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[redacted] CORPORATION

A GEOLOGIC RECONNAISSANCE

of the

ARAVAIPA MINING DISTRICT
GRAHAM COUNTY, ARIZONA

for

JOSEPH MULLER CORPORATION ZURICH

JOB NO. 4268-1

MAY 3, 1968

PARSONS-JURDEN CORPORATION

A WHOLLY OWNED SUBSIDIARY OF THE RALPH M. PARSONS COMPANY
ENGINEERS-CONSTRUCTORS

PARSONS-JURDEN

NEW YORK

Parsons-Jurden Corporation

Engineers • Constructors

26 BROADWAY, NEW YORK 4, NEW YORK

May 3, 1968

Mr. Joseph Muller
Joseph Muller Corporation Zurich
Scheuchzerstrasse 7
Zurich, Switzerland.

SUBJECT: Job 4268-1 - Aravaipa Mining District
Geologic Reconnaissance

Dear Mr. Muller:

In accordance with our letter of agreement dated November 21, 1967, we are pleased to submit our report on the geologic reconnaissance of the Aravaipa Mining District.

In summary, it is our opinion that the large parcel of land held by your United States Mineral Property Corporation in the Aravaipa district contains at least two areas which are good mineral exploration targets. An exploration program of detailed geologic mapping, geochemical and petrographic studies, and ground geophysics should be carried out in these area. This should be followed by a diamond drilling program, the nature of which will be dictated by the results of the exploration work.

Parsons-Jurden Corporation take this opportunity of thanking you for the privilege of undertaking this work on your behalf.

Very truly yours,

PARSONS-JURDEN CORPORATION

By Blair W. Stewart

BWS:pb

Enclosure:
original and four copies

PARSONS

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SECTION A

SCOPE OF REPORT

As a result of a meeting between Joseph Muller, Ray W. Jenkins and Max J. Kennard in Zurich on November 20 and 21, 1967, Parsons-Jurden Corporation were asked to perform engineering services in connection with examination and development of certain mining properties near Klondyke in Graham County, Arizona.

During the period from November 27 to December 18, 1967, a preliminary investigation was made on which to base decisions for subsequent development of the property. The outline of work for the preliminary investigation was as follows:

1. Examine accessible mine workings and prospects to determine the reserves, if any, of either crude shipping ore or sulfide milling ore.

2. Investigate the possible use of the existing 100 ton mill at Klondyke in the event that ore reserves exist or can be developed.

3. Complete the investigation of titles to mineral properties covered by the agreement between Joseph Muller and FAR Mining Enterprises.

4. Provide guidance to FAR in carrying out claim staking and other work on the properties.

In mid-December a preliminary report was made to Mr. Muller which said that reserves of crude shipping ore were nil and that considerable exploration and development work would be necessary to prove any appreciable reserves of milling ore.

Following these initial findings it was agreed that the emphasis would be shifted from exploration and development of the known types of ore deposits in the district to a reconnaissance which would look for indications of a porphyry copper type deposit. This revised outline of work was then followed.

1. Geologic reconnaissance for porphyry copper indications.

2. Consolidate blocks of claims already held by FAR Mining Enterprises into one contiguous group by locating new claims and securing prospecting permits on State land.

3. Direct FAR Mining Enterprises personnel in carrying out discovery drilling and other work necessary to the project.

This report is concerned with the latter schedule of work which was begun in mid-December 1967. Early April 1968 was set as the completion date for the work.

It is our intention to deal only briefly with those geologic features which have already been discussed in detail in the available literature. Our emphasis is on certain features brought out by our reconnaissance study which

will contribute to the search for possible porphyry copper type exploration targets.

SECTION B

CONCLUSIONS AND RECOMMENDATIONS

Geologic reconnaissance of the approximately 11,000-acre block of mineral property has pointed out two areas which have good exploration possibilities. These areas, referred to as the north zone and the south zone, are discussed below.

North Zone

This area is outlined by the northeast structural trend which takes in the Paleozoic limestone block in which the Iron Cap ore body occurs and extends into the Goodman Canyon Quartz Monzonite. A hidden apophysis of intrusive is inferred to occur within this zone. Such an intrusive body would be an excellent exploration target. Evidence of this hidden intrusive includes:

1. The suggestion of a projection of Goodman Canyon Quartz Monzonite at the northeast corner of the map area. This is along the general direction of schistosity and bedding in the Pinal Schist and would be a likely path for an intrusive to follow.
2. Tactite development in the limestone of this zone, while not intense, is somewhat more than can be accounted for by the known rhyolite and latite dikes.
3. The ore mineral showings require a source other than the rhyolite and latite dikes.
4. A dome-like structure is suggested by the scattered Paleozoic outcrops around a central outcrop of Pinal Schist. This doming could be the result of, or favorable to, the emplacement of an intrusive body.

5. Magnetic anomaly "P" is interpreted as being due to a deep intrusive.

Recommendations - North Zone

An exploration program is recommended in the north zone. The target is a mineralized intrusive. Indications are that it is a deep target. A suggested program should include:

1. Detailed geologic mapping
2. Petrographic study -- geochemical sampling
3. Geophysics

Such a program would narrow down the rather broad zone to one or two prime target areas and a diamond drilling program could then be proposed.

In view of the nature of the target, it will probably be possible to test it with a minimum program of three 2,000-foot holes.

South Zone

This zone is shown by the faults bounding the projecting arm of Santa Teresa Granite intruded between Precambrian Laurel Canyon Granodiorite on the north and Precambrian Pinal Schist on the south. These faults strike northeast in the general direction of schistosity and bedding in the Pinal. There is a good possibility that the abrupt termination of the granite along the Grand Reef fault does not show the true extent of this projecting arm and that there are offshoots underlying the Horse Mountain Volcanics on the west (down-dropped) side of the Grand Reef fault.

The geologic evidence suggests that the stratigraphic throw on the Grand Reef fault is at least equal to the total thickness of Paleozoic strata, or something over 1,000 feet. Paleozoic strata may underlie the Horse Mountain Volcanics on the west side of the fault. The combination of Paleozoic carbonate rocks and buried intrusive give this zone a good exploration potential.

Magnetic anomalies G and H are reportedly due to polarization in Horse Mountain Volcanics but it is suggested here that a buried skarn could be in part responsible.

Recommendations - South Zone

An exploration program is recommended in the south zone whose target would be the Paleozoic carbonate rock-skarn section and related intrusive. Such a program should include:

1. Detailed geologic mapping
2. Geophysics

If the above provide some narrowing down of the zone to a reasonably well defined target area, it should be possible to test the target with one 2000-foot diamond drill hole.

SECTION C

PROGRAM OF WORK

The area held by Joseph Muller and FAR Mining Enterprises shown on the property map in the folder comprises approximately 11,000 acres. United States Mineral Property Corporation is owned by the Muller-FAR interests.

To carry out the geologic reconnaissance of this large area in as short a time as possible, black and white and color ektachrome aerial photographs at a scale of 1:24,000 were employed. This service was furnished by Geotronics of Monrovia, California. Charles L. Fair of Space Sensor Systems, Inc., Tucson, Arizona, was retained to prepare an areal and structural interpretation map from the color photographs. Heinrichs Geoexploration Company was retained to conduct an airborne magnetic survey of the area.

During the investigation, Fred Riebold of FAR Mining Enterprises furnished people from his organization to maintain roads, stake claims, drill discovery holes and otherwise help with the project under the direction of Parsons-Jurden Corporation. The Lenon Engineering Company of Patagonia, Arizona, was employed to stake 161 lode claims, using FAR people as helpers. Mr. Riebold also made additional acquisitions of patented and unpatented claims in order to secure control of nearly all the important mineral showings in the district.

On the initiative of Parsons-Jurden Corporation, 11 State of Arizona prospecting permits covering approximately 6,177 acres were secured for the client in order to consolidate the FAR acquisitions into one contiguous block.

Geologic field checks, examination of mines and prospects, and other mineral showings were made with the help of Hal Gardner, FAR geologist. Mr. Gardner had spent most of the summer of 1967 in the district and his knowledge of the various mineral showings was extremely helpful.

Parsons-Jurden field work was completed by the end of March, 1968. During April the field data were studied, maps prepared, and the report written.

LOCATION MAP

SECTION D

LOCATION AND EXTENT OF AREA

The Aravaipa Mining District lies along the western flank of the Santa Teresa - Turnbull Mountains in Southeastern Graham Country, Arizona. A post office and store exist in Klondyke, the historic center of activity for the district, but the nearest town offering general facilities is Safford, 50 miles to the east.

Access to the block of property held by United States Mineral Property Corporation is generally very easy by way of a well-maintained dirt road. Thorough coverage of the area for the purposes of this study required the use of four-wheel drive vehicles and a great deal of footwork over rugged terrain.

The U. S. Mineral Property Corporation have mineral rights on a block of land approximately two miles wide in an east-west direction and eight miles long in a north-south direction. This block covers most of the old mines and prospects in the Aravaipa mining district as well as an extensive area overlain by volcanics and gravel on the western edge of the district. (See property map in pocket).

Property acquired from American Zinc includes a 100-TPD mill at Klondyke along with water rights and a power line. (See report on mill in Appendix 2).

Mineral rights accrue from ownership of patented and unpatented lode claims, and State prospecting permits, as shown below.

Name	Type	No.	Approx. Acres
American Zinc	Pat. lode	29	580
Aravaipa Leasing	Pat. lode	7	140
Dowdle	Pat. lode	32	640
American Zinc	Unpat. lode	7	140
Gerstenberg	Unpat. lode	32	640
Botts	Unpat. lode	22	440
Bellman	Unpat. lode	25	500
U.S.M.P. Corp.	Unpat. lode	161	2,220
U.S.M.P. Corp.	State P.P.	11	6,200
		Total	11,500

Names of the above groups of claims (excepting U.S.M.P. Corp.) relate to ownership prior to acquisition by United States Mineral Property Corporation.

The property map which accompanies this report uses these same names to designate the various groups of claims, with the exception of the 7 Aravaipa Leasing claims which are included with American Zinc.

Although not included in this report, a listing of the various acquisitions which make up the 11,500 acre block has been prepared for Joseph Muller. This list shows the schedule of payments, dates and amounts of assessment work necessary to keep unpatented claims valid, State of Arizona prospecting permit requirements, and other pertinent data.

SECTION E

PHYSICAL FEATURES

The Santa Teresa-Turnbull mountain mass occupies a transition zone between the Plateau physiographic province of Northeastern Arizona and the Basin and Range province of Southwestern Arizona. The block of property under study here lies along the southwestern flank of the above mountain mass, just east of the valley of Aravaipa Creek. Relief on the property is moderate to rugged, with elevations ranging from about 3,500 feet in Section 31 (west of Laurel Canyon) to a little over 5,600 feet on Imperial Mountain.

The climate in this part of Arizona is warm and dry with hot summers and rather mild winters. This past winter was somewhat unusual inasmuch as three fairly heavy snowfalls occurred. Snow from the heavier fall remained on the ground, even at the lower elevations, for over a week.

Some of the higher slopes are covered with a dense growth of chaparral but, in general, it can be characterized as open country.

SECTION F

LITERATURE ON THE DISTRICT

Frank S. Simons' Geological Survey Professional Paper 461 "Geology of the Klondyke Quadrangle Graham and Pinal Counties Arizona" along with its geologic map, is the best available source of published geologic data on the district. It was studied extensively in carrying out the field work for the present report.

U. S. Bureau of Mines Report of Investigations, R.I. 4007, February 1947, "Aravaipa Lead-Zinc Deposits, Graham County, Arizona" describes a sampling and core drilling program undertaken by the Bureau.

U.S.G.S. Bulletin 763, "Geology and Ore Deposits of the Aravaipa and Stanley Mining Districts, Graham County, Arizona", by Clyde P. Ross is helpful in studying the old mines and prospects in the district. Because this bulletin may not be readily obtainable by the reader of this report, certain sections pertaining to ore deposits have been excerpted from Bulletin 763 and presented in the Appendix.

The Appendix also contains an excerpt from Arizona Bureau of Mines Bulletin 156, Arizona Zinc and Lead Deposits, E. D. Wilson, 1950.

SECTION G

SUMMARY OF GEOLOGY

Precambrian Pinal Schist, the oldest stratigraphic unit in the district, outcrops in the north-central and southern part of the map area. The former is the most extensive outcrop, covering something over a square mile in the Tule Canyon - Landsman Camp area. The lithologic character of the Pinal is diverse. Generally, the rocks are dark colored and granular, hornfels being more common than schist, as noted by Simons. In the color ektachrome photos, a number of color anomalies can be seen in this north-central outcrop of Pinal.

Pinal is intruded by a porphyritic granitic rock, rich in biotite and having a characteristic greenish-pink color in outcrop. This rock, which occupies the east-central portion of the map area, has been named Laurel Canyon Granodiorite by Simons. He assigns it to the Precambrian. One of the striking features of the granodiorite in the photos is the occurrence of rhyolite dike swarms which cut it and give it an almost banded appearance.

Bolsa quartzite, lying unconformably over schist and granodiorite, crops out in a series of scattered blocks in the northern part of the area. The distinctive pebble conglomerate forming the base of the Bolsa can be seen in a number of these outcrops.

Overlying these scattered exposures of Bolsa are some larger outcrops of Paleozoic carbonate rocks. Simons has separated them into Martin Formation,

Escabrosa Limestone, and Horquilla Limestone. His measurements of sections indicates possible 300 feet of Bolsa and a combined thickness of possibly 750 feet of carbonate rocks in the best exposures in the area.

Cretaceous Pinkard Formation (clastic sediments) rests unconformably on Horquilla Limestone east of the Iron Cap mine in the map area. A section can also be seen in the Iron Cap adit. In the latter case, the rock appears to have been derived in large part from volcanic material.

Tertiary Williamson Canyon and Horse Mountain Volcanics outcrop extensively in the eastern and northern part of the map area. These silicic to intermediate volcanics rest unconformably on all of the previously described older rocks in the north part of the map area. Along the Grand Reef fault, which bisects the southern two thirds of the map area, Horse Mountain Volcanics are in fault contact with the older rocks.

Tertiary Santa Teresa Granite outcrops along the southern and eastern part of the map area. The granite cuts both Laurel Canyon Granodiorite and Pinal Schist in this area. There is some evidence that dikes related to the granite cut Horse Mountain Volcanics, thus making the granite youngest of the igneous rocks in the immediate map area. The granite is generally medium grained, equigranular and light colored.

Although only a small amount of it shows on the map, a granitic rock somewhat different from Santa Teresa Granite outcrops to the northeast. Simons has designated this rock as Goodwin Canyon Quartz Monzonite.

The Santa Teresa Granite and Goodwin Canyon Quartz Monzonite are parts of the main batholith which forms the backbone of the Santa Teresa - Turnbull mountain ranges. Their relative ages within the Tertiary have not been established.

Gila type conglomerate of the Quaternary System outcrops along the southwest edge of the map area. This alluvium has been deeply dissected along Laurel Canyon, where terraces 100 feet or more above the present drainage can be seen.

SECTION H

STRUCTURES

Two dominant structural trends can be observed in the map area. The most obvious is the northwest trend shown by the Grand Reef fault and the rhyolite dikes in the nearby granodiorite. (See adjoining foldout.) Less obvious is the northeast trend shown by the granodiorite-granite contact in the southeast part of the map area and a similar series of lineations through the Landsman Camp - Tule Spring area. The northwest trend seems to be related to Tertiary tectonics while the northeast trends are probably related to Precambrian deformation. The northeast trend, while not so well defined, is believed to have provided an easy direction for the emplacement of Tertiary granitic rocks as evidence the arm of Santa Teresa granite abutting the Grand Reef structure south of the Laurel Canyon granodiorite mass. A similar projecting mass of Goodwin Canyon Quartz Monzonite in the northeast part of the map area suggests this same Precambrian grain. These two northeast trends are referred to hereafter as the north zone and the south zone.

The Grand Reef fault structure is worthy of further note here because of its striking features. It can be followed for at least five miles through the map area and a number of ore occurrences are known along it. In width, it measures from a few feet to over 100 feet and it is characterized by numerous zones of silicious breccia fragments cemented by quartz, specular

hematite and less commonly, fluorite. The Paleozoic section seen in the north central map area is presumed to be buried beneath Horse Mountain Volcanics on the down-dropped, west side of the Grand Reef fault. As pointed out by Simons, the minimum stratigraphic throw probably exceeds the entire thickness of the Paleozoic section; perhaps some 1000 feet.

Another structural feature is suggested in the north central map area where scattered blocks of Paleozoic rocks lie in a crude circle around an exposed core of Precambrian Pinal Schist, reflecting what may be a dome. This structure lies within the north zone.

SECTION J

MINES - ORE

A dozen or more small mines and prospects produced ores containing lead, zinc, copper, silver and gold during the period from 1870 into the 1950's from claims now held by United States Mineral Property Corporation. Included in their holdings is a 100 ton per day concentrator near Klondyke. (It is presently being fed zinc-copper ores trucked from the Moore shaft, Johnson Camp, Arizona.) The more promising of the old mines were examined to determine the reserves, if any, of sulfide milling or shipping ores. Mines examined with this in mind included the Iron Cap, Grand Central and Grand Reef.

The conclusions reached as a result of the above study conducted early in the present program, were as follows:

1. Reserves of accessible crude or shipping ore are nil.

2. Reserves of accessible sulfide milling ore in sight are insufficient to run the 100 ton concentrator.

3. Development work guided by geologic study and relatively shallow diamond drilling might stand a fair chance of finding extensions and/or repetitions of known ore bodies, but -

4. It is not likely that the economics of developing and mining such extensions or new ore bodies would be particularly attractive to a large mining company.

This last point is based upon an analysis of the known ore occurrences in the district. The ore bodies have been rather small and the tenor of the ores not particularly high.

SECTION K

THE DEPOSITS AS EXPLORATION GUIDES

Ore occurrences in the district may be of considerable importance as guides in a reconnaissance for possible porphyry copper exploration targets. The deposits fall into two general classes, fissure veins and replacements in limestone. The Grand Central and Iron Cap are examples of low angle fissure vein deposits. The Iron Cap also has some irregular replacement in limestone. The Grand Reef mine is a good example of a steeply dipping fissure vein deposit. Numerous minor occurrences of all three types can be seen in the district.

The overall pattern of these various showing of ore mineralization is most strikingly shown by an early day claim map of the area. The pattern of claims forms a letter 'Y' with the long axis inclined a little to the west of north. The 'Y' is about six miles in length and about three miles across the open part of the letter on the north end. Essentially, the Grand Reef fault forms the main stem of the 'Y' with the Grand Reef mine near the bottom. The left arm of the 'Y' is formed by the north-west trending fissures and replacement lodes represented by the Arizona Mine. The right arm of the 'Y' is less distinct (somewhat thickened) and it represents the various deposits from Tule Springs through the Iron Cap and Head Center mines.

The broad northeast structural trend described in Section H takes in practically all of the ore mineral showings in the open part of the 'Y' (north zone). The Grand Reef mine lies on a similar structural trend,

at the south end of the 'Y' (south zone). There is a suggestion here that the mass of Laurel Canyon Granodiorite may have acted as a buttress with a zone of weakness at its north and south boundaries.

The adjoining foldout sheet shows an inferred apophysis of porphyry underlying these two mineralized areas.

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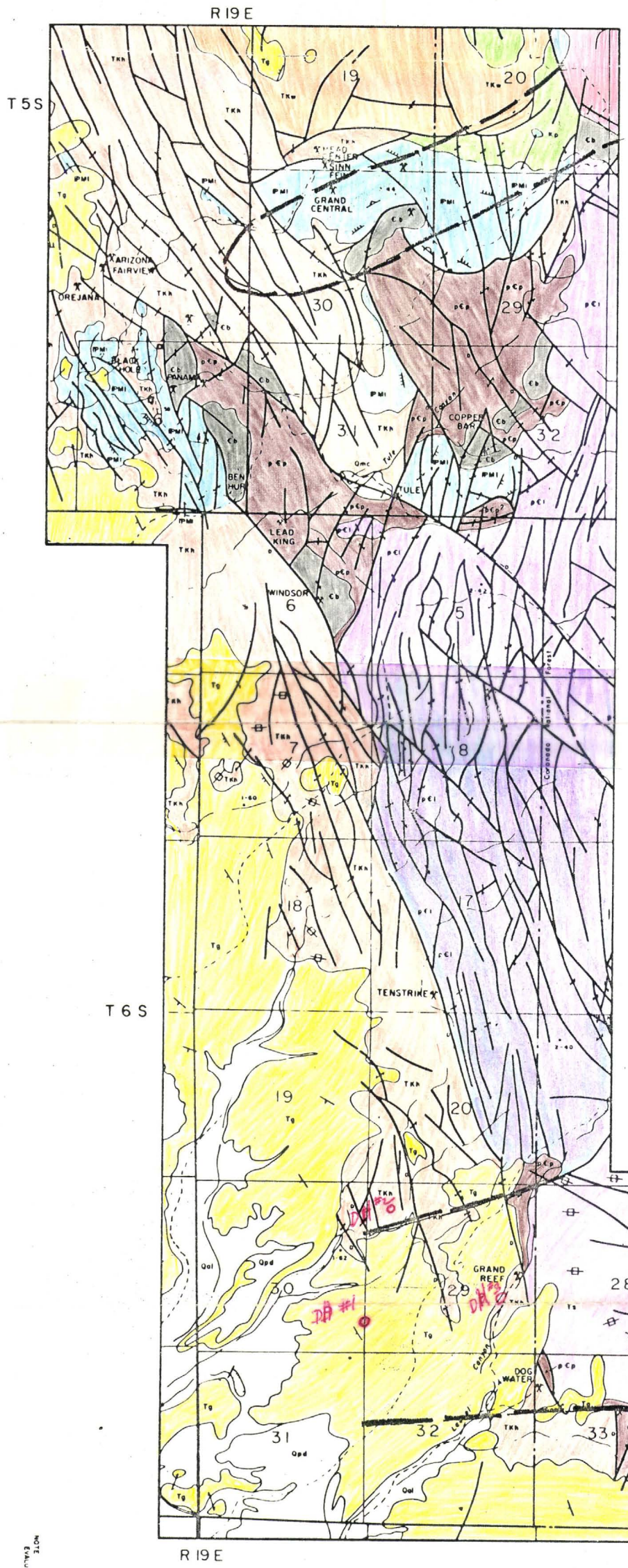


INFERRED HIDDEN INTRUSIVE BODIES

GEOLOGIC SYMBOLS

STRIKE AND DIP — DIP COMPONENT

- GROUP 1: 3 OR LESS
- GROUP 2: 3 TO 10
- GROUP 3: 10 TO 25
- GROUP 4: 25 TO 45
- GROUP 5: 45 TO VERTICAL
- BEDDING APPEARS VERTICAL
- OVERTURNED BEDDING
- BEDDING APPEARS HORIZONTAL
- LINEAR OUT CROP APPEARS HORIZONTAL
- FIELD OBSERVED
- AMOUNT OF DIP CANNOT BE ESTIMATED
- QUESTIONABLE
- JOINTS
- FAULT: DASHED WHERE APPROXIMATE; D INDICATES DOWNTHROWN SIDE
- FAULT: AND/OR DIKE
- THRUST FAULT: INDICATES UPPER PLATE
- FAULT WITH DOMINANTLY HORIZONTAL DISPLACEMENT
- ALIGNMENT: TOPOGRAPHIC OR VEGETATIONAL
- GEOLOGIC CONTACT: DASHED WHERE APPROXIMATELY LOCATED
- KEY BED
- INTERTONGUING CONTACT
- NOMENCLATURE OR FACIES CHANGE
- ANTICLINE: DASHED WHERE APPROXIMATELY LOCATED
- ANTICLINE: PROBABLE
- ANTICLINE: OVERTURNED
- SYNCLINE: DASHED WHERE APPROXIMATLY LOCATED
- SYNCLINE: PROBABLE
- SYNCLINE: OVERTURNED
- MONOCLINE
- STRUCTURAL TERRACE

CULTURAL & GEOGRAPHIC SYMBOLS

- INTERSTATE HIGHWAY DESIGNATION
- FEDERAL HIGHWAY DESIGNATION
- STATE AND COUNTY ROAD DESIGNATION
- PAVED ROAD
- MAINTAINED ROAD
- MINOR ROAD OR TRAIL
- RAILROAD
- ABANDONED RAILROAD
- DAM
- STREAM
- LAKE OR RESERVOIR
- TOWN
- PIPELINE
- PLAYA
- PICTURE CENTER
- 5-72 GROUP AND PICTURE NUMBER

LEGEND

QUATERNARY	Qal	Alluvium	Qmc Mantle cover
	Qpd	Pediment gravels	
	Qhw	Hillwash	
	Tg	Gila-type fanglomerates	
TERTIARY	Ts	Santa Teresa granite	Tgc Goodwin Canyon quartz monzonite
	TKh	Horse Mountain volcanics	
	TKw	Williamson Canyon volcanics	
CRETACEOUS	Kv	Undifferentiated volcanics	
	Kp	Pinkard fm	
PENNSYLVANIAN	IPh	Horquilla ls	IPMi undifferentiated
MISSISSIPPIAN	Mo	Escabrosa ls	
DEVONIAN	Dm	Martin fm (not identified)	
CAMBRIAN	Cb	Bolsa qtzite	
PRECAMBRIAN	pCl	Laurel Canyon granodiorite	
	pCp	Pinal schist	

N

SCALE

0 — 1/2 — 1 — 2 MILES

NOTE
EVALUATION CONDUCTED WITHOUT BENEFIT OF FIELD CHECK

PREPARED BY SPACE SENSOR SYSTEMS, INC. TUCSON, AR (CONT) MODELER: [illegible]

SCALE

THE RALPH M. PARSONS COMPANY
LOS ANGELES

DRAWING CODE 4268

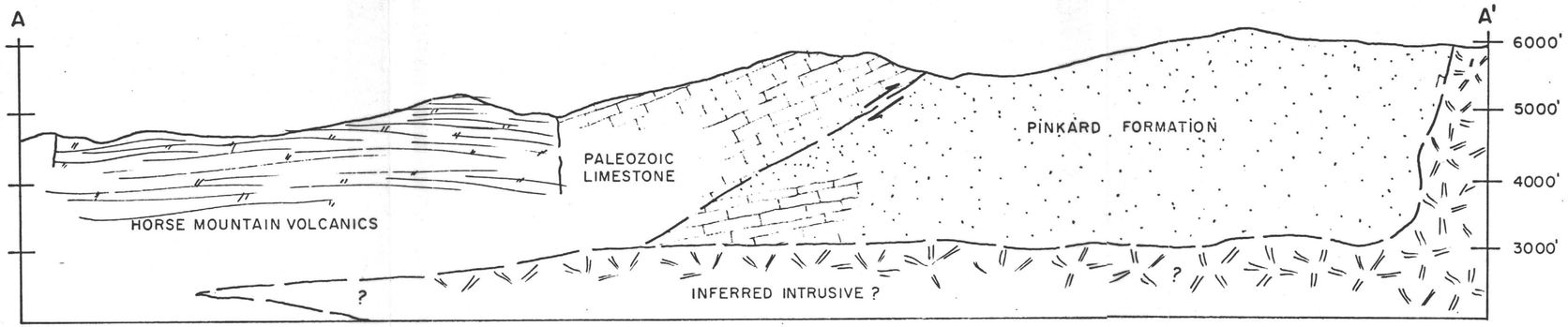
INFERRED HIDDEN INTRUSIVE BODIES

SECTION L

SOME UNUSUAL FEATURES

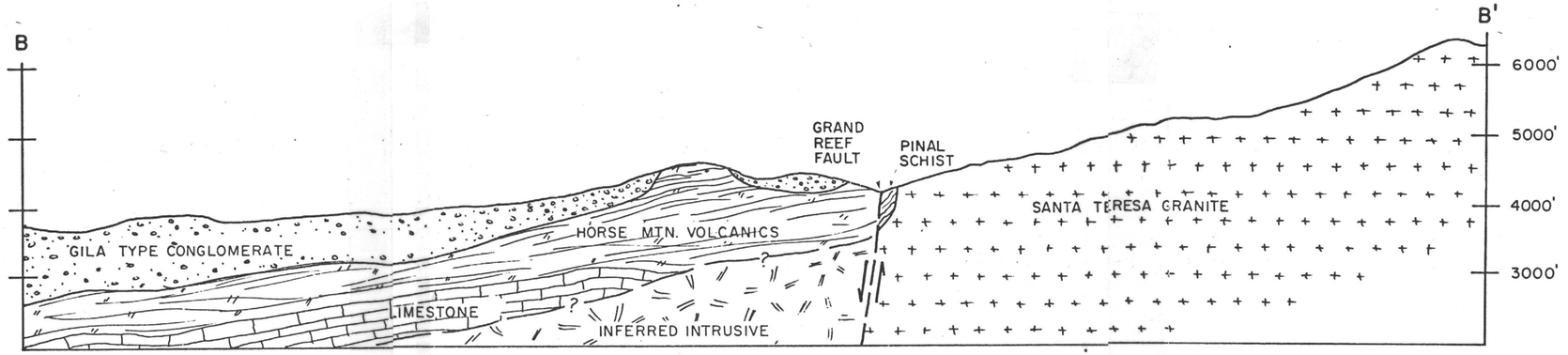
Spectacular exposures of fault breccia can be seen along the Grand Reef fault zone from Waterfall Canyon northward across the eastern flank of Imperial Mountain and then branching through the Tule Springs area; a distance of more than five miles. In many exposures, specular hematite is the conspicuous cementing material of the silicious breccia fragments. Where sulfide minerals have been introduced into the structure, fluorite and amethystine quartz are also common gangue minerals. Breccia reef structures occur in the northwestern area (the left arm of the 'Y') but specular hematite is much less common there. Some of the heavier concentrations of specularite are in the Waterfall Canyon area (south end of the Grand Reef fault) and in the Tule Spring area both of which areas fall within the northeast structural trends.

The Waterfall Canyon occurrence is adjacent to the arm of Santa Teresa granite which may have been the source of the specularite but the Tule Springs area is less easily explained. Ross describes specularite replacing magnetite in the Landsman Camp area, so it is possible that much of the widespread breccia reef specularite was originally magnetite. As a geologic thermometer, the specularite and/or magnetite suggests high temperatures and nearness to intrusive.



SECTION A-A'

PARALLEL TO NORTHEAST STRUCTURAL TREND
LOOKING NORTHWEST



SECTION B-B'

ACROSS GRAND REEF STRUCTURE
LOOKING NORTH

SCALE 1" = 1500'

MULLER (ARAVAIPA) PROJECT

SECTIONS A-A' & B-B'

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LOS ANGELES

4268

REV.

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RMP-315 REV. 2

Also suggestive of high temperatures are the zones of garnet and monoclinic pyroxene, Johannsenite, in the carbonate rocks of the Tule Springs - Iron Cap area. The rather small latite and other silicic dikes can account for some minor contact effects in this area but some of the larger occurrences of tactite are not easily explained.

There is a strong suggestion that an apophysis or satellite of the main batholith could underlie this area.

Lack of appreciable pyritization in an area which otherwise has a considerable showing of metallogenic mineralization is worth noting. As stated by Simons, "Although pyrite is present in every sulfide ore assemblage seen in the Klondyke region, in general it is not abundant." This may be directly related to the abundance of hypogene hematite which occurs as a gangue mineral in the veins and breccia reefs of the district. Hematite is also common as films and scales coating fractures in granodiorite granite, Pinal Schist, Horse Mountain Volcanics and other rocks near the main structural trends.

The adjoining foldout sheet shows vertical sections along the north and south zones with the inferred underlying intrusives.

SECTION M

COMMENTS ON MAGNETIC SURVEY

Heinrichs report on the aerial magnetic survey is presented as an appendix to our report. Their survey covers an area of approximately 128 square miles (see Magnetic and Interpretation Plan Map in folder), and goes considerably beyond the United States Mineral Property Corporation's property lines.

Nineteen specific anomalies or anomalous zones were interpreted within the area surveyed by Heinrichs and they considered seven of them to be worthy of further evaluation and examination. Based on our field study, we have the following comments on the seven anomalies.

Anomalies M, N, and O

Heinrichs interprets these as being of shallow depths and probably due to magnetite along the Goodman Canyon Quartz Monzonite contact.

Our field work included inspection of the areas covered by anomaly 'M' and anomaly 'N' and part of anomaly 'O'. We suggest some alternate interpretations as follows: Anomaly 'M' seems quite similar to anomaly 'E'. Both are over large outcrops of Pinal Schist and are probably the result of dark colored intrusives within this unit. Anomaly 'N' is in an area where limestone has been altered to calc-silicate rock and presumably some magnetite, but showings of ore mineralization are nil. Anomaly 'O' is over an area of

Pinkard Formation and Williamson Canyon Volcanics with no showings of mineralization. None of these three rather shallow anomalies would appear to be prime exploration targets.

