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REPORT ON THE INDUCED POLARIZATION AND RESISTIVITY SURVEY ON THE HORTENSIA CLAIMS SUPERIOR MINING DISTRICT PINAL COUNTY, ARIZONA FOR MR. SHERWOOD B. OWENS

McPHAR GEOPHYSICS

NOTES ON THE THEORY, METHOD OF FIELD OPERATION, AND PRESENTATION OF DATA FOR THE INDUCED POLARIZATION METHOD

Induced Polarization as a geophysical measurement refers to the blocking action or polarization of metallic or electronic conductors in a medium of ionic solution conduction.

This electro-chemical phenomenon occurs wherever electrical current is passed through an area which contains metallic minerals such as base metal sulphides. Normally, when current is passed through the ground, as in resistivity measurements, all of the conduction takes place through ions present in the water content of the rock, or soil, i.e. by ionic conduction. This is because almost all minerals have a much higher specific resistivity than ground water. The group of minerals commonly described as "metallic", however, have specific resistivities much lower than ground waters. The induced polarization effect takes place at those interfaces where the mode of conduction changes from ionic in the solutions filling the interstices of the rock to electronic in the metallic minerals present in the rock.

The blocking action or induced polarization mentioned above, which depends upon the chemical energies necessary to allow the ions to give up or receive electrons from the metallic surface, increases with the time that a d. c. current is allowed to flow through the rock; i. e. as ions pile up against the metallic interface the resistance to current flow increases. Eventually, there is enough polarization in the form of excess ions at the interfaces, to appreciably reduce the amount of current flow through the metallic particle. This polarization takes place at each of the infinite number of solution-metal interfaces in a mineralized rock.

When the d. c. voltage used to create this d. c. current flow is cut off, the Coulomb forces between the charged ions forming the polarization cause them to return to their normal position. This movement of charge creates a small current flow which can be measured on the surface of the ground as a decaying potential difference.

From an alternate viewpoint it can be seen that if the direction of the current through the system is reversed repeatedly before the polarization occurs, the effective resistivity of the system as a whole will change as the frequency of the switching is changed. This is a consequence of the fact that the amount of current flowing through each metallic interface depends upon the length of time that current has been passing through it in one direction.

The values of the per cent frequency effect or F. E. are a measurement of the polarization in the rock mass. However, since the measurement of the degree of polarization is related to the apparent resistivity of the rock mass it is found that the metal factor values or M. F. are the most useful values in determining the amount of polarization present in the rock mass. The MF values are obtained by normalizing the F. E. values for varying resistivities.

The induced polarization measurement is perhaps the most powerful geophysical method for the direct detection of metallic sulphide mineralization, even when this mineralization is of very low concentration. The lower limit of volume per cent sulphide necessary to produce a recognizable IP anomaly will vary with the geometry and geologic environment of the source, and the method of executing the survey. However, sulphide mineralization of less than one per cent by volume has been detected by the IP method under proper geological conditions.

The greatest application of the IP method has been in the search for disseminated metallic sulphides of less than 20% by volume. However, it has also been used successfully in the search for massive sulphides in situations where, due to source geometry, depth of source, or low resistivity of surface layer, the EM method can not be successfully applied. The ability to differentiate ionic conductors, such as water filled shear zones, makes the IP method a useful tool in checking EM anomalies which are suspected of being due to these causes.

In normal field applications the IP method does not differentiate between the economically important metallic minerals such as chalcopyrite, chalcocite, molybdenite, galena, etc., and the other metallic minerals such as pyrite. The induced polarization effect is due to the total of all electronic conducting minerals in the rock mass. Other electronic conducting materials which can produce an IP response are magnetite, pyrolusite, graphite, and some forms of hematite.

In the field procedure, measurements on the surface are made in a way that allows the effects of lateral changes in the properties of the ground to be separated from the effects of vertical changes in the properties. Current is applied to the ground at two points in distance (X) apart. The potentials are measured at two other points (X) feet apart, in line with the current electrodes is an integer number (n) times the basic distance (X).

The measurements are made along a surveyed line, with a constant distance (nX) between the nearest current and potential electrodes. In most surveys, several traverses are made with various values of (n); i.e. (n) = 1, 2, 3, 4, etc. The kind of survey required (detailed or reconnaissance) decides the number of values of (n) used.

In plotting the results, the values of the apparent resistivity, apparent per cent frequency effect, and the apparent metal factor measured for each set of electrode positions are plotted at the intersection of grid lines, one from the center point of the current electrodes and the other from the center point of the potential electrodes. (See Figure A.) The resistivity values are plotted above the line as a mirror image of the metal factor values below. On a second line, below the metal factor values, are plotted the values of the per cent frequency effect. In some cases the values of per cent frequency effect are plotted as superscripts of the metal factor value. In this second case the frequency effect values are not contoured. The lateral displacement of a given value is determined by the location along the survey line of the center point between the current and potential electrodes. The distance of the value from the line is determined by the distance (nX) between the current and potential electrodes when the measurement was made.

The separation between sender and receiver electrodes is only one factor which determines the depth to which the ground is being sampled in any particular measurement. The plots then, when contoured, are not section maps of the electrical properties of the ground under the survey line. The interpretation of the results from any given survey must be carried out using the combined experience gained from field results, model study results and theoretical investigations. The position of the electrodes when anomalous values are measured is important in the interpretation.

In the field procedure, the interval over which the potential differences are measured is the same as the interval over which the electrodes are moved after a series of potential readings has been made. One of the advantages of the induced polarization method is that the same equipment can be used for both detailed and reconnaissance surveys merely by changing the distance (X) over which the electrodes are moved each time. In the past, intervals have been used ranging from 25 feet to 2000 feet for (X). In each case, the decision as to the distance (X) and the values of (n) to be used is largely determined by the expected size of the mineral deposit being sought, the size of the expected anomaly and the speed with which it is desired to progress.

The diagram in Figure A demonstrates the method used in plotting the results. Each value of the apparent resistivity, apparent metal factor, and apparent per cent frequency effect is plotted and identified by the position of the four electrodes when the measurement was made. It can be seen that the values measured for the larger values of (n) are plotted farther from the line indicating that the thickness of the layer of the earth that is being tested is greater than for the smaller values of (n); i. e. the depth of the measurement is increased. When the F. E. values are plotted as superscripts to the MF values the third section of data values is not presented and the F. E. values are not contoured.

The actual data plots included with the report are prepared utilizing an IBM 360/75 Computer and a Calcomp 770/763 Incremental Plotting System. The data values are calculated, plotted, and contoured according to a programme developed by McPhar Geophysics. Certain symbols have been incorporated into the programme to explain various situations in recording the data in the field.

The IP measurement is basically obtained by measuring the difference in potential or voltage (ΔV) obtained at two operating frequencies. The voltage is the product of the current through the ground and the apparent resistivity of the ground. Therefore in field situations where the current is very low due to poor electrode contact, or the apparent resistivity is very low, or a combination of the two effects; the value of (ΔV) the change in potential will be too small to be measurable. The symbol "TL" on the data plots indicates this situation.

In some situations spurious noise, either man made or natural, will render it impossible to obtain a reading. The symbol "N" on the data plots indicates a station at which it is too noisy to record a reading. If a reading can be obtained, but for reasons of noise there is some doubt as to its accuracy, the reading is bracketed in the data plot ( ).

In certain situations negative values of Apparent Frequency Effect are recorded. This may be due to the geologic environment or spurious electrical effects. The actual negative frequency effect value recorded is indicated on the data plot, however the symbol "NEG" is indicated for the corresponding value of Apparent Metal Factor. In contouring negative values the contour lines are indicated to the nearest positive value in the immediate vicinity of the negative value.

The symbol "NR" indicates that for some reason the operator did not attempt to record a reading although normal survey procedures would suggest that one was required. This may be due to inaccessible topography or other similar reasons. Any symbol other than those discussed above is unique to a particular situation and is described within the body of the report.

METHOD USED IN PLOTTING DIPOLE-DIPOLE
INDUCED POLARIZATION AND RESISTIVITY RESULTS

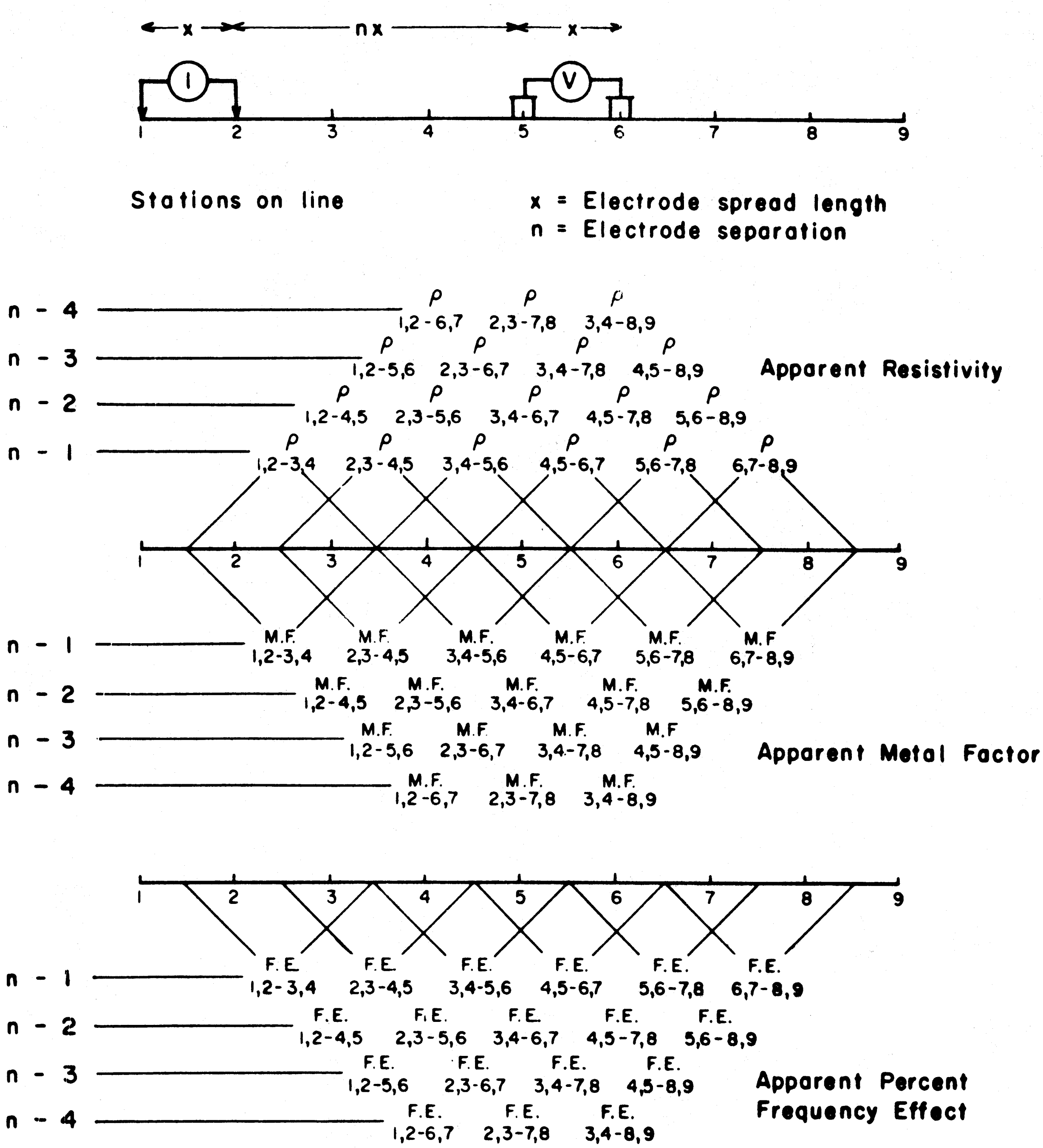

Fig. A

McPHAR GEOPHYSICS

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA
FOR
MR. SHERWOOD B. OWENS

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1. INTRODUCTION

At the request of Mr. Sherwood B. Owens, McPhar has completed an induced polarization and resistivity survey on the Hortensia Claims, Superior Mining District, Pinal County, Arizona. Vertical intensity ground magnetic measurements were also made at 100-foot intervals along the survey lines. The survey grid was laid out by Mr. Richard E. Mieritz, consultant to Mr. Owens, who furnished geological information and a plan map of the survey area.

Within the survey area, Upper Precambrian diabase intrudes the Dripping Spring quartzite and Pioneer shale members of the Upper Precambrian Apache Group. These rocks overlie the Lower Precambrian Pinal schist and are overlain by Quaternary basalt. The area is transected by several northwest-trending faults which divide the Precambrian units into blocks. The southwesternmost fault, the Concentrator fault, brings the Tertiary (?) Whitetail conglomerate down against the Precambrian rocks.

The area is of exploration interest because of its proximity to the Magma mine to the southeast.

The purpose of the induced polarization and resistivity survey was to prospect for sulphide mineralization within 500 feet of the surface. The survey was performed by Raymond Monarez, crew chief.

2. PRESENTATION OF RESULTS

The induced polarization and resistivity results are shown on the data plots listed below and are summarized on a plan map, Dwg. I.P.P. 4628, at a scale of 1" = 200'.

Line	Electrode Intervals	Dwg. No.
10.4E	500 feet	IP 5460-1
10.9E	500 feet	IP 5460-2
11.4E	500 feet	IP 5460-3
11.9E	500 feet	IP 5460-4

The ground magnetic survey results are shown on a separate map, Dwg. No. M3429, also at a scale of 1" = 200'.

In this report both percent frequency effect (PFE) anomalies and metal factor (MF) anomalies are shown on the plan map. Percent frequency effect is a measure of the intensity of polarization, and anomalies are classified as very weak - very strong. The percent frequency effect results indicate polarizable areas without taking into account the resistivity of the areas. Metal factor (MF) is obtained by combining the percent frequency effect and the resistivity. A good conductor (low resistivity) that is strongly polarizable (high percent frequency effect) will give a well-defined or definite metal factor anomaly. Less well-defined metal factor anomalies are designated as probable or possible.

The percent frequency effect and metal factor parameters are complementary. The relative importance of each type of information depends upon the particular geophysical environment and the type of target expected. For example, a mineralized silicified zone will give a strong percent frequency effect anomaly, but may not give a definite metal factor anomaly. Alternatively, an oxidized ore zone may only give a weak percent frequency effect anomaly, but will give a definite metal factor anomaly pattern. Judicious consideration of both the percent frequency effect and the metal factor results permits a comprehensive evaluation of the geophysical environment.

The anomalies as shown on the data plots and plan map represent the surface projection of the polarizable zones. Contacts or faults inferred from the resistivity patterns are also shown, on plan only. Anomaly boundaries and fault locations should be considered accurate to the electrode interval used.

The anomalies shown on the plan map are designated apparent depths of shallow, moderate, or deep. At larger dipole separations a greater volume of rock is averaged, in lateral extent as well as depth. Thus, the source of a deep-appearing anomaly detected along a single line may be at shallow depth to one side of the line. The data plots, therefore, cannot represent true depth. Depths can be calculated from the apparent resistivity data in the case of ideal horizontal layers, but even this calculation depends on an assumed resistivity contrast between the zone at depth and the overlying rock. Although ambiguous, the simple depth designations are useful for correlating or comparing anomalous zones obtained on adjacent survey lines. Drill hole information from one or more zones frequently permits one to make a fair depth estimate for other zones. The following depth generalizations apply to porphyry copper and contact-replacement bodies:

	Apparent Depth (dipole separations)	Drill Hole Depth (in dipole lengths)
Shallow	1 - 2	½ - 1
Moderate	2 - 3	1 - 1½
Deep	3 - 5	1½ - 2+

Thus, a shallow zone is one detected at a one-to-two dipole separation and should be tested by a drill hole from a half-to-one dipole length deep.

An appendix on the interpretation of induced polarization anomalies is enclosed in this report. It shows the desirability of detailing with shorter spreads when the anomaly is shallow and the source may be narrow.

The induced polarization method is a geophysical tool used to determine the electrical properties of the earth. The final evaluation of the induced polarization anomalies, e.g., which of the anomalies constitutes the most favourable exploration target, must be based on available geologic evidence and concepts.

3. DISCUSSION OF RESULTS

As shown on the plan map, the induced polarization results indicate a possible metal factor anomalous zone and a single probable metal factor anomaly in the southern portion of the grid. The metal factor anomalies are due to low resistivities and quite weak, but above-background percent frequency effects (PFE's). The results obtained along each line are discussed in detail below.

Line 10.4E

The resistivity results indicate a fault or contact in the vicinity of 11.25N, with high resistivity rock north of the contact. A resistivity low occurs at shallow-moderate depth in the interval (?)8.5N - 9.75N. The possible metal factor anomaly within this interval is due to both low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.0N - 10.5N and at shallow-moderate depth in the interval 12.5N - 13.0N(?).

Line 10.9E

The resistivity results indicate faults or contacts in the vicinity of 9.5N and 11.0N, with low resistivity rock south of 9.5N and high resistivity rock north of 11.0N. The shallow, probable metal factor anomaly in the interval 9.0N - 9.5N is due to very low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.5N - 11.0N and at shallow-moderate depth in the interval 11.75N - 12.25N(?).

Line 11.4E

The resistivity results indicate faults or contacts in the vicinity of 9.25N and 11.0N, with low resistivity rock south of 9.25N and very high resistivity rock at depth north of 11.0N. The possible metal factor anomaly in the interval (?)7.5N - 8.5N is due to very low resistivities and background-above-background PFE's. Above-background PFE's occur at moderate-deep depth in the interval 9.5N - 10.0N and at shallow depth in the interval 10.5N - 11.0N.

Line 11.9E

The resistivity results indicate a possible contact at 9.0N and a distinct resistivity low zone at shallow-moderate depth in the interval 8.0N - 8.5N. The possible metal factor anomaly in the interval 8.0N - 8.5N is due to the low resistivities and to above-background PFE's. Above-background PFE's also occur at shallow depth in the interval 10.25N - 10.75N.

As shown on the magnetic map, the vertical intensity ground magnetic results show a distinct northwest trend. The southeastern and eastern portions of the grid are higher in magnetic intensity than the northwestern portion of the grid. A strong magnetic anomaly occurs in the interval 9.1N - 9.6N along Line 10.9E. The anomaly is characteristic of a vertical dike centred at 9.25N. The fact that the magnetic high lies north of the magnetic low suggests that the dike has a reverse remnant component. The magnetic anomaly occurs at the northern edge of an outcrop of Quaternary basalt, and lies within the probable metal factor anomaly obtained along Line 10.9E. Magnetic anomalies also occur in the interval 10.0N - 10.4N along Line 11.4E and in the interval 9.6N - 10.0N along Line 11.9E. These anomalies form a northwest-trending zone that persists across the entire grid. The anomaly along Line 11.4E is characteristic of a vertical dike centred at 10.2N. A strong magnetic low is centred at 11.7N along Line 10.4E.

4. CONCLUSIONS AND RECOMMENDATIONS

The percent frequency effects (PFE's) associated with the possible-probable metal factor anomalies detected in the southern portion of the grid are too weak to be indicative of large massive sulphide bodies such as those at the Magma mine. However, the possible economic significance of the anomalies should be assessed in light of geological and geochemical results.

The probable metal factor anomaly along Line 10.9E coincides with a strong magnetic anomaly. The above-background PFE's associated with the probable metal factor anomaly could be due to magnetite. The anomaly pattern suggests that the source of the anomaly dips to the south. Since the source is apt to be narrow, the anomalous zone should be detailed at 100-foot electrode intervals if drilling is contemplated.

