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JEROME INSTRUMENT CORPORATION

# CASE HISTORIES: SOIL MERCURY PROFILES

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## Introduction:

The most commonly used geochemical sampling techniques depend on the occurrence of rock outcrops, stream sediments, residual soils or derivative waters spatially related to an ore occurrence. However, the correlation between the observed anomalies and the associated ore bodies is not generally simple. The use of Hg as a tracer has great advantages over conventional geochemical techniques because of:

a) the simplicity and low cost of sampling,
b) the common occurrence of trace Hg in many sulfides, and
c) the relative ease of relating anomalies to an underlying base or precious metal source.

The chemical characteristics of Hg permit its release from oxidizing sulfides and, being extremely volatile, it can migrate upwards through a considerable thickness of overburden. As actively oxidizing sulfide ore bodies continually release Hg, post-mineral overburden does not limit the validity or usefulness of the technique.

The following case histories are from various company files and illustrate the use of the Au film Hg detector over a variety of massive sulfide deposits. In addition to the included studies, extensive field work has been done over a number of Au and Ag deposits, both in the U. S. and Canada. A summary of points regarding Hg geochemistry have evolved as a result of this work and are detailed below:

(1) The analytical ability to differentiate between low Hg levels in soil samples can often provide critical information that would otherwise be lost. Profiles across massive sulfide deposits commonly show threshold anomalies, 1 to 2 times background, often extending for 1000 feet or more on the flanks of a deposit. This halo effect could have important consequences for regional exploration programs, serving to minimize the number of soil samples needed to effectively cover an area.

(2) A number of the profiles show Hg anomalies that are off-set, corresponding to the dip of the ore body. This effect, as well as the depth of burial of many of the studied deposits, illustrates the vertical migration of Hg vapor to the surface from an oxidizing sulfide source. Thus, Hg anomalies seldom show the down-slope dispersion that is common with other geochemical techniques.

(3) The use of a gold film Hg detector offers the obvious advantage of providing accurate and economical geochemical measurements in field situations.

(4) Sample collection, preparation and storage are extremely important and are fully detailed in Appendix I.

### The Iron King Deposit, Humboldt, Arizona (Fig. 1)

The deposit occurs in a group of steeply dipping metamorphosed eugeosynclinal

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sedimentary and volcanic rocks of Precambrian age. The deposit consists of a series of overlapping conformable lenses of massive pyrite containing recoverable amounts of gold, silver, zinc, lead and copper. A parallel zone of copper mineralization occurs within the stratigraphic footwall rock to the west. Ore samples from the mine ran as high as 30 ppm mercury. Traverse T-1, approximately one mile south of the main workings, shows a distinct anomaly over the southern projection of the Iron King sulfide zone. This traverse also appears to have a local background which is higher than the regional value. This mercury halo could have important consequences on any sampling program designed to find such deposits.

Traverse T-2 is located near the main workings of the mine and shows a correspondingly intense anomaly. This line had to be discontinued to the east because of the mine plant. (There is a parallel bleached zone about 350 feet east of the main sulfide zone but, where tested for base metals, it was not mineralized.)

Traverse T-3 is along a ridge approximately one mile north of the main workings, where there is over 400 feet of gravel cover. Although this traverse would be near the northern limit of significant mineralization, a broad, distinct anomaly is present. The high flanking values on this line may, in part, be due to contamination, although samples were carefully collected at a depth of 4 inches to minimize this problem. A large tailings dump contains approximately 2 ppm mercury and presumably influenced some soil values, especially those in traverse T-3, which was downwind of the dump. Whereas background in the region is about 60 ppb Hg, contamination in the area of traverse T-3 may locally have increased background to the 200-300 ppb range.

The last traverse, T-4, is beyond the northern limit of known bedrock mineralization and shows no anomaly.

Old Dick Mine, Yavapai County, Arizona (Fig. 2)

The massive sulfide bodies in this area are confined to steeply dipping contact zones between rhyolite and andesitic schist. The main host rock is quartz-sericite schist which is roughly 100 feet thick or less. The Old Dick ore body dips 60° to 70° northwest with a strike length of about 300 feet. The sulfides are pyrite, chalcopyrite and sphalerite with minor galena and arsenopyrite.

Traverse A-A' crosses the gossan of the outcropping ore body. Traverses B-B' and C-C' are 150 feet and 450 feet, respectively above the plunging southern limit of the massive sulfide lens. Traverse C-C' was discontinued to the west due to mine construction and tailings. The anomalies shown in these profiles clearly define the projection of the Old Dick ore body.

Eulamina - Anaconda Zn-Cu Mine, Leonora, West Australia (Fig. 3)

This massive sulfide deposit is 1,250 feet long, 10 feet thick, dips steeply eastward and has primary grades of 0.05% to 3.0% Cu, 2% to 25% Zn. Traverse T-1 over the deposit shows an anomaly peak of over 1700 ppb and is displaced 50 feet east in the direction of dip, indicating a vertical depth to the source material of at least 200 feet. A second strong response of over 400 ppb occurs 200 feet west of the exposed gossan and probably reflects base metal sulfide mineralization which has no surface expression. Also shown in traverse T-1 are values for rock chip samples. With the exception of one value of 80 ppb from the outcroping gossan, the values are generally less than 40 ppb.

Traverse T-2 was run 1600 feet north of T-1 across an unmineralized region. Here the soil Hg profile is essentially flat at a value of 30 to 40 ppb.

Lake Yindarlgooda Massive Pyrite Deposits, Kalgoorlie, West Australia (Fig. 3)

These extensive deposits crop out as spectacular gossans. Drilling has shown very low primary base metal content. The soil mercury background is 25 to 35 ppb. The nearly 800 foot wide anomaly shown in the upper left hand corner of Figure 3 is clearly defined even though values never exceed 90 ppb. This low anomaly may reflect the paucity of base metals in the massive pyrite bodies. Asymmetry of the anomaly is very important. No response is obtained over the western gossan because unoxidized sulfides occur only down-dip to the east. By contrast, the anomaly continues far to the east of the eastern gossan indicating vertical migration of these traces of Hg through approximately 900 feet of overlying black shales.

Binghamton - Copper Queen Mines, Yavapai County, Arizona (Fig. 4)

The Binghamton and Copper Queen deposits occur in two parallel alteration zones sandwiched between tightly folded Precambrian andesitic volcanics. The ore bodies consist of massive pyrite and chalcopyrite lenses about 10 feet thick and 50 to 100 feet long.

Two traverses were made and cross zones of strong silicification and sericitization. Traverse A-A' recorded a strong anomaly corresponding to the Binghamton deposit, and a subordinate anomaly at the projection of the Copper Queen orebody. Traverse B-B' across the main section of the Copper Queen deposit shows a similarly intense anomaly.

Antler Mine, Mohave County, Arizona (Fig. 5)

The Antler massive sulfide orebody is located near and parallel to the contact of two mappable rock units shown on Figure 5. The maximum thickness of the massive sulfide ore bed is 40 feet and it extends more than 2000 feet along the dip. The principal sulfide minerals are sphalerite, chalcopyrite, pyrrhotite, galena and pyrite.

Several short traverses recorded on Figure 5 were run across the gossan approximately 100 feet apart. All three traverses, A-A', B-B' and C-C' show anomalies corresponding to the vertical projection of the massive sulfide lens. A steep meandering canyon and a wash plain prevented additional sampling towards the southeast.

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## APPENDIX I

## COLLECTION, PREPARATION AND STORAGE OF SAMPLES FOR MERCURY ANALYSIS

A major problem in Hg analysis is the preparation and storage of geologic samples prior to analysis. This problem is due to the nature of the element i.e. high vapor pressure, presence in the atmosphere and generally low levels in naturally occurring materials. A number of procedures have been developed to adjust for the above factors and are detailed below.

### Collection:

Soil samples are normally collected at a depth of 4" to 6". As the Hg concentration in soils often varies considerably within a soil profile, a standardized depth of collection is important. In areas with a thick organic horizon, such as British Columbia, samples should be collected below the obvious organic horizon.

### Storage:

If the soil samples are dry they should be sieved to -80 mesh in the field, using a stainless steel sieve and stored in air-tight screw top glass vials, available at any laboratory supply house. As a typical analysis requires only .25 grams, a small quantity of soil is adequate.

Wet samples should be dried at room temperature or in the shade before sieving. Heat lamps should not be used as this could result in volatilization of Hg from the sample.

### Rock Samples:

Rock samples should not be ground in a ceramic plate mill. The heat generated by such grinding tends to volatilize a significant portion of the included Hg, especially in samples containing sulphides.

Instead, rock samples should be coarsely crushed in a jaw crusher and the +20 mesh fraction removed. This fraction should then be hand ground to -80 mesh. Sample pulps should then be stored in air-tight glass vials.

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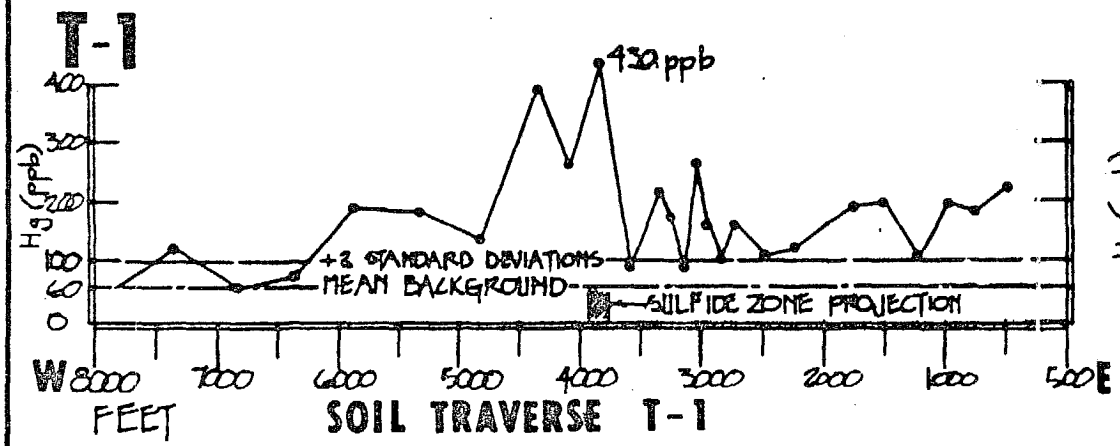


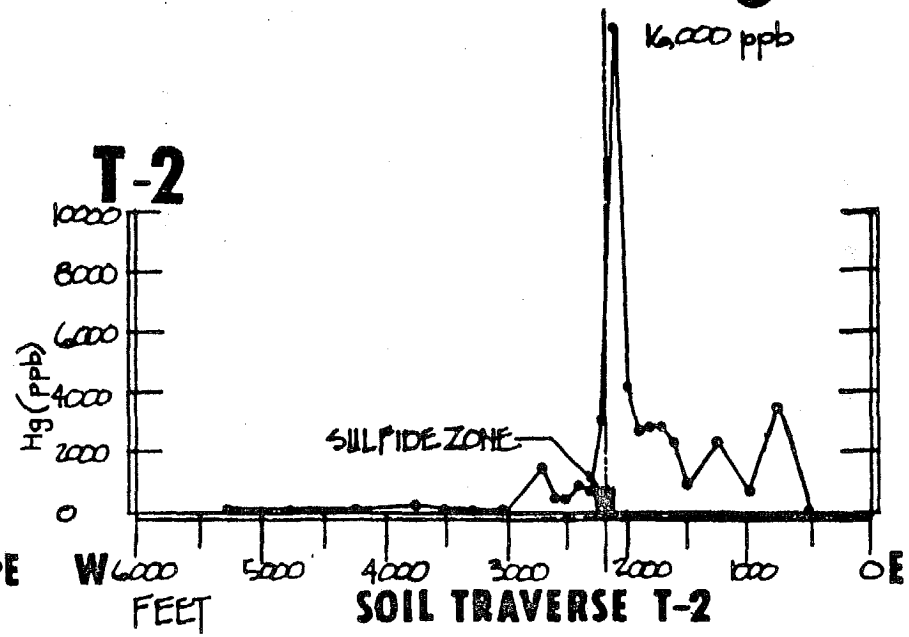


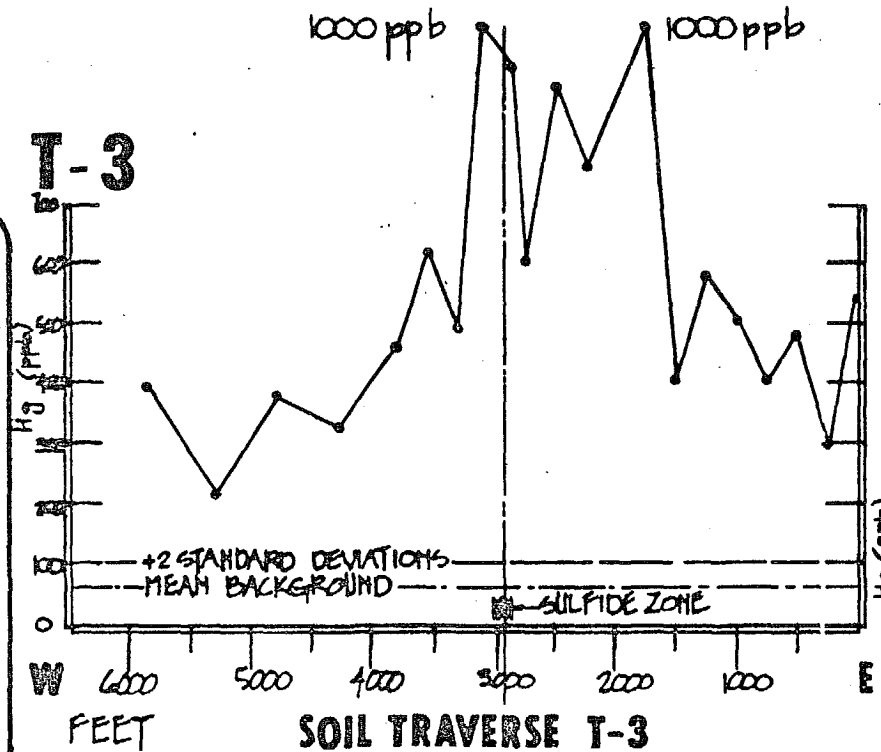


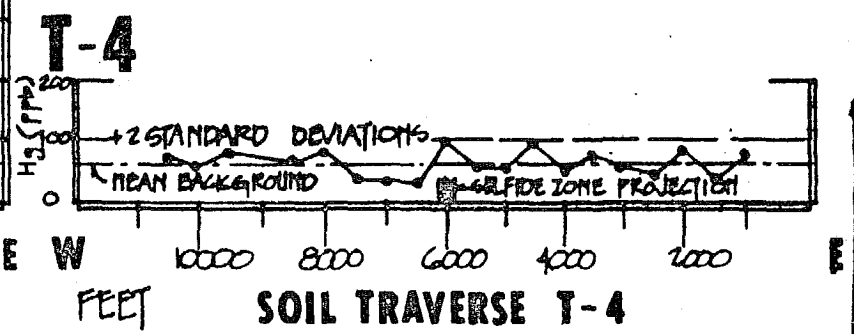


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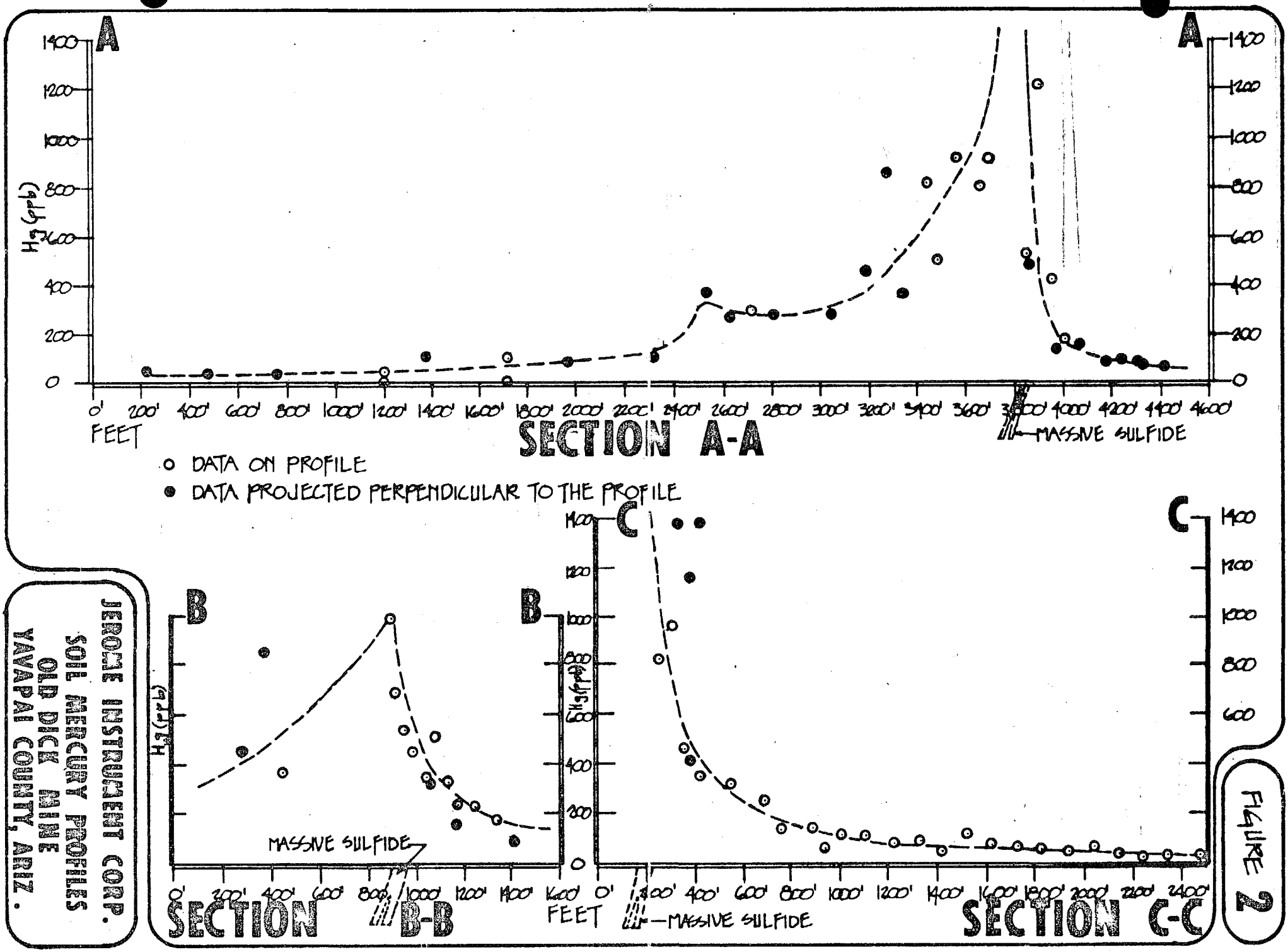
SOIL MERCURY PROFILES
IRON KING MINE
HUMBOLDT, ARIZONA

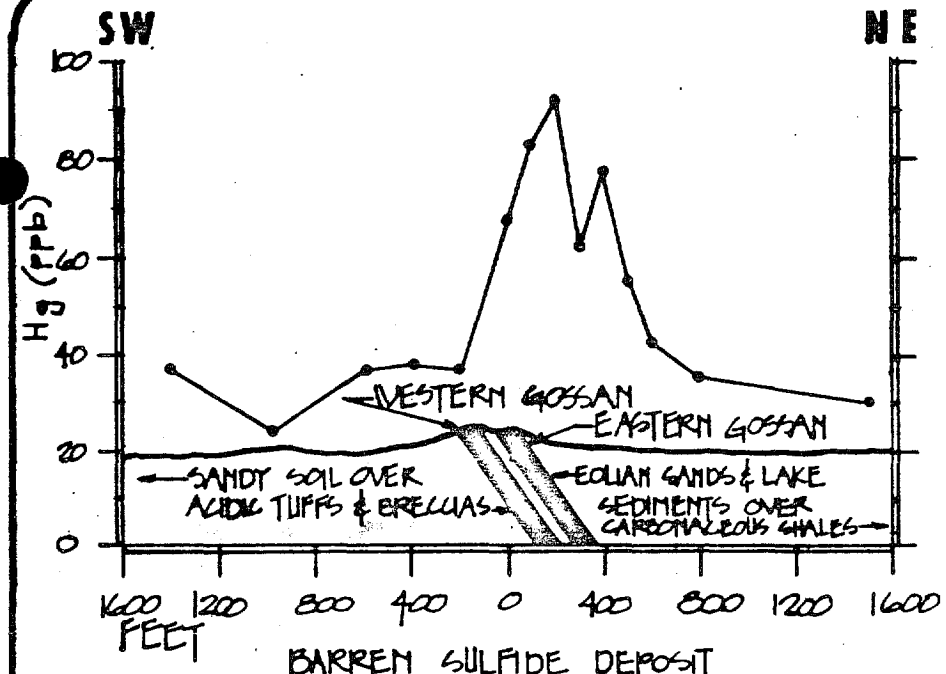
FIGURE 1



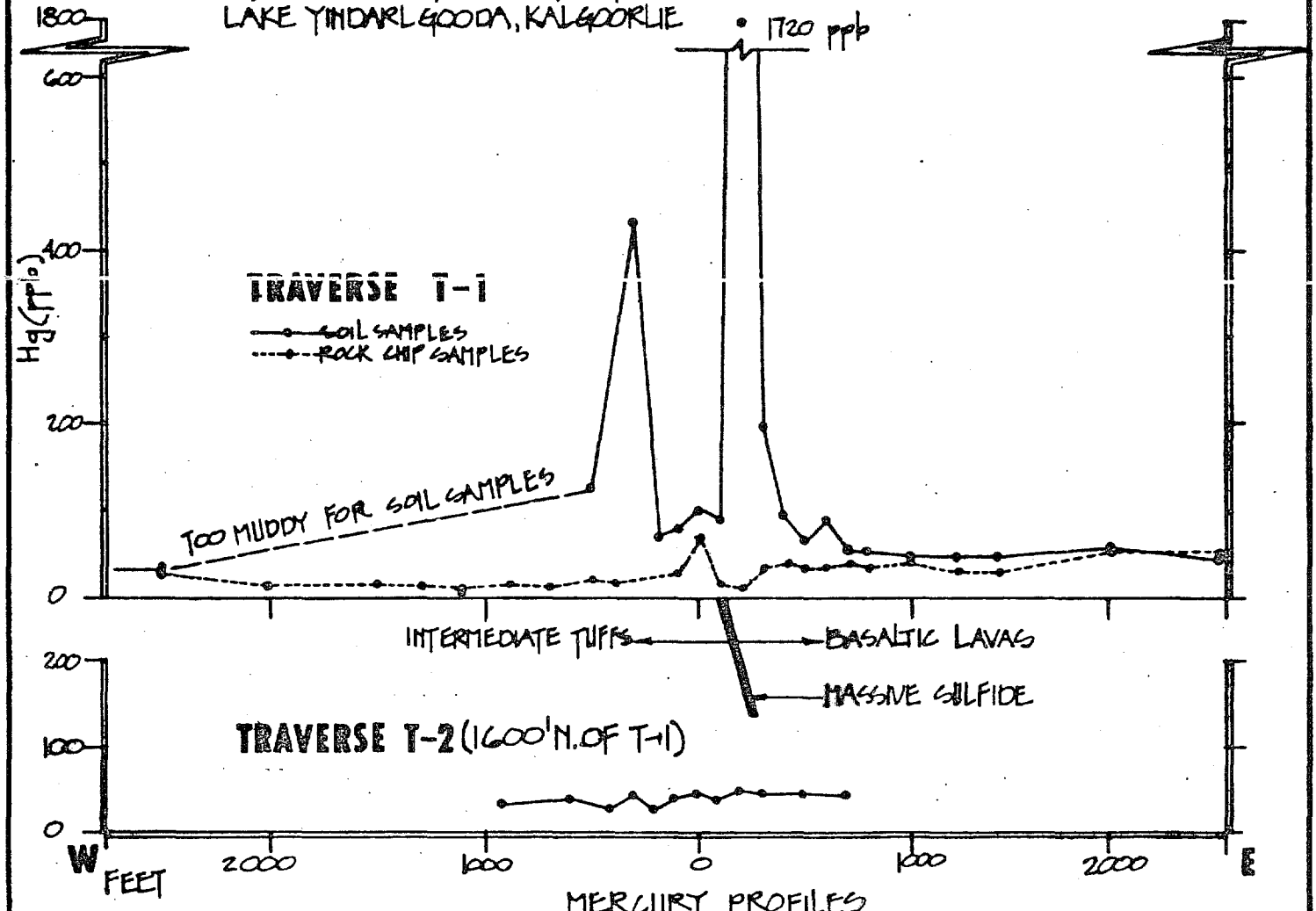

JEROME INSTRUMENT CORP.
SOIL MERCURY PROFILES
OLD DICK MINE
YAVAPAI COUNTY, ARIZ.

