Expenditures Included with the reports of July 19/68 and July 24/68 for a Total $64,500

REPORT ON
INDUCED POLARIZATION
AND MAGNETOMETER SURVEYS
WHITEHORSE AREA, YUKON
ON BEHALF OF
LEWES RIVER MINES LIMITED

060689

by

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February 28, 1969

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SUMMARY

The present report is a compilation of induced polarization, resistivity and magnetic data taken on the Lewes River Mines property in the Whitehorse area, Yukon.

The induced polarization surveys have revealed two well defined areas of above normal chargeabilities plus a number of lesser indications. Two diamond drill holes each 500' in length are herein recommended to test the anomalous areas.

Further exploration by magnetometer and induced polarization surveys may be warranted on other areas of potential geologic interest revealed by the aeromagnetic survey which have not as yet been subjected to ground investigation.

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INTRODUCTION

In the spring and summer of 1968, airborne magnetic, ground magnetic and induced polarization-resistivity surveys were carried out in the Whitehorse area on behalf of Lewes River Mines Limited and have been described in a report by J. G. Baird dated July 24, 1968. Additional ground magnetic and induced polarization-resistivity surveys were carried out during the period November 13 to December 16, 1968. The ground geophysical data from both periods of exploration are considered in the present report.

The survey area is a belt of claims approximately 2 miles wide and 17 miles long trending northwest. The nearest point on the edge of the area is about one mile east of the town of Whitehorse. The Lewes (Yukon) River and the Alaska Highway run west of and parallel to the length of the claim group except at the south end where they turn eastwards across the property. Access to most of the property is by foot from the Alaska Highway. The claims covered in whole or part by the present surveys are held by Lewes River Mines Ltd.

The terrain is hilly and wooded and dotted with lakes. Elevations range from approximately 2100' above sea level to about 2500'. Rock outcrops are scarce.

In April and May, 1968, Seigel Associates executed a low level airborne magnetometer survey designed primarily to locate a contact between igneous and sedimentary rocks considered to be a favourable locale for ore deposits. The results of this survey have been discussed by R. O. Crosby, P.Eng. in a report dated July 8, 1968. On the basis of these airborne magnetics, areas have been chosen for ground magnetic and induced polarization-resistivity surveys.

Seigel MkVI time domain (pulse-type) induced polarization equipment was employed. The transmitting unit has a rating of 2.5 kw and equal on and off times of 2 seconds. The receiving unit was a remote ground-pulse type triggered by the rising and falling primary voltages set up in the ground by the transmitter. The integration of the transient polarization voltages takes place for 0.65 seconds after a 0.45 second delay time following the termination of the current-on pulse.

The purpose of an induced polarization survey is to map the subsurface distribution of metallically conducting mineralization beneath the grids covered. In the present area such mineralization could include chalcopyrite, bornite and other metallic sulphide minerals as well as magnetite, graphite and other minerals not always distinguishable from sulphides.

The accompanying copy of H. O. Seigel's paper entitled "Three Recent Irish Discovery Case Histories Using Pulse Type Induced Polarization" gives a description of the phenomena involved in this type of survey, the equipment employed, the field procedures and the nature of the results obtained over various base metal ore bodies.

Five grid systems, labelled Grid One through Grid Five, were cut with grid lines at 400' centres. The locations of the grid systems are shown on Plate 1 on the scale of 1" = ½ mile.

The three electrode array, with electrode separations of 300', was employed for the first stage of induced polarization survey on Grids One and Two. During the most recent survey, the three electrode array with electrode separations of 400' was employed. Station intervals were 200'. Certain areas of interest revealed by the reconnaissance work were covered in detail employing the three array and electrode spacings of 100', 200' and 400'. In one place on Grid Two a sounding using the Wenner expanding electrode array was made to attempt to determine the depth and characteristics of the overburden.

Sharpe MF-1 vertical force fluxgate magnetometers were used for the magnetometer surveys. The survey lines were 400' apart and stations were occupied each 100' along the lines.

GEOLOGY

The Lewes River Mines claims cover an area about 2 miles wide and 17 miles long trending in a northwesterly direction parallel to and about 4 miles east of the geologic horizon known as the Whitehorse Copper Belt. This horizon is approximately delimited by the boundary of the claims held by New Imperial Mines Ltd. as shown on Plate 1.

Sedimentary rocks of the Triassic Lewes River Group (largely limestone, dolomite and quartzite) have been intruded by the Cretaceous Coastal Intrusive batholith consisting of granite, granodiorite and dioritic rocks. In the Copper Belt, where the sedimentary and intrusive rocks come into contact, the sedimentary rocks have often been metamorphosed to scarns which in places contain copper mineralization. Two types of mineralized scarns are distinguishable:

1 - Bornite and chalcopyrite associated with magnetite

2 - Bornite and chalcopyrite associated with silicate gangue minerals and low magnetite content.

In addition, "Porphyry type" deposits with bornite and chalcopyrite disseminated in the intrusive rocks may occur.

The contact zones between limestone and granite are the most favourable locations for the formation of the scarn deposits although scarn mineralization often extends into the sedimentary rocks as much as 500' from such contacts. Roof pendants of limestone, embayments in the granite-limestone contact, and places where faults cross the contact are considered to be the most favourable locations for prospecting.

The best published description of the economic geology of the area is contained in G.S.C. Paper 63-41 "Copper and Iron Resources, Whitehorse Copper Belt, Yukon Territory" by E. D. Kindle, 1964. The report includes Map 49-1962, on a scale of 1" = 1 mile, which is a geological map of the region including and surrounding the present survey area.

G.S.C. Memoir 312 "Whitehorse Map Area, Yukon Territory" by J. O. Wheeler, 1961 and the accompanying map 1093A on the scale of 1" = 4 miles covers the geology of a large region around Whitehorse including the Copper Belt.

The following G.S.C. 1" = 1 mile aeromagnetic maps cover the Lewes River claims and surrounding area: Map 1342G - 'Cap Creek', Map 1341G - 'MacRae', Map 3376G - 'Whitehorse', and Map 3377G - 'Upper

Laberge'.

The surveys were flown with a 100' nominal terrain clearance and a three quarters of a mile to one mile interline spacing.

PRESENTATION OF RESULTS

Plate 1 shows the results of the low level aeromagnetic survey on a scale of 1" = ½ mile. This plate is a reduction of five plates presented by R. O. Crosby on a scale of 1" = 1000'. The approximate locations of the present survey grids are shown.

Plates 2, 5 and 9 are chargeability contour plans for all of the induced polarization data available on Grids One, Two and Four. The actual chargeability values are shown in milliseconds and a 2.0 millisecond contour interval has been adopted. On Plates 2 and 5 the results of magnetic surveys executed by Eagle Geophysics Limited have been shown in schematic form. The plan scale for all the plates is 1" = 400'.

Plates 3, 6 and 10 are resistivity contour plans for Grids One, Two and Four respectively. These data have been contoured at a logarithmic contour interval by showing the 200, 400, 800 and 1600 ohm-metre contours. The plan scale is again 1" = 400'.

Plates 4 and 7 show the results of the detailed induced polarization surveying on Grids One and Two in profile form. The vertical scales for these profiles are 1" = 5 milliseconds for chargeability and 1" = 500 ohm-metres for resistivity.

Plates 8, 11 and 12 show the results of magnetometer surveys on Grids Three, Four and Five respectively in contour form. The vertical magnetic intensity values are shown in gammas. Plate 8 has a 50 gamma contour interval while 100 gamma intervals have been adopted for the other grids. The plan scale is 1" = 400'.

DISCUSSION OF RESULTS

Grid One

As shown on Plate 2, the ground magnetics clearly define a southerly trending embayment in the interpreted intrusive-sedimentary contact. The present induced polarization survey grid covers most of the embayment and extends along the contact to the north. In addition, an area of high magnetic intensities occuring east of the contact has been covered by induced polarization surveying on lines 800' apart.

The chargeability contour plan reveals that background chargeability values vary from about 1.0 to 7.0 milliseconds, a range considered normal non-metallic response for the rock types expected to underlie the grid under conditions of variable overburden depth. The background readings in the north part of the grid are seen to be slightly higher than those in the south. This may be due to a shallower thickness of overburden in the north part of the grid or a change in rock type. Responses in excess of 8.0 milliseconds and well supported responses in excess of 6.0 milliseconds are considered worthy of further investigation.

One area of anomalous response is centred at about 59 E on L 20 N. Detail induced polarization results covering the anomalous sections of lines 16 N and 20 N are shown on Plate 4. The chargeability responses on L 16 N reveal a broad zone of moderately above normal values extending for about 1200' from 52 E to 64 E and the source is interpreted to approach to within about 50' of the surface at about 58 E. On L 20 N the profiles for all electrode spacings show nearly coincident peaks, and the anomaly is centred about station 59 E. The depth to the upper surface of the body may be somewhat deeper than on L 16 N. The chargeability response for this anomaly indicates that the polarizable source likely contains of the order of 1% average by volume of metallically conducting material. The anomaly lies within the area of higher magnetic response and just west of the interpreted contact.

