)
Sorting: good

Roundness: angular to subangular

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	100%

Matrix: N/A

Cement: N/A

Alteration: No visible alteration

Deposit: North Peak
Sample I.D.: NP-105

Location: 15.0 ft east of flt
Barren traverse

Grain size: 100 μm (fine sand)
Sorting: moderate to good

Roundness: subangular to subrounded

Rock name: Sandstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	100%

Matrix: 5% qtz

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	trace (<5%)	Qtz grains (1000 μm).	Veinlet (1000 μm) wide.

Deposit: Trenton Canyon
Sample I.D.: TC-6

Location: 10.0 ft northeast of flt
Gold-bearing traverse

Grain size: 2 cm to 100 μm
Sorting: poor

Roundness: subangular to subrounded

Rock name: Clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	50%
Qtzite clasts	25%
Siltstone clasts	25%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	min. to mod. (5-10%)	Qtz grains (125-40 μm).	As qtz veinlets or vugs, and commonly w/ sulfides.
Phyllo-silic.	minor (5%)	White phyllo (sericite).	Mainly as rims around grains, but locally disseminated in clasts and in vugs.
Sulfide/oxidation	minor (5%)	Py(?)/ hem(?) or lim(?)	Mostly in matrix, but locally w/ qtz in vugs.

Deposit: Trenton Canyon
Sample I.D.: TC-3

Location: 1.0 ft northeast of flt
Gold-bearing traverse

Grain size: 2.5 mm to 25 μm
Sorting: poor

Roundness: subangular to subrounded

Rock name: Clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	50%
Qtzite clasts	50%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	moderate (10%)	Qtz grains (250-10 μm).	In vugs or voids, commonly w/ opaques, and locally as veinlets (25 μm).
Phyllo-silic.	minor (5%)	White phyllo (sericite).	Patchy aggregates found mostly in rx fragments.
Sulfide/oxidation	mod. (10%)	Hematite after sulfide.	Prevalent in matrix.

Deposit: Trenton Canyon
Sample I.D.: TC-2

Location: 0.5 ft northeast of flt
Gold-bearing traverse

Grain size: 2 mm to 10 mm
Sorting: poor

Roundness: subangular to subrounded

Rock name: Clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	70%
Qtzite grains	30%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	minor (5%)	Qtz grains (25-50 µm).	As vug or void fillings.
Oxidation	minor (5%)	Hematite after sulfide.	Disseminated throughout matrix.

Deposit: Trenton Canyon
Sample I.D.: TC-1

Location: w/ in flt zone
Gold-bearing traverse

Grain size: 5 mm to 50 µm
Sorting: poor

Roundness: subangular to subrounded

Rock name: Flt breccia in clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	lrg grains 20%
Qtzite clasts	sml grains 80%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains (75-15 µm).	In veinlets (400-20 µm) wide.
Phyllo-silic.	minor (5%)	White phyllo (sericite).	In veins and vugs, and locally around clasts.
Sulfide/oxidation	min. to mod. (5-10%)	Hematite after sulfide.	Mostly in matrix.

Deposit: Trenton Canyon
Sample I.D.: TC-8

Location: 0.5 ft southwest of flt
Gold-bearing traverse

Grain size: 10-40 µm (med. slt)
Sorting: moderate to poor

Roundness: subangular to subrounded

Rock name: Fine grain section of Battle conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz	100%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	mod. to high (10-15%)	Qtz grains (10-375 μm).	As veinlets 2 mm to 25 μm wide.
Type:	Degree:	Minerals:	Occurrence:
Phyllo-silic./oxidized sulfide	min. to mod. (5-10%)	White phyllo (sericite) w/ oxidized (hem) sulfides.	Mostly as veinlets, but locally in vugs or disseminated.

Deposit: Trenton Canyon
Sample I.D.: TC-9

Location: 1.0 ft southwest of flt
Gold-bearing traverse

Grain size: 1 cm to mostly 250 μm
Sorting: moderate

Roundness: subangular to subrounded

Rock name: Clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	50%
Qtzite clasts	30%
Wacke siltstone clasts	20%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	min. to mod. (5-10%)	Qtz grains (35-10 μm).	Replacement of matrix.
Phyllo-silic.	minor (5%)	White phyllo (sericite).	Disseminated
Sulfide/oxidation	mod. to high (10-15%)	Hem./lim(?) after sulfide.	In matrix, but locally in grains.

Deposit: Trenton Canyon
Sample I.D.: TC-12

Location: 10.0 ft southwest of flt
Gold-bearing traverse

Grain size: 1.5 cm to 50 μm
Sorting: poor

Roundness: angular to subangular

Rock name: Clast supported conglomerate

Grains/Clasts	Percentage (%) (of grains)
Siltstone wacke clasts	60%

Qtzite clasts	40%

Matrix: oxidized stained qtz and k-fsp grains <10%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica/phyllo-silic.	moderate (10%)	Qtz grains (250-25 µm) and white phyllo (sericite).	As vugs and veinlets (125 µm), and disseminated in matrix.
Sulfide/oxidation	mod. to high (10-15%)	Hem./lim(?) after sulfide.	Alt. of sulf. in veins, vugs, and matrix.

