

REPORT ON  
INDUCED POLARIZATION SURVEY  
WHITE RIVER AREA, YUKON  
ON BEHALF OF  
SILVER CITY MINES LTD.

115-F-15

by  
Jon G. Baird, B.Sc., P.Eng.  
July 28, 1969

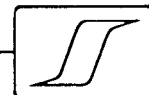
CLAIMS:  
(See attached sheet)

LOCATION:  
Near Yukon-Alaska Boundary about  
220 miles northwest of Whitehorse.  
61° 47' north latitude, 140° 48' west longitude  
Whitehorse Mining Division

DATES: July 18 to August 8, 1968  
May 18, to June 27, 1969

CLAIMS

<u>Name</u>	<u>Record Number</u>
NUK Fr. 3 - 6	Y24195 - Y24198
NUK Fr. 8 & 9	Y24202 - Y24203
NUK 9 - 12	Y4999 - Y5001
NUK Fr. 12 & 13	Y24200 - Y24201
NUK 14	Y5004
NUK 20	Y24211
NUK Fr. 22	Y24213
NUK Fr. 23 & 24	Y24207 - Y24208
MARC 1 - 8	Y4991 - Y4998
MARC 17 - 24	Y5007 - Y5014
MARC 54	Y5042
MARC 69	Y5228
MARC 71 - 78	Y5230 - Y5237
GOLDEN HORNE 1 - 4	90563 - 90566
SLAGGARD 1 & 2	90561 - 90562
HANNA 17 - 22	Y21296 - Y21301
HANNA 25, 26, 28	Y21304, 05, 07
HANNA 42	Y21321
HANNA 45 to 48	Y21324 - Y21327
HANNA Fr. 49 - 50	Y21328 - Y21329



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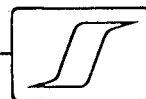


## SUMMARY

The present induced polarization surveys have revealed that certain parts of the grid are underlain by rocks containing the equivalent of at least 1% by volume, and locally higher amounts of disseminated metallicly conducting mineralization.

Diamond drilling proposed on the basis of data from the first induced polarization survey in the area of Grid A revealed the coincidence of copper mineralization with anomalous induced polarization responses. Further drilling on the basis of the present data has revealed that some of the present responses may be, at least in part, caused by disseminated pyrite and/or amygdalar chlorite in volcanic rocks.

Since there is no way of distinguishing between the various possible chargeability sources from the geophysical data alone and since copper mineralization is known to occur on the property, an attempt should be made to determine the type of polarizable material in each of the areas of high chargeability response. To this end, any or all of; surface geological examinations, geochemical soil sampling, magnetometer surveying and diamond drilling may be warranted.



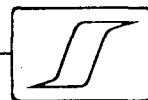
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INTRODUCTION

During the period from July 18 to August 8, 1968, and again from May 18 to June 27, 1969, geophysical field parties under the direction of Mr. Ron Sheldrake and Mr. Armidas Lefebvre, respectively, executed induced polarization surveys in the White River area, Yukon, on behalf of Silver City Mines Ltd. The present report incorporates all the data from the 1969 survey with most of the results from the previous work. A complete discussion of the 1968 survey results is contained in a report by J. G. Baird dated August 22, 1968.

The present property covers an area of about 15 square miles and comprises 172 mineral claims. The actual claims covered, in whole or part, by the present surveys are listed on the title page of this report and are shown on Plate 2 on a scale of 1" = 400'. These claims are held by United Pemetex Ltd. in which Silver City Mines is the major shareholder.

The property lies between the White and Generc Rivers at a point about  $6\frac{1}{2}$  miles east of the Alaska boundary and 220 air miles northwest of Whitehorse, the nearest aircraft charter base. The claims are reached by float-equipped aircraft landing on Rifle Lake or by truck, using a winter road. The topography of the survey area may be described as rolling except where the river and lake banks occur. In these places there are steep cliffs which at times inhibited the progress of the survey.

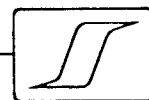


Seigel Mk VI time domain (pulse-type) induced polarization equipment has been employed on this property. The transmitting unit has a rating of 2.5 kw and equal on and off times of 2 seconds. The receiving unit is a remote, ground-pulse type triggered by the rising and falling primary voltages set up 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 metallicly conducting mineralization beneath the grids covered. In the present area such mineralization could include native copper, chalcocite, chalcopyrite, bornite and other sulphide minerals. As well, magnetite, graphite and other minerals can cause responses not always distinguishable from sulphide mineralization by the electrical characteristics alone.

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.

On the present property two grid systems have been established. Grid A was originally cut to explore a surface showing and consists of a base line oriented N 10° W and about 3 miles of cross lines spaced 200' and in places, 100' apart. The main grid, with base lines oriented north-south at 2400' intervals, was established for reconnaissance purposes. About 24 miles of cross lines were



established perpendicular to the base lines at 400' intervals. The grid layout is shown on Plate 2 along with some topographic features and the mineral claims.

The three electrode array with electrode spacings of 200' and station intervals of 200' was employed for reconnaissance purposes. Much of Grid A has been covered with the three electrode array and 100' electrode spacings with 100' station intervals. As well, on several profiles of the main grid where detailed information was desired, additional observations employing the three array and 400', 100' and 50' electrode spacings have been employed.

GEOLOGY

The geology of the Silver City property is the subject of reports by Robert J. Cathro and W. V. Smitheringale.

The major rock types believed to underlie the property are andesites, basalts, argillites and limestones of the Upper Triassic, Mush Lake Group and limestones and argillites of the Cache Creek Group. The two ages of rocks are separated by a north-northwesterly trending fault running through Rifle Lake.

A showing near the base line of Grid A at line 100 contains native copper-bornite-chalcopyrite-chalcocite mineralization as fissure fillings or disseminations in the Mush Lake volcanic rocks. A good deal of diamond drilling has been carried out in this area which seems to indicate that the mineralization may occur in narrow, steeply dipping intermittent zones.



## PRESENTATION OF RESULTS

Plate 3, on the scale of 1" = 400', shows the chargeability (the induced polarization characteristic of the rock) results for the 200' reconnaissance electrode spacings in contour form. The actual chargeability values are shown and a 4.0 millisecond contour interval has been used. Areas exhibiting chargeabilities in excess of 8.0 milliseconds have been shaded.

Plate 4 is a resistivity contour plan of the survey grid for the 200' electrode spacings. The resistivity values have been contoured using a logarithmic contour interval by showing the 1000, 2000, 4000, 8000, 16000 and 32000 ohm-metre contours. Areas exhibiting chargeabilities in excess of 2000 ohm-metres have been shaded. Both Plates 3 and 4 show all the data taken for the 200' electrode spacings during both periods of the work.

Plate 5 shows detail chargeability and resistivity profiles executed on the north end of Grid A during the 1969 survey. Further detailed profiles on this grid are shown on Plate 5 of the writer's 1968 report. The vertical scales for these profiles are 1" = 10.0 milliseconds for chargeability and 2" = 1 logarithmic cycle with the line trace taken as 1000 ohm-metres for resistivity. The plan scale is 1" = 200' although the interline spacings are not shown to scale in order to accommodate the geophysical profiles.

Plates 6 and 7, on the scale of 1" = 200', are chargeability and resistivity detail profiles for the area of the main survey grid. The vertical scales for these plates are the same as for Plate 5. The interline spacing is not to scale.

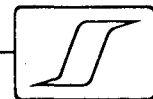
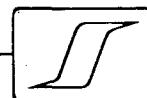


Plate 8 shows the results in profile form of a limited amount of magnetic data taken in the areas of some of the induced polarization disturbances in the south part of the grid. The plan scale is 1" = 200' and the vertical scale is 1" = 500 gammas.

#### DISCUSSION OF RESULTS

Plate 3 reveals that the chargeability values over much of the area surveyed lie in the 1.0 to 4.0 millisecond range, a normal non-metallic response range. With this low background level, a uniform distribution of 1% by volume of metallicly conducting material in the subsurface is expected to add approximately 6.0 milliseconds to the background level. Since low concentrations of copper mineralization may be of economic significance and since small mineralized bodies may not reveal their peak inherent chargeabilities for the reconnaissance electrode spacings, chargeabilities in excess of 8.0 milliseconds are deemed worthy of further investigation.

