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 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.

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

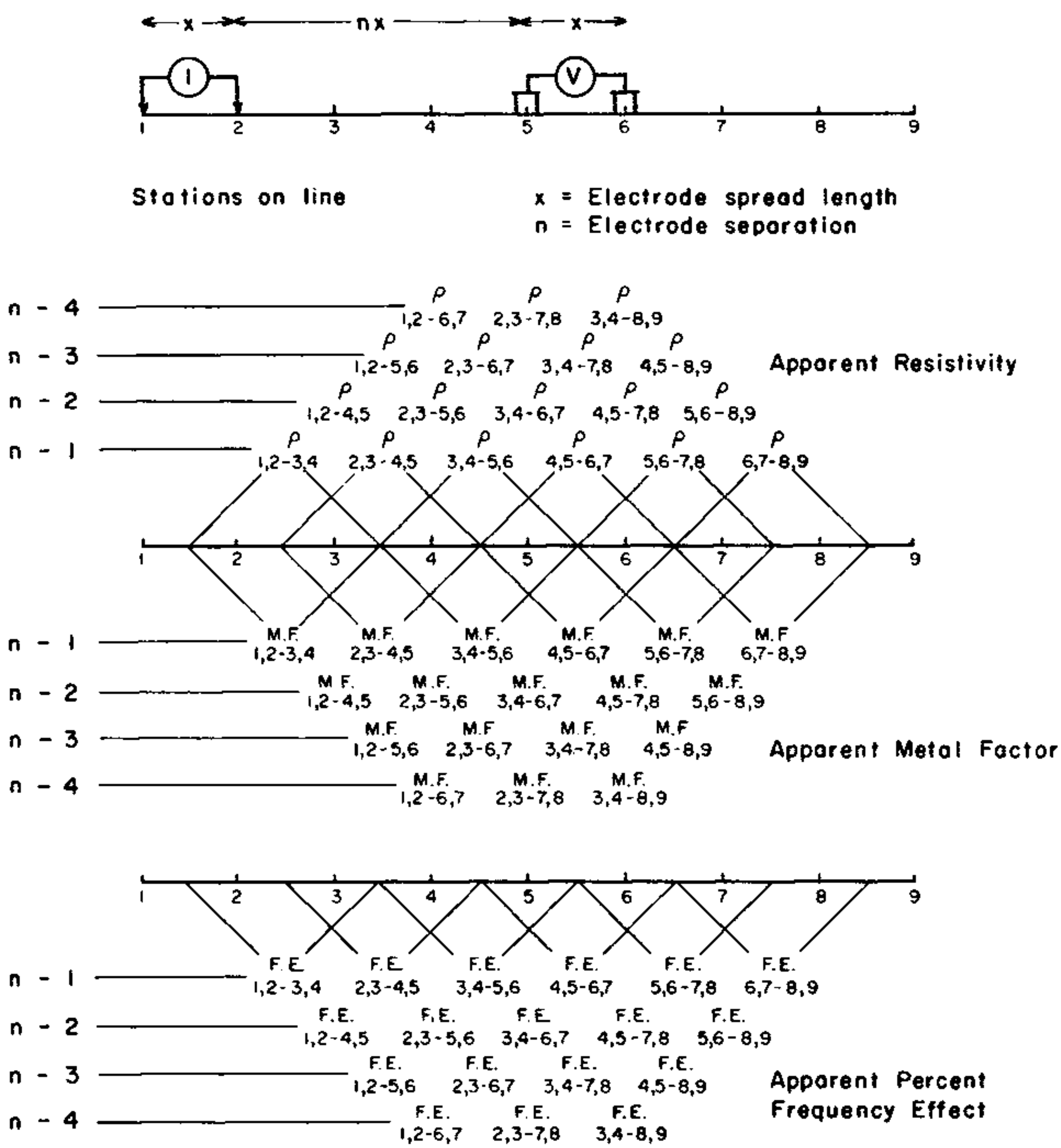


Fig. A

4887

92I/6E

92I/6E

REPORT ON THE
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
JAN CLAIMS
KAMLOOPS MINING DIVISION, B.C.
FOR
K & D ROSS

BY

ASHTON W. MULLAN, B.Sc.

AND

PHILIP G. HALLOF, Ph.D.

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4887 MAP

~~NAME AND LOCATION OF PROPERTY:~~

JAM CLAIMS, HIGHLAND VALLEY AREA, B.C.

KAMLOOPS MINING DIVISION, B.C. 50°29'N - 121°08'W

DATE STARTED: DECEMBER 26, 1973

DATE FINISHED: DECEMBER 30, 1973

TABLE OF CONTENTS

McPHAR GEOPHYSICS

REPORT ON THE INDUCED POLARIZATION AND RESISTIVITY SURVEY ON THE JAN CLAIMS, KAMLOOPS MINING DIVISION, B.C. FOR K & D ROSS

---

1. INTRODUCTION

An Induced Polarization and Resistivity survey was carried out on the Jan Claims in December, 1973. The property is located about nine miles west of the operating copper mine belonging to Bethlehem Copper Corp. Ltd., in the Highland Valley Area, Kamloops Mining Division, B.C. The centre of the property is located at 50°29' North latitude and 121°08' West longitude.