FIGURE 2

FIGURE 3




BARREN SULFIDE DEPOSIT
LAKE YINDARLGOODA, KALGOORLIE




MERCURY PROFILES
EULAMINNA-ANACONDA Zn-Cu MINE, LEONORA

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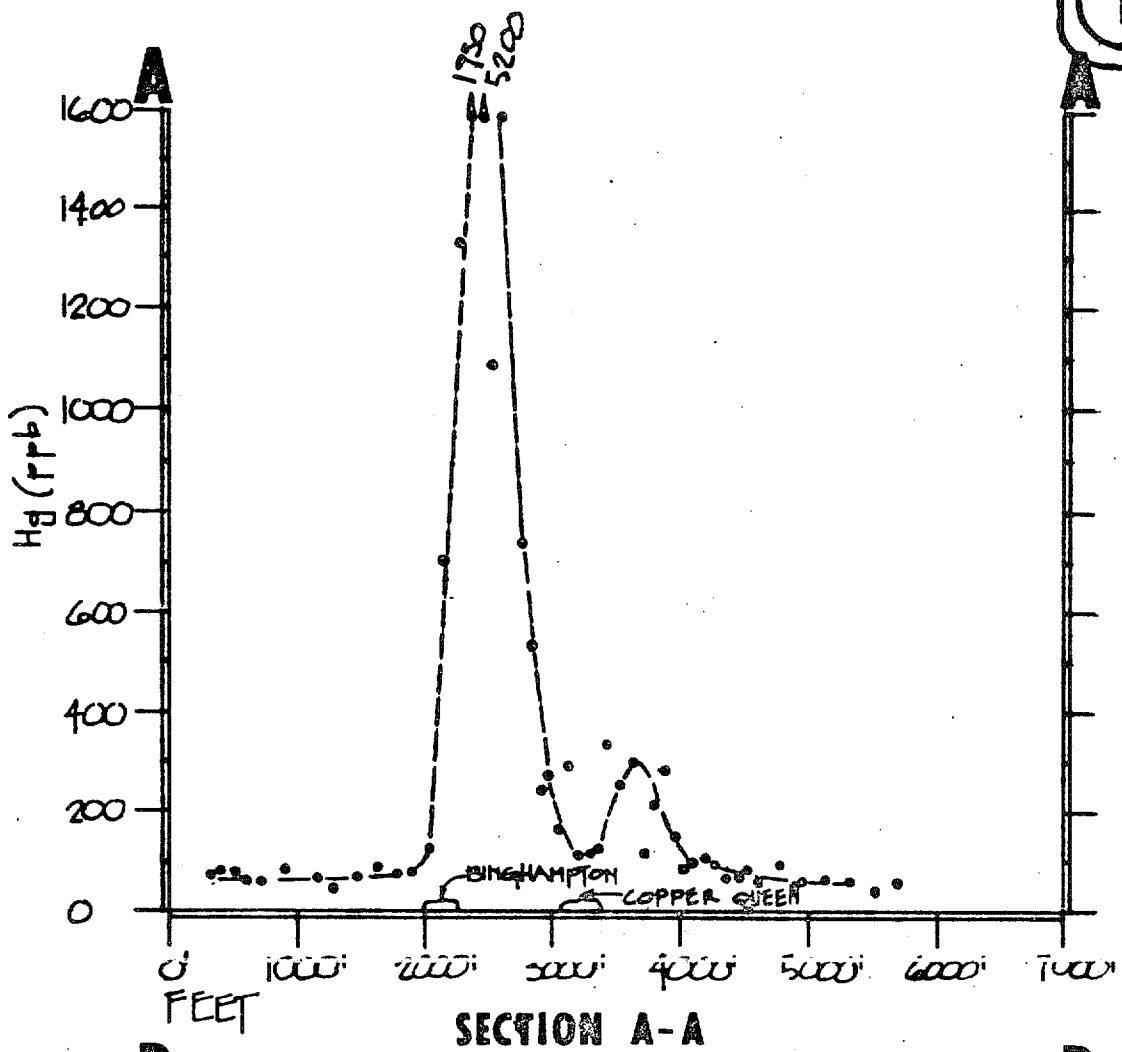
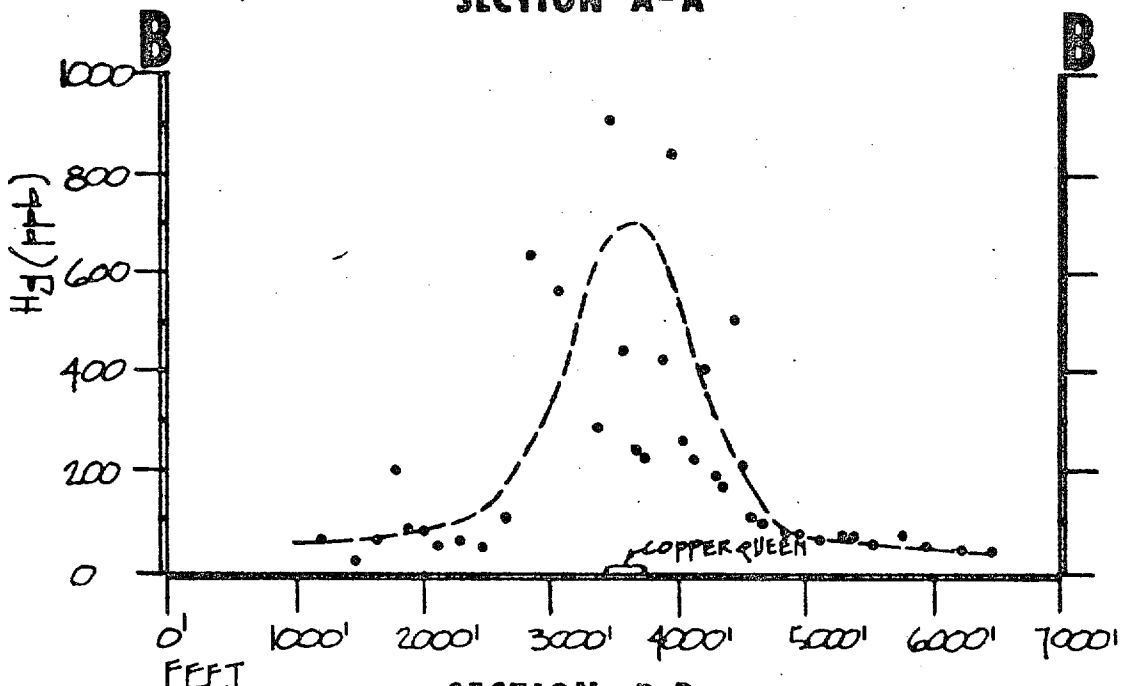
**SOIL MERCURY PROFILES**
**WESTERN AUSTRALIA**

FIGURE 4



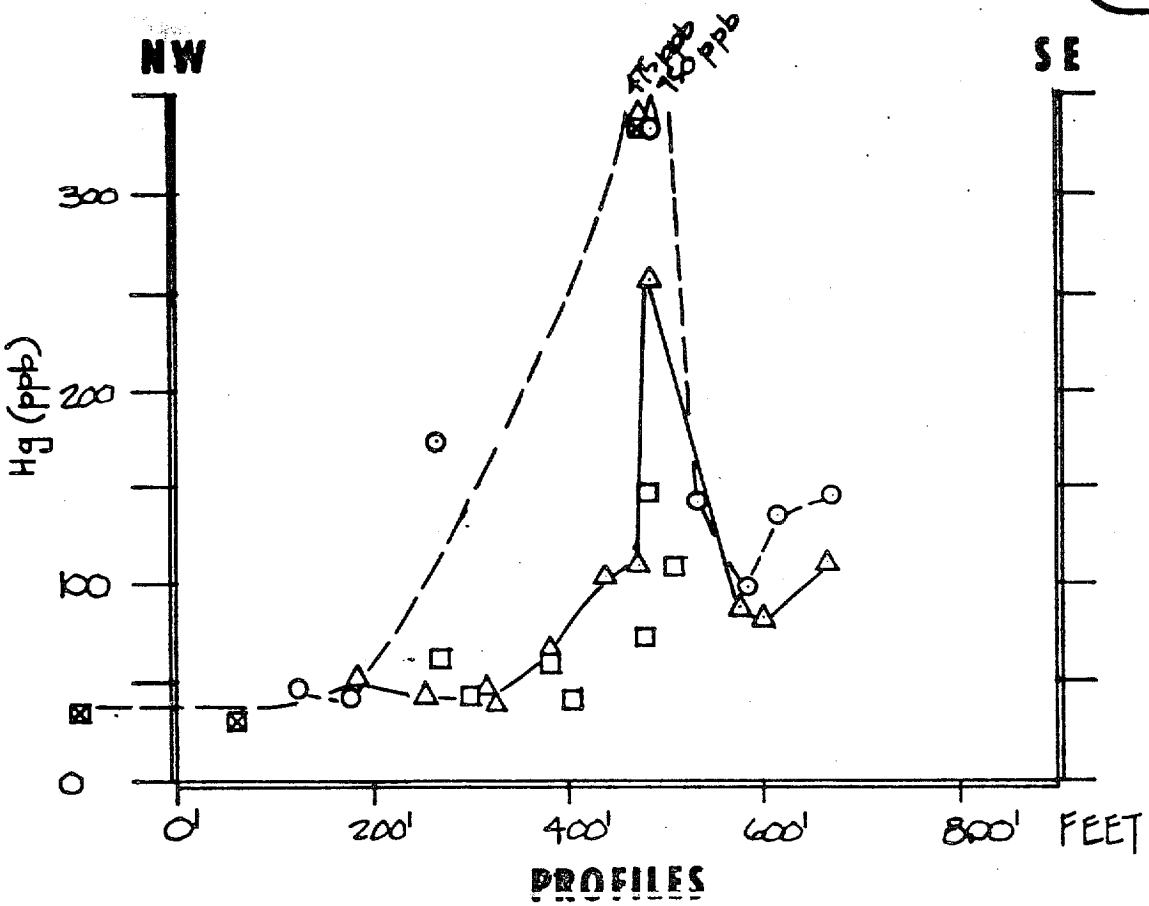

SECTION A-A

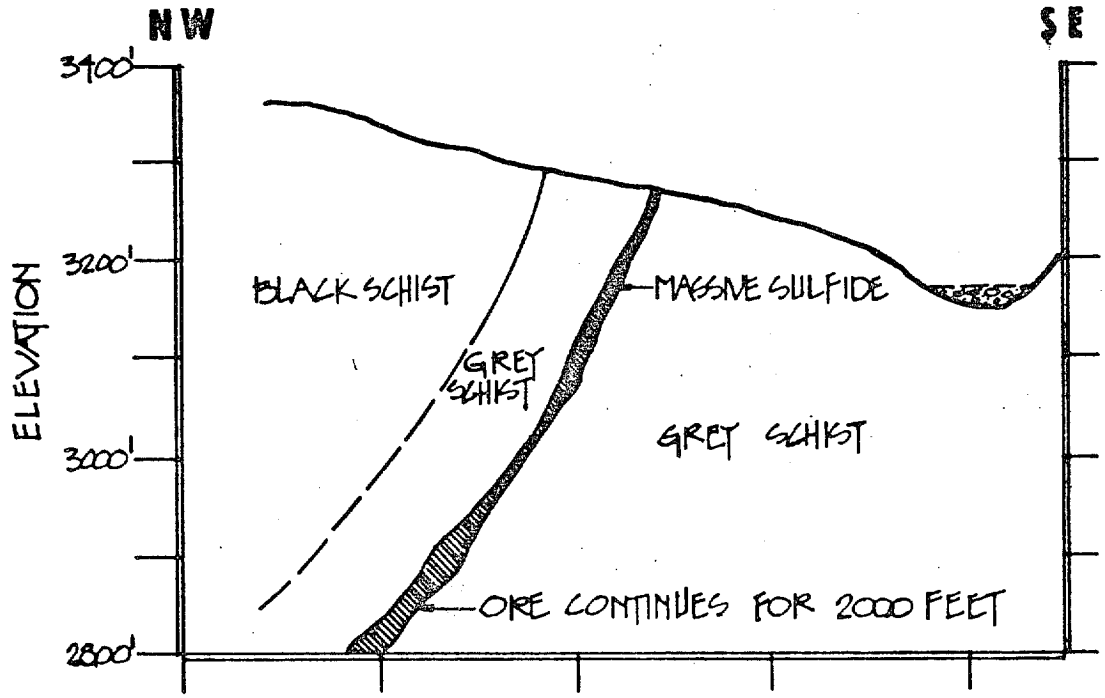



SECTION B-B

JEROME INSTRUMENT CORP.
SOIL MERCURY PROFILES
BINGHAMPTON - COPPER QUEEN
YAVAPAI COUNTY, ARIZONA

FIGURE 5




GEOLOGIC CROSS SECTION OF PROFILE A-A

EXPLANATION OF MERCURY DATA

△ PROFILE A-A

○ PROFILE B-B

ON LINE PROJECTED ⊠ □ } PROFILE C-C

JEROME INSTRUMENT CORP.
SOIL MERCURY PROFILES
ANTLER MINE
MOHAVE COUNTY, ARIZONA

# MERCURY IN SOILS GEOCHEMISTRY ON MASSIVE SULFIDE DEPOSITS IN ARIZONA

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**2300 W. 1700 S**
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## ABSTRACT

Soil mercury geochemical surveys were conducted over three massive sulfide deposits in west-central Arizona, U.S.A. Results indicate that this technique may have widespread applicability in massive sulfide exploration in semi-arid regions, such as the southwestern United States.

All deposits studied occur in Precambrian metavolcanic and metasedimentary rocks. At the Old Dick deposit south of the Bagdad district, a broad, strong soil mercury anomaly of more than 500 ppb covers an area in which gossan and buried ore occur. A traverse over the orebody located at a depth of 150 meters below surface shows a response equal to that obtained over the gossan. At the Copper Queen deposit about 1000 meters south of the Old Dick deposit, a rather weak soil mercury response was obtained. A regional threshold of about 100 ppb Hg outlines all known mineralization in the Old Dick area.

Soil mercury traverses across two parallel massive sulfide lenses in the Binghampton area east of Prescott show broad strong anomalies of 200 to more than 1000 ppb Hg over a background of about 50 ppb. At the Antler mine southeast of Kingman, anomalous values are limited to gossan or quartz-biotite schist which hosts the orebody.

The soil mercury halos in the Old Dick and Binghampton areas strongly indicate the presence of a hypogene mercury halo in the host rocks of massive sulfide bodies. Such hypogene mercury halos are significantly larger than the corresponding massive sulfide bodies and are probably the major source of mercury anomalies likely to be detected in mineral exploration. The size and intensity of the hypogene mercury halo may be related to the distance from, and the maturity of the massive sulfide forming hydrothermal system. Large hypogene mercury halos appear to be associated with massive sulfide ores formed near the volcanic centers or during the mature stage of an ore-forming hydrothermal system, whereas weak hypogene mercury halos may be associated with massive sulfides deposited far away from the volcanic vent areas or during the waning stage of an ore-forming hydrothermal system.

## INTRODUCTION

A relatively small, portable mercury detector (McNerney *et al.*, 1972) with both detection limit and precision in the range of a few parts per billion was used in these studies. Case studies over three massive sulfide deposits in west-central Arizona (Figure 1) in this report are portions of a program to test the applicability of such a new mercury detector in exploration for several types of mineral deposits under different geologic and climatic conditions. Sampling and analyses for this report were conducted in 1974 by the authors while employed by Kennecott Exploration, Inc.

Saukov (1946) published the first comprehensive study on the geochemistry of mercury in nature and suggested the use of mercury as a geochemical tracer

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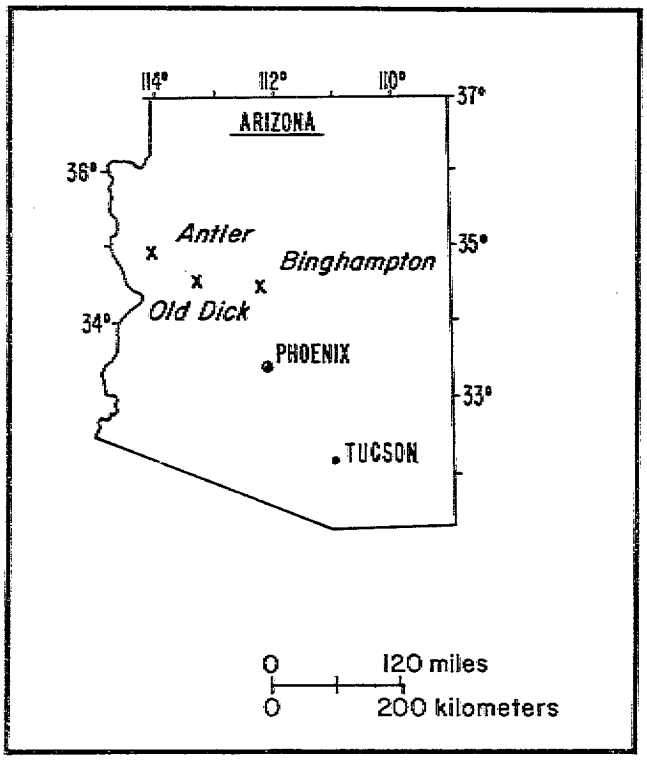


FIGURE 1. Locations of massive sulfide deposits studied in Arizona.

in mineral exploration. The mercury geochemical exploration technique was applied and described in several Russian publications during the late 1950's, and later by Fursov (1961), Ozerova (1962), Hawkes and Williston (1962), James and Webb (1964), Freidrich and Hawkes (1966), Maksimovic, *et al.*, (1972), McCarthy (1972), Baird and Robbins (1973), McNerney and Buseck (1973), and many others. Most of the studies on mercury halos associated with mineral deposits, particularly massive sulfide deposits, conducted by private exploration companies in the U.S. and Canada, were unfortunately not published.

## SAMPLING AND ANALYTICAL METHODS

The mercury content of soils, rocks and soil gases was analyzed in previous studies in the aforementioned Kennecott test program. The results demonstrated that soils are the best sampling medium for efficient application in geochemical exploration, because mercury in soils is more reproducible than mercury in soil gases and provides higher anomaly to background ratios than those obtained from mercury in rocks. Surface soil samples were sieved to −80 mesh in the field and placed in glass vials with air-tight plastic snap caps. Because mercury loss from soil samples does occur in storage, it is important to use air-tight glass containers if analysis is delayed. For this study, most soil samples were analyzed in the field within a few hours of collection by a prototype gold-film mercury detector built for Kennecott Exploration, Inc. by McNerney.

The gold-film mercury detector measures the increase in resistivity of a very thin gold-film (about 200Å) when elemental mercury is absorbed on the film surface. A 10–20 mg soil sample was heated in a combustion tube. The Hg-bearing vapor was passed through moisture and acid scrubbers and then a noble metal collector, where the mercury in vapor was stripped. Mercury in the noble metal collector was subsequently driven off by electric heating and analyzed using the detector described by McNerney *et al.*, (1972). The detection limit of this instrument is significantly below the range of mercury concentrations found in most soils studied.

## CASE HISTORIES

### OLD DICK AREA

Massive sulfide deposits in the Old Dick area occur in thick volcanic flows that were deposited near the volcanic vent areas. Most of the geologic information at the Old Dick area was obtained from Baker and Clayton (1968) and Clayton (Personal Communications, 1974; 1977). Three known orebodies in the area are Old Dick, Bruce and Copper Queen located at approximately the three shafts shown in Figure 2. The Old Dick and Bruce orebodies occur in the same 30-meter-thick quartz-sericite schist in the overturned andesite-rhyolite contact zone.

The lenticular Old Dick orebody, about 300 meters by 100 meters, dips 70° northwest. Its long axis plunges 45° southwest. The buried Bruce orebody, about 400 meters by 100 meters, dips 75° northwest. Its long axis starts at 270 meters below surface and plunges vertically. The Old Dick and Bruce orebodies are up to 20 meters thick, and each contains about one million tons of ore averaging 3.5% Cu and 12% Zn. The sulfide minerals are pyrite, chalcopyrite, and sphalerite with lesser amounts of pyrrhotite, galena and tetrahedrite.