The shaded areas on Plate 3 are those in which chargeabilities of above 8.0 milliseconds have been observed. The general contour pattern shows that these zones trend generally north-south and occur within 4.0 millisecond contour closures. Care must be taken in using contours to interpret the location of the bodies causing the high chargeabilities. Because of the asymmetry of the electrode array used, profiles are usually best for interpretive purposes and additional traverses employing differing electrode separations are necessary for a good quantitative interpretation.



Detailed traverses employing varying electrode separations have been carried out on at least one or two lines in each zone of chargeability response in excess of 8.0 milliseconds. These results are shown on Plates 5, 6 and 7.

The profiles on Plate 5 correlate with the 1968 data and indicate a northward extension of the interpreted axis A 1 to at least L 115 N of Grid A.

The chargeability profiles on Plate 6 show the results of detailed surveying on the part of the main grid covered during the 1969 survey. These results reveal that the areas bounded by the 8 millisecond contour on the chargeability contour plan may be considered as underlain by relatively large volumes of rock containing the equivalent of at least 1% by volume of metallicly conducting mineralization. The detailed traverses reveal however, that within these large areas smaller zones, some of them approaching to very near the surface, contain significantly greater amounts of polarizable material. In some areas such as near 30 W on L 72 S, 17 W on L 60 S, and 9 E on L 42 S, these small high chargeability zones approach to within a few feet of the ground surface.

The resistivity contour plan on Plate 4 reveals that resistivity values vary from below 1000 ohm-metres to above 32000 ohm-metres. Resistivity variations may be affected by the type and thickness of overburden but it is thought that variations of this order of magnitude may be caused, at least in part, by changes in the physical characteristics of the bedrock. Two Wenner expander arrays executed during the 1968 survey indicated that overburden depths for at least two



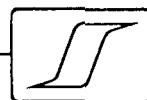
points on the survey grid did not exceed 25' and outcrops are known to exist on the property.

While there is no universal correlation between chargeability and resistivity responses, there are some zones where high chargeability responses correspond to low resistivity values. Specific instances of this inverse relationship are seen on the west end of line 72 S, and lines 92 S and 96 S near 2900 W.

The limited amount of magnetic data shown on Plate 8 are not sufficient to make a general correlation between magnetic and induced polarization responses. It is noted however that the sharp magnetic disturbances on lines 42 S, 44 S and 48 S correspond to zones of anomalous chargeabilities. These magnetic responses could be partly due to near surface concentrations of magnetic material. All three profiles, but particularly the profile on L 42 S, may be expressive of a contact occurring at about 10 E however additional data covering a wider area would be necessary to support such an interpretation. There is no direct correlation of the magnetic data with anomalous chargeability responses on lines 56 S through 96 S.

CONCLUSIONS AND RECOMMENDATIONS

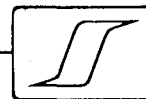
The present induced polarization surveys have revealed several large zones containing greater amounts of polarizable material than the surrounding bedrock. In one place, on Grid A, high chargeability responses correlate with copper mineralization in a surface showing and in diamond drill holes. Farther along this same zone however, diamond drilling has not revealed copper.



mineralization in locations indicated as anomalous by the induced polarization survey. This may be due in part to the fact that short electrode separations were chosen to allow the best resolution of the narrow mineralized bodies, resulting in a loss in depth penetration. Due in part to the effect of a steep slope, much of the diamond drilling may have been directed beneath the zone of polarizable material.

In other areas of the property such as on L 44 S, widely disseminated pyrite found in sections of diamond drill holes does not appear to provide sufficient explanation for the induced polarization responses. One possible cause of the anomalous responses could be chlorite which occurs within amygdules in volcanic rocks. Some laboratory testing of the cores from these holes or down-hole induced polarization surveying may reveal if the chlorite is indeed responsible for the observed responses.

Since there is no geophysical method of distinguishing whether any one of the present anomalous areas may be due to native copper - copper sulphide mineralization, and since such mineralization is known to exist on the property, an attempt should be made to determine the cause of each of the present anomalies. Surface geological examinations and possibly geochemical soil sampling should be undertaken in all areas where the 50' electrode separation results indicate that the polarizable source comes near the ground surface. The resistivity pattern may be useful in geological interpretations which could reveal most favorable areas for copper mineralization. Magnetic data for the entire grid may also aid in this regard. As further information becomes available, the correlations of resistivity

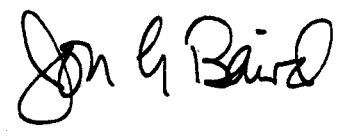


and chargeability within the high chargeability zones may possibly be used to resolve sulphide from non-sulphide (e.g. chlorite) responses.

Space has not provided a thorough quantitative discussion of all of the detail results shown on Plate 5, 6 and 7. If diamond drilling is to be undertaken in any of these areas further quantitative interpretations should be undertaken in order to precisely locate diamond drill holes.

Respectfully submitted,

SEIGEL ASSOCIATES LIMITED



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Vancouver, B.C.  
July 28, 1969



Harold O. Seigel

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

## 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

\*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.

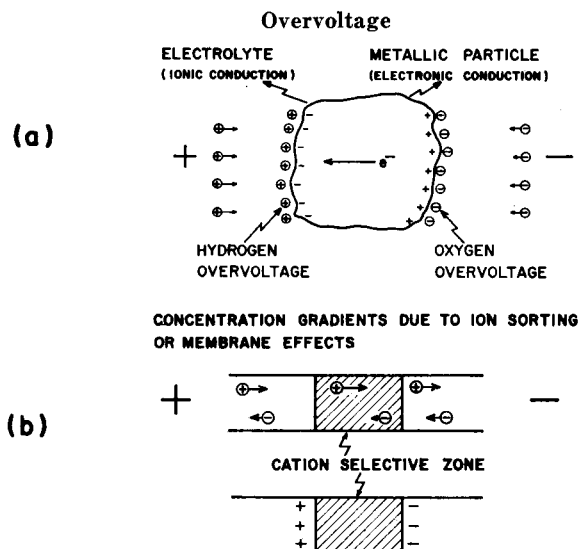


Figure 1.—Induced Polarization Agents.

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).\*\*

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

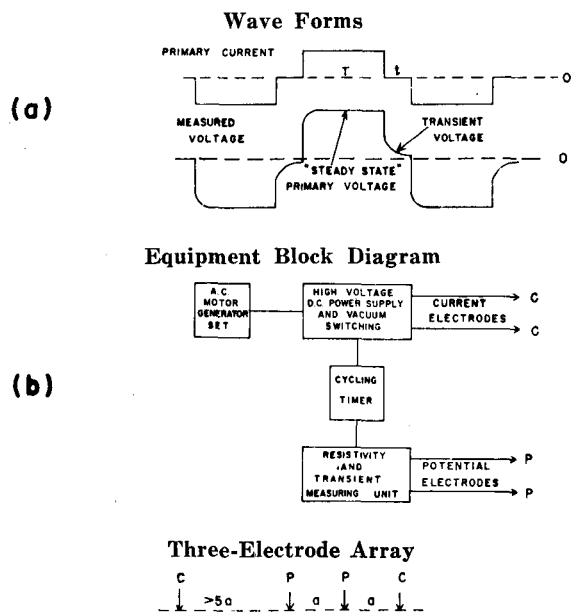


Figure 2.—The Pulse System.

### 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.

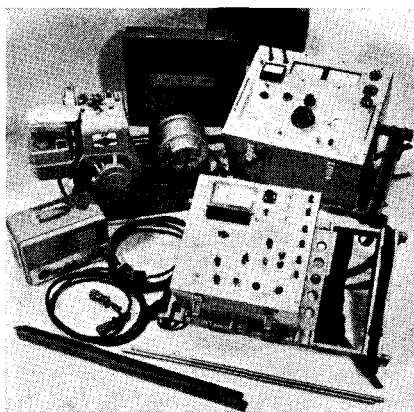


Figure 3.—(above)—The Seigel Mk V Induced Polarization Unit.