A second area of anomalous induced polarization response is centred about 48 E on L 52 N. Detail profiles for the 200', 100' and 50' electrode spacings as well as the reconnaissance 400' spacing profile are shown on Plate 4. A peak chargeability observation of 18.8 milliseconds for the 50' electrode spacing occurs at 46 + 25 E on L 48 N. At this point the anomalous material may approach to within 15' of the ground surface. Quantitative interpretation of the detail profiles for L 48 indicates that most of the source material underlying the grid line occurs between stations 46 and 49 E. The depth to the upper surface of the major anomalous body is of the order of 30' and the body may contain approximately 2 to 3% by volume of metallically conducting material. The high chargeability area lies within an area of increased resistivities and straddles the contact as interpreted from the magnetics.

A third anomalous indication consists of two observations of 8.2 and 8.0 milliseconds at stations 140 and 142 E on L 56 N. The low amplitude and isolation of this response make it of lesser potential importance at the present time, however the indication does occur near the flank of an area of higher magnetic intensities and within a consistent zone of readings in excess of 6.0 milliseconds. As the line spacing in this area is 800', a sizeable body could lie just north or south of the present indication and not be detected on the flanking lines.

The resistivity contour plan on Plate 4 reveals that apparent resistivity values over most of the grid range from about 100 ohm-metres to about 800 ohm-metres. There is a steady gradient from low to higher resistivities in a westerly direction and the area of higher resistivities corresponds at least in part with the area of higher magnetic intensities. This resistivity pattern may indicate changes in the type or depth of overburden or changes in the bedrock. Igneous rocks are expected to have higher resistivity than sediments.

Grid Two

The background chargeability values in this area are much the same as over Grid One. Several localized indications of chargeabilities in excess of 6.0 milliseconds are noted and the highest amplitude chargeability observation is 10.0 milliseconds occurring at 8 W on L 98. Several profiles have been covered in detail and the results are shown on Plate 7. Changes in the electrode spacing did not cause increased chargeability response in any case.

The apparent resistivity values range from about 100 to 800 ohm-metres. Areas exhibiting apparent resistivities in excess of 600 ohm-metres have been shaded.

An attempt was made to determine the overburden depth using the Wenner expanding array centred about 10 E on L 82. The three array resistivity profile on L 82 shows a sharp high near the location of the test. This may reveal a sharp lateral change in resistivity such that an interpretation based on horizontal layers may not be valid. On the basis of only the shorter spacing values there is probably less than 10' of overburden near 10 E, however the overburden appears to deepen considerably immediately to the west.

Grid Three

The only geophysical work done to date on this grid is a magnetometer survey, the results of which are shown on Plate 8. The magnetic relief is seen to be much more subdued than that on the other survey grids. Except for a north-south trending high in the areas of Lines 32 and 36 E, the magnetic pattern is quite random and shows gentle gradients. The north-south distortion may be due to a near surface occurrence of igneous rocks or perhaps a dike, however if any further work is to be considered based on this magnetic feature, a few magnetic observations should be made to rule out the possibility of a base level error for the readings on L 36 E.

Grid Four

The contour pattern for the ground magnetometer survey reveals a feature similar to that shown by the low level airborne magnetometer survey. On Plate 11 areas exhibiting magnetic intensities in excess of 900 gammas have been shaded. The dominant feature is an arcuate magnetic high in the south central part of the grid which shows a magnetic relief in excess of 1500 gammas. Several steep gradients and sharp distortions are seen. The magnetic sources could lie within intrusive rocks or basaltic volcanic rocks which lie quite near the ground surface.

The chargeability contour plan of Plate 9 reveals that the background chargeability values are in the range of 1.0 to 6.0 milliseconds which is the same non-metallic response range observed on other grids. Areas exhibiting chargeabilities in excess of 6.0 milliseconds have been shaded. Such areas are randomly spaced throughout the grid and are quite small in area. The peak observed chargeability value is 8.0 milliseconds and occurs at 34 S on L 56 W. It is noted that this indication occurs on the flank of a prominent magnetic high and is still open to the south.

The apparent resistivity values range from a low of 17 ohm-metres to a maximum observed value of 1085 ohm-metres. The resistivity contour pattern does not bear any direct relation to either the chargeability contours or the isomagnetic contours and it is noted that one area of very low resistivities corresponds to a lake which was frozen at the time of the survey.

Grid Five

The only ground geophysical work done to date on this grid consists of a magnetometer survey, the results of which are shown on Plate 12. Areas exhibiting magnetic intensities in excess of 1000 gammas have been shaded. A gentle but steady gradient is seen to increase from east to west across the grid indicating that intrusive rocks may occur nearer the surface in the western portion of the grid. The results of the ground survey are quite in agreement with the results of the airborne survey.

CONCLUSIONS AND RECOMMENDATIONS

Induced polarization surveys to date have located two zones containing sufficient metallically conducting mineralization to warrant exploration by drilling. The following two holes located in Grid 1 are recommended to test these two zones:

Collar	Bearing	Inclination	Minimum Length
L 20 N, 62 E	S 70° W	45°	500'
L 48 N, 50 E	S 70° W	45°	500'

Many possibilities for exploration are still open within the area covered by the magnetic survey shown on Plate 1. The following is a list of possible exploration targets, the priority of which is subject to discussion and may be controlled as much by logistics and cost as by geological or geophysical inference. The exploration procedure in all areas would appear to be to cut grids, execute ground magnetic surveys and then cover selected areas with induced polarization surveys.

1. The area east of Grid 1 and south of Grid 4 should be well covered. There is some question as to how closely Grids 1 and 4 tie together so that there may be considerable area near the present anomalies which would require coverage by magnetics and induced polarization. A correlation of a limited chargeability rise with a sharp magnetic feature has been noted in Grid 4. Since magnetite is associated with contact metamorphic deposits on the New Imperial ground, this indication should be investigated.
2. Since fault A as interpreted from the magnetics shown on Plate 1 lies near the present two anomalies and to the Cowley Park deposit of New Imperial Mines, further exploration along the fault to the north may be warranted. The area on the northwest side of the fault may be of particular interest since the distortion of the magnetic contours as shown on Plate 1 may indicate the occurrence of intrusive rocks.
3. Ground surveys could be executed further north along the interpreted contact. Grid 5 has already been cut and magnetometer surveys show that the intrusive-sedimentary contact likely exists within the grid area. The north end of Grid 4 and Grid 5 could readily be covered by induced polarization surveying. It is noted that fault C as interpreted on Plate 1 occurs in the area.
4. The magnetic interpretation on Grid 3 indicates that the contact may not lie beneath the grid. The magnetic survey could be extended towards the south to locate the position of the contact. Induced polarization surveys may then be warranted.

5. The areas of low magnetics at D and E on Plate 1 may be associated with roof pendants of sedimentary rock. These structures have been found to be most favourable for formation of skarn mineralization in the Whitehorse Copper Belt.

6. The areas of the outlying intrusives G, H, I and J could be studied.

7. The distortions of the contact at locality C may reveal a favourable environment for ore deposition.

Considerable comment has been made about the possibility that great depths of overburden overlie the area, however little evidence of this is seen in the geophysical data to date. The low level airborne and ground magnetics indicate that in many places the magnetic sources are very close to ground surface. In addition, the background level of induced polarization chargeabilities generally indicates that there is not much more than 50' of overburden in the area surveyed. Further tests employing Wenner expander arrays may be used to provide precise interpretations of overburden depth.

Respectfully submitted,

SEIGEL ASSOCIATES LIMITED

Jon G. Baird

Jon G. Baird, B.Sc., P.Eng.
Geophysicist Ont and Y.T.

Vancouver, B.C.
February 28, 1969

DOMINION OF CANADA:

PROVINCE OF BRITISH COLUMBIA.

TO WIT:

In the Matter of

a geophysical survey on behalf of Lewes River Mines Ltd.

I, E. M. Flett of Seigel Associates Limited

of 750 - 890 West Pender St., Vancouver

in the Province of British Columbia, do solemnly declare that an induced polarization and magnetometer survey has been executed on behalf of the above company in the Whitehorse area, Yukon between November 13 to December 16, 1968. The following expenses were incurred:

(1)	Wages			
	R. Lebrun	34 days @ $35/day		$1,190.00
	F. Bourqui	15 days		
	U. Kalbbrunner	34 days		
	R. Kirk	34 days		
	A. Albert	34 days		
	G. Potvin	34 days		
	R. Frisch	16 days		
		167 days @ $27.50/day		4,592.50
(2)	Transportation to the job			1,578.12
(3)	Transportation on the job			676.60
(4)	Food & Living Expenses			2,927.50
(5)	Electrodes			755.92
(6)	Use of geophysical equipment:			
	I.P. equipment - 34 days @ $50/day		$1,700.00	
	Magnetometer " - 34 days @ $10/day		340.00	2,040.00
(7)	Consulting Fees:			
	34 days @ $61.22/day			2,081.63
				$15,842.27

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 3rd day of April, 1969, A.D.

x E M Flett

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

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.

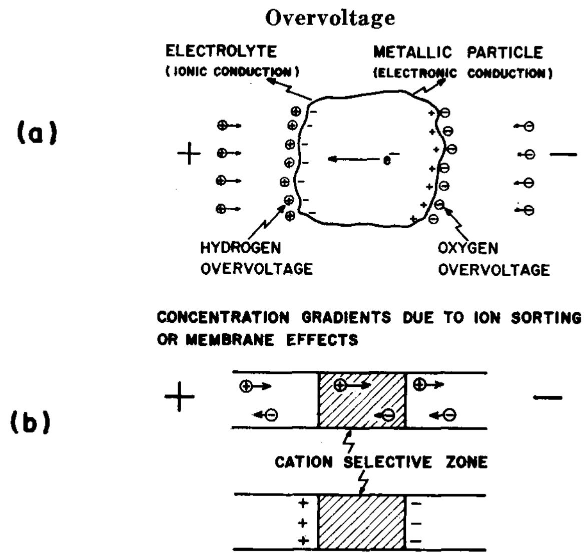


Figure 1.—Induced Polarization Agents.

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.

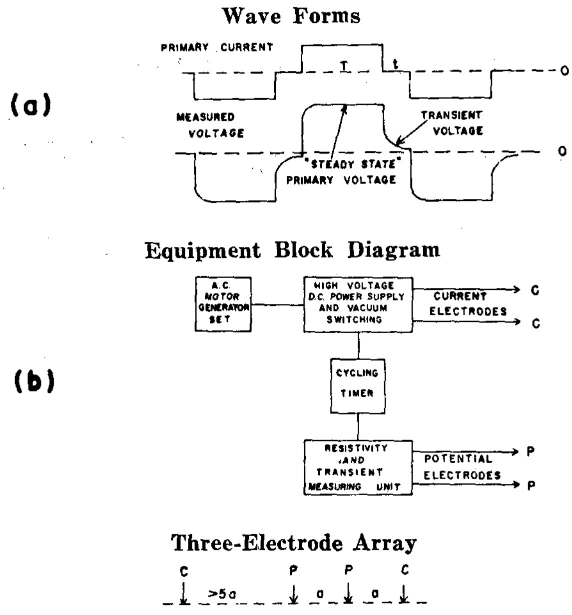


Figure 2.—The Pulse System.

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.

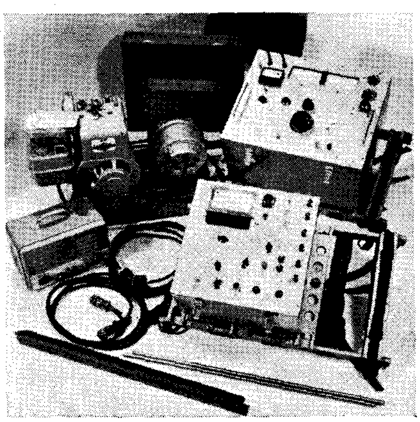


Figure 3.—(above)—The Seigel Mk V Induced Polarization Unit.

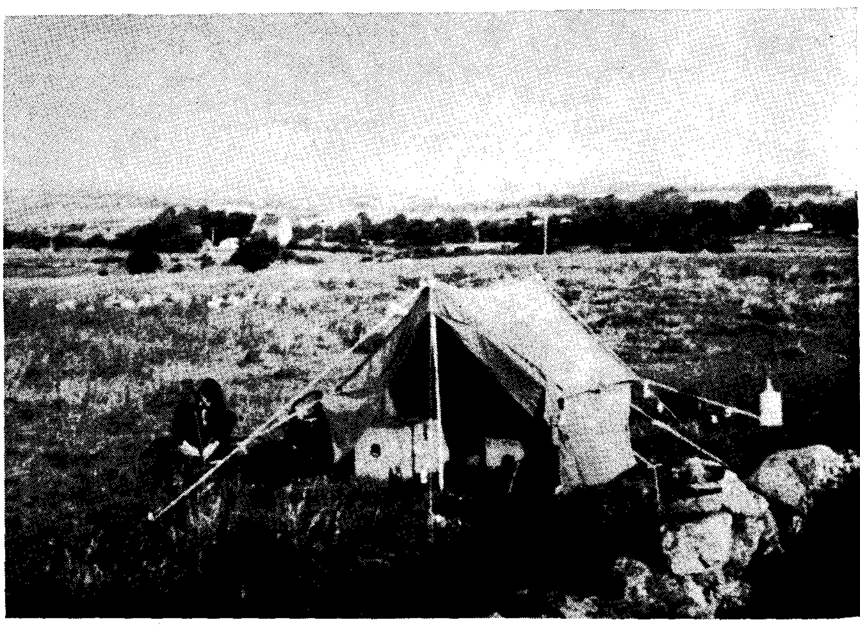


Figure 4.—(right)—Typical Field Operational Base in Ireland.

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.

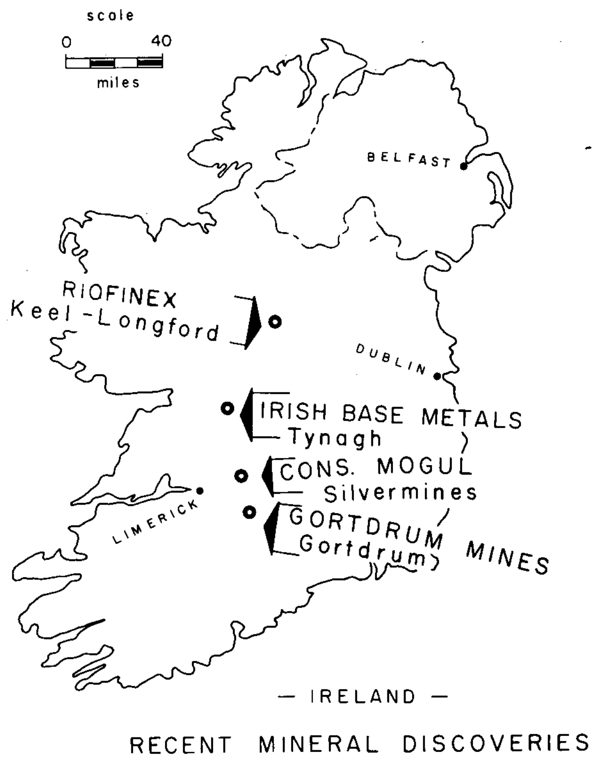


Figure 5.—Location Plan of Recent Mineral Discoveries in Ireland.

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.

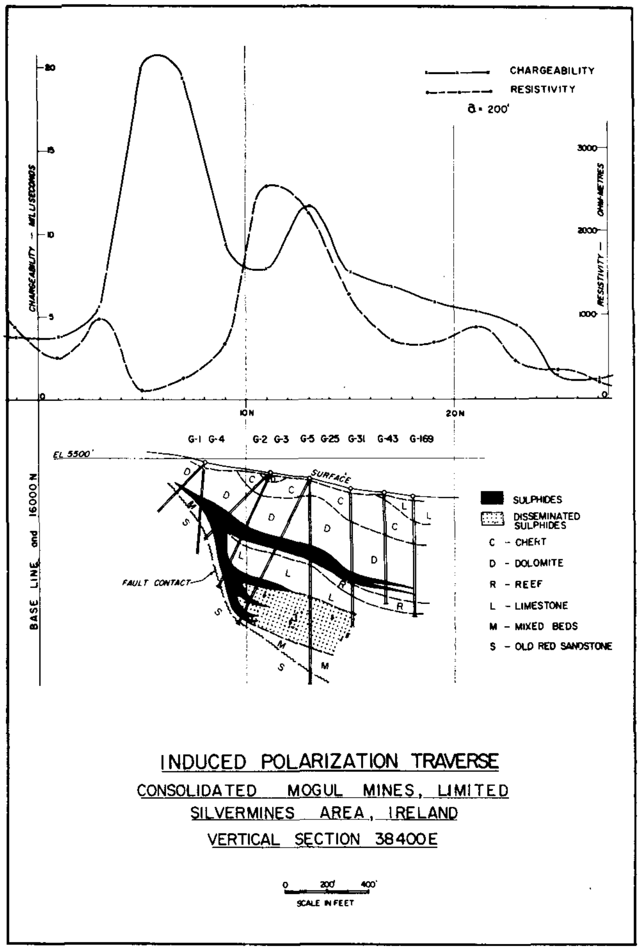


Figure 6.—Typical Discovery Traverse, Silvermines Deposit.

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.

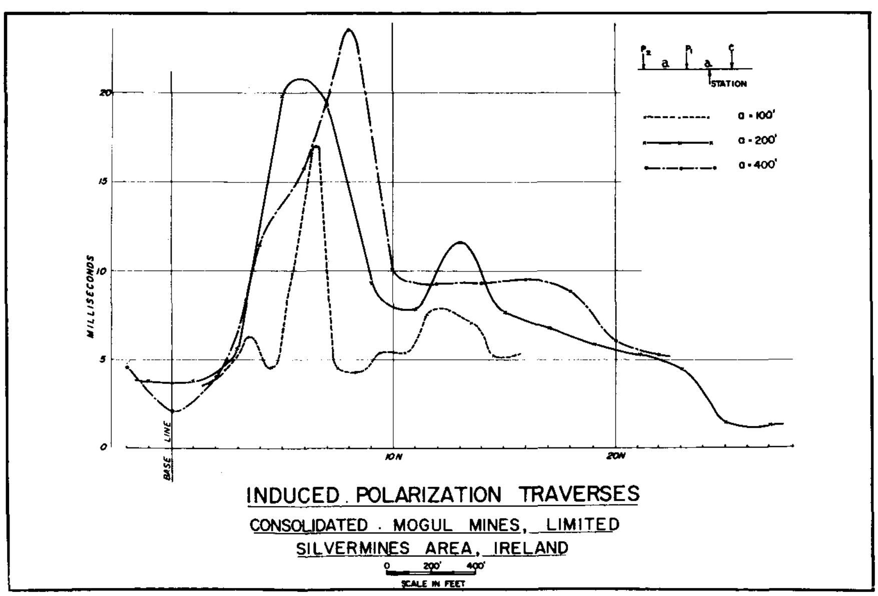


Figure 7.—Multiple Spacing Results, Silvermines Deposit.

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

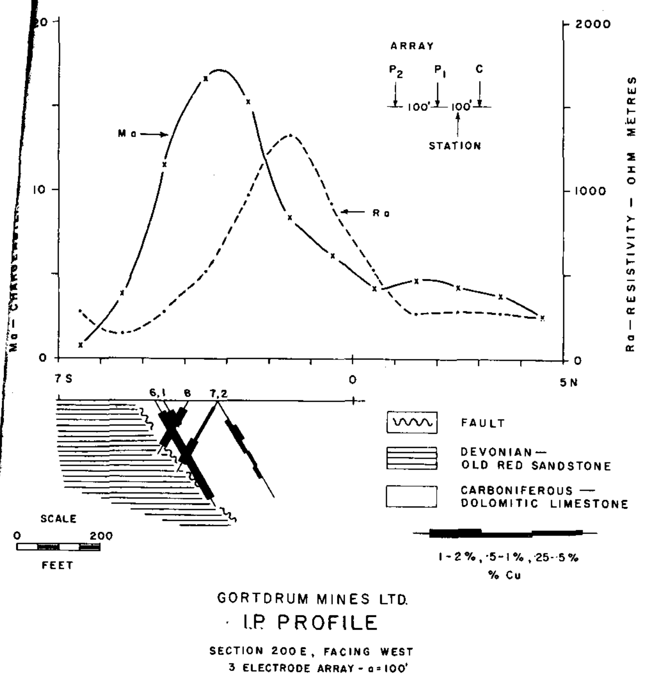


Figure 8.—Typical Discovery Traverse, Gortdrum Deposit.

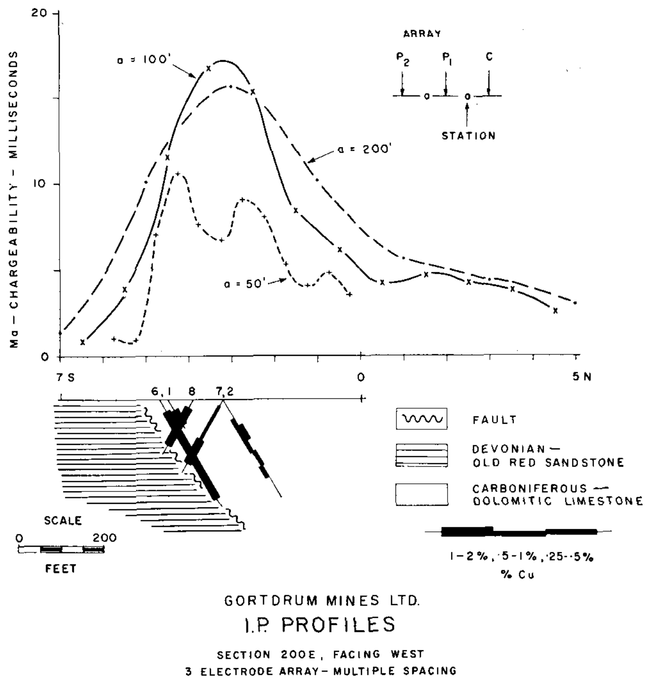


Figure 9.—Multiple Spacing Results, Gortdrum Deposit.

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.

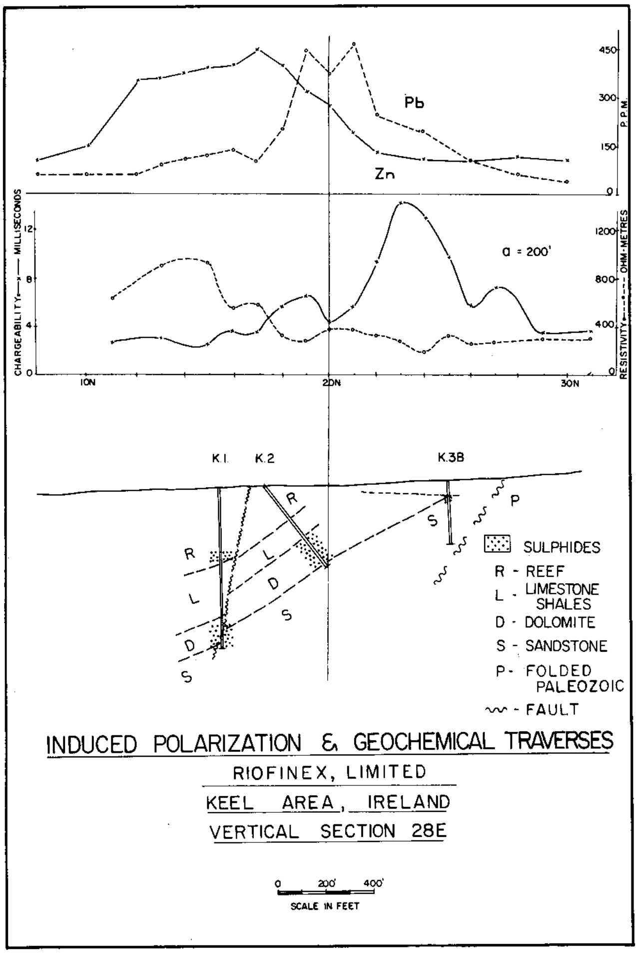


Figure 10.—Typical Discovery Traverse, Keel Deposit.

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.

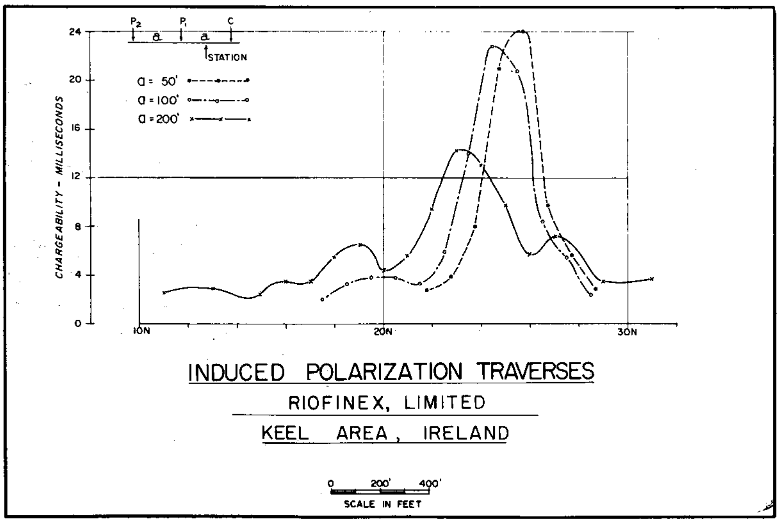


Figure 11.—Multiple Spacing Results, Keel Deposit.

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.

(*Reprinted from The Canadian Mining and Metallurgical Bulletin, November,* 1965)
Printed in Canada

LEGEND FOR ISOMAGNETIC CONTOURS

The planimetry for this map was obtained from a photo mosaic furnished by Lewes River Mines Ltd.

Total magnetic intensity at centre of survey area approximately 57,900 gammas with inclination 77° north.

Flight altitude normally 200 feet above ground

Flight line spacing approximately 500 and 1000 feet.

Base intensity arbitrary

Flight lines and photo identity points — 3870 — 3864 — 3860

Isomagnetic contours 500 Gammas
100 Gammas
Mag. Dep.

Interpreted contact — Igneous rocks / sedmentory rocks

Magnetic lineaments, Possible Faults

Possible upwards warping of Igneous rock

TO ACCOMPANY A GEOPHYSICAL REPORT BY
J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE I

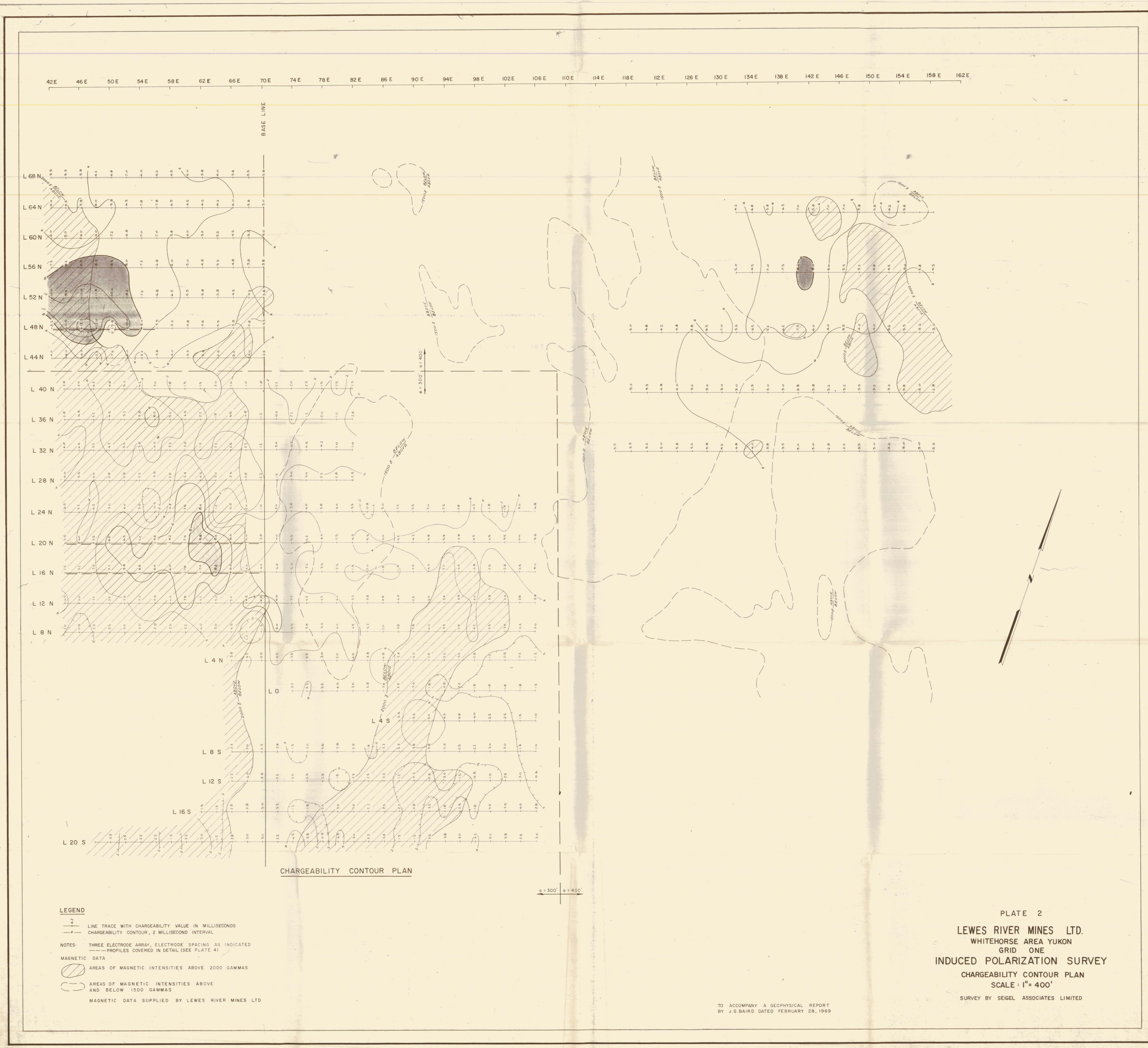
LEWES RIVER MINES LTD.

WHITEHORSE AREA, Y.T.

SURVEY GRID LOCATION PLAN

SCALE: 1" = 1/2 MILE

COMPILED FROM PLATES 1 THROUGH 5 OF A REPORT BY
R.O. CROSBY, SEIGEL ASSOCIATES LIMITED, JULY 8, 1968



CHARGEABILITY CONTOUR PLAN
BASE LINE
LEGEND
LINE TRACE WITH CHARGEABILITY VALUE IN MILLISECONDS
CHARGEABILITY CONTOUR, 2 MILLISECOND INTERVAL
NOTES: THREE ELECTRODE ARRAY, ELECTRODE SPACING AS INDICATED
PROFILES COVERED IN DETAIL (SEE PLATE 4)
MAGNETIC DATA
AREAS OF MAGNETIC INTENSITIES ABOVE 2000 GAMMAS
AREAS OF MAGNETIC INTENSITIES ABOVE AND BELOW 1500 GAMMAS
MAGNETIC DATA SUPPLIED BY LEWES RIVER MINES LTD
TO ACCOMPANY A GEOPHYSICAL REPORT BY J.G.BAIRD DATED FEBRUARY 28, 1969
PLATE 2
LEWES RIVER MINES LTD.
WHITEHORSE AREA YUKON
GRID ONE
INDUCED POLARIZATION SURVEY
CHARGEABILITY CONTOUR PLAN
SCALE : 1"= 400'
SURVEY BY SEIGEL ASSOCIATES LIMITED

PLATE 3

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON

GRID ONE

INDUCED POLARIZATION SURVEY

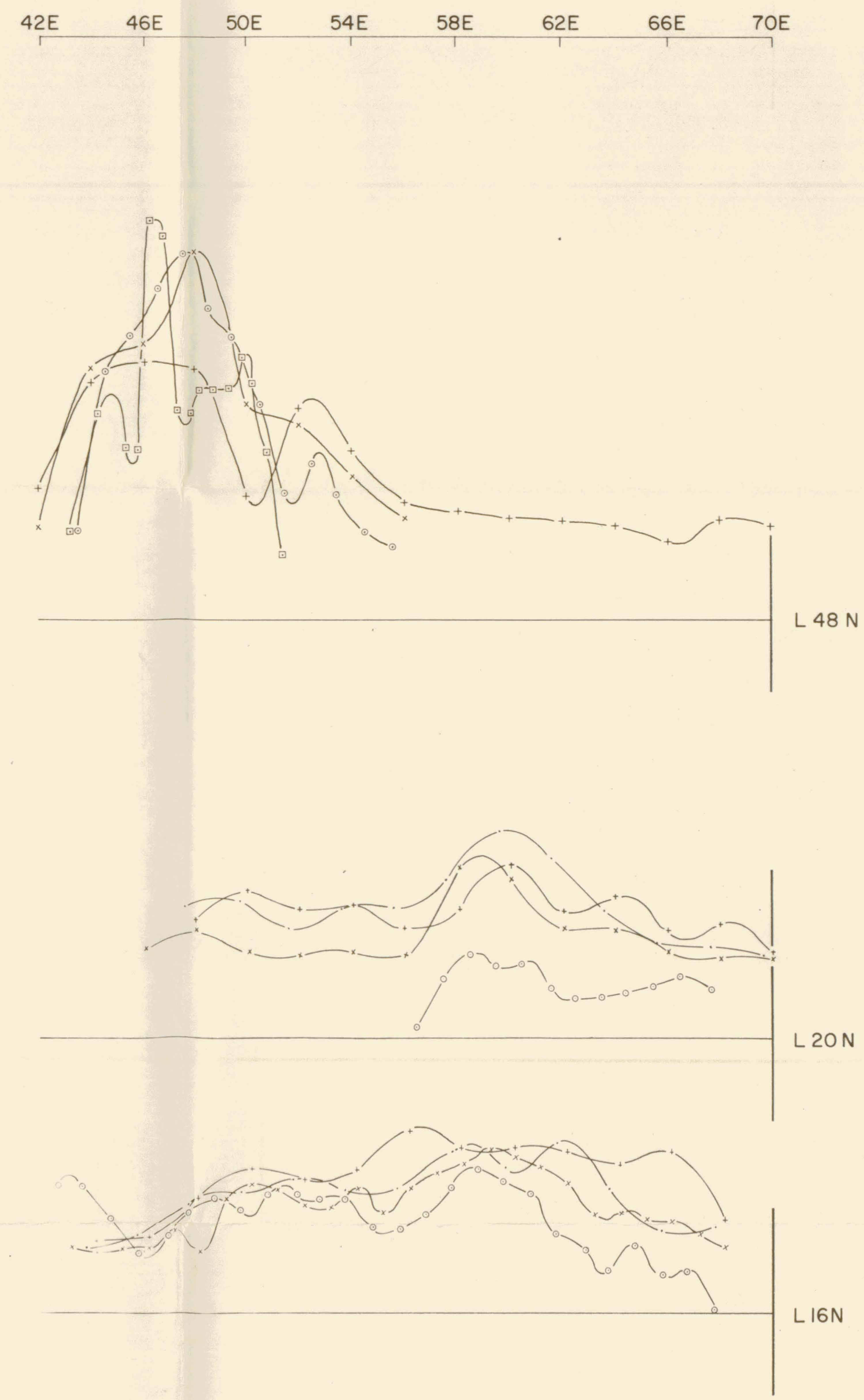
RESISTIVITY CONTOUR PLAN

SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED

TO ACCOMPANY A GEOPHYSICAL REPORT BY J.G. BAIRD DATED FEBRUARY 28, 1969

DETAIL RESISTIVITY PROFILES



DETAIL CHARGEABILITY PROFILES

LEGEND

SCALE: 1" = 500 OHM - METERS
ELECTRODE SPACING a = 400'
a = 300'
a = 200'
a = 100'
a = 50'

NOTES: THREE ELECTRODE ARRAY
MOVING CURRENT ELECTRODE TO EAST OF ARRAY
ELECTRODE SPACING AS INDICATED

SCALE: 1" = 5 MILLISECONDS
ELECTRODE SPACING a = 400'
a = 300'
a = 200'
a = 100'
a = 50'

PLATE 4

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON
GRID ONE

INDUCED POLARIZATION SURVEY

DETAIL PROFILES

SCALE: 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

CHARGEABILITY CONTOUR PLAN

PLATE 5

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON

GRID TWO

INDUCED POLARIZATION SURVEY

CHARGEABILITY CONTOUR PLAN

SCALE 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J. G. BAIRD DATED FEBRUARY 28, 1969

RESISTIVITY CONTOUR PLAN

PLATE 6

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON

GRID TWO

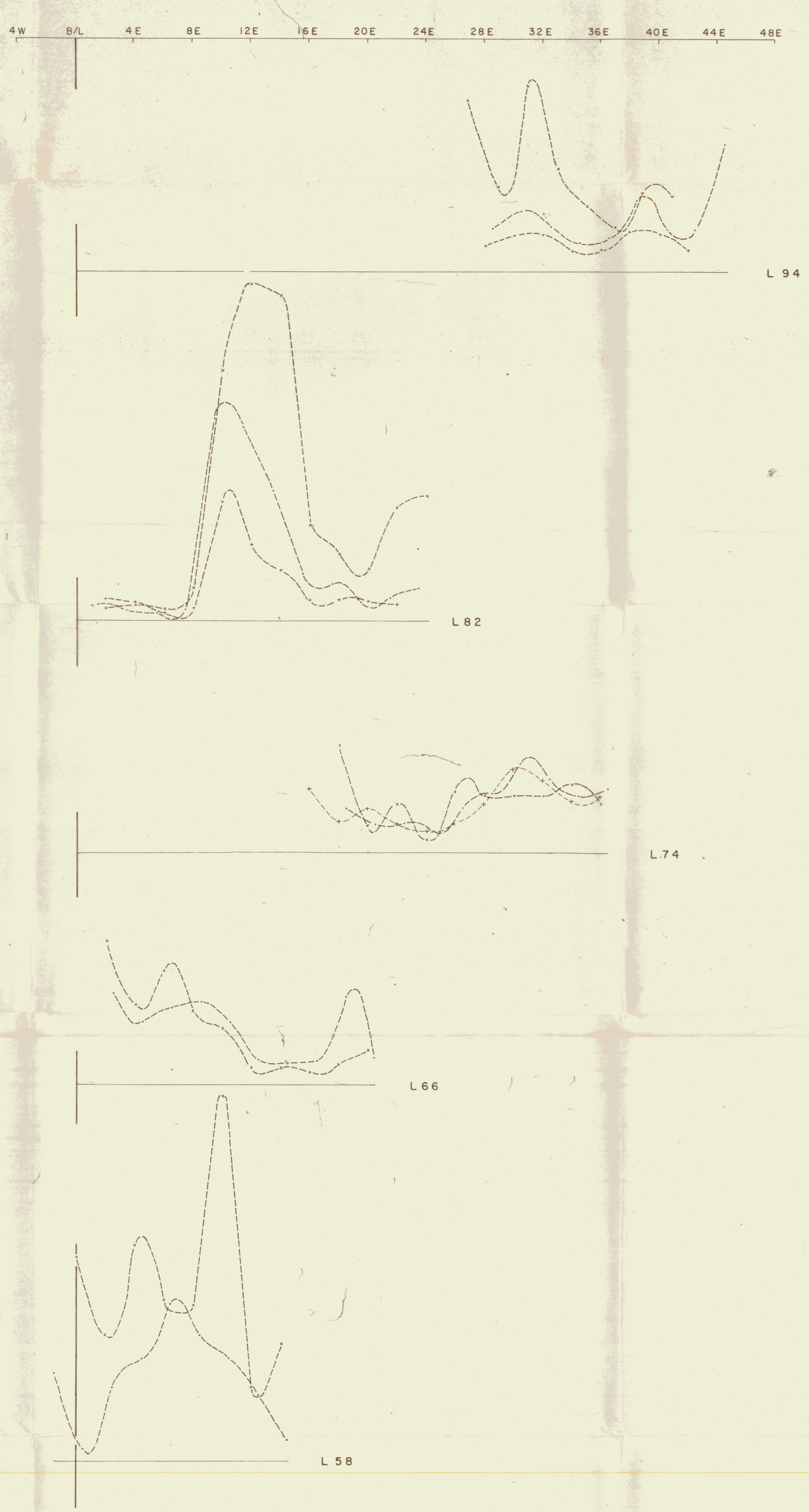
INDUCED POLARIZATION SURVEY

RESISTIVITY CONTOUR PLAN

SCALE 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969



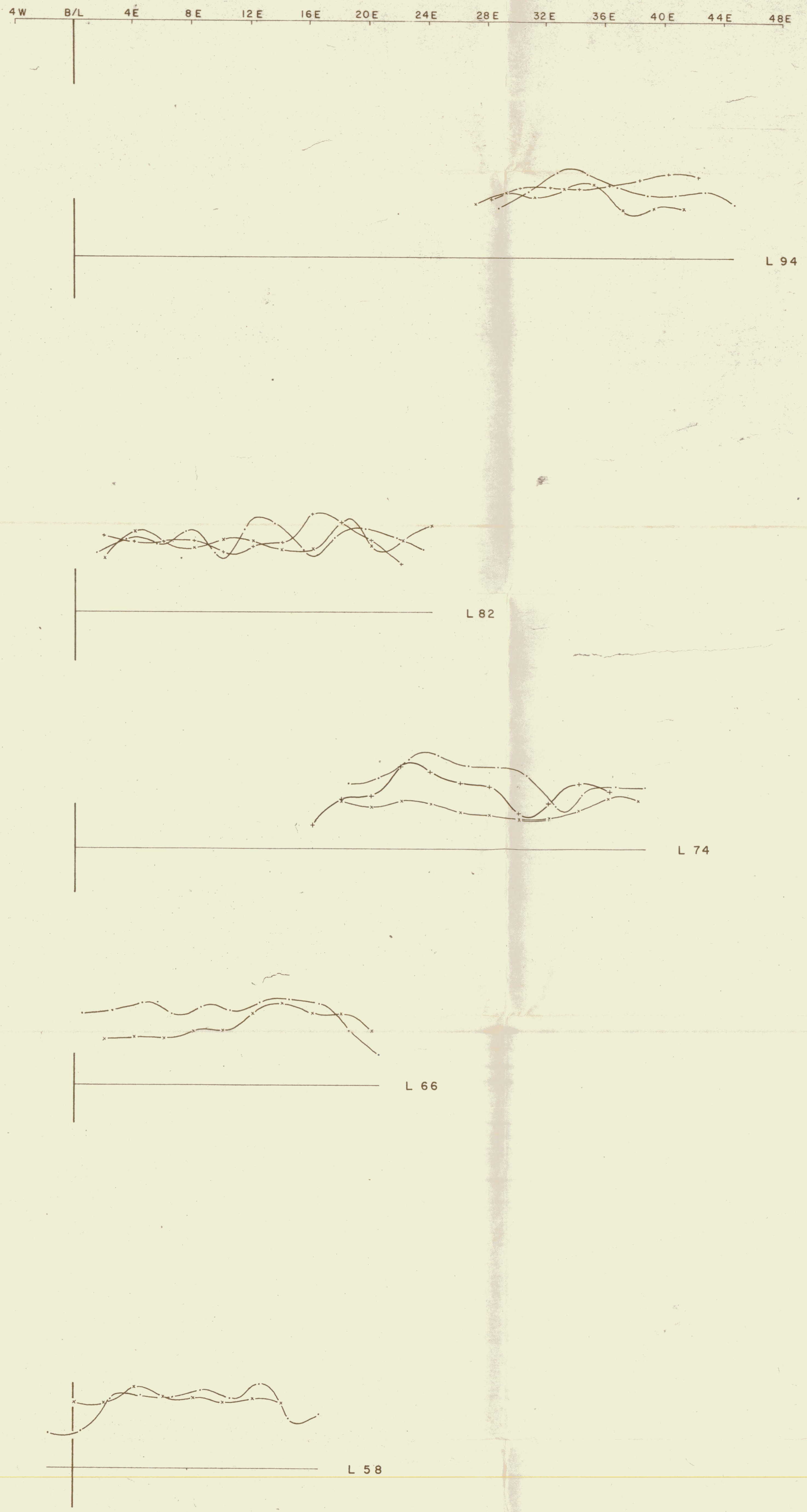
DETAIL RESISTIVITY PROFILES

LEGEND

RESISTIVITY SCALE : 1" = 500 OHM - METERS
ELECTRODE SPACING : a = 400' +——+——+
a = 300' ·——·——·
a = 200' ×——×——×
a = 100' ⊙——⊙——⊙

NOTES : THREE ELECTRODE ARRAY
MOVING CURRENT TO EAST OF ARRAY
ELECTRODE SPACING AS INDICATED

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969



DETAIL CHARGEABILITY PROFILES

LEGEND

CHARGEABILITY : SCALE : 1" = 5 MILLISECONDS
ELECTRODE SPACING : a = 400' +——+——+
a = 300' ·——·——·
a = 200' ×——×——×
a = 100' ⊙——⊙——⊙

NOTES : THREE ELECTRODE ARRAY
MOVING CURRENT ELECTRODE TO EAST OF ARRAY
ELECTRODE SPACING AS INDICATED

PLATE 7

LEWES RIVER MINES LTD.

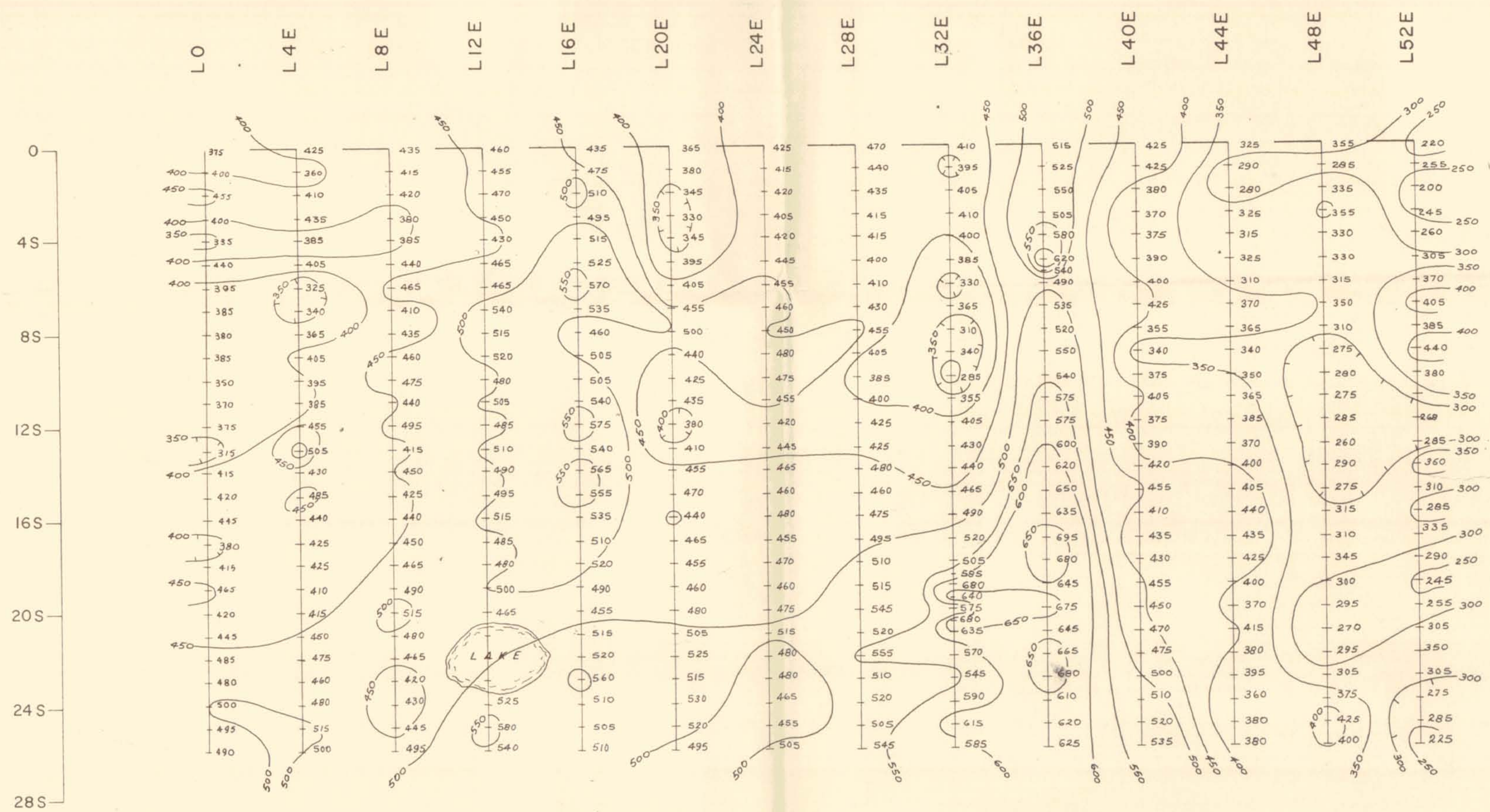
WHITEHORSE AREA, YUKON

INDUCED POLARIZATION SURVEY

GRID TWO

SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED



LEGEND

LINE TRACE WITH VALUE IN GAMMAS

ISOMAGNETIC CONTOURS.
50 GAMMA CONTOUR INTERVAL

NOTES:
MAGNETOMETER: SHARPE MF-1 VERTICAL FORCE FLUXGATE.

TO ACCOMPANY A GEOPYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE 8

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON

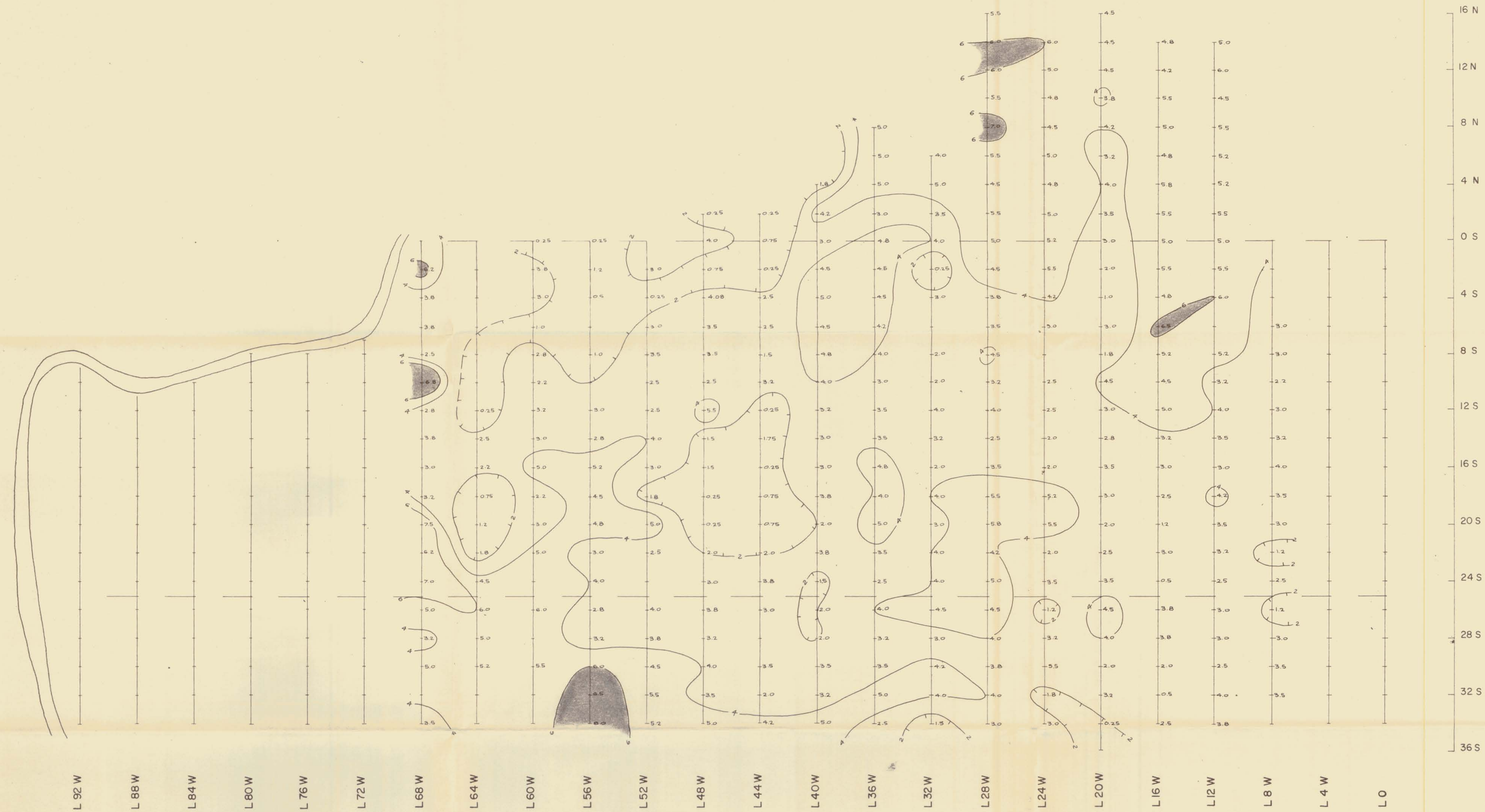
GRID THREE

MAGNETOMETER SURVEY

ISOMAGNETIC CONTOUR PLAN

SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED



LEGEND

LINE TRACE WITH CHARGEABILITY VALUE IN MILLISECONDS

CHARGEABILITY CONTOUR, 2 MILLISECOND INTERVAL

NOTES:

THREE ELECTRODE ARRAY a = 400'
SEIGEL MK.VI INDUCED POLARIZATION DATA

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE 9

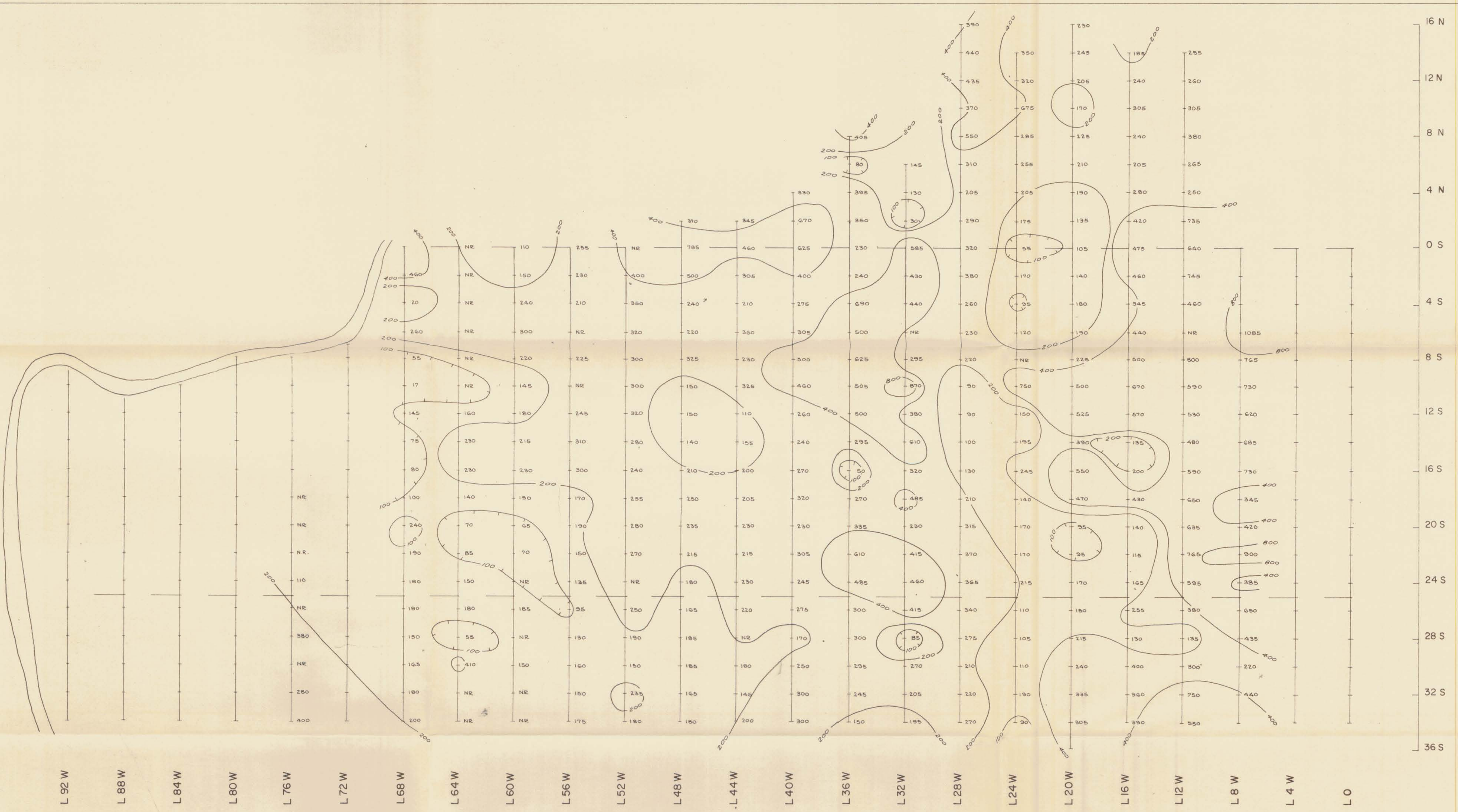
LEWES RIVER MINES LTD.

WHITEHORSE AREA, YUKON
GRID FOUR

INDUCED POLARIZATION SURVEY

CHARGEABILITY CONTOUR PLAN
SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED



LEGEND

205 LINE TRACE WITH RESISTIVITY VALUES IN OHMS-METRES

—200— 100, 200, 400 AND 800 OHM METRE CONTOURS

THREE ELECTRODE ARRAY

ELETRODE SEPERATION a = 400

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE 10

LEWES RIVER MINES LTD.

WHITEHORSE AREA, YUKON

GRID FOUR

INDUCED POLARIZATION SURVEY

RESISTIVITY CONTOUR PLAN

SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED

LEGEND

LINE TRACE MAGNETIC VALUE IN GAMMAS.

ISOMAGNETIC CONTOUR. 100 GAMMA INTERVAL

NOTES:
MAGNETOMETER: SHARPE MF-1 VERTICAL FORCE FLUXGATE.

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE II

LEWES RIVER MINES LTD.

WHITEHORSE AREA, YUKON

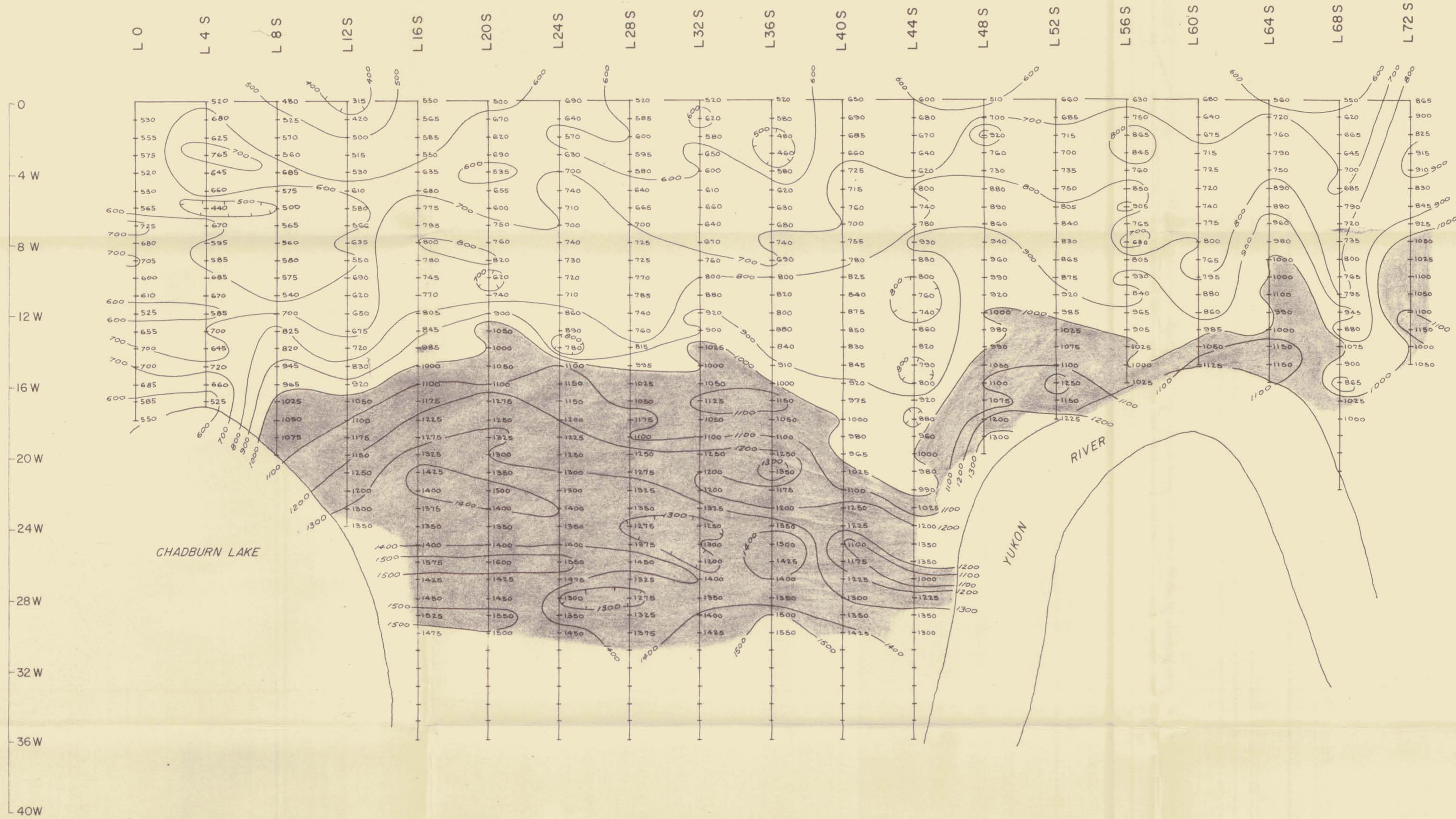
GRID FOUR

MAGNETOMETER SURVEY

ISOMAGNETIC CONTOUR PLAN

SCALE: 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED



LEGEND

LINE TRACE WITH MAGNETIC VALUE IN GAMMAS.

ISOMAGNETIC CONTOURS. 100 GAMMA INTERVAL.

NOTES: MAGNETOMETER: SHARPE MF-1 VERTICAL FORCE FLUXGATE.

TO ACCOMPANY A GEOPHYSICAL REPORT
BY J.G. BAIRD DATED FEBRUARY 28, 1969

PLATE 12

LEWES RIVER MINES LTD.

WHITEHORSE AREA YUKON
GRID FIVE

MAGNETOMETER SURVEY

ISOMAGNETIC CONTOUR PLAN

SCALE : 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED