2774

PART 1

2 parts

92I/10W

REPORT ON
INDUCED POLARIZATION
AND RESISTIVITY SURVEY
ON THE
LARGO PROJECT (PROJECT 95)
HIGHLAND VALLEY AREA, B.C.
FOR
PHELPS DODGE CORPORATION
OF CANADA LIMITED

HIGH 1-100
NO DEPOSIT plotted

#1 Fig A.
#2 I.P & Resistivity Survey
#3 Duplicate of Map #2 - in other part

PHELPS DODGE CORPORATION OF CANADA, LIMITED
904-55 YONGE STREET
TORONTO 215, ONTARIO

NEW YORK OFFICE
300 PARK AVENUE
NEW YORK, N.Y. 10022

VANCOUVER OFFICE
1112 WEST PENDER STREET
VANCOUVER, BRITISH COLUMBIA

May 13th, 1970.

Certificate of Expenditure
for Assessment Purposes
for the period December 1st, 1969 to March 31st, 1970

on
Project No. 95
Arlington Silver Mines Ltd. (NPL)
Largo Mines Ltd. (NPL)

Under Joint Venture Agreement
dated November 15th, 1969

Diamond Drilling - Canadian Longyear Limited	$41,663.90
Ground Geophysics - I.P. Survey McPhar Geophysics Limited	2,933.63
	$44,597.53

AFFIDAVIT

I, George W. Stanley - Accountant
residing at Apt. 201 - 100 Coe Hill Dr.
Toronto, Ontario, do solemnly declare
the above to be true and correct.
DECLARED before me at Toronto, Ontario
in the County of York this 13th day of
May 1970.

A Notary Public in and for
the Province of Ontario.

Certified Correct

G. W. Stanley -
Accountant

DOMINION OF CANADA:
PROVINCE OF BRITISH COLUMBIA.
TO WIT:

In the Matter of

I, Robert C. Cunningham

of 11328 Glen Avon Drive, Surrey, B.C.

in the Province of British Columbia, do solemnly declare that

Monies expended on the "High" Claims numbered 1 to 100, Kamloops M.D., under Joint Venture Agreement with Arlington Silver Mines Limited (N.P.L.) and Largo Mines Limited (N.P.L.) by Phelps Dodge Corporation of Canada, Limited.

Diamond Drilling - Canadian Longyear Limited		$ 41,663.90
Ground Geophysics - I.P. Survey McPhar Geophysics Limited		2,933.63
	Total	$ 44,597.53

as per attached, notarized statement.

And I make this solemn declaration conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath and by virtue of the "Canada Evidence Act."

Declared before me at the City
of Vancouver, in the
Province of British Columbia, this 19th
day of June, A.D. 1970

R. C. Cunningham

[signature]

~~A Commissioner for taking Affidavits within British Columbia or~~
A Notary Public in and for the Province of British Columbia.

McPHAR GEOPHYSICS LIMITED

REPORT ON

INDUCED POLARIZATION

AND RESISTIVITY SURVEY

ON THE

LARGO PROJECT (PROJECT 95)

HIGHLAND VALLEY AREA, B.C.

FOR

PHELPS DODGE CORPORATION

OF CANADA LIMITED

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1. INTRODUCTION

At the request of Mr. John Ratcliffe, geophysicist for the Company, we have carried out a brief induced polarization survey in the Highland Valley Area. The property is referred to as Tunkwa Lake, Largo Option, Project 95, and is located in the Kamloops Mining Division. The purpose of the survey was to test anomalies, indicated by a previous time-domain IP survey, currently being drilled by the Company.

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.

Base Line	200 foot spreads	Dwg. IP 5387-1
Line 40N	200 foot spreads	Dwg. IP 5387-2

Enclosed with this report is Dwg. I.P.P. 3407, a plan map of the 2 lines 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

Base Line

The portion of the line from about station 30N to station 50N is characterized by moderate resistivities, high frequency effects and anomalous Metal Factor values. Included in this section is a deep anomaly between 36N and 46N; it is not certain whether this represents a single broad source, or two sources centred at 38N - 39N and 44N - 45N.

The north and south sections of the line exhibit much lower levels of resistivity and frequency effect that may represent changes in rock type. No strong or definite anomalies were found on the north section but there are probable sources on the south part at 26N to 28N and 32N to 34N.

Line 40N

Moderate to high frequency effects were measured throughout this traverse. The resistivity data is similar to that obtained on the Base Line, with a corresponding section of moderate level from about 1W to 25E and lower levels to the east and west. In addition there are narrow resistivity highs at 8W and 22W. These results should be compared with the available geological data to ascertain if the change in resistivity level can be correlated with changes in lithology.

Anomalous M.F. values were measured from about 10W to 38W, with stronger sections at 12W to 16W, 22W to 24W and 26W to 28W. It is our understanding that a vertical hole drilled at 28W to a depth of 370 feet encountered 40' of overburden, 40' of volcanics, then arkose and clay. Laboratory tests on a sample of this clay provided by the Company indicated low resistivity (8 - 14). low frequency effect (0.4 - 0.9%) and low to moderate M.F. (30-110). These IP effects are much lower than the apparent effects measured in the field which suggests that the clay is not the source of the IP anomaly. However, the field data indicate a source about one unit deep (i.e. 200') whereas the hole was drilled to a depth of two units without encountering any metallic mineralization.

A second vertical hole being drilled at 1E on Line 40N has reportedly intersected similar material. At this location the IP results indicate a deep source.

Normally, the shallow definite anomaly from 12W to 16W should be detailed with shorter electrode intervals (i.e. 100-foot dipoles); a drill hole would then be recommended. However, this should be postponed until more information has been obtained on the first two holes.

4. SUMMARY AND CONCLUSIONS

The two IP traverses indicate the presence of several anomalies of moderate to high magnitude, with respect to both apparent frequency effect and Metal Factor. Additional reconnaissance traverses would be required to determine the extent of the anomalous zones (i.e. N-S lines at 1000-foot spacings).

Two test holes have been drilled to depths of about 400 feet without encountering any metallic mineralization. The first hole, at 28W on Line 40N, is slightly off the centre of the anomaly and was drilled well beyond the expected depth of the source. Laboratory tests on a single core sample gave IP effects much smaller than those measured in the field. Either the drill hole has missed the source of the anomaly or the clay gives rise to much larger IP effects than we have encountered before, and much larger than the sample submitted for testing.

The second hole, at 1E on Line 40N, encountered similar material to the first, but at this location the source of the anomaly appears to be deep. If possible the hole should be continued to at least 400 feet and preferably to

600 feet. If no metallic mineralization is intersected, tests should be run on several samples from each hole before making a decision on further field investigation.

McPHAR GEOPHYSICS LIMITED

Robert A. Bell.

Robert A. Bell,
Geologist.

