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ARIZONA

CLARA PEAK PROSPECT: Section 3 of T9N, R15W; Yuma County, Arizona

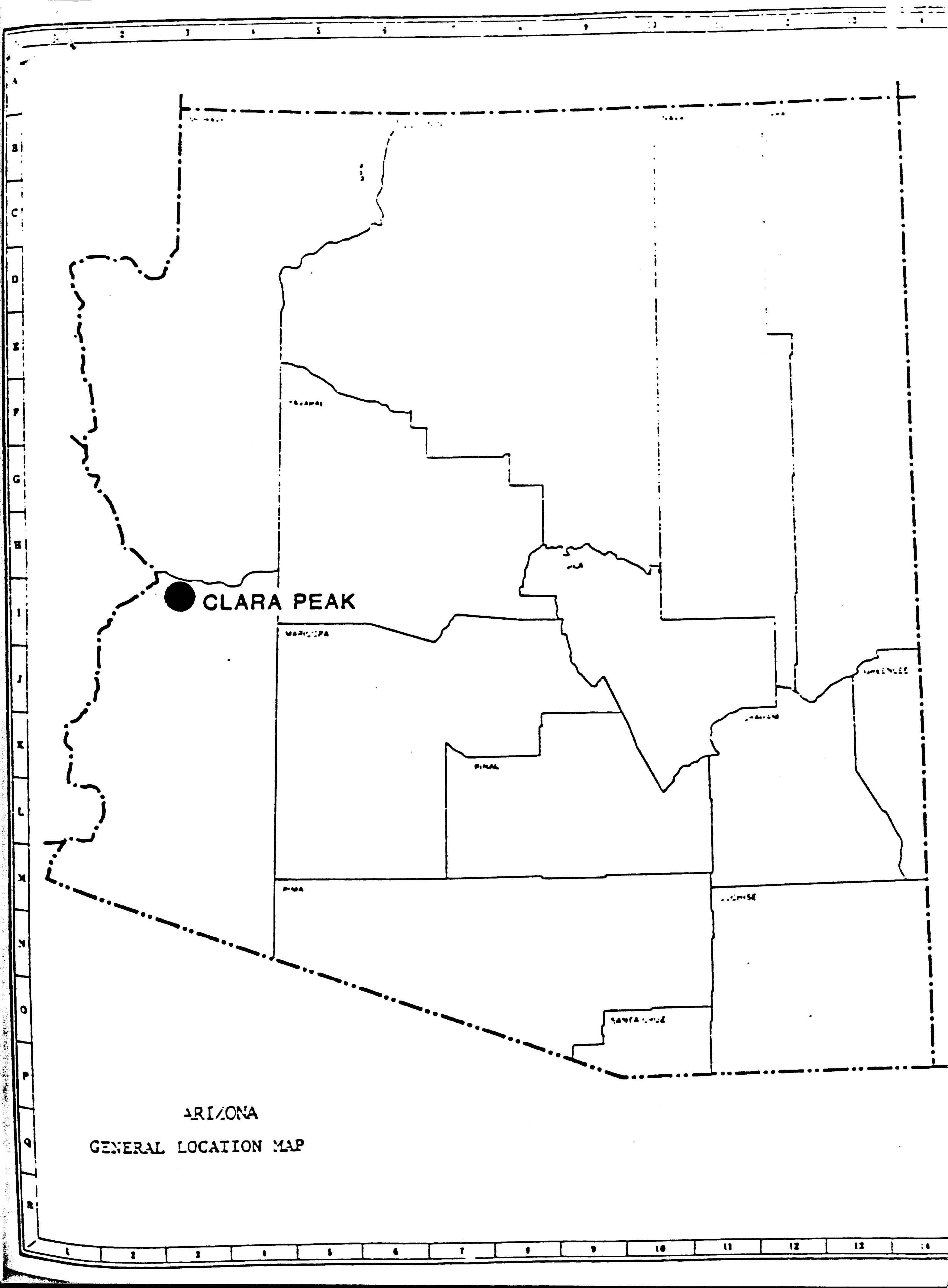
Acreage: ±200 acres

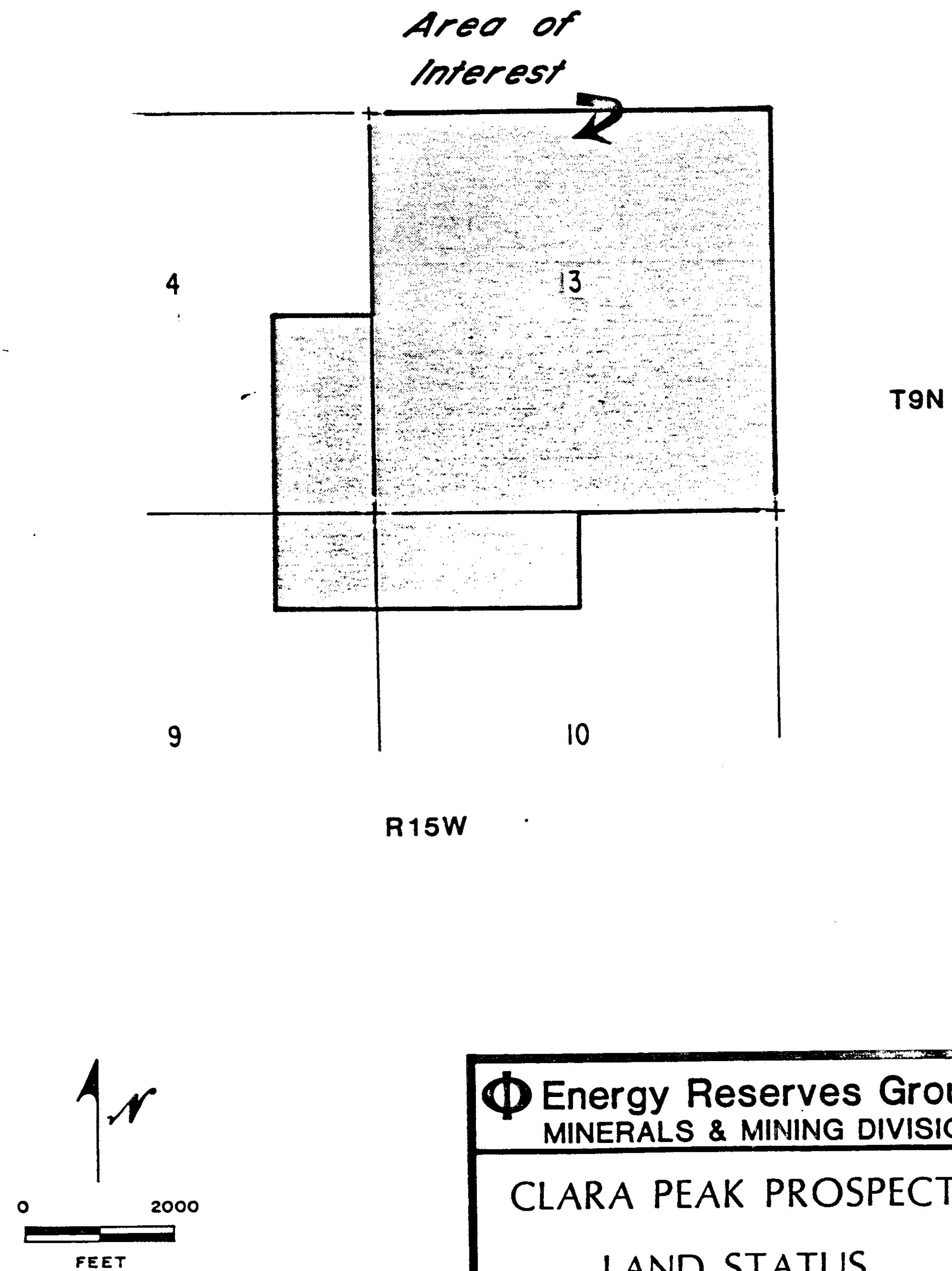
Land Status: Mining Lease covering 10 unpatented lode mining claims.

Royalty Burden: 5% NSR production royalty covering the claims subject to ERG's Mining Lease.

History: ERG obtained a Mining Lease covering ten claims in this prospect during July of 1982.

Rationale: Geologically, the Clara Peak Prospect represents a Carlin model disseminated gold prospect. Anomalous to ore grade gold mineralization occurs in silicified Tertiary sediments and Precambrian gneiss along thrust faults and normal faults where gold occurs as disseminated micron size particals and as gold leaf on shale partings. Barite mineralization is a common accessory mineral with the gold mineralization. Exploration drilling targets at Clara Peak include the mineralized breccia zone that has formed from thrusting along the Tertiary-Precambrian contact and the mineralized Tertiary Precambrian that abuts normal faults which extend upward from the thrust faults into the Tertiary section.


CLARA PEAK
ARIZONA
GENERAL LOCATION MAP



Energy Reserves Group
MINERALS & MINING DIVISION

CLARA PEAK PROSPECT

LAND STATUS

DATE: 8/9/82		
DRAFTED BY: MH		

[redacted] [redacted]

~~A295~~ [redacted] wt %

	out	wt %
A 295 –	<.01	.01
	1.03 FA	
296 –	1.15 out AA	2.15
297 –	.02	5.95
298	.02	.35
299	.02	3.40
300	.04	2.00
301	.15	1.00
302	.04	.50
303	.12	.95

[illegible]

YR 1982

BASE AND PRECIOUS METAL MINERALIZATION RELATED TO LOW-ANGLE TECTONIC FEATURES IN THE WHIPPLE MOUNTAINS, CALIFORNIA AND BUCKSKIN MOUNTAINS, ARIZONA

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ABSTRACT

Specular hematite mineralization with varying Cu, Au, and Mn contents commonly associated with quartz, barite, or fluorite is present in a variety of lithologic settings immediately above, along, and below the Whipple-Buckskin detachment fault. The major deposits, Copper Basin, Planet-Mineral Hill, and Swansea-Copper Penny are localized along ENE- to NE-trending synformal and antiformal megagrooves on the fault surface associated with a thick sequence of non-mylonitic, but cataclastically deformed, metamorphosed middle-plate rocks. Extensional tectonics related to NE- to ENE-directed movement in late Oligocene to mid-Miocene time created tectonic crush breccias, open to overturned folds, synthetic and antithetic listric faults, and gash veins that, along with the detachment surface and its underlying shatter breccia, served as loci for deposition of the metals, gangue minerals, and alteration aureoles.

A detachment fault mineralization model generated from detailed mapping, drill core analyses, and geochemical determinations at the Copper Penny prospect is characterized by: 1) specularite-chalcopyrite ± Ba, Mn, F, Au concentrated along and decreasing away from the fault surface, 2) chlorite-dominated alteration envelopes coplanar with the fault , 4) deposition in extension-related structures, and 5) localization along megagrooves associated with thick upper-middle plate sequences. The consistency of the model holds when extrapolated to other Whipple-Buckskin deposits with variations only in concentration intensities despite widely varying upper-middle plate lithologies.

INTRODUCTION

The Whipple-Buckskin Mountains detachment surface constitutes a small portion of a mid-Tertiary, low-angle tectonic phenomena that is associated with metamorphic core complexes which extend the length of the North American Cordillera (Coney, 1979, 1980; Rehrig and Reynolds, 1977, 1980; Davis and others, 1980). The detachment fault tectonically juxtaposes Precambrian, Paleozoic(?), Mesozoic, and Tertiary units onto a mylonitically deformed, lower-plate sequence (Davis and others, 1977, 1980; Lingrey and others, 1977; Shackelford, 1977). Mines and prospects with specular hematite containing variable amounts of copper, gold, and manganese are consistently located immediately above, along, and below the detachment surface (Fig. 1) demonstrating a spatial and suggesting a tectogenetic dependency.

Past Production

The history of production in the Buckskin and Whipple Mountains is dominated by entrepreneurial promotion, bankruptcy, and copper's cyclical price structure (Spude, 1976). Early ore shipments from the Planet mine in 1862 and from the Sue and Lion Hill mines (Keith, 1978) were followed by a period of promotional development at Planet in 1907 and at Swansea in 1908 (Spude, 1976). Significant ore shipments began with the completion of the Parker-Wickenburg and Bouse-Swansea rail lines in 1914 (Keith, 1978). Intermittent shipments and mine closures, corresponding to the rise and fall of copper prices, continued until 1923 when the Planet mine closed and until 1937 when Swansea ceased production. The Mineral Hill mine, operated initially in the 1900's, was an active producer from 1964 to 1970. In total, 63.0 million pounds of copper, 11,900 ounces of gold, and about 1,000 tons of manganese were produced from mines along the detachment surface (Jones, 1919; Keith, 1978; Spude, 1976). Production from the major mines is listed in Table 1.

Table 1. Copper and Gold Production from the Buckskin Mountains, Arizona

Mine	Ore (10^3 tons)	Cu %	Cu (10^6 lbs)	Au (10^3 oz)
Planet	50	10.0	10.0	0.2
Mineral Hill	1,000	0.65	13.0	
Swansea	490	4.0	39.2	
Empire-Sue-Lion Hill	20	20.0	0.8	11.7
Totals	1,560	2.0 (avg.)	63.0	11.9

Previous Investigations

The iron deposits in the Buckskin Mountains briefly mentioned by Blake (1865, 1898) and by McCarn (1904) were described at the Planet by Upham (1911) who ascribed their origin to derivation"....from alteration of the ferromagnesian minerals in the adjoining rocks". Bancroft (1911) noted the marked lithologic and mineralogic similarity between many of the deposits and assigned a Precambrian age to them. He commented on the intense structural deformation within the orebodies but apparently did not recognize their tectonic setting. Blanchard (1913) mapped the detachment fault as an erosional surface between Precambrian units and suggested that the deposition of cupriferous specularite was due to hot springs activity associated with Tertiary volcanism. Jones and Ransome (1919) and Jones (1919) described the occurence of manganese with specularite and barite in brecciated rocks adjacent to low-angle faults in the Buckskin and Whipple Mountains. Wilson and Butler (in Cummings, 1946) mapped the Planet mine in detail and interpreted the detachment surface as a thrust fault. Wilson's subsequent mapping for the Geologic map of Yuma County (1960) expanded the extent of Laramide thrusting (Wilson, 1962) throughout the Buckskin Mountains.

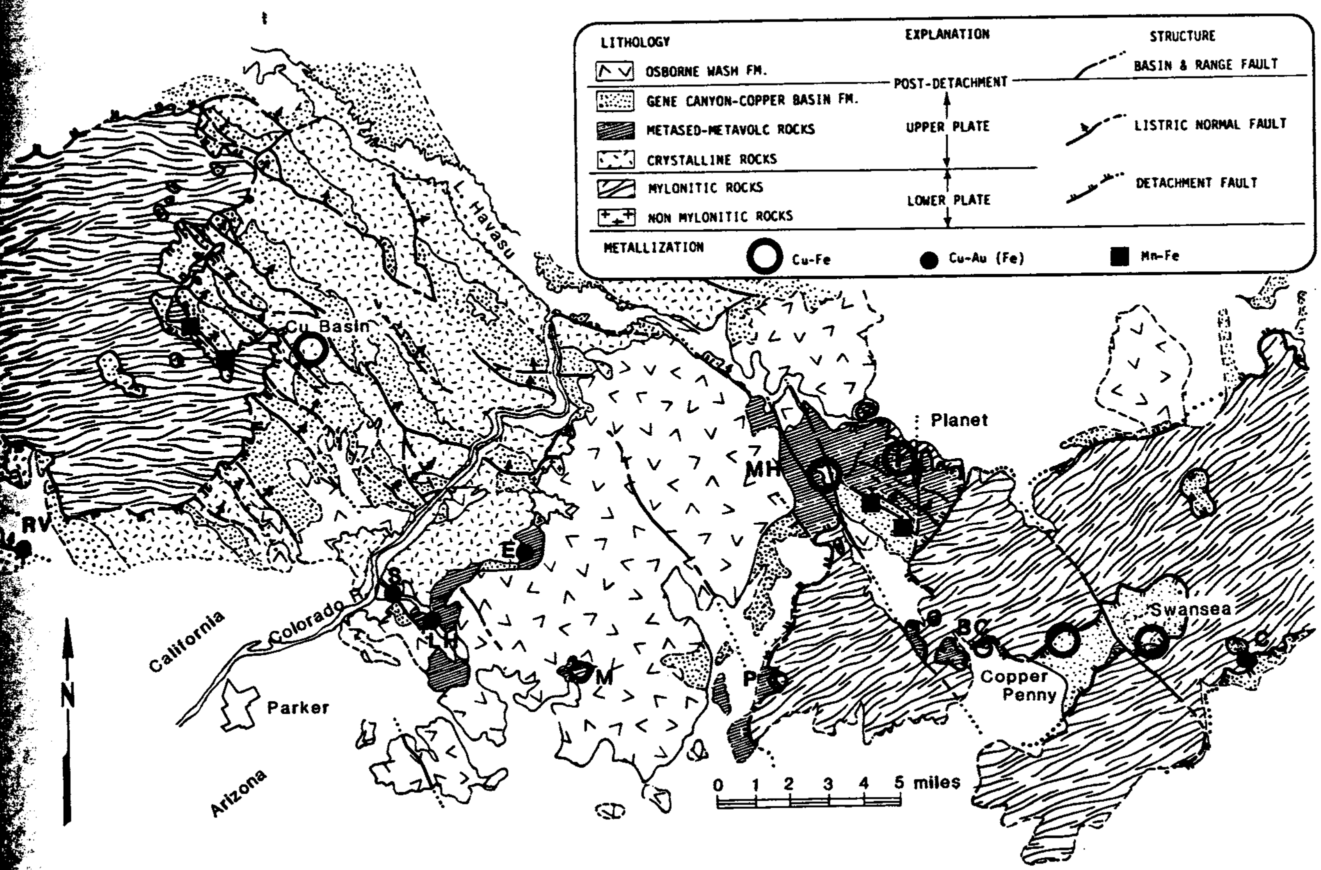


Figure 1. Regional geologic map of the Whipple Mountains, California and Buckskin Mountains, Arizona as modified from compilations by Stone and Howard (1979), and Davis and others (1980). Prospects and mines designated by initials are: BC = BCC mine; C = Clara; E = Empire; LH = Lion Hill; M = Mammon; MH = Mineral Hill; P = Pride; RV = Riverview. The large open circles are mines and deposits discussed in the text.

Even though the low-angle faults in the Buckskin and Whipple Mountains were mapped by a number of geologists (Ransome, 1931; Wilson, 1960; and Terry, 1972) the magnitude of the involvement of the Tertiary units was not recognized prior to work by Shackelford (1976, 1977) in the Rawhide Mountains and by Lingrey and others (1977) and Davis and others (1977) in the Whipple Mountains. Recognition of the metamorphic core complex setting was virtually simultaneous (Davis and others, 1977, 1980; Lingrey and others, 1977; Anderson and others, 1979). The delineation of the lithology, structure and age of movement in the Buckskin and Whipple Mountains established a critical data base for clarifying the geology of the enigmatic mineral deposits in these ranges.

Mineral Deposits - Their Regional Setting

From Figure 1, it is apparent that all of the major mines and the larger prospects are spatially related to the detachment surface. Although mineralization along the surface is widespread - almost ubiquitous - the more notable concentrations are positioned within thick accumulations of upper-plate rocks. At Swansea, Planet, Empire-Lion Hill, Copper Basin, and Copper Penny, the upper-plate rocks lie within NE- to ENE-trending troughs or megagrooves on the detachment surface that are subparallel to antiformal arches in the adjacent mylonitic terrain (Rehrig and Reynolds, 1980). As shown by Woodward and Osborne (1980), the megagrooves are primary structures and do not represent a folded detachment surface.

The upper plate moved NE to ENE relative to the lower plate during the Oligocene(?) to mid-Miocene extensional tectonic event (Anderson, 1971; Shackelford, 1976; Davis and others, 1977, 1980; and Dokka and Lingrey, 1979). This movement created tectonic crush breccias, open to overturned folds, synthetic and antithetic listric normal faults, and gash veins (Davis and others, 1977, 1980; Frost, 1981) that, along with the detachment fault and its underlying shatter breccia, served as loci for deposition of the metals, gangue minerals and alteration aureoles. All of these features are found at the Copper Penny prospect in varying degrees of intensity. The recently completed investigation of this deposit (1979) provides a data base for interpreting the complex geology of other, less clearly defined base, precious and ferroalloy mineral occurrences in the Whipple and Buckskin Mountains.

GEOLOGY OF THE COPPER PENNY AREA

Between 1977 and 1979, a detailed geologic map (Fig. 2) of the Copper Penny prospect was prepared, the deposit was geochemically sampled and 8 diamond drill holes (Figs. 2 and 3) plus a detailed core analysis were completed. The results of these investigations conclusively demonstrate that the sulfide and oxide metallization in the upper, middle, and lower plates are coplanar with, and tectogenetically

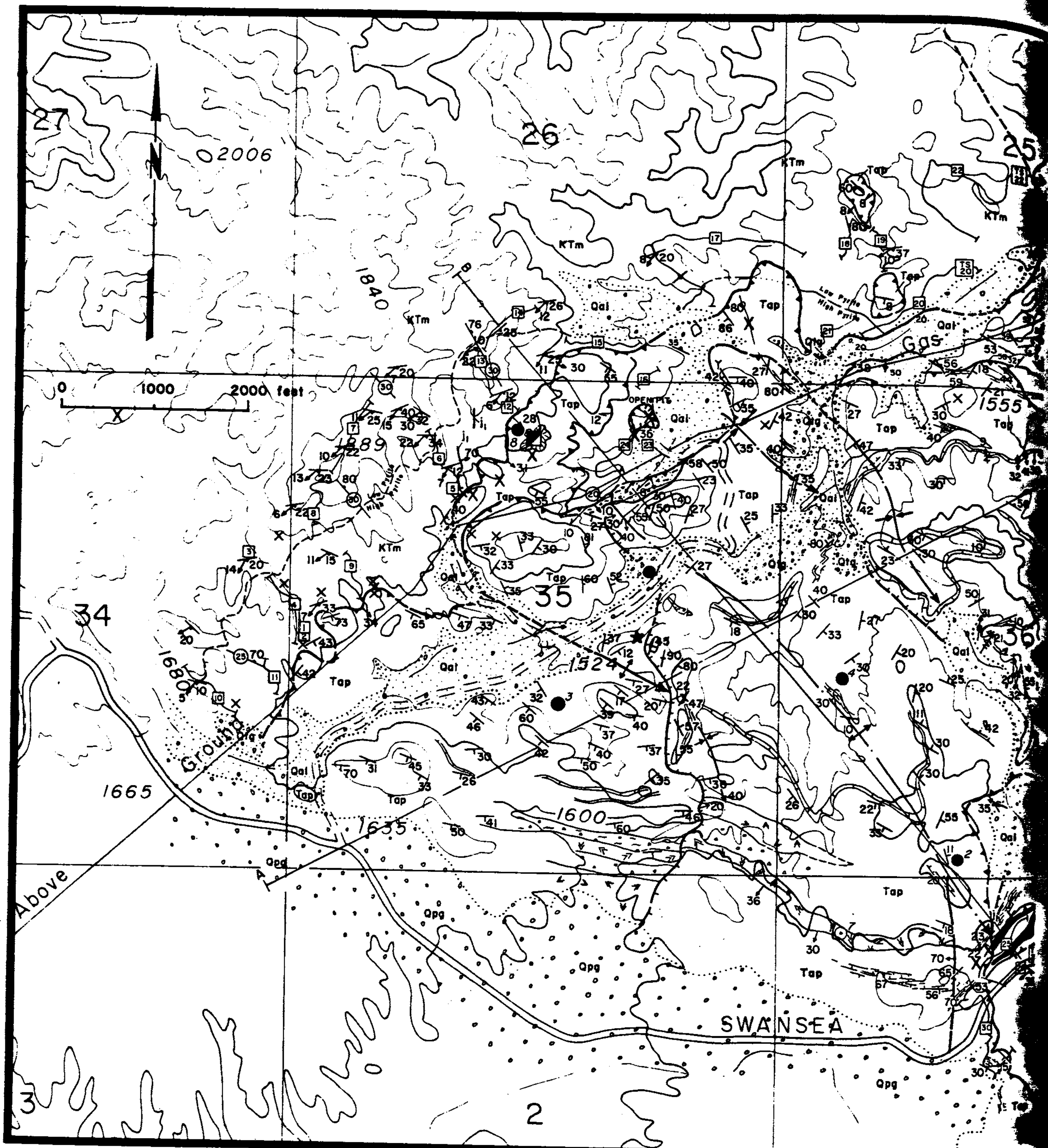
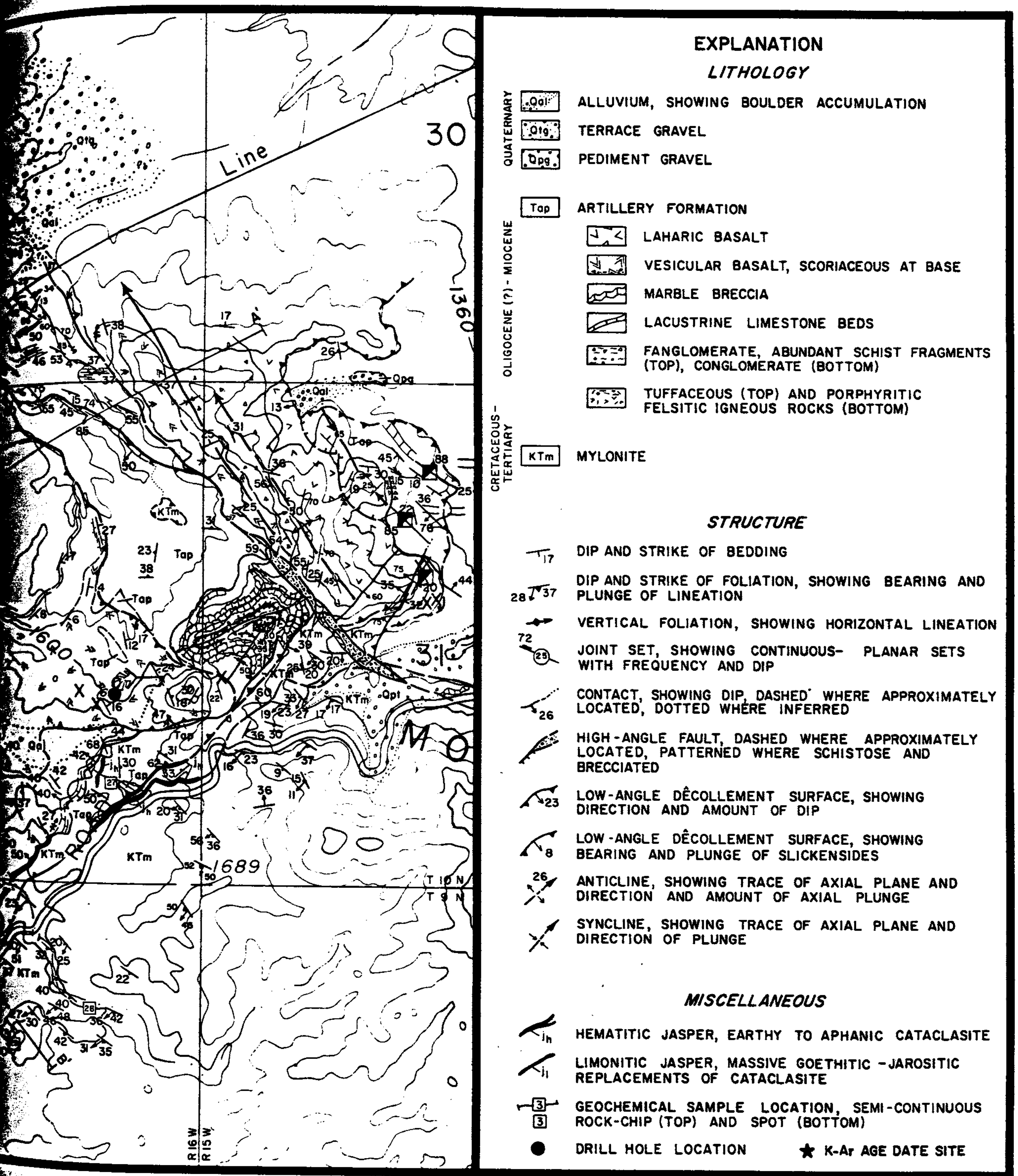


Figure 2. Geologic map of the Copper Penny prospect, Santa Maria mining district, Yuma County, Arizona, showin
Geology by Tom L. Heidrick and Joe Wilkins, 1977-1979.



the location of drill holes 1 through 8, rock-chip samples collected for geochemical analyses, and K-Ar age dates.

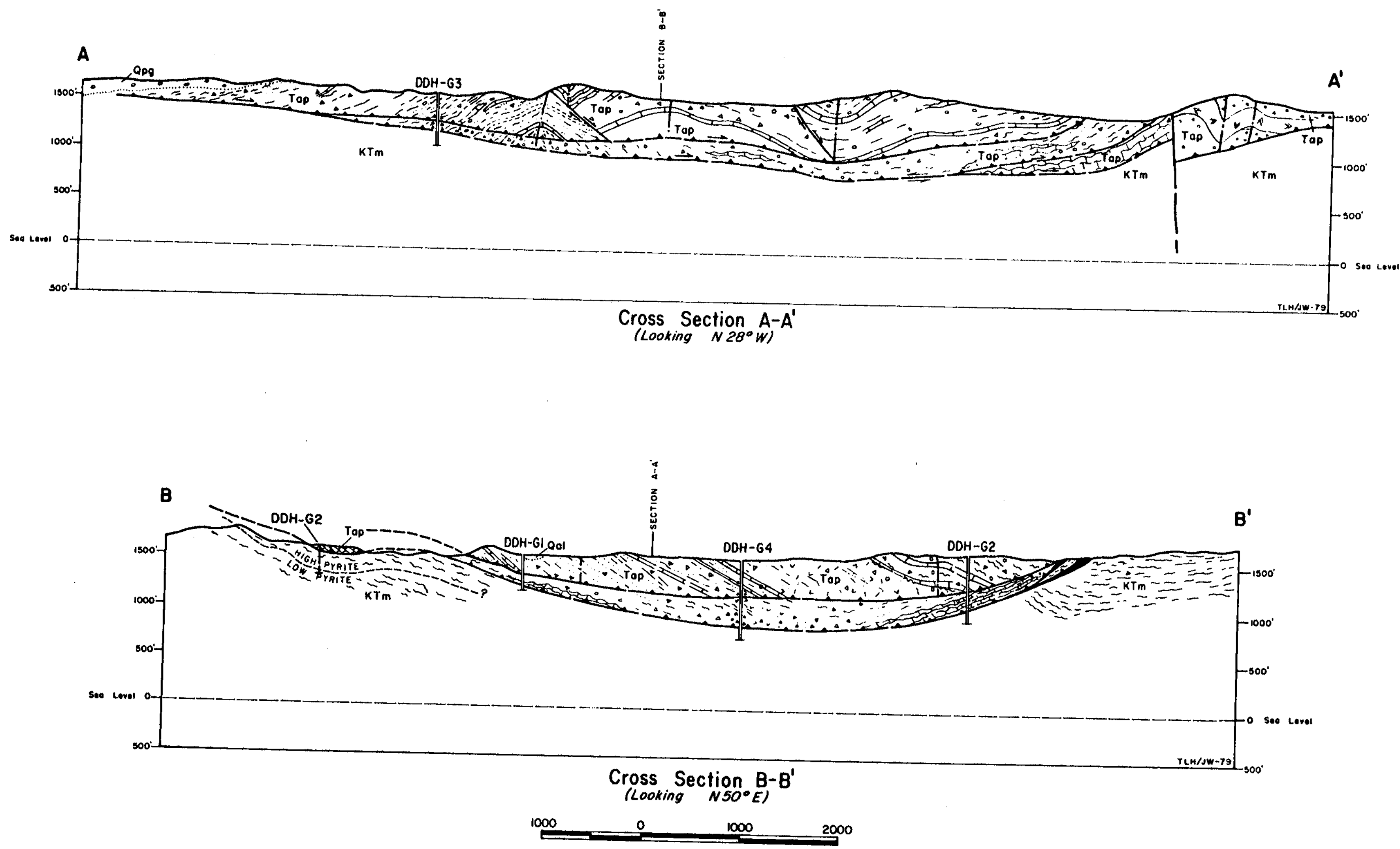


Figure 3. Geologic cross-sections A-A' and B-B', Copper Penny prospect, Yuma County, Arizona. The location of each respective cross-section along with the explanation for structural elements and lithologic symbology are provided on Figure 2.

related to, the detachment fault.

Lithology

Lower-Plate Rocks

The lower-plate rocks are coarse to fine grained quartzo-feldspathic, augen to compositionally banded mylonitic gneiss (Fig. 4). The gneiss possesses a well developed, gently dipping foliation, elongate quartz rods, and flattened K-feldspar porphyroblasts typical of metamorphic core complex terrains (Davis, 1980; Rehrig and Reynolds, 1980; and Davis and others, 1980). The penetrative lineation direction in the gneiss, present throughout the Copper Penny area, will be discussed in succeeding sections. The mylonitic fabric is always deformed by a shatter breccia at the base of the detachment surface. The flinty microbrecciated surface grades downward to various combinations of shatter, crush, and crackle breccia; a relationship consistently found by Davis (1980), Rehrig and Reynolds (1980), and Davis and others (1980). Chlorite, epidote, pyrite, chalcopyrite, calcite, and rare fluorite accompanies the shatter breccia. At Copper Penny, the chlorite breccia gradually decreases in intensity and disappears 300 to 600 feet below the detachment surface but occasionally continues uninterrupted to depths greater than 1200 feet.

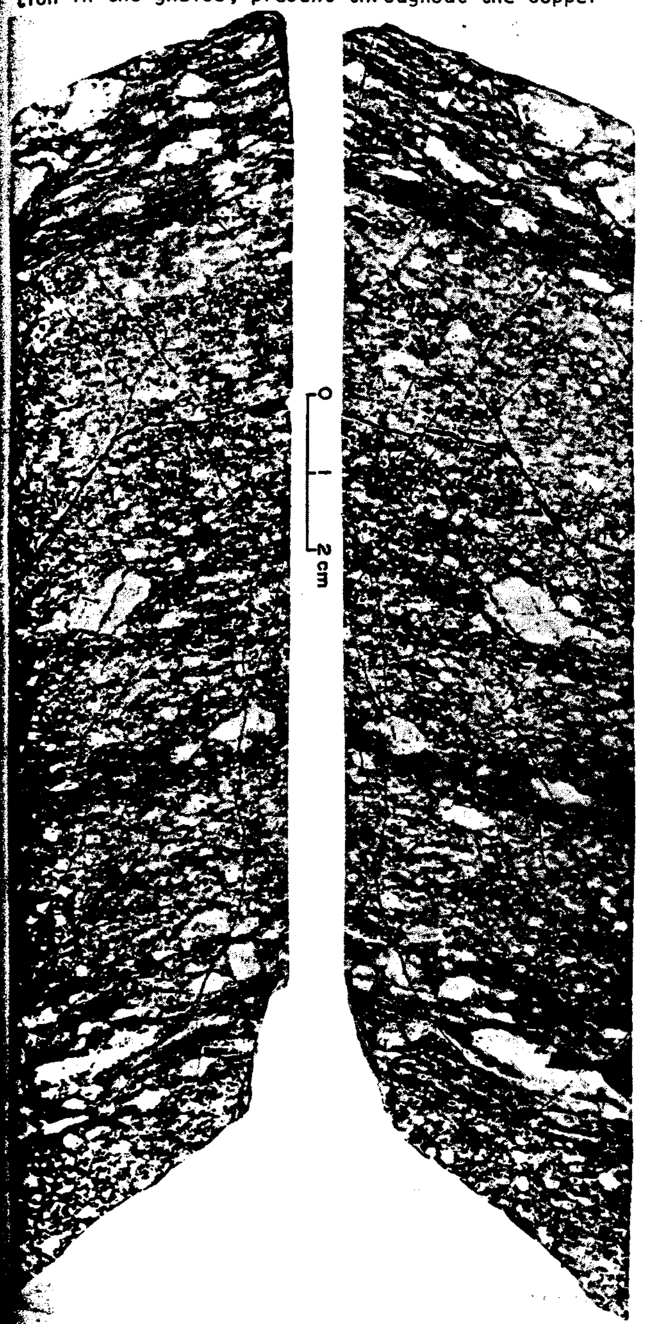


Figure 4. Polished slab of augen and compositionally banded mylonitic gneiss from 225' in DH-8. The fractures are filled with black greasy chlorite.

A K-Ar age derived from feldspar at the bottom of DH-8 (Fig. 2), gave an age of 17.7 ± .7 m.y., suggesting a reset minimum age for the time of movement.

Detachment Surface

The detachment surface is a dense, compact, flinty, comminuted microbreccia that weathers dark reddish-brown to patina. At Copper Penny, the sole of the Buckskin fault is a readily mappable, resistant, ledge-forming unit, identical to the surface found in the Whipples (Davis and others, 1977, 1980). The detachment surface is overlain by diverse sets of lithologies which include andesitic and clastic rocks of the Gene Canyon Formation, redbed sedimentary rocks of the Copper Basin Formation, Mesozoic(?) metamorphic rocks, and limestone and fanglomerate of the Artillery Formation.

The results of several whole rock analyses of microbreccias summarized on Table 2, were collected from sites overlain by a variety of upper-plate lithologies. Also included, for comparision, are average compositions of Laramide plutonic rocks and several lower-plate mylonitic gneisses. Figure 5 recasts these data on K_2O+Na_2O-SiO_2 and K_2O-Na_2O-CaO diagrams. These data demonstrate that major element composition of the microbreccia is not influenced by the composition of the hangingwall rocks. It is also apparent that losses in Al_2O_3 and Na_2O are balanced by gains in K_2O and FeO + Fe_2O_3. The Whipple-Buckskin detachment surface, once conceived, acted much like a conveyor belt, paying little attention to what was being moved across its surface.

Middle-Plate Rocks

A sequence of moderate to highly metamorphosed, weak to intensely foliated but non-lineated rocks occurs above the detachment surface and below the upper-plate rocks. The upper contact is an undulating, low-angle zone of intense brecciation that is subparallel to the detachment surface. Identifiable middle-plate rocks include: granite breccia (Fig. 6A) composed of rounded to subangular fragments of Precambrian(?) granite, intensely brecciated dolomitic to limey marble breccia (Fig. 6B), and cataclastic schist (Fig. 6C). In drill holes 3 and 4, these units are not present in the middle plate. Instead, a sequence of brecciated, bleached, and slightly chloritized arkosic mudstone, siltstone and shale is present showing the affects of weak to moderate dynamothermal metamorphism. The affects and intensity of the metamorphism are midway between unmetamorphosed upper-plate rocks, and the intensely deformed marble and schist. Hence, the middle plate is more a metamorphic zone than a distinct

Table 2. Average and Comparative Major Element Analyses of Flinty Tectonic Microbreccia from the Whipple and Buckskin Mountains Detachment Faults, California and Arizona. Data from Heidrick and Wilkins (1979).

Avg. of 9 flinty tectonic breccias, AZ and CA	
SiO_2	65.8 %
Al_2O_3	12.78
MgO	2.00
CaO	2.72
Ma_2O	1.39
K_2O	4.19
Fe_2O_3	3.48
FeO	3.94
L.O.I.	2.66
Sr	.02
Rb	.01
TiO_2	.49
P_2O_5	.25
MnO	.10
F	.09
S	.05

SAMPLE DESCRIPTION	SiO	K_2O+Na_2O	K_2O/Na_2O
Avg. of 75 fresh Laramide (75-50 m.y.b.p.) plutonic rocks	67.5%	7.2%	1.0%
Avg. mylonitized augen gneiss (Swansea) and hornblende biotite quartz diorite (Davis et al., 1979)	68.3	7.2	1.7
Avg. of 5 analyses of tectonic microbreccia from AGS Stop 2 and 3, Whipple Mts., AZ	65.8	4.2	2.0
Avg. of 3 analyses of tectonic microbreccia from AGS Stop 11, Buckskin Mts., AZ	65.5	6.9	3.9

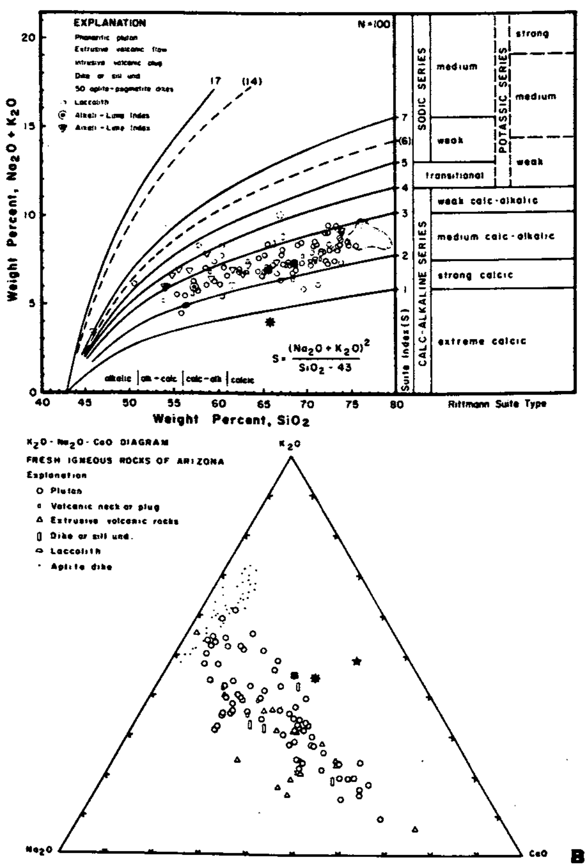


Figure 5. $K_2O+Na_2O-SiO_2$ diagram (A) with rocks classified according to the Pittman suite index and K_2O-Na_2O-CaO ternary plot (B) of 100 fresh Laramide (75-50 m.y.) plutonic and volcanic rocks of Arizona. Analyses from Table 1 include: ▪, average mylonitized augen gneiss; ✱, tectonic microbreccia from the Whipple Mts., CA; and ⁎, tectonic microbreccia from the Buckskin Mts., AZ.

lithologic packet.

The granite breccia is not exposed in the map area but does outcrop near Swansea and was encountered in drill holes 5 and 6 in the Copper Penny area. The granite is porphyritic with large pink feldspar phenocrysts set in a crystalline matrix; all ferromagnesian minerals are altered to bright green chlorite. This unit appears to correlate with Precambrian(?) granite porphyry described by Anderson and others (1979) in the Whipple Mountains.

Along the northeast side of the middle plate margin (the SE¼ Sec. 25 and NE½ Sec. 36, Fig. 2), outcrops of marble breccia show decreasing metamorphic affects along strike away from the plate margin. Several outcropping beds, traced to the northwest along strike, show a continuous metamorphic spectrum ranging from thoroughly recrystallized marble breccia at the detachment to weakly recrystallized, bleached, and slightly brecciated lacustrine limestone away from the fault. The low ragged hill ENE of DH-6 (Fig. 2), is composed of a brown-grey, rough-weathering, brecciated marble breccia forming an ENE-trending arch and trough pair resting on the detachment surface. To the northwest, the marble breccia is tectonically kneaded into poorly exposed quartz mica schist. The middle-plate marble breccia unit is abruptly truncated to the east by a NNW-trending Basin and Range fault (Fig. 2) showing 3500 feet of right-lateral separation. The marble breccia hosting the high-grade copper mineralization at Swansea represents the faulted-off extension.

In detail, the marble breccia is a brecciated breccia, with subrounded to subangular clasts in a microbreccia matrix. Vugs up to 5 cm. in diameter are common and clasts of schist, chert, and arkose (Artillery Formation) are present in the marble breccia. A penetrative low-dipping foliation marked by chlorite (or hematite where oxidized) veinlets that occurs throughout the unit could easily be mistaken for bedding planes. Workers in the past have consistently mapped this unit as Paleozoic(?), (Wilson, 1960; Shackelford, 1976; and Woodward and Osborne, 1980) but it may also represent an intensely

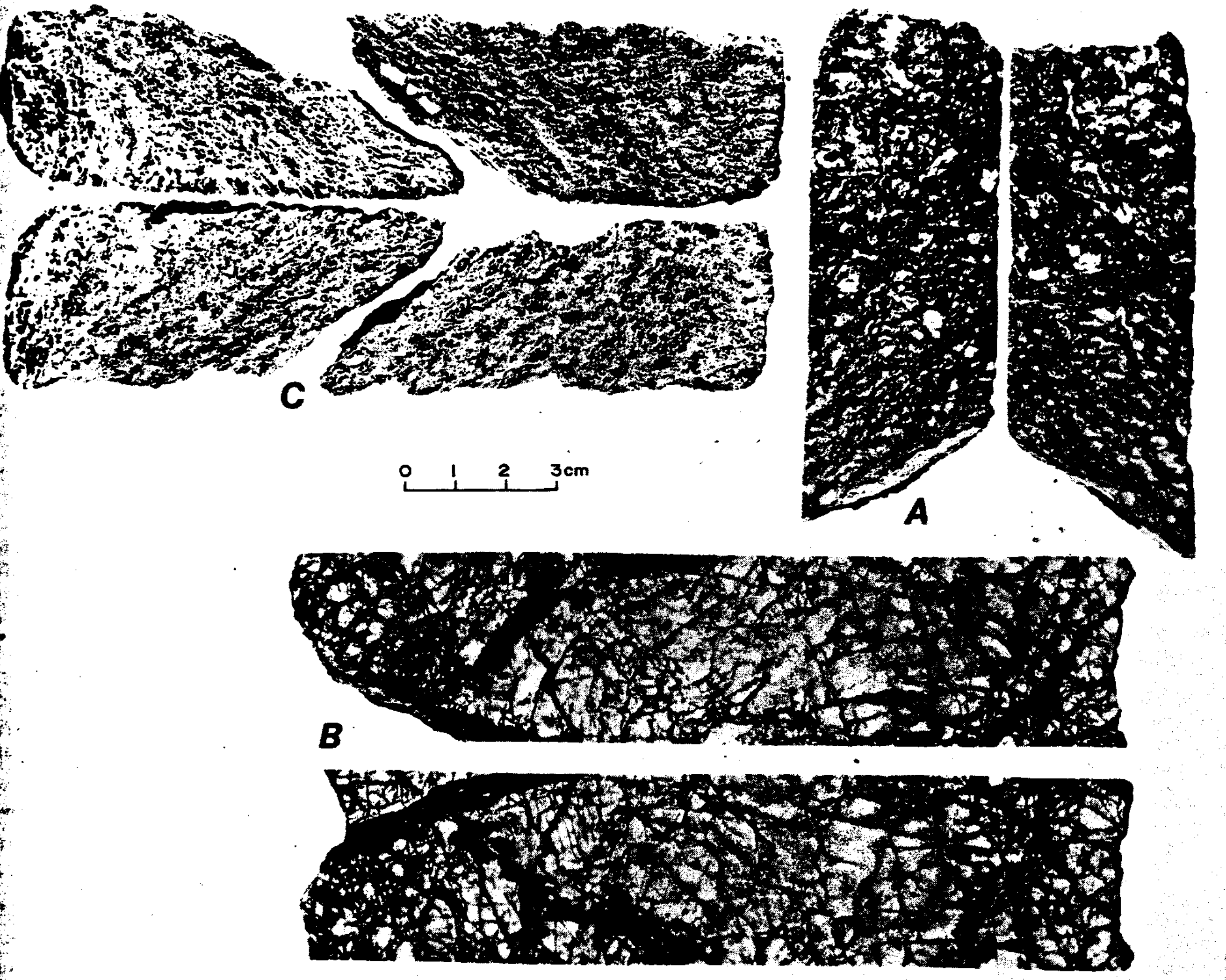


Figure 6. Polished slabs of middle-plate lithologies. A. Granite breccia; rounded fragments of granite porphyry in a chlorite matrix. B. Marble breccia; clasts set in a matrix of supergene hematite developed from oxidized pyrite and chalcopyrite. C. Cataclastic schist; grey-green schist derived from Artillery Formation.

metamorphosed limestone sequence of the Artillery Formation similar to that found along the northeast margin of the middle plate.

The middle-plate cataclastic schist cut in drill holes 2, 4, 5, and 6 (Fig. 2) forms a fault-bounded sandwich between the lower marble breccia and the upper plate. At the base, it appears as a grey-green, impure quartz sericite schist but as one moves structurally upward, Artillery shale, mudstone, and siltstone fragments gradually increase to a point where they comprise 100% of the unit.

Data compiled from our investigation of middle-plate rocks help define the presence of strong to very strong vertical and lateral dynamothermal gradients within this structural unit. Supporting evidence include: 1) variable lithologies of the Artillery Formation are progressively transformed with increasing depth to cataclastic quartz sericite schist, 2) slightly brecciated and bleached lacustrine limestone of the Artillery Formation grades laterally into thoroughly recrystallized and brecciated marble breccia, 3) the abundance of incompletely to weakly metamorphosed Artillery arkose clasts within marble breccia increases structurally upward, and 4) the dynamothermal metamorphic affects on middle-plate Artillery lithologies increase markedly in moving laterally from drill holes 3 and 4 to holes 2, 5, and 6 (Fig. 2). The data indicate that virtually all of the middle-plate lithologies at Copper Penny were derived from the Artillery Formation.

Upper-Plate Rocks

The precise stratigraphic succession of the sedimentary and volcanic rocks in the upper plate is difficult to ascertain since most contacts are structural in character and monotonously repeated or truncated by listric normal faults. The apparent section, estimated at 1600 feet, consists of a basal sequence of arkosic sandstone and siltstone with shale partings, a middle sequence of fetid lacustrine limestone beds intercalated with limey mudstone, siltstone, and shale, and an upper fanglomerate and maroon arkose unit. Rhyolite vitric tuff is interbedded with the lower clastic unit and trachybasalt flow caps the fanglomerate sequence. The basal and middle clastic lacustrine limestone sequence is fine grained and weathers grey or grey black to black. It contains a high organic content with carbonized plant debris; syngenetic pyrite is rare. The upper fanglomerate unit contains well-rounded, cobble-sized clasts of lineated quartz mica schist, granite porphyry, upper-plate mudstone and limestone, and mylonitic gneiss in a matrix of chloritic to arkosic mud.

K-Ar age dates obtained on fresh biotite from the rhyolite tuff unit and on hornblende from the capping trachybasalt were 27.3 ± 1.1 m.y. and 18.6 ± 1.5 m.y. Although some confusion exists regarding the age of the Artillery Formation (Gassaway, 1972, 1977; Shackelford, 1976), the late Oligocene to early Miocene K-Ar ages identify these rocks as belonging to the Artillery Formation (Lasky and Weber, 1949; Otton, 1981).

Structure - Tectonics

The Copper Penny area is dominated by low-angle, extensional tectonic features with all units showing some degree of cataclasis. Lithologic disruption and deformation in the upper plate increases downward culminating in total brecciation in the middle plate and along the detachment fault. The intense cataclasis immediately below the fault (sharply at first, then gradually) decreases downward. The net effect is extreme distension creating countless voids that inflate the section to give it a megabreccia appearance. The primary structural features are low-angle faults at the tops of the lower and middle plates, sympathetic listric normal faults, open to overturned folds, tectonic crush breccias, bedding plane slips, gash veins, and sandstone, shale, and pebble dikes. A NW-trending high-angle fault, showing 3500 feet of right-lateral separation, offsets both the detachment surface and the plates above and below.

Low-Angle Faults, Slickensides, and Quartz Lineation

The spatial distribution of NE-dipping listric normal faults, the Buckskin Mountains detachment surface, and the middle-plate fault, is shown on Figure 2 and corresponding cross-sections A-A' and B-B' on Figure 3. The detachment surface, a strand of the Whipple-Buckskin-Rawhide detachment surface (Shackelford, 1976; Davis and others, 1980), forms a slightly asymmetrical trough elongate ENE with low (10-30°) dips along the northwest margin and moderate (40-50°) dips on the southeast. Brecciation on both sides of the fault surface is intense, 20 to 50 feet of gouge breccia occurs above, and 10 to 50 feet below the flinty microbreccia surface.

In order to better define the geometrical distribution of linear kinematic indicators in the map area, we compiled lower-plate mylonitic quartz lineation and slickensided striae from the flinty microbreccia zone. As shown on Figure 7, the mylonitic quartz lineation in lower-plate rocks, north of the Copper Penny prospect, form a double-maxima: N70°E±5° and N55°E±5°. On the other hand, striae from the detachment surface in the northern portion of the map area are unidirectional: N40°E±5° (Fig. 7D). Comparable analyses were made in the southern portion of the area. As indicated on Figure 7B and 7E, both elements are unidirectional: N55°E±10° (quartz lineation) and N60°W±5° (striae). The

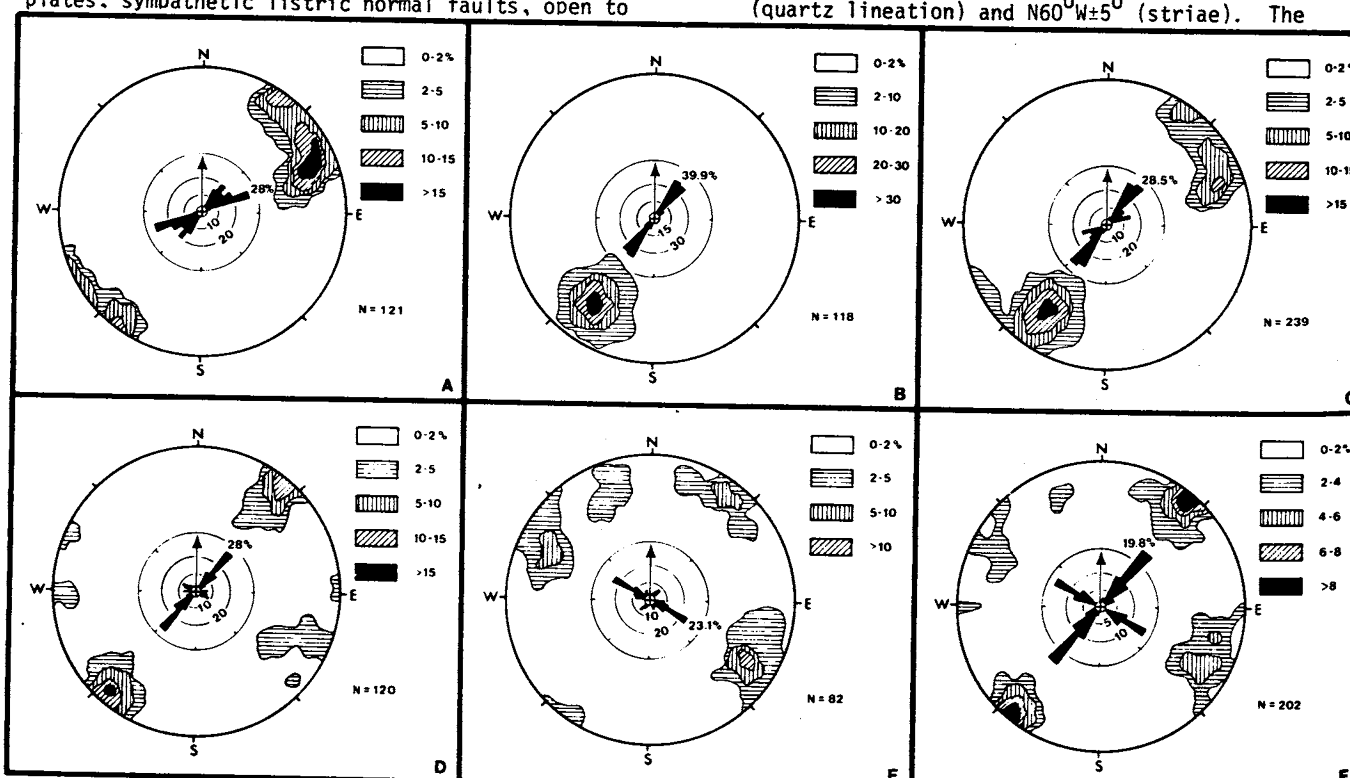


Figure 7. Lower hemisphere Schmidt equal-area net and corresponding strike frequency rosettes (all in percent) for penetrative lineation in lower-plate mylonite (A, B, and C) and striae, slickensides, and grooves from the prominent, smooth, polished Buckskin detachment surface (D, E, and F). Data sets A and D were collected along or north of the detachment surface while B and E are from the southern portion of Figure 2. Plots C and F are corresponding summations. N equals the number of linear elements plotted.

summation of lower-plate lineations and striae from the Buckskin detachment surface are given on Figures 7C and 7F respectively. A common direction is shared by both elements: N40°E. Statistically significant secondary trends, however, are clearly evident on these synoptic plots. These data, when considered in concert with the N40-50°W-trend of major upper-plate fold axes (Fig. 2), suggest that upper-plate rocks were transported in a N40°E-S40°W±5° direction. Similarly, it is apparent that the lower-plate mylonites do not possess the single unidirectional lineation cited in Davis and others (1977, 1980). At least three domains are present in the area investigated with each being pervaded by either NE- or ENE-trending mylonitic quartz lineations.

The middle-plate fault actually represents the top of a zone of intense distributed shear which extends upward from the detachment surface. As illustrated on Figure 3, it is subparallel to the detachment surface and marks the boundary between unmetamorphosed and metamorphosed rocks of the Artillery Formation. The fault often merges with the detachment surface, particularly in the southwestern half of the map area (Fig. 2).

Folds

The S45°E, 40°-plunging axis of an open, upright anticline in the Artillery Formation is flanked by a S45°E-trending syncline in the center of the map area (Fig. 2). The anticline is coincident with the greatest concentration of metallic mineralization in the upper and lower plates. A similar fold pair in the trachybasalt (NE¼, Sec. 31, Fig. 2) plunges N35°W, 20-30°.

Throughout the upper and middle plates, a diverse assortment of small scale mesoscopic fold styles were noted. Although many trends are present, a statistical analysis clearly defines a marked preference for axes to plunge S20-50°E, 40-45°; a direction coaxial to the megascopic, upright, open folds of the mapped area.

A doubly plunging, N65°E-trending anticline flanked by a S40°W-plunging syncline in marble breccia is shown in Section 30 (Fig. 2). The arch and trough are not defined by bedding or foliation, but by the overall form of the outcrop. They represent a megaboudin elongated into the direction of transport. Identical forms have been described by Davis (1980) in the Catalina-Rincon complex.

Listric Normal Faults

Although only a few NE-dipping listric normal faults are shown on Figures 2 and 3, the extent of this style of faulting is considerably greater. As seen in the drill core, faults with gouge and crush breccias occur at intervals of tens of feet suggesting several orders of magnitude more faulting than were actually mapped. None of the listric faults cut the detachment surface; moreover, they flatten

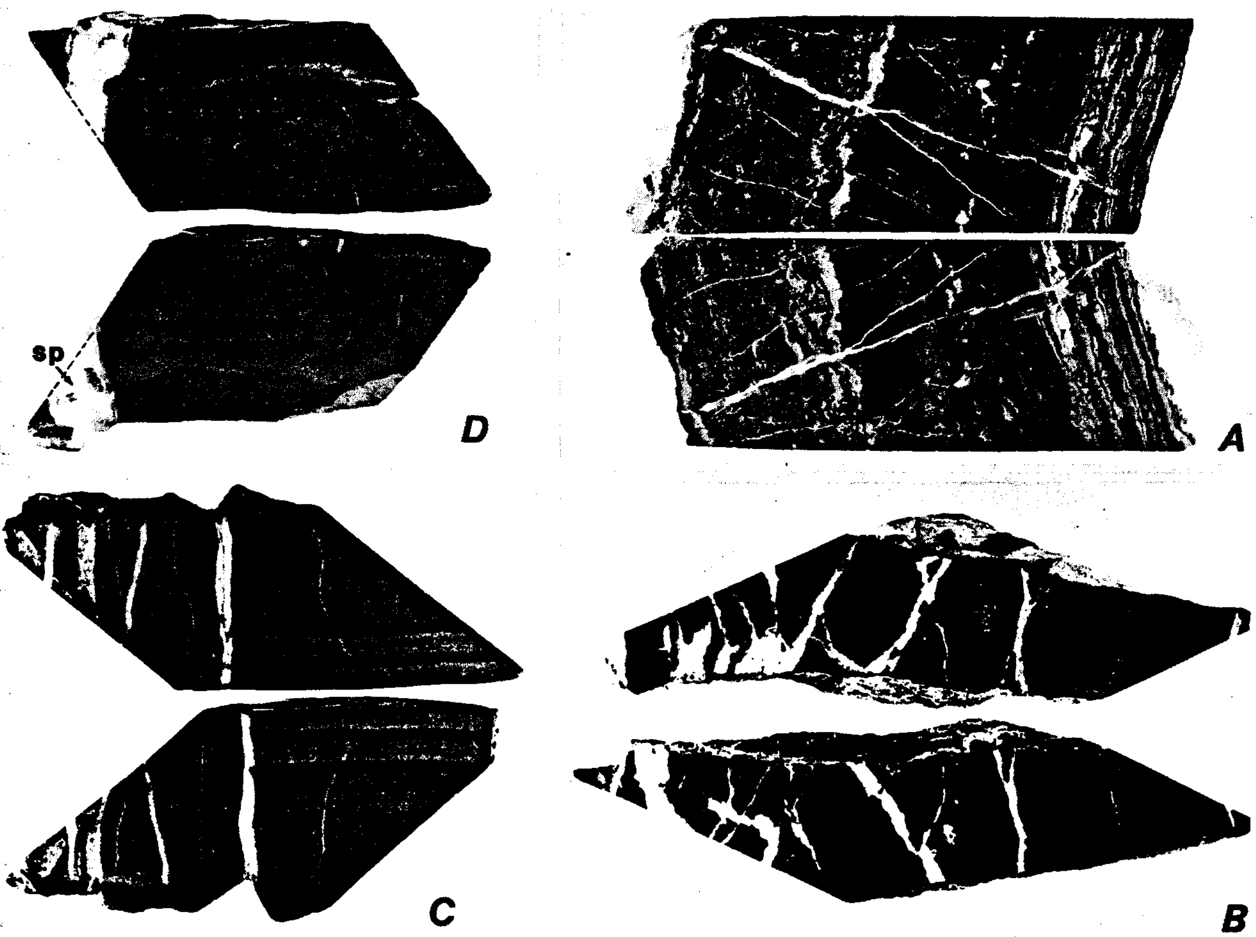


Figure 8. Polished slabs of organic-rich, arkosic siltstones from the upper-plate Artillery Formation showing gash veins with a variety of sizes and intensities. Note the sphalerite grain (sp) in D.

into it or into the middle-plate fault, comparable to geometries described by Shackelford (1976) in the Rawhide and by Davis and others (1980) and Frost (1981) in the Whipple Mountains.

Small Scale Features

Small scale structures include sandstone, shale, and pebble dikes, bedding plane slips and gash veins which are volumetrically the dominant style of deformation in the upper and middle plates. Clastic dikes and dikelets commonly follow bedding planes or occupy gash veins. Clasts vary in size from 1 to 2 inches in diameter to silt-sized particles, or smaller, set in a fine-grained matrix of hematitic or chloritic mud. Virtually all bedding planes show evidence of slippage with slickensides and contain a lustrous schistose sheen, especially on the parting shales. Gash veins, usually filled with gangue or ore minerals, form in brittle units sandwiched between plastically deformed units (Fig. 8). The frequency of gash veins increases downward in the upper plate.

Basin and Range Faults

A NW-trending, sub-vertical fault that cuts and displaces the detachment surface is present in the northeast corner of the map area (Figs. 2 and 3). NW-trending faults with lateral movement are relatively common in the Buckskin Mountains (Fig. 1). At Mineral Hill, the Norma-Continental fault system (Harrer, 1964) displays similar characteristics but also cuts and displaces the Osborne Wash volcanics. A post-10 m.y., Basin and Range age is indicated by comparative features of both fault systems.

Mineralization

Sulfide-oxide metallization consisting of pyrite, specularite and chalcopyrite with minor sphalerite, galena, and manganese oxides is present in varying amounts throughout the lower, middle, and upper plates. The metallic minerals typically fill an assortment of open spaces created by thin-skinned, brittle deformation of extensional type with minor but important replacements in brecciated-sheared reactive units. The overall distribution of mineralization is coplanar with the detachment surface, decreasing both above and below the fault. Mineral fabrics and textures indicate deposition during and after final movement of the allochthonous units suggesting a tectogenesis related to the low-angle process.

Mode and Distribution of Mineralization

The ore minerals, in decreasing order of abundance, are: chalcopyrite, specularite, pyrite, sphalerite, manganese oxides, and galena. Associated gangue minerals are: calcite, gypsum, fluorite, barite, and quartz, opal or jasper. Mineralization is distributed between five separate but structure-tectonically related settings: 1) comminuted disseminations within the flinty chlorite microbreccia, 2) massive sulfide-oxide replacements after reactive brecciated marble, 3) open space filling of shoots and sheets of tectonic crush breccia at the intersection of synthetic listric normal faults and the detachment surface, 4) antithetic and synthetic gash- and fault-veins, and 5) longitudinal fissure fillings along the crest or trough of megascopic folds. Volumetrically, gash- and fault-vein occurrences are the most important while the most spectacular and highest metal concentrations occur along the detachment fault and in listric fault zones. Figure 9 shows the distribution of copper and fluorine in the four drill holes along cross-section B-B' plotted adjacent to a generalized geologic log of the holes. Note the 6 feet of significant copper mineralization localized along the detachment surface in DH-2 and the 40 feet of >0.1% Cu in DH-4 related to a listric normal fault. The fluorine distribution mimics that of the copper, except in the lower-plate mylonites where the total fluorine rapidly decreases to a background level.

In the chlorite shatter breccia, pyrite, chalcopyrite and specularite plus rare fluorite occur as disseminated grains and in microveinlets that cut fragmental mylonitic gneiss. Individual sulfide and oxide grains are euhedral, subhedral, and anhedral displaying variable degrees of cataclastic textures. Sulfide concentrations seldom exceed 2% and will average 0.2 to 0.5% and contain pyrite/chalcopyrite ratios of 0.1 to 0.3. Specularite averages 0.2 to 0.5% with up to 4% in places.

Finely comminuted and abraded sulfides and specularite set in a matrix of sulfide-hematite (probably derived from specularite) mud was encountered at each drill hole penetrating the detachment surface (Fig. 10A). In DH-2, this zone was 6 feet thick and assayed 1.48% Cu (Fig. 9). The significant copper zone cut in DH-2 involves part of the flinty microbreccia and the gouge-breccia above the surface with well-rounded chalcopyrite and specularite grains (up to 0.2 in. diameter) set in a foliated matrix of finely abraded specularite and sulfides (Figs. 10B and 10C). Although the limits of this zone are unknown (it was missed in DH-7, -4, and -5) the up-dip continuation of it probably correlates with the copper-rich hematitic jasper mapped to the south along the Swansea road (Fig. 2).

Oxide and sulfide replacement of marble breccia was economically important at Planet and Swansea (Bancroft, 1911; Cummings, 1946) but rarely occurs at the Copper Penny. Traces of sulfides replacing marble breccia were encountered in DH-6 (Fig. 2) where remnant chalcopyrite, superficially altered to chalcocite and earthy red hematite, replaces marble breccia in the vicintiy of DH-3 (Figs. 2 and 9) and contains numerous veinlets, microveinlets and irregular clots of specularite and malachite-azurite-chrysocolla indicating partial replacement. At Swansea, Bancroft (1911) mapped large, irregular masses of cataclastically deformed chalcopyrite that are rimmed by massive specularite which replaces the same marble breccia.

In the upper plate, chalcopyrite with gypsum (Fig. 10D), fluorite, and/or calcite is found in breccias associated with listric faults. The crush breccias range from 0.2 to 6.0 inches thick and repetitiously offset beds in the Artillery Formation. Chalcopyrite, up to 0.5 in. diameter, is the dominant ore mineral with occasional traces of honey-colored sphalerite and pyrite. Cataclastic textures in the sulfides are always present; usually the exploded texture illustrated in Figure 10D. The gangue minerals are similarly shattered, sheared, rotated and mixed with rounded wall rock fragments giving the vein a fluidized microbreccia appearance.

The gash veins, generated during movement in brittle units, bounded on either side by ductilly deforming shales, are common to abundant in the upper

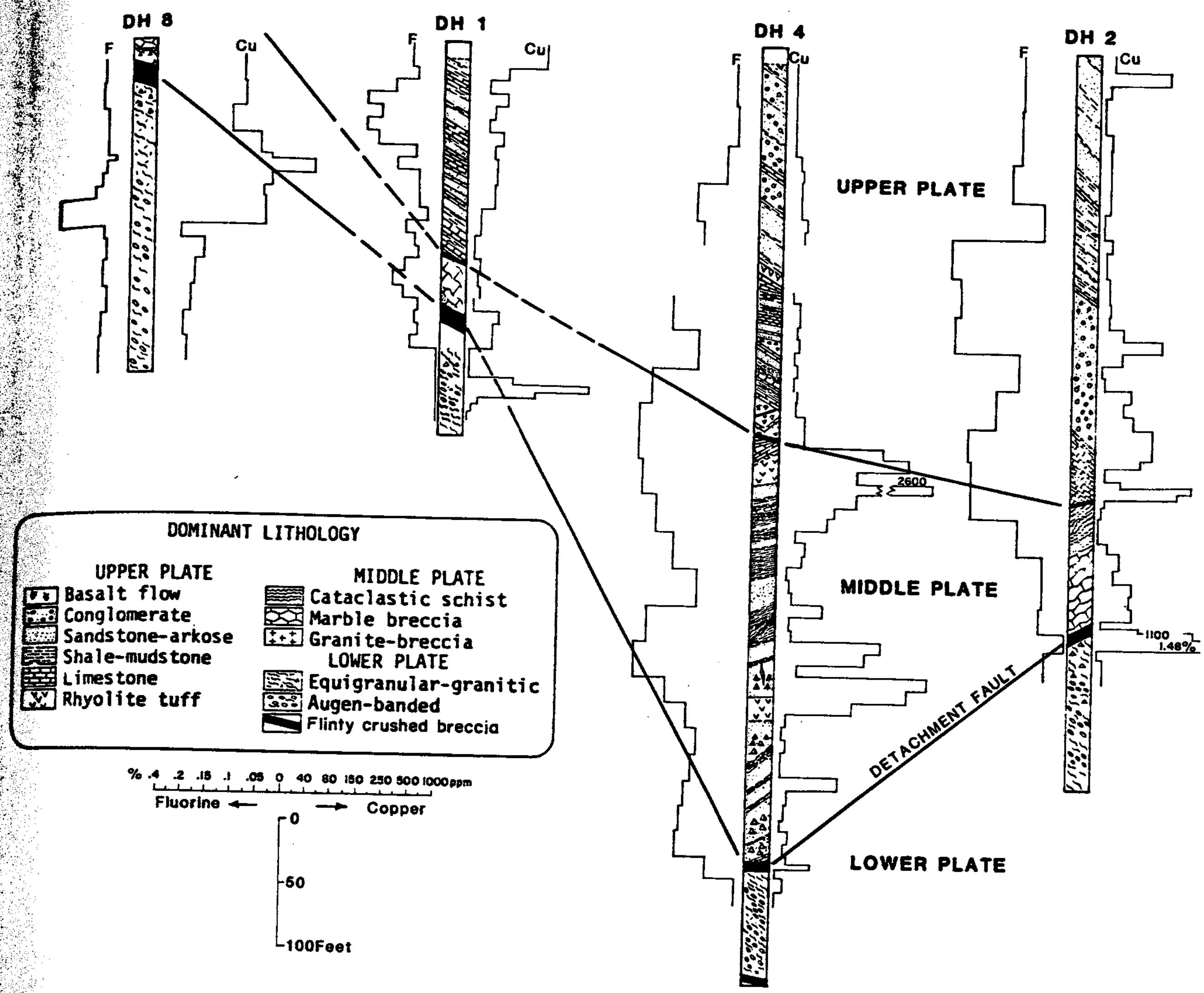


Figure 9. Cross-section B-B' detailing lithologic, structural, and copper-fluorine gradients in four drill holes. Copper and fluorine histograms are plotted to the right and left respectively of each schematic log. Copper assays were derived from 10' split intervals while fluorine assays are from 10' intervals in DH-1 and 50' composites from DH-2, -4, and -8.

plate. Figure 11 shows the intensity of calcite-filled gash veins plotted in veinlets/foot (actual count during core logging) for the 4 drill holes shown on Figure 9. The remarkable correlation between the calcite intensity (Fig. 11) and fluorine assays (Fig. 9) suggest a correspondence between calcite gash veins and fluorite content. A series of gash veins cutting Artillery arkose and siltstone is illustrated in Figure 8. The veins are invariably confined to the brittle unit and seldom propagated through the bounding shale. The veins range in thickness from hairline cracks to 0.5 inches. Fillings consist of calcite or gypsum with subordinate fluorite, barite, chalcopyrite, sphalerite (Fig. 8D) and rare galena. The mineral grains in the veins usually have euhedral to subhedral outlines and almost never have cataclastic textures.

Alteration

The dominant wall-rock alteration of Copper Penny is propylitic and characterized by the development of chlorite and calcite with subordinate amounts of epidote, gypsum and clay. Figure 11 shows the distribution of chlorite-,epidote-, calcite-, and gypsum-filled fractures in veinlets/foot encountered in the 4 drill holes shown on cross-section B-B'. As illustrated in this figure, the chlorite is asymmetrically centered on the detachment surface decreasing above and below the fault. Calcite and epidote appear to decrease with increasing chlorite. Epidote occurs only in the lower plate while the apices of the calcite curve, though strongest in the upper plates, flank the chlorite zone.

Chlorite and Epidote

The chlorite is a black-green, greasy variety in the mylonite and bright to apple green in the upper plates. Chlorite pervasively replaces biotite and hornblende within the shatter breccia; an observation not shown by the mineral distribution in Figure 11. However, total veinlet chlorite greatly exceeds rock chlorite after mafics. The intensity of chlorite-filled veinlets is a direct function of the degree of brecciation found along the detachment surface. The increasing intensity of chlorite in DH-4 (Fig. 11)

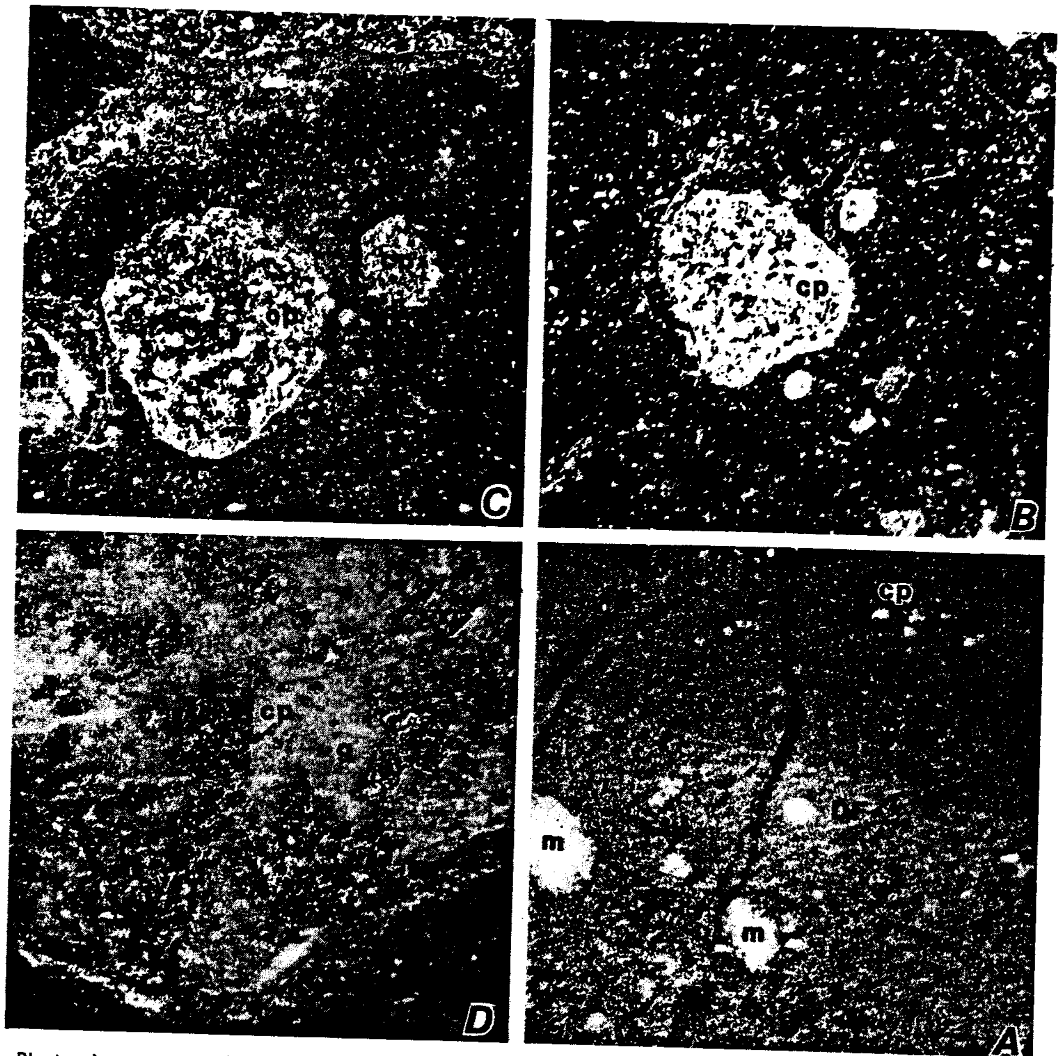


Figure 10. Photomicrographs (X30) of polished core showing A) detachment fault (DF) separating hematite-rich flinty microbreccia from hangingwall marble breccia (DH-4); B-C) abrasively rounded chalcopyrite (cp)and marble (m) clasts set in a finely comminuted specularite microbreccia matrix (DH-2); and D) chalcopyrite breccia cemented by shattered gypsum (g) from a listric normal fault zone (DH-4).

is due to chlorite selvages along gypsum veinlets. Other minerals commonly associated with chlorite are pyrite, chalcopyrite, specularite, and fluorite.

Epidote (probably clinozoisite) is a pea-green variety occurring in shatter breccia veinlets, replacing mafic minerals and feldspars, and occasionally flooding the footwall mylonitic gneiss. Although the chlorite-epidote relatioship is antithetic, the total epidote rarely exceeds the chlorite content. Outside the Copper Penny area, widespread epidote mineralization occurs in areas well below the detachment suggesting a regional metamorphic origin.

Calcite

Calcite is commonly crypto-crystalline (white, pink, or green) with a modest percentage of euhedral to subhedral crystals or crystalline aggregates. Calcite is found in gash veinlets (Fig. 8), breccia matrices and veins. Minor amounts of calcite, in the lower plate, increase with decreasing chlorite below the detachment fault. Calcite-filled vein intensity decreases in intervals where gypsum-filled veins are present. Minerals associated with calcite are fluorite, barite, pyrite, sphalerite, galena, and chalcopyrite.

Clay and Gypsum

Gypsum-filled veinlets are found only in the middle plate where they are associated with the weakly metamorphosed Artillery Formation (DH-4 on Fig. 8 and in DH-7). The gypsum fills gash veins which cut calcite veins indicating a late stage of formation. Veins up to .5 in. thick are filled with cryptocrystalline and cross-fiber gypsum associated with chlorite, pyrite and chalcopyrite. The white swelling variety of clay was recognized only in lower-plate rocks filling thin hairline cracks which cut all other veinlets. Clay alteration may be more widespread in the upper plates but it was not recognized in the drill core. The clay, where substantiated as non-supergene, is mineral destructive; pyrite was altered to earthy hematite.

Summary

The principal geologic characteristics of the Copper Penny deposit are summarized as follows:

1. Mineral deposition occurs within and below a pile of allochthonous rocks preserved in

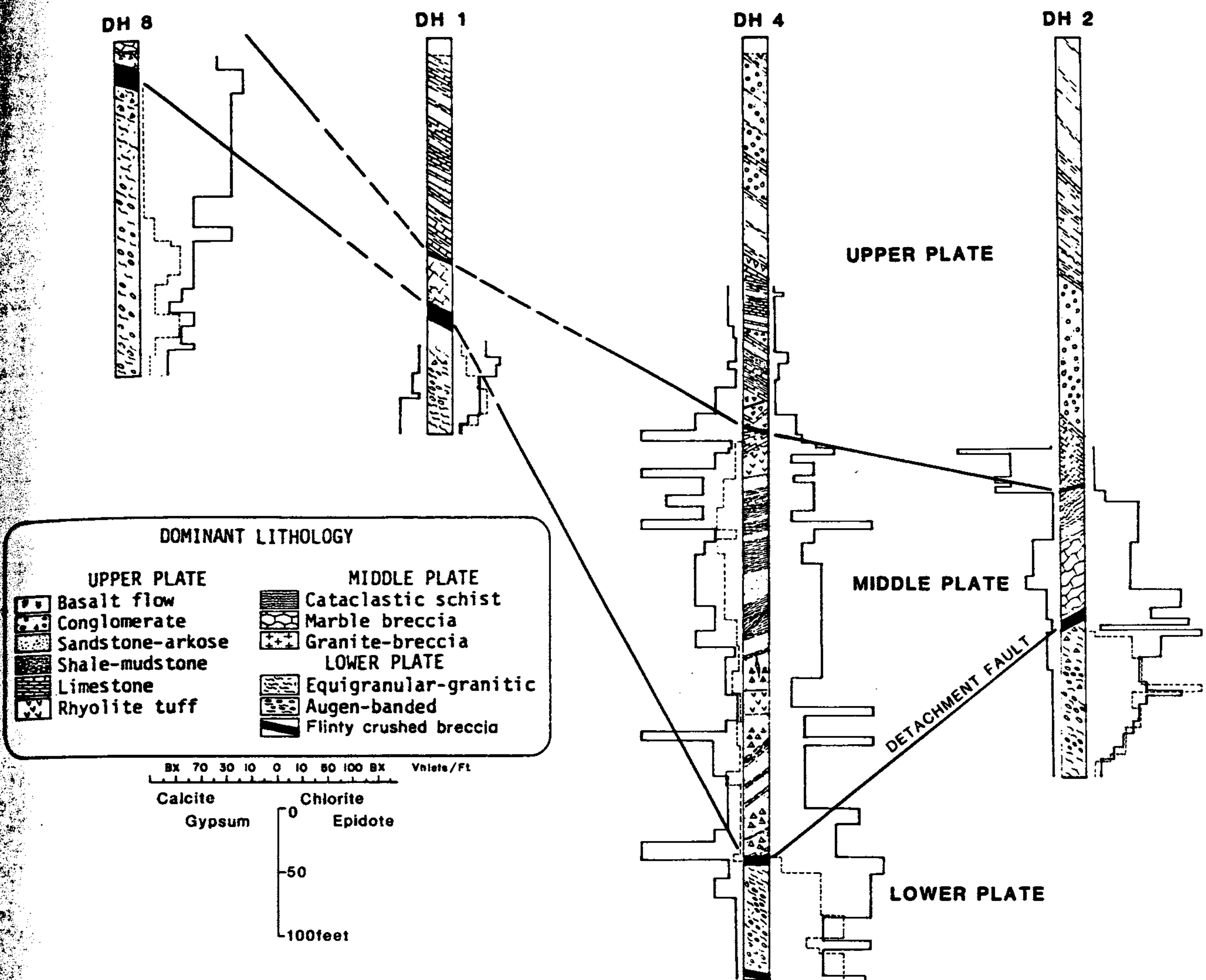


Figure 11. Cross-section B-B' detailing litholgic, structural, and chlorite, epidote, calcite, and gypsum distributions and intensities in four drill holes. Chlorite (solid line) and epidote (dashed line) histograms of the number of veinlets per foot cutting the rocks are plotted to the right of the schematic log. Calcite (solid line) and gypsum (dashed line) histograms are plotted to the left.

an ENE-trending megagroove within metamorphic core complex terrain.

2. The allochthonous sequence consists of gently folded, penetratively faulted, and intensely brecciated but unmetamorphosed units of the Artillery Formation in the upper plate and cataclastically deformed, metamorphosed, but non-lineated rocks of the Artillery Formation in the middle plate. Both sequences overlie the Whipple-Buckskin Mountains detachment fault and the footwall foliated and lineated mylonitic gneiss.
3. The structure-tectonic setting is dominated by extreme thin-skinned distension of upper- and middle-plate lithologies due to ENE-directed movement of hangingwall rocks along the detachment fault. Tectonic crush breccias, synthetic and antithetic gash veins, and high-to low-angle faults that formed in response to this movement created innumerable voids above and below the detachment fault.
4. The movement-generated open spaces were filled with varying concentrations of ore, gangue, and alteration minerals during and following final movement of the allochthonous blocks. The rounded finely abraded chalcopyrite and specularite along the detachment fault and ubiquitous cataclastic ore textures along listric-faults indicate deposition contemporaneous and after movement. Conversely, footwall shatter breccia and gash vein oxide and sulfide mineralization evidence exponentially decreasing cataclasis with increasing depth beneath the detachment surface.
5. A rudimentary alteration-mineralization zoning pattern is recognized centered about the detachment surface. The quantified changes in alteration intensity are accompanied by systematic variations in ore minerals, gangue, and alteration products above and below the fault.
6. Assuming the K-feldspar K-Ar age data from GH-8 accurately records the annealling-

cooling age of the footwall mylonitic shatter breccia, late stage mineralization continued until 17.7 ± .7 m.y. This age date is congruent with the 18.6 ± 1.5 m.y. K-Ar date for the mineralized trachybasalt and the 15.9 m.y. upper limits for detachment faulting established by Martin and others (1980).

7. NW-trending Basin and Range faults have appreciable right lateral oblique slip components and offset portions of the mineralized systems.

Physical and Chemical Constraints on Mineral Deposition

A preliminary synthesis of assembled geologic and geochemical data allows one to place qualitative constraints on the temperature of deposition, fluid flow paths, and determine the rudimentary chemistry of the mineralizing solutions.

The maximum temperature range was estimated from the thermal resetting of the K-Ar age dates. Mylonitization ages in the Whipple and Rawhide Mountains range from 78.5 m.y. (Martin and others, 1980) to 52.3 m.y. (Shackelford, 1977). However, a pronounced younging-trend, upward to the detachment fault, is consistently present throughout the complex (Dokka and Lingrey, 1979; Davis and others, 1980). Martin and others (1980) found that age dates for synkinematic sills, dikes, and anastomosing apophyses deep in the complex decrease structurally upward in a systematic manner from 25.5 to about 15.3 m.y. at or immediately above the flat detachment fault, implying a thermal and/or physical resetting of the K-Ar ages by detachment faulting. Damon (1968) documented similar conditions in the Catalina-Rincon complex and suggested that the mylonites must have sustained temperatures in excess of 400°C to completely reset the K-Ar ages. The 17.7 m.y. K-feldspar K-Ar age obtained from mylonitic shatter breccia gneiss in DH-8 represents an annealling-cooling date of older 52-78 m.y. core complex mylonites.

Quantity and distribution of alteration, ore, and gangue minerals in concert with the distribution of breccia and open space development are useful fluid flow indicators. That the detachment fault was the primary path for mineralizing solutions is indicated by: 1) the asymmetrically centered distribution and intensity of chlorite, 2) the highest concentrations of sulfide and oxide mineralization, and 3) the inverse relationship of chlorite and copper to lower-temperature phases such as calcite, epidote, clay and gypsum (Figs. 9 and 11). Cataclastic deformation in middle-plate rocks permitted widespread circulation of the fluids through these units as evidenced by pervasive but low concentrations of chlorite, chalcopyrite, gypsum, calcite, and minor specularite mineralization. Upward migration of the fluids was largely restricted to listric fault zones because chalcopyrite, gypsum, chlorite, and fluorite only occur in crush breccias along these faults. Widespread, low-temperature fluid flow in the upper plate is indicated by the appreciable volume of sphalerite-bearing gash veins that occur in unaltered, organic-rich arkose and fetid limestone.

The mineralizing fluids were highly oxidizing with high CO_2, moderate to low fluorine and low sulfur concentrations. The percentage of iron, magnesium, and manganese was high, copper and zinc were moderate to low, and lead, molybdenum, gold and silver were very low. Species of anions are denoted by the widespread calcite distribution (CO_2), the low sulfide to specularite ratio (O_2 and S), and the presence of fluorite (F). Inferred cationic concentrations are suggested by coexisting chlorite compositions (7 hand-picked chlorite samples averaged 9.9% Fe and 5.6% Mg), the ubiquitous occurrence of pyrite and specularite, and drill core assays for Cu, Mo, Pb, Zn, Au, and Ag.

We conclude that isothermal surfaces were centered on, and subparallel to, the detachment surfaces and that very close-spaced isotherms occurred above and below the fault. An internal maximum temperature of 400°C is probably high due to substantial argon loss through mechanical annealling and cataclasis. We suspect that the ore-forming fluids actually attained temperatures ranging from 100 to 150°C at the detachment surface.

Genesis of the Copper Penny Deposit

The genesis of this deposit is indirectly related to the development of Laramide metamorphic core complexes and intimately related to detachment fault tectonics. A variety of models have been proposed to explain the features that, in aggregate, define a metamorphic core complex (Coney, 1980; Davis, 1980; Rehrig and Reynolds, 1980; Davis and others, 1980). Although many details of each model differ, all agree that detachment faulting was the terminal event and that it disrupted and deformed upper- and lower-plate rocks.

Our investigations demonstrate that mineralization is spatially related to the detachment fault and we strongly imply a tectogenetic relationship of it to the fault process. We propose that the flow of mineralizing fluids at elevated temperatures were channeled into dilatant settings along: 1) the detachment surface, 2) listric normal faults, 3) crush/shatter breccias, and 4) axial plane joint sets; however, the origin of the fluid and heat sources responsible for fluid circulation are not readily apparent in the Copper Penny-Swansea area.

Potential sources of heat include that released by friction drag during movement of the allochthonous blocks and intrusion of syn- or post-kinematic dikes, sills and necks. Post-kinematic dikes, similar to the microdiorite dikes described by Rehrig and Reynolds (1980) in the nearby Harcuvar Mountains, were not identified in the Copper Penny area.

A contribution to the overall heat budget probably involved heat produced by movement of the upper plates along the detachment fault. This could constitute a significant contribution of heat according to the stick-slip theory proposed by Brace and Byerly (1966).

We propose that the observed lithologic, structural, alteration-mineralization, and geochemical data suggest a tectogenetic relationship between the detachment fault process and ore localization. Movement of the upper plates generated widespread shatter/crush breccias and gash veins that provided paths for metal-bearing fluid flow at elevated temperatures. The oxidizing, carbonate- and fluorine-bearing solutions leached-out pre-existing unstable mineral phases prior to and during ore deposition. Ore and gangue minerals were deposited from the solution in the dilatant movement-generated voids or replaced reactive marble breccia units in the upper, middle, and lower plates. Mineral position, alteration, and movement along the tachment surface were coeval; they ceased prior the outpouring of the Osborne Wash volcanics.

HER DEPOSITS IN THE WHIPPLE AND BUCKSKIN MOUNTAINS

Most important mines and prospects in the Buckskin and Whipple Mountains (Fig. 1) have many geologic features in common with the Copper Penny prospect. The dominating characteristics shared by the deposits are as follows:

1. All mines and prospects occur immediately above, below, or along the Whipple-Buckskin detachment fault or along tectogenetically related structures.
2. All are positioned in upper- and middle-plate rocks along ENE-trending megagrooves and warps in the detachment surface.
3. A district-wide mineral suite is dominated by specularite and chalcopyrite.
4. The mineral fabrics and textures consistently denote syn- and post-kinematic ore deposition.
5. Wall-rock alteration is always propylitic (chlorite-dominant) and asymmetrically centered about the detachment fault.
6. The geologic relationships indicate a post-Artillery Formation and pre-Osborne Wash Formation period of oxide-sulfide deposition.

The three major producers (Swansea, Planet, and Mineral Hill) and one fully explored deposit of major proportions (Copper Basin) were re-examined within the context of the data gleaned from the Copper Penny occurrences.

Figure 12, a schematic cross-section depicting the mode and distribution of metallization at Copper Penny, illustrates the format used in describing ore localized at each subsequent deposit. This cross-section was generalized from section B-B' (Fig. 3) and shows our interpretation of the data compiled. Important settings depicted include the massive chalcopyrite-specularite metallization along and immediately above the detachment surface (hachured), marble breccia replacements (solid), and metallization controlled by veinlets in footwall chlorite shatter breccia, open space filling in listric fault breccias and gash veins (stippled pattern).

SWANSEA

The geologic cross-section and schematic showing orebody distribution (Fig. 3) were constructed from drill hole data supplied by one of the property owners (J. Challinor), from Bancroft (1911), and unpublished mapping by the authors. Following cessation of operations in 1937 (Keith, 1978), Swansea lay dormant until 1959 when it was acquired by the current owners. A succession of mining groups since 1979 have explored the property, completing several geophysical and geochemical surveys plus about 50 drill holes. Exploratory drilling was confined to the immediate mine area resulting in the data void northwest of the mine (Fig. 13).

The lithologic sequence and structural setting at Swansea is identical, in many aspects to Copper Penny. The lower plate consists of mylonitic gneiss with a gently dipping foliation and a penetrative lineation. The detachment surface, a faulted offset continuation of the fault at Copper Penny, is gently and steeply dipping along the NW and SE margins respectively. Details of the middle plate are lacking in the mine area for want of outcrops. At the main workings, a megaboudin of marble breccia overlies the detachment fault and interfingers with cataclastic schist. In outcrop, the marble forms a N65°E-trending, doubly plunging anticline that is an offset continuation of the middle-plate Copper Penny marble breccia. The cataclastic schist, poorly exposed in outcrop, is believed correlative with the schist at the Copper Penny prospect.

The granite breccia, identical to the Copper Penny unit, outcrops NW and WNW of Swansea but the geologic relationship between it and the schist is uncertain. Chapin Wash redbeds, consisting of coarse-grained clastics and interbedded lacustrine limestone showing camel tracks, outcrop 1 mile NE-ENE of Swansea (Gassaway, 1972). This homoclinal dipping sequence (N20°W, 45°SW) of Chapin Wash Formation represents the remaining remnants of the upper plates at Swansea.

The orebodies at Swansea occurred in two separate but interrelated modes: the "footwall orebody" and the "replacement orebodies" (Challinor, pers. comm.). The ore zones were described by Bancroft (1911) as specularite with chalcopyrite and minor pyrite replacing marble breccia with a quartz-epidote gangue and "...large limestone boulders...". He also noted "Evidences of extreme movement..." and "...great slickensided surfaces and severe contortions..." in the underground workings. He stated that the "movement appears to be more recent than Precambrian". Bancroft's observations on the structural deformation confirms the post-tectonic nature of ore deposition

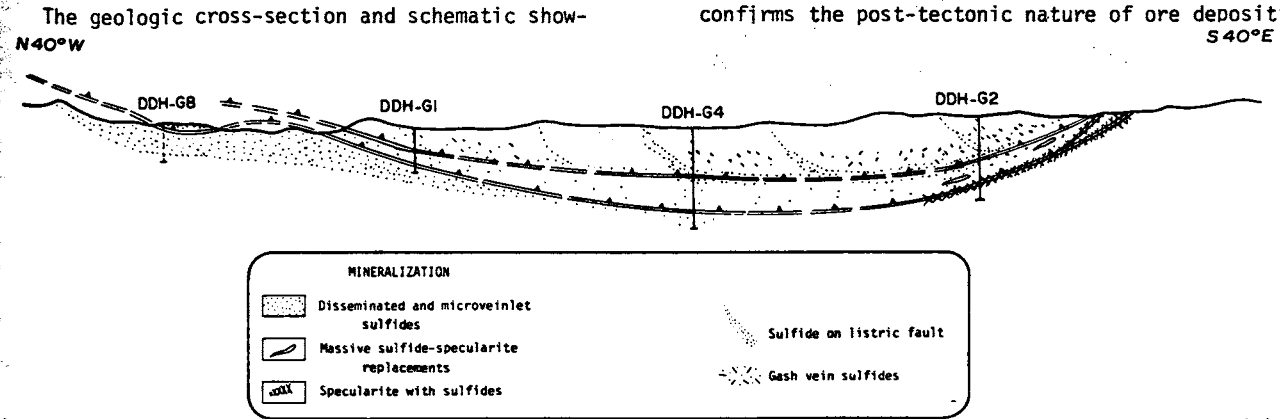


Figure 12. Schematic representation of cross section B-B', Copper Penny prospect (Fig. 3), showing five (5) principal structure-tectonic settings supporting significant Cu-Fe metallization.

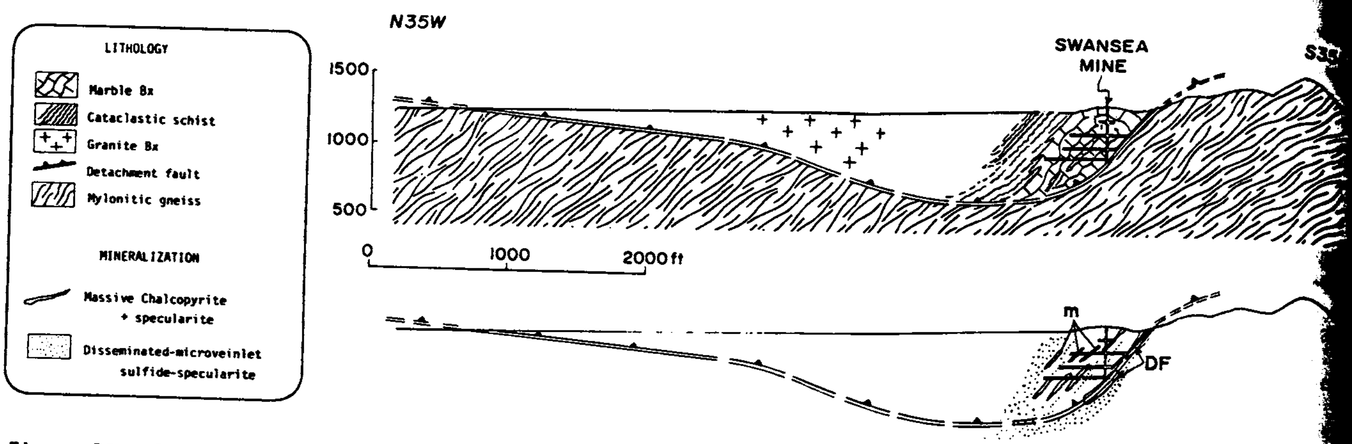


Figure 13. Generalized geologic cross-section at the Swansea mine (top) and schematic representation of the principal structural-tectonic setting hosting Cu-Fe orebodies and other metallization (bottom). DF, detachment fault ore; and m, marble breccia replacement ore.

as documented at Copper Penny. The footwall ore is comparable (except in tonnage and grade) to the detachment fault mineralization encountered in DH-2.

The extent of the metallization at Swansea was expanded by the post-1959 drilling program. A zone of microveinlet to disseminated sulfides (including chalcopyrite, pyrite and bornite), specularite and native copper was found in the hangingwall cataclastic schists. Pyrite and specularite with minor chalcopyrite were encountered in the footwall chlorite shatter breccia immediately beneath the detachment surface (Challinor, pers. comm.).

The geologic features of the Swansea orebody closely resemble the features noted at Copper Penny. The lithologic and structural characteristics, excepting the well-defined upper plate, are identical overall but differ in detail.

Planet - Mineral Hill

The Mineral Hill to Planet cross-section and corresponding mineralization schematic was prepared from Harrer (1964), unpublished geologic maps by J. Wilkins (1969) and F. Bergwell (1978) and from drill hole data supplied by one of the property owners (E. R. Alcott). The Planet mine was explored for its iron potential by the U. S. Bureau of Mines who completed 12 churn and 10 diamond drill holes in the immediate vicinity of the mine. The results of a 15 hole -1979- drilling program that explored the interval between Planet and Mineral Hill were provided by Alcott. A structure contour map on the top of the detachment surface provides the data base for preparing the geologic cross-sections shown on Figure 14.

The lower-plate mylonite is foliated, lineated, augen to compositionally banded gneiss inherent to most core complexes. The detachment surface is a flinty microbreccia overlying an extensive chlorite shatter breccia. A thin wedge of marble breccia lies paraconformably on the detachment surface at Planet, Mineral Hill, and in several drill holes located midway between the mines (Fig. 14). The marble breccia represents a middle-plate tectonite.

The Planet - Mineral Hill upper plate constitutes a homoclinal series of NW-striking, 30-50° SW-dipping, weakly foliated and lineated metasedimentary and metavolcanic rocks. This ±2200 foot-thick sequence is tentatively identified as Mesozoic(?) based on its physical resemblance to Mesozoic units in the Dome Rock Mountains (Marshak, 1980), and the Plomosa Mountains (Harding, 1980). The Chapin Wash Formation outcrops along a WNW-trending belt about 1.5 miles southwest of the Planet mine. Here the Chapin Wash Formation consists of a NW- to WNW-strik[ing] 40-50° SW-dipping sequence of redbed conglomerates and pebbly sandstone with intercalated basalt flows. An anastomosing dike-like body of breccia with clasts ranging from less than 0.1 cm. to 25-30 feet across crops out along a WNW trend, 4000 feet southwest of the Planet mine. This tectonic or intrusion breccia is shown in the center of the cross-section (Fig. 14). The dike-like body dips about 50°NNE and cuts, deforms and displaces the intruded metatuff unit. It was initially mapped as a low-angle fault breccia, but, upon completion of the structure contour map of the detachment surface, the dike appears to upwarp and displace the detachment fault. The breccia matrix is stained brick-red by finely comminuted hematite particles surrounding large clasts (±20 feet diameter) of marble breccia partially replaced by specularite and chalcopyrite. A post-detachment fault and post-mineral origin for the breccia body is indicated.

Extensive drilling along the Mineral Hill-Planet section (Fig. 14) demonstrates convincingly that the NE-dipping listric-normal faults flatten progressively with depth as shown. At Planet and Mineral Hill the detachment fault is repeatedly cut and offset by a series of NW- to NNW-trending high-angle normal faults possessing significant oblique-slip. North of Mineral Hill, these same faults cut and displace 8 to 13 m.y. old volcanics of the Osborne Wash Formation.

Mineralization at Planet and Mineral Hill is dominated by specularite, chrysocolla, ± malachite derived from the supergene oxidation of chalcopyrite. Specularite occurs predominately along the detachment fault partially replacing superjacent marble breccia as well as shatter veinlets and microveinlets above and below the fault (Fig. 14). Relict sulfides found on the dump at Planet are pyrite and chalcopyrite showing cataclastic textures. Drill holes penetrating the detachment fault encountered chlorite shatter breccia with microveinlet and disseminated specularite, pyrite, chalcopyrite, and in some instances, native copper. Metallization along listric faults is widespread consisting of pyrite-chalcopyrite ± native gold

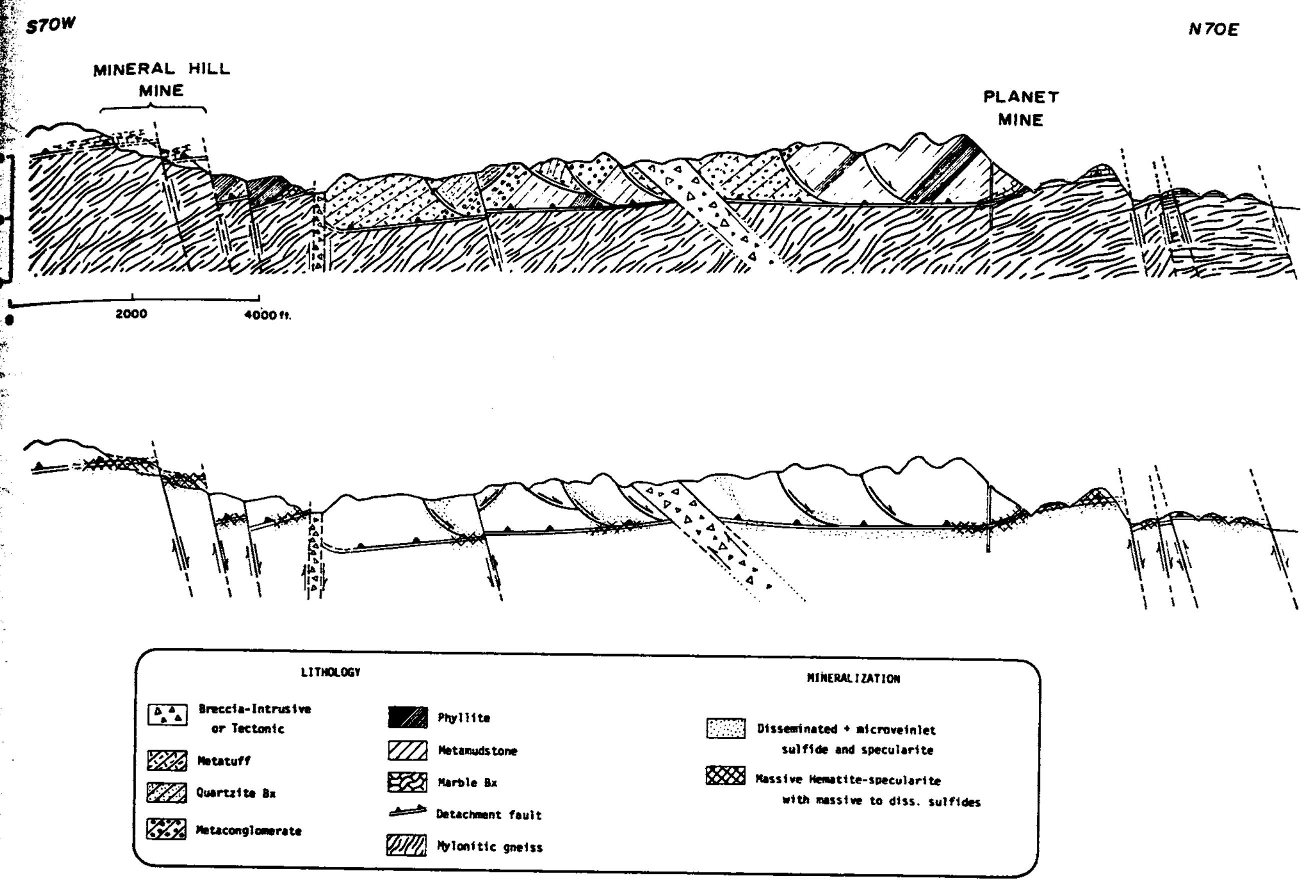


Figure 14. Generalized geologic cross-section through the Planet and Mineral Hill mines (top) and schematic representation of the principal structure-tectonic settings hosting Cu-Fe orebodies and significant sulfide-oxide metallization (bottom).

and their supergene oxidation products (earthy hematite, malachite, and chrysocolla). Gangue minerals include quartz and cryptocrystalline silica pervading marble breccia at the Planet mine with barite-calcite in attendant listric faults.

Copper Basin

The Copper Basin cross-section (Fig. 15) was constructed by T. L. Heidrick and E. G. Frost for the 1980 Arizona Geological Society Road Log (Heidrick and others, 1980) and subsequently discussed in detail by Frost (1981). The cross-section was prepared utilizing a geologic map completed by Lingrey and others (1977). Metallization details were derived from unpublished maps and reports provided by Mr. R. Odien of the Louisiana Land and Exploration Company.

Augen to compositionally banded mylonitic gneiss, inherent to metamorphic core complexes, comprise the lower-plate sequence (Fig. 15). The detachment fault is a curviplanar surface composed of microbreccia that dips 9 SE and overlies a variable thickness (10 to 300 feet) of sheared, shattered, and chlorite-flooded breccia. At Copper Basin, the detachment surface is warped into a series of low amplitude (200 to 300 feet) synformal and antiformal megagrooves with axial trends of N50-60°E, 6° (Heidrick and others, 1980; and Frost, 1981). The metallization at Copper Penny is likewise concentrated along the flanks of antiforms.

The upper-plate crystalline rocks consist of cataclastically deformed but non-mylonitic gneiss and schist intruded by diorite to granodiorite and andesite to dacite plutons, sills and dikes. The non-mylonitic crystalline rocks are paraconformably overlain by the Copper Basin Formation: a basal basalt flow (K-Ar age dated at 18 m.y.) and a succession of redbed conglomerates, fanglomerates, and pebbly to medium-grained sandstone (Frost, 1981).

The cataclastically deformed upper-plate rocks are pervasively altered by chlorite and epidote. Greasy black chlorite and to a lesser extent epidote replace mafic minerals and occur in veins, veinlets, and microveinlets cutting upper-plate crystalline rocks.

Although a minor amount of sulfide mineralization occurs below the detachment fault in the chlorite shatter breccia, the bulk of the metallic minerals lie within the upper plate. Three significant concentrations of copper mineralization were delineated during the drilling program. Each concentration has a somewhat triangular outline in plan with their bases striking NW and their apices dipping gently to the NE; an orientation roughly coplanar with mapped sympathetic listric faults. The hypogene minerals consist of intimately intergrown pyrite-chalcopyrite-specularite and minor amounts of bornite and molybdenite. Both sulfides and oxides occur predominantly in short discontinuous veins, veinlets, and microveinlets of quartz and epidote or structureless green chlorite + quartz. Mineralization in the Copper Basin Formation occurs as pyrite-chalcopyrite - specularite plus their oxidation products in veinlets and micro-

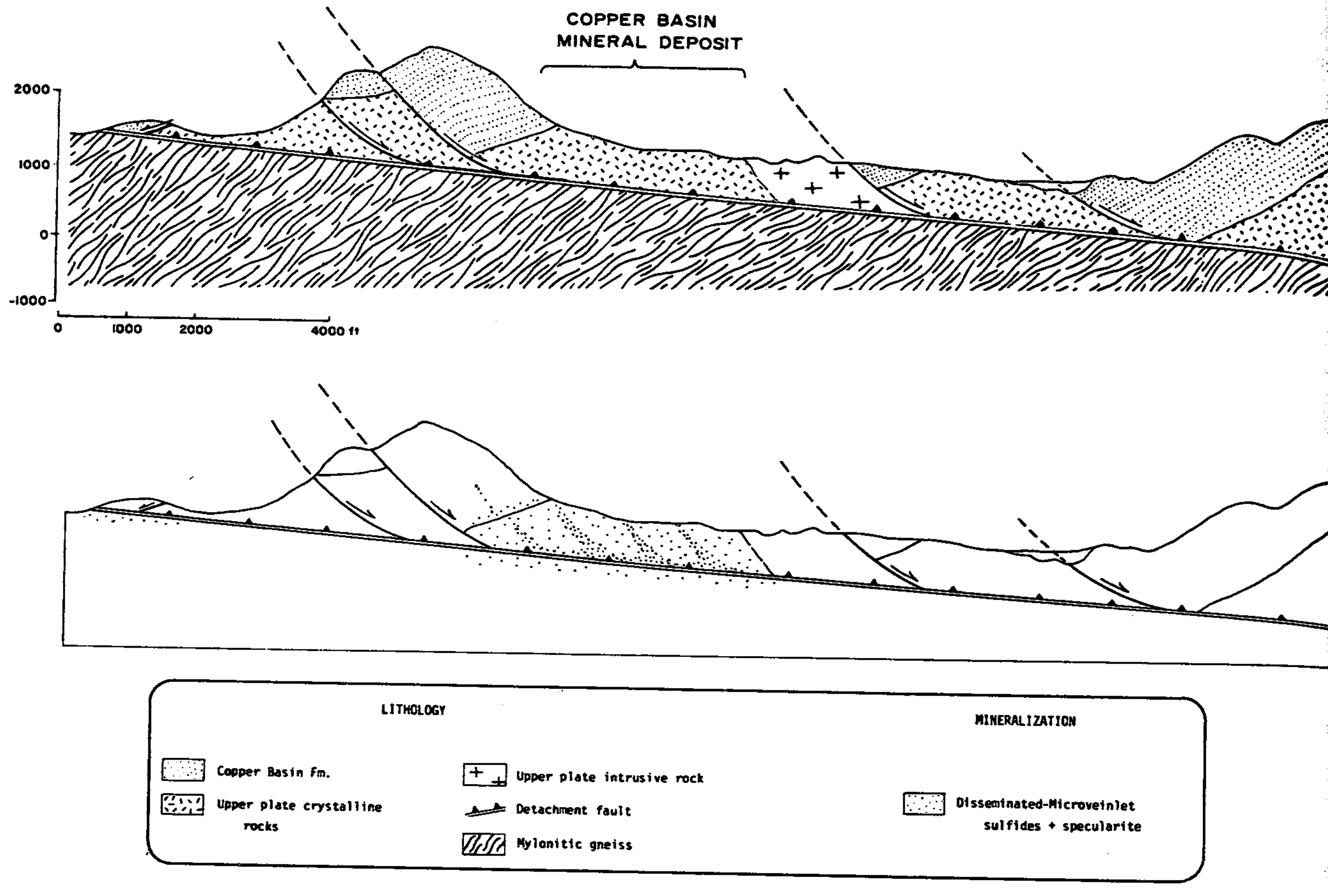


Figure 15. Generalized geologic cross-section through the Copper Basin deposit (top) adapted from Heidrick and others (1980) and a schematic representation of the structural-tectonic setting hosting significant Cu-Fe mineralization (bottom)

veinlets near the base of the section and throughout listric fault breccias (Fig. 15).