The smaller Copper Queen Mine occurs in a quartz-sericite schist stratigraphically above the Dick rhyolite. The tabular massive sulfide, up to 10 meters thick, extends 70 meters along strike and 300 meters downdip. The Copper Queen Mine produced a total of about 140,000 tons of ore, averaging 4.7% Cu and

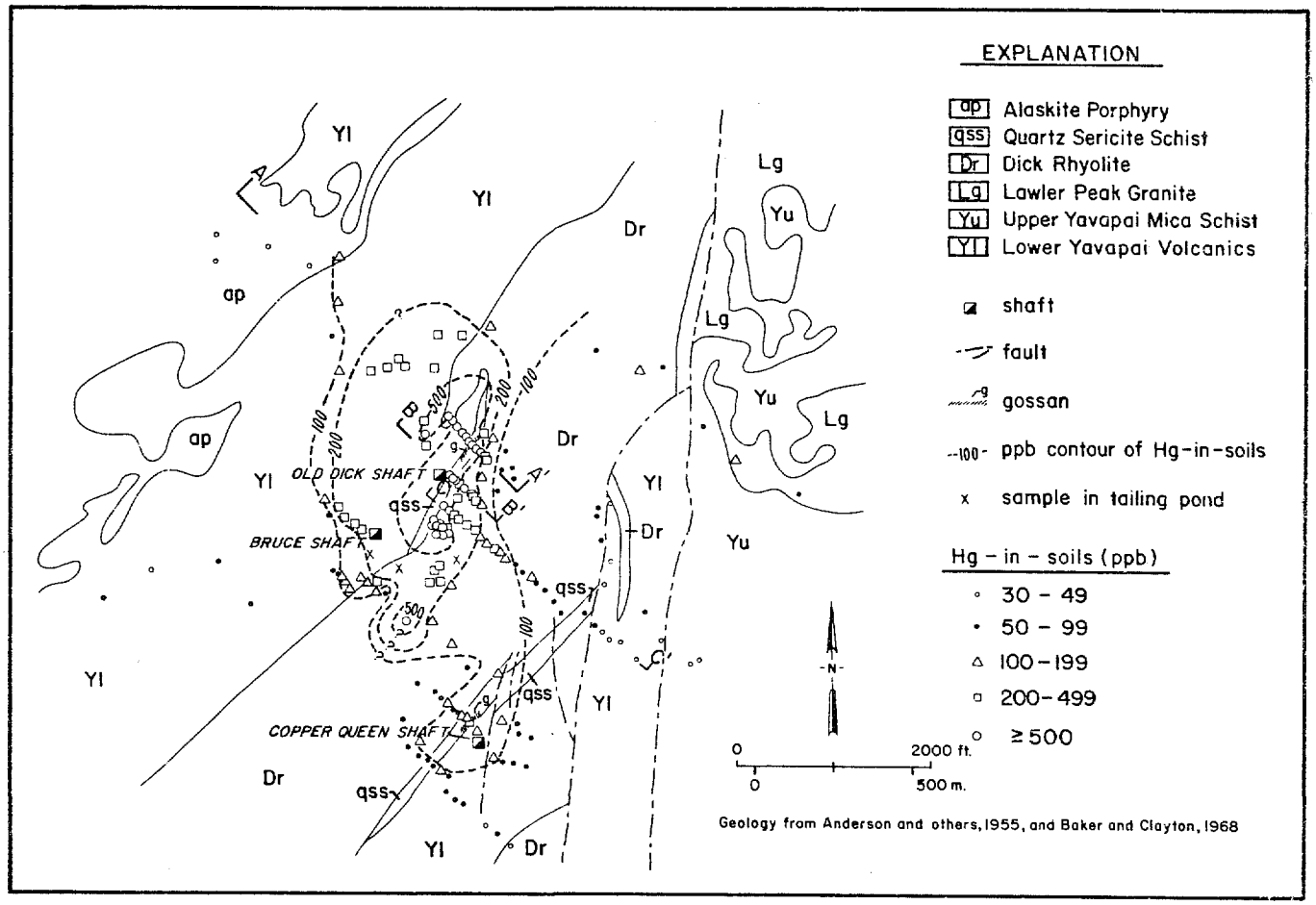


FIGURE 2. Simplified geology and Hg in soils, Old Dick area.

14.4% Zn (Collins and Clayton, 1977). The sulfide mineralogy is similar to that of the Old Dick and Bruce mines.

The contoured mercury data from 156 samples are shown in Figure 2. Sampling to the west of Old Dick and over part of the Bruce orebodies was not possible, due to mine construction and tailings. The reconstructed cumulative frequency curve for the background population of soil mercury data in this area has a geometric mean of 45 ppb and a threshold of 90 ppb. Thus, the 100 ppb contour encloses the soil mercury anomaly. The 500 to 600 meter wide anomalous zone is significantly wider than the massive sulfide orebodies and their vertical projection.

Traverses AA′, BB′ and CC′ across the strike of massive sulfide ores are shown in Figure 3. Only traverse AA′ crosses the outcropping 1–2 meter wide gossan of the Old Dick orebody. Traverses BB′ and CC′ in Figure 3 are 50 and 150 meters, respectively, above the upper edge of the Old Dick ore lens.

Tailing contamination in soil samples may occur within part of the 500 ppb contour area south of traverse CC′ (Figure 2). In this area, mercury values range from 1160 to 3516 ppb where the massive sulfide orebody is 160 to 300 meters deep. Samples from three tailings ponds in the area contain 321, 559 and 1600 ppb mercury, respectively. Thus, tailing contamination can not wholly account for the high mercury values southwest of the traverse CC′.

Mercury traverses over the nearly outcropping Copper Queen orebody southeast of the Old Dick mine show a very weak anomaly that is included within the 100 ppb contour. This significantly weaker mercury anomaly as compared with that found over the Old Dick and Bruce orebodies will be discussed later.

## BINGHAMPTON AREA

Sulfide mineralization in the Binghampton area is closely associated with two bands of quartz porphyry (Figure 4). The quartz porphyries probably are metamorphosed rhyolite occurring in tightly folded meta-andesite. The silicified and sericitzed rocks may be a unit of the Spud Mt. volcanics.

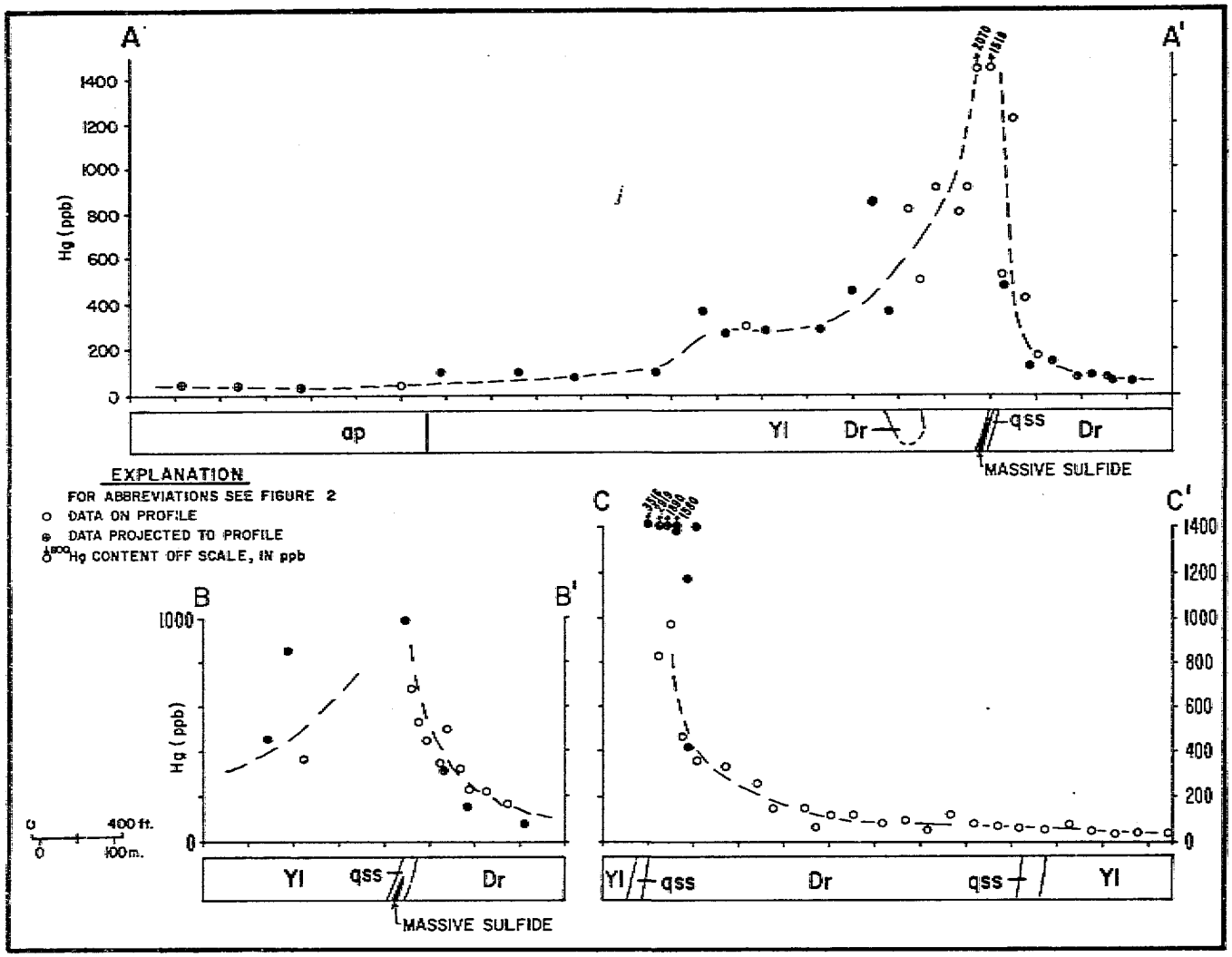


FIGURE 3. Profiles of Hg in soils along traverses AA', BB' and CC', Old Dick area.

Binghampton and Copper Queen are parallel ore zones and may be the same mineralized horizon which has been isoclinally folded. Lindgren (1926) reported that through 1923 Binghampton produced 150,000 tons of 3% Cu, 2 oz/ton Ag. The ores occur in three lenses, each of which is about 35 meters or less in length and 3.3 meters or less in width. The Copper Queen mine has two ore lenses 2 to 4 meters wide, containing about 200,000 to 300,000 tons of 2 to 3% Cu (Aguilar, 1966). The sulfide minerals in ores from the Binghampton and Copper Queen mines are pyrite, chalcopyrite, tetrahedrite, minor sphalerite and rarely galena.

Three mercury traverses were made in this area, as shown in Figure 4. Traverses AA' and BB' were approximately normal to the strike of the mineralized zones. A strong Hg in soil anomaly on traverse AA' corresponded to the Binghampton ore zone, and a smaller anomaly occurred at the projection of the Copper Queen orebody (Figure 5). The highest mercury reading, 5200 ppb, came from a soil sample near the contact of rhyolite and andesitic schist. Traverse BB' showed a series of erratic but high mercury values. Traverse CC', 4 km south of the mines, was made to determine regional background. A reconstructed cumulative frequency curve for the background population of Hg in soils in the Binghampton area gives a geometric mean of 45 and a threshold of about 90 ppb, almost identical to that of the Old Dick area.

## ANTLER AREA

The Antler massive sulfide orebody occurs near the contact between black biotite-hornblende-feldspar-quartz schist and a distinctly lighter grey quartz-

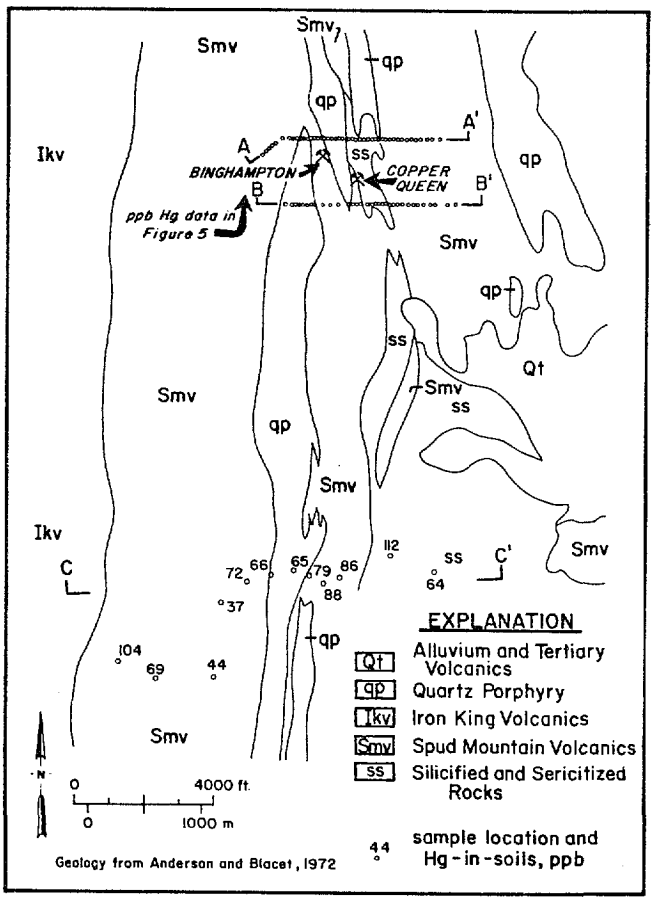


FIGURE 4. Simplified geology and Hg in soils, Binghampton area.

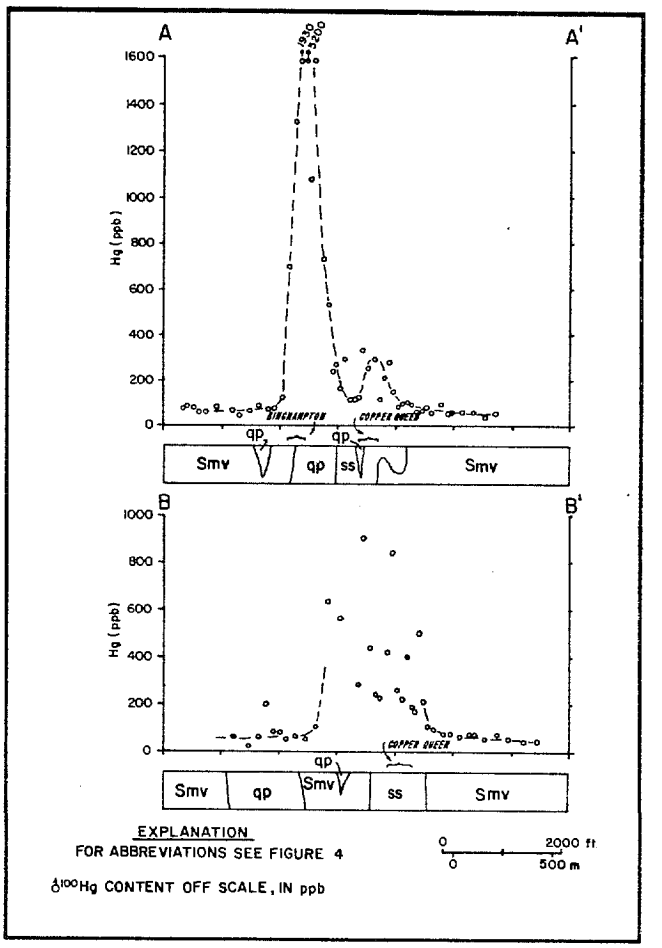


FIGURE 5. Profiles of Hg in soils along traverses AA' and BB', Binghampton area.

feldspar-muscovite-biotite schist (Figure 6). The black and grey schists are probably metamorphosed andesitic and felsic tuffaceous sediments, respectively. The quartz-biotite schist is the ore host.

A NE-trending gossan in quartz-biotite schist near the Antler shaft dips 70° northwest, and measures about 70 meters along strike. The southwest extension of the gossan, characterized by weak to moderate limonite stains in quartz-biotite schist, can be traced for about 220 meters on the surface. Although the orebody pinches and swells, it extends more than 600 meters downdip. This deposit contains several million tons of ore averaging 2% Cu, 4% Zn, and some Pb and Ag. The sulfide minerals are pyrrhotite, pyrite, sphalerite, chalcopyrite and galena.

Several short traverses, as shown in Figure 6, were made across the gossan and its southwest projection. A steep meandering canyon and a wash prevented extension of the traverses toward the southeast. The relatively high mercury values on the southeast side of the gossan suggest that the regional background has not been reached. The data seem also to indicate that the grey schist has a higher Hg background than the black schist. Northwest of the gossan, however, mercury values drop to a probable background value of about 40 ppb within a short distance. As shown in Figure 7, the measureable anomalies have a width of only 30 meters or much less.

## DISCUSSION

### MERCURY DISPERSION HALO AND MASSIVE SULFIDE DEPOSITS

Common sulfide minerals in massive sulfide deposits, especially tennantite-tetrahedrite and sphalerite, contain significantly more mercury than the host rocks. Therefore, the massive sulfide orebodies are generally believed to be the primary source of mercury in secondary dispersion halos, such as the mercury in soil anomalies. However, the following evidence suggests that hypogene Hg dispersion halos are responsible for the significantly larger secondary dispersion halos.

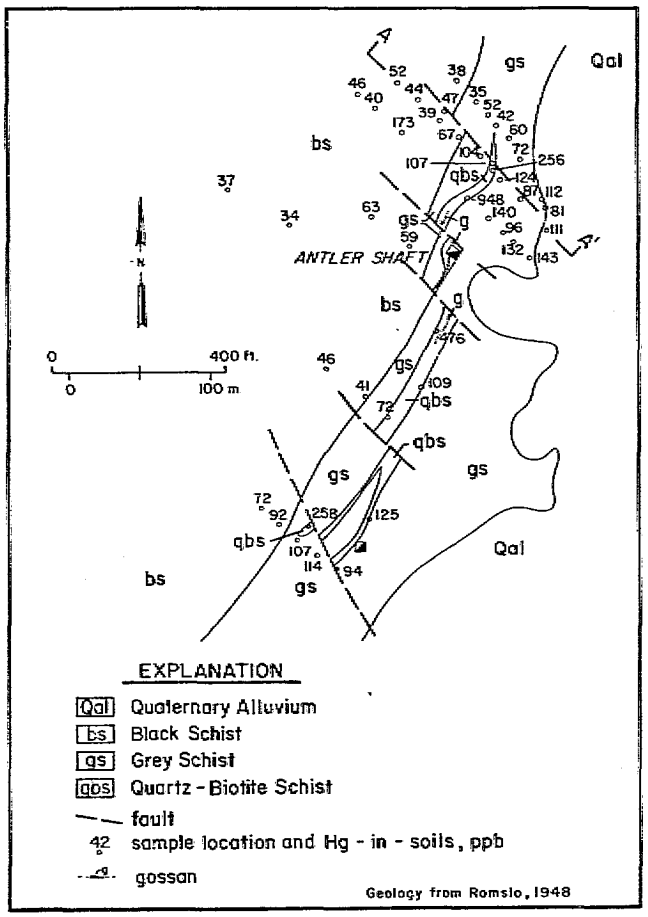


FIGURE 6. Simplified geology and Hg in soils, Antler area.

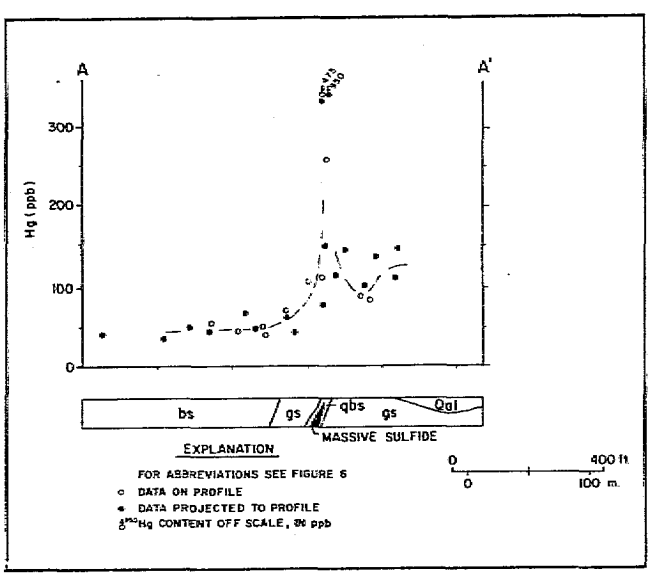


FIGURE 7. Profile of Hg in soils along traverse AA', Antler area.

1. The Hg in soil anomalies at Old Dick and Binghampton are significantly wider than the massive sulfide orebodies themselves. The anomalies at Old Dick and Binghampton have a width of more than 400 meters. Emanation of Hg from the massive sulfide orebodies alone can not account for the broad mercury in soil anomalies observed.
2. Between Old Dick and Copper Queen in the Old Dick area, marked similarities exist in the soil development, vegetation, host rock lithology and fracture density, sulfide mineralogy in ores, and the closeness of the massive sulfide orebodies to the surface. However, mercury in soil traverses over the outcropping Copper Queen orebody detected only a very weak anomaly. Such a significantly weaker mercury in soil anomaly, as compared with that found over the Old Dick and Bruce ore bodies, suggest that the source of mercury in soil is not the massive sulfide orebody alone.

Most of the hypogene mercury halo postulated at the Old Dick-Bruce deposit may be associated with the hydrothermal fluid conduit for the massive sulfide orebodies. The footwall of Old Dick and Bruce orebodies contain sulfide-bearing chloritized zones. The chloritized footwall rocks adjacent to the massive sulfide orebodies contain numerous pyrite-chalcopyrite stringers that were mined as ores (Clayton, personal communications, 1977). The chloritized rocks of the footwall are probably part of the hydrothermal fluid feeder zone for the massive sulfide deposit, similar to those found at Jerome, Arizona, and well-documented in Noranda (Spence and Spence, 1975) and Flin Flon (Byers, *et al.*, 1965) districts in Canada.

Part of the hypogene Hg halo postulated in the Old Dick area is in the hanging wall Dick rhyolite. Persistence of the hydrothermal system after the emplacement of Dick rhyolite may have introduced the hypogene mercury into the hanging wall rocks. This is supported by some brecciation (Clayton, personal communications, 1977), and strong sericitization-silicification in parts of the Dick rhyolite.

The Copper Queen orebody in the Old Dick area occurs in rocks stratigraphically younger than the Dick rhyolite. It may have been deposited peripheral to the volcanic vent area during the waning stage of the massive sulfide-forming hydrothermal system. This may be the cause of a weak primary mercury dispersion halo associated with this deposit.

The large Hg halo at Binghampton probably indicates a similar genetic link between Hg halo and mas-

sive sulfide genesis, as suggested at the Old Dick area. However, the meager geologic information available at Binghampton prevents meaningful discussion of this aspect. A similar situation exists at the Antler mine where the mercury anomalies are narrow and relatively weak. However, the rocks at Antler are more highly metamorphosed and appear to be less permeable.

## MERCURY GEOCHEMISTRY AND MINERAL EXPLORATION

A soil mercury survey can sharply define a near-surface massive sulfide deposit which has a strong hypogene mercury halo. The anomalous area surrounding the Old Dick mine is about 900 meters by 600 meters; that surrounding Binghampton has a width of about 600 meters. In such cases, mercury geochemistry is very useful in locating targets in a wider-spaced sampling survey following preliminary geologic mapping. On the other hand, as in the case of the Antler mine and the Copper Queen mine in the Old Dick area where the anomalies are either narrow or weak, mercury geochemistry is probably only useful as an aid in drill target selection following detailed geologic mapping.