Deposit: Lone Tree

Sample I.D.: Hgs

Location: N/A

Background sample

Grain size: aphanitic

Sorting: N/A

Roundness: N/A

Rock name: Havallah greenstone

Grains/Clasts	Percentage (%) (of grains)
Plagioclase	70%
Pyroxene	30%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Chlorite	moderate (10%)	Chlorite	Altering the pyx.

Deposit: Lone Tree

Sample I.D.: Hms

Location: N/A

Background sample

Grain size: 6-40 µm (fine to mod. slt.)

Sorting: moderate

Roundness: subangular to subrounded

Rock name: Havallah mudstone

Grains/Clasts	Percentage (%) (of grains)
Qtz	47%
Mica	47%
Opaques	6%

Matrix: 60% clays

Cement: N/A

Alteration: No visible alteration

Deposit: Lone Tree

Location: N/A

Sample I.D.: Hc

Background sample

Grain size: N/A

Roundness: N/A

Sorting: N/A

Rock name: Havallah chert

Grains/Clasts	Percentage (%) (of grains)

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Sulfide/oxidation	trace (<5%)	Py(?) or asp(?)/ hem.	In veinlets and disseminated.

Deposit: Lone Tree

Location: N/A

Sample I.D.: Hst

Background sample

Grain size: 6-20 μm (v. fine to fine slt)

Roundness: subrounded to subangular

Sorting: poor to moderate

Rock name: Havallah siltstone (wacke)

Grains/Clasts	Percentage (%) (of grains)
Qtz	50%
Mica	40%
Opaques	10%

Matrix: grundgy 15%

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	trace (<5%)	Qtz grains (5-10 μm).	As veinlets (15 μm) wide._
Oxidized	min. to mod.	Hematite	Veinlets (10 μm) wide, with oxidized material.

Deposit: North Peak

Location: N/A

Sample I.D.: Hls-Np

Background sample

Grain size: 120 μm (fine sand)

Roundness: subrounded to rounded

Sorting: good

Rock name: Havallah limy siltstone

Grains/Clasts	Percentage (%) (of grains)
qtz	100%

Matrix: 10% of rx, calcite

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:

Carbonate	trace (<5%)	Calcite	Veinlets

Deposit: Trenton Canyon
Sample I.D.: Bc

Location: N/A
Background sample

Grain size: cm's to 10 μm
Sorting: poor

Roundness: rounded to subrounded

Rock name: Battle conglomerate (clasts supported conglomerate)

Grains/Clasts	Percentage (%) (of grains)
Qtz grains	65%
Qtzite clasts	20%
Siltstone clasts	10%
Grains/Clasts	Percentage (%) (of grains)
Plagioclase grains	2.5%
K-fsp grains	2.5%

Matrix: N/A

Cement: N/A

Alteration:

Type:	Degree:	Minerals:	Occurrence:
Silica	trace (<5%)	Qtz grains (100-20 μm).	Veinlets (25-250 μm) wide.

Appendix 5

Oxygen Isotope Analysis

Yield was estimated for whole rock analysis by calculating the amount of oxygen produced from an equal amount of pure quartz. * indicates a duplicate sample.

DATE	VESSEL #	SAMPLE #	ANALYSIS	WEIGHT	Delta18O	STDV	YIELD
				(mg)	(permil)		(%)
1/6/98	1	LT-1	Whole Rx	10	9.383	0.06	91.1
1/6/98	2	NBS-28	Whole Rx	10	9.311	0.07	85.3
1/6/98	3	LT-2	Whole Rx	10.2	9.817	0.05	94.0
1/6/98	4	LT-3	Whole Rx	10.4	No Sample		96.0
1/6/98	5	LT-4	Whole Rx	10	9.124	0.11	74.5
1/6/98	6	LT-5	Whole Rx	10	11.14	0.16	92.5
1/6/98	7	LT-6	Whole Rx	10	12.864	0.19	73.6
1/6/98	9	LT-7	Whole Rx	10	13.91	0.12	100.8
1/6/98	10	LT-8	Whole Rx	10.2	7.172	0.15	81.2
1/6/98	11	LT-9	Whole Rx	10	6.97	0.15	86.2
1/6/98	12	LT-10	Whole Rx	10.2	10.082	0.13	67.9
1/7/98	1	LT-9*	Whole Rx	10	10.52	0.07	73.5
1/7/98	2	LT-6*	Whole Rx	10	13.84	0.08	92.4
1/7/98	3	LT-3*	Whole Rx	10	12.04	0.08	90.1
1/7/98	4	LT-11	Whole Rx	10	12.659	0.1	94.1
1/7/98	5	LT-12	Whole Rx	10.1	10.417	0.08	87.1
1/7/98	6	LT-13	Whole Rx	10	12.278	0.09	90.6
1/7/98	7	LT-14	Whole Rx	10	12.82	0.1	95.1
1/7/98	9	LT-15	Whole Rx	10	12.38	0.12	83.8
1/7/98	10	LT-16	Whole Rx	10	10.743	0.09	92.8
1/7/98	11	LT-17	Whole Rx	10.6	9.391	0.03	89.5
1/7/98	12	LT-18	Whole Rx	10.1	12.756	0.05	90.2
1/8/98	2	LT-21	Whole Rx	10.4	20.515	0.06	93.4
1/8/98	3	LT-22	Whole Rx	10	20.279	0.08	95.0
1/8/98	4	LT-23	Whole Rx	10.1	18.591	0.02	93.6
1/8/98	5	LT-12*	Whole Rx	10	10.638	0.07	91.5
1/8/98	6	LT-17*	Whole Rx	10.1	9.818	0.03	90.8
1/8/98	7	LT-24	Whole Rx	10.2	20.484	0.12	94.1
1/8/98	9	LT-25	Whole Rx	10	20.39	0.15	88.8
1/8/98	10	LT-26	Whole Rx	10.1	20.356	0.11	92.0
1/8/98	11	LT-27	Whole Rx	10.8	20.429	0.08	91.2
1/8/98	12	LT-28	Whole Rx	10.6	21.347	0.04	92.8

DATE	VESSEL #	SAMPLE #	ANALYSIS	WEIGHT	Delta18O	STDV	YIELD
				(mg)	(permil)		(%)
1/9/98	2	LT-20*	Whole Rx	10.1	18.395	0.17	91.4
1/9/98	3	LT-20*	Whole Rx	10.2	18.906	0.04	92.1
1/9/98	4	LT-29	Whole Rx	10.1	19.343	0.07	95.0
1/9/98	5	LT-30	Whole Rx	10	18.129	0.07	93.9
1/9/98	6	LT-31	Whole Rx	10.1	17.513	0.1	92.4
1/9/98	7	LT-32	Whole Rx	10.2	17	0.11	91.3
1/9/98	9	LT-33	Whole Rx	10.1	19.419	0.13	90.4
1/9/98	10	LT-34	Whole Rx	10.1	15.749	0.05	90.9
1/9/98	11	LT-35	Whole Rx	10.1	15.902	0.12	92.9
1/9/98	12	LT-36	Whole Rx	10	17.977	0.07	92.9
1/28/98	2	NP-90	Whole Rx	10.8	17.153	0.03	88.7
1/28/98	3	NP-93	Whole Rx	10.1	17.637	0.08	92.1
1/28/98	4	NP-95	Whole Rx	10	16.661	0.07	95.8
1/28/98	5	NP-100	Whole Rx	10.3	17.977	0.07	90.5
1/28/98	6	NP-105	Whole Rx	10	17.211	0.07	94.0
1/28/98	7	NP-110	Whole Rx	10.1	16.719	0.1	93.5
1/28/98	9	NP-87	Whole Rx	10.1	17.471	0.04	89.6
1/28/98	10	NP-85	Whole Rx	10.4	17.564	0.06	87.1
1/28/98	11	LT-1*	Whole Rx	10.5	9.511	0.04	97.0
1/28/98	12	LT-20*	Whole Rx	10.4	18.911	0.06	91.6
1/29/98	2	NP-80	Whole Rx	10.1	17.475	0.05	91.3
1/29/98	3	NP-75	Whole Rx	10.4	17.475	0.04	91.3
1/29/98	4	NP-70	Whole Rx	10.1	18.256	0.07	91.0
1/29/98	5	NP-90*	Whole Rx	10.3	20.021	0.04	78.7
1/29/98	6	NP-100*	Whole Rx	10	17.127	0.05	96.2
1/29/98	10	NP-284	Whole Rx	10.1	16.259	0.15	92.9
1/29/98	11	NP-300	Whole Rx	10.1	13.679	0.02	91.1
1/29/98	12	NP-0.5W	Whole Rx	10	18.351	0.07	91.9
2/5/98	2	NP-1.0W	Whole Rx	10.3	17.669	0.12	92.2
2/5/98	3	NP-314	Whole Rx	10.3	19.663	0.09	91.3
2/5/98	4	NP-317	Whole Rx	10.3	20.173	0.08	92.2
2/5/98	5	NP-322	Whole Rx	10.1	19.487	0.12	93.1
2/5/98	6	NP-327	Whole Rx	10.4	19.295	0.12	89.8
2/5/98	7	NP-332	Whole Rx	10.3	19.757	0.08	88.5
2/5/98	9	NP-337	Whole Rx	10.3	18.734	0.09	86.4
2/5/98	10	NP-40W	Whole Rx	10.5	17.245	0.08	93.4
2/5/98	11	NP-95*	Whole Rx	10.5	16.74	0.03	91.0
2/5/98	12	NP-300*	Whole Rx	11.3	13.713	0.04	89.2

DATE	VESSEL #	SAMPLE #	ANALYSIS	WEIGHT	Delta18O	STDV	YIELD
				(mg)	(permil)		(%)
2/6/98	2	NP-0.5E	Whole Rx	10.3	18.924	0.07	88.2
2/6/98	3	NP-1.0E	Whole Rx	10.2	20.061	0.07	91.5
2/6/98	4	NP-317*	Whole Rx	10.9	19.949	0.12	84.9
2/6/98	5	NP-332*	Whole Rx	10.4	19.668	0.09	87.5
2/6/98	6	NP-252	Whole Rx	10.2	16.976	0.05	86.3
2/6/98	7	NP-257	Whole Rx	10.1	16.107	0.06	90.2
2/6/98	9	NP-262	Whole Rx	10.5	17.212	0.07	86.2
2/6/98	10	NP-267	Whole Rx	10.3	17.382	0.11	93.4
2/6/98	11	NP-269	Whole Rx	10.1	17.19	0.12	89.8
2/6/98	12	NP-40E	Whole Rx	10.1	19.373	0.08	85.1
3/5/98	2	TC-1	Whole Rx	10.4	13.434	0.06	89.7
3/5/98	3	TC-2	Whole Rx	10.7	14.676	0.07	91.6
3/5/98	4	TC-3	Whole Rx	10.6	14.152	0.07	94.8
3/5/98	5	TC-4	Whole Rx	10.5	14.816	0.08	94.2
3/5/98	6	TC-5	Whole Rx	10.4	14.406	0.07	92.7
3/5/98	7	TC-6	Whole Rx	10	13.692	0.09	93.9
3/5/98	9	TC-7	Whole Rx	10.3	16.65	0.03	95.0
3/5/98	10	TC-8	Whole Rx	10.4	15.039	0.05	93.9
3/5/98	11	TC-9	Whole Rx	10.3	14.459	0.06	93.2
3/5/98	12	TC-10	Whole Rx	10.3	14.449	0.08	93.8
3/6/98	2	TC-6*	Whole Rx	10.1	13.719	0.09	92.2
3/6/98	3	TC-1*	Whole Rx	10.3	14.035	0.06	89.0
3/6/98	4	TC-11	Whole Rx	10.2	15.841	0.07	92.3
3/6/98	5	TC-12	Whole Rx	10.3	15.426	0.08	92.7
3/6/98	6	TC-13	Whole Rx	10.7	14.905	0.06	87.4
3/6/98	7	TC-14	Whole Rx	11	16.154	0.03	92.2
3/6/98	9	PLT1164-530	Whole Rx	11.2	13.317	0.09	84.0
3/6/98	10	PLT1164-535	Whole Rx	10.2	12.82	0.06	88.9
3/6/98	11	PLT1164-540	Whole Rx	11.2	11.099	0.04	86.5
3/6/98	12	PLT1164-545	Whole Rx	10.1	11.49	0.11	89.1
3/11/98	2	PLT1164-550	Whole Rx	11.1	12.052	0.09	86.4
3/11/98	3	PLT1164-555	Whole Rx	10.7	13.255	0.04	88.3
3/11/98	4	PLT1164-560	Whole Rx	10.5	13.158	0.04	91.1
3/11/98	5	TC-12*	Whole Rx	10.4	15.405	0.06	89.1
3/11/98	6	PLT1164-565	Whole Rx	10.2	11.808	0.07	88.1
3/11/98	7	PLT1164-585	Whole Rx	10.1	11.778	0.05	86.5
3/11/98	9	PLT1164-590	Whole Rx	10.3	12.237	0.07	87.8
3/11/98	10	PLT1164-595	Whole Rx	10.4	11.976	0.06	102.3
3/11/98	11	PLT1164-600	Whole Rx	10.4	11.557	0.09	86.6
3/11/98	12	PLT1164-605	Whole Rx	10.8	11.745	0.07	74.5

DATE	VESSEL #	SAMPLE #	ANALYSIS	WEIGHT	Delta18O	STDV	YIELD
				(mg)	(permil)		(%)
5/28/98	2	DNT-36 420	Whole Rx	9.9	15.912	0.04	88.6
5/28/98	3	DNT-36 425	Whole Rx	11.6	16.769	0.07	91.3
5/28/98	4	DNT-36 430	Whole Rx	10.2	14.91	0.06	88.7
5/28/98	5	DNT-36 435	Whole Rx	11	15.114	0.04	90.5
5/28/98	6	DNT-36 440	Whole Rx	10.1	14.5	0.11	86.2
5/28/98	7	DNT-36 455	Whole Rx	10.6	15.305	0.09	93.1
5/28/98	9	DNT-36 460	Whole Rx	10.2	14.966	0.06	92.9
5/28/98	10	DNT-36 465	Whole Rx	10.5	15.72	0.07	92.8
5/28/98	11	DNT-36 470	Whole Rx	10	15.813	0.1	91.2
5/28/98	12	DNT-36 485	Whole Rx	10	16.368	0.06	89.3
5/29/98	2	DNT-36 490	Whole Rx	11.9	17.048	0.11	94.5
5/29/98	3	DNT-36 420*	Whole Rx	10	16.18	0.04	91.1
5/29/98	4	DNT-36 490*	Whole Rx	10.6	17.052	0.08	92.4
5/29/98	5	DNT-36 495	Whole Rx	10.2	16.873	0.12	89.9
5/29/98	6	DNT-36 515	Whole Rx	10.8	16.714	0.05	89.9
5/29/98	7	DNT-36 520	Whole Rx	10.1	16.306	0.05	91.7
5/29/98	9	DNT-36 525	Whole Rx	10.9	15.998	0.03	90.8
5/29/98	10	DNT-36 455*	Whole Rx	10.5	15.204	0.07	92.0
6/1/98	2	NP-QV1	Quartz	10.6	19.006	0.06	80.7
6/1/98	3	TC-A	Quartz	9.8	9.028	0.07	89.8
6/1/98	4	TC-16	Quartz	10.4	18.817	0.09	86.2
6/1/98	5	NP-104 5600	Quartz	10	13.44	0.03	82.6
6/1/98	6	NP-QV	Quartz	10.9	19.668	0.06	90.7
6/1/98	7	NP-QV1*	Quartz	9.9	19.375	0.06	87.2
6/1/98	9	TC-A*	Quartz	10.3	9.329	0.09	89.5
6/1/98	10	TC-16*	Quartz	10.3	18.23	0.04	90.9
6/1/98	11	NP-104 5600*	Quartz	10.1	13.464	0.11	78.0
6/1/98	12	NP-QV*	Quartz	10.2	19.957	0.03	90.2
6/2/98	2	NP-104 5740	Quartz	10.9	23.4	0.08	90.9
6/2/98	3	LT-C	Quartz	10.1	17.426	0.07	93.0
6/2/98	4	LT-A	Quartz	10.2	20.854	0.08	100.2
6/2/98	5	TC-15	Quartz	10.4	7.934	0.07	96.3
6/2/98	6	NP-QV2	Quartz	10.9	18.286	0.06	77.3
6/2/98	7	LT-B	Quartz	9.8	20.408	0.02	96.5
6/2/98	9	NP-104 5740*	Quartz	10.6	23.862	0.06	89.5
6/2/98	10	LT-C*	Quartz	10.3	17.696	0.05	93.9
6/2/98	11	LT-A*	Quartz	10.4	21.525	0.05	93.5
6/2/98	12	TC-15*	Quartz	10	8.1	0.04	91.3

DATE	VESSEL #	SAMPLE #	ANALYSIS	WEIGHT	Delta18O	STDV	YIELD
				(mg)	(permil)		(%)
6/4/98	2	Hc	Whole Rx	10	19.203	0.1	89.2
6/4/98	3	Hls-np	Whole Rx	10.4	16.237	0.07	90.1
6/4/98	4	Hms	Whole Rx	10.6	10.866	0.07	87.9
6/4/98	5	Bc	Whole Rx	10.8	16.45	0.09	86.3
6/4/98	6	Hgs	Whole Rx	10.3	7.125	0.07	77.3
6/4/98	7	Hst	Whole Rx	10.8	13.305	0.09	87.9
6/4/98	9	LT-min	Whole Rx	10.3	12.391	0.1	89.5
6/4/98	10	NP-QV2*	Whole Rx	10.5	18.787	0.05	89.9
6/4/98	11	LT-B*	Whole Rx	10.6	20.641	0.03	91.0
6/4/98	12	LT-min*	Whole Rx	10.2	12.403	0.06	92.6

Appendix 6

Fluid Inclusions

Doubly polished waffers were used on all fluid inclusion analyses and were performed on a Linkam heating stage using an 80 power objective. Data from gold-bearing samples at Lone Tree are Taken from Kamali 1996, unpublished thesis, New Mexico Tech.

P = Primary S = Secondary PS = Psuedo-secondary Th = Homogenization temp. F= degree of fill
Tm = final melting TsNaCL = homogenization of daughter mineral cor. = corrected data

Lone Tree, Gold-bearing, Sample LT-MIn (quartz)

Th	Tm	TsNaCl	Th cor.	Tm cor.	Ts cor.	F	Salinity
305		240	298		232	0.85	33.6
278	-3.5		271	-3.4		0.9	5.56
310		321	303		314	0.7	38.9
355	-1.2		332	-1.1		0.1	1.91
355	-1.1		332	-1		0.1	1.74
395	-0.8		369	-0.7		0.1	1.23
415	-0.9		389	-0.8		0.1	1.4
406	-8.4		380	-8.3		0.7	12.05
335	-19.5		314	-19.4		0.9	21.96
398	-1.7		372	-1.6		0.25	2.74
408	-1.6		382	-1.5		0.25	2.57
386		128	362		121	0.8	28.6
370		132	346		125	0.7	28.7
307		180	289		169	0.7	30.5
320		170	300		159	0.7	30
315		145	295		138	0.7	29.2
325	-20		305	-19.9		0.7	22.31
350	-21		328	-20.9		0.7	22.98
343	-13.5		321	-13.4		0.8	17.26
337	-14.2		316	-14.1		0.8	17.87
325		173	304		162	0.8	30.2
333		185	312		174	0.8	30.7

Lone Tree, barren, Sample LT-A (quartz)

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	7	2 (l+v)	0.85			250.7	ps
2	2	2 (l+v)	0.8			280.6	ps
3	7	2 (l+v)	0.8			333.6	ps
4	13	2 (l+v)	0.8			306.6	ps
5	10	2 (l+v)	0.85			331.8	ps
6	7	2 (l+v)	0.85			276.7	ps
7	7	2 (l+v)	0.8			281	ps

Lone Tree, barren, Sample LT-A (quartz)