The possible metal factor anomalies at the southern ends of Line 10.4E, Line 10.9E, and Line 11.4E occur in the vicinity of the Concentrator fault. Low resistivities which appear to be due to the Whitetail conglomerate contribute to these anomalies. The possible metal factor anomaly in the interval 8.0N - 8.5N along Line 11.9E appears to be more significant. From the geology map, the low resistivities which contribute to this anomaly cannot be attributed to the Whitetail conglomerate.

The shallow, above-background PFE zones in the northern portion of the grid could be due to widely-spaced, mineralized veins or shears. If close surface examination or geochemical sampling indicates these zones to be of further interest, they should be detailed at 100-foot electrode intervals.

McPHAR GEOPHYSICS INCORPORATED

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Dated: June 15, 1970

APPENDIX
THE INTERPRETATION OF INDUCED POLARIZATION ANOMALIES FROM RELATIVELY SMALL SOURCES

The induced polarization method was originally developed to detect disseminated sulphides and has proven to be very successful in the search for "porphyry copper" deposits. In recent years we have found that the IP method can also be very useful in exploring for more concentrated deposits of limited size. This type of source gives sharp IP anomalies that are often difficult to interpret.

The anomalous patterns that develop on the contoured data plots will depend on the size, depth and position of the source and the relative size of the electrode interval. The data plots <u>are not</u> sections showing the electrical parameters of the ground. When the electrode interval (X) is appreciably greater than the width of the source, a large volume of unmineralized rock is averaged into each measurement. This is particularly true for the large values of the electrode separation (n).

The theoretical scale model results shown in Figure 1 and Figure 2 indicate the effect of depth. If the depth to the top of the source is small compared to the electrode interval (i. e. d X) the measurement for n = 1 will be anomalous. In Figure 1 the depth is 0. 5 units (X = 1. 0 units) and the n = 1 value is definitely anomalous; the pattern on the contoured data plot is typical for a relatively shallow, narrow, near-vertical tabular source. The results in Figure 2 are for the same source with the depth increased to 1. 5 units. Here the n = 1 value is not anomalous; the larger values of (n) are anomalous but the magnitudes are much lower than for the source at less depth.

When the electrode interval is greater than the width of the source, it is not possible to determine its width or exact position between the electrodes. The true IP effect within the source is also indeterminate; the anomaly from a very narrow source with a very large true IP effect will be much the same as that from a zone with twice the width and 1/2 the true IP effect. The theoretical scale model data shown in Figure 3 and Figure 4 demonstrate this problem. The depth and position of the source are unchanged but the width and true IP effect are varied. The anomalous patterns and magnitudes are essentially the same, hence the data are insufficient to evaluate the source completely.

The normal practise is to indicate the IP anomalies by solid, broken, or dashed bars, depending upon their degree of distinctiveness. 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. As illustrated in Figure 1, Figure 2, Figure 3 and Figure 4, no anomaly can be located with more accuracy than the spread length. While the centre of the solid bar indicating the anomaly corresponds fairly well with the source, the length of the bar should not be taken to represent the exact edges of the anomalous material.

If the source is shallow, the anomaly can be better evaluated using a shorter electrode interval. When the electrode interval used approaches the width of the source, the apparent effects measured will be nearly equal to the true effects within the source. When there is some depth to the top of the source, it is not possible to use electrode intervals that are much less than the depth to the source. In this situation, one must realize that a definite ambiguity exists regarding the width of the source and the IP effect within the source.

Our experience has confirmed the desirability of doing detail. When a reconnaissance IP survey using a relatively large electrode interval indicates the presence of a narrow, shallow source, detail with shorter electrode intervals is necessary in order to better locate, and evaluate, the source. The data of most usefulness is obtained when the maximum apparent IP effect is measured for $n = 2$ or $n = 3$. For instance, an anomaly originally located using X = 300' may be checked with X = 200' and then X = 100'. The data with X = 100' will be quite different from the original reconnaissance results with X = 300'.

The data shown in Figure 5 and Figure 6 are field results from a greenstone area in Quebec. The expected sources were narrow (less than 30' in width) zones of massive, high-grade, zinc-silver ore. An electrode interval of 200' was used for the reconnaissance survey in order to keep the rate of progress at an acceptable level. The anomalies located were low in magnitude.

The very weak, shallow anomaly shown in Figure 5 is typical of those located by the X = 200' reconnaissance survey. Several anomalies of this type were detailed using shorter electrode intervals. In most cases the detail measurements suggested broad zones of very weak mineralization. However, in the case of the source at 20N to 22N, the measurements with shorter electrode intervals confirmed the presence of a strong, narrow source. The X = 50' results are shown in Figure 6. Subsequent drilling has shown the source to be 12.5' of massive sulphide mineralization containing significant zinc and silver values.

The change in the anomaly that results when the electrode interval is reduced is not unusual. The X = 50' data more accurately locates the narrow source, and permits the geophysicist to make a better evaluation of its importance. The completion of this type of detail is very important, in order to get the maximum usefulness from a reconnaissance IP survey.

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Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

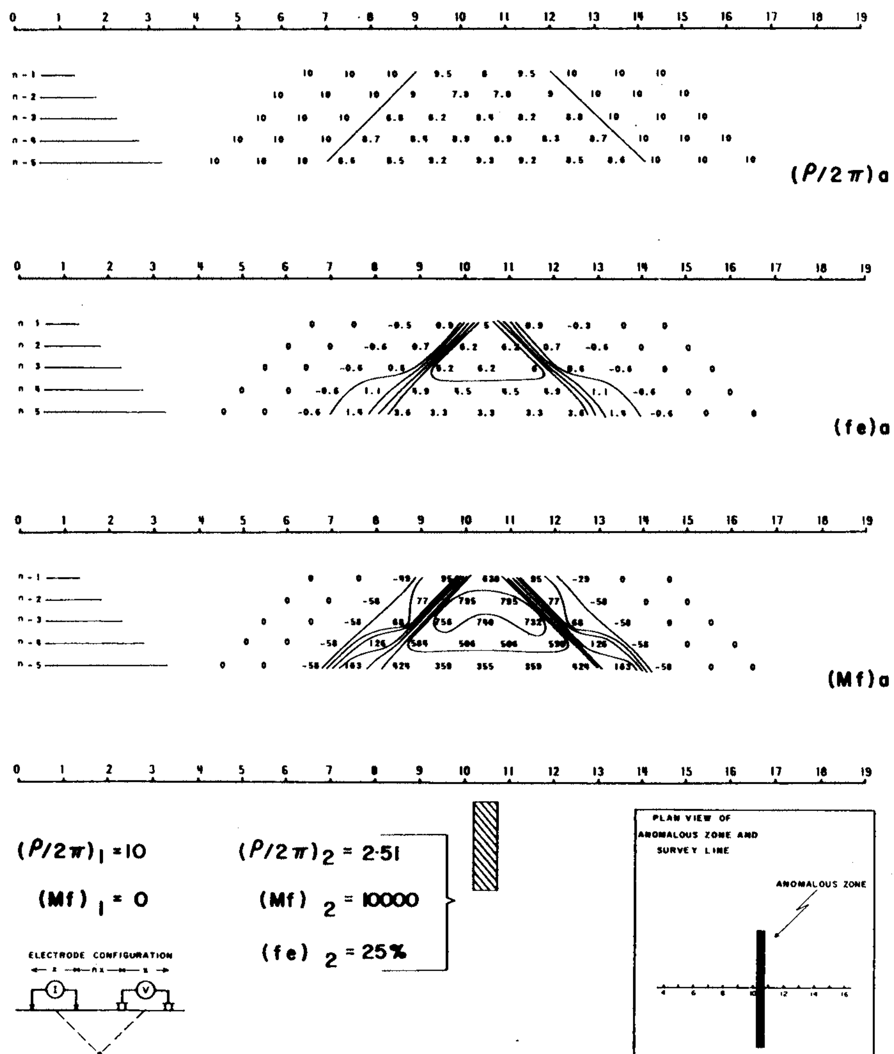


FIG 1

CASE II-0·5-BU-10-a

McPHAR GEOPHYSICS LIMITED

Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

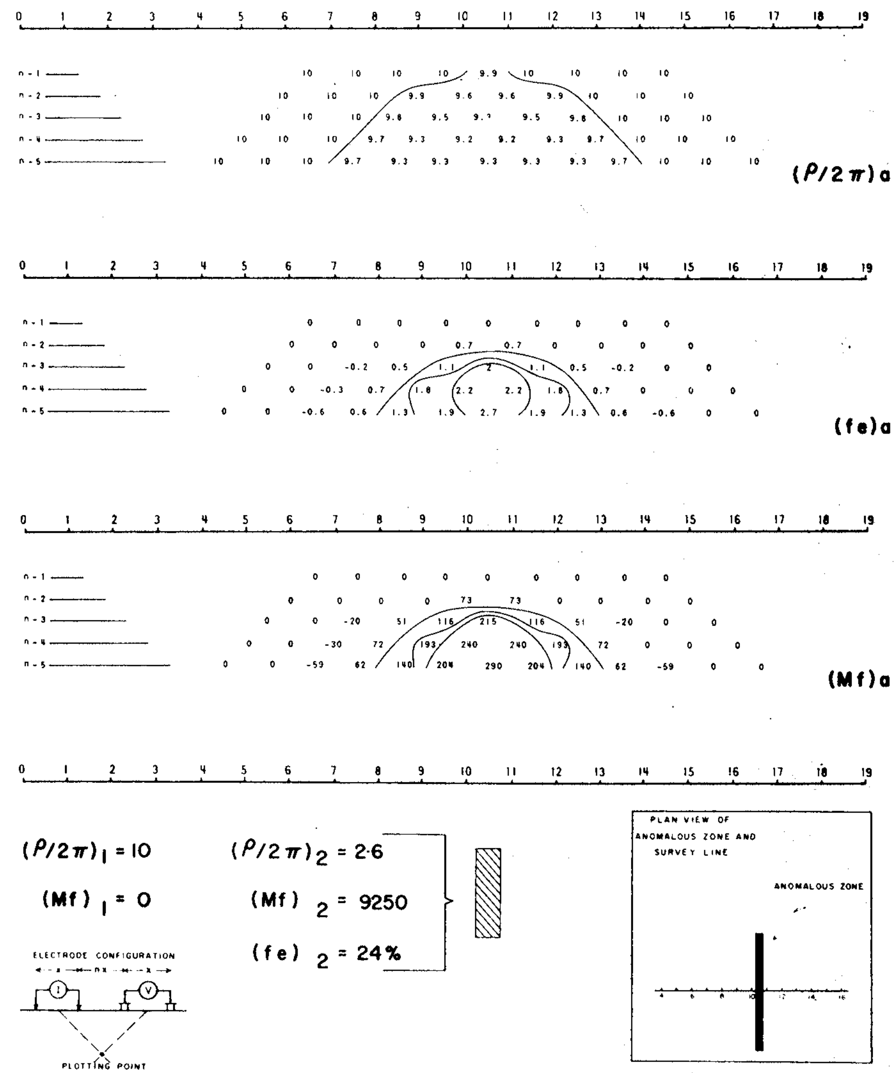


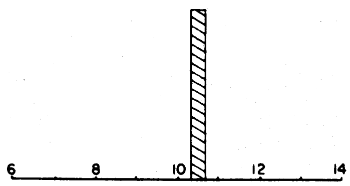
FIG 2

CASE II-1·5-BU-10-a

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW



Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho/2\pi)a$

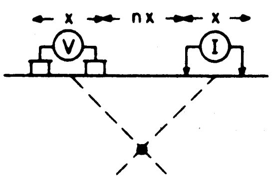
n												
n-1	10	10	10	9·7	8·8	9·7	10	10	10			
n-2	10	10	10	9·5	8·7	8·7	9·5	10	10	10		
n-3	10	10	10	9·3	8·8	8·9	8·8	9·3	10	10	10	
n-4	10	10	10	9·0	8·8	9·0	9·0	8·8	9·2	10	10	10

(Fe)a

n												
n-1	-0·2	0	-0·5	0·7	3·6	0·7	-0·3	-0·2	-0·2			
n-2	0	0	-0·6	0·7	4·0	4·0	0·7	-0·6	0	0		
n-3	0	0	-0·5	0·7	4·7	4·3	4·6	0·7	-0·6	0	0·2	
n-4	0	-0·3	-0·6	1·1	3·5	4·2	4·2	3·5	1·1	-0·6	-0·3	0

(Mf)a

n												
n-1	17	0	-49	72	410	72	-30	-17	17			
n-2	0	0	-59	74	460	460	74	-59	0	0		
n-3	0	0	-59	75	534	489	523	75	58	0	0	
n-4	0	-30	-59	141	382	467	467	363	120	-59	-30	0



X EQUALS 1 UNIT

$(\rho 2\pi)_1 = 10$
$(Mf)_1 = 0$

$(\rho 2\pi)_2 = 2{\cdot}57$
$(Mf)_2 = 11700$
$(Fe)_2 = 30\%$

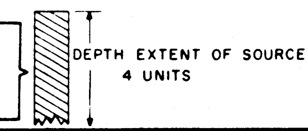
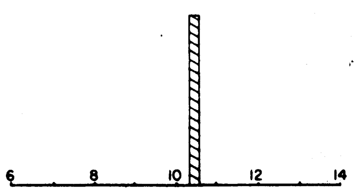


FIG. 3

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW



Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho/2\pi)a$

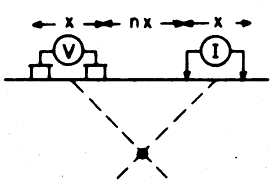
n												
n-1	10	10	10	9·9	9·3	9·9	10	10	10			
n-2	10	10	10	9·7	9·1	9·1	9·7	10	10	10		
n-3	10	10	10	9·7	9·2	9·2	9·2	9·7	10	10	10	
n-4	10	10	10	9·6	9·3	9·3	9·3	9·3	9·6	10	10	10

(Fe)a

n												
n-1	0	0	-0·3	0	3·5	0	-0·3	0	0			
n-2	0	0	-0·8	0	3·8	3·8	0	-0·8	0	0		
n-3	0	0	-0·8	0·5	4·5	4·5	4·6	0·5	-0·8	0	0	
n-4	0	0	-0·7	0·8	4·2	5·1	5·1	4·2	0·7	-0·7	0	0

(Mf)a

n												
n-1	0	0	-30	0	376	0	-30	0	0			
n-2	0	0	-79	0	417	417	0	-79	0	0		
n-3	0	0	-79	52	490	490	501	52	-79	0	0	
n-4	0	0	-70	83	452	548	555	452	74	-71	0	0