CONCLUSIONS

Detailed geologic field studies augmented by substantial diamond drilling, geochemical, petrochemical, and petrofabric data, K-Ar age dating, and previous underground mining activity provide a unique 3-dimensional data base depicting the geology and ore deposits of the Copper Penny-Swansea mine area. Our structure-tectonic synthesis of the area indicates that upper-plate Artillery Formation rocks were actively transported in an N40-45^{o}E direction across the gently dipping Buckskin detachment fault during late-Oligocene to middle-Miocene time. Detachment faulting was protracted, thin-skinned, and distensional in nature, producing profound faulting, brecciation, and shattering throughout upper- and middle-plate rocks and in lower-plate mylonites immediately beneath the detachment surface. Low-grade hydro-dynamothermal alteration and attendant base-precious metal mineralization occurred intermittently throughout the structurally disturbed sequence, but was restricted to the period of detachment-related tectonism.

Our interpretation of the data assembled clearly defines six (6) principal structural tectonic loci proven favorable for the localization of significant metallization. All recognized settings are structure-dominated and without exception they are extensional and dilatent in character. Figure 16 schematically portrays the spatial distribution of each respective locus within upper- and lower-plate rocks including, in order of their economic significance, the:

1. Granulated, brecciated, smeared-out, disseminated to massive, subhorizontal orebodies within and immediately above the flinty, chlorite, microbrecciated detachment surface.
2. Massive replacement and stringer orebodies localized in silicified and brecciated marble that was juxtaposed onto the detachment surface.
3. Open space filling ores forming moderately dipping sheets and gently raking shoots within dilatant crush breccia that are spatially restricted to both synthetic and antithetic listric normal faults.
4. Fissure filling mineralization restricted to moderately dipping conjugate systems of antithetic and synthetic gash veins and to joint planes adjoining listric normal faults.
5. Fissure filling mineralization localized longitudinally along the dilatant crests and troughs of upright-open to overturned-closed, megascopic folds.
6. Veinlet to microveinlet controlled mineralization restricted to the footwall chlorite

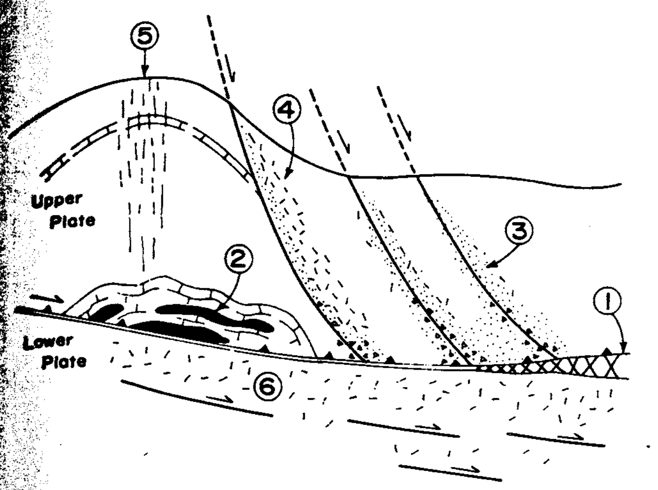


Figure 16. Structural-tectonic model of mineralization loci related to the Whipple-Buckskin detachment fault. Numbered loci 1-6 are keyed to text.

shatter breccia zone found immediately beneath the detachment fault and occasionally extending downward for several hundred feet into the footwall mylonite.

Although each tectonic-mineralization setting (1 through 6, Fig. 16) is present at all of the major deposits in the Whipple-Buckskin Mountains, economically significant concentrations are dominated by one (or more) settings. The principal loci for ore-grade metallization at each mine or prospect are, in their order of importance, (keyed to Fig. 16) as follows:

Copper Penny:	1, 3
Swansea:	2, 1
Planet-Mineral Hill:	2, 1, 3
Copper Basin:	3, 4

The existence of base or precious metals orebodies in settings 5 and 6 (or combination of these and the others) have never been fully explored and are distinct and viable targets.

This discussion of the detachment fault-related mineralization is a progress report representing the work completed to date in our ongoing efforts to clarify the nature of these deposits. Investigations using fluid inclusions, ore microscopy, and petrofabric studies were undertaken in order to further our understanding of the ore-forming process.

The detachment-listric fault structure-tectonic setting in the Mohave and adjacent terranes are current targets for additional exploration. Our reconnaissance of many of these areas demonstrate that the tectonic-mineralization relationships, shown in Figure 16, are present. We firmly believe that concentrated efforts by the exploration industry will locate orebodies in one, or combinations of the loci shown on Figure 16.

ACKNOWLEDGEMENTS

Our knowledge about and understanding of the nature and magnitude of thin-skinned detachment faulting in the Whipple-Buckskin Mountains was greatly expanded during field trips with Eric Frost and in-depth discussions with him, Greg Davis, and members of the Arizona Geological Society. Many details of mine geology were kindly provided by John Challinor, Earl Alcott, John Livermore of Cordex Exploration, and Robert Odien of Louisiana Land and Exploration Co.

We gratefully acknowledge Gulf Mineral Resources Co. for their continuing support and permission to publish these data. We wish to thank Parry Willard, Grant Cummings, and Bill Hardtke for editing the manuscript and Robert White-Harvey for drafting the figures. Norman Lehman critically reviewed early drafts and suggested changes which greatly promoted text clarity.

And finally, we are forever indebted to Georgia Recchio who so ably typed the final manuscript. Her cheerful and attentive attitude was instrumental in our completing the report on schedule.

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APPENDIX

is appendix presents the results of three Ar ages from the Whipple-Buckskin detachment area, Yuma County, Arizona. Constants used calculations are $\lambda_e = 0.575 \times 10^{-10}\ yr^{-1}$, .905 x $10^{-10}\ yr^{-1}$, and $^{40}K/K$ total = 1.18 mol/mol. Analysts: Geochron Labs., Cambridge,

e Descriptions

K-Ar

ite vitric tuff, Artillery Formation (34°09'49"N, 53'44"W; Yuma County, AZ). Quartz, orthoclase oclase and biotite noted in compacted, devitri- and slightly welded tuff. Sinuous veinlets lcite, gypsum and quartz with fluorite, barite yrite are present. Sample is about 500 feet cturally above the Whipple-Buckskin detachment t. Analytical data: (biotite) K = 5.817%, 1%; $^{*40}Ar$ = 0.01114 ppm $^{*40}Ar/\Sigma Ar^{40}$ = 45.4%, %. Collected by: T. L. Heidrick

(biotite) 27.3 ± 1.1 m.y.

-95 K-Ar

chybasalt flow, at the top of the Artillery ation (34°09'49"N, 113°52'20"W; Yuma County, Plagioclase (56%), olivine (22%), hornblende %), and magnetite (4%) with a faintly diabasic ture. Olivine is replaced by fibrous dellessite bowlingite. Sample is from drill core 100 feet ve the Whipple-Buckskin detachment fault. lytical data: (hornblende) K = 0.526%, 0.536%; Ar = 0.00696 ppm $^{*40}Ar/\Sigma Ar^{40}$ = 17.8%, 14.8%, 5%. Collected by: J. Wilkins

(hornblende) 18.6 ± 1.5 m.y.

-8-262 K-Ar

artzo-feldspathic gneiss, Buckskin Mountains meta- rphic core complex (34°10'12"N, 113°53'49"W; Yuma unty, AZ). Mylonitic augen gneiss with a grano- orite porphyry composition. The fabric is laced th pennine veinlets with quartz, epidote, pyrite d fluorite. Sample is from drill core 240 feet low the Whipple-Buckskin detachment fault. alytical data: (feldspar) K = 9.911%, 9.888%, 0.041%; $^{*40}Ar$ = 0.01240 ppm $^{*40}Ar/\Sigma Ar^{40}$ = 50.3%, .4%. Collected by: T. L. Heidrick

(feldspar) 17.7 ± .7 m.y.

FROM USBM IC 8236

Yuma

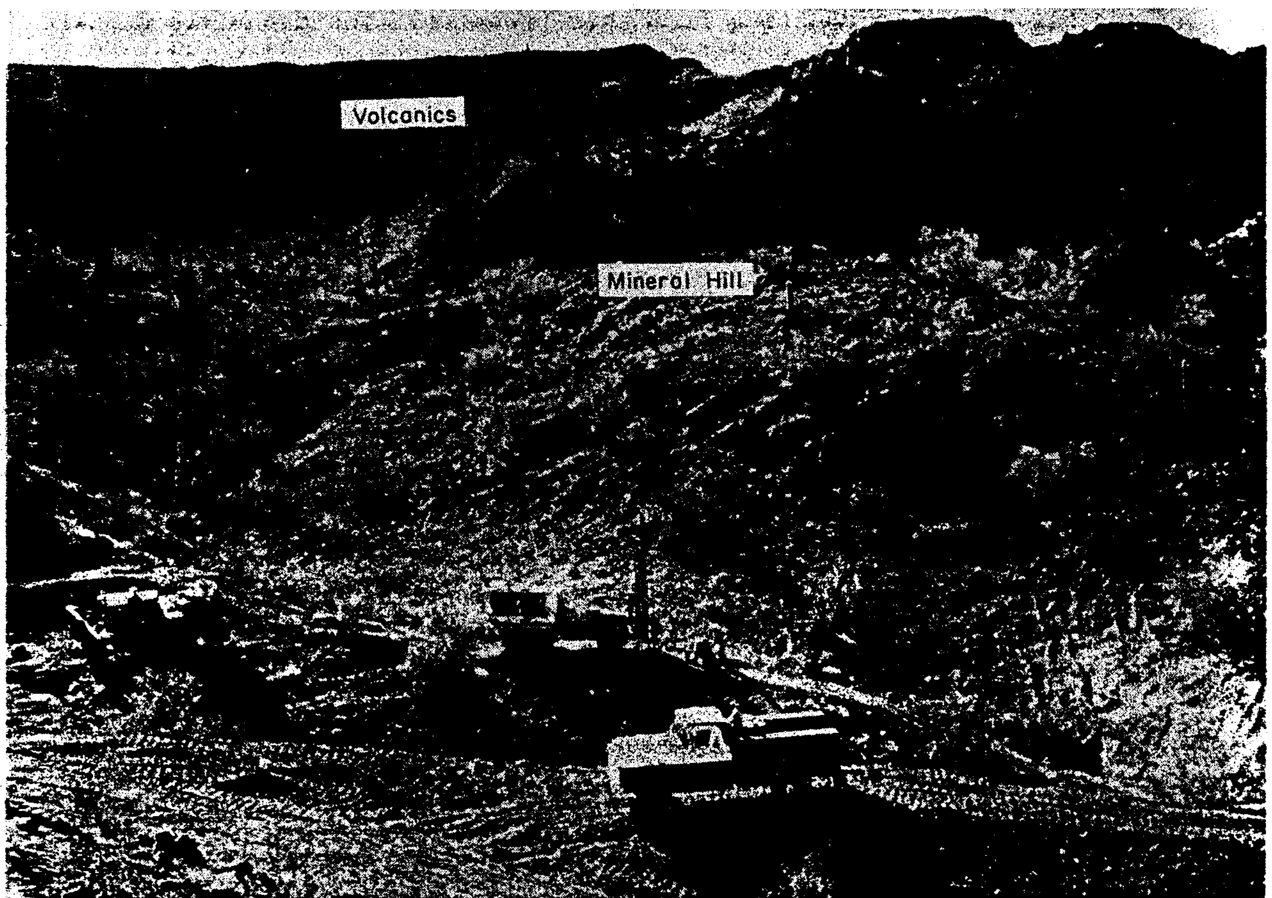

FIGURE 51. - Exploration Drilling, Marvel Mining Co., at Mineral Hill, T 10 N, R 17 W, Yuma County, Ariz.

cut by an intrusive rock metamorphosed to schist. About 9 miles east-southeast of the New Planet mine in the vicinity of Swansea the country rock is granitic gneiss overlain unconformably by dark brown massive limestone, as much as 100 feet thick, with layers of amphibolite. The limestone is cut by diabase dikes. At Brown Mountain, about 8 miles west-southwest of the New Planet mine, a large area and many smaller areas of dark brown, massive limestone occur above gneiss.

Numerous concentrations of cupreous hematite have long been known within the Buckskin Mountains at Brown Mountain, Highline, Mammoth, Mineral Hill, New Planet, Ruthie-Linda, and Swansea. Their descriptions follow:

Brown Mountain Cupreous Hematite

Massive hematite and specularite are prominent across approximatgly 2,000 acres on Brown Mountain (110, fig. 1) in the vicinity of the Copper Pride mine, approximately in secs 3 and 4, T 9 N, R 17 W, and secs 33 and 34, T 10 N, R 17 W. The deposits are 14 miles east of Parker and 7 miles southwest of Planet. During 1913 the area was located as a northeast trending block of claims, (3,600 by 7,500 feet) including the Copper Pride, Gold Cliff, Elizabeth, Elizabeth's Pride, Grande, Marshall, Clime, Circle, Hole, Admiral, General, Keepsake, Moonbeam, Copper Ridge, Mound, Axe, Square, Triangle, Home, Drum, Bell, Black Copper, Baby's Dream, Nugget Nos. 1 and 2, Chunck Nos. 1 and 2, Ocean, Bay, Bond, and Copper Gap group of claims (7).

Hematite associated with malachite and chrysocolla and some gold occurs largely as partial and irregular replacements of Paleozoic dolomitic limestones in contact with Precambrian gneiss. Accessory minerals include chlorite, epidote, sericite, biotite, muscovite, hornblende, and calcite. The deposits are similar to those at Planet, Mineral Hill, and Swansea to the north. Where observed, the deposits crop out in thicknesses of 2 to 15 feet and range from 18° to 80° in dip.

The size and quality of the hematite deposits could not be ascertained, and the area remains a prospect (4, p. 123; 7, pp. 42-57).

Highline Hematite

Hematite was noted in 1957 on the Highline No. 1 claim (115, fig. 1), west of Planet Peak and about 16 miles east of Parker, in T 10 N, R 17 W. The hematite occurs as irregular contact metamorphic replacement bodies in altered Paleozoic limestone beds. The claims were located by B. M. Reynolds and Henrietta Miller.

The hematite occurrence is insufficiently disclosed to determine the size of the deposit.

Knight Group Hematite

Hematite is (118, fig. 1) abundant on the Knight group of claims, about 5 miles south to southwest of Swansea. The occurrence is a replacement of metamorphosed Paleozoic sediments similar to many others in the Buckskin (Williams) Mountains area. A sample of the hematite-rich outcrop contained 49.4 percent iron, 0.1 percent manganese, 0.2 percent titania, 0.09 percent phosphorus, 0.10 percent sulfur, and 23.0 percent silica.

Mammoth (Corona Copper) Hematite

Hematite and some chrysocolla, quartz, barite, and fluorite occur in a silt-like formation a few feet thick along the contact between a gneiss schist complex and overlying granite breccia at the Mammoth prospect on the old Corona Copper Co. property in the Buckskin (Bill Williams) Mountain area, in the northwest corner of T 8 N, R 14 W, (120, fig. 1). The deposit is small (4, p. 122).

Mineral Hill Cupreous Hematite

Specular hematite crops out prominently at Mineral Hill (fig. 50) in the Buckskin Mountains area (121, fig. 1) in secs 2, 3, 10, and 11, T 10 N, R 17 W, in the northwest corner of Yuma County, just west of Mineral Wash and about a mile south of its confluence with the Bill Williams River. It is 3 miles west of the New Planet hematite deposit. The hematite occurrence is best reached by driving 24.7 miles northeast from Parker through Osborne and Mineral Washes. It can be reached also by driving north across desert terrain from Bouse about the same distance over poorer roads.

The hematite-rich area comprises 15 patented mining claims, 14 lode locations, and 2 placer claims, listed in appendix table A-2. The terrain is rugged between Mineral Wash, about 500 feet altitude, and the crest of Mineral Hill, about 1,200 feet altitude. Topography is characterized by shallow-walled canyons and isolated hills. Farther west, about 1,500 feet altitude, a basalt-covered plateau (figs. 50, 51) extends toward the Colorado River.

Specular hematite occurs as irregular hydrothermal replacements of metamorphosed Paleozoic sediments similar to those at New Planet and Swansea and the rocks forming Mineral Hill appear to be continuous with those overlying the Precambrian gneiss in the vicinity of the New Planet mine. Both areas were probably lifted, folded, and faulted at the same time. Dips range widely from horizontal to 50° SW due to folding and faulting. Specularite occurs with the oxidized copper minerals malachite, azurite, and chrysocolla of later origin, since they are commonly found in fractures in the hematite.

Massive hematite occupies several horizons. Outcrops more than 25 feet thick were noted. In addition, the host rock is heavily impregnated and stained with hematite. Veinlets, disseminations, and coatings of specularite occur between the beds of massive hematite. Specularite was observed also as films and layers from 1/64 inch to as much as 4 inches thick along jointing and fractures in the brown-stained country rock. As shown on the map (fig. 52) two replacement beds of cupreous hematite crop out and can be traced east-northeast towards Specularite Point and southeast paralleling the Norma Fault more than 2,200 feet. The beds appear to merge to a composite thickness of more than 40 feet around Specularite Point. The average thickness between the top of the "Upper Iron Bed" and the bottom of the Basal Iron Bed is about 75 feet.

Mineral Hill has been sporadically explored (fig. 52) by shallow pits and cuts along the outcrop, shallow adits, and shafts in search of gold and copper. The workings did not expose the hematite to advantage. From January to May 1961 the property was explored further by Marvel Mining Co. of Salt Lake City, Utah, for copper and hematite. Exploration drilling (figs. 51, 52) was accomplished by a truck-mounted wagon drill (fig. 51). In the softer formations a rotary head was substituted for the percussion drill. Cuttings, about 25 pounds per 3 feet of hole, were blown out of the hole and collected in plastic containers and then split for storage and analysis. Drill roads required blasting and grading with a bulldozer.

A character grab sample taken by the Bureau in 1961 of the outcrop material at Mineral Hill contained 38.1 percent iron, 0.1 percent manganese, 0.1 percent titania, 5.55 percent copper, 0.07 percent phosphorus, 0.36 percent sulfur, and 27.6 percent silica; spectrographic analysis indicated the presence of 1 to 10 percent aluminum, calcium, and copper; 0.1 to 1.0 percent

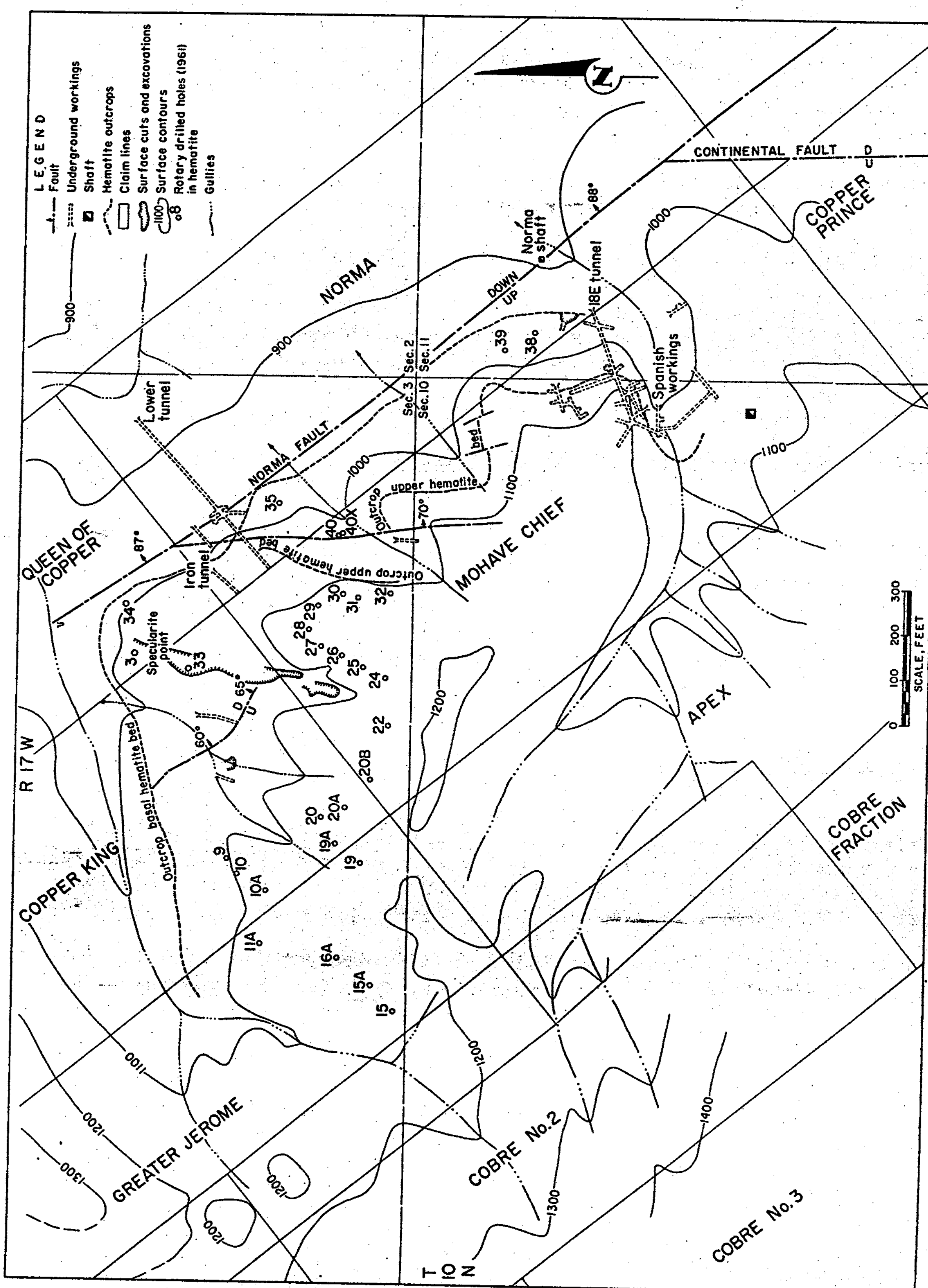

FIGURE 52. - Exploration Map, Cupreous Hematite Area, Mineral Hill, Yuma County, Ariz. (Adapted from surface map of Marvel Mining Co., Salt Lake City, Utah.)

magnesium, manganese, and titanium; 0.01 to 0.1 percent cobalt and nickel; and 0.001 to 0.01 percent vanadium. Samples from 22 exploration holes taken by Marvel Mining Co. in 1961 throughout the Upper Iron Bed contained 35.8 to 55.7 percent averaging 45.1 percent iron; samples from 15 exploration holes through the lower bed of hematite contained 33.0 to 63.2 percent iron, averaging 49.3 percent iron. In several places, particularly in the Upper Iron Bed, considerable copper is present. Sulfides were not visible at Mineral Hill. Two samples contained 4.6 and 6.4 percent manganese.

Marvel Mining Co. has proven extensions southwest from about 2,200 feet of outcrop, comprising at least two beds with thicknesses of from 10 to 40 feet. The company estimated iron reserves,[7] as of June 1961, at 3,356,000 tons of specularite ore, averaging 48.3 percent iron and an additional million tons of lower grade siliceous copper-hematite ore represented by the Bureau of Mines 1961 character sample. In addition, considerably more siliceous and lower-grade hematitic material is known to exist in the area.

The Mineral Hill deposit is one of several similar cupreous hematite occurrences in the Buckskin (Williams) Mountain area (4, pp. 55-59).

New Planet Cupreous Hematite

Hematite shows prominently in the Buckskin Mountains (122, fig. 1) in an area of approximately 4 square miles, adjacent to the Bill Williams River and the corner common to Tps 10 and 11 N, Rs 16 and 17 W, in the Planet mining district of northwest Yuma County. At the New Planet Copper mine, a solid block of 89 patented claims and lode locations, covers the area in sec 36, T 11 N, R 17 W; sec 30, T 11 N, R 16 W; sec 1, T 10 N, R 17 W; and sec 6, T 10 N, R 16 W. The claims are the property of the New Planet Copper Mining Co., N.Y.; E. R. Alcott, G. L. Gibbons, J. Buzard, Phoenix; and others. The claims are listed in appendix table A-3.

The property is reached from Bouse by driving either 29 miles north across desert- and wash-terrain to the hematite-stained hills and Smelter and Planet Washes near the Bill Williams River or 24 miles west-northwest from Parker.

Specular hematite crops out (figs. 53, 54) extensively at the New Planet copper mine and an idea of their extent is obtained from the geologic map and section (fig. 55).

Formations in the vicinity of the hematite deposits (fig. 55) comprise Precambrian gneiss and a Paleozoic complex made up of thin beds of limestone and shale, sandwiched between amphibolite, massive limestone, some quartzite and hornfels, and a sequence of fine-grained quartz-mica-sericite schists. There is evidence of faulting in the area. The hematite occurs as irregular hydrothermal replacements of the Paleozoic limestone and schist above the Precambrian gneiss.

[7] D. E. Harrison, vice-president Marvel Mining Co., Salt Lake City, Utah, Sept. 12, 1962.

magnesium, manganese, and titanium; 0.01 to 0.1 percent cobalt and nickel; and 0.001 to 0.01 percent vanadium. Samples from 22 exploration holes taken by Marvel Mining Co. in 1961 throughout the Upper Iron Bed contained 35.8 to 55.7 percent averaging 45.1 percent iron; samples from 15 exploration holes through the lower bed of hematite contained 33.0 to 63.2 percent iron, averaging 49.3 percent iron. In several places, particularly in the Upper Iron Bed, considerable copper is present. Sulfides were not visible at Mineral Hill. Two samples contained 4.6 and 6.4 percent manganese.

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Specular hematite crops out (figs. 53, 54) extensively at the New Planet copper mine and an idea of their extent is obtained from the geologic map and section (fig. 55).

Formations in the vicinity of the hematite deposits (fig. 55) comprise Precambrian gneiss and a Paleozoic complex made up of thin beds of limestone and shale, sandwiched between amphibolite, massive limestone, some quartzite and hornfels, and a sequence of fine-grained quartz-mica-sericite schists. There is evidence of faulting in the area. The hematite occurs as irregular hydrothermal replacements of the Paleozoic limestone and schist above the Precambrian gneiss.

[7] D. E. Harrison, vice-president Marvel Mining Co., Salt Lake City, Utah, Sept. 12, 1962.

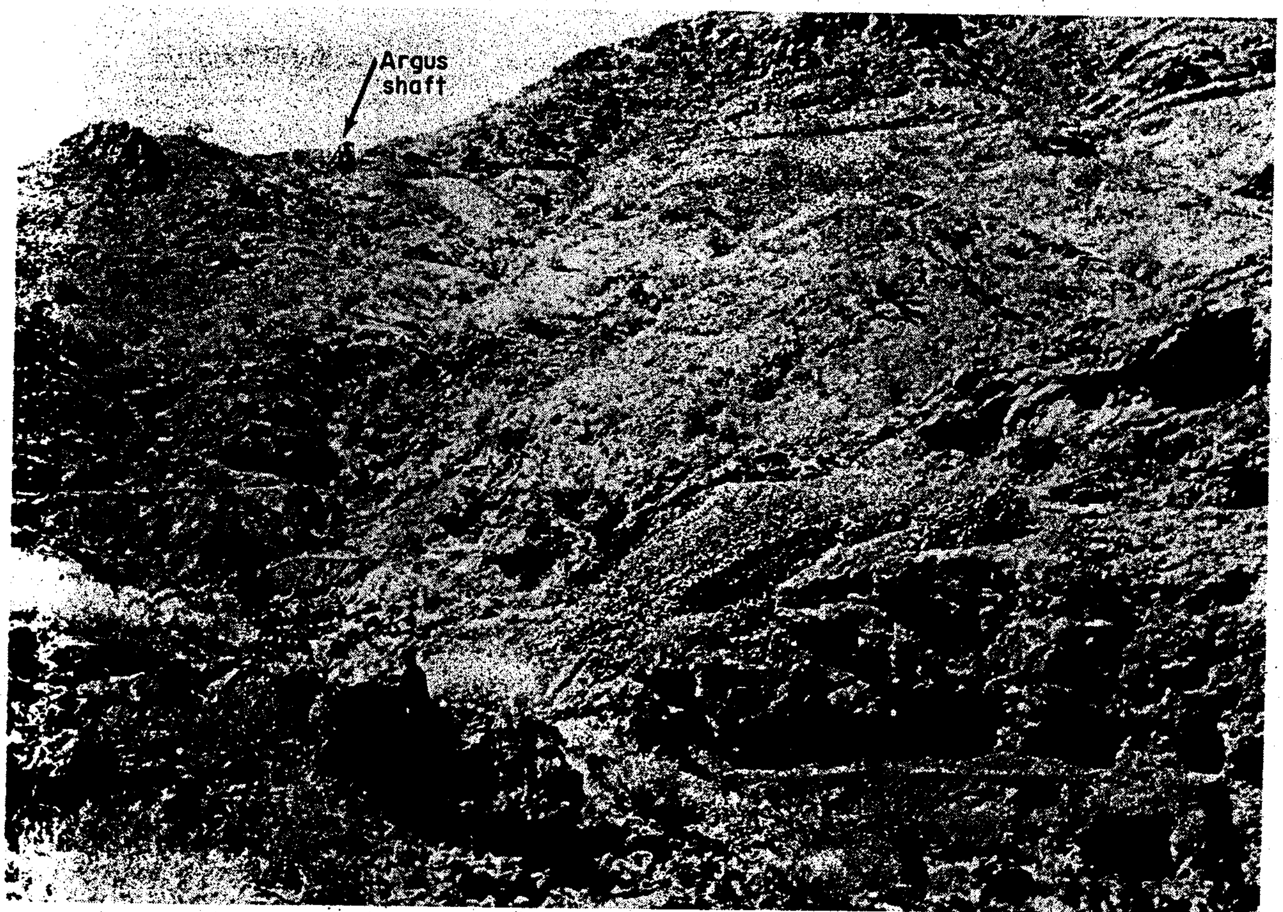

FIGURE 53. - Looking Southwest at Hematite Outcrops, Old Copper Workings and Argus Headframe, New Planet, Tps 10 and 11 N, Rs 16 and 17 W, Yuma County, Ariz.

Individual bodies of hematite are as much as 700 feet long, 250 feet wide, and 50 feet thick--consisting mainly of specularite and massive hematite with some limonite, malachite, azurite, chrysocolla, and a little pyrite, chalcopyrite, bornite, gold, and silver. Gangue minerals include quartz, calcite, and limestone. Mineralogic investigation disclosed a fine intergrowth of tabular crystals of specularite with sporadic grains of quartz, orthoclase, pyrite, bornite, and chalcopyrite. Interstices and fracture planes were filled with malachite. Hematite to a depth of about 10 feet is hard; below this depth it appears increasingly pulverulent.

The iron content of the hematite deposits varies widely, depending on completeness of replacement of limestone and schist. For comparison, hematitic schist samples contained as low as 6 percent iron, while a 5-foot Bureau core-drill sample (DDH-3, fig. 55) of the best hematite contained 67.82 percent iron, 0.013 percent copper, 0.030 percent sulfur, and 1.16 percent silica. A character sample of the more cupreous hematite taken in 1961 contained 57.9 percent iron, 7.90 percent copper, 0.05 percent lead, 0.09 percent sulfur, 0.1 percent lime, 1.65 percent alumina, 1.6 percent silica, and 2.4 percent insoluble. Spectrographic analysis indicated the presence of copper and small

magnesium, manganese, and titanium; 0.01 to 0.1 percent cobalt and nickel; and 0.001 to 0.01 percent vanadium. Samples from 22 exploration holes taken by Marvel Mining Co. in 1961 throughout the Upper Iron Bed contained 35.8 to 55.7 percent averaging 45.1 percent iron; samples from 15 exploration holes through the lower bed of hematite contained 33.0 to 63.2 percent iron, averaging 49.3 percent iron. In several places, particularly in the Upper Iron Bed, considerable copper is present. Sulfides were not visible at Mineral Hill. Two samples contained 4.6 and 6.4 percent manganese.

Marvel Mining Co. has proven extensions southwest from about 2,200 feet of outcrop, comprising at least two beds with thicknesses of from 10 to 40 feet. The company estimated iron reserves,[7] as of June 1961, at 3,356,000 tons of specularite ore, averaging 48.3 percent iron and, an additional million tons of lower grade siliceous copper-hematite ore represented by the Bureau of Mines 1961 character sample. In addition, considerably more siliceous and lower-grade hematitic material is known to exist in the area.

The Mineral Hill deposit is one of several similar cupreous hematite occurrences in the Buckskin (Williams) Mountain area (4, pp. 55-59).

New Planet Cupreous Hematite

Hematite shows prominently in the Buckskin Mountains (122, fig. 1) in an area of approximately 4 square miles, adjacent to the Bill Williams River and the corner common to Tps 10 and 11 N, Rs 16 and 17 W, in the Planet mining district of northwest Yuma County. At the New Planet Copper mine, a solid block of 89 patented claims and lode locations, covers the area in sec 36, T 11 N, R 17 W; sec 30, T 11 N, R 16 W; sec 1, T 10 N, R 17 W; and sec 6, T 10 N, R 16 W. The claims are the property of the New Planet Copper Mining Co., N.Y.; E. R. Alcott, G. L. Gibbons, J. Buzard, Phoenix; and others. The claims are listed in appendix table A-3.

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Formations in the vicinity of the hematite deposits (fig. 55) comprise Precambrian gneiss and a Paleozoic complex made up of thin beds of limestone and shale, sandwiched between amphibolite, massive limestone, some quartzite and hornfels, and a sequence of fine-grained quartz-mica-sericite schists. There is evidence of faulting in the area. The hematite occurs as irregular hydrothermal replacements of the Paleozoic limestone and schist above the Precambrian gneiss.

[7] D. E. Harrison, vice-president Marvel Mining Co., Salt Lake City, Utah, Sept. 12, 1962.

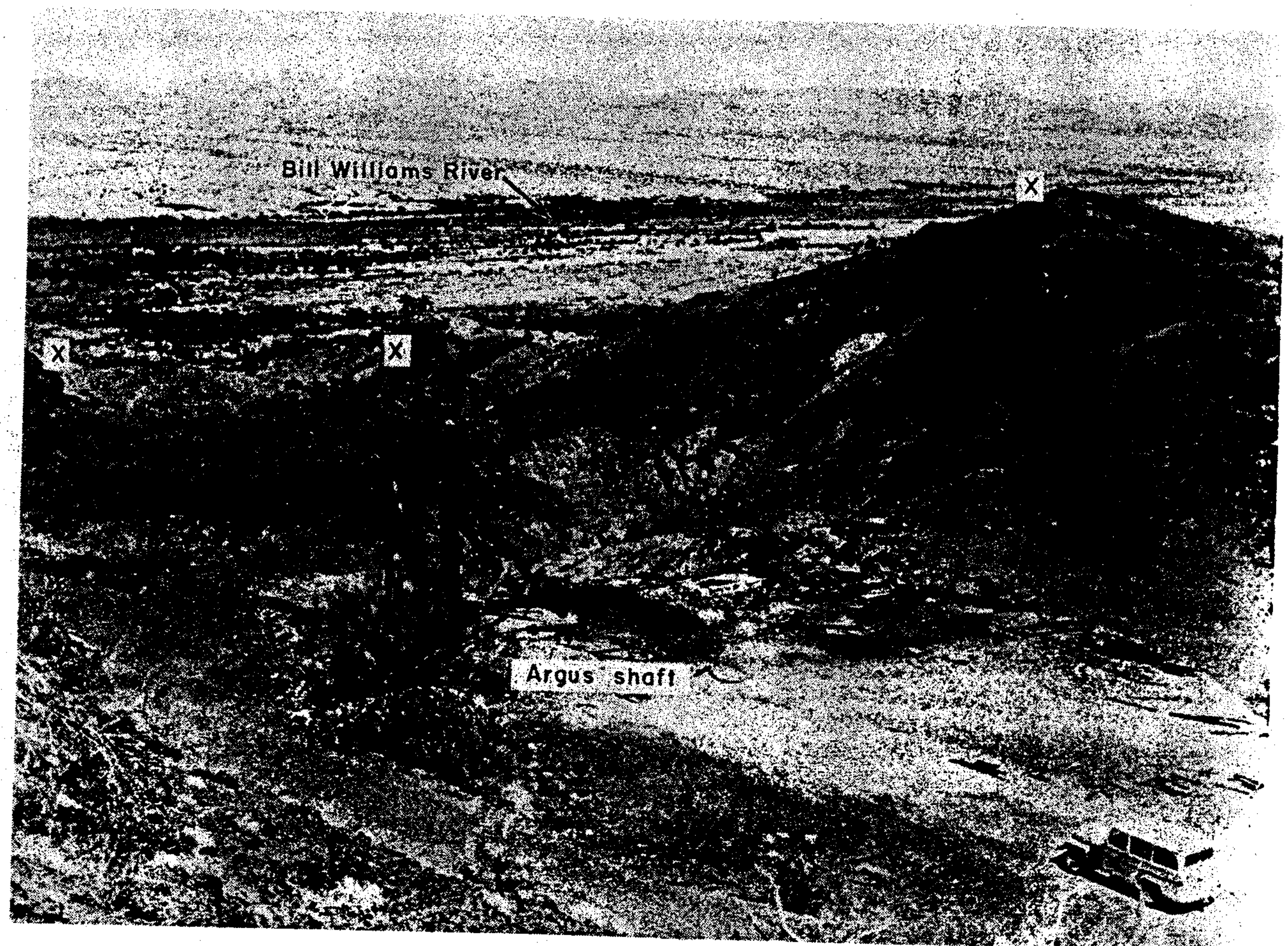

FIGURE 54. - Looking Northeast at Argus Shaft, Hematite Outcrops (X), and Distant Bill Williams River, New Planet, Yuma County, Ariz.

amounts of manganese, titanium, nickel, vanadium, chromium, cobalt, zinc, lead, silver, gallium, zirconium, and strontium.

The cupreous hematite deposits were discovered in 1863 and were developed as the New Planet copper mine. By 1906, about 50,000 tons of 10 percent copper ore was produced. The property has been idle since. During 1943-44 the New Planet mine area (fig. 55) was partly explored by the Bureau (15), and during 1945, hematite reserves were estimated (32) at 1.25 million long-tons, averaging 60 percent iron. As of 1961 there had been no production of iron from the property; however, there has been a renewed interest in this area.

With a lower grade cutoff, beneficiation, and advances in technology, very much larger reserves of hematite might be developed in this area (4, pp. 41-44, 46-55; 6, p. 388; 15, 37 pp.; 32, pp. 7, 10; 44, pp. 26, 27; 70, pp. 521, 523).

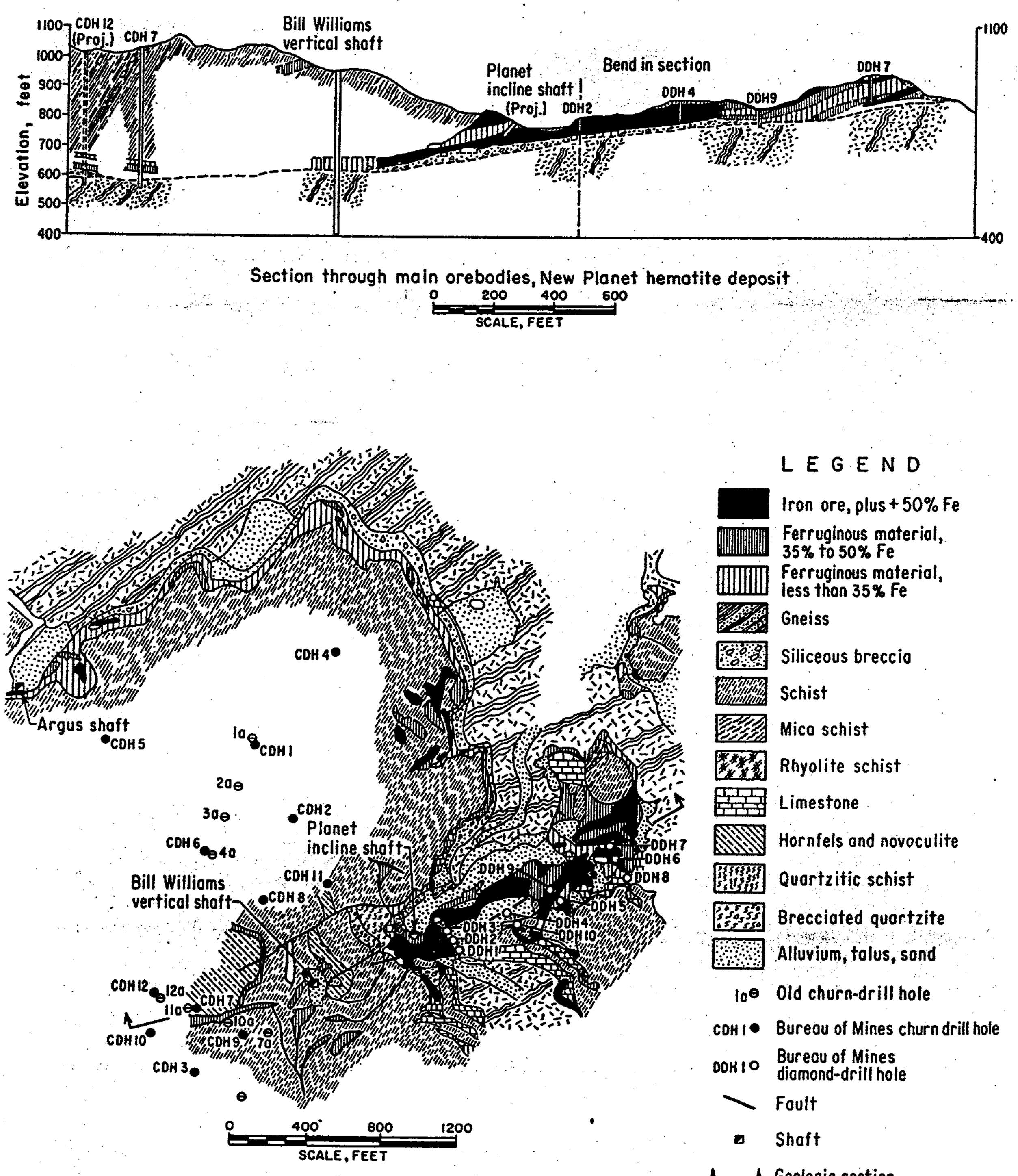

FIGURE 55. - Geologic Map and Section, New Planet Hematite Deposit, Yuma County, Ariz. (Geology by Arizona Bureau of Mines and U. S. Geological Survey.)

Ruthie and Linda Hematite

Hematite was noted in 1958 on the Ruthie and Linda group of 11 claims about 18 air miles east-northeast of Parker and 4 miles south of the New Planet property, in secs 24 and 25, T 10 N, R 17 W. In 1958 they were the property of R. M. Driver and F. and A. McHenry of Parker.

The hematite (125, fig. 1) reportedly occurs along faults cutting Precambrian gneiss, schist, and Paleozoic limestone. The largest exposure is about 150 feet long, 4 feet thick, and 20 feet deep. The deposits strike northeast to northwest with various dips. The hematite contains as much as 65 percent iron, however, much will average about 30 percent.

This hematite occurrence is being prospected.

Planet Peak Cupreous Hematite

Cupreous hematite occurs on the Dome-El Molino group at Planet Peak (124, fig. 1), approximately in secs 20, 21, 28, and 29, T 10 N, R 16 W. The claims are the property of Harry Osborne and Clara Botzum of Parker. The hematite occurs as irregular replacements of Paleozoic sedimentary rocks similar to those at New Planet and Swansea. The hematite is insufficiently disclosed to evaluate.

Hematite is exposed in an interrupted pattern on a group of 9 claims, located by H. C. Horn, and others, of Parker, about 5 miles due west of Swansea in the Cienega district. Exposures are scattered over a square mile as sporadic outcrops of hematite replacing Paleozoic rocks similar to those at New Planet. The hematite is insufficiently exposed for evaluation.

Swansea Cupreous Hematite

Specular hematite occurs in the vicinity of the ghost-mining town of Swansea (fig. 56) in the Buckskin (Williams) Mountains area (126, fig. 1), approximately in adjoining secs 29 and 32, T 10 N, R 15 W, about 23 road miles northeast of Bouse. This occurrence is on the old Clara Consolidated-Signal Mining Co. group of 61 claims. The best exposures noted were on the Copper Prince claim as several large, steeply dipping, overlapping, and irregular replacement bodies of specular hematite with some chalcopyrite, pyrite, oxidized copper minerals, quartz, and epidote in a fault block of Paleozoic limestone and amphibolite schist. It is similar in origin to the deposits at New Planet and Mineral Hill. The main deposit, exposed on the surface, strikes N 20° W and dips 45° NE. It crops out and is exposed in underground workings. The main deposit extends about 100 feet along the strike, 200 feet down dip, and is 20 to 30 feet thick. At least 2 other hematite bodies (4) are exposed on the 145- and 200-foot levels. The hematite contains as much as 2.5 percent copper and dump rock indicates manganese oxides also. Samples of the specularite contained 40 to 60 percent iron. A character sample of dump rock taken by the Bureau in 1961 contained 20.4 percent iron, 0.54 percent copper, 0.15 percent titania, 0.63 percent sulfur, 0.01 percent phosphorus, 0.08 percent manganese, and 55.8 percent silica.

FIGURE 56. - Swansea and Old Clara-Signal Mining Co., T 10 N, R 15 W, Yuma County, Ariz.

The property was developed for copper and gold through 6 shafts and 5 levels that were inaccessible in 1961. The deposits are within an area 2,500 feet long and as much as 150 feet wide. There has been no production as iron ore to date.

Samples of mill tailings, almost entirely specularite, contained 57.8 to 61.0 percent iron, 0.07 to 0.13 percent copper, 0.8 to 1.2 percent sulfur, 4.8 to 8.2 percent silica, and 1.4 to 1.6 percent lime. The mill tailings were being shipped to Victorville, Calif., for use in manufacturing cement.

The Swansea mine area would add to total reserves that could be developed in the Buckskin Mountains area; however, the copper content presents a problem (4, pp. 60-65).

Dome Rock Mountains Magnetite

Magnetite (4, 38) is a prominent feature in part of the Mesozoic schist series in the Cunningham Mountain area (111, fig. 1) of the southern Dome Rock Mountains. The occurrence was noted at the old Cinnabar mine of Colonial Mining Co., approximately in sec 28, T 3 N, R 20 W, about 9 miles southwest of Quartzsite. The occurrence is reached by driving 12 miles south of Quartzsite on U.S. Highway 95, then 15 miles southwest and north to the end of the road at the Cinnabar mine.

At the Cinnabor mine, country rock consists of a series of fine-grained quartz-mica schists of sedimentary origin. Part of the schist sequence contains an abundance of finely crystalline magnetite, giving it a mottled appearance. Schists at the mine strike N 53° W and dip 15° to 45° NE (4, pp. 82-84; 38, p. 27).

Granite Wash Mountains Cupreous Magnetite

Cupreous magnetite (113, fig. 1) occurs as a contact metamorphic replacement on the Yuma Copper and Iron Dike group of claims being developed by C. R. King and T. H. Crawford, approximately in secs 24, 25, 29, and 30, T 6 N, R 14 W, in the rugged Granite Wash Mountains of the Harcuvar range. The deposit is in the Harcuvar-Ellsworth mining district, 5.5 miles northeast of McVay and 6.5 miles north of Vicksburg.

Magnetite (fig. 57) partly replaces a bed of yellow, crystalline limestone in a Precambrian complex of metamorphosed sediments, sedimentary schists, and granite gneiss-schist and Tertiary quartz monzonite intrusives. The

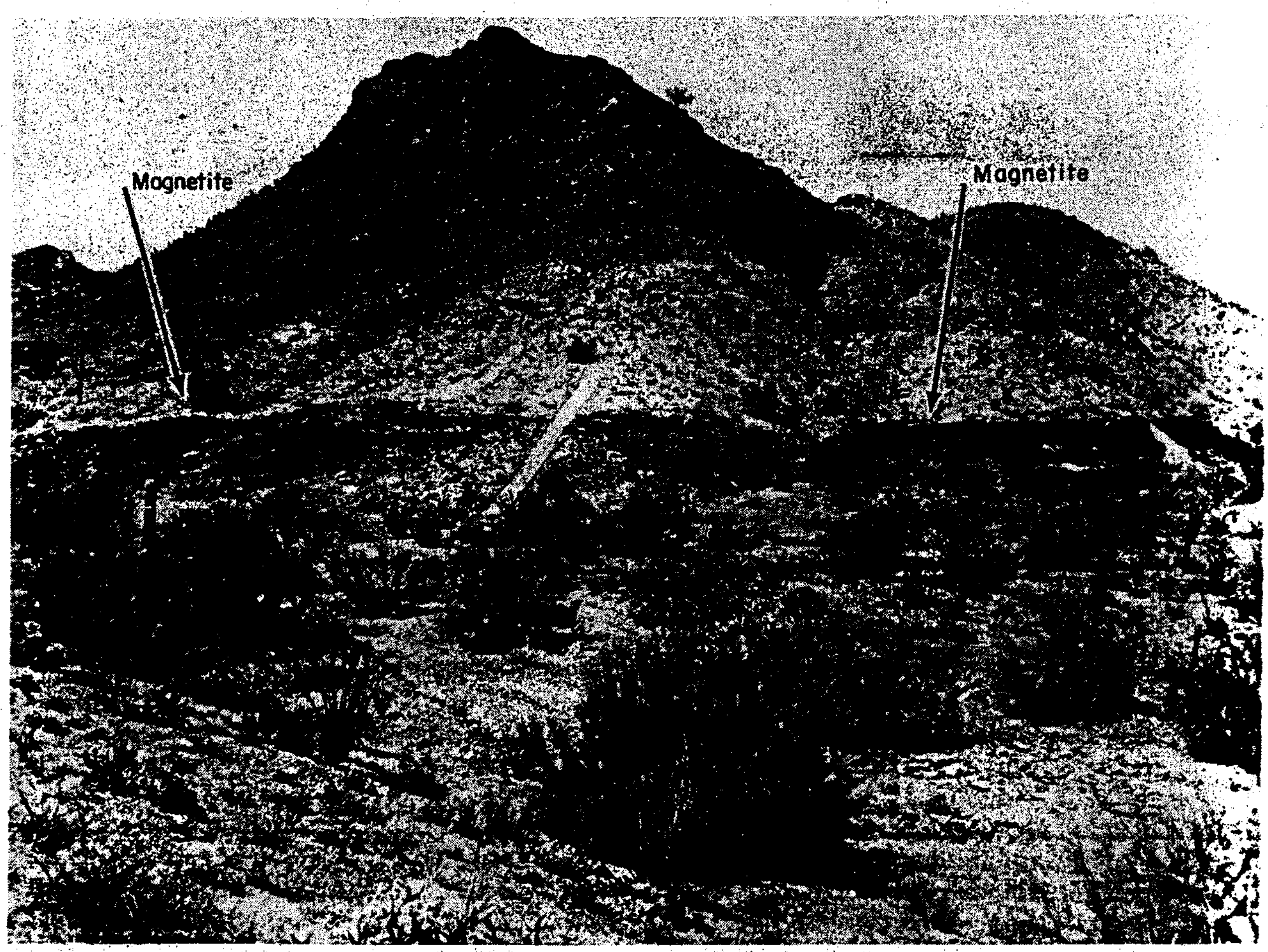

FIGURE 57. - Cupreous Magnetite Outcrop (Arrows), Yuma Copper Co., T 6 N, R 14 W, Yuma County, Ariz.

magnetite is associated with copper sulfides and their oxidation products, pyrrhotite, pyrite, garnet, actinolite, calcite, and quartz. The magnetite can be traced (fig. 57), as masses and disseminations as much as 50 feet thick, in an interrupted pattern along its north strike for several thousand feet. Dip is 15° to 35° W. A character sample of the magnetite taken by the Bureau in 1960 contained 58.4 percent iron, 0.2 percent titania, 0.3 percent manganese, 0.13 percent phosphorus, 0.14 percent sulfur, and 12.2 percent silica.

The deposit has been developed for copper by several small cuts, pits, shallow shafts, and an adit level. In 1961 underground exploration by King and Crawford indicated a cupriferous pyrrhotite-magnetite deposit, estimated to contain 50 percent iron, 0.75 to 1.6 percent copper, and 0.04 ounce gold a ton (4, pp. 95-96).

Harcuvar Mountains Hematite

Many ledges of impure siliceous hematite, some of considerable thickness, occur at Cunningham Pass (114, fig. 1) and in the vicinity of the Cunningham Pass copper mine in the Harcuvar Mountains, in T 7 N, R 12 W, about 9 miles north of Wenden. The deposits are small (4, p. 119).

Hope (Bauer-Kelly) Alluvial Magnetite

Titaniferous magnetite sand (116, fig. 1) is prominent in the alluvium of the southwest peneplain from the Little Harquahala Mountains in T 4 N, R 14 W. The alluvial deposits are about 2.5 miles south of Hope and U.S. Highway 60-70, in the valley and dry-wash areas of secs 2, 3, 9, 10, 11, 12, 13, 14, 15, 16, 17, 21, and 22 in T 4 N, R 14 W.

The magnetitic alluvium of the area was located by Paul Bauer, D. W. Kelly, and others of Wickenburg and Quartzsite. The deposit has been superficially explored with test pits and bulldozer trenches to depths from 6 to 10 feet. A sampling by Arizona Metals Co., R. R. Langley, president, indicates a 3 to 4 percent magnetite content with local concentrations as much as 10 percent magnetite. Screening and magnetic concentration tests yielded a concentrate containing as much as 68 percent iron and 0.9 percent titania. Magnetic separation of 20- to 30-mesh screened material reportedly yielded a concentrate containing 62 to 65 percent iron and 1 percent titania. Another trial resulted in a final concentrate reported as 66.11 percent iron, 0.9 to 1.01 percent titania, 0.008 percent sulfur, and 0.19 percent phosphorus.

Tank Mountains Magnetite, Hematite, Limonite, Jarosite

Magnetite, hematite, limonite, and jarosite occur in a lenticular vein filling a shear zone in granite on the Johnnie or Engesser prospect (127, fig. 1) in the northeastern part of the Tank Mountains, T 2 S, Rs 15 and 16 W., about 10 miles from Kofa and 30 miles from Clanton across desert terrain. The vein outcrop pinches to a few inches wide and swells as much as 3 feet wide. The vein strikes N 20° E, and dips 45° to 70° W. At the surface hematite is hard to pulverulent with some quartz and is flanked by like thicknesses of jarosite and limonite. Dump rock includes large aggregates of granular hematite, magnetite, and some pyrite and chalcopyrite. In depth iron grades into magnetite and considerable pyrite. Samples contained 37 to 56 percent iron.

The property is developed by a 200-foot deep shaft; 90 feet was accessible in 1960.

The deposit is considered small (74, pp. 124-125).

Trigo Mountains Hematite-Limonite

Hematite and limonite are reported (128, fig. 1) in an east-trending vein near the crest of the north end of the Trigo Mountains, approximately in T 1 S, R 22 W, 18 miles southeast of Blythe, Calif. The property is known as the E. E. Carlisle prospect. The vein is 3 to 4 feet thick and crops out about 500 feet. To the west the vein terminates against a fault, and to the east it grades into a quartz cemented breccia. A sample of the hematite taken by the Bureau in 1942 contained 63 percent iron.

Production in 1942 was about 100 tons, and the property was last operated by E. E. Carlisle of Blythe, Calif. The deposit is small.

Hematite occurs also on the southwest slope of the north Trigo Mountains (129, fig. 1), approximately in secs 5 and 6, T 1 N, R 21 W, inside the Yuma Test Station withdrawal. It is reached by driving 12 miles southeast of Ehrenberg on the Cibola Lake road, and 4 miles east along Trigo Wash. The deposit is reported as 2 to 4 feet thick and crops out in an interrupted pattern along a fracture in schist for a mile. Several shallow prospect pits and cuts expose the hematite along the outcrop. A sample of the better hematite contains 58 percent iron. Three claims along the outcrop were located by E. E. Carlisle of Blythe, Calif.

BENEFICIATION

General

Little is known about the metallurgical problems peculiar to low-grade iron deposits in Arizona. To arrive at some impression of the amenability of the iron-rich, low-grade materials to beneficiation, a few outcrop and character chip and grab samples were collected and sent to the Salt Lake City Metallurgical Research Center of the Bureau for pioneer appraisal and preliminary beneficiation testing. These studies were purely qualitative and preliminary because the samples formed part of a reconnaissance investigation and were not the results of any acceptable exploration program or fully representative metallurgical sampling. The samples, generally less than 50 pounds, were grab and chip collections spread over large areas. Results of preliminary tests on them should be considered only as a first impression. Samples from 16 localities and their chemical analyses are listed in table 28.

R.I. 3982
December 1946.

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

EXPLORATION OF NEW PLANET IRON DEPOSIT, YUMA COUNTY, ARIZ.[1]

By Joseph B. Cummings[2]

CONTENTS

ILLUSTRATIONS

INTRODUCTION

The property was first examined by an engineer[3] of the Bureau of Mines in December 1942 and was later investigated by the same engineer in January and February 1943. Prominent outcrops and underground exposures of high-grade iron ore, together with mention of sizable intersections of

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote is used: "Reprinted from Bureau of Mines Report of Investigations 3982."

2/ Mining engineer, Bureau of Mines.

3/ Thomas L. Chapman.

hematite in logs of four widely scattered churn-drill holes, indicated the possible occurrence of a substantial tonnage of iron ore at this old copper producer.

From March to May 1943, detailed topographic and geologic mapping of the property was done by the Federal Bureau of Mines, the Federal Geological Survey, and the Arizona Bureau of Mines.

Funds were allotted for exploration of the property by churn and diamond drilling. This work was started in December 1943 and completed in June 1944.

ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, Chief, conducts preliminary examination, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, Chief, analyzes samples and performs beneficiation tests. Both these branches are under the supervision of Dr. R. S. Dean, Assistant Director.

With respect to this report, special acknowledgment is due to J. H. Hedges, district engineer, and S. R. Zimmerley, regional engineer, of the Western Region of the Bureau. Work on the project was facilitated by the assistance of Eldred Wilson, of the Arizona Bureau of Mines, and Arthur P. Butler, Jr., of the Federal Geological Survey, who mapped the geology of the area.

Chemical analyses included in this paper were performed at the Bureau's laboratory, Reno, Nev., under the direction of A. C. Rice, acting supervising engineer.

LOCATION AND ACCESSIBILITY

The property is on the south bank of the Bill Williams River 12 miles above its junction with the Colorado River, in the Planet mining district, and the northwest corner of Yuma County, Ariz. (fig. 1). It is 28 miles north of Bouse, which is on the Atchison, Topeka & Santa Fe Railroad and may be reached from Bouse by a dirt road, 18 miles of which is graded county road and 10 miles unimproved desert road.

PHYSICAL FEATURES AND CLIMATE

At the property the Bill Williams River has a permanent flow. The topography is rugged. Hills, 100 to 500 feet high, are cut by numerous small canyons with steep walls, and there is little soil on the slopes. The average altitude at the property is 800 feet. The climate is hot and dry in summer but mild in winter. Vegetation is scant, except along the river bottom, where brush and cottonwood trees are plentiful. There is no timber on the property suitable for mining operations.

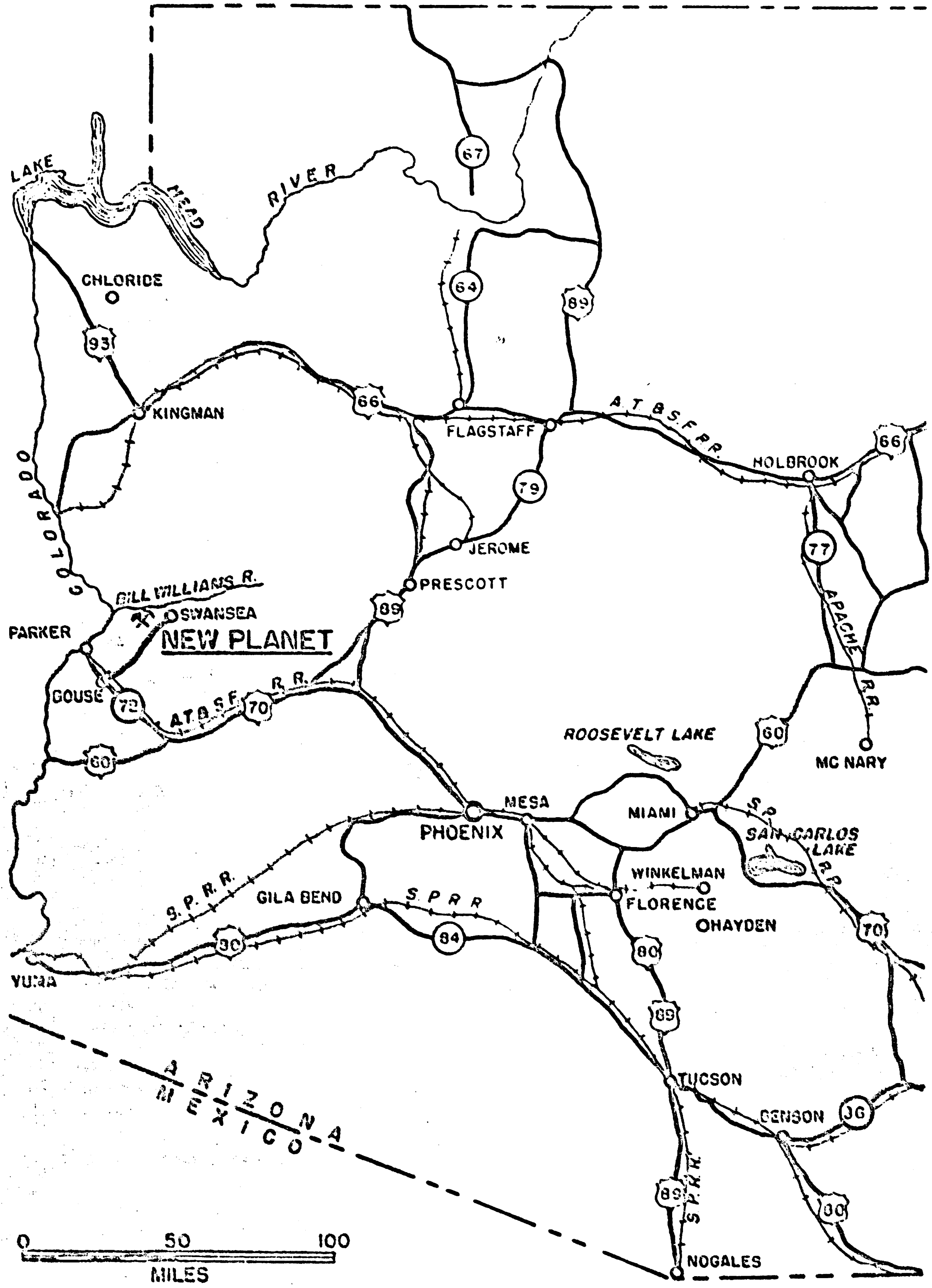

Figure 1. - Location map, New Planet iron project, Yuma County, Ariz.

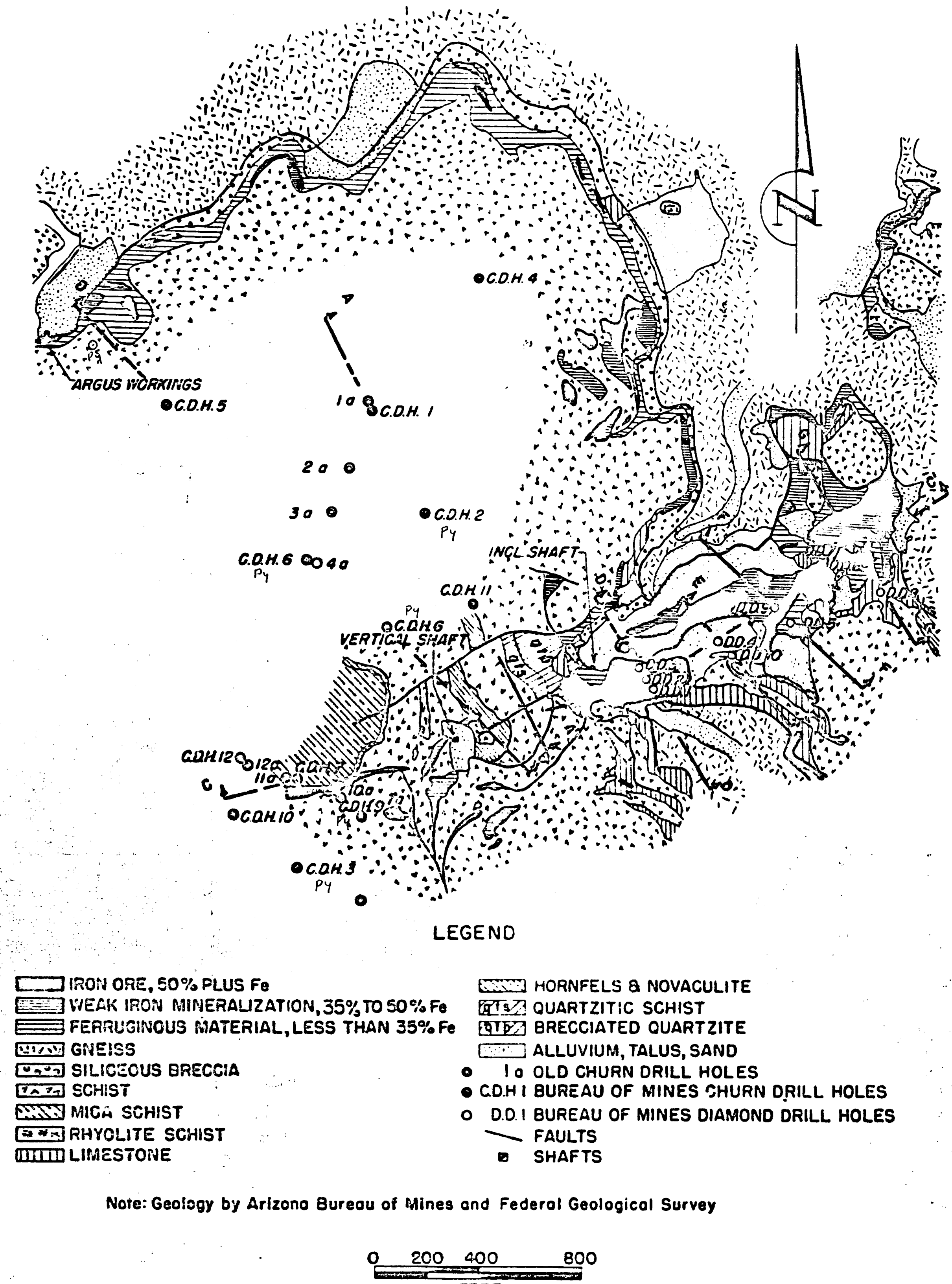

Figure 2. - Geologic map, New Planet iron mine, Yuma County, Ariz.

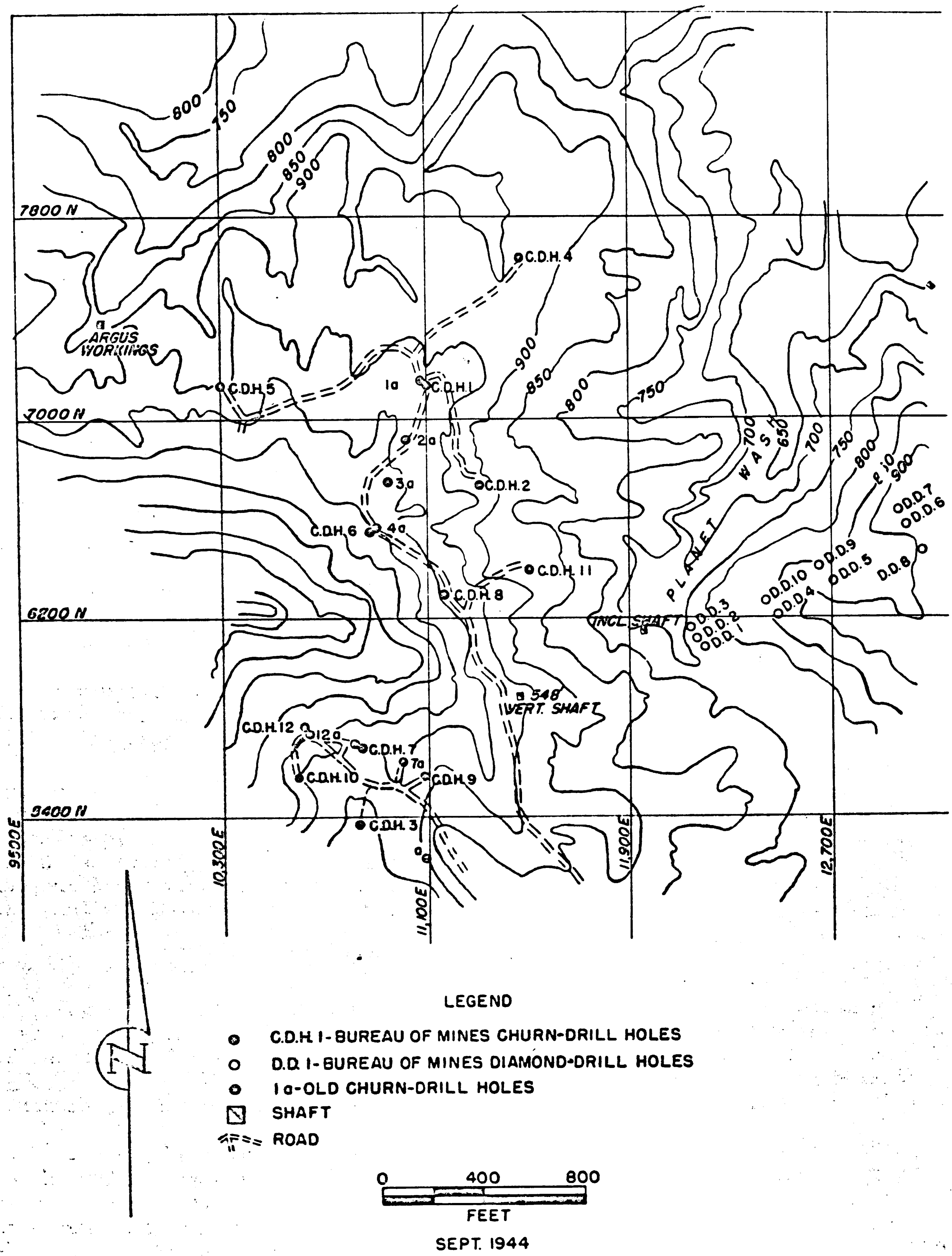

Figure 3. - Topographic map, New Planet iron project, Yuma County, Ariz.

HISTORY AND PRODUCTION

The first claims, now held by the New Planet Copper Mining Co., were located in 1863. By 1884 about 6,000 tons of highgrade copper ore had been shipped to Swansea, Wales, and to San Francisco. The ore was hauled by mule teams to Aubrey, on the Colorado River, and thence by boat to the Gulf of California, where it was loaded on ships. In 1884, a small water-jacketed smelter was installed. It operated for 6 months, treating about 1,200 tons of copper ore assaying approximately 14 percent copper. Work was carried on intermittently from 1884 to 1906, and some copper was shipped. (See fig. 2.)

In 1906, General Development Co. took an option on the property and put down nine churn-drill holes, sank a vertical shaft to a depth of 548 feet, and drove a 900-foot crosscut. Upon completion of this work, the option was relinquished.

Beginning in March 1915, the property was worked under the terms of a 3-year lease. All readily accessible copper ore was mined and shipped, together with 1,500 tons of slag. No development work was done, and the lease was relinquished. In all, about 50,000 tons of ore averaging approximately 10 percent copper has been produced. ~ 10 (10⁶) lbs Cu

Consolidated Arizona Smelting Co. sampled the property in 1920 under terms of a lease. Results were said to be disappointing, and the lease was relinquished.

Throughout the operation of the property, little attention was paid to the iron ore, although the Colorado Fuel & Iron Co. sampled it for iron in 1906. The property was still idle when the Bureau's project was in progress.

PROPERTY AND OWNERSHIP

The property consists of 31 lode-mining claims, comprising an area 3,600 feet wide by 8,000 feet long. Thirty of the claims are patented, and one claim is held by right of location and annual assessment work. It is owned by the New Planet Copper Mining Co., 61 Broadway, New York City.

DESCRIPTION OF THE DEPOSIT[4]

The rocks in the vicinity of the iron deposit comprise two series - a gneissic basement complex of probably pre-Cambrian age and a younger series of undetermined age made up of schist and limestone (see fig. 3). The ore is in the younger series of rocks, where, for the most part, it has replaced limestone. The contact between the two series is nearly flat.

Massive, brownish gray, medium-grained limestone, which weathers to a rough surface, is confined to the lower part of the younger series; however, at some places limestone is missing, and at others two or three layers of limestone are present, separated by schist. Individual bodies of limestone range in thickness from a maximum of 50 feet down to a vanishing point. Some are irregular tabular bodies; others are lenses as little as 100 feet long.

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[4] Abstracted from a report by Eldred D. Wilson, Arizona Bureau of Mines, and A. P. Butler, Jr., Federal Geological Survey.

The schistose rocks are composed mainly of quartz-mica or quartz-sericite schist but include calcareous schist, some beds of quartzite, and some hornfels.

An extensive thrust fault separates the limestone-schist series and the gneiss throughout the area. Although undulating, the fault has an essentially flat dip.

Breccia is as much as 60 feet thick along this contact. A layer of gouge from 1 to 2 feet thick is present at places along the bottom of the thrust plate, and some gouge is locally interlayered with breccia.

Several other faults exist and are believed to be subsidiary breaks in the overthrust plates, for they do not appear to displace the top of the gneiss. Mineralization along some of the faults and replacement in the brecciated rock suggest that most of the movement on the faults and the main overthrust antedated ore deposition.

Although the schistose rocks are folded and crumpled, the sharp folding of the schist is not reflected in the boundary between the gneiss and the younger rocks, and the larger bodies of limestone and schist are in discontinuous layers that are approximately concordant with the top of the gneiss or intersect the contact at low angles and are cut off by it. In the main area of outcrop of the iron ore, these layers are in broad folds, whose axes trend, and for the most part plunge gently, southwesterly in common with the top of the gneiss.

The ore occurrences consist of discontinuous lenses, irregular bodies and, in some instances, small veins. The ore bodies range in size from a few tens of cubic feet to as large as 660 feet long by 250 feet wide by 15 to 50 feet thick.

The ore is of hydrothermal replacement origin and consists of specular hematite, associated with quartz, some calcite, and sparse pyrite and chalcopyrite, also with chrysocolla and other oxidized copper minerals. The presence of some small stringers of quartz, veined by hematite, indicates that some silicification preceded deposition of the iron. At the surface and to a depth of about 10 feet the ore is very hard. Underground, the high-grade ore is pulverulent.

Ore is confined to the lower part of the younger series of rocks, but some weak iron mineralization extends well up into the series. The contacts of bodies of hematite with limestone clearly show that the hematite replaced limestone. No intrusive rock younger than the gneiss that might have served as a source of mineralizing solutions is exposed in the immediate vicinity of the ore deposit.

MINE WORKINGS AND DEVELOPMENT[5/]

Development workings aggregate about 8,000 linear feet of shafts, raises, drifts, crosscuts, and winzes. A small amount of stoping has been done. Approximately 3,000 feet of the development is between the inclined shaft and the vertical shaft. The latter is 548 feet deep. Copper ore has been produced

5/ Prior to work by the Bureau of Mines.

