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item 10

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
RED TOP PROSPECT
YERINGTON AREA, LYON COUNTY, NEVADA
FOR
PAN-NEVADA, INC.

188

item

10

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.

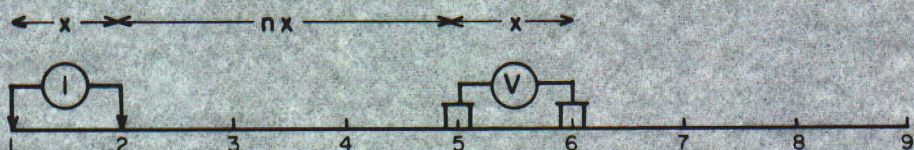
In some situations spurious noise, either man made or natural, will render it impossible to obtain a reading. The symbol "N" on the data plots indicates a station at which it is too noisy to record a reading. If a reading can be obtained, but for reasons of noise there is some doubt as to its accuracy,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



Stations on line

x = Electrode spread length

n = Electrode separation

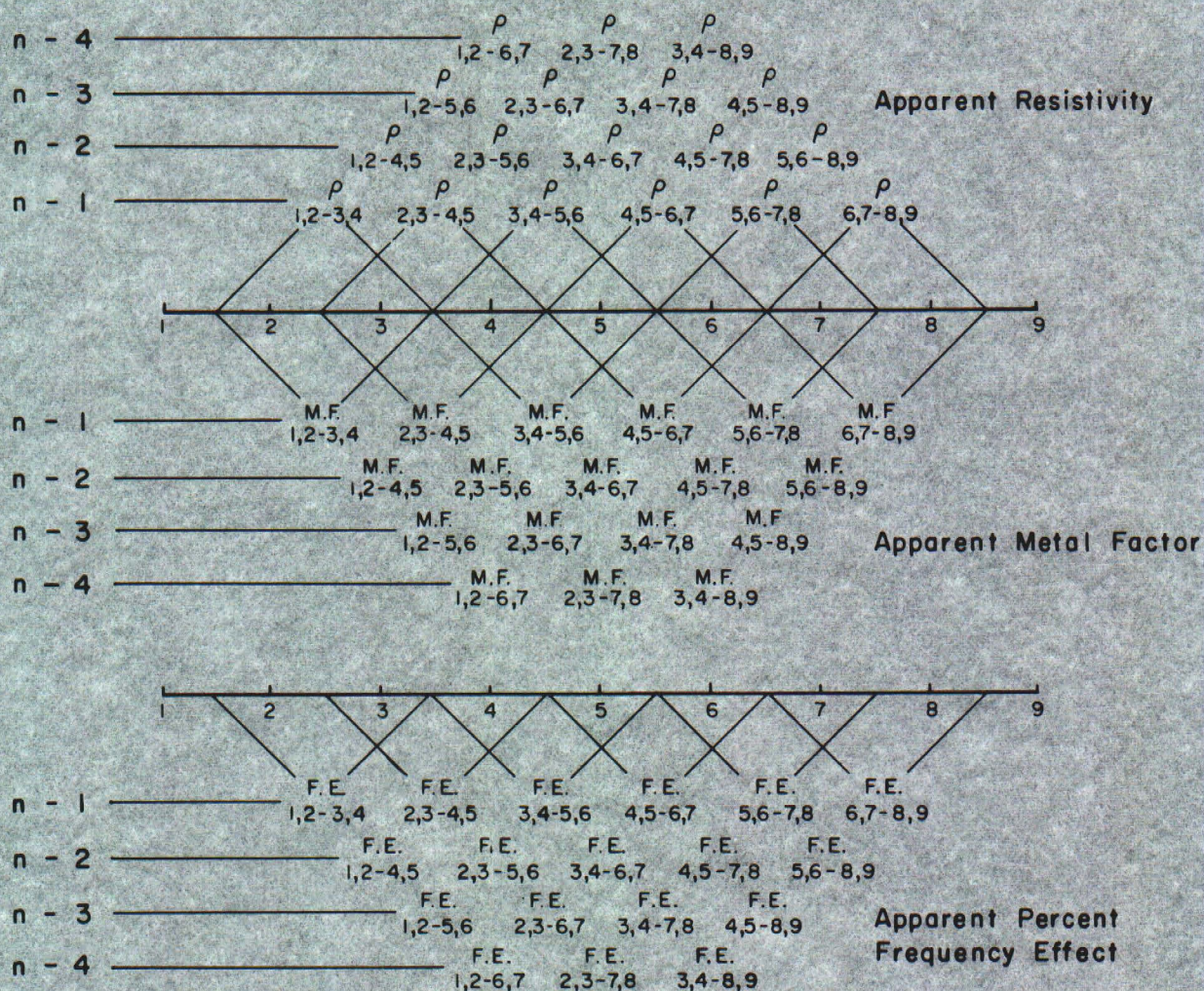


Fig. A

McPHAR GEOPHYSICS

REPORT ON THE INDUCED POLARIZATION AND RESISTIVITY SURVEY ON THE RED TOP PROSPECT YERINGTON AREA, LYON COUNTY, NEVADA FOR PAN-NEVADA, INC.

1. INTRODUCTION

At the request of Pan-Nevada, Inc. a reconnaissance induced polarization and resistivity survey was carried out on the company's Red Top property. Geological information was supplied by Pan-Nevada's staff.

There are outcrops of altered granodiorite, ultramafic breccia, granodiorite porphyry and basalt. Many of the altered granodiorite outcrops show alteration with secondary iron and copper minerals, suggesting the possible presence of a large zone of disseminated mineralization of the porphyry copper type. The induced polarization and resistivity survey was planned to try to locate any metallic mineralization present; previous experience has shown that the method can be successfully used to locate and outline mineralization of this type. (See Appendix).

2. PRESENTATION OF RESULTS

The induced polarization and resistivity results are shown on the following data plots in the manner described in the notes preceding this report.

<u>Line</u>	<u>Electrode Intervals</u>	<u>Dwg. No.</u>
2W	200 feet	IP 5308-1
0	500 feet	IP 5308-2
0	200 feet	IP 5308-3
2E	200 feet	IP 5308-4
4E	200 feet	IP 5308-5
10E	200 feet	IP 5308-6
20E	200 feet	IP 5308-7
11S	200 feet	IP 5308-8

Enclosed with this report is Dwg. I.P.P. 3374, a plan map of the project at a scale of 1" = 400'. The definite and possible induced polarization anomalies are indicated by solid and broken bars respectively on this plan map as well as the data plots. These bars represent the surface projection of the anomalous zones as interpreted from the location of the transmitter and receiver electrodes when the anomalous values were measured.