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
8	3	2 (l+v)	0.85			268.2	ps
9	7	2 (l+v)	0.85			263.8	ps
10	3	2 (l+v)	0.85			299.6	ps
11	17	2 (l+v)	0.85			224.7	p
	DUPLICATE					224.7	
12	17	2 (l+v)	0.85			254.4	p
13	10	2 (l+v)	0.85			271.9	p
14	13	2 (l+v)	0.85			267.2	p
15	13	2 (l+v)	0.85			273.3	p
16	7	2 (l+v)	0.85			246.2	p
17	7	2 (l+v)	0.85			304.6	p
18	7	2 (l+v)	0.85			270.1	p
19	7	2 (l+v)	0.85			275	p
20	13	2 (l+v)	0.85			283.9	p
21	10	2 (l+v)	0.85			270.9	p
22	4	2 (l+v)	0.85			274.1	p
23	7	2 (l+v)	0.8			273.4	ps
24	3	2 (l+v)	0.8			262.4	ps
25	17	2 (l+v)	0.8			272.3	p
26	7	2 (l+v)	0.9			213.4	ps
27	13	2 (l+v)	0.8			168.8	ps
28	13	2 (l+v)	0.8	0.3	15.2 (cl)	271.9	ps
29	13	2 (l+v)	0.8	0.3	15.2 (cl)	267.2	ps
30	13	2 (l+v)	0.85	0.3	15.2 (cl)	273.3	ps
31	7	2 (l+v)	0.85	0.1	15.4 (cl)	304.6	p(?)
32	7	2 (l+v)	0.85	0.5	15 (cl)	246.2	p(?)
	DUPLICATE			0.5	15 (cl)		
33	13	2 (l+v)	0.85	0.3	15.2 (cl)	283.9	ps
	DUPLICATE			0.4	15.1 (cl)		
34	10	2 (l+v)	0.85	0.3	15.2 (cl)	270.9	ps
	DUPLICATE			0.3	15.2 (cl)		
35	5	2 (l+v)	0.85	-0.5	16.1 (cl)	274.1	ps
	DUPLICATE			-0.4	16.0 (cl)		
	Trenton Canyon, Gold-bearing Sample TC-A (quartz)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	3	2 (l+v)	0.9			232.9	ps
2	3	2 (l+v)	0.85			235.1	ps
3	4	2 (l+v)	0.85			269.1	ps
4	3	2 (l+v)	0.8			230.2	ps
5	17	2 (l+v)	0.85			201.2	s
6	13	2 (l+v)	0.85			285.7	ps
7	7	2 (l+v)	0.95			277.7	ps
	Trenton Canyon, Gold-bearing Sample TC-A (quartz)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
8	7	2 (l+v)	0.85			194.4	ps(?)
9	6	2 (l+v)	0.85			264.2	ps
10	17	2 (l+v)	0.9			257.1	p
11	7	2 (l+v)	0.8			346.9	p
12	12	2 (l+v)	0.9			256.9	p
DUPLICATE						254.7	
13	3	2 (l+v)	0.85			265.6	ps
14	7	2 (l+v)	0.9			250	ps
15	7	2 (l+v)	0.9			234.5	ps
16	3	2 (l+v)	0.75			320.6	ps
17	3	2 (l+v)	0.75			279.4	ps
18	3	2 (l+v)	0.75			279.4	ps
	Trenton Canyon, Gold-bearing Sample TC-15 (quartz)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	7	2 (l+v)	0.8			297.3	p
2	2	2 (l+v)	0.85			275.3	p(?)
3	2	2 (l+v)	0.85			274.6	p(?)
4	4	2 (l+v)	0.9			236.4	ps
5	3	2 (l+v)	0.85			235.9	ps
6	3	2 (l+v)	0.9			254.7	p(?)
7	3	2 (l+v)	0.85			245.1	ps
8	4	2 (l+v)	0.9			262.4	p(?)
9	3	2 (l+v)	0.85			293.7	ps
10	10	2 (l+v)	0.8			321.3	p(?)
11	3	2 (l+v)	0.85			271.8	p(?)
12	3	2 (l+v)	0.8			215.1	ps
13	4	2 (l+v)	0.85			232.1	ps
14	7	2 (l+v)	0.8			323.5	p
15	10	2 (l+v)	0.8			272.5	p
16	13	2 (l+v)	0.85			270	p
17	13	2 (l+v)	0.75			289.4	p
18	10	2 (l+v)	0.85			250.9	ps
19	3	2 (l+v)	0.85			237.2	ps
20	7	2 (l+v)	0.8			255	ps
21	4	2 (l+v)	0.85			288.8	ps
22	10	2 (l+v)	0.85			246.5	ps
23	7	2 (l+v)	0.85			245.4	ps
24	10	2 (l+v)	0.75			274.5	p
25	13	2 (l+v)	0.7			280.2	p
26	4	2 (l+v)	0.8			258.5	ps
27	3	2 (l+v)	0.8			277.1	ps
28	7	2 (l+v)	0.85			277.1	ps
	Trenton Canyon, Gold-bearing Sample TC-15 (quartz)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
29	7	2 (l+v)	0.8			256.8	ps
30	7	2 (l+v)	0.85			277.5	ps
31	3	2 (l+v)	0.8			285	ps
32	7	2 (l+v)	0.8			275.6	ps
33	7	2 (l+v)	0.8			282.5	ps
34	4	2 (l+v)	0.85			283.8	ps
35	10	2 (l+v)	0.8			323.2	p(?)
36	7	2 (l+v)	0.85	-2.2	3.71	233	ps
37	7	2 (l+v)	0.8	1.2	14 (cl?)	201.3	s
38	7	2 (l+v)	0.8	-6.7	10.1	244.9	ps
39	7	2 (l+v)	0.8	-3.7	6.01	264.2	ps
40	3	2 (l+v)	0.85	-5.3	8.28	275.1	ps
41	7	2 (l+v)	0.85	-5.6	8.68	255.6	ps
42	7	2 (l+v)	0.85	-7.3	10.86	250.7	ps
43	4	2 (l+v)	0.85	-9.1	12.96	258.6	ps
44	4	2 (l+v)	0.85	-9.3	13.18	266.3	ps
45	13	2 (l+v)	0.85	-1.8	3.06	242.4	ps
46	7	2 (l+v)	0.85	-3.3	5.41	180.5	ps
47	7	2 (l+v)	0.85	-4.8	7.59	252.6	ps
48	20	2 (l+v)	0.8	-4.3	6.88	249.8	p(?)
	Trenton Canyon, barren Sample TC-16 (quartz)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	10	2 (L+V)	0.8			249.9	ps
2	17	2 (L+V)	0.8			249.2	ps
3	17	2 (L+V)	0.85			250.4	ps
4	3	2 (L+V)	0.9			233.7	s(?)
5	3	2 (L+V)	0.9			234.8	s(?)
6	7	2 (L+V)	0.85			258.3	ps
7	17	2 (L+V)	0.95			83.9	ps
8	3	2 (L+V)	0.8			217.5	ps
9	10	2 (L+V)	0.8			285.4	ps
10	3	2 (L+V)	0.85			230.7	ps
11	7	2 (L+V)	0.8			238.5	ps
12	3	2 (L+V)	0.8			218.3	ps
13	3	2 (L+V)	0.8			219.5	ps
14	4	2 (L+V)	0.85			79	ps
15	4	2 (L+V)	0.85			252	ps
16	13	2 (L+V)	0.85			232.5	ps
17	3	2 (L+V)	0.8			238.5	ps
18	7	2 (L+V)	0.8			217.5	ps(?)
19	4	2 (L+V)	0.8			253.7	ps(?)