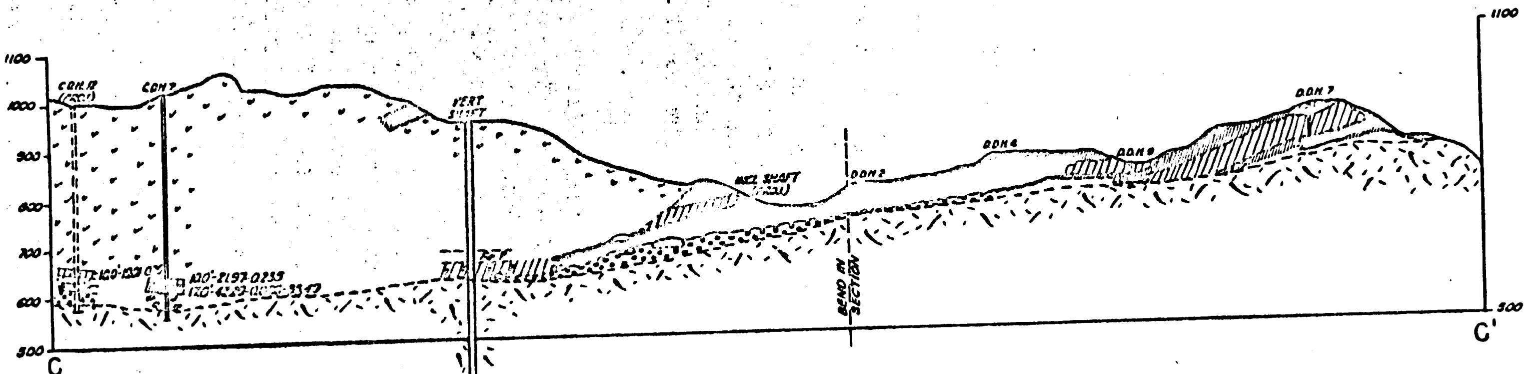


Figure 6. - Longitudinal section through churn-drill hole 7 and diamond-drill holes 2, 4, 7, and 9.

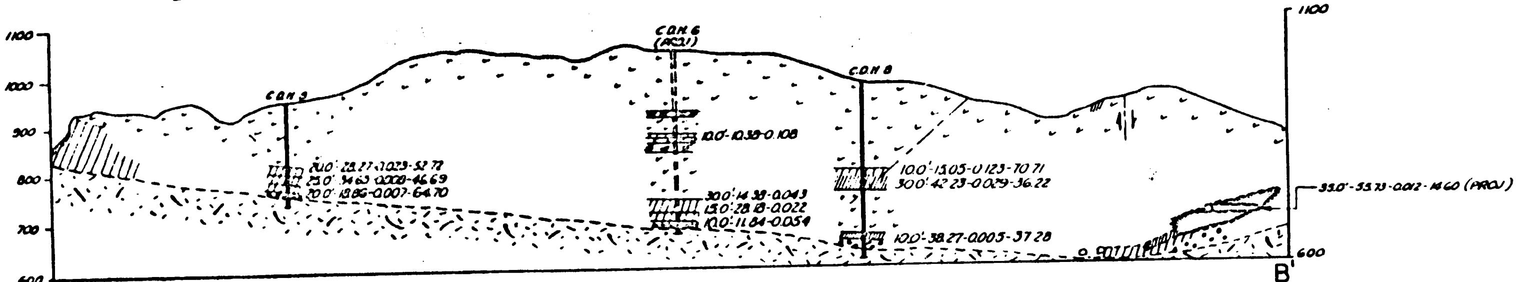


Figure 5. - Section through churn-drill holes 5 and 8.

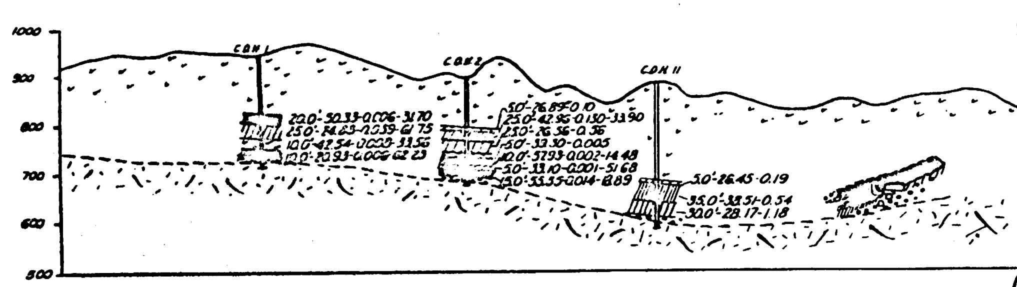


Figure 4. - Section through churn-drill holes 1, 2, and 11.

NOTES: 20.0'-50.33-0.006-31.70
FIRST FIG. INDICATES LENGTH OF SAMPLE
SECOND FIG. INDICATES % Fe
THIRD FIG. INDICATES % Cu
FOURTH FIG. INDICATES % SiO_2

0 — 250' — 500'

SEPT. 1944

LEGEND

- IRON ORE, 50% + Fe
- WEAK IRON MINERALIZATION, 35-50% Fe
- VERY WEAK IRON MINERALIZATION, 35%- Fe
- SILICEOUS BRECCIA
- GNEISS
- LIMESTONE
- SCHIST
- RHYOLITE SCHIST
- ALLUVIUM

from virtually all the workings, and iron ore is exposed in some of them. As all work was done in search of copper ore, only in a few places have the iron-ore deposits been crosscut.

The nine churn-drill holes put down by the General Development Co. lie southwest and northwest of the vertical shaft. Although drilled for copper, old logs of four of these holes reported intersections of iron ore.

WORK DONE BY THE BUREAU OF MINES

Preparatory Work

Preparatory work in connection with the exploratory project by the Bureau of Mines consisted of construction of a camp to accommodate Bureau employees and the drilling crew, repairing the desert road from the Bouse-Swansea road to the property, and construction of roads to drilling sites.

Churn Drilling

Twelve holes aggregating 3,742.5 feet were drilled. Eight of the holes - 1, 2, 4, 5, 6, 7, 8, and 11 (see figs. 4-6) - served to prospect an area containing, roughly, 4,400,000 square feet and bounded on the west and north by a continuous outcrop containing iron mineralization of varying degrees of intensity. A portion of the southern part of this area has been explored by underground workings in which is exposed a good grade of iron ore of an average thickness of 30 to 35 feet. These drill holes indicate the presence of an extensive zone of iron mineralization at an average depth of 175 feet below the surface. However, with the exception of 15 feet of 55.55-percent iron ore at hole 2 and 20 feet of 50.33-percent iron ore at hole 1, the intensity of mineralization is too slight to constitute ore of a commercial grade.

Drill holes 3, 7, 9, and 12 served to prospect for the southwesterly extension of the ore bodies that outcrop east of Planet Wash and extend into the mine workings between the inclined shaft and 548-foot vertical shaft. No commercial ore was found in these four holes.

To safeguard against possible contamination of sludge, all holes except hole 1, were cased from the collar to the top of each mineralized zone. A bottom-valve-type bailer was employed for cleaning cuttings from the hole, while drilling in mineralized zones. When approaching and while drilling in mineralized zones, 2-1/2-foot runs were made. The 2-1/2-foot runs were combined in 5-foot samples, except where a change in sludge color and panning indicated a change in the degree of mineralization.

All samples showing iron mineralization were mechanically split by using a Ray-type splitter. This consists of three Jones-type splitters set one above the other in such a manner that the sample obtained is about 12-1/2-percent of the material entering the splitter. After drying, the sample was split several times with a Jones-type splitter. The final sample, which was generally about 1.6 percent of the total sludge, was weighed and sacked. A reject, generally about 3 percent of the total sludge, was also saved. In all, 214 samples were taken.

Diamond Drilling

Ten holes, aggregating 569.4 feet, were drilled to determine the grade and extent of the ore that outcrops east of Planet Wash. (see figs. 7-10).

Sampling (Surface and Underground Exposures)

Channel samples were taken of ore exposures in the underground workings between the inclined and vertical shafts. This sampling was done during the time that the initial survey of the property was made in 1943. The results of this sampling are shown on figure 11.

During the time that the drilling program was in progress, 36 channel samples were taken along the northwest edge of the mineralized outcrop, east of Planet Wash. The locations of these samples are shown on figures 7, 8, and 10.

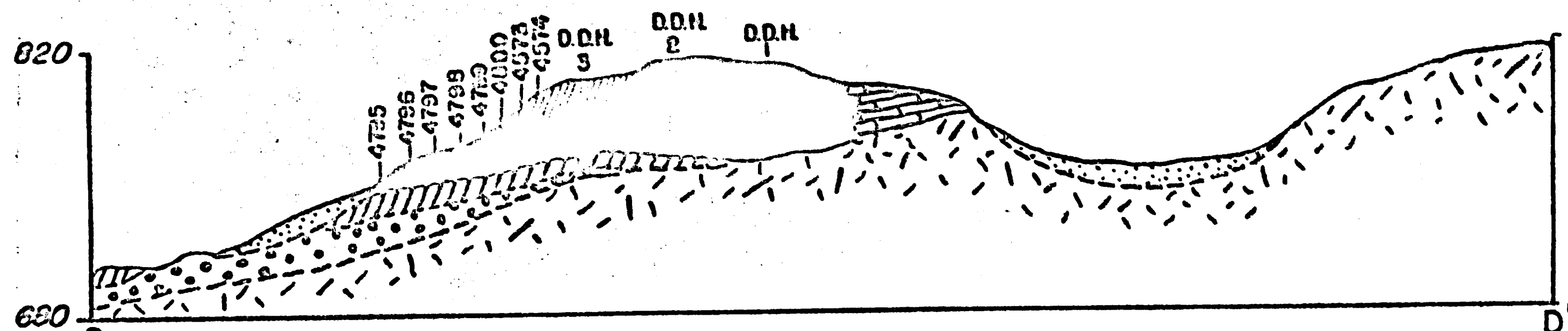


Figure 7. - Section D-D' along diamond-drill holes 1, 2, and 3.

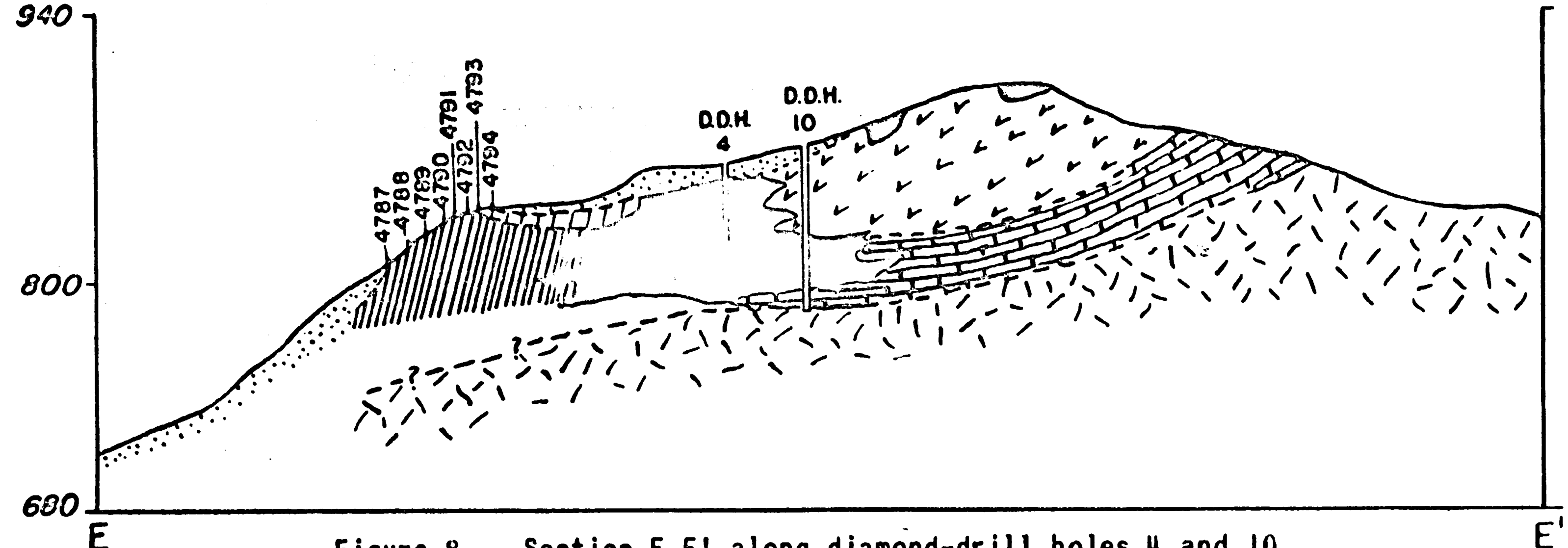


Figure 8. - Section E-E' along diamond-drill holes 4 and 10.

LEGEND

- IRON ORE, 50% PLUS Fe
- IRON MINERALIZATION, 35-50% Fe
- FERRUGINOUS MATERIAL, LESS THAN 35% Fe
- ALLUVIUM
- LIMESTONE
- SCHIST
- GNEISS
- 4795 SAMPLE NUMBER

0 50 100 200 FEET

SEPT. 1944

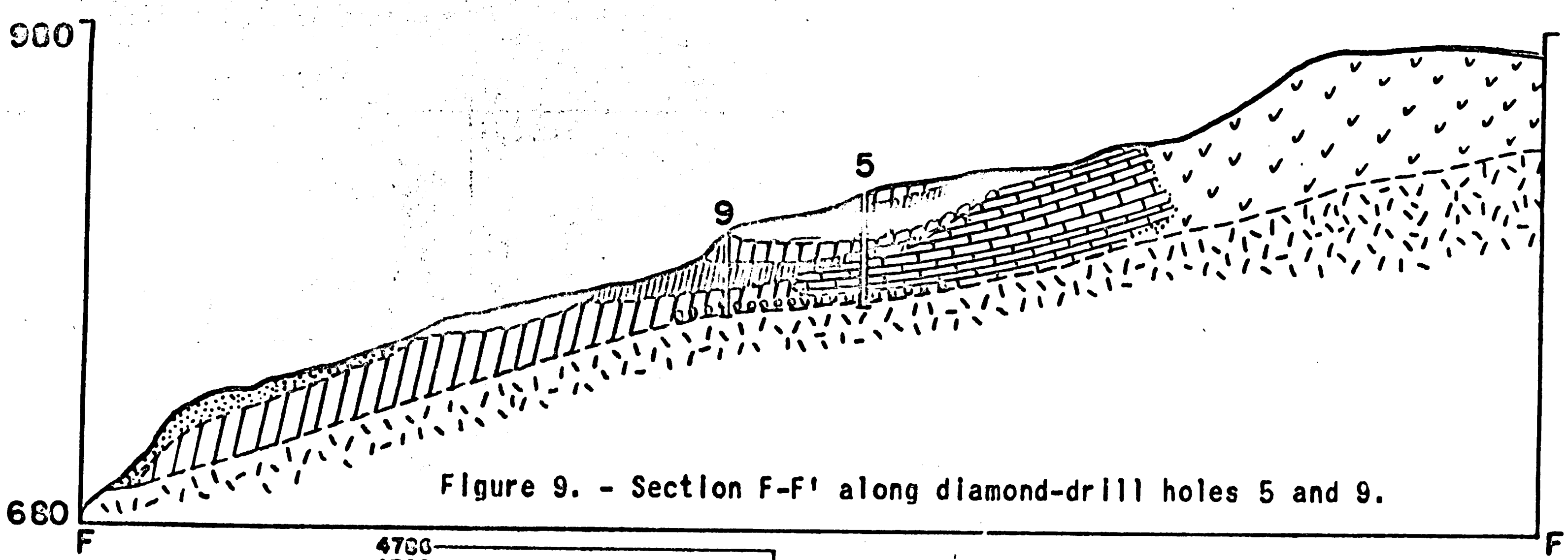


Figure 9. - Section F-F' along diamond-drill holes 5 and 9.

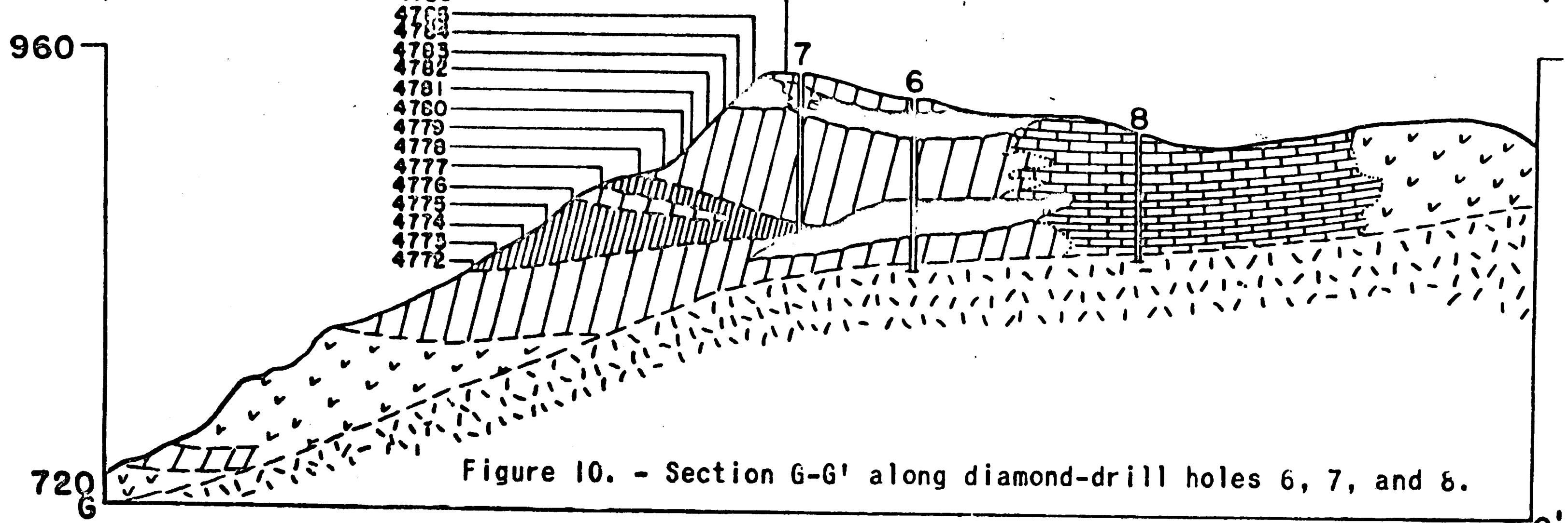
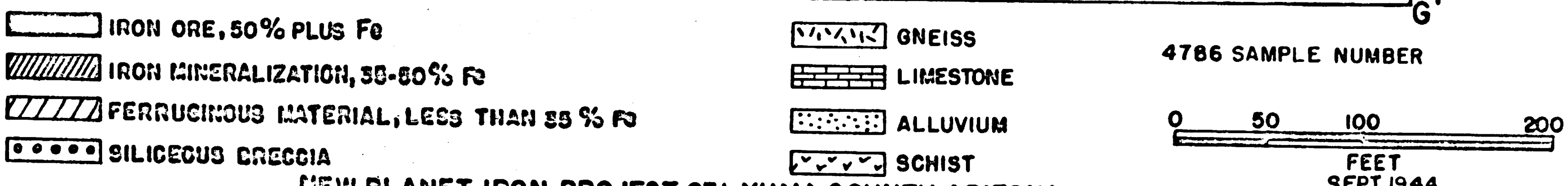


Figure 10. - Section G-G' along diamond-drill holes 6, 7, and 8.



NEW PLANET IRON PROJECT 931, YUMA COUNTY, ARIZONA

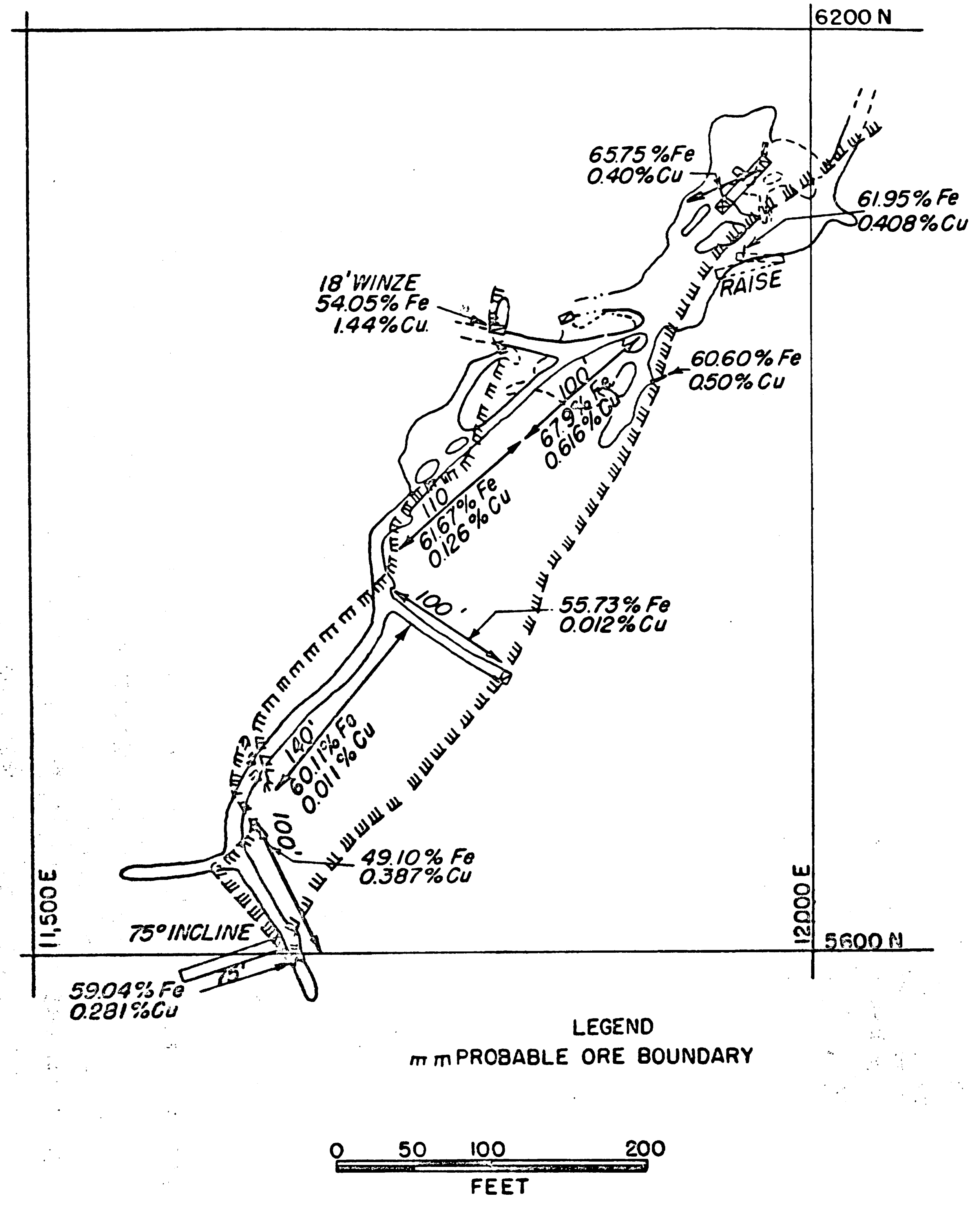


Figure 11. - Plan of drift level, New Planet iron project, Yuma County, Ariz.

LOGS OF CHURN-DRILL HOLES

The location of churn-drill holes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 as shown on figs. 2 and 3.

CHURN-DRILL HOLE 1.

Location: 7,085 N., 11,100 E. Elevation of collar: 955 feet Depth: 230 feet

Interval From	Interval To	Fe	Cu	SiO_2	S	P	Al_2O_3	CaO	Formation
0	85								Schist, slight spec. hematite 0-115.
85	90	8.17	0.010						
90	95	7.41	.012						
95	100	7.82	.002						
100	105	11.62	.010						
105	110	9.93	.002						
110	115	10.14	.002						
85	115	Composite		78.64	0.08	0.046	2.40	0.42	
115	120	51.92	0.005						Specular hematite, quartz, and some schist, 115-135.
120	125	51.36	.039						
125	130	47.71	.090						
130	135	38.31	.056						
115	135	Composite		31.70	.24	.101	1.42	.20	
135	140	30.88	0.052						Schist, some specular hematite, and limonite, 135-185.
140	145	28.40	.096						
145	150	21.30	.012						
150	155	16.69	.010						
155	160	13.70	.003						
135	160	Composite		61.75	.18	.090	2.12	.15	
160	165	9.26	0.025						
165	170	10.10	.003						
170	175	9.94	.015						
175	180	9.90	.010						
180	185	10.20	.015						
160	185	Composite		76.56	.33	.087	3.19	.21	
185	190	41.16	0.003						Siliceous specular hematite, 185-195.
190	195	43.92	.003						

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CHURN-DRILL HOLE 1.

From	To	Analysis, Percent Fe	Cu	SiO2	S	P	Al2O3	CaO	Formation
185	195	Composite		33.56	0.28	0.064	1.28	0.09	
195	200	27.54	0.010						
200	205	14.32	.002						
195	205	Composite		62.23	.23	.049	2.03	.33	Schist, quartz, some spec. hematite, 195-205.
205	230	-	-	-	-	-	-	-	Gneiss, 205 - 230.

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CHURN-DRILL HOLE 2.

Location: 6,695 N., 11,501 E. Elevation of Collar: 895 feet Depth: 215 feet

Interval From	Interval To	Fe	Cu	SiO_2	S	P	Al_2O_3	CaO	Formation
0	90								Schist and quartz, 0 - 90.
90	95	26.89	0.100						Slight spec. hematite, 90 - 95.
95	100	43.41	.176						
100	105	44.03	.063						Specular hematite, some schist and
95	105	Composite		30.90	0.100	0.056	2.28	0.18	quartz, 95 - 120.
105	110	42.33	.028						
110	115	42.21	.044						
115	120	42.59	.202						
105	120	Composite		36.00	.074	.113	1.50	.12	Schist, quartz, some specular
120	125	26.51	.229						hematite, 120 - 155.
125	130	23.71	2.158						Chrysocolla, 120 - 135.
130	135	30.60	.127						
135	140	24.72	.048						
140	145	27.38	.038						
145	155	-	-						
155	160	39.30	.005						Specular hematite, schist and quartz,
160	165	59.83	.002						155-160.
165	170	56.03	.002						Specular hematite, 160 - 170.
160	170	Composite		14.48	.104	.063	.61	.01	Specular hematite, schist, and quartz,
170	175	33.10	.001	31.63	.102	.054	.81	.01	170 - 175.
175	180	55.67	.011						Specular hematite, very hard, 175-190.
180	182	61.54	.016						
175	182	Composite		17.14	.072	.051	.47	.02	
182	187	52.93	.015						
187	190	55.63	.011						
182	190	Composite		20.42	.034	.074	1.09	.01	
190	195	25.21	.031						Schist, quartz, and gneiss, 190 - 195.
195	215	-	-						Gneiss, considerable pyrite, 195 - 215.

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CHURN-DRILL HOLE 3.

Location: 5,314 N., 10,835 E. Elevation of collar: 940 feet Depth: 477 feet

Interval		Analysis			Formation
From	To	Cu, Percent	Ozs. Ag.	Ozs. Au.	
0	5	-	-	-	Hornfels.
5	44	-	-	-	Schist and hornfels.
44	387	-	-	-	Schist, water at 350.
387	392	0.508	none	trace	
392	424				Gneiss, considerable pyrite, some copper sulphide and native copper, 387 - 477.
424	429	.122	none	trace	
429	434	.110	"	"	
434	439	.140	"	"	
439	444	.120	"	"	
444	449	.220	"	"	
449	454	.148	"	"	
454	459	.122	"	"	
459	464	.272	"	"	
464	469	.176	"	"	
469	474	.208	"	"	
474	477	.142	"	"	

CHURN-DRILL HOLE 4.

Location: 7,600 N., 11,500 E. Elevation of collar: 908 feet Depth: 150 feet

Interval From	Interval To	Analysis, Percent Fe	Analysis, Percent Cu	Formation
0	45	-	-	Schist, 0 - 45.
45	50	16.50	0.018	Schist, quartz and slight specular hematite, 45 - 67.5.
50	55	-	-	
55	60	18.60	.017	
60	62.5	14.48	.017	
62.5	67.5	14.90	.012	
67.5	72.5	42.51	.007	Specular hematite, considerable quartz, 67.5 - 72.5.
72.5	77.5	28.31	.012	Schist, quartz, some spec. hematite, 72.5 - 107.5.
77.5	82.5	25.59	.013	
82.5	87.5	16.50	.019	
87.5	92.5	13.47	.020	
92.5	97.5	14.41	.019	
97.5	102.5	20.22	.011	
102.5	107.5	21.58	.028	
107.5	112.5	-	-	Breccia and gouge, 107.5 - 112.5.
112.5	150	-	-	Gneiss - 112.5 - 150.

CHURN-DRILL HOLE 5.

Location: 7,083N., 10,300 E. Elevation of collar: 955 feet Depth: 218 feet

Interval From	Interval To	Fe	Cu	SiO_2	S	P	Al_2O_3	CaO	Formation
		Analysis, Percent							
0	75								Schist and quartz, 0 - 75.
75	80	11.95	0.008						Schist, quartz, slight specular hematite, 75 - 130.
80	85	15.85	.002						
85	90	14.49	.010						
90	95								
95	100	14.50	.003						
100	105	13.01	.007						
105	110	10.49	.005						
110	115	11.39	.038						
115	120	11.06	.035						
120	125	10.86	.020						
125	130	21.84	.023						
130	135	29.90	.017						
135	140	29.79	.013						Specular hematite, considerable quartz, 130 - 175.
130	140	Composite		51.83	0.326	0.043	0.71	0.37	
140	145	34.51	.015						
145	150	18.89	.045						
140	150	Composite		53.66	.344	.062	1.13	.34	
150	155	39.90	.008						
155	160	31.78	.005						
160	165	31.31	.002						
165	170	35.81	.021						
170	175								
150	175	Composite		46.69	.468	.025	.53	.21	
175	180	25.50	.022	57.35	1.930	.032	.33	.22	Schist quartz, some specular hematite, 175 - 200.
180	185	14.09	.002						
185	190	21.65	.002						
190	195	13.45	.002						
180	195	Composite		67.14	1.288	.028	.53	.19	
195	218								Gneiss, 200 - 218.

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CHURN-DRILL HOLE 6.

Location: 6,496 E., 10,872 E. Elevation of collar: 1050 feet Depth: 380 feet

Interval From	Interval To	Analysis, Percent Fe	Analysis, Percent Cu	Formation
0	170			Schist and some quartz, 0 - 170.
170	175	11.76	0.150	Schist, slight specular hematite, 170 - 180.
175	180	9.00	.065	
180	307			Schist and quartz, 180 - 307.
307	312	10.75	.040	Schist, quartz, and slight specular hematito, 307 - 337.
312	317	13.26	.042	
317	322	16.50	.030	
322	327	13.20	.097	
327	332	12.60	.043	
332	337	19.96	.005	
337	342	31.90	.035	Specular hematite, considerable quartz, and schist, 337 - 352.
342	347	24.99	.030	
347	352	27.65	.002	
352	357	14.70	.045	Breccia and gouge, 352 - 359.
357	362	8.98	.063	Gneiss, some pyrite, 359 - 380.
362	380	-	-	

CHURN-DRILL HOLE 7.

Location: 5,654 N., 10,835 E. Elevation of collar: 10,19 feet Depth: 475 feet

Interval		Analysis, Percent							Formation
From	To	Fe	Cu	SiO_2	S	P.	Al_2O_3	CaO	
0	151								Schist, 0 - 151.
151	156	9.21	0.100						Schist, slight specular hematite, 151 - 161.
156	161	9.62	.080						
161	310	-	-						Schist, 161 - 310.
310	315	7.28	.045						Schist, slight specular hematite, 310 - 342.5.
315	320	7.02	.055						
320	325	6.35	.075						
325	335	-	-						
335	340	7.05	.030						
340	342.5	9.08	.005						
342.5	375	-	-						Schist and quartz, 342.5 - 375.
375	380	13.82	.225						Schist, quartz slight specular hematite, some chrysocolla, 375 - 395.
380	385	13.80	.203						
385	390	27.04	.302						
390	395	16.90	.168						
395	400	36.95	.031	44.50	0.124	0.033	1.38	0.23	Specular hematite, quartz, and schist, 395 - 412.
400	405	49.72	.087	25.50	.112	.051	1.14	.36	
405	410	41.28	.095	35.06	.58	.058	2.03	.30	
410	412	39.40	.125	36.68	.38	.041	2.84	.37	
412	417	7.32	.050	-	-	-	-	-	Rhyolite schist, 412 - 452.
417	475	-	-	-	-	-	-	-	Gneiss, 452 - 475.

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CHURN-DRILL HOLE 8.

Location: 6,250 N., 11,150 E. Elevation of collar: 981 feet Depth: 365 feet

Interval From	Interval To	Fe	Cu	SiO_2	S.	P.	Al_2O_3	CaO	Formation
0	185								Schist and quartz, 0 - 185.
185	190	17.40	0.095						Schist, quartz, and slight specular
190	195	12.71	.150						hematite, 185 - 195.
185	195	Composite		70.71	0.042	0.032	4.38	0.33	
195	200	42.81	.018						Specular hematite, considerable
200	205	42.15	.055						quartz, 195 - 225.
205	210	43.34	.052						
210	215	47.53	.013						
215	220	39.68	.020						
200	220	Composite		34.33	.038	.077	2.80	.54	
195 to 200 & 220 - 225		Composite		40.00	.046	.112	2.56	.33	Lost sludge 225-230, fault?
225	230	-	-						Schist, 230 - 315.
230	235	6.00	.552						
235	315	-	-						
315	320	44.47	.002						Specular hematite, considerable
320	325	32.08	.003						quartz and schist, 315 - 325.
315	325	Composite		37.28	.080	.072	4.59	.15	
325	330	16.38	.030						
330	335	10.91	.038						Breccia and gouge, 325 - 342.
335	340	6.02	.568						
325	340	Composite		71.10	1.75	.030	6.37	.29	
340	345	5.01	.242						Gneiss, considerable pyrite, 342 - 365.

CHURN DRILL HOLE 9.

Location: 5,518 N., 11,081 E. Elevation of collar: 958 feet Depth: 420 feet

Interval From	Interval To	Analysis, Percent Fe	Analysis, Percent Cu.	Formation
0	369	-	-	Schist and quartz, 0 - 369.
369	373	14.88	0.015	Schist, quartz, slight specular hematite, and chrysocolla, 369 - 388.
373	378	14.08	.850	
378	383	22.90	3.525	
383	388	17.10	1.693	
388	393	4.99	.417	Breccia and gouge, 388 - 393.
393	420	-	-	Gneiss, considerable pyrite, 393 - 420.

CHURN-DRILL HOLE 10.

Location: 5,522 N., 10,589 E. Elevation of collar: 1028 feet Depth: 52.5 feet

Interval From	Interval To	Formation
0	52.5	Hornfels and quartz, very hard and beds dip steeply. Unable to keep the hole straight, so it was abandoned.

R.I. 3982

CHURN-DRILL HOLE 11.

Location: 6,347 N., 11,505 E.   Elevation of collar: 904 feet   Depth: 300 feet

Interval		Analysis, Percent							Formation
From	To	Fe	Cu	SiO_2	S.	P.	Al_2O_3	CaO	
0	193								Schist, 0 - 193.
193	203	26.45	0.19						Schist, slight spec. hematite, 198-203.
203	208	41.70	.11						specular hematite, schist, quartz,
208	213	42.25	.10	37.03	0.032	0.144	0.69	0.45	and some chrysocolla, 203 - 238.
213	218	37.75	.17	43.48	.058	.144	.84	.55	
218	223	35.05	.05	47.69	.040	.116	.55	.44	
223	228	35.80	.31	44.74	.054	.173	1.07	.98	
228	233	35.10	1.96	40.84	.045	.224	3.24	1.11	
233	238	41.95	.98	34.00	.110	.194	2.31	.86	Schist, slight specular hematite,
238	243	31.60	.87						and chrysocolla, 238.- 268.
243	248	36.05	.80						
248	253	29.75	.70						
253	258	27.70	.87						
258	263	15.10	.97						Breccia and gouge, 268 - 283.
263	268	28.80	2.85						Gneiss, 283 - 300.
268	300	-	-						

CHURN-DRILL HOLE 12.

Location: 5,711 N., 10,629 E. Elevation of collar: 1,035 feet Depth: 460 feet

Interval		Analysis, Percent		Formation
From	To	Fe	Cu	
0	310			Schist and quartz, 0 - 310.
310	315	7.90	0.014	Schist, quartz, and slight specular hematite, 310 - 335.
315	320	10.20	.020	
320	325	8.76	.021	
325	330	10.13	.020	
330	335	10.89	.050	
335	385	-	-	Schist and quartz, 335 - 385.
385	390	12.02	.34	Schist, quartz, and slight specular hematite, 385 - 410.
390	395	26.00	.16	
395	400	17.65	.47	
400	405	10.49	.069	
405	410	5.10	.077	
410	415	4.57	.87	Phyolite schist, 410 - 425.
415	460	-	-	Siliceous breccia and gouge, 425 - 445. Gneiss, 445 - 460.