X EQUALS 1 UNIT

$(\rho 2\pi)_1 = 10$
$(Mf)_1 = 0$

$(\rho 2\pi)_2 = 2{\cdot}41$
$(Mf)_2 = 22800$
$(Fe)_2 = 55\%$

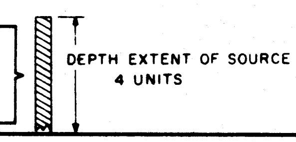


FIG. 4

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

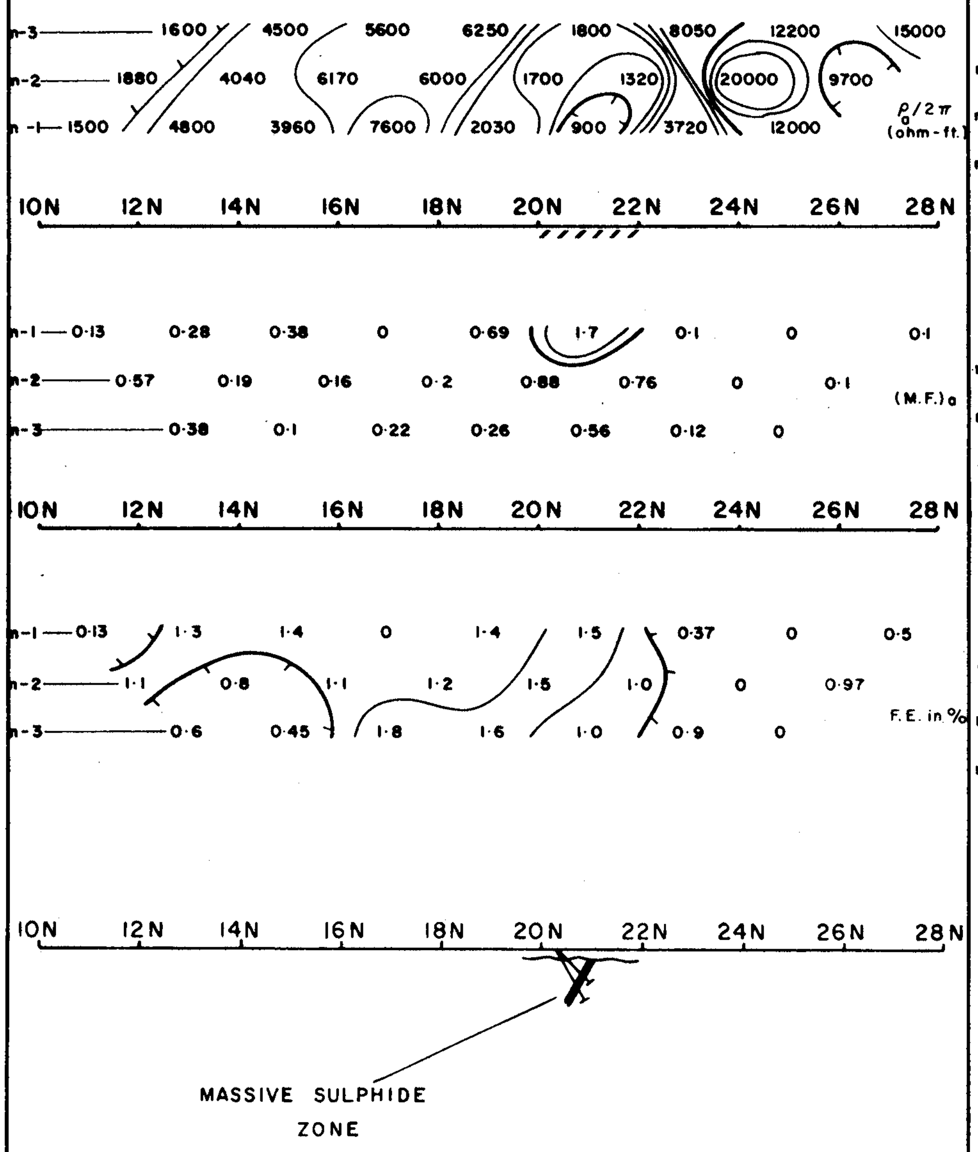


FIG. 5

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

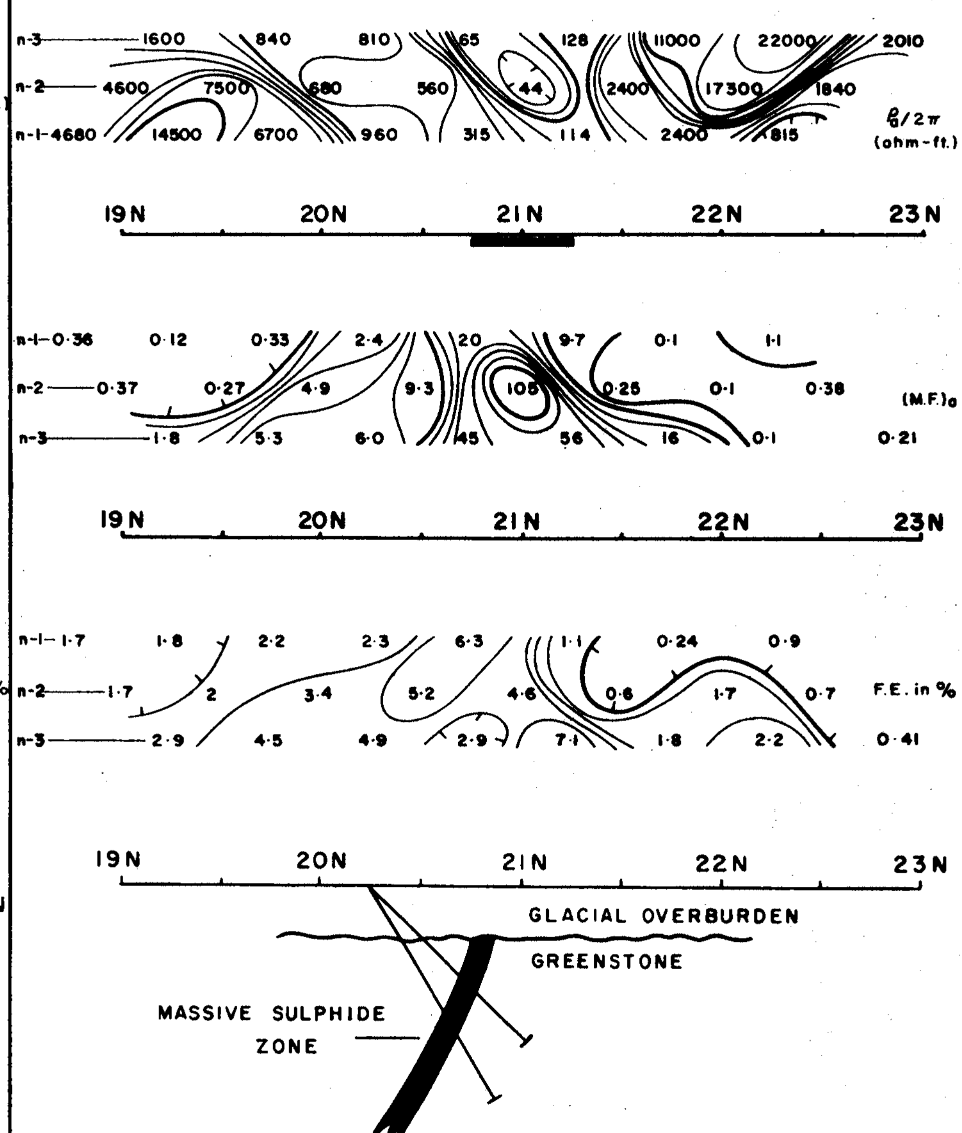


FIG. 6

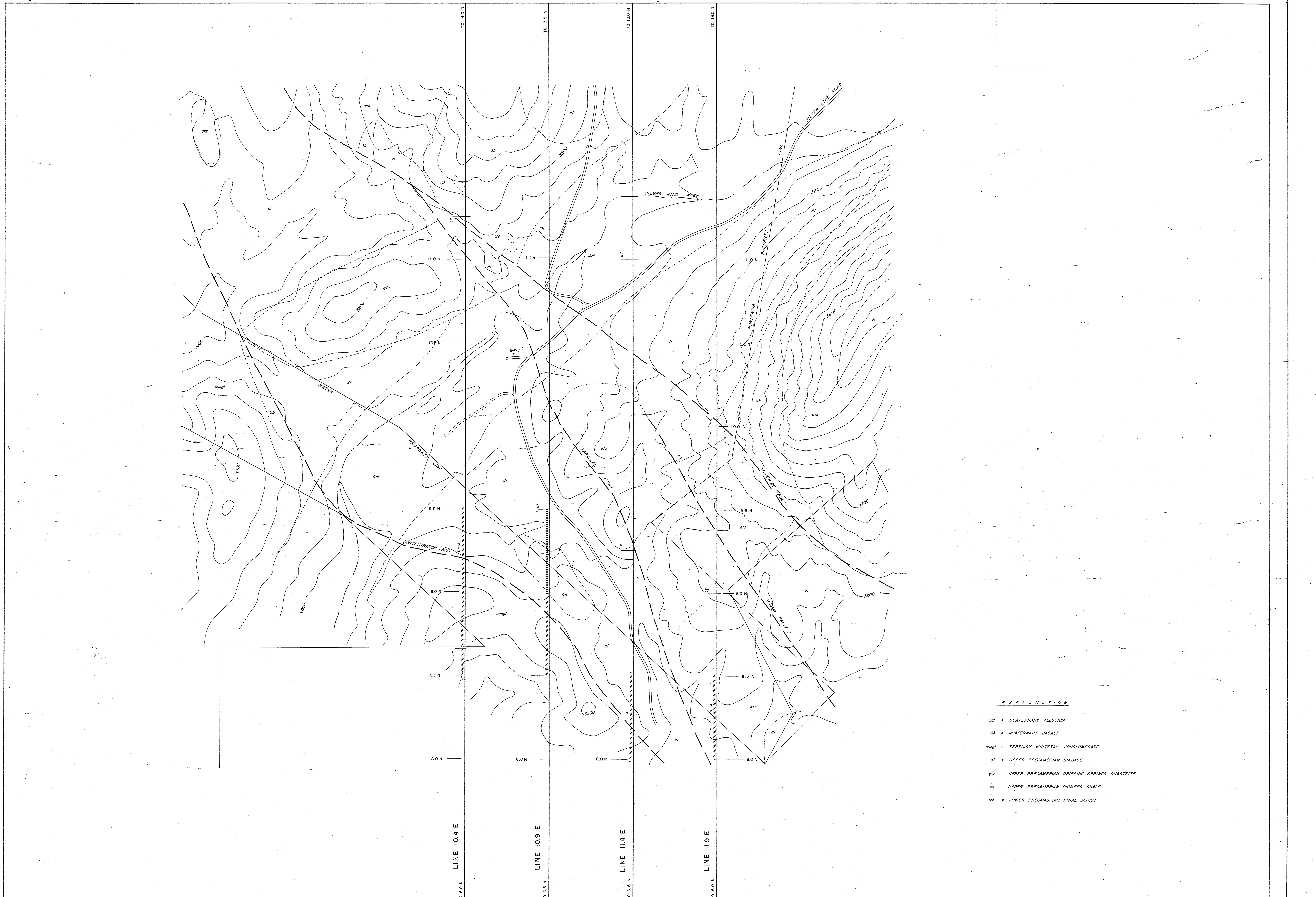
Dwg. I.P.P. 4628

DWG. I.P.P. 4628

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP



SURFACE PROJECTION OF METAL FACTOR ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

NOTE: Number at the end of anomaly indicates spread used

APPARENT DEPTH (S=shallow, M=moderate, D=deep)

C= CONTACT, F= FAULT

SURFACE PROJECTION OF PERCENT FREQUENCY EFFECT ANOMALOUS ZONES

0.1–1.25 ~		0.3–2.5 ~
> 10	VERY STRONG	> 7.5
7.5 – 10	STRONG	5 – 7.5
5 – 7.5	MODERATE	3 – 5
3 – 5	WEAK	2 – 3
2 – 3	VERY WEAK	1.5 – 2

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS, SUPERIOR MINING DISTRICT, PINAL COUNTY, ARIZONA

SCALE

FEET 200 0 200 400 600 800 1000 FEET

1 INCH EQUALS 200 FEET

DRAWN: JK
DATE: MAY, 1970
APPROVED:

DATE

REGISTERED GEOLOGIST CERTIFICATE NO. [illegible]5 ROBERT ALAN BELL ARIZONA, U.S.A. Signed

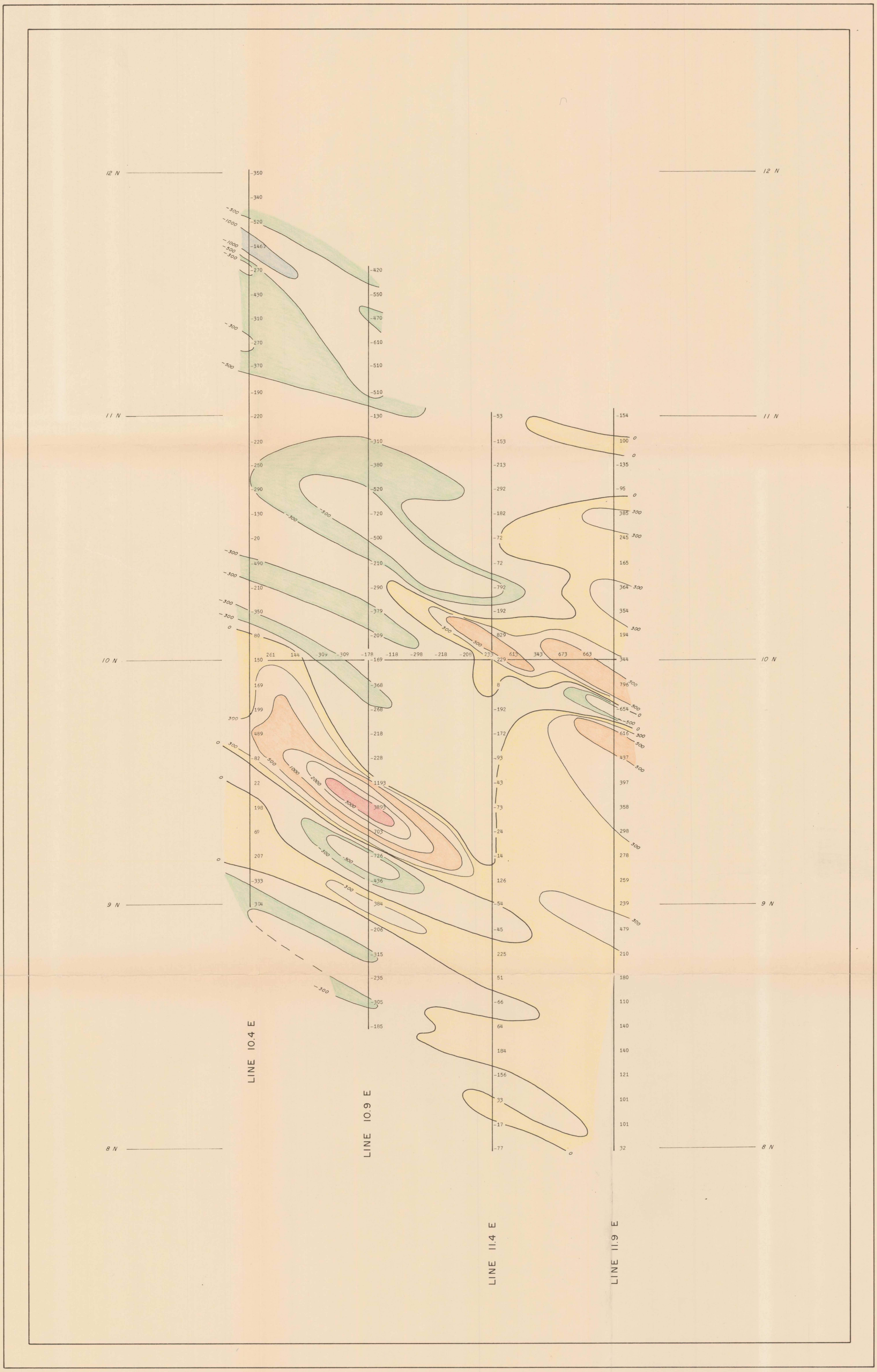
June 12, '70

DWG. I.P.P. 4628

Dwg. No. M3429

McPHAR GEOPHYSICS

VERTICAL INTENSITY MAGNETIC MAP



MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS, SUPERIOR MINING DISTRICT, PINAL COUNTY, ARIZONA

SCALE

FEET 200 0 200 400 600 800 1000 FEET

1 INCH EQUALS 200 FEET

DRAWN: JK
DATE: MAY, 1970
APPROVED
DATE June 12/70

ROBERT ALAN BELL
ARIZONA, U.S.A.

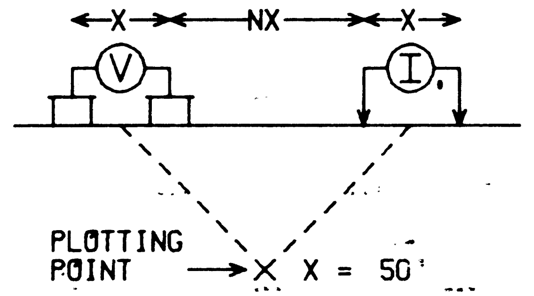
DWG. NO.- I.P.- 5460-1

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 10.4E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬
PROBABLE ||||||||||
POSSIBLE / / / / /

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED: [signature]

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

DATE: June 12/70

REGISTERED GEOLOGIST CERTIFICATE NO. 1105 BELL ARIZONA, U.S.A.

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

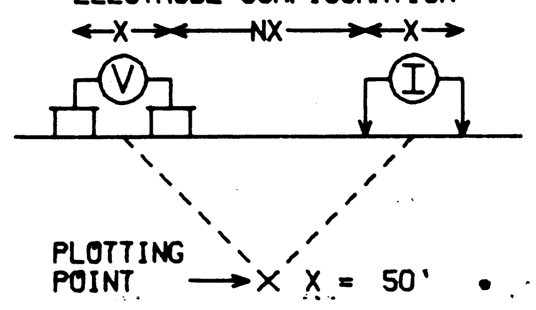
DWG. NO.- I.P.- 5460-2

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 10.9E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬
PROBABLE ||||||||||
POSSIBLE / / / / /

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED:

DATE: June 12 1970

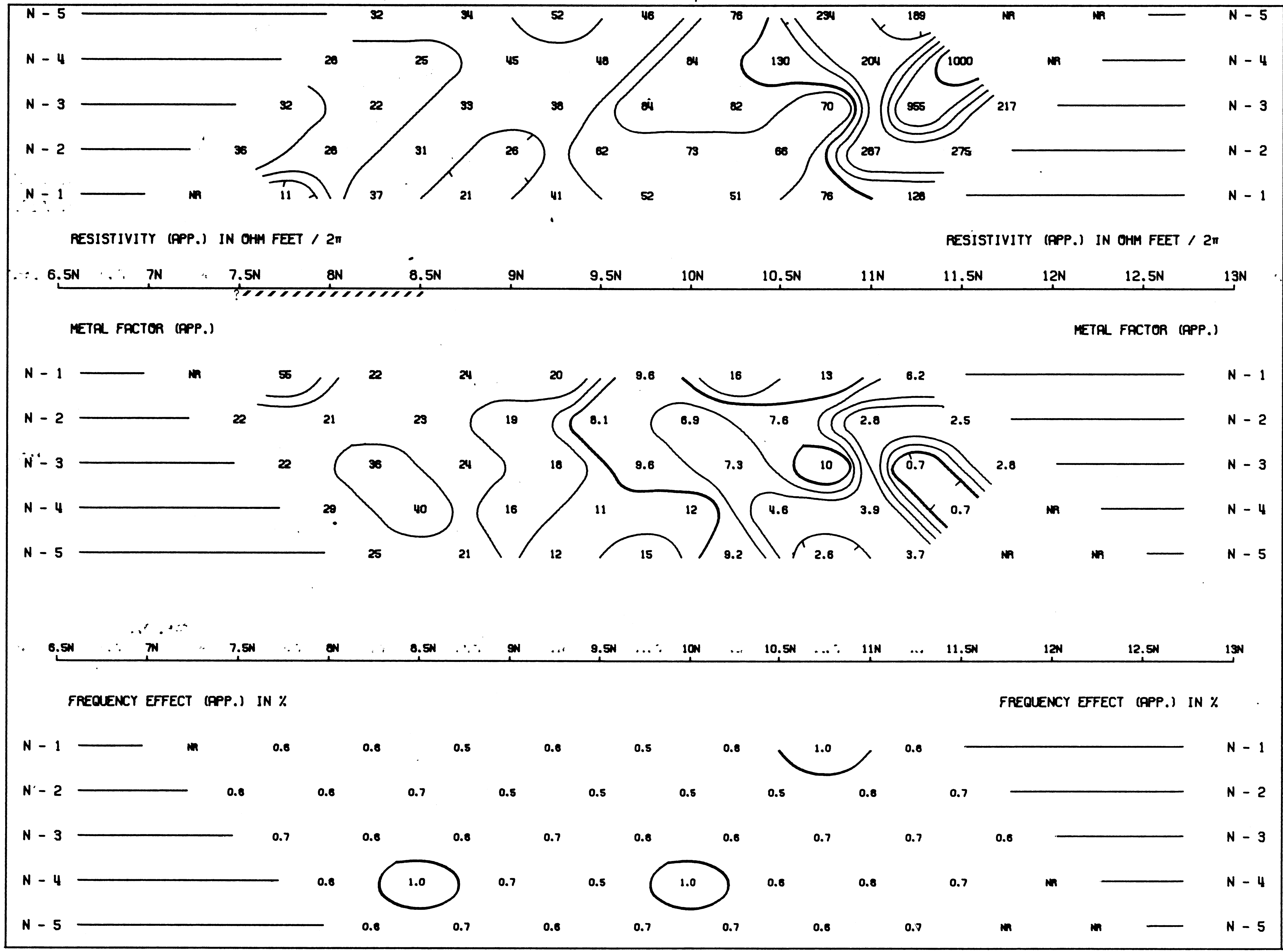
REGISTERED GEOLOGIST CERTIFICATE NO. 7185 ROBERT ALAN BELL ARIZONA, U.S.A.