Since the induced polarization measurement is essentially an averaging process, as are all potential methods, it is frequently difficult to exactly pinpoint the source of an anomaly. Certainly, no anomaly can be located with more accuracy than the spread length; i.e. when using 200' spreads the position of a narrow sulphide body can only be determined to lie between two stations 200' apart. In order to locate sources at some depth, larger spreads must be used, with a corresponding increase in the uncertainties of location. Therefore, while the centre of the indicated anomaly probably corresponds fairly well with source, the length of the

indicated anomaly along the line should not be taken to represent the exact edges of the anomalous material.

3. DISCUSSION OF RESULTS

The induced polarization and resistivity survey found anomalies on all lines of the survey. The anomalies fell into two groups, or zones, which differ appreciably.

Zone A consists of definite, strong anomalies on Line 0, Line 2E, Line 4E and Line 11S. The Zone A anomaly on Line 0 was tested with 500 foot electrode intervals and appears to be shallow; i.e. less than 200 feet from surface. This zone has for its source more concentrated mineralization than that of the porphyry copper type. The anomaly on Line 0 should be checked by drilling.

The second type of anomalies present indicate broad, weak zones of weak mineralization representing probably from 1% to 3% total sulphides. If these sulphides were the proper minerals, the source of the anomalies could be important. The pattern of the anomalies is so irregular that they do not form a recognizable zone. (See Appendix).

Within these broad anomalies on Line 10E and Line 20E are two stronger areas. On Line 10E this occurs at 6S on $n = 4$ and on Line 20E at 6S to 4S on $n = 2$ and $n = 3$. These are typical patterns off the end of a source or of a narrow deep source. There are two possibilities: an enriched zone of mineralization lies between Line 10E and Line 20E, or an enriched zone could be rising to near the surface from a depth that is not reflected by 200 foot electrode intervals. Lines parallel to Line 20E would test these possibilities.

4. CONCLUSIONS AND RECOMMENDATIONS

There are two types of mineralization present in the survey area. Zone A represents a probable concentrated mineralization and should be tested by drilling. A 45° hole collared at station 12+50 S on Line 0, drilled north, should test the zone.

Two intermediate lines between Lines 10E and 20E, at 13+00E and 16+00E, would help to determine the source of the stronger reflection in the weak anomalies in this area of the survey, if it is felt that further work is warranted.

McPHAR GEOPHYSICS INCORPORATED

Marion A. Goudie

Marion A. Goudie,
Geologist.

Philip G. Haller

Philip G. Haller,
Geophysicist.