As with any other geochemical exploration technique, understanding the variables and controlling factors in both primary and secondary mercury dispersion halos is the first step to make mercury geochemistry a useful tool in mineral exploration. The factors controlling the secondary mercury dispersion halo are relatively well-known. Improved understanding of the relation between hypogene mercury halos and massive sulfide genesis should be the key to a more effective application of mercury geochemical exploration techniques.

## ORGANIC CARBON AND SOIL MERCURY

In order to evaluate the possible correlation between mercury content and organic material in soils, nine soil samples from the Antler mine area were analyzed for total carbon. Lack of effervescence with acid suggests no appreciable carbonate content, hence these values probably approximate the organic carbon content. As shown in Table 1, no correlation is evident.

The role of organic carbon in fixing soil mercury has been investigated further in samples from different mineral deposits in the southwestern United States, where either organic carbon or total carbon were analyzed. About 130 soil samples from four different mineral deposits show that the correlation coefficient between mercury and organic carbon, or the total carbon in soils in each group of samples is invariably so low that, for all practical purposes, there is no correlation.

**TABLE 1**
**CONCENTRATION OF TOTAL CARBON AND MERCURY IN SOILS FROM ANTLER MINE AREA, ARIZONA**

| Sample No. | $CO_2$* Weight % | Hg ppb |
|---|---|---|
| A-28 | 2.23 | 107 |
| A-27 | 3.80 | 81 |
| A-35 | 2.18 | 72 |
| A-32 | 2.05 | 52 |
| A-33 | 1.92 | 42 |
| A-30 | 1.52 | 38 |
| A-31 | 1.85 | 35 |
| A-39 | 2.12 | 33 |
| A-46 | 2.18 | 26 |

*Analyst: R. Bianchi, Geochemical Research & Lab. Div., Kennecott Exploration Service Dept.

## CONCLUSIONS

These case histories reveal that some massive sulfide deposits have broad and strong mercury in soil anomalies and some do not. Taking the secondary dispersion factors into consideration, such as post-mineral mercury dispersion, metamorphism and fracturing of host rocks, the data strongly indicate the presence of a strong hypogene mercury dispersion halo associated with some massive sulfide deposits.

The hypogene mercury dispersion halos of massive sulfide bodies are products of the ore-forming hydrothermal systems and seem to be closely associated with the feeder zone of the hydrothermal fluids. Large and strong hypogene mercury halos are probably associated with massive sulfide ores formed near the volcanic centers or during the mature stage of an ore-forming hydrothermal system. Thus, the size and intensity of the hypogene mercury halo may be related to the distance from, and the maturity of the massive sulfide-forming hydrothermal system.

## ACKNOWLEDGMENTS

We are grateful to Lloyd Clark for his critical review of an earlier manuscript for a company report. He initiated the program to test the new mercury detector at the former Exploration Service Dept. of

Kennecott Exploration, Inc. We appreciate the permission of Kennecott Exploration, Inc. to publish this study. Permission by Cyprus Mines Corp. and Standard Metals Corp. to conduct the field work, and comments on the manuscript from Mr. R. C. Dwelley of Standard Metals Corp. is gratefully acknowledged. Bob Clayton of Cyprus Mines Corp. kindly reviewed the geology of Old Dick area with the first author on two occasions, in 1974 and 1977. We would also like to thank J. Howard McCarthy, Jr., Tom Patton, and an anonymous reviewer for their thoughtful reviews of this paper.

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with Geochem Case History

*Journal of Geochemical Exploration*, 8 (1977) 169—188

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# GEOCHEMICAL INDICATIONS OF CONCEALED COPPER MINERALIZATION IN AN AREA NORTHWEST OF MOUNT ISA, QUEENSLAND, AUSTRALIA

Geochem
Case History

*Journal of Geochemical Exploration*, 8 (1977) 105--115

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# USE OF PRIMARY DISPERSION FOR EXPLORATION OF MISSISSIPPI VALLEY-TYPE DEPOSITS

*Journal of Geochemical Exploration*, 8 (1977) 189—202
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# THE DISCOVERY OF THE LADY LORETTA ZINC-LEAD-SILVER DEPOSIT, NORTHWEST QUEENSLAND, AUSTRALIA — A GEOCHEMICAL EXPLORATION CASE HISTORY

cent file geph & geochemistry

GEOCHEMICAL OFFICE - EXPLORATION DEPARTMENT
3422 South 700 West
Salt Lake City, Utah 84119

RECEIVED
SEP 2 1976
EXPLORATION DEPARTMENT

August 30, 1976

MEMORANDUM TO: J. H. Courtright
W. L. Kurtz
J. C. Balla
D. P. Cadwell
R. E. Gale
F. T. Graybeal
S. VonFay

geographically not geometry

Attached is a copy of a paper entitled "The Zonal Distribution of Selected Elements Above the Kalamazoo Porphyry Copper Deposit, San Manuel District, Pinal County, Arizona" by Maurice A. Chaffee, which appeared in the May 1976 issue of Journal of Geochemical Exploration. This is an updated version of a paper originally presented at the AIME meeting in New York, February 1975.

L. D. James

L. D. JAMES

LDJ:db
Encl.

N. L. Kurtz

*Journal of Geochemical Exploration*, 5 (1976) 145–165

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# THE ZONAL DISTRIBUTION OF SELECTED ELEMENTS ABOVE THE KALAMAZOO PORPHYRY COPPER DEPOSIT, SAN MANUEL DISTRICT, PINAL COUNTY, ARIZONA

# A Geochemical Exploration Experiment on the Texas Canyon Stock, Cochise County, Arizona

Alt Kerby porph. & Gen.

MOLYBDENUM IN TREE ASH AS AN EXPLORATION GUIDE

By

James E. DeLong, Jr.
Climax Molybdenum Company

Talk Presented July 29, 1971, at AIME Meeting, Vail, Colorado

Filed in Porph Copper General

# MOLYBDENUM IN TREE ASH AS AN EXPLORATION GUIDE

This article is a case history of a biogeochemical prospecting survey carried out at one of Climax's molybdenum prospects. Trees were sampled rather than soil because of the particular geologic conditions at this prospect.

The molybdenum prospect is in extreme western Nevada about 20 miles south-southeast of Carson City and the same distance southeast of Lake Tahoe (Figure 1). The Yerington copper deposit is about 30 miles east. The prospect is in the western foothills of the Pine Nut Mountains, the first range east of the Sierra Nevada in the Basin and Range.

The Sierra Nevada is underlain by a composite granitic batholith of Cretaceous age. Similar granitic rocks are exposed in the core of the Pine Nut Range. In the broad valley between the two mountain ranges, the rocks are primarily pre-batholithic Mesozoic sediments and volcanics overlain by Tertiary sediments and Quaternary gravels.

The generalized surface geology is shown in Figure 2. The main features are the west-dipping volcanics (v) and interbedded limestones (ls) which are cut by numerous faults and intruded by several bodies of quartz monzonite (qm). A prominent east-dipping normal fault with several hundred feet of displacement occurs along Pine Nut Creek and essentially bounds the prospect on the east. The southern intrusive is a slightly unroofed quartz monzonite stock whose dimensions rapidly expand with depth. The form of the two other intrusives is uncertain because they are poorly exposed.

There has been sporadic tungsten production from tactized limestone units all through this area. Low-grade scheelite ore was treated at the mill site shown on Figure 2. Most of the tungsten production was during World War II. During the past few years Climax geologists outlined a sizable molybdenum deposit related to the southern intrusive herein called the Mill stock and Mill deposit.

During geologic mapping of the prospect, similarities were noted in the geologic setting of the Mill area and the area around the two intrusives to the north. One step in further investigation of the area around these intrusives was a geochemical sampling program. Experience with geochemistry over the Mill deposit, however, had pointed out a serious problem in the usual soil sampling method: anomalous concentrations of molybdenum in the soils were found to be restricted almost entirely to the volcanic rock, yet a significant portion of the deposit is under limestone as drilling has shown. Apparently the limestones are masking the mineralization even where it is quite shallow.

In an attempt to avoid this problem a biogeochemical approach was tried - that is, plants, in this case trees, were sampled. It was hoped that the extensive root systems required to sustain tree life in the semi-arid Nevada climate would extend deep enough to detect "blind" mineralization in or below the limestones.

The biogeochemical approach, in brief, is based on the fact that many metals, including molybdenum, are essential in trace amounts to plant nutrition. Some plants are known to concentrate far greater amounts of these metals than others during their growth, hence their potential usefulness in prospecting.

The degree of concentration in a given plant is dependent upon many variables, such as the nutritional requirements of the plant, the absolute concentration of the metal in the ground and the soil pH. A notable example of a plant which concentrates molybdenum is the mesquite tree of the southwest which has been used successfully to detect anomalous molybdenum in the vicinity of some porphyry copper deposits. Although no mesquite trees grow on this prospect, there are two abundant and evenly distributed tree species: piñon and juniper.

Before sampling these trees on any large scale, it was necessary to find out if either species concentrates molybdenum during its growth and, if so, in which of its organs. It was also necessary to know if the concentration in any part of the tree was greater than that of the soil in which it grows - if not, trees would probably not be any more useful than soils as a prospecting tool.

An orientation survey was run east-west along line A-A' (Figure 2) to cross the major rock units and structures. It also crossed the northern end of the soil anomaly related to the Mill deposit. At sites 200 feet apart, needles and second-year twigs of both tree species were collected, as well as a B horizon soil sample. Berries from some of the junipers were collected as a curiosity. The tree samples were collected with ordinary garden pruning shears at waist or chest height all around the tree. Notes were taken as to the height and the diameter at the base of each tree as a rough estimate of the degree of root development. The needles and twigs were separated in the lab, oven dried and ashed. The ash was analyzed colorimetrically for molybdenum. The minus 35 mesh fraction of the soils was also analyzed colorimetrically.

Figure 3 shows the results of the orientation survey. Molybdenum in ppm in the ash is shown for each tree species. A dashed line shows the molybdenum content of the B soil horizon at each tree sample site.

A single line for the piñon samples represents the average molybdenum value of the needle ash and twig ash because these organs had nearly identical molybdenum concentrations. Note that the highest molybdenum concentrations in the combined piñon ash occur in the same place as the highest concentrations in soil but the magnitude of most piñon ash values is lower and the main peak is smaller in lateral extent. Based on these results, piñon samples were judged to be less sensitive than soil and, therefore, less useful.

Molybdenum concentrations in juniper needle ash and twig ash are significantly different from each other and from the soil. The needle ash values are consistently higher than twigs from the same tree and also higher than the corresponding soil, commonly by a factor of 6 to 10 times. The twig ash values, in contrast, are both higher and lower than soil. Based on the results shown here, juniper needles were judged to be the best plant organ to sample.

Figure 4 compares the juniper needle ash and soil molybdenum values with bedrock geology and molybdenite mineralization of the Mill deposit. Threshold values are 75 ppm in the juniper needle ash and 10 ppm in the soil. As shown in this figure, the largest molybdenum kick shown by both soil and needle ash is strongly anomalous and reflects subsurface mineralization. The highest values occur over the shallowest mineralization, at location DH. However, the soil has an anomalous response over mineralization only where the bedrock is volcanic, which is the problem with soil sampling on this prospect as noted earlier. In contrast, the juniper needle ash contains anomalous molybdenum

over the mineralization even where the bedrock is limestone; in fact, it almost precisely defines the width of the mineralized zone.

To the west of the mineralized zone where the limestone thickens, the juniper needles picked up a molybdenum anomaly where the soils are only at background values.

The results of this orientation traverse were very encouraging. The next step was to grid the entire northern half of the prospect on 200-foot centers collecting juniper needles.

The juniper needle samples outlined three molybdenum anomalies shown by the shaded areas on Figure 5. The anomaly on the west side of the prospect was first picked up in the orientation traverse. It is entirely over limestone. The anomaly around the intrusive at the north end of the prospect extends partially into limestone. The largest anomaly is on the east side of the prospect. This anomaly is apparently related in part to the intrusive near its center but is quite complex. (The ragged edge at the south end of this anomaly merely indicates that sampling stopped there - it is not a wild attempt at contouring.)

The results thus far were highly encouraging for further exploration work. To get more comparative data for this case study, however, it was decided to go one step further and analyze the soil samples from these three anomalous areas. A comparison of the tree and soil results gives the interesting picture shown on Figure 6.

Surprisingly, the soils picked up the anomaly in the limestone - something not predicted from the orientation traverse. However, the juniper needle ash anomaly is considerably larger than the soil anomaly. A close check of the bedrock in this limestone anomaly revealed some molybdenum-bearing silicified breccia cutting the limestone.

In the area around the north intrusive, the soil anomaly is nearly as extensive as the juniper needle anomaly which is not unexpected since most of the host rock is volcanic. In this area the only soil samples higher in molybdenum than corresponding juniper needle ash were collected.

The anomaly to the east is more complex than the others. The juniper needle anomaly is very elongate and much larger than the soil anomaly. The juniper needle anomaly starts near the north end of the prospect and continues southward until it connects with the Mill deposit anomaly around the orientation line A-A'. The soil anomaly is in two parts: one is spatially related to the intrusive; the other, to the south, is over the Mill deposit and should be considered a separate anomaly.

The combined soil and juniper needle patterns suggest that the entire elongate area is underlain by molybdenum mineralization. Faulting has probably had a considerable influence on the mineralization.

In summary, the data presented here show that the molybdenum concentrating ability of juniper needles can substantially increase the areal extent of an anomaly and make the anomaly more accurately reflect mineralization. The data also show that the ash of the juniper needles can magnify an anomaly ... by as much as 6 to 10 times. These features certainly increase the probability of detecting anomalous molybdenum concentrations in geochemical surveys.

This case history is one more example of the application of biogeochemical sampling in exploration. In this case, it was fortunate to have considerable subsurface information available with which to verify the surface sampling results.

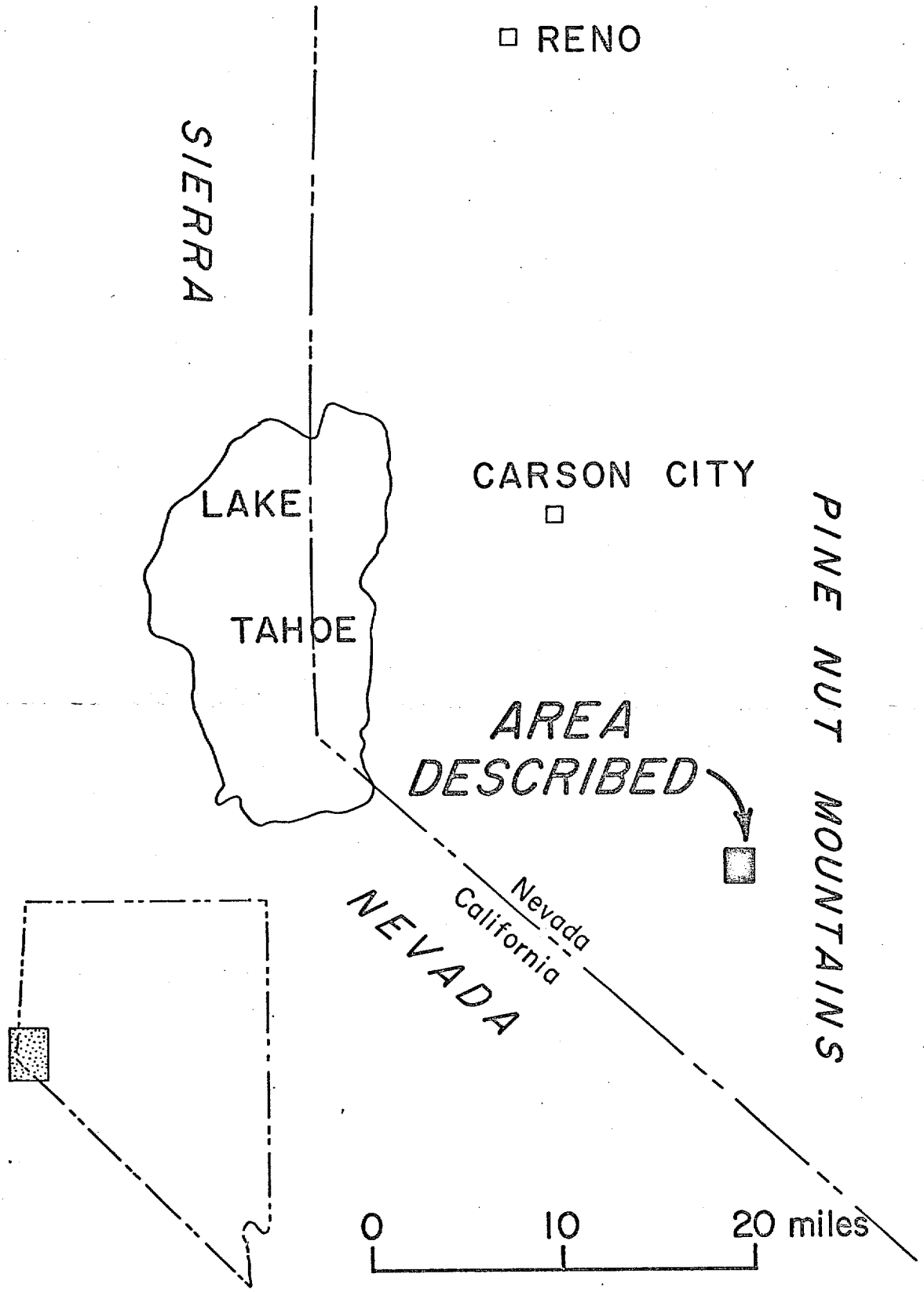
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Figure 1

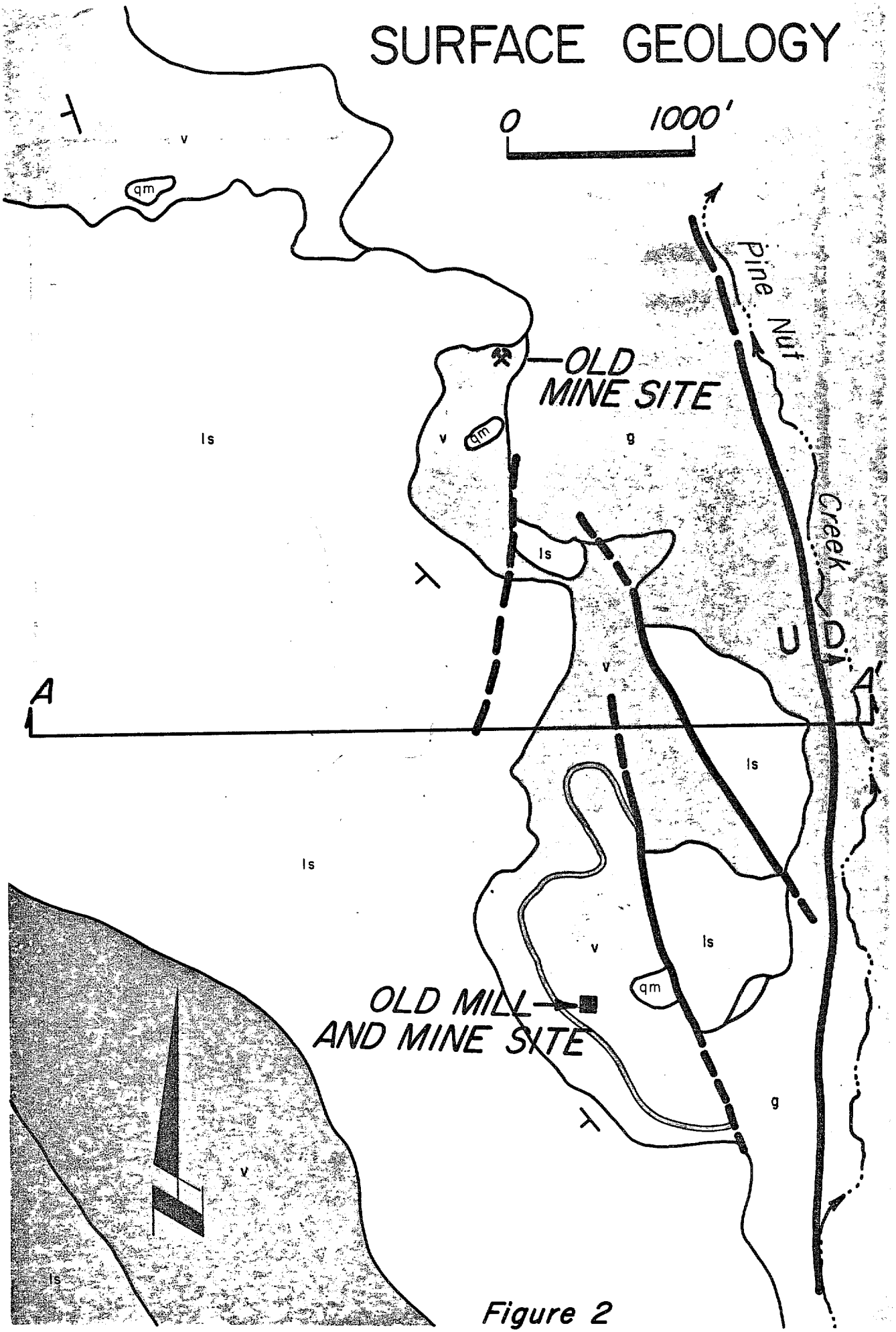
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Figure 2