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

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER



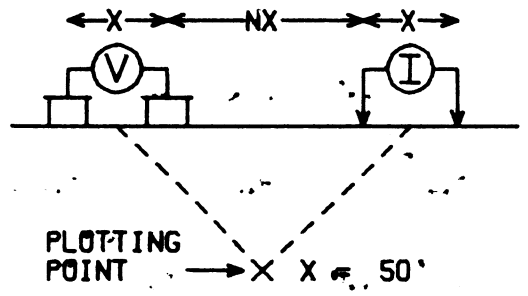
DWG. NO.- I.P.- 5460-3

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 11.4E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED: R. A. Bell

DATE: June 12/70

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 GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

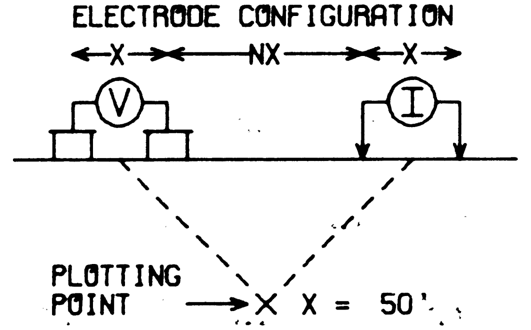
DWG. NO.- I.P.- 5460-4

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 11.9E

ELECTRODE CONFIGURATION



PLOTTING POINT → X = 50'

SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED:

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

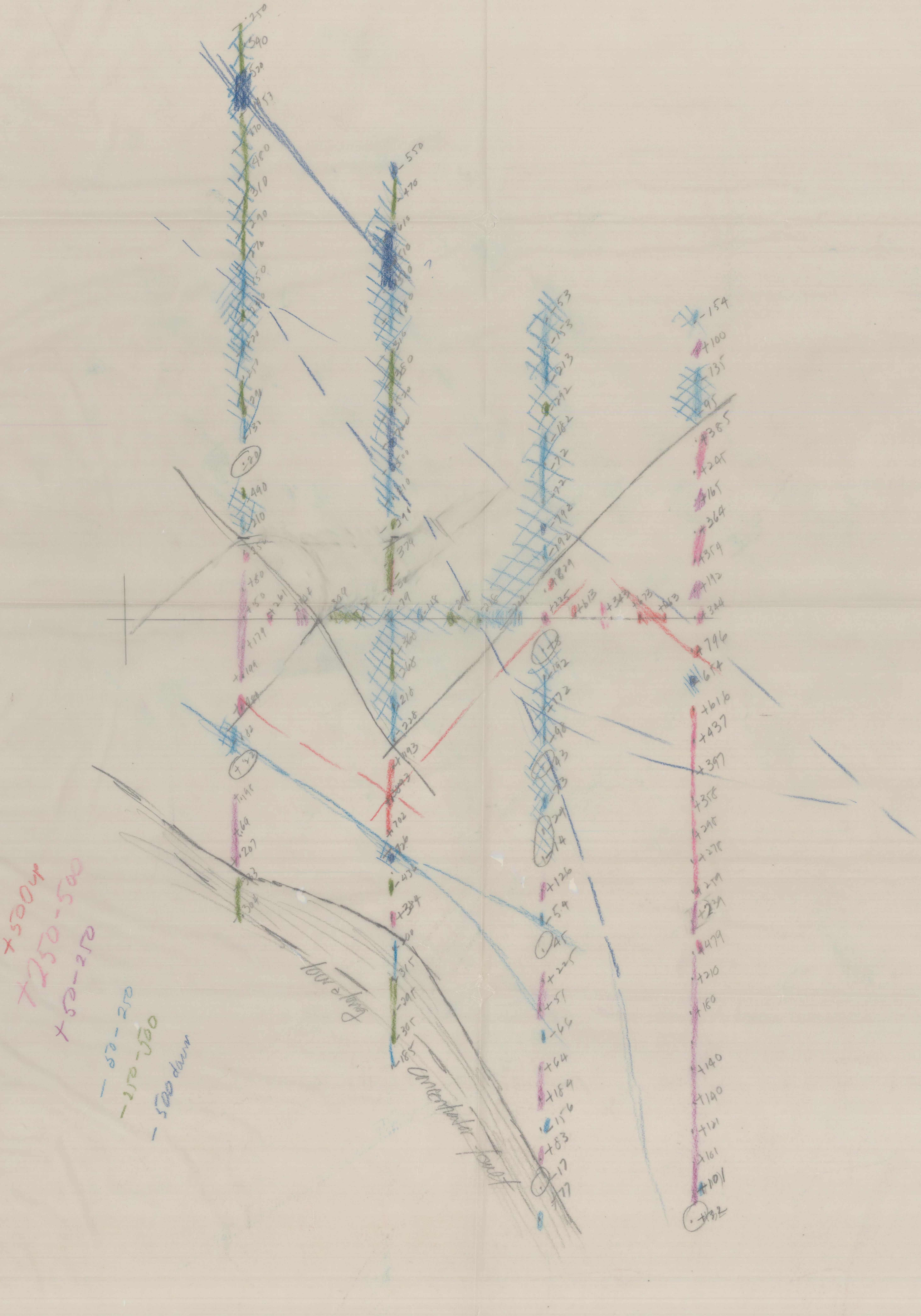
DATE: June 1970

REGISTERED GEOLOGIST CERTIFICATE ROBERT ALAN BELL ARIZONA U.S.A.

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER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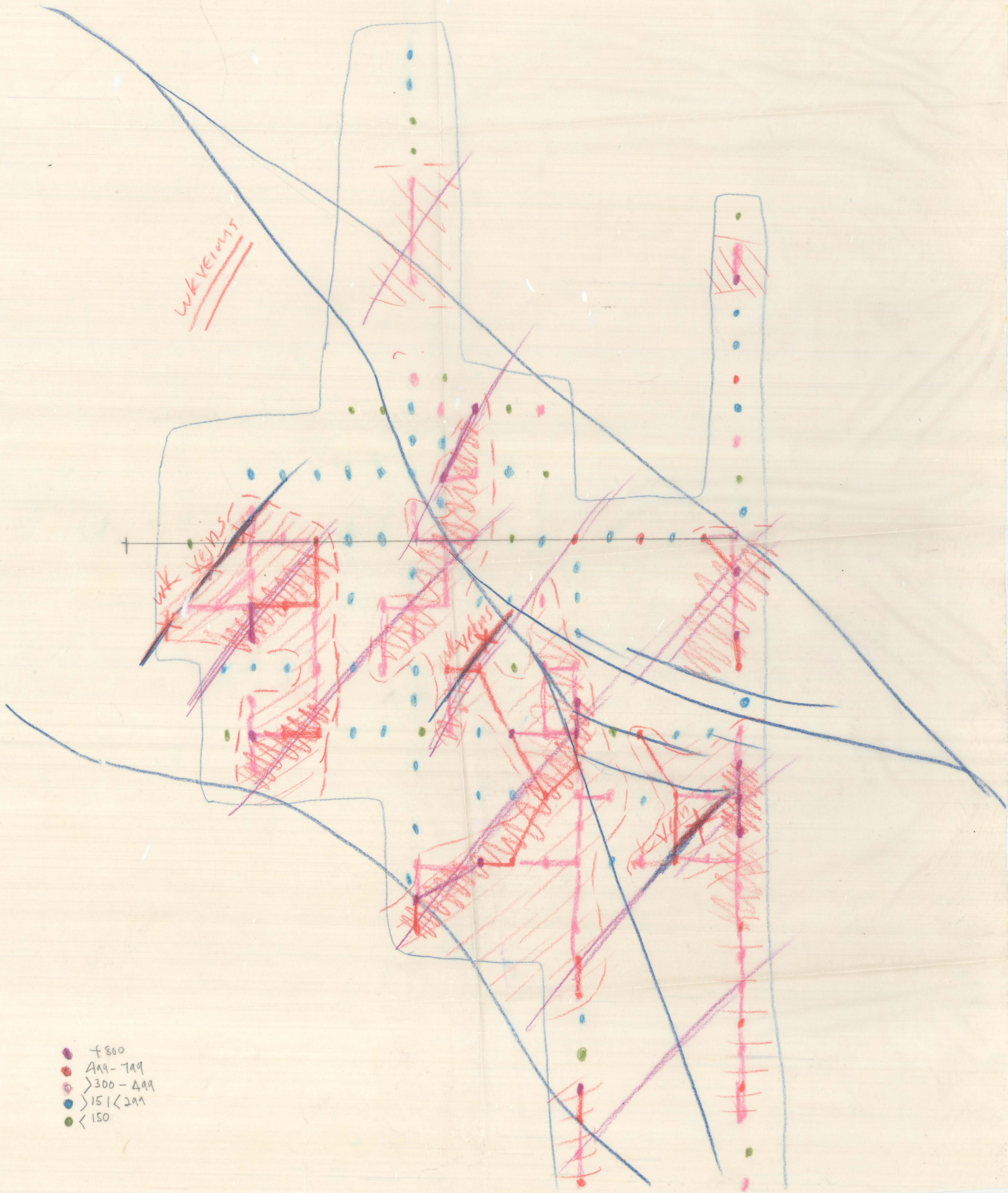
+250-500
+50-250
-50-250
-250-500
-500 down


wk veins
wk veins
wk veins
veins
+800
499 - 799
>300 - 499
>151 | <299
< 150

ADVANCE COPY

RICHARD E. MIERITZ
CONSULTING MINING ENGINEER
PHOENIX, ARIZONA

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

FOR

MR. SHERWOOD B. OWENS

1.0 INTRODUCTION

At the request of Mr. Sherwood B. Owens, McPhar has completed an induced polarization and resistivity survey on the Hortensia Claims, Superior Mining District, Pinal County, Arizona. Vertical intensity ground magnetic measurements were also made at 100-foot intervals along the survey lines. The survey grid was laid out by Mr. Richard E. Mieritz, consultant to Mr. Owens, who furnished geological information and a plan map of the survey area.

Within the survey area, Upper Precambrian diabase intrudes the Dripping Spring quartzite and Pioneer shale members of the Upper Precambrian Apache Group. These rocks overlie the Lower Precambrian Pinal schist and are overlain by Quaternary basalt. The area is transected by several northwest-trending faults which divide the Precambrian units into blocks. The southwesternmost fault, the Concentrator fault, brings the Tertiary (?) Whitetail conglomerate down against the Precambrian rocks. The area is of exploration interest because of its proximity to the Magma mine to the southeast.

The purpose of the induced polarization and resistivity survey was to prospect for sulfide mineralization within 500 feet of the surface. The survey was performed by Raymond Monarez, crew chief.

2.0 PRESENTATION OF RESULTS

The induced polarization and resistivity results are shown on the data plots listed below and are summarized on a plan map, Dwg. No. ______.

LINE	ELECTRODE INTERVAL	DWG. NO.
10.4E	500 feet	
10.9E	500 feet	
11.4E	500 feet	
11.9E	500 feet	

The ground magnetic survey results are shown on a separate map, Dwg. No. _____.

In this report both percent frequency effect (PFE) anomalies and metal factor (MF) anomalies are shown on the plan map. Percent frequency effect is a measure of the intensity of polarization, and anomalies are classified as very weak - very strong. The percent frequency effect results indicate polarizable areas without taking into account the resistivity of the areas. Metal factor (MF) is obtained by combining the percent frequency effect and the resistivity. A good conductor (low resistivity) that is strongly polarizable (high percent frequency effect) will give a well-defined or definite metal factor anomaly. Less well-defined metal factor anomalies are designated as probable or possible.

The percent frequency effect and metal factor parameters are complementary. The relative importance of each type of information depends upon the particular geophysical environment and the type of target expected. For example, a mineralized silicified zone will give a strong percent frequency effect anomaly, but may not give a definite metal factor anomaly. Alternatively, an oxidized ore zone may only give a weak percent frequency effect anomaly, but will give a definite metal factor anomaly pattern. Judicious consideration of both the percent frequency effect and the metal factor results permits a comprehensive evaluation of the geophysical environment.

The anomalies as shown on the data plots and plan map represent the surface projection of the polarizable zones. Contacts or faults inferred from the resistivity patterns are also shown. Anomaly boundaries and fault locations should be considered accurate to the electrode interval used.

The anomalies shown on the plan map are designated apparent depths of shallow, moderate, or deep. At larger dipole separations a greater volume of rock is averaged, in lateral extent as well as depth. Thus, the source of a deep-appearing anomaly detected along a single line may be at shallow depth to one side of the line. The data plots, therefore, cannot represent true depth. Depths can be calculated from the apparent resistivity data in the case of ideal horizontal layers, but even this calculation depends on an assumed resistivity contrast between the zone at depth and the overlying rock. Although ambiguous, the simple depth designations are useful for correlating or comparing anomalous zones obtained on adjacent survey lines. Drill hole information from one or more zones frequently permits one to make a fair depth estimate for other zones. The following depth generalizations apply to porphyry copper and contact-replacement bodies:

	Apparent Depth (dipole separations)	Drill Hole Depth (in dipole lengths)
Shallow	1 - 2	1/2 - 1
Moderate	2 - 3	1 - 1-1/2
Deep	3 - 5	1-1/2 - 2+

Thus, a shallow zone is one detected at a one-to-two dipole separations and should be tested by a drill hole from a half-to-one dipole length deep.

An appendix on the interpretation of induced polarization anomalies is enclosed in this report. It shows the desirability of detailing with shorter spreads when the anomaly is shallow and the source may be narrow.

The induced polarization method is a geophysical tool used to determine the electrical properties of the earth. The final evaluation of the induced polarization anomalies, e.g., which of the anomalies constitutes the most favorable exploration target, must be based on available geologic evidence and concepts.

3.0 DISCUSSION OF RESULTS

As shown on the plan map, the induced polarization results indicate a possible metal factor anomalous zone and a single probable metal factor anomaly in the southern portion of the grid. The metal factor anomalies are due to low resistivities and quite weak, but above-background percent frequency effects (PFE's). The results obtained along each line are discussed in detail below.

Line 10.4E. The resistivity results indicate a fault or contact in the vicinity of 11.25N, with high resistivity rock north of the contact. A resistivity low occurs at shallow-moderate depth in the interval (?)8.5N-9.75N. The possible metal factor anomaly within this interval is due to both low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.0N-10.5N and at shallow-moderate depth in the interval 12.5N-13.0N(?).

Line 10.9E. The resistivity results indicate faults or contacts in the vicinity of 9.5N and 11.0N, with low resistivity rock south of 9.5N and high resistivity rock north of 11.0N. The shallow, probable metal factor anomaly in the interval 9.0N-9.5N is due to very low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.5N-11.0N and at shallow-moderate depth in the interval 11.75N-12.25N(?).

Line 11.4E. The resistivity results indicate faults or contacts in the vicinity of 9.25N and 11.0N, with low resistivity rock south of 9.25N and very high resistivity rock at depth north of 11.0N. The possible metal factor anomaly in the interval (?)7.5N-8.5N is due to very low resistivities and background-above-background PFE's. Above-background PFE's occur at moderate-deep depth in the interval 9.5N-10.0N and at shallow depth in the interval 10.5N-11.0N.

Line 11.9E. The resistivity results indicate a possible contact at 9.0N and a distinct resistivity low zone at shallow-moderate depth in the interval 8.0N-8.5N. The possible metal factor anomaly in the interval 8.0N-8.5N is due to the low resistivities and to above-background PFE's. Above-background PFE's also occur at shallow depth in the interval 10.25N-10.75N.

RICHARD E. [illegible]
CONSULTING [illegible] ENGINEER
[illegible]

As shown on the magnetic map, the vertical intensity ground magnetic results show a distinct northwest trend. The southeastern and eastern portions of the grid are higher in magnetic intensity than the northwestern portion of the grid. A strong magnetic anomaly occurs in the interval 9.1N-9.6N along Line 10.9E. The anomaly is characteristic of a vertical dike centered at 9.25N. The fact that the magnetic high lies north of the magnetic low suggests that the dike has a reverse remnant component. The magnetic anomaly occurs at the northern edge of an outcrop of Quaternary basalt, and lies within the probable metal factor anomaly obtained along Line 10.9E. Magnetic anomalies also occur in the interval 10.0N-10.4N along Line 11.4E and in the interval 9.6N-10.0N along Line 11.9E. These anomalies form a northwest-trending zone that persists across the entire grid. The anomaly along Line 11.4E is characteristic of a vertical dike centered at 10.2N. A strong magnetic low is centered at 11.7N along Line 10.4E.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The percent frequency effects (PFE's) associated with the possible-probable metal factor anomalies detected in the southern portion of the grid are too weak to be indicative of large massive sulfide bodies such as those at the Magma mine. However, the possible economic significance of the anomalies should be assessed in light of geological and geochemical results.

The probable metal factor anomaly along Line 10.9E coincides with a strong magnetic anomaly. The above-background PFE's associated with the probable metal factor anomaly could be due to magnetite. The anomaly pattern suggests that the source of the anomaly dips to the south. Since the source is apt to be narrow, the anomalous zone should be detailed at 100-foot electrode intervals if drilling is contemplated.

RICHARD E. MERITT
CONSULTING MINING ENGINEER

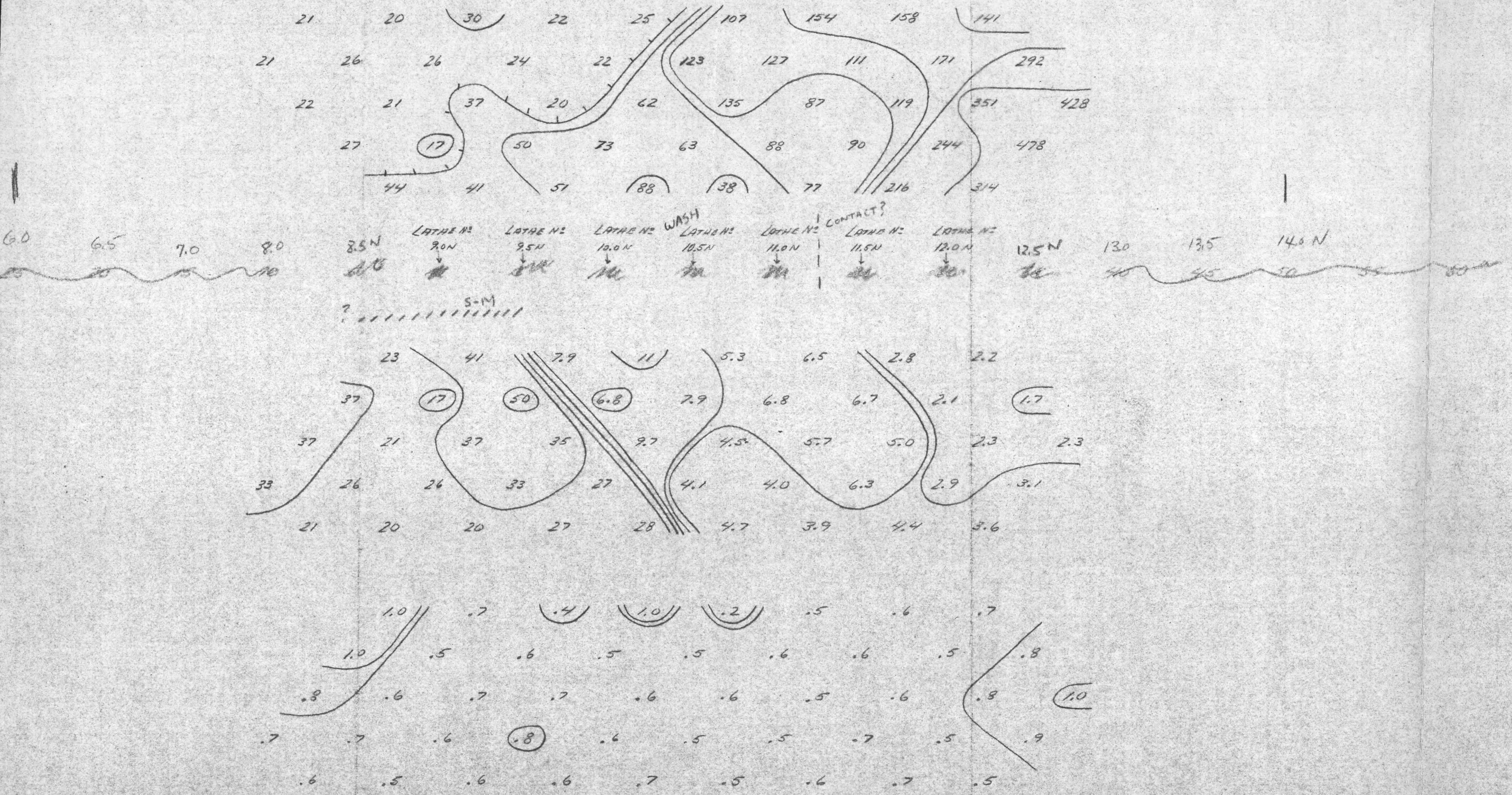
The possible metal factor anomalies at the southern ends of Line 10.4E, Line 10.9E, and Line 11.4E occur in the vicinity of the Concentrator fault. Low resistivities which appear to be due to the Whitetail conglomerate contribute to these anomalies. The possible metal factor anomaly in the interval 8.0N-8.5N along Line 11.9E appears to be more significant. From the geology map, the low resistivities which contribute to this anomaly cannot be attributed to the Whitetail conglomerate.

The shallow, above-background PFE zones in the northern portion of the grid could be due to widely-spaced, mineralized veins or shears. If close surface examination or geochemical sampling indicates these zones to be of further interest, they should be detailed at 100-foot electrode intervals.

