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GEOPHYSICAL REPORT ON THE SOUTH WEST, SOUTH EAST, MID EAST, NORTH AND SOUTH GROUPS OF CLAIMS

Gypsum Lake : 50° 120° S.W.

by

J.P. Weeks, P. Eng.

for

Bralorne Pioneer Mines Limited

Introduction

This report has been prepared for submission as assessment work and describes an induced polarization survey carried out on the above claims during the period 16th November, 1965 to 19th April, 1966.

The geophysicist and equipment were supplied under contract with H.O. Seigel and Associates Limited and operating procedures and results are described in a report by Dr. H.O. Seigel which is attached as Appendix I.

Property

The area has been staked many times in the past, the present claims having been located between 1963 and 1966. The claim group consists of 136 claims, the names of which follow:

WIZ	Nos.	12 to 31 inclusive.
"	"	34 to 107 inclusive.
"	No.	108 Fraction to 113 Fraction inclusive.
"	Nos.	120 to 121 Fraction inclusive.
DOT	Nos.	2, 4, 6, 8, 10, 12, 23, 24, 25, 26.
SHO	Nos.	7 and 8.
ROSE	Nos.	1 and 2.
INS	Nos.	1 to 3 inclusive.
"	"	10 to 12 inclusive.
"	"	14 and 15.
"		A and B Fractions.
PAL	Nos.	1, 2, 3, 4, 6, 7, 8, 9, 11 and 12.

It should be noted that the lines covered by the geophysical survey are shown on the attached claim maps and so provide a means of locating the geophysical results with respect to the claim boundaries.

For purposes of recording assessment work the claims have been grouped and details of these groups and the claims upon which assessment work is to be recorded may be found under the heading "Assessment Work".

Regional Geology

The regional geology is well described by W.E. Cockfield in G.S.C. Memoir 249, "Geology and Mineral Deposits of Nicola Map Area, B.C." and the accompanying map No. 886 A, published in 1948. Additional information on the rock types found in the region may be obtained from papers by J.M. Carr in the Annual Report of the B.C. Minister of Mines and Petroleum Resources for the years 1960 and 1962 and no purpose will be served by repeating this information here.

Property Geology

The property is on the eastern flank of the Guichon batholith, a large body of plutonic rock regarded as being of Mesozoic age. On the claims the most commonly occurring rocks are medium grained to fine grained quartz monzonite with smaller areas of quartz diorite and granodiorite.

The granitic rocks have been intruded locally by dykes of porphyry similar to those at the Bethlehem mine some 10 miles to the North.

The batholith is overlain by volcanic flows and tuffs of the Kamloops group of Cenozoic age in the northeast corner of the claim block. Some volcanic rocks are also present in the southeast corner of the property and are believed to be older than the quartz monzonite. However the area has not been mapped in detail and the relationship between the two rock types cannot yet be established with any degree of certainty.

Copper mineralization, consisting principally of chalcopyrite and bornite with lesser amounts of chalcocite and malachite is principally found in shear planes traversing the granitic rocks. Structurally it is evident that movement along the faults, which mostly strike N 30° W and dip at 65° to the southwest, has produced tension fractures in the hanging wall that were later healed with quartz and mineralized with copper sulphides.

Property Geology (c'td.)

Subsequent movement on the fault has produced gouge containing comminuted fragments of chalcopyrite, some of which show slickensides.

In the vicinity of the mineralization the country rock shows considerable alteration, the most distant from the veins being a change of the feldspars to a salmon pink colour. More pronounced alteration closer to the veins is exhibited by the presence of marked chloritization. Talc and sericite are developed to some extent wherever there is shearing.

Statement of Expenditures

(a) Line Cutting:

Line cut by hand was paid at a rate of $100.00 per mile including chaining. The majority of the lines had previously been used during a magnetometer survey and the cost of these lines has been recorded previously as assessment work. However an additional 19.6 miles of line were cut in January and February 1966 to extend the surveyed area and the cost of this extension only was as follows:-

19.6 miles at $100.00 per mile	$ 1,960
Fringe benefits: 18.2% of $1960	$ 357
Field maintenance: 3 man months at $150 per man month	$ 450

(b) Contractors Charges:

Geophysicist, equipment and interpretation	$ 12,598

(c) Labour, I.P. Survey:

Linemen used during the survey were provided by Bralorne Pioneer Mines. In addition to their monthly salary they were paid a bonus of $2.00 per 1000' accomplished daily in excess of 3000' and $3.00 per 1000' accomplished daily in excess of 6000'.

Salaries and bonus	$ 5,862
Fringe benefits: 18.2% of $5862	$ 1,067
Field Maintenance: 10 man months at $150 per man month	$ 1,500

Statement of Expenditures (c'td.)

(d) Supervision:

Field Supervisor: 10% of 2½ months at $575/month	$ 144
Chief Geologist: 5% of 2½ months at $950/month	$ 119
Fringe benefits: 18.2% of $263	$ 48
Field maintenance: 1/3 month at $150/month	$ 50

(e) Preparation of Report:

Salaries	$ 94
Fringe benefits: 18.2% of $94	$ 17
Total Expenditure -	$ 24,266

Assessment Work

Assessment work is to be applied as follows:

South Group	North Group	Mid East Group
PAL 1	DOT 23	WIZ 22 A
" 2	24	
" 3	25	One year's work
" 4	26	to be applied.
" 6	WIZ 72	
" 7	73	
" 8	74	
" 9	75	
" 11	76	
" 12	77	
	78	
	79	
Five years' work to be applied to each claim.	One year's work to be applied to each claim.	

Respectfully submitted,

J.P. Weeks, P. Eng.
Chief Geologist.

Vancouver, B.C.
April 20th, 1966

Form No. 220 Statutory Declaration. 6-64 WILLSON STATIONERY COMPANY LIMITED -- CLARKE & STUART CO. LTD.

Canada

Province of British Columbia

To Wit:

In the Matter of

Assessment work on the Mid East, South East, South West, North and South Groups of Mineral Claims.

I, James Peter Weeks, of 1285 Bracknell Place, North Vancouver, in the Province of British Columbia.

Do Solemnly Declare that the following persons were employed on the field work:

R. Osterhout, Lineman	16 Nov.1965 to 12 Jan.1966.	15 working days.	$ 375/ month.	$ 408
T. Reid, "	18 Nov.1965 to 24 Feb.1966.	68 working days.	$ 450/ month.	$1912
M. Brackman, "	24 Nov.1965 to 24 Feb.1966.	63 working days.	$ 325/ month.	$1423
T. Armitage, "	24 Nov.1965 to 11 Jan.1966.	24 working days.	$ 325/ month.	$ 627
A. Toth, "	5 Dec.1965 to 16 Dec.1965.	11 working days.	$ 325/ month.	$ 328
P. Sterling, "	6 Jan.1966 to 6 Feb.1966.	28 working days.	$ 325/ month.	$ 483
E. Chapman, "	16 Jan.1966 to 27 Jan.1966.	11 working days.	$ 325/ month.	$ 186
C. Green, "	30 Jan.1966 to 24 Feb.1966.	23 working days.	$ 325/ month.	$ 495
R. Osterhout, Line Cutter	16 Nov.1965 to 12 Jan.1966.	13 working days.	$100.00/ mile.	($ 208
B. Findlay, " "	16 Nov.1965 to 11 Jan.1966.	13 working days.	$100.00/ mile.	($ 208
B. Corrigan, " "	19 Jan.1966 to 9 Feb.1966.	22 working days.	$100.00/ mile.	($ 772
W. Sanders, " "	19 Jan.1966 to 9 Feb.1966.	22 working days.	$100.00/ mile.	($ 772
G. Rose, Field Supervisor	16 Nov.1965 to 24 Feb.1966.	6 working days.	$ 575/ month.	$ 144
P. Weeks, Chief Geologist	16 Nov.1965 to 24 Feb.1966.	3 working days.	$ 950/ month.	$ 119

Persons employed in the preparation of this report were:

P. Weeks, Chief Geologist	18 Apr.1966 to 19 Apr.1966.	2 working days.	$1000/ month.	$ 94

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 Vancouver

in the Province of British Columbia.

this 26 day of April A.D. 19 1966

J. P. Weeks

Shirley Jeannotte

A Notary Public in and for the Province of British Columbia
~~A Commissioner for taking affidavits for British Columbia~~
Sub-mining Recorder

REPORT ON
INDUCED POLARIZATION SURVEY
ON BEHALF OF
BRALORNE PIONEER MINES LIMITED
CHATAWAY PROPERTY
BRITISH COLUMBIA

by

Harold O. Seigel, Ph.D., P.Eng.

Toronto, Ontario.

March 25, 1966.

SUMMARY

A minimum of twelve more or less distinct zones of high polarization has been revealed by the present induced polarization survey. Three of these zones include known copper mineralized showings and a fourth has already been partially investigated by trenching by Bralorne Pioneer Mines Limited to reveal some copper mineralization.

At least one section warranting additional investigation has been selected on each of the twelve anomalous zones. Some detail induced polarization traverses would appear to be desirable on the majority of these sections of interest to obtain greater precision as to location and depth of burial of the high polarization material.

It appears to be a reasonable assumption that the bulk of these high polarization zones will be associated with disseminated sulphide mineralization, although it cannot be decided from the induced polarization survey alone as to whether or not appreciable copper mineralization will be encountered therein. If taken literally, the geochemical data obtained from soil sampling on this property would tend to give rise to rather pessimistic predictions. There is some evidence to suggest, however, that the geochemical information should not be relied upon too explicitly, due possibly to extensive soil creep, etc.

SEIGEL ASSOCIATES, LIMITED
GEOPHYSICAL CONTRACTORS AND CONSULTANTS
79 MARTIN ROSS AVENUE • DOWNSVIEW, ONTARIO • CANADA
TELEPHONE: 633-2450, 636-0801 • CABLE: "SEIGEO", TORONTO • TELEX: 02-29891

REPORT ON INDUCED POLARIZATION SURVEY CHATAWAY PROPERTY, BRITISH COLUMBIA ON BEHALF OF BRALORNE PIONEER MINES LIMITED

INTRODUCTION

During the period from November 1965 to February 1966 inclusive a geophysical party executed an induced polarization survey on a property in the Chataway District, British Columbia, held under option by Bralorne Pioneer Mines Limited. The property is located approximately 15 miles northwest of the town of Merritt. Access is by means of paved highway No. 8 for 11 miles west from Merritt and thereafter approximately 9 miles by dirt road north from highway No. 8. The geophysical party was initially under the direction of Mr. John Denholm, B.A.Sc. and later Mr. John Irvine, B.A.Sc.

The attached copy of the writer's paper entitled 'Three Recent Irish Discovery Case Histories Using Pulse Type Induced Polarization' describes the method and equipment employed on the present survey and gives some examples of the type of results to be experienced therewith and the nature of the interpretive procedures. For the present survey a Seigel Mark V time domain induced polarization unit was employed with a current-on time of 1.5 seconds and an integrating time of 0.5 seconds. Measurements were made of the chargeability in units of milliseconds and resistivity in units of ohm metres. An equi-spaced three electrode array was employed with basic electrode spacing of 400' for the initial reconnaissance coverage (November-December 1965) and 200' for the remaining reconnaissance coverage. In general, the station interval was equal to the electrode spacing for both the 200' and 400' spacings. The grid lines surveyed were normally at 400' intervals and are oriented due east-west.

The purpose of the present survey was to map the distribution of metallic sulphide mineralization in the bedrock underlying this property. Such mineralization could be of interest for copper as a large number of copper exposures are known on the property, several of which exposures have been investigated by trenching, etc.

For purposes of correlation with the geophysical information the writer has been supplied with a plan showing the distribution of copper values in the soils on the bulk of the property covered.

As the present induced polarization survey was conducted

during the height of the winter considerable difficulty was encountered at times in making adequate ground contact. This had the effect of reducing the rate of production and, in the worst case, giving rise to an occasional reading of doubtful authenticity.

DISCUSSION OF RESULTS

The geophysical results are presented in profile form on Plates 1A, 1B and 1C (for A = 200') and 2A, 2B and 2C (for A = 400'). Plate 1D shows the detail results employing spacings of 100' and 50' over certain areas indicated to be of interest by the reconnaissance survey. The data are presented in profile form with the following scales: 1" = 400' for all plans except 1D which is 1" = 200', 1" = 5 milliseconds for chargeability and a logarithmic scale for the resistivity.

Plate 3, on the scale of 1" = 400', shows the chargeability data obtained by the 200' spacing profiles only, in contour form. The contour interval is 2 milliseconds.

The normal non-mineralized background polarization level in this area is observed to be between 1 and 4 milliseconds. Chargeabilities in excess of 6 milliseconds may therefore be considered to be appreciably anomalous and worthy of further consideration. At least 12 more or less distinct zones of peak chargeabilities in excess of 6 milliseconds are to be seen on Plate 3. These have been designated by letter A to L inclusive and will be discussed, in turn, below.