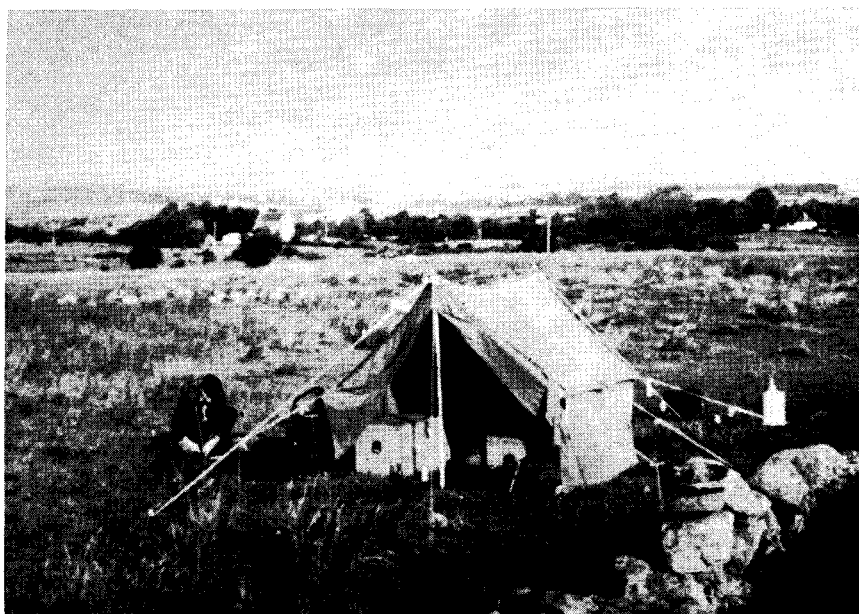


Figure 4.—(right)—Typical Field Operational Base in Ireland.

## 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.

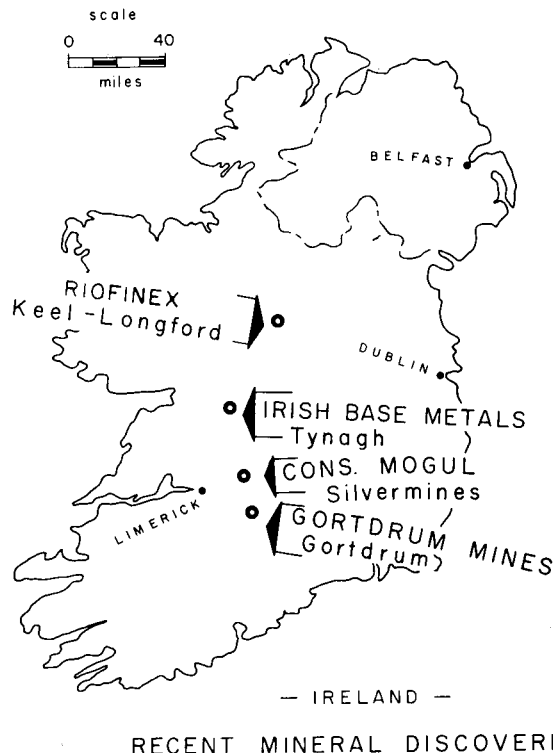


Figure 5.—Location Plan of Recent Mineral Discoveries in Ireland.

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 ore-body is located in gently north-dipping dolomitic limestones adjacent 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.

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.

### 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

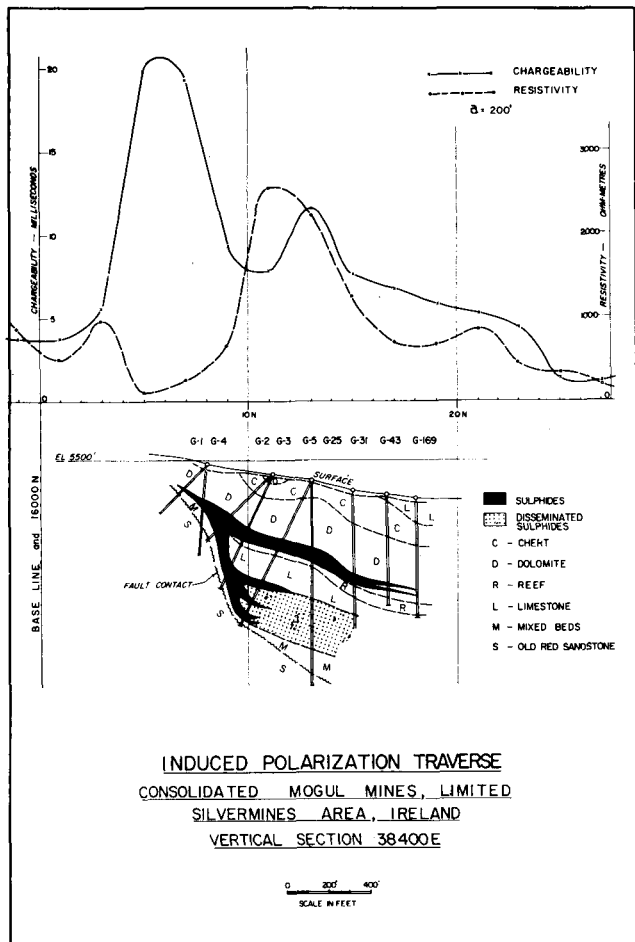


Figure 6.—Typical Discovery Traverse, Silvermines Deposit.

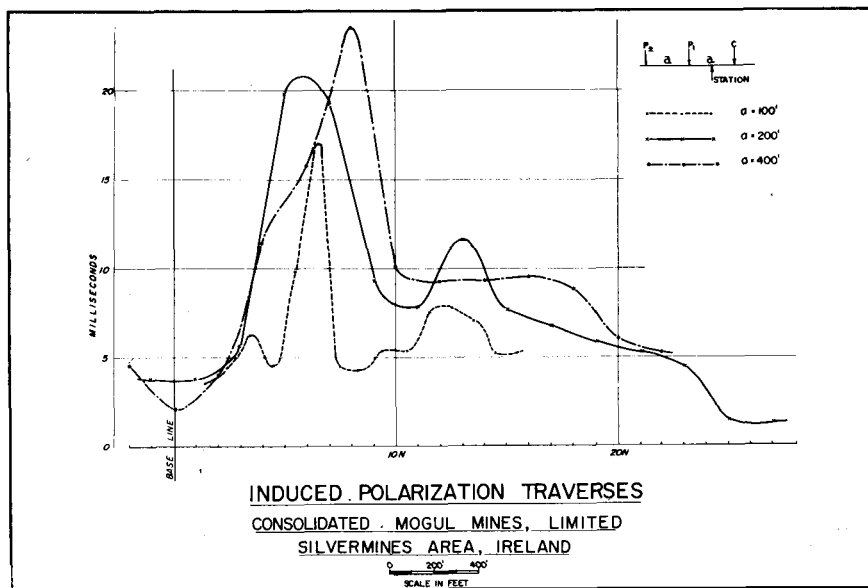


Figure 7.—Multiple Spacing Results, Silvermines Deposit.

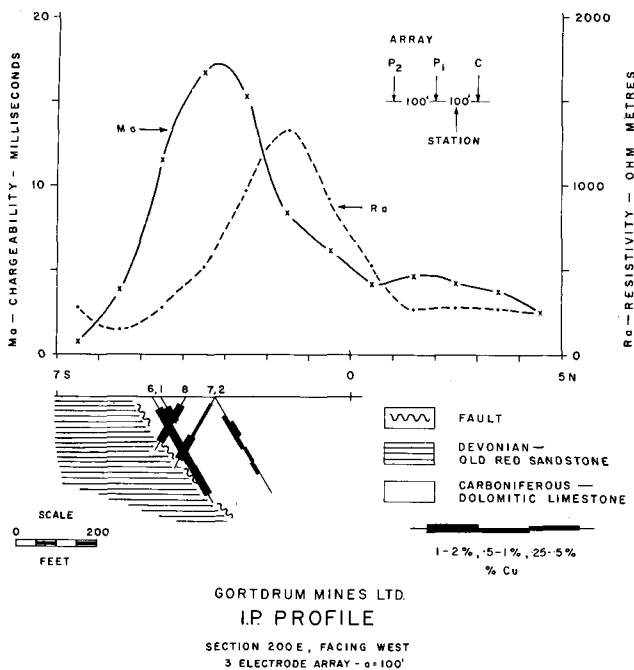


Figure 8.—Typical Discovery Traverse, Gortdrum Deposit.