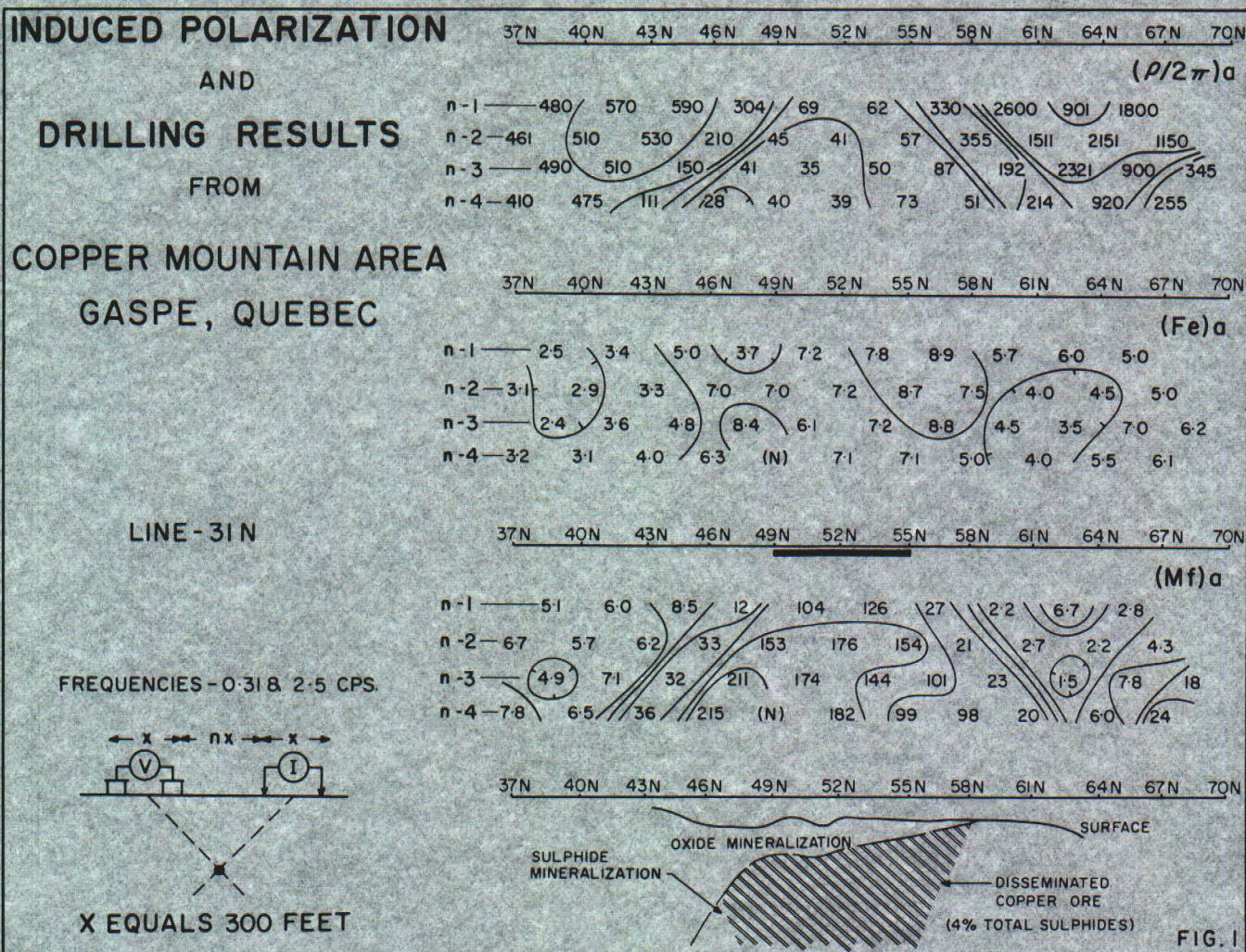
Dated: August 13, 1969

McPHAR GEOPHYSICS

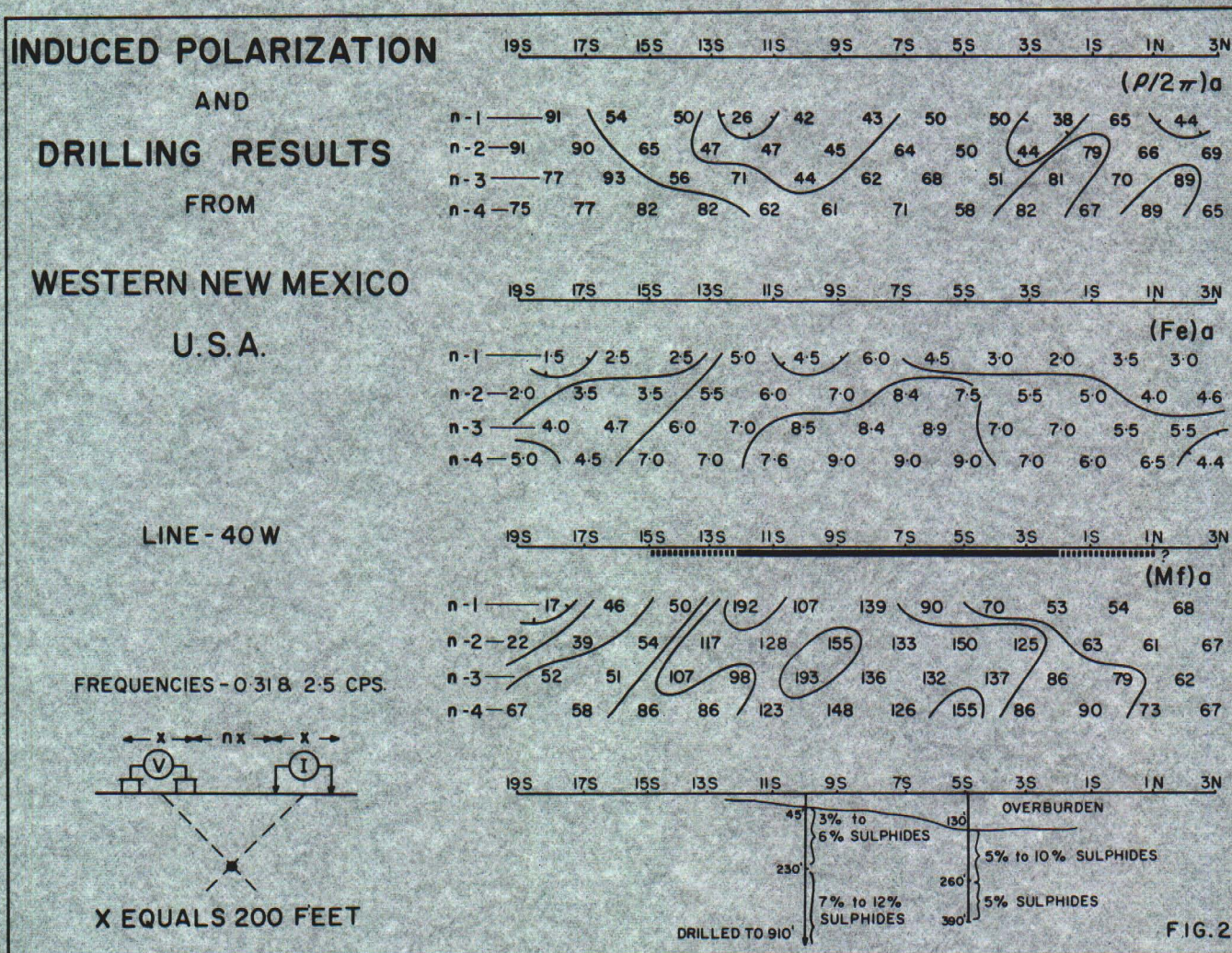
APPENDIX

EXPECTED IP ANOMALIES FROM "PORPHYRY COPPER" TYPE ZONES OF DISSEMINATED SULPHIDE MINERALIZATION

Our experience in other areas has shown that the induced polarization method can be successfully used to locate, and outline, zones of disseminated sulphide mineralization of the "porphyry copper" type. In most cases the interpretation of the IP results is simple and straightforward. The results shown in Figure 1 and Figure 2 are typical.



The source of the moderate magnitude IP anomaly shown in Figure 1 contains approximately 4% metallic mineralization. The zone is of limited lateral extent and enough copper is present to make the mineralization "ore grade". The presence of the surface oxidation can be seen in the fact that the apparent IP effects increase for $n = 2$.



The IP anomaly shown in Figure 2 has about the same magnitude as that described above. It should be noted that appreciably greater concentrations of metallic mineralization are present; further, there is little or no copper present. These results illustrate the fact that IP results can not be used to determine the exact amount of metallic mineralization present or to determine the economic importance of a mineralized zone. In some geologic situations zoning is present; the zones of mineralization of greatest economic value may contain less total metallic mineralization than other zones in the same general area.

In the proper geologic environment, the method will detect even very low concentrations of metallic mineralization. The IP results shown in Figure 3 located the ore zone at the Brenda Property near Peachland, B.C. The zone contains 1.0 to 1.5 per cent metallic mineralization; however, the mineralization is "ore grade" because only molybdenite and chalcopyrite are present.

INDUCED POLARIZATION

AND

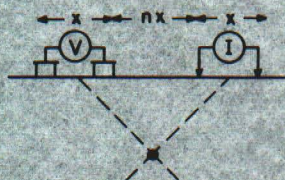
DRILLING RESULTS

FROM

BRENDA AREA
PEACHLAND, B.C.

LINE-8S

FREQUENCIES - 0.31 & 5.0 CPS.



X EQUALS 400 FEET

24W 20W 16W 12W 8W 4W 0 4E 8E 12E 16E 20E
($\rho/2\pi$)a

n-1	267	222	242	287	245	396	850	238
n-2	420	200	228	272	310	346	387	334
n-3	320	100	242	302	356	290	236	247
n-4	322	297	192	270	322	368	245	196

24W 20W 16W 12W 8W 4W 0 4E 8E 12E 16E 20E
(Fe)a

n-1	0.9	1.5	4.0	4.3	3.5	3.0	2.6	1.4
n-2	0.5	0.6	5.0	3.5	3.0	3.0	2.0	1.2
n-3	0.3	3.7	2.5	3.2	3.0	3.0	1.8	1.0
n-4	0.3	1.7	3.1	3.0	5.0	1.0	(N)	1.5

24W 20W 16W 12W 8W 4W 0 4E 8E 12E 16E 20E
(Mf)a

n-1	3.3	6.7	17	15	14	7.5	2.9	5.8
n-2	0.7	3.0	22	13	9.8	8.7	6.3	3.6
n-3	0.9	3.6	10	10	8.4	10	7.6	4.0
n-4	0.9	5.7	16	11	15	2.7	(N)	7.9

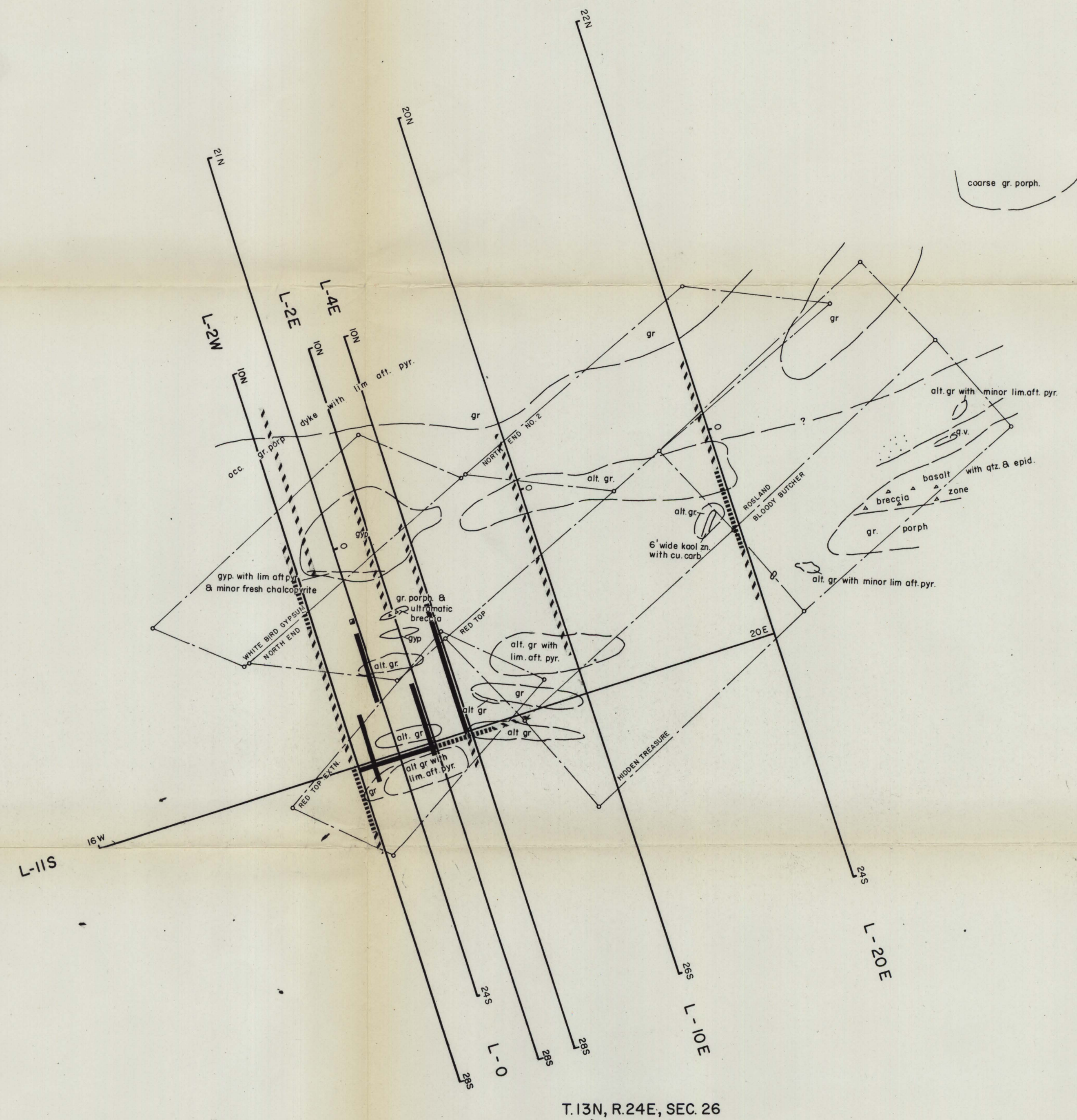
24W 20W 16W 12W 8W 4W 0 4E 8E 12E 16E 20E

DISSEMINATED
SULPHIDE ZONE
1.3% to 1.5%
SULPHIDES

FIG.3

DWG. I.P.P.-3374

Mc PHAR GEOPHYSICS
INDUCED POLARIZATION AND RESISTIVITY SURVEY
PLAN MAP



EXPLANATION

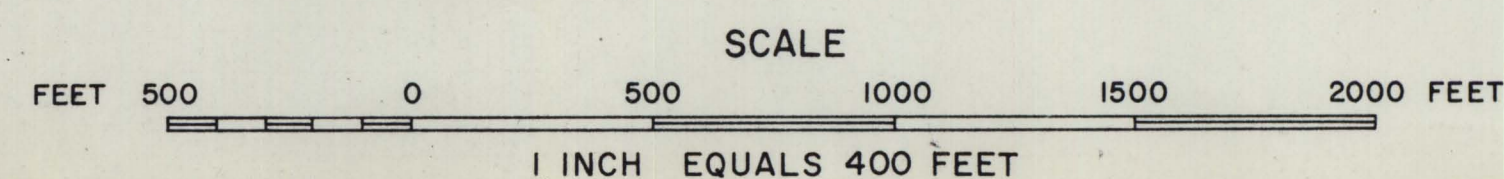
- FLOAT
- BRECCIA
- QUARTZ VEIN
- BASALT
- GRANODIORITE PORPHYRY
- ALTERED GRANODIORITE
- GRANODIORITE
- GYPSUM
- SHAFT

SURFACE PROJECTION
OF ANOMALOUS ZONES

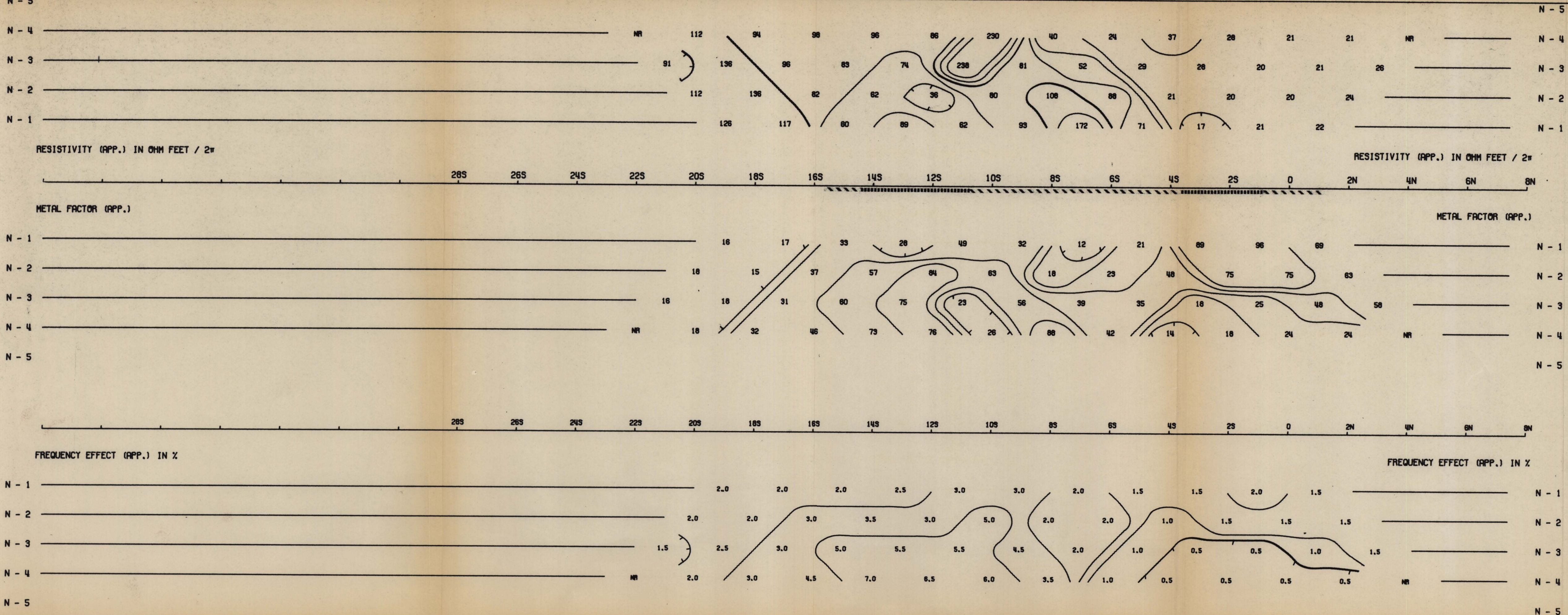
DEFINITE —————
PROBABLE
POSSIBLE - - - - -

Number at the end of anomaly
indicates spread used

PAN-NEVADA INC.
RED TOP PROJECT, YERINGTON AREA, LYON COUNTY, NEVADA



DRAWN: M.C.G.
DATE: JULY 89
APPROVED: *Mal*
DATE: *Aug 89*



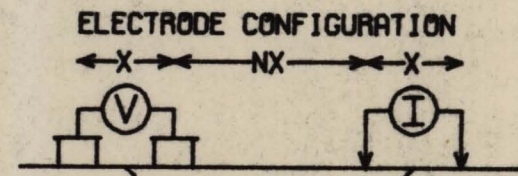
DWG. NO.- I.P.-5308-1

5430 0011

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA
LYON COUNTY, NEVADA

LINE NO.- 2W



PLOTTING POINT
X = 200'

SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

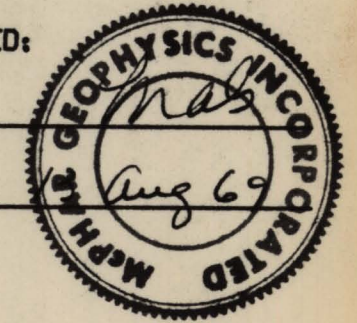
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DATE SURVEYED: JUN 1969

APPROVED:

NOTE: CONTOURS AT
LOGARITHMIC INTERVALS
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DATE:



McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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

N - 5

N - 4

N - 3

N - 2

N - 1

N - 5

N - 4

N - 3

N - 2

N - 1

RESISTIVITY (APP.) IN OHM FEET / 2π

RESISTIVITY (APP.) IN OHM FEET / 2π

METAL FACTOR (APP.)

METAL FACTOR (APP.)

N - 1

N - 2

N - 3

N - 4

N - 5

N - 1

N - 2

N - 3

N - 4

N - 5

FREQUENCY EFFECT (APP.) IN %

FREQUENCY EFFECT (APP.) IN %

N - 1

N - 2

N - 3

N - 4

N - 5

N - 1

N - 2

N - 3

N - 4

N - 5

DWG. NO.- I.P.-5308-2

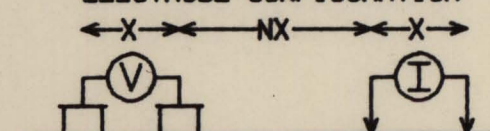
5430 001

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA
LYON COUNTY, NEVADA

LINE NO.- 0

ELECTRODE CONFIGURATION



PLOTTING POINT
X = 500'

SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

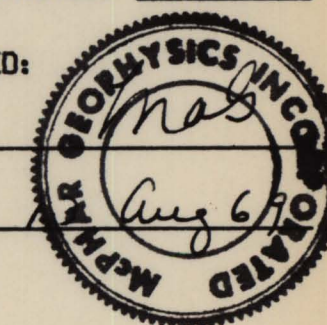
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DATE SURVEYED: MAY 1969

APPROVED:

NOTE: CONTOURS AT
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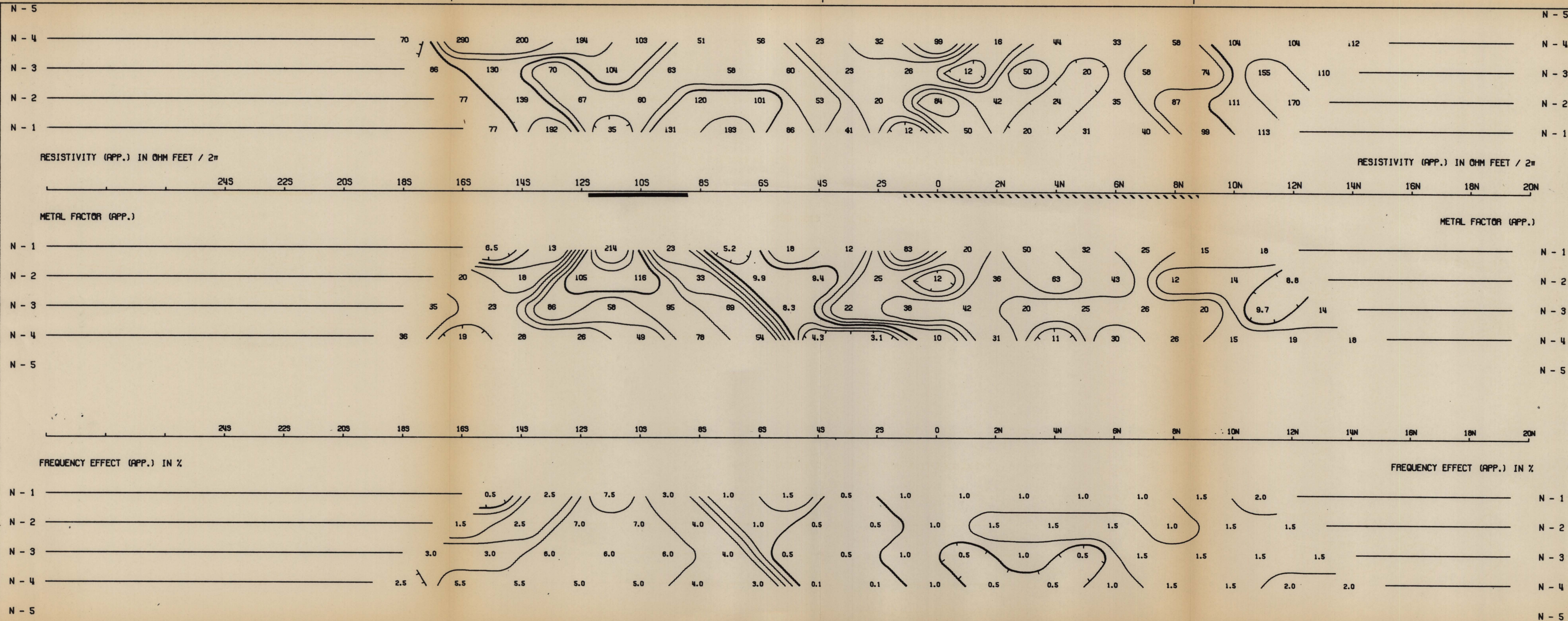
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INDUCED POLARIZATION AND RESISTIVITY SURVEY

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



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5430 0011

PAN-NEVADA INCORPORATED

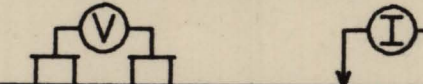
RED TOP PROJECT, YERINGTON AREA

LYON COUNTY, NEVADA

LINE NO. - 0

ELECTRODE CONFIGURATION

X X X



PLOTTING POINT X X = 200'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

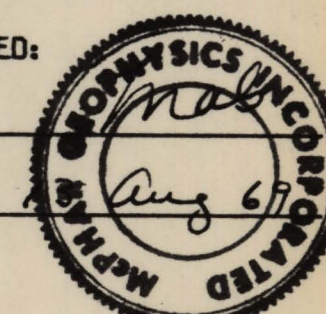
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DATE SURVEYED: MAY 1969

APPROVED:

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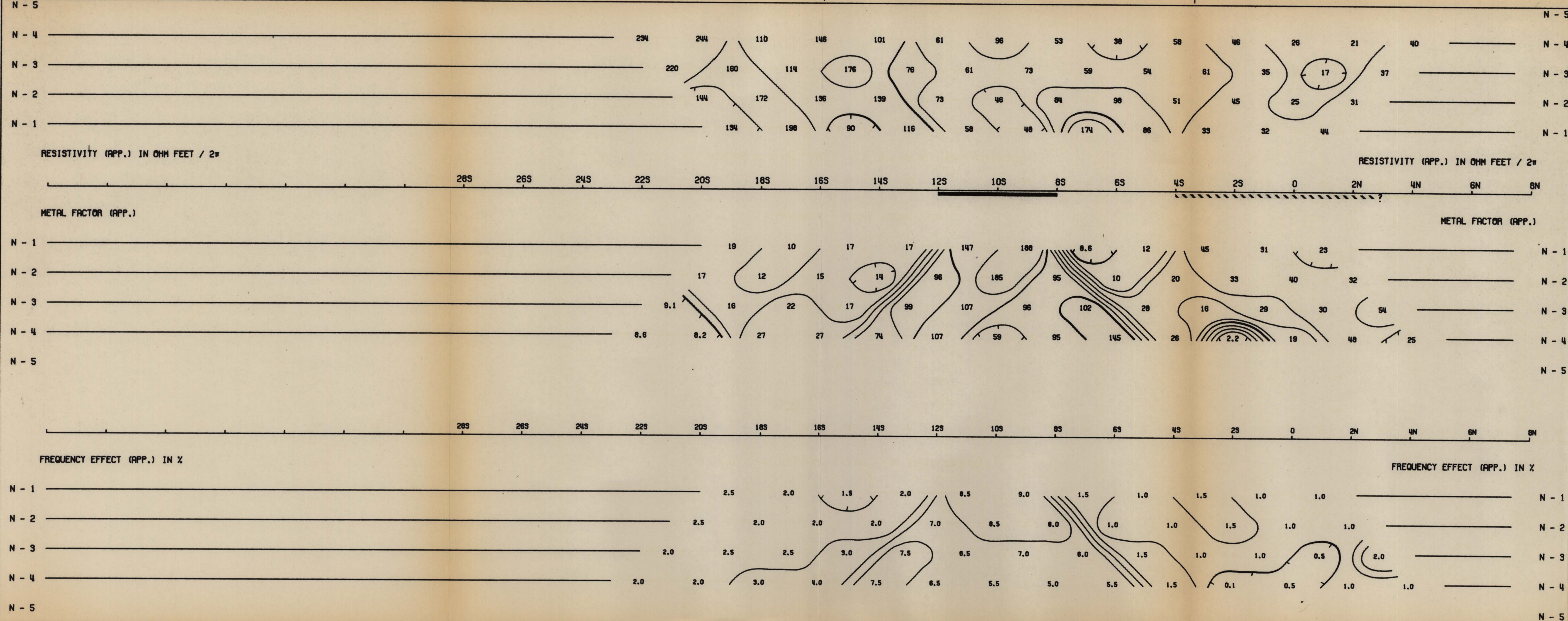
DATE:



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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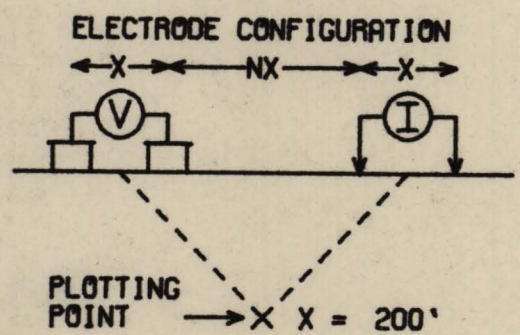
5430 0011

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA

LYON COUNTY, NEVADA

LINE NO.- 2E



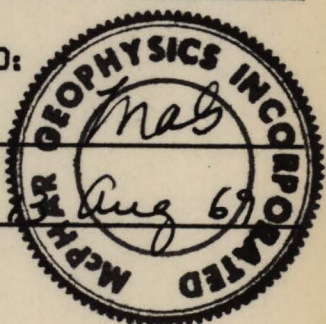
SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE ———
PROBABLE ———
POSSIBLE ———

FREQUENCIES: .05-1.25 CPS

DATE SURVEYED: JUN 1969

APPROVED: _____



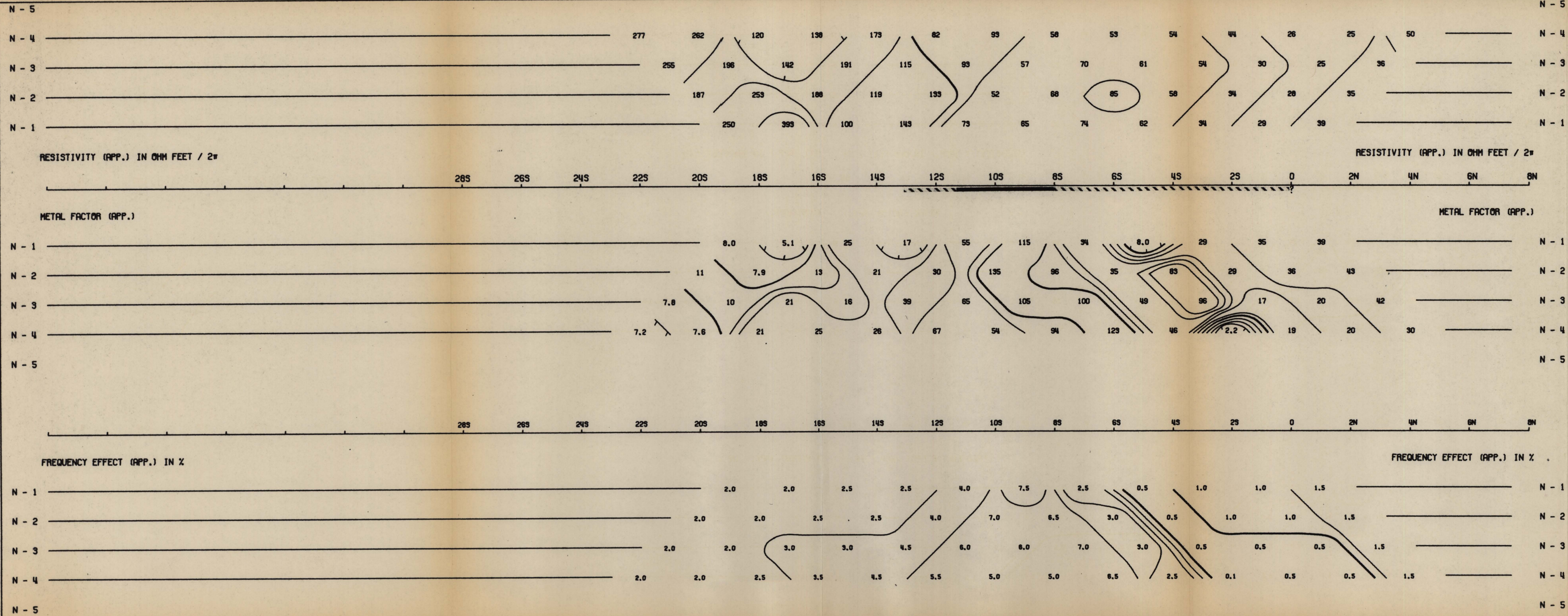
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DATE: _____

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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



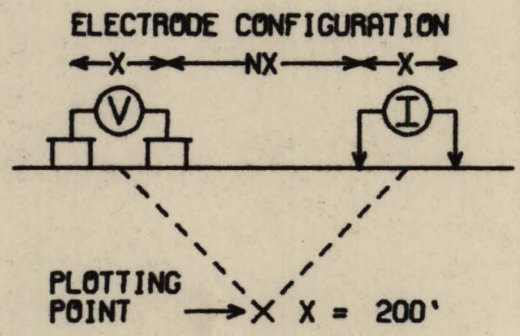
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5430 0011

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA
LYON COUNTY, NEVADA

LINE NO. - 4E



SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE —————

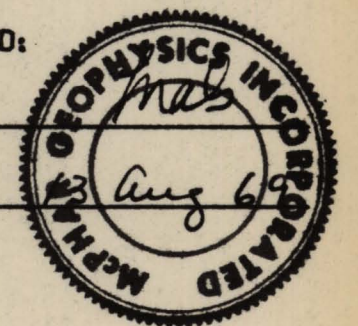
PROBABLE |||||||

POSSIBLE / / / /

FREQUENCIES: .05-1.25 CPS

DATE SURVEYED: JUN 1969

APPROVED:



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

DATE:

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

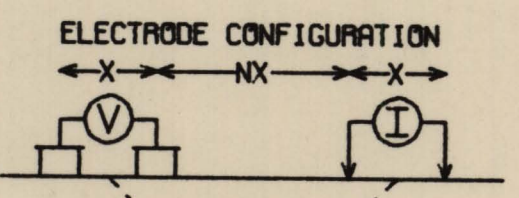
NOTE: THIS PLOT WAS PRODUCED WITH AN IBM 360/75 COMPUTER AND A CALCOMP PLOTTER

5430 0011

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA
LYON COUNTY, NEVADA

LINE NO.- 20E



PLOTTING POINT
X = 200'

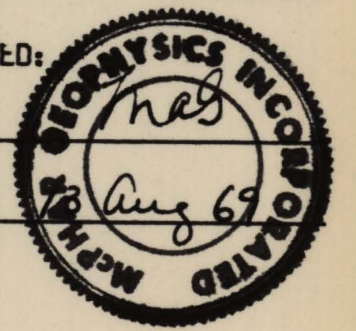
SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE —————
PROBABLE - - - - -
POSSIBLE / / / / /

FREQUENCIES: .05-1.25 CPS

DATE SURVEYED: MAY 1969

APPROVED: _____



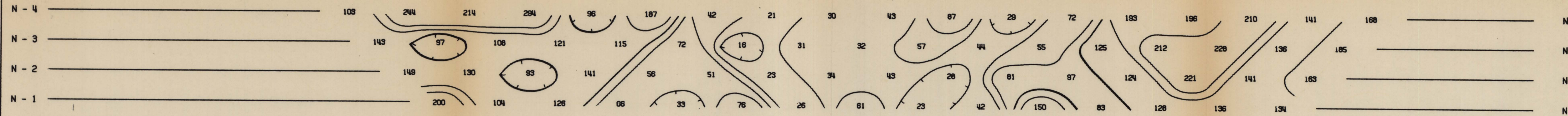
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LOGARITHMIC INTERVALS
1.-1.5-2.-3.-5.-7.5-10

DATE: 18 Aug 69

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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

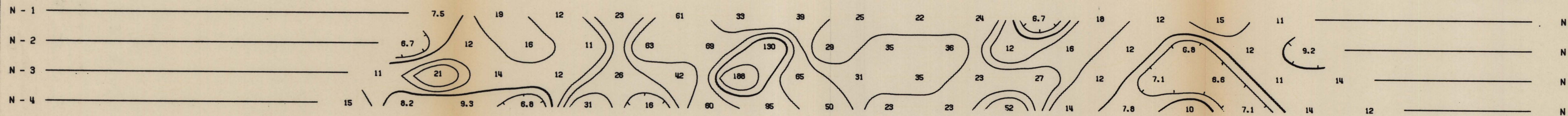


RESISTIVITY (APP.) IN OHM FEET / 2 π

RESISTIVITY (APP.) IN OHM FEET / 2 π

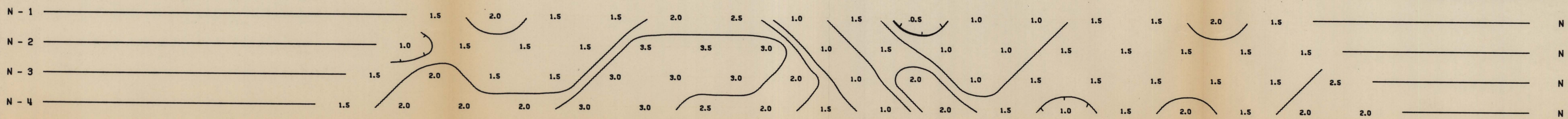
METAL FACTOR (APP.)

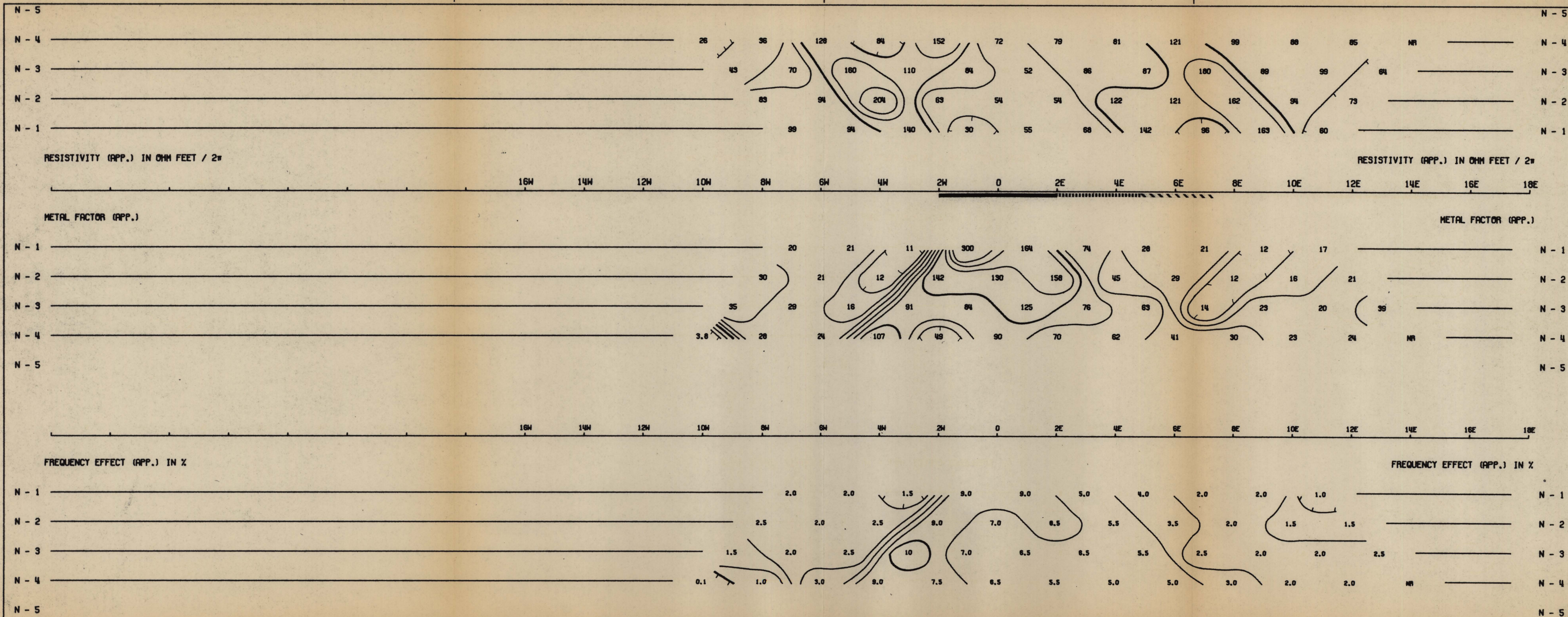
METAL FACTOR (APP.)



FREQUENCY EFFECT (APP.) IN %

FREQUENCY EFFECT (APP.) IN %





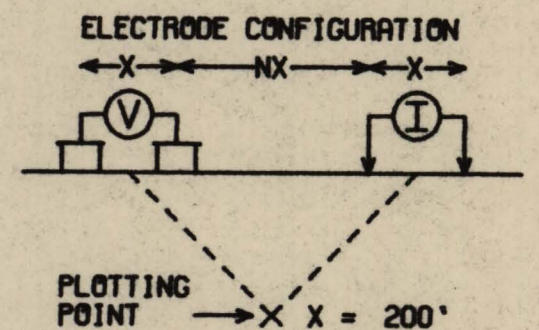
DWG. NO.- I.P.-5308-8

5430 0011

PAN-NEVADA INCORPORATED

RED TOP PROJECT, YERINGTON AREA
LYON COUNTY, NEVADA

LINE NO.- 11S



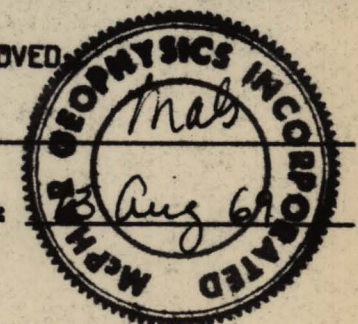
SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 05-125 CPS

DATE SURVEYED: JUN 1969

APPROVED



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

DATE:

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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