4526

92H/8W

GEOPHYSICAL REPORT

of the

INDUCED POLARIZATION SURVEY

on the

TAS-TAT CLAIM GROUP

COPPER MOUNTAIN AREA, B. C.

on behalf of

PHELPS DODGE CORPORATION OF CANADA LIMITED

Lat. 49°17'N
Long. 120°28'W

SIMILKAMEEN MINING DIVISION

Claim Name	Record No.	Expiry Date
Tat 1 - 12	37077 - 37088	July 27, 1973
Tas 1 - 39	35862 - 37900	June 14, 1973

by

P. P. NIELSEN, B.Sc., GEOPHYSICIST

G. C. GUTRATH, B.Sc., P.ENG., GEOLOGIST

ATLED EXPLORATION MANAGEMENT LTD.
VANCOUVER B. C.

July, 1973

NTS 92H/7 and 8

TABLE OF CONTENTS

INTRODUCTION

Commencing October 24, 1972, an Induced Polarization survey was conducted on the Tas Tat claim group in the Copper Mountain, Princeton, B. C. area on behalf of Phelps Dodge Corporation of Canada Limited.

The survey was executed under the field supervision of P. P. Nielsen, geophysicist on a grid established by Phelps Dodge to investigate possible porphyry type copper deposits known to occur in the area adjacent to the Copper Mountain stock. Previous work on the grid consisted of a geochemical soil survey and a ground magnetometer survey.

A total of 3.48 line-miles of Induced Polarization survey was carried out in the late Fall of 1972 using the pole-dipole array with three electrode spacings. The survey was tentatively postponed until the following Spring due to extreme magneto-telluric interference and because of a poor production rate due to an excessive wet snow and windfall condition.

The survey has not been continued to date.

LOCATION AND ACCESS

The property is located at the headwaters of Wolfe Creek about 4 miles southeast of the old Copper Mountain Mine.

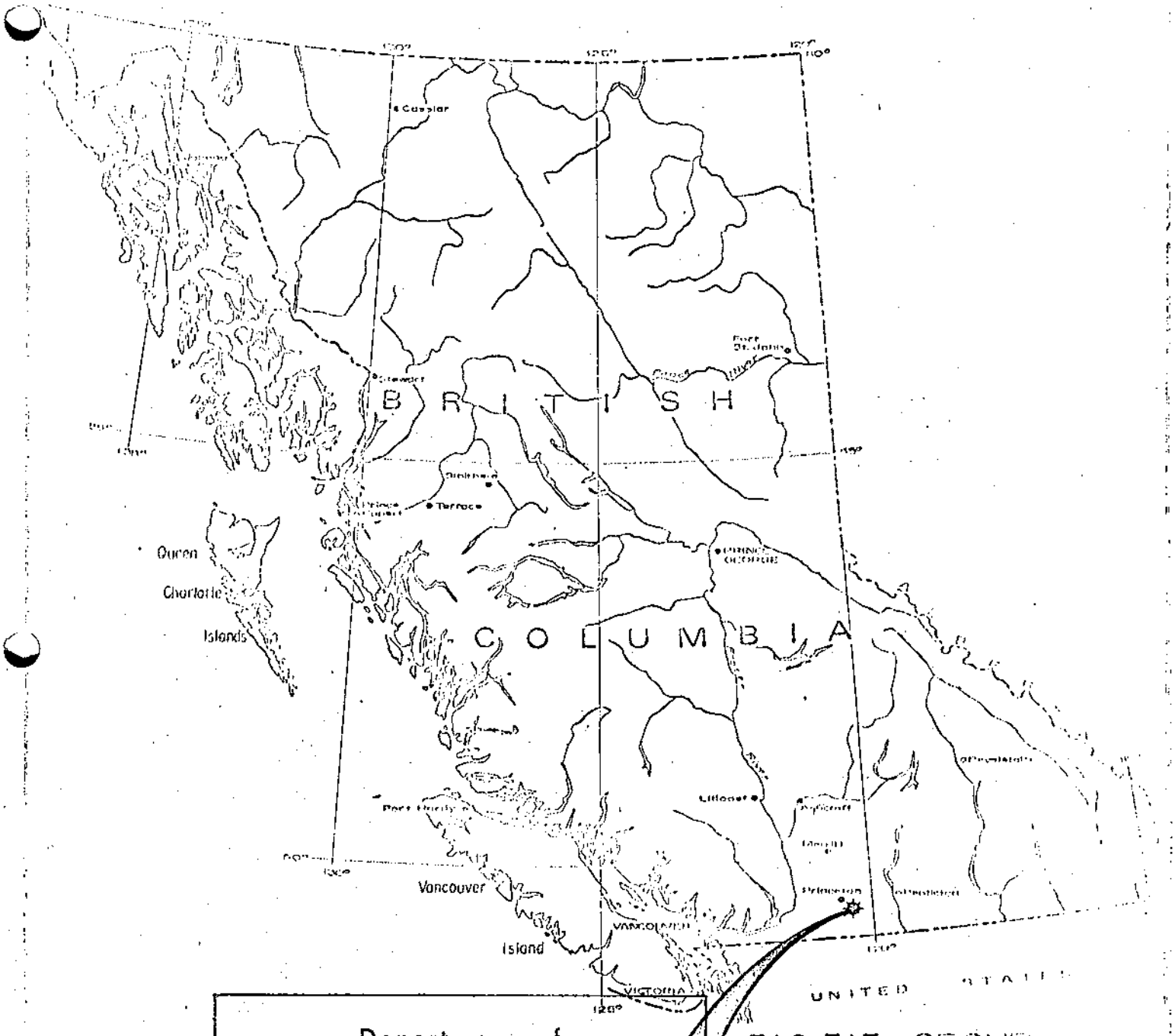
Access to the claims is by way of the Copper Mountain road which leaves Highway N°. 3 approximately 1/4 mile east of the village of Princeton. This paved (gravel in sections) road runs south for ten miles to Lost Horse Gulch. A narrow gravelled road then follows Wolfe Creek and crosses the claims 5 miles to the south-southeast.

Most of the grid is accessible by foot only due to the dense tree cover.

CLAIMS

The following 51 claims were staked by Phelps Dodge in the summer of 1972.

CLAIM NAME	RECORD NUMBER	EXPIRY DATE
Tat #1 - #12 incl.	37077-37088 incl.	July 27, 1973
Tas #1 - #39 incl.	35862-37900 incl.	June 14, 1973



Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4526 MAP #1

TAS-TAT GROUP

PHELPS DODGE CORP. of CANADA LTD.
LOCATION MAP

PRINCETON GROUP

OTTER INTRUSIONS

COPPER MTN. INTRUSIONS

COAST INTRUSIONS

NICOLA GROUP

PHELPS DODGE CORPORATION OF CANADA LTD.

TAS-TAT CLAIM GROUP

REGIONAL GEOLOGY & LOCATION MAP

Scale - 1" = 2 miles (approx)

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 4526 MAP #2

GEOLOGY

(after J. H. Montgomery (1961-63) and H. M. A. Rice (1939, 1941 and 1944)

The property is thought to be underlain by Upper Triassic Nicola volcanics and possibly intercalated sediments, but primarily augite andesites near the Copper Mountain Intrusives. There is a strong likelihood that the claims area has been intruded by small Cretaceous plutons and transected by an important northwest striking fault passing through the Ingerbelle, Copper Mountain and Ashnola properties.

Outcrop exposures on the grid total less than four percent by area although overburden thicknesses are variable but less than 100 feet.

Mineralization nearby consists of pyrite, minor chalcopyrite, magnetite and hematite primarily related to Nicola augite andesites. Pyrite has also been observed in intercalated argillites to the west of the property. (See regional geology map previous page.)

TOPOGRAPHY AND GROUND CONDITIONS

The grid area varies in elevation from 4,700 feet at the north end to about 5,500 feet at the southeast corner.

Terrain is considered rolling with slopes up to 15°. The headwaters of Wolfe Creek are at the south end of the grid, and drainage is to the north and east.

The grid is covered by fir and pine. Underbrush is almost non-existant although large windfalls of pine impeded progress over all portions of the survey area.

No serious electrical contact problems were encountered due the the excess snow melt at the time of the survey. The area does get extremely dry in the late Summer, however.

There was no indication of the presence of conductive overburden, and the bedrock was sampled to depths in excess of 500 feet with the wide electrode separation.

Magneto-telluric interference from solar magnetic storms was severe during a large portion of the survey and combined with the hazardous snow-covered windfalls led to the cancellation of the survey.

GRID INSTALLATION

The I. P. survey was conducted over east-west directed lines installed earlier by Phelps Dodge Corporation of Canada Limited in order to carry out the geochemical soil survey and magnetometer survey.

The lines were installed using a chain and compass. Marked flags were attached to trees and pickets at a station interval of 100 feet. The I. P. survey was executed on lines spaced 800 feet apart.

THE INDUCED POLARIZATION SURVEY

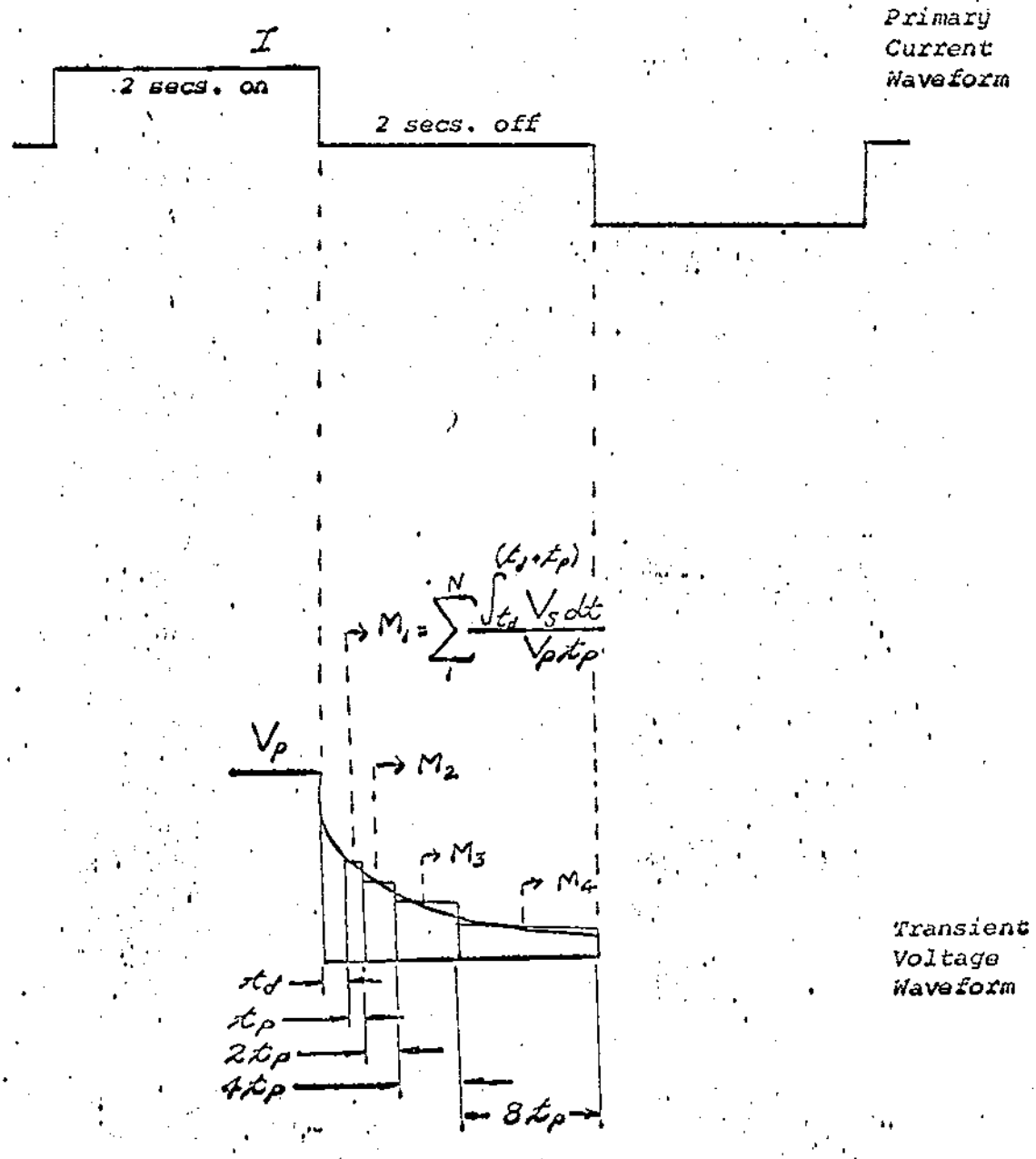
(a) Theory of Method Used

Induced Polarization refers to the polarized distribution of electrical charges throughout a medium to which an electric field has been applied.

When current is passed across an interface between an electrolyte and a metallic conducting body, double layers of charge build up at the interface creating the phenomenum known as "overvoltage" or the "I.P. effect".

This effect can be used for the detection of conducting metallic material such as disseminated sulphides ("porphyry" copper deposits) or massive sulphides containing appreciable amounts of non-conducting sphalerite. Other materials likely to give rise to anomalous responses are pyrite, magnetite, specular hematite, graphite and certain clay-micas such as montmorillonite, vermiculite, saponite and bentonite.

In time-domain (Pulse) I.P., a transmitter injects an alternating square wave signal into the ground at two electrodes C_1 and C_2. The signal seen by the receiver at two other electrodes P_1 and P_2 provides an indication of the apparent chargeability (M_a). By observing the input current (I) and primary "on-time" voltage, (V_p) the apparent resistivity ρ_a is calculated using Ohm's Law and a geometric factor dependent upon the electrode array used and the units (ohm-meters or ohm-feet) desired.



The polarization voltages established during the current "on" time decay (discharge) slowly during the current "off" time. The receiver amplifies and integrates the decay curve at four pre-selected positions in time, normalizes these amplitudes with respect to the primary voltage Vp and presents the results as M_1, M_2, M_3, and M_4 readings on digital display for logging.

The times at which the decay curve is sampled, are selected by means of a switch making it possible to obtain up to 56 distinct points on the decay curve.

This allows one to obtain the actual decay curve shape and to better estimate the size, depth and type of the causative source.

A further step which can be taken is to factor the decay curve to separate the unwanted electromagnetic transient coupling effects and background effects from the true overvoltage effects. This extends the usefulness of the I. P. method in areas of high overburden conductivity. It also assists the geophysicist in distinguishing between effects of metallic and nonmetallic conductive material, between oxides and sulphides, between large and fine-grained particules, and between massive and disseminated portions of a polarizable body.

(b) Theory of the Pole-Dipole Electrode Configuration

The I. P. response due to a particular distribution of polarizable material is dependent upon the electrode array employed, the geometry of the polarized body and its location relative to the array, and on the resistivity and polarization contrast between the body and surrounding environment.

Although anomalies are asymmetrical and the anomaly peaks do not always fall directly over the centre of the causative source, the advantages of the pole-dipole array more than outweigh this one disadvantage. This array requires only three men on the survey line, has good depth pnetration, responds well to both flat-lying and steeply-dipping bodies and maintains good resolution.

The maximum anomaly is obtained for the spacing equal to the depth to the centre of an idealized sphere, although spacings of 3/4 to 1-1/2 times the depth give at least 90% of the maximum likely anomaly.

The use of two or more spacings (na) gives a more reliable estimate of depth, attitude and continuity with depth. An accurate estimate of resistivity and polarization of the body cannot be made since the variables of size, conductivity, and polarizability cannot be separated, hence the term "apparent" chargeability is used.

(c) Field Procedure

(i) Electrode Configuration Used

A pole-dipole electrode array was used whereby the current electrode C_1 and the two potential electrodes P_1 and P_2 were moved in a "leap-frog" manner along the survey lines varying the distance between C_1 and the nearest potential electode, P_1, by factors of 1, 2, and 3 (called "n" values) while maintaining the potential electrode separation "a" of 200 feet. Hence, readings were taken with $C_1 - P_1$ separations of 200, 400 and 600 feet. The second current electrode C_2 is fixed at "infinity" (∞) which is a minimum distance of 5a to the nearest station measured.

The station location is halfway between the current electrode C_1 and the nearest potential electrode P_1. All lines were surveyed with C_1 to the west of the potential electrodes as the three men moved along the survey lines.

(ii) Measurements taken in the Field

1. The Primary voltage Vp between the measuring (potential) electrodes during "current on".
2. The current flowing through the current electrodes C_1 and C_2.
3. Four pre-selected gates called M factors (M_1, M_2, M_3 and M_4) using timing settings of:
   (a) delay time t_d = 240 msecs.
   (b) basic integration time t_p = 60 msecs.
   (c) total integration time t_t = 900 msecs.
   (d) basic period t_c = 8 secs. (2 secs. on and 2 secs. off).

(d) Equipment Description and Specifications

(i) Receiver

The Huntec MKIII Receiver is a portable, remote sensing pulse-type instrument incorporating the following features:

- Adjustable timing cycle.
- Up to 56 distinct sample points measured on the decay curve.
- Automatic S.P. buck-out.
- Direct digital read out of Vp and M factors including sign.
- High noise rejection allows operation in Vp levels down to 30 micro volts with 0.1 micro volt resolution.
- Greater than 10 megohm input impedance.

Specifications

- Sensitivity: $Vp = 10^{-7}$ to 10^{-6} volts for low noise 1% resolution.

  $Vp = 10^{-6}$ to 10 volts for 0.1% resolution.

  Total Range 30×10^{-6} volts to 10 volts in 11 ranges.

- Self Potential: MAXIMUM $\pm$ 1 volt.
- Power consumption: 0.7 ampere at 12 volts.
- Dimensions: 16" x 9" x 5 3/4".
- Weight: 12.5 lbs. (without battery pack).

(ii) Transmitter - Alternator

The Huntec Pulse type transmitter alternator is a high-powered, 7.5 Kilowatt system utilizing the following:

- Solid state power control and switching mechanism.
- Produces high currents into low resistance loads.
- Accurate and adjustable timing using Crystal Clock.
- Voltage regulator with push-button field energizer.
- Dummy Load.
- 2 cylinder ONAN engine driving a Bendix alternator.

Specifications

1. *Transmitter*

   - *Output: 100 to 3,250 volts in 10 steps*
     16 amps maximum.
   - *Cycling Rates: Normally 2 sec. ON, 2 sec. OFF.*
   - *Dimensions: 21 in. x 17 in. x 17 in.*
   - *Weight: 75 lbs.*

2. *Alternator*

   - *Output: 18 K.V.A. 120/208 volts 3 phase 400 Hz.*
     52 amps/phase.
   - *Engine: 2 cylinder, 4 cycle, air-cooled 16.5 H.P.*
     ONAN at 3,600 R.P.M.
   - *Alternator: 3,600 R.P.M. direct driven Bendix with sealed bearings and rotating field.*
   - *Dimensions: 42 in. x 17 in. x 26 in.*
   - *Weight: 225 lbs.*

(e) *Data Presentation*

1. *Calculations*

(i) The apparent resistivity ρ_a *is calculated by dividing Vp by I and multiplying by a factor appropriate to the electrode array used and the ohm-meter units desired.*

(ii) The four M factors were weighted and added to obtain a single apparent chargeability parameter (called M_a *) for contouring purposes.*

$$M_a \begin{matrix} t_f \\ t_d \end{matrix} = t_p \, (M_1 + 2M_2 + 4M_3 + 8M_4) \times .01$$

where M_a = *milliseconds*

t_d = *initial delay time*

t_f = *final time at end of* $M_4 = t_d + 15\ t_p$

t_p = *integrating time of* M_1

2. Profiles ("pseudo-sections")

The Ma and ρ_a readings are plotted in "pseudo-section" for n = 1, 2, and 3 and are contoured at appropriate intervals.

The lateral positions of the values are determined by the location along the survey line of the centre point between the current electrode (C_1) and the nearest potential electrode electrode (P_1). The vertical distance of the values from the line is determined by the distance na between C_1 and P_1 and is related to the depth of penetration for that electrode separation at the station measured.

Chargeabilities are shown below the survey line and the resistivities are shown as mirror images above the line.

DISCUSSION OF RESULTS AND INTERPRETATION

General Remarks

The electrode configuration was chosen to provide a depth investigation in excess of 500 feet for large "porphyry" type deposits while maintaining sufficient resolution for detection of residual effects such as vein-type mineralization, overburden thickness estimations, and structural information.

The data is only shown in pseudo-section as an insufficient number of contiguous lines were surveyed to warrant the contouring in plan of the results.

Pseudo-Section Line 32N

Line 32N was surveyed from Station 41W to Station 85W at n = 1, 2, and 3 with a basic potential distance "a" of 200 feet.

Apparent chargeability (Ma) values varied from 2.3 milliseconds at Station 47W (n=1) to a high of 29.9 milliseconds at Station 79W (n=3). Background of the n=2 coverage is estimated to be 5 milliseconds, and areas above three times background, i.e. 15 milliseconds, are considered anomalous and are shown hacheured on the pseudo-section.

A sub-anomalous dike-like feature (10 milliseconds contour) is observed at Station 52W dipping steeply westerly at the wider electrode spacings. This feature is interpreted as a fault parallel to and dipping towards Wolfe Creek. A "Y" shaped Ma response on the west end of the line likely is caused by a sulphide zone truncated

sharply on the west, but appears to fall off more gradually to the east.

The possibility exists that the higher Ma values are due to higher concentrations of sulphides (likely pyrite), and that the area between Station 68W and Station 76W might be the most favourable target for copper-bearing sulphides such as chalcopyrite.

The area exhibiting the highest Ma response is interpreted as being caused by a conductive body containing approximately two percent by volume equivalent conducting sulphides.

The apparent resistivity ρ_a portion of the survey is shown as a mirror-image of the Ma results and indicates generally a high ρ_a correlation with high Ma readings.

Normally, sulphide deposits exhibit low ρ_a and high Ma correlation due to increased concentrations of conducting metallic material. The higher ρ_a observed here could be due to increased fracturing and/or brecciation within the mineralized zone within a low ground water environment.

The small Ma low of 15.1 msecs. at Station 79W could be due to leaching of surface material, increased overburden thickness or irregularity of the conductive zone. No double-peaking is suspected here.

Pseudo-Section L40N

Only the western-most 1,000 feet have been surveyed for n=1, 2 and 3. The whole line from Station 43W to Station 83W has been covered using the n=3 electrode separation.

The Ma anomalous zone on L 32N which is 800 feet to the south continues across L 40N.

The Ma's vary from 2.8 msecs. at Station 43W (n=3) to a high of 36.1 msecs. at Station 79W (n=1). The anomaly is still cut off sharply on the west by either an easterly dipping fault or contact. Although data is incomplete, there appears to be a broadening of the zone at depth on the east flank of the zone.

Again there is a general high Ma-high ρ_a *correlation in the anomalous zone.*

The 9.9 msec. chargeability reading at Station 59W (n=3) is probably a continuation of the sub-anomalous feature observed on L 32N at Station 52W discussed above as being caused by a fault.

I.P.--Magnetic Correlation

The fault interpreted from the Ma results along the north-east side of Wolfe Creek is not confirmed by the ground magnetometer survey data.

The peak Ma's on the western ends of the I.P. lines do correlate very well with the-500 gamma contour which strikes north-south. The interpreted easterly dipping fault or contact west of the Ma anomaly is not expressed clearly magnetically.

CONCLUSIONS AND RECOMMENDATIONS

The very limited I.P. coverage to date makes interpretation and the drawing of any conclusions quite difficult.

The I.P. results have indicated a conductive zone varying in width from 1,000 feet near the surface to over 1,500 feet at depth striking north-south along the western edge of the grid in the area covered.

The area of peak chargeabilities are thought to be pyrite rich (up to 2.5% by volume) with the eastern flank being the most favourable for the deposition of copper-bearing sulphides.

Sulphides appear to come within 100 feet or less of the surface in the Station 78W to 80W area.

Further I.P. coverage is recommended to the north and south of the lines surveyed west of and perhaps slightly east of the baseline which is at Station 70W and locally in other areas over interesting geochemical and magnetic results. Initially, the I.P. coverage should be carried out on every second line for an inter-line spacing of 800 feet.

Respectfully submitted,

P. P. Nielsen, B.Sc. Geophysicist

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA

G. C. Gutrath, P.Eng. Geologist
ATLED EXPLORATION MANAGEMENT LTD.

STATEMENT OF AUTHOR'S QUALIFICATIONS

I DO HEREBY STATE THAT:

1. I am the author of this report.

2. I have been actively and responsibly involved in mining exploration using airborne, ground and computer applied geophysics in Western Canada and the United States for the past nine years.

3. I graduated with a B.Sc., degree in Geophysics from the University of British Columbia in 1969.

4. I am presently Manager, Geophysical Division, Atled Exploration Management Ltd., at #420 - 475 Howe Street, Vancouver, B. C.

5. I am a member of the Society of Exploration Geophysicists, the Canadian Institute of Mining and Metallurgy and the B. C. Geophysical Society.

Signed P. P. Nielsen

P. P. Nielsen

Date July 19, 1973

ENGINEER'S CERTIFICATE

I, GORDON C. GUTRATH, of 3636 Lakedale Avenue, in the Municipality of Burnaby, in the Province of British Columbia, DO HEREBY CERTIFY:-

1. That I am a consulting geologist with a business address of #420-475 Howe Street, Vancouver 1, B. C.
2. That I am a graduate of the University of British Columbia where I obtained my B.Sc. in geological science in 1960.
3. That I am a Registered Professional Engineer in the Geological Section of the Association of Professional Engineers in the Province of British Columbia.
4. That I have practised my profession as a geologist for the past twelve years, and
5. That I have no interest in the property with which this report is concerned, nor do I expect to receive any such interest. I have no interest in the securities of Phelps Dodge Corporation.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA G. C. GUTRATH

Gordon C. Gutrath, B.Sc., P.Eng.

DATED at the City of Vancouver, Province of British Columbia, this 19 day of July, 1973.

PERSONNEL

P. P. Nielsen	Geophysicist-I.P. Operator
H. Huckson)	
R. Klanjscek)	I. P. Crewmen
H. P. Winzeler)	

COSTS

The following are Atled's charges to conduct 3.48 line miles on pre-cut lines.

1.	*Men and equipment: 4 days @ $235.00*	*$ 940.00*
2.	*Food and accommodation*	*246.00*
3.	*Transportation*	*350.00*
4.	*Report*	*600.00*
		$2,136.00

Declared before me at the

of [redacted], in the

Province of British Columbia, this

day of , A.D.

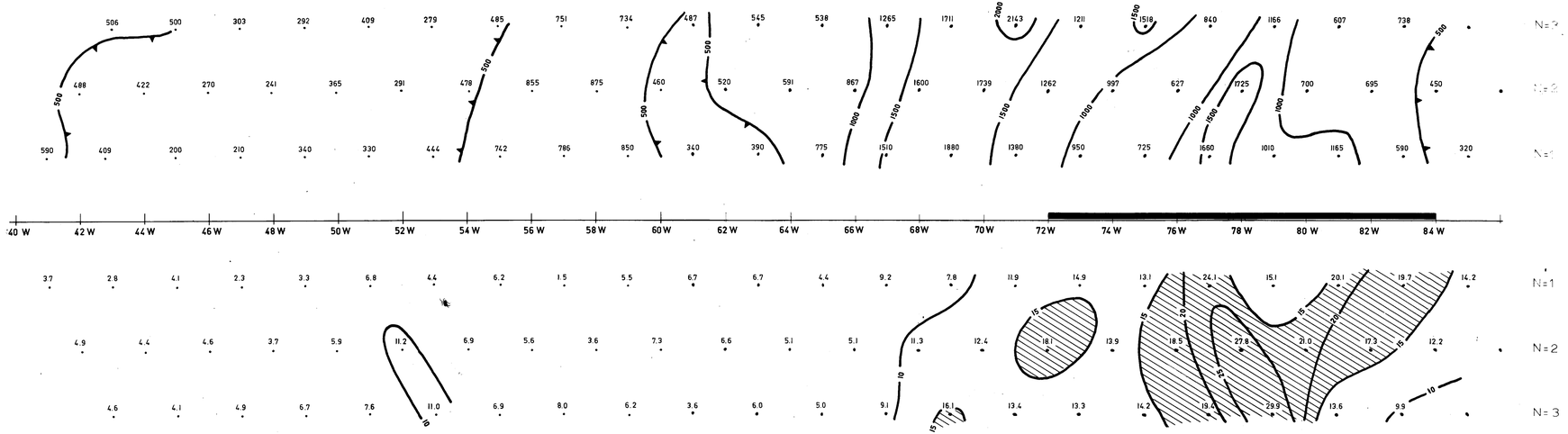
VANCOUVER, B. C.

JUL 30 1973

Sub - Mining Recorder

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

A P P E N D I C E S

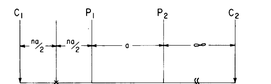


LINE 32N

APPARENT RESISTIVITY & CHARGEABILITY PSEUDO SECTION

LEGEND

POLE-DIPOLE ELECTRODE ARRAY



a = 200 feet — low ρ_a

anomalous zone — high M_a

INSTRUMENT PARAMETERS

Tx on	2.0 SECONDS
Tx off	2.0 SECONDS
DELAY (td)	240 MILLISECONDS
INTEGRATE	900 MILLISECONDS

PHELPS DODGE CORP. of CANADA LIMITED

TAS & TAT CLAIM GROUP

COPPER MOUNTAIN AREA, B. C.

INDUCED POLARIZATION SURVEY

SCALE IN FEET

200 0 200 400 600

MINING DIV. SIMILKAMEEN

N.T.S. 92H/7&8

TO ACCOMPANY A REPORT BY P. P. NIELSEN, B.Sc., GEOPHYSICIST AND G. C. GUTHRATH, B.Sc., P.Eng.

ATLED EXPLORATION MANAGEMENT LTD.

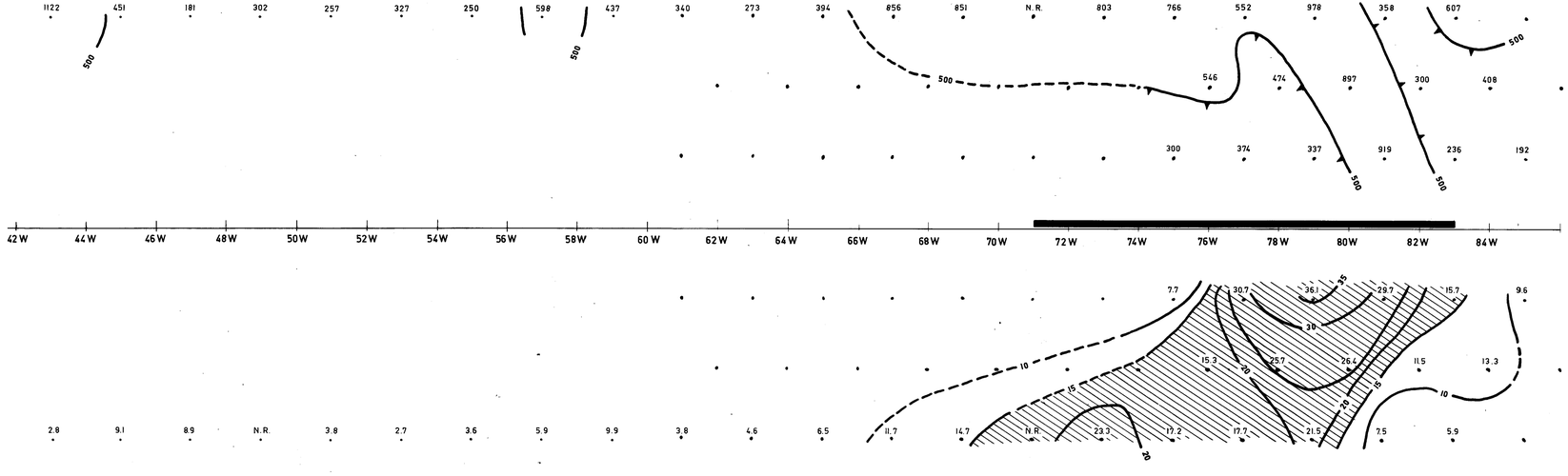
VANCOUVER, B.C.

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA G. C. GUTHRATH

4526

DRAWN BY-

DATE-JULY 1973.

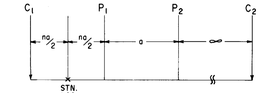


LINE 40 N

APPARENT RESISTIVITY & CHARGEABILITY PSEUDO SECTION

LEGEND

POLE-DIPOLE ELECTRODE ARRAY



a = 200 feet

anomalous zone

– low ρ_a

– high M_a

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SCALE IN FEET

200 0 200 400 600

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VANCOUVER, B.C.

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DRAWN BY N.C.L.

4526

DATE - JULY 1973

0 8 N 16 N 24 N 28 N 32 N 36 N 40 N 44 N 48 N 52 N 56 N 60 N 64 N 68 N 72 N 76 N 80 N 84 N 88 N 92 N

80 W — 70 W — 60 W — 50 W — 40 W — 30 W — 20 W — 10 W — 0

TAT 2 | TAT 4 | TAT 6 | TAT 8 | TAT 10 | TAT 12

TAT 1 | TAT 3 | TAT 5 | TAT 7 | TAT 9 | TAT 11

TAS 15 | TAS 1 | TAS 2

TAS 29 | TAS 16 | TAS 17 | TAS 3 | TAS 4

TAS 31 | TAS 18 | TAS 19 | TAS 5 | TAS 6

TAS 33 | TAS 20 | TAS 21 | TAS 7 | TAS 8

TAS 35 | TAS 22 | TAS 23 | TAS 9 | TAS 10

N

Mine: [illegible] Resources

NO. 4526 M.P. #4

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA

P. P. Nieben 4526-M14

PHELPS DODGE CORPORATION of CANADA LTD.

TAS & TAT CLAIM GROUP

COPPER MOUNTAIN AREA, B.C.

CLAIM & GRID LOCATION MAP

SIMILKAMEEN M. D. N.T.S. 92 H/7 & 8

ATLED EXPLORATION MANAGEMENT LTD.

VANCOUVER, B.C.

400 0 400 800

Scale in feet

DATE: JULY 1973