McPHAR GEOPHYSICS INCORPORATED

Anthony M. Hauck III
Geophysicist

VW



ρa/2π

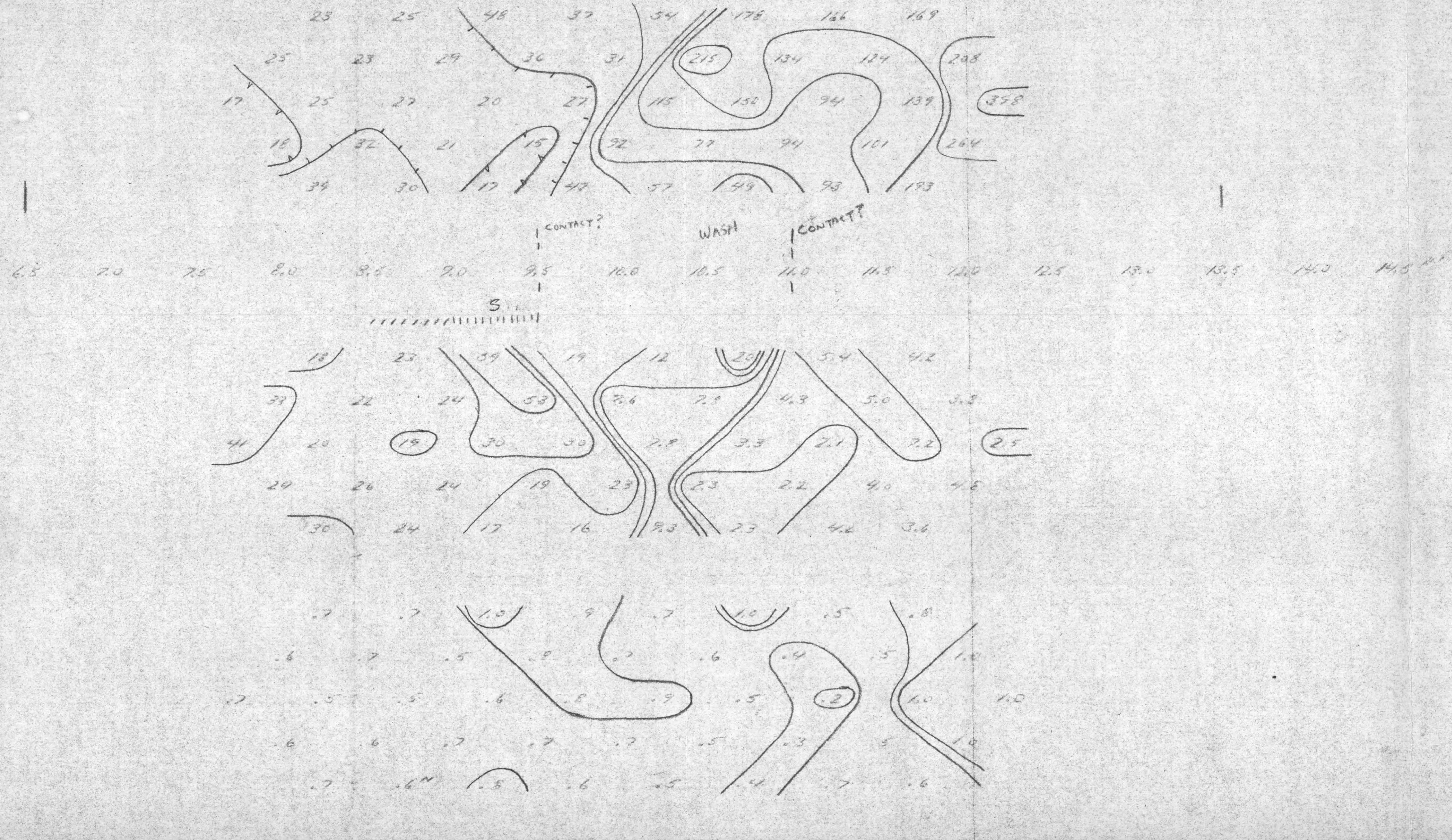
M.F.

P.E.

Sherwood B. Owens Company
Hortencia Project
Superior, Arizona
Frequencies 2.5 + .3 C.P.S.
Scale 1 inch = 500'
Date May 11, 1970
Operator Ray Monarle

RICHARD E. MIERITZ
CONSULTING MINING ENGINEER
PHOENIX, ARIZONA

Line No 109 E



ρa/2π

M.F.

P.E.

Sherwood B. Owens Company

Hortencia Project

Superior, Arizona

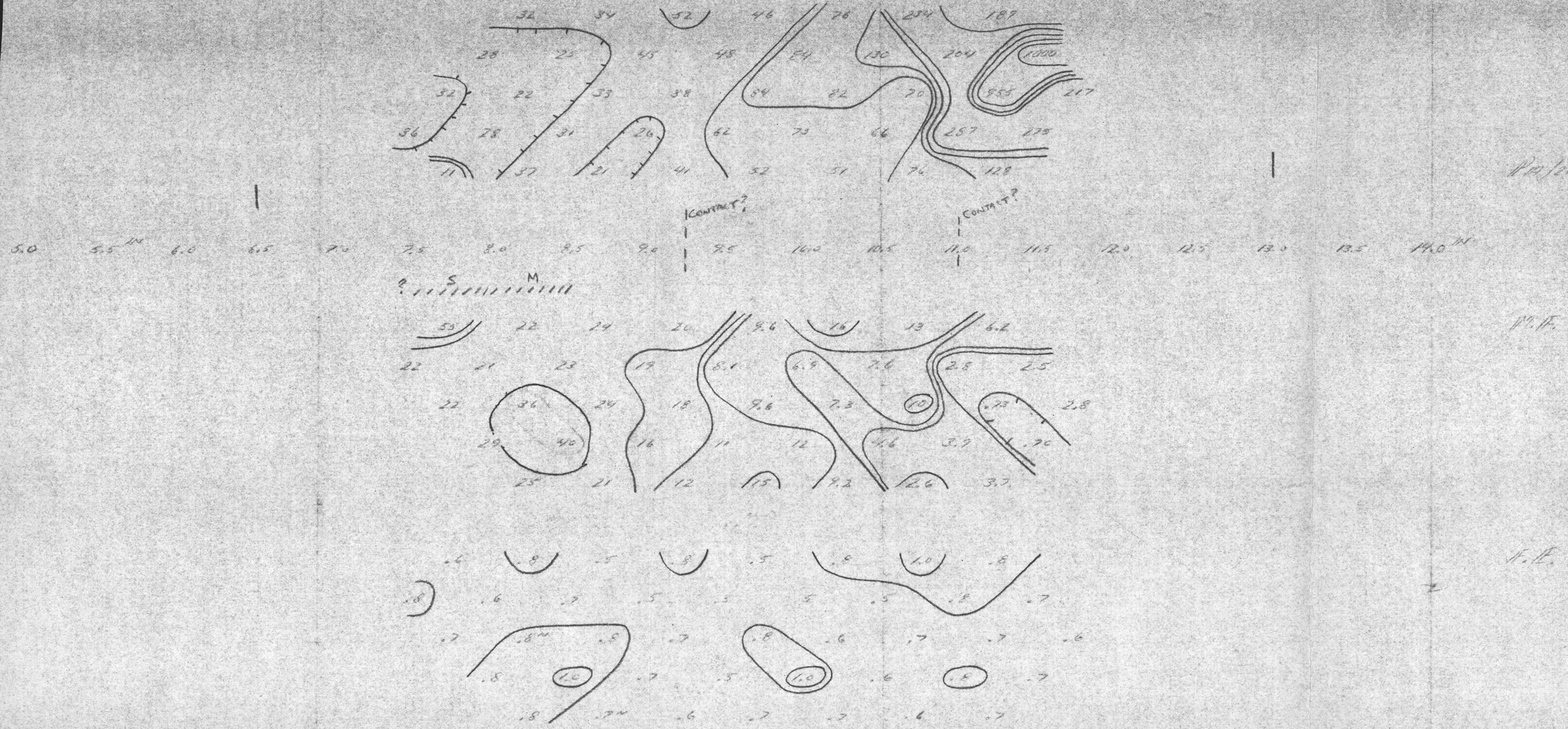
Frequencies 2.54, .3 C.P.S.

Scale 1 inch = 500'

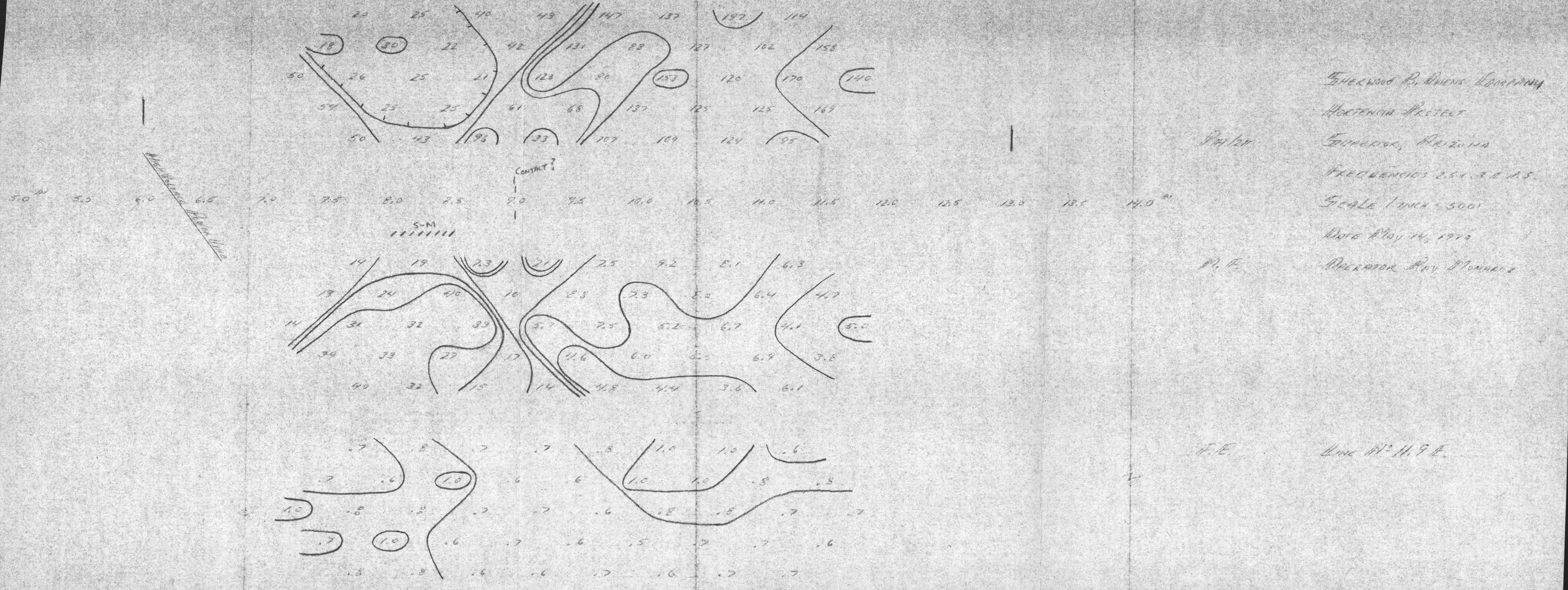
Date May 12, 1970

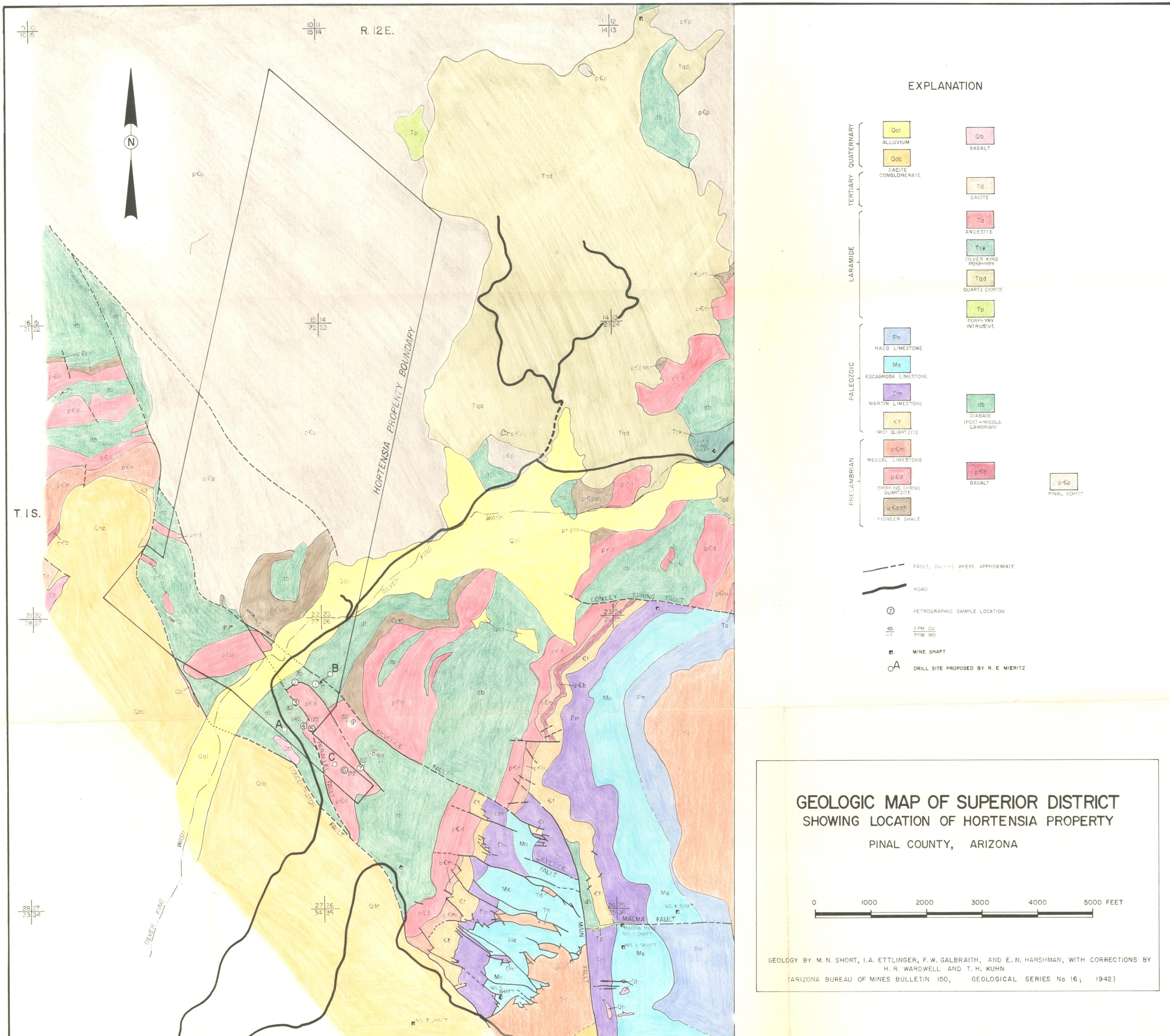
Operator Roy Monarez

Line No. 10.9 E.



Sherwood B. Owens Company
Hortencia Project
Superior, Arizona
Frequencies: 2.5 & .3 C.P.S.
Scale 1 inch = 500'
Date May 14, 1970
Operator Ray Monarrez
Line No 11.4 E


Sherwood B. Owens Company
Hortensia Project
Superior, Arizona
Frequencies 2.5 & 3.0 C.P.S.
Scale 1 inch = 500'
Date May 14, 1970
Operator Ray Monnahs
Line No. 11.9 E.
Pa/2π
M.F.
F.E.
Contact?
S-M
5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0



GEOLOGIC MAP OF SUPERIOR DISTRICT
SHOWING LOCATION OF HORTENSIA PROPERTY
PINAL COUNTY, ARIZONA

GEOLOGY BY M. N. SHORT, I. A. ETTLINGER, F. W. GALBRAITH, AND E. N. HARSHMAN, WITH CORRECTIONS BY H. R. WARDWELL AND T. H. KUHN
(ARIZONA BUREAU OF MINES BULLETIN 150, GEOLOGICAL SERIES No. 16; 1942)

J. DAVID LOWELL
CONSULTING GEOLOGIST
5211 N. ORACLE TUCSON, ARIZONA 85704 PHONE 887-5341

September 11, 1970

Mr. George Freeman
P.O. Box 7277
Phoenix, Arizona 85011

Dear Mr. Freeman:

As you requested in our conversation of July 28, we have visited the Hortensia property in the Superior district and reviewed the exploration project proposed by Mr. R. E. Miertz. Our work has revealed several inconsistencies in the proposed project and we are recommending that the property not be optioned.

The Proposed Project

The program suggested by Mr. Miertz calls for 6,000 feet of initial drilling to test three closely spaced targets in the southeastern part of the property. The project is based on the following:

1. The proximity of the Hortensia property to the Magma mine.

2. The similarity of rock types and controlling structural features in the Magma mine and Hortensia property.

3. Hydrothermal alteration of the diabase in the target area.

4. The presence of limonite derived from sulfides.

5. Geochemical and geophysical anomalies in the target area.

The Magma Mine

Mineralization at the Magma mine consists of steeply dipping east-west veins which carry copper, zinc, gold and silver. The Magma vein and associated porphyry dikes cut Precambrian schist and sedimentary rocks as well as diabase and lower Paleozoic sedimentary rocks. The vein is 12-15 feet wide and has been explored to a depth of 4,800(?) feet and along its strike for 9,000 feet.

Postore faults, including the Main fault, Parallel fault, Silveride fault, Conley Spring fault and Concentrator fault, vary in strike from northwest to northeast and offset the older preore structures.

Faults ((post ore))

The Hortensia Property

The Hortensia property containing 43 unpatented lode claims is located about 1.5 miles north-northwest of the Magma mine. Precambrian Pinal schist as well as quartzite and Paleozoic diabase is well exposed on the property.

No faults or strong veins of preore age have been recognized, but several postore faults are present on the south side of the property. These include the Concentrator, the Silveride, the Parallel, and the Conley Spring faults.

Diabase and Precambrian sedimentary rocks are weakly altered and iron stained. Rock chip samples collected in the target area east of Silver King Road contain 35 to 155 ppm Cu and less than 1 ppm Mo. The highest copper values were found in quartzite and diabase along the Parallel fault, which strikes north-northwest across the south side of the Hortensia property.

Alteration of diabase in the target area has produced clay and chlorite. Quartzite in the same area shows slight recrystallization. Weak transported limonite is present especially in the strongly broken rocks near the Parallel fault, but indigenous limonite is very sparse and almost invariably formed after pyrite.

Evaluation and Recommendation

Having summarized very briefly the geology of the Superior district and the Hortensia property, it is possible to make a rather specific evaluation of the proposed exploration project.

The proximity of the Hortensia property to the Magma mine is favorable only in a general way since the mineralized structures sought are typically quite limited in areal extent. The similarity of rock types at Magma and Hortensia is also only slightly favorable because the same rock types are present throughout the Superior quadrangle. The absence of porphyry dikes or other Laramide intrusive rocks on the Hortensia property is distinctly unfavorable.

The faults present on the property are known to be of post-mineral age in the Magma area and consequently fail to qualify as possible ore controls. Projection of the preore Magma fault onto the property requires a right-angle turn and I know of no evidence that the structure makes such a turn or that it branches northwestward. The recently publish-d U.S.G.S. geologic map of the Superior quadrangle indicates that the Magma fault does not turn into the Hortensia property.

Hydrothermal alteration in the target area is generally weak, and limonite texture does not suggest the former presence of strong sulfides.

Our rock chip sampling on the Hortensia property suggests weakly anomalous values for copper and background values for molybdenum. The anomalies present appear to be related to post-mineral faults which strike northwest.

The previous soil sampling revealed several rather sharp anomalies having a definite southwest trend. Copper tends to be concentrated in soils which may explain the relatively high copper values obtained in the soil survey. The reason for the orientation of the anomalies, however, is uncertain. No faults, veins or other structures were recognized which might account for the configuration of the copper anomalies. It is probable that the soil samples reflect airborne contamination from the nearby smelter stack as well as copper being transported down Silver King Wash from the area of the Silver King mine.

The proposed correlation of geophysical anomalies with geologic structure appears consistent. However, the faults reflected by the survey are of post-mineral age and the lithologic contacts lack surface evidence of strong mineralization.

Because evidence suggesting strong mineralization was not observed on the Hortensia property and because productive structures in adjacent areas do not appear to extend into the Hortensia area we suggest that the property not be optioned.

Yours very truly,

L. Clark Arnold

L. Clark Arnold

LCA:H

References

Peterson, D. W., 1969, Geologic map of the Superior quadrangle, Pinal County, Arizona: U.S. Geological Survey.

Short, M. N. and others, !943, Geology and ore deposits of the Superior mining area, Arizona: Univ. of Ariz. Bureau of Mines Bull. 151.

Steel, H. S., 1952, Superior area, Arizona, in Ariz. Geol. Soc.-Geol Soc. America Guidebook Southern Arizona, p. 107-111.

KENNETH WILSON & ASSOCIATES

Lands and Minerals Exploration

PHONE 392-4313
Cable: ELKEN

315 MONTGOMERY STREET
SAN FRANCISCO, CALIF. 94104

KEN WILSON
Registered Geologist
Land Consultant
BILL COX
Professional Geologist
Registered Engineer

PLEASE ADDRESS REPLY TO:

Suite 1120

November 16, 1970

Mr. Dennis Pickiens
Home-Stake Production Company
Financial Center
Phoenix, Arizona

HORTENSIA GROUP,
SUPERIOR, ARIZONA

Report by Manning W. Cox

Dear Sir:

I inspected the surface of the Hortensia group of unpatented lode locations, just north of the town of Superior, Arizona, on November 2, 1970, guided by Richard Mieritz, consulting mining engineer of Phoenix. On November 3 I studied detailed geochem and geophysical work by Mieritz and McPhar and the U. S. G. S. rectnt mapping. Herewith my opinion.

The Hortensia claims straddle the northwest trending fault system that marks the east edge of the Superior Mountains. The same faults that so far have terminated Magma ore to the west, to wit, the Main and Concentrator faults, pass through these claims. Here they displace the older units of the Apache group, to wit, the Dripping Springs Quartzite, Barnes conglomerate, Pioneer shale, and the intrusive Diabase, as well as the older Pinal Schist. The younger rocks, host for much of the ore at Magma mine, specifically the O'Carroll beds of the Martin formation, are not present.

The northwest trending faults are rubble zones in siliceous rocks and wide shears in the diabase and schist. They give no sign of mineralization. There are, however, weak veins of quartz and iron oxide with occasional copper stains that trend in a northeast to east direction. There are also northeast trending bull quartz veins in the Pinal schist. These weak evidences of mineralization are offset by the range front fault system with an apparant left lateral movement, that is looking along the fault strike the left side has apparently moved away from the observer. To the west and south, on the west or hanging wall side of the Concentrator fault, the only exposed rock in this area is the post-ore Gila conglomerate. From deep Magma mine workings it is known that the Gila rests on several thousand feet of Tertiary dacite flows. But about a mile northwest of Silver King Wash (the center of the Hortensia claims), the upper Apache group limestones once again reach the surface west of the range front faults.

Mieritz took several hundred soil samples on a brunton-tape grid that were analyzed for total copper. There are indicated several anomalies that align themselves along northeast trends, at least two of which are visibly related to northeast veining in diabase. Some of the samples are very high -- so much so that others have suggested contamination from the nearby smelter. I think this most unlikely, since the highest samples were only 0.13% copper. I believe these are real anomalies and likely are related to copper mineralization of greater strength at depth.

McPhar ran vertical magnetic and IP/Resistivity readings over a part of the Mieritz grid. The magnetic data are in my opinion not close enough together to truly delimit trends; in other words, one can connect highs and lows in many patterns without proof. The Pinal schist seems to show consistently very low readings and the quartzites very high readings (this is exactly reversed from what I should have expected and leads me to suggest the instrument in use was reversely polarized. At any rate, the only real trend seems to be a low (or high?) along the Concentrator fault.

The IP work showed weak anomalies but when the resistivity is considered there seems to be general weak polarization but widely varying resistivity giving rise to weak MF anomalies. Restivity is low in the diabase and high in the Pinal Schist. In reality there is not enough data over a wide enough area to permit any solid conclusions.

The above data lead me to believe that exploration of the Hortensia group would be a very, very long shot and that if mineralization were to be found its certain depth continuation would lie on Magma ground. For these reasons I do not recommend this prospect to you at this time.

Respectfully submitted,

Manning W. Cox
Consulting Geologist
KENNETH WILSON & ASSOCIATES

Professional Engineer
Colorado No. 5388
Registered Geologist
California No. 1037

MWC/ca

Letter report, no encls.

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA
FOR
MR. SHERWOOD B. OWENS

McPHAR GEOPHYSICS

NOTES ON THE THEORY, METHOD OF FIELD OPERATION, AND PRESENTATION OF DATA FOR THE INDUCED POLARIZATION METHOD

Induced Polarization as a geophysical measurement refers to the blocking action or polarization of metallic or electronic conductors in a medium of ionic solution conduction.

This electro-chemical phenomenon occurs wherever electrical current is passed through an area which contains metallic minerals such as base metal sulphides. Normally, when current is passed through the ground, as in resistivity measurements, all of the conduction takes place through ions present in the water content of the rock, or soil, i.e. by ionic conduction. This is because almost all minerals have a much higher specific resistivity than ground water. The group of minerals commonly described as "metallic", however, have specific resistivities much lower than ground waters. The induced polarization effect takes place at those interfaces where the mode of conduction changes from ionic in the solutions filling the interstices of the rock to electronic in the metallic minerals present in the rock.

The blocking action or induced polarization mentioned above, which depends upon the chemical energies necessary to allow the ions to give up or receive electrons from the metallic surface, increases with the time that a d. c. current is allowed to flow through the rock; i. e. as ions pile up against the metallic interface the resistance to current flow increases. Eventually, there is enough polarization in the form of excess ions at the interfaces, to appreciably reduce the amount of current flow through the metallic particle. This polarization takes place at each of the infinite number of solution-metal interfaces in a mineralized rock.

When the d. c. voltage used to create this d. c. current flow is cut off, the Coulomb forces between the charged ions forming the polarization cause them to return to their normal position. This movement of charge creates a small current flow which can be measured on the surface of the ground as a decaying potential difference.

From an alternate viewpoint it can be seen that if the direction of the current through the system is reversed repeatedly before the polarization occurs, the effective resistivity of the system as a whole will change as the frequency of the switching is changed. This is a consequence of the fact that the amount of current flowing through each metallic interface depends upon the length of time that current has been passing through it in one direction.

The values of the per cent frequency effect or F. E. are a measurement of the polarization in the rock mass. However, since the measurement of the degree of polarization is related to the apparent resistivity of the rock mass it is found that the metal factor values or M. F. are the most useful values in determining the amount of polarization present in the rock mass. The MF values are obtained by normalizing the F. E. values for varying resistivities.

The induced polarization measurement is perhaps the most powerful geophysical method for the direct detection of metallic sulphide mineralization, even when this mineralization is of very low concentration. The lower limit of volume per cent sulphide necessary to produce a recognizable IP anomaly will vary with the geometry and geologic environment of the source, and the method of executing the survey. However, sulphide mineralization of less than one per cent by volume has been detected by the IP method under proper geological conditions.

The greatest application of the IP method has been in the search for disseminated metallic sulphides of less than 20% by volume. However, it has also been used successfully in the search for massive sulphides in situations where, due to source geometry, depth of source, or low resistivity of surface layer, the EM method can not be successfully applied. The ability to differentiate ionic conductors, such as water filled shear zones, makes the IP method a useful tool in checking EM anomalies which are suspected of being due to these causes.

In normal field applications the IP method does not differentiate between the economically important metallic minerals such as chalcopyrite, chalcocite, molybdenite, galena, etc., and the other metallic minerals such as pyrite. The induced polarization effect is due to the total of all electronic conducting minerals in the rock mass. Other electronic conducting materials which can produce an IP response are magnetite, pyrolusite, graphite, and some forms of hematite.

In the field procedure, measurements on the surface are made in a way that allows the effects of lateral changes in the properties of the ground to be separated from the effects of vertical changes in the properties. Current is applied to the ground at two points in distance (X) apart. The potentials are measured at two other points (X) feet apart, in line with the current electrodes is an integer number (n) times the basic distance (X).

The measurements are made along a surveyed line, with a constant distance (nX) between the nearest current and potential electrodes. In most surveys, several traverses are made with various values of (n); i.e. (n) = 1, 2, 3, 4, etc. The kind of survey required (detailed or reconnaissance) decides the number of values of (n) used.

In plotting the results, the values of the apparent resistivity, apparent per cent frequency effect, and the apparent metal factor measured for each set of electrode positions are plotted at the intersection of grid lines, one from the center point of the current electrodes and the other from the center point of the potential electrodes. (See Figure A.) The resistivity values are plotted above the line as a mirror image of the metal factor values below. On a second line, below the metal factor values, are plotted the values of the per cent frequency effect. In some cases the values of per cent frequency effect are plotted as superscripts of the metal factor value. In this second case the frequency effect values are not contoured. The lateral displacement of a given value is determined by the location along the survey line of the center point between the current and potential electrodes. The distance of the value from the line is determined by the distance (nX) between the current and potential electrodes when the measurement was made.

The separation between sender and receiver electrodes is only one factor which determines the depth to which the ground is being sampled in any particular measurement. The plots then, when contoured, are not section maps of the electrical properties of the ground under the survey line. The interpretation of the results from any given survey must be carried out using the combined experience gained from field results, model study results and theoretical investigations. The position of the electrodes when anomalous values are measured is important in the interpretation.

In the field procedure, the interval over which the potential differences are measured is the same as the interval over which the electrodes are moved after a series of potential readings has been made. One of the advantages of the induced polarization method is that the same equipment can be used for both detailed and reconnaissance surveys merely by changing the distance (X) over which the electrodes are moved each time. In the past, intervals have been used ranging from 25 feet to 2000 feet for (X). In each case, the decision as to the distance (X) and the values of (n) to be used is largely determined by the expected size of the mineral deposit being sought, the size of the expected anomaly and the speed with which it is desired to progress.

The diagram in Figure A demonstrates the method used in plotting the results. Each value of the apparent resistivity, apparent metal factor, and apparent per cent frequency effect is plotted and identified by the position of the four electrodes when the measurement was made. It can be seen that the values measured for the larger values of (n) are plotted farther from the line indicating that the thickness of the layer of the earth that is being tested is greater than for the smaller values of (n); i. e. the depth of the measurement is increased. When the F. E. values are plotted as superscripts to the MF values the third section of data values is not presented and the F. E. values are not contoured.

The actual data plots included with the report are prepared utilizing an IBM 360/75 Computer and a Calcomp 770/763 Incremental Plotting System. The data values are calculated, plotted, and contoured according to a programme developed by McPhar Geophysics. Certain symbols have been incorporated into the programme to explain various situations in recording the data in the field.

The IP measurement is basically obtained by measuring the difference in potential or voltage (ΔV) obtained at two operating frequencies. The voltage is the product of the current through the ground and the apparent resistivity of the ground. Therefore in field situations where the current is very low due to poor electrode contact, or the apparent resistivity is very low, or a combination of the two effects; the value of (ΔV) the change in potential will be too small to be measurable. The symbol "TL" on the data plots indicates this situation.

In some situations spurious noise, either man made or natural, will render it impossible to obtain a reading. The symbol "N" on the data plots indicates a station at which it is too noisy to record a reading. If a reading can be obtained, but for reasons of noise there is some doubt as to its accuracy, the reading is bracketed in the data plot ( ).

In certain situations negative values of Apparent Frequency Effect are recorded. This may be due to the geologic environment or spurious electrical effects. The actual negative frequency effect value recorded is indicated on the data plot, however the symbol "NEG" is indicated for the corresponding value of Apparent Metal Factor. In contouring negative values the contour lines are indicated to the nearest positive value in the immediate vicinity of the negative value.

The symbol "NR" indicates that for some reason the operator did not attempt to record a reading although normal survey procedures would suggest that one was required. This may be due to inaccessible topography or other similar reasons. Any symbol other than those discussed above is unique to a particular situation and is described within the body of the report.

METHOD USED IN PLOTTING DIPOLE-DIPOLE INDUCED POLARIZATION AND RESISTIVITY RESULTS

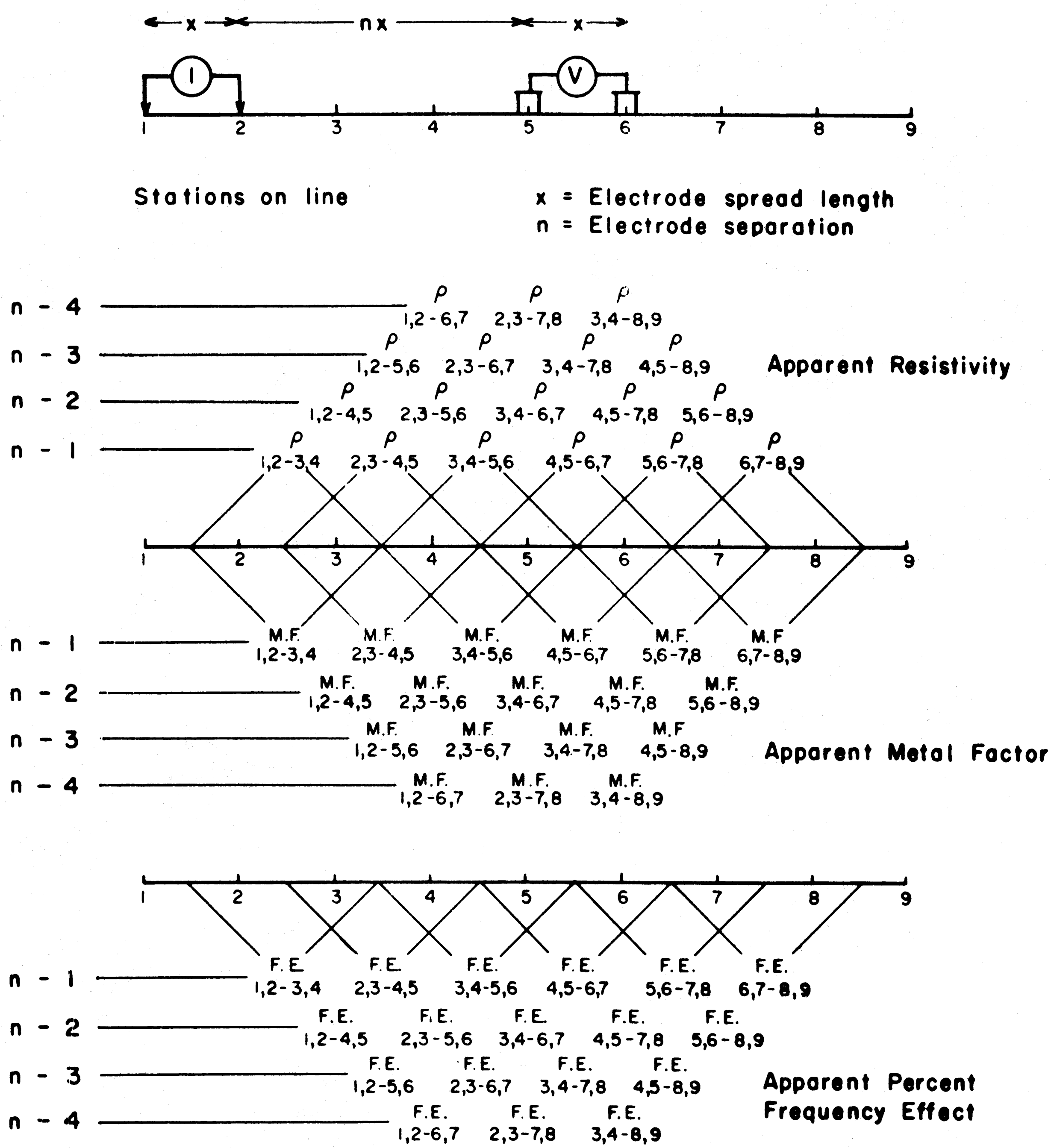


Fig. A

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA
FOR
MR. SHERWOOD B. OWENS

1. INTRODUCTION

At the request of Mr. Sherwood B. Owens, McPhar has completed an induced polarization and resistivity survey on the Hortensia Claims, Superior Mining District, Pinal County, Arizona. Vertical intensity ground magnetic measurements were also made at 100-foot intervals along the survey lines. The survey grid was laid out by Mr. Richard E. Mieritz, consultant to Mr. Owens, who furnished geological information and a plan map of the survey area.

Within the survey area, Upper Precambrian diabase intrudes the Dripping Spring quartzite and Pioneer shale members of the Upper Precambrian Apache Group. These rocks overlie the Lower Precambrian Pinal schist and are overlain by Quaternary basalt. The area is transected by several northwest-trending faults which divide the Precambrian units into blocks. The southwesternmost fault, the Concentrator fault, brings the Tertiary (?) Whitetail conglomerate down against the Precambrian rocks.

The area is of exploration interest because of its proximity to the Magma mine to the southeast.

The purpose of the induced polarization and resistivity survey was to prospect for sulphide mineralization within 500 feet of the surface. The survey was performed by Raymond Monarez, crew chief.

2. PRESENTATION OF RESULTS

The induced polarization and resistivity results are shown on the data plots listed below and are summarized on a plan map, Dwg. I. P. P. 4628, at a scale of 1" = 200'.

Line	Electrode Intervals	Dwg. No.
10.4E	500 feet	IP 5460-1
10.9E	500 feet	IP 5460-2
11.4E	500 feet	IP 5460-3
11.9E	500 feet	IP 5460-4

The ground magnetic survey results are shown on a separate map, Dwg. No. M3429, also at a scale of 1" = 200'.

In this report both percent frequency effect (PFE) anomalies and metal factor (MF) anomalies are shown on the plan map. Percent frequency effect is a measure of the intensity of polarization, and anomalies are classified as very weak - very strong. The percent frequency effect results indicate polarizable areas without taking into account the resistivity of the areas. Metal factor (MF) is obtained by combining the percent frequency effect and the resistivity. A good conductor (low resistivity) that is strongly polarizable (high percent frequency effect) will give a well-defined or definite metal factor anomaly. Less well-defined metal factor anomalies are designated as probable or possible.

The percent frequency effect and metal factor parameters are complementary. The relative importance of each type of information depends upon the particular geophysical environment and the type of target expected. For example, a mineralized silicified zone will give a strong percent frequency effect anomaly, but may not give a definite metal factor anomaly. Alternatively, an oxidized ore zone may only give a weak percent frequency effect anomaly, but will give a definite metal factor anomaly pattern. Judicious consideration of both the percent frequency effect and the metal factor results permits a comprehensive evaluation of the geophysical environment.

The anomalies as shown on the data plots and plan map represent the surface projection of the polarizable zones. Contacts or faults inferred from the resistivity patterns are also shown, on plan only. Anomaly boundaries and fault locations should be considered accurate to the electrode interval used.

