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REPORT ON THE INDUCED POLARIZATION AND RESISTIVITY SURVEY ON THE LINDA PROJECT, FROG RIVER AREA LIARD MINING DIVISION, B.C. FOR CORDILLERAN ENGINEERING LIMITED

BY

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AND

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NAME AND LOCATION OF PROPERTY

LINDA PROJECT, FROG RIVER AREA

LIARD MINING DIVISION, B.C. 58°N, 127°W - SE

DATE STARTED SEPTEMBER 8, 1970

DATE FINISHED SEPTEMBER 25, 1970

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

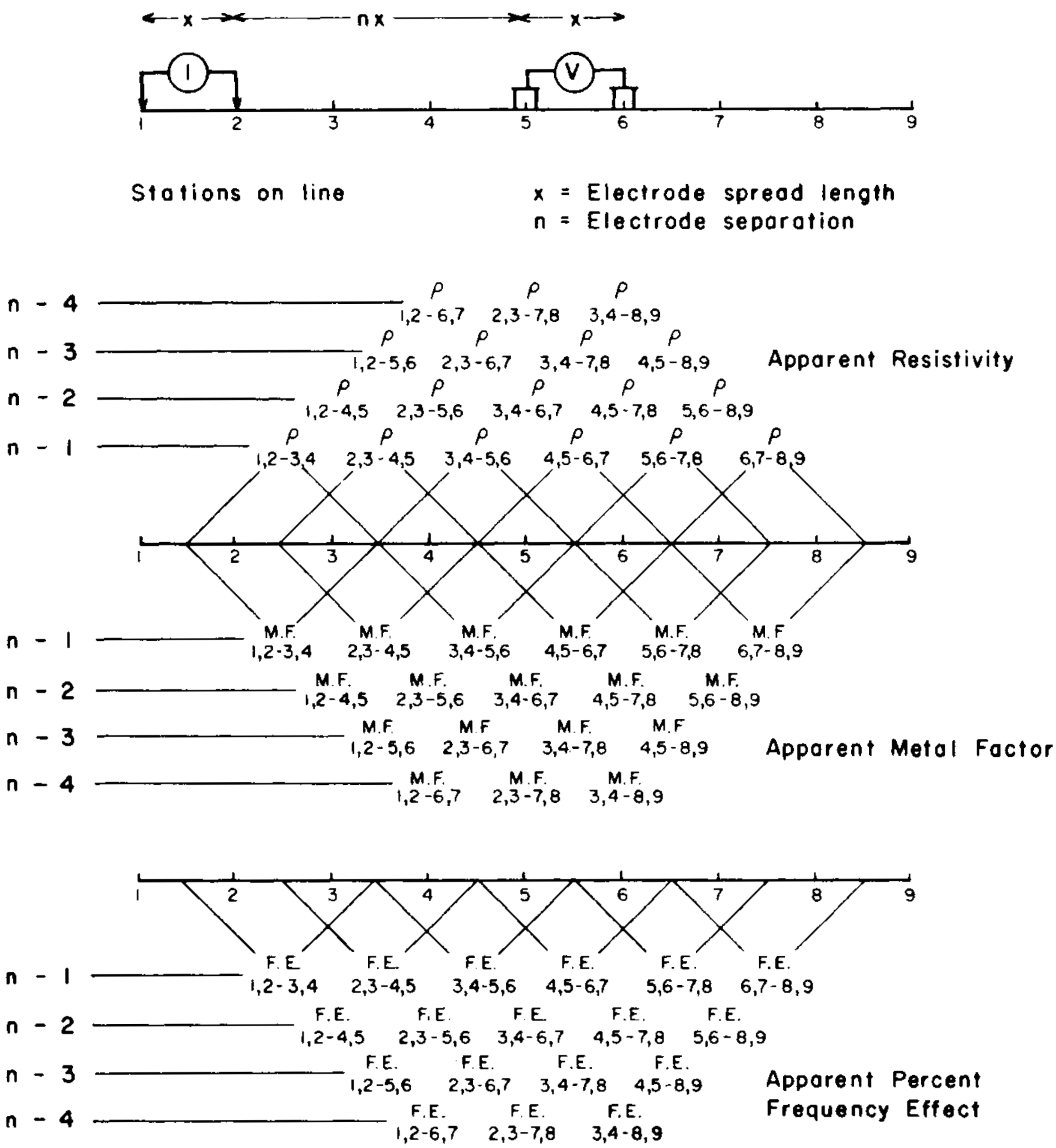

Fig. A

McPHAR GEOPHYSICS

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.

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 noisey 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.

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.

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Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

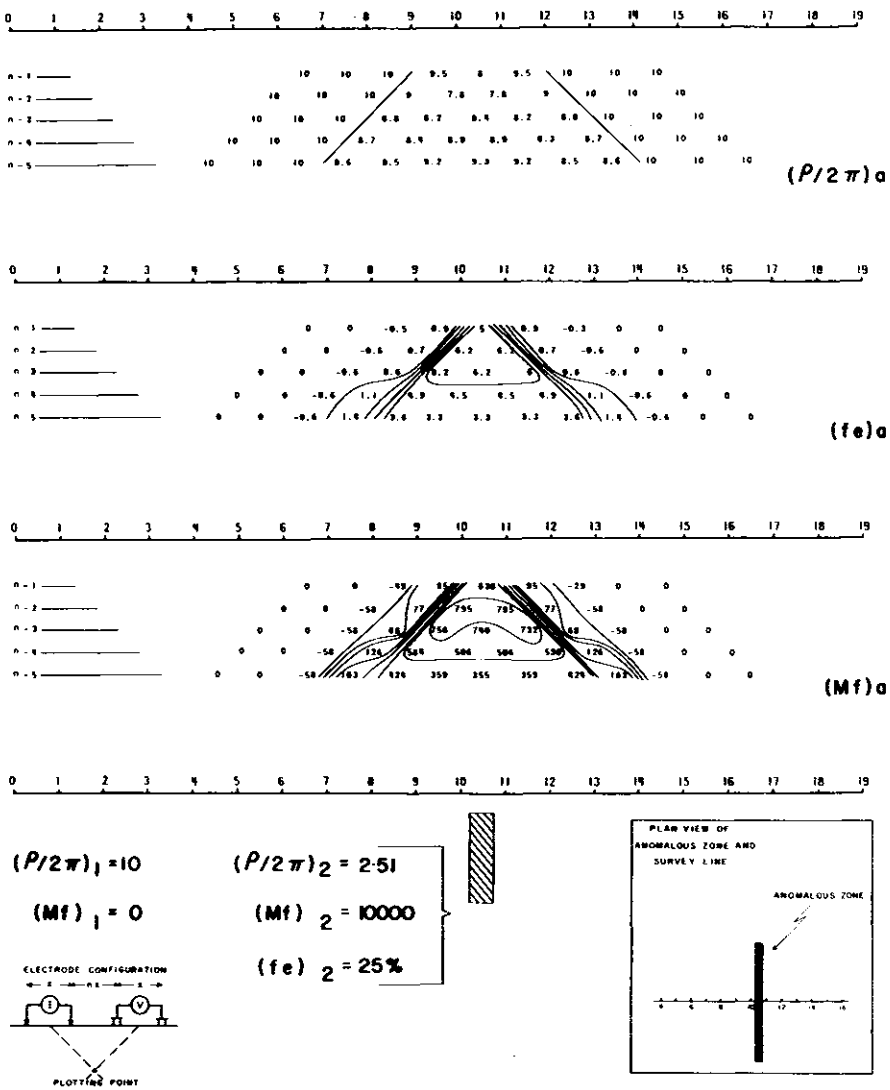

FIG 1

CASE II-0·5-BU-10-a

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Theoretical Induced Polarization and Resistivity Studies

