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PORPHYRY COPPER-MOLYBDENUM ORE TARGET

PERRY CANYON AREA

PYRAMID MINING DISTRICT

WASHOE COUNTY, NEVADA

by

Richard L. Nielsen

Consulting Geologist

Evergreen, Colorado

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SUMMARY

The Perry Canyon area located in the Pyramid Mining District, 30 miles north of Sparks, Nevada, contains a target for a disseminated and veinlet porphyry copper-molybdenum bulk-tonnage ore body exceeding 100 million tons at grades better than 0.8% copper with significant credits in MoS_2 and gold lying 500 to 3,000 feet below the surface.

The target area is covered by patented and unpatented lode mining claims and fee land. No serious problems are foreseen in consolidating the four properties into a single unit. Work done so far consists of geologic mapping, limonite evaluation, alteration studies and rock-chip geochemical data analyses.

Host rocks for mineralization are rhyolite and quartz-latite tuffs, lavas and sills of Oligocene to Miocene age. Post-mineral andesites of late Tertiary age cover part of the mineralized system. Productive Cu-Ag-Zn-Pb vein mineralization shows a district zoning similar to that at Butte, Montana and suggests a center of Cu-Mo mineralization in the Perry Canyon area. An ore target is defined by co-extensive areas of: (1) strong advanced argillic, clay-sericite and silica flooding alteration; (2) strong pervasive disseminated pyrite as inferred from limonite minerals; (3) mineralized breccia zones similar to high-level breccia pipes in other porphyry systems; and (4) anomalous metal-in-rock values (Cu, Mo, Pb, Au, Ag, Sn, W, F).

A discovery drilling program is proposed and consists of drilling 3 diamond drill holes each to 3,000 feet in depth. Estimated costs are about $450,000 which includes contract drilling costs, site preparation, road work, reclamation, salaries, travel and assays.

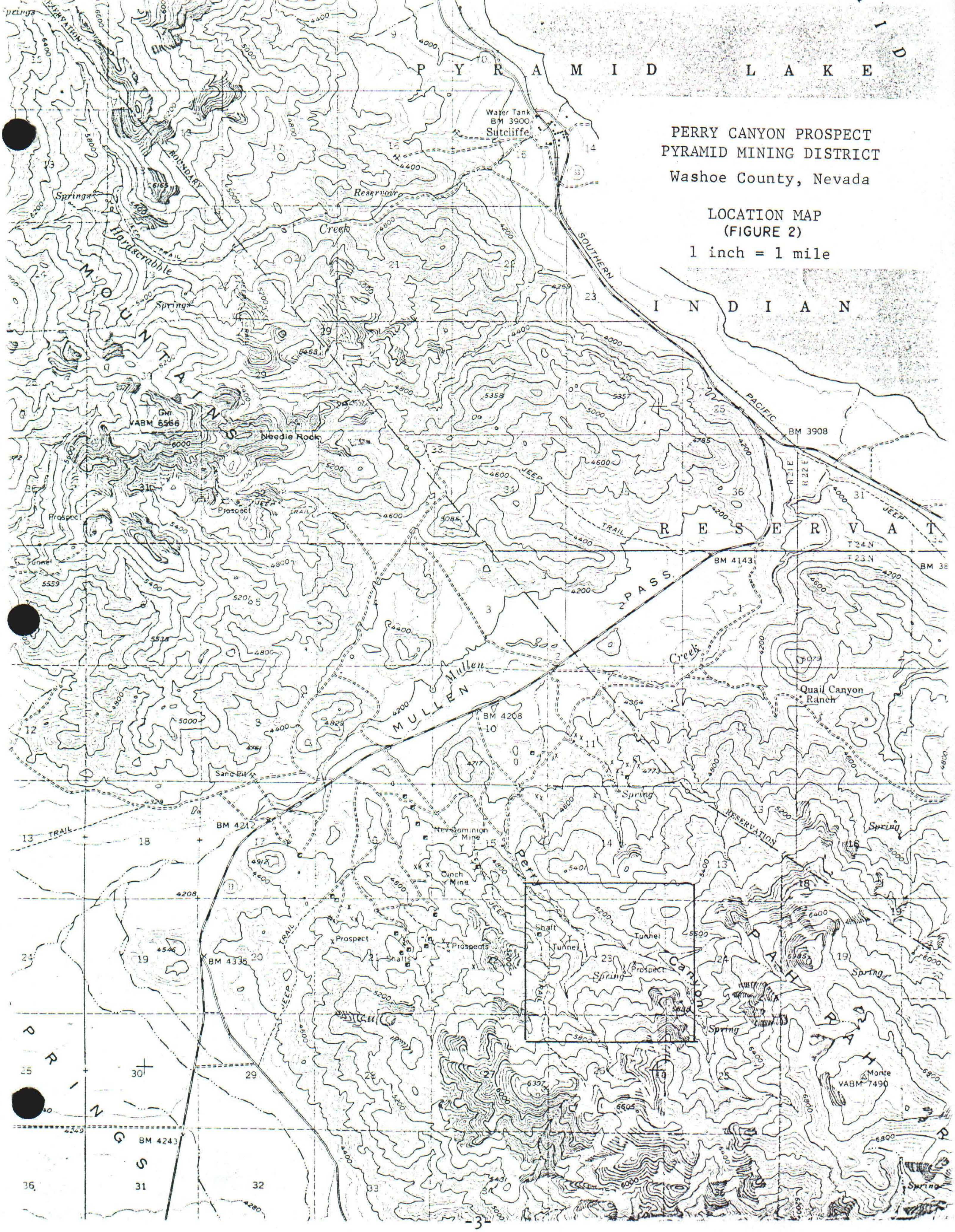
LOCATION AND HISTORY

The Perry Canyon area is located in the Pyramid Mining District, within the Pah Rah Range, about 30 miles north of Sparks, Nevada. Access into the Perry Canyon claim block is by two miles of fair to poor un-maintained dirt road which turns off of State Highway 445 in Mullen Pass near the center of section 10. The location of the area is shown in Figures 1 and 2.

Relief is moderately rugged with elevations from 4,800 to 5,600 feet. Vegetation consists predominantly of sage brush cover with scattered juniper and mohogany. Snow cover in winter is light and year around exploration and development activities are possible.

PERRY CANYON PROSPECT
PYRAMID MINING DISTRICT
Washoe County, Nevada

LOCATION MAP
(FIGURE 1)
1 inch = 4 miles



PERRY CANYON PROSPECT
PYRAMID MINING DISTRICT
Washoe County, Nevada

LOCATION MAP
(FIGURE 2)
1 inch = 1 mile

Mining in the Pyramid District began about 1875 and past production came largely from northwest-trending copper-gold-silver veins which are located to the west and adjacent to the Perry Canyon center of alteration and mineralization. Some uranium was produced from the district in the 1960's. Production figures are imcomplete but indicate less than 100 ounces gold and about 3,000 ounces of silver were produced from copper-rich ores of the Jones-Kincaid and Monarch mines. The district presently is inactive.

LAND STATUS

Current ownership and location of unpatented lode mining claims, patented mining claims and fee land is shown in Figure 3 and summarized below.

. Perry Canyon claims No.'s 1-43.
    Owner: W. T. Probandt
    1206 Wilco Building
    Midland, Texas 79701
    Ph: (915) 683-6114

    Located: May, 1980 (Assessment due September 1, 1981).

. Fox claims No.'s 1-6.
    Owner: Andy B. Wallace
    c/o Cordex, Inc.
    Reno, Nevada 89500
    Ph: (702) 825-6731

    Located: April, 1980 (Assessment due September 1, 1981).

. Patented mining claims sec. 22,23.
    Owner: Mark Emerson (AMDEC Corp.)
    131 W. 69th Street
    New York, New York 10023
    Ph: (212) 724-2537

. Patented Fee land, sec. 24.
    Owner: David G. and Patricia Pumphry
    P.O. Box 250
    Minden, Nevada 89423
    Ph: (702) 782-2081

The Perry Canyon lode mining claims were staked in May, 1980 to cover open ground over the inferred target area of strong pervasive alteration. Location posts were placed on open ground but these lode claims overlap valid patented and unpatented claims.

Two unpatented lode mining claims (Bee Lost 1-2) in the southeast part of the area apparently are valid, but the present owners are unknown. These claims are outside the principal ore target area. Several patented millsites are present in Perry Canyon. Present owners of these are not known.

At the present time Andy Wallace has agreed to lease his 6 claims for a 10 year period for a 4 to 5% NSR production royalty. A lease agreement is being prepared. Mark Emerson is interested in a JV or lease agreement on the patented claims but he would like an agreement that permits him to explore and develop near surface gold ore potential on at least part of the patented ground. David Pumphry confirms that mineral rights have been deeded to him with surface rights and is very interested in leasing his fee property in section 24.

In summary, no serious land problems are anticipated. All present land owners appear interested in leasing their lands and terms probably will be reasonable. The properties are in an established mining area. No environmental problems are expected which could limit or restrict exploration and development activities.

GEOLOGY

Regional geology is described by Bonham in the Washoe County Report (NBM Bull. 70). Detailed district geology and mineralization is described by Andy Wallace in a Ph D. thesis (U. of N., 1975) and later published in Mining Engineering (March 1980). Adjacent areas are being remapped and stratigraphic nomenclature being revised by H. W. Bonham of the Nevada Bureau of Mines and Geology.

The mining district lies in the Pah Rah Range, a northwesterly-trending Basin-range mountain lying between Pyramid Lake and Warm Springs Valley. Bedrocks exposed in the Pyramid district are middle to upper Tertiary in age and rest upon a basement of Mesozoic metasedimentary, metavolcanic and granitic rocks which are exposed several miles from the district. Tertiary volcanic rocks (Fig. 4) are divided into two groups. An Oligocene to Miocene sequence of rhyolite to quartz latite ash-flow tuffs, lavas and breccias are host to mineralization in the Pyramid District. This unit formerly was mapped as Hartford Hill rhyolite and is being remapped and renamed by Bonham. A younger Miocene to Pliocene post-ore sequence of dacite stocks and lavas, basalt lavas and breccias overlap part of the mineralized area. These post-mineral rocks principally are basaltic andesite lavas in the prospect area.

We tentatively correlate mineralized and altered crystal-rich rhyolite tuff in the Perry Canyon area with the Chimney Springs formation mapped by H. W. Bonham several miles south. Vein deposits of the district are in latite tuff which lies above the Chimney Springs rhyolite tuff. All host rocks in the district were formerly mapped as middle to upper Hartford Hill formation, and we estimate the rhyolite tuffs in the Perry Canyon are about 1,000 to 2,000 feet thick.

Wallace (1975, 1980) states that the source vent for the rhyolitic tuff may be within the Pyramid district. This is suggested by rapid thickening of tuff beds, presence of breccia, and clustering of sub-volcanic dikes and domes. The Pyramid hydrothermal system may have developed soon after the siliceous volcanism, probably near the vent complex.

The principal rock type exposed in the strongly mineralized and altered area is quartz crystal-rich ryholite tuff of the Chimney Springs formation (Fig. 4). Up to 60 percent of the rock is crystal fragments, mainly quartz, with subordinate sanidine and biotite. Color is variable owing to various degrees of hydrothermal alteration and bleaching superimposed on vapor-phase alteration.

The other principal rock type in the mineralized area is green-gray quartz latite to rhyodacite exposed in the Jones-Kinkaid mine area and further west. This rock has abundant plagioclase phenocripts, with local pyroclastic texture. It hosts vein mineralization and pervasive propylitic alteration. We tentatively interpret this rock as a shallow intrusive sill but emphasize that it also may be a tuff, faulted into its present position against quartz-rich rhyolite.

Basaltic andesite lava flows underlie the high ridge to the north of Perry Canyon. This is a dark gray, dense, fine-grained lava that weathers into platy fragments. This unit clearly caps and covers mineralized and altered rocks.

The mineralized rhyolite tuff in Perry Canyon appears to strike east-west and dip north at 20 to 30 degrees. This dip probably reflects regional tilting associated with faulting. Indeed, much of the present rock distribution patterns is related to complex interplay of Basin-Range vertical faults and right-lateral displacement on faults related to the Walker Lane fault system. Mineralized veins and shears generally trend northwest near the west edge of the claim group and trend east-west or northeast in highly mineralized target area. This northeast structure may reflect a cross-structure or a zone of tensional opening and clearly is not parallel to the dominant northwest trend of most faults in the range.

Mineralized breccia is common in the area of strong alteration. This breccia consists of strongly altered fragments of rhyolite tuff in a fine silicified fragmental matrix. Breccia grades into strongly fractured outcrops and both generally are strongly silicified. The breccia appears very similar in type to that found in large mineralized breccia pipes in other porphyry systems.

MINERALIZATION AND ORE DEPOSITS

Mine production has come from narrow veins in west to northwest faults and fractures, most of which cut rhyodacite or quartz latite host rocks. Principal hypogene vein minerals are pyrite, enargite tetrahedrite, sphalerite, galena and chalcopyrite. Gangue minerals are barite and quartz. The productive and developed veins are located west and northwest of the Perry Canyon area and are covered by patented lode claims.

Zoning of ore minerals is evident. Veins in the western outer fringes of the district contain pyrite and galena. Veins in an intermediate zone contain tetrahedrite, galena, sphalerite and chalcopyrite. Veins of the inner zone adjacent to the Perry Canyon target area contain enargite and pyrite. This overall district zoning pattern is similar to that at Butte, Montana.

The inferred center of hydrothermal mineralization and alteration is the Perry Canyon target area in section 23. This is the area of strong hydrothermal alteration, breccia development, silicification and pervasive sulfide mineralization. Limonites (Fig. 5) derived from oxidized sulfides are abundant over an area 6,000 feet northeast by 3,000 feet northwest. The northeast boundary of this limonite cap is not visible and lies concealed beneath post-mineral basaltic andesite. This area of limonite is one of the principal features that defines the Perry Canyon target area.

Limonite abundance and relative amounts of geothite, jarosite and hematite were recorded in a semi-quantitative manner throughout the capping. A large area of the limonite-cap, roughly 2,000 feet wide and 6,000 feet long in a northeast direction, consists of limonite with more than 50 percent jarosite and or hematite (Fig. 6,7). Jarosite is the dominant limonite in this zone with relatively small patches rich in hematite. Jarosite is considered to be the principal limonite derived from oxidation of a high pyrite assemblage and the former pyrite content of this area is estimated at 2 to 3 volume percent or about 5 to 6 weight percent. This is an area of inferred relatively strong supergene leaching and this feature must be taken into account when interpreting rock geochemical data.

A second center of mineralization apparently is present at Guanomi, 6 miles east of Perry Canyon, where Cu-Mo sulfides are disseminated in a quartz monzonite intrusion. The relation of Guanomi mineralization to the Pyramid district is unknown but it may be related to the same deep seated east-west structure that may control some mineralization features at Perry Canyon.

HYDROTHERMAL ALTERATION

Propylitic alteration of the district is widespread in rhyolite and quartz latite and is characterized by calcite, epidote, chlorite, clay, albite and adularia. Productive veins of the Pyramid district are encased in envelopes of bleached rock which contains quartz, sericite and pyrite.

Widespread propylitic alteration gives way to pervasive clay-sericite alteration in the Perry Canyon target area (Fig. 8). Rhyolite is bleached to a pale light color; biotite and feldspars are replaced by phyllic minerals (clay and sericite). The original tuffaceous texture generally is preserved.

An inner zone of pervasive advanced argillic alteration is enclosed in the zone of clay-sericite alteration. Advanced argillic alteration is characterized by complete destruction of the original tuffaceous texture which is replaced by a fine granular aggregate of alteration minerals - mainly quartz, pyrophyllite, diaspore, pyrite, rutile and hydromicas (Wallace, 1980). Mineralized breccia is common in this zone and some areas are replaced by vitreous secondary quartz flooding. Advanced argillic alteration extends up to and presumably is covered by post-basaltic andesite.

The zone of advanced argillic alteration coincides with the area of very high original pyrite content as inferred from limonite minerals. This zone is thought to be the center of hypogene hydrothermal alteration and a center of strong hypogene acid leaching of major and minor elements.

GEOCHEMISTRY

Rock-chip samples, each weighing two to five pounds, were collected on a grid pattern with 500-foot spacing throughout the principal target area (Fig. 9). Each sample was a representative chip sample of mineralized rock at each locality; attempts were made to chip rock containing disseminated and veinlet limonite. Samples were submitted for geochemical analyses to Hunter Geochemical Inc. in Reno, Nevada and Cone Geochemical Inc. in Lakewood, Colorado. Data sheets are attached. No attempt was made to statistically manipulate results. The geochemical values as obtained from the labs were plotted and contoured by inspection.

Copper-in-Rock (Fig. 10)

Detection level is 5 PPM and values up to 315 PPM were measured. A coherent copper-in-rock anomaly with values exceeding 75 PPM is about 1,500 feet wide, 3,500 feet long and elongate in a east-northeast direction. It is located in an area of very high sulfide and strong hydrothermal alteration. A small and uneconomic amount of supergene chalcocite may be expected at the base of oxidation in this anomalous area.

Molybdenum-in-Rock (Fig. 11)

Detection level is 1 PPM and values up to 61 PPM were measured. A long narrow coherent molybdenum-in-rock anomaly with values exceeding 10 PPM, is about 4,500 feet long and 500 to 1,000 feet wide and elongate in a east-northeast direction. This anomaly lies along the axis of strong sulfide mineralization and alteration. It occurs in areas of silicification and brecciation and is partly co-extensive with the copper anomaly.

Lead-in-Rock (Fig. 12)

Detection level is 5 PPM and values up to 4,000 PPM are recorded. A broad coherent anomaly with values exceeding 100 PPM with local highs up to 400 PPM is at least 7,000 feet long and 1,000 to 4,000 feet wide. The axis of this broad anomaly is east-northeast and lies along the axis of strong sulfide mineralization and alteration. The northeast end of the anomaly is open where mineralized rocks are covered by post-mineral andesites. The lead-in-rock anomaly closely corresponds to the zone of strong limonites, high inferred sulfides and strong alteration.

Zinc-in-Rock (Fig. 13)

Detection level is 5 PPM and values up to 300 PPM are measured. The area of strong alteration and mineralization is anomalously low in zinc, generally less than 15 PPM. Values increase to 100 PPM in weakly altered and un-mineralized rocks peripheral to the target area. The zinc "geochemical low" probably represents the results of strong leaching in the mineralized area.

Gold-in-Rock (Fig. 14)

Detection level is 0.1 PPM and values up to 0.6 PPM are measured. All values exceeding 0.1 PPM lie in a belt about 500 feet wide and 4,000 feet long and elongate northeast. This long anomaly lies on axis of strong sulfide mineralization and strong alteration.

Silver-in-Rock (Fig. 15)

Detection level is 1 PPM and values up to 37 PPM are recorded. All values exceeding 1 PPM form a coherent anomalous belt about 1,000 feet wide and 5,000 feet long. This anomaly is elongated roughly east-west and appears to be similar in shape and extent to the lead anomaly. The axis of this anomaly also lies along the axis of strong alteration and mineralization.

Tin-in-Rock (Fig. 16)

Detection level is 5 PPM and values up to 45 PPM are recorded. All anomalous tin values, those exceeding 5 PPM lie in a relatively small tight belt about 5,000 feet long and 500 feet wide. This anomaly is elongated roughly east-west and is closely co-extensive with the molybdenum gold and silver anomalous. It lies in the area of strong mineralization and alteration.

Tungsten-in-Rock (Fig. 17)

Detection level is 1 PPM and values up to 15 PPM are recorded. Anomalous values in the 5-15 PPM range are scattered through the area of strong alteration and mineralization but no clearly coherent anomalous area was defined.

Fluorine-in-Rock (Fig. 18)

Detection level is 100 PPM and values up to 1,200 PPM were measured. No strong coherent anomalies are defined but values that exceed 500 PPM are considered anomalous and these values seem to lie in the area of mineralized breccia and strong advanced argillic alteration.

Summary

Distinctly coherent but low level anomalies are defined for copper, molybdenum, lead, gold, silver and tin. Each anomaly is elongated in a east-northeast or east-west direction probably reflecting structural control be veins and fractures. These anomalies are roughly co-extensive and lie along the axis of strong sulfide mineralization (as defined by limonites) and strong advanced argillic alteration. Fluorine and tungsten samples giving weakly anomalous values also are located in same general area as other anomalous metals but no coherent fluorine and tungsten anomalies are defined. Zinc forms a geochemical "low" over the altered and mineralized area.

The most significant feature of the geochemical data is the similar pattern and location for each metal anomaly and the position of anomalies along the east-northeast axis of strong alteration and disseminated sulfide mineralization. The actual metal values within the anomalies are low (except for gold, which is at least 100 times normal gold value in granitic igneous rocks). The low levels may be expected in view of the evidence for strong hypogene leaching indicated by advanced argillic alteration, and evidence for strong supergene leaching indicated by abundant jarosite and hematite limonites. That coherent metal anomalies are detected at all in these strongly leached rocks is surprising and encouraging. Therefore, we conclude that the area of co-extensive coherent metal anomalies (Cu, Mo, Pb, Ag, Au, Sn) defines a target for deep concealed mineralization (Fig. 4).

POTENTIAL ORE TARGET

Mineralization and alteration described above and summarized below suggest the target area contains a target for disseminated and veinlet copper-molybdenum mineralization in a large bulk tonnage orebody exceeding 100 million tons at grades better than 0.8% copper with significant credits in MoS_2 and gold, at depths 500 to 3,000 feet below the surface.

The Pyramid Mining District is a very large area of hydrothermal mineralization exceeding 6 square miles in area. It produced copper ores and may be on structural trend with the mineralized quartz monzonite at Guanomi 6 miles east, which contains sub-economic disseminated copper-molybdenum mineralization. The productive Cu-Ag-Zn-Pb vein mineralization is thought to be halo indicators of a major porphyry copper-molybdenum system. District zoning patterns of vein mineralization with peripheral lead, intermediate lead-zinc-silver, and central copper - zoning patterns similar to Butte, Montana - indicate presence of copper-rich hydrothermal center in sections 22 and 23. Geologic mapping, limonite evaluation, alteration studies and geochemical data suggest the present land surface cuts the system at a relatively high structural level. Mineralized breccia, strong advanced argillic alteration, pervasive silica flooding, apparent structural control to anomalous metal values and lack of mineralized intrusive rocks all suggest a relatively near-surface level to the system in Perry Canyon.

RECOMMENDATIONS

A discovery drilling project of 3 deep holes is recommended to test the ore target outlined on the geologic map. Estimated total depth for each hole is 3,000 feet and estimated costs are summarized below:

Drilling 9,000' @ $40.00	$ 360,000
Drilling support preparation, and reclamation	30,000
Personnel	45,000
Assaying	15,000
	$ 450,000

REFERENCES

Bonham, H. F. and Papke, K. G., 1969, Geology and mineral deposits of Washoe and Storey Counties, Nevada: Nev. Bur. Mines, Bull. 70.

Wallace, A. B., 1975, Geology and mineral deposits of the Pyramid District, Southern Washoe County, Nevada: Unpub. PhD dissert., Univ. of Nevada.

Wallace, A. B., 1980, Geochemistry of polymetallic veins and associated wall rock alteration, Pyramid district, Washoe County, Nevada: Mining Engineering, March 1980, p. 314-320.

recovery from an all-dragline method (Fig. 3). Since mining commenced in the dredged-over area in July 1977, a 95% ore recovery has been sustained. Experience in the first 11 years of mining proved that an 80% recovery by an all-dragline method is impossible on a sustained basis.

Another major attribute of increased ore recovery is the conservation of a natural resource and, from a socioeconomic standpoint, it may be the most important.

Reclamation improvement is a major benefit of dredging where mined-over areas left after dragline casting at approximately 8 m below mean sea level are selectively filled with hydraulic fill. New well-drained land is being created several meters above the level of the original swampy areas and will be grassed, planted to forest, or put to some other useful purpose.

Dredging has been used in other mining ventures to assist in excavating unstable overburden material. One operation includes the removal of unstable overburden from bauxite deposits in Surinam and another involved the removal of glacial tills at the Steeprock iron ore operation in Ontario, Canada.

Necessary conditions for dredging involve:

An adequate supply of water.

Discharge areas adequate to accept the material and to contain the water for recycling or discharging.

Reasonably level land rough-cleared of large wood and material that would inhibit pumping.

A dredge-dragline surface mining method has been successful in overcoming unstable overburden conditions at Texasgulf's Lee Creek phosphate mining operations. Increased ore recoveries and increased production coupled with lowered unit costs have resulted from the conversion to the unorthodox system.

Geochemistry of Polymetallic Veins and Associated Wall Rock Alteration, Pyramid District, Washoe County, Nevada

Andy B. Wallace

Abstract— *Veins in the Pyramid district of northwestern Nevada occur along steep fractures in Oligocene and Miocene quartz latite tuffs. The vein mineralization is zoned from a central enargite-pyrite zone outward through a complex polymetallic pyrite-tetrahedrite-sphalerite-galena-chalcopyrite-bornite-chalcocite zone, and finally to an outer zone of pyrite and galena. Wall rock alteration includes advanced argillic and sericitic envelopes along veins superimposed on district-wide propylitization. The ore distribution and alteration patterns were probably produced by an increase in pH, a decrease in sulfur fugacity, along with cooling of the migrating hydrothermal fluid.*

Introduction

In several respects mineralization in the Pyramid district (50 km north-northeast of Reno, Nevada) approaches the classic epithermal type with the ores emplaced as open fracture fillings at shallow depths in young volcanic rocks of the Cordillera. However, compared to other Nevada bonanza camps also discovered in the late 1800s, Pyramid was a disappointment due to low precious metal values below the oxidized zone. The district was abandoned after a few years prospecting and $100,000 total production.

The ores also differ from those of many epithermal districts in being dominated by base metals and, probably, by relatively high emplacement temperatures. In fact, the main exploration potential for the district may lie in deep base metal and molybdenum targets (Wallace, 1979, 1975 a,b). Part of the purpose of the original mapping and sampling project was to evaluate the potential for such targets, but the major emphasis was on understanding the geochemistry and evolution of the exposed sulfidic vein systems and associated wall rock alteration, to which the following discussion will be confined.

A. B. Wallace, is with Cordex Exploration Co., Reno, NV. SME preprint 78L3, AIME Annual Meeting, Denver, Feb. 1978. Manuscript Feb. 1978. Discussion of this paper must be submitted, in duplicate, prior to April 30, 1980.

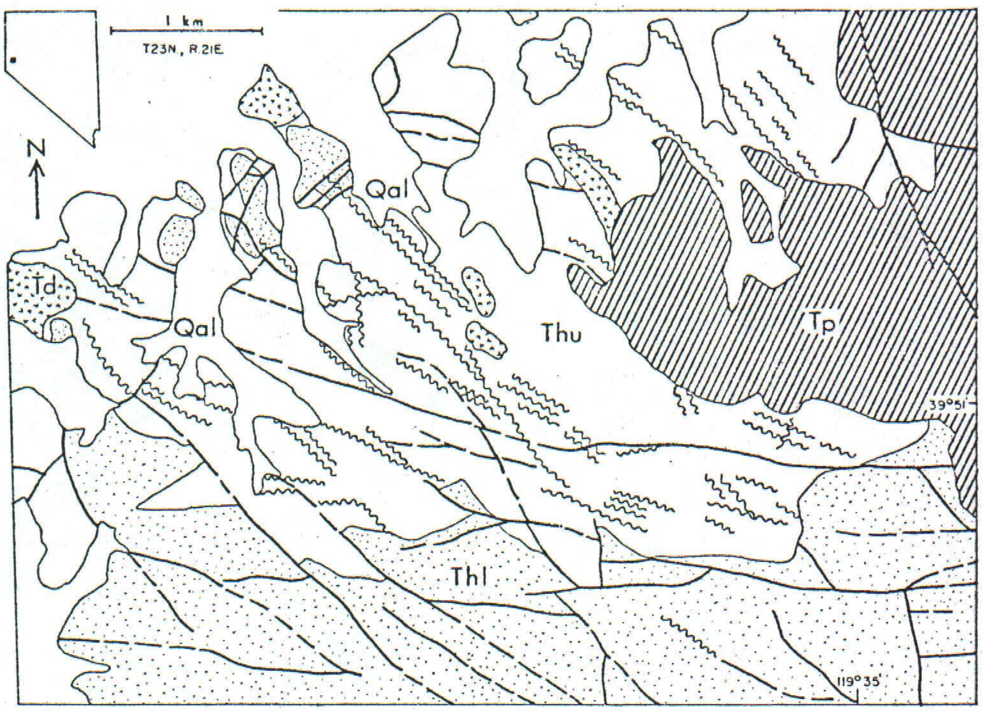


Fig. 1—Generalized geologic map of the Pyramid district showing the distribution of lower Hartford Hill rhyolite tuffs and lavas (Thl), upper Hartford Hill quartz latite tuffs (Thu), dacite stocks and lavas (Td), basaltic lavas and tuff-breccia of the Pyramid Sequence (Tp), and Quaternary alluvium (Qal). Veins and associated alteration haloes are shown in curly lines. Location of the district is shown on the inset of the state of Nevada at upper left.

Mineralogy was determined by X-ray diffraction and from several hundred thin and polished sections. Major element analyses of altered and fresh rocks were determined by standard X-ray fluorescence techniques. Assay values for metal ratio plots were determined by fire assay (Au, Ag), atomic absorption analysis (Cu, Pb, Zn, Ag, Mo, Sb), and emission spectrometry (Bi). Some trace element data were also obtained from six-step semiquantitative emission spectrographic analyses for 30 elements provided by the US Geological Survey. Analytical techniques are described more thoroughly in Wallace (1975 a).

General Geology

All rock units exposed in the Pyramid district are Tertiary in age (Fig. 1). Although no pre-Tertiary rocks are exposed in the district, Mesozoic metavolcanic, metasedimentary, and granitic intrusive rocks crop out within a few kilometers, and form the basement for the Tertiary section of northwestern Nevada. The Tertiary rocks can be divided by age into two groups. An Oligocene to Miocene volcanic sequence hosts the mineralization and consists of six cooling units of rhyolite to quartz latite ash-flow tuff with minor rhyolite lava and mud flow breccia. This silicic ash-flow sequence has formerly been assigned to the Hartford Hill Rhyolite, but the local stratigraphic nomenclature is presently being revised by H.W. Bonham of the Nevada Bureau of Mines and Geology. A younger, post-ore sequence of dacite stocks and lavas, tuff-breccia, basalt lavas, and dacite ash-flow tuffs overlap part of the mineralized area. These mafic and intermediate rocks are locally known as the Pyramid Sequence.

The vent for the Hartford Hill ash-flows has not been precisely located due to complexities caused by faulting, hydrothermal alteration, and burial by younger volcanic rocks. Several lines of stratigraphic evidence including rapid changes in ash-flow thicknesses, presence of breccia horizons resembling caldera-margin features, and the clustering of sub-volcanic feeders indicate the source is in the vicinity of the Pyramid district. The Pyramid hydrothermal system developed soon after or during cessation of the siliceous volcanism, probably very near the vent complex (Wallace, 1975 a,b).

The local structural pattern consists of several different ages and trends of block faulting. Northwest and west trending faults and fractures of small displacement control the veins and alteration haloes. An older northeast trending series of normal faults caused the topographic divide of Mullen Pass, which is the northern boundary of the Pah Rah Range as well as the district. A few north trending, basin-and-range faults are present and are interpreted to be post-ore. Determination of relative age of faulting is complicated by recurrent movement along faults of all the trends and members of each set can be seen to offset young alluvium locally.

Mineral Deposits

Nature of the Ore

Mineralization occurs as narrow veins (gener- less than 0.5 m in width) along northwest and west trending faults + fractures. Most of the veins are confined to th upper ash flow tuffs of the Hartford Hill which are quartz latite (see Fig. 1). Open space-filling textures are abundant + some [illegible] of been crushed by post-ore movement along controlling fractures.

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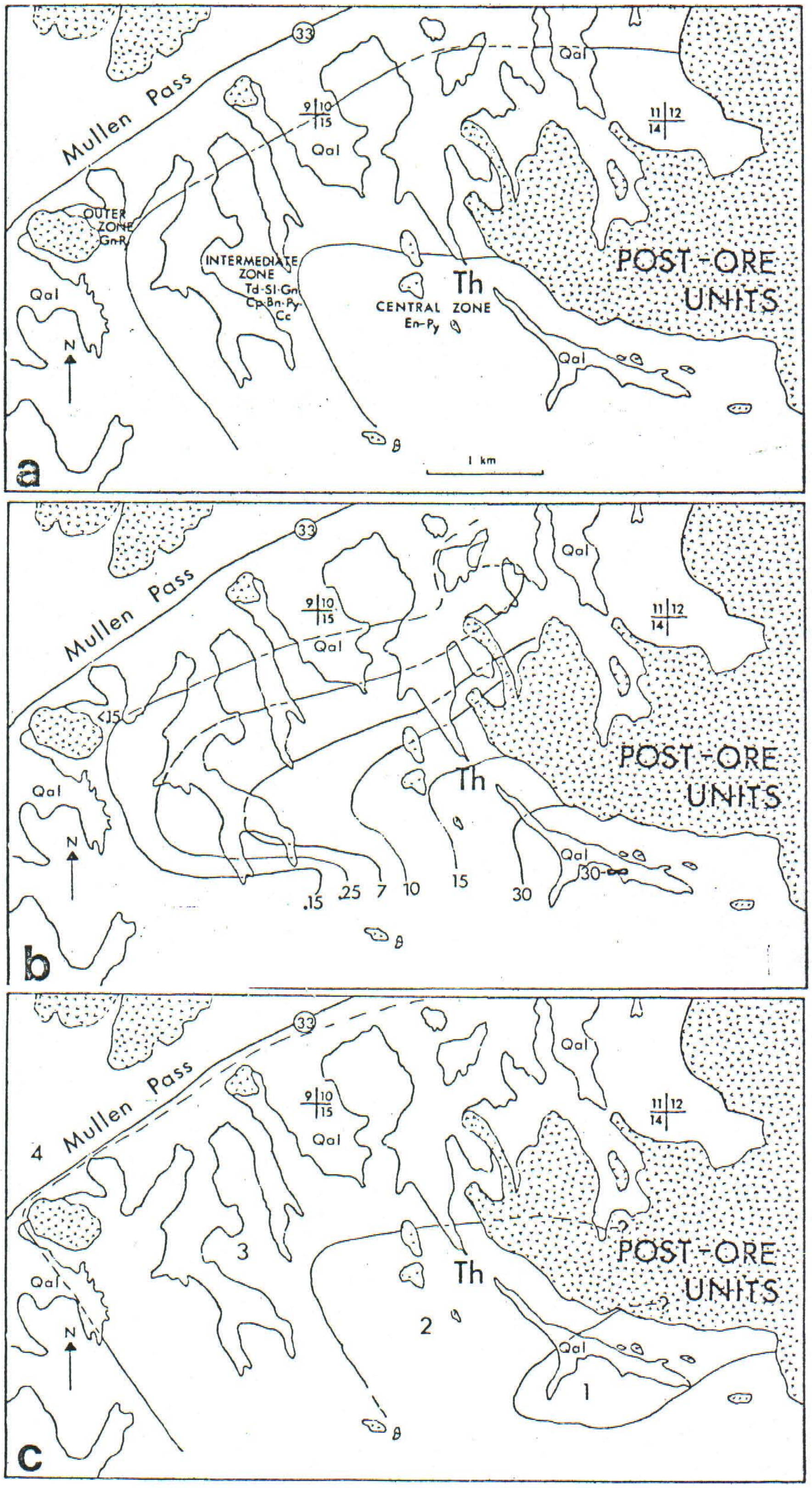

Fig. 2—(a) Map showing distribution of hypogene sulfide and sulfosalt minerals; (b) Metal ratio contour map for Cu/Pb + Zn; (c) Map showing the distribution of alteration zones. Zone 1 has nearly pervasive sericitic alteration with advanced argillic ribs along veins. Zone 2 veins have envelopes of sericitic alteration with advanced argilic ribs along veins. Zone 3 has pervasive propylitic alteration with sericitic envelopes bordering veins. Rocks in zone 4 are either propylitized or unaltered.

Hypogene ore minerals include enargite, luzonite, tetrahedrite, low-iron sphalerite, galena, and chalcopyrite with minor amounts of bornite, chalcocite, and arsenopyrite. The most common gangue minerals are barite and quartz but pyrophyllite, diaspore, and other products of wall rock alteration can be intergrown with the sulfides. Enargite is seven to eight times as abundant as luzonite (its low temperature, tetragonal polymorph) and the two are always intimately intergrown. Trace elements anomalous in the veins include Ag, Au, Bi, Mo, Sn, and Sr, with W, Co, Ni, and Cr anomalous in pyritized wall rocks along the veins. Oxidation and supergene processes have produced covellite, chalcocite, several "oxide" copper minerals, hemimorphite, cerussite, and several forms of "limonite."

One of the most striking features of the Pyramid mineralization is the zoning of the ore minerals (Fig. 2a). In the outer part of the district, veins contain pyrite and galena. Moving into the center of the mineralized area, the galena-pyrtie ores grade into a complex, intermediate zone where the veins contain tetrahedrite, galena, sphalerite, and chalcopyrite, with minor bornite and chalcocite. Finally, moving across a sharper transition into the center of the district, the veins contain only enargite (with luzonite) and pyrite with traces of chalcopyrite and arsenopyrite. No cross-cutting veins belonging to differeint zones or telescoping has been observed.

The zoning can also be demonstrated by metal ratio plots across the district of major and trace constituents of unoxidized ores. Figure 2b shows the pattern for Cu/Pb + Zn and similar patterns have been demonstrated for Cu/Pb, Pb/Zn, As/Pb, Sb/Pb, Sb/Ag, and in other metal ratios (Wallace, 1975a). Al though samples suitable for metal ratio work are difficult to obtain in small, nonproducing districts (particularly where oxidation is deep), careful sampling can yield valuable data for exploration for understanding the path of the hydrothermal fluid. Only 19 of the small workings in the Pyramid district yielded unoxidized hypogene sulfides suitable for analysis, but the consistent variations obtained from ratios of several different elements indicate the contour patterns are meaningful.

The contour patterns are convex to the northwest, which is also the direction of decreasing Cu/Pb values. Following the techniques outlined by Goodell and Petersen (1974) the pattern suggests that the solutions emanated from the southeast part of the district (near the southeast corner of Fig. 2a) and flowed toward the north and west. The distension of the contours toward the west probably indicates less restricted flow in that direction. The abrupt cut-off of the contour lines to the south is near the southern limit of mineralization and of the outcrop belt of the upper quartz latite tuffs. The sharpness of the cut-off (and lack of contour closure) may be in part due to faulting and the erosion of some mineralization along with the upper tuffs originally south of the boundary, and in part to the lack of workings for sampling along this margin. The metal ratio patterns also clearly indicate that some of the mineralized area is covered to the east by post-ore lavas.

Wall Rock Alteration

Propylitization is volumetrically the most important type of alteration and affects the tuffs pervasively throughout the district and an area even broader than that outlined by the limits of the sulfide veins. The propylitization is in all ways similar to that of other Cordilleran mineralization hosted in silicic to intermediate igneous rocks with the new minerals created in the tuffs including calcite, epidote, chlorite, montmorillonite, fine white micas, albite, and adularia. The alteration is pervasive but seldom complete and original pyroclastic textures are well preserved.

Propylitic alteration gives way near veins to sericitic alteration which extends for widths up to 4.5 m from the ore. Although complete replacement is only rarely achieved, the sericitic alteration tends toward the assemblage quartz-sericite-pyrite with minor amounts of rutile. Unidentified clays and minor montmorillonite are present near the outer part of some sericitic haloes. Sericite was the 2M polytype in the few cases examined and increases in size and percentage as the veins are approached.

In the central part of the district, corresponding to the appearance of the higher sulfur-to-metal assemblage enargite-luzonite-pyrite, an advanced argillic assemblage occurs between the sericitic haloes and the veins (Fig. 2c). Phases present include quartz, pyrophyllite, diaspore, pyrite, rutile, hydromicas, and traces of topaz which also occur intimately intergrown with the copper sulfosalts as well as in vein walls. This alteration is highly destructive and complete producing a vuggy, highly leached rock in which only a few relicts of the original textures remain.

The leaching is also reflected in major element chemistry of the altered rocks, shown in Fig. 3. Relative increases in Al_2O_3 and TiO_2 are produced by the progressive leaching of the more mobile elements. The leaching reaches the extreme in the advanced argillic zone where even the alkalies are removed and partial aluminum mobility is indicated by the presence of euhedral diaspore in veinlets. The large SiO_2 increase may be due partially to introduction of silica into the system by the hydrothermal fluids.

The last wall rock alteration event at Pyramid was produced by acid supergene solutions derived from near-surface weathering of the sulfide veins (Fig. 4). The alteration produces a dense or vuggy, highly siliceous capping which is heavily iron-stained near the surface. The siliceous cap does not extend more than 5-10 m below the surface and grades laterally and downward in the oxidized zone into soft masses of quartz-kaolinite-allophane-iron oxides. The thin siliceous cap is evidently produced by removal of the soft clays at the surface. Although low temperature advanced argillic alteration could produce similar assemblages, the quartz-kaolinite-allophane assemblage is thought to be supergene because it is strictly confined to rocks in which the sulfides are oxidized or partially oxidized.

Conditions of Ore Deposition and Alteration

No quantitative data for temperatures of ore deposition are available but 300°C is a reasonable estimate for the central veins. Fortunately almost identical ore and alteration assemblages from several similar ore deposits have been studied in detail. Similar ore assemblages in the central zone at Butte (Mexer, 1950, and Lange and Cheney, 1971), at Chinkuashih in Taiwan (Folinsbee, et al, 1972) and at Julcani, Peru (Goodell, 1970, and Petersen, et al, 1977) give temperatures around 300°C for enargite-rich ores with neighboring advanced argillic alteration containing pyrophyllite. Feiss (1974) reports temperatures of 325 – 350°C from several Peruvian deposits containing enargite in association with tetrahedrite and that are otherwise quite similar to Pyramid. The enargite-luzonite inversion point, through which the Pyramid ores have passed, lies at about 290 – 300°C (Maske and Skinner, 1971). The effect of compositional variations and impurities on this point are not fully known, but the presence of the most common impurity at Pyramid, antimony, may increase that temperature. The presence of pyrophyllite instead of kaolinite in the Pyramid alteration assemblage also supports a temperature estimate of 300°C or higher (Hemley, et al, 1969).

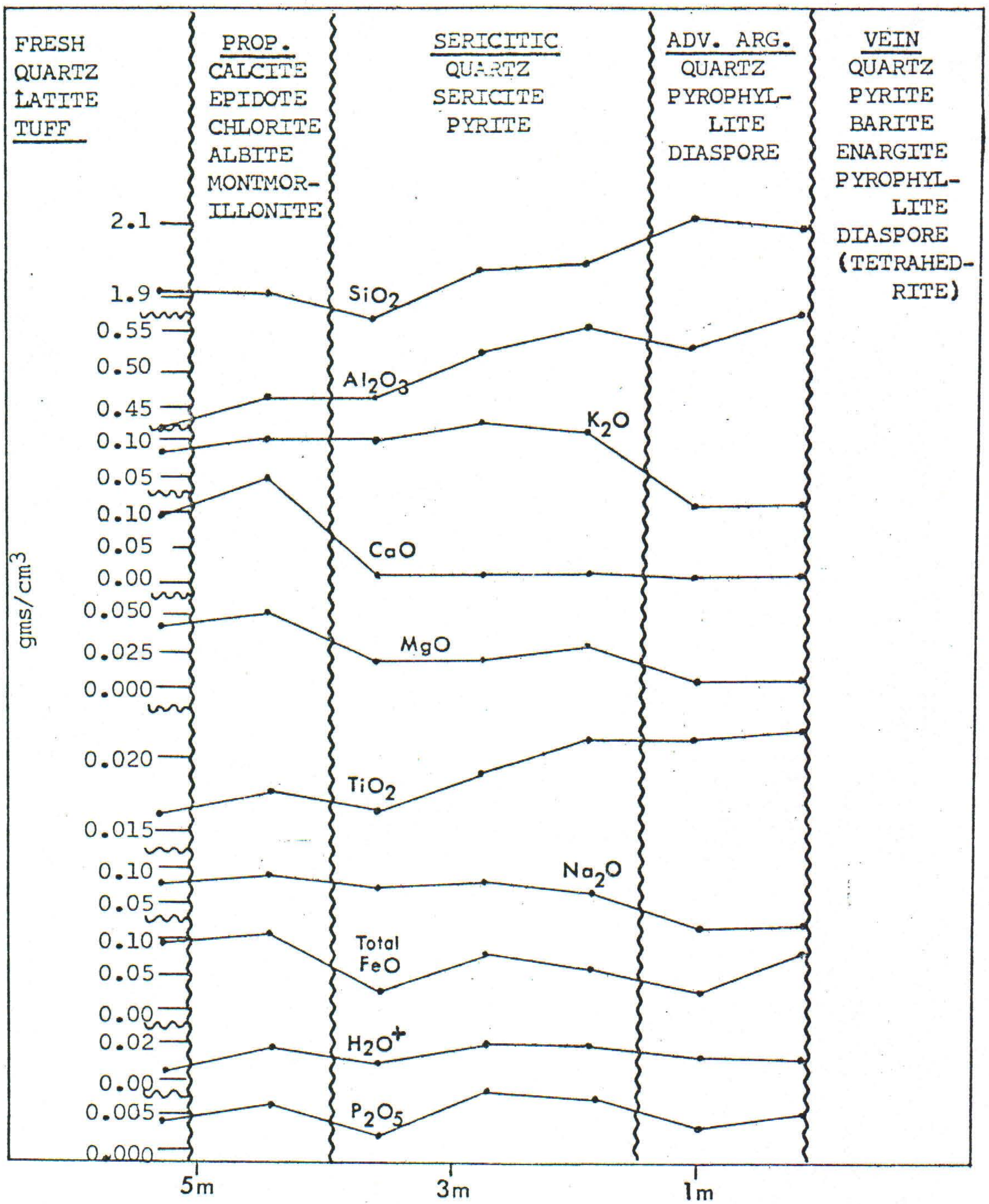

Fig.. 3—Graph showing major element and mineralogic variations compared with distance from the main vein, Burrus mine, Pyramid district. Samples were taken along the vein wall and at 0.9-m (3-ft) intervals outward from the vein, and analyzed for major elements by X-ray fluorescence. Each vertical row of dots represents analysis of a single sample. Values are given in grams/cm^3 rather than weight percent due to the presence of voids created during alteration. Limits of analytical precision are not shown but do not affect the shapes of the graphs.

The correlation between the appearance of advanced argillic alteration and the higher sulfur-to-metal enargite zone suggests that the ore-forming fluid was also that involved in the wall rock alteration. Therefore the reactions of wall rock alteration can also be used to approximate the nature of the ore-forming fluid. Pyramid is in fact just one example of an almost universal correlation of advanced argillic alteration with high sulfidation ore assemblages. Experimental work presented by Hemley, et al (1969), Meyer and Hemley (1967), and Hemley and Jones (1964) indicate that the Pyramid alteration pattern could have been produced by an acid fluid which became progressively neutralized with migration into, and reaction with, the wall rocks (Fig. 5). The acid fluid formed pyrophyllite and diaspore in the tuffs near conduit or fracture walls and then sericite became the stable alteration phase as hydrolytic leaching or H_2SO_4 activity decreased. A similar neutralization occurred with outward migration of the fluid along fractures toward the margins of the district until sericite became the stable alteration phase bordering the vein walls.

The vein assemblages indicate relatively high sulfur and oxygen fugacities for the central enargite zone, as shown in Fig. 6. Although the phase transitions shown do not perfectly correspond to Pyramid assemblages (e.g. tennantite rather than tetrahedrite), several generalizations can be drawn. The outward transition from enargite to tetrahedrite as the dominant copper sulfosalt marks a decrease in sulfur fugacity in the migrating fluid. Such a decrease in sulfur and the increase in pH indicated by the change from pyrophyllite to sericite could be accounted for by the fluid path from I to II on Fig. 6. Although the zonal transitions described so far could have been produced with little or no change in temperature, the strong thermal gradients characteristic of the epithermal environment were undoubtedly present. The gradients are reflected in the outward change from Cu, Zn, and then Pb sulfides deposited with falling temperature in order of solubilities as the solutions became spent near the margins of the district.

Summary

The nature and distribution of the Pyramid ores and alteration assemblages indicate the hydrothermal system cen-

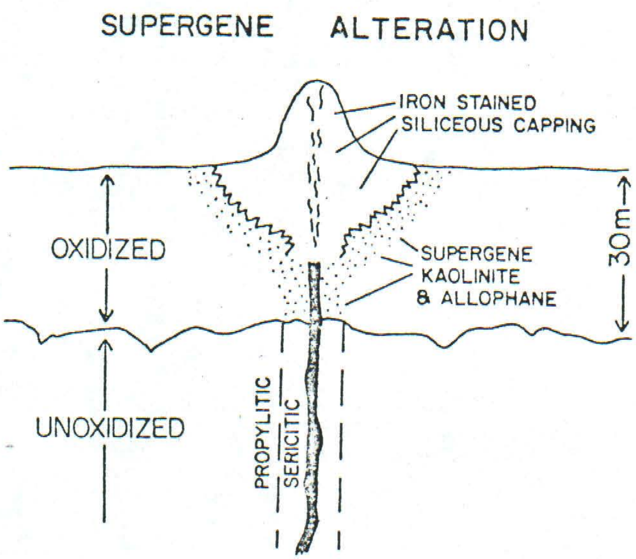

Fig. 4—Illustration of supergene alteration in the oxidized zone superimposed on hydrothermally altered tuffs near a vein.

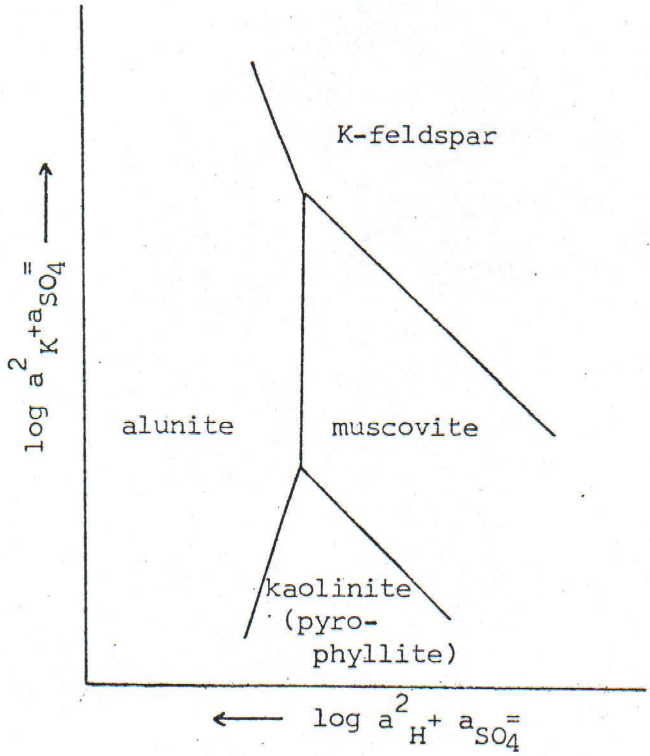

Fig. 5—Generalized illustration of stability relationships of alteration products as a function of K_2SO_4 and H_2SO_4 activities. Kaolinite is stable rather than pyrophyllite below 310°C. Quartz is present and temperature and pressure constant. Diagram and phase relationships after Hemley and others (1969).

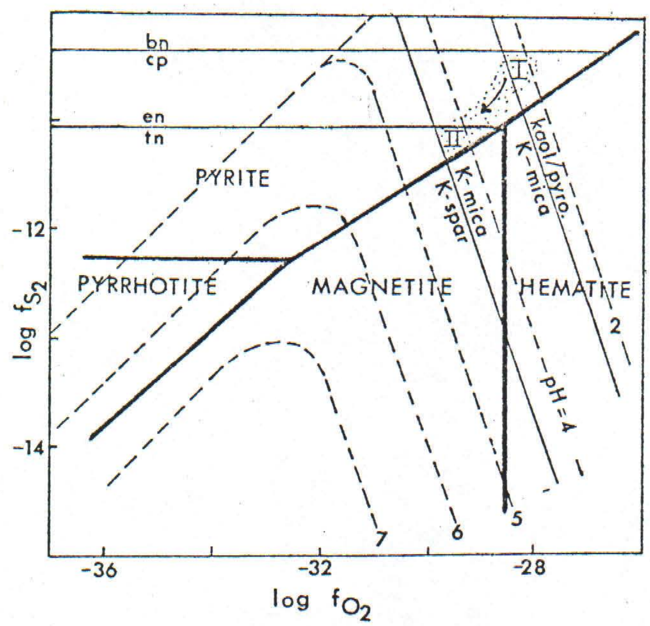

Fig. 6—Plot showing mineral stability fields at 300°C which provide limits on oxygen and sulfur fugacity of Pyramid fluids. Dashed lines are iso-pH contours. Quartz is present in all assemblages. Pyrophyllite replaces kaolinite with a slight temperature increase. Pyramid fluids probably followed the path from I (central zone, enargite-pyrite and kaolinite/pyrophyllite stable) to II (tennantite-pyrite and K-mica stable). Diagram modified slightly after Einaudi (1977), and Meyer and Hemley (1967).

tered at or below the southeastern part of the district (enargite-pyrite zone of Fig. 2a). At the level exposed, the central zone is characterized by high sulfidation ores with borders of advanced argillic alteration produced by extreme acid leaching. As the fluids migrated outward along fractures to the north and west, they became progressively neutralized by interaction with the wall rocks, lower in sulfur fugacity, and probably lower in temperature. The metal content of the veins also shows a systematic change outward, most likely in response to the variation in solubilities of the major and minor elements. It is feasible that all changes could have taken place during the simple migration of the hydrothermal fluid. However, the possibility of the involvement of other fluids, in particular the potential for dilution of the ore fluid by normal groundwater in the outer zones, has not yet been evaluated.

Acknowledgments

This paper is based on parts of the author's doctoral thesis at the Mackay School of Mines, University of Nevada. I am grateful to Arthur Baker III, who suggested and guided the project, and to D. C. Noble and L. C. Hsu who provided encouragement and helpful discussions of the work. M. L. Silberman of the US Geological Survey arranged for critical analytical support. Partial financial aid was received from the University of Nevada Research Fund.

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HUNTER MINING LABORATORY, INC.

994 GLENDALE AVENUE • SPARKS, NEVADA 89431 • TELEPHONE: (702) 358-6227

REPORT OF ANALYSIS

Submitted by:

NIELSEN GEOCONSULTANTS, INC.
P. O. Box 2093
Evergreen, Colorado 80439

Date: October 10, 1980

Laboratory Number: 7864

Analytical Method: AA
Colorimetric

Your Order Number:

Report on: 138 samples

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver ppm
PY Series						
1	105	25	95	10	0.1	2
2	25	5	45	5	-0.1	-1
[illegible]	45	7	110	10	0.1	1
4	20	1	10	85	-0.1	-1
5	30	3	20	50	-0.1	-1
6	10	-1	10	160	-0.1	-1
7	10	1	5	95	-0.1	-1
8	5	1	5	65	-0.1	-1
9	15	1	10	65	-0.1	-1
10	10	1	10	100	-0.1	-1
11	15	1	10	100	-0.1	-1
12	15	4	185	5	-0.1	-1
13	30	3	160	10	-0.1	-1
14	110	5	130	10	-0.1	1
15	135	5	200	25	-0.1	1
16	90	3	50	15	-0.1	-1
17	80	2	135	15	-0.1	1
18	315	1	160	20	0.6	16
19	45	17	185	15	0.2	14
20	65	3	180	20	-0.1	3

continued to page 2

ppm = parts per million. **oz/ton** = troy ounces per ton of 2000 pounds avoirdupois. **percent** = parts per hundred. **fineness** = parts per thousand. **ppb** = 0.001 ppm. Read — as "less than." 1 oz/ton = 34.286 ppm. 1 ppm = 0.0001% = 0.029167 oz/ton. 1.0% = 20 pounds/ton.

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver ppm
PY Series						
21	75	4	360	10	0.2	2
22	45	11	105	15	0.1	-1
23	45	13	145	10	0.2	4
24	10	2	15	10	-0.1	-1
25	10	3	10	15	-0.1	-1
26	5	1	15	45	-0.1	-1
27	5	2	15	15	0.1	1
28	5	2	5	25	-0.1	-1
29	5	2	10	30	-0.1	-1
30	5	1	90	55	-0.1	-1
31	10	2	10	75	-0.1	-1
32	30	2	50	15	-0.1	-1
33	50	3	335	10	-0.1	1
34	20	3	165	-5	0.1	1
35	75	3	85	15	-0.1	1
36	10	2	25	15	-0.1	-1
37	5	2	15	15	-0.1	-1
38	10	2	10	20	-0.1	-1
39	5	2	15	10	-0.1	-1
40	30	1	80	15	-0.1	-1
41	15	8	250	-5	0.3	2
42	20	1	10	40	-0.1	1
43	15	2	10	100	-0.1	-1
44	25	1	60	25	-0.1	-1
45	30	2	165	5	-0.1	-1
46	45	17	455	5	0.1	2
47	50	21	375	5	0.1	1
48	55	2	145	25	-0.1	-1
49	15	1	60	5	-0.1	-1
50	100	11	60	5	-0.1	2

continued to page 3

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver
PY Series						
51	5	1	10	40	-0.1	-1
52	10	-1	15	30	-0.1	-1
53	15	1	5	60	-0.1	-1
54	10	1	10	85	-0.1	-1
55	10	2	5	70	-0.1	-1
56	10	2	100	5	-0.1	-1
57	25	9	100	-5	0.1	1
58	35	-1	110	45	-0.1	3
59	160	10	495	5	0.1	18
60	20	1	10	250	-0.1	-1
61	80	1	470	5	-0.1	1
62	10	1	5	115	-0.1	-1
63	170	11	120	10	-0.1	8
64	55	2	5	130	-0.1	-1
65	5	4	10	-5	-0.1	-1
66	60	7	165	10	-0.1	1
67	30	4	40	5	-0.1	-1
68	-5	2	15	25	-0.1	-1
69	5	2	5	65	-0.1	-1
70	5	2	5	115	-0.1	-1
71	20	2	10	35	-0.1	-1
72	15	3	10	75	-0.1	-1
73	5	2	15	65	-0.1	-1
74	5	5	15	45	-0.1	-1
75	120	61	325	10	0.1	37
76	160	49	0.40%	15	-0.1	11
77	15	2	10	60	-0.1	-1
78	280	3	50	45	-0.1	2
79	10	4	15	10	-0.1	-1

continued to page 4

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver ppm
PY Series						
80	5	3	10	15	-0.1	-1
81	5	3	25	40	-0.1	-1
82	5	2	5	60	-0.1	-1
83	5	2	10	85	-0.1	-1
84	5	2	10	80	-0.1	-1
85	10	2	10	50	-0.1	-1
86	5	2	10	40	-0.1	-1
87	5	3	10	195	-0.1	-1
88	5	5	30	15	-0.1	-1
89	5	2	10	30	-0.1	-1
90	5	5	20	45	-0.1	-1
91	5	1	20	50	-0.1	-1
92	5	2	60	30	-0.1	-1
93	15	1	75	20	-0.1	1
94	10	2	25	45	-0.1	-1
95	40	2	100	5	-0.1	-1
96	20	3	160	5	-0.1	1
97	60	3	200	5	-0.1	1
98	60	5	245	10	-0.1	1
99	75	2	130	15	-0.1	2
100	30	2	20	175	-0.1	-1
101	25	3	135	10	-0.1	2
102	20	9	300	30	-0.1	2
103	15	4	180	-5	-0.1	1
104	45	2	135	55	-0.1	-1
105	10	4	100	35	-0.1	-1
106	5	3	20	20	-0.1	-1
107	20	3	210	20	-0.1	-1
108	10	2	95	5	-0.1	-1
109	15	6	40	15	-0.1	-1

continued to page 5

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver ppm
PY SERIES						
110	25	2	90	50	0.1	-1
111	10	2	10	20	-0.1	-1
112	35	8	120	15	-0.1	1
113	20	5	145	5	-0.1	-1
114	10	5	200	10	-0.1	-1
115	30	2	115	5	-0.1	-1
116	95	4	160	5	0.1	2
117	45	1	245	10	-0.1	-1
118	30	1	215	5	-0.1	-1
119	125	6	205	5	-0.1	1
120	125	61	140	5	-0.1	-1
121	85	5	510	5	-0.1	3
122	15	4	75	10	-0.1	-1
123	50	2	65	45	-0.1	-1
124	65	1	25	15	-0.1	-1
125	85	1	30	145	-0.1	-1
126	250	1	25	25	-0.1	-1
127	45	10	15	90	-0.1	-1
128	60	1	5	215	-0.1	-1
129	45	1	5	70	-0.1	-1
130	55	2	5	300	-0.1	-1
131	10	2	5	70	-0.1	-1
132	10	1	10	75	-0.1	-1
133	10	1	10	85	-0.1	-1
134	10	1	10	75	-0.1	-1
135	15	1	10	60	-0.1	-1
136	25	1	20	80	-0.1	-1
137	10	1	5	65	-0.1	-1
138	5	1	5	65	-0.1	-1

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Gary M. Fechko

Gary M. Fechko

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994 Glendale Ave.

REPORT OF ANALYSIS

Submitted by:

NIELSEN GEOCONSULTANTS
Mr. R. Nielsen
P. O. Box 2093
Evergreen, Colorado 80439

Date: September 11, 1980

Laboratory Number: 8100

Analytical Method: AA
Colorimetric

Your Order Number:

Report on: 5 samples

Sample Mark:	Copper ppm	Molybdenum ppm	Lead ppm	Zinc ppm	Gold ppm	Silver ppm
PY - 139	40	3	140	50	-0.1	-1
140	65	2	65	25	-0.1	-1
141	60	3	70	10	-0.1	1
142	35	3	100	10	-0.1	-1
143	30	1	300	15	-0.1	-1

HUNTER MINING LABORATORY, INC.

Gary M. Fechko

Gary M. Fechko

ppm = parts per million. **oz/ton** = troy ounces per ton of 2000 pounds avoirdupois. **percent** = parts per hundred. **fineness** = parts per thousand. **ppb** = 0.001 ppm. Read — as "less than." 1 oz/ton = 34.286 ppm. 1 ppm = 0.0001% = 0.029167 oz/ton. 1.0% = 20 pounds/ton.

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REPORT OF ANALYSIS

Submitted by:

NIELSEN GEOCONSULTANTS, INC.
P. O. Box 2093
Evergreen, Colorado 80439

Date: November 26, 1980

Laboratory Number: 8833

Analytical Method: AA
Colorimetric

Your Order Number:

Report on: 138 samples submitted under Laboratory No.: 7864.

Sample Mark:	Tin ppm	Tungsten W ppm	Sample Mark:	Tin ppm	Tungsten W ppm
PY-1	-5	1	Y-23	8	4
2	-5	2	24	-5	2
3	-5	-1	25	-5	1
4	-5	1	26	-5	1
5	-5	-1	27	-5	1
6	-5	1	28	-5	-1
7	-5	-1	29	-5	-1
8	-5	1	30	-5	1
9	-5	-1	31	-5	-1
10	-5	-1	32	-5	-1
11	-5	-1	33	-5	-1
12	-5	2	34	-5	1
13	-5	2	35	-5	-1
14	-5	1	36	-5	2
15	-5	-1	37	-5	1
16	-5	-1	38	-5	1
17	-5	-1	39	-5	1
18	45	-1	40	-5	2
19	30	-1	41	-5	-1
20	-5	1	42	-5	1
21	19	2	43	-5	1
PY-22	-5	2	PY-44	-5	1

continued to page 2

ppm = parts per million. **oz/ton** = troy ounces per ton of 2000 pounds avoirdupois. **percent** = parts per hundred. **fineness** = parts per thousand.
ppb = 0.001 ppm. Read — as "less than." 1 oz/ton = 34.286 ppm. 1 ppm = 0.0001% = 0.029167 oz/ton. 1.0% = 20 pounds/ton.

NIELSEN GEOCONSULTANTS, INC. Page 2 Laboratory No.: 8833

Sample Mark:	Tin ppm	Tungsten as W ppm	Sample Mark:	Tin ppm	Tungsten as W ppm
PY-46	-5	2	PY-76	5	1
47	5	10	77	6	-1
48	-5	10	78	8	-1
49	-5	1	79	-5	2
50	-5	1	80	-5	2
51	-5	1	81	-5	2
52	-5	1	82	6	2
53	5	1	83	-5	2
54	-5	-1	84	5	1
55	-5	1	85	-5	1
56	5	-1	86	-5	1
57	-5	2	87	6	1
58	-5	-1	88	-5	1
59	9	2	89	-5	3
60	-5	-1	90	-5	-1
61	-5	2	91	-5	1
62	-5	1	92	-5	1
63	-5	1	93	-5	2
64	5	-1	94	-5	-1
65	-5	1	95	8	2
66	-1	1	96	-5	3
67	-5	-1	97	-5	5
68	-5	1	98	-5	7
69	-5	1	99	-5	1
70	6	1	100	15	1
71	-5	1	101	-5	1
72	7	-1	102	-5	2
73	-5	2	103	-5	10
74	-5	2	104	-5	5
PY-75	5	1	PY-105	-5	2

continued to page 3

HUNTER MINING LABORATORY,INC.

Sample Mark:	Tin ppm	Tungsten as W ppm	Sample Mark:	Tin ppm	Tungsten as W ppm
PY-106	-5	1	PY-123	-5	-1
107	-5	2	124	-5	-1
108	-5	2	125	-5	-1
109	-5	1	126	-5	-1
110	-5	2	127	-5	-1
111	-5	2	128	-5	-1
112	-5	1	129	-5	-1
113	-5	30	130	-5	1
114	-5	4	131	-5	1
115	-5	5	132	-5	1
116	-5	5	133	-5	-1
117	-5	2	134	-5	1
118	-5	5	135	-5	-1
119	-5	3	136	-5	-1
120	-5	3	137	-5	-1
121	7	-1	PY-138	-5	-1
PY-122	-5	2	PY-45	-5	-1

HUNTER MINING LABORATORY, INC.

H H Scales

H. H. Scales

CONE GEOCHEMICAL INC.
810 Quail Street, Suite I
Lakewood, Colorado 80215
(303) 232-8371

ANALYTICAL REPORT

Mr. R. Nielsen
Nielsen Geoconsultants Inc.
P.O. Box 2093
Evergreen, CO 80439

PO #
Project:

SAMPLE NUMBER	% F
PY-1	0.03
PY-2	0.02
PY-3	0.05
PY-4	0.07
PY-5	0.08
PY-6	0.05
PY-7	0.06
PY-8	0.05
PY-9	0.05
PY-10	0.07
PY-11	0.12
PY-12	0.05
PY-13	0.05
PY-14	0.05
PY-15	0.06
PY-16	0.05
PY-17	0.04
PY-18	0.03
PY-19	0.03
PY-20	0.07
PY-21	0.03
PY-22	0.07
PY-23	0.03
PY-24	0.04
PY-25	0.04
PY-26	0.05
PY-27	0.04
PY-28	0.02
PY-29	0.02
PY-30	0.04
PY-31	0.03
PY-32	0.03
PY-33	0.06
PY-34	0.04
PY-35	0.04
METHOD	SpIon
DIGESTION	Fus'n
PRECISION	20%

CONE GEOCHEMICAL INC.
810 Quail Street, Suite I
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Job # 1099
08-Jan-81

ANALYTICAL REPORT

Mr. R. Nielsen
Nielsen Geoconsultants Inc.
P.O. Box 2093
Evergreen, CO 80439

PO #
Project:

SAMPLE NUMBER	% F
PY-36	0.01
PY-37	0.02
PY-38	0.01
PY-39	0.01
PY-40	0.04
PY-41	0.03
PY-42	0.04
PY-43	0.04
PY-44	0.02
PY-45	0.05
PY-46	0.03
PY-47	0.02
PY-48	0.04
PY-49	0.02
PY-50	0.03
PY-51	0.04
PY-52	0.04
PY-53	0.04
PY-54	0.04
PY-55	0.03
PY-56	0.06
PY-57	0.06
PY-58	0.04
PY-59	0.02
PY-60	0.04
PY-61	0.07
PY-62	0.05
PY-63	0.02
PY-64	0.03
PY-65	0.06
PY-66	0.03
PY-67	0.06
PY-68	0.03
PY-69	0.05
PY-70	0.06

METHOD	SpIon
DIGESTION	Fus'n
PRECISION	20%

CONE GEOCHEMICAL INC.
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Job # 1099
08-Jan-81

ANALYTICAL REPORT

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P.O. Box 2093
Evergreen, CO 80439

PO #
Project:

SAMPLE NUMBER	% F
PY-71	0.02
PY-72	0.03
PY-73	0.04
PY-74	0.04
PY-75	0.08
PY-76	0.06
PY-77	0.04
PY-78	0.05
PY-79	0.01
PY-80	0.01
PY-81	0.02
PY-82	0.05
PY-83	0.05
PY-84	0.06
PY-85	0.05
PY-86	0.08
PY-87	0.02
PY-88	0.02
PY-89	0.04
PY-90	0.04
PY-91	0.05
PY-92	0.03
PY-93	0.05
PY-94	0.05
PY-95	0.05
PY-96	0.03
PY-97	0.03
PY-98	0.03
PY-99	0.05
PY-100	0.04
PY-101	0.02
PY-102	0.05
PY-103	0.02
PY-104	0.03
PY-105	0.04

METHOD	SpIon
DIGESTION	Fus'n
PRECISION	20%

CONE GEOCHEMICAL INC.
810 Quail Street, Suite I
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Job # 1099
08-Jan-81
Page 4

ANALYTICAL REPORT

Mr. R. Nielsen
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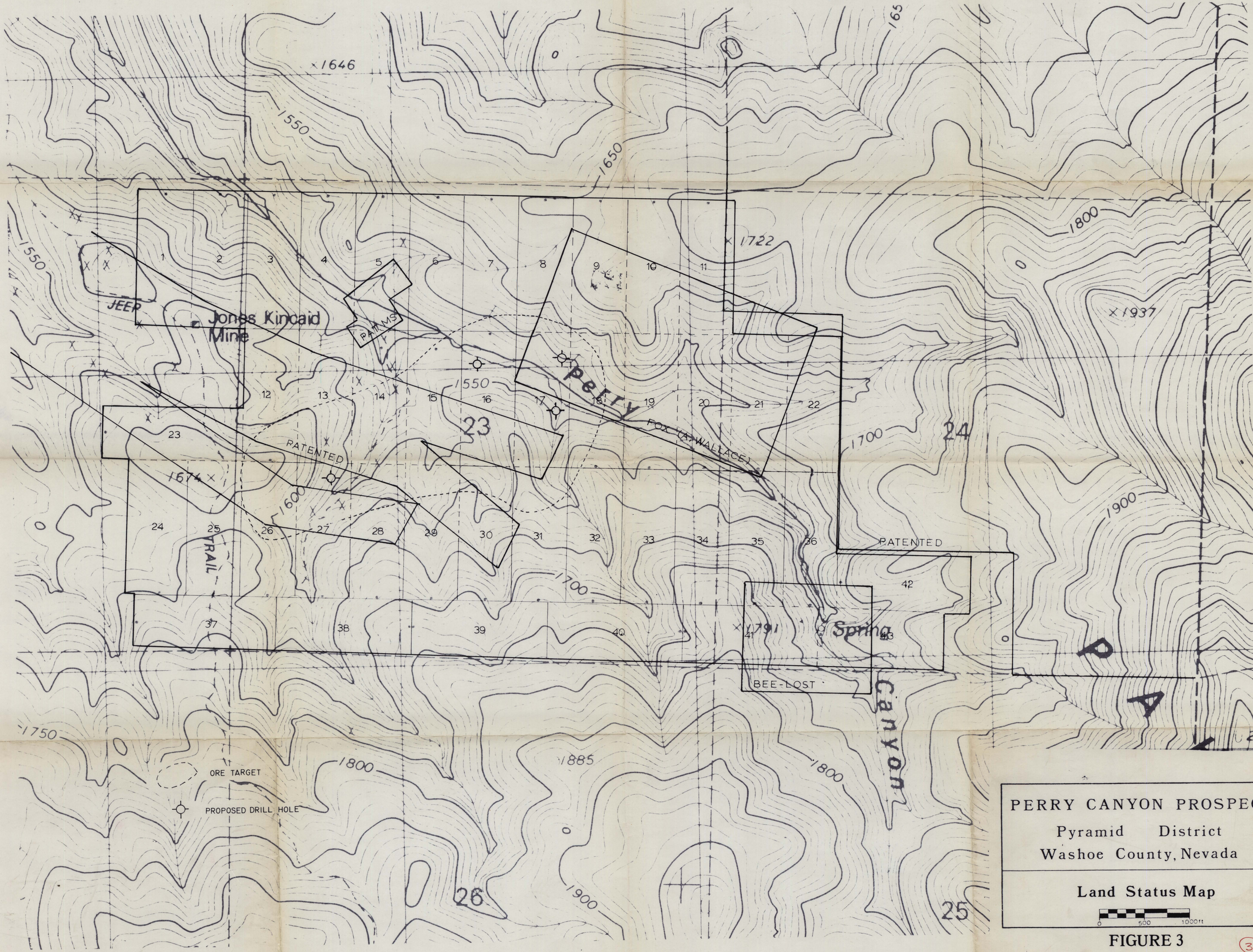
Evergreen, CO 80439

PO #
Project:

SAMPLE NUMBER	% F
PY-106	0.03
PY-107	0.07
PY-108	0.04
PY-109	0.03
PY-110	0.03
PY-111	0.03
PY-112	0.04
PY-113	0.02
PY-114	0.03
PY-115	0.03
PY-116	0.02
PY-117	0.04
PY-118	0.03
PY-119	0.03
PY-120	0.02
PY-121	0.02
PY-122	0.06
PY-123	0.03
PY-124	0.06
PY-125	0.03
PY-126	0.02
PY-127	0.03
PY-128	0.03
PY-129	0.03
PY-130	0.04
PY-131	0.03
PY-132	0.04
PY-133	0.03
PY-134	0.04
PY-135	0.04
PY-136	0.03
PY-137	0.03
PY-138	0.04
METHOD	SpIon
DIGESTION	Fus'n
PRECISION	20%

T23N, R21E / FIGURE 3



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Land Status Map

0 500 1000ft

FIGURE 3

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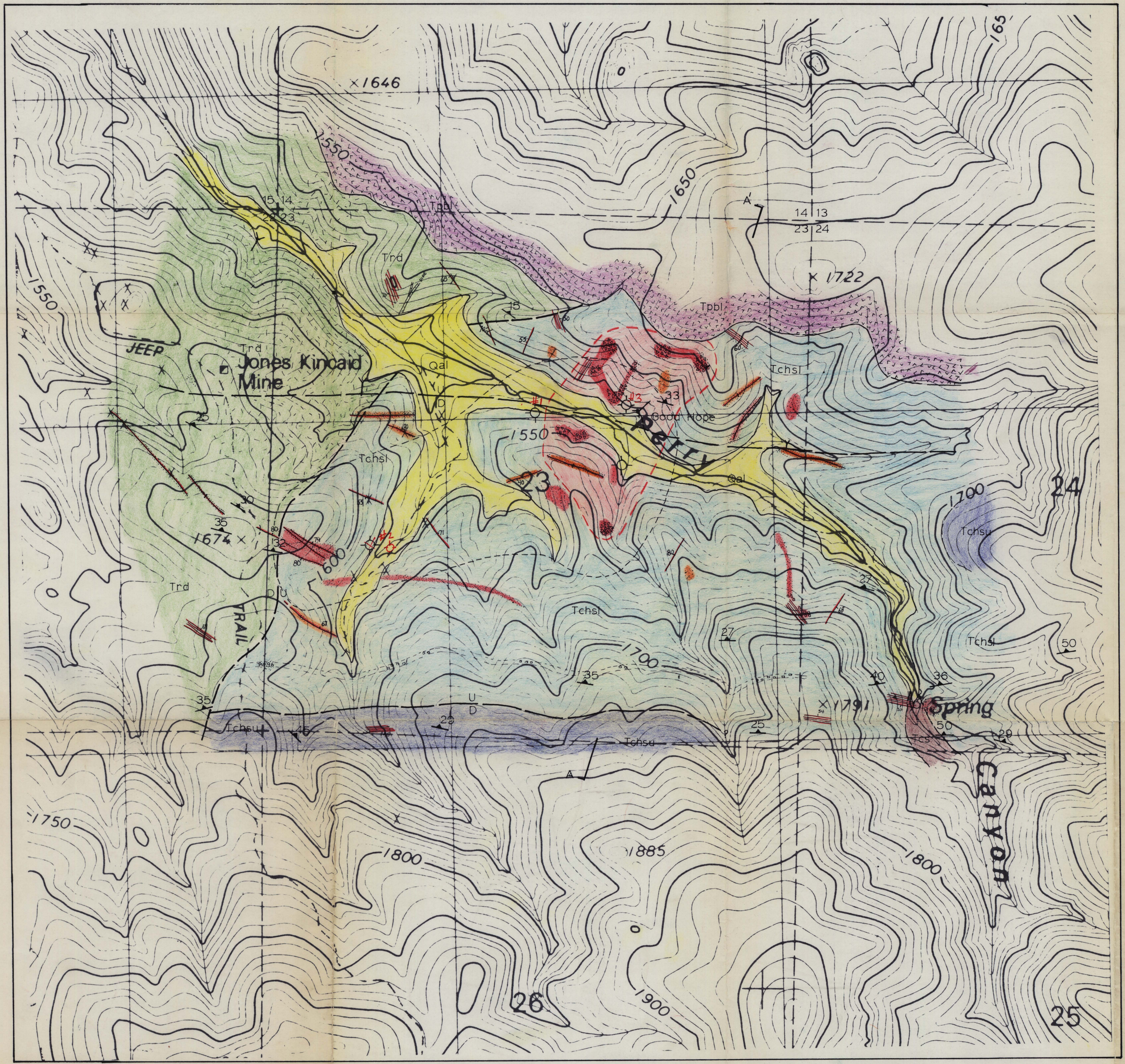
Item 35
(part 2 of 2)

37200030

FIGURE 4



EXPLANATION

Qal — stream gravels, valley fill, and talus

Tpbl — Basaltic Andesite lava flows; post mineralization Pyramid Sequence; thickness varies: 30-250 ft.

Trd — Rhyodacite, olive green, pyroclastic texture, crystal rich
-hypabyssal dacite intrusive sill (?); olive green, dense, relatively fresh, low quartz content.

CHIMNEY SPRINGS FORMATION

Tchsu / **Tchsl** — crystal rich tuff; 1.) upper, more biotite rich flow, purplish ground mass; non bleached (dense). 2) lower, crystal rich (qtz & sanidine) rhyolite tuff; locally porphyritic (very large feldspar phenocrysts)

Tcs — coyote Springs Formation (?) - crystal poor tuff; weakly altered

silicification

gossanous outcrop

mineralized breccia zone

geologic contact, dashed where inferred

U/D — Fault, showing relative displacement, dashed where inferred.

80 — mineralized fractures, showing dip, zone of silicification

75 — parallel fracture (sheeted) zone, mineralized and nonmineralized

35 — strike and dip of compaction foliation, flow structure, and bedding

shaft, prospect, adit

ore target

proposed drill hole

N

PERRY CANYON PROSPECT

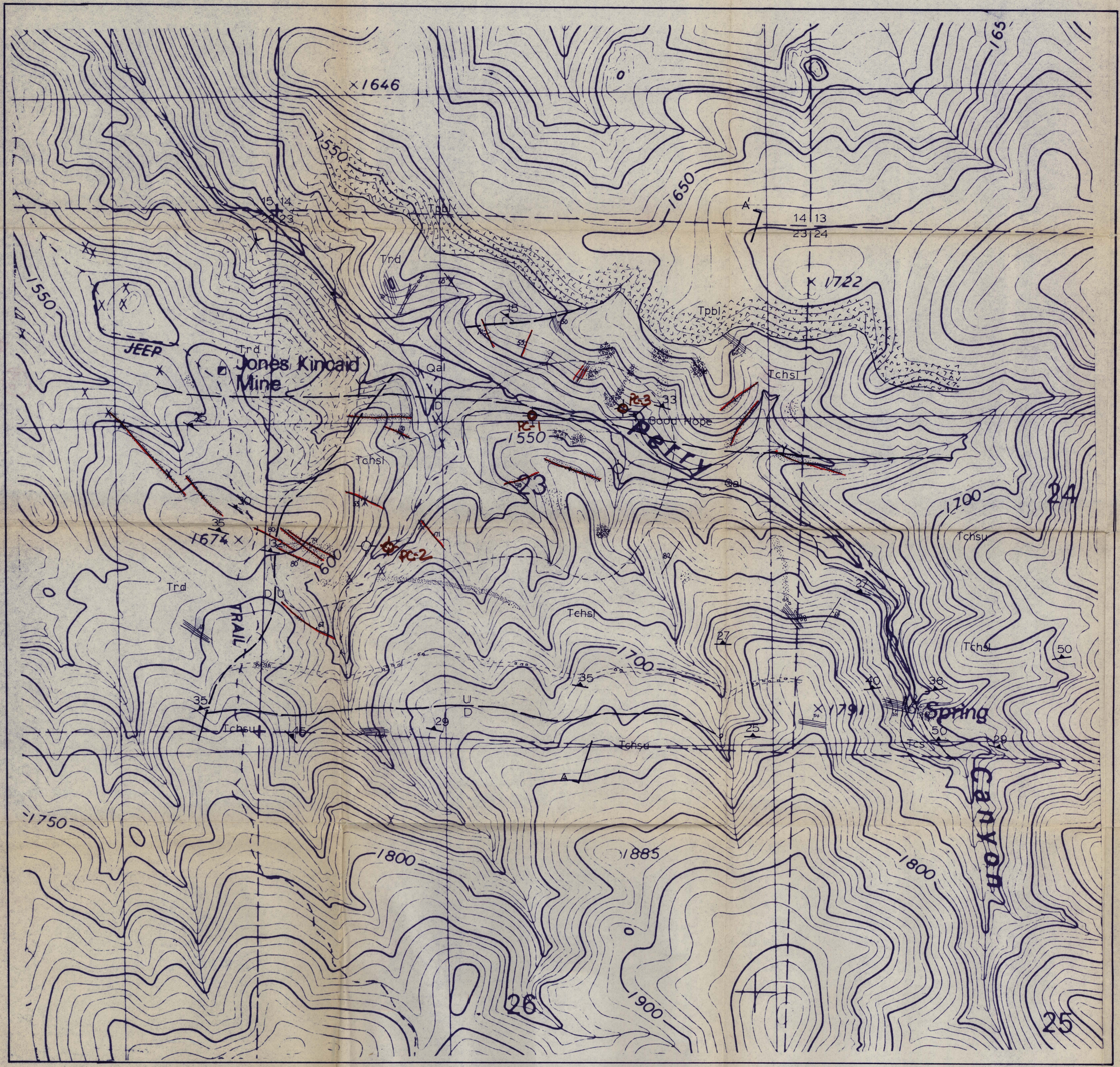
Pyramid District
Washoe County, Nevada

Geologic Map

0 500 1000ft

FIGURE 4

FIGURE 4



EXPLANATION

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geologic contact, dashed where inferred

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35 — strike and dip of compaction foliation, flow structure, and bedding

shaft, prospect, adit

ore target

proposed drill hole

N

PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Geologic Map

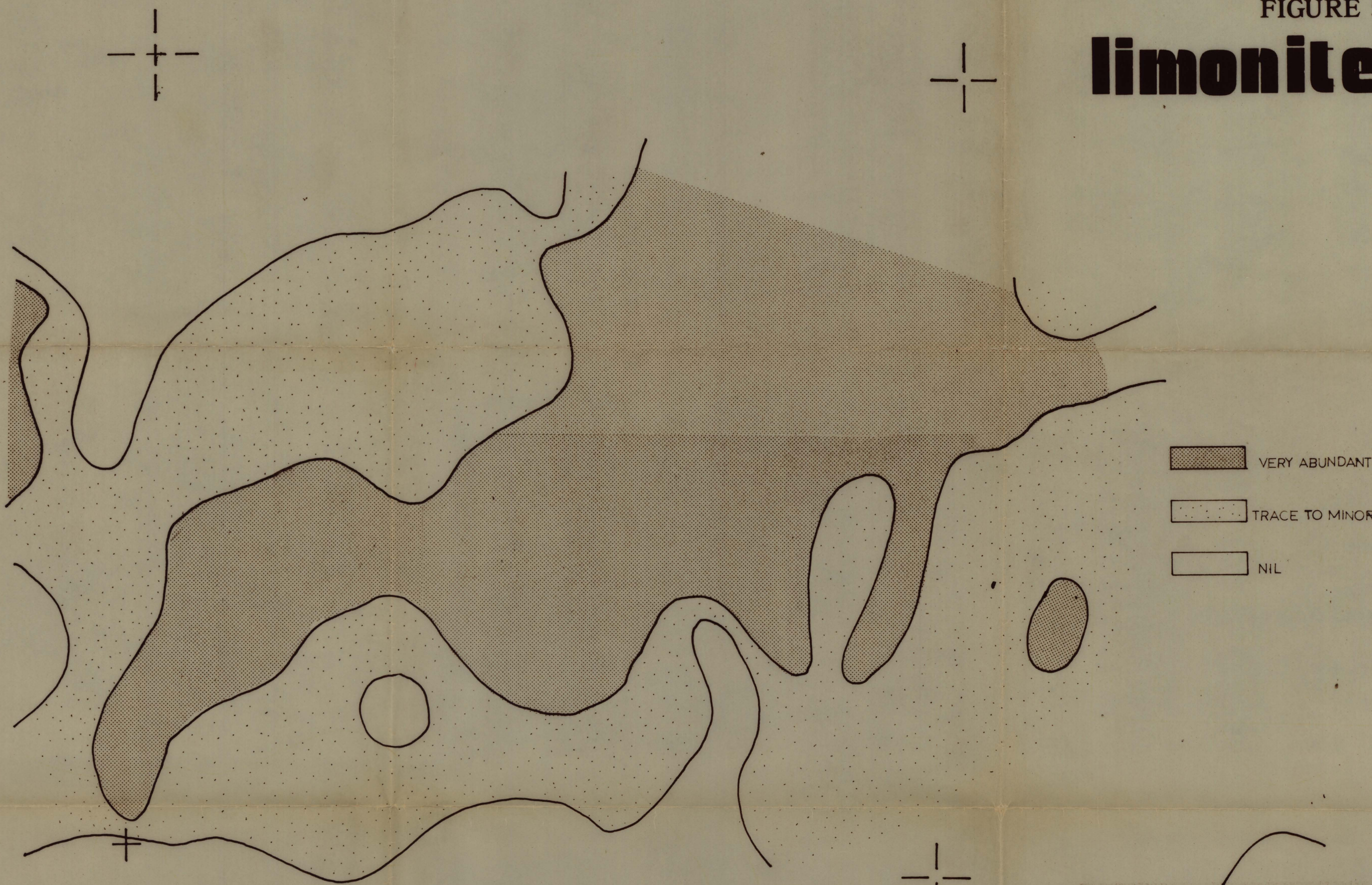
0 500 1000ft

FIGURE 4

3720 0038

FIGURE 5

limonite



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

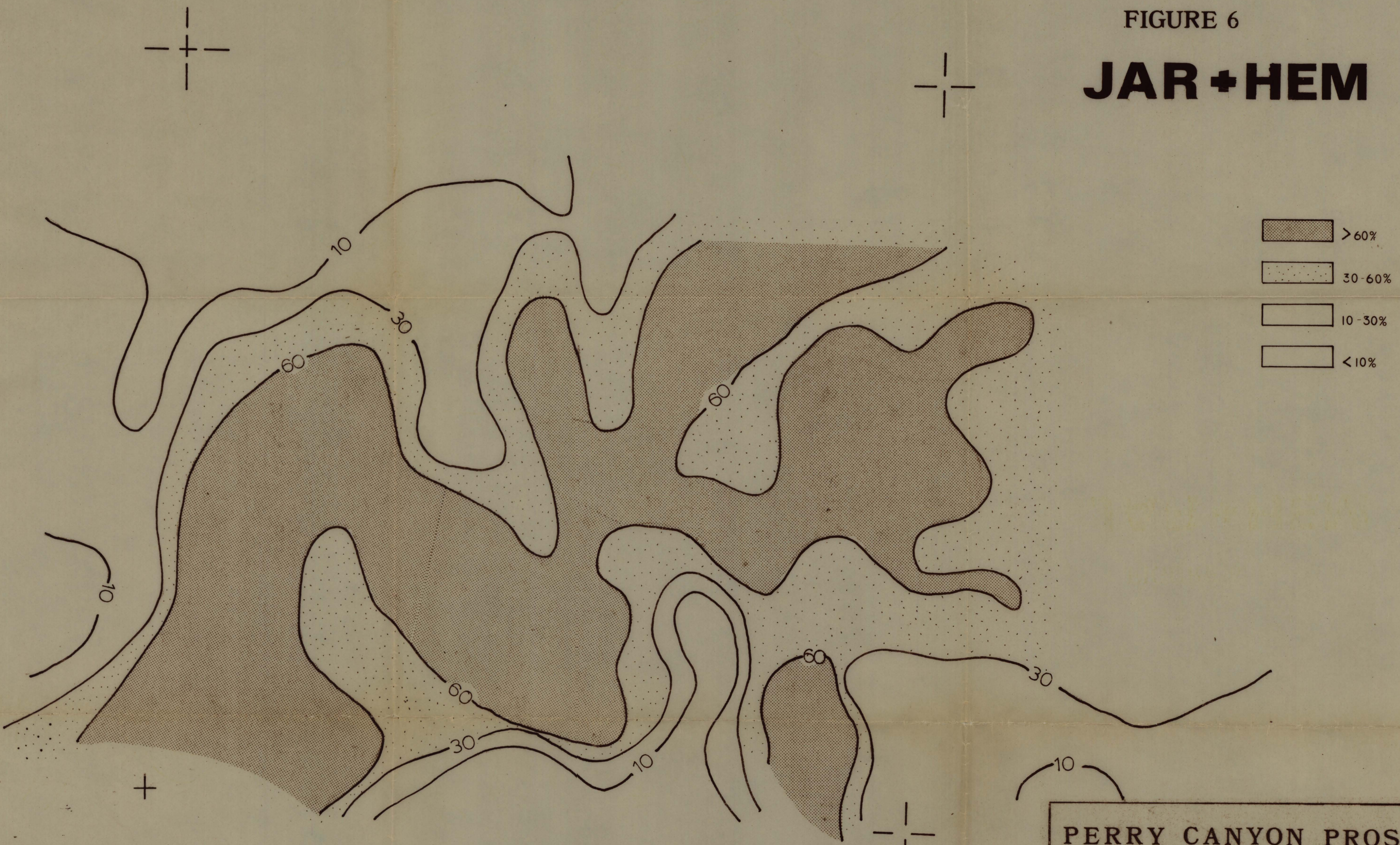
Limonite in Rock (relative abundance)

0 500 1000ft

FIGURE 5

FIGURE 6

JAR + HEM



PERRY CANYON PROSPECT
Pyramid District
Washoe County, Nevada

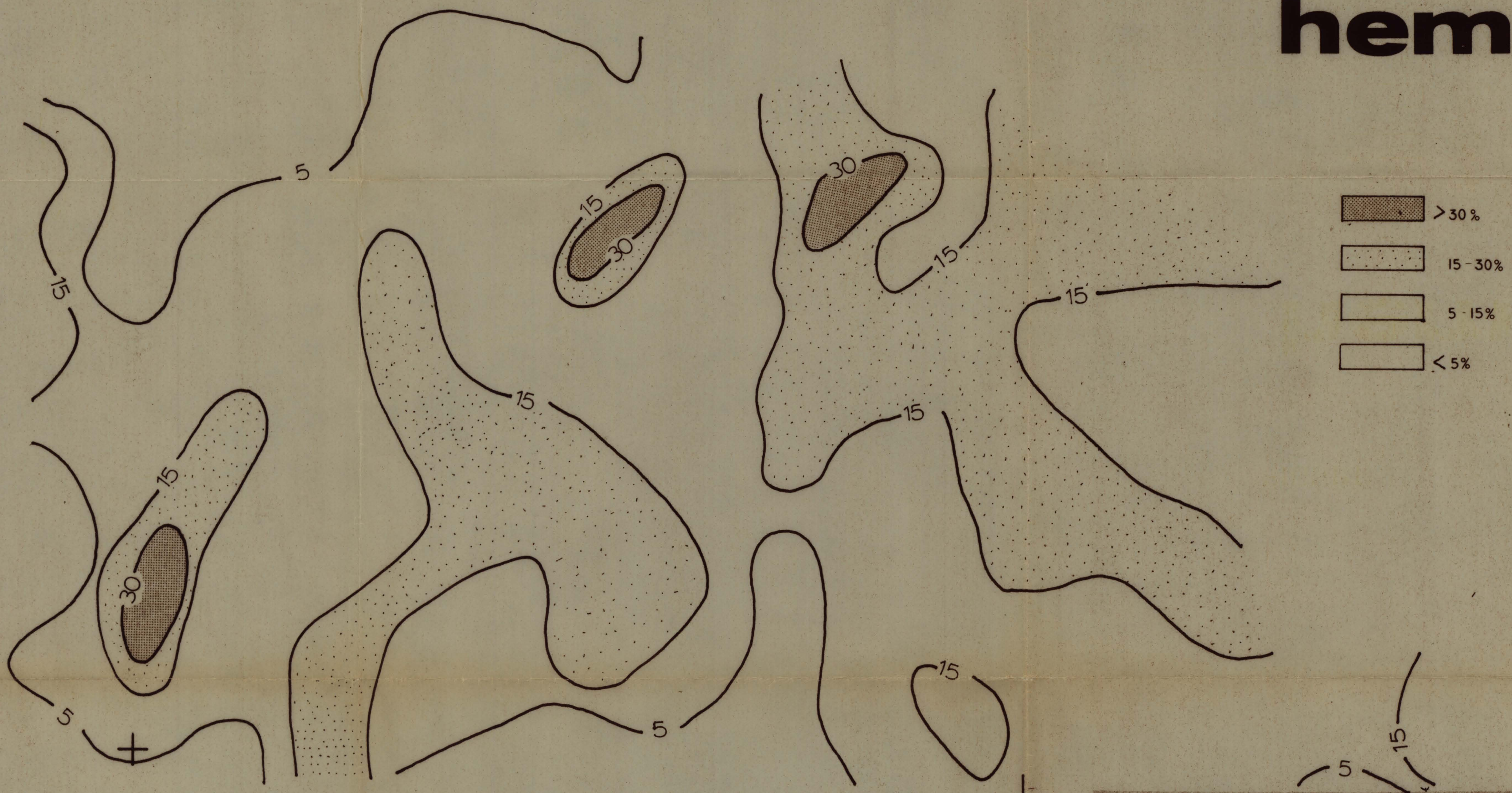
Jarosite + Hematite in Limonite (%)

0 500 1000 ft

FIGURE 6

FIGURE 7

hem



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Hematite in Limonite (%)

0 500 1000ft

FIGURE 7

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Item 35 (part 2 of 2)

3720 0030

FIGURE 8

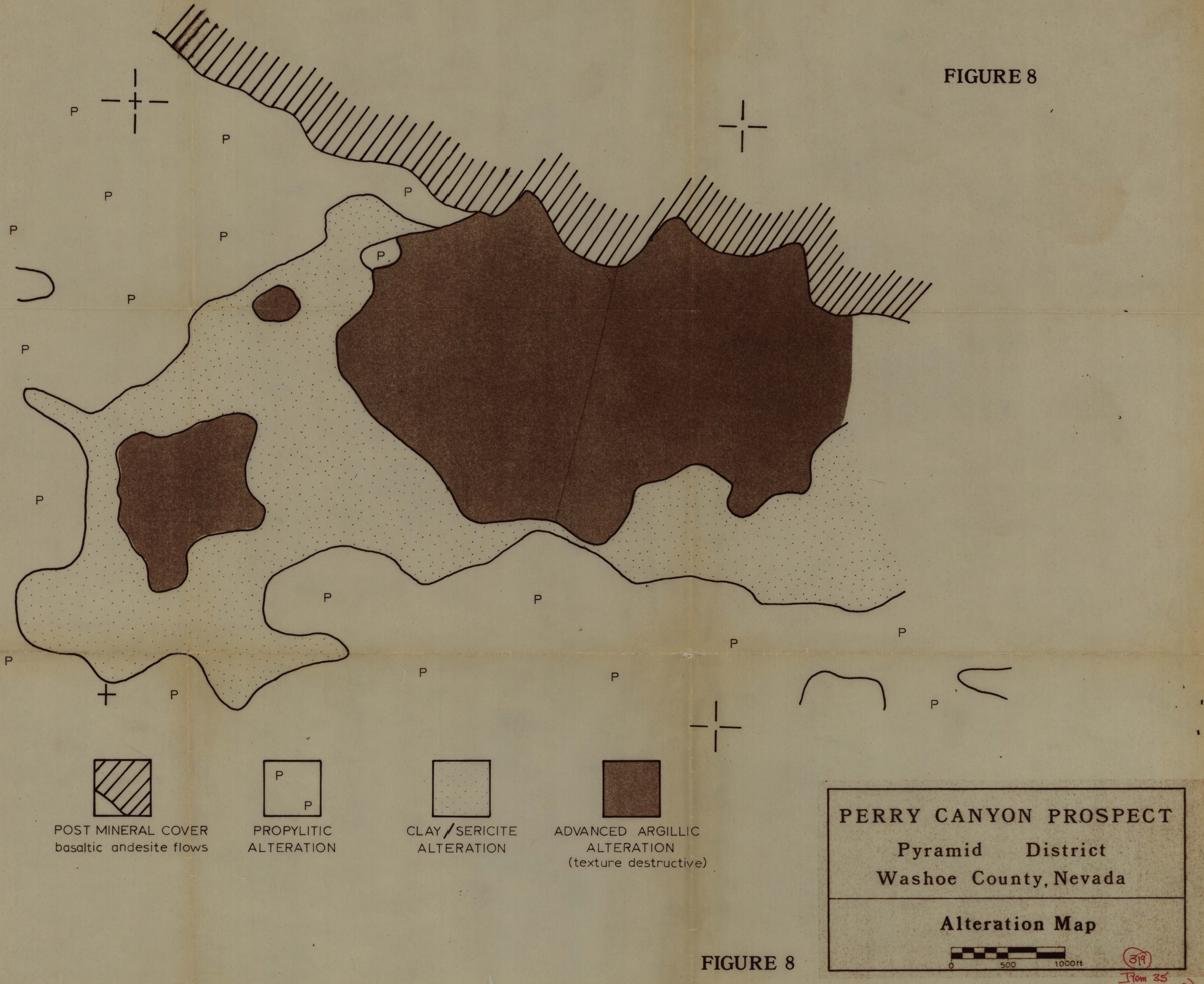
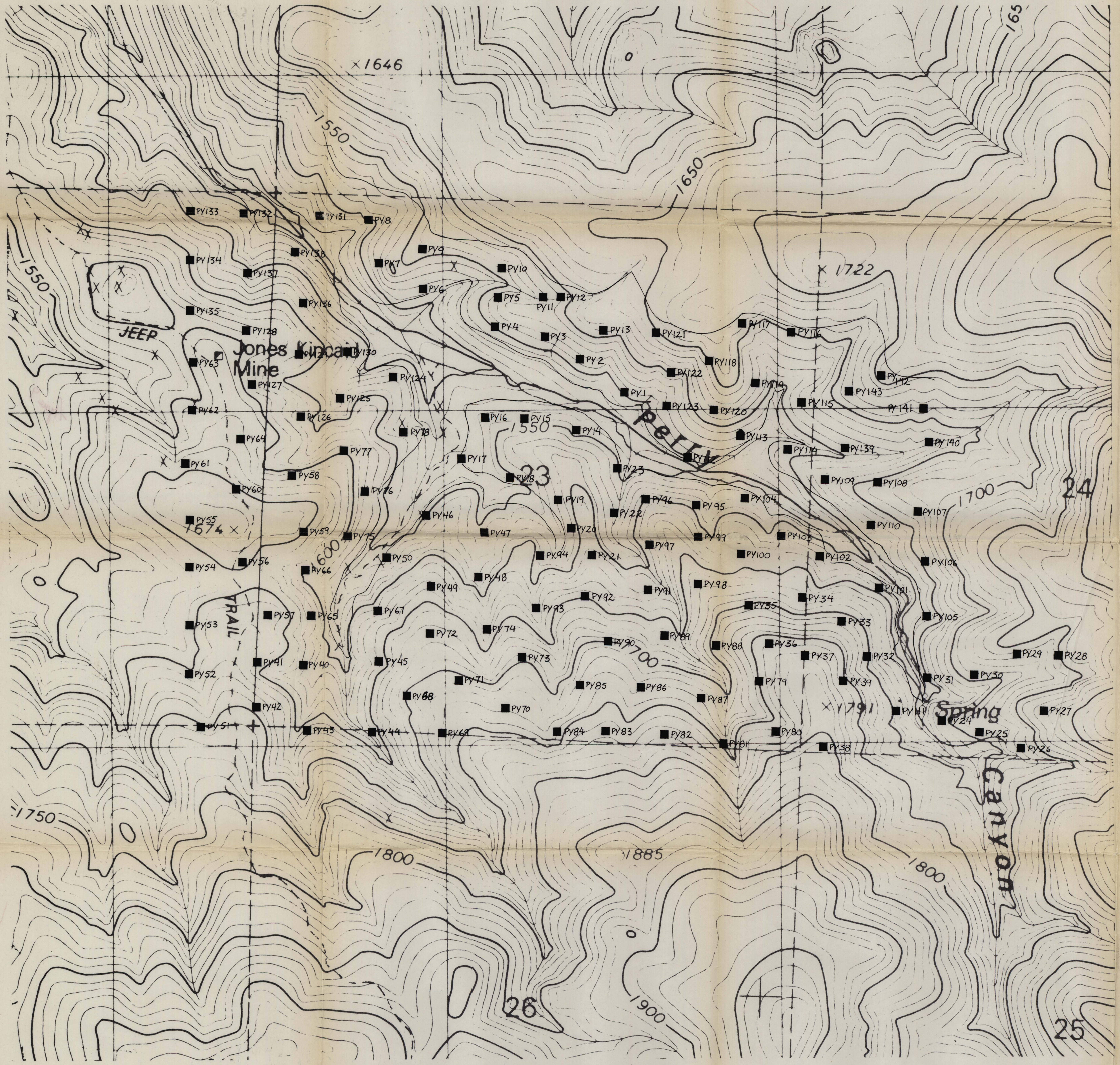


FIGURE 8

FIGURE 9



PERRY CANYON PROSPECT
Pyramid District
Washoe County, Nevada

Sample Location Map

0 500 1000ft

FIGURE 9

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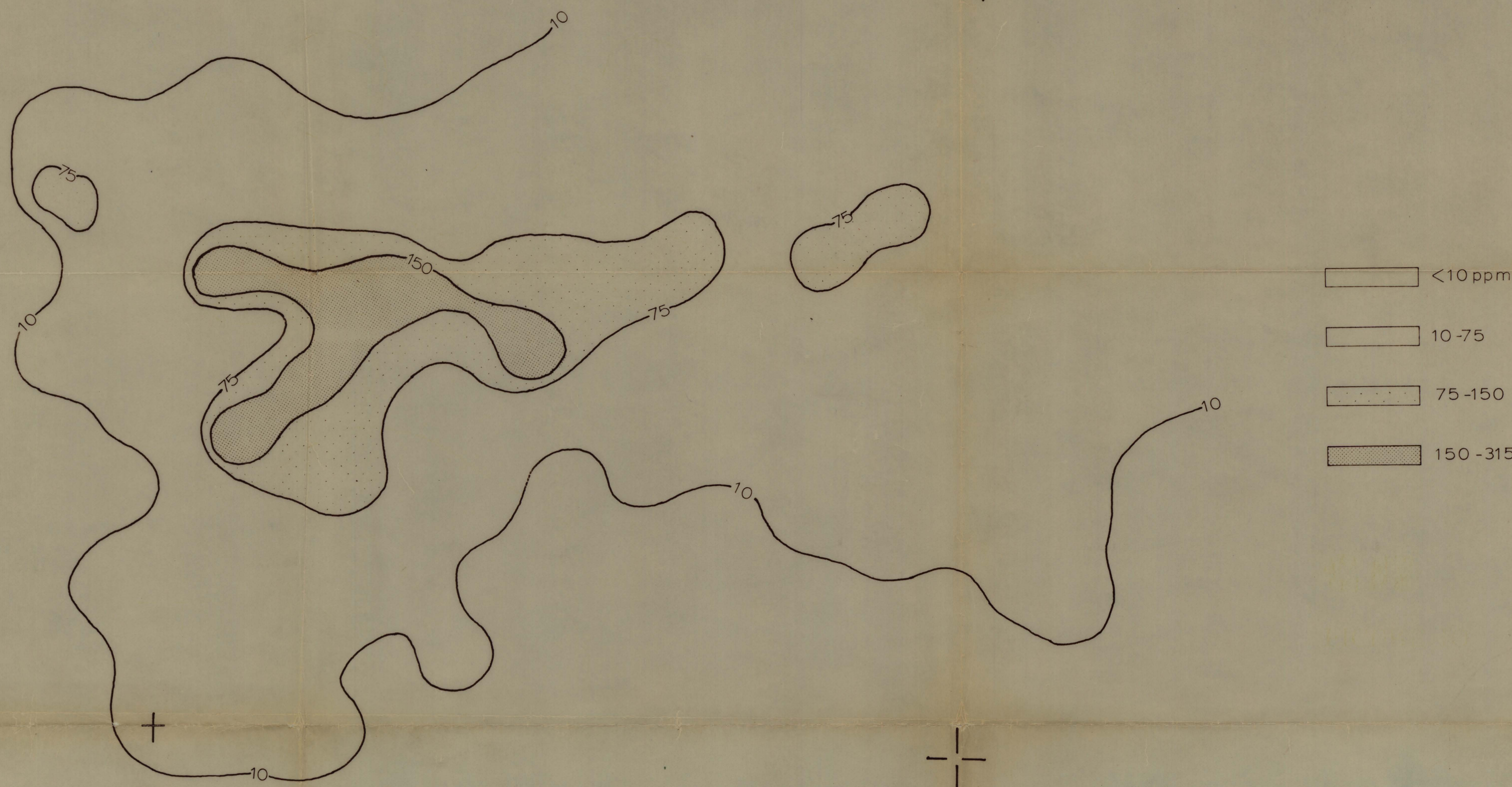
Item 35
(part 2 of 2)

3720 0030

FIGURE 10

Cu



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Cu in Rock (ppm)

0 500 1000ft

FIGURE 10

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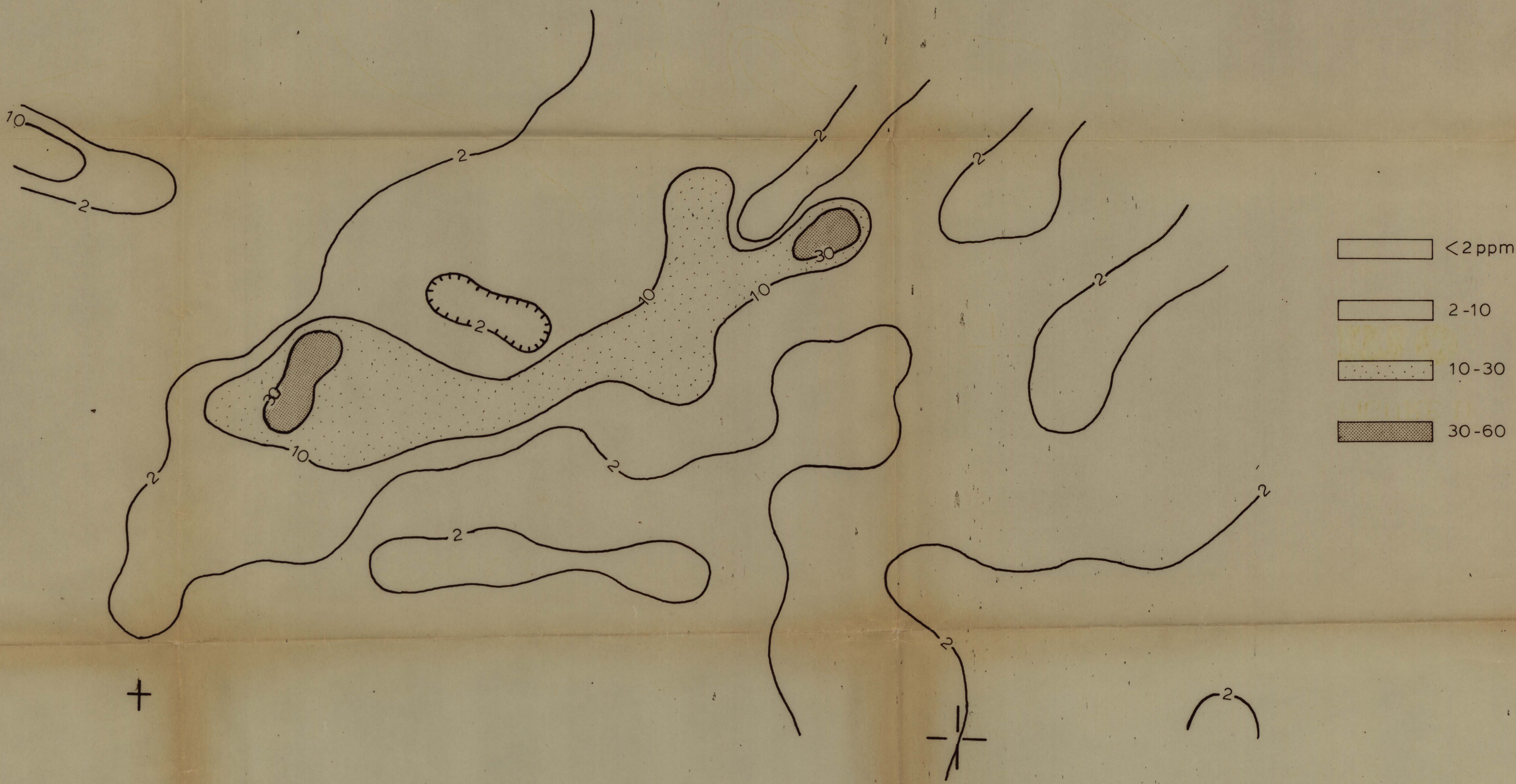
FIGURE 11

mo



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Mo in Rock (ppm)

0 500 1000ft

319

Item 35 (part 2 of 2)

FIGURE 11

3720 0030

FIGURE 12

pb

PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Pb in Rock (ppm)

0 500 1000ft

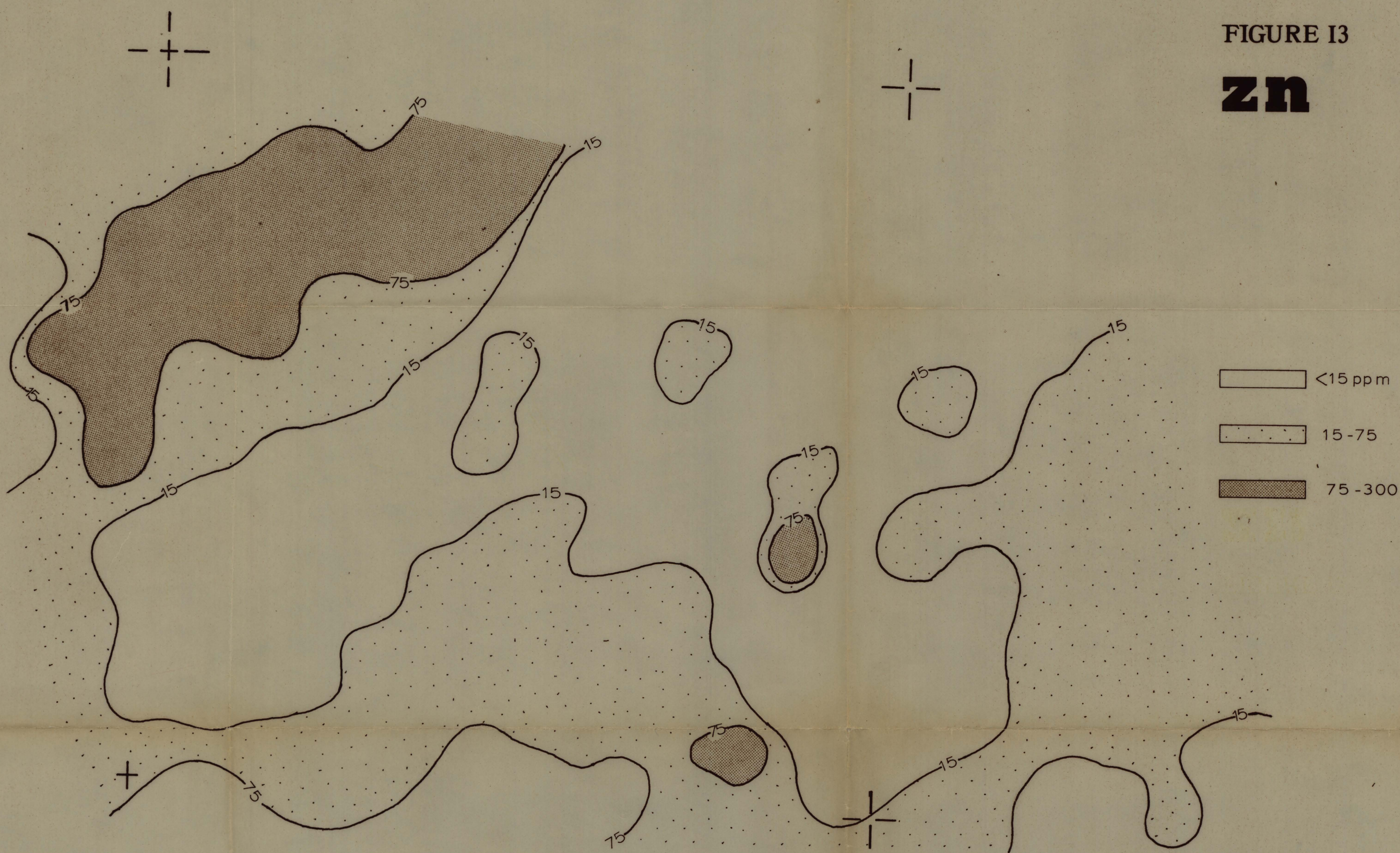
(319) Item 35 (part 2 of 2)

FIGURE 12

5720 0030

FIGURE I3

Zn



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Zn in Rock (ppm)

0 500 1000ft

319

Item 35

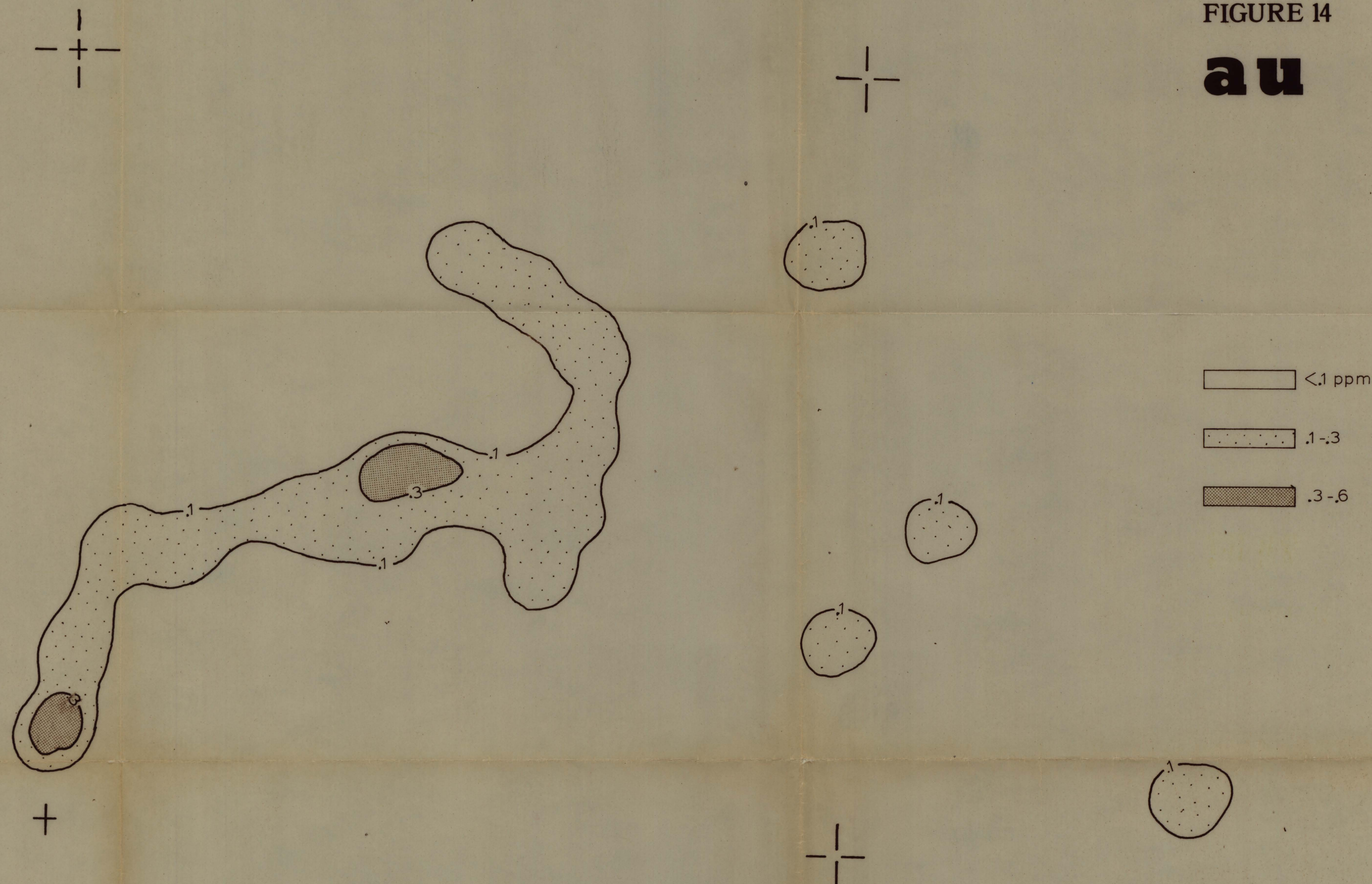
(part 2of 2)

FIGURE I3

3720 0030

FIGURE 14

au



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Au in Rock (ppm)

0 500 1000ft

319

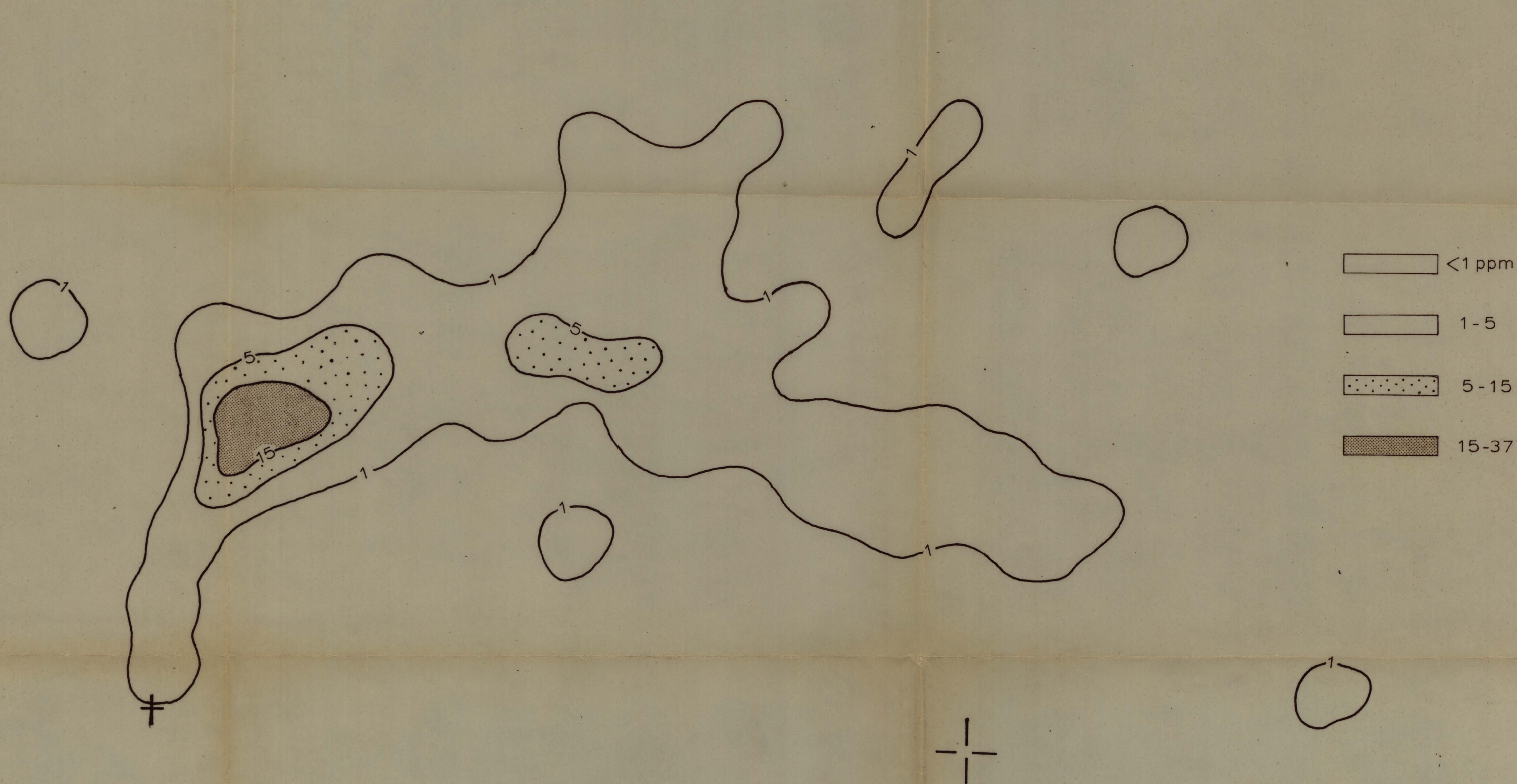
Item 35 (part 2 of 2)

FIGURE 14

3720 0030

FIGURE 15

ag



PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

Ag in Rock (ppm)

0 500 1000

319

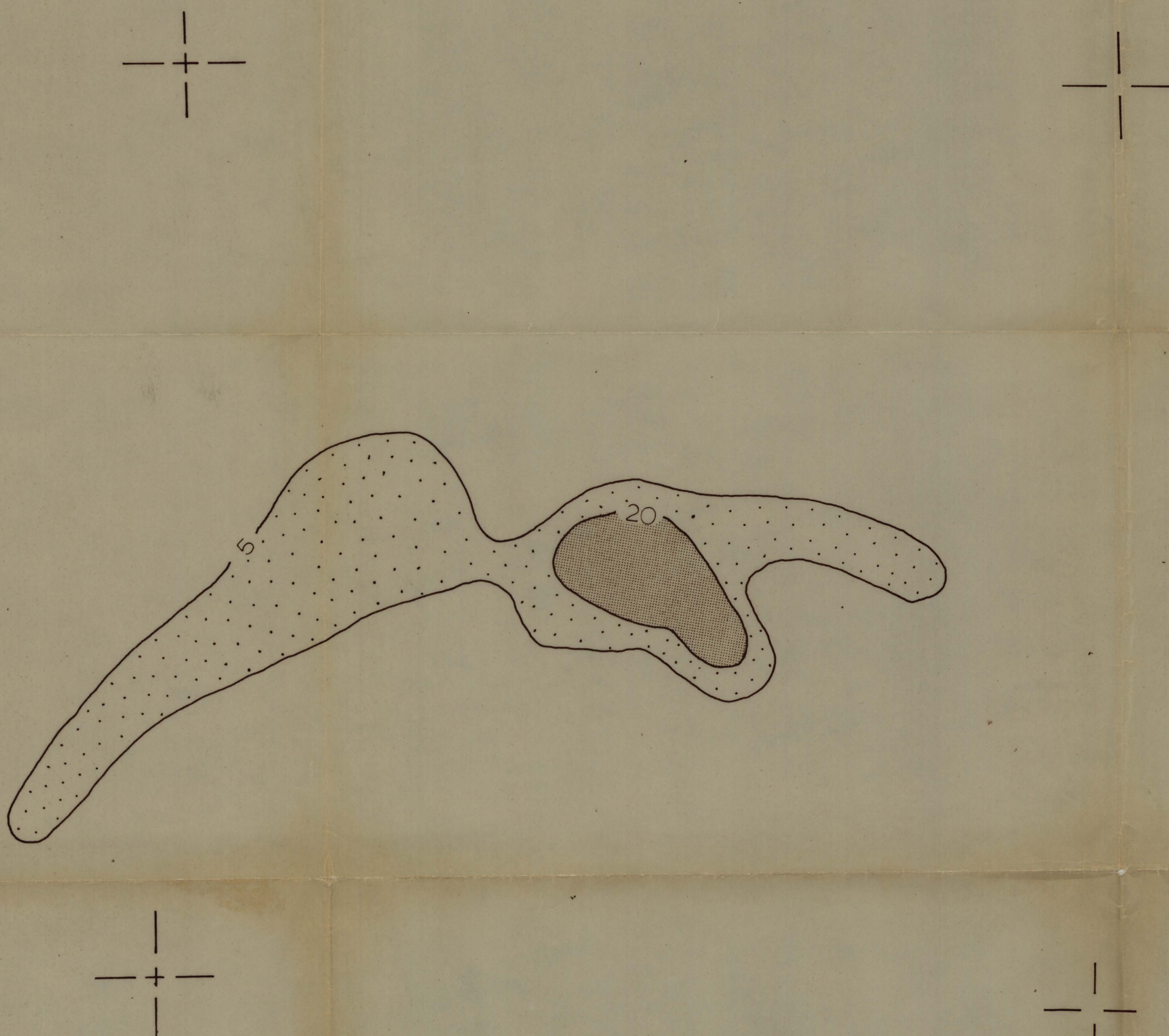
Item 35 (part 2 of 2)

FIGURE 15

3720 0030

FIGURE 16

Sn



- >20 PPM
- 5–20 PPM
- <5 PPM

PERRY CANYON PROSPECT

Pyramid District

Washoe County, Nevada

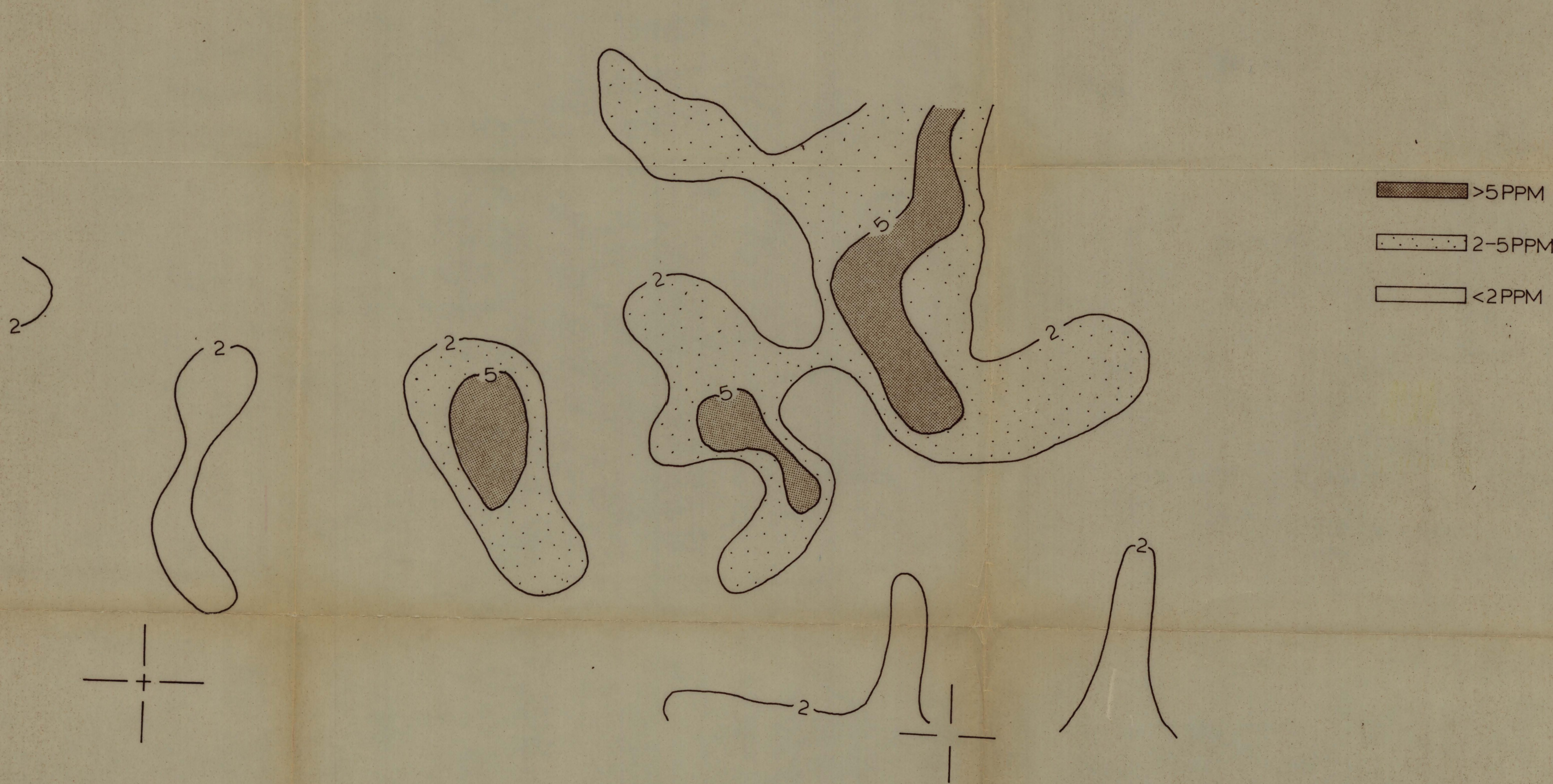
Sn in Rock (ppm)

0 500 1000 ft

FIGURE 16

FIGURE 17

W



PERRY CANYON PROSPECT
Pyramid District
Washoe County, Nevada

W in Rock (ppm)

0 500 1000ft

319
Item 35
(part 2 of 2)

FIGURE 17

FIGURE 18

F

PERRY CANYON PROSPECT

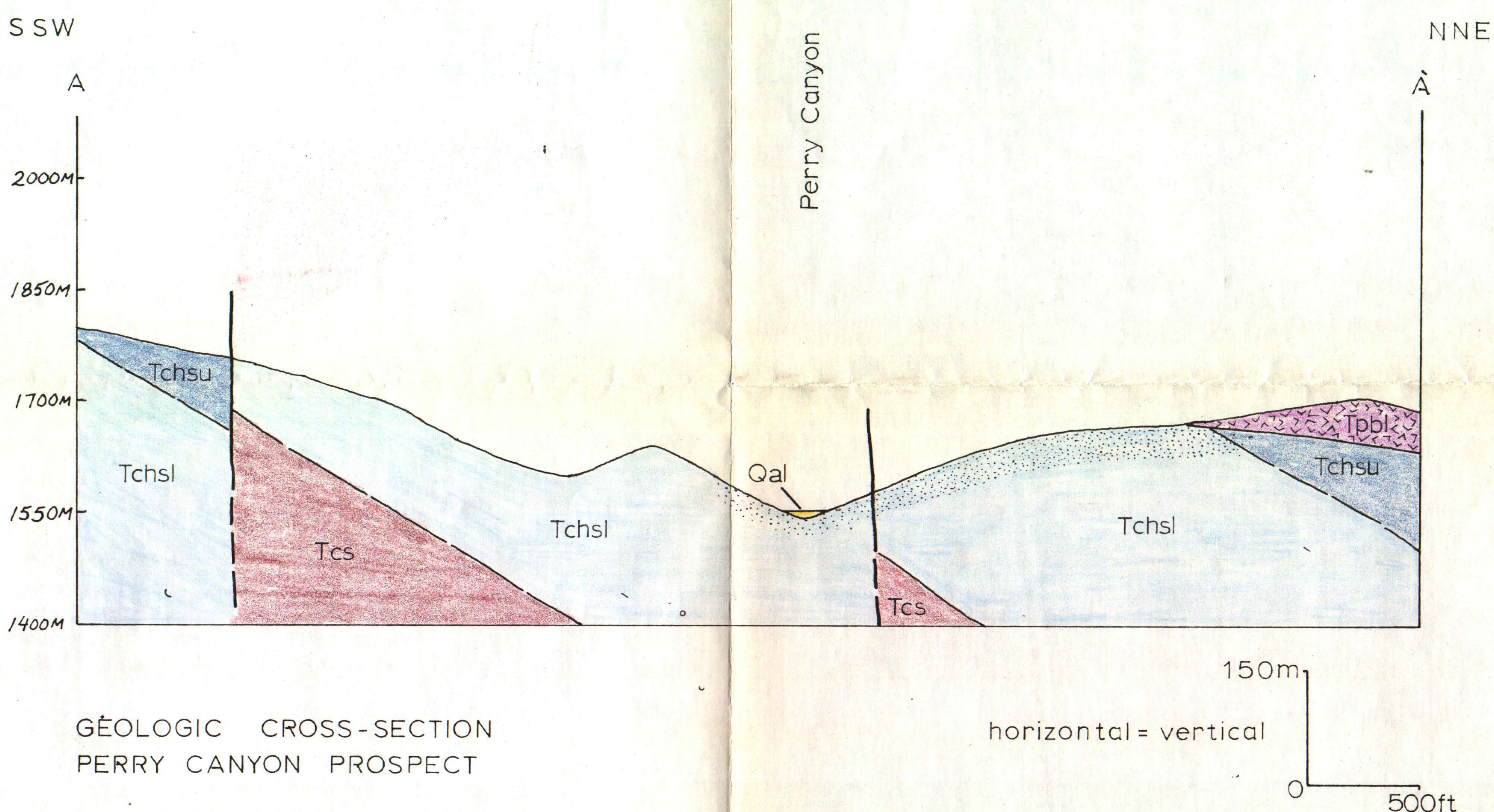
Pyramid District

Washoe County, Nevada

Flourine in Rock (ppm)

0 500 1000ft

FIGURE 18



GEOLOGIC CROSS-SECTION
PERRY CANYON PROSPECT

FIGURE 19

3720 0030

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Item 35
(2 of 2)