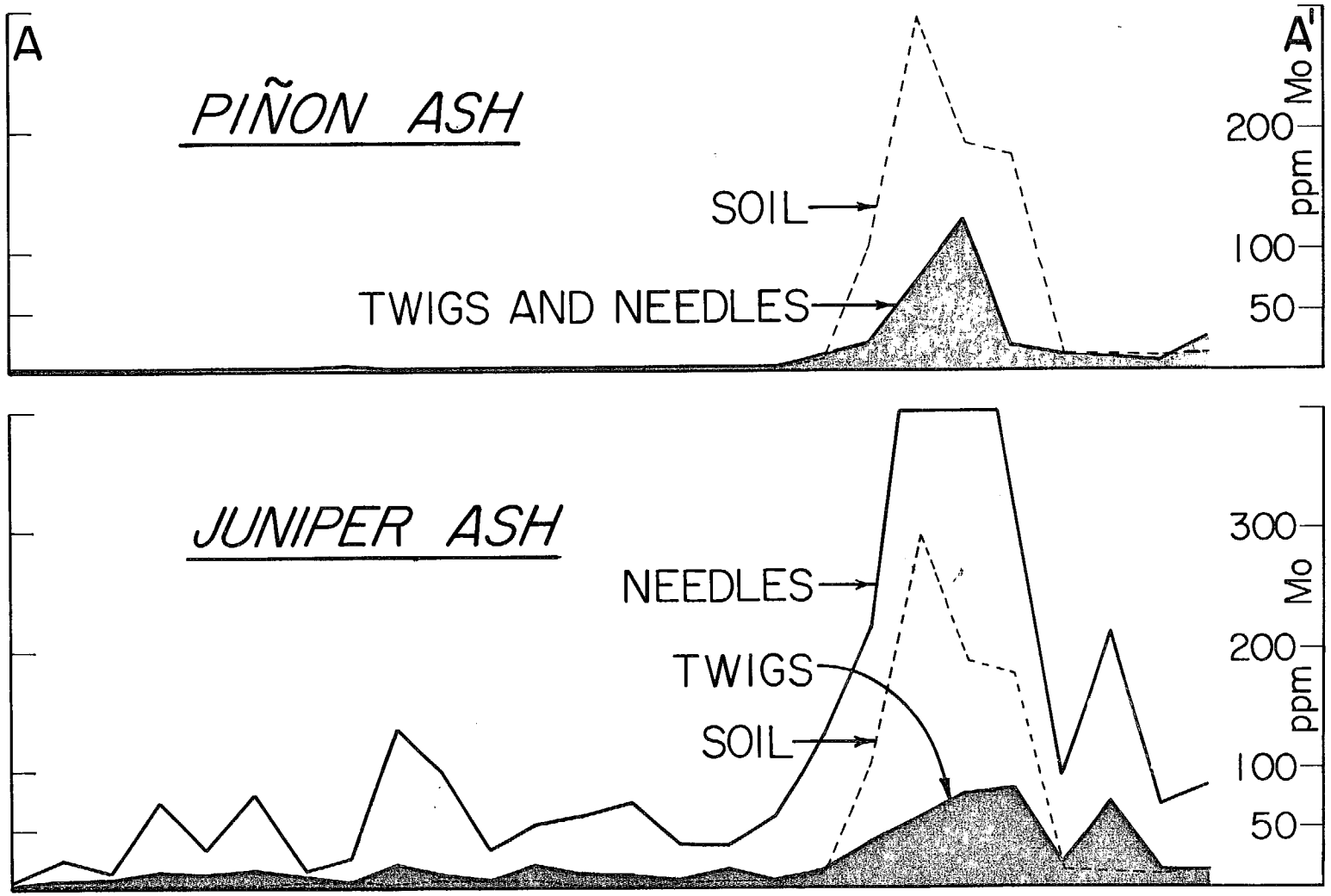
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*Figure 3*

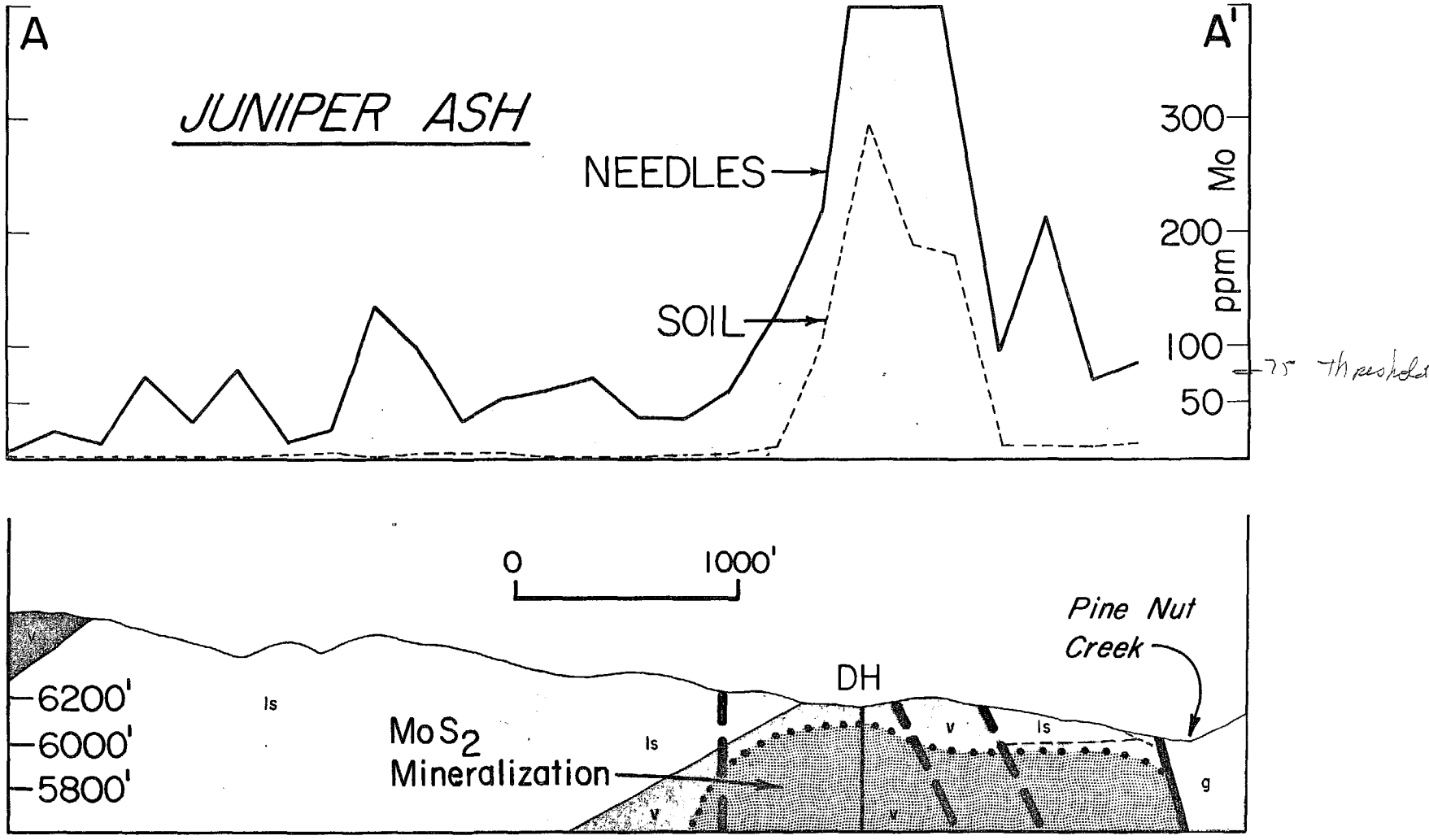
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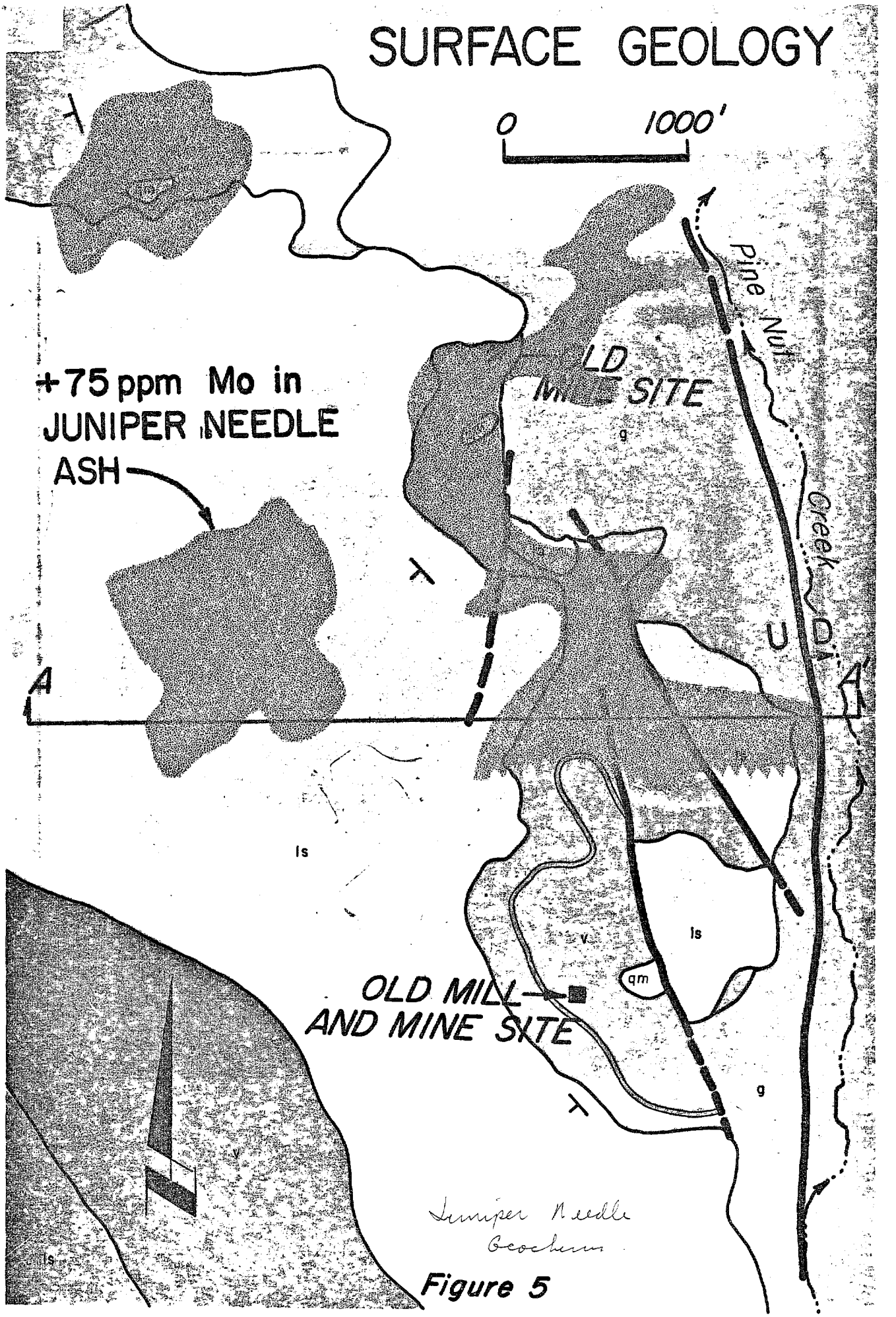
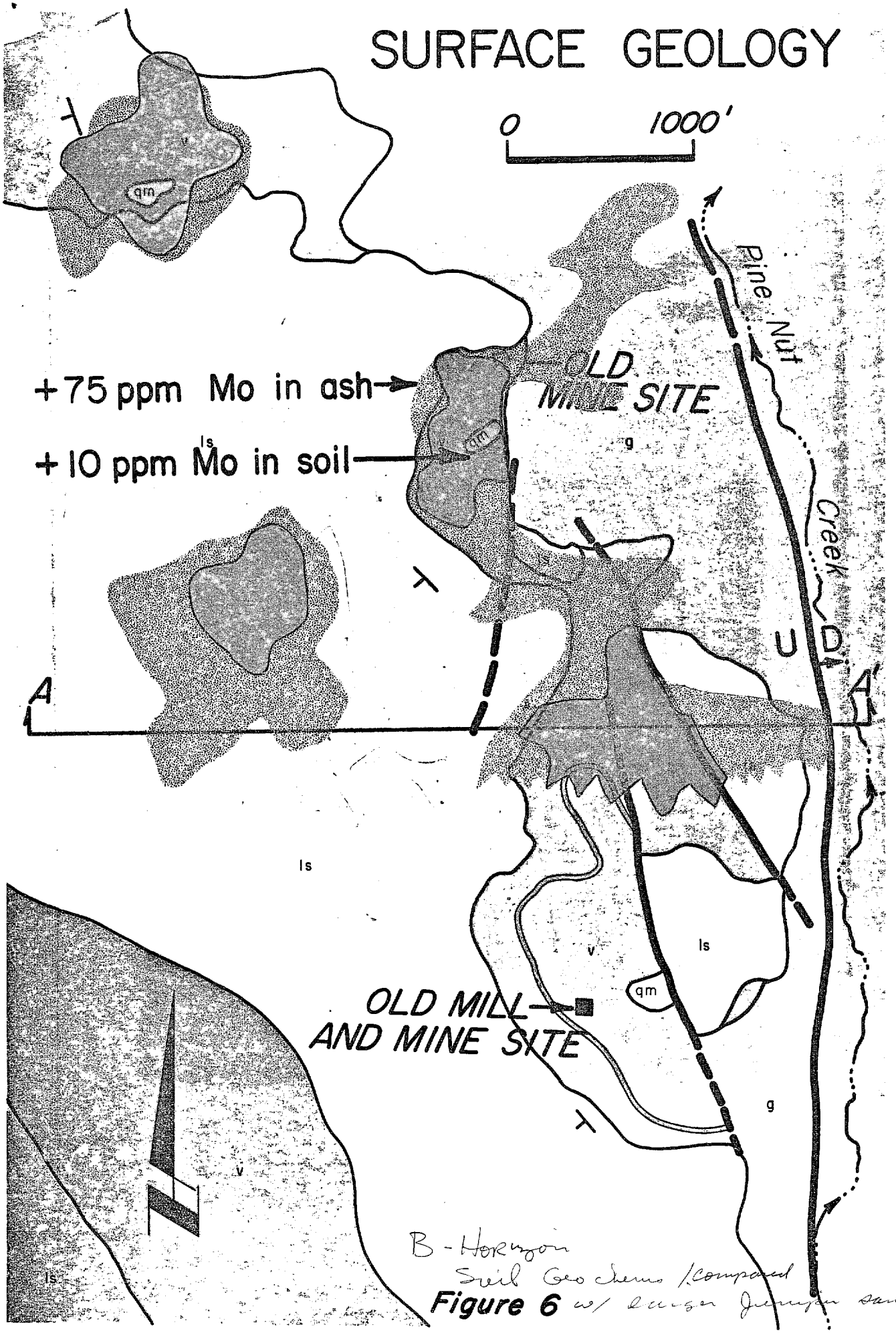
*Figure 4*




Juniper Needle
Geochem

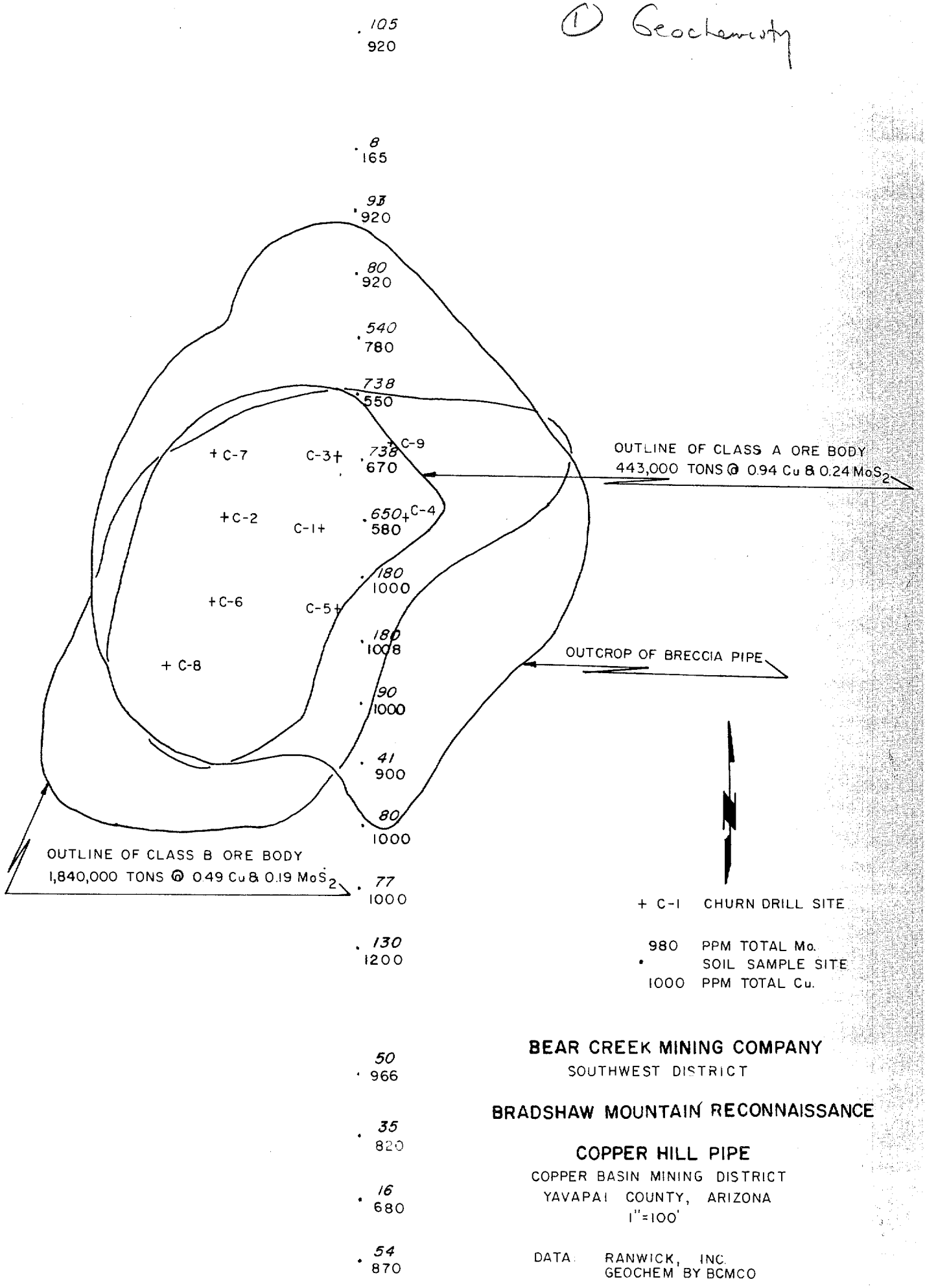
Figure 5




B-Horizon
Soil Geochem / Compared
w/ larger jumpin samples

**Figure 6**

① Geochemistry




**BEAR CREEK MINING COMPANY**

SOUTHWEST DISTRICT

**BRADSHAW MOUNTAIN RECONNAISSANCE**

**COPPER HILL PIPE**

COPPER BASIN MINING DISTRICT

YAVAPAI COUNTY, ARIZONA

1"=100'

DATA: RANWICK, INC.
GEOCHEM BY BCMCO

FIGURE I

Mercury - Soil Gas ~~EL 1.20~~
method - WES

# GEOPHYSICAL DIVISION

3422 South 700 West
SALT LAKE CITY, UTAH 84119

April 5, 1971

RECEIVED
APR 7 1971
S. W. U. S. EXPL. DIV.

Mr. Whit Cameron
American Smelting and Refining Company
Silver Bell, Arizona 85270

Dear Mr. Cameron:

Attached are analytical data (including Hg) for the samples we collected from in and around the El Tiro pit last fall. Of particular interest is the occurrence of relatively high Hg concentrations in the monzonite samples from location SB-9, outside the zone of alteration as mapped.

Many thanks for your assistance in this matter.

Yours very truly,

L. D. James

L. D. JAMES

LDJ:db
Encl.

cc:R.J.Lacy w/encl.
J.H.Courtright/W.E.Saegart w/encl.

# ASARCO
# GEOCHEMICAL DATA

TABLE 3

Area: Silver Bell (Hg. Project)

Date: 3/25/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| Hg-70-1a | Silver Bell SB-9 | .08 | 30 | 125 | 1 | 270 | Propylitic Alt. Monzonite |
| HG-70-1b | " SB- 9 | .03 | 24 | 80 | < 1 | 135 | Propylitic Alt. Monzonite |
| Hg-70-2a | " SB-10 | .01 | 18 | 125 | 2 | 71 | Propylitic Alt. Alaskite |
| Hg-70-2b | " SB-10 | .01 | 8 | 95 | 1 | 42 | Propylitic Alaskite |
| Hg-70-2c | " SB-11 | < .01 | 10 | 75 | 1 | 42 | " " |
| | El Tiro Pit | | | | | | |
| Hg-70-3 | " SB- 3 | 2.25 | 10 | 50 | 140 | 1920 | Min. & Alt. Monzonite Dyke |
| 4 | " SB- 3 | .23 | 240 | 134 | 3 | 690 | " " Alaskite |
| 5 | " SB-4 | .56 | 12 | 64 | 46 | 1330 | " " Monzonite |
| 6 | " SB-5 | .15 | 22 | 100 | 42 | 330 | " " Hornfels |
| 7 | " SB-5 | .13 | 18 | 136 | 23 | 240 | " " Metasediment |
| 8 | " SB-6 | .17 | 10 | 110 | 60 | 330 | " " Dacite |
| 9 | " SB-6 | .08 | 14 | 26 | 270 | 260 | " " Dacite |
| 10 | " SB-6 | .08 | 12 | 80 | 67 | 470 | " " Dacite |
| 11 | " SB-6 | 2.92 | 22 | 5000 | 70 | 500 | " " Tactite |
| 12 | " SB-6 | .12 | 12 | 122 | 11 | 330 | " " Monzonite |
| 13 | " SB-7 | .19 | 34 | 344 | 16 | 290 | " " Hornfels |
| 14 | " SB-7 | .68 | 72 | 1680 | 25 | 280 | " " Metasediment |
| 15 | SB-8 | .05 | 12 | 78 | 5 | 210 | Leached Capping - Monzonite |
| 16 | SB-8 | .01 | 8 | 22 | 57 | 100 | " Dacite |
| 18 | SB-8 | .08 | 12 | 30 | 130 | 180 | " Alaskite |

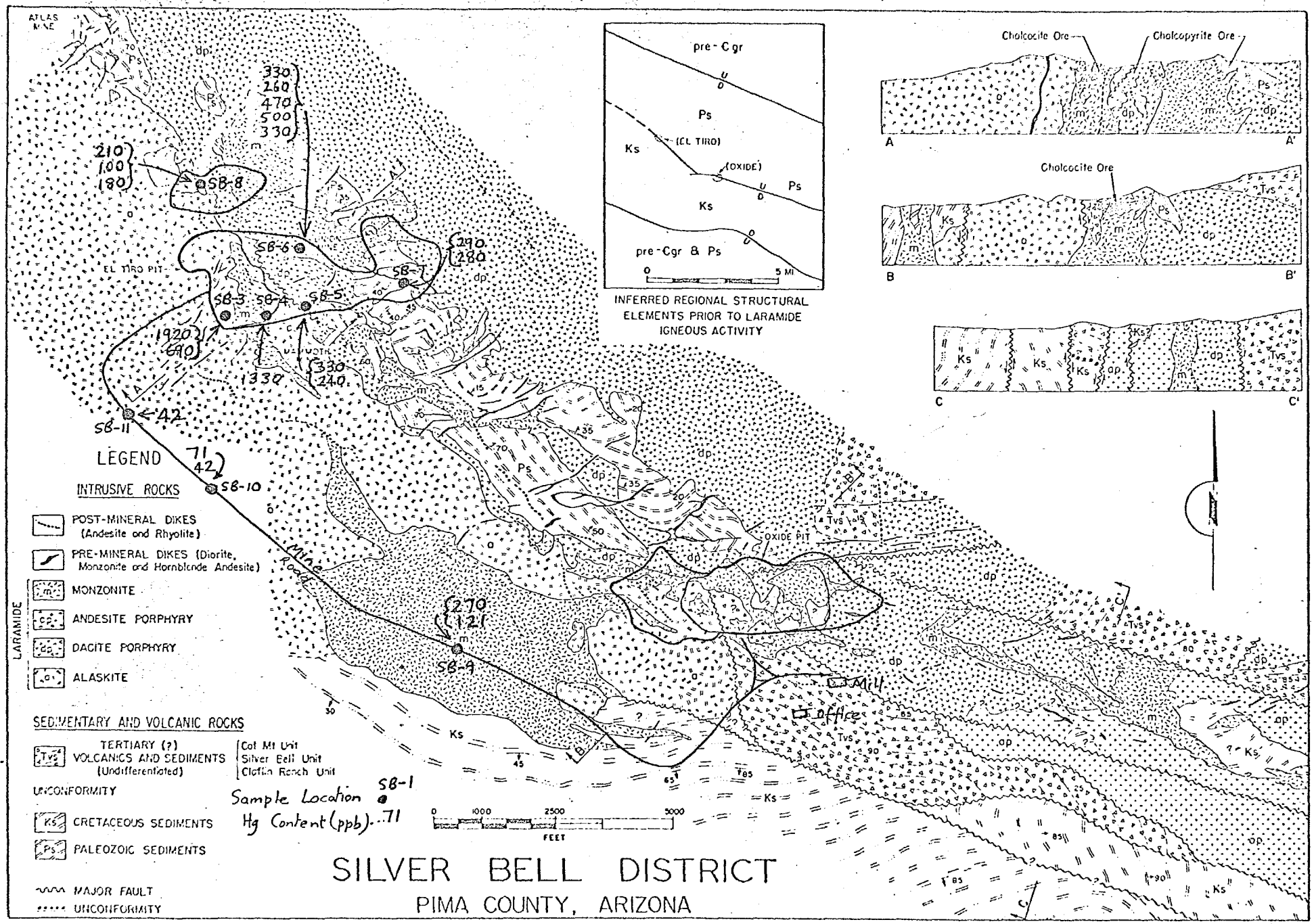



FIGURE 2.

Fig. 2 - Hg (ppb) Content Selected Mineralized and Non-Mineralized Rock Samples. (Sample Descriptions, etc., attached)

Mercury - Soil Gas Pit
method - WES

# GEOPHYSICAL DIVISION

3422 South 700 West
SALT LAKE CITY, UTAH 84119

RECEIVED
APR 7 1971
S. W. U. S. EXPL. DIV.

April 5, 1971

Mr. Lew Jansen
American Smelting and Refining Company
P. O. Box 111
Sahuarita, Arizona 85629

Dear Mr. Jansen:

Attached are analytical data (including Hg) for the samples we collected from in and around the Mission Pit last fall. Many thanks for your assistance in this matter,

Yours very truly,

L. D. James

L. D. JAMES

LDJ:db
Encl.

cc: R. J. Lacy w/encl.
W. E. Saegart

# ASARCO
# GEOCHEMICAL DATA

TABLE 2

Area: Mission (Hg Project)

Date: 3/24/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 30 | Mission | .27 | 14 | 70 | 57 | 130 | Min.& Alt.Argillite (little dissem.Py.) |
| 31 | | .10 | 8 | 14 | 63 | 160 | Min. & Alt. Monzonite. |
| 32 | | .11 | 8 | 16 | 110 | 190 | Min.& Alt.Monzonite(dissem.Py.) |
| 33 | | .68 | 30 | 696 | 18 | 520 | Meta Dolomite (Dissem.sulphide) |
| 34 | | .52 | 18 | 680 | 160 | 260 | Min. & Alt.Argillite (low sulphide.) |
| 35 | | 5.20 | 32 | 3600 | 100 | 270 | Min. & Alt.Argillite (high sulphide.) |
| 35A | | .09 | 118 | 1400 | 83 | 130 | Min. & Alt.Argillite (medium sulphide.) |
| 37 | | .06 | 32 | 272 | 120 | 170 | Min. & Alt.Argillite (medium sulphide.) |
| 38 | | 8.40 | 24 | 1200 | 98 | 210 | Garnet Tactite(High sulphide) |
| 39 | | 1.84 | 6 | 52 | N.D. | 190 | Min.& Alt.Argillite (high sulphide.) |
| 40 | | .28 | 28 | 128 | 7 | 130 | Green Garnet Tactite |
| 41 | | 2.00 | 12 | 154 | 10 | 260 | Min. & Alt.Pre-Mineral Breccia Dyke.) |
| 43 | | .01 | 32 | 28 | 3 | 80 | Marble |
| 44 | SanXavier | .01 | 14 | 36 | N.D. | 220 | Leached Capping |

JDS - BEF - FTG - JRK
JCB - SRD

Kurtz your copy

# GEOPHYSICAL DIVISION

3422 South 700 West
SALT LAKE CITY, UTAH 84119

RECEIVED
MAR 31 1971
S. W. U. S. EXPL. DIV.
W.E.S.
APR 5 1971

March 25, 1971

MEMORANDUM to R. J. LACY:

Hg CONTENT PORPHYRY Cu TYPE MINERALIZATION

Introduction:

In view of the potential value of anomalous Hg distribution patterns in bedrock, soil-gas and air as exploration tools for porphyry Cu type mineralization, particularly in the southwest, a limited program of Hg analysis of rock samples from in and around known porphyry copper deposits was initiated last October. This program is not yet complete but the data obtained up-to-date is considered worth reporting.

In the case of Asarco properties it was possible to obtain representative suites of samples but only single samples were generally available from other deposits. Obviously single samples cannot be assumed to be representative of whole deposits but the resultant overall data does probably give general indication of Hg concentrations to be expected in Cu porphyry type mineralizations.

Conclusions and Recommendations:

1. The porphyry Cu deposits "sampled" in general appear to contain "average" Hg concentrations of the order 200 - 600 ppb. These concentrations are likely markedly anomalous in relation to those in the non-mineralized host rocks. In certain areas (e.g. Sacaton - Poston Butte) the average level of Hg concentration in porphyry Cu deposits appears to be fairly low and contrast to host rocks is minimal. Cu ang Hg concentrations within individual samples from particular deposits display no apparent close consistent relationship.

2. An additional limited program of Hg analysis of mineralized and non-mineralized rock samples from in and around porphyry Cu deposits particularly in the southwest appears warranted. As well as providing further indications of the potential value of any Hg in soil-gas or air studies such a program should also indicate whether Hg concentrations in non-mineralized bedrock can provide any evidence of the potential favorability of an area for the presence of porphyry Cu mineralization. Preliminary data for the Silver Bell area and the Ruby Star Granodiorite suggest that this might be the case.

3. Despite earlier evidence to the contrary our new more comprehensive data indicates that the Sacaton deposits have an extremely low average Hg content. This fact probably explains the lack of success of our earlier Hg in soil-gas test program over the area, and suggests that a similar test program over a more favorable area is warranted. A limited test program is therefore being scheduled for the East Silver Bell extension area in the near future.

4. Developments in sample preparation and analytical technique enable trace Hg determinations to be carried out with far greater accuracy and precision than was previously the case.

Analytical Technique:

Consistent accurate and precise Hg analysis (in the sub-ppm range) of rock and ore samples has not previously proven possible. Our recent modification of the so called Hatch and Ott technique has, however, apparently improved the situation. That our new data are valid is indicated by our ability to generally obtain reasonable checks using the completely different "sniffer" approach.

In the course of the present study it was found that Hg losses in sample preparation (i.e. in the grinding stage) can be unacceptably large. Mechanical comminution of rock samples can produce sufficient heat to result in the breakdown of Hg minerals with subsequent loss of Hg in gaseous form. Losses of up to 95% were noted. Fortunately our recent development of a simple low temperature sample comminution procedure now enables avoidance of this problem.

In addition to Hg the majority of rock samples in the present study were analyzed for Cu, Pb, Zn and Mo.

Data:

General

The data obtained in our recent studies are shown on the attached Tables (1 through 7) and Figures (1a, 1b, 2 & 3). They indicate (Table 7) that the Hg contents of porphyry Cu deposits are generally of the order of 200 - 800 ppb. Published data indicate that non-mineralized rock commonly contain $\leq$ 50 ppb Hg so in general the Hg content of the Cu porphyries is likely anomalously high relative to the host rocks.

La Caridad Deposit, Mexico

37 drill-core samples from La Caridad deposit in Sonoro, Mexico were analyzed for Hg (Table 1 and Figs. 1a and 1b). As the analysis was of pulps originally prepared for routine Cu analysis it is possible that the resultant data are somewhat on the low side. All the samples came from the sulphide zone, well below the zone of oxidation. The range of Hg values encountered in the samples is from 121 to 330 ppb (average 203 ppb) (Table 7). The average Cu content of these same samples is 0.70% (range 0.12 - 1.56%). There is no consistent relationship between Cu and Hg concentrations. Neither are any distinct Hg distribution patterns within the orebody indicated.

Mission Deposit, Arizona

12 "representative" mineralized rock samples from the Mission Pit were analyzed for Hg (Table 2). The average Hg content was 218 ppb (range 130 - 520 ppb) whilst the average Cu concentration was 1.63% (range 0.06 - 8.40%) (Table 7). Again there was no consistent relationship between Cu and Hg concentrations.

Silver Bell Deposit, Arizona

12 "representative" mineralized rock samples from the El Tiro Pit averaged 581 ppb in Hg content (range 240 - 1920 ppb) (Tables 3 and 7). The Cu content of these samples average 0.63% (range0.08 - 2.92%) and again displayed no consistent relationship to Hg.

3 samples of alaskite from locations outside the zone of alteration (as mapped) some 2500 feet southwest of the El Tiro Pit had an average Hg content of 52 ppb (range 42 - 71 ppb). In contrast two samples of "unaltered" monzonite from locations 3000 feet west of the Oxide Pit had Hg contents of 121 and 270 ppb (Fig. 2). The significance of these latter relatively high Hg concentrations is at present uncertain but will be the subject of investigation in the near future.

Sacaton Deposits, Arizona

Both the East and West Sacaton deposits are remarkable for their apparent low Hg content (Table 4 and 7). The primary sulphide and chalcocite enriched zones contain an average of around 40 ppb. Somewhat higher average concentrations were detected in the leached caps--possibly indicating some weak enrichment?

Poston Butte Deposit, Arizona

Poston Butte samples also display relatively low average Hg concentrations (i.e. 115 ppb in altered zone of relatively strong mineralization and 73 ppb in altered zone of weak mineralization) although these are somewhat higher than those encountered at Sacaton (Tables 5 and 7).

Ruby Star Granodiorite, Arizona

Samples of the Ruby Star Granodiorite (in the southwestern part of the Pima mining district), which were primarily collected for our "Biotite Study", have also been analyzed for Hg. Many of the concentrations detected are surprisingly high (range 70 - 250 ppb; mean 135 ppb - Fig. 3). It is as yet uncertain whether these relatively high concentrations are in any way related to the nearby Esperanza and Sierrita porphyry deposits.

L. D. James.

L. D. JAMES

LDJ:db
Encls.

cc:S.A.Anzalone w/encl.
J.J.Collins "
J.H.Courtright "
T.C.Osborne "
W.E.Saegart ✓ "

# ASARCO
# GEOCHEMICAL DATA

TABLE 1

Area: La Caridad (Hg Project)

Date: 3/24/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | Location | Cu (ElPaso) % | Hg ppb | Sample Description | | | |
|---|---|---|---|---|---|---|---|
| 57 | LaCaridad | .73 | 251 | D.D.H. AN- 2 | Depth 140.83m | Intercept 2.03m | |
| 17 | | 1.00 | 330 | 3 | 59.96 | 1.68 | |
| 77 | | .73 | 297 | 3 | 156.35 | 1.27 | |
| 79 | | .17 | 192 | 3 | 159.45 | 0.91 | |
| 44 | | .76 | 160 | 4 | 95.00 | 3.00 | |
| 104 | | .72 | 160 | 9 | 296.47 | 2.22 | |
| 77 | | .74 | 296 | 10 | 200.26 | 3.06 | |
| 25 | | .77 | 195 | 16 | 61.93 | 2.45 | |
| 35 | | .71 | 231 | 17 | 124.15 | 3.05 | |
| 48 | | .69 | 242 | 18 | 99.55 | 0.80 | |
| 55 | | 1.36 | 152 | 18 | 108.35 | 1.40 | |
| 103 | | .12 | 152 | 18 | 208.75 | 2.40 | |
| 64 | | .75 | 244 | 25 | 324.99 | 2.03 | |
| 38 | | .50 | 286 | 30 | 93.2 | 2.50 | |
| 32 | | .54 | 247 | 32 | 65.25 | 1.30 | |
| 6 | | .75 | 199 | 37 | 30.38 | 2.43 | |
| 49 | | .75 | 198 | 49 | 179.77 | 0.42 | |
| 33 | | .70 | 158 | 40 | 67.45 | 1.50 | |
| 12 | | .69 | 230 | 52 | 21.07 | 1.78 | |
| 17 | | 1.06 | 261 | 52 | 28.90 | 3.00 | |
| 55 | | .15 | 151 | 52 | 116.05 | 2.95 | |
| 29 | | .65 | 204 | 58 | 73.30 | 1.75 | |
| 16 | | .75 | 126 | 63 | 50.05 | 1.98 | |
| 29 | | 1.56 | 239 | 63 | 77.32 | 2.05 | |
| 36 | | .14 | 133 | 63 | 93.54 | 2.81 | |
| 32 | | .70 | 206 | 67 | 86.26 | 1.94 | |
| 65 | | 1.40 | 121 | 68 | 292.01 | 1.64 | |
| 95 | | .15 | 222 | 68 | 360.28 | 1.55 | |
| 142 | | .73 | 146 | 68 | 450.15 | 1.18 | |
| 32 | | .84 | 154 | 73 | 78.30 | 1.00 | |
| 12 | | .67 | 150 | 79 | 31.98 | 1.49 | |
| 85 | | .76 | 184 | 82 | 237.30 | 1.45 | |
| 31 | | .68 | 174 | 86 | 74.96 | 1.07 | |
| 13 | | .92 | 159 | 96 | 41.55 | 2.30 | |
| 24 | | .69 | 144 | 96 | 58.82 | 2.26 | |
| 53 | | .12 | 217 | 96 | 123.90 | 1.60 | |
| 46 | | .30 | 294 | 134 | 163.20 | 2.30 | |

# ASARCO
# GEOCHEMICAL DATA

TABLE 2

Area: Mission (Hg Project)

Date: 3/24/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 30 | Mission | .27 | 14 | 70 | 57 | 130 | Min.& Alt.Argillite (little dissem.Py.) |
| 31 | | .10 | 8 | 14 | 63 | 160 | Min. & Alt. Monzonite. |
| 32 | | .11 | 8 | 16 | 110 | 190 | Min.& Alt.Monzonite(dissem.Py.) |
| 33 | | .68 | 30 | 696 | 18 | 520 | Meta Dolomite (Dissem.sulphide) |
| 34 | | .52 | 18 | 680 | 160 | 260 | Min. & Alt.Argillite (low sulphide.) |
| 35 | | 5.20 | 32 | 3600 | 100 | 270 | Min. & Alt.Argillite (high sulphide.) |
| 35A | | .09 | 118 | 1400 | 83 | 130 | Min. & Alt.Argillite (medium sulphide.) |
| 37 | | .06 | 32 | 272 | 120 | 170 | Min. & Alt.Argillite (medium sulphide.) |
| 38 | | 8.40 | 24 | 1200 | 98 | 210 | Garnet Tactite(High sulphide) |
| 39 | | 1.84 | 6 | 52 | N.D. | 190 | Min.& Alt.Argillite (high sulphide.) |
| 40 | | .28 | 28 | 128 | 7 | 130 | Green Garnet Tactite |
| 41 | | 2.00 | 12 | 154 | 10 | 260 | Min. & Alt.Pre-Mineral Breccia Dyke.) |
| 43 | | .01 | 32 | 28 | 3 | 80 | Marble |
| 44 | SanXavier | .01 | 14 | 36 | N.D. | 220 | Leached Capping |

# ASARCO
# GEOCHEMICAL DATA

TABLE 3

Area: Silver Bell (Hg. Project)

Date: 3/25/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| Hg-70-1a | Silver Bell SB-9 | .08 | 30 | 125 | 1 | 270 | Propylitic Alt. Monzonite |
| HG-70-1b | " SB- 9 | .03 | 24 | 80 | < 1 | 135 | Propylitic Alt. Monzonite |
| Hg-70-2a | " SB-10 | .01 | 18 | 125 | 2 | 71 | Propylitic Alt. Alaskite |
| Hg-70-2b | " SB-10 | .01 | 8 | 95 | 1 | 42 | Propylitic Alaskite |
| Hg-70-2c | " SB-11 | < .01 | 10 | 75 | 1 | 42 | " " |
| | El Tiro Pit | | | | | | |
| Hg-70-3 | " SB- 3 | 2.25 | 10 | 50 | 140 | 1920 | Min. & Alt. Monzonite Dyke |
| 4 | " SB- 3 | .23 | 240 | 134 | 3 | 690 | " " Alaskite |
| 5 | " SB-4 | .56 | 12 | 64 | 46 | 1330 | " " Monzonite |
| 6 | " SB-5 | .15 | 22 | 100 | 42 | 330 | " " Hornfels |
| 7 | " SB-5 | .13 | 18 | 136 | 23 | 240 | " " Metasediment |
| 8 | " SB-6 | .17 | 10 | 110 | 60 | 330 | " " Dacite |
| 9 | " SB-6 | .03 | 14 | 26 | 270 | 260 | " " Dacite |
| 10 | " SB-6 | .08 | 12 | 80 | 67 | 470 | " " Dacite |
| 11 | " SB-6 | 2.92 | 22 | 5000 | 70 | 500 | " " Tactite |
| 12 | " SB-6 | .12 | 12 | 122 | 11 | 330 | " " Monzonite |
| 13 | " SB-7 | .19 | 34 | 344 | 16 | 290 | " " Hornfels |
| 14 | " SB-7 | .68 | 72 | 1680 | 25 | 280 | " " Metasediment |
| 15 | SB-8 | .05 | 12 | 78 | 5 | 210 | Leached Capping - Monzonite |
| 16 | SB-8 | .01 | 8 | 22 | 57 | 100 | " Dacite |
| 18 | SB-8 | .08 | 12 | 30 | 130 | 180 | " Alaskite |
| Hg-70-19 | Silver Bell E. | .02 | 44 | 400 | N.D. | 190 | Min. & Alt. Porphyritic Monzonite |
| 20 | " | .02 | 22 | 64 | N.D. | 300 | Dacite |
| 21 | " | < .01 | 10 | 80 | 3 | 300 | Metasediment |
| 22 | " | < .01 | 10 | 80 | 2 | 120 | Schist |

ASARCO

# GEOCHEMICAL DATA

TABLE 4

Area: SACATON, ARIZONA (Hg Project)

Date: 3/24/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu ppm | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hg 71- 1 | Sacaton | .11 | N.D. | 40 | 40 | 201 | W.Orebody | DDH S-94 | 110' | L |
| 2 | " | .09 | N.D. | 40 | 150 | 99 | " | " " | 200' | L |
| 3 | " | .07 | N.D. | 60 | 100 | 77 | " | " " | 300' | Ox |
| 4 | " | 3.08 | < 50 | 100 | 50 | 50 | " | " " | 400' | Cc |
| 5 | " | .56 | < 50 | 340 | 20 | 22 | " | " " | 500' | Cpy |
| 6 | " | .34 | N.D. | 180 | 190 | 76 | " | " " | 600' | Cpy |
| 7 | " | .32 | N.D. | 40 | < 10 | 45 | " | " " | 700' | Cpy |
| 8 | " | .24 | N.D. | 220 | 10 | 32 | " | " " | 800' | Cpy |
| 9 | " | .11 | N.D. | 20 | 60 | 51 | " | DDH S-97 | 400' | Ox |
| 10 | " | .16 | N.D. | 40 | 10 | 15 | " | " " | 500' | Ox |
| 11 | " | .05 | N.D. | 20 | 90 | 24 | " | " " | 600' | Ox |
| 12 | " | .02 | < 50 | N.D. | 80 | 24 | " | DDH S-95 | 200' | L |
| 13 | " | 1.34 | < 50 | 140 | 150 | 159 | " | " " | 300' | Ox |
| 14 | " | 2.62 | < 50 | 40 | 150 | 55 | " | " " | 400' | Cc |
| 15 | " | 2.18 | N.D. | 20 | 20 | 18 | " | " " | 500' | Cpy |
| 16 | " | .56 | N.D. | 20 | 20 | 29 | " | " " | 600' | Cpy |
| 17 | " | .38 | N.D. | 40 | < 10 | 46 | " | " " | 700' | Cpy |
| 18 | " | .26 | N.D. | 20 | 10 | 23 | " | " " | 800' | Cpy |
| 19 | " | .14 | < 50 | 100 | 10 | 47 | " | " " | 900' | Cpy |
| 20 | " | .02 | N.D. | 40 | 170 | 21 | " | DDH S-112 | 300' | L |
| 21 | " | 3.56 | N.D. | 560 | 20 | 25 | " | " " | 400' | Ox |
| 22 | " | .06 | < 50 | 40 | 120 | 59 | " | " " | 500' | Ox |
| 23 | " | .03 | N.D. | 200 | < 10 | 227 | " | " " | 600' | Ox |
| 24 | " | .60 | N.D. | 200 | 30 | 30 | " | " " | 700' | Cc |
| 25 | " | .05 | N.D. | 20 | 30 | 63 | " | " S-124 | 300' | L |
| 26 | " | .21 | N.D. | 20 | 100 | 41 | " | " " | 400' | Ox |
| 27 | " | .38 | N.D. | 20 | 30 | 47 | " | " " | 500' | Cpy |
| 28 | " | .02 | < 50 | 20 | 30 | 68 | " | " " | 600' | Cpy |
| 29 | " | .94 | < 50 | 120 | 190 | 25 | " | " " | 700' | Cpy |
| 30 | " | .38 | < 50 | 40 | 150 | 48 | " | " S-112 | 780' | Cpy |
| | | | | | | | | | | |
| Hg-71-61 | Sacaton | .46 | < 50 | 10 | 110 | 67 | E.Orebody | DDH S-98 | 1406' | Ox |
| 62 | " | 3.02 | " | 12 | 250 | 82 | " | " " | 1502' | Cc |
| 63 | " | 2.54 | " | 12 | 910 | 60 | " | " " | 1603' | Cc |
| 64 | " | 2.32 | " | 28 | 340 | 36 | " | " " | 1703' | Cc |
| 65 | " | .93 | " | 257 | 290 | 50 | " | " " | 1801' | Cpy |
| 66 | " | .03 | " | 21 | 90 | 84 | " | " S-99 | 1106' | L |
| 67 | " | .01 | " | 14 | 70 | 68 | " | " " | 1216' | L |
| 68 | " | .05 | " | 14 | 20 | 79 | " | " " | 1311' | L |
| 69 | " | .02 | " | 8 | 110 | 57 | " | " " | 1414' | L |
| 70 | " | .01 | " | 12 | 130 | 55 | " | " " | 1509' | L |
| 71 | " | .67 | " | 32 | 210 | 32 | " | " " | 1609' | Ox |
| 72 | " | .71 | " | 20 | 20 | 45 | " | " " | 1707' | Ox |
| 73 | " | .61 | " | 76 | 30 | 54 | " | " " | 1825' | Cpy |
| 74 | " | .05 | " | 15 | 180 | 71 | " | "S-104 | 1368' | L |
| 75 | " | .97 | " | 14 | 100 | 43 | " | " " | 1468' | Cc |
| 76 | " | 1.84 | " | 15 | 1230 | 35 | " | " " | 1566' | Cc |
| 77 | " | 1.25 | " | 27 | 310 | 29 | " | " " | 1660' | Cc |
| 78 | " | .70 | " | 258 | 310 | 39 | " | " " | 1770' | Cc |