The Jan claims are underlain by basic intrusives of the Guichon Creek batholith. The vicinity of the IP survey grid is believed to be underlain by the Chataway and Guichon varieties of granodiorite.

Field work was carried out using a McPhar P-660 variable frequency IP system operating at frequencies of 0.3 and 5.0 Hz.

2. DESCRIPTION OF CLAIMS

The survey was carried out over the following claims:

Jan - 3 - 6 inclusive

Jan - 11 - 16 inclusive

3. PRESENTATION OF RESULTS

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

Line	Electrode Intervals	Dwg. No.
2800W	300 feet	IP 6130-1
2000W	300 feet	IP 6130-2
1200W	300 feet	IP 6130-3
400W	300 feet	IP 6130-4
400E	300 feet	IP 6130-5

Also enclosed with this report is Dwg. I.P.P. 3612, a plan map of the Jan Claims Grid at a scale of 1" = 400'. The definite, probable and possible Induced Polarization anomalies are indicated by bars, in the manner shown on the legend, on this plan map as well as on 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 electrode interval length; i.e. when using 300' electrode intervals the position of a narrow sulphide body can only be determined to lie between two stations 300' apart. In order to definitely locate, and fully evaluate, a narrow, shallow source it is necessary to use shorter electrode intervals. In order to locate sources at some depth, larger electrode intervals 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.

The Picket Line Grid and Claim information shown on Dwg.I.P.P. 3612 has been taken from maps made available by the Line Cutting Contractor and Mr. D. Ross.

4. DISCUSSION OF RESULTS

The area covered by the IP survey is characterised by relatively high resistivities, generally typical of the unaltered areas of the Guichon Creek batholith. Lower resistivities on Line 1200W and Line 400W for the n = 1 separation probably reflect deeper overburden cover.

The IP effects recorded for the survey were low and mostly not anomalous. A possible IP anomaly was located on Line 400W centred at 16+50N. It correlates with the north edge of a lower resistivity zone. A probable IP anomaly was located on Line 400E centred at about 17N.

It may extend to the south at depth. This anomaly would be representative of very weakly disseminated metallic material.

5. SUMMARY AND CONCLUSIONS

An IP and resistivity survey has been carried out over part of the Jan Claim Group. A very weak probable IP anomaly was located on the most easterly line, Line 400E. Since the common claim boundary between the Jan Claims and Valley Copper Mines Ltd., is located approximately half a mile to the east, it is recommended that the IP survey should be extended to cover this intervening area.

McPHAR GEOPHYSICS COMPANY

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A. W. MULLAN

Ashton W. Mullan,
Geologist

Philip G. [illegible]
Geophysicist

[illegible] February [illegible], 1974

Dated: January 16, 1974

ASSESSMENT DETAILS

PROPERTY: Jan Claims		MINING DIVISION: Kamloops	
SPONSOR: K. & D. Ross		PROVINCE: British Columbia	
LOCATION: Highland Valley Area			
TYPE OF SURVEY: Induced Polarization			
OPERATING MAN DAYS:	9	DATE STARTED: December 26, 1973	
EQUIVALENT 8 HR. MAN DAYS:	13.5	DATE FINISHED: December 30, 1973	
CONSULTING MAN DAYS:	1	NUMBER OF STATIONS: 70	
DRAUGHTING MAN DAYS:	5	NUMBER OF READINGS: 441	
TOTAL MAN DAYS:	19.5	MILES OF LINE SURVEYED: 3.69	

CONSULTANTS:

A.W. Mullan, 1440 Sandhurst Place, West Vancouver, B.C.
P.G. Hallof, 15 Barnwood Court, Don Mills, Ontario.

FIELD TECHNICIANS:

P. Makulowich, 669 Valdes Drive, Kamloops, B.C.
K. Hoeberg, 602 Windsor Street, Kamloops, B.C.
plus Extra Labour:
R. Bing, 1078 Lamal Drive, Kamloops, B.C.

DRAUGHTSMEN:

R. Koenig, 3125 Lawrence Ave. E. Apt. 702, Scarborough, Ontario.
B. Boden, 103 Petworth Crescent, Agincourt, Ontario.
V. Young, 64 Highcourt Crescent, Scarborough, Ontario.

McPHAR GEOPHYSICS COMPANY

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A.W. MULLAN

Ashton W. Mullan
Ashton W. Mullan,
Geologist

Dated: January 16, 1974

STATEMENT OF COST

K. & D. Ross - Jan Claims - IP Survey
Kamloops Mining Division, B.C. - Highland Valley Area

Consulting Geologist: A.W. Mullan

Crew: P. Makulowich - K. Hesberg

1 day Consulting	@ $200.00/day	200.00
3.69 line miles	@ $505.00/mile	1,863.45
Snowmobile Rental		150.00
		$2,213.45

Breakdown of above

1 day Consulting	@ $200.00/day	$ 200.00	
3 days Operating	@ $358.67/day	1,076.01	
2 days Travel & Preparation	@ $125.00/day	250.00	

Expenses

Truck rental	158.84	
Vehicle expense	25.60	
Snowmobile rental	150.00	
Meals & Accommodation	153.70	
Supplies	1.18	
	489.32	
+ 10%	48.93	
		538.25
Extra Labour	124.32	
+ 20%	24.86	
		149.18
		$2,213.44

McPHAR GEOPHYSICS COMPANY

Ashton W. Mullan
Ashton W. Mullan
Geologist

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — A. W. MULLAN

Dated: January 16, 1974

CERTIFICATE

I, Ashton W. Mullan, of the City of Vancouver, in the Province of British Columbia, hereby certify:

1. That I am a geologist and a fellow of the Geological Association of Canada with a business address at Suite 811, 837 West Hastings Street, Vancouver, B.C.

2. That I am registered as a member of the Association of Professional Engineers of the Provinces of Ontario and British Columbia.

3. That I hold a B.Sc. degree from McGill University.

4. That I have been practising my profession as a geologist for about twenty 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 K. & D. Ross 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 16th day of January, 1974

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A. W. MULLAN

A.W. Mullan, B.Sc., P.Eng.

CERTIFICATE

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

1. I am a geophysicist residing at 15 Barnwood Court, Don Mills, 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 K. & D. Ross or any affiliate.

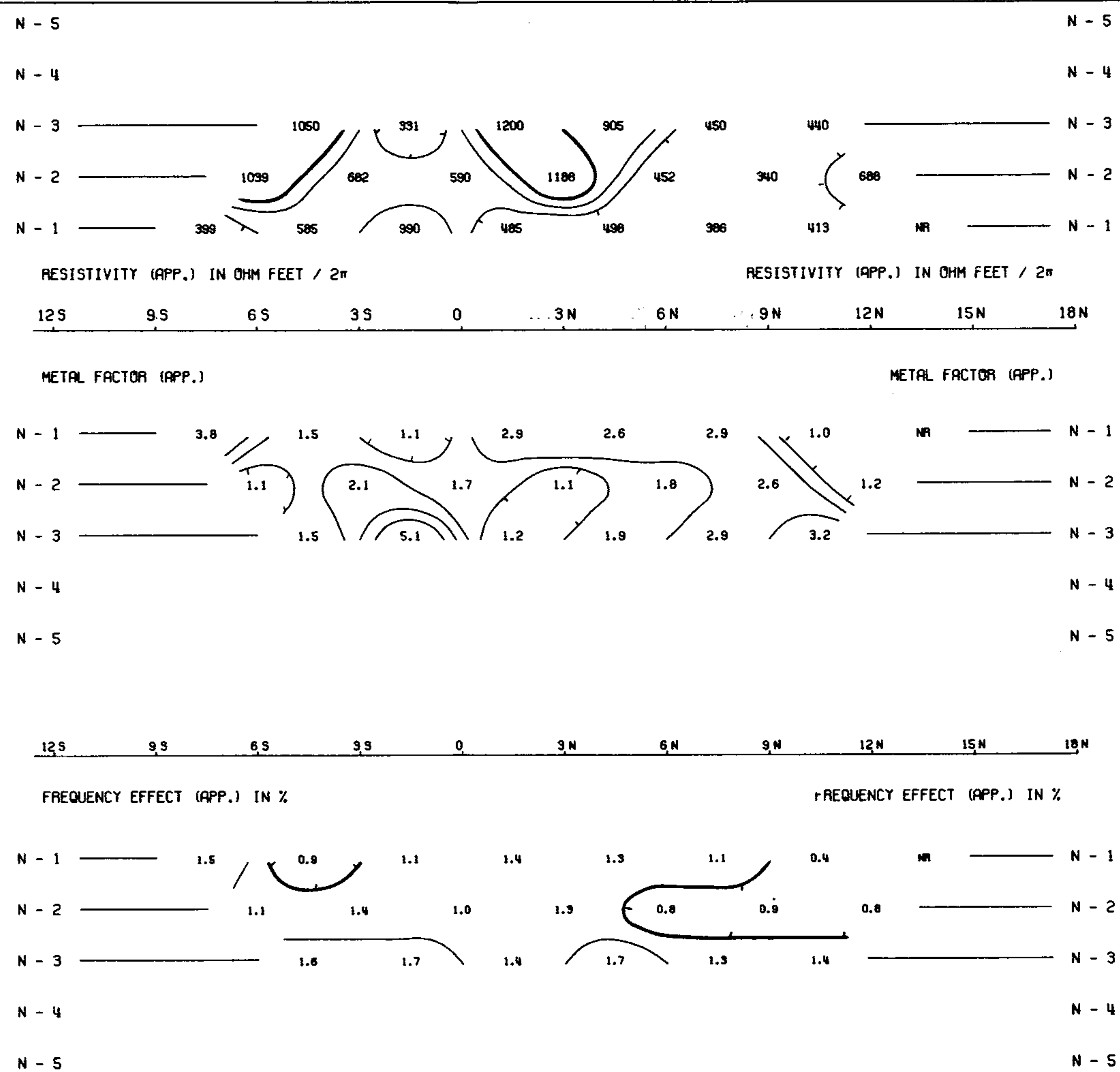
6. The statements made in this report are based on a study of published geological literature and unpublished private reports.