20	13	2 (L+V)	0.75			205.3	p
	Trenton Canyon, barren Sample TC-16 (quartz)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
21	7	2 (L+V)	0.85			217.9	ps
22	3	2 (L+V)	0.85			222.9	ps
23	7	2 (L+V)	0.7			221.6	ps
24	10	2 (L+V)	0.8			205.4	ps(?)
25	3	2 (L+V)	0.85			227	p(?)
26	4	2 (L+V)	0.8			276.1	p(?)
27	3	2 (L+V)	0.85			202.1	ps
28	3	2 (L+V)	0.8			228.8	ps
29	10	2 (L+V)	0.85			205.2	ps
30	3	2 (L+V)	0.85			209	s
31	3	2 (L+V)	0.8			210.6	ps
32	3	2 (L+V)	0.8			212.4	ps
33	7	2 (L+V)	0.9			288.6	p(?)
34	7	2 (L+V)	0.85			215.9	ps(?)
35	3	2 (L+V)	0.9			227.9	p(?)
36	4	2 (L+V)	0.85			210.6	p(?)
37	3	2 (L+V)	0.8			253.4	p
38	3	2 (L+V)	0.85			198.8	ps
39	3	2 (L+V)	0.8			216.5	ps
40	10	2 (L+V)	0.8			246.3	ps
41	10	2 (L+V)	0.85			206.6	ps
DUPLICATE						207.1	
42	7	2 (L+V)	0.85	-2.2	3.71	238.3	ps
43	7	2 (L+V)	0.85	-1.4	2.41	235.2	ps
44	4	2 (L+V)	0.85	-4.8	7.59	231.2	ps
45	7	2 (L+V)	0.85	-4.4	7.02	216.4	ps
46	10	2 (L+V)	0.8	-2.4	4.03	237.1	ps
47	10	2 (L+V)	0.8	-2	3.39	233.8	ps
48	7	2 (L+V)	0.8	-1.8	3.06	215.5	ps
49	17	2 (L+V)	0.75	-2.9	4.8	234.5	p
	North Peak, Gold-bearing Sample NP-QV1 (quartz)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	3	2 (l+v)	0.85			243.6	ps
2	7	2 (l+v)	0.85			196	ps
3	7	2 (l+v)	0.85			207.3	ps
4	7	2 (l+v)	0.8			203.3	ps
5	3	2 (l+v)	0.8			221.9	ps
6	3	2 (l+v)	0.8			206.3	ps
7	3	2 (l+v)	0.85			182.1	ps
8	10	2 (l+v)	0.75			245.6	p
9	10	2 (l+v)	0.75			244.1	p
10	7	2 (l+v)	0.9			181.6	ps
	North Peak, Gold-bearing Sample NP-QV1 (quartz)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
11	3	2 (l+v)	0.8			249.4	ps
12	3	2 (l+v)	0.85			209.4	ps
13	3	2 (l+v)	0.8			222.9	ps
14	4	2 (l+v)	0.8			220.3	ps
15	4	2 (l+v)	0.8			171.2	p
	DUPLICATE					170.9	
16	7	2 (l+v)	0.75			210.5	p
17	7	2 (l+v)	0.8			228.9	ps
18	3	2 (l+v)	0.85			170.5	ps
19	7	2 (l+v)	0.85			199.8	ps
20	7	2 (l+v)	0.85			234	ps
21	7	2 (l+v)	0.85			228.4	ps
22	10	2 (l+v)	0.8			242	p
23	3	2 (l+v)	0.85			144	ps
24	3	2 (l+v)	0.8			196.9	ps
25	7	2 (l+v)	0.8			236.9	p
26	7	2 (l+v)	0.8			205.1	p
27	3	2 (l+v)	0.8			187.9	ps
28	3	2 (l+v)	0.85			261.1	ps
29	3	2 (l+v)	0.85			202.3	ps
	North Peak, Gold-bearing Sample NP-QV (quartz)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	3.3	2 (L+V)	0.8			220.3	ps
	DUPLICATE					220	
2	3.3	2 (L+V)	0.85			179.1	ps
3	3.3	2 (L+V)	0.8			211.5	ps
4	3.3	2 (L+V)	0.85			172.2	ps
5	3.3	2 (L+V)	0.85			195.2	ps
6	3.3	2 (L+V)	0.85			165.8	ps
7	3.3	2 (L+V)	0.8			225	ps
8	3.3	2 (L+V)	0.85			238	ps
9	7	2 (L+V)	0.9			188.3	p(?)
10	3	2 (L+V)	0.85			221	ps
11	3	2 (L+V)	0.85			203.2	ps
12	4	2 (L+V)	0.8			203.2	ps
	DUPLICATE					202.9	
13	4	2 (L+V)	0.85			220.1	ps
	DUPLICATE					222.3	
14	7.4	2 (L+V)	0.85			207.5	ps
	DUPLICATE					205.4	
15	3	2 (L+V)	0.8			215.5	ps
16	4	2 (L+V)	0.85			217.4	ps
	North Peak, Gold-bearing Sample NP-QV (quartz)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
17	3	2 (L+V)	0.85			164.5	ps
	DUPLICATE					163.9	
18	3	2 (L+V)	0.9			120.7	ps
19	3	2 (L+V)	0.9			126.5	ps
20	3	2 (L+V)	0.85			144.6	ps
21	10	2 (L+V)	0.85			146.9	p
22	7	2 (L+V)	0.85			191.9	ps
	DUPLICATE					191.6	
23	7	2 (L+V)	0.85			219.8	ps
24	7	2 (L+V)	0.85			206.4	ps
25	4	2 (L+V)	0.8			204	ps
	DUPLICATE					203.6	
26	7	2 (L+V)	0.85			205	ps
27	3	2 (L+V)	0.85			219.1	ps
28	3	2 (L+V)	0.8			215.8	p(?)
29	7	2 (L+V)	0.9			250.9	ps
30	7	2 (L+V)	0.8			221.7	p
31	7	2 (L+V)	0.85			174.9	ps
32	7	2 (L+V)	0.9	-1.5	2.57	188.3	p(?)
33	3	2 (L+V)	0.85	-2.3	3.87	221	ps
34	3	2 (L+V)	0.85	-2.6	4.34	203.2	ps
35	4	2 (L+V)	0.8	-2.2	3.71	202.9	ps
36	8	2 (L+V)	0.85	-2.9	4.8	207.5	ps
37	4	2 (L+V)	0.85	-3.5	5.71	220.1	ps
38	3	2 (L+V)	0.85	-2.1	3.39	215.5	ps
39	7	2 (L+V)	0.85	-2.3	3.87	216.8	ps
	North Peak, barren Sample NP-104 (5740)						
#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
1	4	2 (l+v)	0.85			267.5	ps
2	3	2 (l+v)	0.85			210	ps
3	3	2 (l+v)	0.8			215.7	ps
4	4	2 (l+v)	0.8			224.5	ps
5	3	2 (l+v)	0.8			160.7	ps
6	3	2 (l+v)	0.8			213.6	ps
7	3	2 (l+v)	0.85			234.1	ps
8	3	2 (l+v)	0.8			164.5	ps
9	3	2 (l+v)	0.8			224.3	ps
10	3	2 (l+v)	0.8			205.2	ps
11	3	2 (l+v)	0.8			209.3	ps
12	2.9	2 (l+v)	0.85			192.3	ps
13	2.9	2 (l+v)	0.85			185.6	ps
14	3.5	2 (l+v)	0.85			253	ps
	North Peak, barren Sample NP-104 (5740)						

#Meas.	Size(microns)	Phase	F	Tm	Salinity	Th	P, S, or PS
15	3.3	2 (l+v)	0.85			211.7	ps
16	4	2 (l+v)	0.8			223.6	ps
	DUPLICATE					223.5	
17	4	2 (l+v)	0.8			209.9	ps
18	4	2 (l+v)	0.8			200.4	ps
19	3	2 (l+v)	0.85			186.4	ps
20	3	2 (l+v)	0.8			196.7	ps
21	4	2 (l+v)	0.8			227.4	ps
22	3	2 (l+v)	0.8			228.1	ps
23	3	2 (l+v)	0.85			215.7	ps
24	3	2 (l+v)	0.85			215	ps
25	2.75	2 (l+v)	0.8			215.9	ps
26	3	2 (l+v)	0.85			210.5	ps
27	2.75	2 (l+v)	0.85			199	ps
28	3	2 (l+v)	0.85			195.2	ps
29	3	2 (l+v)	0.85			211.8	ps
30	3	2 (l+v)	0.85			230.4	ps
31	7	2 (l+v)	0.85	3.0	12(cl)	238.4	ps
32	7	2 (l+v)	0.85	3.9	10.6(cl)	211.8	ps
33	4	2 (l+v)	0.8	1.3	14.1(cl)	227.6	ps
34	7	2 (l+v)	0.85	5.2	8.7(cl)	198.6	ps
35	7	2 (l+v)	0.8	0.4	15.1(cl)	199.5	ps
36	7	2 (l+v)	0.85	-4.1	6.59	215.4	ps
37	4	2 (l+v)	0.85	-3.6	5.86	197.9	ps