# ASARCO
# GEOCHEMICAL DATA

TABLE 4
Continued

Area SACATON, ARIZONA (Hg Project) Date 3/24/71
Requested By
No. Samples

| SAMPLE NUMBER | LOCATION | Cu ppm | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hg-71-79 | Sacaton | 1.09 | < 50 | 178 | 670 | 44 | E.Orebody | DDH S-104 | 1866' | Cpy ? |
| 80 | " | 1.09 | " | 71 | 360 | 39 | " | " " | 1962' | Cpy |
| 81 | " | .01 | " | 92 | 10 | 37 | " | " " | 2063' | ?Base-ment |
| 82 | " | .83 | " | 13 | 110 | 27 | " | " S-118 | 1345' | Ox |
| 83 | " | 1.25 | " | 11 | 650 | 32 | " | " " | 1439' | Cc |
| 84 | " | 1.46 | " | 12 | 200 | 26 | " | " " | 1538' | Cc |
| 85 | " | 1.86 | " | 95 | 60 | 35 | " | " " | 1639' | Cc |
| 86 | " | .50 | " | 208 | 260 | 41 | " | " " | 1731' | Cpy |
| 87 | " | .62 | " | 153 | 460 | 38 | " | " " | 1838' | Cpy |
| 88 | " | .86 | " | 84 | 60 | 37 | " | " " | 1934' | Cpy |
| 89 | " | .14 | " | 34 | 10 | 52 | " | " " | 2040' | Base-ment ? |
| Hg-71-55 | Sacaton | .27 | 12 | 50 | 3 | 22 | Zone Alteration | S-4 | 635' | |
| 56 | " | .66 | 22 | 29 | 1 | 14 | " | S-15 | 752' | |
| 57 | " | .01 | 24 | 66 | 1 | 19 | " | S-28 | 590' | |
| 58 | " | .02 | 16 | 23 | 14 | 16 | " | S-29 | 1089' | |
| 59 | " | .13 | 20 | 14 | 10 | 21 | " | S-29 | 1258' | |
| 60 | " | .01 | 24 | 68 | 1 | 30 | " | S-54 | 1963' | |

Note: Sacaton D.D.H. descriptive data based on section interpretations of Mr. N.P. Whaley, Feb. - March 1969.

L - Leached capping
Ox - Zone Oxidized Cu Mineralization
Cc - Zone Cc enrichment
Cpy - Zone primary Cpy Mineralization

# ASARCO
# GEOCHEMICAL DATA

Area: Poston Butte (Hg Project)

Date: 3/24/71

Requested By: L. D. James

No. Samples:

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION | | |
|---|---|---|---|---|---|---|---|---|---|
| Hg-70-52 | Poston Butte | .11 | 10 | 22 | 3 | 90 | DDH PB-23 | - 2248' | ) DDH classifie |
| Hg-70-53 | " | 1.32 | 12 | 156 | 66 | 270 | " " | 2251' | ) as containing |
| Hg-70-54 | " | .16 | 10 | 32 | 12 | 290 | " " | 2253' | ) significant |
| | | | | | | | | | ) Min.& Alt. |
| Hg-71-31 | " | .27 | 8 | 29 | < 1 | 64 | " PB-23 | 2056' | ) intercept |
| 32 | " | .43 | 12 | 25 | < 1 | 54 | " " | 2100' | ) (NPW Sept.1970) |
| 33 | " | .17 | 6 | 9 | 3 | 52 | " " | 2150' | ) |
| 34 | " | .22 | 12 | 29 | 5 | 65 | " " | 2183' | ) |
| 35 | " | .13 | 12 | 27 | 35 | 68 | " " | 2256' | ) |
| 36 | " | .07 | 10 | 24 | 3 | 84 | " " | 2258' | ) |
| | | | | | | | | | |
| Hg-71-37 | " | .40 | 40 | 58 | 43 | 52 | DDH PB-27 | 1650' | ) |
| 38 | " | .22 | 12 | 26 | 21 | 89 | " " | 1800' | ) Generally |
| 39 | " | .18 | 14 | 35 | 21 | 136 | " " | 1900' | ) DDH's |
| 40 | " | .08 | 8 | 28 | 10 | 73 | " " | 2000' | ) classified as |
| 41 | " | .01 | 6 | 29 | < 1 | 44 | " " | 2161' | ) containing |
| 42 | " | .03 | 10 | 36 | 10 | 57 | " " | 2179' | ) minor min. & |
| 43 | " | .01 | 8 | 20 | < 1 | 47 | " PB-28 | 735' | ) alt. |
| 44 | " | .01 | 10 | 27 | < 1 | 45 | " " | 780' | ) intercepts |
| 45 | " | .02 | 12 | 23 | 1 | 84 | " " | 800' | ) |
| 46 | " | < .01 | 6 | 23 | < 1 | 64 | " " | 832' | ) (N.P.W., |
| 47 | " | .02 | 6 | 27 | 3 | 77 | " " | 840' | ) Sept.1970) |
| 48 | " | .01 | 8 | 6 | 1 | 49 | " PB-29 | 1330' | ) |
| 49 | " | .02 | 6 | 25 | 1 | 68 | " " | 1370' | ) |
| 50 | " | .02 | 10 | 115 | < 1 | 66 | " " | 1500' | ) |
| 51 | " | .02 | 6 | 6 | 1 | 51 | " " | 1600' | ) |
| 52 | " | .02 | 10 | 58 | 8 | 108 | " PB-30 | 1495' | ) |
| 53 | " | .02 | 8 | 24 | < 1 | 44 | " PB-31 | 805' | ) |
| 54 | " | .02 | 4 | 27 | 3 | 154 | " " | 900' | ) |

ASARCO

TABLE 6

# GEOCHEMICAL DATA

Area MISCELLANEOUS (Hg Projects) Date 3/24/71

Requested By L. D. James

No. Samples

| SAMPLE NUMBER | LOCATION | Cu % | Pb ppm | Zn ppm | Mo ppm | Hg ppb | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| Hg-70-23 | Ajo | .40 | 10 | 22 | 3 | 790 | Min. & Alt.Quartz Monzonite |
| Hg-70-24 | Esperanza | .44 | 84 | 70 | 230 | 220 | Porphyritic Monzonite |
| Hg-70-25 | Inspiration | .52 | 8 | 28 | 78 | 290 | Satellitic Granite Porphyry |
| Hg-70-26 | Santa Rita | .01 | 10 | 4 | 25 | 230 | Breccia pipe |
| Hg-70-27 | Sierrita | .06 | 22 | 140 | 1530 | 170 | Andesite |
| Hg-70-28 | Tyrone | .01 | 34 | 18 | 37 | 150 | Min.& Alt. Pre-Cambrian Granite |
| Hg-70-29 | I X L | 1.64 | 16 | 162 | 5 | 340 | Min.& Alt. Quartz Diorite |
| Hg-70-45 | Bethlehem | .52 | 12 | 28 | 7 | 640 | Min. & Alt. Granodiorite with Cc |
| Hg-70-46 | Chataway (11) | .28 | 12 | 70 | < 2 | 170 | Min. & Alt. Granodiorite with Cu staining. |

TABLE 7

Hg PROJECT

Cu, Zn, Mo & Hg Content of Selected Samples from Various Porphyry Cu Deposits

| Deposit | No. of Samples | | Cu % | Zn ppm | Mo ppm | Hg ppb |
|---|---|---|---|---|---|---|
| La Caridad | 37 | Ave. | 0.70 | – | – | 203 |
| | | Range | 0.12-1.56 | | | 121-330 |
| Silver Bell (El Tiro Pit) | 12 | A. | 0.63 | 653 | 64 | 581 |
| | | R. | 0.08-2.92 | 26-5000 | 3-270 | 240-1920 |
| Silver Bell (Leached Capping) | 3 | A. | 0.05 | 42 | 64 | 163 |
| | | R. | 0.01-0.08 | 22-78 | 5-130 | 100-210 |
| Mission (Pit) | 12 | A. | 1.63 | 690 | 69 | 218 |
| | | R. | 0.06-8.40 | 14-3600 | 5-160 | 130-520 |
| San Xavier (Leached Capping) | 1 | | 0.01 | 36 | < 2 | 220 |
| Sacaton (E.Orebody) (Cpy Zone) | 7 | A. | 0.79 | 147 | 304 | 43 |
| | | R. | 0.50-1.09 | 71-257 | 30-670 | 37-54 |
| Sacaton (E.Orebody) (Cc Zone) | 10 | A. | 1.86 | 48 | 436 | 42 |
| | | R. | 0.70-3.02 | 11-258 | 60-1230 | 26-82 |
| Sacaton (E.Orebody) (Ox Zone) | 4 | A. | 0.67 | 19 | 131 | 43 |
| | | R. | 0.46-0.83 | 10-32 | 110-210 | 27-67 |
| Sacaton (E.Orebody) (Leached Cap) | 6 | A. | 0.03 | 14 | 100 | 69 |
| | | R. | 0.01-0.05 | 8-21 | 20-180 | 55-84 |
| Sacaton (W. Orebody) (Cpy Zone) | 13 | A. | 0.52 | 91 | 53 | 40 |
| | | R. | 0.02-2.18 | 20-340 | < 10-190 | 18-76 |
| Sacaton (W.Orebody) (Cc Zone) | 3 | A. | 2.10 | 113 | 77 | 45 |
| | | R. | 0.60-3.08 | 40-200 | 30-150 | 30-55 |
| Sacaton (W. Orebody) (Ox Zone) | 9 | A. | 0.62 | 122 | 73 | 75 |
| | | R. | 0.05-3.56 | 20-560 | < 10-150 | 15-227 |
| Sacaton (W. Orebody (Leached Cap) | 5 | A. | 0.06 | 30 | 94 | 82 |
| | | R. | 0.02-0.11 | < 20-40 | 30-170 | 21-201 |
| Sacaton (Zone Wk. Min.& Alt.) | 4 | A. | 0.06 | 29 | 7 | 18 |
| | | R. | 0.02-0.13 | 14-66 | 1-14 | 14-22 |
| Poston Butte (Zone Rel.Strong Min.) | 9 | A. | 0.32 | 39 | 14 | 115 |
| | | R. | 0.07-1.32 | 9-156 | < 1-66 | 52-290 |
| Poston Butte (Zone Wk.Alt.& Min.) | 18 | A. | 0.06 | 33 | 7 | 73 |
| | | R. | <0.01-0.40 | 6-115 | < 1-43 | 44-154 |

Hg PROJECT

Cu, Zn, Mo & Hg Content of Selected Samples from Various Porphyry Cu Deposits

| Deposit | No. of Samples | Cu % | Zn ppm | Mo ppm | Hg ppb |
|---|---|---|---|---|---|
| Ajo | 1 | 0.40 | 22 | 3 | 790 |
| Esperanza | 1 | 0.44 | 70 | 230 | 220 |
| Sierrita | 1 | 0.06 | 140 | 1530 | 170 |
| Inspiration | 1 | 0.52 | 28 | 78 | 290 |
| Bethlehem | 1 | 0.52 | 28 | 7 | 640 |

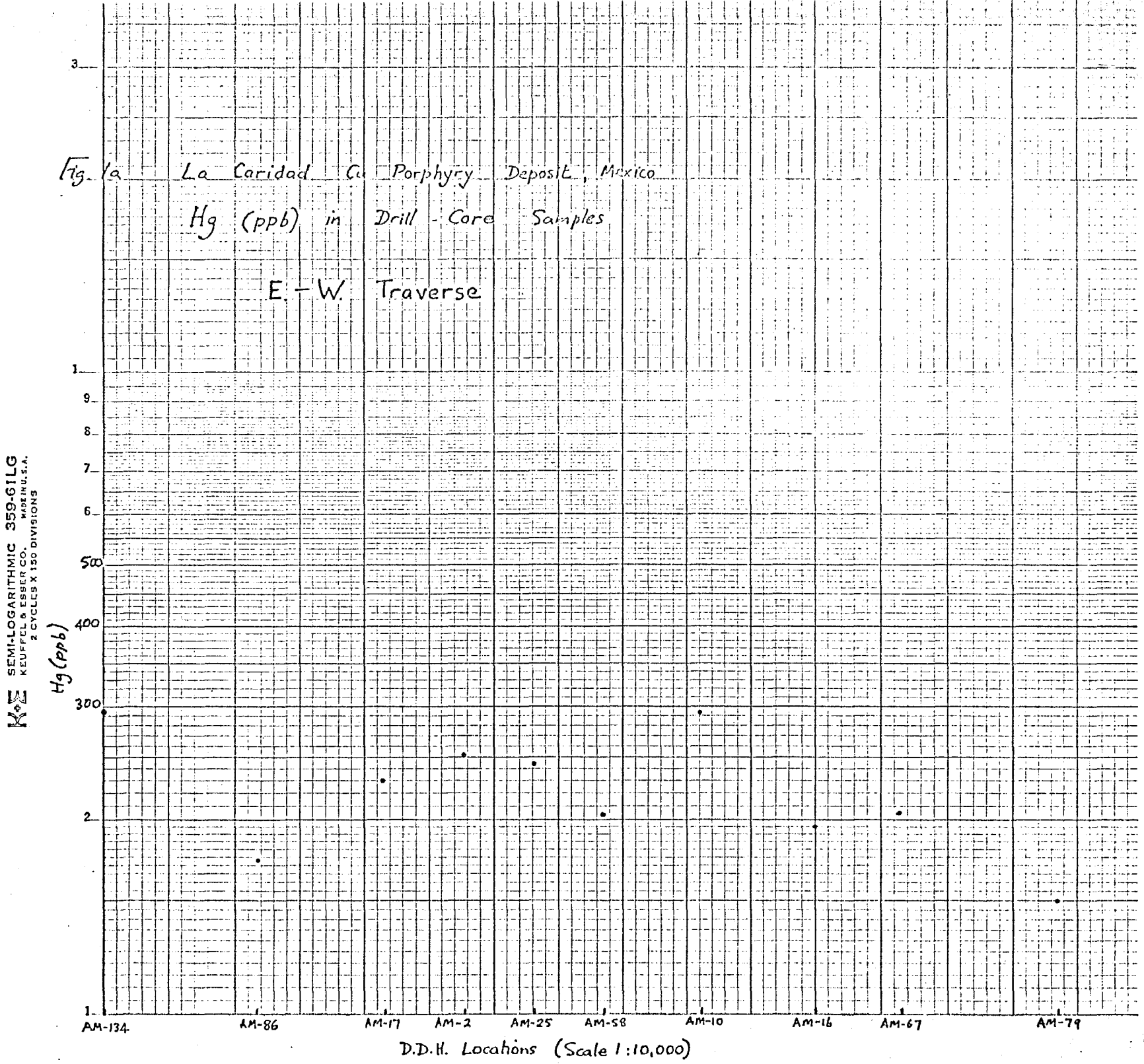
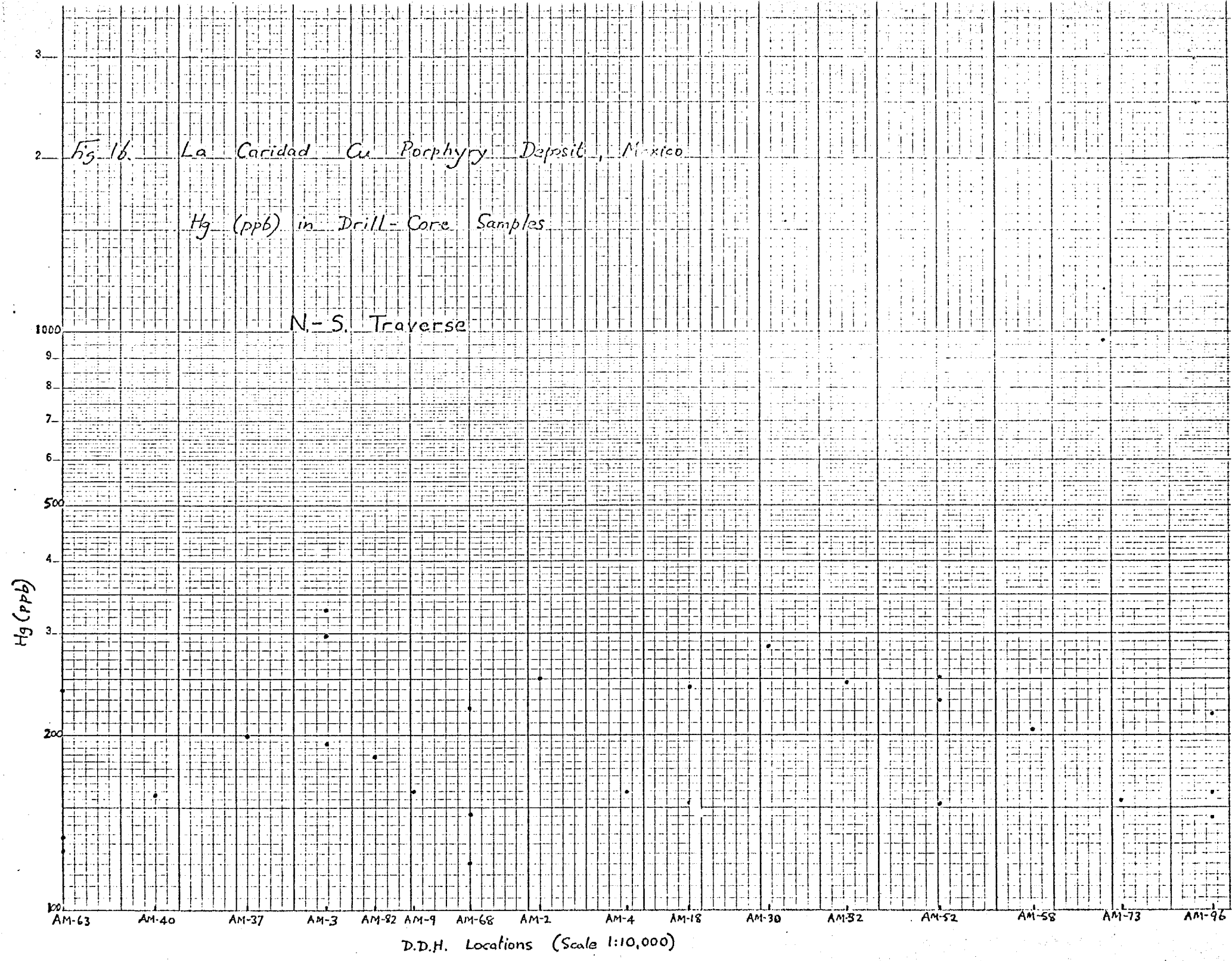


Fig. 1a La Caridad Cu Porphyry Deposit, Mexico
Hg (ppb) in Drill - Core Samples
E. - W. Traverse
Hg (ppb)
3
1
9
8
7
6
500
400
300
2
1
AM-134
AM-86
AM-17
AM-2
AM-25
AM-58
AM-10
AM-16
AM-67
AM-79
D.D.H. Locations (Scale 1:10,000)
K+E SEMI-LOGARITHMIC 359-61LG
KEUFFEL & ESSER CO. MADE IN U.S.A.
2 CYCLES X 150 DIVISIONS

Fig 16. La Caridad Cu Porphyry Deposit, Mexico

Hg (ppb) in Drill-Core Samples



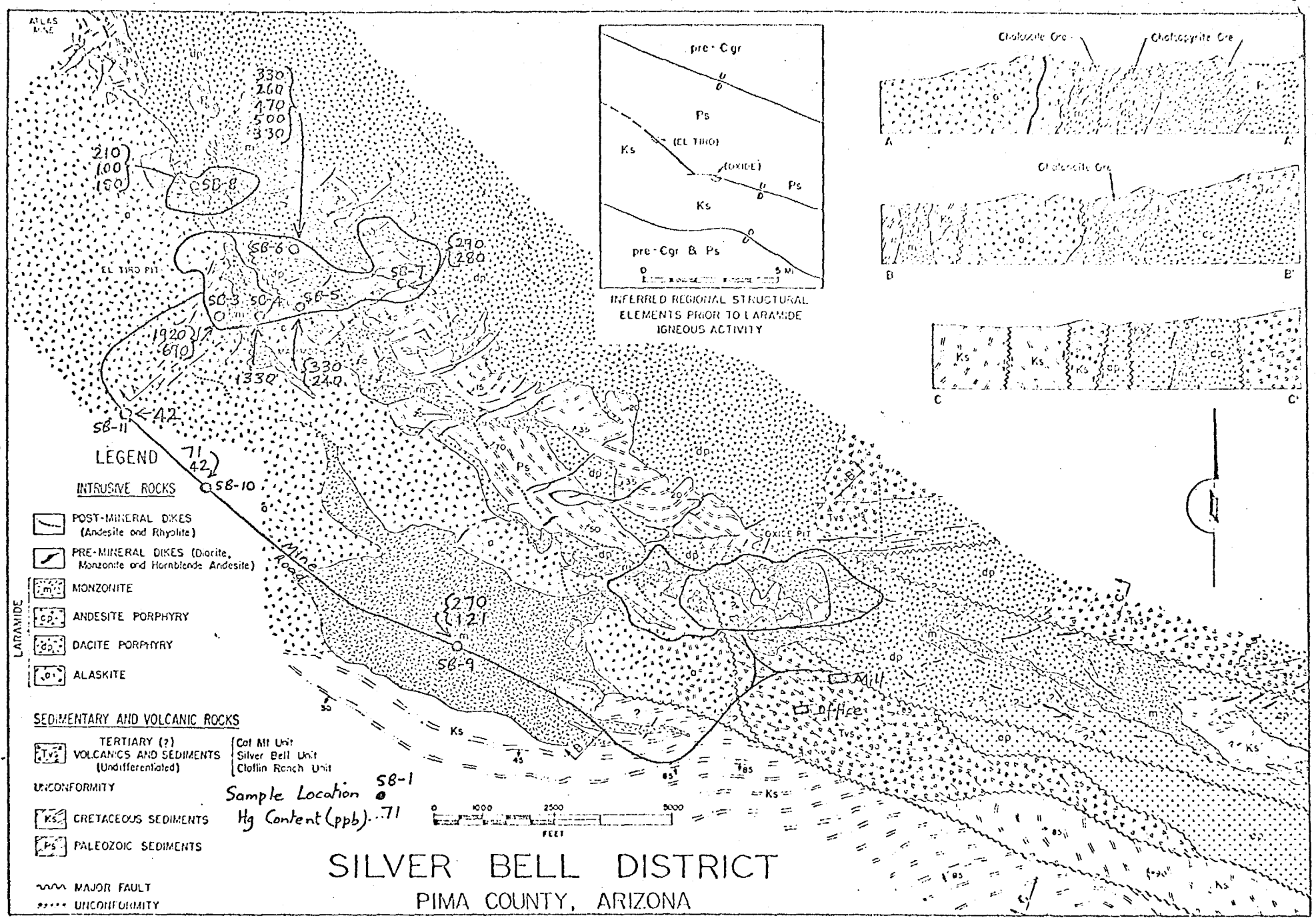



FIGURE 2.