Anomaly P

This anomaly which lies within the north zone is interpreted as possibly being due to an intrusive at depth. This is supported by the geologic evidence developed earlier in our report.

Anomaly Q

The source of this anomaly is reported to be very shallow. There are no mineral showings on the surface and we do not have any other geologic evidence to lend support to this area as an exploration target.

Anomaly J

Probably worth an I.P. line as recommended.

Anomalies G and H

We question this magnetic high as being entirely due to effects from Horse Mountain Volcanics. Similar rocks to the north do not look like this (magentically). Our geologic interpretation points toward limestone and possibly skarn in this area on the down dropped side of the Grand Reef fault.

APPENDIX 1

AERIAL MAGNETIC SURVEY OF A PORTION OF THE KLONDYKE MINING DISTRICT

GRAHAM COUNTY, ARIZONA

for

THE RALPH M. PARSONS COMPANY

April 1968

by

HEINRICHS GEOEXPLORATION COMPANY
P. O. Box 5671 Tucson, Arizona

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In Pocket:

One Composite Magnetic and Interpretation Plan Map

One Topographic Map

INTRODUCTION

During the period February 22, 1968 to March 12, 1968, Heinrichs Geoexploration Company of Tucson, Arizona conducted an aerial magnetic survey over a portion of the Aravaipa District, located in the western portion of Graham County, Arizona. The work was done at the request of The Ralph M. Parsons Company. The area flown consisted of approximately 128 square miles and lies between latitudes 32° 47'N to 33° 02'N and longitudes 110° 15'W to 110° 23'W.

The survey flight lines were run on a bearing of approximately N 15° W and S 15° E. Tie-lines were run at right angles to the main survey lines. A total of 27 lines and two tie-lines were flown for a total of approximately 470 line miles. The survey altitude was 500 ft. above terrain.

A Fairchild-Hiller Heli-porter turbo-prop aircraft with a Varian Model 4937-A Proton Precession, total intensity measuring magnetometer was used for this survey. Sensitivity of this instrument is +/- one gamma when used on the one cycle sample rate. Additional equipment included a ten inch rectilinear chart recorder to record magnetic data, a 35 mm camera, a Bonzer radar altimeter and associated recorder to monitor terrain clearance. Sensitivity of the radar altimeter is within +/- 1.0 percent at 500 ft. Flight line recovery was accomplished by correlating the 35 mm camera strips with high altitude photographs and then plotting the data on U.S.G.S. topographic maps.

The base map used for the contour-plan map was a blow-up of portions of the San Carlos Reservation, Klondyke and Jackson Mountain U.S.G.S. quadrangles which are at a scale of 1:62,500. Geologic correlation with magnetic features was by the geologic map supplied by the client and by the U.S.G.S. by F. S. Simons (1957-59) P.P. #461. The scale of the base map is 1:24,000. The total magnetic contour interval of the plan map is 20 gammas. Reduction and compilation of the magnetic data was done using a Univac 1108 computer. A regional gradient was removed by fitting a third order polynomial to the data. All data from the computer was then fed into a Benson & Lehner X-Y Plotter, which performed the actual contouring of the magnetic information as presented on the magnetic contour plan map.

The determination of anomaly depths was done using the Peter's half slope method with an index of 1.6. These depths are considered only approximate, but of sufficient accuracy for this stage of evaluation. As more information is obtained, these depths undoubtedly will be revised and refined. The precision of depth estimates will usually be better than +/- 50%.

An examination of the altimeter records showed that, generally the prescribed terrain clearance (500 ft.) was maintained within +/- 200 ft. The one exception to this is a portion of the north end of the area in which terrain clearance, because of high topographic relief, was as great as 1,500 ft. Because of the good terrain clearance control, topography did not have a significant effect on the observed magnetics.

CONCLUSIONS AND RECOMMENDATIONS

Broadly speaking, the magnetics and geology conform well with each other. Suspected down dropping of the area along Aravaipa Creek is inferred magnetically by fairly abrupt depth changes up to the order of 1,000 ft. plus. The geology suggests this and the magnetic data helps confirm it plus showing a definite lineation or boundary condition which coincides with the postulated fault line. Possible displacement aspects are not indicated magnetically except that the top of the volcanics are about 1,000 ft. to 1,500 ft. below surface.

Nineteen specific anomalies and/or anomalous zones have been interpreted within the specific Aravaipa Area. Of these, seven of the more interesting are considered worthy of further evaluation and examination. These are identified by alphabetical letters on the plan map.

Anomalous zones M, N and O lie along the contact of the Goodwin Canyon quartz monzonite, and are generally associated with or near exposures of undifferentiated limestones and the Pinkard Formation and possibly schist. The presence of magnetic anomalism in and near to these sediments is definitely interesting, as some have been locally good hosts for economic mineralization produced in the past. Because of the shallow depths to these anomalies they take on even more interest and therefore should certainly be further evaluated by geophysical and other appropriate methods.

Anomaly Q lies over a tongue of the Williamson Canyon volcanics between outcrops of undifferentiated limestones and the Pinkard Formation. The depth to the source of this anomaly is very shallow and may in fact extend down from the surface. This anomaly is likely due to variations within the volcanics. However, because of the close proximity to mineralization the feature could still be related to factors of economic importance. It is recommended that several rock samples be obtained from the volcanics and any other rocks exposed in the vicinity of the anomaly so that their magnetic susceptibilities may be obtained.

An evaluation of these susceptibilities should help determine the cause of the anomaly and advisability of any further work. If the anomaly is due to the Williamson Canyon volcanics, probably the presence of an intrusive at depth would be impossible to confirm by magnetics. Probably the best solution would be one or two induced polarization traverses across the anomaly which might indicate the presence of an intrusive and tell if sulfide mineralization is present.

Anomaly P probably is as much as 2,000 ft. below the surface and could be due to an igneous intrusive at depth. In view of this, the possibility of mineralization in or near the overlying sediments is considered good. Several lines of induced polarization (I.P.) are recommended to evaluate the potential of this anomaly.

Anomaly J, because of its close proximity to the Grand Reef fault system, is considered a target for further work. The depth to this feature is estimated at 400 ft. One or two I. P. lines are recommended across this feature.

Anomalies G and H are directly attributed to polarization and generally high magnetic susceptibility within the Horse Mountain volcanics. However, there is still definite indirect interest because of the related strong structural intersection nearby of the Grand Reef and Waterfall Canyon faults and the suggestion of continuation of the Grand Reef fault south of the Waterfall Canyon fault. If this fault does continue on to the south, the possibility of associated mineralization is considered good. A careful geologic examination to determine if the fault continues is recommended. Several east-west I. P. lines are also recommended to attempt to determine the existance of a fault and/or mineralization.

INTERPRETATION

The Aravaipa Area is characterized in general by a series of north-south to northwest-southwest to east-west trending magnetic lineations. These lineations seem to map the major fault structures through the area.

The area is divided roughly into two zones by characteristics of magnetic intensity. The greatest portion of the area lies east of Aravaipa Creek and is characterized by relatively near surface magnetic features. The western strip, which lies in the center of the Aravaipa Basin is rather smooth magnetically as would be expected over areas of deeper alluvial cover.

Within the eastern portion of the survey there are four major magnetic zones. The most pronounced of these has a total magnetic relief of 2,500 gammas and lies adjacent to the Grand Reef fault, in the Horse Mountain volcanics. The other three lie respectively; south of the Waterfall Canyon fault, in the Pinal schist; along the Tule Springs fault; and along the Cobre Grande and Landsman Camp fault.

Anomaly A is over an area covered by Quaternary alluvium and Gila fanglomerate. The source depth to this feature is on the order of 1,000 ft. and probably represents the top of volcanics underlying the surface exposed Gila fanglomerate.

Anomaly B lies approximately one-half mile west of the outcropping Buford Canyon volcanics. Assuming that they continue under the Gila fanglomerate, the anomaly, which is about 500 ft. below the surface, could be attributed to them.

Anomaly C. has a magnitude of 250 gammas and a source depth of about 1,000 ft. This is beyond the area covered by the areal geology map, but it may be related to northwest trending faults and contacts.

Anomaly D and E are a complex of several features which lie almost wholly within the Pinal schist. The anomalies, which are caused by at or very near surface effects, are probably explained by the diabase intrusives in the Pinal schist itself. The northern portion of the anomalism is very probably strongly influenced by the fault contact between Pinal schist and Santa Teresa granite.

Anomalies F, G and H all lie along a northerly trend which generally is bordered on the east by the Grand Reef fault, and the projection of it to the south. All of these features are at or very near surface and probably are caused by the locally exposed Horse Mountain volcanics. Several rock samples furnished by the client from the field have been run for magnetic susceptibility and are generally strongly polarized. Differences in susceptibility and degree of polarization within the various elements of the total volcanic sequence comprising one formation probably explains the different magnetic character which is observed over the Horse Mountain volcanic complex. Nothing in this either specifically confirms or refutes this area being substantially down dropped and/or otherwise importantly cross-faulted.

Anomaly I lies about two miles due west of Anomaly H in the Gila fanglomerate and alluvium. This feature is possibly caused by volcanics or other igneous material at a depth of 1,200 - 1,500 ft.

Anomaly J has a depth to source of approximately 400 ft. and is located in the Laural Canyon granodiorite.

Anomaly K consists of two north trending magnetic lows over the diabase intrusives in the Laurel Canyon granodiorite. These lows may be caused, at least in part, by reverse polarization in the diabase, although the anomaly appears to be fairly deep seated. Depth estimate reliability factors are not high and range from 1,500 ft. to 2,000 ft. maximum.

Anomaly L has a magnetic relief of 100 gammas and is situated near the contact between the Santa Teresa granite and the Laurel Canyon granodiorite. The depth to the source is estimated at approximately 250 ft. below surface.

Anomalies M, N and O all lie along the northwest trending contact between Goodwin Canyon quartz monzonite and the various rock types to the southwest. All of these features are near surface and probably related to concentrations of magnetite along the contact.

Anomaly P has an estimated source depth which may be as great as 2,000 ft. This feature is possibily caused by the presence of an intrusive body at depth.

Anomaly Q lies near the contact between the Williamson Canyon volcanics and the Pinkard formation. Depth estimates indicate that the source of anomalism is at the surface, which would limit it to the Williamson Canyon volcanics. Possibly this anomaly is due to polarization effects in the volcanics.

Anomaly R appears to be due to reverse polarization within the Goodwin Canyon quartz monzonite.

Anomaly S lies at the extreme northwest corner of the survey area. The depth to this anomaly is approximately 600 ft. This anomaly is out of the area covered by the areal geology map and no interpretation was made. A geologic check of this area is recommended.

Respectfully submitted,
HEINRICHS GEOEXPLORATION CO.

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W. E. Heinrichs, Jr.
President & General Manager

April 23, 1968

REFERENCE

Simons, S.F., 1964, Geology of the Klondyke Quadrangle Graham and Pinal Counties, Arizona. U.S. Geological Survey Prof. Paper 461, 171 p.

RESULTS OF SUSCEPTIBILITY MEASUREMENTS

The following table gives the measured magnetic susceptibilities of eleven rock samples from the Klondyke Mining District. Their location is shown on the Composite Magnetic and Interpretation Plan Map.

SAMPLE	ROCK TYPE	SUSCEPTIBILITY x 10^6 in c.g.s. units
1	Tkh	very strong & polarized
2	rhyolite	21,000 & polarized
2A	rhyolite	7,100
3	Tkh	41,000 & polarized
4	rhyolite	nil
5	granodiorite	nil
6	andesite	nil
7	altered limestone	nil
8	Tkh	nil
9	altered schist	6,800
10	tactite in limestone	nil
11	Bolsa Quartzite	nil

APPENDIX 2

REPORT ON 100-TPD MILL

AT

KLONDYKE, ARIZONA

FOR

JOSEPH MULLER CORPORATION

SAFFORD WEST PROJECT

Job No. 4268-1

December 13, 1967

SUMMARY

The 100-ton-per-day lead zinc mill at Klondyke is reported to have been built in 1947.

Owned by American Zinc, who purchased it from Athletic Mining Company, with their Aravaipa Group claims, it is presently under option to lease by W. Stauffer who operates it intermittently on a copper-zinc ore mined at Johnson Camp, Arizona.

This mill is included with the properties under negotiation for lease to FAR Mining Company.

The equipment is in good condition, and follows the classic circuit for selective flotation of lead and zinc sulfide ores. With minor modifications, it could process oxidized ores, and ultimately complex ores with slimes.

To duplicate existing mill equipment only on the used equipment market would cost approximately $42,000.00. Design and construction of a new 100T/day mill would cost in the range of $300,000.00 to $400,000.00.

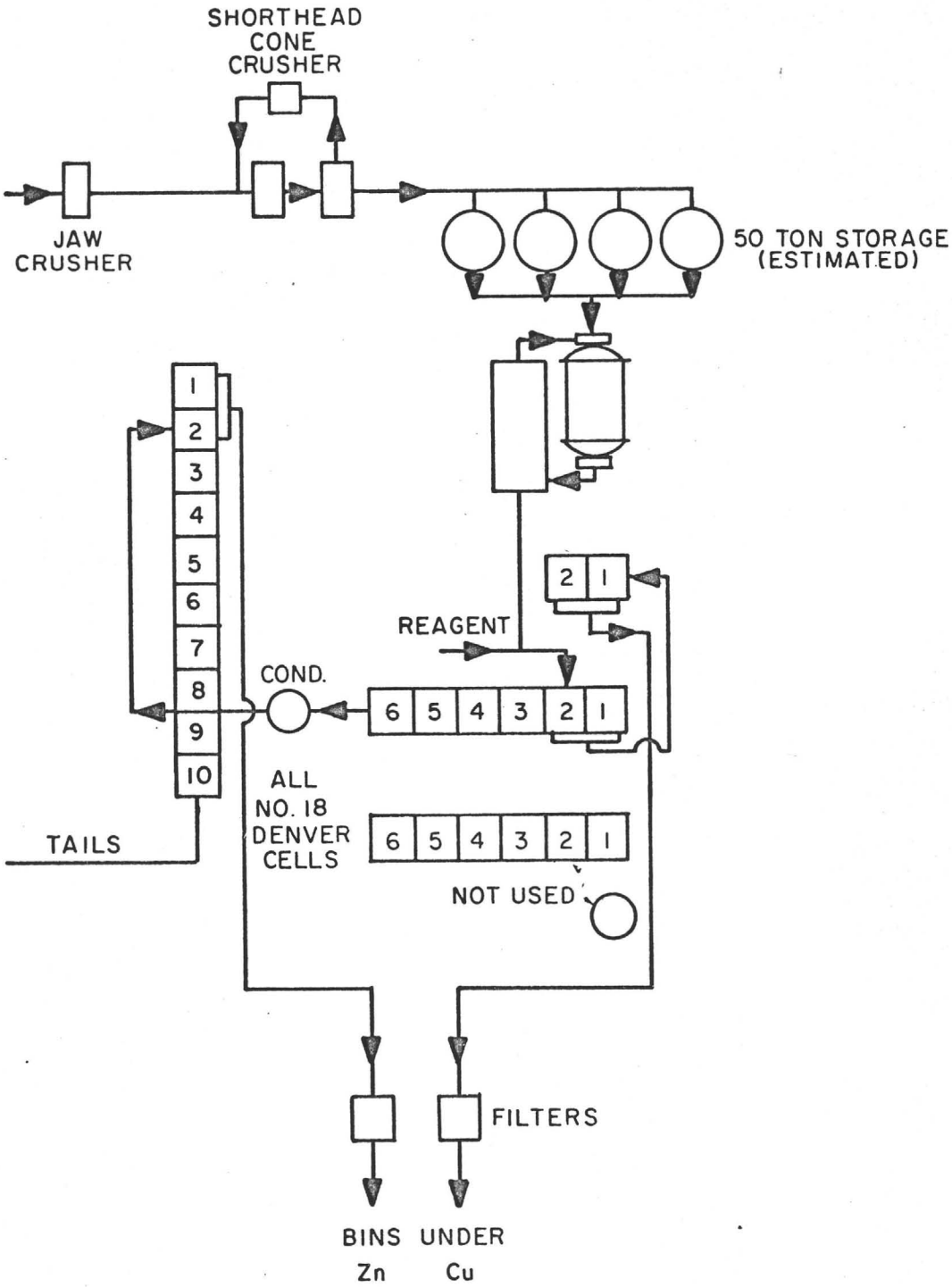
Although this mill is being operated as is, and is in good condition, there are three modifications which should be done before it is reactivated on a 24-hr./day basis.

1. Replace wood framing and support structure, belt conveyor from the primary crusher to the secondary crusher, and screen; order of magnitude cost: $7,000.00 to $10,000.00.

2. Increase raw crushed ore storage capacity to 100 tons; order of magnitude cost: $4,000.00 to $5,000.00.

3. Increase the electrical service to the plant to carry the full operating power load. Assuming power available in the valley, an order of magnitude cost of transformers and switch gear would be $5,000.00.

AS PRESENTLY IN USE ON COPPER - ZINC ORE



100 TON
KLONDYKE MILL

The 100-ton-per-day mill located at Klondyke, Arizona, is owned by American Zinc Company and would be included in the properties to be leased to FAR Mining Company by American Zinc.

It was reported by Mr. F. Riebold that the mill is currently under option to lease to an operator named W. Stauffer, who is mining a copper-zinc ore at Johnson Camp, Arizona, and trucking it to Klondyke for concentration prior to shipment to a smelter. The mill is only operating intermittently.

It was reported that the composition of the Stauffer mill feed is approximately:

2.5 % Cu (Copper)
7-8 % Zn (Zinc)
trace% Pb (Lead)

and that the concentrates shipped are 32% copper and 45% zinc.

A list of major mill equipment and a flow sheet are attached. Equipment sizes were estimated during a visit to the mill. At the time the mill was not in operation and no personnel were present. Some equipment specifications may be available at the Home Office of American Zinc.

It was reported in Bulletin 140, Arizona Bureau of Mines (1936) that this mill was built in 1947 after the Athletic Mining Company had bought the Aravaipa Group claims and developed the Iron Cap and Head Center mines. It operated throughout 1948 and part of 1949 on Iron Cap ores, and subsequently on other ores.

The Iron Cap ores consist essentially of sphalerite and galena, together with a little pyrite and chalcopyrite. Small amounts of chalcocite and covellite are present locally, but in general the ores are not oxidized to any important extent.

The mill circuit is essentially a classic circuit for the concentration of lead and zinc by selective flotation. As presently operated by Stauffer, copper is floated in four cells of one bank of six #18 Denver machines, the concentrate cleaned in the last two cells then recleaned in a separate two-bank unit. The tails from the copper float are conditioned prior to zinc flotation in a ten-cell bank of #18 Denver machines arranged for roughing, cleaning, and recleaning.

A second bank of six #18 Denver flotation machines is not presently in use, but could be reactivated.

Buildings on the property include the mill proper, with a small incompletely supplied laboratory and separate maintenance shop, and a separate combination storage building and garage. A third building was locked, preventing examination. There are about a dozen houses along the entrance road to the mill, most of which are in need of some repair.

Two tailings dumps from past operations are located to the left and right rear of the buildings. Estimates from the tailings dumps indicate that the mill has processed about 50,000 tons of ore. At various times operators have offered to purchase the tailings for reprocessing. Mr. Jim Malloy of FAR Mining Co. advised that one assay of the smaller of the two dumps reported:

5 %	Pb
1 %	Cu
7-8 %	Zn

A third tailings dump from the present operation has been started.

It is difficult to judge how many modifications have been made to the mill circuit over the years since its installation in 1947.

Operation of the plant in what might be considered a classic circuit for low slimes sphalerite galena lead-zinc ores, such as the Iron Cap ores are reported to have been, would be as follows:

1. Two-stage crushing (jaw and cone) to minus 3/4".
2. Ball milling in closed circuit with a single or two-cell float machine and a spiral classifier to obtain maximum recovery of the lead as soon as released.
3. Classifier overflow to the lead flotation circuit, zinc depressed.
4. Zinc flotation.
5. Separate filtration of the lead and zinc concentrates.

It has been noted that under certain conditions it is economically profitable to separate a lead-copper flotation concentrate by further selective flotation if the copper is over 0.8% in the ore.

The presence of a second bank of six #18 cells in the mill suggests that this might have been carried out in the past. It would be necessary to both explore the economics and run laboratory tests on ores intended to be mill feed if this were to be considered for future operations.

Basically the identical mill circuit could be used for oxidized lead-zinc ores such as carbonates. Two basic modifications would permit operation on sliming oxidized ores: (1) pre-conditioning the classifier overflow with sodium sulphide to sulphidize the lead minerals; (2) cyclone classification followed by hydroclassification of the tails from the lead float to remove slimes. The underflow from both classifiers would be the feed to zinc flotation.

The capacities of the crushing and grinding equipment (sizes as estimated and shown on attached Appendix "A") have been checked. The primary and secondary crushers (jaw and cone) can be operated at a 100-ton per 8-hour rate. The balance of the plant equipment would then operate at the 100-ton/24-hour rate.

It should be noted that final selection of the circuit should only be made after determination of the composition of the ore which will be the feed to the mill. However, it is possible to state that the mill as now constituted should be able to handle ores of the compositions reportedly available on the properties held by FAR Mining Co.

In order to establish a value on this mill for FAR Mining Co., the major equipment listed in Schedule "A" was submitted to an original equipment manufacturer and a used equipment dealer for budget pricing. It is interesting to note that the total used equipment price is less than one half that of the same equipment new.

Cost, used equipment ----------	$ 42,000.00
Cost, new equipment ----------	$ 94,700.00

The prices include motors, but in most cases not starting equipment; launders, piping, pumps, or reagent feeders are not included. The total cost of these items should not exceed 10% of the equipment cost, and the electrical starting gear 5%.

At the present time it would appear that the electrical service to the plant is insufficient, since the ball mill was being driven by a separate motor-generator set to supply power to the 60 HP motor.

An order of magnitude figure for complete design and construction from the ground up of a new 100-ton mill with the circuit and equipment installed in the present Klondyke Mill would be in the range of $300,000.00 to $400,000.00, without the personnel housing facilities.

There are several modifications to the 100-ton Klondyke Mill which should be made before it is reactivated for operation on a 24-hour/day, 300-day per year basis.

The first is primarily concerned with fire prevention and safety : replacement of the wood framing and support structure for the belt conveyor from the jaw crusher to the screens and cone crusher.

It would appear more practical and probably less expensive to consider replacement of the entire conveyor, support and screens with new package type units rather than attempt to build a new steel support frame and tear down and replace the existing framing, supports and screens.
Order of magnitude cost = $7,000.00 - $10,000.00.

The second concerns crushed raw ore storage : addition of approximately 50 tons of storage capacity, with necessary feeding equipment.
Order of magnitude cost = $4,000.00 - $5,000.00.

The third is to increase the electrical service at the mill to carry the present power load plus an allowance for future expansion. Present motor generator equipment can be maintained on standby basis.

Assuming that the power is available in the valley, and only transformers and switch gear are required, the order of magnitude cost would be $5,000.00.

Since the mill will be receiving ore from local mines which are part of the FAR Mining Group, and delivering concentrate to the nearest railroad siding 40 miles away, the present garage facilities should be enlarged to maintain all rolling equipment.

APPENDIX "A"

100-Ton Mill ---------- Klondyke, Arizona

		HP
1	- 15" x 24" Jaw Crusher	50
1	- 24" Symons Shorthead Cone Crusher	30
1	- 5' x 6' Ball Mill	60
1	- 36" x 24' Spiral Classifier	3
2	- 4' x 4' Agitated Conditioners	4
1	- 2-cell #18 Denver float machines	5
2	- 6-cell #18 Denver float machines	30
1	- 10-cell #18 Denver float machines	25
2	- 48" 2-disc filters	2
	Total Estimated HP	149

APPENDIX 3

GRAND REEF LODE SYSTEM

The following are excerpts from Ross, C. P., 1925, Geology and Ore Deposits of the Aravaipa and Stanley Mining Districts, Graham County, Arizona, United States Geological Survey Bulletin 763:

"On the west side of the Santa Teresa Mountains there is a group of lodes which, although differing in details, have sufficient characteristics in common to indicate that they are genetically related. The principal mineralization in all of them took place during the same period and under similar conditions. They thus form a single lode system. The largest of the lodes and the one on which most development work has been done is known as the Grand Reef, and the group as a whole may for convenience be designated the Grand Reef system.

The system extends from a point west of Buford Hill through Imperial Hill to Old Deer Creek, a distance of more than 11 miles in a straight line. The claim map (Pl.XI) serves to bring out the trend of the deposits in a general way, as the longer sides of many of the claims are approximately parallel to the strike of the lodes in them. The larger group of claims, however, have been laid out so as to cover a number of adjoining lodes, and the claims do not necessarily bear any relation to the strike. The Landsman claims cover contact-metamorphic deposits of irregular extent, which do not form part of the Grand Reef system. The deposits on the other claims shown on Plate XI probably all belong to this sytem. The strike of the system as a whole is about N.20°W. Most of the lodes strike somewhat west of north, but there is a considerable variation, especially near the ends of the system, and a few strike nearly east. Most of the lodes dip steeply west, and many are nearly vertical. A few dip east.

The width ranges from a few inches to 200 feet. The lodes clearly extend much deeper than development work has yet gone. Comparison with deposits of similar origin in other regions leads to the supposition that they may in places continue hundreds or even thousands of feet below the lowest points yet reached in the mines. Mineralized outcrops are by no means continuous throughout the 11 miles of extent of the system. It is probably not possible to trace any lode in the district continuously on the surface for much over a mile and most exposures are

far shorter than this. Underground the deposits would probably be found to be more continuous. It seems that at the Grand Reef mine and for several miles north of it the zone in which mineralization took place is narrow, although some of the individual lodes here are wider than any known in other parts of the system. In Imperial Hill several lodes are recognized. Beyond it the lode system spread out. To the northeast are those of the Aravaipa Mining Co. and the apparently less continuous deposits to the east of them. South of the Grand Reef a number of lodes are also known. The Dog Water and Silver Cable mines are clearly on separate lodes. East of these are still other lodes whose strikes diverge widely from that of the Grand Reef. Farther south are the La Clede and Silver Coin lodes, which are parallel to each other and strike approximately east. It may be noted that the portion of the Grand Reef system in which the zone of mineralization is narrow is entirely in the intrusive rhyolite near its contact with the granite of the main batholith. North and south of this locality, where there is a larger number of loes and greater divergence in strike, other rocks either form the wall rocks of the deposits or are near at hand. Perhaps the differences in strike of the fracture zones that contain the deposits bear some relation to the differences in the effects of pressure exerted on rocks of different types and powers of resistance.

The country rock at nearly all exposures has been brecciated and in many places has been intensely shattered. The deposits formed in the fracture zones have a composite character. They are made up in part of mineral matter introduced from without, in part of fractured and highly altered country rock which has been incorporated in them. They are termed lodes to distinguish them from veins formed essentially by the deposition of mineral matter as filling in fissures, with or without alteration of the wall rocks. The country rock of the lodes in the different parts of the Grand Reef system varies markedly in chemical composition and other characterstics, yet the chemical composition of all the lodes is in general similar, though local variations have been noted. The chemical composition of the lode matter also differs markedly from that of the unaltered country rock. For these reasons it seems clear that a large part of the mineral matter in the lodes has been introduced from some outside source. On the basis of the mass of evidence accumulated by the study of similar deposits in other regions by many geologists it can be affirmed with confidence that deposits exhibiting such mineral associations as those found in these lodes have derived part of the material composing them from igneous rock. It is highly probable that in this region the magma which formed the granite batholith was the source of mineralization. The contact-metamorhphic deposits and the copper deposits of

the Fisher prospect, which are even more intimately related to the intrusion, show conclusively that the valuable metals and most of the nonmetallic constituents of the lodes here described were present in the magma from which the granite consolidated. The processes by which the lodes were produced are outlined below. The molten mass that was intruded into the rocks of the crust to form the batholith contained besides the material that consolidated into granite considerable material that did not become solid under the conditions existing when the minerals of the granite crystallized. These volatile constituents were squeezed out of the rocks. The process was gradual, continuing throughout the period of consolidation of the batholith, which probably occupied a long time measured in terms of human experience. Part of the volatile constituents went to form the contact-metamorphic deposits and those represented by the Fisher prospect, both of which are described below. Part of them got farther from their sources and under the lower temperature and pressure there encountered became liquid solutions. The fracture zones on the west side of the Santa Teresa Mountains afforded convenient paths for the ascending solutions, and the deposits were consequently localized along these zones. The fractures may originally have been opened in the course of adjustments in the rocks brought about by the intrusion of the batholith. Movement recurred along them during the mineralization, as is abundantly shown by the brecciation and sheeting in the deposits. Emanations and solutions thus genetically related to igneous rocks are termed hypogene to distinguish them from descending waters containing matter dissolved out of rocks near the surface by processes of weathering, which are termed supergene. These terms are also applied to the deposits thus formed. The material of which the hypogene minerals in these lodes consist came in large part from the ascending solutions, but part of it came from the brecciated rock through which the solutions circulated and which they attacked chemically. The differences in mineral composition in the lodes in the various parts of the system result in part from differences in the composition of the rocks traversed by the solutions. The process of hypogene mineralization probably occupied a considerable time and appears to have been divided into several stages. With the possible exception of some of the minerals in the lodes in limestone the minerals are such as do not require very high temperature for their formation.

In most of the lodes of the Grand Reef system the gangue is quartz and fluorite. In lodes in and near the Tornado limestone chlorite, epidote, actinolite, and small amounts of specularite and calcite have also been found. The hypogene sulphides found are galena, sphalerite, pyrite, chalcopyrite, and argentite. Products of oxidation and secondary deposition from surficial water were noted in most of the deposits.

The dominant alteration in the country rock is silicification. The brecciated rock incorporated in the lodes is largely replaced by quartz and cut by numerous later stringers of the same mineral. Rock at some distance from the lodes is similarly affected but to a less degree. The feldspar of the igneous rocks near the lodes, especially the rhyolite and quartz latite in the vicinity of the Grand Reef and neighboring lodes, is sericitized, but in

general sericite is not much more abundant in rock near the lodes than in similar rock at a distance. It is noteworthy that primary ferromagnesian minerals are almost completely absent in the igneous rocks close to the lodes. They have broken down into chlorite and other alteration products.

Quartz is present in irregular masses and distinct veins in the lodes as well as in the replacement deposits already mentioned. The texture displayed by it is various. In the stopes above the adit in the Grand Reef mine gray chert is present in the breccia. On the 100-foot level are irregular masses of white and pink glassy quartz. In several places on this level and above there is medium-grained thin-banded quartz with narrow drusy cavities. Clear quartz forms only a small proportion of the parts of the Grand Reef lode seen during the present investigation, but in most of the other lodes it is more abundant. In some mines and prospects the deposits are essentially quartz veins. The wall rocks are altered and fractured, but fragments of them do not enter into the composition of the vein itself. The veins exposed in the Arizona and Orejana tunnels, near Arivaipa, are examples. In most such veins the quartz is thin banded and contains druses. The banding approximately parallels the sides of the vein and appears to have resulted from shearing of the quartz after deposition. The drusy openings common in the quartz appear to indicate that the pressure existing at the time of formation was moderate, as deposits formed under great pressure do not contain open cavities. This inference is also in accord with the probable depth of the parts of the lodes now exposed at the time mineralization commenced.

Fluorite is widespread in the Grand Reef mine. It has also been noted in some of the others and may be present in a number of places where it was not detected, as it is most inconspicuous. Clear, roughly cubical grains, visible only under the microscope, were found in quartz from the Grand Reef. In the breccia of this reef there are in places numerous small fragments composed of fine-grained fluorite that looks more like chert than like typical fluorite. A veinlet over half an inch wide of similar white fine-grained fluorite cuts galena in one of the Mountain Spring prospect tunnels. The fluorite is cut by tiny stringers of quartz. The veinlet is indistinctly banded by shearing, and the sides of the veinlet and sheared surfaces in it are coated by a thin film of some micaceous mineral.

Galena is as a rule the most abundant of the sulphides. It is of variable texture. Most specimens from the Grand Reef and neighboring lodes show considerable crushing. Specimens of galena from this and a number of other deposits when polished, etched with acid, and examined under the microscope are found to contain blebs of a mineral which appears to be argentite, the sulphide of silver. Probably most of the silver found by assay in the galena ore is in this form, and it is likely that most of the galena in the deposits of the Aravaipa-Stanley region contains argentite. Where exposed in the deposits on Imperial Hill and north of it the galena is coarse and shows little evidence of having been crushed. Sphalerite is associated with the galena in most places but in small amount. Only in the deposits on the north flank of Imperial Hill is it conspicuous. Pyrite is nowhere abundant and in

many specimens is absent. Chalcopyrite is of irregular distribution. It is present as microscopic blebs in some sphalerite grains and has also been noted in irregular masses and veinlets cutting galena. The records of the Aravaipa Leasing Company indicate an apparent increase with depth in the copper content of the ore in the Grand Reef mine."

CONTACT-METAMORPHIC DEPOSITS

"There are mineral deposits in nearly all the masses of Tornado limestone scattered over the region. Most of them have the characteristics of contact-metamorphic deposits and will be described in this section. These include the deposits on the Landsman property, at the Cobre Grande mine,and on Satisfaction, Packwood, Limestone, and Copper Reef mountains. Some deposits in limestone form parts of the Grand Reef lode system,already described. Even these have characteristics in common with the contact-metamorphic deposits and form connecting links between them and the lodes. A few deposits,such as those of the Starlight mine and southwest of Rawhide Mountain, are not known to contain contact-metamorphic minerals and are too greatly separated from the lodes of the Grand Reef system to be assigned to that system. When more is learned regarding these deposits it will probably be found that their mode of formation is similar to that of the lode system or the contact-metamorphic deposits. There are certain features of the Starlight mine, however, which suggest that there may be material differences between the method of formation of the deposits here and that of any of the others in the region. In the lack of fuller knowledge these deposits are discussed in the present section.

Contact metamorphism is a process of alteration by which changes are produced in rocks as a result of the intrusion of igneous magma into them. The changes are in part produced by the mechanical disturbance and heating of the rocks, but of much greater importance in connection with ore deposits are the chemical changes produced by the injection of hot fluids, probably largely gaseous, from the cooling magma. Calcareous rocks are affected to a much greater degree by such emanations than others, and ore deposits formed in this way are therefore more likely to be found in such rocks. The name contact metamorphism was given to the process because as a rule the rocks near the contact of the igneous mass that supplies the agents of metamorphism are most intensely altered by it. In many places, however, rocks at considerable distances from known masses of igneous rock show contact-metamorphic changes. It appears that under favorable conditions emanations from the magma can penetrate long distances into the surrounding rocks. The deposits typical of contact metamorphism are produced by rearrangement of the substances present and the introduction of others, forming a new set of minerals in rock already existing, rather than by the deposition of bodies of foreign mineral matter from solution along channels opened in the rocks, as in the vein deposits. The silicate minerals, such as garnet, epidote, and actinolite, are characteristic of contact-metamorphic deposits, although rare in mineral deposits of most other types. The iron oxide minerals magnetite and specularite, the crystalline form of hematite, are frequently found. Pyrite and chalcopyrite are among the common sulphides in such deposits. The texture of most of the deposits is coarse, and some minerals exhibit crystal form. The shape of the deposits depends partly on the ease

with which the different rocks that came within the influence of the emanations were attacked by them, and partly on the freedom of access from the igneous rock that was the source of supply. Slight differences in original composition may cause marked differences in the amount of metamorphism. In some deposits the shape can be seen to have resulted from selective replacement along beds of favorable composition. Other deposits have formed where fractures offered convenient paths for the emanations, and such deposits may be intermediate in character between those typical of contact metamorphism and veins.

The following general description and the accounts of individual deposits show that all the deposits in limestone, with such exceptions as have already been noted, are in form, texture, and mineral associations characteristic of contact-metamorphic deposits. They resemble in many respects the contact-metamorphic ore bodies of the Clifton-Morenci district [4] and are of about the same age. Some of them,like those at the Copper Reef mine, are at a distance from outcrops of granitic rock, but all of these are near felsitic porphyry dikes that may have contributed to their formation. Near some dikes there is notable contact metamorphism, and the dike rock itself is partly replaced, but near others there is little alteration in the adjacent limestone. There may be granite below the surface which is nearer to some of these deposits than can be determined from the outcrops of such rock.

The forms assumed by these deposits are various. Some representative ones are shown diagrammatically in Figure 1. In many deposits the replacement has been guided by the bedding planes in the limestone,and the original sedimentary structure is preserved in the metamorphic rock. Replacement may occur in a number of contiguous strata or may be approximately confined to a single bed. Locally fractures in the rock have furnished channels along which replacement has occurred. Replacement along fissures appears to have produced more irregular,smaller, and less continuous deposits than that along the bedding, but there may well be exceptions to this rule. Some of the deposits are most irregular in shape and are independent both of the bedding and of visible fractures. The larger deposits can be traced in places hundreds of feet laterally along the limestone beds. The transition into unaltered limestone is generally rather abrupt, although more gradual transitions were also noted. In places the major part of the limestone exposed over a considerable area has been altered, and there is a progressive decrease in the amount of limestone so affected at increasing distances from this area, although the replacement in the rock that has been affected may be as complete in one place as in the other. These deposits are so irregular in shape and have boundaries so indefinite that it is not safe to predict the continuation of a given deposit far in advance of actual exposures.

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[4] Lindgren, Waldemar. The copper deposits of the Clifton-Morenci district, Ariz.: U.S. Geol. Survey Prof. Paper 43, 1905.

The minerals noted in the deposits are quartz, garnet, actinolite, chlorite, epidote, fluorite, barite, calcite, specularite, magnetite, pyrite, chalcopyrite,sphalerite,galena, stibnite, and various oxidized minerals and secondary sulphides. Most of the galena contains tiny blebs that are probably argentite. The proportions of the minerals differ in different places, and in no single deposit have all the minerals listed above been found. Quartz is abundant in a number of exposures, but in some it is inconspicuous. It is clearly of two generations, both later than most of the metallic minerals. There are in a number of places drusy cavities lined with well-formed quartz crystals. The garnet resembles andradite, but its exact composition has not been determined. It occurs in massive form and in crystals projecting into cavities. The quantity of garnet in most of the ore deposits is small, and in many none was found. In the contact-metamorphic rock of Crystal Peak garnet is abundant. Actinolite is locally prominent in masses composed of groups of needles radiating in all directions from common centers. Chlorite is found in masses of flakes of various sizes but is not a conspicuous constituent in much of the ore. Epidote forms small groups of crystals but is nowhere very abundant. It is associated with garnet in most specimens in which it has been identified. Fluorite was found in the deposits on the Landsman property. Crystals of it nestle among the quartz prisms in druses, and it was also noted in massive quartz veinlets. Calcite is present in many of the deposits but everywhere in small amount. Barite was noted only in specimens from the Copper Reef mine.

Specularite and magnetite occur in all the deposits seen. In most specimens the former is the more abundant. The relations of these two minerals to each other are complicated and present many features of interest. Each may replace the other, and it is evident that this reversible chemical process has taken place in both directions in the deposits of this region. In specimens from the Landsman property magnetite that was formed early in the process of mineralization has been extensively replaced by specularite. Small rounded grains of magnetite penetrated along octahedral partings by specularite and surrounded by that mineral can still be found. Such relations clearly indicate that the specularite has formed at the expense of the magnetite. The specularite inclosing such residual magnetite grains is irregular in outline, but crystal plates of the mineral project from it into the quartz gangue, in which numerous well-formed specularite plates are embedded. The long axes of the plates have a subparallel arrangement strongly suggestive of flowage. It seems that the specularite formed from the magnetite had so strong a tendency to crystallize that it assumed the plate form characteristic of the mineral. Evidently this took place before complete consolidation of the quartz in which the iron minerals are embedded, for the plates could not have been rearranged along lines of flowage if they had been inclosed in solid material. However, the specularite tends to segregate along lines around quartz grains, proving that part of the quartz had already crystallized before the specularite assumed its present arrangement. These plates are themselves embedded in quartz, which crystallized after they did. Some of the specularite may have originally crystallized as such instead of being derived from magnetite.

Some specimens from the Cobre Grande mine show entirely different conditions. Here there are grains that are composed of magnetite but have the crystal form of specularite. These are clearly pseudomorphs produced by the conversion of original specularite into magnetite. In specimens from the same deposit there are foils of micaceous specularite containing small amounts of magnetite. All the specimens of black iron ore from various parts of the region that have been tested contain both specularite and magnetite, but the visible crystal forms in all of them are those of specularite.

Pyrite is abundant in many specimens of ore. It was one of the first sulphides to form and crystallized in more or less cubical grains, which were later broken apart, shattered, and embedded in gangue minerals or chalcopyrite that subsequently consolidated. Only small quantities of chalcopyrite were noted in any of the deposits except at the Cobre Grande mine. In some of the specimens from this mine the mineral is abundant in structureless masses inclosing pyrite grains. Some specimens contain a few small grains that appear to be sphalerite and galena, but both these minerals are rare in all the contact-metamorphic deposits visited. A few small crystals of stibnite were found in ore specimens from the Cold Spring prospect, but the mineral was not observed elsewhere, and tests on ore specimens from other deposits failed to reveal any antimony.

The distribution of the different minerals within the contact-metamorphic deposits is variable. In places one of the nonvaluable minerals is the most abundant constituent, in others another. Parts of some deposits contain so high a percentage of magnetite and specularite as to constitute iron ore, which might be utilized if it were found in sufficient quantity and if a suitable market for such material were sufficiently convenient. Under present conditions iron ore in this region is of little value. The metallic sulphides are of particularly irregular distribution and make up only a small part of the exposed contact-metamorphic deposits. This is strikingly shown on Crystal Peak, were thousands of tons of intensely contact-metamorphosed limestone is exposed. The only prospect known here is at Cold Spring, on the edge of the contact-metamorphosed mass, and the development work at this prospect appears to have discovered little of value. Elsewhere on Crystal Peak no sulphides or evidences of their former presence appear to have been found. The distribution of minerals in such deposits and the shape and size of the deposits themselves are so diverse that prospecting in them presents even more uncertainties than in veins, but valuable ore bodies occur in other regions under conditions similar to those which exist here, and small amounts of copper ore have been found in contact-metamorphic deposits in so many places in this region as to encourage the hope that deposits of sufficient size and grade to be commercially valuable may be present in the Aravaipa-Stanley region.

As has been mentioned, the Starlight mine presents some features of interest. The rocks in the vicinity of the mine comprise the Tornado limestone, Cambrian quartzite, pre-Cambrian schist, and an altered intrusive rock. The Paleozoic strata are fractured, tilted, and even in part overturned. Schist

is exposed under these rocks in Godless Gulch. Just east of the mine is the altered igneous rock, a dark-green fine-grained rock having the composition of an altered soda-rich granodiorite or soda granite that originally consisted of micrographic intergrowths of quartz, alkali feldspar, and plagioclase, and also presumably ferromagnesian minerals, although none now remain. The alteration of this rock produced chlorite, epidote, calcite, and secondary quartz and was probably effected under the influence of moderately heated solutions that seeped up through the rock from below. Some of the original minerals broke down and formed new combinations, and some water, carbon dioxide, and perhaps other things were added. Although the appearance and mineral composition have changed notably, the chemical composition may not be much different from that of the original rock. Such alteration differs markedly from that produced by contact metamorphism. This fact, coupled with the apparent lack of contact-metamorphic minerals in the ore, makes it appear that the deposits of the Starlight mine, may differ in origin from most of the ore deposits in limestone in the region.

MINES AND PROSPECTS

Aravaipa Leasing Company

PROPERTY - The Aravaipa Leasing Company, of Boston, Massachusetts, owns the Grand Reef mine, the principal producer of lead-silver ore in the Aravaipa district, and several smaller mines and prospects. The mill and principal workings of this company are in Laurel Canyon, on the west flank of the Santa Teresa Mountains, about 3-1/2 miles from Klondyke, the supply point for the vicinity. The property comprises seven patented and eighteen unpatented claims stretching north and south from the main camp. Their location is shown on Plage XI. There are also two mill-site claims in Laurel Canyon, and 160 acres of land in Arivaipa Valley. Thomas Finnegan has one-third interest in one of the unpatented claims. In Laurel Canyon there are a small ore-dressing mill, now partly dismantled, a blacksmith shop, an engine house, a boarding house, a school, and other buildings. In Silver Cable Canyon, half a mile to the south, there are also small buildings.

The deposits have been prospected by means of a number of tunnels, pits, and small shafts. The principal workings are in the Grand Reef claim, in Laurel Canyon, the Dogwater and Silver Cable claims, in Silver Cable Canyon, and the Aravaipa claim, 1-1/2 miles north of the main camp. The Grand Reef workings consist of an adit some 1,400 feet long, with crosscuts off it and stopes above it, a winze extending 300 feet below the adit level, and levels leading off from the qinze at intervals of 100 feet below the adit, making a total of over 4,000 feet. The principal workings are shown in Figure 3. On the top of the ridge on the north side of Laurel Canyon is a shallow shaft, known as No. 4 shaft, not shown in the sketches. On the Mountain Spring claim there are two short tunnels. On the Silver Cable claim is a tunnel a few hundred feet long with stopes above. On the Dogwater claim is a tunnel about 140 feet long, a little over 100 feet from the mouth is a stope that extends up to the surface, and just beyond is a short winze off which a little work has been done. (See figure 4.) On the Aravaipa claim is a shaft somewhat less than 100 feet deep off which about 500 feet of drifting and some stoping has been done. These workings are shown in Figure 5. They connect underground with workings on the Tenstrike group, and

such data as are available regarding the mineralization at the Aravaipa mine are given in the description of the Tenstrike mine.

HISTORY [5] - The principal claims of the group were purchased by John W. Mackay from the locators in the nineties. He carried development at the Grand Reef to a depth of 300 feet, did considerable other work on the property, and planned extensive exploration, which was terminated by his death in 1902. No further work was done until 1915, when a lease was obtained by local people, who erected a small mill and shipped most of the ore and concentrates that had been produced from the property. After about four years of activity their operations ceased because of litigation, in June, 1919. At this time the property was taken over by the Aravaipa Leasing Company, first under lease and later by purchase. In 1919 and 1920 this company unwatered the Grand Reef mine, sampled it, did considerable exploration work on this and on other properties in the district, and mined, concentrated, and shipped some ore. The major efforts of the company during this period were directed rather to exploration than to mining ore; consequently the total of the shipments, as shown in the table below, was not large.

The company suspended operations late in 1920, and the mines were closed down and left in charge of a watchman early in 1921. The shutdown was the result of general business conditions in the United States, which, in the opinion of the company's officials, made it inadvisable to continue work. It is expected that operations will be resumed when conditions become more favorable.

PRODUCTION - If any ore shipments were made prior to 1915, no records of them are now available. Below is given a table showing the amount of ore and concentrates shipped from the several mines of the group from 1915 to 1920. The table is compiled from data assembled by C. E. Minor from the records of the Aravaipa Leasing Company. It has been estimated that the total ore mined is about 30,000 tons [6]. This small tonnage by no means represents the capacity of the mine, for no systematic campaign of development and mining backed by adequate capital has yet been undertaken. It is to be hoped that as soon as favorable business conditions return the present owners will continue their development of the property and give the mine a thorough test.

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[5] Most of this section is based on notes by C. E. Minor, who was superintendent in 1920 and 1921 at the Grand Reef for the Aravaipa Leasing Company.

[6] Weed, W. H., Mines Handbook, Vol. 15, p. 197, 1922.

ORE AND CONCENTRATES SHIPPED FROM THE GRAND REEF GROUP, 1915-1920, IN DRY TONS

Year	Ore from Grand Reef Mine	Mixed ore from Grand Reef, Aravaipa, and Dogwater Mines	Concentrate		
			Grand Reef Mine	Aravaipa Mine	Dogwater Mine
1915	61	-------	110	-------	-------
1916	247	-------	392	-------	-------
1917	423	-------	841	-------	-------
1918	341	-------	885	-------	-------
1919	242	-------	385	-------	-------
1920	75	117	-------	89	160
	1,389	117	2,613	89	160

Total ore, 1,506 tons; total concentrate, 2,862 tons.

CHARACTER OF THE DEPOSITS - The Grand Reef mine takes its name from the remarkable outcrop of the lode. In Laurel Canyon, where the reef is most prominently exposed, it is indeed a grand and impressive sight. It is a great mass of iron-stained rock composed of brecciated and silicified igneous rock and vein material cemented with quartz and other vein minerals. Plate X gives some idea of the way in which it towers above the softer rocks on either side of it. The exposure of the reef along the stream bed in Laurel Canyon is 200 feet wide. This is about the maximum width, but the outcrop is over 100 feet wide for a considerable distance on either side of the stream. The average strike is approximately N.12 degrees W., and the dip ranges from about 70 degrees W. to vertical. To the south, the reef splits up into several smaller and less conspicuous lodes. The Mountain Spring, Silver Cable, and Dogwater mines and prospects are on such extensions of the main reef. Southeast of these there is a group of four claims on similar deposits. The country rock of the Grand Reef and the deposits near it belongs for the most part to what has been here termed the intrusive rhyolite. Some of it has the composition of quartz latite and is very fine grained. The rock near the lodes, especially west of the main reef, is sufficiently altered to make accurate determination of its original characteristics difficult. Just east of the Grand Reef is the granite of the main batholith, which here clearly intrudes the rhyolite porphyry. The porphyry east of the reef seems coarser and is somewhat darker than that west of it, but this difference is thought to have resulted from differences in hydrothermal alteration. On the 300-foot level of the Grand Reef mine just east of the footwall of the lode diabase is reported [7] to have been encountered. A short distance farther

[7] Wentworth, H. A., letter of Feb. 2, 1923

east the diabase is in contact with granite. The contact strikes approximately parallel to the vein and dips 70 degrees W.

The adit level, parts of the stopes above it, the first 100 feet of the winze, and part of the 100-foot level were the only portions of the Grand Reef mine accessible at the time of visit. Water stood in the winze 30 or 40 feet below the 100-foot level, but at most seasons the water is reported to stand above that level.

The following data regarding the ore shoots are abstracted from records furnished by H. A. Wentworth, the president of the Aravaipa Leasing Company. The principal known ore shoot is the one in which the winze is sunk. Stoping has been done on this shoot from the adit level up into the portion of the reef that projects above the surface of the ground, and ore has been found vertically below these stopes as far as development has gone. On the adit level the ore shoot has a stope length of more than 120 feet and a width ranging from 15 feet to considerably more than 30 feet.

Besides the principal ore shoot described above, several smaller ones have been found. West of the principal shoot and separated from it by about 10 feet of barren material is the hanging-wall or No. 3 ore shoot. It has been stoped and back-filled from the adit level down about 30 feet and up nearly to the surface; the stope length is about 60 feet and the width of the shoot about 3 feet. The outcrop above this stope shows mineralization. No. 4 shoot is developed by a shallow shaft on the top of the ridge 600 feet north of the Dey stope, and what is believed by company officials to be the same shoot has been encountered at the adit level vertically below this shaft. Ore is also reported to have been found in the adit north of this shoot. On the 200-foot level a body of soft ore was encountered south of the main ore shoot.

Most of the ore mined in the Grand Reef mine has come from the stopes in the principal ore shoot and the hanging-wall shoot above the adit level, so that the table below showing the average content of the crude ore shipped will serve to give an idea of the character of the ore of shipping grade found in the upper 200 feet of these shoots.

ASSAYS OF CRUDE ORE SHIPPED FROM GRAND REEF MINE, 1915-1920

Year	Ore (dry tons)	Gold* (ounce per ton)	Silver (ounces per ton)m	Lead (per cent	Copper (per cent)	Insoluble (per cent)	Iron (per cent)	Lime* (per cent)	Zinc* (per cent)	Sulphur (percent)
1915	61	0.01	17.3	52.9	2.06	20.3	1.2	4.7	1.7	6.5
1916	247	.01	19.2	46.1	2.12	21.3	2.8	3.5	1.9	5.8
1917	423	.01	23.9	40.4	3.21	37.4	3.0	2.2	1.8	7.4
1918	341	.01	21.9	40.3	2.85	32.0	1.9	4.5	1.2	6.6
1919	242	----	13.4	34.8	3.56	36.9	2.2	3.0	.9	5.5
1920	75	----	15.4	37.0	1.15	33.9	1.8	.9	.6	4.3
	1.389	.01	20.0	40.9	2.83	32.3	2.4	3.1	1.4	6.4

* Not reported in all assays.

A large part of the ore is of sufficiently low grade to require concentration before shipping. The company estimates that it has 90,000 tons of ore reserves.[8] The computations of the company's engineers[9] indicate that the ore in No. 1 shoot between the adit and 100-foot levels, estimated to be 43,000 tons, averages 7.0 ounces of silver to the ton, 1.5 percent of copper, and 8.8 percent of lead; this gives an idea of the tenor of the average ore in the mine.

It has already been stated that the country rock on the hanging-wall side of the lode is hydrothermally altered. In places on the hanging wall there is reported to be a distinct gouge. No gouge has been found on the footwall, and on that side on the 300-foot level both the diabase and the granite beyond it are iron stained and contain pyrite and a little chalcopyrite.

Most of the deposit is a breccia composed of angular fragments many of which are less than an inch in greatest dimension. The fragments are in part silicified and otherwise altered wall rock, in part vein minerals. A large number of the light-colored fragments abundant in parts of the deposits are fine-grained fluorite. Many of the fluorite fragments are white; others have pinkish or violet casts. Some of them show distinct banding. Their appearance more closely resembles that of chert than of the commonly observed forms of fluorite. The matrix of the breccia in most places is a dark-purplish mass composed principally of fine-grained quartz in which comparatively large clear grains of fluorite are embedded. In places tiny flakes of chlorite are scattered through the matrix. Some of the fragments are green with chlorite, and a few are entirely composed of that mineral.

Quartz is the most abundant of the gangue minerals and occurs in various forms. The fine-grained quartzose matrix of the breccia has already been mentioned. Brecciated ore from the large stope above the adit is cut by irregular bands of light-grey chert which have themselves been fractured. Here and in the small opening at the 55-foot level are narrow quartz veinlets with comb structure and drusy cavities, which were apparently the latest products of hypogene mineralization. On the 100-foot level the ore in places is sheeted and banded rather than brecciated, and there is considerable clear massive quartz which is in part white, in part pink and vitreous. Adjoining such banded ores is breccia like that elsewhere, containing little sulphide.

Galena is the most abundant sulphide. It is of variable texture. In places it occurs in irregular curved bands, but in probably most of the ore it shows marked evidence of having been brecciated. Argentite in tiny blebs is present in much of the galena. Veinlets and small irregular masses of chalcopyrite are prominent in some specimens. Sphalerite is associated with the galena but in subordinate amounts. A little pyrite was noted, but

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[8]Weed, W. H. Mines Handbook, Vol. 15, p. 197, 1922.
[9]Wentworth, H. A., Letter of Feb. 2, 1923

it is nowhere abundant. In the floor of the main adit near the north end there is reported to have been found a hard black mineral resembling tetrahedrite. C. E. Minor states that a specimen of this ore given to him was found to assay 7 ounces of silver to the ton and 5.1 percent of copper.

Films of the supergene copper sulphide covellite were noted on chalcopyrite in specimens from the large stope above the adit and from the 55-foot level. No chalcocite was found.

The ore in the large stope above the adit and that visible on the 55 and 100 foot levels showed no evidence of oxidation except superficially. Within 50 feet or less of the surface in the upper stopes there is unaltered galena, and chalcopyrite is reported to occur also, but much of the ore in these stopes is oxidized. Cerusite, anglesite, and probably other sulphates of lead are present. The copper carbonates, malachite and azurite, and the silicate, chrysocolla, are also found. Limonite occurs in places in the ore and stains the outcrops of the reef but is nowhere present in great quantity. On the 300-foot level there is reported to be a mass of highly oxidized ore.

The short tunnels on the Mountain Spring claim penetrate an outcrop of breccia similar to and in line with the Grand Reef but much smaller. A small amount of ore has been found here.

The tunnel on the Silver Cable claim is in shattered igneous rock, most of which is altered beyond recognition. It is thoroughly silicified, and the feldspars that remain are clouded with alteration products. No ferromagnesian minerals were noted in it. Near the tunnel mouth there are several slips. Most of the tunnel follows a fairly well defined lead that strikes about N. 30 degrees W. and dips steeply to the east. It is composed of sheared and altered rock and ribbon-banded and drusy quartz. The stope above is reported[10] to have been opened in mining oxidized ore supposed to contain lead vanadate, for a mill test in 1915 or 1916. The so-called vanadate was probably the molybdate wulfenite, such as occurs at the Dogwater and Silver Coin mines.

The lode in the Dogwater tunnel is doubtless similar to that in the Silver Cable. The only place where ore was noted was in the face of the tunnel, that in the back having been stoped out. At the face there is a mineralized zone 2 or 3 feet wide which contains wulfenite and some galena. The ore mined is reported[11] to have contained cerusite, galena, wulfenite, and a small amount of argentite. There was considerable fluorspar in the gangue. The galena was found to contain silver, which was doubtless in the form of invisible blebs of argentite. The ore from this mine carried considerable silver and lead. High-grade ore is reported to have been found in the shallow shaft in the gulch below the Dogwater tunnel.

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[10] Wentworth, H. A., letter of December 1, 1922.

[11] Minor, C. E., notes furnished by H. A. Wentworth.

Little development work has been done on the claims in the southeast end of the group owned by the Aravaipa Leasing Company. On the Junction and Varick claims is a reef similar to and almost as impressive as that at the Grand Reef mine. In places on this reef ore containing galena and assaying well in lead and silver is reported to crop out. On the west side the wall rock is rhyolitic porphyry. On the east a large part of the wall is pre-Cambrian schist, although porphyry is also present, and the granite is close at hand. The Blank and Conundrum claims were not examined during the present investigation but are reported by Mr. Minor to follow the outcrops of a lode striking approximately east.

PROSPECTS SOUTH OF THE ARAVAIPA LEASING COMPANY'S PROPERTY

From the Aravaipa Leasing Company's property south to the Tertiary beds near the Safford road a considerable number of claims have been staked, but on many of them no work has ever been done.[12] Some shallow workings were noted during the present investigation, but no prospects of any consequence were found here except the La Clede and Silver Coin mines, described below. Most of such deposits as exist in this part of the district are probably of the same general type as those just described. In the vicinity of Oak Canyon there is in places considerable micaceous specularite along partings in the schist. This indicates a concentration of iron by hydrothermal processes but may have no relation to the formation of ore deposits.

LA CLEDE MINE

The La Clede mine, owned by James Quinn, of Klondyke, is in a narrow gulch southwest of the Santa Teresa Mountains and about 2-1/2 miles east of Klondyke, with which it is connected by a road. The property comprises about five unpatented claims. There is a shallow shaft in the side of the gulch and a tunnel entering near stream level. Mr. Quinn states that he has shipped about three carloads of ore in 12 years of operation.

The country rock is a bluish-purple fine-grained porphyry, which has been fractured,silicified, and altered even at some distance from the vein. The rock is highly silicified but contains microcline and sodic plagioclase, which are probably hypogene. Some of the quartz may also be hypogene. The rock may have been a latite, but whether it is related to the intrusive rhyolite or to the later volcanic rocks is conjectural. Sparingly disseminated through it are tiny black grains, which are in part specularite. Small areas of later albite have formed by replacement of the rock.

The vein strikes nearly east and stands almost vertical. Assessment work was in progress when the mine was visited, but most of the workings were inaccessible. Near the surface there appears to be considerable oxidation in the vein and its wall rocks, with the development of limonite, some malachite, and other oxidation products. The owner reports that native silver has been found here and that some of the ore assays very high in silver.

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12 Koch, A. W., letter of Jan. 24, 1923.

SILVER COIN MINE

The Silver Coin mine is in the gulch immediately south of the one in which the La Clede mine is situated, about 3 miles east of Klondyke, with which it is connected by a road. The property comprises five unpatented claims owned by Ted Quinn, who resides on it with his family. The position of the group is only approximately shown on Plate XI, but the relations of the claims to one another are essentially as there shown.

The developments consist of a tunnel 180 feet long with short crosscuts off it, a winze about 50 feet deep at the end of the tunnel, and a shaft more than 200 feet deep which passes at one side of the winze and is connected with it. Part of this work was done by the Aravaipa Leasing Company when it had the property under lease. The workings are shown in Figure 6 as they were in July, 1919, when the Aravaipa Leasing Company ceased work. The winze and probably also the shaft have been deepened since then. Small lots of ore have been shipped at different times.

The country rock is a highly altered and weathered light-colored igneous rock, which may have been a fine-grained granite. It contained some original quartz and alkali feldspar, a few flakes of bleached biotite and chlorite, and much secondary quartz both in veinlets and as fine-grained aggregates replacing original minerals. The lode is made up of brecciated rock of this character and quartz. The average strike is nearly east, and the dip is steep to the north. Wulfenite and other oxidized minerals are present in the lode and also in the altered igneous rock at some distance from the lode, but the most valuable ore is that containing unoxidized galena. The distribution of the galena is irregular, but in places it is reported to have been found in sufficient abundance to make ore with a good content of silver and lead.

TENSTRIKE GROUP

The four unpatented claims comprising the Tenstrike group, owned by James Quinn, of Klondyke, stretch between the north end of the main group of claims owned by the Aravaipa Leasing Company and the Aravaipa claim of the same company. The property was formerly connected with Klondyke by a wagon road forking off the main road a short distance above the upstream end of the Aravaipa box canyon. This road has been out of use so long that repairs are needed to make it available for vehicles. There is a cabin on the Tenstrike claim, and considerable underground development work has been done on this and the other claims of the group. A tunnel on the Tenstrike extends north into the Aravaipa claim. Ore has been stoped from this and other workings on the property, and probably a few carloads have been shipped.

These claims are evidently on a northward extension of the Grand Reef vein, and the deposits in them, like those of the Grand Reef mine, are in brecciated and mineralized rhyolite. The rock is silicified and shot through with numerous narrow quartz stringers, most of them distinctly banded. There are small druses with well-developed quartz crystals. Narrow seams of calcite were noted, but these may be of supergene origin. The hypogene metallic minerals

are galena, pyrite, sphalerite, and chalcopyrite, of which the galena is much the most abundant. The galena occurs in coarsely crystaline masses; the other sulphides in small individual grains irregularly disseminated in the quartz. Supergene chalcocite is a prominent constituent of some specimens. Galena has oxidized to anglesite and cerusite. There is a small amount of linarite, a basic sulphate of lead and copper, but, except for occasional slight stains, other oxidized copper minerals were not noted.

FINNEGAN GROUP

Thomas Finnegan, of Klondyke, owns four unpatented claims just south of the Bullis property and a third of the Blevin claim, at the north end of the Grand Reef group. These are on the northern part of the Grand Reef vein and have outcrops of iron-stained, silicified, brecciated rhyolite like that at the Grand Reef mine, but smaller. The deposits have been prospected by means of tunnels.

BULLIS GROUP

PROPERTY - The Bullis group consists of 9 patented and 19 unpatented claims on Imperial Hill, shown on Plate XI. The northern part of the group is little more than a mile southeast of Arivaipa, but the intervention of the steep-walled Tule Canyon makes it inaccessible from that side. The property is reached from the southwest by a road from the valley containing the Dowdle ranches. The two shacks on the south side of Imperial Hill, the only buildings on the property, are nearly 9 miles from Klondyke by this road.

A considerable amount of miscellaneous development work has been done in various places on this property, principally in the course of annual assessment work. There has been more systematic work done in the Windsor workings, shown in Figure 7, than elsewhere. These workings, which aggregate over 1,100 feet, consist of an inclined shaft and drifts and crosscuts at the 60 and 200 foot levels connecting with the surface by an adit at the lower level. The shaft reaches a depth of 190 feet vertically below the collar. Besides the Windsor workings there is a shaft farther down the hill to the east and tunnels, cuts, pits, and small shafts scattered over the property.

HISTORY - The deposits on Imperial Hill are reported to have been found in the early seventies, but little work appears to have been done on them until 20 years later, when Gen. J. L. Bullis began to acquire the group of claims now owned by his estate. Under his direction all parts of the property were prospected, but little development work was done, and little or no ore was shipped. At the time of his death, about 10 years ago, he is reported to have been planning more intensive development. For some years after his death little was done. The Aravaipa Leasing Company had a lease on the property in 1918 and 1919 and did some development work on the Windsor and on several other claims. Since this company's operations ceased nothing beyond annual assessment work has been done, except that in

1922 the Windsor workings were sampled by E. H. Bachman, of Globe, Arizona. He and his associates hope to develop this part of the property under lease and to erect a cyanide mill of some 20 to 30 tons daily capacity to treat the ore mined.

CHARACTER OS THE DEPOSITS - The greater part of Imperial Hill is composed of intrusive rhyolite. The contact between it and the granite to the east is gradational, and numerous dikes and irregular masses of granite cut the rhyolite. On the northeast flank of the hill are blocks of Paleozoic limestone and quartzite inclosed in the rhyolite. The presence of these rocks is indicated diagrammatically on Plate I, but the strata are actually more broken and scattered about in smaller blocks than it was possible to show on the map. Less limestone than quartzite is exposed.

Several lodes crop out on the property. According to Thomas Finnegan, who has charge of the annual assessment work, there are four principal lodes. The exposures of mineralized rock have not been mapped, but in a broad way it may be said that there is a group of veins and zones of mineralization outcropping over a broad area on the east side of Imperial Hill. The strikes measured at different exposures range from N. 40 degrees W. to almost N. 40 degrees E., but the average is womewhat west of north. The lodes cut representatives of all the rocks mentioned in the last paragraph. The quartzite, rhyolite, and granite are cut by quartz stringers, brecciated, and somewhat altered and replaced. The limestone has locally been permeated with mineralizing solutions, and small portions of it have been thoroughly altered. The igneous rocks in the vicinity of the deposits are somewhat chloritized and fractured, but the feldspars in them seem as fresh as in similar rocks that have not been exposed to mineralization. In some exposures the brecciated quartzite or rhyolite is permeated irregularly with quartz. Elsewhere there are distinct veins of quartz, which in places are sheeted. The quartz in most exposures has drusy cavities lined with well-developed quartz crystals. The deposits contain lead, copper, and silver both as sulphides and in oxidized minerals. The exposures seen during the present investigation showed only small amounts of metallic minerals. Samples taken by E. H. Bachman, of Globe, at 5-foot intervals down the Windsor shaft contained, according to Mr. Bachman, both lead and silver. One of these samples assayed slightly over 100 ounces in silver, but the average of the assays is less than 15 ounces. The lead content of the samples ranged from a few tenths of 1 percent to more than 9 percent. The distribution of both lead and silver is irregular and appears to bear no relation to depth. Assays from the 60 and 200 foot levels also show some lead and silver, but the average amount is small. A composite sample from the shaft contained 0.14 percent of copper. Copper is present in spots on the 200-foot level, one assay of 1.5 percent and several of less amounts being reported,but the average amount is small, and in places, notably in the crosscut where the ore carrying the most silver found on the level is exposed, no copper is present. The drift on the lower level south of the adit is in brecciated quartzite that shows a little mineralization. Mr. Bachman's assays show from 0.94 to 2.42 ounches of silver to the ton in this part of the mine. A short distance north of the adit there is broken ground and the

drift has caved in. According to the map prepared by the Aravaipa Leasing Company's engineers there is a fault here which shifts the lode westward about 40 feet, as indicated in Figure 7. A green fine-grained rock collected at the point where the drift is caved proved on examination to be quartzite containing a little feldspar and partly replaced by calcite and chlorite. The map just referred to shows limestone in this drift beyond the caved portion, and the calcite in the altered quartzite may be derived from this rock. The same map indicates that rhyolite forms the hanging wall south of the adit and that there is porphyry in the north end of the mine beyond the limestone.

The quartzite at the mouth of the Windsor shaft contains small amounts of horn silver, malachite, colper pitch, covellite, and chalcocite. The two sulphides occur together in small black blebs. They carry silver, perhaps in solid solution as sulphide.

The shaft east of and down the hill from the Windsor is in coarse porphyritic granite, which has been somehwat crushed. The biotite in it is chloritized, and quartz has been introduced since the formation of the rock. Ore containing 4 or 5 percent of copper is reported to have been found in the shaft, and a number of pieces containing malachite and azurite were noted on the dump. If any considerable quantity of ore was taken out, it has since been removed.

BULLIS-LANDSMAN GROUP

There are nine unpatented claims which adjoin the Bullis property on the northwest and the Norton group on the south. These may be called the Bullis-Landsman group, as Mrs. J. L. Bullis and Frank Landsman hold them in common. They are developed by several branching tunnels. Part of the work was done by the Aravaipa Leasing Company when it leased the claims in 1919.

The country rock is largely intrusive rhyolite, but there is also a little limestone which is cut by dikes of the rhyolitic rock and of a dark trap. Streaks of copper sulphide are reported to have been found in dike rock of both these types. On these claims there are several lodes, which in general strike west of north and have a nearly vertical dip. In the rhyolite there are iron-stained outcrops which resemble the Grand Reef in miniature. Underground stringers of sulphides and specularite are found on small slips in the brecciated rock. Galena, pyrite, and chalcopyrite are found, but if sphalerite is present it is in small amount. The galena here, as elsewhere, doubtless contains argentite. In the limestone, which is brecciated and partly silicified, the ore is in irregular stringers and small masses. The gangue minerals are quartz, actinolite, specularite, calcite, and chlorite. The only sulphides noted are galena and sphalerite. The quartz, which is the most abundant gangue mineral, varies in texture from cherty rims around sulphide grains to rather coarsely crystalline masses, with drusy cavities. The actinolite masses are made up of small bunches of radiating needles. Specularite, which is not abundant, is in scattered flakes and fine -grained

aggregates. There is only a little calcite. The sulphides are in part in fine-grained aggregates, in part in scattered grains, some of which are an inch wide. They show almost no oxidation.

ROYAL TINTO MINING AND SMELTING COMPANY

PROPERTY - The property of the Royal Tinto Mining and Smelting Company of New York, consists of 22 patented and 10 unpatented claims on Tule and Copper Bar gulches 2 miles east of Arivaipa. (See Pl. XI.) Except for a shaft house on the Copper Bar claim, there are no buildings on the property.

The principal underground workings are the Sam Jones and Copper Bar tunnels, named from the claims in which they start. They are shown in Figure 8. There is also a shaft near the mouth of the Copper Bar tunnel, reported to be 100 feet deep; other shafts on the Tinto claim, one of which is reported to have been 100 feet deep; and several excavations, mostly small and shallow, on the other claims. At the time of visit it was possible to get underground only in the two tunnels.

HISTORY [13] - The ore deposits of this group have been known for at least 20 years. In 1902 Frank Landsman had a lease on the New York claim and shipped 15 tons of carefully picked chalcocite ore reported to have assayed 29.7 percent of copper and several dollars' worth of gold and silver to the ton. This seems to be the only ore that has been shipped from the property. In 1905 the Royal Tinto Mining and Smelting Company, the present owner, was organized under the laws of New Jersey. Most of the work was done in 1906 and 1907, and, except for annual assessment work,little has been done since then.

CHARACTER OF THE DEPOSITS - The deposits lie in a complex of fault blocks of pre-Cambrian schist and Paleozoic sedimentary strata, bordered on the south and east by the granite batholith and cut by rhyolitic apophyses of the granite. There are numerous faults, most of them small. Many strike northwest, but some trend in other directions. An idea of the extent to which the rocks have been shattered and broken into small blocks can be gained from Figure 8. This sketch, showing the geologic features exposed in the two tunnels, is copied from a report on the property made for the company by C. F. Tolman, from which some of the facts given below are taken. The deposits are on fracture zones that cut altered rhyolitic facies of the granite along the contact and extend northward beyond the igneous rock into the quartzite and limestone. The zones fork and pinch out in irregular fashion, but the resultant trend of the group of zones is to the northeast. The mineralized outcrops are in most places inconspicuous features on the brush-covered hillsides, but in some places, notably at the mouth of the Copper Bar tunnel, there are prominent exposures of iron-stained siliceous breccia. Mineralization can be traced on the surface for an air-line distance of over a mile on the property, and according to Tolman the outcrops of the zones range in width from about 8 feet on the New York claim to 300 feet on the Copper Spar claim.

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[13] From H. W. Darling's report on the property of the Royal Tinto Mining and Smelting Co., supplemented by information furnished by Charles Firth of Arivaipa.

The rock along the zones has been sheared, brecciated, and replaced by chlorite, hematite, quartz, pyrite, chalcopyrite, and products of oxidation and supergene deposition. In some places the original rocks have been completely replaced; elsewhere there has been sufficient alteration to make it difficult to recognize the rock. The wall rocks were altered to some distance beyond the fracture zones in places, but this alteration is irregular, and so far as can be judged from the exposures in the two tunnels the amount of metallic minerals deposited is small, with the exception of some small irregular bodies in limestone. No primary copper minerals were observed during the present investigation, but chalcopyrite is reported to have been found in the bottom of the shaft at the mouth of the Copper Bar tunnel, and Tolman noted small quantities of the mineral in some of the surface cuts. Copper oxidation products and supergene sulphides exist in a number of places, proving the original presence of hypogene copper minerals in the deposits. The amount of copper originally formed in parts of the deposits was negligible, but it may well be that in places ore shoots containing considerable copper were produced. Chlorite is one of the most abundant minerals in the deposits exposed in the Copper Bar tunnel. Intimately mixed with it are seams and aggregates of quartz, hematite in fine disseminated flakes and aggregates, and pyrite in streaks and irregular groups of small cubes disseminated in the masses of chlorite and hematite. Elsewhere chlorite is not so abundantly exposed. In places reticulating veinlets of hematite are the only evidence of hypogene mineralization.

The outcrops of the mineralized rocks all show weathering, but the oxidation is neither intense nor deep. Limonite occurs only in superficial stains and small masses. Malachite, azurite, cuprite, and copper pitch are found on the Tinto and New York claims and have also been reported on the Newark, but the amount at all exposures is small. In the Copper Bar tunnel the pyrite has been tarnished and loosened by leaching and there is an efflorescence of hydrous iron sulphate on the walls. The end of this tunnel is about 100 feet below the surface, which is the greatest depth at which the deposits are now exposed. From this it appears that incipient oxidation reached depths as great as 100 feet, but that its effects were slight. The supergene sulphides, chalcocite and covellite, are present in varying amount in many of the exposures of mineralized rock, although in some the amount is so small that it can not be seen. A little massive chalcocite can still be found on the Tinto dump. It evidently formed veinlets and irregular masses in the altered and brecciated rock. Chalcocite ore is also reported to have been found in the shaft at the mouth of the Copper Bar tunnel. For the first 25 feet this shaft is reported to be in mineralized rock like that exposed in the tunnel except that considerable chalcocite was noted. Below this the rock penetrated is reported to be barren except at the bottom, at a depth of about 100 feet, where chalcopyrite was found. The small amount of copper found by chemical tests in specimens from the Copper Bar tunnel is probably present as films of chalcocite and perhaps also covellite on the pyrite. Specks of covellite were noted by Tolman on the New York claim and it is probably also present elsewhere. H. W. Darling, in the course of an examination of the property for its owners in 1918, took several grab samples for assay, and the results show that copper is present in a number of

places. Part of the copper is in the form of carbonates and oxides, and a little may be in hypogene chalcopyrite, but much of it is probably in supergene sulphides. In some of the places where he sampled such sulphides are visible. In others there is no visible copper mineral, and the copper is probably in films of supergene sulphides, a form in which it is less conspicuous than in either hypogene sulphides or oxidation products.

C. A. FIRTH GROUP

Charles A. Firth has four unpatended claims adjoining the property of the Royal Tinto Mining and Smelting Company. As is shown on Plate XI, two of these claims are south of that property, and the other two are northwest of it. Only a little development work has been done on these claims. Presumably the deposits here are similar to those on the Royal Tinto ground.

ARAVAIPA MINING COMPANY

PROPERTY - The property of the Aravaipa Mining Company of New York, consists of 19 patented and 5 unpatented claims. These claims, on which mining for lead-silver and copper ores has been carried on intermittently for many years, extend from Arivaipa north to Deer Creek. They are shown on Plate XI. There is an engine house at the Arizona shaft and about eight buildings at Arivaipa, including the residence of H. T. Firth, superintendent, the post office, the houses used by the workmen when the mines were running, and outbuildings.

The principal workings of this company are on the Arizona, No.1, and Orejana claims. No maps of these workings are available, and considerable parts of them are now inaccessible, so that only approximate data can be given.

At the Arizona mine there is a shaft about 580 feet deep. The lower part of this shaft is now full of water, and the whole was inaccessible at the time of visit. The deposit is also developed by means of a tunnel entering farther down the hillside, which encountered the vein about 200 feet from its mouth. The tunnel was continued about 500 feet farther without cutting any more veins. From the point where the vein was cut drifts were run on it about 400 feet in a southerly and 700 feet in a northerly direction. The north end of the north drift is close to the shaft, at a depth estimated by Mr. Firth as 125 feet below the collar.

On the Orejana claim a tunnel about 700 feet long follows another vein. On the No. 1 there is a shaft a few hundred feet deep and a short tunnel connected with it. There has been some stoping and a little drifting off this shaft, which was inaccessible at the time of visit. Other workings on the company's claims include a tunnel several hundred feet long on the Gordon, irregular tunnels on the Grand Central and Head Center, and tunnels and pits on the Iron Cap and elsewhere.

HISTORY - The principal deposits have been known for nearly 50 years. Among the early locators were W. C. Bridwell, Charles Cunningham, the Dunlap brothers, John Harr, and Charles McGeary. Col. W. C. Bridwell had a smelter

near Arivaipa in the late seventies in which he treated ore from these deposits. In 1889 the deposits were acquired by a group of men who formed the present Aravaipa Mining Company. At one time this organization was known as the Aravaipa Leasing Company, a name that has since been adopted by the company which owns the Grand Reef group. The Aravaipa Mining Company operated from 1890 to 1895 and is reported to have shipped two cars of ore obtained from different places on the property for the purpose of a mill test. In 1916 John Gleason and T. C. Parker leased the No. 1 claim and are reported to have shipped lead carbonate ore of a gross value of about $90,000. No other work except the annual assessment work on the unpatented claims has been done on the property.

CHARACTER OF THE DEPOSITS - The rocks that crop out on the Aravaipa Mining Company's property comprise fault blocks of Paleozoic quartzite and limestone cut by a number of dikes and irregular intrusive masses of felsite, andesite, and basalt. Several veins crop out on the property but are probably all parts of the same vein system. One group of mineralized outcrops extends northward from Arivaipa through the Arizona claim to Gordon Canyon and beyond, on Abe Reed's claims, as far as Old Deer Creek. Another line of outcrops lies to the west on the Standish, Orejana, and Winthrop claims. These two groups are principally in quartzite and felsite with limestone in the vicinity of Arivaipa. To the east, on the Grand Central and neighboring claims, there are deposits in limestone. The line of claims from Imperial Hill through Arivaipa to Old Deer Creek is over 3 miles long. The principal workings of the Aravaipa Mining Company are in this group, and most of the claims are held by the company. Mineralized outcrops are found at short intervals on these claims, but the exposures are by no means continuous. It is probable that there is a zone of mineralization made up of a series of genetically related lodes, which may be connected with one another at depth. The deposits on the Orejana group are similar and related to the deposits of this zone but lie somewhat to the west. The deposits in quartzite are veins with definite walls and approximately constant strikes which range from north to about N. 20 degrees W., but those in limestone are more irregular, and the strikes of the mineralized fractures vary widely.

The vein exposed in the drift of the tunnel at the Arizona mine is in an altered fine-grained porphyry. It strikes about N. 20 degrees W. and dips steeply west. The maximum exposed width is over 10 feet. The vein filling is banded quartz with quartz crystals on partings and in vugs. Galena is present in the quartz at the north end of the drift. Cerusite is irregularly distributed along the vein in streaks and bunches. The quartz is impregnated with manganese oxide in places. Mr. Firth states that the ore in the drift has an average content of 12 to 15 ounches of silver to the ton, 10 to 15 percent of lead, and a little gold. The shaft is said to have passed through broken ground containing fragments of limestone between depths of 450 and 500 feet. On the dump is sulphide ore reported to have come from a depth of 560 feet. This ore contains galena, argentite, sphalerite, pyrite, chalcopyrite, quartz, and calcite. Other specimens on the dump consist largely of calcite and quartz stained dark red with hematite. In this fine-grained mass are small aggregates of pyrite and grains of sphalerite speckled

with chalcopyrite. The rock is reticulated with tiny branching veinlets and irregular masses of earthy hematite. It is probable that these specimens represent silicified and mineralized limestone and therefore that the vein intersects a fault block of limestone at a depth of about 560 feet. Mr. Firth is authority for the statement that no ore was encountered in the shaft until this depth was attained and that all the mineralized rock on the shaft dump came from this depth. This is the greatest depth so far reached by mine workings in the Aravaipa district, and the presence of products of oxidation in rock found near the bottom of the shaft is interesting as indicating the depth to which oxidation has extended. Water was encountered in this shaft at a depth of 500 feet in sufficient quantity to be a handicap in sinking the shaft deeper. Work finally ceased in May, 1895, when the shaft was down about 580 feet.

The ore found on the No. 1 claim is cerusite, which was found in irregular masses in the limestone. Most of it so far discovered is reported to have been stoped out, but other bodies may well be found if development work is carried farther. No sulphides appear to have been encountered. Near by the limestone is silicified and replaced by actinolite in places.

The tunnel on the Orejana claim is in quartzite with a dike of altered trap showing near the mouth. The tunnel follows a vein striking approximately N. 15 degrees W. and ranging in width from a few inches to 2 feet. The vein filling is ribbon-banded quartz, in places with coarse galena. The galena is altering to anglesite and cerusite. Both the chloride and the bromide of silver are reported to have been found. The highest silver assays are obtained from narrow streaks of soft material on the vein walls. Small amounts of ore containing as much as 300 ounces of silver to the ton are reported to have been shipped.

The other workings on the claims of the Aravaipa Mining Company do not appear to have developed ore bodies of commercial importance. On the Grand Central and Head Center sulphides occur along irregular slips in limestone exposed in short tunnels and pits. The Iron Cap and adjoining claims were not visited, but the development work on them is reported to be small. The limestone is somewhat mineralized, but valuable ore bodies have not been discovered. A long tunnel on the Gordon claim disclosed nothing of value.

MOLTKE GROUP

The Moltke group consists of four unpatented claims owned by Mrs. H. T. Firth and Frank Landsman. It is on the road between Arivaipa and Tule Spring, about a mile from Arivaipa. There are some short tunnels on the property on slips in the altered rock. Most of the rock in this vicinity appears to be related to the intrusive rhyolite, but pre-Cambrian schistose rocks are also present.

NORTON GROUP

The Norton group consists of four unpatented claims owned by Mrs. H.T. Firth and C. A. Firth. They border the south end of the Aravaipa Mining Company's property on the east, near Arivaipa, and contain principally Paleozoic sedimentary strata that show brecciation and some mineralization. The development work on these claims is small.

There is an unpatented claim north of this group which appears to belong to H. T. Firth.

H. T. AND C. A. FIRTH GROUP

A group of six unpatented claims belong to H. T. and C. A. Firth lies north of Arivaipa, bordering the principal group of claims belonging to the Aravaipa Mining Company on the west. Little work has been done on these claims.

TOLMAN-BABCOCK GROUP

The six unpatented claims that constitute the Tolman-Babcock group lie east of the Arizona mine and about a mile north of Arivaipa. They are owned by Mrs. H. T. Firth, of Arivaipa. Two or three cars of cerusite ore have been shipped from this property. There is a short tunnel and a 75-foot winze on the Babcock claim, a shallow shaft on the La Sorilla claim from which 55 tons of cerusite ore has been stoped, and other workings elsewhere.

The workings on the Babcock and La Sorilla claims of this group were the only ones examined. At the Babcock there is a zone about 3-1/2 to 5 feet wide without definite walls composed of brecciated and altered fine-grained porphyry. It strikes northwest and dips about 60 degrees W. The ore is reported to assay about 10 percent of lead and 5 ounches of silver to the ton. The rock of the brecciated zone contains somewhat crushed and altered phenocrysts of alkali feldspar, quartz, and chloritized biotite in a groundmass so fine that it can not be satisfactorily resolved even under the microscope. It is cut by stringers of vein quartz. The rock is too much altered and too fine grained for exact determination. In the hand specimen it is of a dirty heliotrope color dotted with white specks of feldspar and green chlorite patches. In the field it was thought to be an altered variety of the intrusive rhyolite, but the composition appears to be too calcic. It might be related to either the Miocene (?) or the Cretaceous volcanism.

At the La Sorilla claim there is glassy vein quartz in a brecciated and altered porphyry, which in the hand specimen resembles intrusive rhyolite. A basalt dike cuts the brecciated porphyry and the vein matter. There was renewed brecciation and deposition after the basalt intrusion. The zones along which both the original and the postbasalt fracturing and mineralization took place strike in about the same direction, somewhat west of north. The lode now consists of fragments of porphyry, quartz vein matter, and basalt. The basalt has been markedly altered, the original augite and olivine

being almost completely converted to chlorite, epidote, and iron-oxide dust. The groundmass is composed of feldspar microliths with flow structure. About 55 tons of cerusite ore has been mined from a pocket in this lode.

BRYCE-MERRILL PROSPECT

E. W. Bryce and W. P. Merrill have some unpatented claims in Williamson Canyon east of the Arizona mine and about a mile north of Arivaipa. A shaft about 50 feet deep has been sunk on one of the veins belonging to the zone of mineralization that extends through this part of the district.

SINN FEIN PROSPECT

The Sinn Fein prospect is owned by James Quinn and Thomas Finnegan, of Klondyke. It is on the north side of Williamson Canyon, west of the Head Center claim of the Aravaipa Mining Company and somewhat over a mile northeast of Arivaipa. It is developed by an irregular tunnel that begins a short distance above the level of the stream bed. This prospect was formerly owned by H. T. Firth, of Arivaipa, who shipped one carload of ore. The present owners have shipped two carloads. About half a mile east of this prospect, on the west slope of Satisfaction Mountain, are some pits and shallow cuts. These are reported to be on claims belonging to the owners of the Sinn Fein.

The Sinn Fein tunnel is in Tornado limestone and follows a mineralized shear zone that strikes north and dips 60 degrees to 70 degrees E. The ore contains galena and sphalerite in good-sized crystals and some cerusite.

The pits on Satisfaction Mountain are also in Tornado limestone. They are sunk on irregular masses of rather coarsely crystalline dalcite and quartz impregnated with iron and manganese oxides. A little copper stain was noted, and specularite is present in small flakes.

RAWHIDE GROUP

Between the north end of the Aravaipa Mining Company's property and Old Deer Creek are four unpatented claims known as the Rawhide group and owned by Abe Reed, of Stanley. On this group there is reported to be a tunnel about 300 feet long and another about 50 feet long which expose a vein carrying lead and silver in Paleozoic strata.

WARM SPRING PROSPECT

Warm Spring is in the bed of Old Deer Creek on the trail between Arivaipa and Stanley 2 miles north of Arivaipa. There are corrals and a cabin here and a fenced pasture near by. The Old Rawhide Development Company owns one or more unpatented mining claims at this locality. There is a short tunnel on the north side of the stream just below the spring.

A small block of Tornado limestone is inclosed in the rhyolitic rock. The tunnel follows slips in the limestone. It has caved and been partly reopened. Little evidence of mineralization could be seen in the part now accessible.

LANDSMAN GROUP

PROPERTY - The compact group of 37 unpatented claims which lie on the slopes soutwest of Cobre Grande Mountain has for a number of years been controlled by Frank Landsman and may be termed the Landsman group. He has from time to time shared his interest in them with different partners. The location of the claims is shown on Plate XI. The only buildings on the property are the tent house and cabin at Lawrence Spring where Mr. Landsman lives.

There are a considerable number of shallow holes on the claims, also several short tunnels, most of which were caved and inaccessible at the time of visit. No developments beyond the required annual assessment work have been attempted, and the excavations serve principally to give fresh exposures of the rocks that crop out at the surface. No ore has been shipped.

CHARACTER OF THE DEPOSITS - Most of the mineralization on the Landsman group is in the Tornado limestone, which is cut by a number of rhyolite dikes that are in places themselves mineralized. These dikes are similar to the rhyolite associated with the main granite batholith and are probably related to it. There is also some mineralization in the schist. The mineralization in the limestone in part conforms to the bedding, in part forms irregular masses of indefinite extent, and in part follows lines of fracturing transverse to the bedding, most of which strike west of north and dip west. In several places rhyolitic dikes cut the replacement bodies and have been shattered and partly replaced, but not so completely as the limestone. The metamorphic rocks also are less thoroughly replaced than the limestone. Replacement in limestone is conspicuous over hundreds of square feet of the lower slopes of Lime Hill. In places the ore minerals have been almost completely substituted for those of the original rock over a considerable area of outcrop. In many of the irregular replacement deposits specularite predominates, but in those that accord with the bedding silicate minerals are more abundant.

The minerals formed by hypogene deposition are specularite, magnetite, pyrite, chalcopyrite, quartz, fluorite, actinolite, epidote, and garnet. Oxidation has produced copper pitch, cuprite, malachite, and manganese and iron oxides. The supergene sulphides, chalcocite and covellite, are also present, principally in association with the oxidized copper minerals. In many outcrops specularite is one of the most abundant minerals. It occurs in the limestone in aggregates of shining plates, intermingled in places with silicate minerals, and in the other rocks in fine-grained intersecting stringers. There are cavities in rhyolite in which thin bands of specularite cover the walls and into which crystals of quartz and fluorite project from the specularite. A small quantity of magnetite is almost invariably found

associated with the specularite. Sulphides are not abundant in any of the exposures. They are most conspicuous where there are veinlets or irregular masses of quartz. Actinolite is abundant in places, parts of some limestone beds being almost completely replaced by this mineral, but it is less widespread than specularite. Garnet and epidote were noted in a number of places, but they are not abundant in most exposures. The oxidized minerals are irregularly and rather widely distributed but are nowhere abundant. Assays as high as 1 percent of copper and a little gold are reported to have been obtained from specimens of specularite containing no visible copper minerals. Microscopic examination of such a specimen revealed small quantities of chalcocite. This mineral associated with copper pitch ore and a little covellite is also found around residual cores of chalcopyrite, but in most specimens the quantity of chalcocite is so small that it can not be distinguished with the unaided eye.

APPENDIX 4

ORE DEPOSITS - HISTORICAL OUTLINE[1]

The following is from Wilson, E. D., 1950 Aravaipa District in Arizona Zinc and Lead Deposits, Arizona Bureau Mines Bulletin 156, Geological Series 18:

"1870-89. Mineral deposits were discovered in the Aravaipa district before 1880. A small smelter is reported to have been built here in the late seventies by Col. C. W. Birdwell, but little is known about production or operations prior to 1890.

1890-95. Aravaipa Mining Corporation, operating in northern part of the district, sank Arizona shaft to its present depth of 580 feet and shipped two cars of ore.

1890-1900. J. W. Mackay opened Grand Reef mine to a depth of 300 feet. Other properties in the district were worked, and presumably some lead-silver and copper ores were shipped.

1900-14. Small-scale operations, mainly by lessees.

1915-19. Grand Reef mine leased by local people who built a small mill and shipped ore and concentrates.

1916. John Gleeson and T. C. Parker, lessees, reportedly shipped $90,000 worth of lead carbonate ore from No. 1 claim.

1919-20. Aravaipa Leasing Company obtained Grand Reef property and made some production.

1921-24. Little activity in district. No production reported during 1921-22.

1925-28. Grand Central Mining Company, headed by Lewis Douglas, acquired the old Aravaipa property, including the Iron Cap and other claims near Aravaipa, in 1925 and built a mill with a flotation capacity of 90 tons per day. In 1927 this plant was operated for five months. Production from crude ore and concentrates shipped during 1926-28 was approximately 3,500,000 pounds of lead, 1,214,797 pounds of zinc, and $20,000 worth of silver.[2]

---

[1] Data for years prior to 1923 abstracted from C. P. Ross, work cited.

[2] M.J. Elsing and R.E. Heineman, Arizona metal production: Univ.Ariz., Ariz. Bur. Mines Bull. 140, 1936.

1929-31. Production was mainly oxidized lead ore from the Grand Reef which in 1931 ranked second as a producer of lead in Arizona. [3]

1932. Little activity and small production.

1937-41. Base-metal production was resumed in the district. The Grand Reef Mining Corporation in 1939 installed a milling plant of 100 tons daily capacity. During 1941, the Calistoga Mining and Development Company treated Grand Reef tailings.

1942-49. Athletic Mining Company bought the Aravaipa group of claims, developed the Iron Cap and Head Center mines, and became the district's largest shipper of lead and zinc ores. This company built at Klondyke a flotation concentrator of 100 tons daily capacity, which was operated throughout 1948 and part of 1949 chiefly on Iron Cap ores, and subsequently on other ores."

---

[3] U.S. Bureau of Mines, Mineral Res. of the U.S., 1931, pt. I.

CORPORATION

Copy No. 9

EXPLORATION PROGRAM

JOSEPH MULLER CORPORATION ZURICH

ARAVAIPA PROJECT
PHASE II

Job No. 4268-01

November 29, 1968

PARSONS-JURDEN CORPORATION

A WHOLLY OWNED SUBSIDIARY OF THE RALPH M. PARSONS COMPANY
ENGINEERS-CONSTRUCTORS

PARSONS-JURDEN

NEW YORK

Parsons-Jurden Corporation

A SUBSIDIARY OF THE RALPH M. PARSONS COMPANY

26 BROADWAY, NEW YORK, N. Y. 10004

December 3, 1968

Mr. Joseph Muller
Joseph Muller Corporation Zurich
Scheuchzerstrasse 7
CH-0886
Zurich, SWITZERLAND

SUBJECT Joseph Muller - Aravaipa Project
Phase II Report
P-J Job Number 4268-1

Dear Mr. Muller:

We are pleased to submit our Phase II Report on the Aravaipa Project.

The Phase II exploration work was carried out in accordance with our Letter of Approval dated July 12, 1968, as a recommended followup of our original Reconnaissance Report.

In summary, results from work performed during Phase II have been sufficiently encouraging to enable us to recommend that three target areas be tested by drilling. The targets are as follows:

Target 1 is the broad Induced Polarization [I.P.] Anomaly, the edge of which is about one mile west of the Grand Reef mine. This I.P. Anomaly overlaps Magnetic Anomaly "H" and a common source is implied. The top of the source is interpreted as being in bedrock, and less than 1000 feet beneath the surface. We have recommended a minimum program of two 1000-foot holes to determine if the source is disseminated sulfide mineralization.

Target 2 is an I.P. Anomaly just west of the Grand Reef mine. The source is interpreted as being narrow and deep. We have recommended a 2000-foot hole to test this target. In the report we point out that the merits of this target should be re-evaluated after drilling results from Target 1 are available.

Target 3, lying within the outline of Magnetic Anomaly "P", will require a 2000-foot hole to test what we interpret as a favorable northeast structural trend. The factual support for this recommendation is perhaps not as compelling as that which we have for Target 1, and the element of risk is correspondingly greater.

The above targets are covered in detail in the following report.

Yours very truly,

PARSONS-JURDEN CORPORATION

Max J. Kennard
Vice-President

MJK/RS:mec

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INTRODUCTION

The concept of exploration targets discussed in the following report was developed in the Parsons-Jurden Corporation report titled A Geologic Reconnaissance of the Aravaipa Mining District, Graham County, Arizona.

The reader is referred to the above for an understanding of the work which preceeded, and led to Phase II.

Appended to the Phase II Report are two reports from McPhar Geophysics Incorporated which should be referred to for a detailed description of the Induced Polarization work.

The appendix of the Phase II Report also contains data on the Geochemical Sampling work.

OBJECTIVE

The objective of the Phase II program was the carrying out of certain geologic and geophysical exploration work in target areas outlined in the Parsons-Jurden Corporation's report titled A Geologic Reconnaissance of the Aravaipa Mining District, Graham County, Arizona.

This latter report, submitted on May 3, 1968, described work performed for Joseph Muller Corporation Zurich under a letter of agreement dated November 21, 1967. Authorization to proceed with Phase II was received on July 12, 1968, and work was started at once.

It will be seen by comparing the following excerpt from the May 3 Report titled Conclusions and Recommendations, with the Plan of Approach for Phase II, that the latter does not follow the previous recommendations in exact detail. This does not reflect any change in thinking as to the merits of the targets, but was done instead to budget for those items which seemed to stand the best chance of answering certain basic geologic questions and thus providing immediately useful exploration results.

Section B of the May 3 Report titled Conclusions and Recommendations states as follows:

Geologic reconnaissance of the approximately 11,000-acre block of mineral property has pointed out two areas which have good exploration possibilities. These areas, referred to as the North Zone and the South Zone, are discussed below.

NORTH ZONE

This area is outlined by the northeast structural trend which takes in the Paleozoic limestone block in which the Iron Cap ore body occurs and extends into the Goodwin Canyon Quartz Monzonite. A hidden apophysis of intrusive is inferred to occur within this zone. Such an intrusive body would be an excellent exploration target. Evidence of this hidden intrusive includes the following:

1. The suggestion of a projection of Goodwin Canyon Quartz Monzonite at the northeast corner of the map area. This is along the general direction of schistosity and bedding in the Pinal Schist and would be a likely path for an intrusive to follow.

2. Tactite development in the limestone of this zone - while not intense - is somewhat more than can be accounted for by the known rhyolite and latite dikes.

3. The ore mineral showings require a source other than the rhyolite and latite dikes.

4. A dome-like structure is suggested by the scattered Paleozoic outcrops around a central outcrop of Pinal Schist. This doming could be the result of, or favorable to, the emplacement of an intrusive body.

5. Magnetic Anomaly "P" is interpreted as being due to a deep intrusive.

RECOMMENDATIONS - NORTH ZONE

An exploration program is recommended in the north zone. The target is a mineralized intrusive. Indications are that it is a deep target. A suggested program should include the following:

1. Detailed geologic mapping
2. Petrographic study - geochemical sampling
3. Geophysics

Such a program would narrow down the rather broad zone to one or two prime target areas and a diamond drilling program could then be proposed.

In view of the nature of the target, it will probably be possible to test it with a minimum program of three 2000-foot holes.

SOUTH ZONE

This zone is shown by the faults bounding the projecting arm of Santa Teresa Granite intruded between Precambrian Laurel Canyon Granodiorite on the north, and Precambrian Pinal Schist on the south. These faults strike northeast in the general direction of schistosity and bedding in the Pinal. There is a good possibility that the abrupt termination of the granite along the Grand Reef fault does not show the true extent of this projecting arm and that there are offshoots underlying the Horse Mountain Volcanics on the west [down-dropped] side of the Grand Reef fault.

The geologic evidence suggests that the stratigraphic throw on the Grand Reef fault is at least equal to the total thickness of Paleozoic strata, or something over 1000 feet. Paleozoic strata may underlie the Horse Mountain Volcanics on the west side of the fault. The combination of Paleozoic carbonate rocks and buried intrusive give this zone a good exploration potential.

Magnetic Anomalies "G" and "H" are reportedly due to polarization in Horse Mountain Volcanics, but it is suggested here that a buried skarn could be in part responsible.

RECOMMENDATIONS - SOUTH ZONE

An exploration program is recommended in the south zone whose target would be the Paleozoic carbonate rock-skarn section and related intrusive. Such a program should include the following:

1. Detailed geologic mapping
2. Geophysics

If the above provide some narrowing down of the zone to a reasonably well defined target area, it should be possible to test the target with one 2000-foot diamond drill hole.

PLAN OF APPROACH

It was decided that Induced Polarization [I.P.] surveys would provide the most ready means of finding the hidden intrusives postulated in the reconnaissance report. McPhar Geophysics Incorporated was retained to carry out the program of I.P. work. The I.P. geophysical method is generally accepted as being capable of detecting disseminated sulfide mineralization of the porphyry copper type. The theory behind the method and the mechanics of carrying out the survey are described in the appended McPhar reports. It should be pointed out that the I.P. method is not generally considered to be effective much beyond 1000 feet of depth. It was felt that even though the hidden intrusive might be as deep as 2000 feet, the expected halo of alteration and associated mineralization might extend upward into the effective depth of penetration of the survey.

A program of collecting rock-chip samples for geochemical determination of copper and molybdenum content was carried out in the two main areas of interest. Data from such a survey can be of value in defining zones and trends of dispersed mineralization, thus augmenting geologic interpretation. The sampling program was carried out under the direction of Dr. Charles L. Fair of Computec Research, Ltd., Tucson, Arizona.

Sample preparation and metal determinations were done by Rocky Mountain Geochemical Corporation of Tucson, Arizona.

Details of the geochemical work can be found in the Appendix.

DETAIL OF WORK

NORTH ZONE INDUCED POLARIZATION

Approximately 34 miles of Induced Polarization [I.P.] line was run in this area to test for a possible body of buried intrusive extending southwestward from the Goodwin Canyon Quartz Monzonite. The lines were run due east - west one-quarter mile apart, using Brunton compass and tape control. [An exception to the one-quarter mile line spacing was employed between L-5280S and L-8400S, in order to extend the budgeted I.P. coverage southward into the Tule Spring area.] A dipole spread of 1000 feet was used, in keeping with the idea that the target was located at a considerable depth.

NORTH ZONE GEOCHEMICAL SURVEY

A 2-square-mile area was sampled on a 500-foot grid system in this area. Rock-chip samples were taken uniformly within a 30-foot radius of each point indicated on the grid, in order to lessen the possibility of erratic high values which might occur with small samples. Soil-covered areas were not sampled. Samples were analyzed for copper and molybdenum. Copper was determined by atomic absorption and molybdenum was determined colorimetrically.

SOUTH ZONE INDUCED POLARIZATION

Approximately 19 line miles of Induced Polarization [I.P.] survey were run in this area: 16 line miles in the original survey, and approximately three line miles in a followup survey. As in the north area, a 1000-foot dipole spacing was used and the original lines were one-quarter mile apart and run in an east - west direction. After the completion of this work, one line was extended and closer dipole spreads and line spacing were used in the followup work in two anomalous areas. The target in the south area was an apophysis of porphyry and possible Paleozoic sedimentary rocks on the west side of the Grand Reef fault, west of the Grand Reef mine. This target was considered to lie at a considerable depth.

SOUTH ZONE GEOCHEMICAL SURVEY

An area of approximately three-quarters of a square mile was sampled on a 500-foot grid. Rock-chip samples were collected and copper and molybdenum determinations made as described for the north area. The limited area of rock outcrop compared to alluvium in the south area of interest did not lend itself to establishing definite trends, but it was felt that the data could be meaningful.

SOUTH ZONE GRAVITY SURVEY

The initial Induced Polarization [I.P.] coverage of the south area was followed by a recommendation that an east - west gravity profile be run across the broad probable I.P. anomaly west of the Grand Reef mine. The purpose of the gravity survey was to determine the approximate thickness of alluvium as an aid to interpretation of the I.P. results.

RESULTS OF WORK

NORTH ZONE INDUCED POLARIZATION

(Refer to McPhar Report on Grand Central, Tule Grids)

Induced Polarization [I.P.] results in this area do not seem to show any indication of the inferred apophysis of mineralized intrusive. The minor I.P. affects which seem to be related to narrow near-surface sources were anticipated and are not considered to be of interest at this point.

The effective depth factor of this I.P. work must be assumed to be no greater than the electrode interval of 1000 feet.

NORTH ZONE GEOCHEMICAL SURVEY

Results of the rock-chip geochemical sampling in this area show a concentration of copper values within the Pinal Schist along the northern margin of the Tule - Copper Bar block of Paleozoic rocks. Several nearby copper prospects occur near the Bolsa - Pinal contact, but copper showings in the Pinal itself are less common.

The large block of Paleozoic rocks of the Iron Cap area with its numerous patches of tactite shows relatively low copper values. An exception is the Lead Saddle area [NE Cor. Sec. 30], again near the Bolsa - Pinal contact.

Between the Paleozoic block of the Iron Cap and that of the Tule - Copper Bar is a small copper anomaly in Pinal Schist. Overlapping the copper anomaly is a molybdenum anomaly which trends toward the southwest, then turns and parallels the copper anomaly at the north margin of the Tule - Copper Bar block. This molybdenum anomaly is roughly shaped like the letter "C" - with the open part to the east. Related to the geology, this "C" shaped anomaly roughly defines the Pinal Schist block of the Tule Canyon area.

SOUTH ZONE INDUCED POLARIZATION

(Refer to McPhar Report on Grand Reef Grid)

Results of the Induced Polarization [I.P.] survey indicate a broad probable I.P. anomaly with a north - south trend, beginning approximately one mile west of the Grand Reef mine. The anomalous situation was detected on all east - west lines from L-31200S through L-36400S, giving an indicated north - south length of one mile. L-33800S, which appears to define the western limits of the anomalous area, indicates an east - west dimension of possibly one mile. The source of the anomaly is considered to be shallow, relative to the 1000-foot electrode spread.

A second probable I.P. anomaly was detected approximately 1500-feet southwest of the Grand Reef mine. The source of this anomaly is considered to be narrow, and deep, relative to the 1000-foot electrode spread.

SOUTH ZONE GEOCHEMICAL SURVEY

The area sampled was rather small and no anomalous trends can be detected. Higher copper values do show up in the zone of metamorphic rock between Santa Teresa Granite and the Grand Reef structure. Also, based on the limited data, it appears that both copper and molybdenum values are higher in Santa Teresa Granite than in Horse Mountain Volcanics, in the area sampled.

SOUTH ZONE GRAVITY PROFILE

A gravity profile was run along L-33800S to help in interpreting the I.P. anomaly described previously. The results indicate an alluvial cover of only 400 or 500 feet over the I.P. anomaly and thus indicate a bedrock source for the I.P. effect.

CONCLUSIONS

NORTH ZONE

Results of the Induced Polarization [I.P.] coverage do not seem to show any evidence of the postulated intrusive through the effective depth of coverage which is estimated to be approximately 1000 feet.

Possible significance should be attached to the fact that a large area of Pinal Schist between the Iron Cap and Tule - Copper Bar blocks contains anomalous copper and molybdenum trends. [The question arises as to what constitutes background copper or molybdenum values. It would seem that any given district must be considered as a separate case. In the areas covered by our present work in the Aravaipa District we consider copper values above 50 parts per million and molybdenum values above five parts per million to be anomalous.]

An inferred regional structure whose topographic expression is Tule Canyon cuts through the copper - molybdenum anomaly area, continuing northeastward into Goodwin Canyon Quartz Monzonite.

A third factor to be considered in this area is Magnetic Anomaly "P" [see Figure 1].

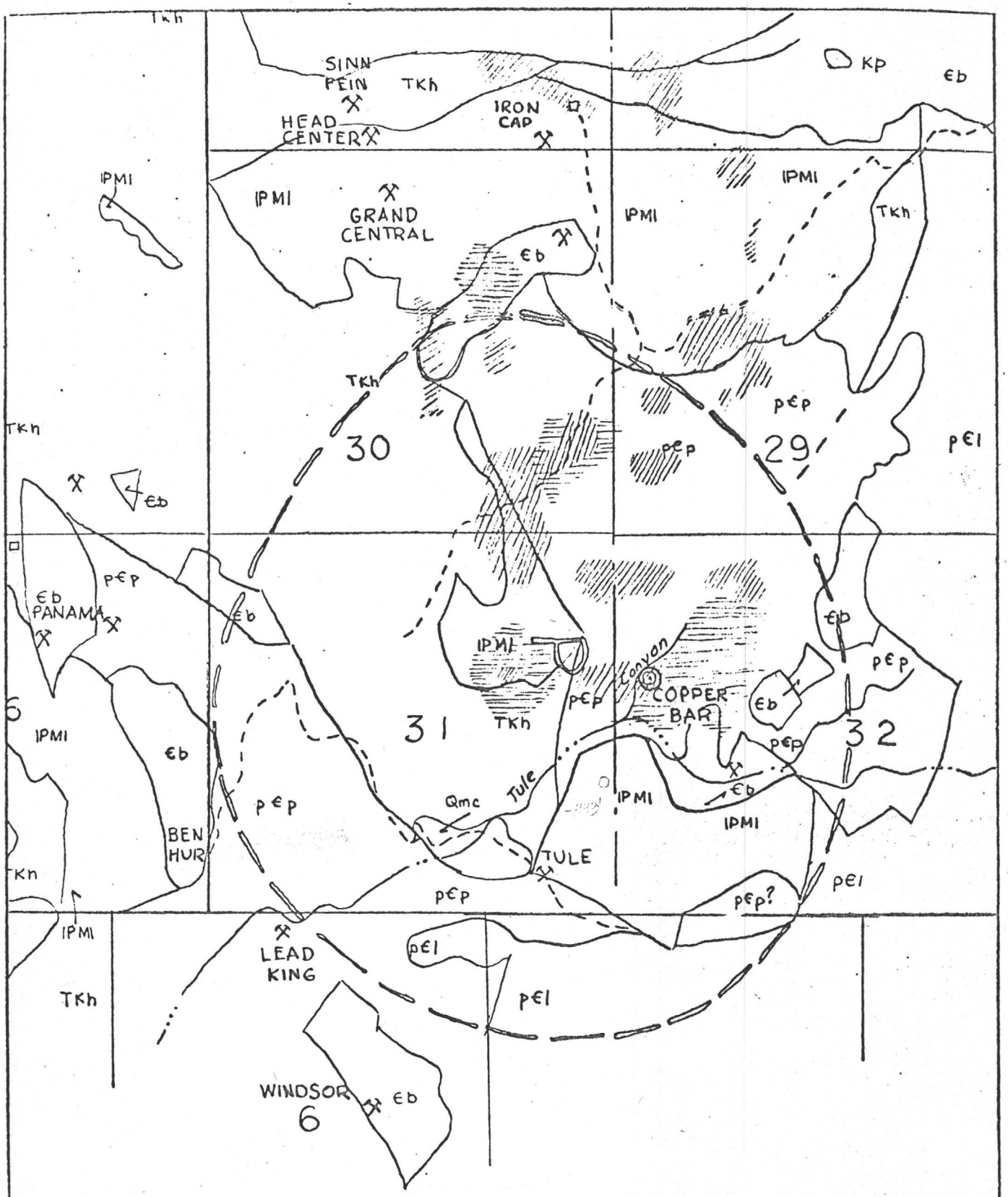

FIGURE 1.- NORTH ZONE

MAGNETIC HIGH 'P'

COPPER +50 PPM MOLYBDENUM +6 PPM

PROPOSED DRILL HOLE

A second possible cause of I.P. effects of this magnitude could conceivably be inductive coupling. The usual method of determining the effects, if any, of inductive coupling is to check a number of stations with low frequency: i.e., at 0.125 and 1.25 cycles per second, instead of the regular frequencies [used in this survey] of 0.31 and 2.5 cycles per second. This check was attempted but was inconclusive because of the volume of noise encountered. Such noise might originate from telluric currents or from a massive sulfide conductor - but the latter would not be suspected in this case.

Analyzing this broad I.P. effect in relation to the geology, it would seem that the source [if it is in bedrock] would most likely be in Tertiary volcanic rocks. This follows from the assumption that the down-drop on the west side of the Grand Reef fault is something like 1000 feet - which should put any possible Paleozoic strata considerably beneath the estimated source of the anomaly.

There is a general coincidence of this broad, weak I.P. anomaly with Magnetic Anomaly "H" which was interpreted as being rather shallow and due to polarization in the volcanics. [See Figure 2.] These features do not necessarily reinforce the thesis developed in the Reconnaissance Report for this area, mainly because of the indicated shallow source for both the I.P. and magnetic anomaly.

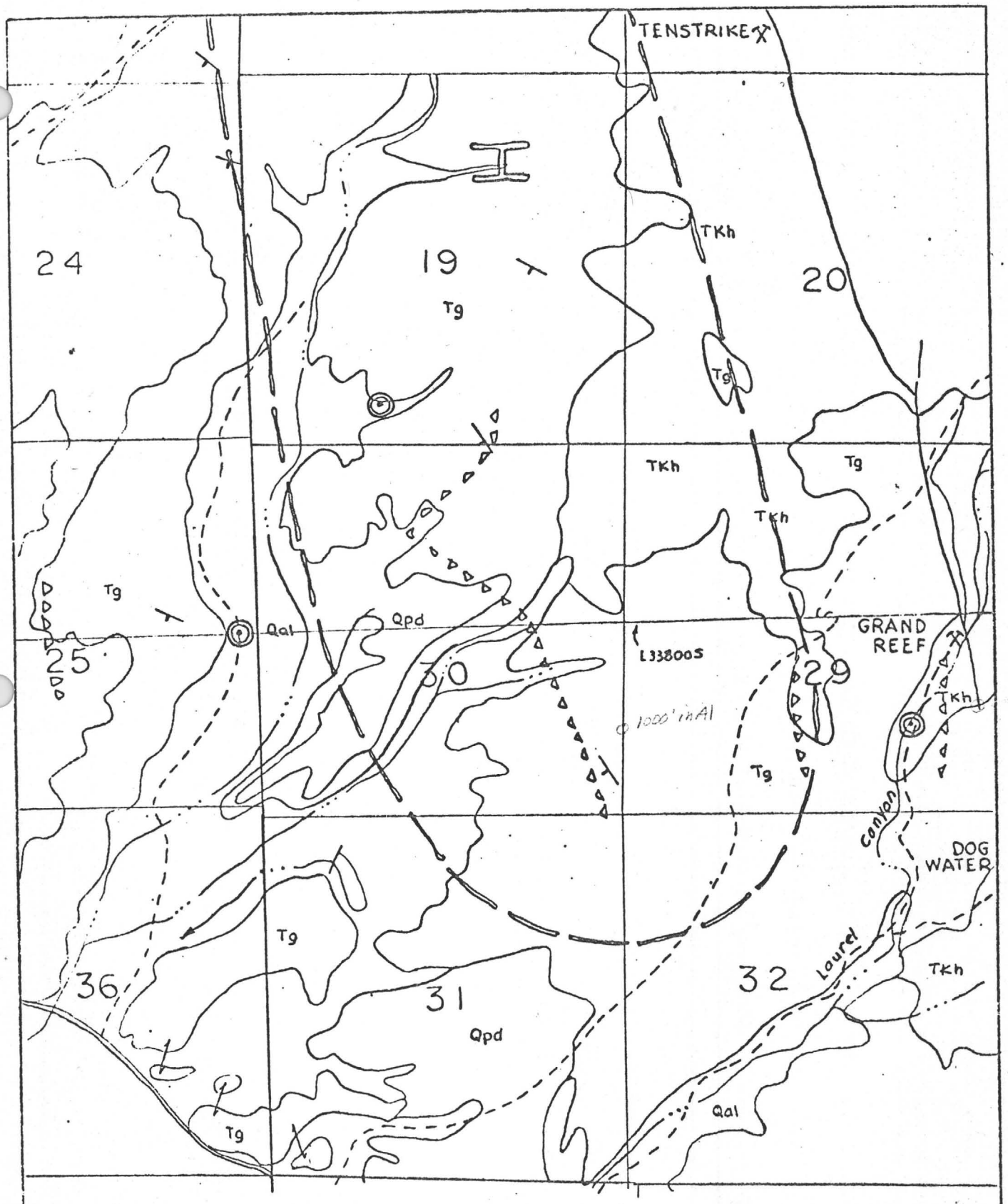

FIGURE 2 - SOUTH ZONE

MAGNETIC HIGH - 'H'

INDUCED POLARIZATION ANOMALY

PROPOSED DRILL HOLE

Despite the somewhat ambiguous nature of the I.P. anomaly, it is of sufficient interest to merit testing of the source of drilling.

The second probable I.P. anomaly, located about 1500 feet southwest of the Grand Reef mine, is smaller in areal extent but with about the same magnitude of I.P. effect as for the anomaly discussed above. The source is considered to be deep with respect to the electrode spacing, or something greater than 1000 feet. The data suggests a narrow, deep source with some minor effects reaching to near surface. Again, the probable host rock would seem to be Tertiary volcanics. Based on the known ore occurrences in the area, this source might be a Grand Reef type vein-like ore shoot.

Another possibility which should be given some consideration is that the deep narrow source could be related to the top of the inferred mineralized intrusive.

RECOMMENDATIONS

Based on the foregoing, drill testing of target areas is recommended in the following order of priority:

1. The broad I.P. anomaly whose eastern edge is approximately one mile west of the Grand Reef mine.

2. The smaller I.P. anomaly located approximately 1500 feet southwest of the Grand Reef mine.

3. The area of Magnetic Anomaly "P".

TARGET AREA 1

This broad zone should be tested by a minimum of two holes drilled to at least 1000 feet of depth. Proposed hole locations are shown on Figure 2 which can be related to the areal geologic map. Both locations are well within the eastern boundary of the I.P. anomaly. The southernmost hole is off the west edge of Magnetic Anomaly "H" - while the hole to the north is located on Magnetic Anomaly "H". The locations are situated in areas where a minimum of drill site preparations will be necessary.

It is recommended that a rotary drill rig be used to penetrate the alluvial section to bedrock. The predicted depth of alluvium is something less than

500 feet. It should be possible to rotary drill the alluvial section with air. Cuttings should be collected and examined at 5-foot intervals. If water is encountered within the alluvial section so that it is necessary to drill with mud, the same procedure should be followed with cuttings from the mud trough. The bedrock section should be diamond drilled [NX core size] with a rig capable of coring to beyond 2000 feet of depth, in the event that early coring results indicate that deeper penetration is necessary.

TARGET AREA 2

This target should be tested with a minimum of one hole drilled to a depth of at least 2000 feet. The proposed location shown on Figure 2 places the hole slightly to the east of the center of the anomaly. The choice of this location was influenced in part by the topography. To move the hole farther west to the exact center of the I.P. anomaly would require considerable road construction in Gila Conglomerate. It seems doubtful that the added expense would be warranted.

This hole will collar in Horse Mountain [Tertiary] volcanics. It should be diamond drilled [NX core size] all the way, and a drill rig capable of drilling in excess of 2000 feet should be used.

TARGET AREA 3

The target outlined by Magnetic Anomaly "P" seems, at this point, to have less merit than Target 1. However, in the event that drilling results on Target 1 are negative, a case could be made for testing Target 3 rather than Target 2. The reason for this is that Targets 1 and 2 are in a similar environment, while Target 3 - approximately five miles to the north - derives its drilling potential from a completely different set of geologic circumstances.

It is recommended that a minimum of one hole, drilled to a depth of at least 2000 feet, be drilled to test Target Area 3. The hole location, as shown on Figure 1, is near the center of the magnetic anomaly and within the copper - molybdenum geochemical trend.

The hole will collar in Pinal Schist and should be diamond drilled with NX coring tools as described for the previous holes.

REPORT ON
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
GRAND CENTRAL,
TULE AND GRAND REEF GRIDS
MUELLER PROJECT, GRAHAM CO., ARIZONA
FOR
THE RALPH M. PARSONS COMPANY

McPHAR GEOPHYSICS

REPORT ON

INDUCED POLARIZATION

AND RESISTIVITY SURVEY

ON THE

GRAND CENTRAL,

TULE AND GRAND REEF GRIDS

MUELLER PROJECT, GRAHAM CO., ARIZONA

FOR

THE RALPH M. PARSONS COMPANY

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1. INTRODUCTION

At the request of the Ralph M. Parsons Company, reconnaissance induced polarization and resistivity surveys have been carried out on the Mueller Project in Graham County, Arizona. The Project area is situated midway between Florence and Safford, about 100 miles SSE from Phoenix.

Geological maps supplied by the Ralph M. Parsons Company indicate a complex geological history. Generally, the eastern part of the area is underlain by Precambrian granite and schist, with small sections of Paleozoic sediments and larger areas of Tertiary extrusives and intrusives. The western and northwestern sections are covered by an unknown thickness of Tertiary and Quaternary continental clastic sediments. Apparently a major fault or fault zone trends NNW through the Project area, separating the older formations to the east from the younger sediments to the west. There is some indication from local wells that the throw on this fault may be relatively minor and therefore the sediments may be thin.

The region has undergone intensive folding, faulting and fracturing and contains several copper occurrences. These conditions are frequently indicative of a favourable locus for "porphyry copper" type mineralization and hence the area is of considerable interest.

Parts of three grids were surveyed, identified as the Grand Central, Tule and Grand Reef. Lines were run east-west at quarter mile spacings using 1,000 foot electrode intervals, to search for any large disseminated sulphide deposits that might be present.

2. PRESENTATION OF RESULTS

The Induced Polarization and Resistivity results are shown on the following data plots in the manner described in the notes preceding this report.

A) Grand Central Grid

Line 1320N	1,000 foot spreads	Dwg. IP 5164-1
Line 0	1,000 foot spreads	Dwg. IP 5164-2
Line 1320S	1,000 foot spreads	Dwg. IP 5164-3
Line 2640S	1,000 foot spreads	Dwg. IP 5164-4
Line 3960S	1,000 foot spreads	Dwg. IP 5164-5
Line 5280S	1,000 foot spreads	Dwg. IP 5164-6

B) Tule Grid

Line 8400S	1,000 foot spreads	Dwg. IP 5166-1
Line 9700S	1,000 foot spreads	Dwg. IP 5166-2
Line 11,000S	1,000 foot spreads	Dwg. IP 5166-3

C) Grand Reef Grid

Line 31,200S	1,000 foot spreads	Dwg. IP 5165-1
Line 32,500S	1,000 foot spreads	Dwg. IP 5165-2
Line 33,800S	1,000 foot spreads	Dwg. IP 5165-3
Line 35,100S	1,000 foot spreads	Dwg. IP 5165-4
Line 36,400S	1,000 foot spreads	Dwg. IP 5165-5

Enclosed with this report are Dwgs. I.P.P. 4440 and 4441 plan maps of the grids at a scale of 1" = 1,000' showing the geophysical results in relation to the geology, as provided by the Company. The definite and possible induced polarization anomalies are indicated by solid and broken bars respectively on this plan map as well as the data plots. These bars represent the surface projection of the anomalous zones as interpreted from the location of the transmitter and receiver electrodes when the anomalous values were measured.

Since the induced polarization measurement is essentially an averaging process, as are all potential methods, it is frequently difficult to exactly pinpoint the source of an anomaly. Certainly, no anomaly can be located with more accuracy than the spread length; i.e. when using 1,000' spreads the position of a narrow sulphide body can only be determined to lie between two stations 1,000' apart. In order to locate sources at some depth, larger spreads must be used, with a corresponding increase in the uncertainties of location. Therefore, while the centre of the indicated anomaly probably corresponds fairly well with source, the length of the indicated anomaly along the line should not be taken to represent the exact edges of the anomalous material.

3. DISCUSSION OF RESULTS

A) Grand Central Grid

Line 1320N

The results from this traverse indicate a possible weak anomaly extending from about station 65E to station 90E. The source is shallow relative to the electrode interval (i.e. less than 1,000 feet deep) and must contain only a minor amount of metallic mineralization.

There is also a possible shallow narrow feature between 10W and 20W.

Line 0

Here there is a possible anomaly centred at about station 60E, immediately east of the Iron Cap prospect, that probably correlates with the anomaly on Line 1320N.

Line 1320S

A possible shallow weak source is indicated at 10W to 20W. Minor increases in the Metal Factor values occur elsewhere on the traverse but they do not seem to be important.

Line 2640S

Possible anomalies occur at the east and west ends of these lines but the contour patterns are incomplete. The western anomaly may correlate with the series of prospects between Line 2640S and Line 3960S and therefore it may be advisable to extend the traverse to the west in order to complete the anomaly.

Line 3960S

A possible weak source is present on the east part of this line, comparable to the feature on Line 2640S.

B) Tule Grid

Line 5280S

On this line there is a possible, but incomplete, anomaly at 30W to 50W.

Line 8400S

Possible shallow weak features occur at 10E to 20E and 80E to 90E; the latter may be related to the Copper Bar prospect.

Line 9700S

Weak features are present at 20E to 30E and 40E to 50E, the latter correlating with the Tule Prospect. These appear to represent shallow, narrow sources and could be better evaluated by detailing with shorter electrode intervals, as described in the Appendix following this report.

Line 11,000S

Minor increases in the Metal Factor values were measured on the western part of this line but the patterns are not definite enough to be considered anomalous.

C) Grand Reef Grid

Line 31,200S

A possible weak source, with some depth to the top, is indicated

from 100E to 120E.

The entire western part of the traverse is anomalous from about station 40E. The section between 20E and 30W contains the highest Metal Factor values encountered so far in this area and the anomaly is still open to the west. This area is mapped as Quaternary and Tertiary gravels and alluvium.

Line 32, 500S

Similar results were obtained on the western part of this traverse but the anomaly is stronger, especially the section from 15W to 15E.

Line 33, 800S

Again there is a probable anomaly on the west part of the line but the data does not extend far enough to complete the pattern. In addition there is a possible narrow feature at 70E to 80E.

Line 35, 100S

The western zone is still present but again is incomplete. There is also a moderate magnitude anomaly centred at 80E, correlating with weaker anomalies on the two adjacent lines. This is one of the most definite features encountered during the survey and appears to represent a relatively narrow concentrated source. If the geological data indicates that this type of source could be of interest, then further work should be carried out. First the anomaly should be detailed with shorter electrode intervals, as described in the Appendix on Narrow Sources, and then intermediate lines should be surveyed to determine the optimum location for a drill test.

Line 36,400S

As on the three preceding traverses, the western anomaly is present but incomplete. A possible anomaly occurs at 80E but it is not as strong or definite as on Line 35,100S.

4. SUMMARY AND RECOMMENDATIONS

No strong or definite anomalies were found on the Grand Central and Tule Grids. Weak IP effects were encountered on every traverse and these are shown as possible anomalies on the data plots and plan map. These features are of two types: 1) broad zones suggesting areas of sparsely dispersed metallic mineralization; and 2) relatively narrow sources, possibly concentrated. Anomalies of the first type are too weak to be of immediate interest. The second type may be of interest but require detailing with shorter electrode intervals in order to evaluate them more completely. This would not be warranted unless the geology indicates that vein or replacement type deposits of economic interest may be present.

Stronger and more definite anomalies were located on the Grand Reef Grid and these can be correlated into continuous zones. Broad anomalies of moderate magnitude occur on the west part of all five lines, suggesting an extensive zone of disseminated mineralization. The zone is open to the north, west and east hence the grid should be extended to delimit this feature. It is recommended that Line 33,800S be extended to the west using 1,000 foot dipoles, to complete the pattern from the anomaly. A check should then be carried out at low frequencies (i.e. 0.1 and 1.25 cps) to ascertain the effects, if any, due to inductive coupling.

It would also be advisable to run a gravity profile across this part of the grid in order to estimate the thickness of the clastics. This profile should be run on Line 33,800S from station 13E to station 10W, with observations every 500 feet.

The anomalies centred at 80E on the three southern traverses suggest a narrow, more concentrated, source. This should be evaluated by detailing with shorter electrode intervals (i. e. 750 foot and perhaps 500 foot) and if confirmed then parallel lines should be run, say 500 and 1,000 feet to the north and south of Line 35,100S.

On completion of this additional work, the results would be re-evaluated and a drill test planned if so warranted.

McPHAR GEOPHYSICS INCORPORATED

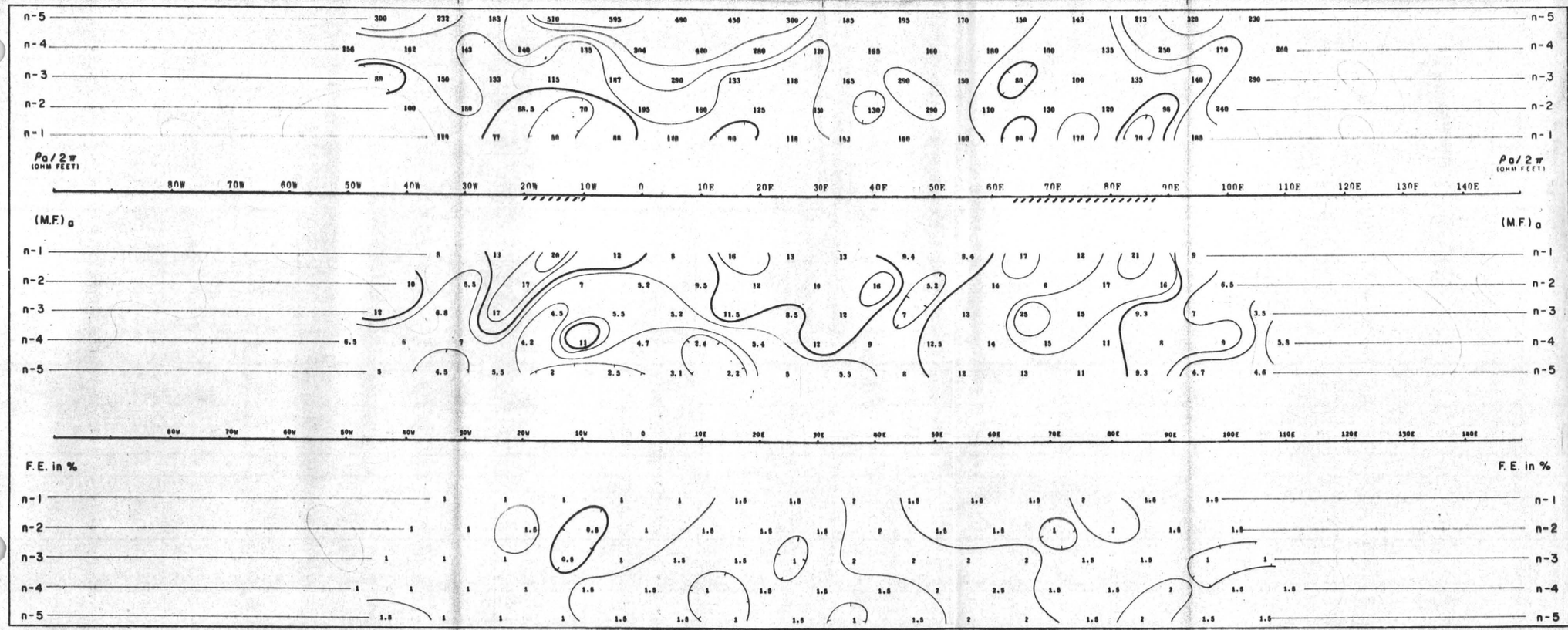
Robert A. Bell

Robert A. Bell,
Geologist.

Philip G. Hallof

Philip G. Hallof,
Geophysicist.

Dated: September 30, 1968



DWG NO.-I.P.-5164-1

THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.- 1320 N

ELECTRODE CONFIGURATION

PLOTTING POINT

x = 1000'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES 0.125-125 cps

DATE SURVEYED JULY 8 SEPT / 68

APPROVED R. S. Bell

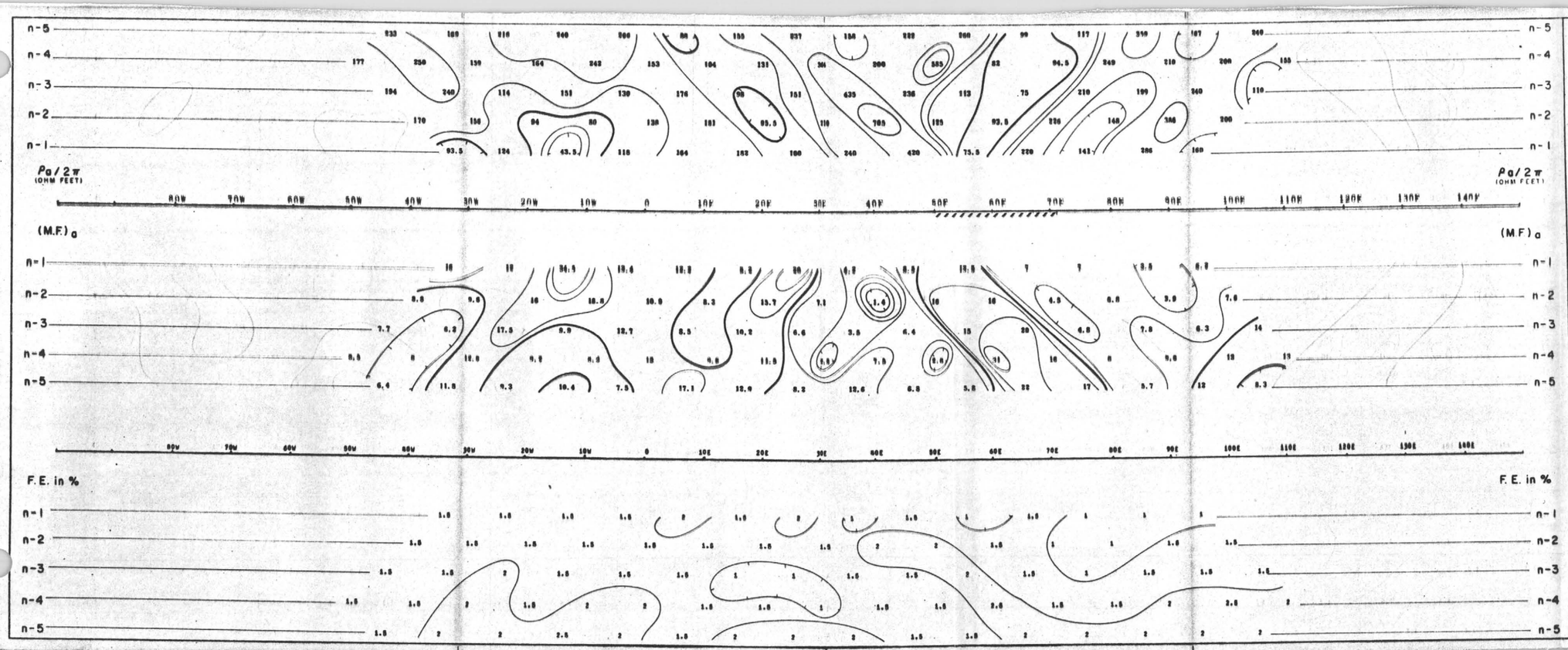
DATE Sept 23/68

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO-IP-5164-2

THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.- 0

ELECTRODE CONFIGURATION

PLOTTING POINT

X = 1000'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES 0.31 - 2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. R. Bell

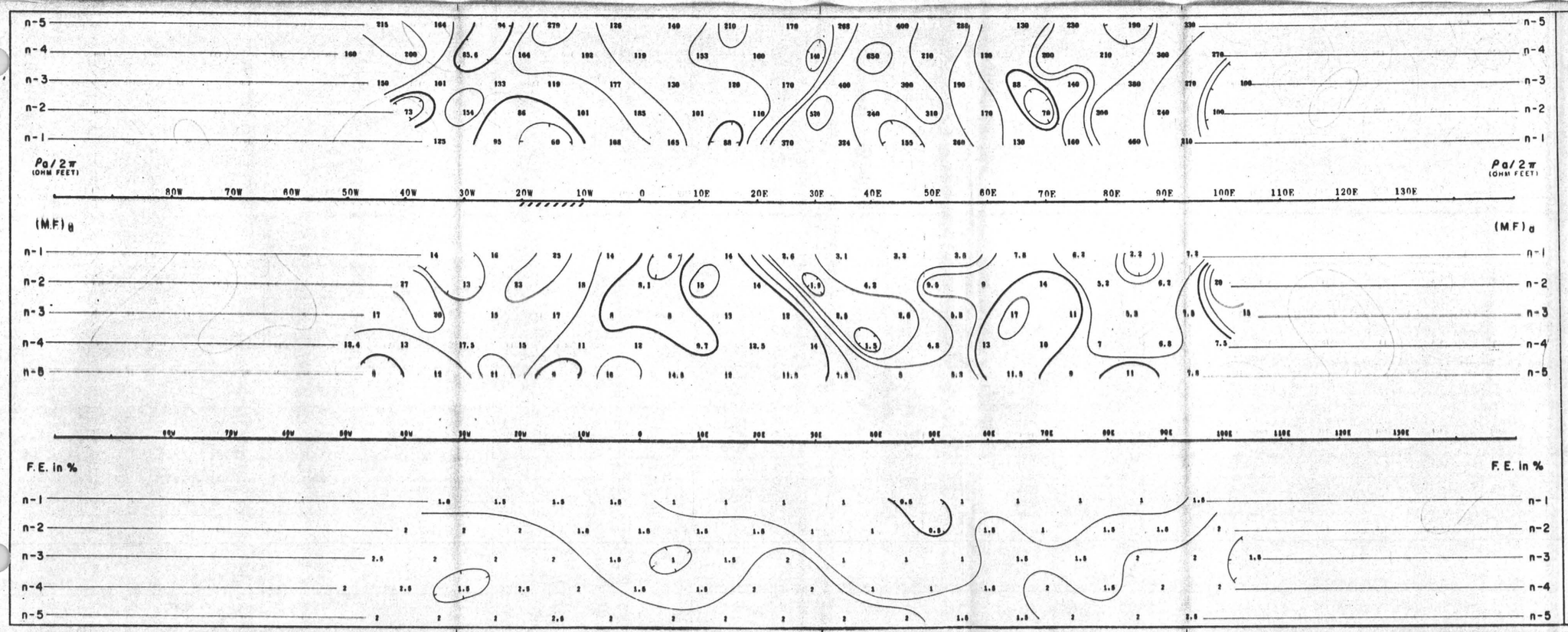
DATE Sept. 12/68

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-I.P.-5164-3

THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.-1320 S

ELECTRODE CONFIGURATION

PLOTTING POINT — X = 1000'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES 0.31 - 2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. C. Bell

DATE Sept 12/69

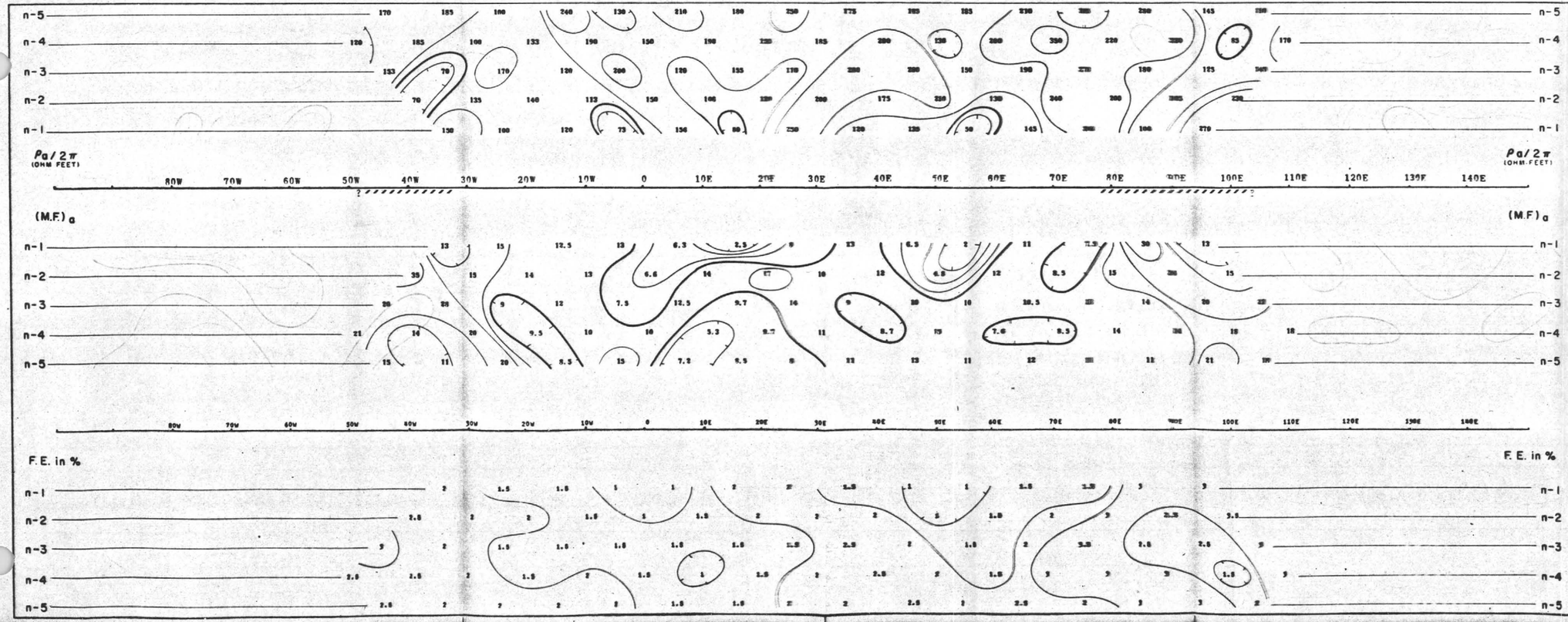
REGISTERED GEOLOGIST — ROBERT ALAN BELL — ARIZONA, U.S.A.

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-I.P.-5164-4

THE RALPH M. PARSONS CO.

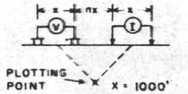
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.- 2640 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0·31 - 2·5 cps

DATE SURVEYED JULY 8 SEPT / 68

APPROVED R. C. Bell

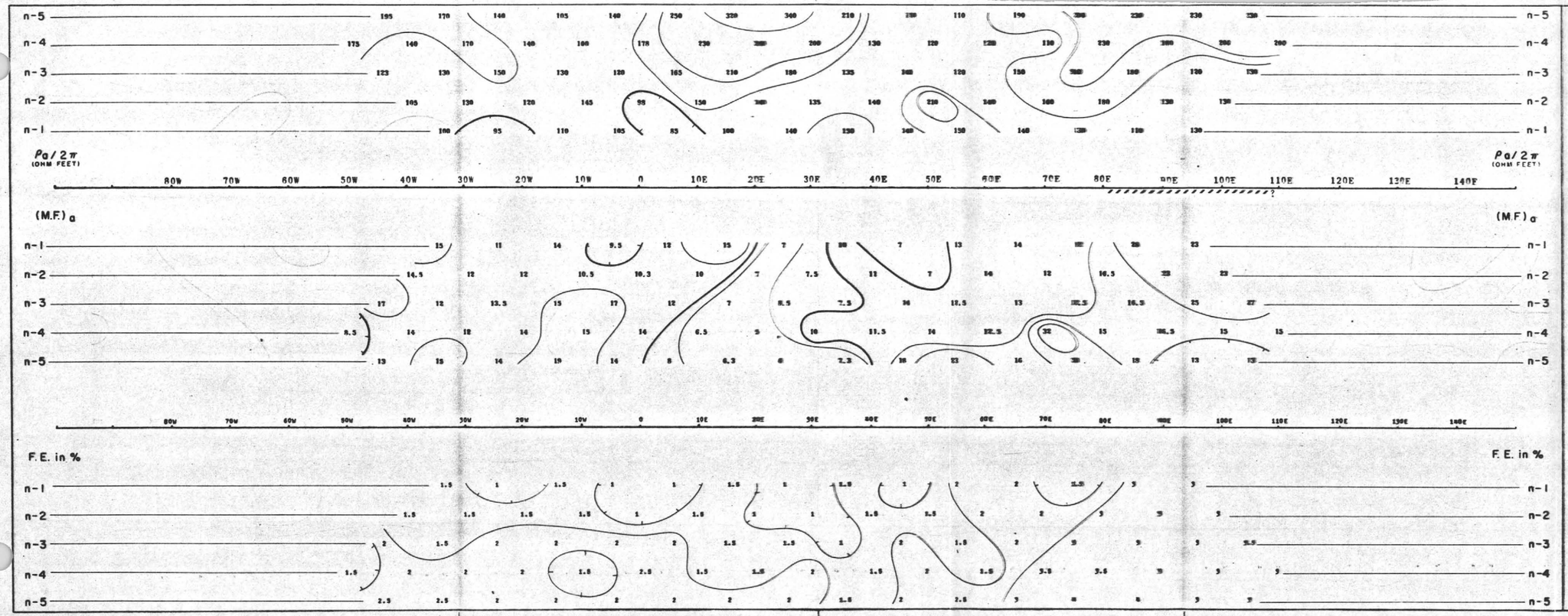
DATE Sept 12/69

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1·5-2-3-5-7·5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-I.P.-5164-5

THE RALPH M. PARSONS CO.

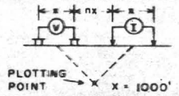
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.- 3960 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31 – 2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. C. Bell

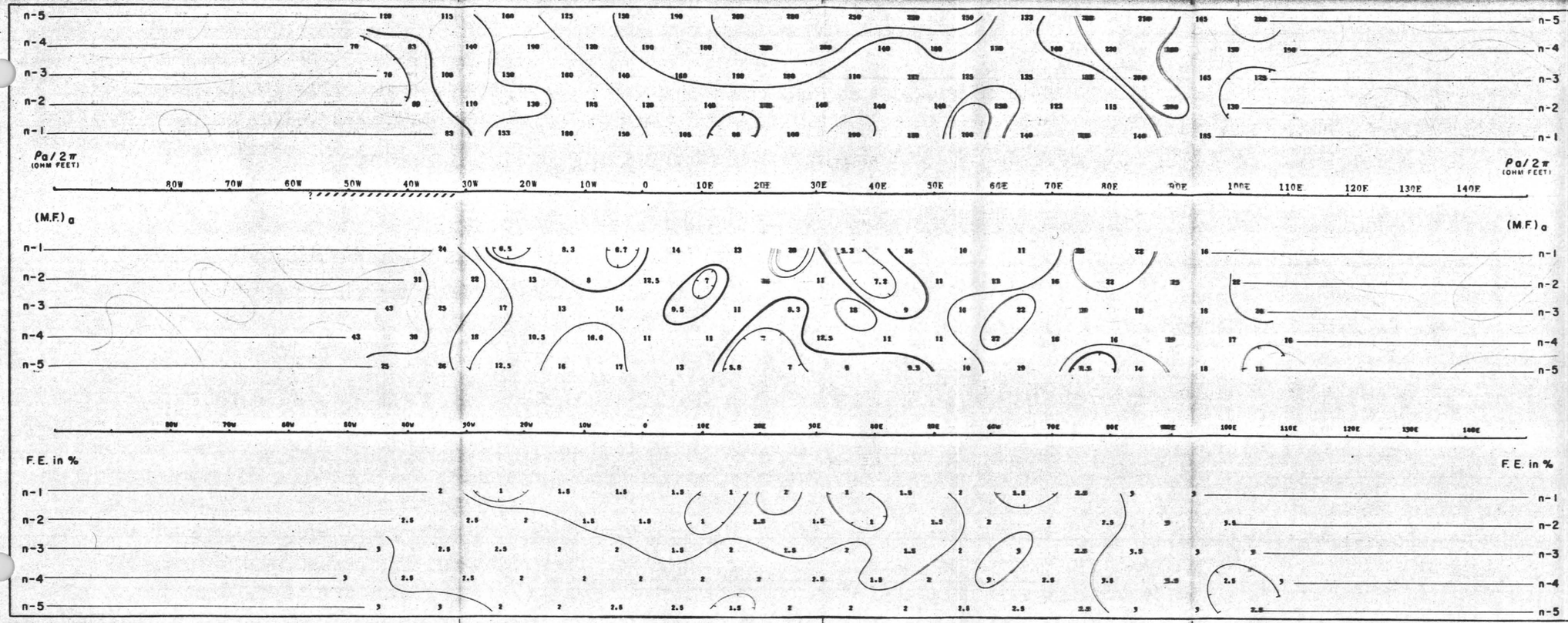
DATE Sept 12/68

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO.-I.P-5164-6

THE RALPH M. PARSONS CO.

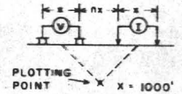
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND CENTRAL GRID

LINE NO.-5280 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0·31 - 2·5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. E. Bell

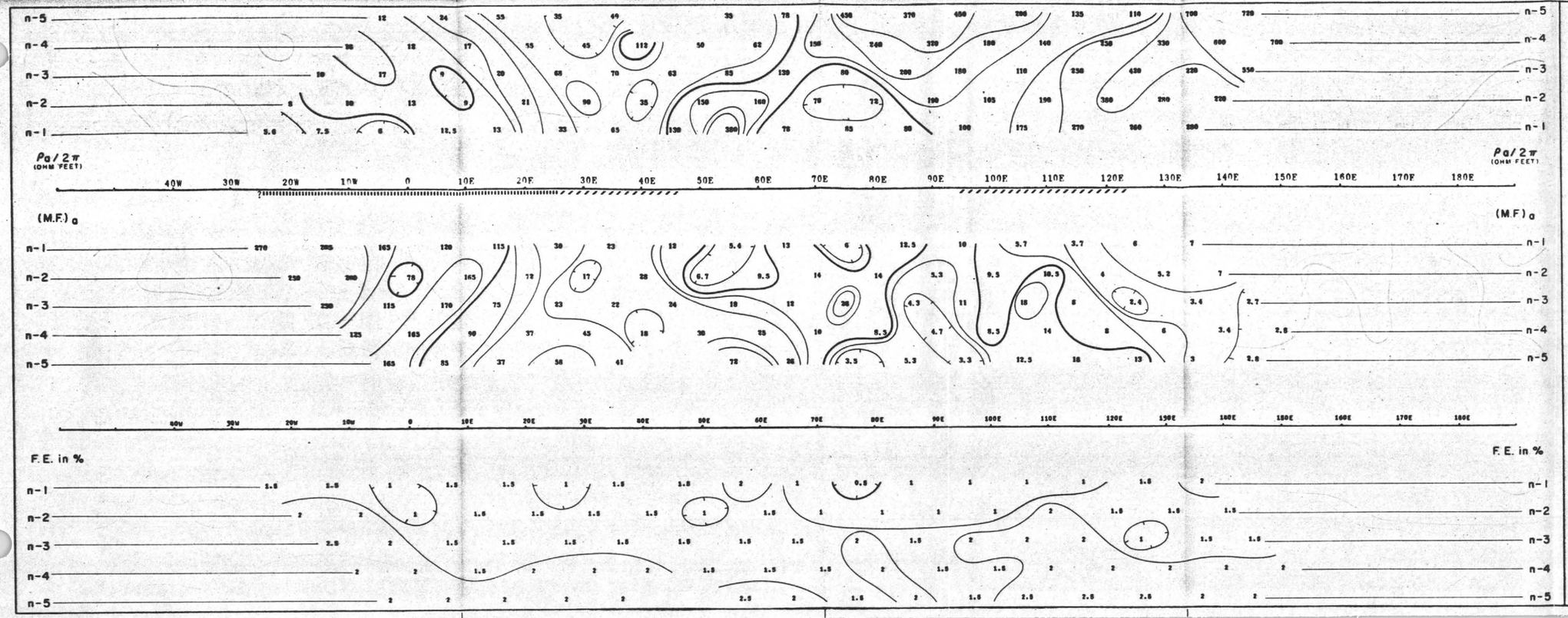
DATE Sept. 12/69

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1·5-2-3-5-7·5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-IP-5165-1

THE RALPH M. PARSONS CO.

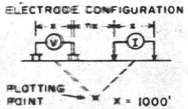
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND REEF GRID

LINE NO.-31200 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED

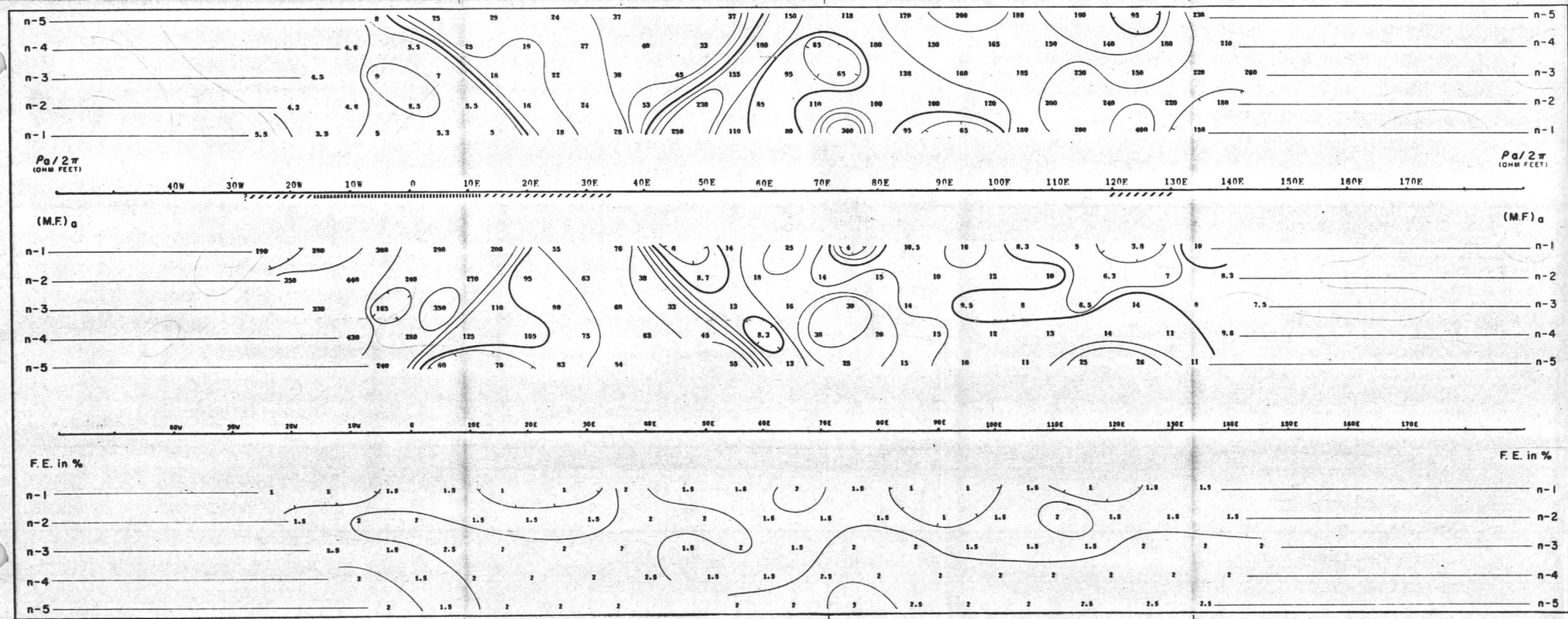
NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

DATE Oct 12/68

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-IP-5165-2

THE RALPH M. PARSONS CO.

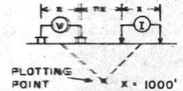
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND REEF GRID

LINE NO.- 32500 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. E. Butler

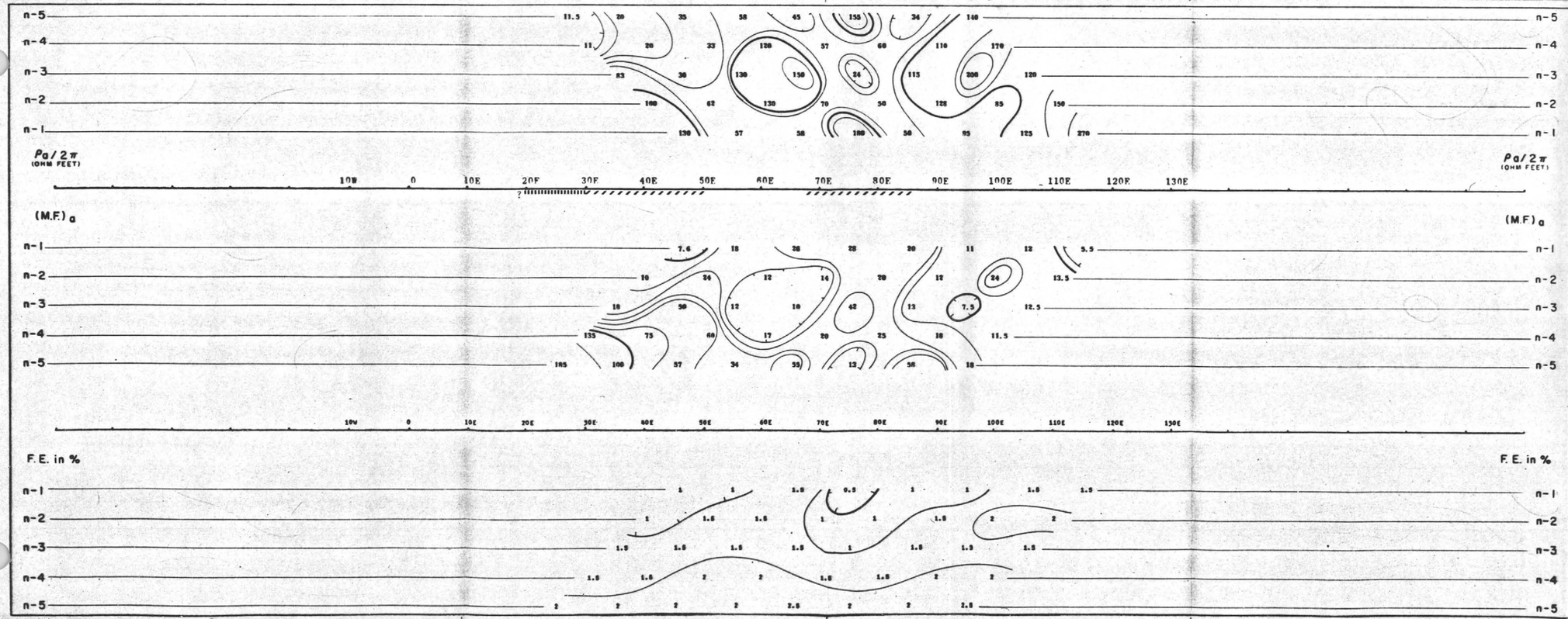
DATE Sept. 12/69

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.-HP-5165-3

THE RALPH M. PARSONS CO.

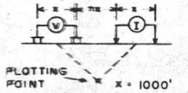
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND REEF GRID

LINE NO.-33800 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. E. Brill

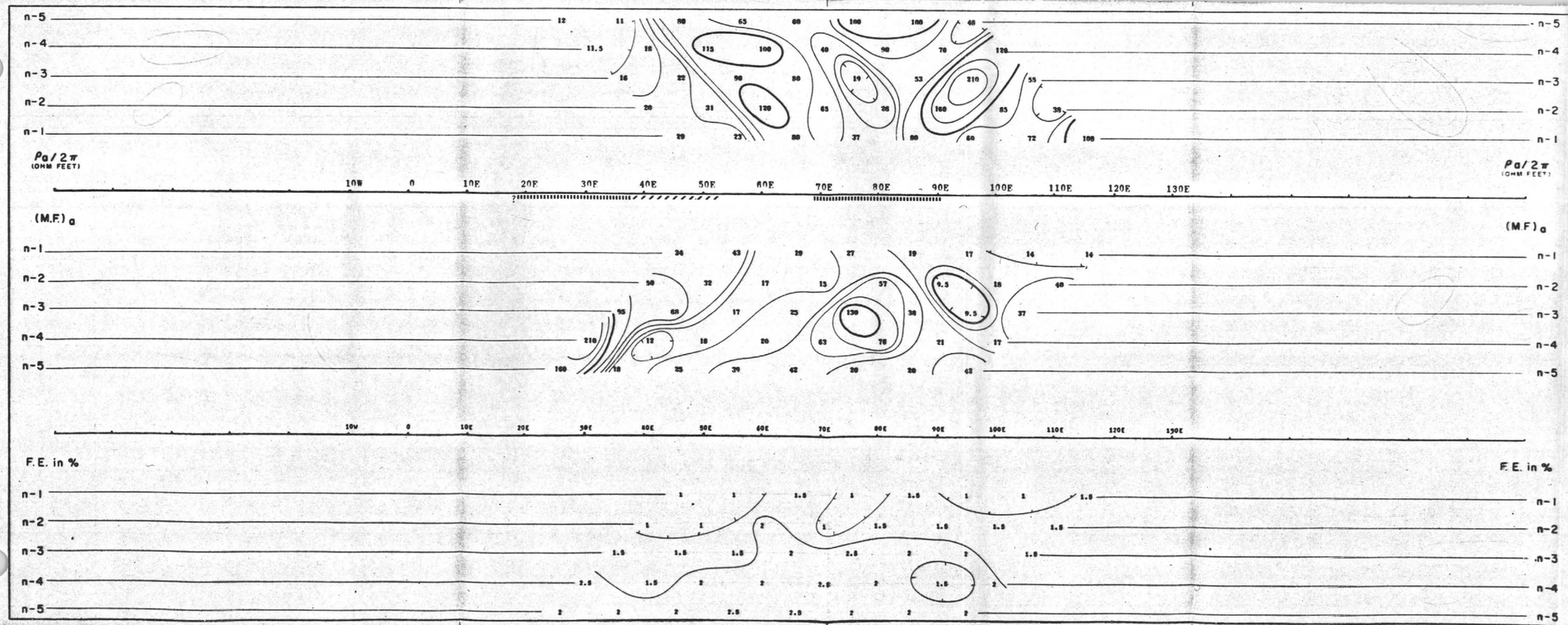
DATE Sept 12/68

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO - I.P - 5165 - 4

THE RALPH M. PARSONS CO.

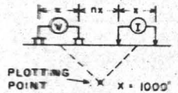
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND REEF GRID

LINE NO.- 35100 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31 - 2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. R. Bell

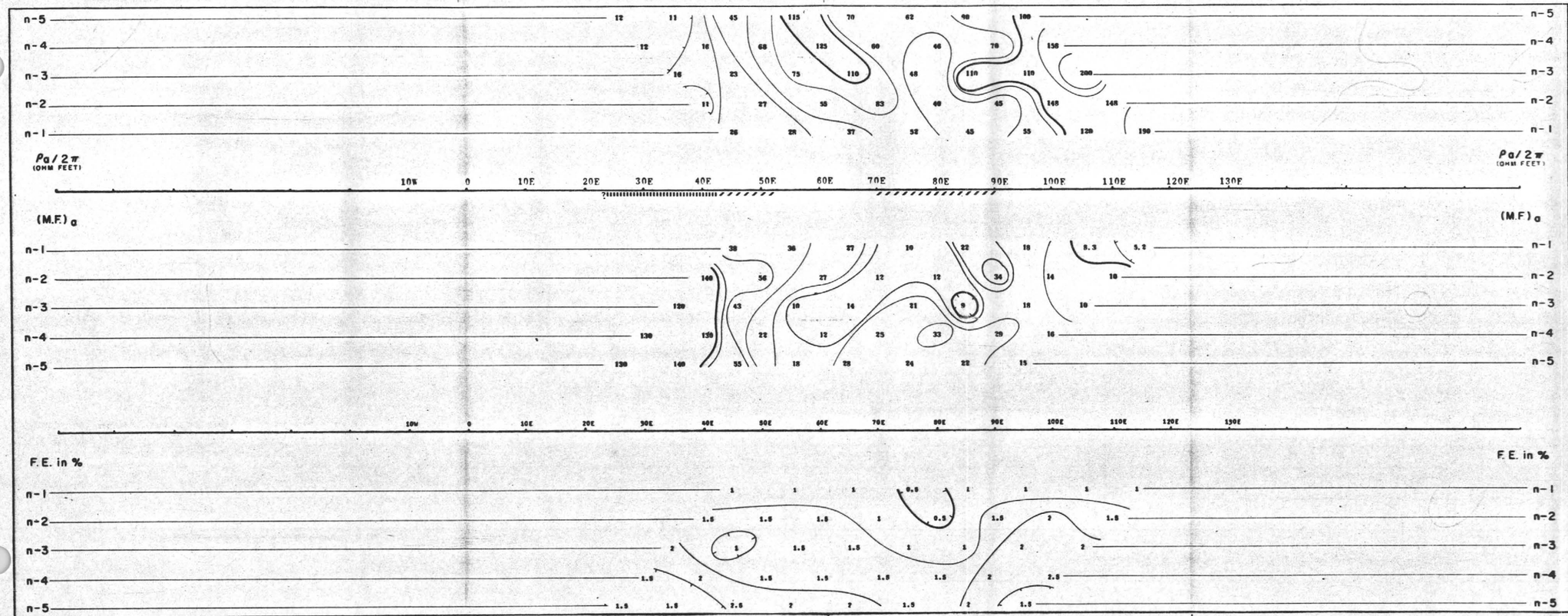
DATE Sept 12/68

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO.-I.P.-5165-5

THE RALPH M. PARSONS CO.

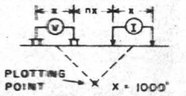
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

GRAND REEF GRID

LINE NO.-36400 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31 - 2.5 cps

DATE SURVEYED: JULY 8 SEPT / 68

APPROVED: R. C. Bell

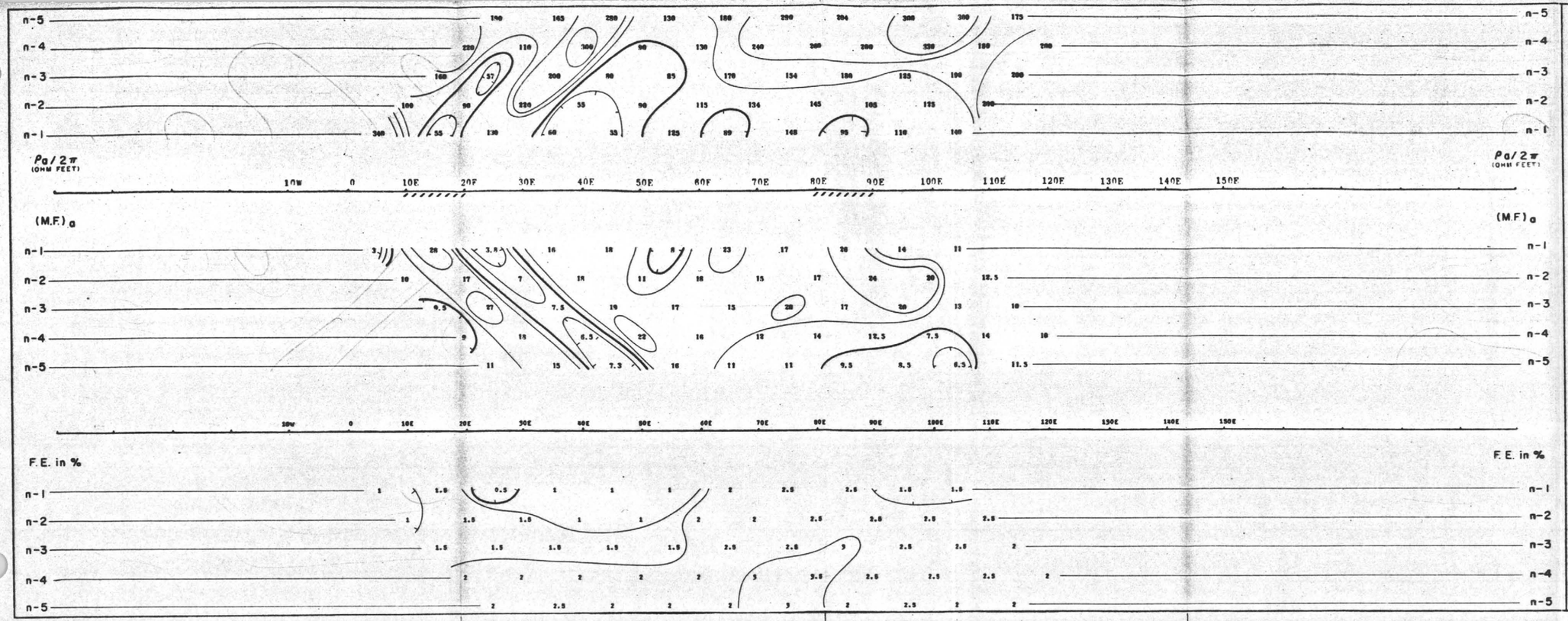
DATE: Sept. 12/69

NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO.-I.P.-5166-1

THE RALPH M. PARSONS CO.

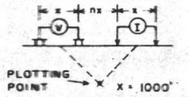
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

TULE GRID

LINE NO.-8400S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31 - 2.5 cps

DATE SURVEYED JULY & SEPT / 68

APPROVED R. C. Bird

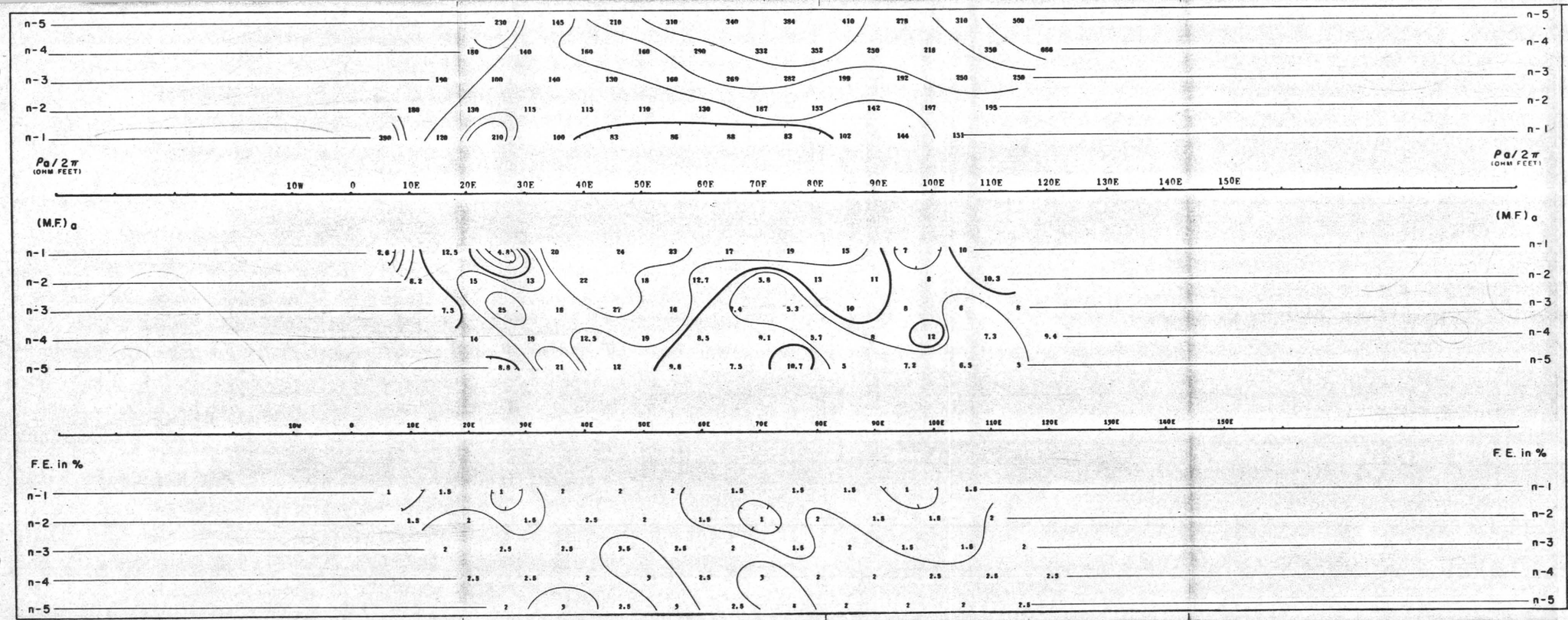
DATE Sept. 12/69

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO - I P - 5166-3

THE RALPH M. PARSONS CO.

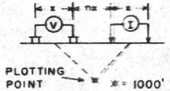
MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

TULE GRID

LINE NO. - 11000 S.

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31 - 2.5 cps

DATE SURVEYED JULY 8 SEPT / 68

APPROVED R. E. Bell

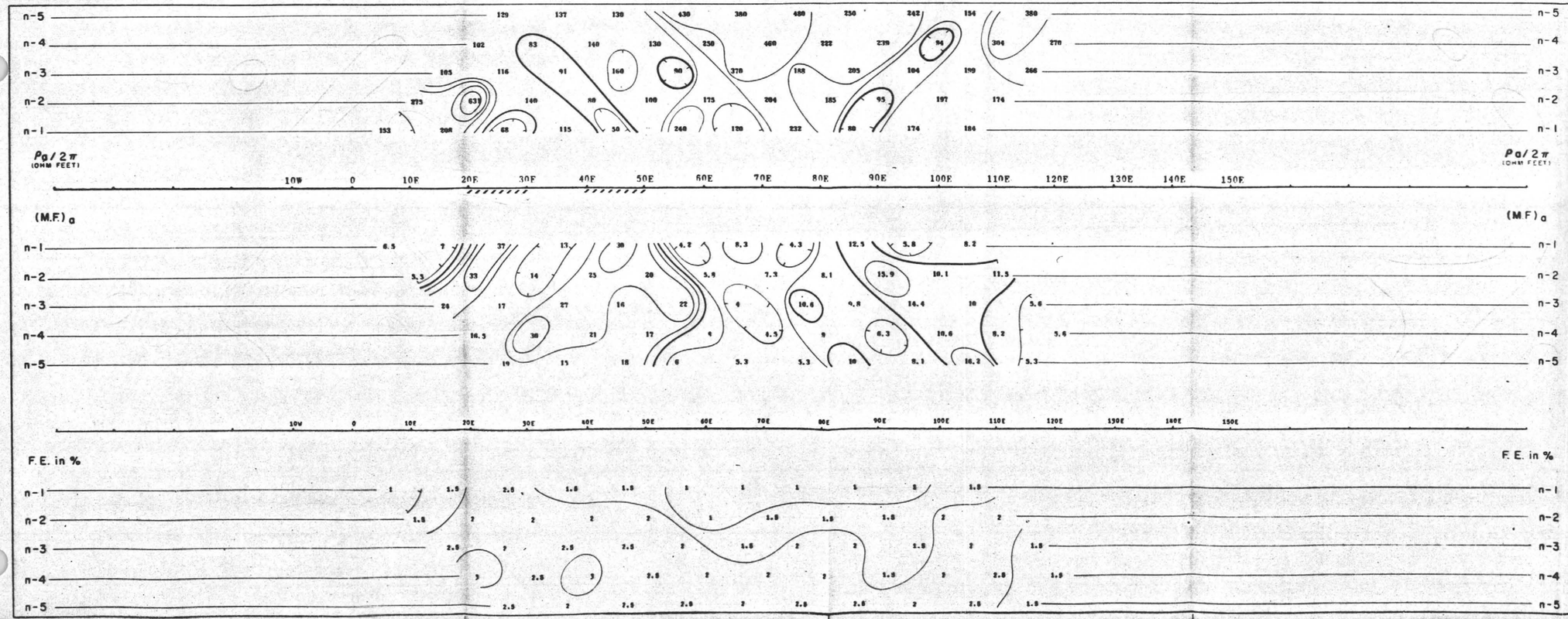
DATE Sept. 12/68

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO.-IP-5166-2

THE RALPH M. PARSONS CO.

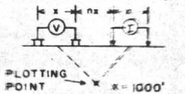
MUELLER ARAVAPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

TULE GRID

LINE NO.-9700S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 cps

DATE SURVEYED JULY & SEPT/68

APPROVED R.A. Bell

DATE Sept 12/69

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

McPHAR GEOPHYSICS

REPORT ON

ADDITIONAL GEOPHYSICAL INVESTIGATIONS

ON THE

GRAND REEF GRID

MUELLER PROJECT, GRAHAM CO., ARIZONA

FOR

THE RALPH M. PARSONS COMPANY

---

1. INTRODUCTION

During the summer of 1968 we carried out reconnaissance induced polarization and resistivity surveys on parts of three grids in the Mueller Project area, Graham County, Arizona and the results were presented in our report dated September 30, 1968. Two zones of probable and possible anomalies were found on the Grand Reef Grid and additional work was recommended in an attempt to confirm the presence of subsurface metallic mineralization. Some additional work was completed in October and the results are presented in the following report.

2. PRESENTATION OF RESULTS

The Induced Polarization and Resistivity results are shown on the following data plots in the manner described in the notes preceding this report.

Line 33,800S	1,000 foot spreads	Dwg. IP 5197-1
Line 34,600S	750 foot spreads	Dwg. IP 5197-2

Line 35, 100S	750 foot spreads	Dwg. IP 5197-3
Line 35, 100S	750 foot spreads	Dwg. IP 5197-4
Line 35, 100S	500 foot spreads	Dwg. IP 5197-5

The gravity profile along Line 33, 800S is shown on Dwg. No. G-5198.

Enclosed with this report is Dwg. I.P.P. 4440 R, a revised plan map of the Main Grid at a scale of 1" = 1,000'. The definite and possible induced polarization anomalies are indicated by solid and broken bars respectively on this plan map as well as the data plots. These bars represent the surface projection of the anomalous zones as interpreted from the location of the transmitter and receiver electrodes when the anomalous values were measured.

Since the induced polarization measurement is essentially an averaging process, as are all potential methods, it is frequently difficult to exactly pinpoint the source of an anomaly. Certainly, no anomaly can be located with more accuracy than the spread length; i.e. when using 1,000' spreads the position of a narrow sulphide body can only be determined to lie between two stations 1,000' apart. In order to locate sources at some depth, larger spreads must be used, with a corresponding increase in the uncertainties of location. Therefore, while the centre of the indicated anomaly probably corresponds fairly well with source, the length of the indicated anomaly along the line should not be taken to represent the exact edges of the anomalous material.

3. DISCUSSION OF RESULTS

Line 33, 800S

The reconnaissance survey results indicated a probable anomaly

extending across the western part of the grid from Line 31,200S to Line 36,400S, still open to the north, south and west. It was recommended that one traverse be extended to the west to determine the full width of the zone and that the anomaly should then be checked at low frequency to test for any possible inductive coupling effects. As a further check, a gravity profile was also recommended to determine the approximate depth to bedrock.

Line 33,800S has now been extended to station 130W, using 1,000 foot dipoles and frequencies of 0.3 and 2.5 cps. The results indicate a probable shallow anomaly (relative to the electrode interval) from about 20E to 40W, with weaker extensions to 50E and 50W. The resistivity level is low from 30E to 40W and quite uniform for all five separations. The apparent frequency effects (and Metal Factor values) are about equal to the expected effects from inductive coupling. Since the anomaly has not been confirmed by checking with low frequencies it is not possible to state unequivocally whether the source is sub-surface metallic mineralization, inductive coupling or a combination of the two.

A gravity profile has also been run along this line and the results are shown on Dwg. G-5198. There is a well defined gravity low, centred at station 20W, that correlates with the gravel-filled valley. It is not possible to do an exact interpretation of bedrock depth from a single profile but a semi-quantitative analysis has been made using the formula developed by Brant (1) and assuming a certain density contrast between the basement

---

1. Brant, Arthur A.; Geophysics in the Exploration for Arizona Porphyry Coppers; Geol. of the Porphyry-Coppers, Titley & Hicks, 1966.

rocks and the clastic sediments. This method suggests a depth of 400' - 500' which we understand is in general agreement with limited well data from this area. Consequently, the observed IP effects must originate from the basement rather than from a thick layer of conductive overburden.

Line 34, 600S

A second anomalous zone was indicated by the original survey just to the west of the Grand Reef prospect and further investigation was recommended. The strongest anomaly was obtained on Line 35, 100S and it was suggested that this be confirmed by detailing and intermediate parallel lines. Line 34, 600S would be 500 feet north of reconnaissance Line 35, 100S and was surveyed with 500 foot dipoles. There is a low magnitude, probable anomaly centred at station 77.5E, with considerable depth to the top of the source. This feature correlates with the previous zone.

In addition there is a possible shallow anomaly at 92.5E and an incomplete anomaly at 115E, but these indications are too weak to be of prime interest.

Line 35, 100S

This line was surveyed twice with 750 foot dipoles, using different stations, and also with 500 foot dipoles. The results with 750 foot dipoles indicate a probable deep source of low to moderate magnitude centred at about 80E, confirming the original data.

With 500 foot dipoles there is a narrow shallow anomaly at 70E to 75E that increases in magnitude with depth. The shallow part of the anomaly is not too apparent with the larger electrode intervals, presumably

because of the size factor.

4. SUMMARY AND RECOMMENDATIONS

The additional IP work on Line 33,800S has defined the western edge of the IP zone but the anomaly has still not been confirmed by checking with low frequencies. A single gravity profile has been surveyed along this traverse and there is a distinct low over the alluvium filled valley. Semi-quantitative analysis of the gravity data suggests only a few hundred feet of overburden, which we believe is consistant with local well data. From this it seems reasonable to conclude that the probable IP anomaly represents a large volume of weak metallic mineralization in the bedrock.

Additional investigations in the vicinity of the Grand Reef prospect have confirmed the presence of a narrow, low magnitude zone trending in a north-south direction. The main source appears to be at considerable depth although there is a weak extension of the anomaly to shallow depth. The anomaly is not strong and therefore would not be of prime interest unless the geological conditions suggest the possibility of vein or replacement type deposits.

McPHAR GEOPHYSICS INCORPORATED

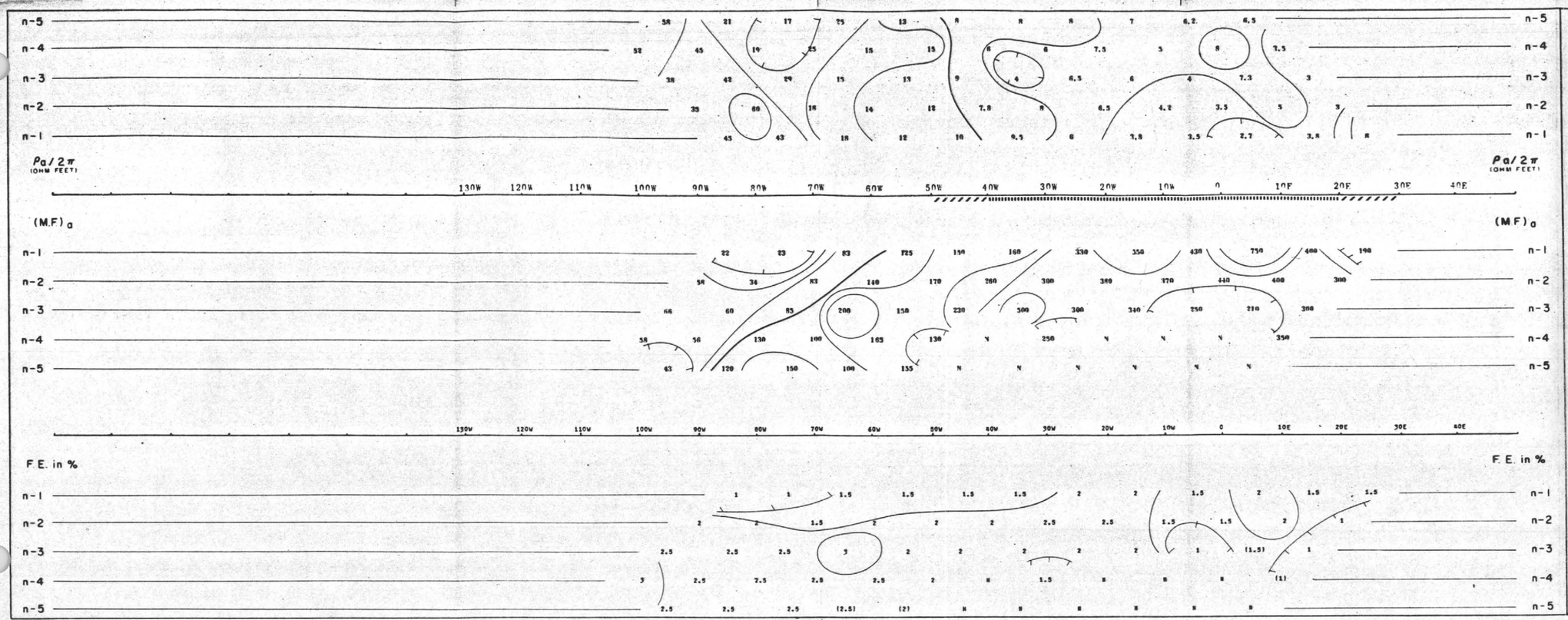
Robert A. Bell.

Robert A. Bell,
Geologist.

David K. Fountain

David K. Fountain,
Geophysicist.

Dated: November 13, 1968



DWG NO.-IP-5197-1

THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO.-33,900S

ELECTRODE CONFIGURATION

PLOTTING POINT

x = 1000'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES 0.31-2.5 CPS

DATE SURVEYED OCT. 1968

APPROVED

DATE

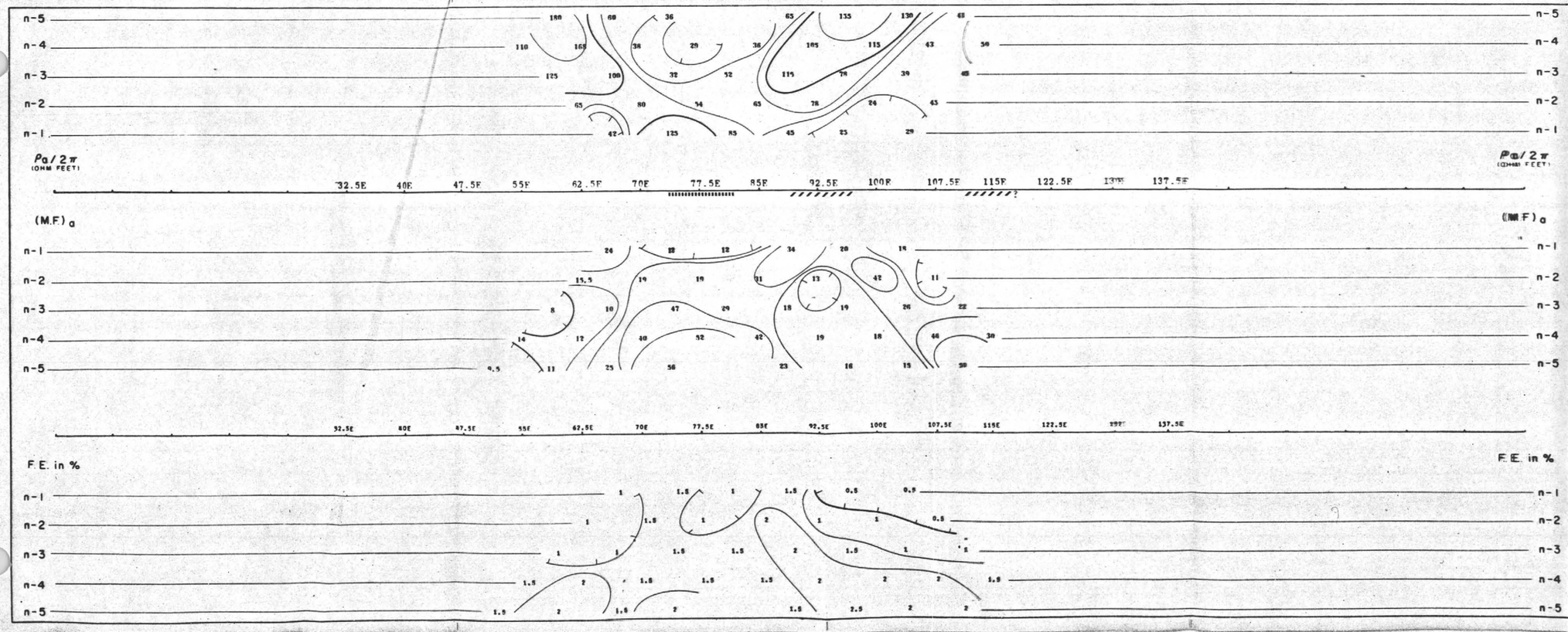
NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

REGISTERED GEOLOGIST ROBERT ALAN BAYLY ARIZONA U.S.A.

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO-IP-5197-2

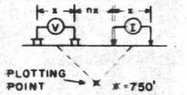
THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO.- 34,600 S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.3Hz – 2.5 CPS

DATE SURVEYED OCT. 1968

APPROVED

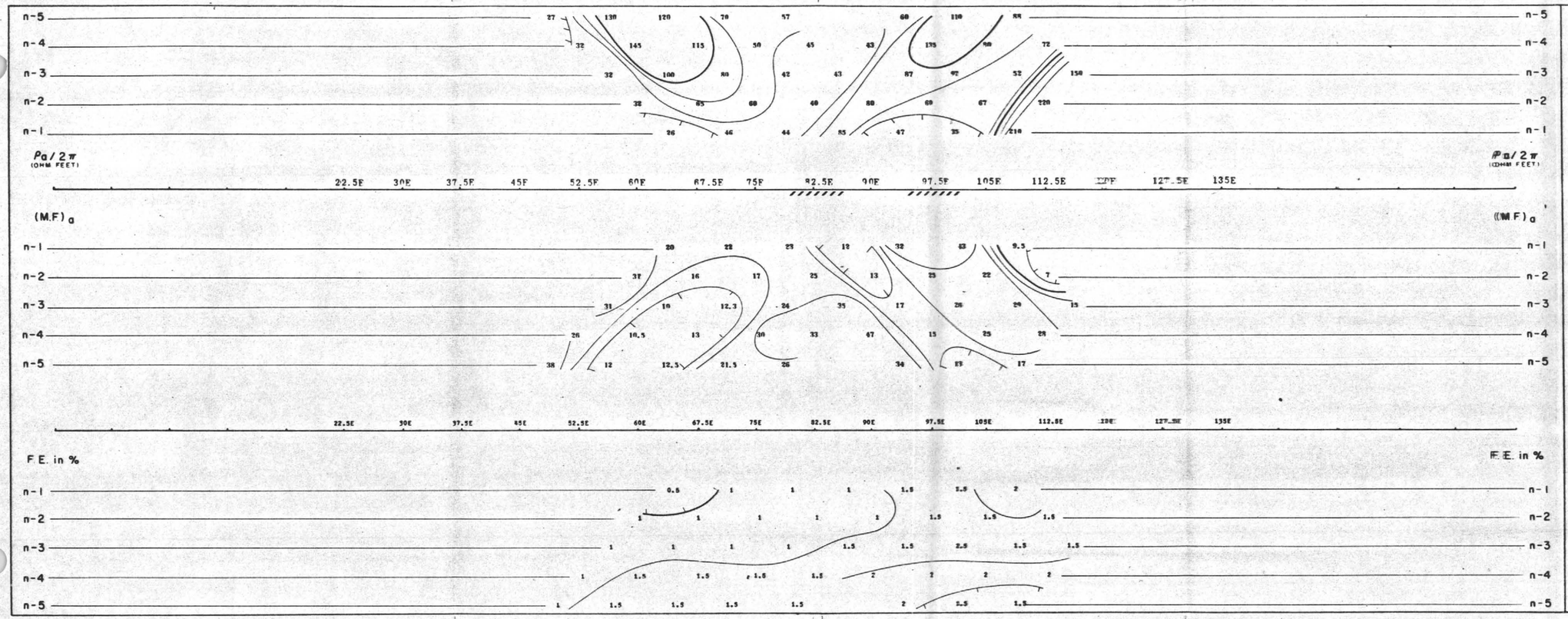
NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

DATE

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO - I P - 5197-3

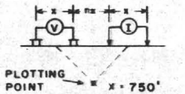
THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO.- 35,100S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 CPS

DATE SURVEYED OCT. 1968

APPROVED

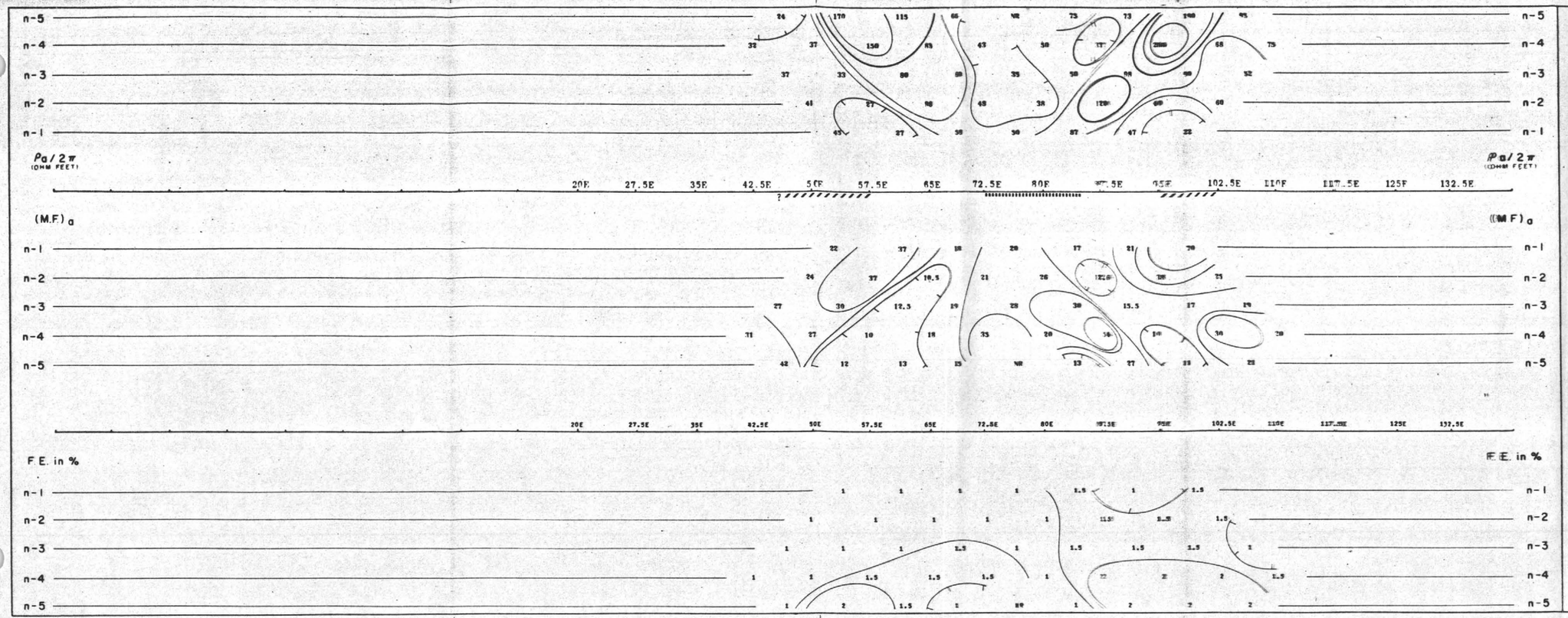
NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

DATE

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO.-I.P-5197-4

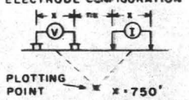
THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO.-35,100S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 CPS

DATE SURVEYED OCT. 1968

APPROVED

DATE

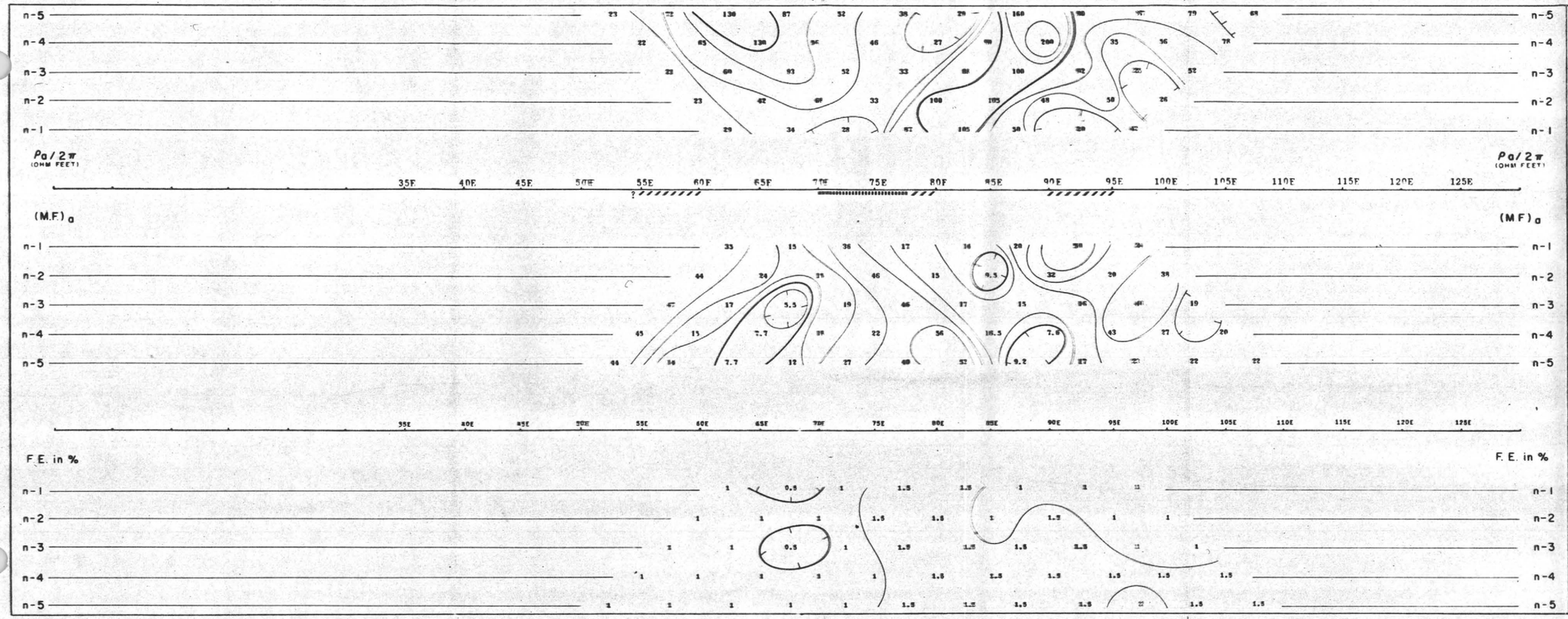
REGISTERED GEOLOGIST CERTIFICATE NO. ROBERT ALAN BELL ARIZONA, U.S.A.

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG NO - I.P - 5197-5

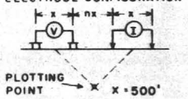
THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO.- 35,100S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES 0.31-2.5 CPS

DATE SURVEYED OCT. 1968

APPROVED

NOTE CONTOURS AT LOGARITHMIC INTERVALS 1-1.5-2-3-5-7.5-10

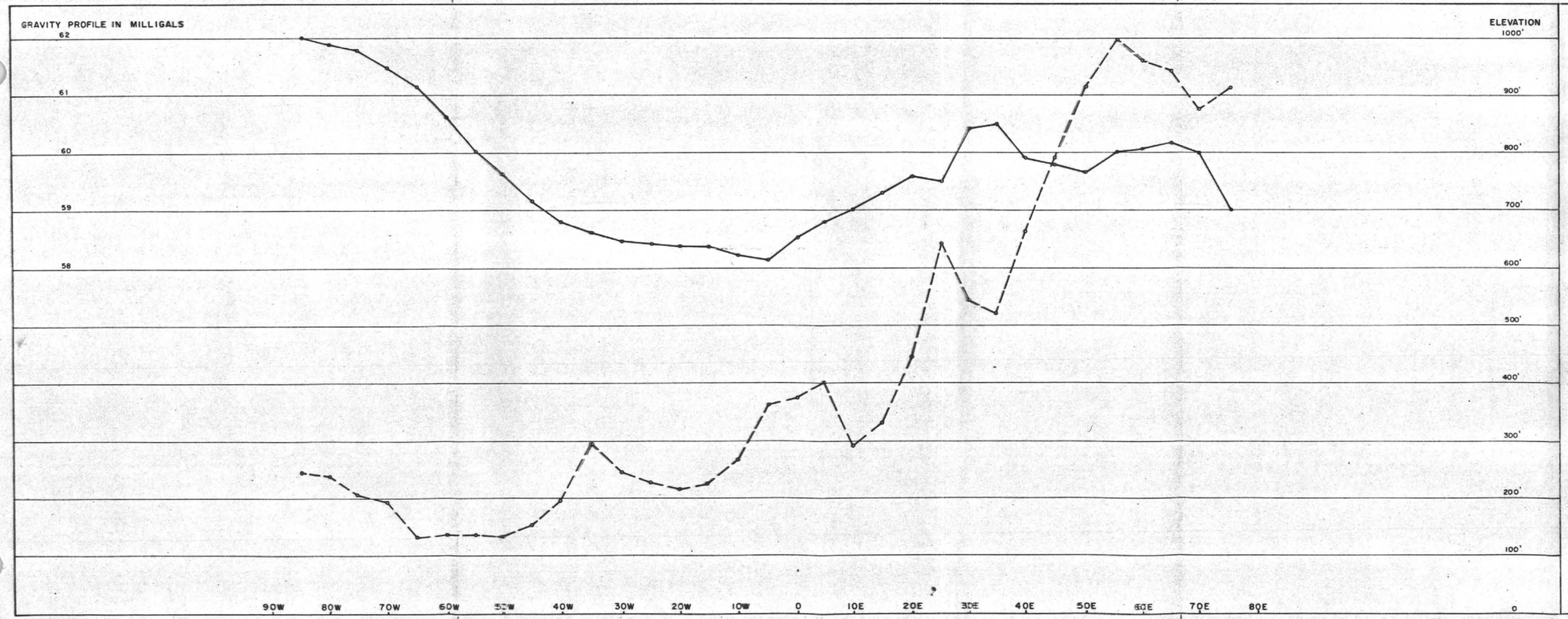
DATE

REGISTERED GEOLOGIST ROBERT ALAR ARIZONA, U.S.A.

McPHAR

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY



DWG. NO.- G-5198

THE RALPH M. PARSONS CO.

MUELLER ARAVAIPA PROJECT

SAFFORD AREA GRAHAM CO. ARIZONA

LINE NO. 33,800S

——— GRAVITY PROFILE WITH BOUGER CORRECTION.

— — — ELEVATION FROM BAROMETRIC SURVEY.

COMBINED BOUGER AND FREE-AIR CORRECTION OF 0·060 MILLIGALS PER FT.

DATE SURVEYED OCT. 1968

APPROVED R. A. Bell

DATE Nov. 11/68

REGISTERED GEOLOGIST CERTIFICATE NO. 1 BELL ARIZONA, U.S.A.

McPHAR GEOPHYSICS

RECONNAISSANCE GRAVITY SURVEY

APPENDIX B

GEOCHEMICAL SAMPLING

The following drawings show the location of, and data plots for, the rock-chip geochemical sampling in the North and South Areas.

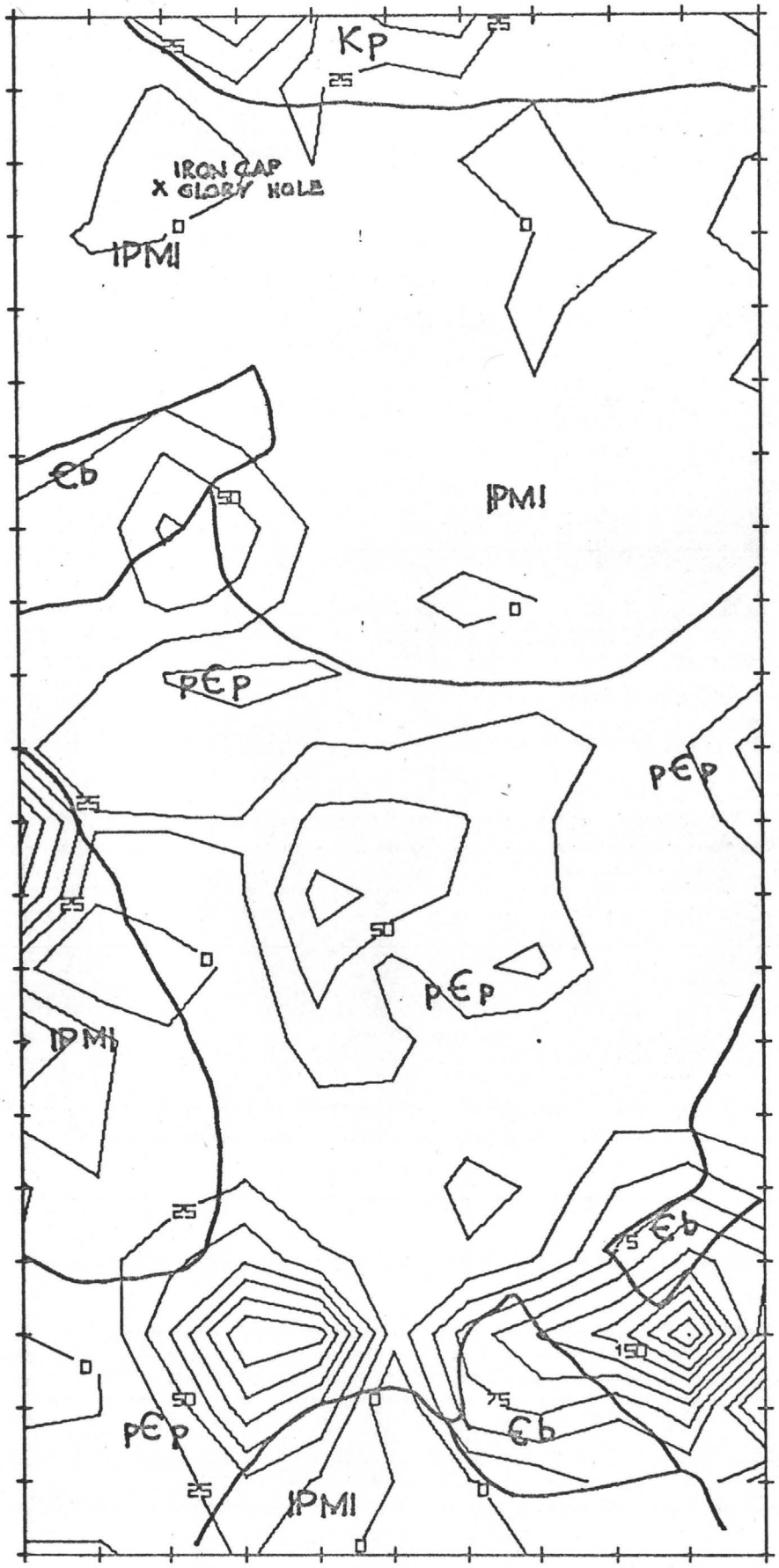
Only rock-chip sample values were considered in this evaluation; therefore, the missing data points in the parts per million [ppm] value plots may be attributed to either soil samples or areas where samples were not collected.

The North Area copper values are contoured at a 25 ppm interval. In this case the contours represent a smoothing of the actual data values so that absolute highs do not appear, but anomalies become more easily recognizable.

The North Area molybdenum values are contoured at a three ppm interval. Since the values are small, a higher degree of resolution is necessary to reflect the anomaly patterns. A 250-foot grid was chosen for interpolation so that the absolute molybdenum values are accurately represented by the contours.

Data from the South Area is confined to a narrow strip and contouring of data points did not appear to be meaningful.

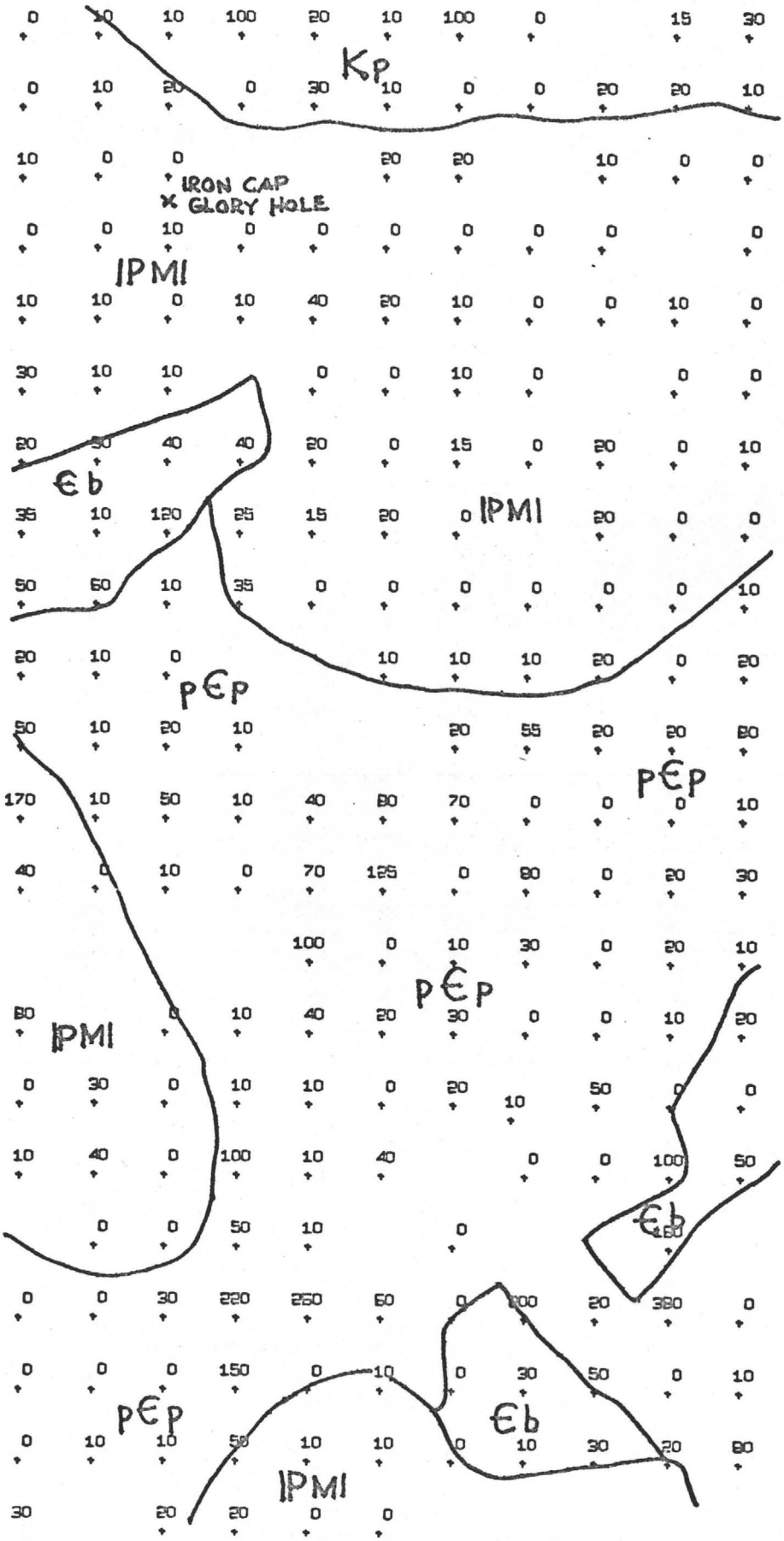
All of the data sheets have been annotated to show the rock types sampled.



COPPER - 25 PPM CONTOUR INTERVAL

1000 0 1000 2000 FEET

GRAPHICAL SCALE

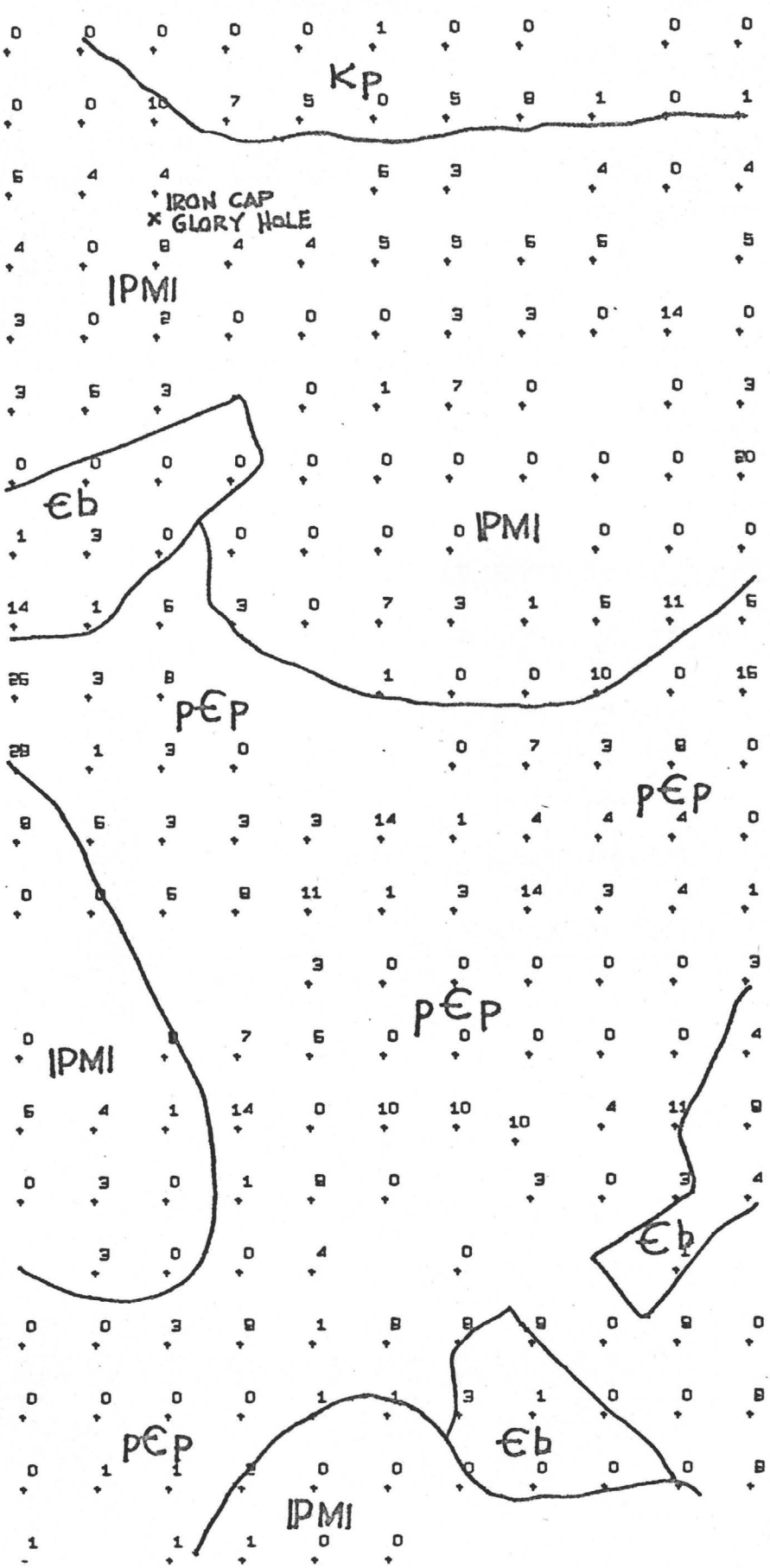


NORTH AREA COPPER VALUES PPM

~~SCALE 1 INCH 1000 FEET~~

1000 0 1000 2000 FEET

GRAPHICAL SCALE

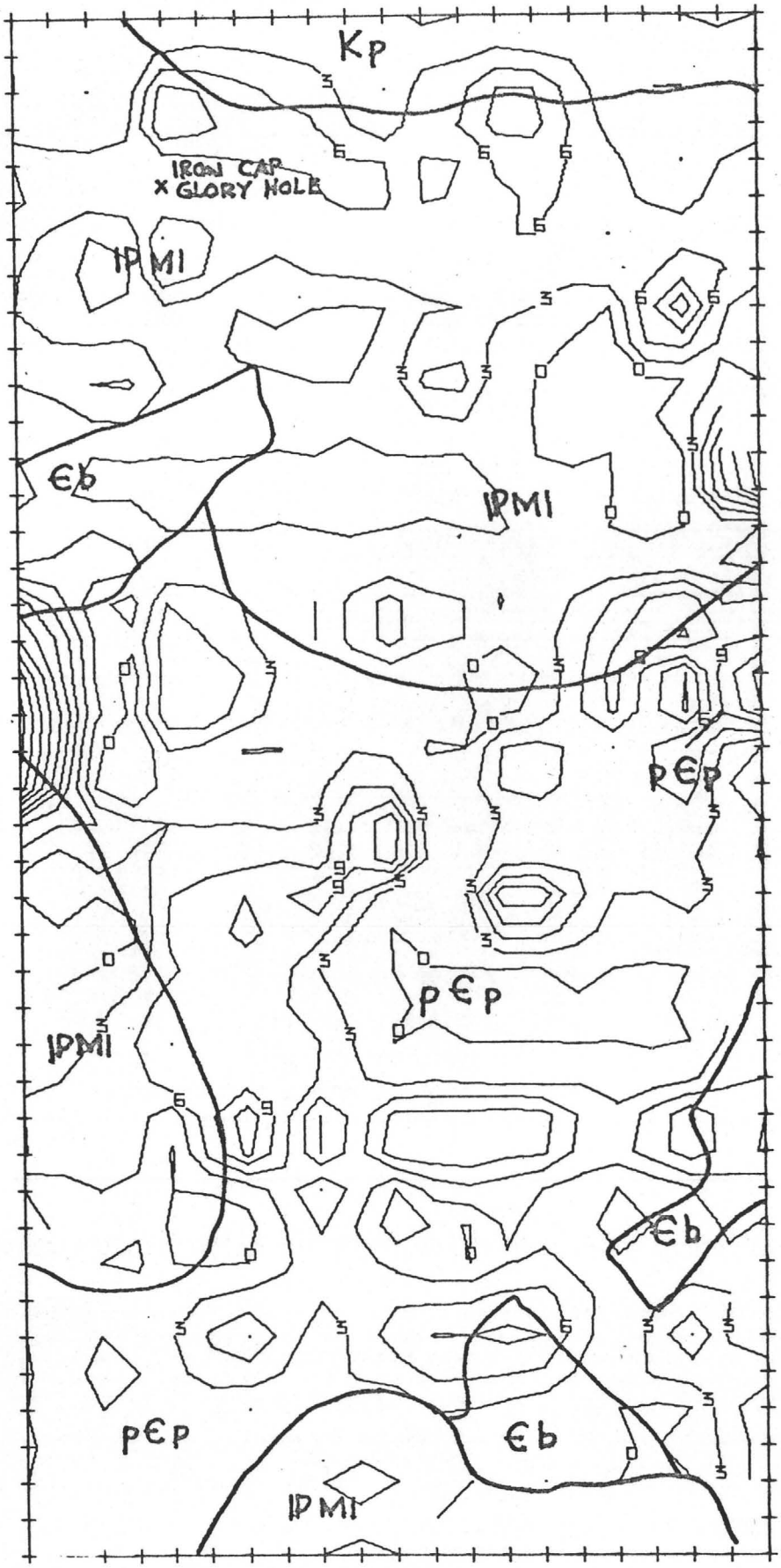


NORTH AREA MOLYBDENUM VALUES PPM

~~SCALE 1 INCH 1000 FEET~~

1000 0 1000 2000 FEET

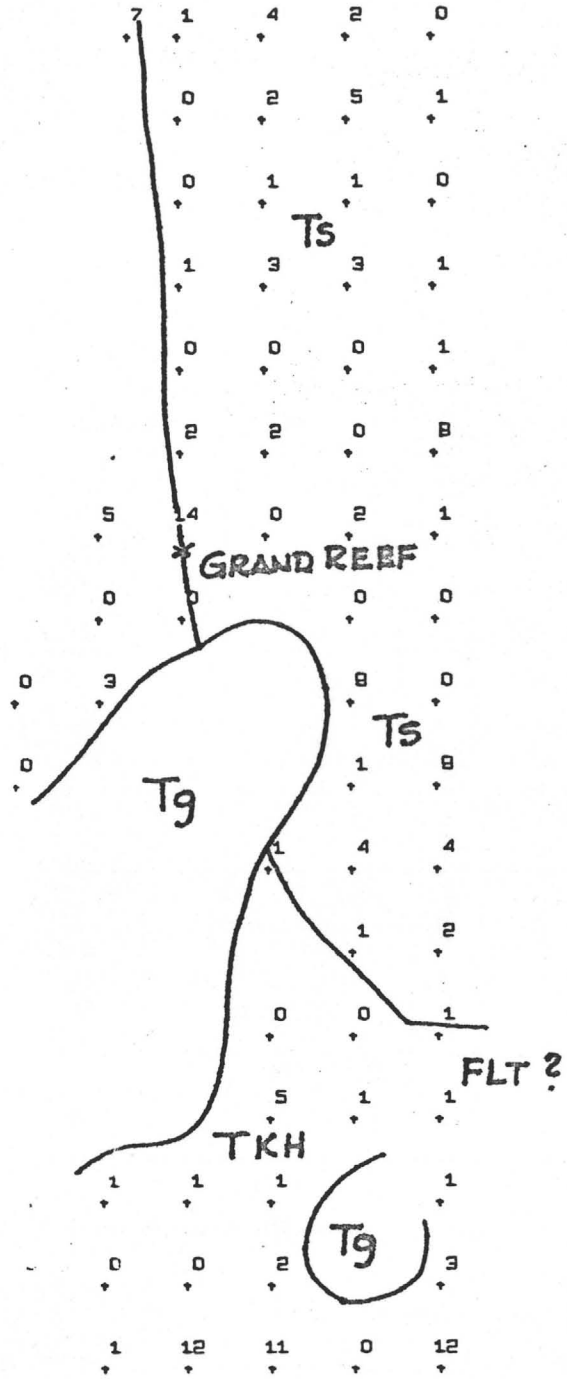
GRAPHICAL SCALE



MOLY. - 3 P.P.M. CONTOUR INTERVAL

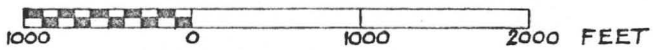
1000 0 1000 2000 FEET

GRAPHICAL SCALE



SOUTH AREA MOLYBDENUM VALUES PPM

~~SCALE 1 INCH 1000 FEET~~



GRAPHICAL SCALE

REPLY

Phoenix

Francis X. Cannaday
Manager, Base & Precious Metals

January 19, 1972

Mr. Richard Kirk,
521 Fifth Avenue,
New York, NY 10017

Dear Mr. Kirk:

Thank you very much for your consideration in bringing to our attention the Aravaipa property.

We have studied and reviewed the subject matter and find that at this time we are not interested in the properties.

Thank you again for your help in this matter.

Very truly yours,

Francis X. Cannaday

Francis X. Cannaday

FXC/dmh

P.S. Original reports returned January 11, 1972

c.c. Kelsey Boltz

FXC

NUCLEAR DYNAMICS

REPLY
Phoenix

KELSEY L. BOLTZ
VICE PRESIDENT

January 11, 1972

Mr. Richard Kirk,
521 Fifth Avenue,
New York, N.Y. 10017.

Dear Mr. Kirk:

We are returning the two reports you furnished us on the Aravaipa Mining District, Graham County, Arizona.

Thank you.

Yours very truly,

Diane Hershberger

(Mrs.) Diane Hershberger,
Secretary to Mr. Boltz.

attach.

NUCLEAR DYNAMICS, INC. PHOENIX, ARIZONA 85036 • P. O. BOX 20766 • 2871 SKY HARBOR BLVD. • 602 : 267-0581
PRESCOTT, ARIZONA 86301 • P. O. BOX 2337 • 100 UNION STREET • 602 : 445-0834

4018 Cheshire Drive
Cypress, California
December 20, 1971

Mr. Francis X. Cannaday
Nuclear Dynamics Inc.
P.O. Box 20766
Phoenix, Arizona 85036

Dear Mr. Cannaday:

I have your letter dated 12/13/71 regarding the Aravaipa property, which you advise me was written on the suggestion of Richard Kirk.

I am contacting Dick at the present time, and I would expect that you will hear further from him regarding this matter in the near future.

Sincerely yours,

Reginald Skiles

Reginald Skiles

RS:yt

cc:R. Kirk, New York

TELEPHONE
(212) 687-4577

CABLE
"GRANKIRK"

RICHARD KIRK
521 FIFTH AVENUE
NEW YORK, N. Y. 10017

December 22, 1971

Mr. Francis X. Cannaday
Nuclear Dynamics, Inc.
P. O. Box 20766
Phoenix, Arizona 85036

re: U. S. Mineral Properties Corporation

Dear Mr. Cannaday:

At the request of Mr. Skiles, I am submitting the following information concerning three test holes drilled on the Aravaipa property under Mr. Skiles' supervision.

Hole No. 1 was a rotary drill hole to test the I.P. anomaly lying between the Grand Reef mine and Stowe Gulch. The hole was drilled to a total depth of 1,000 feet without hitting bed-rock. The apparent I.P. effect was interpreted, on the basis of this hole, as being the result of conductivity in the thick layer of alluvium.

Hole No. 2 was located a little less than a mile northeast of No. 1, and had the objective of determining the source of the magnetic anomaly in that area. The hole was started in Horse Mountain volcanics (rhyolitic) and rotary drilled to 555 feet. The hole was then core drilled to a total depth of 1,097 feet, still in Horse Mountain volcanics. The section of rocks cut by this hole showed a uniformly high magnetic susceptibility, thus verifying Heinrich's interpretation of the anomaly, i.e. 'probably due to polarization in the volcanic rocks-shallow source'.

Hole No. 3 was collared in Horse Mountain volcanics, a few hundred feet down Laurel Canyon from the Grand Reef mine. The objective of the hole was to test for the source of a 'reasonably strong, but narrow' I.P. anomaly whose source was thought to lie at some depth. The hole was rotary drilled to a total depth of 915 feet, still in Horse Mountain volcanics,

December 22, 1971

and with no signs of alteration or mineralization noticably different from those observable in the outcrop near the collar of the hole.

I trust this meets with your satisfaction.

Very truly yours,

Richard Kal

18-D

Mr. Francis X. Cannaday
Nuclear Dynamics, Inc.
P. O. Box 20766
Phoenix, Ariz. 85036

MAIL

file

REPLY

Francis X. Cannaday
Manager/Base and Precious Metals

December 13, 1971

Mr. Reg Skiles
4018 Cheshire Drive
Cypress, California 90630

Dear Mr. Skiles:

Mr. Richard Kirk of 521 Fifth Avenue, New York, New York, has brought the Aravaipa property to our attention. He advises us that you were employed by Parsons at the time the exploration program was on, and that we may contact you. We understand that you have logs of three holes.

We would be interested in obtaining information which you may be in a position to supply, on these and any other holes, such as location, depth and logs.

Sincerely,

Francis X. Cannaday

Francis X. Cannaday

FXC/pf

NUCLEAR DYNAMICS, INC. PHOENIX, ARIZONA 85036 • P. O. BOX 20766 • 2871 SKY HARBOR BLVD. • 602 : 267-0581
PRESCOTT, ARIZONA 86301 • P. O. BOX 2337 • 100 UNION STREET • 602 : 445-0834

TELEPHONE
(212) 687-4577

CABLE
"GRANKIRK"

RICHARD KIRK
521 FIFTH AVENUE
NEW YORK, N. Y. 10017

November 19, 1971

Mr. Francis X. Cannaday, Manager,
Base & Precious Metals
Nuclear Dynamics, Inc.
P. O. Box 20766
Phoenix, Arizona 85036

re: U. S. Mineral Properties Corporation

Dear Mr. Cannaday:

Excuse my delay in replying to your letter of October 19th regarding the drilling results.

Reg Skiles, who was employed by Parsons, advises me that while he has logs of three holes, none of these encountered any mineralization of value. You may contact Mr. Skiles at 4018 Cheshire Drive, Cypress, Calif. 90630, area code 714-821-1464. He further states that the logs on the core I saw were prepared by Hal Gardiner and that he does not have a copy of the same.

Sincerely yours,

Richard Kirk

03-B-1-1

NUCLEAR DYNAMICS

REPLY
Phoenix

Francis X. Cannaday
Manager, Base & Precious Metals

October 19, 1971

Mr. Richard Kirk,
Grant & Kirk,
521 Fifth Avenue,
New York, N.Y. 10017.

Dear Mr. Kirk: Re: U.S. Mineral Properties Corporation

Mr. Boltz has asked me to go over the information you sent him concerning the Aravaipa properties (Parsons-Jurden reports, Volumes I and II). While discussing this matter, Mr. Boltz indicated he was under the impression that some drilling had actually been performed within the properties following the work and recommendations described in the Parsons-Jurden reports.

Since nothing of this nature is indicated by the information we have received, Mr. Boltz suggested I contact you on this matter, which I am doing, and request from you the drilling data if there was drilling done on the property.

Very truly yours,

Francis X. Cannaday

Francis X. Cannaday

FXC/dmh

c.c. K. L. Boltz

TELEPHONE
(212) 687-4577

CABLE
"GRANKIRK"

RICHARD KIRK
521 FIFTH AVENUE
NEW YORK, N. Y. 10017

September 21, 1971

Mr. Kelsey L. Boltz
Nuclear Dynamics, Inc.
2871 Sky Harbor Blvd.
Phoenix, Arizona 85036

re: U. S. Mineral Properties Corporation

Dear Kelsey:

In accordance with our discussion, I am enclosing herewith Volumes I and II of the Parsons-Jurden reports on the Aravaiva properties. When you return to New York we can discuss this matter further to determine whether or not there is a mutual area of interest. In any event, I will need these reports returned to me since they are my only copies.

Sincerely yours,

Richard Kirk

RK:mtc
Enclosures