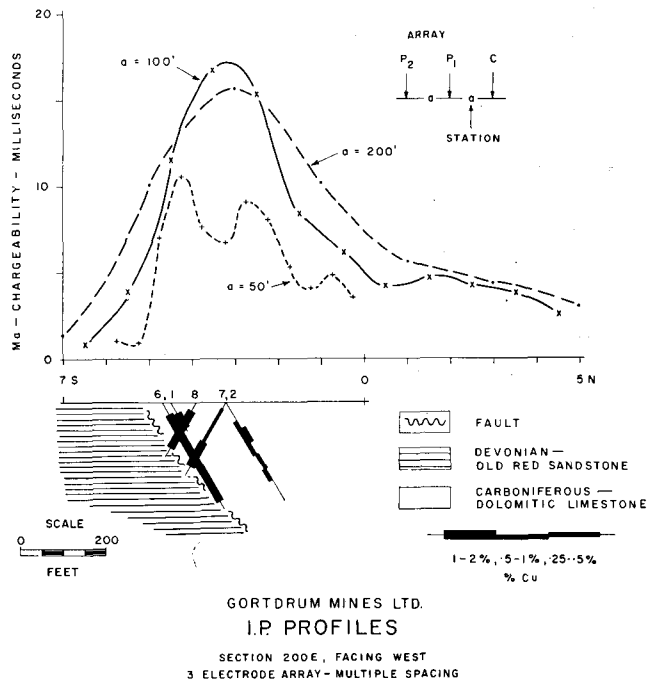


Figure 9.—Multiple Spacing Results, Gortdrum Deposit.

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.

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.

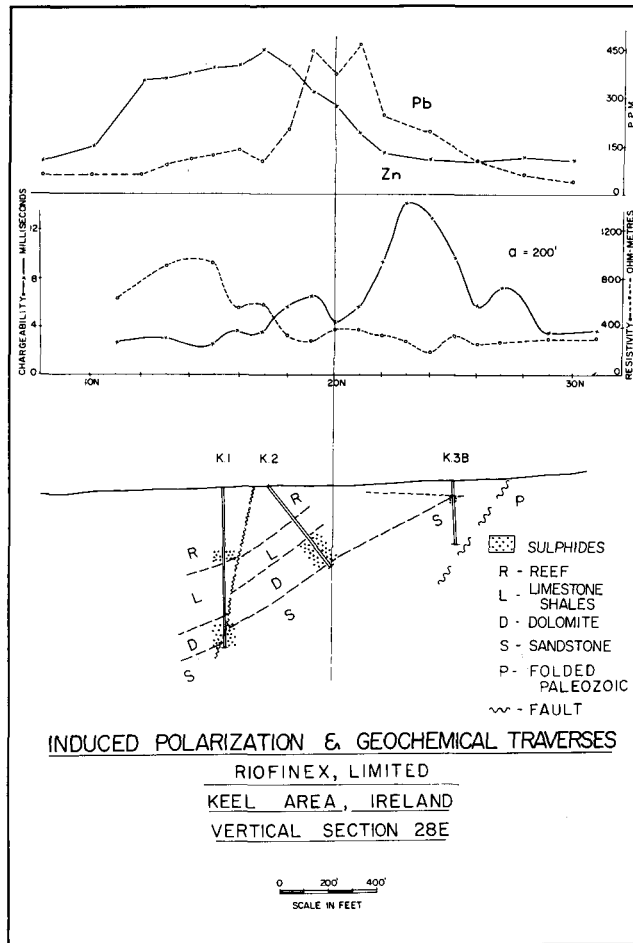


Figure 10.—Typical Discovery Traverse, Keel Deposit.

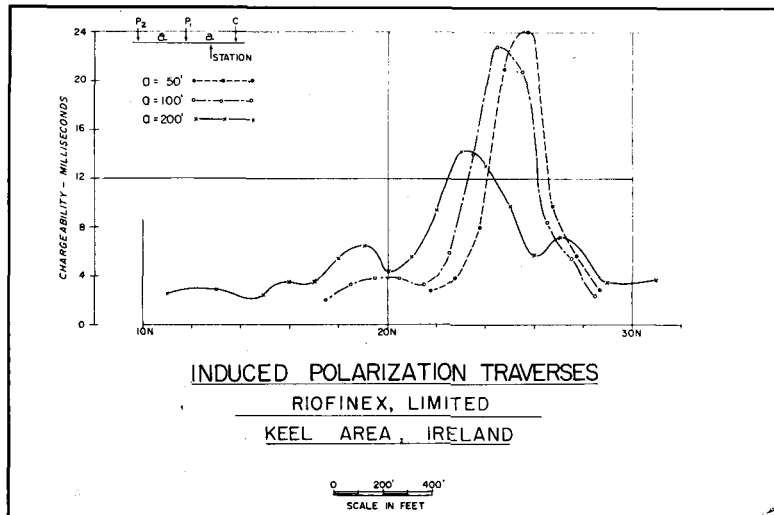


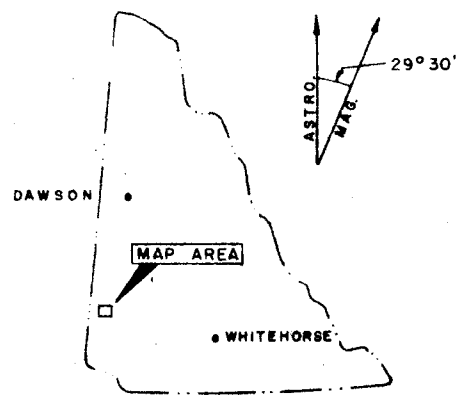
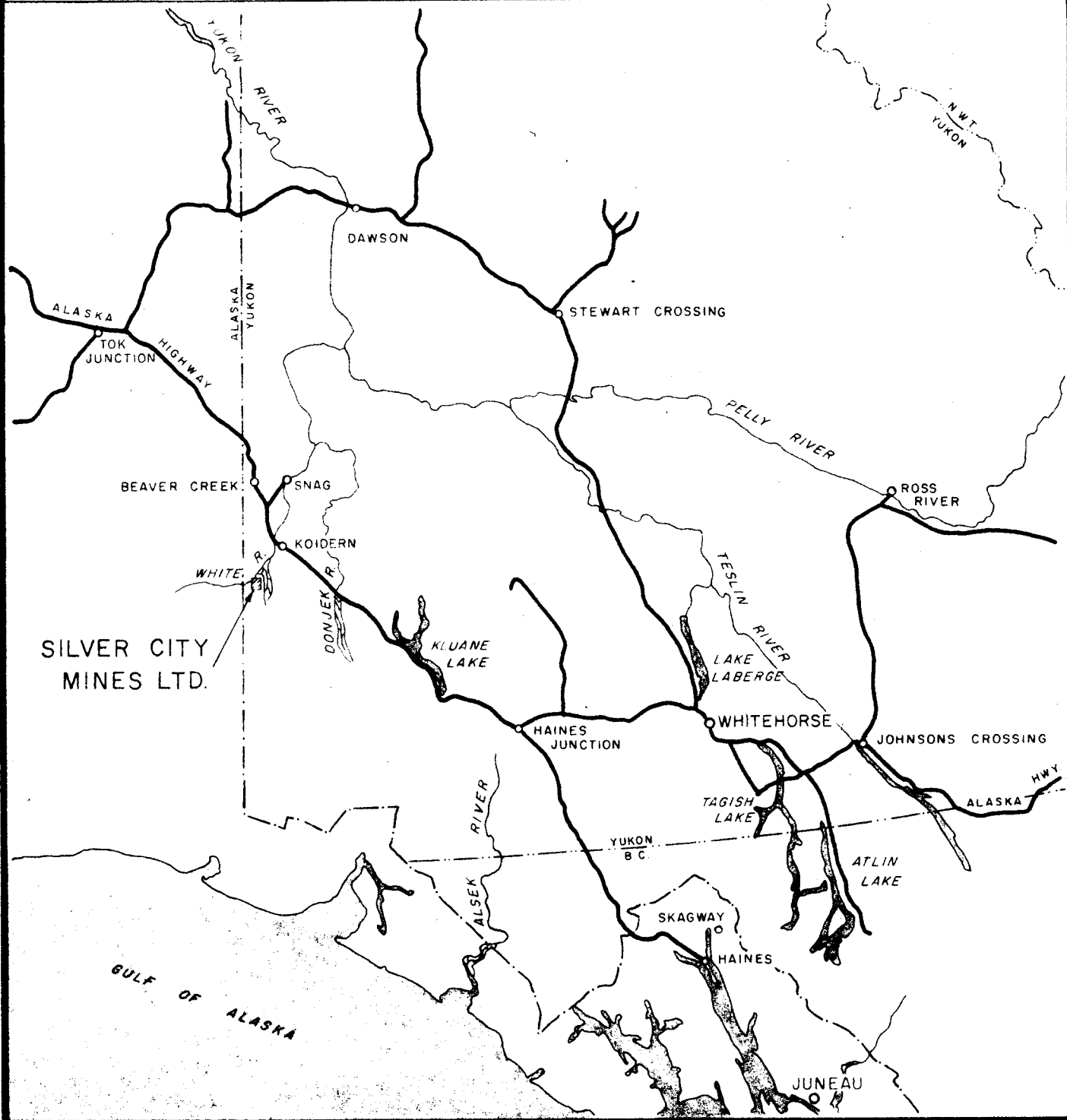
Figure 11.—Multiple Spacing Results, Keel Deposit.