R.I. 3982

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 1

Collar coordinates: Latitude, N. 6093: Departure, E. 12252
Collar Elevation: 806
Inclination: Vertical

New Plant Project 931

Footage From	Footage To	Footage Feet	Recoveries Core Feet	Recoveries Core Grams	Recoveries Sludge Grams	In Percent Core	In Percent Sludge	Core Diam. Ins.	Description and Remarks
0.0	3.4	3.4	2.5	1578	0	73	0	1-1/8	Hard specular hematite.
3.4	8.6	5.2	1.4	898	7923	27	95	"	Medium-hard specular hematite.
8.6	13.8	5.2	.1	- -	12749	2	—	7/8	Soft specular hematite.
13.8	18.8	5.0	2.0	550	2550	40	78	"	ditto
18.8	23.8	5.0	.1	- -	5496	2	—	"	ditto
23.8	28.8	5.0	.1	- -	3621	2	—	"	ditto
28.8	34.8	6.0	.0	0	3200	0	—	"	ditto
									END OF HOLE

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 2

Collar coordinates: Latitude, N. 6129; Departure, E. 12229
Collar Elevation: 806
Inclination: Vertical

Footage From	Footage To	Footage Feet	Recoveries Core Feet	Recoveries Core Grams	Recoveries Sludge Grams	In Percent Core	In Percent Sludge	Core Diam. Ins.	Description and Remarks
0.0	3.0	3.0	0.3	- -	9954	10	- -	1-1/8	Hard specular hematite.
3.0	8.0	5.0	2.5	1076	6517	50	133	"	Hard specular hematite, some quartz.
8.0	13.0	5.0	2.5	1758	4765	50	61	"	Hard specular hematite.
13.0	18.0	5.0	.0	0	21230	0	- -	"	Soft specular hematite.
18.0	23.0	5.0	.0	0	22556	0	- -	"	ditto
23.0	28.0	5.0	.0	0	20059	0	- -	"	ditto
28.0	30.0	2.0	.0	0	3649	0	- -	"	ditto
30.0	35.0	5.0	.0	0	9677	0	- -	7/8	ditto
35.0	40.0	5.0	.3	- -	6499	6	- -	"	Soft specular hematite from 35.0 to 39.5; hard, fractured specular hematite from 39.5 to 40.0.
40.0	42.0	2.0	.2	- -	8376	10	- -	"	Hard and fractured specular hematite.
									END OF HOLE

1257

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 3

Collar corrdinates: Latitude, N. 6165; Departure, E. 12206
Collar elevation: 798
Inclination: Vertical

Footage			Recoveries: Core		Recoveries: Sludge	Recoveries: In Percent		Core Diam.	
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	Description and Remarks
0.0	3.0	3.0	2.0	- -	- -	66-2/3	- - -	1-1/8	Chiefly quartz, slight specular hematite, no sample taken.
3.0	3.5	.5	.5	- -	- -	100	- - -	"	Same as 0.0 to 3.0, no sample taken.
3.5	8.5	5.0	3.5	1922	5395	70	94	"	Hard specular hematite, considerable quartz.
8.5	13.5	5.0	5.0	2758	4670	100	95	"	Hard specular hematite, considerable quartz.
13.5	18.5	5.0	.5	- -	13174	10	- - -	"	Soft specular hematite.
18.5	23.5	5.0	1.0	825	20836	20	196	"	Soft specular hematite from 18.5 to 22.0; hard specular hematite from 22.0 to 23.5.
23.5	27.5	4.0	.3	- -	6110	7-1/2	- - -	"	Specular hematite, badly fractured.
27.5	30.8	3.3	.2	- -	22425	6	- - -	1-1/8 to 29.5; 7/8 from 29.5 to 30.8	
30.8	39.2	8.4	1.2	- -	4233	14	- - -	7/8	Gouge, breccia and quartz, slight specular hematite, from 30.8 to 39.0; gneiss from 39.0 to 39.2

END OF HOLE

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 4

Collar coordinates: Latitude, N. 6255; Departure, E. 12475
Collar elevation: 851
Inclination: Vertical

Footage			Recoveries						Core Diam.	Description and Remarks
			Core		Sludge	In Percent				
From	To	Feet	Feet	Grams	Grams	Core	Sludge		Ins.	
0.0	6.8	6.8	0.7	- -	- -	10	- - -		1-1/8	Overburden, consisting of caliche and small specular hematite boulders.
6.8	11.7	4.9	2.2	1525	3427	44	42		"	Caliche, quartz, and specular hematite.
11.7	14.2	2.5	.0	0	4930	0	- - -		"	Specular hematite, considerable quartz.
14.2	16.7	2.5	.0	0	5422	0	- - -		"	Specular hematite, badly fractured.
16.7	21.7	5.0	.0	0	7262	0	- - -		7/8	Soft specular hematite, an occasional hard seam.
21.7	26.7	5.0	.0	0	24867	0	- - -		"	ditto
26.7	31.7	5.0	.0	0	16383	0	- - -		"	ditto
31.7	34.4	2.7	.0	0	21913	0	- - -		"	ditto
34.4	41.0	6.6	1.2	379	15576	18	269		"	ditto
41.0	47.0	6.0	1.0	305	23198	17	467		"	ditto
47.0	52.0	5.0	1.2	530	6976	24	117		"	Medium hard specular hematite, slight quartz.
52.0	54.0	2.0	.3	50	19467	15	- - -		"	Medium hard specular hematite.
54.0	59.0	5.0	.7	233	15250	14	331		"	Soft specular hematite, an occasional hard seam.
59.0	62.3	3.3	.0	0	27685	0	- - -		"	Soft specular hematite, twisted off bit at 62.3.

END OF HOLE

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 5

Collar coordinates: Latitude, N. 6343; Departure, E. 12736
Collar elevation: 859
Inclination: Vertical

Footage			Recoveries					Core Diam.	Description and Remarks
			Core		Sludge	In Percent			
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	
0.0	3.6	3.6	0.0	0	- -	0	- -	1-1/8	Overburden, consisting of caliche, some specular hematite and quartz.
3.6	8.6	5.0	1.3	730	10535	26	149	"	Specular hematite, considerable quartz.
8.6	13.6	5.0	.7	215	7947	14	205	"	Specular hematite, ditto. and some chrysocolla.
13.6	18.6	5.0	.2	65	5650	4	129	"	Specular hematite, some quartz.
18.6	21.3	2.7	.0	0	2130	0	- -	"	Specular hematite, considerable quartz.
21.3	28.2	6.9	.2	- -	750	3	- -	1-1/8 to 26.2; 7/8 from 26.2 to 28.2	Siliceous breccia and gouge, slight specular hematite.
28.2	32.3	4.1	1.4	293	3883	35	178	7/8	Specular hematite, considerable limestone, slight copper oxide.
32.3	38.0	5.7	2.3	450	3872	40	136	"	Limestone.
38.0	44.4	6.4	2.4	510	- -	38	- -	"	Limestone to 44.0; limonite and gouge from 44.0 to 44.4.
44.4	50.3	5.9	1.5	345	- -	26	- -	"	Limestone, badly fractured, considerable limonite.
50.3	52.1	1.8	1.7	432	- -	94	- -	"	Gneiss.

END OF HOLE

1257

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 6

Collar coordinates: Latitude, N. 6555; Departure, E. 13037
Collar elevation: 934
Inclination: Vertical

Footage			Recoveries						Core Diam.	
			Core		Sludge	In Percent			
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	Description and Remarks
0.0	2.0	2.0	0.0	0	--	0	--	1-1/8	Overburden, caliche and specular hematite.
2.0	7.0	5.0	.0	0	8335	0	--	"	Quartz and slight specular hematite.
7.0	12.0	5.0	.0	0	42193	0	--	"	Soft specular hematite, slight quartz.
12.0	17.0	5.0	.0	0	21295	0	--	"	ditto
17.0	19.4	2.4	.0	0	1450	0	--	"	ditto
19.4	24.4	5.0	1.5	342	3900	30	129	7/8	Specular hematite and siliceous breccia.
24.4	29.4	5.0	1.2	517	4626	24	85	1-1/8	Siliceous breccia, slight specular hematite and copper oxides.
29.4	34.4	5.0	.0	0	14010	0	--	"	Siliceous breccia, slight specular hematite, and copper oxides from 39.4 to 49.4.
34.4	39.4	5.0	.0	0	8540	0	--	"	
39.4	44.4	5.0	.0	0	13905	0	--	"	
44.4	49.4	5.0	.4	125	5820	8	140	"	
49.4	54.4	5.0	.3	109	10188	6	207	"	Soft specular hematite, some quartz.
54.4	59.4	5.0	1.5	917	8673	30	114	"	Hard and broken specular hematite.
59.4	64.4	5.0	3.1	1255	545	62	8	7/8	Hard, vuggy specular hematite.
64.4	68.1	3.7	1.0	275	1130	29	45	"	Hard, siliceous specular hematite.
68.1	72.1	4.0	1.0	207	2034	25	90	"	Siliceous breccia and gouge, slight specular hematite.
72.1	74.4	2.3	.2	22	750	9	--	"	Siliceous breccia to 72.5; gneiss from 72.5 to 74.4.

END OF HOLE

1257

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 7

Collar coordinates: Latitude, N. 6608; Departure, E. 13004
Collar elevation: 943
Inclination: Vertical

Footage			Recoveries					Core Diam.	
			Core		Sludge	In Percent			
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	Description and Remarks
0.0	2.0	2.0	0.0	0	- -	0	- -	1-1/8	Overburden, gravel and caliche.
2.0	7.0	5.0	2.0	977	4093	40	67	"	Specular hematite with considerable quartz from 2.0 to 19.0.
7.0	12.0	5.0	1.0	418	5863	20	109	"	
12.0	15.6	3.6	.2	474	1006	34	30	"	
15.6	19.0	3.4	.2	72	5223	6	48	"	
19.0	24.0	5.0	.0	0	11,210	0	- -	"	Siliceous breccia and limonite, slight specular hematite, from 19.0 to 74.5.
24.0	29.0	5.0	.0	0	11,393	0	- -	"	
29.0	33.5	4.5	.0	0	7093	0	- -	"	
33.5	38.5	5.0	.0	0	5825	0	- -	"	
38.5	43.5	5.0	.0	0	4225	0	- -	"	
43.5	48.5	5.0	.0	0	11,835	0	- -	"	
48.5	53.5	5.0	.0	0	1439	0	- -	1-1/8 to 50.0 7/8 from 50.0 to 53.5	
53.5	58.5	5.0	.0	0	3933	0	- -	7/8	
58.5	64.5	6.0	.0	0	5978	0	- -	"	
64.5	69.5	5.0	.5	85	3250	10	135	"	
69.5	74.5	5.0	.0	0	9418	0	- -	"	
74.5	79.2	4.7	.8	235	4605	17	120	"	Specular hematite, considerable quartz and breccia.
79.2	84.6	5.4	1.0	278	3910	19	97	"	Hard specular hematite, fractured. Hole caved between 70.0 and 80.0 Abandoned at 84.6.

END OF HOLE.

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 8

Collar coordinates: Latitude, N. 6455; Departure, E. 13099
Collar elevation: 918
Inclination: Vertical

Footage			Recoveries						
			Core		Sludge	In Percent		Core Diam.	
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	Description and Remarks
0.0	51.0	51.0	23.6	-	-	56	-	1-1/8 to 34.3 7/8 from 34.3 to 51.0.	Limestone, slight amount of chrysocolla.
51.0	56.0	5.0	1.5	-	-	30	-	7/8	Limestone to 51.3; gneiss from 51.3 to 56.0. END OF HOLE

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 9

Collar coordinates: Latitude, N. 6402; Departure, E. 12697
Collar elevation: 836
Inclination: Vertical

Footage			Core		Sludge	In Percent		Core Diam.	
From	To	Feet	Feet	Grams	Grams	Core	Sludge	Ins.	Description and Remarks
0.0	2.0	2.0	0.0	-	-	0	-	1-1/8	Overburden, consisting of caliche and gravel.
2.0	6.5	4.5	.3	-	6160	7	-	7/8	Siliceous breccia, slight specular hematite, from 2.0 to 11.5.
6.5	11.5	5.0	.1	-	3621	2	-	"	
11.5	16.5	5.0	.0	0	3848	0	-	"	Specular hematite and considerable siliceous breccia and quartz, from 11.5 to 33.0
16.5	21.5	5.0	.0	0	7515	0	-	"	
21.5	26.5	5.0	.1	-	7250	2	-	"	
26.5	31.5	5.0	.0	0	8155	0	-	"	
31.5	33.0	1.5	.0	0	2655	0	-	"	
33.0	37.3	4.3	.0	0	6550	0	-	"	Siliceous breccia, slight specular hematite.
37.3	40.0	2.7	1.5	-	3505	56	-	"	Siliceous breccia and gouge to 38.0; gneiss from 38.0 to 40.0. END OF HOLE.

CONDENSED LOG OF DIAMOND-DRILL HOLE NO. 10

Collar coordinates: Latitude, N. 6202; Departure, E. 12507
Elevation of collar: 865
Inclination: Vertical

FOOTAGE			RECOVERIES					Core Diam.	
			Core		Sludge	Percent			
From	To	Feet	Feet	Grams	Grams	In Core	Sludge	Ins.	Description and Remarks
0.0	3.0	3.0	0.0	0	-	0	- -	1-1/8	Overburden, consisting of caliche and talus.
3.0	13.3	10.3	.3	--	-	3	- -	"	Schist and quartz.
13.3	21.0	6.7	.5	146	10,415	7	184	"	Schist, quartz, and very slight specular hematite, from 13.3 to 30.0.
21.0	30.0	9.0	.3	105	11,480	3	119	"	
30.0	40.0	10.0	.1	--	-	1	- -	7/8	Schist and quartz.
40.0	43.0	3.0	.0	0	-	0	- -	"	Schist and quartz, very slight specular hematite.
43.0	48.0	5.0	1.4	376	1880	28	53	"	Very hard specular hematite, some quartz, from 43.0 to 57.0.
48.0	52.0	4.0	3.6	1380	3430	90	109	"	
52.0	57.0	5.0	4.0	1455	2500	80	64	"	
57.0	62.0	5.0	.4	97	3625	8	105	"	Soft specular hematite, slight quartz,
62.0	67.0	5.0	.0	0	3125	0	- -	"	from 57.0 to 67.0.
67.0	71.4	4.4	1.5	368	2028	34	72	"	Limestone, slight specular hematite.
71.4	78.9	7.5	3.1	--	-	41	- -	"	Limestone.
78.9	84.0	5.1	5.1	--	-	100	- -	"	Gneiss.

END OF HOLE.

DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 1

Coordinates: Latitude, N. 6093; Departure, E. 12252
Elevation of collar: 803

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	3.4	3.4	48.55	0.010	29.27	0.028					48.55	0.010	29.27	0.028
3.4	8.6	5.2	48.17	.010			55.40	0.020	9.90	0.91	54.74	.019	9.90	.91
8.6	13.8	5.2					60.19	.014	8.16	.16	60.19	.014	8.14	.16
13.8	18.8	5.0	42.19	.003			55.91	.006	15.77	.072	53.96	.006	15.77	.072
18.8	23.8	5.0					59.80	.010	11.40	.026	59.80	.010	11.40	.026
23.8	28.8	5.0					56.12	.013	17.81	.028	56.12	.013	17.81	.028
28.8	34.8	6.0					64.71	.010	5.42	.036	64.71	.010	5.42	.036

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	3.4	3.4	0.034	0.30	0.69				0.034	0.30	0.69
3.4	8.6	5.2				0.025	1.01	3.45	.025	1.01	3.45
8.6	13.8	5.2				.020	.93	1.75	.020	.93	1.75
13.8	18.8	5.0				.020	.63	1.37	.020	.63	1.37
18.8	23.8	5.0				.015	.19	.83	.015	.19	.83
23.8	28.8	5.0				.035	.29	.48	.035	.29	.48
28.8	34.8	6.0				.038	.18	.66	.038	.18	.66

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DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 2

Coordinates: Latitude, N. 2169; Departure, E. 12229
Elevation of collar: 806

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	3.0	3.0					51.20	0.008	15.31	0.13	51.20	0.003	15.31	0.13
3.0	8.0	5.0	26.00	0.005			32.29	.043	40.20	.15	31.16	.036	40.20	.15
8.0	13.0	5.0	56.70	.017			61.30	.013	10.13	.040	60.47	.014	10.13	.040
13.0	18.0	5.0					65.74	.004	4.63	.056	65.74	.004	4.63	.056
18.0	23.0	5.0					66.60	.003	4.02	.040	66.60	.003	4.02	.040
23.0	28.0	5.0					64.25	.006	7.17	.020	64.25	.006	7.17	.020
28.0	30.0	2.0					57.93	.009	13.34	.018	57.93	.009	13.34	.018
30.0	35.0	5.0					55.00	.022	19.28	.022	55.00	.022	19.28	.022
35.0	40.0	5.0					55.02	.025	19.98	.018	55.02	.025	19.98	.018
40.0	42.0	2.0					66.30	.055	12.93	.046	66.30	.055	12.93	.046

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	3.0	3.0				0.015	0.73	5.23	0.015	0.73	5.23
3.0	8.0	5.0									
8.0	13.0	5.0				.025	.41	.80	.025	.41	.80
13.0	18.0	5.0				.021	.31	.42	.021	.31	.42
18.0	23.0	5.0				.012	.24	.15	.012	.24	.15
23.0	28.0	5.0				.010	.40	.39	.010	.40	.39
28.0	30.0	2.0				.024	.14	1.46	.024	.14	1.46
30.0	35.0	5.0				.033	.59	1.12	.033	.59	1.12
35.0	40.0	5.0				.020	.40	1.16	.020	.40	1.16
40.0	42.0	2.0				.012	.35	.23	.012	.36	.23

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DIAMOND DRILL-HOLE ASSAY VALUES

Hole No. 3

Coordinates: Latitude, N. 6165; Departure, E. 12206
Elevation of collar: 798

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	3.5	3.5												
3.5	8.5	5.0	20.50	0.010			37.48	0.036			33.57	0.024		
8.5	13.5	5.0	22.32	.002			53.07	.009	22.52	0.008	22.32	.002	22.52	0.008
13.5	18.5	5.0					67.82	.013	1.16	.030	67.82	.013	1.16	.030
18.5	23.5	5.0	53.84	.008			66.46	.005	3.38	.054	65.55	.005	3.38	.054
23.5	27.5	4.0					65.60	.021	4.38	.066	65.60	.021	4.38	.066
27.5	30.8	3.3					65.12	.019	5.10	.056	65.12	.019	5.10	.056
30.8	39.2	8.4												

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	3.5	3.5									
3.5	8.5	5.0									
8.5	13.5	5.0				0.017	0.43	0.22	0.017	0.43	0.22
13.5	18.5	5.0				.026	.36	.32	.026	.36	.32
18.5	23.5	5.0				.018	.38	.10	.018	.38	.18
23.5	27.5	5.0				.032	.33	.21	.032	.33	.21
27.5	30.8	3.3				.017	.17	.61	.017	.17	.61
30.8	39.2	8.4									

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DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 4

Coordinates: Latitude, N. 6255; Departure, E. 12475
Elevation of collar: 851

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	6.8	6.8												
6.8	11.7	4.9	36.81	0.221			21.34	0.421			22.78	0.390		
11.7	14.2	2.5					36.41	.274	37.08		36.41	.274	37.08	
14.2	16.7	2.5					60.00	.085	8.69	0.092	60.00	.085	8.69	0.092
16.7	21.7	5.0					61.90	.030	8.14	.099	61.90	.030	8.14	.099
21.7	26.7	5.0					59.71	.021	11.95	.10	59.71	.021	11.95	.10
26.7	31.7	5.0					61.40	.089	9.79		61.40	.089	9.79	
31.7	34.4	2.7					63.13	.001	6.36	.074	63.13	.001	6.36	.074
34.4	41.0	6.6	46.38	.009	32.54		58.04	.019	11.75	.008	57.29	.018	13.08	.008
41.0	47.0	6.0	37.71	.010	44.80		66.87	.004	2.59	.010	65.12	.004	5.12	.010
47.0	52.0	5.0	53.31	.001	22.39		59.88	.004	3.76	.092	58.60	.004	5.34	.092
52.0	54.0	2.0					67.25	.002	1.59	.040	67.25	.002	1.59	.040
54.0	59.0	5.0	50.72	.003	26.25	0.060	65.18	.009	2.10	.079	64.46	.009	3.31	.078
59.0	62.3	3.3					65.02	.026	3.06	.075	65.02	.026	3.06	.75

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	6.8	6.8									
6.8	11.7	4.9									
11.7	14.2	2.5									
14.2	16.7	2.5				0.024	0.98	1.66	0.024	0.98	1.66
16.7	21.7	5.0				.023	0.76	1.13	.023	.76	1.13
21.7	26.7	5.0				.018	0.83	1.05	.018	.83	1.05
26.7	31.7	5.0									
31.7	34.4	2.7				.023			.023		
34.4	41.0	6.6	0.019			.019	1.60	1.89	.019	1.60	1.89
41.0	47.0	6.0				.007	.45	.62	.007	.45	.62
47.0	52.0	5.0	.010	0.25	0.36	.011	3.88	4.25	.011	3.57	3.92
52.0	54.0	2.0				.008	.61	.85	.008	.61	.85
54.0	59.0	5.0	.015	.27	.32	.009	1.19	1.81	.013	1.14	1.73
59.0	62.3	3.3				.013	1.23	1.38	.013	1.23	1.38

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DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 5

Coordinates: Latitude, N. 6343; Departure, E. 12736
Elevation of collar: 859

Footage			Core (Percent)				Sludge (Percent)				Adjusted Averages (Percent)			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	3.6	3.6												
3.6	8.6	5.0	54.00	0.003	15.94	0.037	35.67	0.029			37.39	0.010		0.037
8.6	13.6	5.0	55.82	.31	9.97	1.26	49.24	.011	24.22	0.32	49.57	.019	23.51	.37
13.6	18.6	5.0					53.24	.018	19.33	.091	53.24	.018	19.33	.091
18.6	21.3	2.7					40.52	.051	33.63	.24	40.52	.051		.24
21.3	28.2	6.9												
28.2	32.3	4.1	8.55	1.70			47.70	.49			42.69	.645		

Footage			Core (Percent)			Sludge (Percent)			Adjusted Averages (Percent)		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	3.6	3.6									
3.6	8.6	5.0	0.055						0.055		
8.6	13.6	5.0	.053			0.071			.060		
13.6	18.6	5.0				.061			.061		
18.6	21.3	2.7				.115			.115		
21.3	28.2	6.9									
28.2	32.3	4.1									

DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 6

Coordinates: Latitude, N. 6555; Departure, E. 13037
Elevation of collar: 934

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	2.0	2.0												
2.0	7.0	5.0					25.38	0.028			25.38	0.028		
7.0	12.0	5.0					61.06	.016	10.43	0.036	61.06	.016	10.43	0.036
12.0	17.0	5.0					61.04	.002	10.64	.032	61.04	.002	10.64	.032
17.0	19.4	2.4					60.95	.002	10.93	.028	60.95	.002	10.93	.028
19.4	24.4	5.0	37.88	0.009			24.00	.008			25.48	.008		
24.4	29.4	5.0	9.48	.141			20.00	.246			19.10	.237		
29.4	34.4	5.0					9.29	.062			9.29	.062		
34.4	39.4	5.0					7.67	.133			7.67	.133		
39.4	44.4	5.0					7.23	.270			7.23	.270		
44.4	49.4	5.0					10.66	.76			10.66	.76		
49.4	54.4	5.0					47.93	.157	22.11	.28	47.93	.157	22.11	.28
54.4	59.4	5.0	67.37	.049	1.07	0.13	56.29	.285	10.88	.37	57.49	.259	9.82	.34
59.4	64.4	5.0	68.03	.060	.65	.044	65.04	.144	3.39	.16	65.69	.126	2.79	.13
64.4	68.1	3.7	42.26	.097	36.82	.20	54.19	.169	17.82	.12	52.96	.153	19.64	.13
68.1	72.1	4.0	19.80	.093			19.38	.150			19.42	.145		
72.1	74.4	2.3					16.72	.087			16.72	.087		

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	P	Al_2O_3	CaO	P	Al_2O_3	CaO	P	Al_2O_3	CaO
0.0	7.0	7.0									
7.0	12.0	5.0				0.023	0.48	0.64	0.023	0.48	0.64
12.0	17.0	5.0				.026	.38	.48	.026	.38	.48
17.0	19.4	2.4				.023	.57	.45	.023	.57	.45
19.4	49.4	30.0									
49.4	54.4	5.0				.048	4.01	.62	.048	4.01	.62
54.4	59.4	5.0	0.098	0.46	0.11	.098	2.98	.91	.098	2.71	.82
59.4	64.4	5.0	.173	.24	.39	.094	.76	.46	.111	.65	.44
64.4	68.1	3.7	.091			.141	.97	.90	.135		
68.1	74.4	6.3									

1257

DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 7

Coordinates: Latitude, N. 6603; Departure, E. 13004
Elevation of collar:

Footage			Core				Sludge				Adjusted averages			
			Percent				Percent				Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	2.0	2.0												
2.0	7.0	5.0	38.42	0.036)			30.62	0.042)(2)			31.74	0.040)(3)		
7.0	12.0	5.0	48.91	.062)(1)	36.61		36.06	.083)	39.27		38.33	.078)	39.03	
12.0	15.6	3.6	36.09	.030)			27.13	.065)		0.28	28.32	.061)		0.28
15.6	19.0	3.4					36.09	.089		.11	36.09	.089		.11
19.0	24.0	5.0					19.20	.121			19.20	.121		
24.0	29.0	5.0					11.20	.089			11.20	.089		
29.0	33.5	4.5					12.13	.091			12.13	.091		
33.5	38.5	5.0					17.88	.065			17.88	.065		
38.5	43.5	5.0					12.40	.123			12.40	.128		
43.5	48.5	5.0					10.82	.108			10.82	.108		
48.5	53.5	5.0					8.36	.72			8.36	.72		
53.5	58.5	5.0					6.33	.68			6.33	.68		
58.5	64.5	6.0					9.28	.41			9.28	.41		
64.5	69.5	5.0					12.20	.026			12.20	.026		
69.5	74.5	5.0					10.63	.074			10.63	.074		
74.5	79.2	4.7	29.80	.036	39.14		37.49	.074	32.12		37.03	.072	32.54	
79.2	84.6	5.4	26.67	.011	42.03		61.70	.066	9.47	.054	59.36	.062	11.65	

(1) Composite sample from 2.0 feet to 15.6 feet.
(2) " " " 2.0 feet to 19.0 feet.
(3) " " " 2.0 feet to 19.0 feet.

DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 9

Coordinates: Latitude, N. 6402; Departure, E. 12679
Elevation of collar: 836

FOOTAGE			CORE Percent			SLUDGE Percent			ADJUSTED AVERAGES Percent		
From	To	Feet	Fe	Cu	SiO_2	Fe	Cu	SiO_2	Fe	Cu	SiO_2
0.0	2.0	2.0									
2.0	6.5	4.5				12.77	0.100		12.77	0.100	
6.5	11.5	5.0				17.05	.78		17.05	.78	
11.5	16.5	5.0				27.21	.094		27.21	.094	
16.5	21.5	5.0				34.49	.098		34.49	.098	
21.5	26.5	5.0				40.68	.097	35.06	40.68	.097	35.06
26.5	31.5	5.0				29.32	.011		29.32	.011	
31.5	33.0	1.5				23.72	.017		23.72	.017	
33.0	37.3	4.3				16.85	.36		16.85	.36	
37.3	40.0	2.7				15.45	.45		15.45	.45	

DIAMOND-DRILL-HOLE ASSAY VALUES

HOLE NO. 10

Coordinates: Latitude, N. 6202; Departure, E. 12507
Elevation of collar: 865

FOOTAGE			CORE Percent				SLUDGE Percent				ADJUSTED AVERAGES Percent			
From	To	Feet	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S	Fe	Cu	SiO_2	S
0.0	13.3	13.3												
13.3	21.0	6.7	16.38	0.32			5.40	0.149			5.67	0.152		
21.0	30.0	9.0	29.23	.225			7.45	.104			7.72	.105		
30.0	43.0	13.0												
43.0	48.0	5.0	44.59	.017	33.46	0.072	37.20	.119	35.43		37.93	.109	35.23	
48.0	52.0	4.0	51.62	.070	20.25	.040	49.58	.202		0.044	50.23	.160	20.25	0.043
52.0	57.0	5.0	53.07	.065	16.66	.035	49.74	.050	22.24	.016	50.68	.054	20.66	.036
57.0	62.0	5.0	59.21	.043	8.72	.026	54.70	.022	18.85	.008	54.82	.023	16.01	.009
62.0	67.0	5.0					58.01	.087	11.74	.100	58.01	.087	11.74	.100
67.0	71.4	4.4	18.47	1.52			17.50	.82			17.61	.090		
71.4	84.0	12.6												

FOOTAGE			CORE Percent	SLUDGE Percent	ADJUSTED AVERAGES Percent
From	To	Feet	ν	P	P
0.0	13.3	13.3			
13.3	21.0	6.7			
21.0	30.0	9.0			
30.0	43.0	13.0			
43.0	48.0	5.0	0.016		
48.0	52.0	4.0	.011	0.034	0.024
52.0	57.0	5.0	.014	.013	.013
57.0	62.0	5.0	.013	.011	.011
67.0	71.4	4.4		.036	.036
71.4	84.0	12.6			

1257

ANALYSIS OF SAMPLES TAKEN AT OUTCROP EAST OF PLANET WASH

Location: North 33° west of D.D. Hole No. 7 (fig. 10)

Sample No.	Length, feet	Analysis - Percent						
		Fe	Cu	SiO_2	S	P	CaO	Al_2O_3
4772	10.0	44.10	0.067					
4773	5.9	45.18	.050					
4774	3.7	50.0	.035	23.34	0.14	0.048	1.61	0.79
4775	6.4	46.58	.046					
4776	7.1	17.51	.034					
4777	6.4	43.52	.012					
4778	3.4	14.33	.020					
4779	3.1	23.44	.050					
4780	4.5	24.85	.018					
4781	5.0	19.28	.022					
4782	3.4	19.01	.030					
4783	4.7	23.92	.028					
4784	6.8	49.88	.010	24.09				
4785	8.7	55.60	.008	17.00	.15	.082	7.07	.40
4786	2.6	16.02	.020					

Location: North 33° west of D.D. Hole No. 4 (fig. 8).

Sample No.	Length, feet	Analysis-percent	
		Fe	Cu
4787	9.4	49.53	0.003
4788	7.1	38.43	.007
4789	1.8	44.17	.002
4790	9.8	36.73	.004
4791	6.4	42.88	.004
4792	6.0	47.85	.008
4793	5.7	27.73	.006
4794	3.8	7.95	.010

Location: North 33° west of D.D. Hole No. 3. (fig. 7).

Sample No.	Length, feet	Analysis - Percent						
		Fe	Cu	SiO_2	S	P	CaO	Al_2O_3
4795	5.0	62.50	0.061	2.13	0.51	0.093	2.11	0.38
4796	7.7	56.45	.033	4.37	.010	.073	6.02	.46
4797	5.9	55.86	.022	4.88	.058	.069	7.07	.40
4798	4.2	48.94	.019	14.24	.010			
4799	4.2	50.53	.009	7.66		.087	9.82	.71
4800	4.7	36.55	.008					
4573	2.6	31.60	.012					
4574	1.5	45.60	.026					

Energy Reserves Group, Inc.
Trinity Place, Suite 500
1801 Broadway
P.O. Box 1407
Denver, Colorado 80201
Phone 303 572 3323

Energy Reserves Group

September 8, 1982

Nicor Minerals
2659-G Pan American Freeway, N.E.
Albuquerque, New Mexico 87107

Attention: Gary Parkinson

Re: Precious Metals - Joint Venture; Clara Peak Prospect

Dear Mr. Parkinson:

I would like to apologize for our error yesterday when forwarding you the prospect brochure you requested. Without noticing the Zebra Prospect brochure was sent rather than the above referenced prospect brochure which you had expressed your interest in. We are at this time mailing the Clara Peak Prospect brochure and would ask that you return the previous report in the enclosed envelope to us.

Thank you for your cooperation and understanding in this matter and if you should have any questions, don't hesitate to call me.

Sincerely,

Lee Halterman

Lee Halterman
Minerals Manager, U.S.A.

LH/kb

Enclosures

Energy Reserves Group

CLARA PEAK

ACQUISITION REPORT

July 28, 1982

ENERGY RESERVES GROUP, INC.
Southwest District Office
Steve Schurman, Minerals Geologist

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LIST OF ILLUSTRATIONS

CLARA PEAK

ACQUISITION REPORT

The Clara Peak Prospect is located in western Arizona in Yuma County in Township 9 North, Range 15 West, Section 3 (Figure 1). The property consists of approximately 200 acres that underlie ten claims. The Clara Peak Prospect is best accessed from Bouse, Arizona where a county maintained dirt road leads to the northeast for approximately 22 miles and the prospect area. Vegetation around Clara Peak is poorly developed and consists mostly of grease brush. At present there is no use of the land.

STRATIGRAPHY

The stratigraphy of the area consists of Precambrian basement gneisses that are unconformably overlain by late Cretaceous-early Tertiary age sandstones, siltstones, mudstones and shales that were deposited in a fluvial-lacustrine environment of deposition (Figure 2). Overlying and intruding into the Precambrian and lower Tertiary rocks is an intermediate composition, subvolcanic intrusive of probable mid-Tertiary age. Quarternary alluvium covers the surrounding valley bottoms.

The Precambrian gneisses are generally fine-grained, massive and exhibit few distinguishing textural features. These gneisses were probably formed at a relatively high thermal gradient which is characteristic of the Precambrian metamorphic rocks of the region.

The lower Tertiary sandstones, siltstones and shales were unconformably deposited in a fluvial-lacustrine environment across the Precambrian basement rocks. These sediments are extremely oxidized and are generally reddish-brown in color on a freshly broken surface. The fluvial sandstones occupy approximately a quarter of the Tertiary section, are often heavily manganese-stained

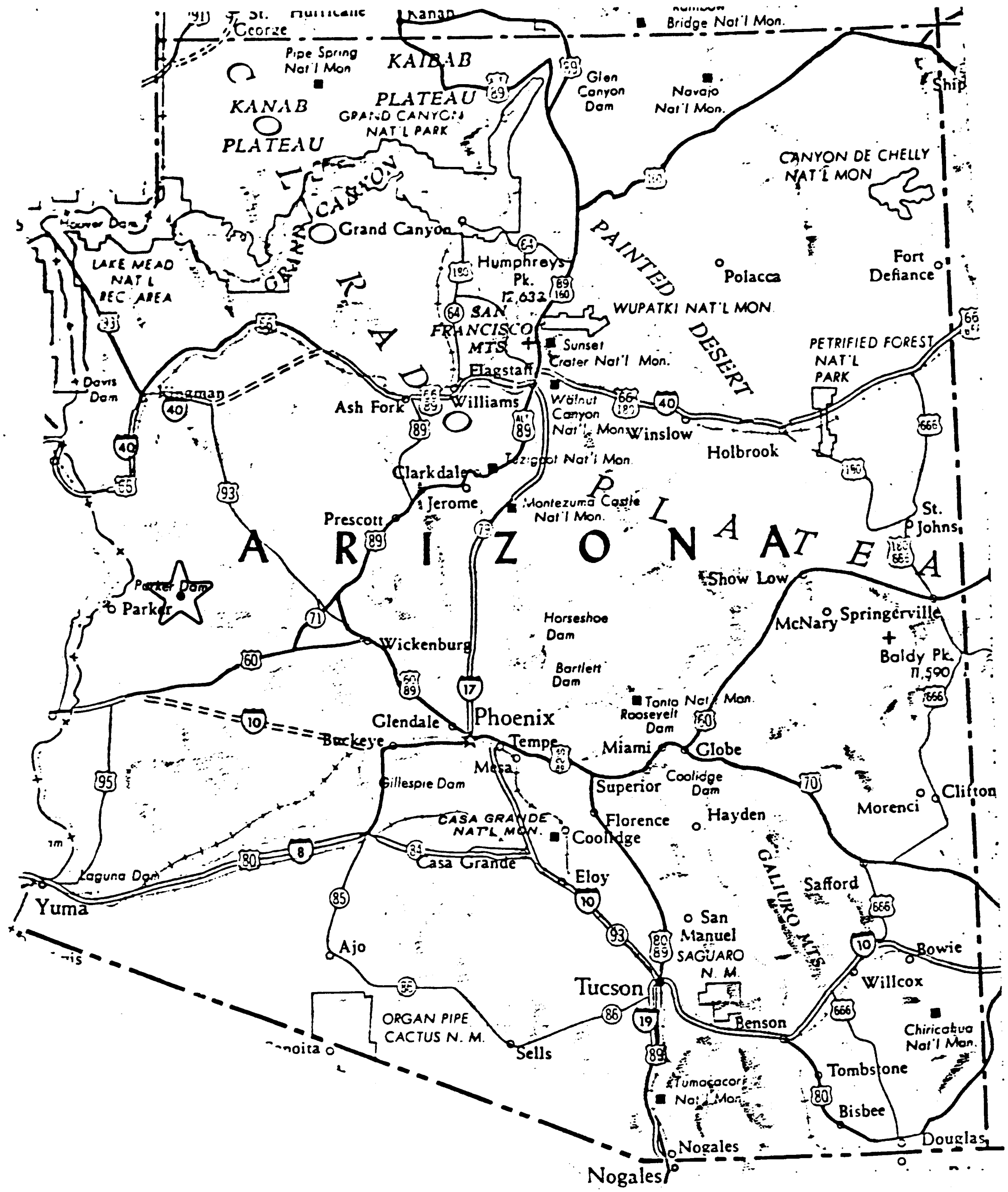

FIGURE 1. LOCATION MAP OF CLARA PEAK PROSPECT, ARIZONA.

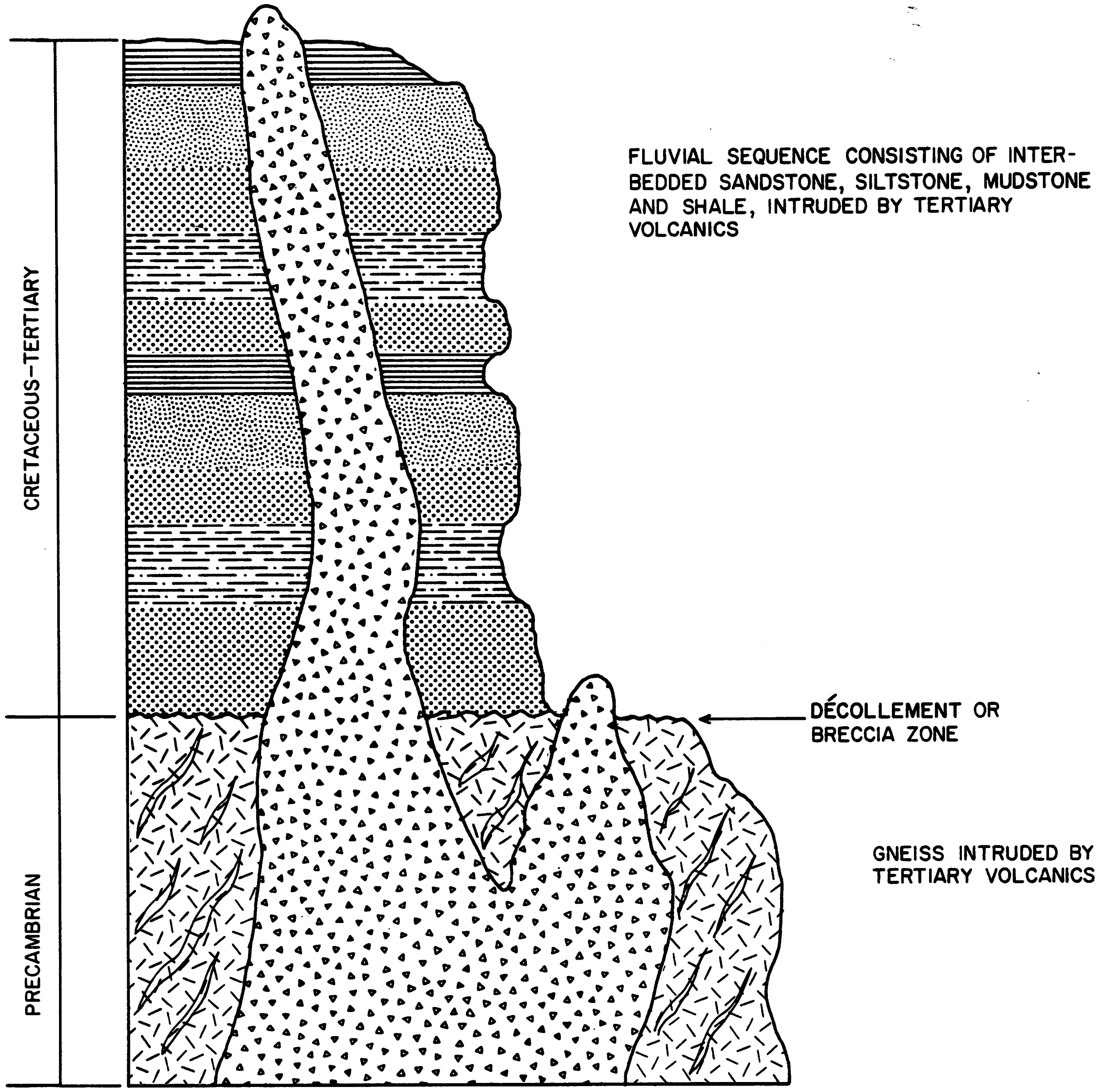

FIGURE 2. GENERALIZED STRATIGRAPHIC COLUMN OF CLARA PEAK PROSPECT, ARIZONA.

(desert varnish) and are resistant to erosion. As a result, the sandstones mantle the hillslopes over the less resistant mudstones and shales making exact section descriptions and prospecting difficult.

The mid-Tertiary subvolcanic intrusive and extrusive rocks penetrate both the Precambrian gneisses and the Tertiary sediments as plug-like masses. These intermediate compositioned volcanic rocks penetrate the Precambrian gneisses in the vicinity of Clara Peak, located approximately one mile north of the Clara Peak Prospect (Figure 3), and form the majority of Clara Peak. Subvolcanic intrusive-extrusive rocks, similar to those that form Clara Peak, also outcrop in the prospect area in the southern half of Section 3 where they intrude and overlie the Tertiary rocks. These volcanic rocks probably overlie deep seated intrusives and represent the only surface expression of the intrusive's emplacement. To date, no intrusive dikes or sills have been identified cutting either the Precambrian gneisses or the lower Tertiary sediments.

STRUCTURE

Structure in the area is dominated by a lower to middle Tertiary age metamorphic core complex. The region around Clara Peak is one of several "type" areas for these unusual structural events that are characterized by a generally heterogeneous, older metamorphic-plutonic basement terrain that is overprinted by low-dipping, lineated and foliated mylonitic and gneissic fabrics. An unmetamorphosed cover terrain is typically attenuated and sliced by numerous subhorizontal younger-on older faults. Between the basement and the cover terrains is a zone of "decollement" and/or steep metamorphic gradient with much brecciation and kinematic structural relationships indicative of sliding and detachment. Plutonic rocks as young as early to middle Tertiary age are deformed in the basement terrains of many of the complexes, and some of the deformed cover includes continental sedimentary and volcanic rocks of early to middle Tertiary age.

At the Clara Peak Prospect, a breccia zone of variable thickness ranging from as little as 5 feet to as much as 20 feet or more has formed at the contact between Precambrian gneiss and the lower Tertiary sediments. This breccia zone has also been the location of strong gold mineralization that was deposited by hydrothermal solutions that used the breccia zone as a conduit for migration. This gold mineralization is the subject of ERG's exploration efforts at the Clara Peak Prospect. The origin of this breccia zone or zone of decollement is thought to be related to the emplacement of the intrusive that resulted in the extrusion of the subvolcanic, intermediate rocks that form Clara Peak and the low hills located in the southern portion of Section 3. As the intrusive mass penetrated the Precambrian gneiss, doming upward of the metamorphic rocks resulted. As doming continued, the relatively thin veneer of Tertiary rocks began to slide away from the slowly rising positive area along the unconformable contact with the Precambrian gneiss. The resulting structure is a breccia or decollement zone that dips at low angles away from the domed area (Clara Peak). Dip measurements from widespread localities of both the breccia zone and of the Tertiary sediments indicate that both features generally dip gently away from Clara Peak supporting the metamorphic core complex structural interpretation for the origin of the breccia zone.

Other structural features identified at the Clara Peak Prospect include two east-west trending high angle faults that cut the Tertiary sediments and trend perpendicular to the proposed glide direction of the decollement zone. These two faults probably formed at the same time as the breccia zone and may represent sympathetic faulting that resulted from stress associated with glide along the breccia zone (Figure 3).

MINERALIZATION

Mineralization in the Clara Peak Prospect area is generally confined to the breccia zone that has formed at the contact between the Precambrian gneiss and to the Tertiary sediments. This contact is remarkably horizontal and dips at low angles of 5-10^{o} to the south-southeast. It is along this breccia zone that the majority of the old prospect pits were developed. As indicated, the breccia zone is of variable thickness and ranges from 5 to more than 20 feet in thickness. The only other locality that has received any mineralization other than the flat-lying breccia zone are the two high angle faults. These faults no doubt extend downward to the flat breccia zone and acted as conduits for the same mineralizing solutions that mineralized the breccia zone to move upward and out into the Tertiary sediments.

Mineralization along both types of faults is characterized by the deposition of weak to moderate silicification, barite, gold and minor copper and silver. Limonite pseudomorphs after pyrite are common in the breccia zone and are generally disseminated through the breccia fragments and can extend into the overlying sediments as well as the underlying gneiss.

Silicification is only weakly to moderately developed throughout the Clara Peak area and is almost exclusively confined to the flat-lying breccia zone. For the most part, the Precambrian gneisses immediately below the breccia zone have received the majority of the silicification. The gneisses are often silicified and contain varying amounts of stockwork silica veinlets that tend to decrease in amount below the contact. It is interesting to note that as the breccia zone is approached, the number of horizontal silica veinlets increase over the number of vertical silica veinlets. It is thought that the horizontal movement of the glide plane created more horizontal fractures in the gneiss nearer the breccia zone than farther away (deeper) and that these fractures became the site of silica deposition. There are two other minor silica occurrences at Clara Peak, one located in the flat-lying breccia zone at sample location 2916 where red silica replaces sheared Tertiary sediments and the second location is approximately 300 feet north of sample location 2912 where sandstone float exhibits some silicification.

Barite mineralization can be found at virtually every old working on the property, but for the most part, is confined to the Tertiary sediments above the breccia zone. White barite crystals can be found as thin coatings on fracture surfaces to massive accumulations that form the cementing material in sandstone breccias that occur well above the contact breccia zone (sample locations 2908, 2912 and 3637). Of significant importance is the barite occurrence near sample locations 2912 and 3637. This mineral occurrence is several hundred feet stratigraphically above the breccia zone and is localized along two east-west trending faults that expose argillically altered shales that are interbedded with heavily iron-stained sandstones. This mineral occurrence would seem to indicate that mineralization extends upward into the Tertiary sediments along faults and that these sediments may represent a potential host for Carlin-type gold mineralization.

Gold mineralization has been detected along both the flat-lying breccia zone and in Tertiary sediments that are adjacent to the east-west trending vertical faults. As indicated, limonite pseudomorphs after pyrite are commonly disseminated throughout the breccia zone and it is suspected that the gold may have originally been deposited with pyrite which has since oxidized. Geochemical chip sampling of the breccia zone has yielded the best results along the west and northwest portion of the breccia zone that is claimed (sample locations 3776, 3777, 2914 and 2916) and adjacent to the vertical faults (sample locations 2912, 3637 and 3638). In sampling the breccia zone, no veining was noted and samples were of silicified, argillized and iron-stained sandstone, siltstone, shale and gneiss breccia (Figure 3 and Appendix 1). Due to slope wash and overall poor exposure the breccia zone is only exposed in a few old prospects. However, the continuity of the gold mineralization found in every cut on the west and northwest edge of the breccia zone would suggest that the gold mineralization is continuous between prospects and extending well into the subsurface.

Strong gold mineralization has been detected in the Tertiary sediments that are adjacent to the two east-west trending faults. Of these faults, the southernmost fault appears to have had the largest amount of displacement. The southern fault is characterized by strong argillization, minor bleaching, barite, silica and gypsum mineralization. A single 200 foot chip sample across this zone and some additional exposures yielded a not very representative but anomalous .21 ppm gold analysis. The northernmost of these faults is also the site of strong iron-staining and barite and minor copper oxide mineralization. A 20 foot chip sample around a small pit developed on this fault yielded a very encouraging .12 ounces/ton gold analysis. The area around these two faults is a very broad area that at present is only adequately sampled and may represent a Carlin-type of exploration target that could equal the potential of the underlying breccia zone.

Additional mineralization found at Clara Peak in both the flat-lying breccia zone and the vertical faults includes minor copper oxides. In the flat-lying breccia the copper oxides tend to occur at the top of the breccia zone rather than disseminated throughout the entire breccia. In the vertical fault zone minor copper oxides occur along preferential planes within the sediments such as shale-sandstone contacts.

The mineralization found at the Clara Peak Prospect is thought to have been deposited in the epithermal temperature range (50^{o}-$250^{o}C$) at shallow depths that, in many respects, strongly resembles the depositional environment under which precious metals are deposited in the Carlin model of deposition. The similarities of the economic geology found at the Clara Peak Prospect to those of Nevada Carlin gold deposits include somewhat similar minerologic suites, similar structural influence on mineral deposition, and similar temperatures and pressures of deposition.

Similarities in mineralization include high gold to silver ratios, the presence of barite, minor silicification and very fine-grained or flour gold. Dissimilarities include the presence of copper oxides and the total lack of arsenic and antimony. Structural similarities include strong precious metal mineralization associated with flat-lying structures (thrust faults) with additional mineralization occurring on vertical "feeder faults" that extend away from the flat structure. Epithermal temperature and pressure similarities are indicated by the strong development of argillic alteration, a common epithermal temperature range alteration product, and the presence of barite indicating boiling of the mineralizing fluids.

The deposition of precious metals at the Clara Peak Prospect is probably related to the emplacement of the mid-Tertiary subvolcanic intrusive, the development of the permeable breccia zone at the Precambrian-lower Tertiary contact and the preferential convection circulation of hydrothermal fluids along the breccia zone that were driven by the intrusive's heat. With the emplacement of the subvolcanic intrusive, regional doming resulted in the sliding of the Tertiary section away from the positive area and the formation of a breccia at this contact. Below and only slightly above the Precambrian-Tertiary contact a high thermal gradient developed which began the convection circulation of hydrothermal fluids that preferentially migrated along the contact breccia zone and upward into the overlying Tertiary section where high angle faults into the Tertiary rocks provided access. Deposition of precious metal mineralization apparently was associated with the boiling of the mineralizing solutions as the gold mineralization at the Clara Peak Prospect is found only in association with barite mineralization.

CONCLUSIONS

The Clara Peak Prospect has significant exploration potential as a disseminated precious metal deposit. Two main exploration areas are obvious at this time and lie on the west-northwestern portion of the claim block along the flat-lying breccia zone and where the high angle faults cut the Tertiary sediments in the center of the claim block. Both areas are characterized by gold and barite mineralization, argillization of host rocks, minor silicification and a total lack of veining indicating a true dissemination of precious metal values into the host rock.

Additional tonnages of similar ore could also be developed at a property located one mile to the northeast of the Clara Peak Prospect in the center of Section 35. This property is known as the Clara Consolidated Gold Mines and is controlled by the same owner that leased ERG the Clara Peak Prospect. As a result, ERG could probably acquire this property for the same favorable terms that were negotiated for the Clara Peak acreage.

ENERGY RESERVES GROUP

PROSPECT: CLARA PEAK PROSPECT

COUNTY/STATE: Yuma Co., AZ

SAMPLE NO	T	R	S	FNL	FEL	COLLECTOR	DATE	Au (ppm)	Ag (Oz/T)	As (ppm)	Sb (ppm)	Cu (Wt.%)				DESCRIPTION
2908	9N	15W	3	2470	4060	SS	6-30-82	.39	<0.1	50	<1	.12				Grab sample from small prospect N hill above mine. Samples chloritic sandstone & mudstone? New alteration to unidentifiable rock type. Area extremely brecciated & cemented with large barite crystals. Pyrite pseudos are disseminated throughout the rock.
2909	"	"	"	2530	4310	"	"	.03	<0.1	40	<1	<0.01				Dump sample of 25' deep shaft. Samples silic. breccia of undeterminable rock type. Minor FeOx, shaft does not go down on a structure
2910	"	"	"	2360	4070	"	"	.11	<0.1	40	<1	.05				Mudstone? above possible mineralized contact, rock is Fe stained & has some thi beddedness, also barite.
2911	"	"	"	2730	3970	"	"	.01	<0.1	40	<1	<0.01				From small prospect. possibly at contact between overlying shale and sandstone and underlying breccia. Good FeOx, no Cu or $BaSO_4$.
2912	"	"	"	2460	3550	"	"	3.73	<0.1	<10	<1	.37				Samples from small pits into sandstone w/ minor shale, sandstone has strong FeOx, shale is argillized. Good $BaSO_4$, some $CuCO_3$ and good FeOx.
2913	"	"	"	2640	4030	RR	"	.97	.2	50	<1	.56				30' sample from inside adite at main pit, rock is brecciated, argillic & very heavily hematite stained.
2914	"	"	"	1710	3740	"	"	4.5	.2	20	<1	.73				40' sample from inside adit and immediate exterior in sedimentary rock near contact w/underlying gneiss, v.heavy Hemw/some brecciation.

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ENERGY RESERVES GROUP

PROSPECT CLARA PEAK PROSPECT

COUNTY/STATE Yuma Co., AZ

SAMPLE NO	LOCATION T	R	S	FNL	FEL	COLLECTOR	DATE	RESULTS Au (ppm)	Ag (Oz/t)	As (ppm)	Sb (ppm)	Cu (Wt.%)				DESCRIPTION
2915	9N	15W	3	1330	3420	SS	6-30-82	<0.01	<0.1	<10	<1	<0.01				Samples Hem cemented breccia formed in chloritic altered gneiss.
2916	"	"	"	2050	3090	"	"	2.16	<0.1	30	<1	.72				Prospect at gneiss sandstone contact Minor CuCO3, good FeOx, noBaSO4. Contact well exposed and almost flat.
2917	"	"	"	2660	750	"	"	.05	.2	20	<1	.05				10' chip(vertical)thru contact between Kss & PG-s. PG schist is somewhat silic. as is the sandstone, Minor FeOx & CuCO3 Contact dips 25°SESE.
2918	"	"	"	2290	1630	"	"	.1	<0.1	40	<1	.04				Chip down 15-20' of breccia zone between contact of Kss & PC gneiss, some SiO2 stockwork in PC gneiss, much FeOx, no CuCO3, some BaSO4, some gypsum.
2919	"	"	"	1700	510	"	"	.02	.3	<10	<1	<0.01				small prospect into contact. Good FeOx MnO, some siliceous thickness undeterminable.
2920	"	"	"	1650	50	"	"	.01	<0.1	40	<1	.08				Chip down 15' face of exposed contact on bottom, not exposed some CuCO3, breccia in middle, argillic at top, good FeOx.
2921	10N	15W	35	2890	3010	"	"	.06	.2	40	<1	.10				Contact zone between sandstone and gneiss Argillic at contact w/some Silic. in gneiss. Good FeOx, MnO, minor Cu on dump.
2922	"	"	"	2660	2160	"	"	2.04	<0.1	70	6	.44				Contact of Kss and PCgneiss, much CuCO3 some argill. some FeOx.
2923	"	"	"	2450	2140	"	"	.22	.2	<10	2	7.3				Contact PCg & Kss, much CuCO3 minor FeOx Quite a bit of mineralization in Pcg, more than usual.

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ENERGY RESERVES GROUP

PROSPECT CLARA PEAK PROSPECT

COUNTY/STATE Yuma Co., AZ

SAMPLE NO	LOCATION T	R	S	FNL	FEL	COLLECTOR	DATE	RESULTS Au (ppm)	Ag (Oz/t)	As	Sb					DESCRIPTION
3634	9N	15W	3	2530	3925	RR	6-6-82	<0.01	<0.1							10' sample from prospect pit of sandstone mudstone, dk. brown, w/no apparent alteration sample probably won't run.
3635	"	"	"	3010	3920	MKP	"	.21	<0.1							Greenish rock, mudstone, slightly calcareous, siliceous in places, not much Cu at all, fractured, mod. Hem & Lim, argillic in places.
3636	"	"	"	2830	3710	"	"	.09	<0.1							Brick red mudstone, minor calcite, fractured Lim after pyrite cubes, mod. to minor Lim, abund Hem stains.
3637	"	"	"	2580	3640	RR	"	.21	<0.1							200' sample of mudstone w/at times, Hem stains & Lim pseudomorphs, also some gypsum (Minor).
3638	"	"	"	2500	2800	"	"	.64	<0.1							15' sample of Hematically stained and argillic mudstone w/calcite & minor specular Hematite.
3639	"	"	"	2140	2340	MKP	"	.28	<0.1							Cu minerals, Hem & Lim abund after pyrite Abund. Hem stains, mod Si in places, very argillic in places, brecciated limestone recemented & altered, Mod. Lim, minor calcite, Mod. MnOx, two other workings up hill.
3640	"	"	"	2630	1740	"	"	.17	<0.1							Brick red siltstone to mudstone, fractured slightly, minor Lim, Minor Mn.
3771	10N	15W	35			RR	5-16-82	oz/ton <0.001	<0.1							100' sample of shale(?)W/argillic alter. maroon, has some areas of Fe staining.

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PROSPECT CLARA PEAK PROSPECT

COUNTY/STATE Yuma Co., AZ

SAMPLE NO	LOCATION T	R	S	FNL	FEL	COLLECTOR	DATE	RESULTS Au (Oz/T)	Ag (Oz/T)	As	Sb					DESCRIPTION
3772	"	"	"	4860	2790	"	"	.008	<0.1							100' sample of brown shale, mudstone, thin
																to med. bedded, slight dip of 10-20°,
																doesn't look altered at all, if this stuff
																runs I'll eat my rock hammer.
3773	"	"	"	4730	3860	"	"	<0.001	.1							Hematically stained, rock in sedimentary
																sequence w/some argillic alteration, 50'
																sample, Cu minerals showing up.
3774	"	"	"	3240	3300	"	"	<0.001	.1							10' section of mudstone, partially silicified
																Cu mineralization and some Hem & Lim
3775	"	"	"	2910	3180	"	"	.040	.6							10' section from prospect pit of shale
																thin to med bedded, Cu in medium bedded
																section, Fe staining in thin-bedded
																section, dip is more than 45°.
3776	"	"	3	4160	2030	"	"	.142	<0.1							40' sample of shale-sandstone unit at adit
																entrance, shale unit is argillic and
																bleached, all rocks have Hem stains
																some Lim. pseudomorphs noted.
3777	"	"	"	1630	3820	"	"	.070	.1							50' sample of same sedimentary unit as 3776
																same description also, shale unit here
																ranges between 3'-4' dip is about 10°.

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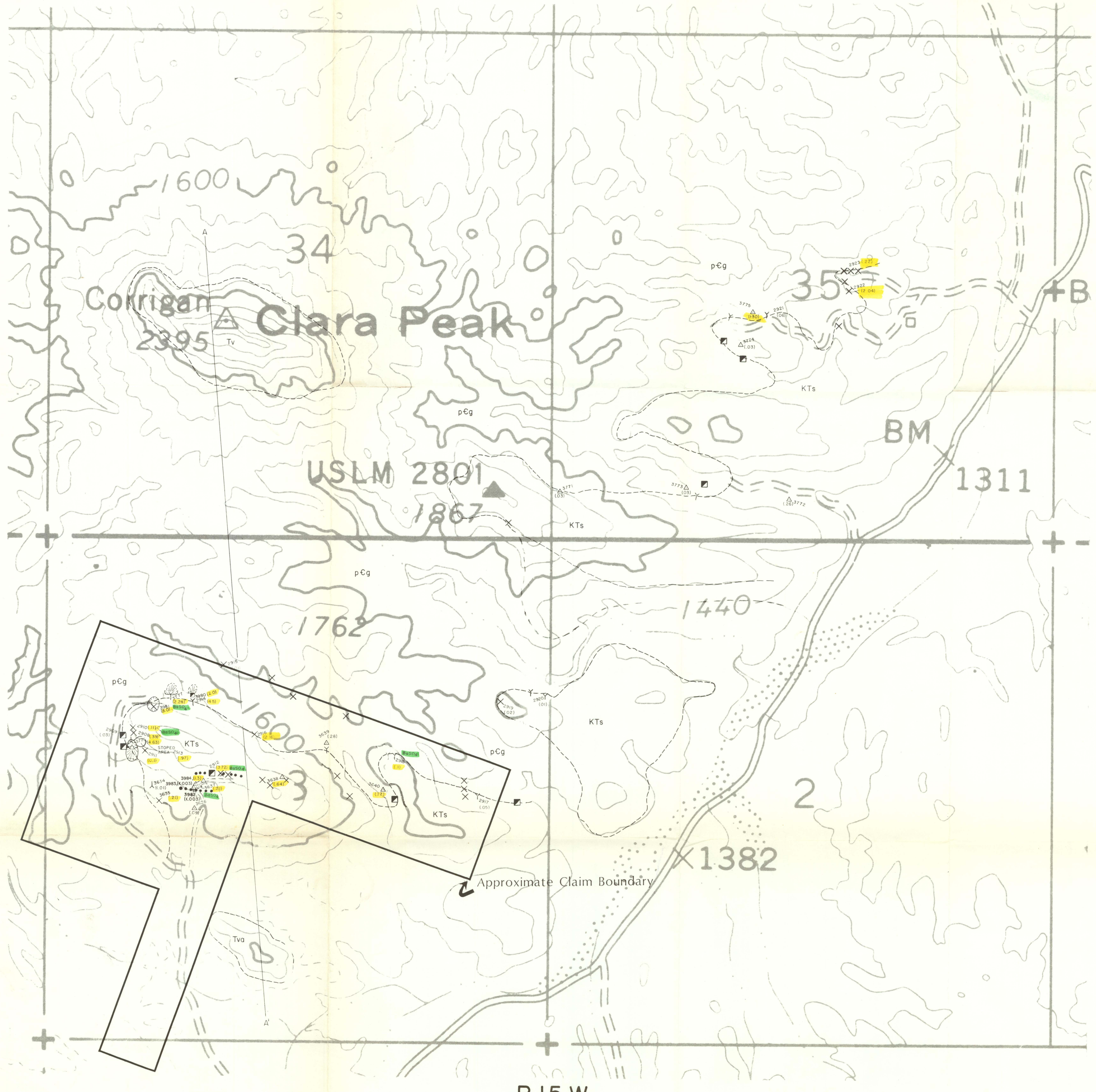
PROSPECT CLARA PEAK PROSPECT

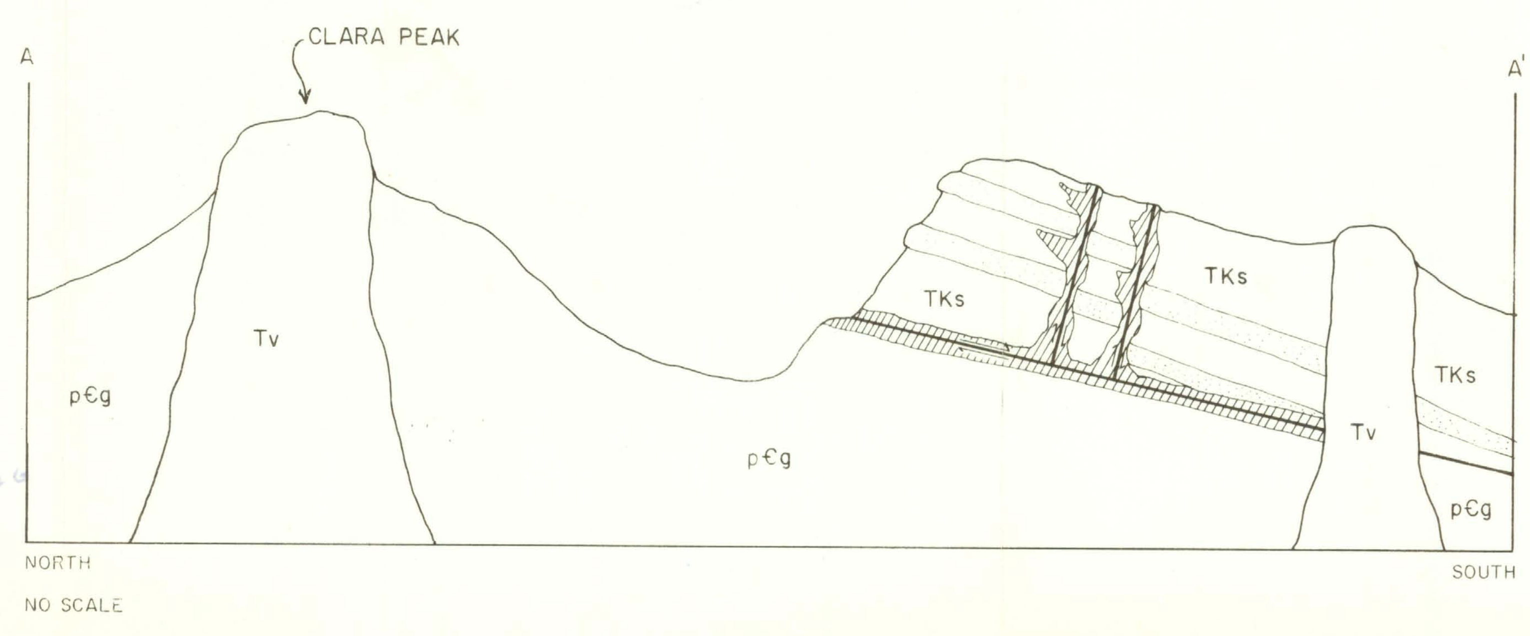
COUNTY/STATE YUma Co., AZ

SAMPLE NO.	LOCATION T	R	S	FNL	FEL	COLLECTOR	DATE	RESULTS Au	Ag	As	Sb	Cu				DESCRIPTION
3980	9N	15W	3	1700	3750	MKP	7-29-82	2.0	0.5			14600				Red siltstone,brecciated,abund. Hem, mod to abund Lim, abund Cu minerals, some sili
3981	"	"	"	1550	4100	"	"	8.0	0.5			13300				Argillic,punky, variable Cu minerals,siltstone,Hem & Lim variable, minor silica,major rattlesnakes!!! Maybe arsenic or Fe or Cu(green) stains, chloritic alt. moderate.
3982	"	"	"	2650	3750	"	"	<0.003	<0.5			33				Red siltstone next to fault(N) abund Hem after pyrite,oxidized pyrite cubes visible Abund barite, rock is punky "Baked".
3983	"	"	"	2600	3700	"	"	<0.003	<0.5			33				Strongly brecciated,Hem & Lim stained & veined,punky, siltstone, looks like ore in Carlin-type pits.
3984	"	"	"	2500	3650	"	"	1.3	<0.5			17				Strongly brecciated, mottled Fe & Lim stained siltstone, Looks like ore . Some strong argillization, much is punky.



Tva	TERTIARY VOLCANIC AGGLOMERATE
Tv	TERTIARY VOLCANICS
KTs	CRETACEOUS-TERTIARY SEDIMENTS
p€g	PRECAMBRIAN GNEISS

CONTACT
FAULT
ADIT
SHAFT
PROSPECT PIT
SAMPLE LOCATION
ARGILLIC ALTERATION
OPEN CUT
DUMP

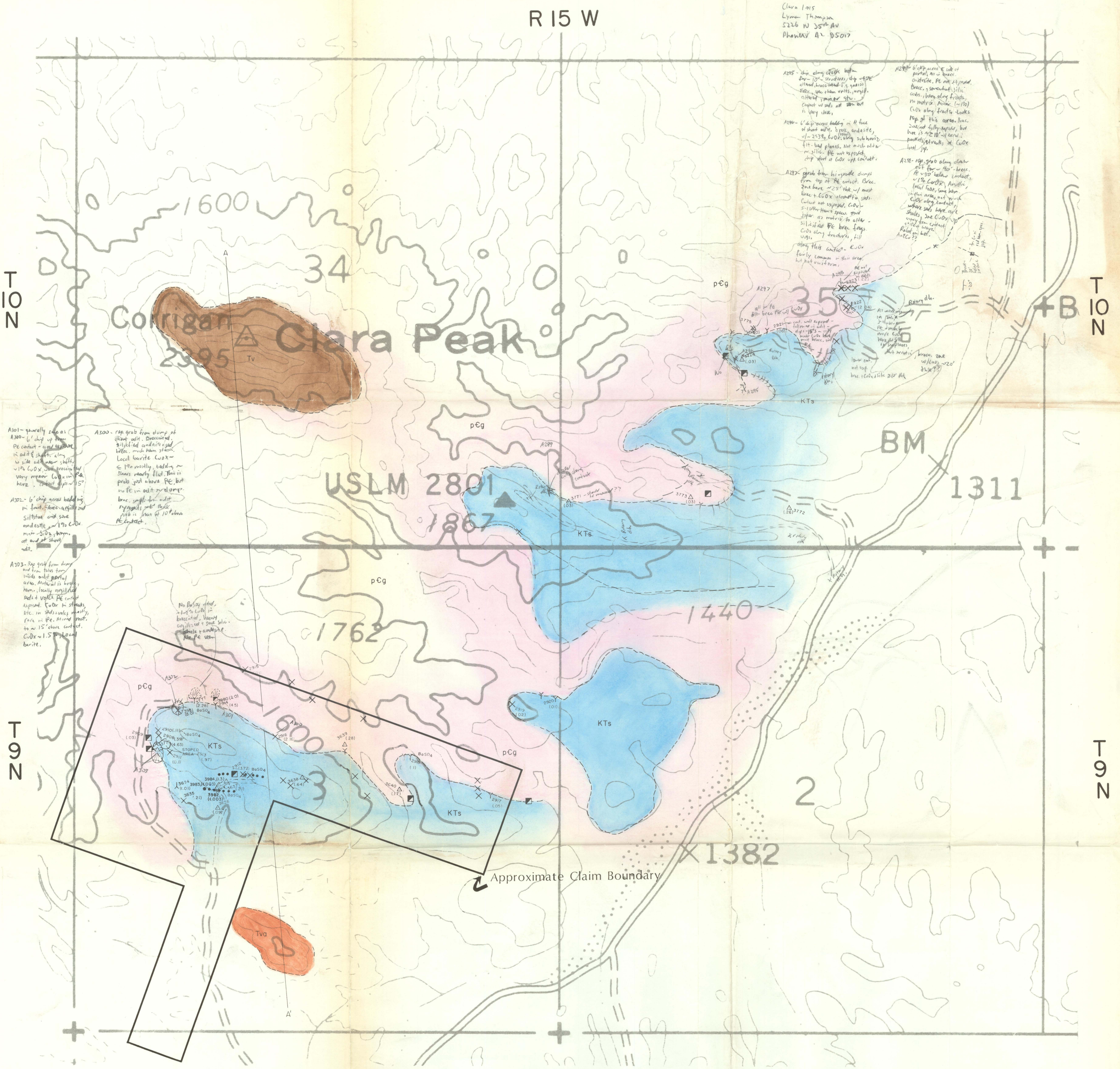


CROSS SECTION A-A'

Energy Reserves Group
SOUTHWEST DISTRICT OFFICE

FIGURE 3
CLARA PEAK
GEOLOGIC AND SAMPLE LOCATION MAP
ANOMALY MAP

SCALE: 1" = 500' | BY: PH & SELKE | DATE: June 18, 1982
UPDATED:



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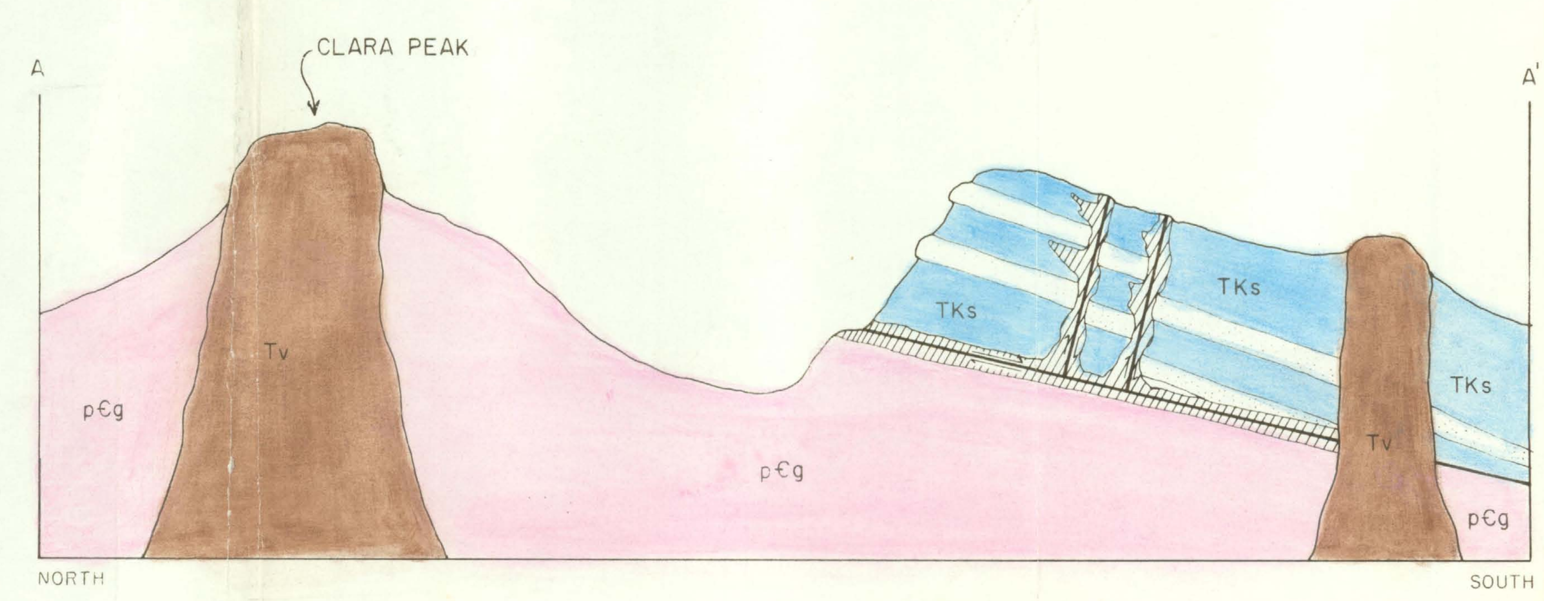
SOUTHWEST DISTRICT OFFICE

FIGURE 3
CLARA PEAK
GEOLOGIC AND SAMPLE LOCATION MAP

SCALE: 1" = 500'	BY: PH / SELKE	DATE: June 18, 1982
C.I. = 80'		UPDATED:

Symbol	Explanation
Tva	TERTIARY VOLCANIC AGGLOMERATE
Tv	TERTIARY VOLCANICS
KTs	CRETACEOUS-TERTIARY SEDIMENTS
p€g	PRECAMBRIAN GNEISS

- CONTACT
- FAULT
- ADIT
- SHAFT
- PROSPECT PIT
- SAMPLE LOCATION
- ARGILLIC ALTERATION
- OPEN CUT
- DUMP



CROSS SECTION A-A'

245 man-days

2916 — 2.16
3980 — 2.0
3914 — 4.5
3777 — 2.28
3981 — 8.0
3776 — 4.63

3.9233 × .0292 oz/T = .1147 oz/T Au

max. area is 1000 x 2000' x 15' ave thick

optimistic pot. is 2.31 MT

~~have~~ assume flat lying structure.

top of hill ~160' above thrust