Scale Model Cases

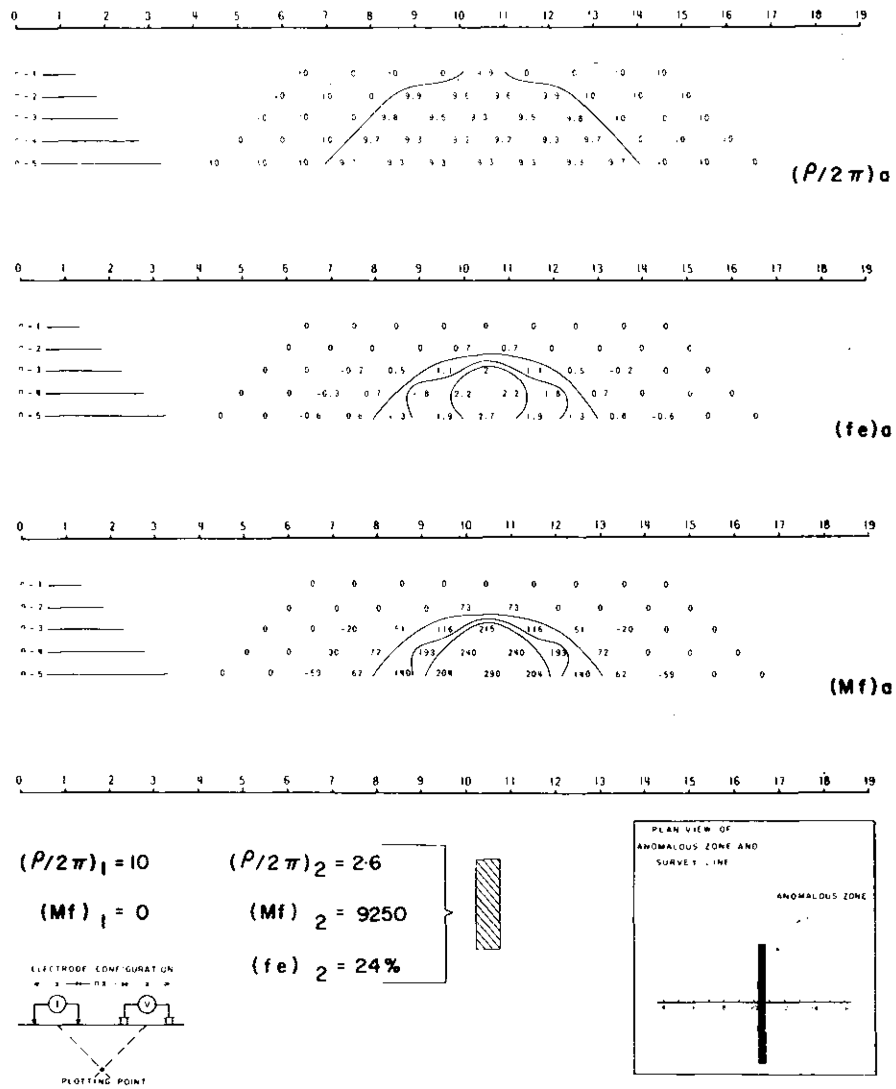


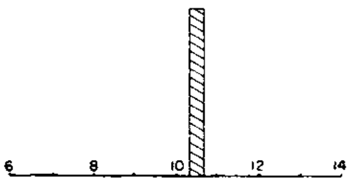
FIG 2

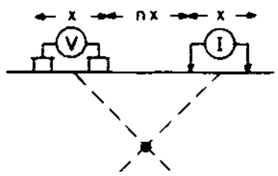
CASE II-1·5-BU-10-a

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW





X EQUALS 1 UNIT

$(\rho/2\pi)a$

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-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-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

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

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

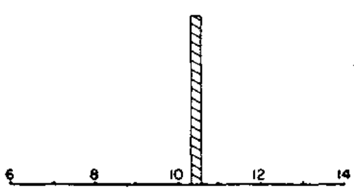
DEPTH EXTENT OF SOURCE 4 UNITS

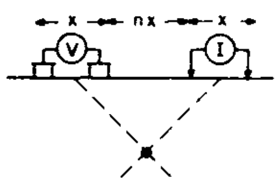
FIG. 3

THEORETICAL INDUCED POLARIZATION AND RESISTIVITY STUDIES

SCALE MODEL CASE

PLAN VIEW





X EQUALS 1 UNIT

$(\rho/2\pi)a$

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-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

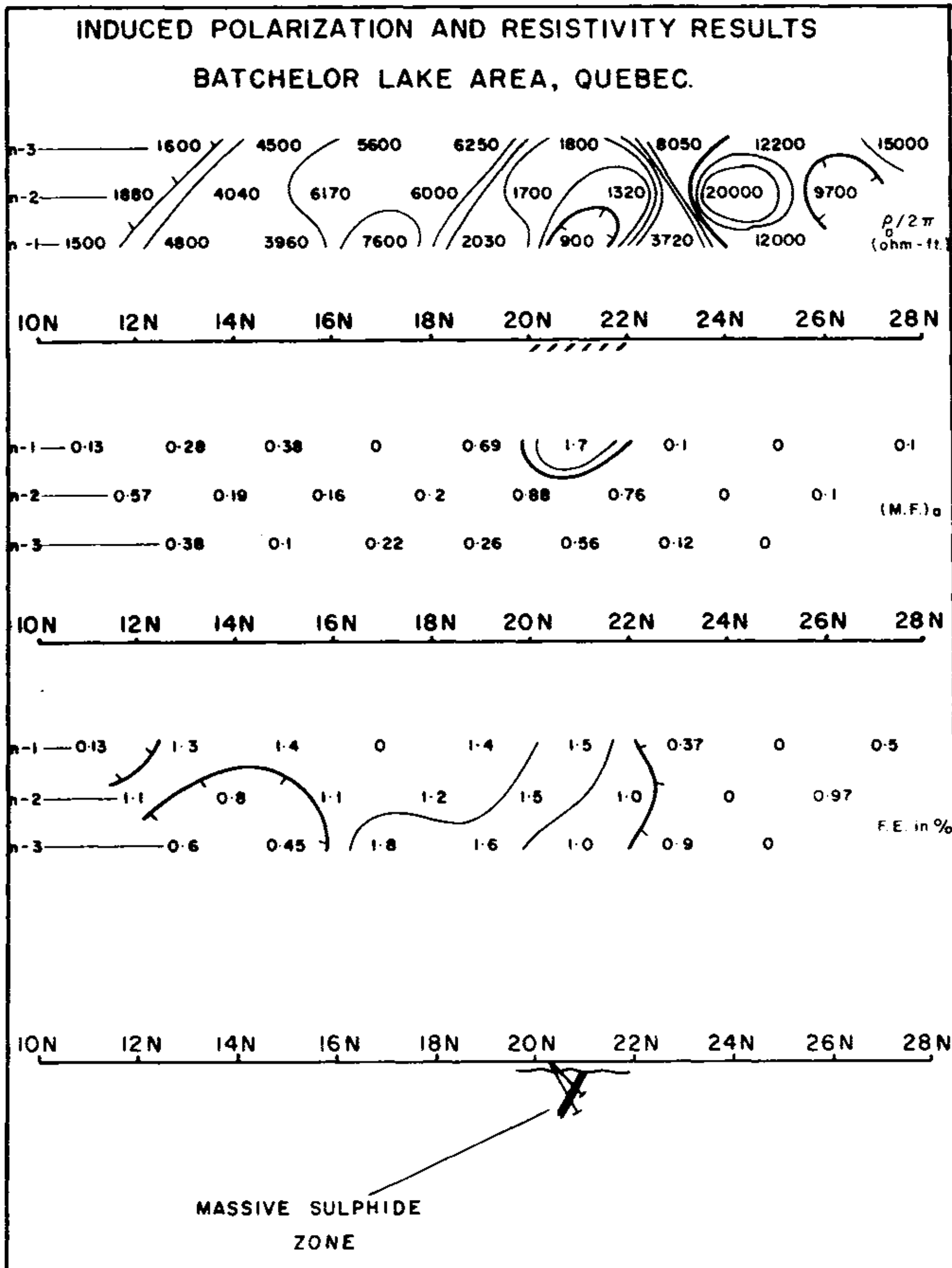
n-1	0	0	-30	0	376	0	-30	0	0			
n-2	0	0	-79	0	417	417	0	-79	0	0		
n-3	0	0	-79	52	490	490	501	52	-79	0	0	
n-4	0	0	-70	83	452	548	555	452	74	-71	0	0

