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REPLY

Francis X. Cannaday
Manager, Base & Precious Metals

Phoenix

November 1, 1971

Ken Jones,
Essex International Inc.,
1704 W. Grant Road,
Tucson, Arizona.

Dear Ken:

Here is the report on the Mammoth property located three miles south of Wickenburg. Since it was written there has been an appreciable amount of drilling done on it for oxide copper and some tonnage of ore has been established, as I mentioned over the telephone.

This report will give you some idea of the property.

I hope to be back here at the office Monday, November 8.

Sincerely,

Francis X. Cannaday

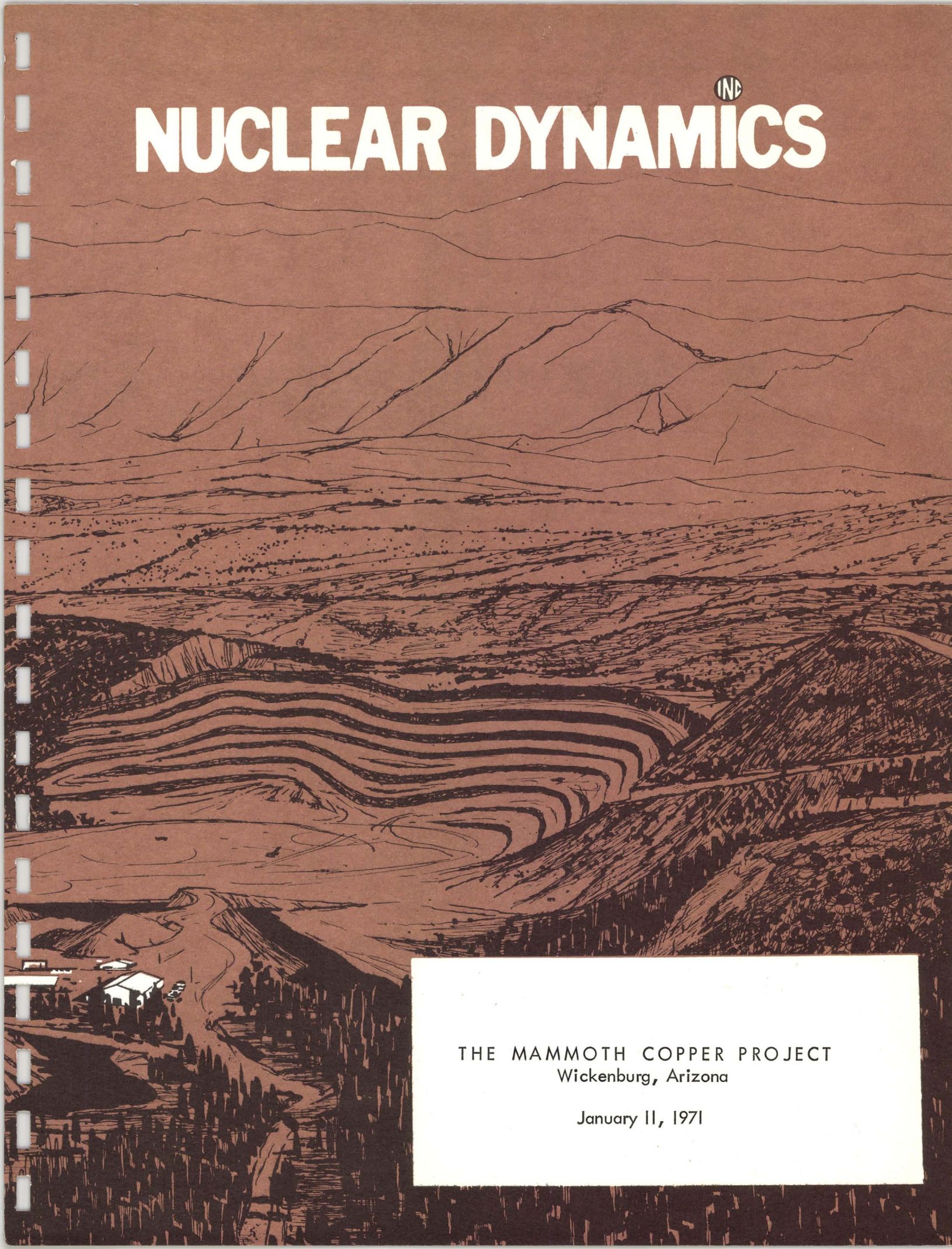
Francis X. Cannaday

FXC/dmh

c.c. K.L.Boltz

encl.

NUCLEAR DYNAMICS INC



THE MAMMOTH COPPER PROJECT
Wickenburg, Arizona

January 11, 1971

THE MAMMOTH COPPER PROJECT

Wickenburg, Arizona

January 11, 1971

NUCLEAR DYNAMICS, INC.
2871 SKY HARBOR BLVD.
P.O. BOX 20766
PHOENIX, ARIZONA 85036

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ILLUSTRATIONS

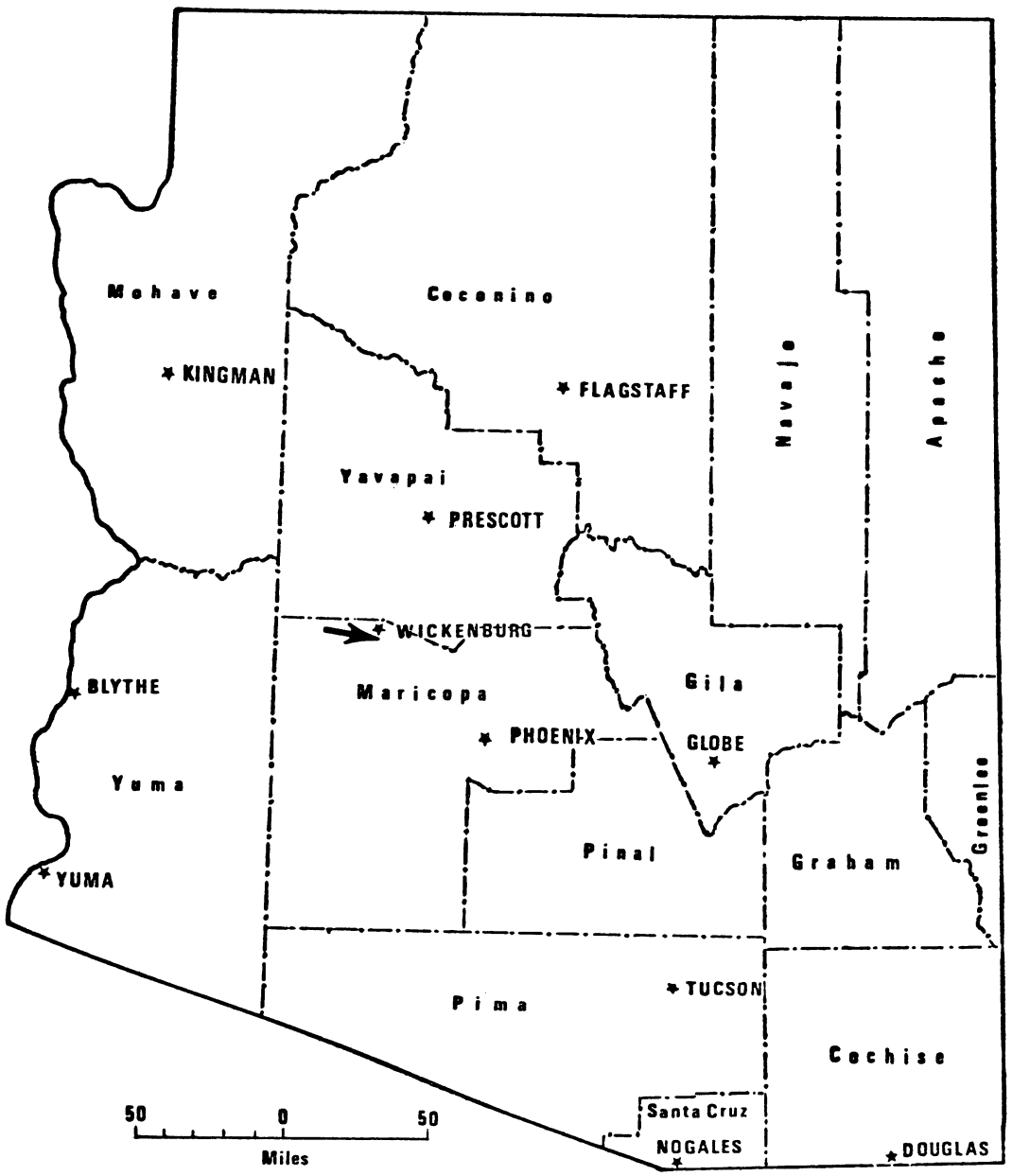
THE MAMMOTH COPPER PROJECT

Wickenburg, Arizona

INTRODUCTION

The Mammoth property consists of 60 Lode Mining Claims known as the Mammoth No. I through No. 60. They are located in the Vulture Mining District, Maricopa County, Arizona, about two to three miles due south of Wickenburg, in parts of Sections 23, 24, 25, 26, 35, and 36, T7N., R5W., G. & S. R. M. The area is shown in the Wickenburg Quadrangle, U. S. G. S. 7½ minute topographic sheet (see Index Map).

Access to the property is obtained over eight miles of dirt roads, from the end of the blacktop pavement on the Vulture Mine Road. The Santa Fe railroad track (Phoenix, Wickenburg, Cadiz Junction, California) on the west bank of the Hassayampa River is two to three miles away by way of Turtleback Wash. Nearest surface water is found at the Hassayampa River.