### 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



YUKON TERRITORY

# SILVER CITY MINES LTD.

## LOCATION MAP

WHITE RIVER AREA, YUKON TERRITORY



APPROXIMATE SCALE IN MILES

SURVEY BY  
SEIGEL ASSOCIATES LIMITED  
MAY - JUNE 1969

PLATE I

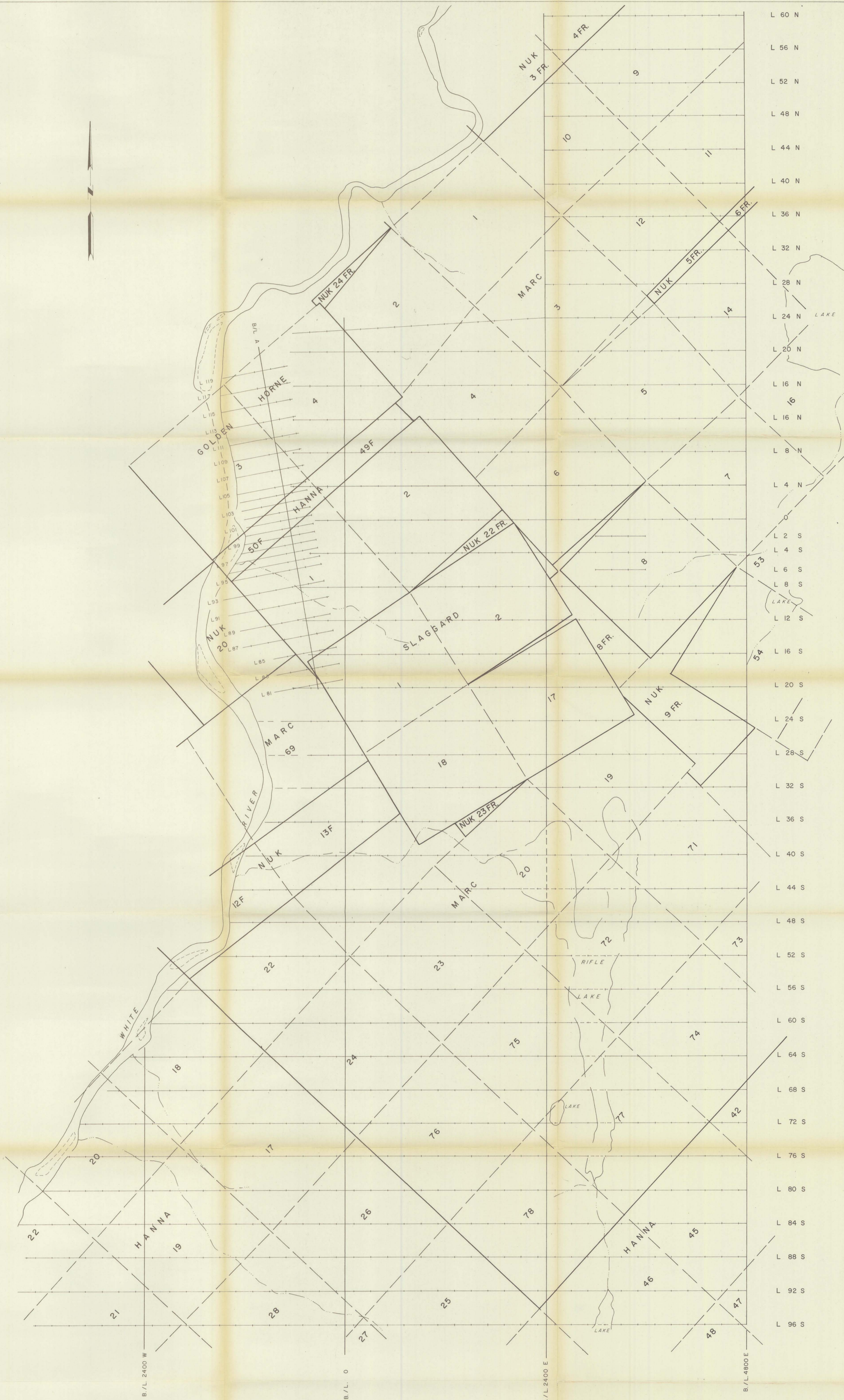


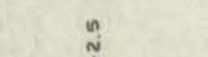
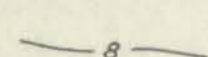
PLATE 2  
**SILVER CITY MINES LTD.**  
 WHITE RIVER AREA, YUKON TERRITORY  
 INDUCED POLARIZATION SURVEY

SCALE: 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED  
 MAY-JUNE, 1969



**LEGEND:**

-  LINE TRACE WITH CHARGEABILITY VALVES IN MILLISECONDS
-  CHARGEABILITY CONTOURS  
4 MILLISECOND CONTOUR INTERVAL

NOTES:  
 SEIGEL MK VII INDUCED POLARIZATION DATA  
 THREE ELECTRODE ARRAY,  $\alpha = 200'$   
 MOVING CURRENT ELECTRODE EAST OF ARRAY

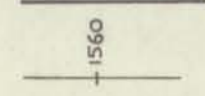
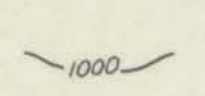
TO ACCOMPANY A GEOPHYSICAL REPORT  
 BY J.G. BAIRD DATED JULY 28, 1969

PLATE 3  
 SILVER CITY MINES LTD.  
 WHITE RIVER AREA, YUKON TERRITORY  
 INDUCED POLARIZATION SURVEY  
 CHARGEABILITY CONTOUR PLAN  
 SCALE: 1" = 400'

SURVEY BY SEIGEL ASSOCIATES LIMITED  
 MAY-JUNE, 1969



**LEGEND:**

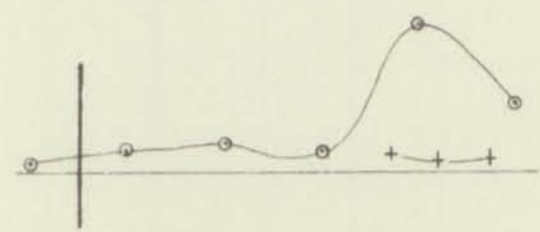
-  LINE TRACE WITH RESISTIVITY VALUES IN OHM-METERS.
-  RESISTIVITY CONTOURS LOGARITHMIC CONTOUR INTERVAL SHOWING 1000, 2000, 4000, 8000, 16,000 AND 32,000 OHM-METRE CONTOURS

**NOTES:**  
THREE ELECTRODE ARRAY  
ELECTRODE SPACING = 200'

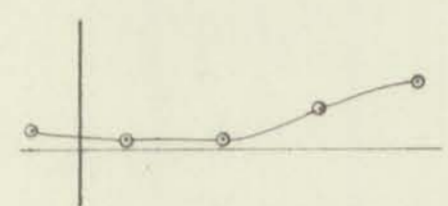
TO ACCOMPANY A GEOPHYSICAL REPORT  
BY J.G. BAIRD DATED JULY 28, 1969

PLATE 4  
SILVER CITY MINES LTD.  
WHITE RIVER AREA, YUKON TERRITORY  
INDUCED POLARIZATION SURVEY  
RESISTIVITY CONTOUR PLAN  
SCALE: 1" = 400'  
SURVEY BY SEIGEL ASSOCIATES LIMITED  
MAY-JUNE, 1969

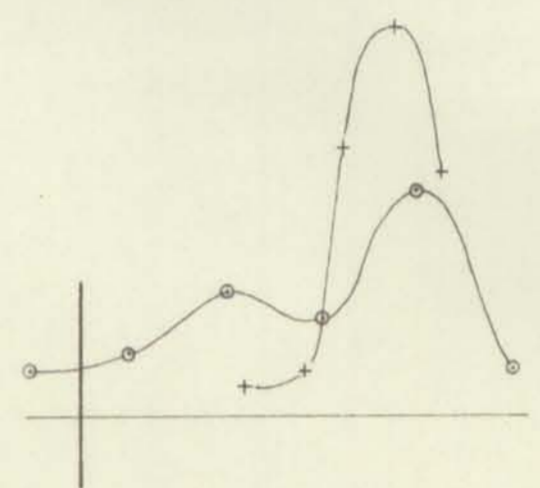
96 E 98 E 100 E 102 E 104 E 106 E 108 E 110 E 112 E 114 E



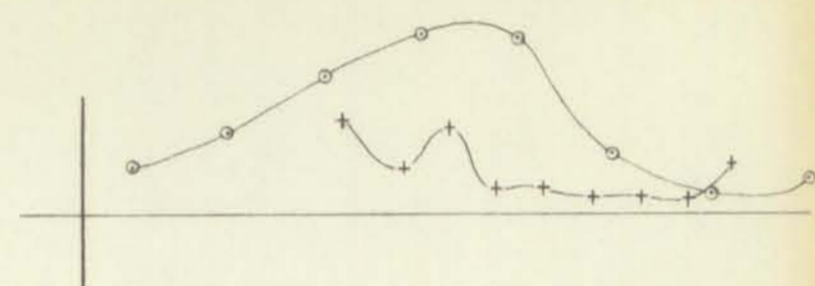
L 119 N



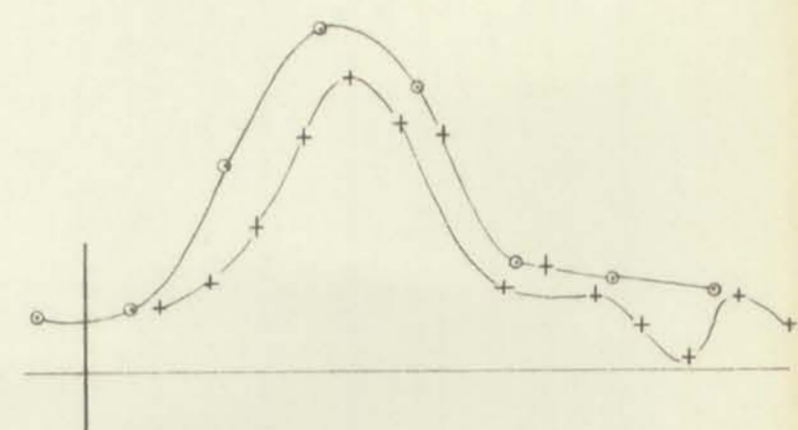
L 117 N



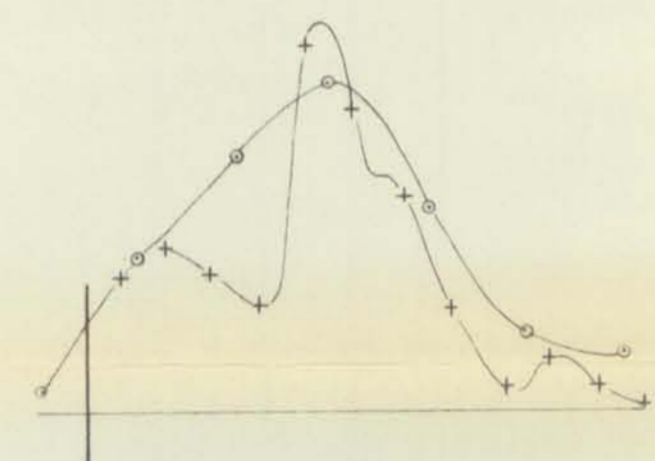
L 115 N



L 113 N



L 111 N

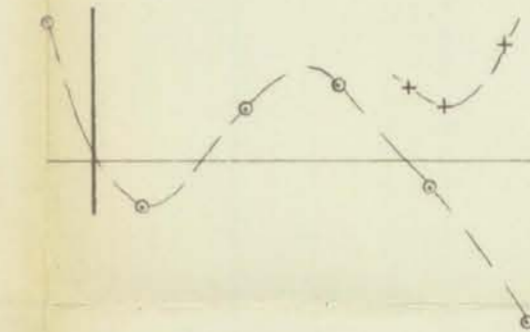


L 109 N

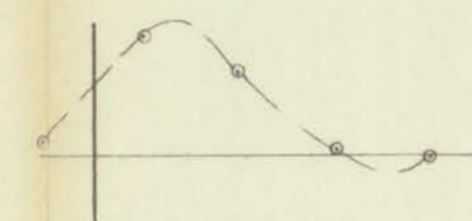
CHARGEABILITY PROFILES



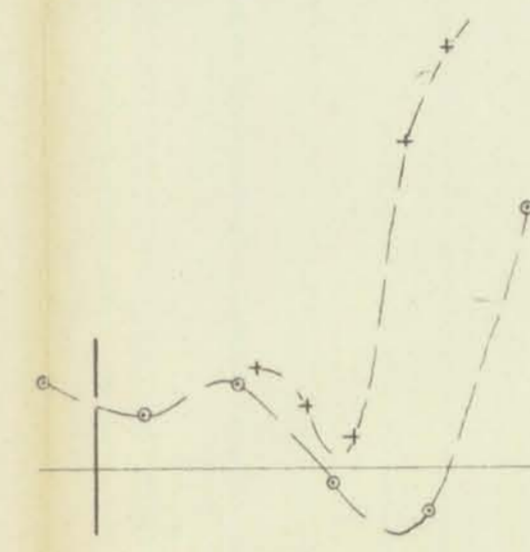
96 E 98 E 100 E 102 E 104 E 106 E 108 E 110 E 112 E



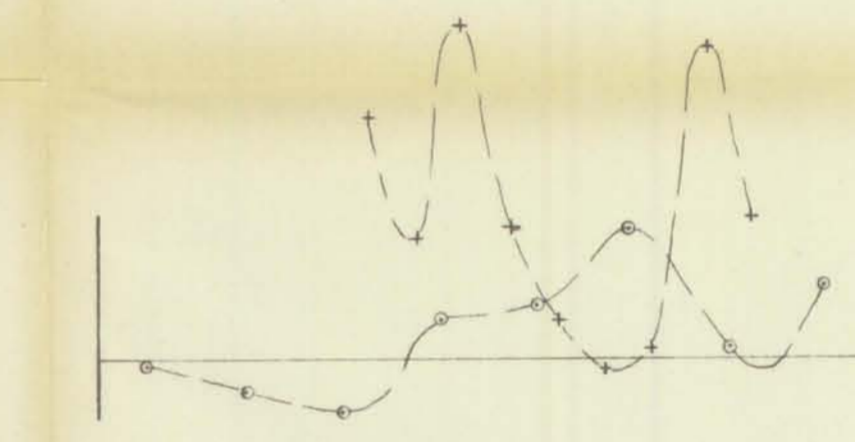
L 119 N



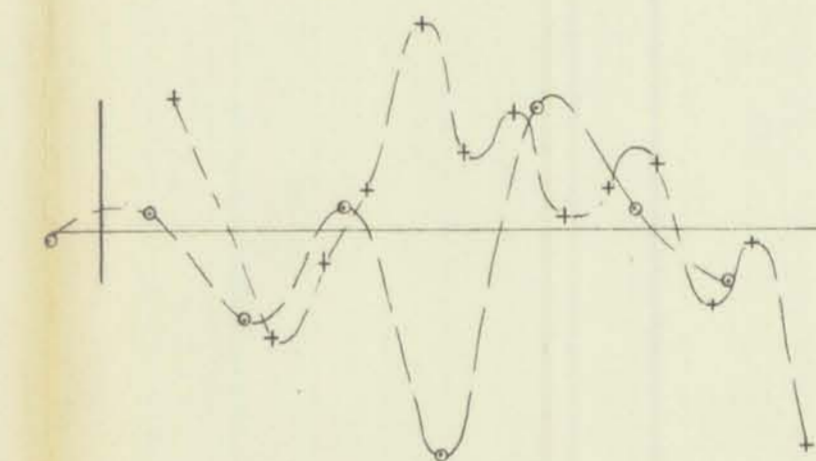
L 117 N



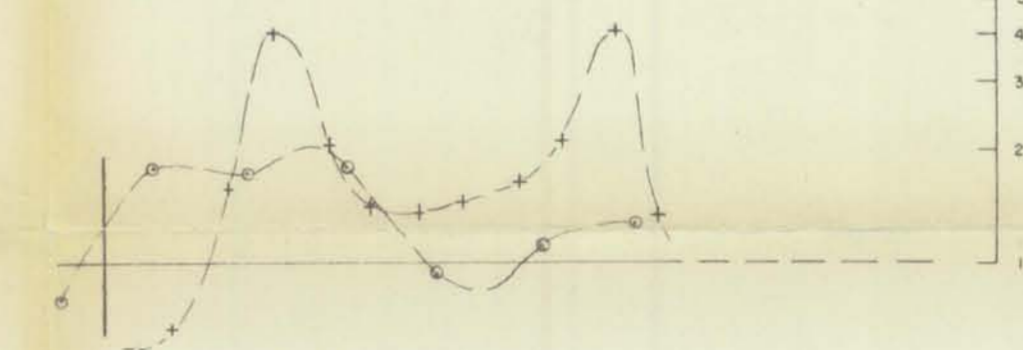
L 115 N



L 113 N



L 111 N



L 109 N

RESISTIVITY SCALE

RESISTIVITY PROFILES

LEGEND

CHARGEABILITY: SCALE - 1" = 10 MILLISECONDS

ELECTRODE SPACING:  $a = 100'$  ○ — ○  
 $a = 50'$  + — +

RESISTIVITY: SCALE - 2" = ONE LOGARITHMIC CYCLE,  
 WITH LINE TRACE TAKEN AS 1000 OHM-METRES.

ELECTRODE SPACING:  $a = 100'$  ○ — ○  
 $a = 50'$  + — +

NOTES

SEIGEL MK VI INDUCED POLARIZATION DATA  
 THREE ELECTRODE ARRAY, CURRENT ELECTRODE EAST OF ARRAY  
 INTERLINE SPACING NOT TO SCALE

TO ACCOMPANY A GEOPHYSICAL REPORT  
 BY JG BAIRD DATED JULY 28, 1969

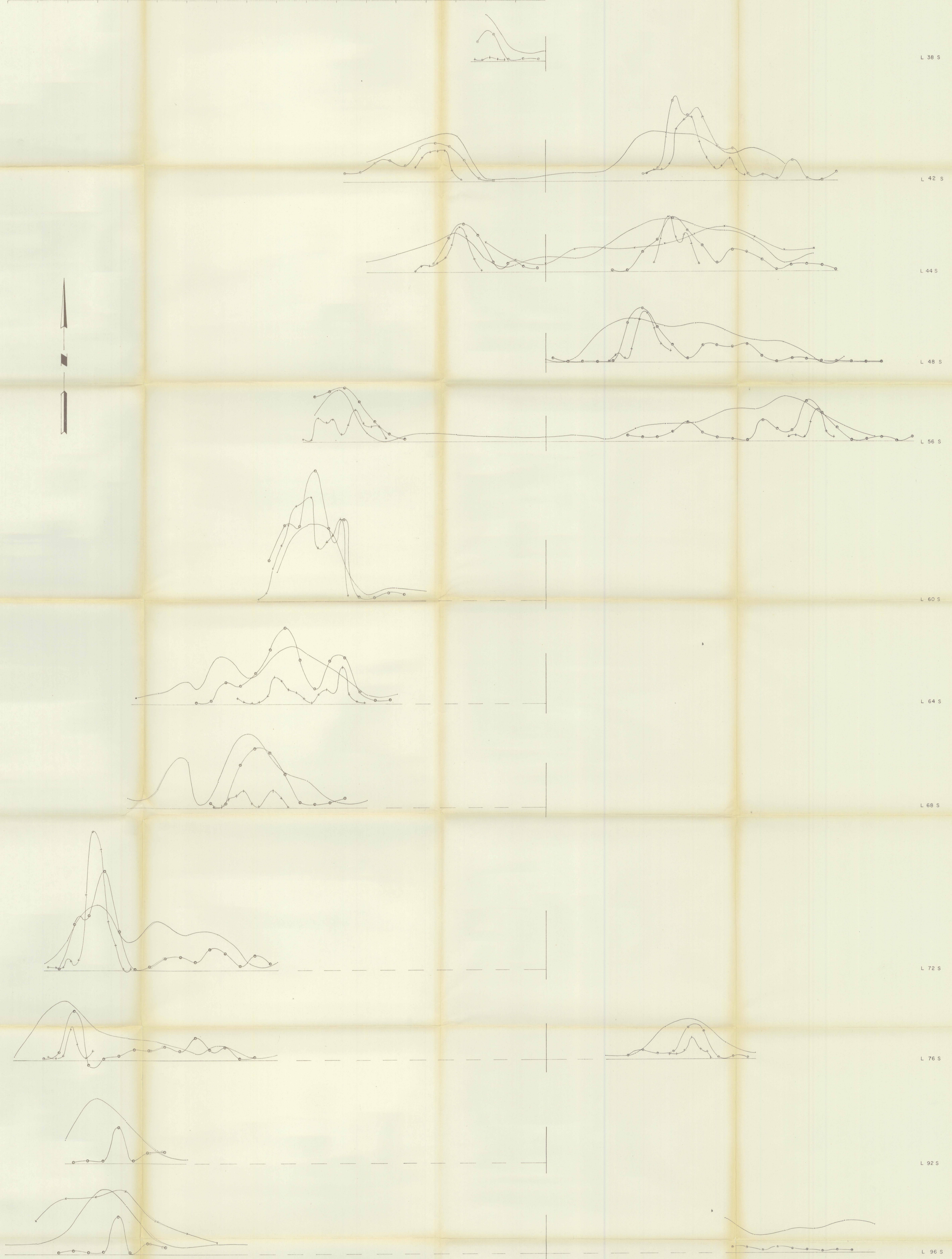
PLATE 5  
 SILVER CITY MINES LTD.  
 WHITE RIVER AREA, YUKON TERRITORY  
 INDUCED POLARIZATION SURVEY  
 DETAIL PROFILES — GRID A  
 SCALE 1" = 200'

SURVEY BY SEIGEL ASSOCIATES LIMITED  
 MAY-JUNE, 1969

36 W  
34 W  
32 W  
30 W  
28 W

26 W  
24 W  
22 W  
20 W  
18 W  
16 W  
14 W  
12 W  
10 W  
8 W  
6 W  
4 W  
2 W  
0

L 01:00  
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18E  
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24E

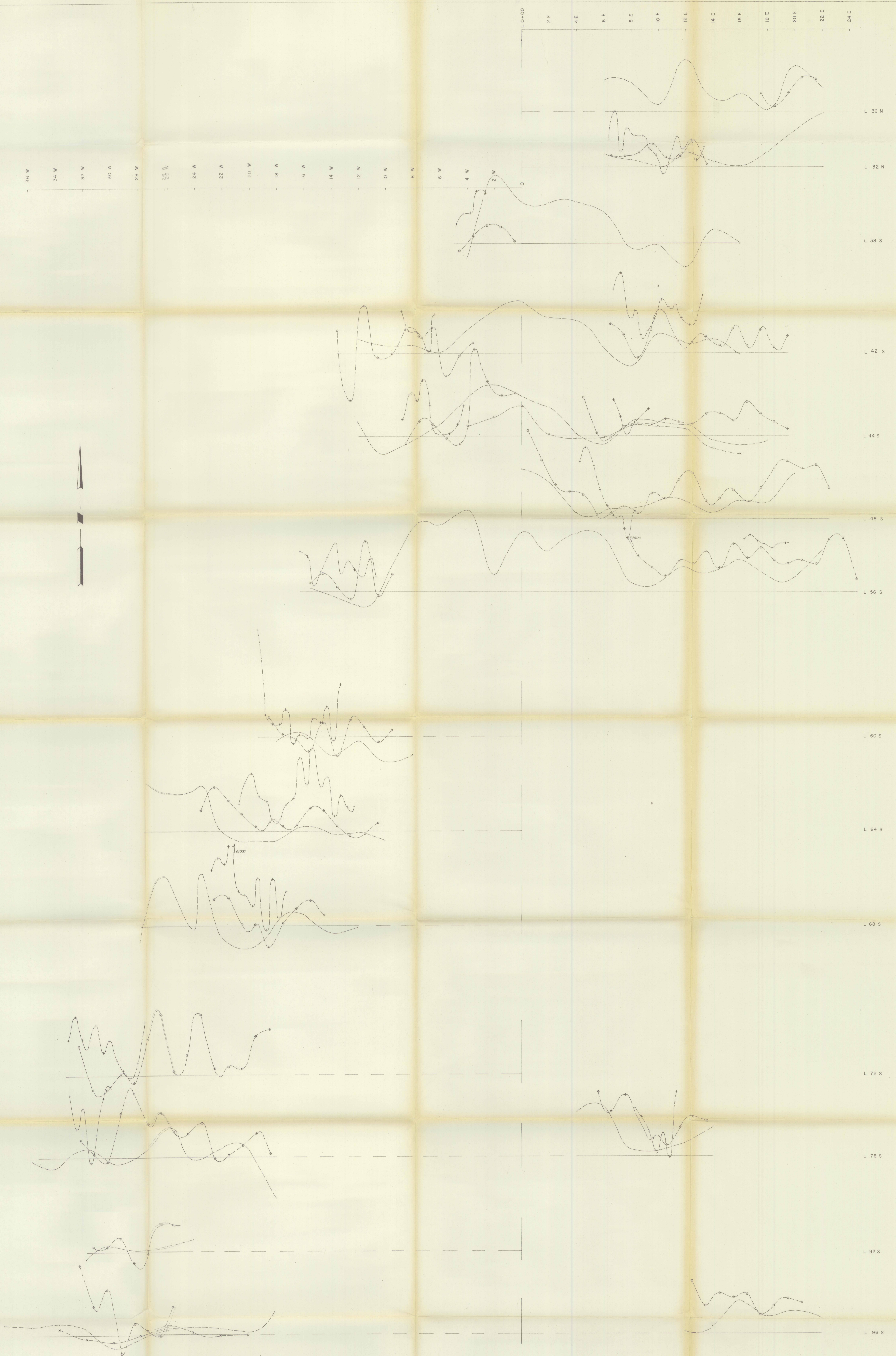


**LEGEND**  
 CHARGEABILITY SCALE - 1" = 10 MILLISECONDS  
 ELECTRODE SPACING: o = 400' ---  
 " = 200' ---  
 + = 100' ---  
 x = 50' ---

**NOTES**  
 SEIGEL MK.VI INDUCED POLARIZATION DATA  
 THREE ELECTRODE ARRAY, CURRENT ELECTRODE EAST OF ARRAY  
 INTERLINE SPACING NOT TO SCALE

TO ACCOMPANY A GEOPHYSICAL REPORT  
 BY J.S. BAIRD DATED JULY 28, 1969

PLATE 6  
 SILVER CITY MINES LTD.  
 WHITE RIVER AREA, YUKON TERRITORY  
 INDUCED POLARIZATION SURVEY  
 CHARGEABILITY PROFILES  
 SCALE 1" = 200'  
 SURVEY BY SEIGEL ASSOCIATES, LIMITED  
 MAY-JUNE, 1969



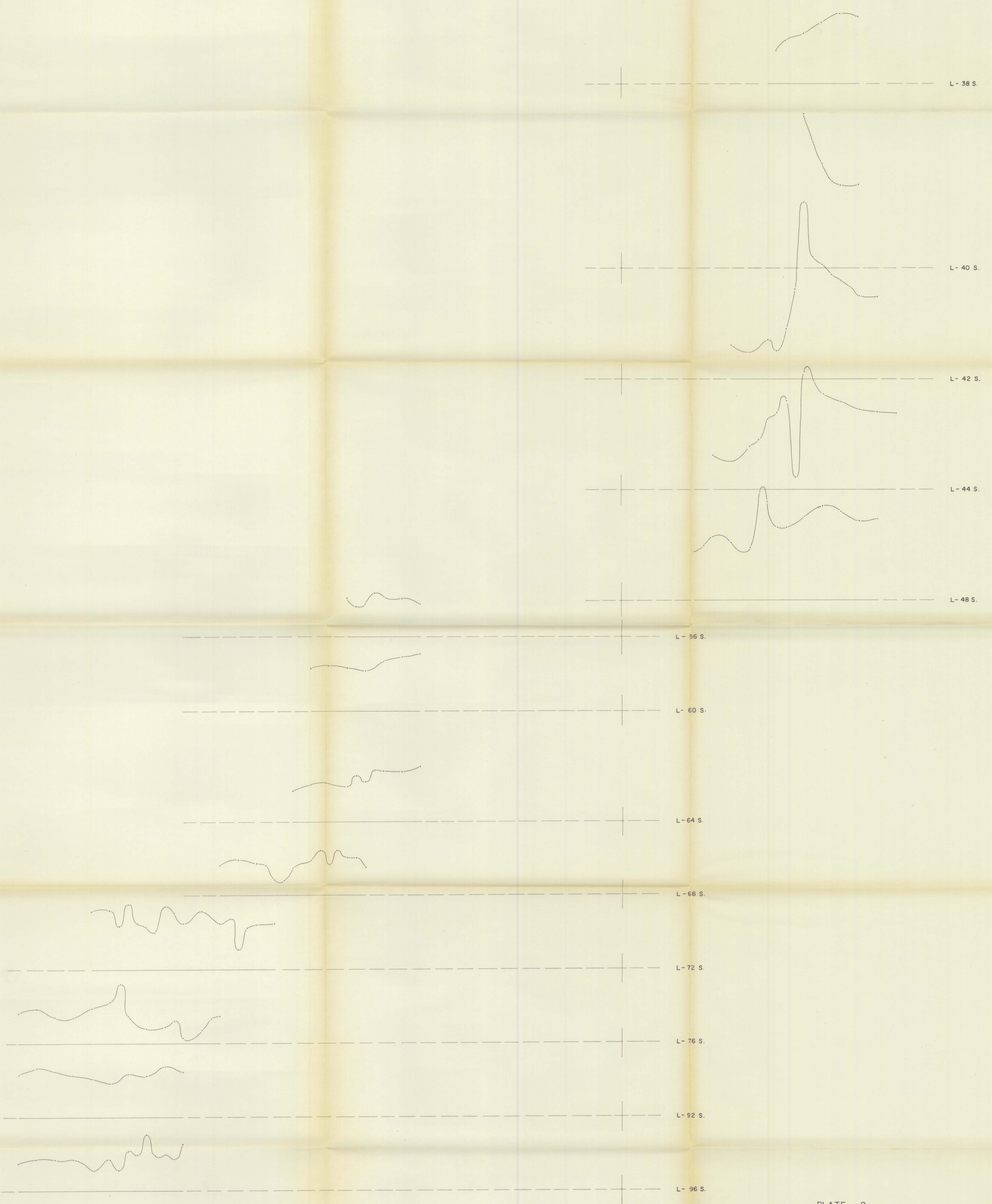
**LEGEND**  
 RESISTIVITY SCALE - 2<sup>nd</sup> ONE LOGARITHMIC CYCLE WITH LINE TRACE TAKEN AT 1000 OHM-METRES.  
 ELECTRODE SPACING  $a=400'$  - - - - -  
 $a=200'$  - - - - -  
 $a=100'$  - - - - -  
 $a=50'$  - - - - -

**NOTES**  
 THREE ELECTRODE ARRAY, CURRENT ELECTRODE EAST OF ARRAY.  
 INTERLINE SPACING NOT TO SCALE

PLATE 7  
 SILVER CITY MINES LTD.  
 WHITE RIVER AREA, YUKON TERRITORY  
 INDUCED POLARIZATION SURVEY  
 RESISTIVITY PROFILES  
 SCALE 1"=200'  
 SURVEY BY SEIGEL ASSOCIATES, LIMITED  
 MAY-JUNE, 1969

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

32 W. 30 W. 28 W. 26 W. 24 W. 22 W. 20 W. 18 W. 16 W. 14 W. 12 W. 10 W. 8 W. 6 W. 4 W. 2 W. 0+00 2 E. 4 E. 6 E. 8 E. 10 E. 12 E. 14 E. 16 E. 18 E.



**LEGEND**

NOTES:  
 VERTICAL SCALE: 1" = 500 GAMMAS.  
 SHARPE MF-1 VERTICAL COMPONENT  
 MAGNETIC DATA.

PLATE 8  
**SILVER CITY MINES LTD.**  
 WHITE RIVER AREA, YUKON TERRITORY  
**MAGNETIC SURVEY**  
 MAGNETIC PROFILES  
 SCALE 1" = 200'  
 SURVEY BY SEIGEL ASSOCIATES, LIMITED  
 MAY-JUNE, 1969.

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