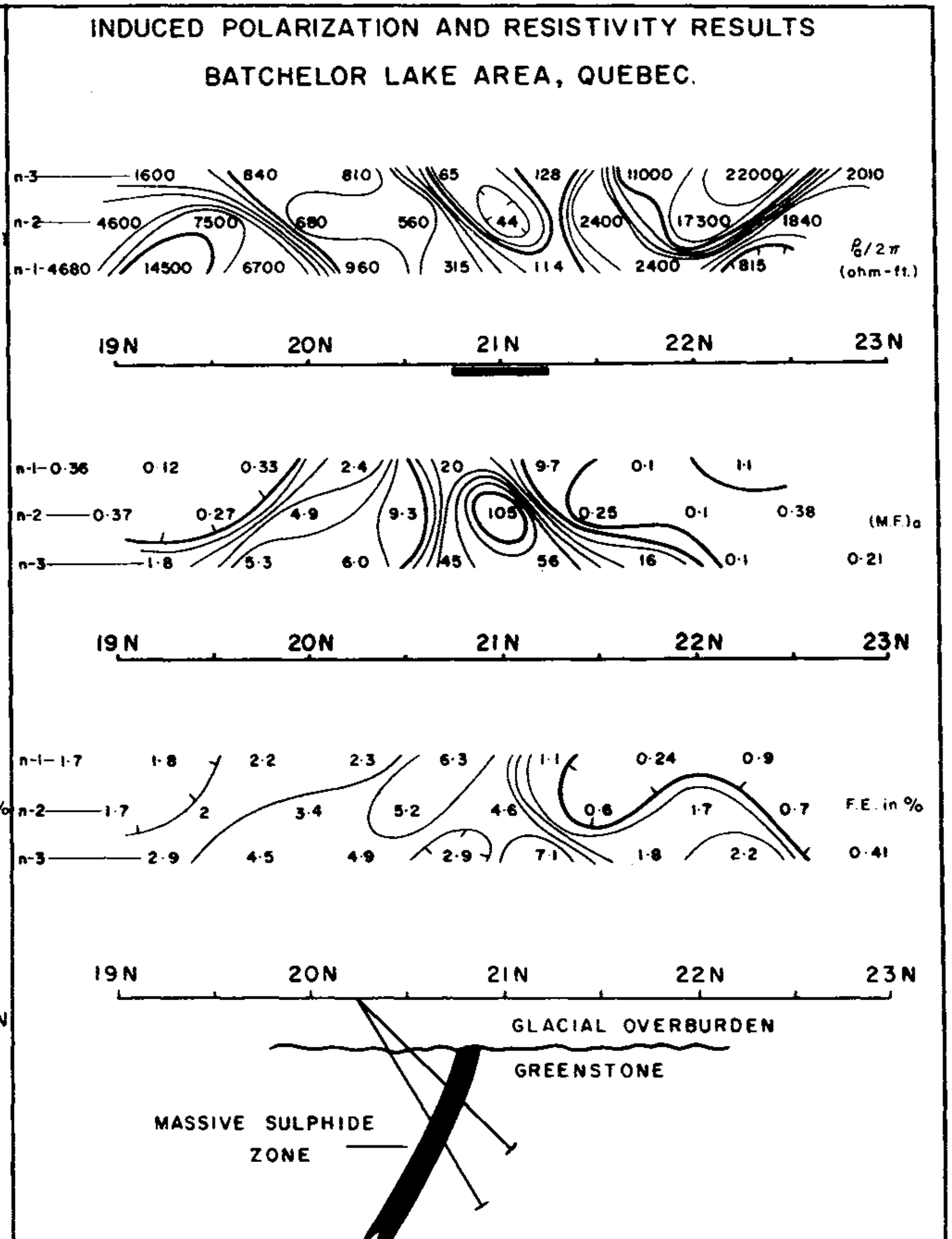
$(\rho 2\pi)_1 = 10$ $(Mf)_1 = 0$

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

DEPTH EXTENT OF SOURCE 4 UNITS

FIG. 4


INDUCED POLARIZATION AND RESISTIVITY RESULTS
BATCHELOR LAKE AREA, QUEBEC.
n-3
n-2
n-1
$\rho_a/2\pi$ (ohm-ft.)
10N 12N 14N 16N 18N 20N 22N 24N 26N 28N
(M.F.)a
F.E. in %
MASSIVE SULPHIDE ZONE
FIG. 5


INDUCED POLARIZATION AND RESISTIVITY RESULTS
BATCHELOR LAKE AREA, QUEBEC.
n-3
n-2
n-1
$\rho_a/2\pi$ (ohm-ft.)
19N 20N 21N 22N 23N
(M.F.)a
F.E. in %
GLACIAL OVERBURDEN
GREENSTONE
MASSIVE SULPHIDE ZONE
FIG. 6

McPHAR GEOPHYSICS LIMITED

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
LINDA PROJECT, FROG RIVER AREA
LIARD MINING DIVISION, B.C.
FOR
CORDILLERAN ENGINEERING LIMITED

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1. INTRODUCTION

At the request of Cordilleran Engineering Limited, we have carried out a combined induced polarization and resistivity survey on the Linda Project located in the Frog River Area of British Columbia. The property is situated in the Liard Mining Division, in the southeast quadrant of the one degree quadrilateral whose southeast corner is at 58°N latitude and 127°W longitude.

It is our understanding that the grid is almost entirely underlain by meta-sediments, now represented by chlorite and sericite schists. Interest in the area is related to a zone of massive galena float and the purpose of the survey was to search for deposits of concentrated metallic mineralization.

Field work was carried out during September, 1970 using a McPhar variable frequency IP system operating at frequencies of 0.3 and 5.0 Hz. A 200-foot dipole-dipole electrode array was employed for most of the survey and three dipole separations were recorded (i.e. n = 1, 2 and 3). Subsequently portions of some lines were detailed with 100-foot dipoles.

The survey was carried out on the following claims:

Linda	2	West	3
	4		4
	6		5
	8		6
	10		
	12		
	13		
	14		
	15		
	16		
	17		

2. PRESENTATION OF RESULTS

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

Line 6E	200 foot spreads	Dwg.IP 5591-1
Line 10E	200 foot spreads	Dwg.IP 5591-2
Line 14E	200 foot spreads	Dwg.IP 5591-3
Line 14E	100 foot spreads	Dwg.IP 5591-4
Line 18E	200 foot spreads	Dwg.IP 5591-5
Line 18E	100 foot spreads	Dwg.IP 5591-6
Line 22E	200 foot spreads	Dwg.IP 5591-7
Line 22E; North	100 foot spreads	Dwg.IP 5591-8
Line 22E; South	100 foot spreads	Dwg.IP 5591-9
Line 28E	200 foot spreads	Dwg.IP 5591-10
Line 36E	200 foot spreads	Dwg.IP 5591-11
Line 40E	200 foot spreads	Dwg.IP 5591-12

Line 44E	200 foot spreads	Dwg.IP 5591-13
Line 48E	200 foot spreads	Dwg.IP 5591-14
Line 30S	100 foot spreads	Dwg.IP 5591-15

Enclosed with this report is Dwg. I.P.P. 4693, a plan map of the grid at a scale of 1" = 200'. 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

Line 6E

Weakly anomalous IP effects were measured on most of this line but it is not clear whether these results reflect small, variable amounts of mineralization or a lithologic unit that is weakly polarizable. Somewhat stronger effects occur between 18S and 20S, and these correlate with definite anomalies to the east forming Zone A.

Line 10E

Similar results were obtained on this line, although Zone A is broader.

Line 14E

A low magnitude but definite anomaly was found at 8S to 10S with a weaker extension to about 12S; this feature has been identified on the accompanying plan as Zone B. Since the source of the definite anomaly is shallow and narrow it could be better evaluated by detailing with 100-foot electrode intervals, as illustrated in the accompanying Appendix. A drill test is probably warranted, particularly if there is any geochemical correlation.

Zone A is extremely broad on this line and extends from at least station 20S to 34S, with stronger sections at 22S, 27S and 33S. Apparently this anomaly correlates with an area of abundant galena float and a geochemical (lead) high, although the geochemical results have not been made available to us, and subsequently it was detailed with 100-foot spreads. These results confirmed the presence of a wide variable zone (or a zone parallel to the traverse) containing several narrow, more concentrated, sections. Cross-sectional drilling would appear to be warranted.

Line 18E

On this line Zone A is much narrower but stronger. Zone B is similar to Line 14E and there is an additional deep anomaly centred at 3S.

The 100-foot detail over Zone A indicates a complex anomaly between 19S and 24S that appears to include a shallow source at 22S and a strong deep source at 20S. Drilling is definitely warranted either here or on Line 22E.

Line 22E

On the north part of Line 22E there is a broad, anomaly between 2N and 8S, with narrow definite sections at 3S and 7S. This feature may correlate in part with Zone B or it may represent a separate zone north of Zone B. Here again, cross-sectional drilling seems to be warranted.

Detailing confirmed both definite sections but the sources now appear to be at some depth, probably about 100 feet.

Zone A appears as a strong anomaly centred between 20S and 22S, with weaker extensions to about 16S and 26S. The results from the 100-foot detail indicate a strong shallow source that is between one and three units wide, with a weak extension for several hundred feet to the south.

Line 28E

Only a wide zone of weak IP effects was found on the north part of the line.

Zone A is much broader than on Line 22E or Line 18E and the strongest section is farther south, between 23S and 29S.

Line 36E

Definite anomalies of low magnitude were located at 11S and 19S, within a broad weak zone. Both features appear to correlate with other anomalies farther east to form Zone C and Zone D, although the latter may be an extension of the main zone.

Line 32E

This line was not picketed and consequently could not be surveyed by the IP crew.

Line 40E

Zone C is very broad on this line and appears to reflect a disseminated source, whereas Zone D appears to be narrow and more concentrated, with some depth to the top. Drilling is probably warranted.

Line 44E

Both Zone C and Zone D are appreciably weaker than on the preceding line.

Line 48E

Zone C is weaker here; the main part of the anomaly is deep (probably 200 feet or more) and centred at station 10S. Zone D is stronger and deeper than on Line 44E. There is also a definite anomaly at 30S to 32S that is typical of a shallow narrow source. A fourth anomaly is present at the south end of the line but the pattern is incomplete.

Line 30S

A short east-west line was run at 30S to check the extensive anomaly on Line 14E which appears to form part of Zone A. The results indicate a shallow narrow source centred between 14E and 15E, suggesting a N-S trending feature parallel to the southern part of Line 14E.

4. SUMMARY AND RECOMMENDATIONS

Several interesting anomalies have been found on the Linda and West claims, most of which can be correlated into four well defined zones. The most interesting of these occurs in the southwest section of the grid in an area of abundant galena float and an extensive geochemical anomaly. Cross-sectional drilling is definitely warranted on Line 22E (i.e. south from 18S and 22S) or on Line 18E.

The results from the south part of Line 14E and from Line 30S indicate the presence of a narrow source roughly perpendicular to the main part of Zone A. This has been shown on Dwg. I.P.P. 4693 as Zone A-2. An angle drill hole is recommended on Line 30S to pass under 14+50E at a depth of 100 to 150 feet.

Zone B is not as strong as most of the other anomalies but still might merit a drill test; a hole could be spotted to pass under 9+00S, Line 14E at a vertical depth of 150 to 200 feet. Drilling is warranted to test the definite anomalies on the north part of Line 22E; two holes would be required, under 3S and 7S at vertical depths of about 150 feet.

Zone C is also weak but drilling may still be warranted on Line 40E if there is any supporting geological or geochemical information.

Zone D occurs in the southeast part of the grid and may represent an extension of Zone A-1. A drill hole is recommended on Line 40E, to pass under 22S at a vertical depth of about 200 feet.

MCPHAR GEOPHYSICS LIMITED

Robert A. Bell,
Geologist.

Philip G. Hallof,
Geophysicist.

Dated: November 17, 1970

Expiry Date: February 25, 1971

ASSESSMENT DETAILS

PROPERTY: Linda Project

MINING DIVISION: Laird

SPONSOR: Cordilleran Engineering Limited

PROVINCE: British Columbia

LOCATION: Frog River Area

TYPE OF SURVEY: Induced Polarization

OPERATING MAN DAYS:	48	DATE STARTED: September 8, 1970
EQUIVALENT 8 HR. MAN DAYS:	72	DATE FINISHED: September 25, 1970
CONSULTING MAN DAYS:	3	NUMBER OF STATIONS: 265
DRAUGHTING MAN DAYS:	9	NUMBER OF READINGS: 1913
TOTAL MAN DAYS:	84	MILES OF LINE SURVEYED: 8

CONSULTANTS:

Robert A. Bell, 50 Hemford Crescent, Don Mills, Ontario.
Philip G. Hallof, 5 Minorca Place, Don Mills, Ontario.

FIELD TECHNICIANS:

D. Morrison, R.R. #1, Gravenhurst, Ontario.
K. Cozens, 1452 Chamberlain Drive, North Vancouver, British Columbia.
Plus 2 Helpers - Supplied by Client

DRAUGHTSMEN:

F. Hurst, 230 Woburn Avenue, Toronto 12, Ontario.
B. Marr, 19 Kenewen Court, Toronto 16, Ontario.
J. Duffy, 7 Waddington Crescent, Willowdale, Ontario.

McPHAR GEOPHYSICS LIMITED

Robert A. Bell

Robert A. Bell,
Geologist

Dated: November 17, 1970

INTERIM

STATEMENT OF COST

Cordilleran Engineering Limited
Linda Project - Frog River Area

Crew - (2 men) - D. Morrison - K. Cozens

12 days Operating	@ $250.00/day	$3,000.00
1 day Travel)		
4 days Preparation) 6 days	@ $100.00/day	600.00
1 day Bad Weather)		

Expenses - Hutade and Frog River

Air Fare	$462.00	
Mileage allowance	16.48	
Rented Vehicles	82.40	
Vehicle Expense	14.50	
Freight and Brokerage	106.01	
Meals and Accommodation	65.50	
Taxi	11.00	
Telephone and Telegraph	14.50	
Miscellaneous	5.22	
	777.61	
+ 10%	77.76	
	$855.37	
Prorated portion of expenses for Frog River - 12/38 x $855.37		270.12
		$3,870.12

McPHAR GEOPHYSICS LIMITED

Robert A. Bell

Robert A. Bell,
Geologist

Dated: November 17, 1970

See over

CERTIFICATE

I, Robert Alan Bell, of the City of Toronto, Province of Ontario, do hereby certify that:

1. I am a geologist residing at 50 Hemford Crescent, Don Mills, (Toronto) Ontario.

2. I am a graduate of the University of Toronto in Physics and Geology with the degree of Bachelor of Arts (1949); and a graduate of the University of Wisconsin in Economic Geology with the degree of Ph.D. (1953).

3. I am a member of the Society of Economic Geologists and a fellow of the Geological Association of Canada.

4. I have been practising my profession for over fifteen years.

5. I have no direct or indirect interest, nor do I expect to receive any interest directly or indirectly, in the property or securities of Cordilleran Engineering Limited or any affiliate.

6. The statements made in this report are based on a study of published geological literature and unpublished private reports.

7. Permission is granted to use in whole or in part for assessment and qualification requirements but not for advertising purposes.

Dated at Toronto

This 17th day of November 1970

Robert A. Bell, Ph.D.

CERTIFICATE

I, Philip George Hallof, of the City of Toronto, Province of Ontario, do hereby certify that:

1. I am a geophysicist residing at 5 Minorca Place, Don Mills, (Toronto) Ontario.

2. I am a graduate of the Massachusetts Institute of Technology with a B.Sc. Degree (1952) in Geology and Geophysics, and a Ph.D. Degree (1957) in Geophysics.

3. I am a member of the Society of Exploration Geophysicists and the European Association of the Exploration Geophysicists.

4. I am a Professional Geophysicist, registered in the Province of Ontario, the Province of British Columbia and the State of Arizona.

5. I have no direct or indirect interest, nor do I expect to receive any interest directly or indirectly, in the property or securities of Cordilleran Engineering Limited or any affiliate.

6. The statements made in this report are based on a study of published geological literature and unpublished private reports.

7. Permission is granted to use in whole or in part for assessment and qualification requirements but not for advertising purposes.

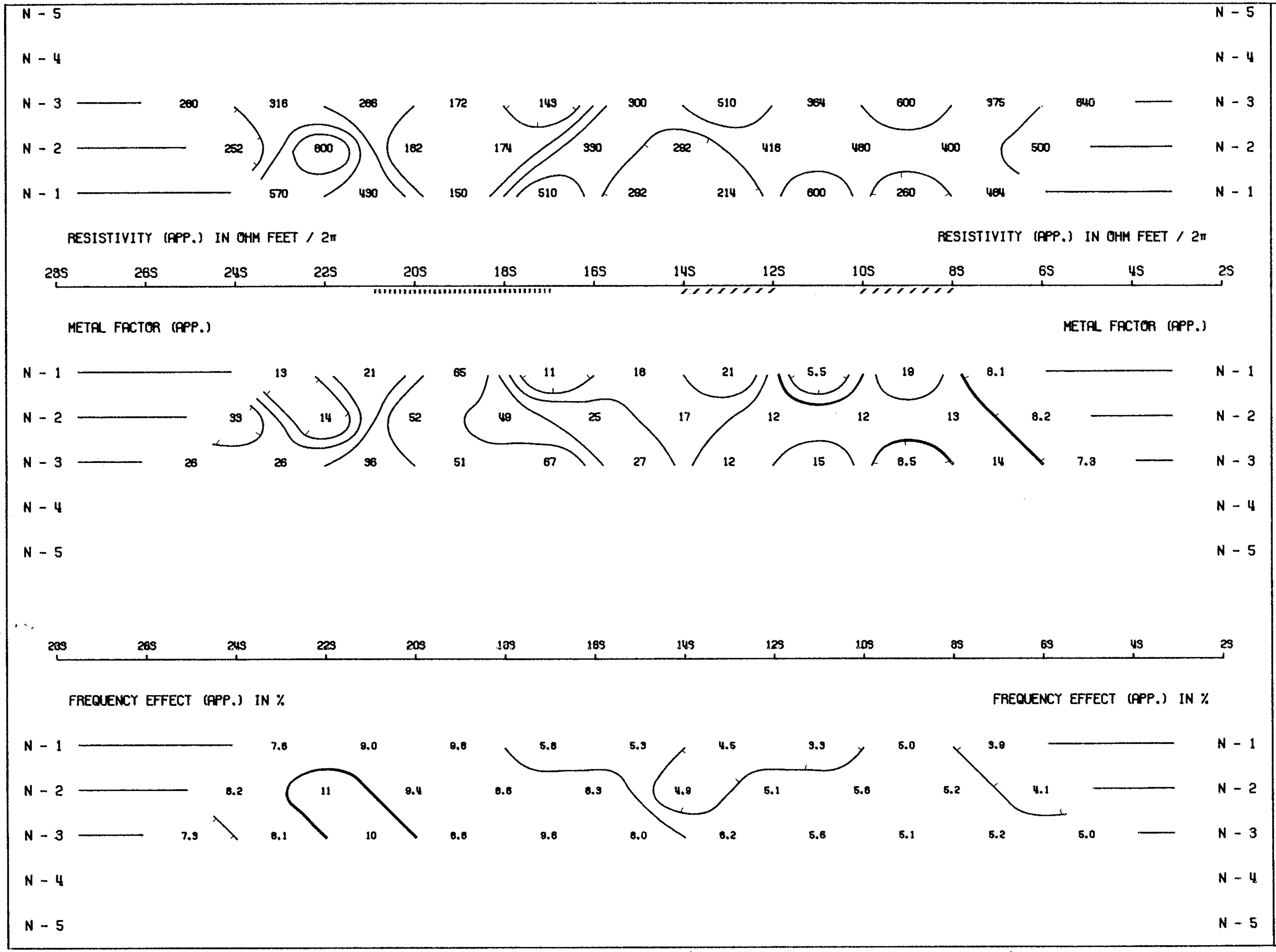
Dated at Toronto

This 17th day of November 1970

Philip G. Hallof, Ph.D.

PROFESSIONAL ... PROVINCE OF ... ENGINEER

Expiry Date: February ... 1971



2995

DWG. NO.- I.P.-5591-1

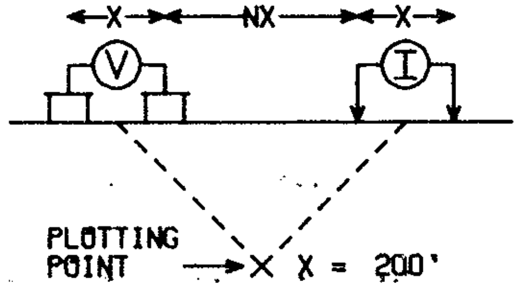
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 6E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

DATE: 17/11/70

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.-5591-2

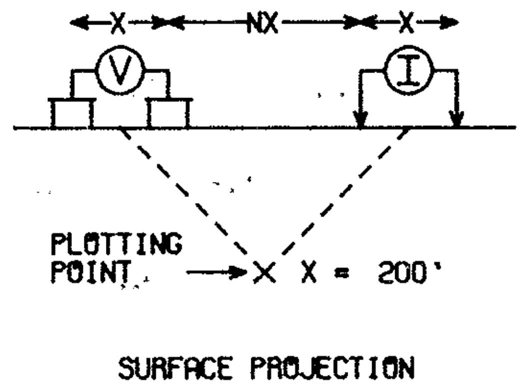
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 10E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 17/11/70

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.-5591-3

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 14E

ELECTRODE CONFIGURATION

—X— —NX— —X—

PLOTTING POINT X X = 200'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬

PROBABLE ||||||||||||

POSSIBLE / / / / /

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 13/11/70

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.-5591-4

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT
FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 14E

ELECTRODE CONFIGURATION
X — NX — X
PLOTTING POINT X = 100'

SURFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

DATE: 11/11/70

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

Expiry Date: February 25, 1971

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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

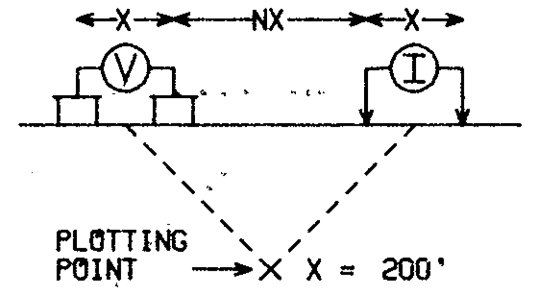
DWG. NO.- I.P.-5591-5

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA; LIARD M.D., B.C.

LINE NO.- 18E



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

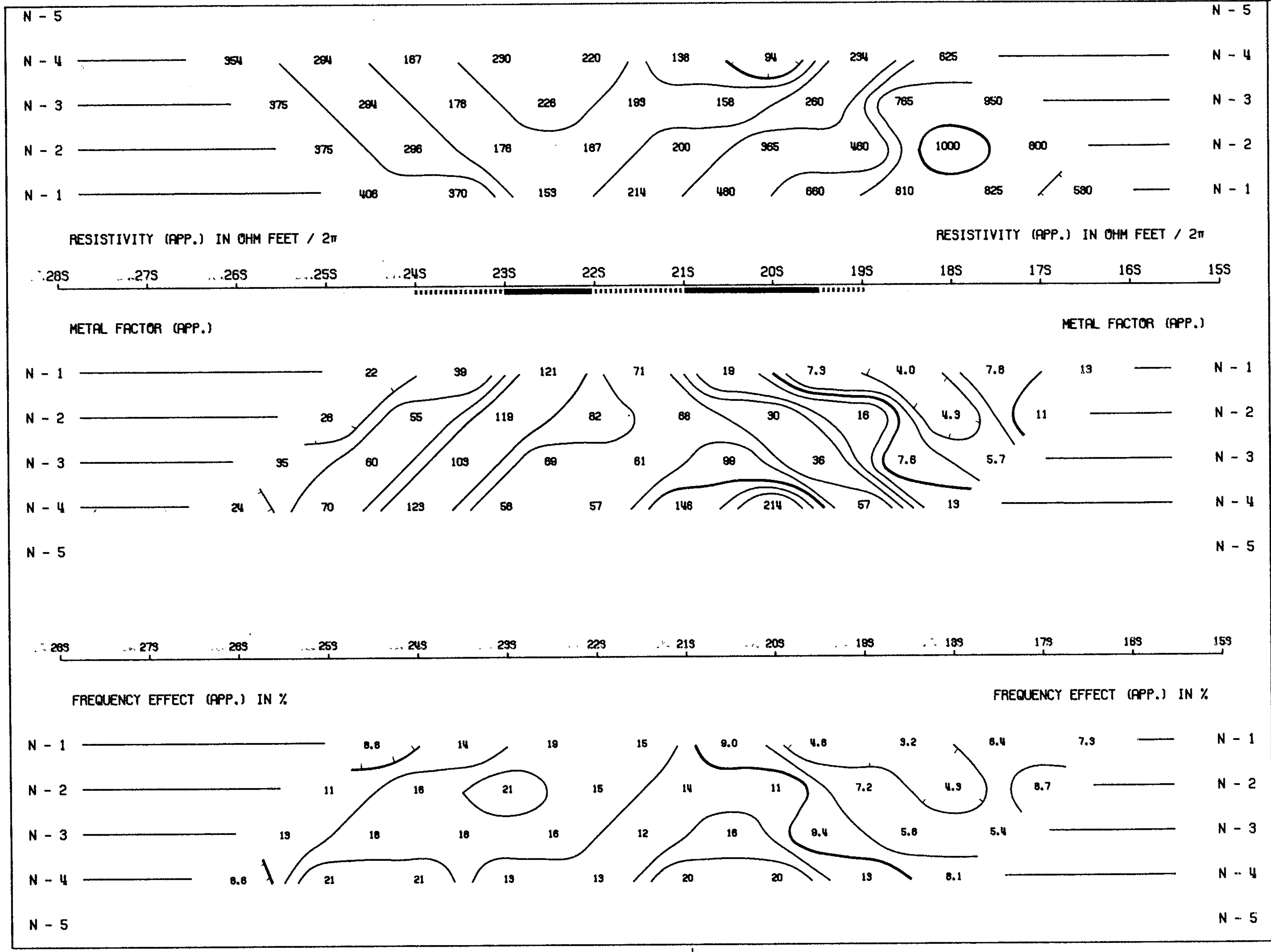
DATE: 17/11/70

Expiry Date February 25, 1971

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.-5591-6

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 18E

ELECTRODE CONFIGURATION

PLOTTING POINT X = 100'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 17/11/70