INDEX MAP

STATE OF ARIZONA

Figure 1

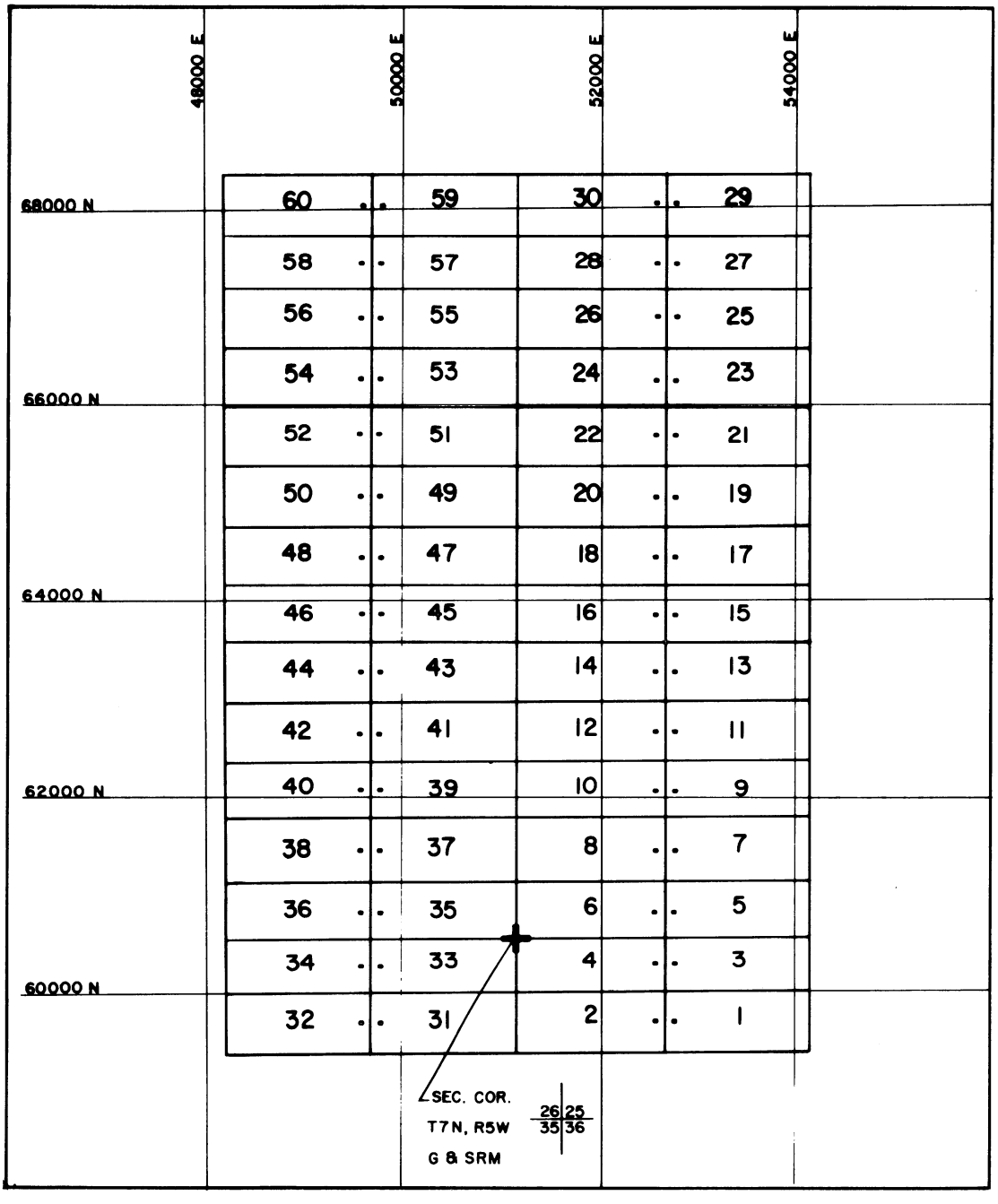
Climate and vegetation is typical of the medium altitude Sonoran desert. The Hassayampa at Turtleback Wash is 2,000 feet above sea level (A. S. L.). Local topographic relief is generally well under 200 feet with a few exceptions, most notable of which is an igneous flow-plug which rises to 2,997 feet A. S. L. in the southeastern part of the property.

The famous Vulture Gold Mine was the important producer in the district. Other minor production in gold, silver, copper and fluorspar has come from a number of prospects and small mines.

HISTORY AND OWNERSHIP

Little is known of the early history of this section of the district. A relatively shallow shaft in rock stained with green copper minerals and one short adit are apparently the oldest workings. On or about 1966-1967, Phelps-Dodge held the property under some form of agreement with the present owner. It is believed that over 100 claims were involved. Four widely spaced, relatively deep core holes were drilled. These were generally three thousand feet apart, with one exception. An additional number of shallow holes were drilled for claim validation. Analyses for copper only is available. Partial data on geochemical surveys for copper and molybdenum is also available.

Presently the property is held by Nuclear Dynamics, Inc., under an Exploration, Lease and Option Agreement (see Property Map).



NUCLEAR DYNAMICS, INC.

MAMMOTH PROJECT

PROPERTY MAP

MAMMOTH CLAIMS 1 THROUGH 60

SECS. 23, 24, 25, 26, 35. 36; T. 7N, R. 5W

MARICOPA COUNTY, ARIZONA

Figure 2

SCOPE OF THE WORK

The major mineralized area in the Mammoth group of claims was mapped by the undersigned on a scale of one inch to 200 feet (see Surface Geology Map and Oversheet No. 4).

Aerial photography of the entire area was contracted for in black and white full-stereographic coverage. Contact prints were 9" x 9" at a nominal scale of one inch to 1,000 feet. Enlargements (5X) as well as contact prints were used for a fracture pattern study in stereo of the area (Fractures, Oversheet No. 1).

A geochemical survey conducted by company personnel and facilities, confirmed, supplemented and extended largely the data previously available. A square grid of samples taken on 200 foot centers for analysis in parts per million (ppm) for copper and molybdenum was completed over the main area of mineralization (Geochemical Data - Molybdenum ppm, Oversheet No. 2; Geochemical Data - Copper ppm, Oversheet No. 3).

GEOLOGY

The area in general is covered with Tertiary surface flows and hypabyssal type rocks, except where erosion removed them and exposed the Precambrian rocks. Recent alluvium is found in the larger washes and stream beds. The Tertiary flows range in composition from rhyolitic through trachytic to andesitic. The early flow rocks are acidic while the more recent ones tend to be basic.

Petrology

Within the Mammoth group of claims, aside from the recent alluvium found in narrow washes, two main groups of rocks were found as follows:

(1) Igneous flows and dikes probably of Tertiary age.
(2) Precambrian granite.

The first group consists of rocks which were deposited before and/or during the hypogene mineral deposition cycles, and rocks which were deposited after the conclusion of these cycles. The Tertiary age igneous rocks associated with the hypogene mineralization sequence include several units which have intruded the Precambrian as dikes and dike-like masses. Megascopically, they are reddish-brown or grey, and have a uniform, fine grained groundmass in which orthoclase phenocrysts are scattered. Some of the units were observed to also contain quartz phenocrysts. Flow banding is apparent occasionally. Therefore, in general, these rocks could be classified as trachytes and rhyolites.

In thin section, phenocrysts of orthoclase are distributed in a felty to pilotaxitic groundmass of chiefly feldspar microlites. Quartz microlites vary in abundance from sparse to frequent. Accessory mica is rare. Consequently, these rocks could be classified as trachytes that grade into rhyolites (Figures 3, 4, 5).

The predominant, Precambrian age rock is a light colored, medium grained granite. Xenoliths rich in ferromagnesian minerals (biotite-amphibolite schist) up to several feet across in size are found occasionally within the rock mass. The granite is generally quite homogenous in appearance

except in an extensive area (see Surface Geology Map) where brecciation followed by recementation has occurred. The recemented fragments vary from inches to feet in size and include some schistose material of amphibolitic and biotitic nature along with ordinary granitic fragments of variable coarseness.

In thin section, the major minerals observed are quartz, orthoclase, some plagioclase and a little biotite. Microfracturing is prevalent. Quartz, in anhedral grains, commonly exhibits strong undulatory extinction and incipient multiple fracturing. Some thin sections show microbrecciation with recementation of angular fragments in a matrix of small grains, many of which appear to be quartz. Orthoclase is predominant over plagioclase. Both show some undulatory extinction and fracturing (Figures 6, 7, 8).

Structure

The main body of the Precambrian granite appears on the surface through an erosional window carved out of overlying Tertiary rocks (see Surface Geology Map). In the southern portion of the window, the granite is fractured considerably along an arcuate zone which follows generally the outline of the window. In the southeastern limb of this zone, over a length of nearly two thousand feet, fracturing attains its greatest intensity (see Fractures, Oversheet No. 1). Also in this zone, the granite appears as an irregular, recemented breccia. Trachyte dikes (Tertiary) in subparallel bands have intruded the granite all along the arcuate zone. In the eastern limb of the arcuate zone the dikes dip from 20° to 40° to the southeast; in the western

limb their dip varies from 35° to 70° to the southwest. The portion of the granite that lies generally towards the geometric center of the arcuate zone is relatively free of dikes and is comparatively lightly fractured.

Major faulting exists along the eastern border of the window where a generally North-South fault or fault zone has dropped the East fault block down with respect to the West fault block. The displacement has brought postmineral flows of Tertiary age into contact with the Precambrian.

Minor faulting is prevalent throughout the area. Displacements (some rather minor) and slickensided fracture planes are visible in the trachyte dikes. Many of these movements were probably postmineral in age. Emplacement of the dikes is believed to follow premineral fractures and planes of weakness.

Fracturing mapped in the field reveals extensive approximately East-West fracture sets as well as numerous other sets in various directions viz: N-S; N 20° W; N 70° E; N 60° E. In the most intensely fractured area several sets are usually present at any given location. Fracturing is most noticeable in the granite. The trachytes appear to be less fractured.

Fracture patterns mapped from aerial stereophotography generally agree in intensity and direction with field readings. Most of the fracturing observed transgresses (without noticeable change of attitude) from granite to trachyte, although there appear to be fewer fractures in the trachytes. This same fracturing does not appear in the younger, clearly postmineral flows around the window.

Alteration

Alteration patterns have not been established. Not enough work, particularly thin section studies, has been done to this effect.

Surface mapping and megascopic examination show zones altered by oxidation of pyrite to ferric oxide by supergene processes. The ferric oxide in the most intensely oxidized rocks is both indigenous, as hematite casts and pseudomorphs after pyrite, and transported, as coatings and fillings in fractures. These conditions are most apparent in the brecciated, intensely fractured granite. Feldspars in this zone show varying intensity of argillic alteration. Trachyte dikes in this general area show hematite casts (cubes) after pyrite which are finely disseminated throughout the rock mass in quantities that vary from little more than traces to about one percent by volume. Some masses of trachyte as a whole appear intensely altered by ferric oxidation.

Epidote occurrence as observed on the surface is noted on Oversheet No. 4. It is usually in, or related to, fractures in the granite, often near contacts with the trachyte. The occurrences appear to be grouped rather than randomly scattered.

A certain amount of thin section work limited to contact zones between granite and trachyte showed argillization of feldspars in individual crystals and in the groundmass, both in the trachyte and in the granite. Sericitization, from only in the plagioclase in some thin sections to pervasive throughout the feldspars in other thin sections, was observed in all granite specimens and to a lesser degree in most trachyte specimens (Figures 5, 9).

Mineralization

The largest area of copper mineralization, roughly 1,500 feet long and as much as 600 feet wide as outlined by surface mapping (Oversheet No. 4), is found in the Precambrian breccia zone previously described. Malachite, some chrysocolla and a little azurite constitute the ore minerals. These are found in veinlets, filling cracks, and in masses upwards in size from minute specks, within the brecciated, fractured, totally oxidized granite. Hematite casts after sulphides in fractures and also disseminated in the rock are visible both with hand lens and in thin sections. Considerable hydrated ferric oxide has been deposited in rock fractures, accompanying the copper values. The intense oxidation and presence of copper oxides is only slightly evident on the undisturbed surface outcrops, which although fractured, appear clean on the surface. The oxidized, mineralized condition becomes quite evident a few feet below the surface as shown in bulldozer cuts and in access roads.

The mineralized zone described above lies within a larger zone outlined by the 400 ppm copper geochemical contour (Oversheet No. 3) and in a zone of molybdenum geochemical anomalies (Oversheet No. 2).

The mineralized zone is also coincident with the most intensely fractured area as shown by the fracture pattern study from stereographic aerial photography (Oversheet No. 1).

Only one hole, M-1, is in this mineralized zone. It was drilled by Phelps-Dodge (1966) to a reported depth of 1,845 feet. Available analysis data show that from 0 to 20 feet the copper content averages 0.10%; and from 20 to 170 feet, the average is 0.464% (this includes two ten-foot intervals

with 0.10% and 0.084%). A 50-foot interval from 20 to 70 feet averages 0.824% copper. Below 170 feet to 720 feet the analyses fluctuate below and above 0.10%. From 720 feet to bottom they are generally 0.03 to 0.05%.

A second deep drill hole, M-2 (1,583 feet), is located outside this mineralized zone. Characteristic of the entire hole are numerous zones 40 to 140 feet thick, averaging from 0.10 to 0.25% copper. The bottom 79 feet averaged 0.135%.

Surface mapping showed two additional small areas of mineralization. One area at the northeast edge of the window has had some surface trenching done. One shallow validation drill hole, M-B (155 feet), located on the western edge of the zone, shows low erratic copper content no higher than 0.23%. No drilling or trenching has been done in the other area on the west side of the window.

GEOCHEMISTRY

Results of the geochemical survey are shown in two contour maps. Oversheet No. 2 shows molybdenum in ppm. General background content for the entire area is in the order of 3 to 5 ppm. Contour interval is 10 ppm to 50 ppm; area with concentrations above this is enclosed by the 50 ppm contour. The molybdenum anomalies are grouped into a roughly circular pattern which generally coincides with the arcuate zone which contains (1) the brecciated, mineralized Precambrian granite; (2) the intruding trachyte dikes; and (3) the most intensely fractured rock. The molybdenum highs are found in trachyte as well as in Precambrian granite terranes.

Oversheet No. 3 shows copper in ppm. General background is in order of 20 to 75 ppm. Contour interval is 200 ppm up to 800 ppm. Concentrations above this are enclosed by the 800 ppm contour. The copper anomalies (1) coincide in part with the molybdenum anomalies; (2) enclose the brecciated, mineralized Precambrian granite; and (3) are generally in areas of considerably to intensely fractured rock.

SUMMARY

(1) A mass of brecciated, fractured Precambrian granite is found within Precambrian granite exposed by an erosional window.

(2) Maximum fracture intensity occurs within the brecciated granite mass.

(3) The brecciated granite mass has been a favorable host for secondary supergene deposition of copper minerals.

(4) Leaching of copper minerals from the surface rocks has resulted in clean-looking outcrops.

(5) Trachyte dikes may have exerted structural control on the deposition of the supergene copper minerals in the brecciated granite.

(6) One hole (M-1) has been drilled in the brecciated granite mass. According to the data available, the copper content averages 0.464% for the 150 feet interval that lies between 20 and 170 feet from the collar of the hole.

(7) In hole M-1, anomalous copper content averaging between 0.10% and 0.19% is found in three zones, 40 to 80 feet in extent, between the 360 and the 720 feet depths.

(8) In hole M-2, anomalous copper content averaging between 0.10% and 0.25% is found in eight zones, each between 40 feet and 140 feet in extent, scattered over the entire depth of the hole (1,589 feet). A 30 foot zone averages 0.50% copper.

Respectfully submitted,

NUCLEAR DYNAMICS, INC.

Francis X. Cannaday

Francis X. Cannaday
Research Geologist - Geophysicist

January 11, 1971

Figure 3

Trachyte. Crossed polarized light. White line represents one millimeter. Sanidine (wedge shaped) and orthoclase phenocrysts (Carlsbad twins) in felty groundmass of feldspar microlites and larger quartz microlites aligned in bands.

Figure 4

Trachyte. Crossed polarized light. White line represents one millimeter. Sanidine phenocrysts in a pilotaxitic groundmass of feldspar and quartz microlites.

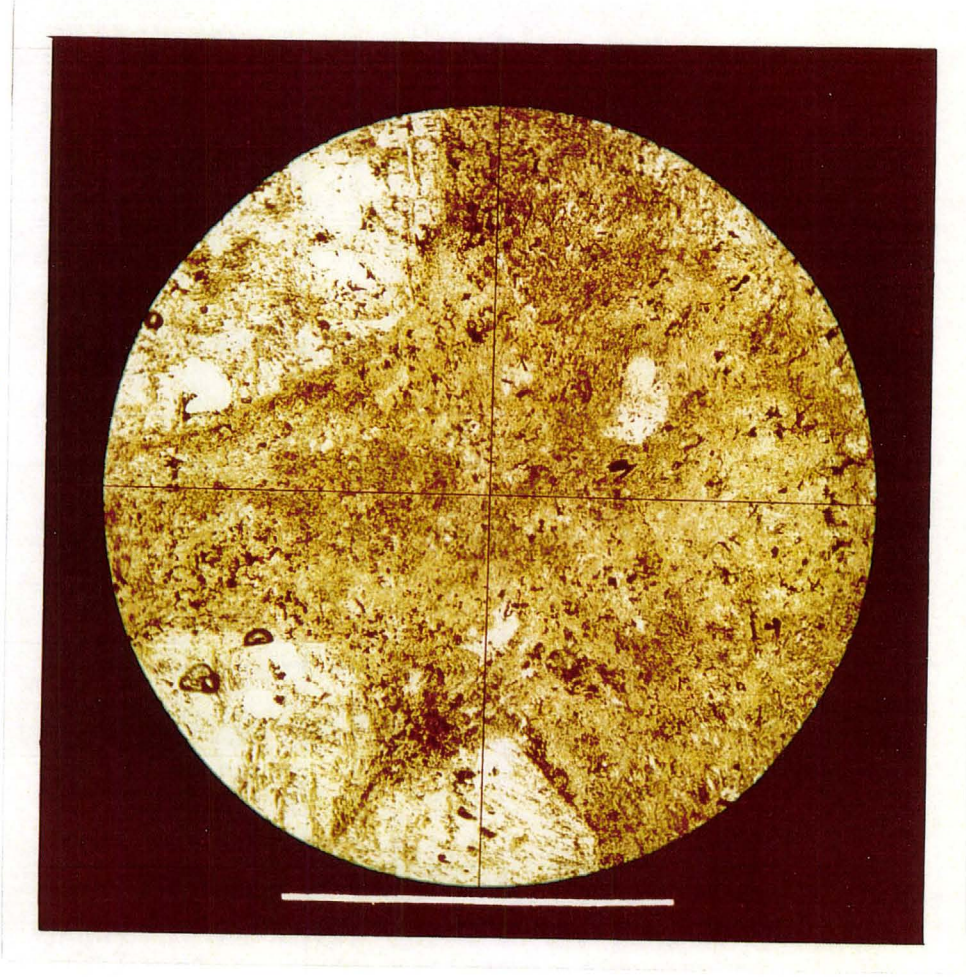


Figure 5

Same as Figure 4, but in plane polarized light. Groundmass is argillized and contains numerous grains of transported hematite.

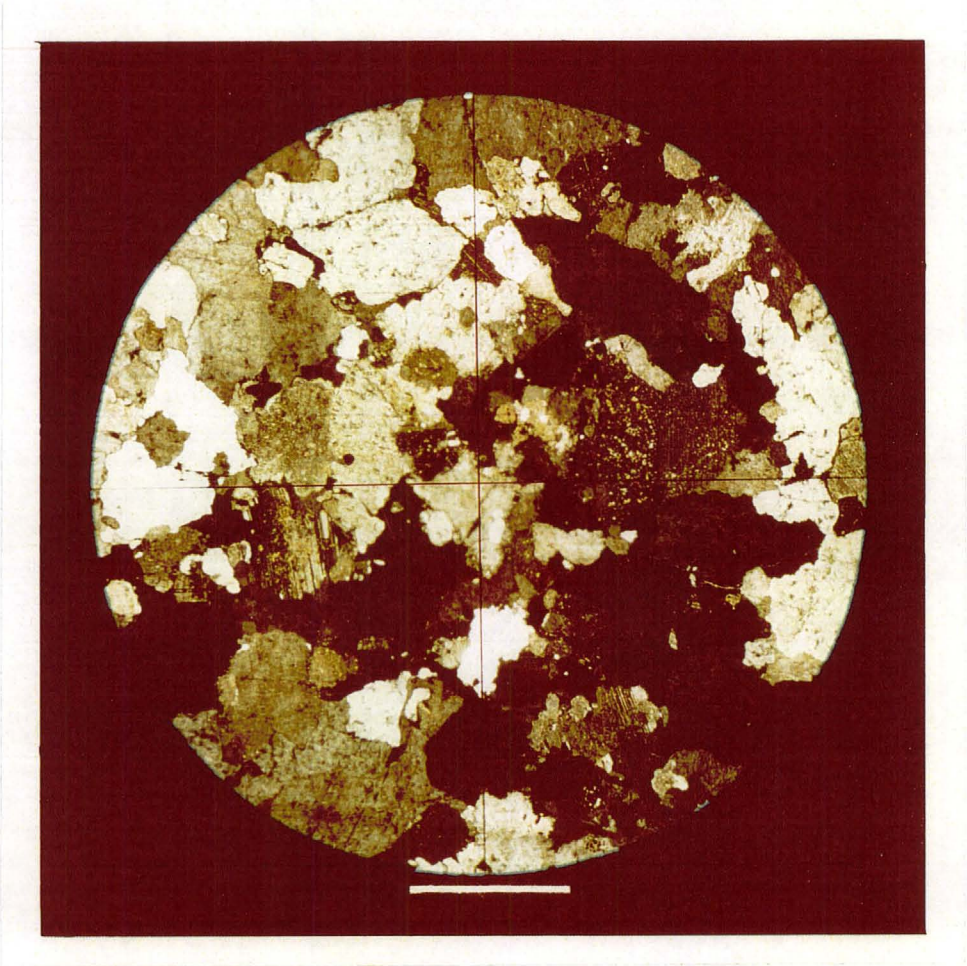


Figure 6

Granite. Crossed polarized light. White line represents one millimeter. Anhedral quartz, orthoclase and some plagioclase. Sericite more abundant in plagioclase.

Figure 7

Granite. Crossed polarized light. White line represents one millimeter. Microbreccia of recemented grains of quartz, some feldspar and a little sericite.

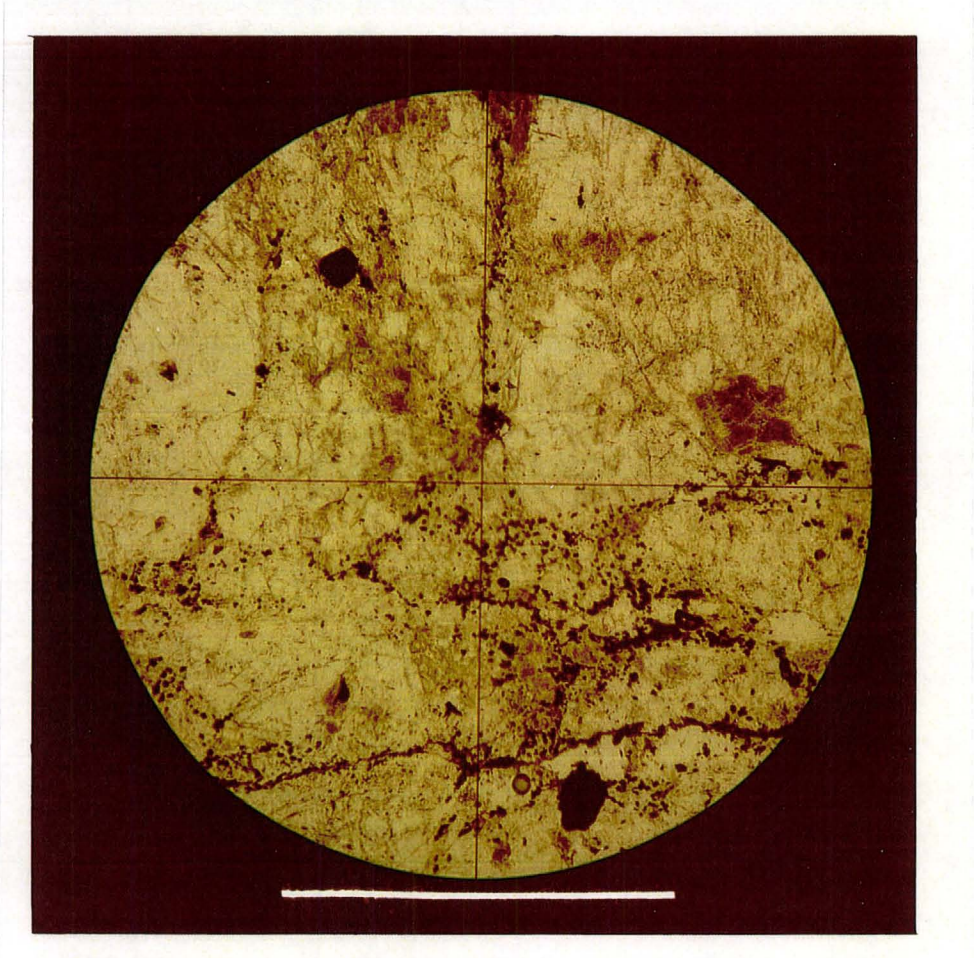


Figure 8

Same as Figure 7, but in plane polarized light. Hematite pseudomorphs after pyrite cubes are shown in the more intensely brecciated zones and along fracture lines.

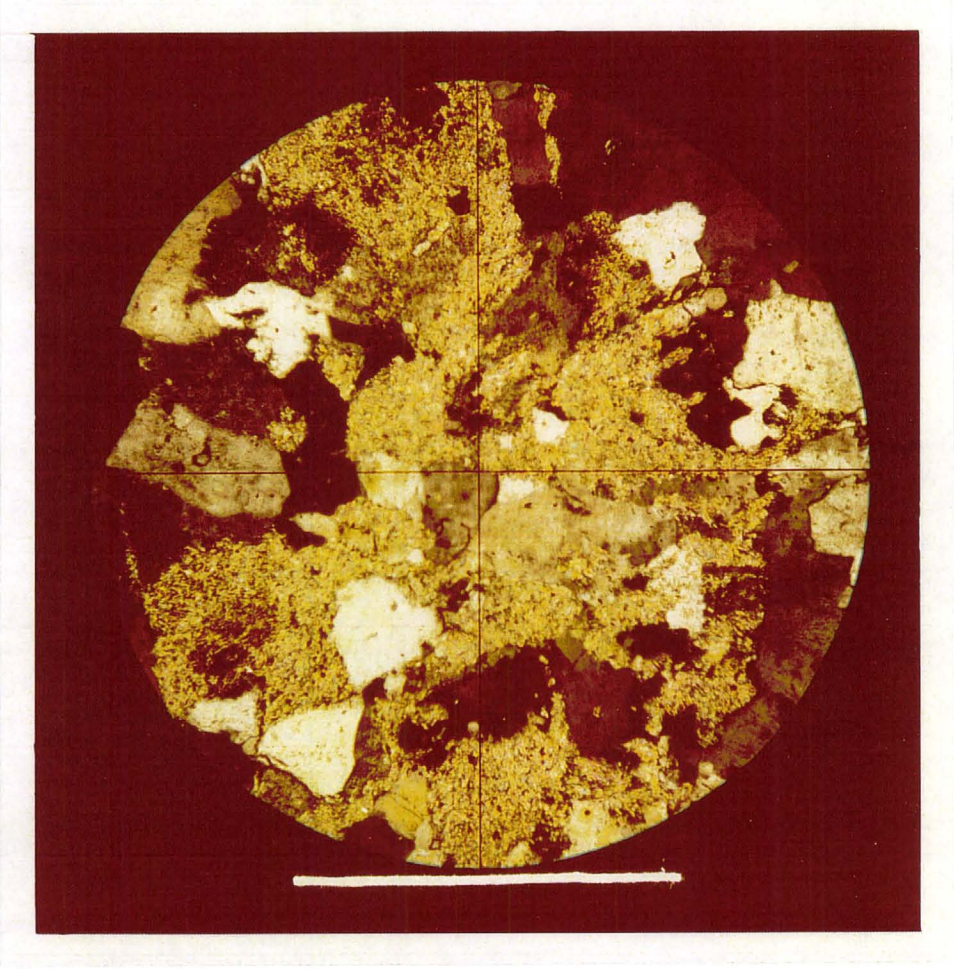


Figure 9

Altered granite. Crossed polarized light. White line represents one millimeter. Anhedral quartz grains in totally sericitized feldspars.

APPENDIX

LEACH EVALUATION
OF
MAMMOTH ORE

PREFACE

The following report on a leach evaluation of Mammoth ore is an extraction from a dual report by Hazen Research, Inc., on Mammoth ore, and ore from another property.

The text is a word for word extraction insofar as possible. All numerical figures and data are those given in the Hazen Research, Inc., report.

INTRODUCTION AND SUMMARY

Nuclear Dynamics, Inc., requested Hazen Research, Inc., to evaluate Mammoth (MAM-7) ore samples as feed material for copper recovery. Leach studies emphasizing percolation leach characteristics were performed when mineralogical and chemical data suggested that the materials would be amenable to dilute acid treatment.

MAM-7 is a hard granitic-type material assaying 0.442% total and 0.381% acid soluble copper. Major copper values occur as secondary minerals.

Although a laboratory evaluation of heap leaching on relatively fine ore cannot directly simulate the leaching behavior of coarse ore in high heaps, laboratory techniques do provide useful preliminary data. Based on the results obtained using these techniques, MAM-7 ore seemed to be a good material both chemically and texturally.

The ore responded well to dilute acid leaching. It appeared that, given sufficient leach contact time, ultimate copper dissolutions could conveniently be estimated as being about equal to the acid soluble copper values determined analytically. This was about 86% for MAM-7. Actual solubilities obtained in roll tests exceeded these values by about 3%.

The ore did not consume large amounts of acid, but consumption was related to leaching techniques. In general, more acid was consumed per pound of dissolved copper when leaching minus 3/8-inch ore by percolation than was consumed leaching minus 6-mesh ore on the rolls.

Acid consumption was also affected by leach contact time. In both roll and percolation tests, optimum acid/copper ratios were obtained during the first two days of leaching. As regards percolation results, two days' contact resulted in 54% copper solubility from the ore at the cumulative expense of 4.0 lb. H_2SO_4/lb. of copper dissolved.

Copper continued to dissolve after two days' percolation contact, but unit acid requirements were disproportionately high for the additional copper dissolved. As an example, the unit requirements increased from 3.1 lb H_2SO_4/lb. of additional copper dissolved on day two to 5.6 lb/lb. on day three.

Although unit acid requirements increased rather abruptly after two days of percolation leaching, the ore did not consume what is considered to be unreasonable overall quantities of acid during six days' contact. The test showed a 79% dissolution of copper at a cumulative ratio of 5.2 lb. H_2SO_4/lb. dissolved copper. Although this terminal figure seems reasonable, the increasing unit acid requirements did suggest that maximum copper dissolution levels might not be economically feasible. The price for acid and fixed processing costs, would, of course, determine the optimum copper dissolution cut-off.

Solution assays showed ferric iron to copper ratio of about 0.89:1.0. This one-pass ratio may affect the choice of subsequent treatment for copper recovery from solution.

ORE PREPARATION AND ANALYSIS

A sample identified as MAM-7 was received for study. It consisted of approximately 50 pounds of minus 2-inch material, which was prepared as generally shown in Figure 1.

A head sample was split and was prepared for chemical analysis, Table 1. MAM-7 assayed 0.442%. Acid soluble copper value was 86% of the total values. No sulfide sulfur was detected analytically. It is assumed, therefore, that the difference between total and acid soluble copper values is the result of refractory non-sulfide copper minerals.

Table 1

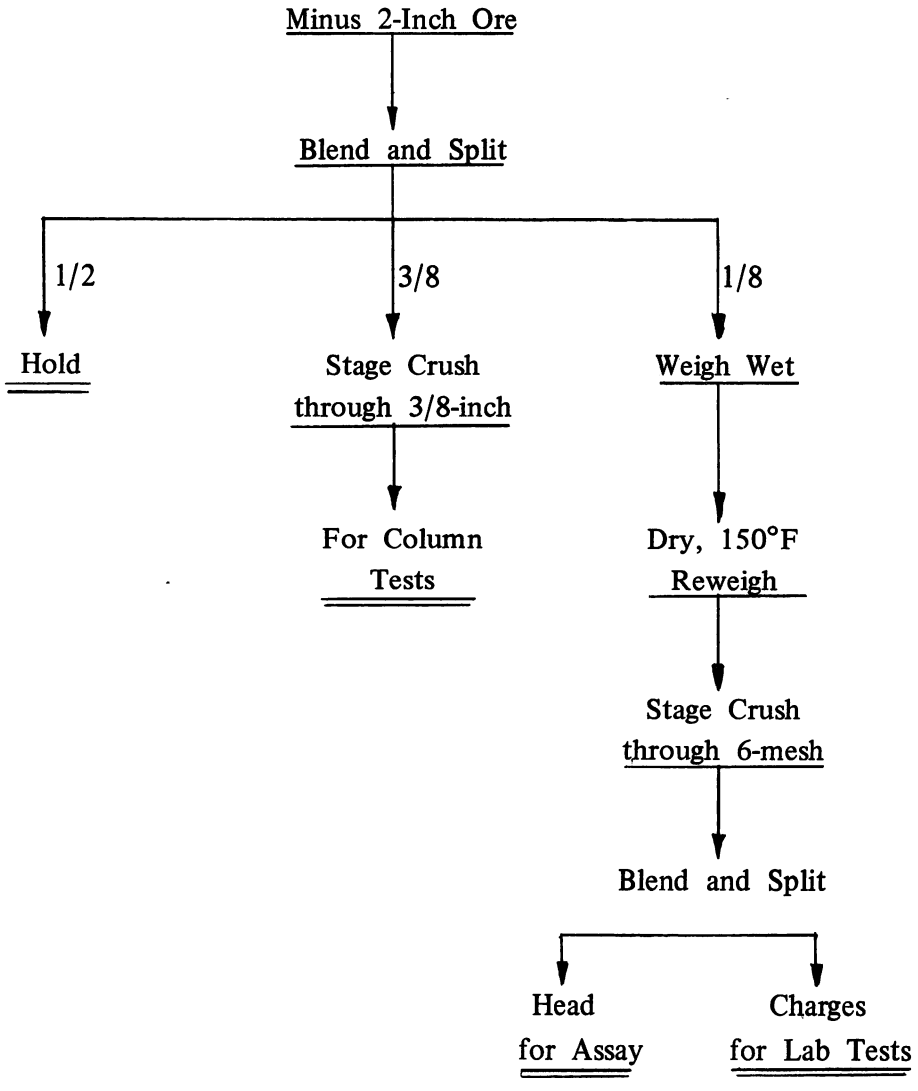
Head Analysis

	Percentage					
	Copper				Acid Consumers	
	Total	Acid Soluble	Fe	$S^{=}/S$	lb H_2SO_4/ton	$\%H_2O$
MAM-7	0.442[1]	0.381	2.6	nd[2]	34	0.3

1 Six heads
2 Sulfide Sulfur not detected

Figure 1

Ore Preparation



The acid consumers assay has been a useful tool for estimating acid consumption for certain oxide ores during laboratory tests. Data given hereafter suggest that with MAM-7 ore the analysis has limited value as a direct analytical measure of acid consumption when the higher copper dissolution levels are attained. The potential usefulness of this analytical tool, however, should not be overlooked if subsequent laboratory work is contemplated.

MINERALOGY

A brief mineralogical examination of MAM-7 ore was made. The sample consists primarily of a granitic-type rock with minor amounts of what appears to be shale. Oxidized areas are abundant and are characterized by the presence of limonite, hematite, and the conspicuous secondary copper minerals, chrysocolla, malachite, and possibly subordinate brochantite. Copper sulfides were not detected in the fragments examined. Minor amounts of calcite are present.

CONSTANT ACID LEACH TEST

Leach tests employing mechanical agitation and a constant leach acidity are frequently used as a preliminary and quick estimate of acid requirements and copper dissolution. In the tests run, Appendix Table 2, 500 grams of the minus 6-mesh ore was pulped with 500 milliliters of water. Acid was added to pulp from burettes to attain and maintain a pH of about 1.0. The test was continued for four hours - a point at which very little additional acid was required to hold the pulp pH.

The result indicated that copper dissolution of at least 78% was possible from MAM-7 ore. At this level, acid consumption[1] was 18 pounds H_2SO_4 per ton of ore.

Although this dissolution level was encouraging, subsequent data reported hereafter indicated that higher laboratory dissolution levels were possible, but acid requirements also increased.

---

[1]Consumption equals total acid added less acid remaining at the end of the test.

AGITATION (ROLL) LEACH TEST

Agitation roll tests were conducted as a measure of copper dissolution and acid consumption with leach contact time. The metallurgical sheet for these tests is given in Appendix Table 4. Data given are averages of duplicate tests.

In these tests, 100-gram charges of the minus 6-inch ore were placed in leaching bottles with 1.0 liter of water containing 10.1 g H_2SO_4/liter. The bottles were closed with drilled caps, allowing access to air, and placed on the rolls for 10 days. At 1, 2, 4, and 8 days, the bottles were removed briefly and small solution samples were removed for copper and acid analyses. At 10 days, the slurries were filtered, and the solids washed, dried, processed and assayed for copper.

Results are summarized in Table 2 and shown graphically in Figures 2 and 3.

The ore was amenable to leaching in a mild acid environment. About 79% copper dissolution was obtained in one day. Although the percentage dissolutions tended to level off after the first day, it appeared that additional leaching would have occurred had the test period been extended beyond 10 days. This was the first indication that the ore was relatively slow to reach maximum dissolution levels. Maximum dissolution obtained was about 89% (7.94 lb. Cu/ton of ore) or very nearly the same as acid soluble copper values indicated by assay.

Acid consumption increased significantly with time, although copper dissolution did not. Table 2 shows that at two and four days contact, for instance, acid/copper ratios were 3.5 and 5.2 lb/lb. After day four, acid/copper ratios worsened steadily.

It appears, therefore, that prolonged leach contact should be avoided. In actual operations it may not be economically feasible, because of acid costs, to reach maximum copper dissolution levels.

Pregnant liquor taken at the end of each test was assayed for copper and for total and ferrous iron. Based on these assays, the liquor had an Fe^{+3}/Cu ratio, 0.89. These ratios would be important were cementation to be considered.

Table 2

Agitation Roll Leach Results
Minus 6-Mesh Ore

	Effluent Assay, g/l		Cu Dissolution			
Day	Cu	Free H_2SO_4	%	lb/ton	lb H_2SO_4 Consumed/ ton Ore[3]	lb H_2SO_4/ lb Cu
1	0.352	8.8	79.1	7.04	26	3.7
2	0.371	8.8	83.1	7.40	26	3.5
4	0.373	8.1[2]	83.6	7.44	39	5.2
8	0.395[1]	5.9[2]	88.3	7.86	81	10.3
10	0.399[1]	6.7[2]	89.2	7.94	66	8.3

Residue - 0.052% total Copper

1 0.363 g total Fe and 0.009 g Fe^{+2}/liter
2 Rerun and Checked
3 Acid consumed equals acid added less that remaining at sampling

Agitation Roll Results
Copper Dissolved

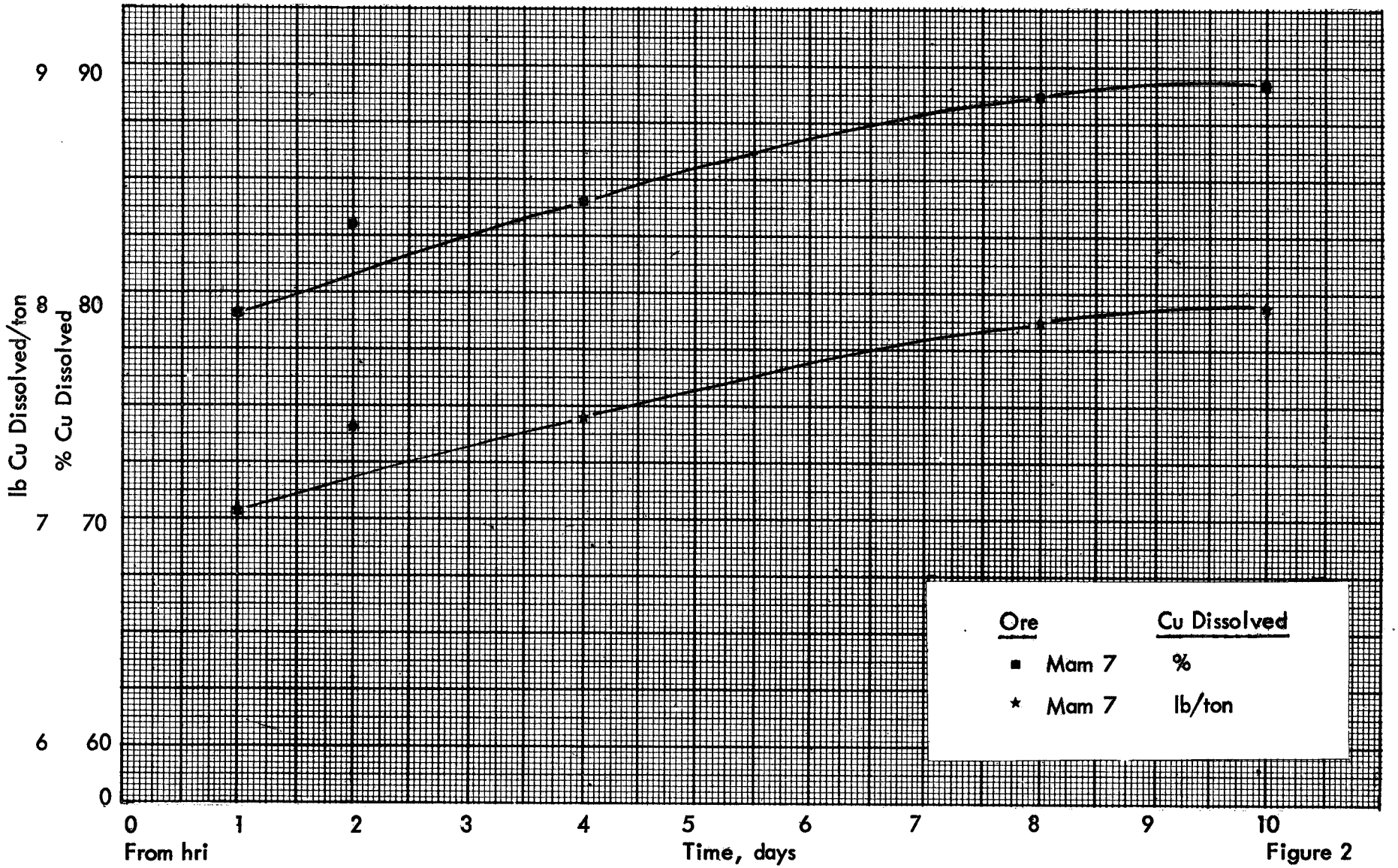
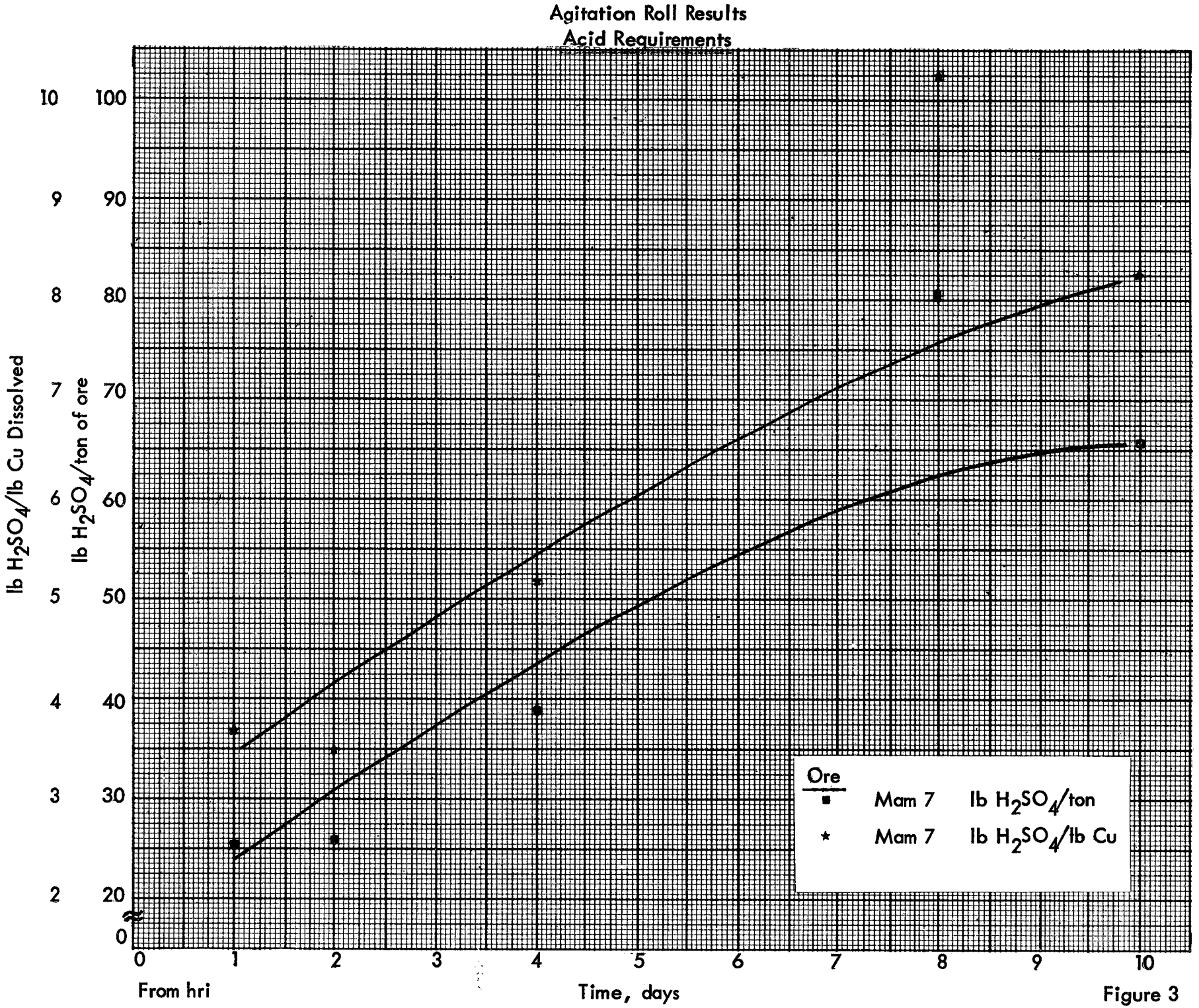


Figure 2



From hri

Figure 3

COLUMN LEACH TESTS

Small scale percolation leach tests are frequently performed on ores having potential heap leach value. Although such tests on relatively fine ore cannot directly simulate the leaching behavior of coarse ore in high heaps or provide absolute metallurgical data on the leaching of coarse ore, data obtained and observations made do provide useful preliminary information for evaluating an ore as potential heap leach feed.

In the present test, a minus 3/8-inch charge of ore was bedded randomly in a 5.5-inch I. D. clear plastic column. The column contained 19 inches or about 24 pounds of ore at a dry bulk density of 88 pounds/cu ft.

The column was then contacted downflow for six days with a water/acid solution containing 10.0 g H_2SO_4/liter. Percolation flow rate was controlled at 4.7 ml $\pm$ 0.2 ml/minute, which was equivalent to a surface area flow of about 0.008 gal/sq. ft/minute. At this flow, the ore appeared to be saturated thoroughly, but no solution flow or hold-up was observed. Collected effluent removed each day was sampled and assayed for copper and free acid. Solution feed throughout the entire leaching period was the acid/water mixture; solution was not recirculated.

At the end of the leaching period the ore was washed thoroughly with slightly acidic water and with unacidified water. Residue was weighed wet and dry and processed for assay.

Operating results are summarized in Appendix Table 6. The data for copper and acid are summarized in Table 3 and are shown graphically in Figures 4 and 5.

Copper dissolution during six days of contact was about 79% (equals 7.6 lb. Cu/ton of ore). Extrapolation of the copper curve suggests that had the leaching period been extended on additional two or three days, percentage dissolution would have very nearly equalled that obtained during roll tests and would, therefore, have approximated the acid soluble copper values indicated by assay.

Table 3

Column Leach Results
Minus 3/8-Inch Ores

	Effluent Assay, g/l		Cu Dissolution		lb H_2SO_4 Consumed/ ton Ore[2]	lb H_2SO_4/ lb Cu	
Day	Cu	Free H_2SO_4	%	lb/ton		Unit	Cum
1	2.55	0	27.7	2.70	13	4.8	4.8
2	1.98	3.7	54.1	5.25	21	3.1	4.0
3	0.883	5.4	65.2	6.33	27	5.6	4.3
4	0.315	6.1	69.3	6.74	32	12.2	4.7
5	0.314	6.6	73.4	7.13	36	10.3	5.0
6	0.237	6.6	78.7[1]	7.64[1]	40	-	5.2

Residue - 0.106% total Copper

1 Including wash
2 Acid consumed equals acid added in feed less acid remaining in pregnant

Acid/copper relationships found to exist during roll tests on 6-mesh ores did not seem to correlate with those existing during percolation leaching of 3/8-inch ore. Based on percentage dissolutions of copper, more acid was required during percolation leaching. Acid/copper ratios obtained during percolation tests, however, were still satisfactory. By the sixth day, for instance, about 79 percent of the copper had dissolved and the ratio was 5.2 lb. H_2SO_4/ lb. of dissolved copper.

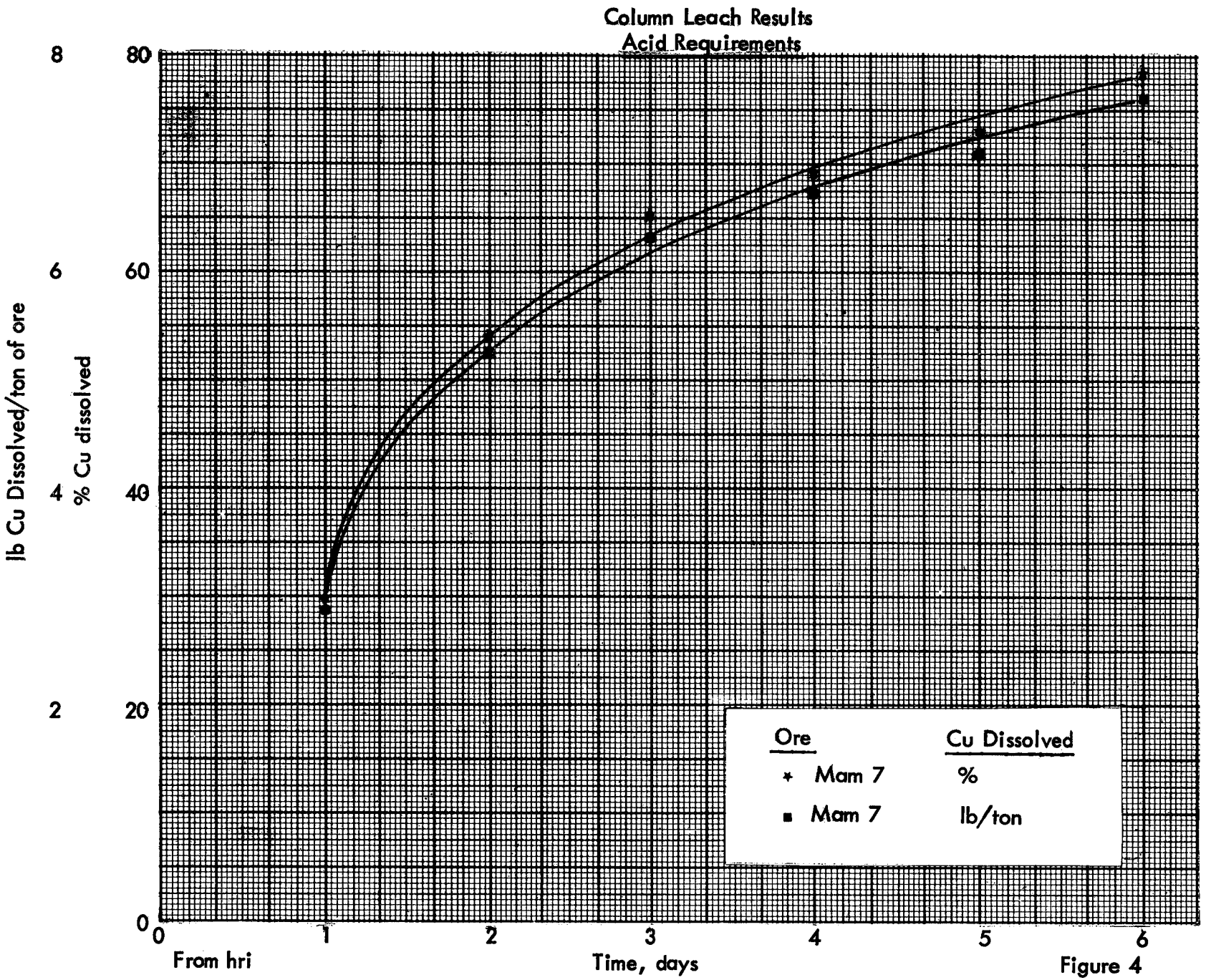

Column Leach Results
Acid Requirements
lb Cu Dissolved/ton of ore
% Cu dissolved
8
6
4
2
0
80
60
40
20
0
1
2
3
4
5
6
From hri
Time, days
Ore
Cu Dissolved
Mam 7
%
Mam 7
lb/ton

Figure 4

Column Leach Results
Acid Requirements

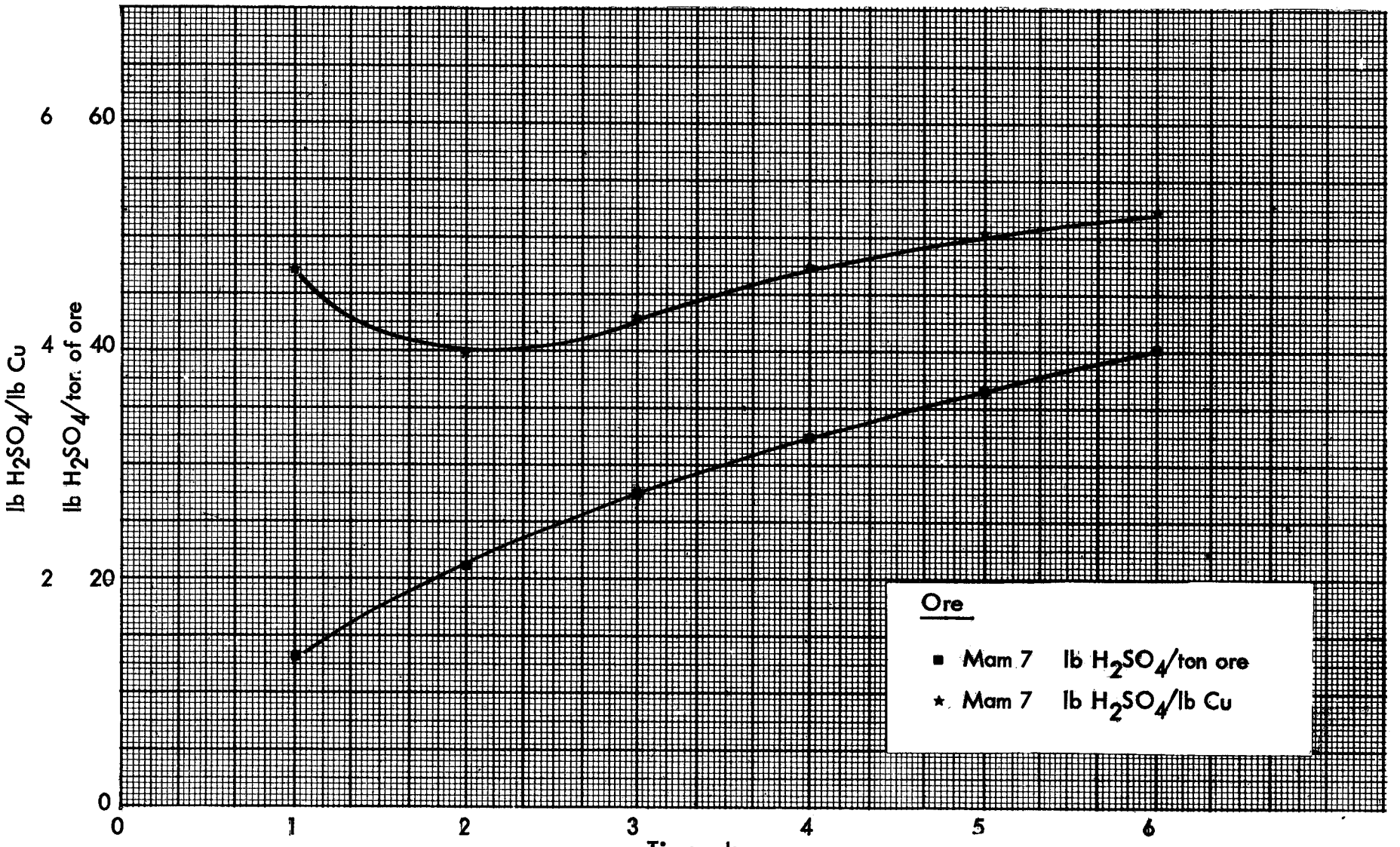


Figure 5
From hri

Daily unit changes in the acid/copper ratios are shown in Table 3. This data shows a unit increase during the second day over the first day. The unit ratio increased rather abruptly during the third day of leaching, although the cumulative ratio was still less than 5 lb. H_2SO_4/lb. of dissolved copper.

As was noted in the section dealing with roll leaching, it appears that prolonged leach contact should be avoided. Although copper continues to be dissolved with contact, the unit consumption of acid increased rather abruptly in terms of the amount of additional copper dissolved. If percolation leaching of the materials were to be contemplated, consideration may have to be given to discontinuing the leaching cycles short of the maximum copper dissolution levels in order to attain economical acid/copper ratios.

Observations made during leaching suggest that MAM-7 ore would be quite suitable for heap leaching. The crushed material was blocky, produced a minimum of fines, and retained only about 8.6% residual moisture. The ore did not appear to break down during acid treatment.

Appendix Table 2

HAZEN RESEARCH, INC.

Constant pH Results, MAM 7

TEST NO. 844-6 PROJ. NO. 844 NOTEBOOK NO. _____ DATE 10/23/70

SAMPLE Mam-7, 6M, dried, 500 g (HRI 3160-2)

PROCEDURE Add 500 g ore to beaker containing 500 ml water. Start mechanical agitator (ambient temperature) and begin adding concentrated H_2SO_4 from burette-obtain and maintain pH 1.0. Continue at least 4 hours or until pH holds at 1.0 for 30 minutes. Filter, collect pregnant and wash with 2 - 500 ml pH 1.5 washes and 1 - 500 ml water. Assay pregnant and wash, prepare and assay solids.

RESULTS

TEST PRODUCT	Sample #	AMT.	emf-mv	ASSAY, g/l			CONTENT, g			DISTRIBUTION		
				Cu		Free H_2SO_4	Cu			% Cu	H_2SO_4/ton	
Head		500.0		0.442%			2.21				Added	Cons.
Pregnant	844-6.1	440ml	540	3.05 2.97	3.01	24.5	1.32	1.68		78.1	68.3	18
Wash	844-6.2	1515ml		0.243 0.230	0.237	(22.0)	0.36					
Residue, wet g		542.1										
dry g	844-6.3	489.6		0.0961 0.0974			0.47			21.9		
				0.0948 0.0932	0.0954%		2.15 97.3%			100.0		

	Time	pH	Cum ml	Time	pH	Cum ml			
REMARKS	0830	6.9^-	0	1030	0.85	9.7	Starting pH (before H_2SO_4) 6.9^-		
	0840	0.85	9.7	1100	0.9	9.7	Started: 0830 Ended: 1300		
	0850	0.8^+	9.7	1130	0.9^-	9.7		760.1	707.6
	0900	0.8^+	9.7	1200	0.9^+	9.7	Tare	218.0	218.0
	0930	0.8^+	9.7	1230	0.9	9.7		542.1	489.6
	1000	0.9^-	9.7						

SIGNED _____

Appendix Table 4

HAZEN RESEARCH, INC.

Average — Agitation Roll Results, Mam 7

TEST NO. 844-3 and 4 PROJ. NO. 844 NOTEBOOK NO. _____ DATE 10/29/70

SAMPLE Mam-7, 6M, dried, 100 g (HRI 3160-2)

PROCEDURE Add ≈200 ml leach solution containing ≈10 g H_2SO_4/l to clean leach bottle (drilled cap). Add ore, add ≈800 ml solution (total = exactly 1.0 l). Cap bottle, place on rolls. Remove at 1.2, 4, 8 days, settle and pipette 20 ml for assay. At 10 days, filter, remove pregnant and wash with 2 - 100 ml pH 1.5 washes, 1 - 100 ml water wash. Assay solutions, prepare and assay solids. Average of 2 Tests.

RESULTS

TEST PRODUCT	AMT.	pH	emf mv	ASSAY, g/l			CONTENT, g			DISTRIBUTION		
				Cu	Free H_2SO_4	Total Fe	Cu	H_2SO_4		% Cu	lb Cu/ton 2/	lb H_2SO_4/ton
Head	100.0			0.442%	10.1		0.442					
Day 1	20	1.15		0.352	8.8		0.007	0.176		79.1	7.04	26
Day 2	20			0.371	8.8		0.007	0.176		83.1	7.40	26
Day 4	20			0.373	8.1		0.008	0.162		83.6	7.44	39
Day 8	20	1.25		0.395	5.9		0.008	0.118		88.3	7.86	81
Day 10	890		475	0.399	6.7	0.306 1/	0.355			89.2	7.94	66
Wash	318			0.064			0.020					
Residue, wet g	107.1											
dry g	95.9			0.052%			0.048					
							0.493					
							102.5%					

REMARKS Start acidity = 10.1 g H_2SO_4/l = 10.1 g

1/ 0.009 g Fe^{+2}/l

2/ Based on metallurgical head

SIGNED _____

Appendix Table 6

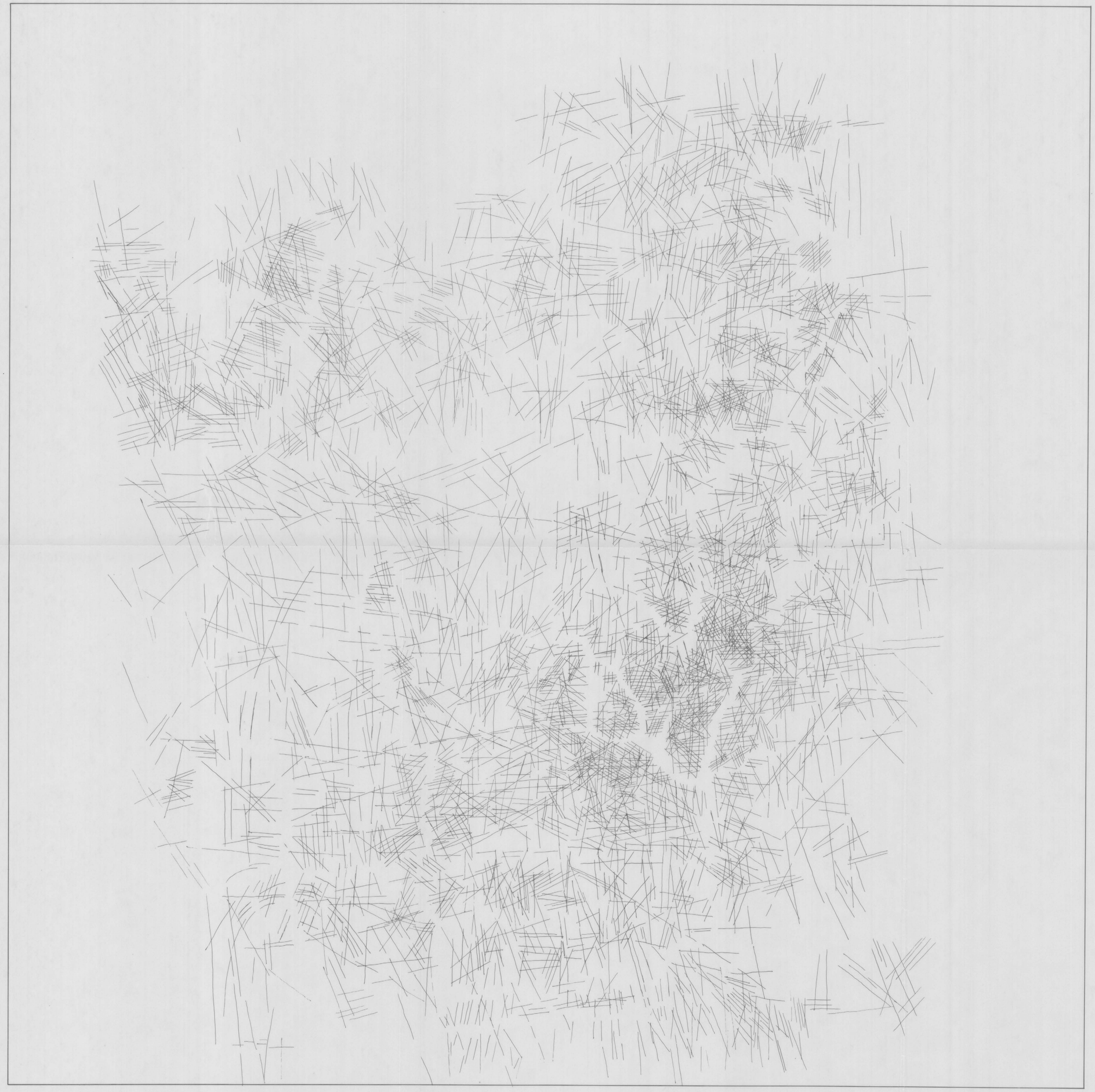
MAM-7
Minus 3/8-Inch Ore, Column Leach

Day	Volume, ml		Effluent Assay, g/l		Emf -mv	Copper, g		H_2SO_4, g				
								Feed		Effluent		Cum
	Feed[1]	Effluent	Cu	Free Acid		Day	Cum	Day	Cum	Day	Cum	Used
1	6,900	5,630	2.55	0	465	14.35	14.35	69.00	69.00	0	0	69.00
2	6,900	6,900	1.98	3.7		13.66	28.01	69.00	138.00	25.53	25.53	112.47
3	6,575	6,530	0.883	5.4	565	5.77	33.78	65.75	203.75	35.26	60.79	142.96
4	6,850	6,830	0.315	6.1		2.15	35.93	68.50	272.25	41.66	102.45	169.80
5	6,675	6,675	0.314	6.6		2.10	38.03	66.75	339.00	44.06	146.51	192.49
6	6,525	6.875	0.237	6.6		1.63	39.66	65.25	404.25	45.38	191.89	212.36
Wash	-	19,050	0.058	-		1.10	40.76	-	-	-	-	-
Residue							11.11					

Total 51.87 = 0.486% calculated head

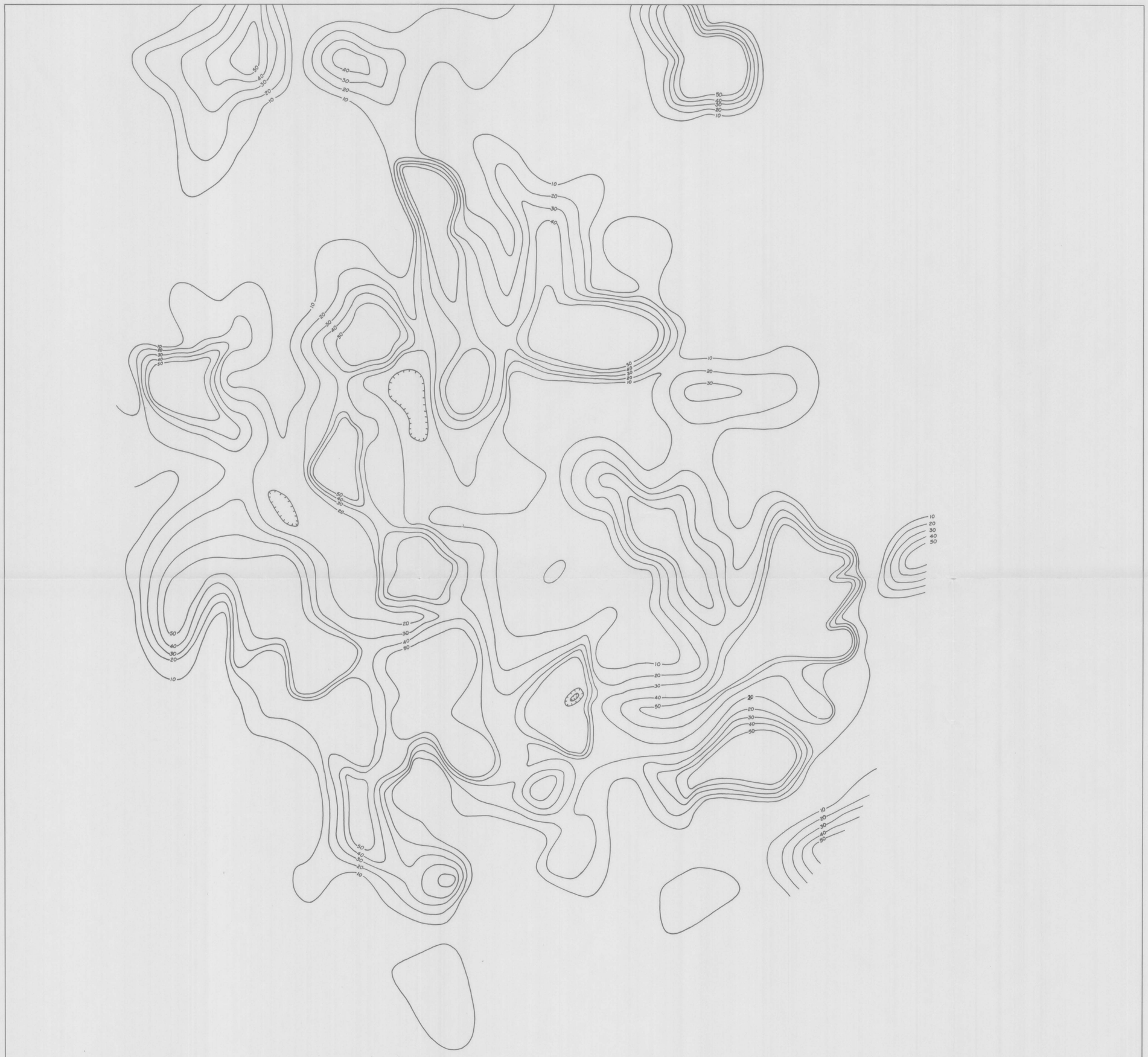
	Weight, g	
Feed, dry	10,667 =	46.93 g Cu at 0.442% total Cu
Residue, wet	11,472 =	8.6% H_2O
dry	10,484 =	1.7% weight loss at 0.106%

[1] 10.0 g H_2SO_4/liter



FRACTURES

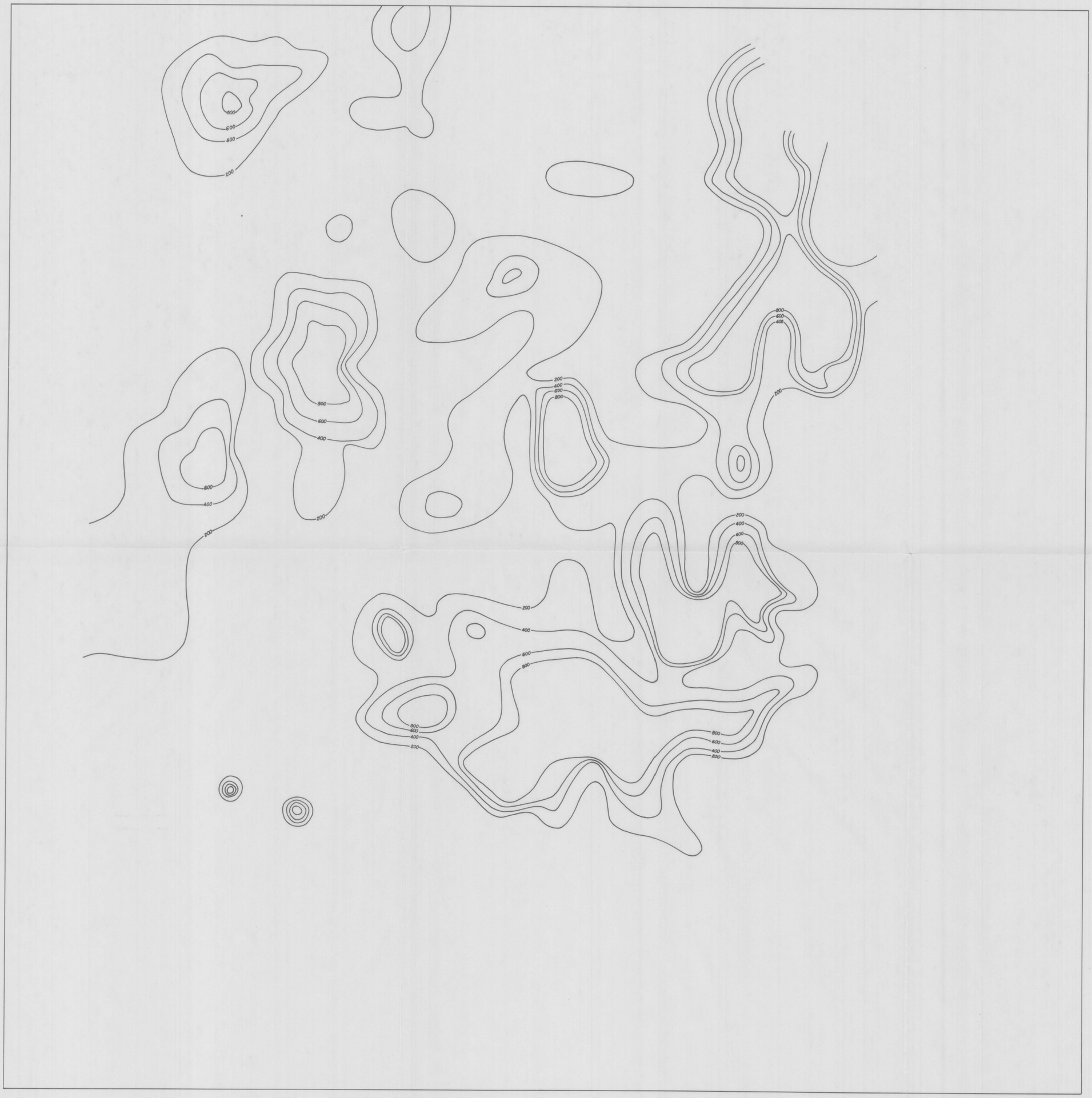
NDI MAMMOTH PROJECT - OVERSHEET NO. 1



GEOCHEMICAL DATA

MOLYBDENUM - PARTS PER MILLION

NDI MAMMOTH PROJECT - OVERSHEET NO. 2



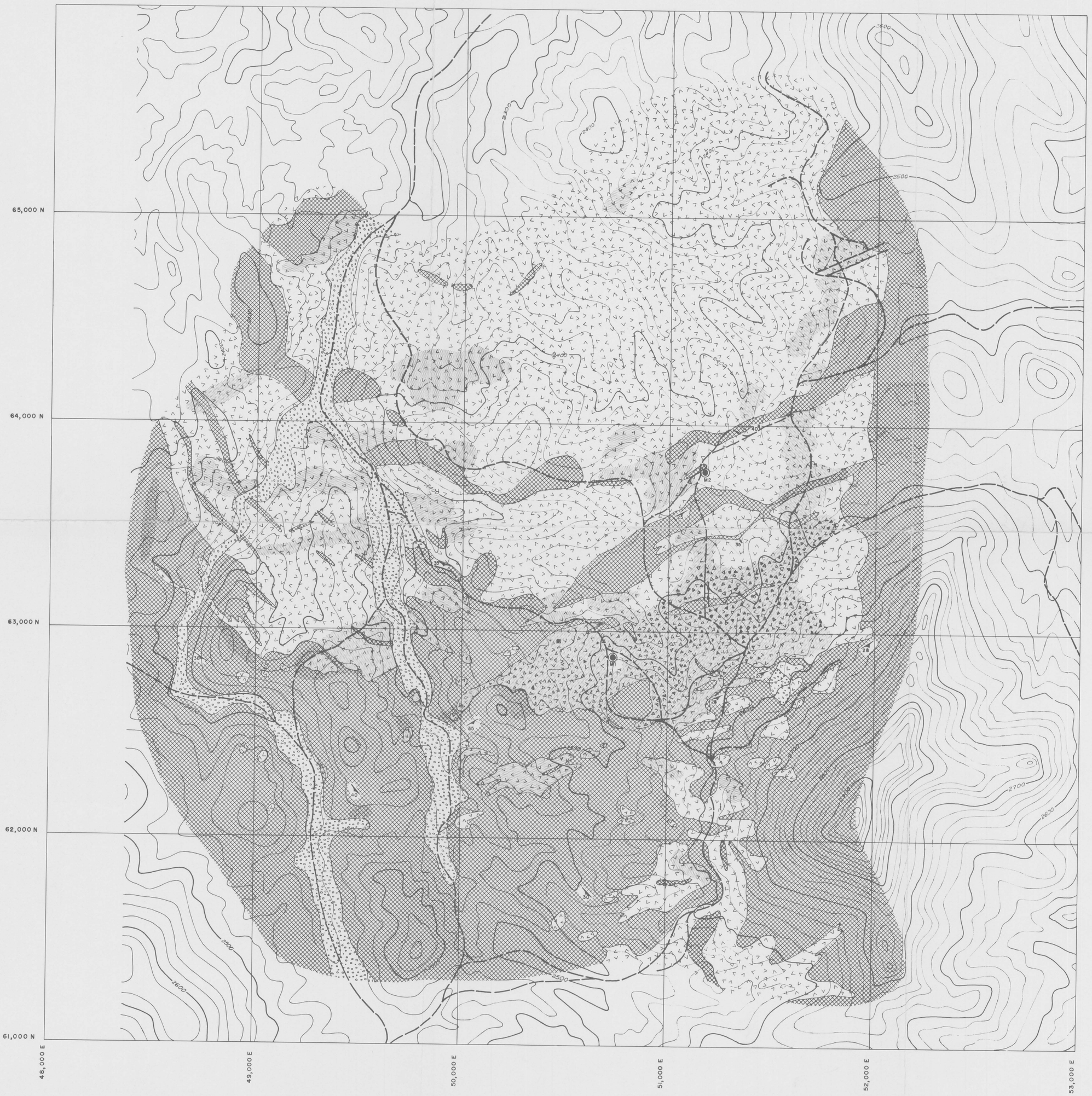
GEOCHEMICAL DATA

COPPER - PARTS PER MILLION

NDI MAMMOTH PROJECT - OVERSHEET NO. 3

SURFACE OCCURRENCES

C - COPPER
E - EPIDOTE



EXPLANATION

ROCK TYPES

ALLUVIUM (QUATERNARY)

RHYOLITE (TERTIARY)

GRANITE

BRECCIA ZONE (PRECAMBRIAN)

ALTERATION

SUPERGENE

STRUCTURAL

RHYOLITE FLOW BANDING ORIENTATION 85

DIKE ORIENTATION 60

CONTACT

ENGINEERING

TOPOGRAPHIC CONTOUR 2700

1/4 COR. SEC. 26|25

CULTURAL

SHAFT

DRILL HOLE

ROAD

NUCLEAR DYNAMICS, INC.

MAMMOTH PROJECT

SECTIONS 25 & 26; T.7 N., R.5 W.

MARICOPA COUNTY, ARIZONA

SURFACE GEOLOGY

0 200 400 600

CONTOUR INTERVAL 20 FEET

MAMMOTH COPPER PROSPECT
Maricopa County, Arizona

I saw this property several years ago. It has some of the earmarks of a porphyry copper, but Phelps-Dodge drilled several holes in 1966 and 1967 and dropped their option. As I remember, the 1845 foot PD hole did not encounter sulphides, or at least was mostly oxidized to the bottom. Since there are post-mineral & volcanic rocks over a portion of the area it is not without some prospecting interest, but I would assume PD made a pretty thorough study.

Phillips Petroleum drilled 25 shallow holes roughly on 200 foot centers and developed ~~approximately~~ 3 to 4 million tons at about 0.4 % oxide Copper. ~~and~~ Frank Canaday of Nuclear Dynamics, present holder of the property, thinks this oxide zone may be open to the southwest, although values appear spotty in this direction. The ~~oxide~~ zone of oxide mineralization has a maximum width of 400 feet, and has a vertical extent ~~of~~ from the surface in the western portion to 200 feet below the surface.

Canaday has information on the shallow drilling by Phillips in Phoenix, and I may have a look at it if I go through there in the near future. However, the oxide potential looks too low grade and small to be of interest, and the sulphide potential

may have been adequately tested by Phelps Dodge.

J. K. Jones
November 29, 1971

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