Dated: March 2, 1970

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

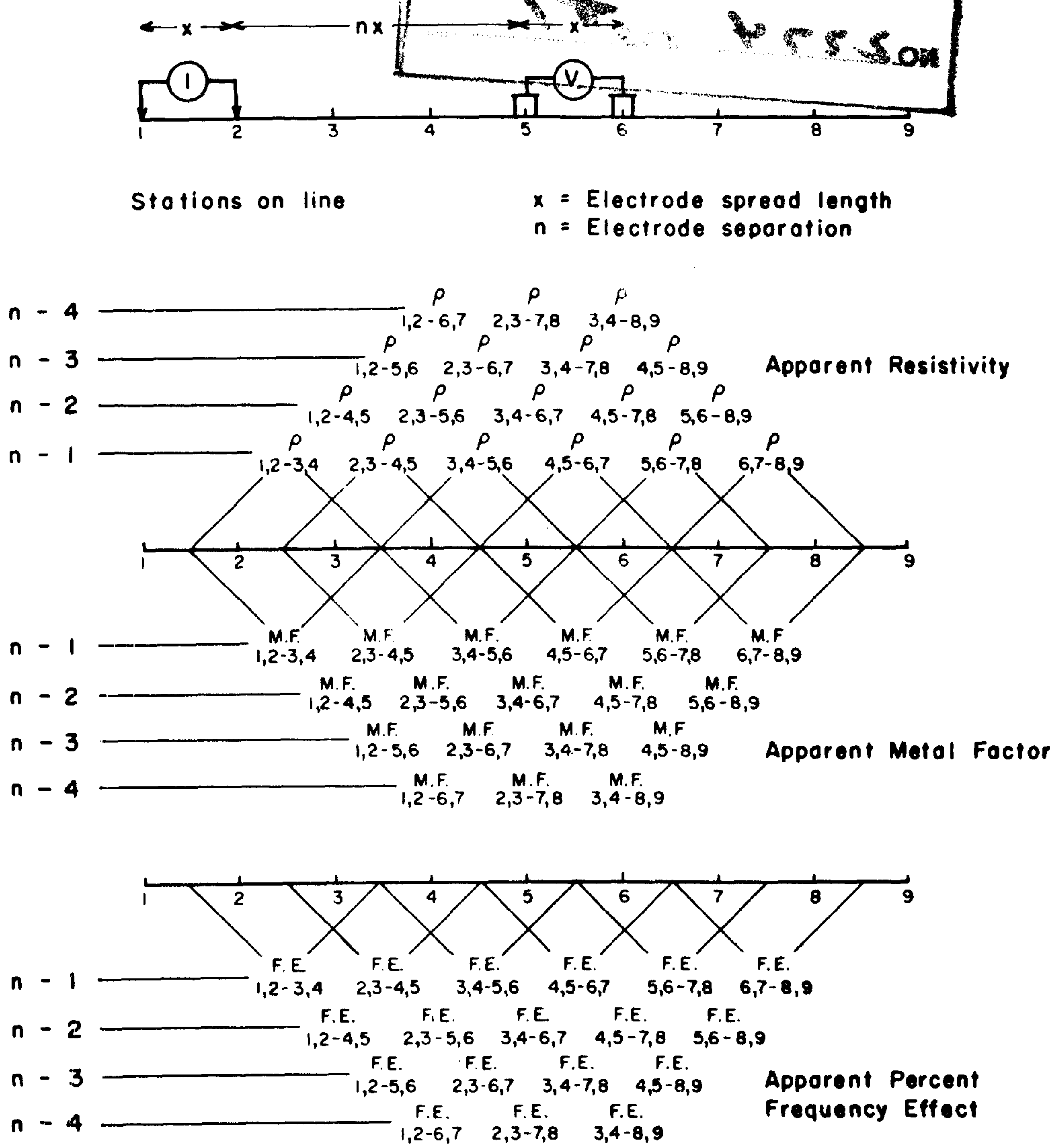

Fig. A

McPHAR GEOPHYSICS

INDUCED POLARIZATION AND RESISTIVITY SURVEY

PLAN MAP

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 2774 MAP #2

SURFACE PROJECTION
OF ANOMALOUS ZONES

DEFINITE
PROBABLE
POSSIBLE

Number at the end of anomaly indicates spread used.

PHELPS DODGE CORPORATION OF CANADA LIMITED

TUNKWA LAKE PROPERTY, LARGO OPTION, PROJECT 95, HIGHLAND VALLEY AREA, KAMLOOPS M.D., B.C.

SCALE

ONE INCH EQUALS FOUR HUNDRED FEET

2774

DRAWN: D N H
DATE: FEBRUARY 1970
APPROVED: R.A. Bell
DATE: Mar 2/70

DWG. I.P.P. 3407