PROFESSIONAL ENGINEER

Expiry Date: February

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.-5591-7

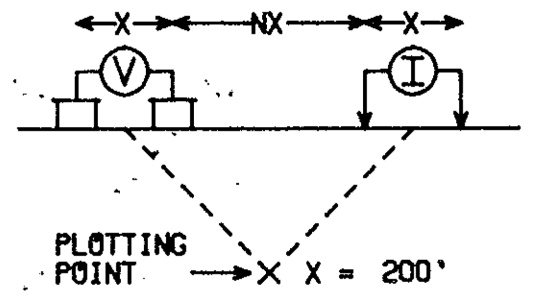
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 22E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

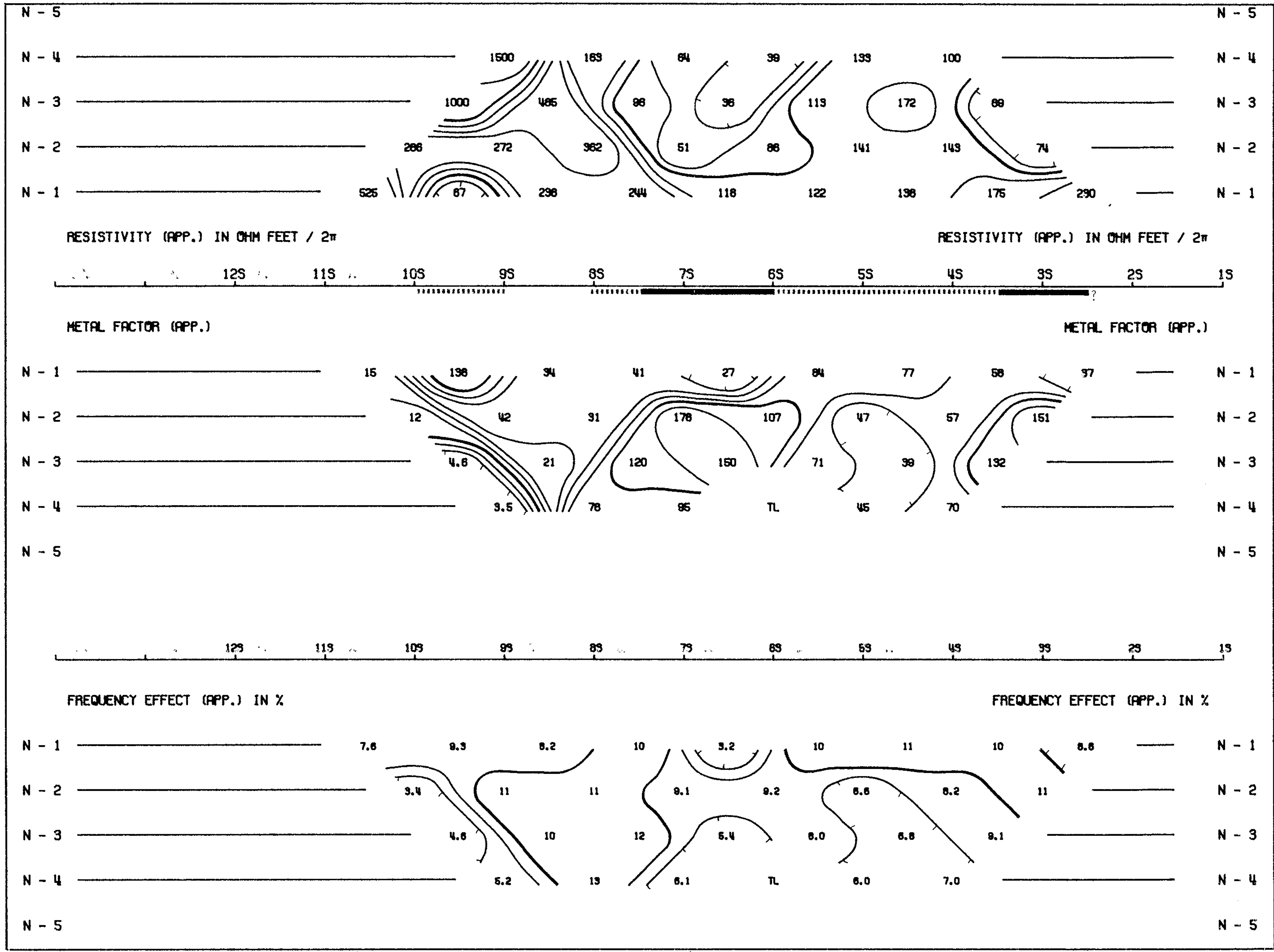
DATE: 17/11/70

Expiry Date: February 25, 1971

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.-5591-8

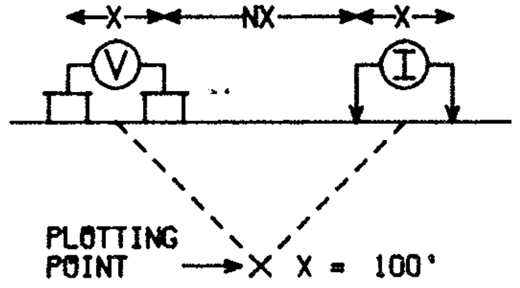
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 22E (NORTH)

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 17/11/70

PROFESSIONAL ENGINEER

Expires February 15, 1971

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.-5591-9

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 22E (SOUTH)

ELECTRODE CONFIGURATION

PLOTTING POINT → X X = 100'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

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

APPROVED:

DATE: 7/11/70

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.-5591-10

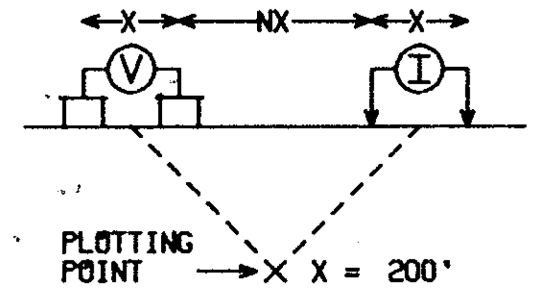
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 28E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

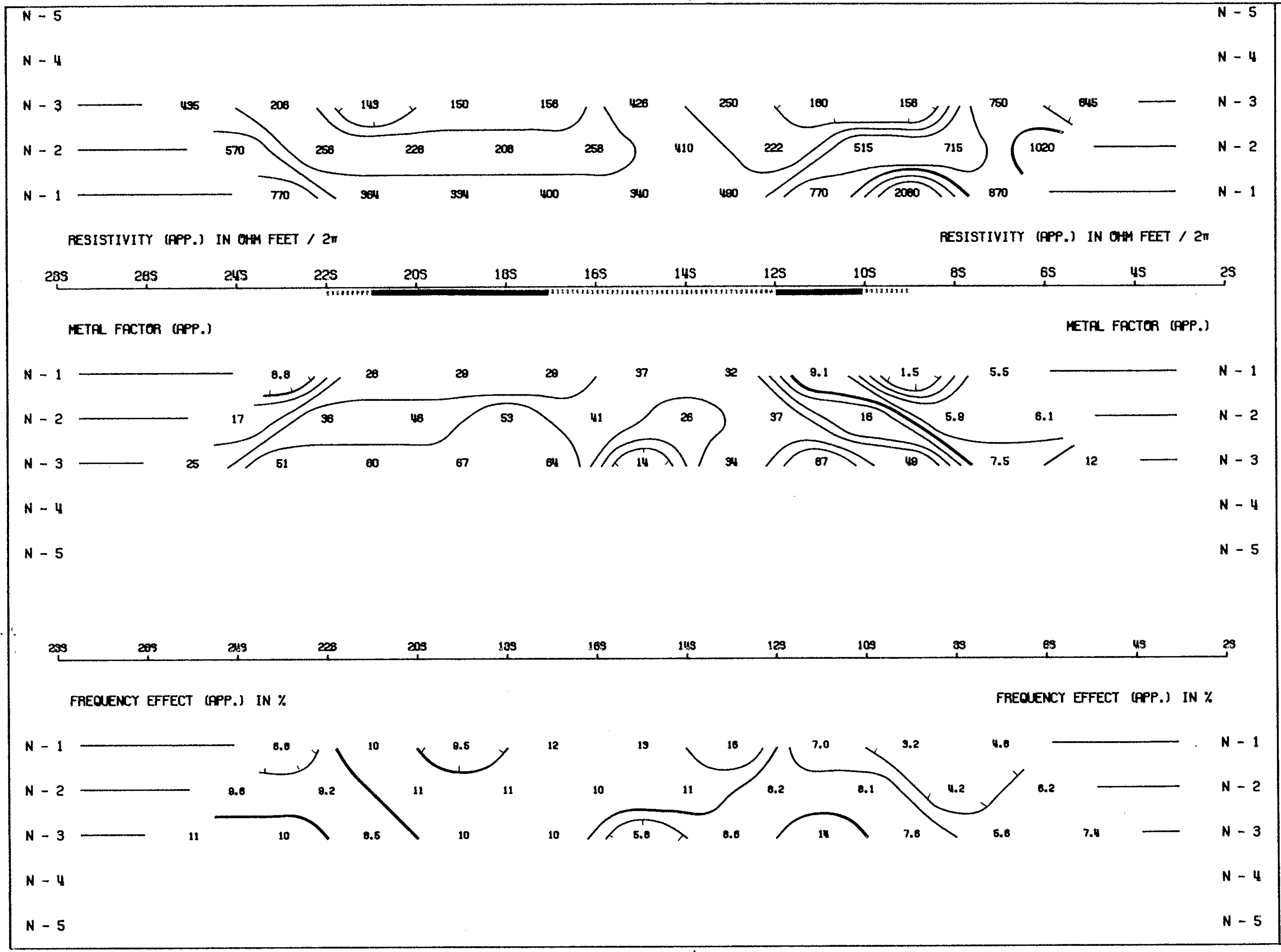
DATE: 12/4/70

[illegible] ENGINEER, Expiry Date: February 28, 1971

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.- 5591-11

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 36E

ELECTRODE CONFIGURATION

X = 200'

PLOTTING POINT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

DATE: 17/11/70

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

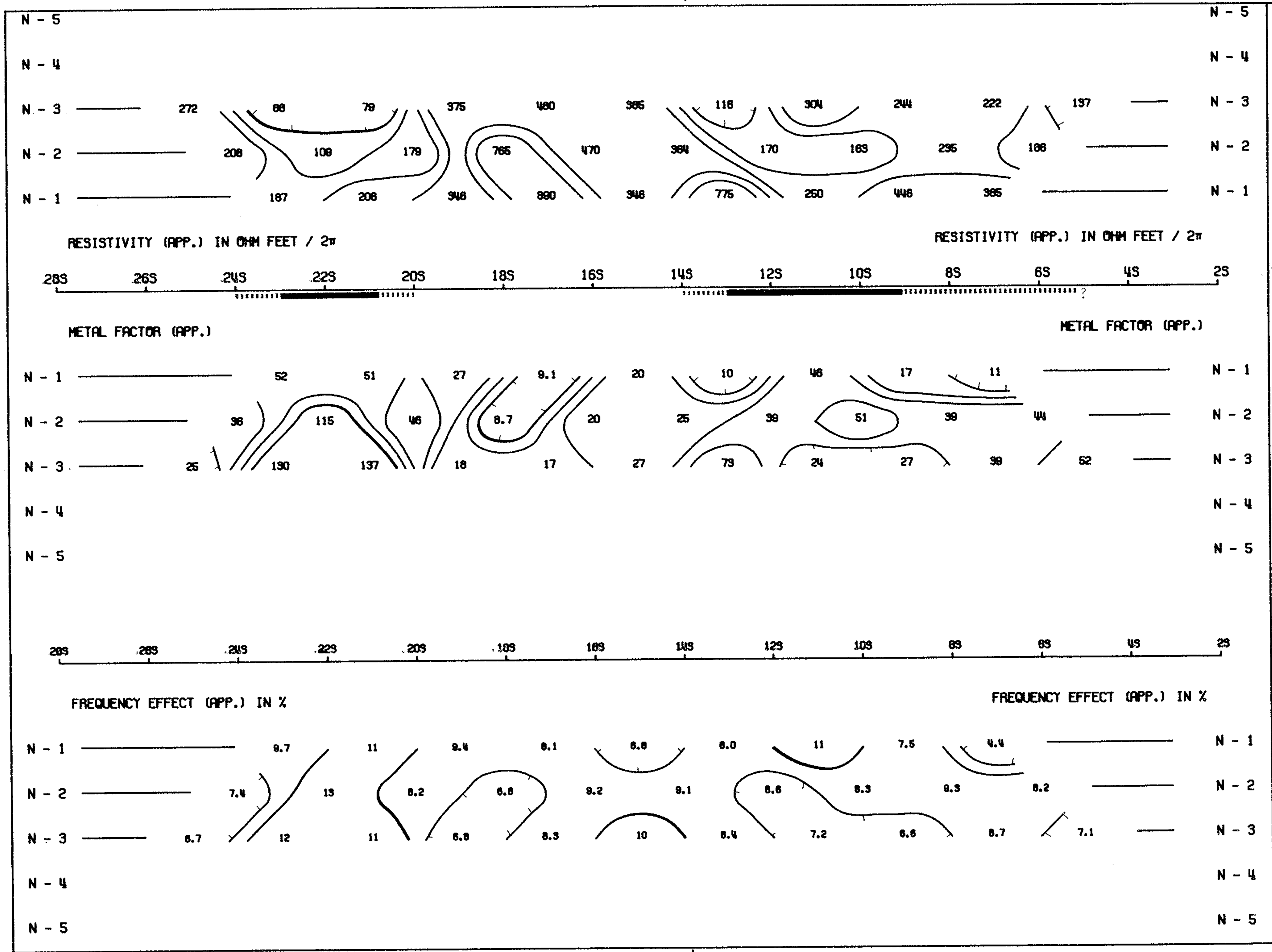
PROFESSIONAL ENGINEER

Expiry Date: February 28, 1971

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.-5591-12

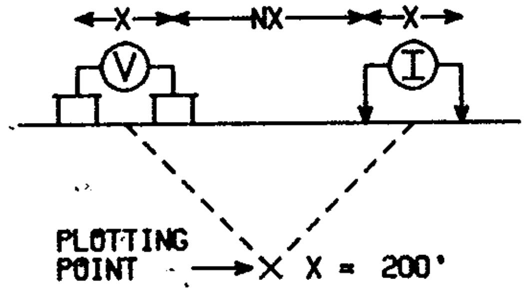
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 40E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 17/11/70

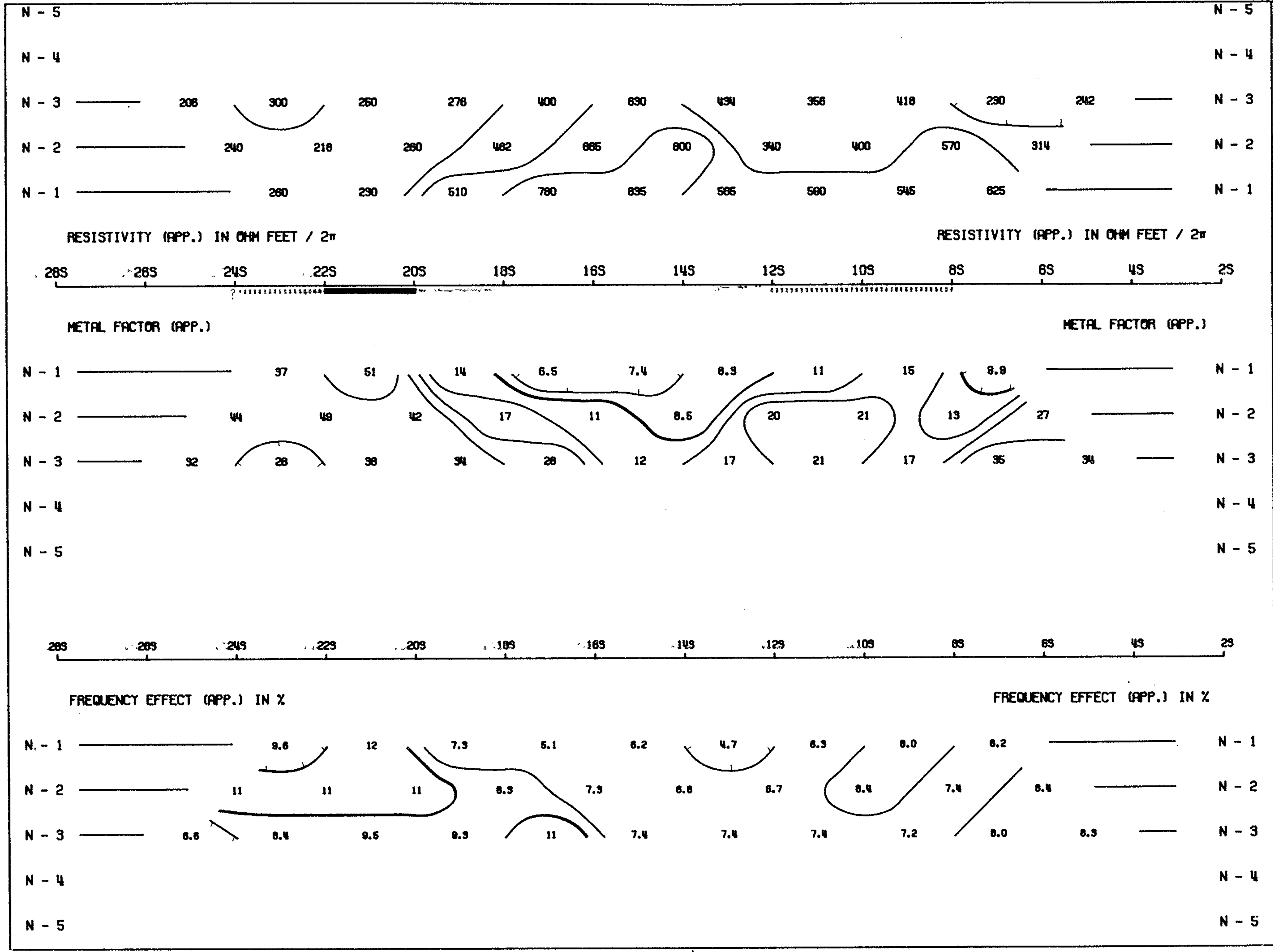
PROFESSIONAL ENGINEER BRITISH COLUMBIA

Expiry Date: February 25, 1971

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.-5591-13

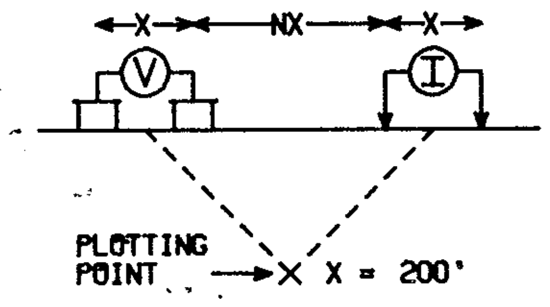
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 44E

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬

PROBABLE ||||||||||||

POSSIBLE /////

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

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

APPROVED: [signature]

DATE: 17/11/70

PROFESSIONAL ENGINEER — BRITISH COLUMBIA

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.-5591-14

CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 48E

ELECTRODE CONFIGURATION

X - NX - X

PLOTTING POINT X = 200'

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE

PROBABLE

POSSIBLE

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

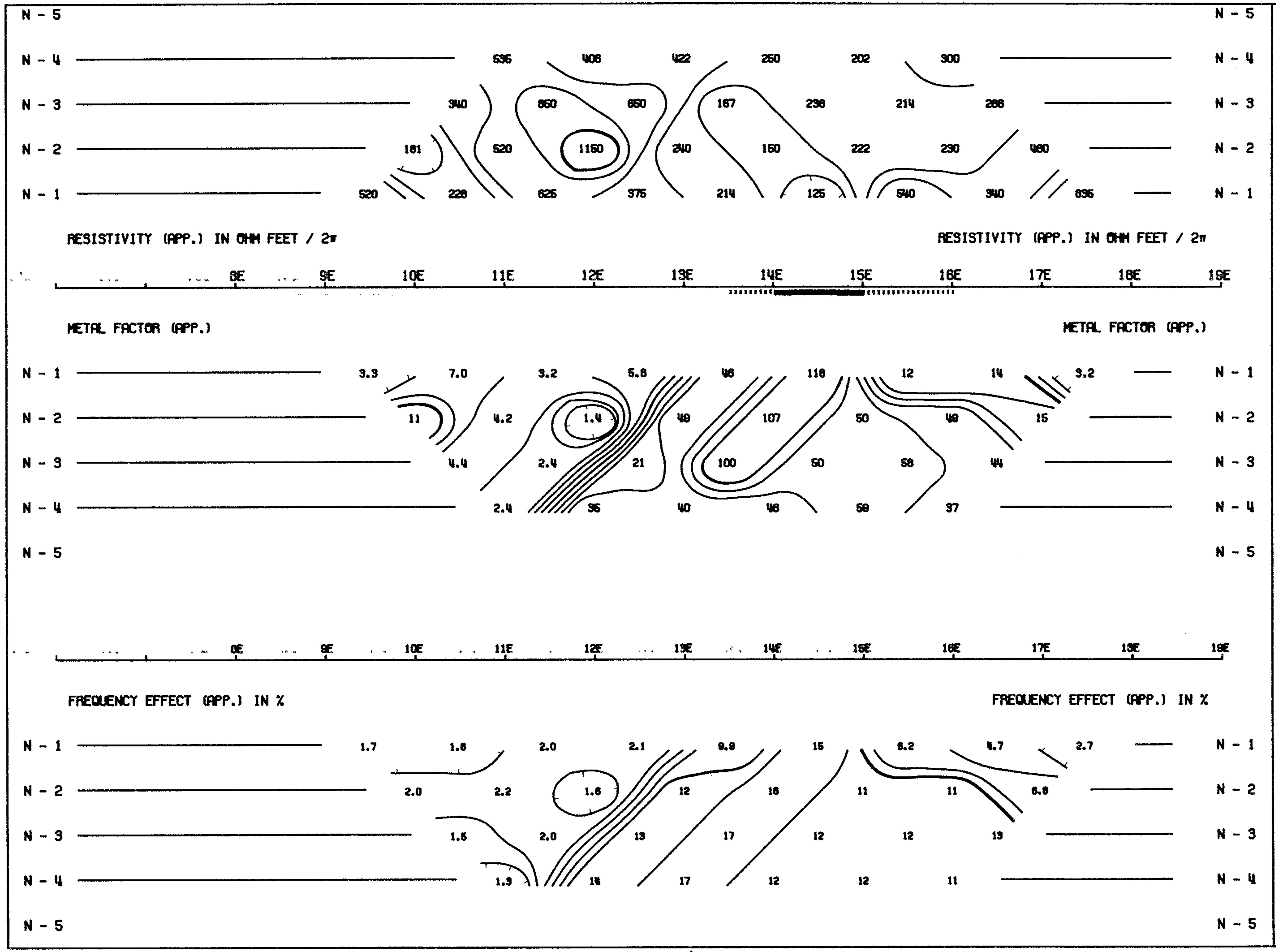
DATE: 17/11/70

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.-5591-15

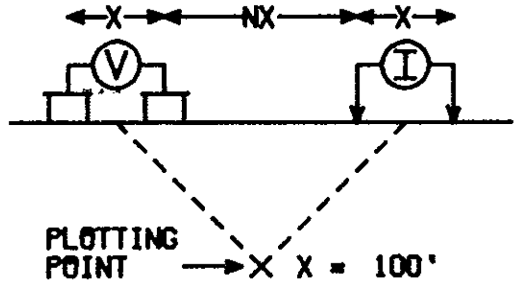
CORDILLERAN ENGINEERING LIMITED

LINDA PROJECT

FROG RIVER AREA, LIARD M.D., B.C.

LINE NO.- 30S

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE ▬▬▬

PROBABLE IIIIIIIIII

POSSIBLE / / / / /

FREQUENCIES: 0.31-5.0 CPS

DATE SURVEYED: SEPT '70

APPROVED:

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

DATE: 17/11/70

Date: February 25, 1971

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

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

DWG. IPP-4693

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP

NOTE:
TO ACCOMPANY GEOPHYSICAL REPORT
BY P. G. HALLOF (P. ENG.) AND R. A. BELL
GEOLOGIST FOR CORDILLERAN ENGI-
NEERING LIMITED ON FROG RIVER AREA
LAIRD M.D. B.C.

DATED: NOV. 17 1970

SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

Number at the end of anomaly
indicates spread used

CORDILLERAN ENGINEERING LTD.

LINDA PROJECT, FROG RIVER AREA,

LIARD M. D. B. C.

SCALE

ONE INCH EQUALS TWO HUNDRED FEET

M-1

DRAWN:
DATE:
APPROVED:
DATE:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
PHILIP G. HALLOF

Expiry Date: February 25, 1971

DWG. IPP- 4693