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 16th day of January, 1974.

Philip G. Hallof, Ph.D.



DWG. NO.- I.P.-6130-1

K. & D. ROSS,

JAN CLAIMS, KAMLOOPS M.D.,
BRITISH COLUMBIA.

LINE NO.- 2800W

ELECTRODE CONFIGURATION

←X→←NX→←X→

PLOTTING POINT → X X = 300FT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: DEC 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER PHILIP G. HALLOF BRITISH COLUMBIA

Expiry Date: February 25, 1974

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

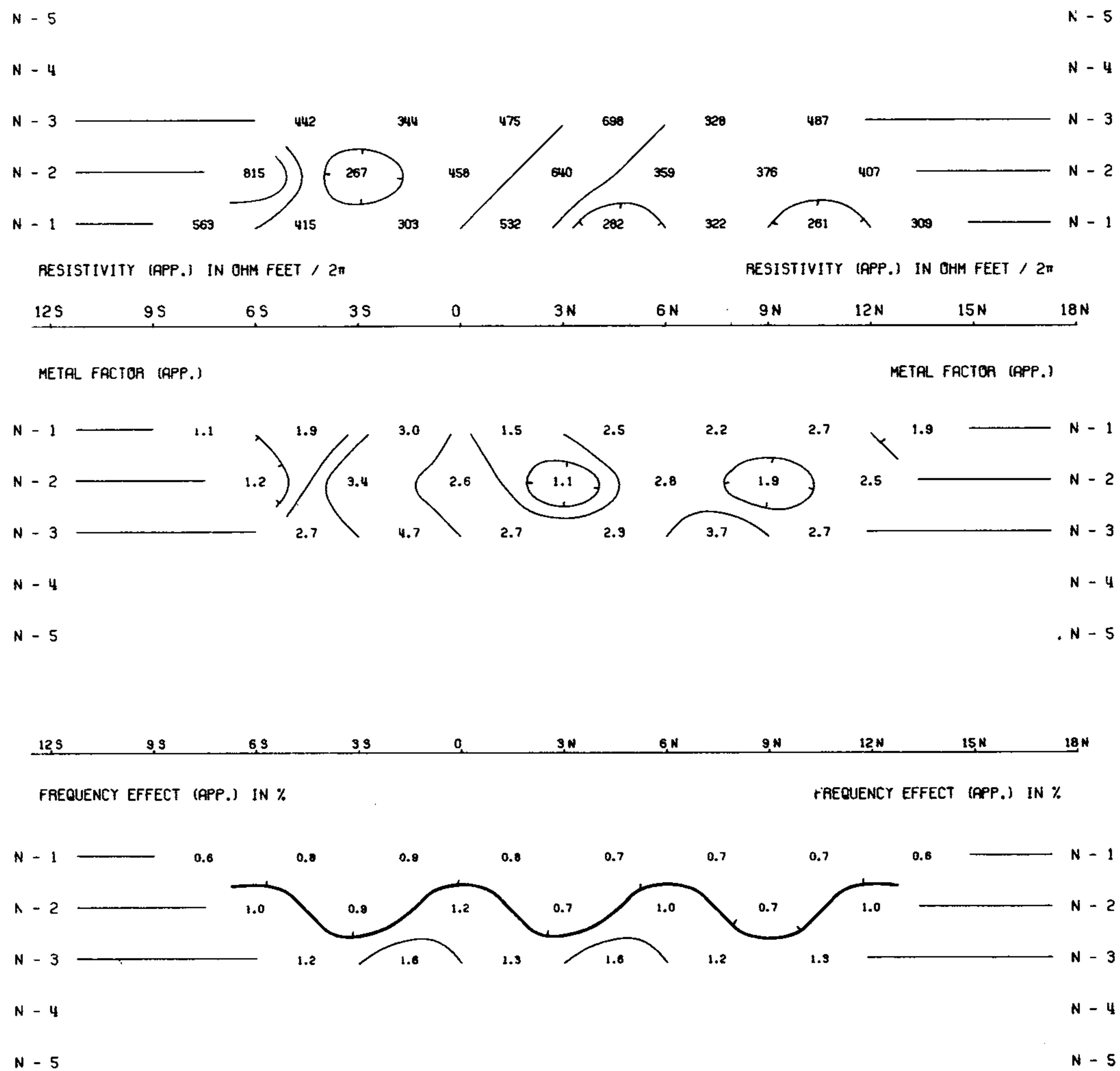
4887

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4887 MAP



DWG. NO.- I.P.- 6130-2

K. & D. ROSS,

JAN CLAIMS, KAMLOOPS M.D.,
BRITISH COLUMBIA.

LINE NO.- 2000W

ELECTRODE CONFIGURATION

X — NX — X

PLOTTING POINT → X X = 300FT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: DEC 1973

APPROVED:

DATE: 3/16/74

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

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — PHILIP G. HALLOF

Expiry Date: February 25, 1974

4887

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

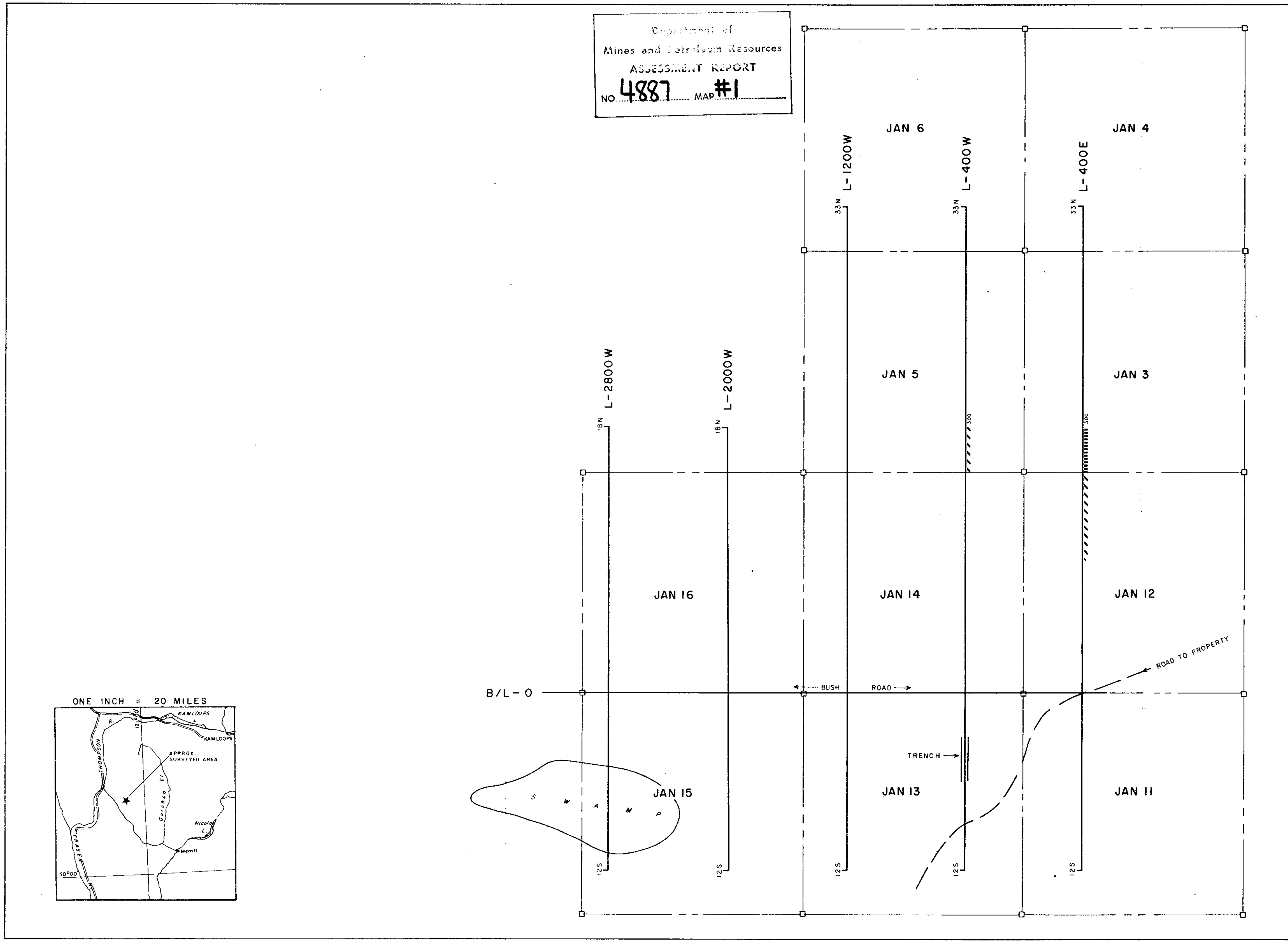
NOTE: THIS PLOT WAS PRODUCED BY McPHAR COMPUTER DIVISION

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4887 MAP

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP



NOTE TO ACCOMPANY GEOPHYSICAL REPORT FOR K.&D. ROSS ON THE JAN CLAIMS, HIGHLAND VALLEY AREA, KAMLOOPS M.D., B.C. BY A.W. MULLAN (GEOLOGIST) AND P.G. HALLOF (GEOPHYSICIST.)

DATED – JANUARY 16, 1974

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

Number at the end of anomaly indicates spread used.

K.& D. ROSS

JAN CLAIMS, HIGHLAND VALLEY AREA,

KAMLOOPS M.D., B.C.

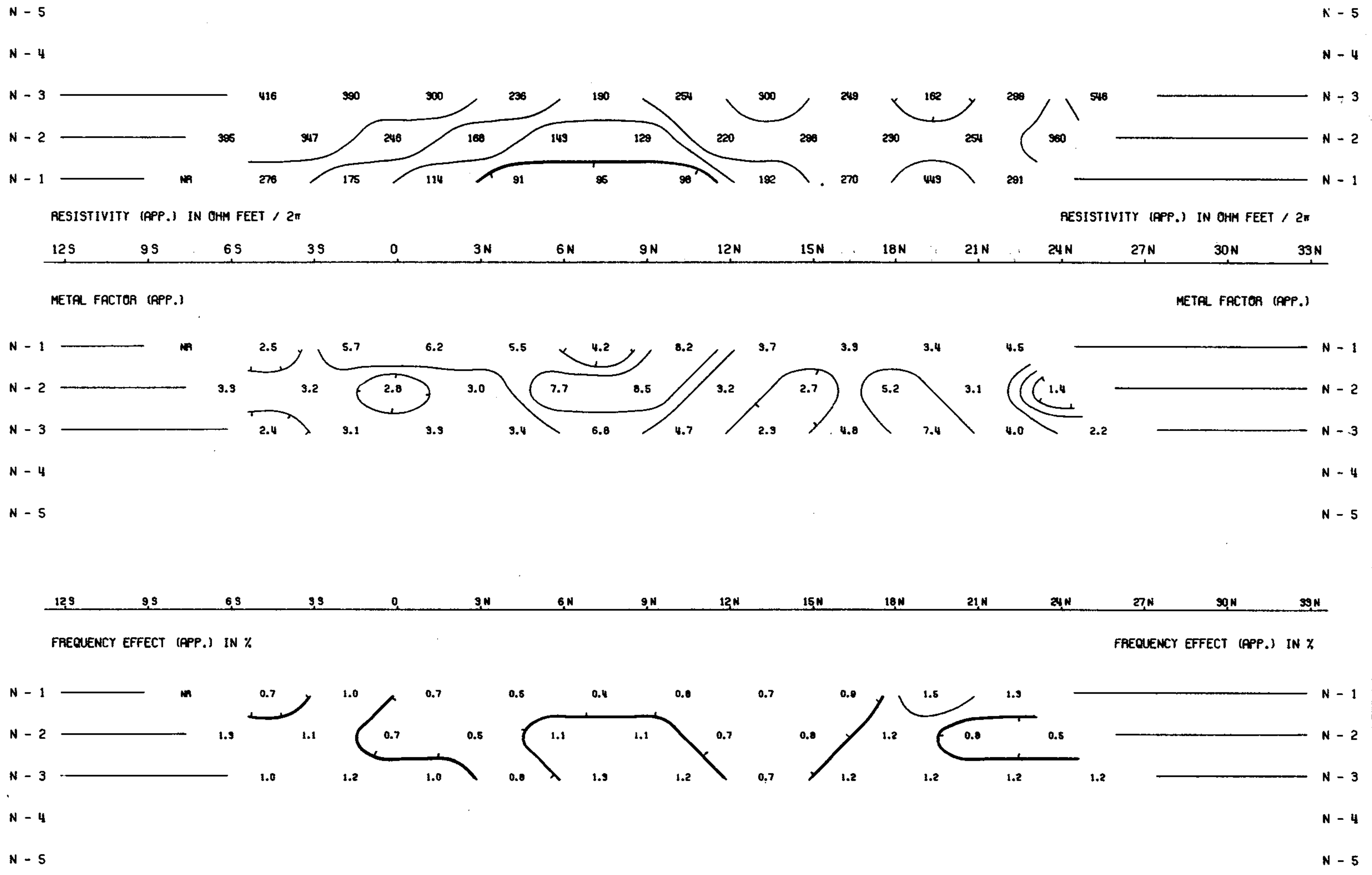
SCALE

One inch = 400 feet

4887 M1

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA PHILIP G. HALLOF APPROVED

Expiry Date: February 25, 1974



DWG. NO.- I.P.- 6130-3

K. & D. ROSS,

JAN CLAIMS, KAMLOOPS M.D.,
BRITISH COLUMBIA.

LINE NO.- 1200W

ELECTRODE CONFIGURATION

PLOTTING POINT → X X = 300FT

SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: DEC. 1973

APPROVED:

DATE:

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

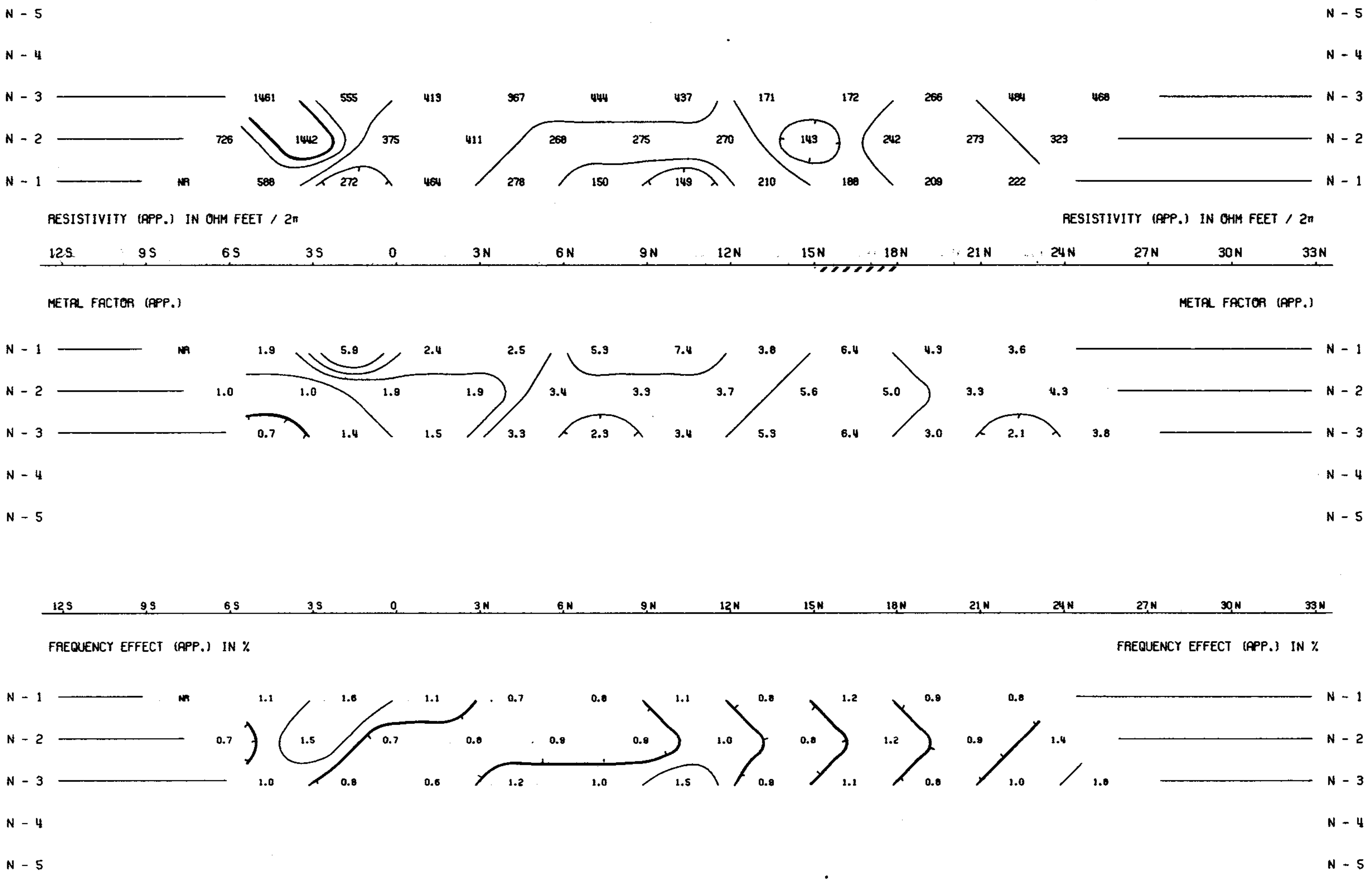
4887

Expiry Date: February 25, 1974

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY McPHAR COMPUTER DIVISION



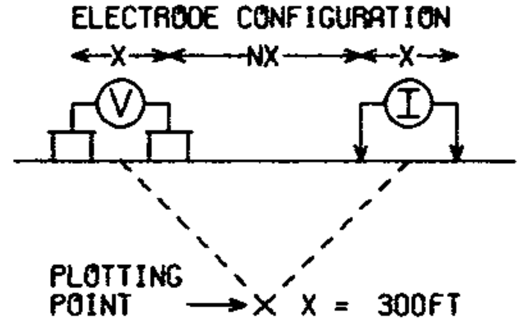
DWG. NO.- I.P.- 6130-4

K. & D. ROSS,

JAN CLAIMS, KAMLOOPS M.D.,
BRITISH COLUMBIA.

LINE NO.- 400W

ELECTRODE CONFIGURATION



SURFACE PROJECTION OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: SEPT 1973

APPROVED:

DATE:

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA

Expiry Date: February 25, 1974

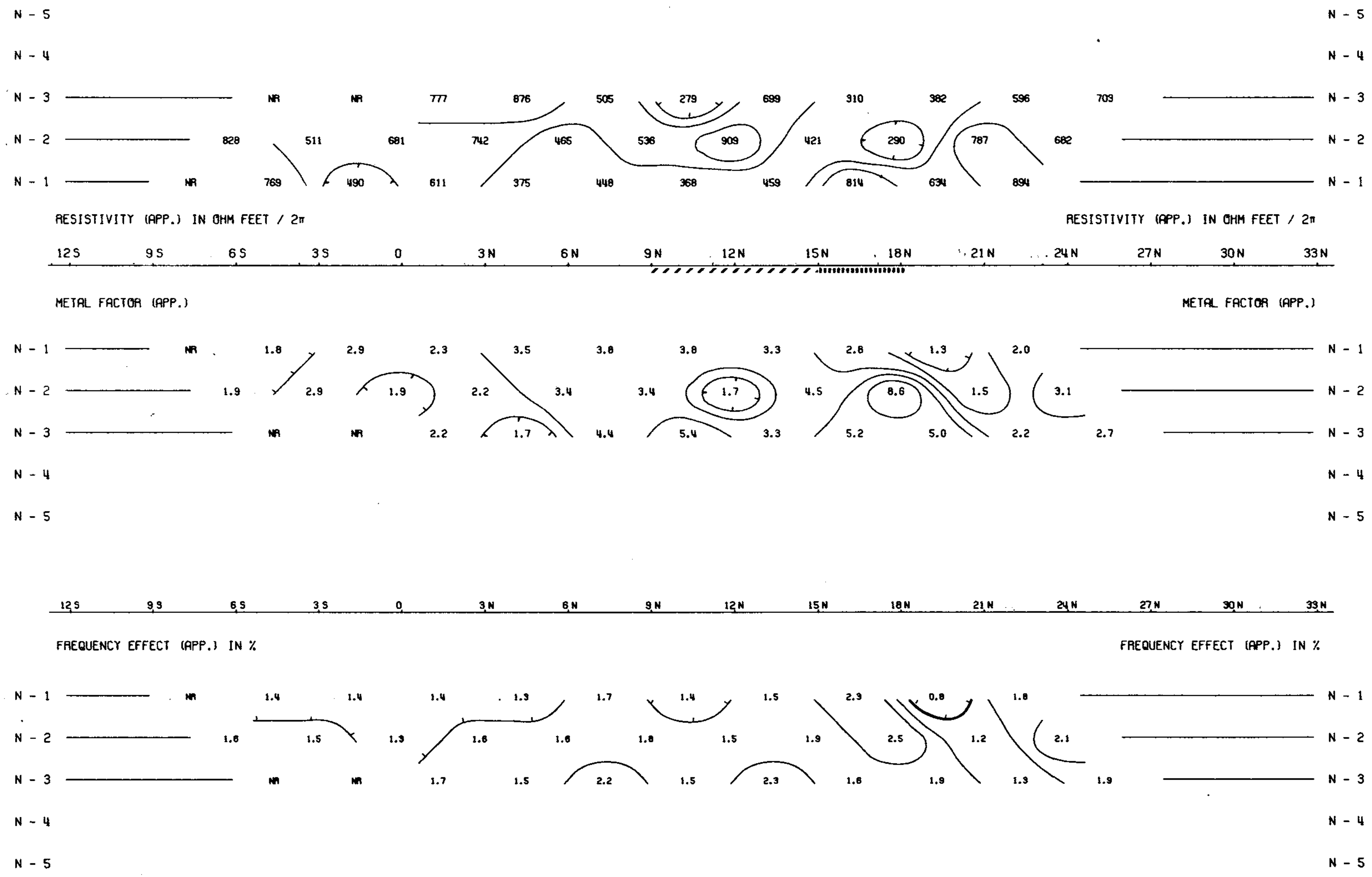
NOTE: CONTOURS AT LOGARITHMIC INTERVALS 1.-1.5-2.-3.-5.-7.5-10

4887

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY McPHAR COMPUTER DIVISION



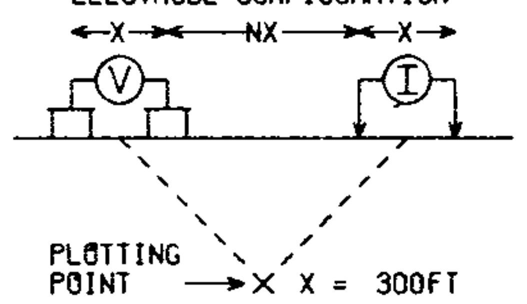
DWG. NO.- I.P.- 6130-5

K. & D. ROSS,

JAN CLAIMS, KAMLOOPS M.D.,
BRITISH COLUMBIA.

LINE NO.- 400E

ELECTRODE CONFIGURATION



SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

FREQUENCIES: 0.31-5.0 HZ

DATE SURVEYED: DEC. 1973

APPROVED:

DATE:

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

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — PHILIP G. HALLOF

Expiry Date: February 25, 1974

4887

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

NOTE: THIS PLOT WAS PRODUCED BY MCPHAR COMPUTER DIVISION