The anomalies shown on the plan map are designated apparent depths of shallow, moderate, or deep. At larger dipole separations a greater volume of rock is averaged, in lateral extent as well as depth. Thus, the source of a deep-appearing anomaly detected along a single line may be at shallow depth to one side of the line. The data plots, therefore, cannot represent true depth. Depths can be calculated from the apparent resistivity data in the case of ideal horizontal layers, but even this calculation depends on an assumed resistivity contrast between the zone at depth and the overlying rock. Although ambiguous, the simple depth designations are useful for correlating or comparing anomalous zones obtained on adjacent survey lines. Drill hole information from one or more zones frequently permits one to make a fair depth estimate for other zones. The following depth generalizations apply to porphyry copper and contact-replacement bodies:

	Apparent Depth (dipole separations)	Drill Hole Depth (in dipole lengths)
Shallow	1 - 2	$\frac{1}{2}$ - 1
Moderate	2 - 3	1 - 1$\frac{1}{2}$
Deep	3 - 5	1$\frac{1}{2}$ - 2+

Thus, a shallow zone is one detected at a one-to-two dipole separation and should be tested by a drill hole from a half-to-one dipole length deep.

An appendix on the interpretation of induced polarization anomalies is enclosed in this report. It shows the desirability of detailing with shorter spreads when the anomaly is shallow and the source may be narrow.

The induced polarization method is a geophysical tool used to determine the electrical properties of the earth. The final evaluation of the induced polarization anomalies, e.g., which of the anomalies constitutes the most favourable exploration target, must be based on available geologic evidence and concepts.

3. DISCUSSION OF RESULTS

As shown on the plan map, the induced polarization results indicate a possible metal factor anomalous zone and a single probable metal factor anomaly in the southern portion of the grid. The metal factor anomalies are due to low resistivities and quite weak, but above-background percent frequency effects (PFE's). The results obtained along each line are discussed in detail below.

Line 10.4E

The resistivity results indicate a fault or contact in the vicinity of 11.25N, with high resistivity rock north of the contact. A resistivity low occurs at shallow-moderate depth in the interval (?)8.5N - 9.75N. The possible metal factor anomaly within this interval is due to both low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.0N - 10.5N and at shallow-moderate depth in the interval 12.5N - 13.0N(?).

Line 10.9E

The resistivity results indicate faults or contacts in the vicinity of 9.5N and 11.0N, with low resistivity rock south of 9.5N and high resistivity rock north of 11.0N. The shallow, probable metal factor anomaly in the interval 9.0N - 9.5N is due to very low resistivities and above-background PFE's. Above-background PFE zones also occur at shallow depth in the interval 10.5N - 11.0N and at shallow-moderate depth in the interval 11.75N - 12.25N(?).

Line 11.4E

The resistivity results indicate faults or contacts in the vicinity of 9.25N and 11.0N, with low resistivity rock south of 9.25N and very high resistivity rock at depth north of 11.0N. The possible metal factor anomaly in the interval (?) 7.5N - 8.5N is due to very low resistivities and background-above-background PFE's. Above-background PFE's occur at moderate-deep depth in the interval 9.5N - 10.0N and at shallow depth in the interval 10.5N - 11.0N.

Line 11.9E

The resistivity results indicate a possible contact at 9.0N and a distinct resistivity low zone at shallow-moderate depth in the interval 8.0N - 8.5N. The possible metal factor anomaly in the interval 8.0N - 8.5N is due to the low resistivities and to above-background PFE's. Above-background PFE's also occur at shallow depth in the interval 10.25N - 10.75N.

As shown on the magnetic map, the vertical intensity ground magnetic results show a distinct northwest trend. The southeastern and eastern portions of the grid are higher in magnetic intensity than the northwestern portion of the grid. A strong magnetic anomaly occurs in the interval 9.1N - 9.6N along Line 10.9E. The anomaly is characteristic of a vertical dike centred at 9.25N. The fact that the magnetic high lies north of the magnetic low suggests that the dike has a reverse remnant component. The magnetic anomaly occurs at the northern edge of an outcrop of Quaternary basalt, and lies within the probable metal factor anomaly obtained along Line 10.9E. Magnetic anomalies also occur in the interval 10.0N - 10.4N along Line 11.4E and in the interval 9.6N - 10.0N along Line 11.9E. These anomalies form a northwest-trending zone that persists across the entire grid. The anomaly along Line 11.4E is characteristic of a vertical dike centred at 10.2N. A strong magnetic low is centred at 11.7N along Line 10.4E.

4. CONCLUSIONS AND RECOMMENDATIONS

The percent frequency effects (PFE's) associated with the possible-probable metal factor anomalies detected in the southern portion of the grid are too weak to be indicative of large massive sulphide bodies such as those at the Magma mine. However, the possible economic significance of the anomalies should be assessed in light of geological and geochemical results.

The probable metal factor anomaly along Line 10.9E coincides with a strong magnetic anomaly. The above-background PFE's associated with the probable metal factor anomaly could be due to magnetite. The anomaly pattern suggests that the source of the anomaly dips to the south. Since the source is apt to be narrow, the anomalous zone should be detailed at 100-foot electrode intervals if drilling is contemplated.

The possible metal factor anomalies at the southern ends of Line 10.4E, Line 10.9E, and Line 11.4E occur in the vicinity of the Concentrator fault. Low resistivities which appear to be due to the Whitetail conglomerate contribute to these anomalies. The possible metal factor anomaly in the interval 8.0N - 8.5N along Line 11.9E appears to be more significant. From the geology map, the low resistivities which contribute to this anomaly cannot be attributed to the Whitetail conglomerate.

The shallow, above-background PFE zones in the northern portion of the grid could be due to widely-spaced, mineralized veins or shears. If close surface examination or geochemical sampling indicates these zones to be of further interest, they should be detailed at 100-foot electrode intervals.

McPHAR GEOPHYSICS INCORPORATED

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ROBERT ALAN BELL
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Robert A. Bell,
Geologist.

Dated: June 15, 1970

APPENDIX
THE INTERPRETATION OF INDUCED POLARIZATION ANOMALIES FROM RELATIVELY SMALL SOURCES

The induced polarization method was originally developed to detect disseminated sulphides and has proven to be very successful in the search for "porphyry copper" deposits. In recent years we have found that the IP method can also be very useful in exploring for more concentrated deposits of limited size. This type of source gives sharp IP anomalies that are often difficult to interpret.

The anomalous patterns that develop on the contoured data plots will depend on the size, depth and position of the source and the relative size of the electrode interval. The data plots are not sections showing the electrical parameters of the ground. When the electrode interval (X) is appreciably greater than the width of the source, a large volume of unmineralized rock is averaged into each measurement. This is particularly true for the large values of the electrode separation (n).

The theoretical scale model results shown in Figure 1 and Figure 2 indicate the effect of depth. If the depth to the top of the source is small compared to the electrode interval (i. e. d X) the measurement for n = 1 will be anomalous. In Figure 1 the depth is 0. 5 units (X = 1. 0 units) and the n = 1 value is definitely anomalous; the pattern on the contoured data plot is typical for a relatively shallow, narrow, near-vertical tabular source. The results in Figure 2 are for the same source with the depth increased to 1. 5 units. Here the n = 1 value is not anomalous; the larger values of (n) are anomalous but the magnitudes are much lower than for the source at less depth.

When the electrode interval is greater than the width of the source, it is not possible to determine its width or exact position between the electrodes. The true IP effect within the source is also indeterminate; the anomaly from a very narrow source with a very large true IP effect will be much the same as that from a zone with twice the width and 1/2 the true IP effect. The theoretical scale model data shown in Figure 3 and Figure 4 demonstrate this problem. The depth and position of the source are unchanged but the width and true IP effect are varied. The anomalous patterns and magnitudes are essentially the same, hence the data are insufficient to evaluate the source completely.

The normal practise is to indicate the IP anomalies by solid, broken, or dashed bars, depending upon their degree of distinctiveness. 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. As illustrated in Figure 1, Figure 2, Figure 3 and Figure 4, no anomaly can be located with more accuracy than the spread length. While the centre of the solid bar indicating the anomaly corresponds fairly well with the source, the length of the bar should not be taken to represent the exact edges of the anomalous material.

If the source is shallow, the anomaly can be better evaluated using a shorter electrode interval. When the electrode interval used approaches the width of the source, the apparent effects measured will be nearly equal to the true effects within the source. When there is some depth to the top of the source, it is not possible to use electrode intervals that are much less than the depth to the source. In this situation, one must realize that a definite ambiguity exists regarding the width of the source and the IP effect within the source.

Our experience has confirmed the desirability of doing detail. When a reconnaissance IP survey using a relatively large electrode interval indicates the presence of a narrow, shallow source, detail with shorter electrode intervals is necessary in order to better locate, and evaluate, the source. The data of most usefulness is obtained when the maximum apparent IP effect is measured for n = 2 or n = 3. For instance, an anomaly originally located using X = 300' may be checked with X = 200' and then X = 100'. The data with X = 100' will be quite different from the original reconnaissance results with X = 300'.

The data shown in Figure 5 and Figure 6 are field results from a greenstone area in Quebec. The expected sources were narrow (less than 30' in width) zones of massive, high-grade, zinc-silver ore. An electrode interval of 200' was used for the reconnaissance survey in order to keep the rate of progress at an acceptable level. The anomalies located were low in magnitude.

The very weak, shallow anomaly shown in Figure 5 is typical of those located by the X = 200' reconnaissance survey. Several anomalies of this type were detailed using shorter electrode intervals. In most cases the detail measurements suggested broad zones of very weak mineralization. However, in the case of the source at 20N to 22N, the measurements with shorter electrode intervals confirmed the presence of a strong, narrow source. The X = 50' results are shown in Figure 6. Subsequent drilling has shown the source to be 12.5' of massive sulphide mineralization containing significant zinc and silver values.

The change in the anomaly that results when the electrode interval is reduced is not unusual. The X = 50' data more accurately locates the narrow source, and permits the geophysicist to make a better evaluation of its importance. The completion of this type of detail is very important, in order to get the maximum usefulness from a reconnaissance IP survey.

McPHAR GEOPHYSICS LIMITED
Theoretical Induced Polarization and Resistivity Studies
Scale Model Cases

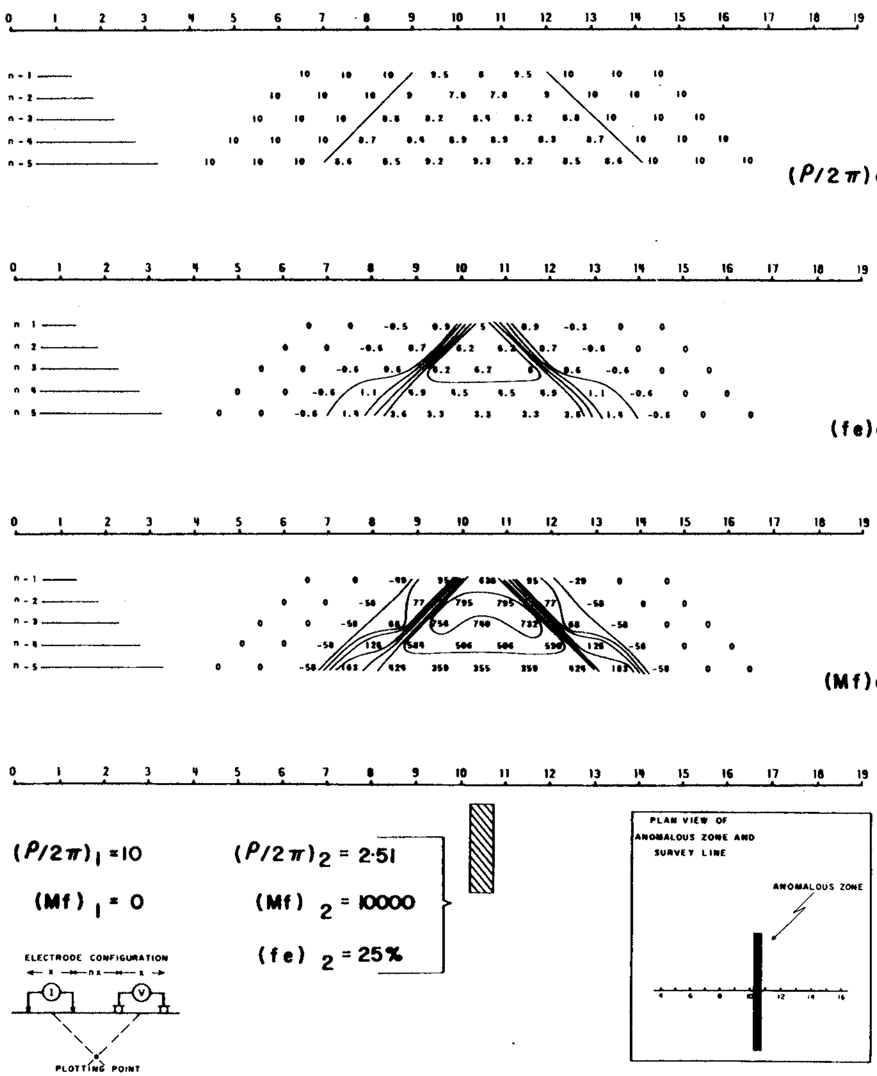


FIG 1

CASE II-0·5-BU-10-a

McPHAR GEOPHYSICS LIMITED
Theoretical Induced Polarization and Resistivity Studies
Scale Model Cases

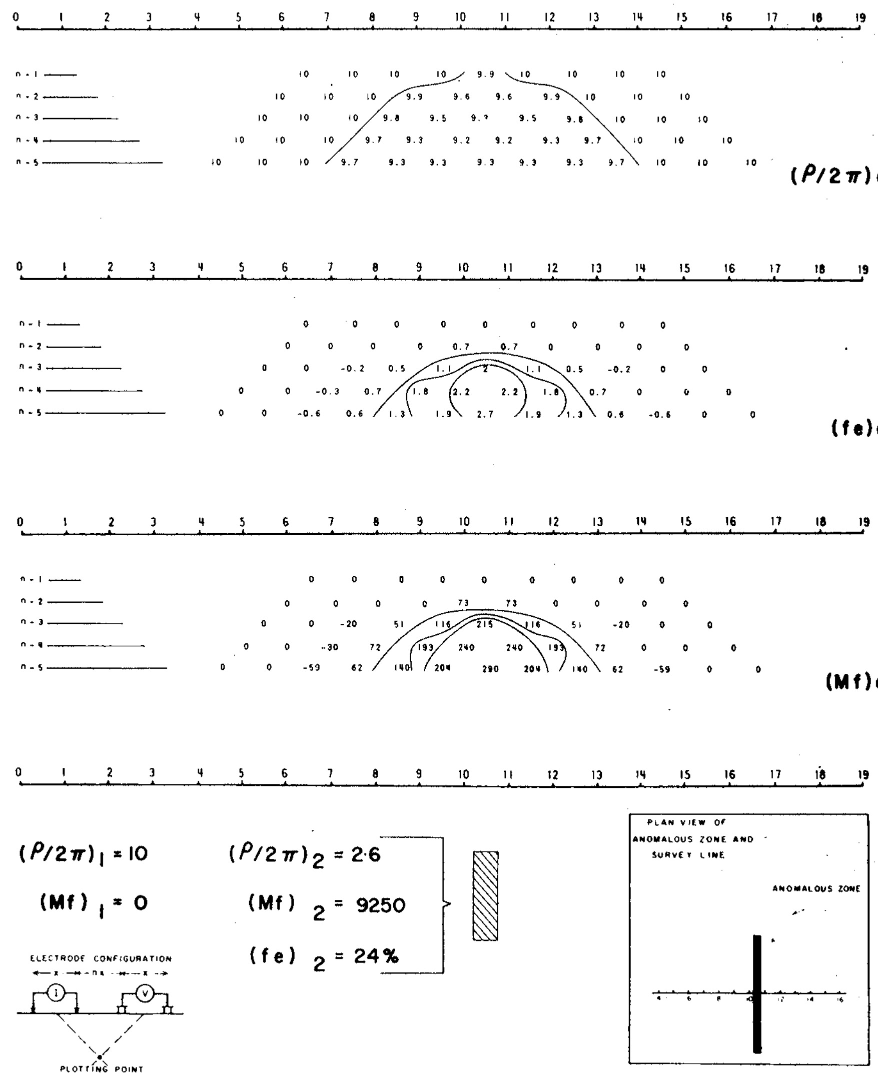


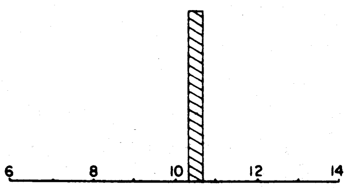
FIG 2

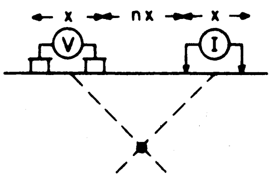
CASE II-1·5-BU-10-a

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW





X EQUALS 1 UNIT

Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho/2\pi)a$

n												
n-1	10	10	10	9.7	8.8	9.7	10	10	10			
n-2	10	10	10	9.5	8.7	8.7	9.5	10	10	10		
n-3	10	10	10	9.3	8.8	8.9	8.8	9.3	10	10	10	
n-4	10	10	10	9.0	8.8	9.0	9.0	8.8	9.2	10	10	10

(Fe)a

n												
n-1	-0.2	0	-0.5	0.7	3.6	0.7	-0.3	-0.2	-0.2			
n-2	0	0	-0.6	0.7	4.0	4.0	0.7	-0.6	0	0		
n-3	0	0	-0.5	0.7	4.7	4.3	4.6	0.7	-0.6	0	0.2	
n-4	0	-0.3	-0.6	1.1	3.5	4.2	4.2	3.5	1.1	-0.6	-0.3	0

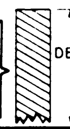
(Mf)a

n												
n-1	17	0	-49	72	410	72	-30	-17	17			
n-2	0	0	-59	74	460	460	74	-59	0	0		
n-3	0	0	-59	75	534	489	523	75	58	0	0	
n-4	0	-30	-59	141	382	467	467	363	120	-59	-30	0

Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho 2\pi)_1 = 10$
$(Mf)_1 = 0$

$(\rho 2\pi)_2 = 2.57$
$(Mf)_2 = 11700$
$(Fe)_2 = 30\%$



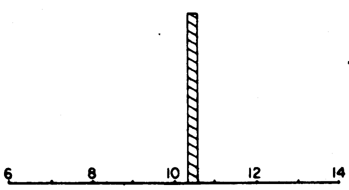
DEPTH EXTENT OF SOURCE 4 UNITS

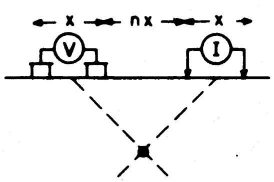
FIG. 3

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW





X EQUALS 1 UNIT

Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho/2\pi)a$

n												
n-1	10	10	10	9.9	9.3	9.9	10	10	10			
n-2	10	10	10	9.7	9.1	9.1	9.7	10	10	10		
n-3	10	10	10	9.7	9.2	9.2	9.2	9.7	10	10	10	
n-4	10	10	10	9.6	9.3	9.3	9.3	9.3	9.6	10	10	10

(Fe)a

n												
n-1	0	0	-0.3	0	3.5	0	-0.3	0	0			
n-2	0	0	-0.8	0	3.8	3.8	0	-0.8	0	0		
n-3	0	0	-0.8	0.5	4.5	4.5	4.6	0.5	-0.8	0	0	
n-4	0	0	-0.7	0.8	4.2	5.1	5.1	4.2	0.7	-0.7	0	0

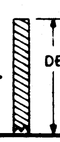
(Mf)a

n												
n-1	0	0	-30	0	376	0	-30	0	0			
n-2	0	0	-79	0	417	417	0	-79	0	0		
n-3	0	0	-79	52	490	490	501	52	-79	0	0	
n-4	0	0	-70	83	452	548	555	452	74	-71	0	0