Zones A and B

These zones occupy the northwest portion of the survey grid and extend from line 456N to 492 N. In this region the contact resistances are so high that the primary currents and observed voltages are extremely low resulting in many instances in results of questionable reliability. In considering all the data available, however, there is little doubt that there is a broad area containing many narrow lenses of high polarization material close to surface in this region. This includes the only anomalous responses revealed by the original 400' spacing traverses. Detail traverses using 100' electrode spacing on lines 468N and 488N confirm the presence and location of multiple high polarization zones on these lines as follows: On line 468N intermittent high polarization material over the region from 473+50E to 479+50E and on line 488N over the region from 473E to 483E. The results on the former line are regarded to be more reliable than on the latter. Geochemical activity in the region of these two zones is sparse and, in fact, the local copper closures appear to studiously avoid the higher polarization areas. It is understood that some trenches have already been put down to bedrock in the region between lines 464N, 484E and line 492N, 476E. Apparently some secondary copper has been exposed in trench No. 20 (Bralorne designation) on line 480N between 471E and 473E. A similar trench on line 468N between 478E and 480E revealed no copper mineralization. It is apparent that this trench should be extended to the west as far as 473+50E to obtain a proper cross section of the anomalous zone in this area.

Zone C

This lies in the northeastern portion of the 200' spacing survey grid and extends in a general northerly direction from line 452N to line 492N. It is still open to the north off the present grid covered. This area has been covered only by the 200' spacing profiles and no shorter or larger spacings have been employed to supply information as to depth, etc. The most reliable anomalous indication appears to be on line 472N near 569E where a peak value of 28.0 milliseconds was observed. This is coincident with a sharp, local resistivity depression. There is little or no geochemical activity in the vicinity of zone C.

On line 444N near 561E there is a sharp, local polarization high of 22.2 milliseconds amplitude and corresponding resistivity depression. As this is just off the south end of zone C,and presumably on strike with it, it has been designated zone C'. No detail traverses have been carried out over this zone as yet.

Zone D

Extending northward from line 432N to line 456N is a very narrow band of high polarization, usually characterized by single point anomalous indications. The strongest and probably most reliable indication on this zone occurs on line 452N near 549E. Once again, detail is lacking in this region. There is no geochemical activity within approximately 400' of this zone on any section.

Zone E

This is a band of moderate polarization activity which extends in a north-south direction between lines 420N and 456N. Its most prominent indication is only 10.4 milliseconds on line 428N at 541E. Its chief merits are geological and geochemical, in fact, as geochemical activity occurs within a few hundred feet of this zone along almost its entire length. In addition, there is known copper mineralization reputedly of up to 2 million tons of .25% copper located in the vicinity of lines 420N to 424N at about 539E. The vicinity of line 428N 541E would, therefore, warrant examination to see firstly whether it has been thoroughly drilled off to date and, if not, it should be subject to detail I.P. traverses to determine precisely where to lay out trenching or drilling.

Zone F

This a relatively low order anomalous indication extending northward from line 448N to line 456N. This apparently includes the main mineralized zone of Chataway Explorations Limited and has been drilled by them in the vicinity of line 456N 512E. Some modest extension of this zone appears possible, although the total amount of mineralization involved must be quite small. The only area of remaining residual interest would lie at approximately 515E on line 448N. It should be determined as to whether or not the Chataway drilling has extended

this far south. If not, and if this type of mineralization is of economic potential, then some detail may be done on line 448N preparatory to trenching or drilling.

Zone G

This is a narrow zone of high polarization, generally a single point indication on each section, which extends from line 408N northward to line 428N. Possibly the most reliable indication on zone G would be on line 408N in the vicinity of 527E to 529E. This region also includes a very minor geochemical indication as well. No detail has been carried out on this zone.

Zone H

This is a contorted band extending from at least line 404N to line 416N. Its most reliable expression is on line 408N near 549E, where a peak amplitude of 15.3 milliseconds was observed. No detail has been carried out on this zone as yet. There is no geochemical activity in its vicinity.

Zone I

This zone strikes in a general north northeasterly direction from line 386N to line 412N. There is some local geochemical activity at its extreme north end but otherwise none in its vicinity. The most reliable section of this zone occurs on line 400N near 539E, although the detail has yet to be done on this section.

Zone J

Zone J extends north from line 394N to line 412N and may, in fact, be a direct northerly continuation of zone K, which will be discussed below. The best indication on zone J occurs on line 397N near 523E. There is no geochemical activity in its vicinity. Detail I.P. remains to be done on this zone.

Zone K

This is a contorted zone containing at least two bands of high polarization which strike generally northerly from line 362N to line 386N and is still open to the south off the present survey grid. Detail has been carried out on line 374N over this zone to confirm the presence of material of high polarization in the vicinity of 522+50E and 526+50E. An additional section of potential interest is a localized anomaly in the same vicinity on line 370N at 515E to 517 E. No detail has, as yet, been carried out on this particular area. There is no geochemical information available to the writer covering zone K as this lies primarily off the geochemical grid supplied. It is reported that the Aberdeen shaft lies 50' north of line 355N at 524E. This shaft was sunk on a zone of chalcocite mineralization occurring in an inclusion of greenstone in the granitic intrusive. This will lie only 700' south of zone K and on strike with it. It is reported also that an old working lies in the vicinity of line 370N near 523E, which is within zone K.

Zone L

This zone lies on the extreme southeast corner of the survey grid and extends between lines 362N and 386N. It must be reflecting an extremely narrow zone of high polarization as generally only a single anomalous value is obtained. No detail information has been obtained on zone L. The most reliable indication on this zone occurs on line 362N in the vicinity of 551E to 553E. Detail traverses are desirable in this vicinity. The zone is still open to the south off the present survey grid.

Respectfully submitted,

Harold O. Seigel

Harold O. Seigel, Ph. D., P. Eng.
Consulting Geophysicist.

Toronto, Ontario.
March 25th, 1966.

To accompany geophysical report by J.F. Weeks, P. Eng. on the South West, Mid East, North, and South groups, Gypsum Lake, Nicola, M.D. dated 20th April, 1966

Figure 1
North Sheet

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 764 MAP #1

764

BRALORNE PIONEER MINES LTD.

CHATAWAY PROPERTY — North Sheet
Claim Post Locations
Figure 1

SCALE 1" = 400' | REF.
DRAWN BY E. LEAMY | DATE JAN 1966 | No.

TWILIGHT LAKE

WIZ 15 | WIZ 17 | WIZ 18 | WIZ 19 | WIZ 20 | WIZ 21 | WIZ 22 | WIZ 23 | WIZ 24 | WIZ 25 | WIZ 26 | WIZ 27 | WIZ 28 | WIZ 29 | WIZ 30 | WIZ 31 | WIZ 32 | WIZ 33 | WIZ 34 | WIZ 35 | WIZ 36 | WIZ 37 | WIZ 38 | WIZ 39 | WIZ 40 | WIZ 41 | WIZ 42 | WIZ 43 | WIZ 44 | WIZ 45 | WIZ 46 | WIZ 47 | WIZ 48 | WIZ 49 | WIZ 50 | WIZ 51 | WIZ 52 | WIZ 53 | WIZ 54 | WIZ 55 | WIZ 56 | WIZ 57 | WIZ 58 | WIZ 59 | WIZ 60 | WIZ 61 | WIZ 62 | WIZ 63 | WIZ 64 | WIZ 65 | WIZ 66 | WIZ 67 | WIZ 68 | WIZ 69 | WIZ 70 | WIZ 71 | WIZ 72 | WIZ 73 | WIZ 74 | WIZ 75 | WIZ 76 | WIZ 77 | WIZ 78 | WIZ 79 | WIZ 80 | WIZ 81 | WIZ 82 | WIZ 83 | WIZ 84 | WIZ 85 | WIZ 86 | WIZ 87 | WIZ 88 | WIZ 89 | WIZ 90 | WIZ 91 | WIZ 92 | WIZ 93 | WIZ 94 | WIZ 95 | WIZ 96 | WIZ 97 | WIZ 98 | WIZ 99 | WIZ 100 | WIZ 101

WIZ-FR 103 | WIZ-FR 109 | WIZ-FR 110 | WIZ-FR 111 | WIZ-FR 120 | WIZ-FR 121

SHO 7 | SHO 8

PAL 1 | PAL 2 | PAL 3 | PAL 4 | PAL 5 | PAL 6 | PAL 7 | PAL 8

L-397 N | L-394 N | L-390 N

Rock Mound

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 764 MAP #2

To accompany geophysical report by J.F.Weeks, P.Eng on the South West, Mid East, North and South groups, Gypsum Lake, Wiseale, M.D. dated 20th April, 1966

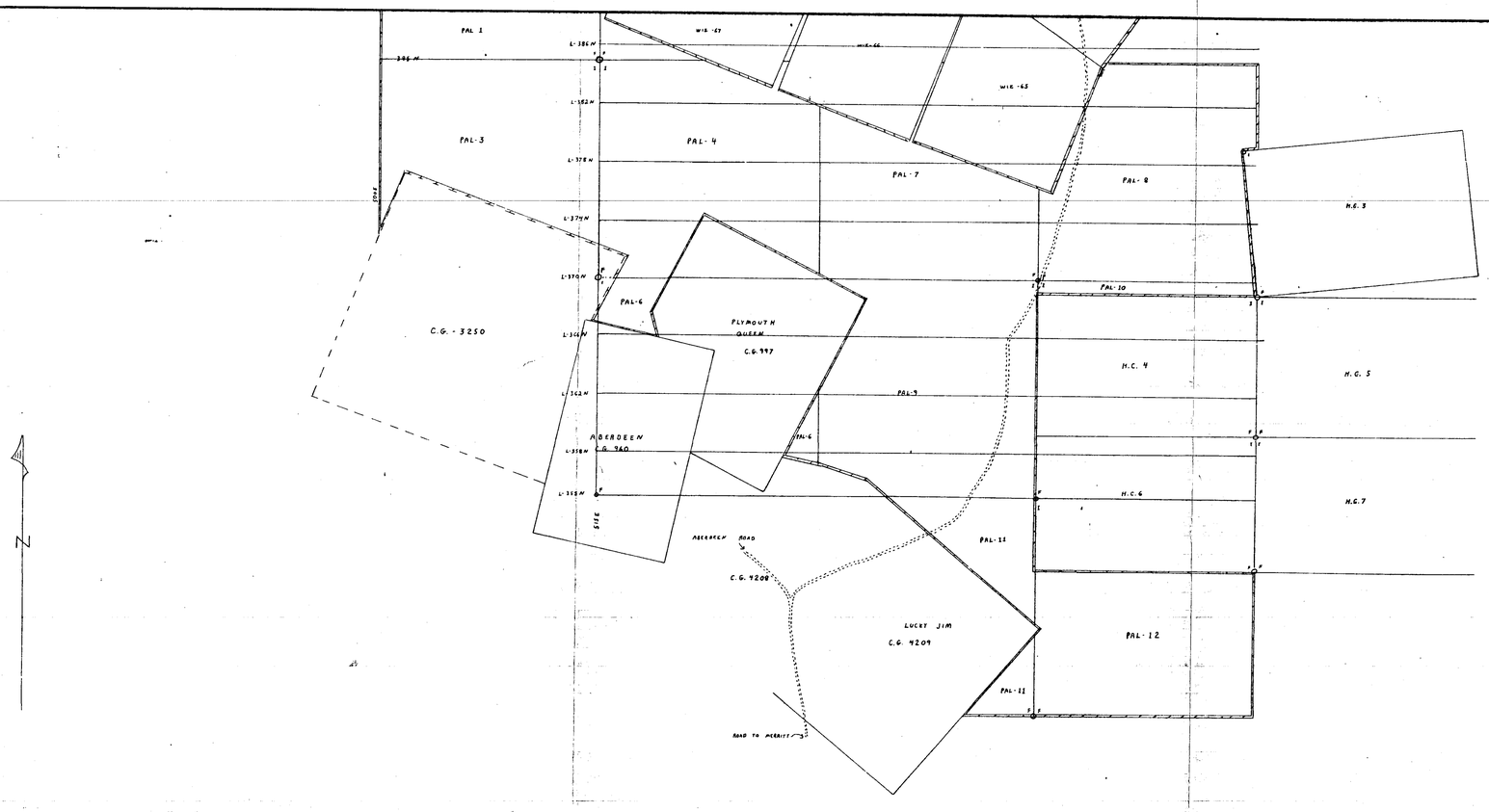
Figure 2
Centre Sheet

764

BRALORNE PIONEER MINES LTD.

CHATAWAY - PROPERTY CENTRE SHEET
Claim Post Locations
Figure 2

SCALE 1" = 400'	REF.	
DRAWN BY F. LEAMY	DATE JAN. - 1966	No.



To accompany geophysical report by J.P. Weeks, P.Eng. on the South West, Mid East, North, and South claims Gypsum Lake, Nicola, M.D. dated 20th April, 1966

Figure 3
South Sheet

764

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
764 MAP #3

BRALORNE PIONEER MINES LTD.

CHATAWAY PROPERTY Figure 3
CLAIM POST LOCATIONS
SOUTH END OF PROPERTY (PAL CLAIMS, GYPSUM
SOUTH SHEET LAKE AREA, MERRITT B.C.)

SCALE 1" = 400 ft.	REF.
DRAWN BY G. LEAMY	DATE MARCH 21/66
	No.

TO ACCOMPANY REPORT ON INDUCED POLARIZATION SURVEY, CHATAWAY PROPERTY BY HAROLD O. SEIGEL AND ASSOCIATES LTD.

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Harold O. Seigel

President,
Harold O. Seigel & Assoc., Ltd.,
Downsview, Ontario

Annual General Meeting,
Toronto, March, 1965

Three Recent Irish Discovery Case Histories Using Pulse-Type Induced Polarization

Transactions, Volume LXVIII, 1965, pp. 343-348

ABSTRACT

In the intensive Irish exploration program which has followed the discovery of the Tynagh deposit (Northgate Exploration, Ltd.) in 1962, three base metal discoveries have been made to date. These include the lead-zinc-silver deposits at Silvermines (Consolidated Mogul Mines, Ltd.), which are now being readied for production, the copper-silver deposit at Gortdrum (Gortdrum Mines, Ltd.) and the lead-zinc deposits near Keel (Rio Tinto-Zinc Ltd.). Each of these discoveries is the result of a combined geological-geochemical-geophysical exploration sequence in which pulse-type induced polarization surveys defined the precise location and lateral extent of the near-surface metallic sulphide mineralization and guided the initial drilling program. Whereas the Silvermines mineralization is, in part, composed of massive sulphides, the other two deposits are characterized by generally less than 5 per cent conducting sulphides and constitute an excellent demonstration of the unique merits of the pulse-type induced polarization system.

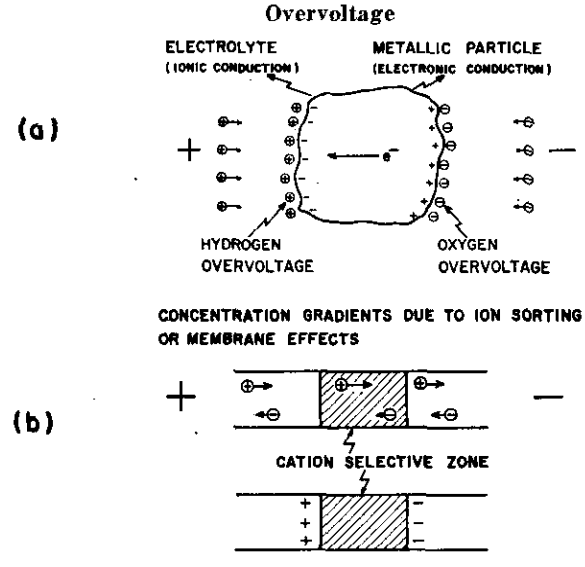

Figure 1.—Induced Polarization Agents.

Introduction

FOR the benefit of those who are unfamiliar with the induced polarization method in general or with the pulse-type method in particular, a few introductory remarks will be directed on the system employed in the present case histories. Those who wish a fuller treatment of the subject are directed to Seigel (1962),* which paper also includes an extensive list of references.

Induced polarization, in its broadest sense, means a separation of charge to form an effective dipolar (polarized) distribution of electrical charges throughout a medium under the action of an applied electric field. When current is caused to pass across the interface between an electrolyte and a metallic conducting body (Figure 1a) double layers of charge are built up at the interface, in the phenomenon known to the electrochemists as "overvoltage." This is the phenomenon which can be utilized for the detection of the metallic conducting rock-forming minerals such as most sulphides, arsenides, a few oxides and, unfortunately, graphite. In addition, effective dipolar charge distributions occur to some extent in all rocks, due to ion-sorting or membrane effects in the fine capillaries in which the current is passing (Figure 1b). Induced polarization responses may therefore arise from metallic or non-metallic agencies. Fortunately, the latter generally fall within fairly low and narrow limits for almost all rock types, although there is still no reliable general criterion for differentiating overvoltage responses from graphite and metallic sulphides, or for distinguishing between the responses of one type of sulphide and another. Despite these limitations, the induced polarization method has amply demonstrated its value in mineral exploration since its initial development as a useful exploration tool in 1948. (Wait *et al.*, 1953).**

*Seigel, H. O., "Induced Polarization and its Role in Mineral Exploration," C.I.M. *Bulletin*, Vol. 55, No. 600, pp. 242-249; *Transactions*, Vol. LXV, pp. 151-158; 1962.

**"Overvoltage Research and Geophysical Applications," *Pergamon Press*, 1959, edited by J. R. Wait.

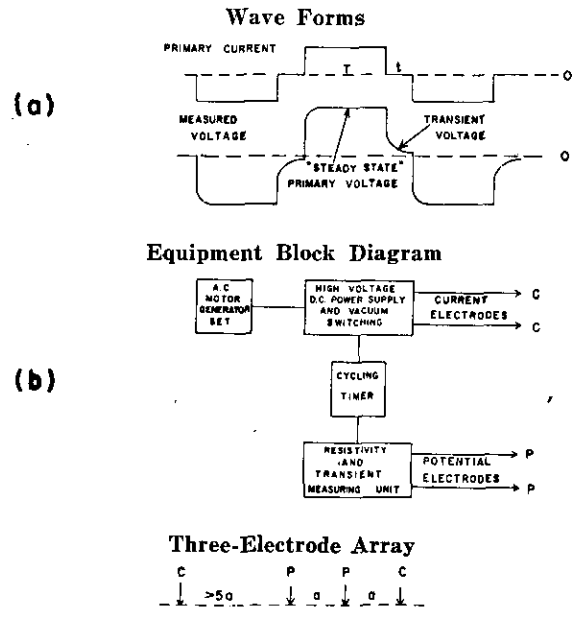

Figure 2.—The Pulse System.

Description of Method

For the present program, the pulse or time-domain system was employed. As shown on Figure 2a, the primary current wave form consists of square wave pulses of 1.5 seconds duration, separated by a 0.5-second gap and alternately reversed in direction. The polarization voltages established during the current-on time decay slowly during the current-off time. They are amplified, integrated over the current-off time and divided by the amplitude of the steady-state voltage measured during the current-on time. In this way, we determine the "chargeability;" i.e., the induced polarization property of the region under investigation. The units of chargeability are milliseconds. Normal (non-metallic) background chargeabilities in most rocks range from 1 millisecond to 5 milliseconds. A distribution of 1 per cent, by volume, of metallic conducting material of an average range of particle size may be expected to increase the response level by about 3 milliseconds, which is readily visible.

The pulse system provides an absolute measurement of induced polarization; i.e., the significant measurement is made in the absence of the primary field. As such, it is inherently more sensitive than the frequency variation system, wherein two measurements are compared, both of which are made in the presence of the primary field. This is a critical consideration when mineralized bodies of low sulphide content, small size or great depth are being sought.

Figure 2b shows a block diagram of the apparatus employed and the electrode array used. The spacing "a" of the three-electrode array determines the effective depth of penetration of the survey and is selected to give adequate penetration to the depth desired. By varying the electrode spacing over an anomalous area and comparing the responses on the various spacings, one may obtain an estimate of the depth of burial of the source and its dip, etc.

A photograph of the type of apparatus employed on these surveys is shown in Figure 3. This is known as Seigel Mk V equipment and consists of the following major components: (a) a 1,200-watt A.C. motor-generator set, (b) a power control unit capable of supplying up to 1000 volts and 2 amperes D.C. output current and (c) a measuring unit. All of these items are packboard-mounted for maximum portability.

Figure 4 shows a typical instrumental set-up in Ireland. In the normal operating procedure, the electronic chassis are set up in a tent and cables are fed out to the line being surveyed. As the line crew is prepared, both mentally and by apparel, to work under all types of weather conditions, the survey is not stopped by rain, etc. This is important in Ireland, where, traditionally, there are no more than 60 rain-free days a year.

For the primary survey coverage on most properties, an electrode spacing of 200 to 300 ft. was generally employed, with a station interval of 200 ft. and a line separation of 300 to 500 ft. On anomalous areas located by the primary coverage, more closely spaced stations and lines are employed, as well as additional spacings to supply the detail necessary for subsequent drilling, etc.

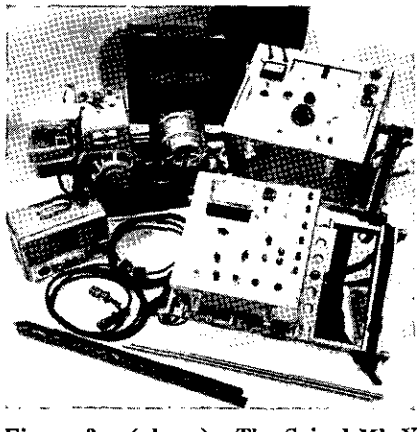

Figure 3.—(above)—The Seigel Mk V Induced Polarization Unit.

Figure 4.—(right)—Typical Field Operational Base in Ireland.

Case Histories

In presenting the three case histories that follow, it must be made perfectly clear at the outset that these mineral discoveries are the product of teamwork, involving geological, geochemical and geophysical phases. It is on the basis of the first two phases that the areas for geophysical investigation have been selected. As the writer and his organization have been concerned only with the geophysical phase, this paper will, naturally, appear to emphasize it. The contribution of others to the broader exploration program must not be minimized, however.

In January, 1962, a large lead-zinc-silver deposit of a very unusual type was discovered near Tynagh, Co. Galway, in the Republic of Ireland. This deposit includes both a supergene enriched, partly oxidized upper zone and a sulphide primary zone and lies in dolomitic reef limestones of Carboniferous age near a fault contact with Devonian sandstones. Similar rock types and contacts occur in many parts of Ireland, so that an extensive program of exploration was initiated by a number of mining companies, starting in the summer of 1962. Although the pace has slowed up somewhat from the hectic days of 1962 and early 1963, this exploration program continues to the present time.

The usual exploration sequence, although not followed in detail by all companies, is as follows:

1 . . . . . .

A selection of areas is made, based on the good government geological maps available. As nearly as possible, rock types and structures similar to those of the Tynagh deposit are sought. Those areas with known mineral showings are given high priority, of course.

2 . . . . . .

The stream sediments in the drainage pattern are sampled and analyzed for significant amounts of copper, lead and zinc. Soil samples may also be taken, often on a regular grid basis, and analyzed. In this fashion, areas of abnormal metal content may be broadly defined. In detail, such geochemical sampling has often been hampered by man-made contamination and confused by soil transport by glacial, fluvial or human agencies.

3 . . . . . .

Geophysical surveys, primarily the induced polarization type, are then conducted to map the subsurface distribution of sulphide mineralization and to provide guidance for a drilling program thereon.

This exploration program has already been remarkably successful, resulting, to date, in a new lead-zinc-silver mine-to-be at Silvermines, Co. Tipperary, for Consolidated Mogul Mines, Ltd., the probable copper-silver mine-to-be at Gortdrum, Cos. Tipperary and Limerick, for Gortdrum Mines, Ltd., and the interesting lead-zinc prospect at Keel, Co. Longford, for the Rio Tinto-Zinc group (Riofinex Ltd.). Figure 5 shows the location of the various recent mineral discoveries in Ireland. Despite a remarkable similarity in geological setting, the deposits are widely separated geographically, over a length of 80 miles, and no two are located on what can be called the same structure. This bodes well for the possibility of further discoveries being made in Ireland.

Each of the three case histories will be discussed below.

Silvermines Deposit

As the very name of the area implies, the Silvermines region had been known, for many centuries, as a locality mineralized with lead, zinc and silver. Metal production had taken place at several periods in the past, although at the time of the present investigations the mines were dormant. The very prominent Silvermines fault, striking about N 70°E, was known to be the significant control in the region, with the old mines and prospect pits scattered along its length over a distance of about 2 miles. Due to the past mining activity and transport by both drainage and man, a very extensive area gave rise to extremely high geochemical indications in lead and zinc. The induced polarization survey executed in late 1962 and early 1963 covered much of the concession area on 800-ft. sections and the geologically interesting portion thereof on 400-ft. sections. The three-electrode array, with 200-ft. electrode spacing, was employed on all lines, and spacings of 100 ft. and 400 ft. were also employed on the 400-ft. detail lines. In all, approximately 5 miles of the strike length of the Silvermines fault were covered by the present survey, 2½ miles in detail. At least ten distinct zones of abnormally high polarization were indicated, of which about half lay in the Silvermines mineralized belt and its extensions to the west and east.

One of these zones, designated the Garryard, has responded favourably to the subsequent drilling, resulting in the discovery of a mineable orebody.

To date, the announced proven tonnage figures include 12 million tons averaging approximately 8 per cent zinc, 3 per cent lead and 1 ounce of silver in the Garryard zone. This zone lies to the west of the zone from which the previous production had taken place.

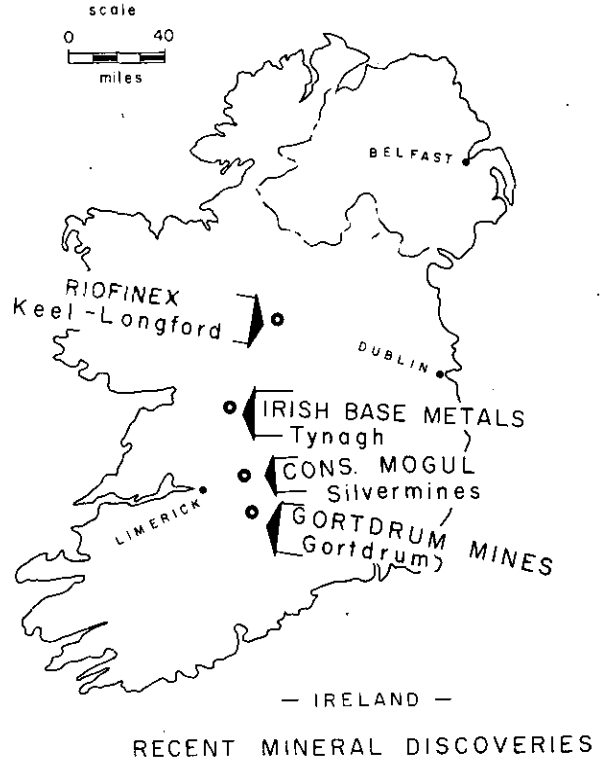

Figure 5.—Location Plan of Recent Mineral Discoveries in Ireland.

Figure 6 shows a typical discovery profile across the main ore zone, on the section 38,400E. The 200-ft. electrode spacing results, both chargeability and resistivity, are shown in profile form. The geologic section, as deduced from nine drill holes, is shown below the geophysical profiles. In a fashion almost identical to that of the Tynagh deposit, the Silvermines orebody is located in gently north-dipping dolomitic limestones adajacent to a fault contact with the Devonian "Old Red" sandstone. The mineralization here is composed of both massive and disseminated sulphides, with the former composed of a high percentage of pyrite. The mineralization is essentially conformable, in two distinct horizons, and is therefore flatly dipping except in the vicinity of the fault, where the dips are much steeper, perhaps due to "drag folding" on the fault.

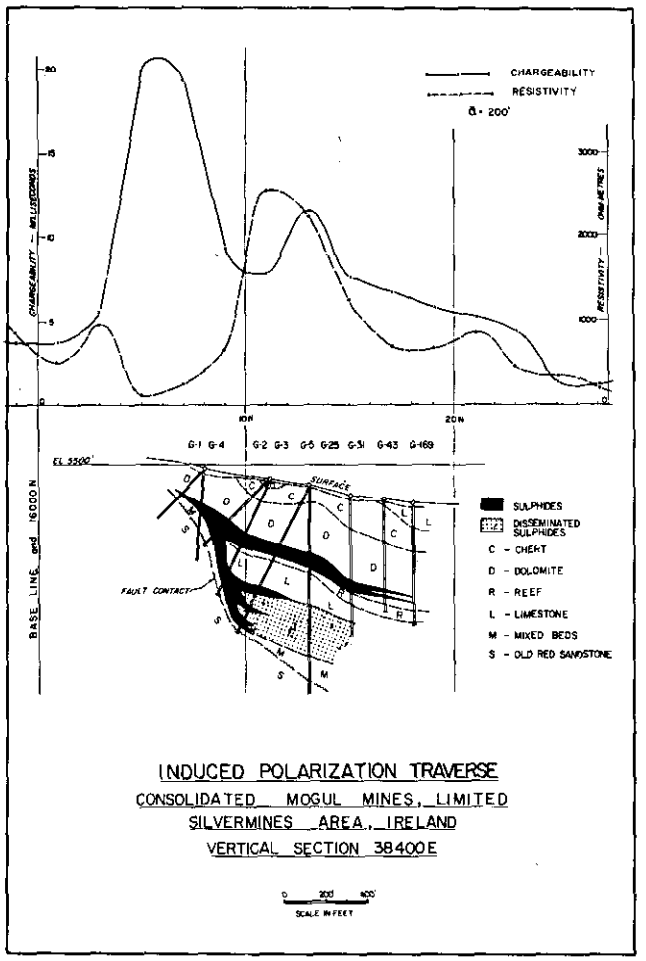

Figure 6.—Typical Discovery Traverse, Silvermines Deposit.

Because of the high pyritic content of the mineralization near the fault, along which it comes closest to the ground surface, we see both a marked increase in chargeability and a sharp decrease in resistivity in that vicinity. From a normal background of 2-4 milliseconds, the chargeability curve rises to a peak response of 20 milliseconds over the sub-outcrop of the body on this section. The subsidiary peak of about 12 milliseconds near 11N is believed to be due to disseminated pyrite in the chert horizon.

Figure 7 shows the multiple spacing chargeability results on the same section, using electrode spacing of 100, 200 and 400 ft. and the three-electrode array. On comparing the results with the various spacings, two items of interest may be noted; firstly, the progressive increase in peak amplitude with spacing, testifying to the increase of mineralization with depth, even down to a depth of 300 ft., and, secondly, the presence of buried material of high polarization at depth beneath section 10N to 18N on this line. The latter is undoubtedly due to the down-dip extension of the upper mineralized horizon, which is present at depths of 300 to 400 ft. over this region.

The induced polarization results on the Silvermines deposit were quite definitive and have provided good guidance for the exploratory drilling. It is true, however, that the massive sulphide portions of this deposit would be amenable to detection by the more conventional electrical methods, such as electromagnetic induction or resistivity. As such, it is not as good a test of the capabilities of the induced polarization method as are the two case histories which follow.

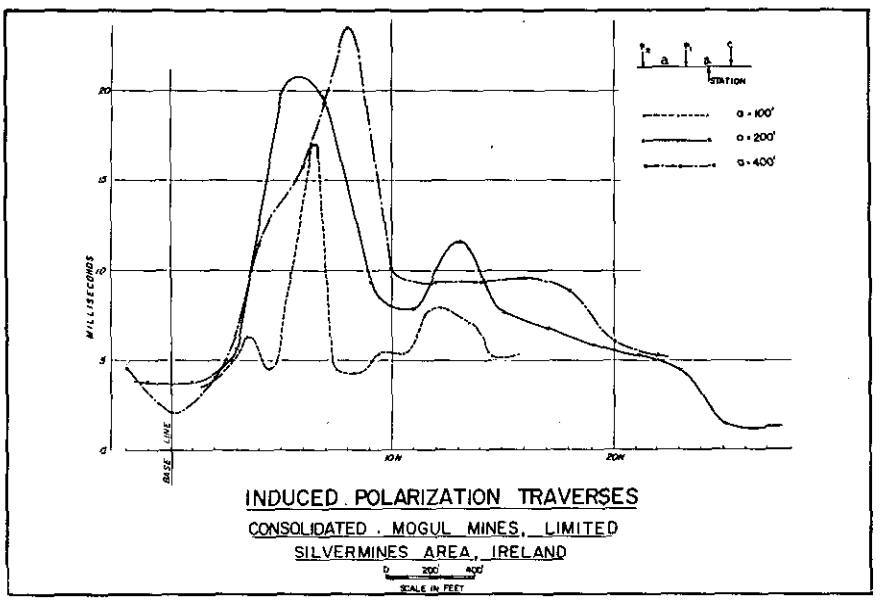

Figure 7.—Multiple Spacing Results, Silvermines Deposit.

Gortdrum Deposit

The Gortdrum area, near the mutual border of Cos. Limerick and Tipperary, was originally selected to cover the eastern extension of the former Oola Mines lead-zinc deposit, some 3 miles to the west. Regional geochemical sampling of the stream sediments in this area, followed by soil traverses, indicated a moderately strong copper soil anomaly. Induced polarization surveys were carried out in May, 1963, and January, 1964, leading to the localization of the sulphide mineralization associated with the geochemical anomaly. As there was a 300-ft. lateral displacement between the centers of the geophysical and geochemical indications and the surface topography is very gentle, it was initially queried as to whether the two indications

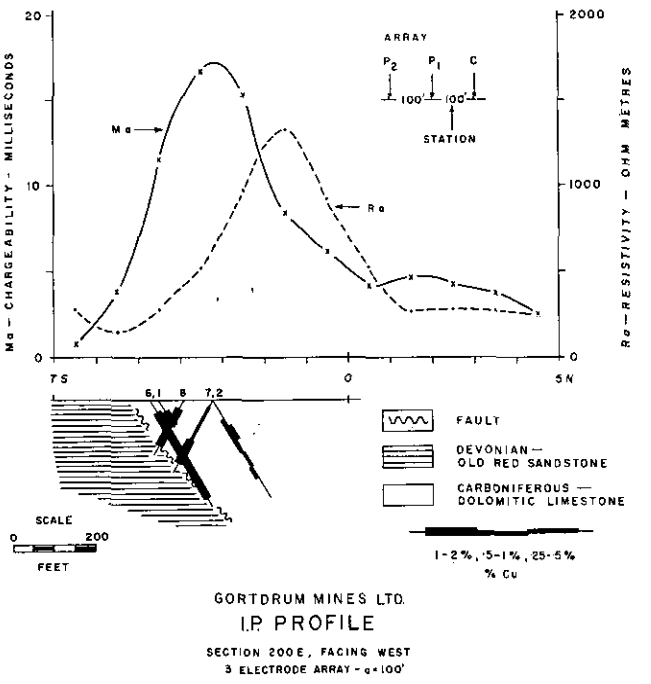

Figure 8.—Typical Discovery Traverse, Gortdrum Deposit.

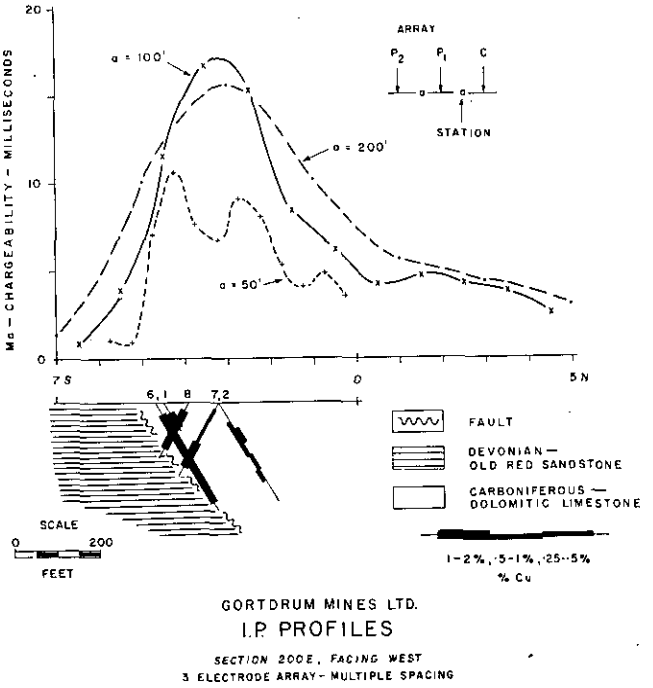

Figure 9.—Multiple Spacing Results, Gortdrum Deposit.

were related. The subsequent drilling has fully confirmed the geophysical predictions.

On the initial two geophysical programs, the three-electrode array with 100-ft. spacing was employed, as a relatively shallow source of the geochemical anomaly was expected. The survey lines were at 200-ft. intervals. Figure 8 presents a typical discovery traverse, showing both the chargeability and resistivity profiles as well as the corresponding geologic section. A peak chargeability of about 17 milliseconds is observed, rising from the normal background of 2-4 milliseconds. There is no resistivity expression of the mineralized zone, lying as it does on the flank of a high-resistivity area.

Figure 9 shows the chargeability profiles for electrode spacings of 50, 100 and 200 ft. Points of special interest deduced from these profiles include the following:

1.—The extremely sharp cut-off of the high chargeability levels on the south side of the area and the gradual drop-off in level on the north side. This was inconsistent with the thought of a bedded-type deposit conformable with the limestones, which are known to dip flatly to the south. A fault or other contact was postulated, dipping steeply, probably to the north. The initial drill holes on the section (Nos. 1, 2 and 6) were drilled to the north on the original geologic-dip premise, but the later holes (e.g., Nos. 7 and 8) have all been drilled to the south.

2.—The high-polarization material does not quite outcrop, but still comes within about 25 ft. of the ground surface across a width of about 200 ft., including two or more lenses. This material extends to at least 200 ft. in depth.

The actual drilling results confirm the presence of a zone of finely disseminated chalcocite and bornite, with very minor chalcopyrite, in dolomitic limestones. The mineralization is somewhat erratically distributed but, in general, increases as one approaches a north-dipping fault, which brings the limestones into contact with the Devonian Old Red sandstones. This fault has been found to strike about N 70°E. Geologically, therefore, this environment is almost identical to that of the Tynagh and Silvermines deposits. The mineralization in the Gortdrum area is quite different, however, both in type and amount. The average grade of the deposit is less than 2 per cent copper, with about 0.65 ounce of silver for each 1 per cent copper (although considerable potential open-pit tonnage may exist), so that the average sulphide content, by volume, is 3 per cent or less. The high chargeability responses observed over this deposit are a remarkable tribute to the sensitivity of the pulse-type induced polarization method, particularly when dealing with truly disseminated-type sulphide mineralization with a small average particle size.

As development drilling is still in progress on this deposit, no over-all grade or tonnage figures have as yet been released.

Keel Deposit

The deposits near Keel and Longford, Co. Longford, occur on a known limestone-sandstone contact, which is, no doubt, one of the reasons why exploration interest was attracted thereto. Soil sampling traverses by Riofinex Ltd., an exploration subsidiary of Rio Tinto-Zinc Corporation, Ltd., established the presence of anomalous lead and zinc concentrations. A horizontal-loop electromagnetic survey was initially executed in another attempt to determine the source of the geochemical indications, but with negative results. This was followed by induced polarization surveys in November and December, 1962. The three-electrode array, with an electrode spacing of 200 ft., was employed on the reconnaissance survey. Anomalous chargeability zones were indicated and exploratory drilling commenced shortly thereafter. Although no publication of results has been made, they are of some potential interest, as drilling has continued, at intervals, to the present time.

Figure 10 shows a typical section across the prospect, presenting the geophysical and geochemical results in profile form, as well as the geological section interpreted from three holes. The relationship between the mineralized horizon, the geophysical peak and the geochemical peaks is a matter of considerable interest. The sub-outcrop of the mineralized horizon and the geophysical peak are in good agreement (see also Figure 11). The lead peak is displaced about 400 - 500 ft. down slope to the south. The zinc peak is displaced still another 300 ft. to the south. The actual topographic slope is only 1-2 degrees to the south, so that this displacement is difficult to account for on the basis of soil creep. There is only a minor resistivity depression associated with the mineralization, indicating why the electromagnetic survey failed to give any positive response to it.

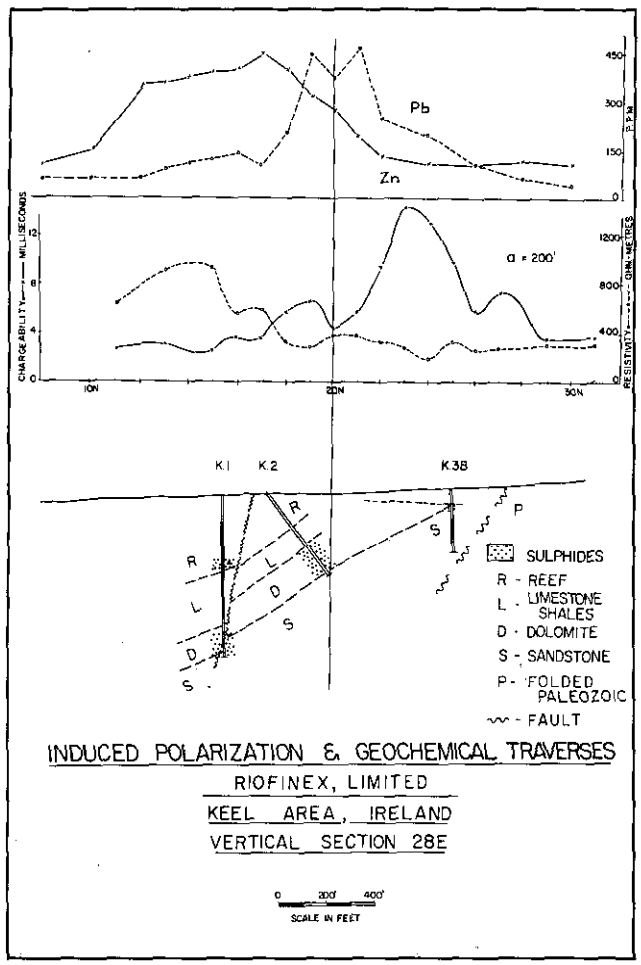

Figure 10.—Typical Discovery Traverse, Keel Deposit.

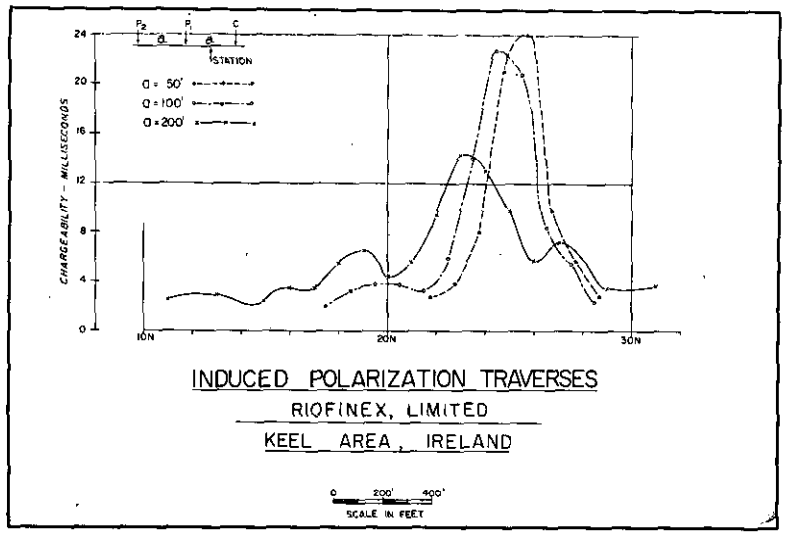

Figure 11.—Multiple Spacing Results, Keel Deposit.

The mineralization itself is primarily sphalerite, with some galena and, on the average, less than 5 per cent pyrite. It is found to lie primarily in a dolomite horizon adjacent to a contact with sandstone. In this case, the contact may be largely a depositional one and not due to a fault. Mineralization occurs to a minor extent in the sandstone as well.

Figure 11 shows the chargeability results of the multiple spacing profiles on this section. Spacings of 50, 100 and 200 ft. were used. The progressive step-out of the peak values to the south with the increase in electrode spacing indicates the effect of the relatively flat dip to the south of the mineralization. The sub-outcrop of the mineralization is near station 26N, at a depth of less than 25 ft. As hole K3B, only 100 ft. away, intersected almost 60 ft. of overburden one must conclude that the bedrock surface is rather irregular in this area. The peak chargeability of 24 milliseconds would suggest a metallic conductor content of the order of 6 to 12 per cent, by volume, in this area.

It is the writer's hope that he has not given the impression that every induced polarization anomaly in Ireland inevitably defines an orebody, or that every exploration venture there is crowned with success. Aside from effects due to the many man-made conductors, such as grounded power lines, rabbit fences and buried pipe lines, there are certain carbonaceous sediments, in particular the Calp limestone, which overlies the ore-bearing dolomitic limestone in some places, which yield high polarization responses. Fortunately, the areal distribution of the latter is usually broad enough to suggest a formational origin. Also, fortunately, the Calp is, stratigraphically, sufficiently well separated from the ore-bearing limestones so that the effect from these two horizons may be resolved. With the geological and geochemical information available, one can usually determine whether a particular induced polarization indication warrants investigation by drilling. Despite its limitations, the pulse-type induced polarization method has well demonstrated its application to a broad range of base metal exploration problems in Ireland.

Acknowledgments

The writer wishes to express his thanks to Consolidated Mogul Mines, Ltd., and Dr. W. W. Weber, to Gortdrum Mines, Ltd. and Dr. D. R. Derry, and to Rio Tinto-Zinc Corp. Ltd. and Mr. Jocelyn Pereira, for their kind permission to present the geophysical and other details relating to their respective mineral discoveries. In addition, the writer wishes to acknowledge the able assistance of the staff of Canadian Aero Mineral Surveys, Ltd., with which our company, Harold O. Seigel & Associates Ltd., has acted on a co-operative basis in Ireland.

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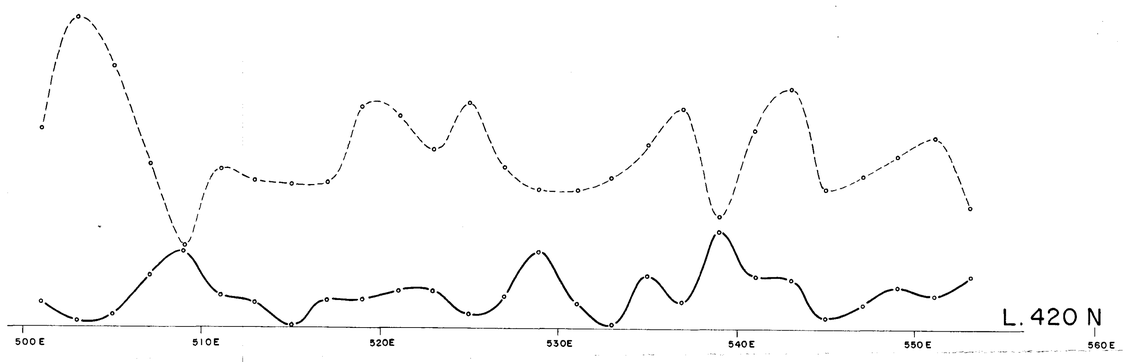
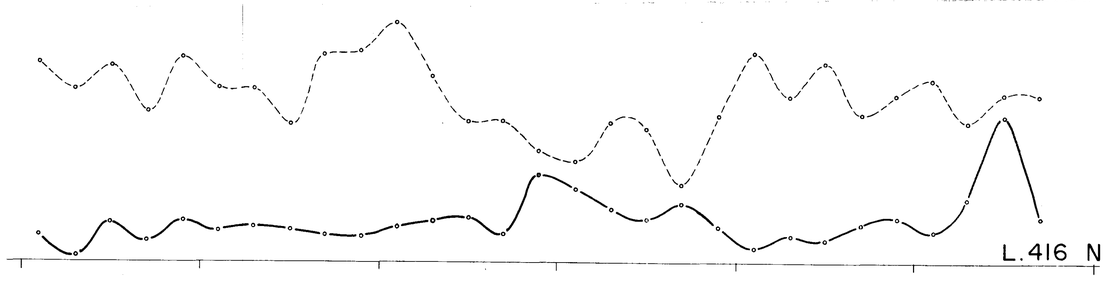
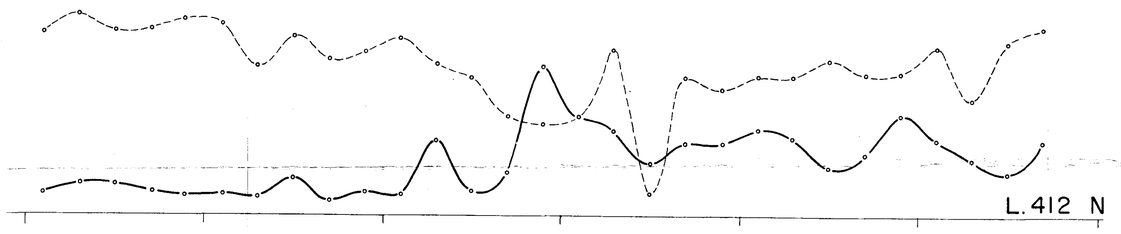
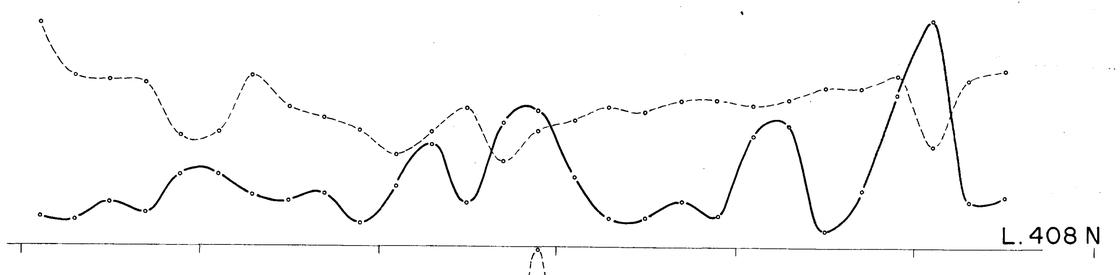
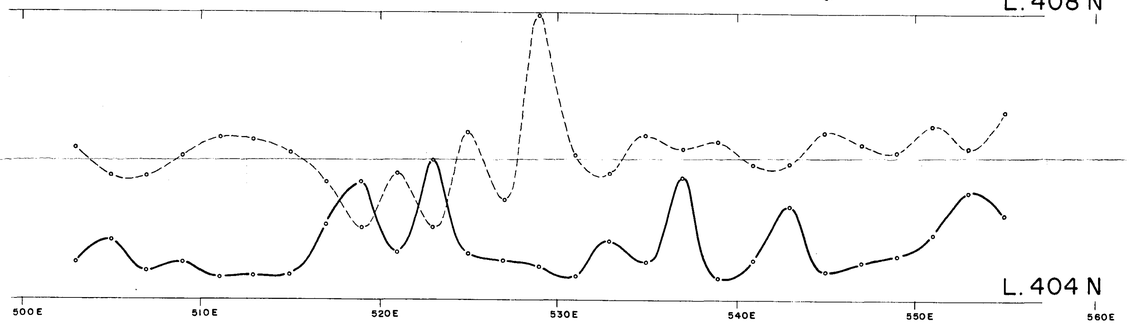
Printed in Canada

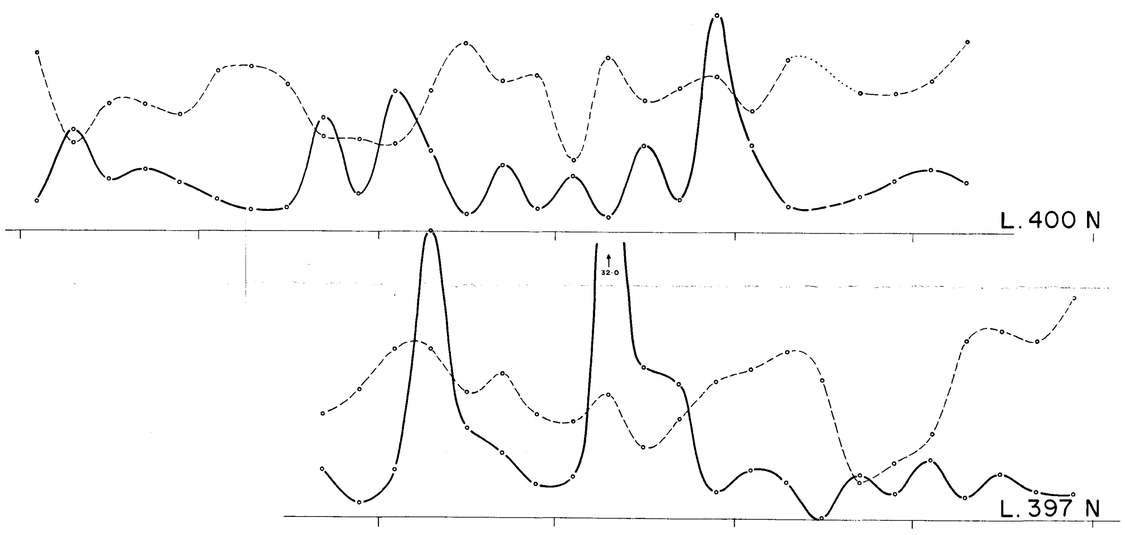


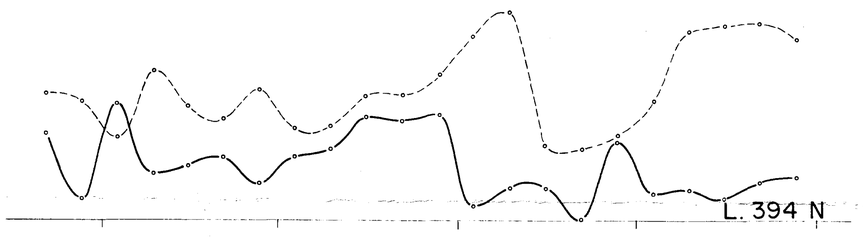


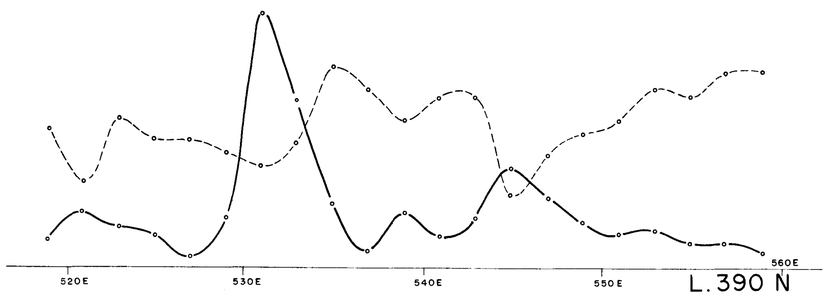


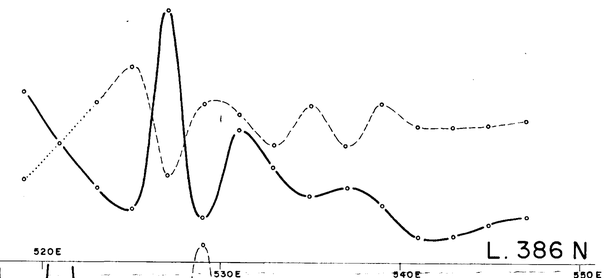


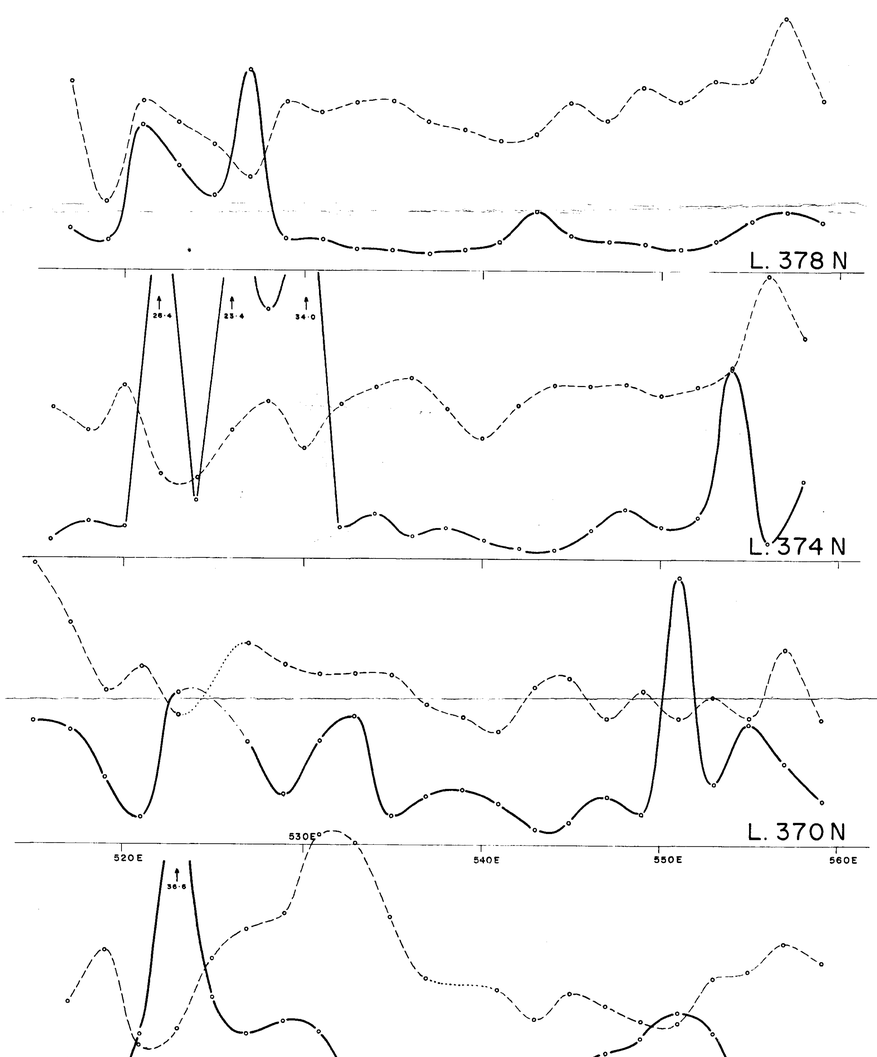


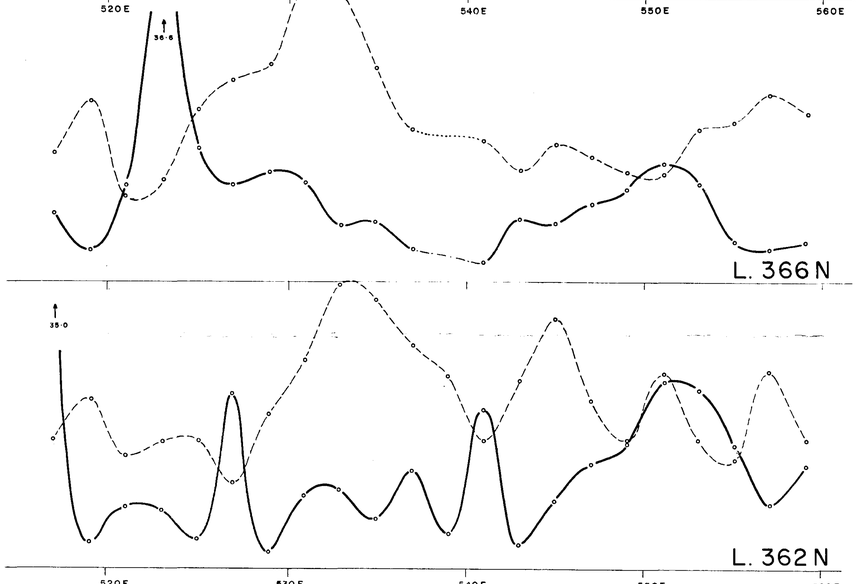












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ELECTRODE SPACING:

a = 400'
a = 200'
a = 100'
a = 50'

NOTES: INTERLINE SPACING NOT TO SCALE
THREE ELECTRODE ARRAY

PLATE I-A

BRALORNE PIONEER MINES, LIMITED

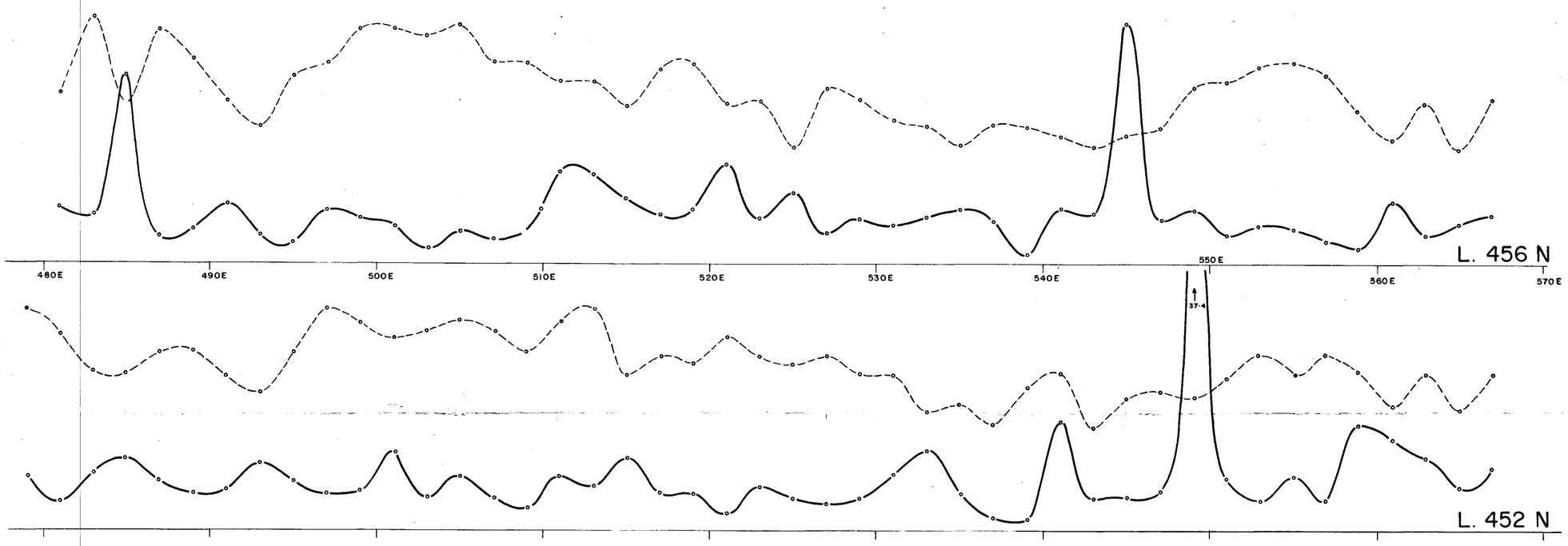
CHATAWAY PROPERTY
BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY

764

SCALE: 1" = 400'

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED
March 1966



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ELECTRODE SPACING :

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a = 200'
a = 100'
a = 50'

NOTES : INTERLINE SPACING NOT TO SCALE.
THREE ELECTRODE ARRAY.

Department of
Mines and Petroleum Resources
ASSESSMENT REPORT
NO. 764 MAP #5

PLATE I-B

BRALORNE PIONEER MINES, LIMITED

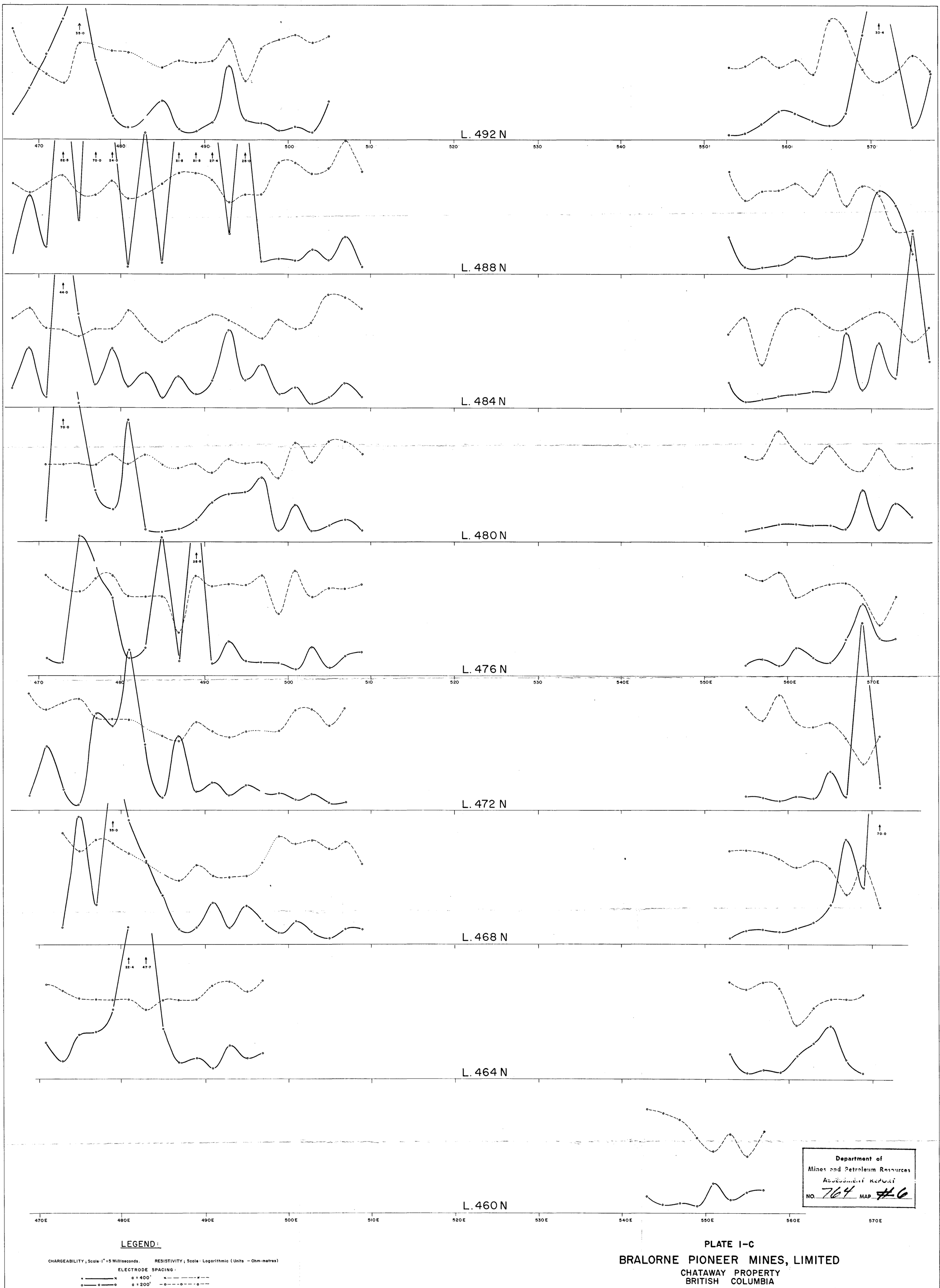
CHATAWAY PROPERTY
BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY

764

SCALE : 1" = 400'

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED
March 1966



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CHARGEABILITY ; Scale: 1" = 5 Milliseconds. RESISTIVITY ; Scale: Logarithmic (Units – Ohm-metres)

ELECTRODE SPACING:

a = 400'
a = 200'
a = 100'
a = 50'

NOTES: INTERLINE SPACING NOT TO SCALE.
THREE ELECTRODE ARRAY

PLATE I-C

BRALORNE PIONEER MINES, LIMITED

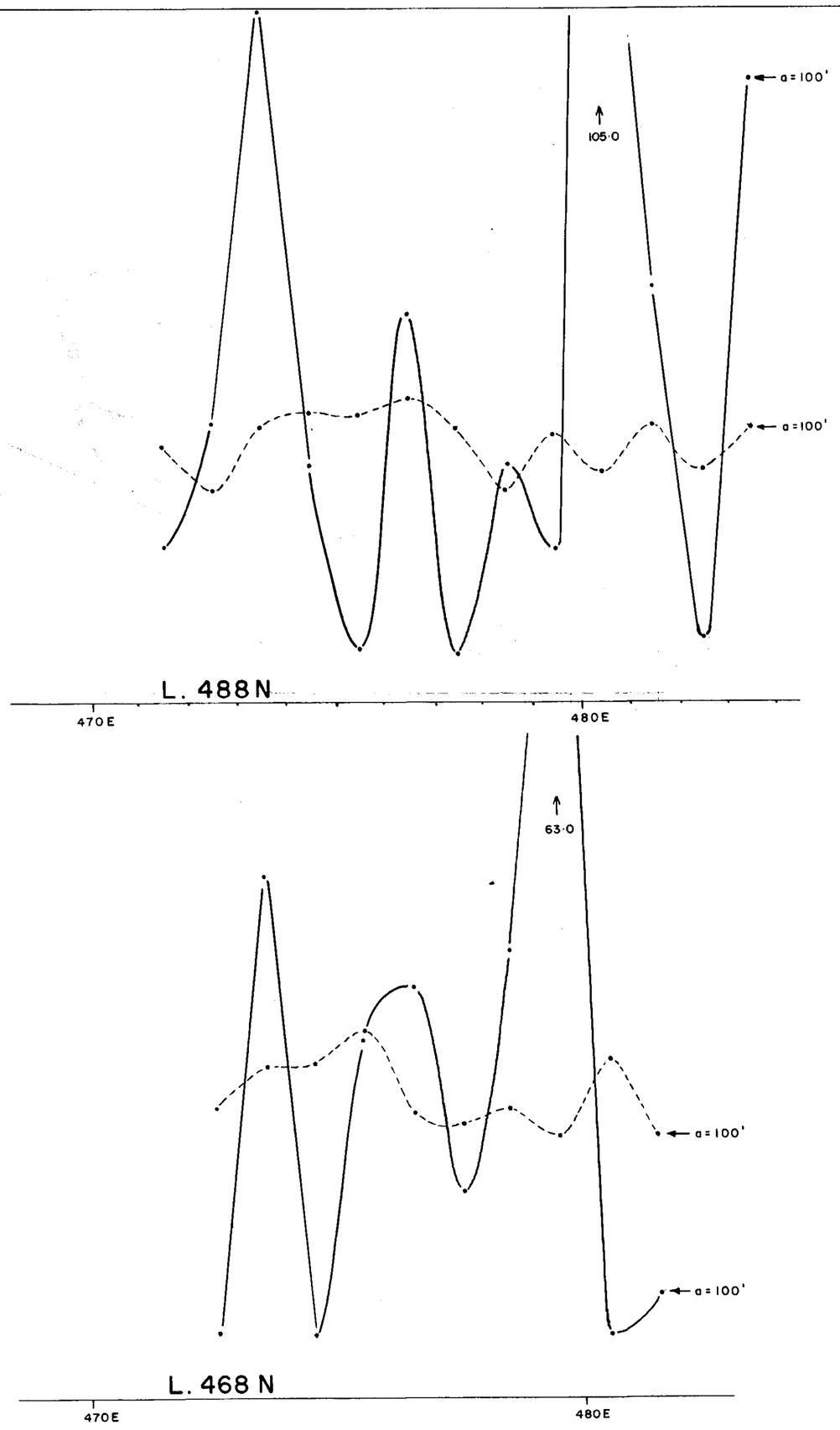
CHATAWAY PROPERTY
BRITISH COLUMBIA

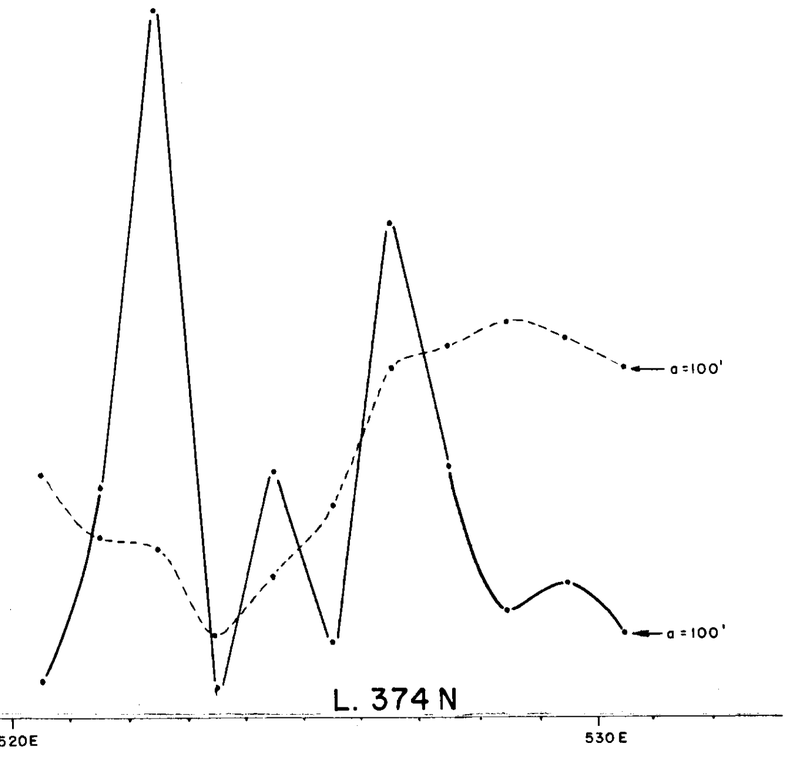
PROFILES OF INDUCED POLARIZATION SURVEY

764

SCALE: 1" = 400'

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED
March 1966





LEGEND :

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RESISTIVITY ; Scale : Logarithmic (See L. 404 N) — Units : Ohm-metres.

NOTES : Three Electrode Array

Electrode Spacing : a = as indicated.

Interline Spacing not to Scale.

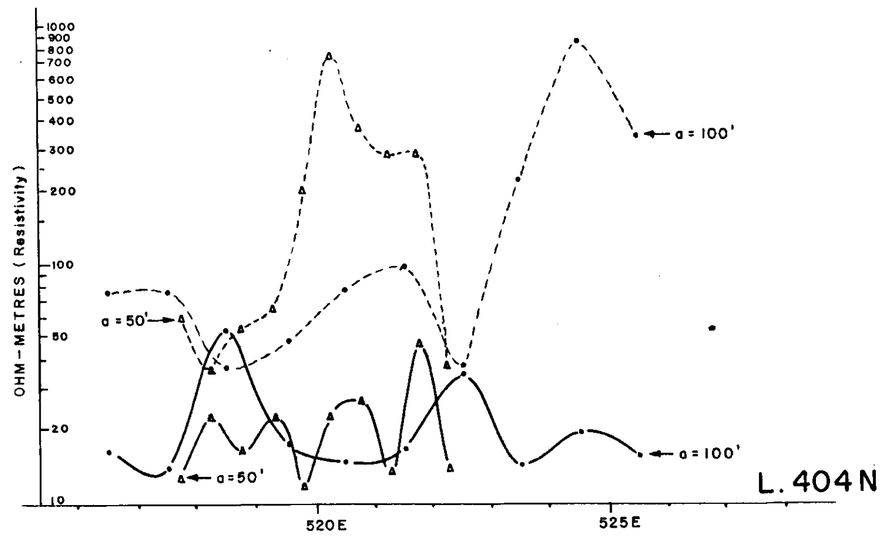


PLATE I-D

BRALORNE PIONEER MINES, LIMITED

CHATAWAY PROPERTY

BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY

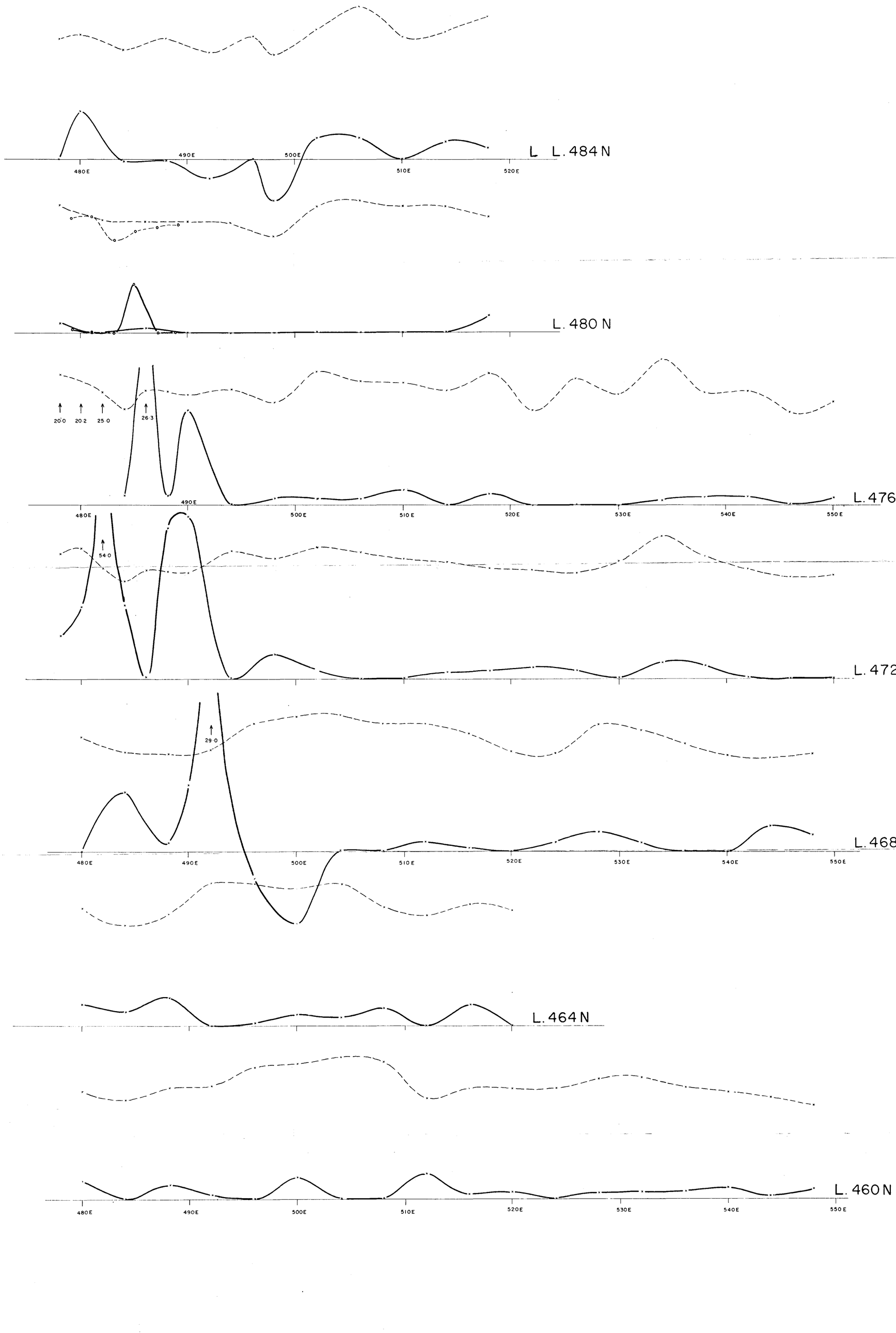
(DETAIL WORK)

SCALE : 1" = 200'

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED

March 1966

764



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ELECTRODE SPACING :

a = 400'
a = 200'
a = 100'
a = 50'

NOTES : INTERLINE SPACING NOT TO SCALE
THREE ELECTRODE ARRAY

PLATE 2-A

BRALORNE PIONEER MINES, LIMITED

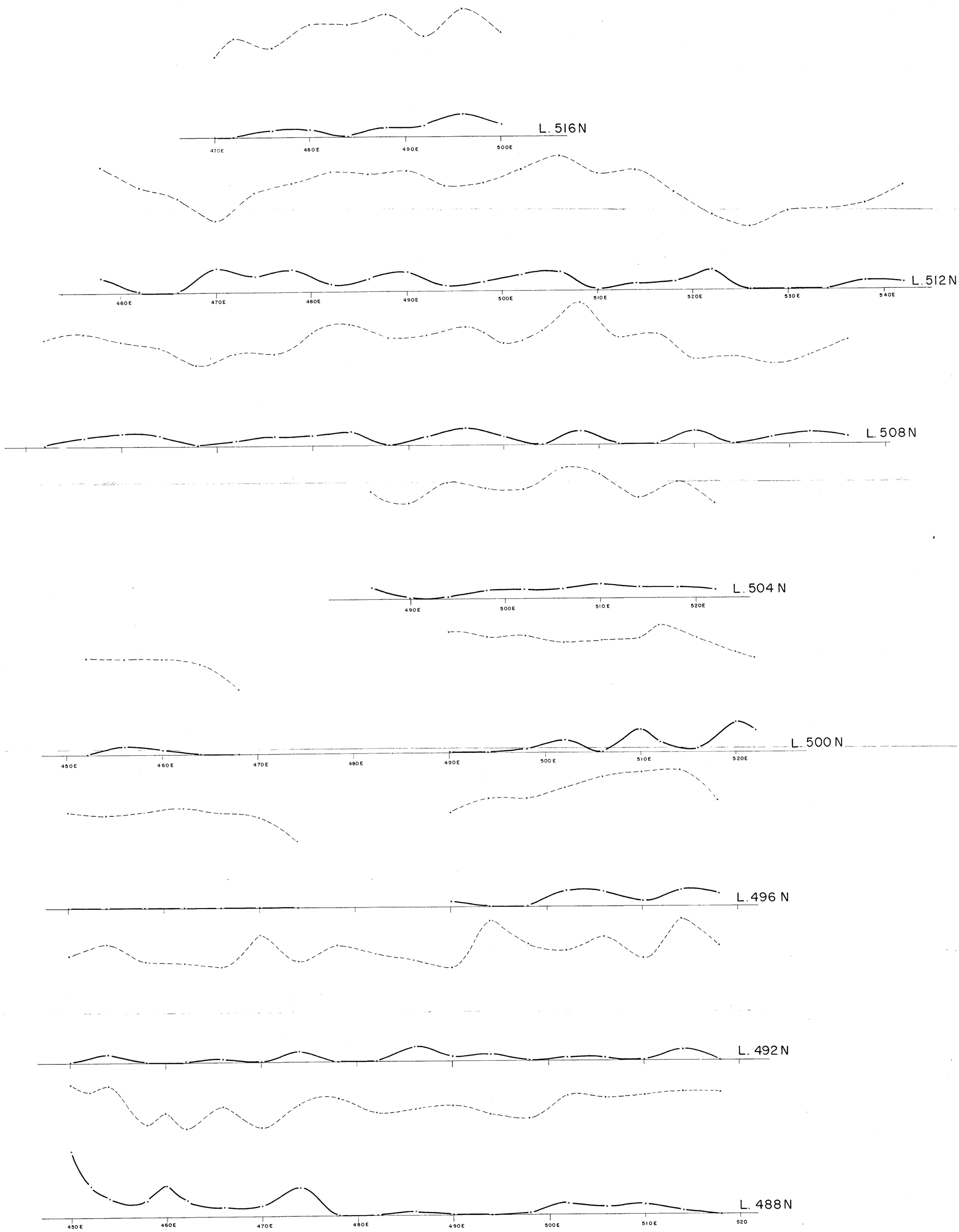
CHATAWAY PROPERTY
BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY

SCALE : 1" = 400'

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED
March 1966.

764



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ELECTRODE SPACING :

a = 400'
a = 200'
a = 100'
a = 50'

NOTES : INTERLINE SPACING NOT TO SCALE
THREE ELECTRODE ARRAY

PLATE 2-B

BRALORNE PIONEER MINES, LIMITED

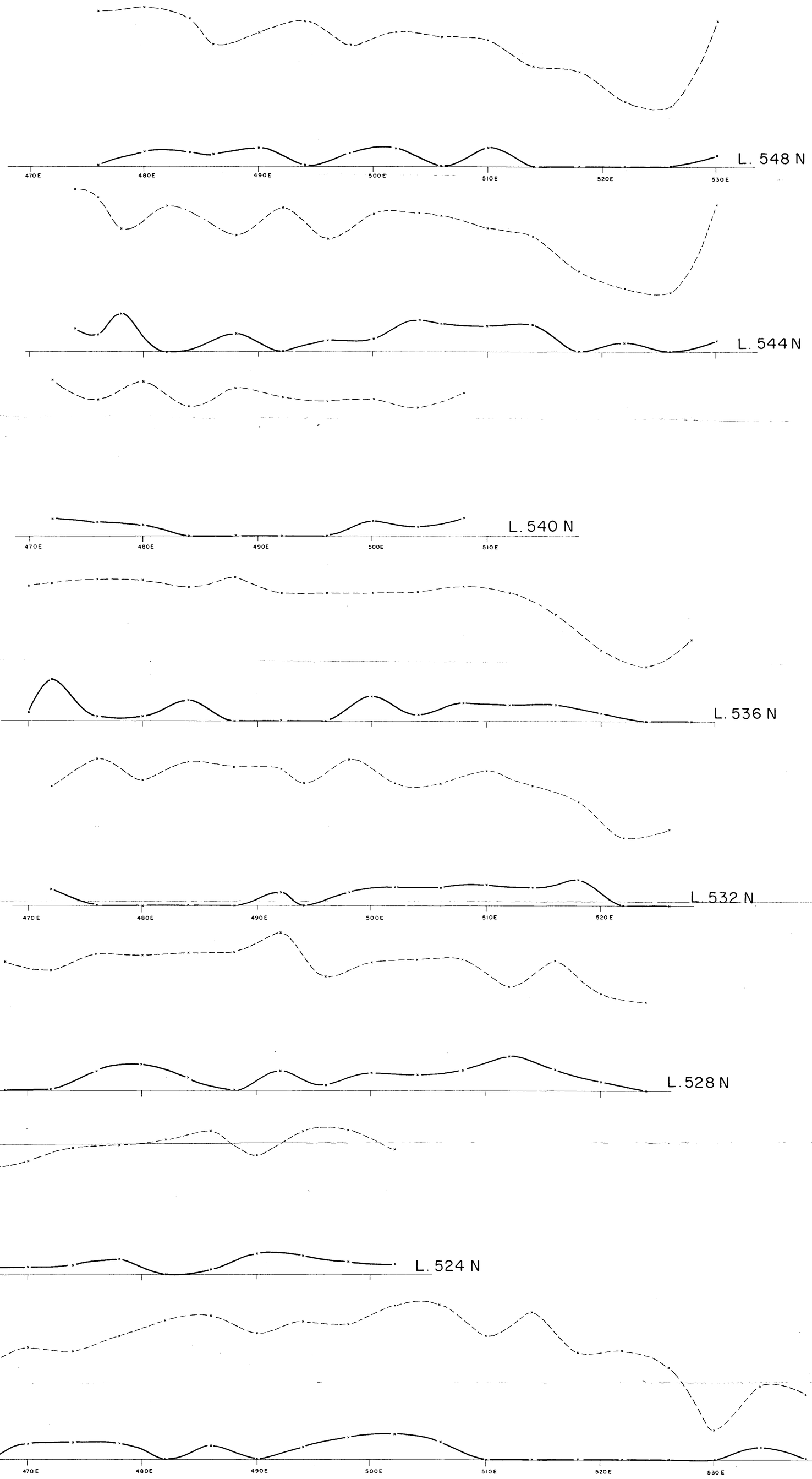
CHATAWAY PROPERTY
BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY

SCALE : 1" = 400'

764

SURVEY BY HAROLD O. SEIGEL & ASSOCIATES, LIMITED
March 1966.



LEGEND:

CHARGEABILITY ; Scale : 1" = 5 Milliseconds. RESISTIVITY ; Scale : Logarithmic (Units – Ohm-metres)

ELECTRODE SPACING :

a = 400'
a = 200
a = 100'
a = 50'

NOTES : INTERLINE SPACING NOT TO SCALE
THREE ELECTRODE ARRAY

PLATE 2-C

BRALORNE PIONEER MINES, LIMITED

CHATAWAY PROPERTY
BRITISH COLUMBIA

PROFILES OF INDUCED POLARIZATION SURVEY 764

SCALE : 1" = 400'

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