Fig. 2 - Hg (ppb) Content Selected Mineralized and Non-Mineralized Rock Samples. (Sample Descriptions, etc., attached)

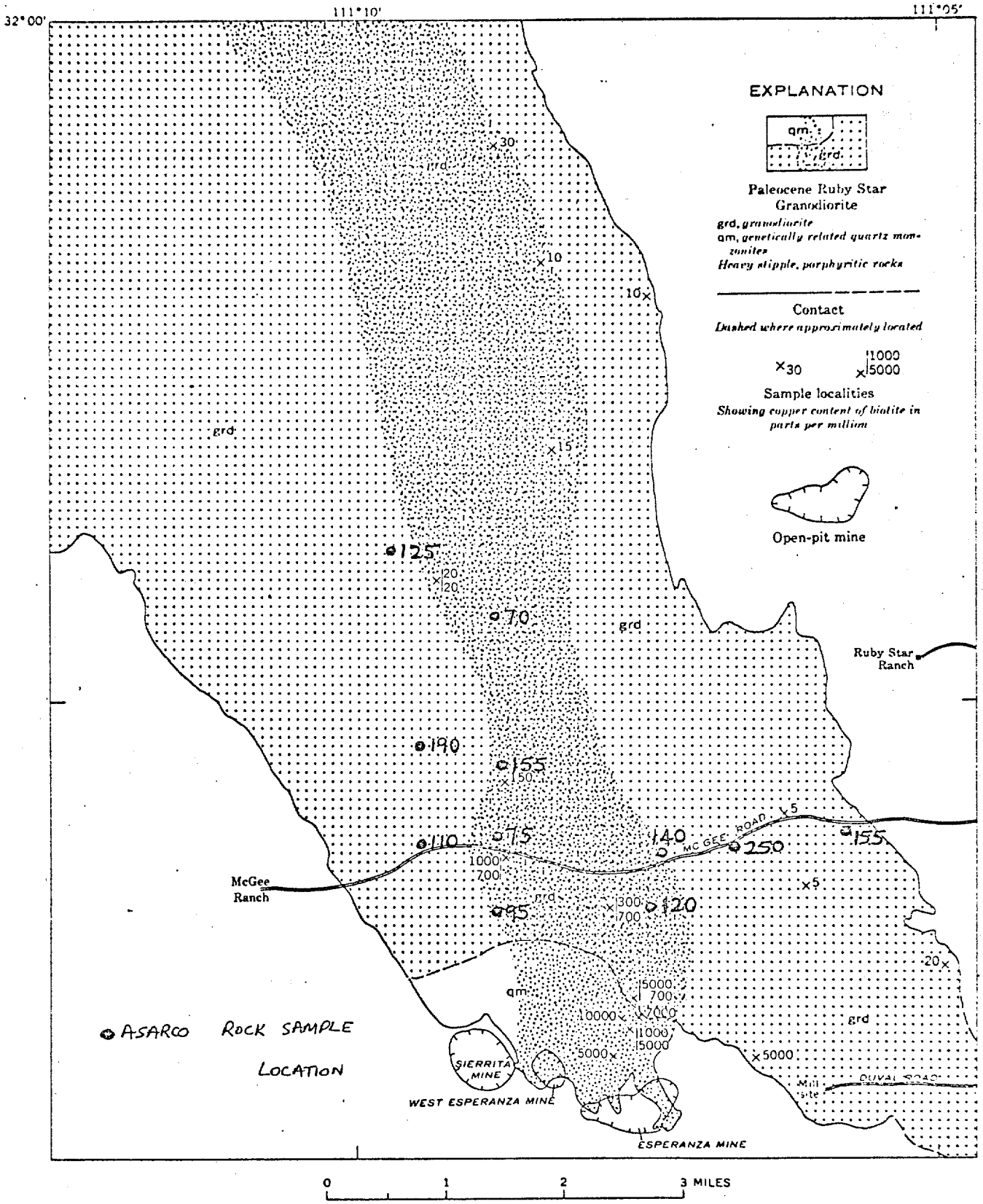
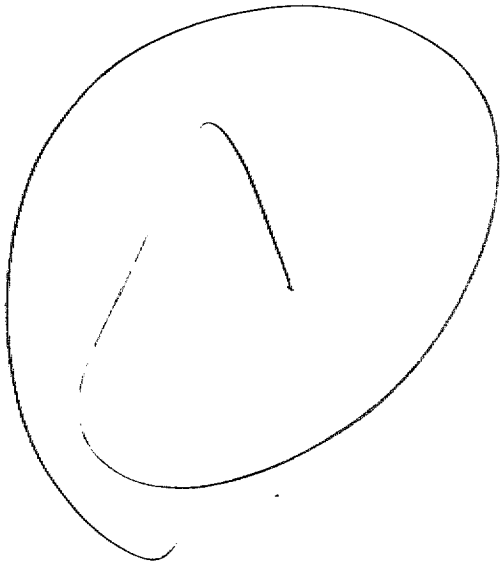



FIGURE 3.—Generalized map of composite stock and associated ore deposits in the southwestern part of the Pima mining district, east of the Sierrita Mountains, showing sample localities and copper content of biotite.

Hg content (ppb) Asarco rock samples
(analysis by Geochemical Laboratory using an A.A.technique)



Mercury Soil Gas
COM For → WLK – file ~~Sacaton~~ H. E. Sargent
new WES file
R. J. L.
JUN 30 1970

# GEOPHYSICAL DIVISION

3422 SOUTH 700 WEST
SALT LAKE CITY, UTAH 84119

RECEIVED
JUL 2 1970
S. W. U. S. EXPL. DIV.

June 25, 1970

W.E.S.
JUL 3 1970

Memorandum to R. J. Lacy:

RE Hg CONTENT SOIL-GAS
SACATON PROSPECT, ARIZONA

In view of the potential value of Hg concentrations in soil-gas as an indicator of significant blind sulphide mineralisation, the Geochemical Section has recently developed apparatus for the collection and measurement of Hg in soil-gas. Instead of depending upon the slow natural transpiration of soil gases into the atmosphere, as have the U.S.G.S., the new apparatus is capable of extracting measured volumes of air from sealed, auger drilled holes (around 3" diameter). The extraction is made by a small gasoline motor driven air pump and the Hg in the soil-gas collected on gold or silver wire mesh. The Hg can then be determined in the laboratory using a newly constructed attachment to a standard atomic absorption spectrophotometer.

Mr. E. H. Phillips spent April 20 and 21 at the Sacaton Prospect, Arizona, carrying out the preliminary field experiments over the known blind Cu orebody, which lies beneath a minimum of 100 feet of alluvium and Tertiary conglomerate. Mr. Wayne Farley of the Tucson Office spent April 20 with Mr. Phillips, advising on location of the mineralised zone, etc.

On April 20, Hg was extracted from 100 cu. ft. soil-gas samples collected at 200 ft. intervals along an approximately NNW - SSE trending traverse whose central section overlay the eastern portion of the "shallow" West Orebody (Fig. 1). The next day similar samples were collected from an E - W traverse along the 1100 N line. This traverse overlies the northern portion of the West Orebody and extends for over 1500 ft to the east, over the deeply buried (i.e. 1000 - 2000 ft.) East Orebody.

The majority of the Hg in soil-gas values are less than or equal to 2.5 ng/100 cu. ft., but a few somewhat higher concentrations are locally present, particularly over the western portion of the West Orebody (Fig. 1). Although the sample traverses are not sufficiently extensive for definite conclusions to be reached, the available data does suggest that the buried orebody could be locally reflected by anomalous Hg concentrations in soil-gas. The reason for the "anomalous" value at the east end of the E - W traverse in uncertain. The possibility of contamination from drill cuttings obviously should not be overlooked,

but the Hg concentrations in the soils (Fig. 2) do not appear to display any obvious features which could be related to this factor.

Further experimental field studies are definitely warranted at Sacaton as well as other suitable locations in the S.W. It is proposed to carry these out as soon as the present schedule (including Hg in soil-gas test in E. Canada) allows, but, in any case, no later than early Fall. High prevailing temperatures in the S.W. this time of the year would, in any case, likely produce severe instrumental problems.

L. D. James

L. D. JAMES

LDJ:bm

cc: JJCollins
JHCourtright
WESaegart

Project 295

# ASARCO
# GEOCHEMICAL DATA

Page

Area SACATON, Arizona

Date 5/4/70

Requested By L. D. James

No. Samples

-80# fraction soil

| SAMPLE NUMBER | | Cu ppm | Pb ppm | Zn ppm | Hg ppb | Hg ppb/100'$^3$ soil gas | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hole #1 | | 33 | 20 | 50 | 19 | 1.1 | | | | |
| 2 | | 20 | 14 | 45 | 24 | 2.7 | | | | |
| 3 | | 17 | 20 | 44 | 19 | 1.5 | | | | |
| 4 | | 19 | 14 | 47 | 26 | 2.2 | | | | |
| 5 | | 21 | 20 | 54 | 26 | 2.0 | | | | |
| 6 | | 20 | 22 | 47 | 23 | 1.8 | | | | |
| 7 | | 20 | 16 | 45 | 19 | 1.5 | | | | |
| 8 | | 17 | 20 | 47 | 18 | 1.8 | | | | |
| 9 | | 21 | 18 | 48 | 15 | 2.3 | | | | |
| 10 | | 16 | 20 | 39 | 18 | 1.0 | | | | |
| 11 | | 16 | 18 | 39 | 23 | 1.5 | | | | |
| 12 | | 15 | 20 | 40 | 21 | 2.3 | | | | |
| 13 | | 18 | 20 | 41 | 19 | 1.6 | | | | |
| 14 | | 21 | 18 | 44 | 23 | 1.3 | | | | |
| 15 | | 23 | 18 | 43 | 31 | 1.8 | | | | |
| 16 | | 23 | 14 | 47 | 18 | 4.3 | | | | |
| 17 | | 23 | 22 | 42 | 23 | 4.7 | | | | |
| 18 | | 18 | 22 | 34 | 26 | 2.5 | | | | |
| 19 | | 21 | 24 | 37 | 32 | 9.2 | | | | |
| 20 | | 20 | 16 | 39 | 29 | 2.8 | | | | |
| 21 | | 23 | 22 | 39 | 38 | 2.5 | | | | |
| 22 | | 21 | 18 | 43 | 41 | 2.5 | | | | |
| 23 | | 20 | 22 | 44 | 45 | 2.5 | | | | |
| 24 | | 23 | 30 | 41 | 37 | 2.5 | | | | |
| 25 | | 19 | 18 | 37 | 27 | 2.2 | | | | |
| 26 | | 20 | 18 | 42 | 24 | 2.5 | | | | |
| 27 | | 21 | 14 | 41 | 20 | 9.8 | | | | |
| 28 | | 21 | 24 | 43 | 29 | 5.3 | | | | |
| 29 | | 19 | 24 | 40 | 19 | 23.0 | | | | |
| 30 | | 17 | 20 | 40 | 20 | 2.5 | | | | |
| 31 | | 19 | 20 | 40 | 17 | 4.0 | | | | |
| 32 | | 17 | 24 | 36 | 30 | 5.3 | | | | |
| Core/East Ore Body | | | | | 216 | | | | | |
| Core/West Ore Body | | | | | 165 | | | | | |

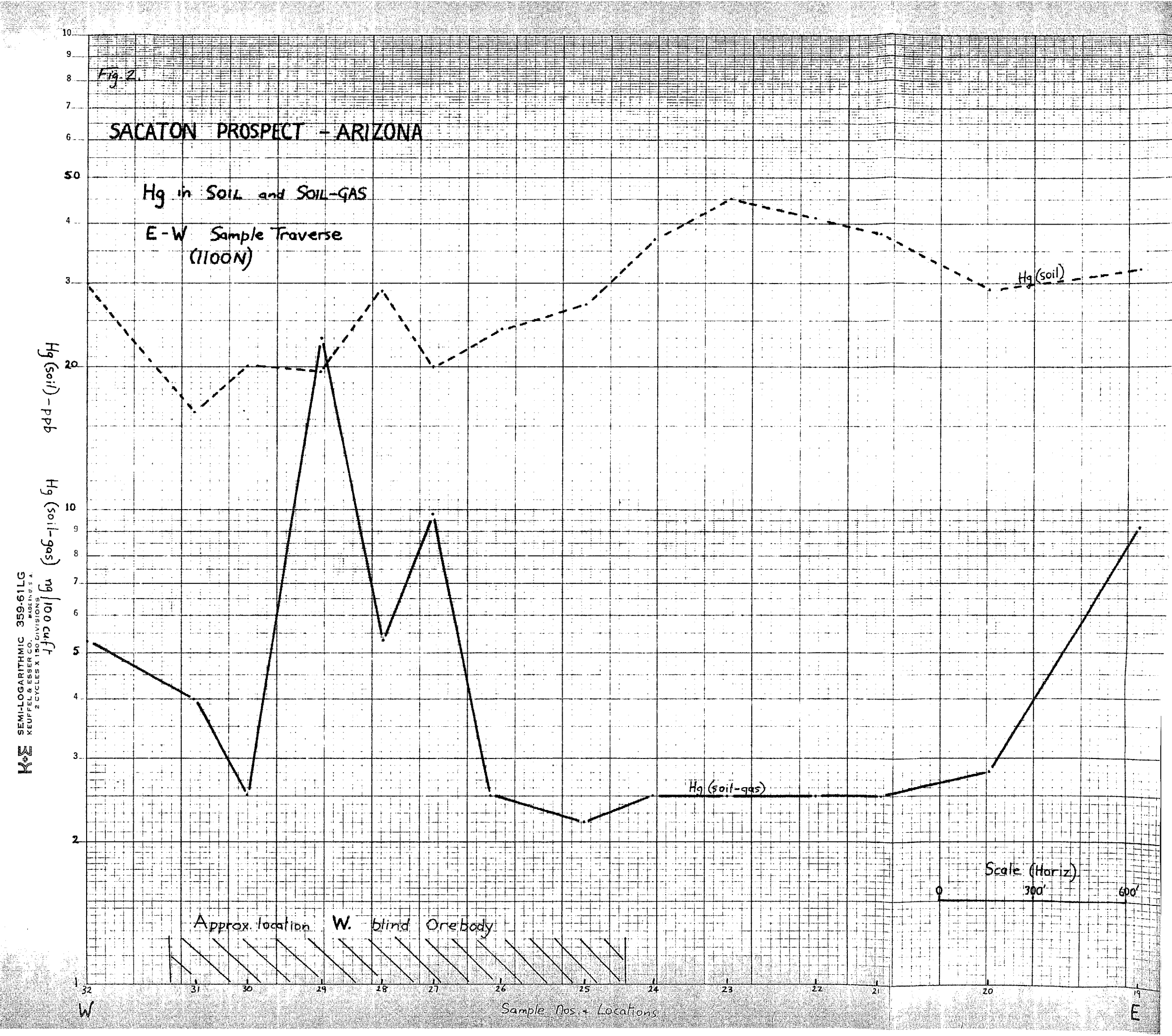


Fig. 2.
SACATON PROSPECT - ARIZONA
Hg in SOIL and SOIL-GAS
E-W Sample Traverse
(1100N)
Hg (soil) - ppb
Hg (soil-gas) mg/100 cu.ft.
Hg (soil)
Hg (soil-gas)
Scale (Horiz)
0
300'
600'
Approx. location W. blind Orebody
Sample Nos. + Locations
W
E
SEMI-LOGARITHMIC 359-61LG
KEUFFEL & ESSER CO. MADE IN U.S.A.
2 CYCLES X 150 DIVISIONS

RECEIVED
FEB 27 1969

W.E.S.
FEB 27 1969

Air Mail

February 25, 1969

Mr. R.J. Lacy
Salt Lake City Office

Mercury Vapor

Dear Mr. Lacy:

We will be interested to have your comments on Mr. Courtright's letter of February 20th to me enclosing USGS Circular #609 entitled, "Mercury and Soil, Gas and Air--A Potential Tool in Mineral Exploration." If Barringer does hold patents which dominate the field, what are chances of making a deal with him??

Also please advise as to the applicability of the method in Tennessee and Kentucky where we presently lack any anomalies as a basis for drill hole locations.

Sincerely yours,

John J. Collins

CC:JHCourtright
WESaegart

new file?
Mercury Vapor
WES

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 20, 1969

W.E.S.
FEB 24 1969

Mr. John J. Collins, Chief Geologist
ASARCO - New York Office

Dear sir:

Enclosed is a xerox copy of USGS Circular # 609, the original of which I received as a complimentary copy this week.

The anomaly obtained over the Cortez gold deposit by the use of collector tents is quite impressive. The airborne results are also impressive, but no data is given on the size or extent of the anomaly in comparison to the target size.

Bill Saegart has phoned Burt Morrison and Jerry Hazelton and learned that they expected to consult with the USGS people on instrumentation in respect to mercury vapor measurement. They also reported that Barringer Research holds patents on the process. This might not prevent use on an experimental basis, but at any rate, if there is no other approach open, the possibilities of a deal with Barringer should be investigated.

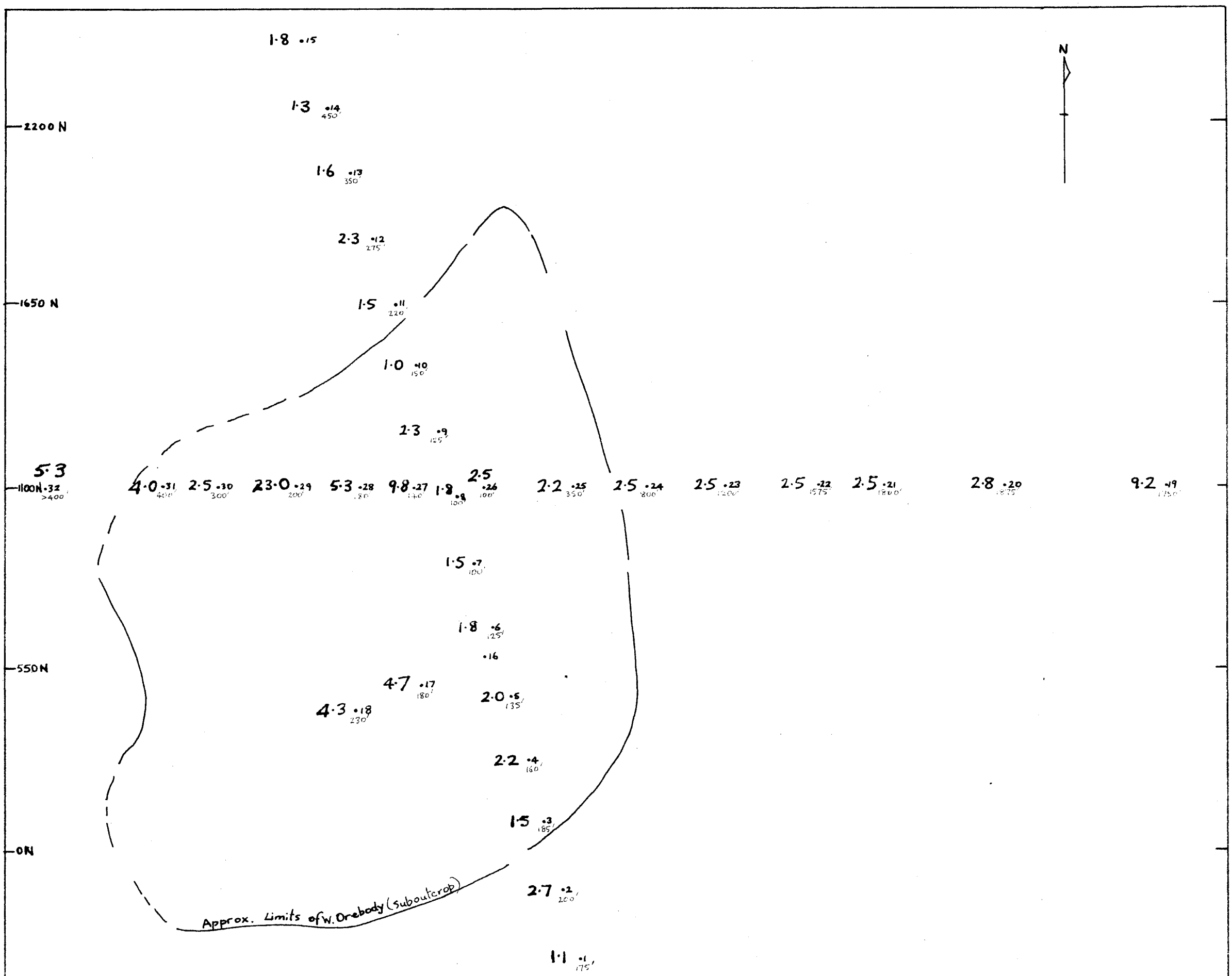
Yours very truly,

J.H. Courtright

J.H. Courtright

JHC:lzb
Encl.

cc: RJLacy, w/o encl.
Morrison, Hazelton, w/encl.
WESaegart, w/o encl.




LEGEND

SOIL GAS SAMPLE LOCATION Hg in soil-gas (ng/100cu.ft.) • Sample no. Approx. depth (ft.) to bedrock

Fig. 1. SACATON PROSPECT - ARIZONA

Hg Content of Soil-Gas

Scale 1" = 300'

L.D.J. June 1970