Stations: 5 6 7 8 9 10 11 12 13 14 15 16

$(\rho 2\pi)_1 = 10$
$(Mf)_1 = 0$

$(\rho 2\pi)_2 = 2.41$
$(Mf)_2 = 22800$
$(Fe)_2 = 55\%$



DEPTH EXTENT OF SOURCE 4 UNITS

FIG. 4

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

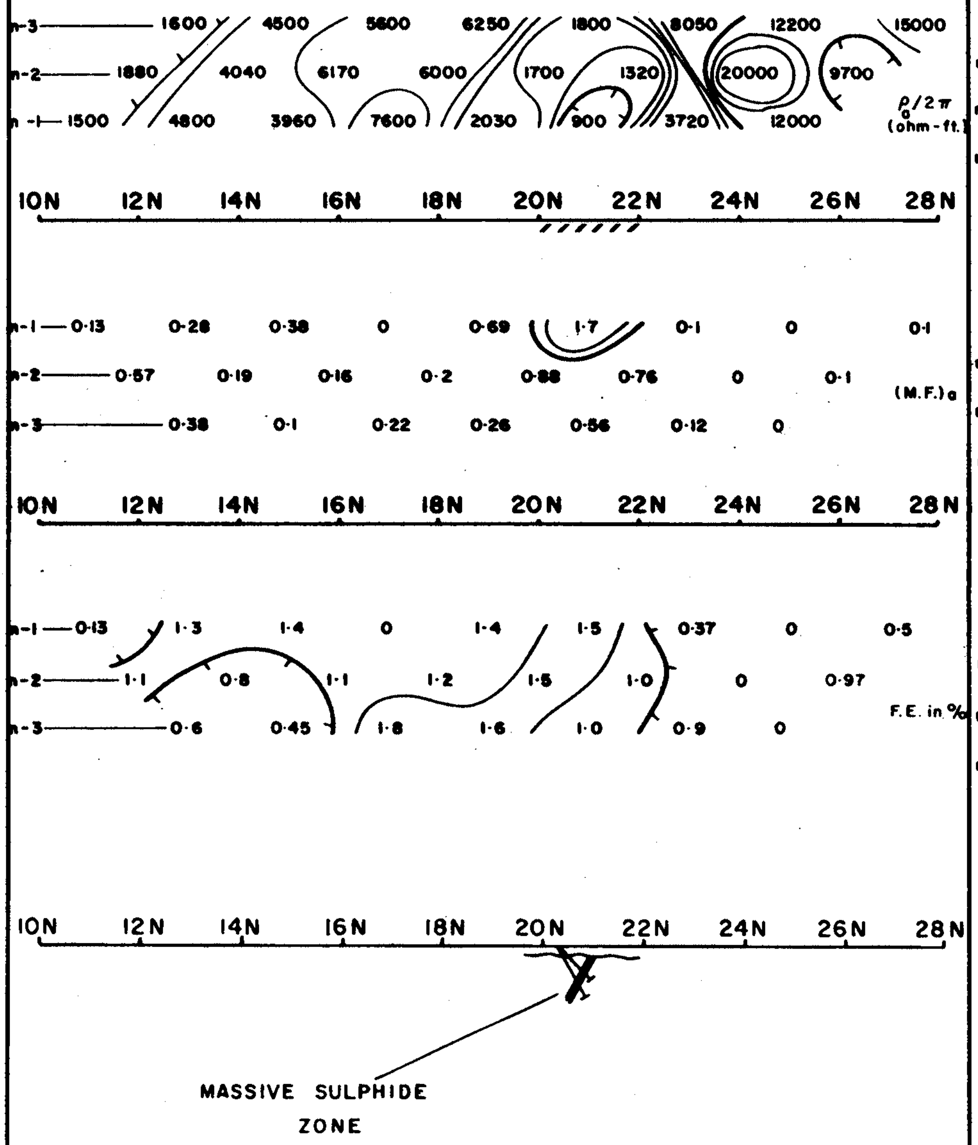


FIG. 5

INDUCED POLARIZATION AND RESISTIVITY RESULTS

BATCHELOR LAKE AREA, QUEBEC.

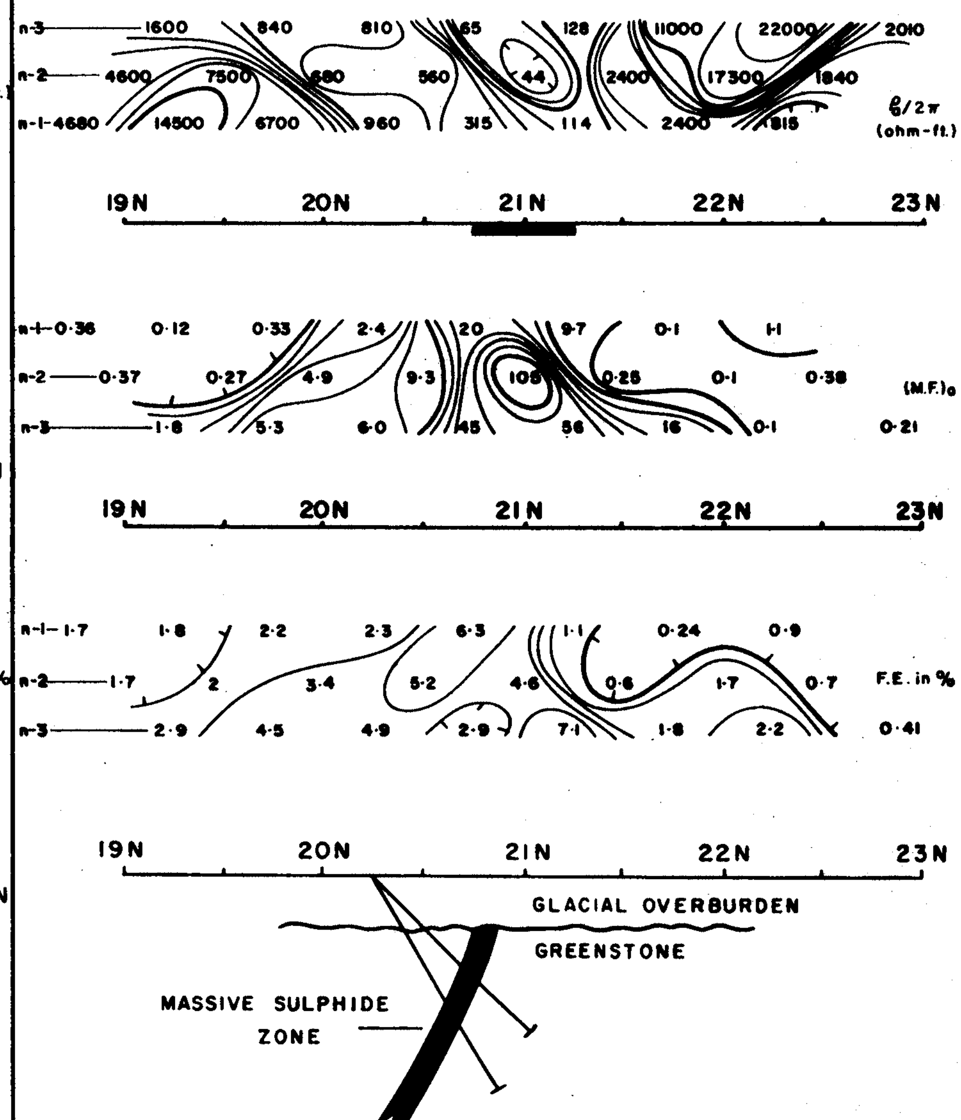


FIG. 6

Dwg. I.P.P. 4628

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP

SURFACE PROJECTION OF METAL FACTOR ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

NOTE: Number at the end of anomaly indicates spread used

APPARENT DEPTH (S=shallow, M=moderate, D=deep)

C = CONTACT, F = FAULT

SURFACE PROJECTION OF PERCENT FREQUENCY EFFECT ANOMALOUS ZONES

0.1–1.25 ~		0.3–2.5 ~
> 10	VERY STRONG	> 7.5
7.5 – 10	STRONG	5 – 7.5
5 – 7.5	MODERATE	3 – 5
3 – 5	WEAK	2 – 3
2 – 3	VERY WEAK	1.5 – 2

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS, SUPERIOR MINING DISTRICT, PINAL COUNTY, ARIZONA

SCALE

FEET 200 0 200 400 600 800 1000 FEET

1 INCH EQUALS 200 FEET

DRAWN: JK

DATE: MAY, 1970

APPROVED:

DATE: June 12 '70

REGISTERED GEOLOGIST ARIZONA, U.S.A.

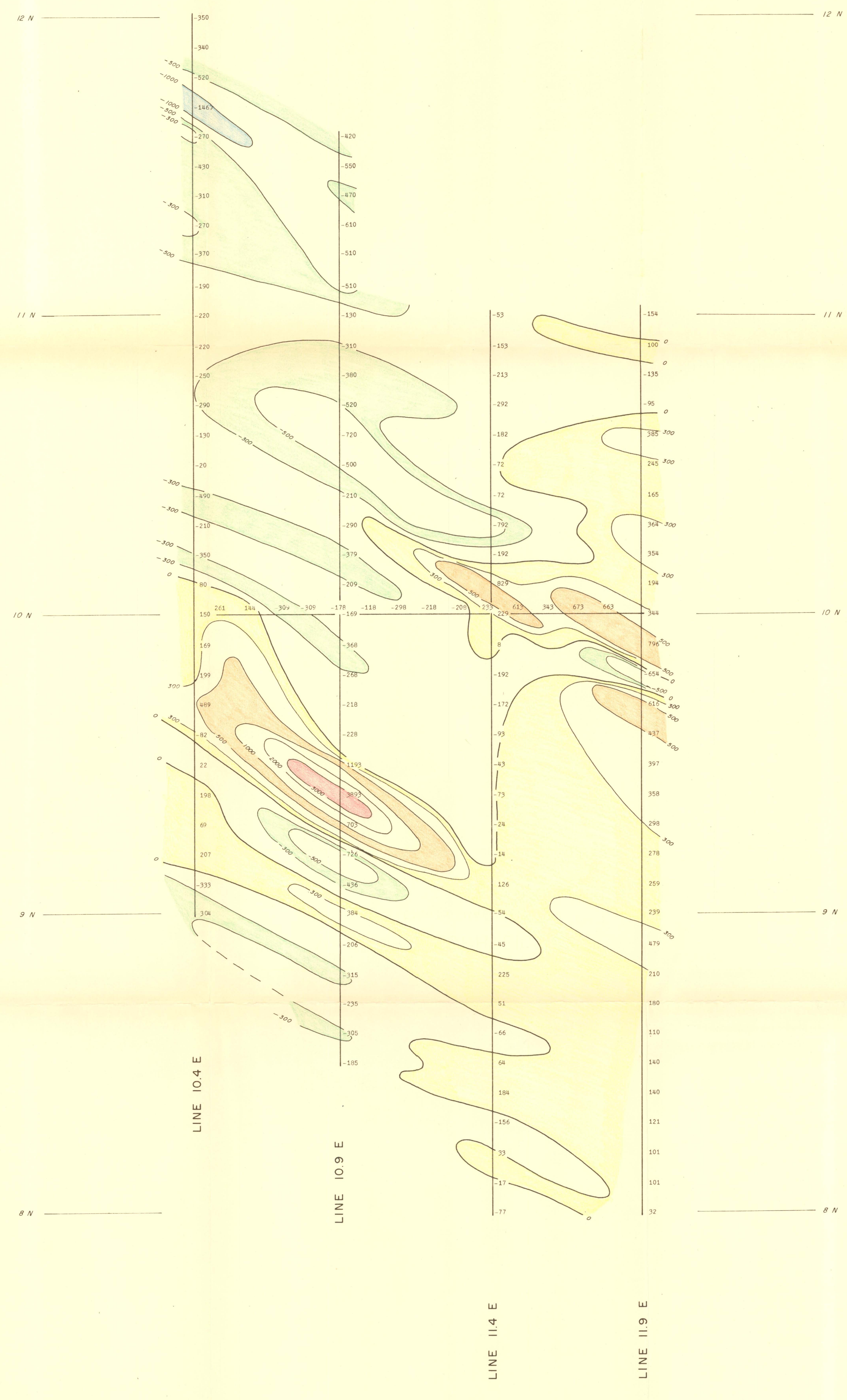
DWG. I.P.P. 4628

Dwg. No. M3429

DWG M-3429

McPHAR GEOPHYSICS

VERTICAL INTENSITY MAGNETIC MAP



N

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS, SUPERIOR MINING DISTRICT, PINAL COUNTY, ARIZONA

SCALE

FEET 200 0 200 400 600 800 1000 FEET

1 INCH EQUALS 200 FEET

DRAWN: JK
DATE: MAY, 1970
APPROVED:

REGISTERED GEOLOGIST
ARIZONA, U.S.A.

DATE: June 12/70

DWG. M-3429

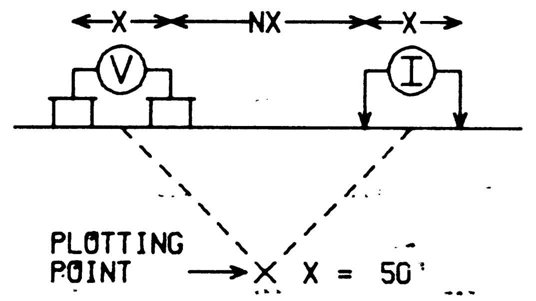
DWG. NO.- I.P.- 5460-1

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 10.4E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED

REGISTERED GEOLOGIST CERTIFICATE NO. 7765 ROBERT ALAN BELL ARIZONA, U.S.A.

DATE: June 12, 70

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

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

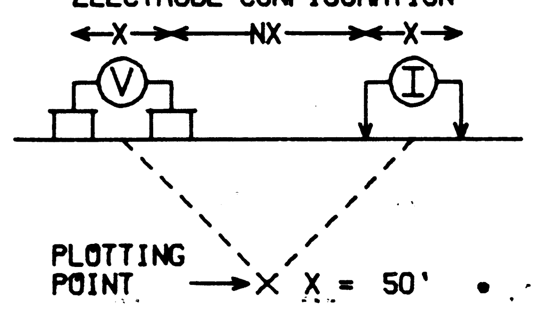
DWG. NO.- I.P.- 5460-2

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 10.9E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED:

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

DATE:

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

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

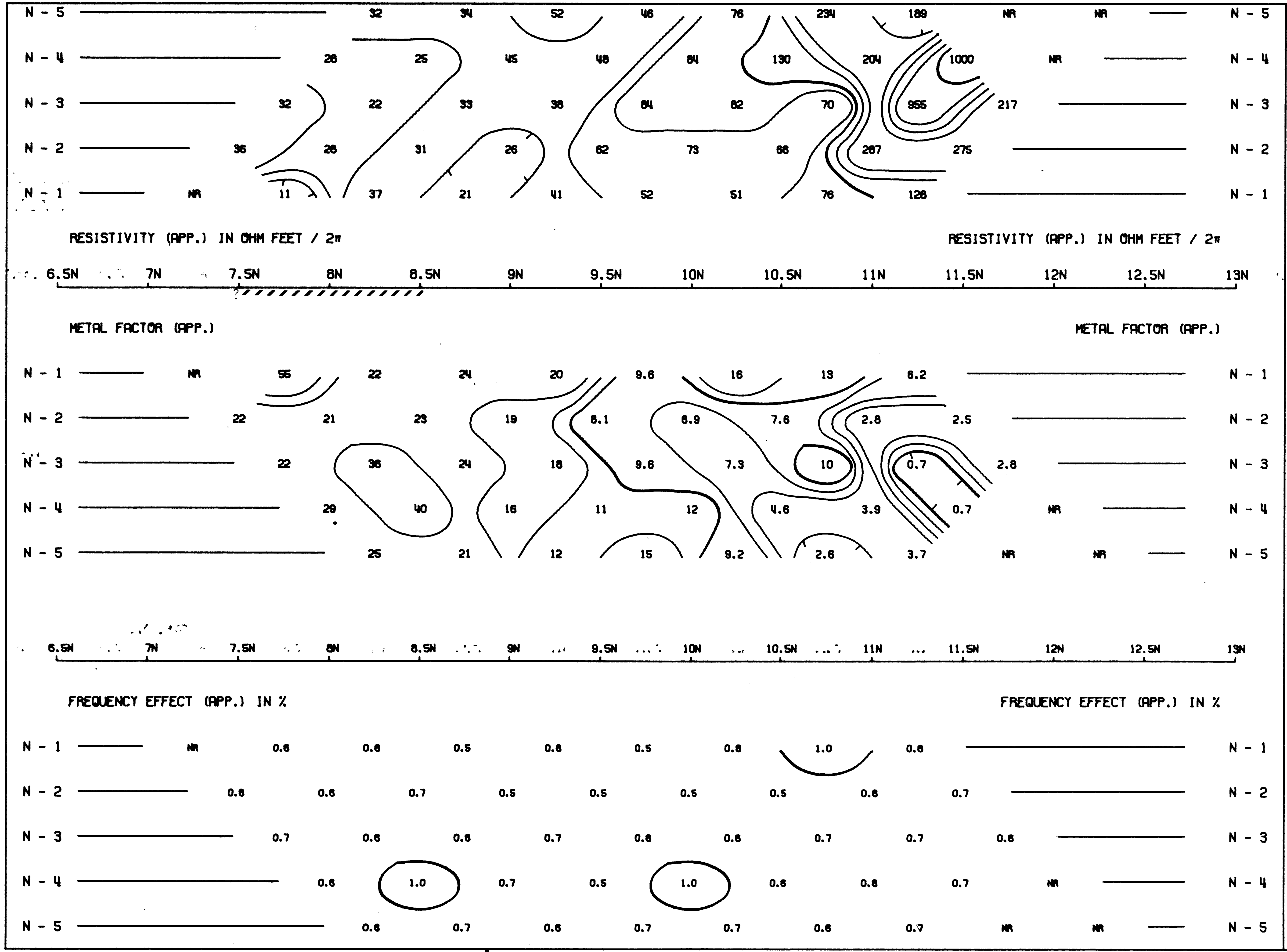
NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

DWG. NO.- I.P.- 5460 - 3

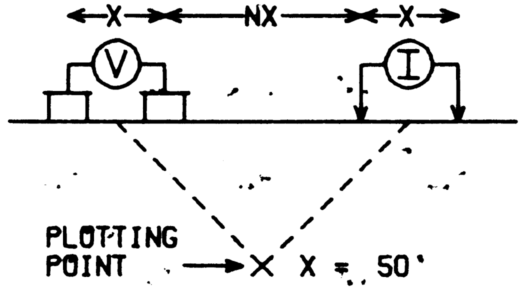
MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 11.4E



ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED: [signature]

REGISTERED GEOLOGIST CERTIFICATE NO. 3155 ROBERT ALAN BELL ARIZONA, U.S.A.

DATE: June 12/70

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

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

DWG. NO.- I.P.- 5460-4

MR. SHERWOOD B. OWENS

HORTENSIA CLAIMS
SUPERIOR MINING DISTRICT
PINAL COUNTY, ARIZONA

LINE NO.- 11.9E

ELECTRODE CONFIGURATION

PLOTTING POINT → X = 50'

SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-2.5 CPS

DATE SURVEYED: MAY 1970

APPROVED:

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

REGISTERED GEOLOGIST CERTIFICATE NO. 7... ROBERT ALAN BELL ARIZONA, U.S.A.

DATE: June .. 1970

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER