REPORT ON A
TURAM ELECTROMAGNETIC SURVEY
LOWER ANVIL CREEK,
FARO, YUKON TERRITORY

ON BEHALF OF

DYNASTY EXPLORATIONS LIMITED

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by:

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Geophysicist

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SCINTREX SURVEYS LIMITED
August 24, 1973

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SUMMARY

A Turam electromagnetic survey was executed over the Jean, Gran, Aro, Lorna and Roto claims in the Lower Anvil Creek area near Faro, Yukon Territory.

The electromagnetic distortion pattern is moderate to strong. This pattern is most likely caused by overburden/weathering or banded horizons containing carbonaceous/graphitic materials.

The potential presence of economic sulphides is not excluded. General recommendations have been made.

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DYNASTY EXPLORATIONS LIMITED

INTRODUCTION

During the period June 25th to August 2nd, 1973, Turam electromagnetic surveys were executed over a group of claims in the Lower Anvil Creek area Yukon Territory on behalf of Dynasty Explorations Ltd. by Scintrex Surveys Limited.

The claims groups covered are named:Jean,Gran,Aro,Lorna and Roto. The survey area is located directly southwest of Lower Anvil Creek, where Lower Anvil, Anvil and Rose creeks join together which is approximately 16 miles NW of the Faro town site and 4 miles NE of Pelly river. (see Fig. 1). The area is rugged and is located between 3500' and 5000' a.s.l.

The geophysical survey party was under the direction of Mr. Tony Geurnier with overall supervision of Mr. Michael Lewis, M.Sc., P. Eng. The survey was executed out of a campsite established on the grid.

The grid comprised of N120^{o}E running baselines and 37 lines varying in length from 2800'-9000' at 800' interval and perpendicular to the baselines.

Sixteen energizing loops were laid out. The purpose of the survey was to locate and map any subsurface sulphide mineralization. The area has high potential with the Faro ore bodies located 10 miles to the SE.

EQUIPMENT AND METHOD

During the present survey a Scintrex SE-71 three frequency Turam-electromagnetic unit was employed. The basic energization frequency was 400 Hz with some details executed with 200 Hz and 800 Hz.

The basic energization loop size was 3000'x3000' and the separation between the receiver coils was 100'.

The enclosed specification sheet and article entitled "Some Aspects of the Turam Electromagnetic Method" give further details on the equipment and technique.

PRESENTATION OF DATA

Plate 1 on a scale of 1"=1000' shows the layout of the grid in respect to the local topography. The different energization loops, marked 1-16, are shown as well.

Plate 2 on a horizontal scale of 1 '=400' shows the electromagnetic results in profile form. Vertical scales used are 1"=20% FSR and 1"= 10° phase.

DISCUSSION OF RESULTS

The Turam results reveal a moderate to strong electromagnetic distortion pattern over most parts of the grid. Background levels of 10-15% FSR and 5-8° phase difference are common. eg. lines 136W-24W between stations 0+00 and 30N and lines 24E-152E.

This general distortion pattern is strongly influenced by the position of the loop. Close to the loop the responses are often weakly anomalous 1-2% FSR and 1° phase difference. Further away from the loop the distortions gradually increase. This is clearly shown on lines 40E-88E stations 30N to 60N. Between 30N and 36N the deflections are weak and gradually increase going north along the line.

Another effect due to the position of the loop is in the difference of results between lines 16W and 24W (station 0+00 to 30N). Lines 24W, 28W etc. have been surveyed from one loop (number 1) while lines 16W, 8W etc. have been surveyed from another loop (number 7). Loop 7 has most likely been positioned on the hanging wall side and loop 1 on the footwall side of the formations resulting in different electromagnetic coupling between source and target.

These distortion patterns shown are typical for overburden/ weathering and for banded formations containing sulphides and carbonaceous materials including graphite.

In most situations where sulphides occur in conjunction with graphitic materials an increase in response and conductivity x width is apparent, giving a "filter" to the interpreter to be used. Unfortunately such a filter is not watertight even when more than one energization frequencies are used, (eg. on lines 128 W, 112W, 88W, 32W, 128E) or when reversed anomalies are present.

In the present survey no clear differences between the conductivity x width values are present. Most conductors shown are therefore unlikely of economic interest. Some intersections that might contain sulphides are as follows: Zone A lines 128W-112W; Zone Blines 136W and 128W; Zone C line 128W; Zone D line 88W; Zone E line 32W; Zone F lines 104E, to 128E.

CONCLUSIONS AND RECOMMENDATIONS

A Turam electromagnetic survey executed over a grid in the Lower Anvil Creek, Faro region, Yukon Territory reveals large areas of moderate to strong electromagnetic distortions. These distortions are most likely related to overburden/weathering or banded horizons containing carbonaceous and graphite rich lenses. The possibility of sulphides being present is not excluded and some zones marked A to F are of potential interest.

Before recommending diamond drilling on any of these zones it is recommended to correlate each one with the geological and/or geochemical data available so that the most interesting targets can be selected.

Respectfully submitted,

SCINTREX SURVEYS LIMITED

Jan Klein

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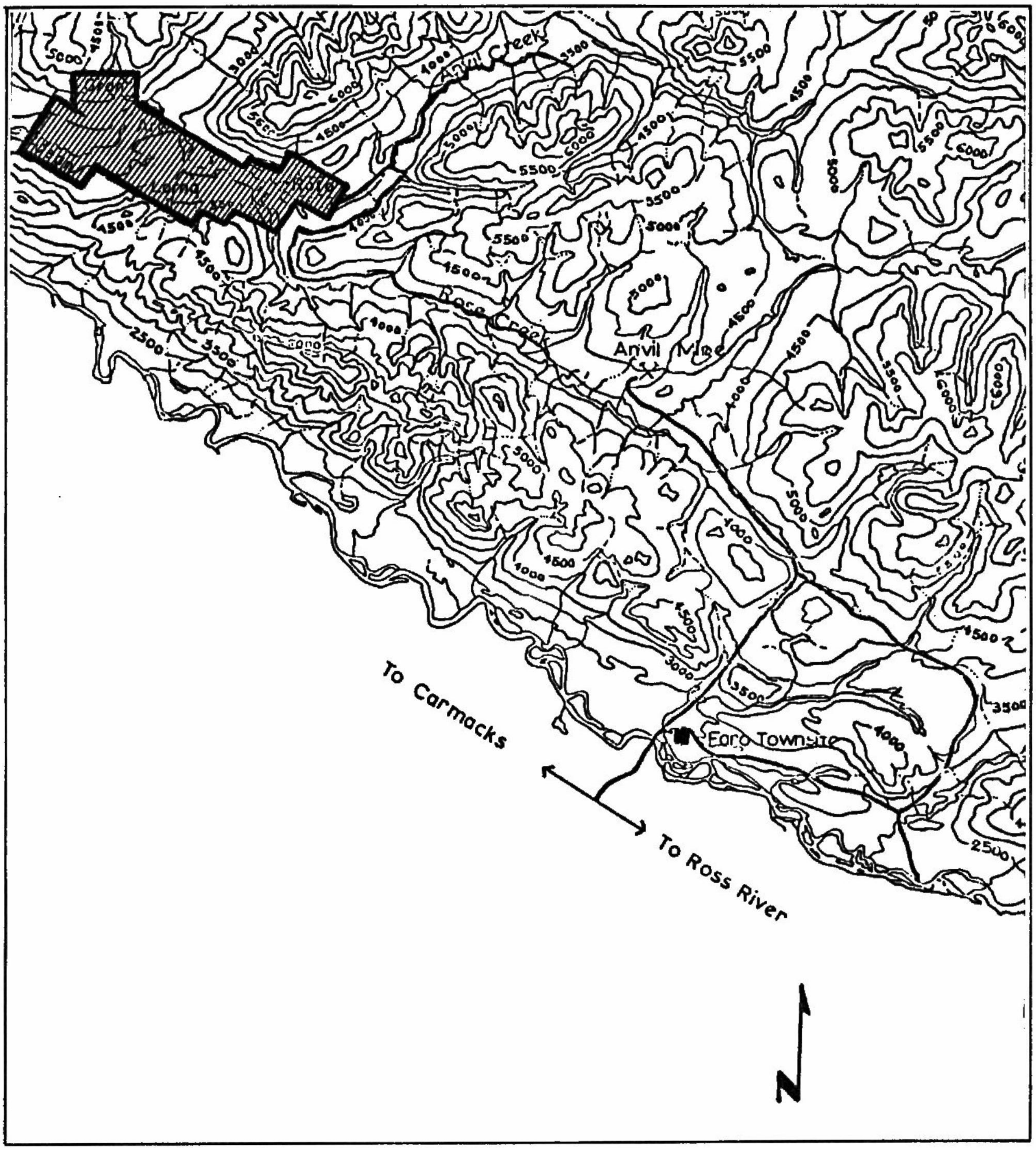


DYNASTY EXPLORATIONS LIMITED

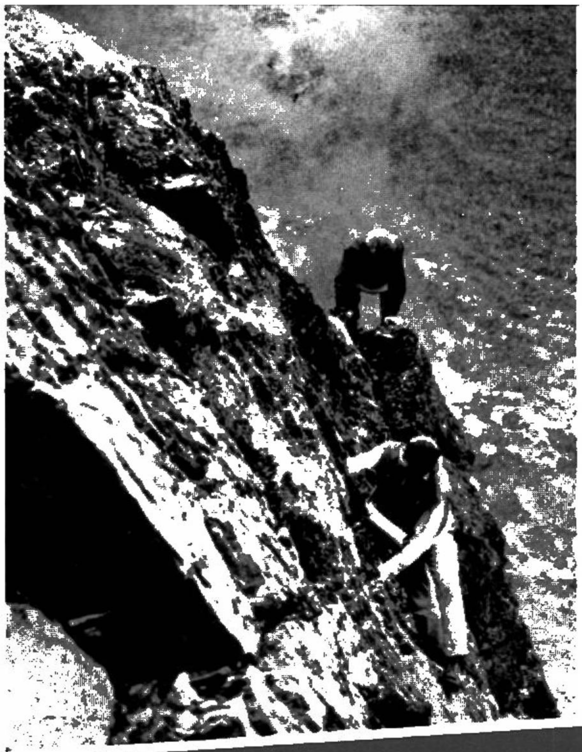
LOWER ANVIL CREEK PROJECT

CLAIM LOCATION MAP

SCALE : 1in. = 4 miles

FIGURE I

73-907



SCINTREX

SE-71

3 FREQUENCY TURAM SYSTEM

The SE-71 is an electromagnetic prospecting system utilizing a fixed source and moving receiver configuration. (Turam Method).

The source consists of a large loop, with sides several thousands of feet long, to which alternating current of 200, 400 or 800 Hz is supplied by a motor generator set which drives an electric convertor.

The receiver system consists of two coils, one of which incorporates the compensator. The latter measures the intensity ratio and phase difference between the fields received in the two coils.

Advanced solid state circuitry, a design based on long experience, and an indestructable fibre glass construction make the SE-71 an instrument combining high sensitivity and a drift free performance with lightness, exceptional reliability and sturdiness.

Specific advantages of the Turam method compared to other electromagnetic procedures are the great depth of exploration, the high accuracy and diagnostic quality of the data, and the absence of topographic distortion in the measurements. It is unique in performing successfully under conditions of heavy overburden and of extremely rugged topography.

SPECIFICATIONS

TRANSMITTER SYSTEM: (Mounted on packframe)

Briggs & Stratton 2 H.P. Engine

Bosch 12V. D.C. Generator

DC-AC Convertor, 200, 400, 800 c.p.s. ±1%

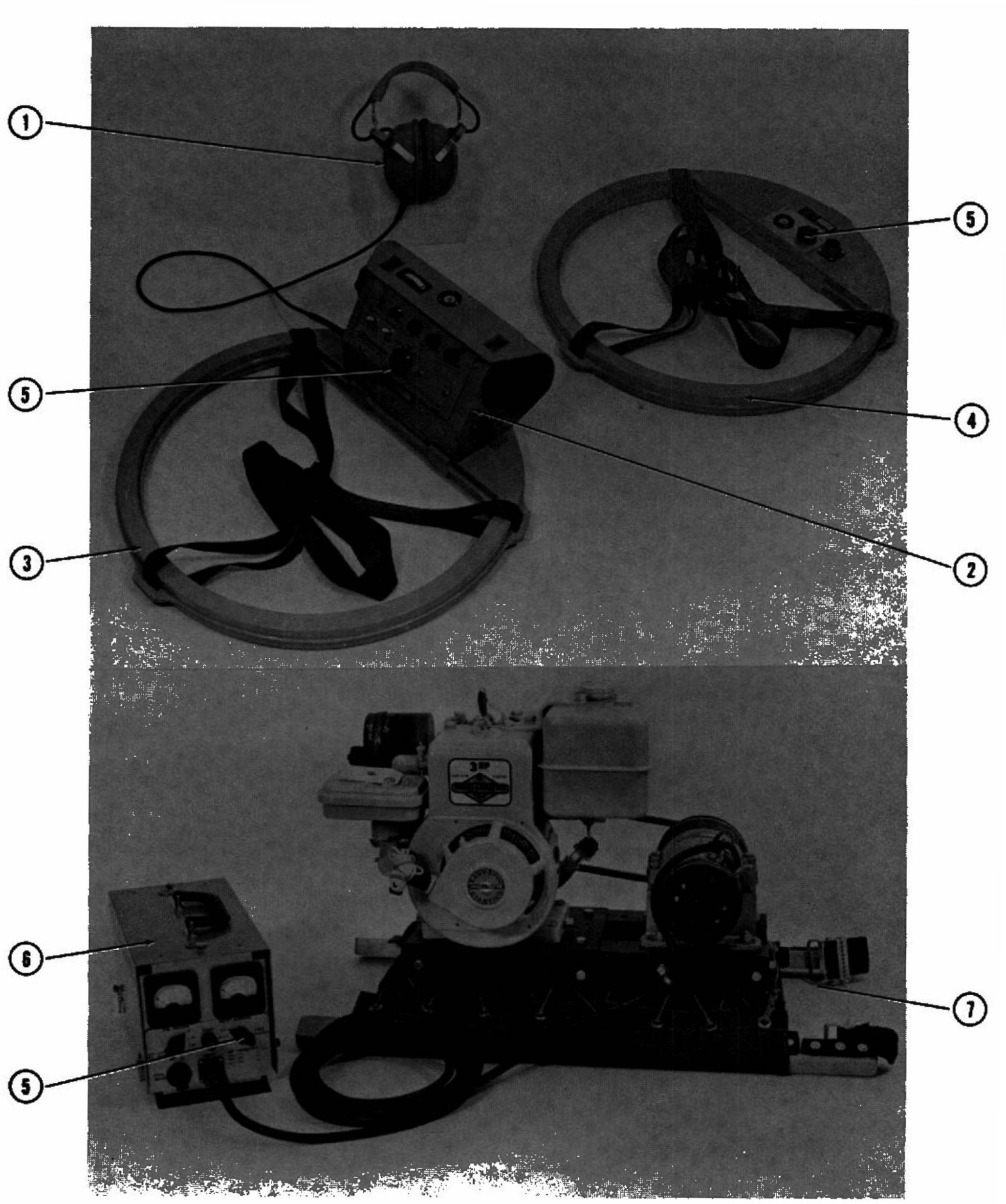
Available output power 180 Watts

Weight complete — 67 lbs. (30 kg.)

RECEIVER SYSTEM:

Coil Size	20½ inches
Frequency	200, 400, 800 c.p.s. tuneable over range of ±5%
Battery	Type Eveready #216, 9V, life expectancy: 2 months
Read-Out	Field strength ratio and phase difference
Read-Out Range	0% to 200% ±20°
Weight —	Each coil — 3 lbs. (1.4 kg.)
Weight —	Console — 5 lbs. (2.3 kg.)
Weight —	Interconnecting cable — 7 lbs. (3.2 kg.)

DESCRIPTION OF THE SE-71
3 FREQUENCY TURAM SYSTEM



1. Headphones
2. Compensator
3. Compensator Coil
4. Assistance Coil
5. Frequency Switch
6. Convertor
7. Motor-generator set

SCINTREX LIMITED
222 Snidercroft Road · Concord, Ontario, Canada

Some Aspects of the Turam Electromagnetic Method

Robbert A. Bosschart
and
Harold O. Seigel

Scintrex Limited
222 Snidercroft Rd.
Concord, Ontario.

Transactions, Volume LXIX, 1966, pp. 156-161

ABSTRACT

Most electromagnetic methods presently used in mining exploration are of the moving source type; i.e., the primary field source is moved simultaneously and in a fixed configuration with the receiver.

Of the fixed-source methods, which employ a stationary primary field and a moving receiver, the Turam method is the most effective and has marked advantages over alternative electromagnetic methods.

The results are little affected by topographic relief, and a high degree of resolution can be obtained because of the constant relation between source field and investigation area.

Another inherent advantage of the Turam configuration is that it provides more favourable dimensional relations. Thus, the primary field attenuates at a much lower rate than in moving-source configurations and, secondly, the method is size sensitive; i.e., conductor size affects the strength of the response, which is not the case with moving-source methods.

These factors result in a considerably better potential depth penetration.

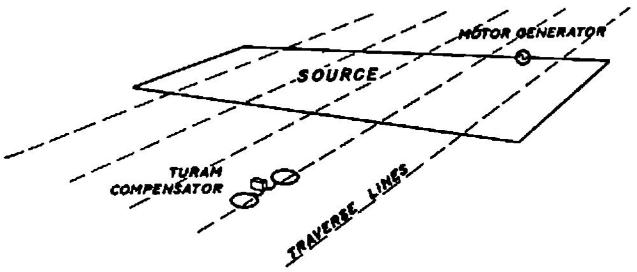


Figure 1.—General layout of the Turam method.

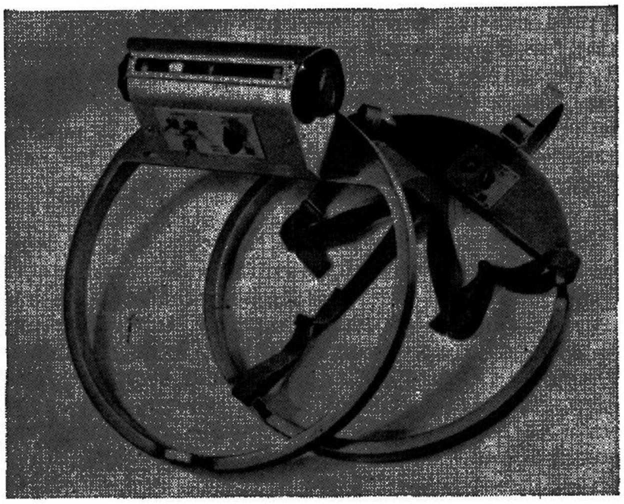


Figure 2.—Three-frequency Turam receiving system (Sharpe SE-700).

Introduction

In the period following the first world war, Scandinavia became the cradle of geo-electrical prospecting. The Swedish "Tvaram" (Sundberg, 1931) and "Compensator" (Sundberg & Hedstrom, 1933) were the forerunners of the large majority of present-day electromagnetic methods. From the Compensator method were derived, in quick succession, the "Turam" (Hedstrom, 1937) and the "Slingram" (Hedstrom, 1945) methods. Both techniques are still being used in virtually unmodified form, although the "Slingram" has been adapted to a variety of airborne applications and has, in the course of time, assumed a confusing array of pseudonyms, such as "Loop Frame," "Horizontal Loop," "E.M. Gun," "Minigun," "Ronka," "Magniphase," etc., as well as a number of names for the airborne adaptations. The Slingram-derived methods are characterized by a constant transmitter-receiver configuration, which is moved over the target area. They are called "Moving Source Compensation Methods."

The Turam method has been in active use since its development in 1932. In principle, it comprises a fixed transmitting layout of large dimensions and a moving receiver system which measures the gradients of phase and amplitude of the induced electromagnetic field. The coupling between the field source and a conductor, which is variable in the moving-source systems, is constant in the Turam or related configurations, resulting in a response of a somewhat different character. Therefore, a distinction is made between "Fixed Source" and "Moving Source" Compensation methods.

A typical Turam layout (*Figure 1*) consists of a rectangular transmitting loop of insulated wire with sides several thousand feet long, to which alternating current of one or more frequencies between 10^2 and 10^3 c.p.s. is fed by a gasoline-engine-driven alternator. The receiver system embodies two induction coils, carried at a constant separation (e.g., 100 ft.) and connected to a compensator which measures the intensity ratio and the phase difference between the fields received by the two coils.

As a rule, profiles are measured outside the transmitting loop, perpendicular to the long axis of the loop and not exceeding the length of the short axis.

The intensity of the induced primary field depends on the size and shape of the transmitting loop and the location of the observation point. The free air field strength ratios between stations successively occupied by the receiving coils are determined by calculation, and the observed ratios are normalized through division by these values. The presence of secondary fields is characterized by abnormal field strength ratios and phase differences.

Although in practice Turam measurements are, because of the light, mobile receiving system (*Figure 2*), made rapidly (at the rate of 3 to 6 miles per day), a change of primary layout at least each alternate day is required under average conditions. In order to maintain this rate of coverage, a crew of four men is employed—two to measure and two to lay out and recover loops. In terms of line miles per man-day, the Turam method is therefore rather less efficient than the moving-source methods. On the other hand, it has specific advantages in results over the latter, as will be shown below.

Quantitative Interpretation

When a block of ground is energized by means of an alternating electromagnetic (E.M.) field, the resulting field at the surface is, when conductors are present, elliptically polarized. This is because the secondary fields are phase-shifted relative to the primary field. With methods measuring a geometrical component (e.g., Vertical Loop E.M. methods), field ellipticity has the effect of blurring the observations; i.e., instead of a precise angle of zero induction a "null width" of minimum induction is obtained, and this null width widens with increasing phase shift. As a result, such methods may become less definitive in the presence of medium to poor conductors, such as conductive overburden or relatively disseminated mineralization.

A major advantage of Compensation methods is that phase shifts are compensated and field components can be measured accurately, independent of the degree of field ellipticity. Moreover, two related components are usually measured (either phase and amplitude, or in-phase and out-of-phase components), which greatly diminishes the possibility of obtaining spurious anomalies, and, more importantly, because the relation between these components depends on the conductor characteristics, renders possible a quantitative interpretation of the obtained data.

In recent years, much work has been done to investigate the response of mathematical or reduced-scale models of geological conductors in moving-source or fixed-source configurations and so provide a basis for the quantitative interpretation of field data (Wait, 1952, '53, '60; West, 1960; Hedstrom & Parasnis, 1958; Paterson, 1961; Bosschart, 1961, '64). As a result, some conductor characteristics can often be closely enough determined to discriminate between anomalies arising from potential ore conductors and those arising from electrolytic conductors (overburden, weathered shear zones, etc.) and the conducting bodies, even at considerable depth, can be accurately located for diamond drilling. The possibility of assigning significance to anomalies on the basis of amplitude ratios rather than on amplitude strength, and giving precedence to weak anomalies among larger and stronger ones, in itself signifies a considerable extension of the capabilities of these methods.

The response of conductors, calculated theoretically or observed in model experiments in a particular measuring configuration, are usually presented in the form of response diagrams showing a set of two curves which represent the variation of peak amplitudes of the in-phase and out-of-phase components with the variation of a response parameter. The latter includes, in some form, the exciting frequency and the relevant conductor characteristics. For instance, for an infinite sheet the response parameter may be written as $\lambda = 10^3 \frac{r}{fd}$, in which r = resistivity in ohm-cm, f = frequency, and d = thickness in m.

Such a diagram, representing the response of a medium-size tabular conductor (1000 ft. strike length) in a Turam configuration, is shown in *Figure 3A*. The straight line marked Q is the in-phase to out-of-phase ratio. This ratio varies with the response parameter and the strike length and thus gives, for a determinate frequency, a value for the resistivity/thickness ratio of the conductor. The validity of this particular diagram is limited to the specified strike length, but it illustrates the general relations. As they show the relation between the relative amplitudes of the response and the frequency, an important function of such diagrams is to indicate how anomalies caused by bodies of different conductivity can be emphasized or de-emphasized by changing the exciting frequency. An example of this application is described below.

In some areas, the overburden is both conductive and of irregular configuration and thickness. At standard prospecting frequencies, the strong field distortion arising from this condition could mask the response of underlying conductors, even when these would have appreciably better conductivity. In *Figure 3B-1*, an example of extreme overburden distortion at a frequency of 800 c.p.s. is shown, with anomalies as strong as 40 per cent field strength ratio (R) and a 24-degree phase difference (P). The same traverse at a frequency of 200 c.p.s. is shown in the bottom profile. The field strength anomaly has almost disappeared; from 40 per cent it has decreased to 4.5 per cent. The phase difference is down to 7.5 from 24 degrees. When these results are compared with the response diagram (*Figure 3-1*) they appear to be entirely predictable. The overburden anomalies have a r/d value of approximately 50 ohm-cm./m. and thus λ equals 62 ohm-cm.sec./m. at 800 c.p.s. and 250 ohm-cm.sec./m. at 200 c.p.s. As the curves show, the in-phase component drops 80 per cent and the out-of-phase component 60 per cent with the change of λ from 62 to 250 ohm-cm.sec./m. This example shows that the overburden response can be drastically reduced by lowering the frequency. The process would, however, be futile if the response from underlying better conductors would be proportionally decreased. With the use of properly selected exciting frequencies, however, this is not the case; for a good conductor with, say, an r/d value of 1.5, the change in frequency would represent a change from $\lambda = 2$ to $\lambda = 8$, with a corresponding drop of the in-phase amplitude of only 25 per cent and an actual gain in out-of-phase amplitude of 75 per cent (*Figure 3A-2*).

Under 200 ft. of cover, this conductor might (subject to size and over-all geometry), at a frequency of 800 c.p.s., give rise to a 22 per cent in-phase and a 4 per cent out-of-phase anomaly (approximately 20 per cent field strength ratio, 2.5 degree phase diference) (*Figure 3B-2*), and would be difficult to distinguish from the 800-c.p.s. overburden noise shown in *Figure 3B-1*. At the lower frequency, the anomaly would be 17 per cent in-phase and 7 per percent out-of-phase (15 per cent field strength ratio, 5-degree phase difference), and it would stand out clearly from the reduced overburden response.

Potential Depth Penetration

In assessing the capabilities of electromagnetic methods, the effective depth penetration is among the most important factors to consider. It can be defined as the maximum depth at which the response of conductors of potential economic interest can be clearly distinguished from electromagnetic fields arising from other sources.

An examination of the descriptions of some fifty producing orebodies on the Canadian and Baltic Precambrian shields shows that the large majority are steeply dipping, lenticular or tabular bodies of concentrated sulphides, with strike lengths varying from 300 to 3,000 ft. *(see Figure 4A)* and depth extensions, where known, of a comparable order of of magnitude. An example of the response of good conductors within this size range in typical moving-source and fixed-source configurations is shown in the same diagram *(Figure 4B)*. The conductor is a tabular body of good conductivity (λ = 10.3 ohm-cm.sec./m.) at a depth of 60 ft. The strike length and height have been increased simultaneously from 10^3 to 10^4 feet. It can be seen that, up to a strike length of 400 ft.,

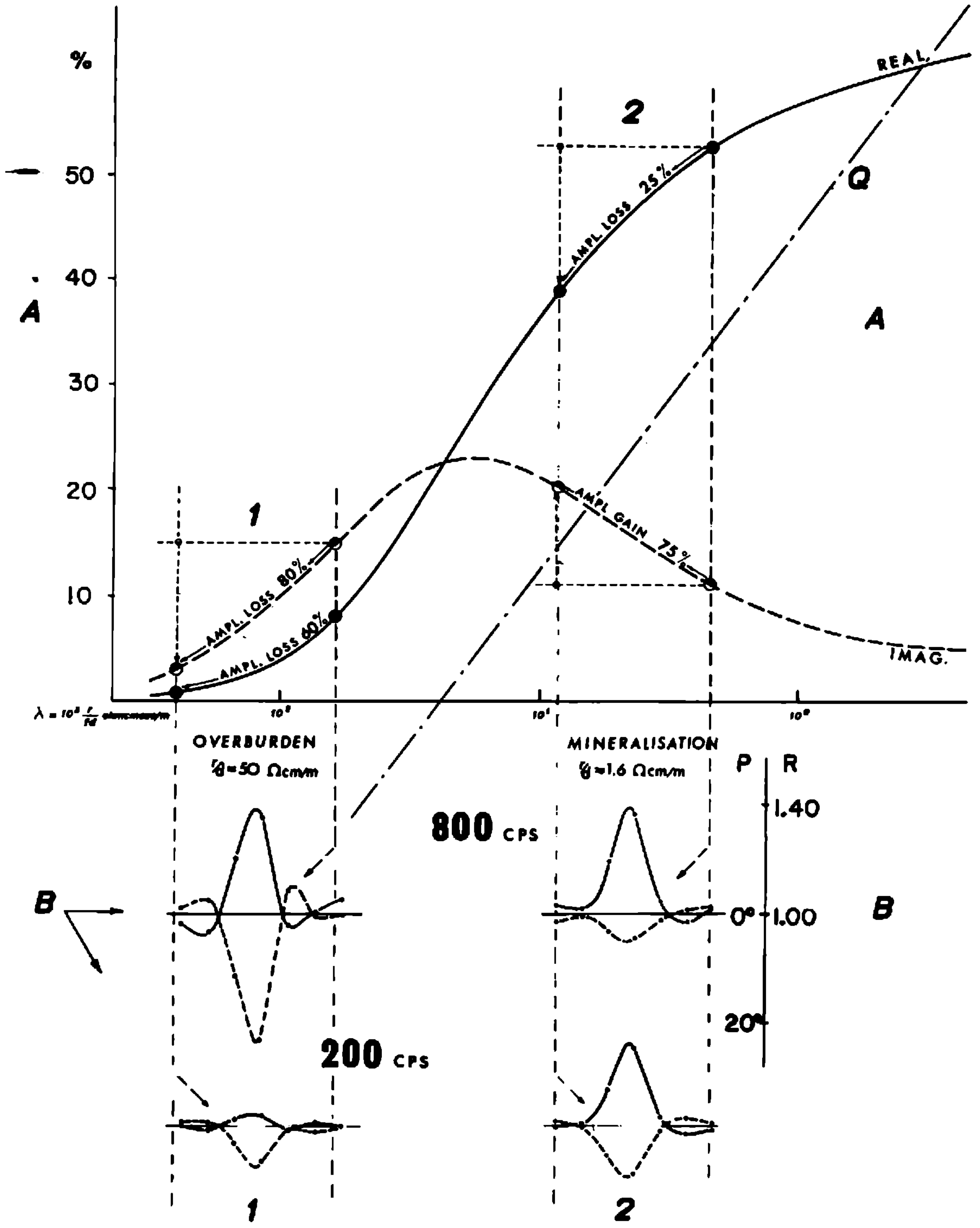


Figure 3.—Response of a thin, medium-size tabular conductor (1000-ft. strike length) in a fixed-source measuring configuration.

the response in both configurations is comparable. In the moving-source configuration (Horizontal Loop), a further increase in size results in very little gain in the response. Saturation is reached at a strike length of 600 to 800 ft.

In the fixed-source (Turam) configuration, the response shows its steepest gain where the moving-source response flattens off; for an increase in strike length from 300 to 3,000 ft., the fixed-source response increases from 6 per cent to 80 per cent, or

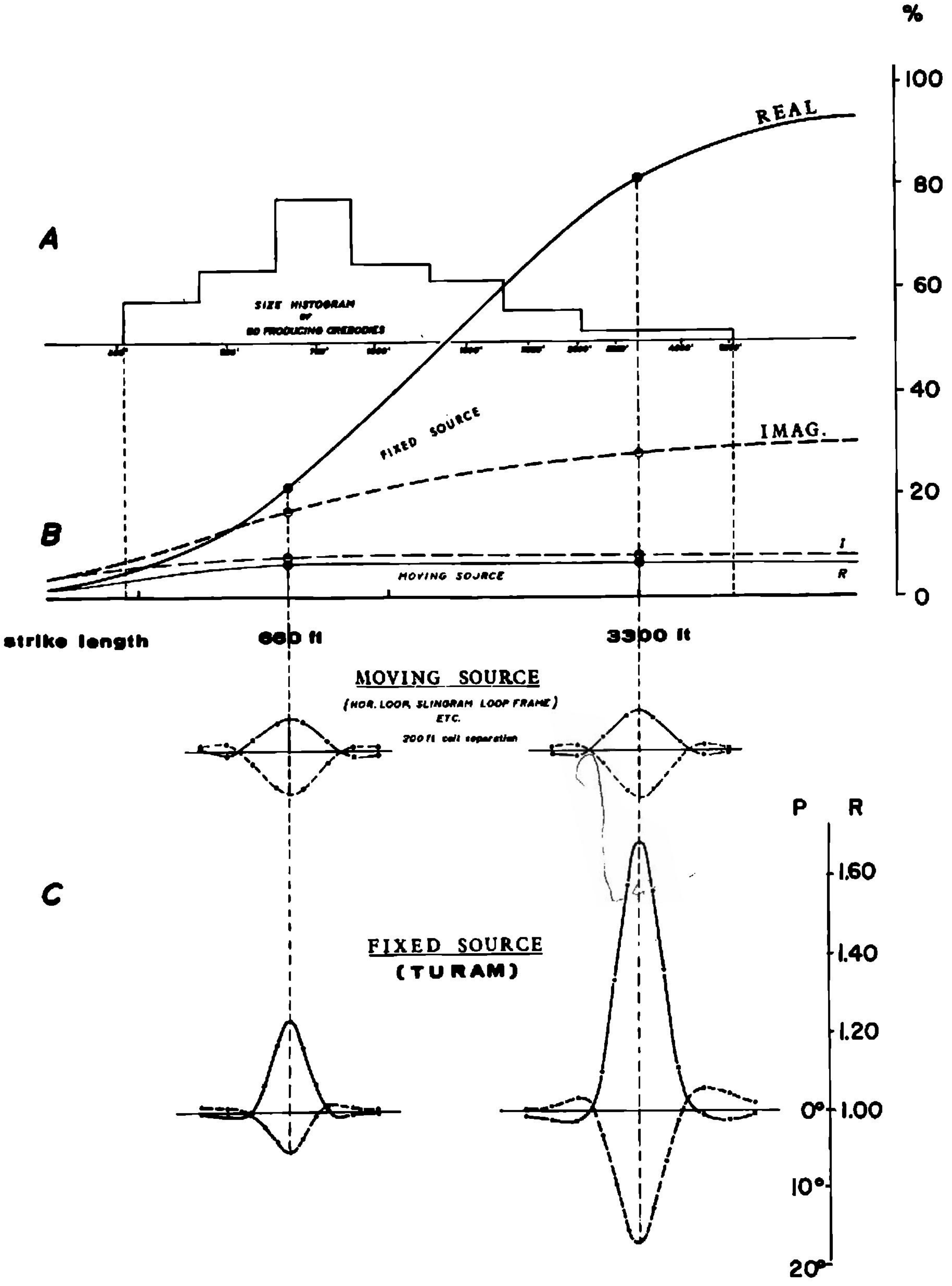


Figure 4.—A comparison of the response of conductors of varying size in moving-source and fixed-source measuring configurations.

more than 13 times, whereas the moving source response increases from 4 per cent to 7.5 per cent, or by a factor of less than 2.

In practical terms, this means that size has a negligible effect on the detectability of a conductor in a moving-source configuration, but contributes materially to its detectability in a fixed-source system. The larger the body, the greater the depth at which it can be found with the Turam method. A major reason for the observed difference in potential depth penetration of the two types of configuration is the different rate of fall-off of the response of bodies of the shapes and dimensions discussed above.

For moving-source configurations, this question has been examined by Hedstrom & Parasnis (1958). In a diagram, for instance, they show the variation of the response of a 2,000 by 2,000 ft. sheet conductor of good conductivity ($\lambda = 4$ ohm-cm.sec./m.) with the depth. *(Figure 5).* Between depth to coil separation ratios of 0.2 and 0.8 the rate of fall-off increases from the 1st to the 5th power of the depth. In ground surveys, where the in-phase noise level is, under average conditions, rarely less than 2 per cent, a discernable anomaly will thus have to have an in-phase amplitude of at least 4 per cent. As the diagram shows, the response falls below this value at a depth to coil separation ratio of 0.57. At 300 ft., which is the largest separation practical, the potential depth penetration is therefore less than 170 ft.; at the standard 200 ft. separation, it is less than 115 ft.

The variation with depth of the response of a smaller conductor (1,000 by 1,000 ft) of comparable conductivity ($\lambda = 3.5$) in a Turam configuration is shown in *Figure 6.* To a depth of 200 ft. the response falls off at a rate of less than the 1st power; to depths of well over 600 ft., it falls off at a rate of less than the 2nd power.

At a 600-ft. depth, the in-phase amplitude is still better than 4 per cent. For a 2,000 by 2,000-ft. body, it would be approximately 6 per cent, and, with a further increase in size, it could reach 8 per cent. The potential depth penetration can thus be conservatively estimated to be 600 ft.

Figure 7 is a field example of a 400-c.p.s. Turam traverse over two steeply dipping mixed graphite and sulphide conductors under 340 ft. of overburden (Timmins area). The field strength ratio anomaly of the strongest conductor is 23 per cent, which is approximately three times stronger than the field strength ratio anomaly of the smaller conductor shown in *Figure 6* at the same depth of burial. This example indicates that the present body could be found at much greater depth and that the estimate of the potential depth penetration, based on the smaller body, is indeed conservative. It may be noted that the in-phase response in a moving-source system (300 ft. coil separation) would be less than 1 per cent and that the body would be undetectable with such a method.

Effect of Topographic Relief

Neglecting external sources, the noise level of moving-source compensation methods is strongly dependent on the coupling between transmitter and receiver; i.e., if the configuration is not rigidly maintained during operation, spurious in-phase anomalies result. For instance, an error of 5 per cent in the

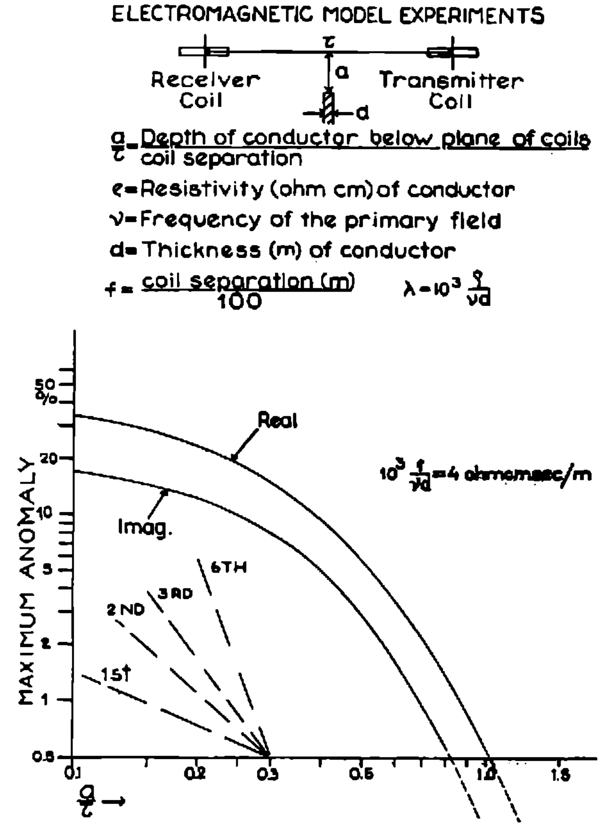


Figure 5.—Variation of the response with depth of a thin tabular conductor of infinite strike length in a moving source configuration.
(Hedstrom and Parasnis, 1958).

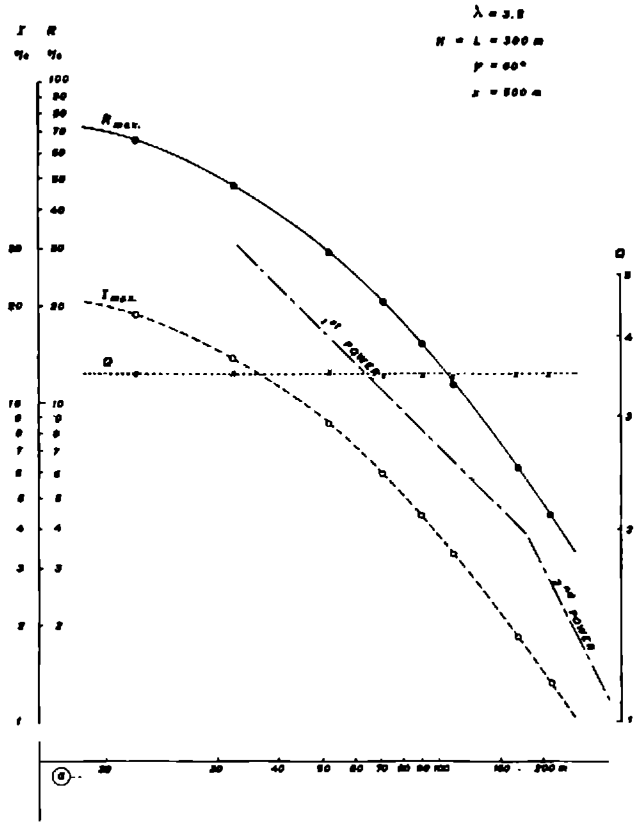


Figure 6.—Variation of the response with depth (a) of a thin tabular conductor of finite strike length (1000 ft.) in a fixed-source measuring configuration.

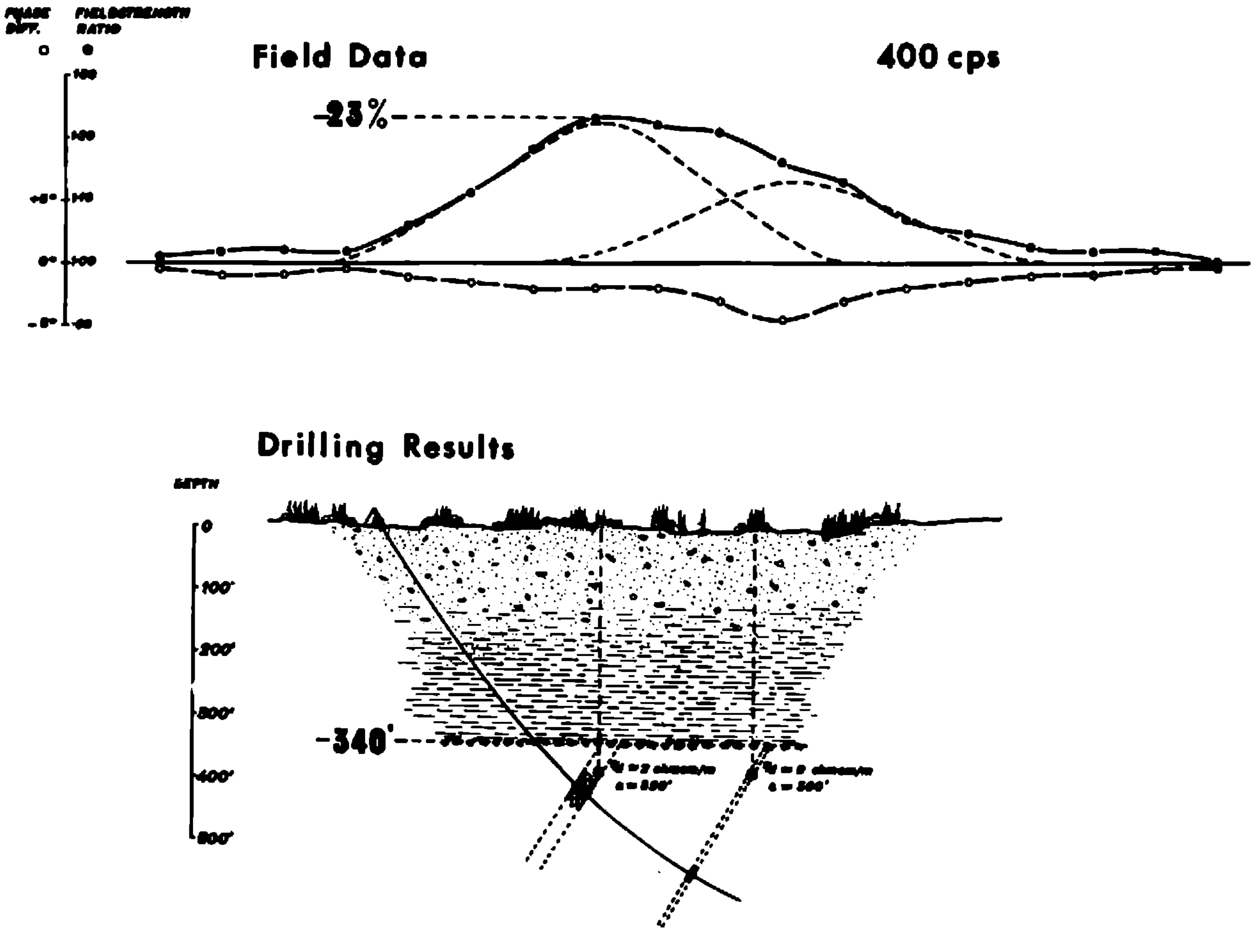


Figure 7.—Turam traverse over deeply buried conductors in the Timmins area.

coil separation causes a change of 15 per cent in the in-phase component. In the presence of secondary fields, both components are affected. Elevation differences between the coils produce a comparable effect. As a result, these methods become impractical in areas of appreciable topographic relief.

With the Turam system, a 5 per cent error in coil separation causes a change of 2 per cent at a distance of 300 ft. from the source, 0.5 per cent at 500 ft. and 0.2 per cent at 1000 ft. The effect of elevation differences between coils is, because the field at the surface is predominantly vertical, even smaller.

The effect of terrain relief on the measurements is therefore negligible, except in areas of very rugged topography. Moreover, where corrections are required, they can be made, because of the fixed relation between source and terrain, in a simple and straightforward manner.

Conclusions

In the foregoing, those aspects of the Turam method that have marked advantages over alternative methods have been stressed. It is, at present, the most powerful electromagnetic prospecting tool at our disposal.

It is also a rather elaborate method and therefore does not necessarily represent the most efficient approach under all circumstances.

In areas of thin cover and level topography, systematic surveys may, for instance, be done more economically with moving-source compensation methods. Also, for fast ground follow-up of airborne electromagnetic surveys, where the problem is usually confined to determining the accurate location of preselected anomalies, methods measuring geometrical components will yield the desired information more rapidly and at less expense.

The proper field of application of the Turam method lies where conditions are more difficult and the requirements severe; in particular in cases where a high degree of discrimination between conductors is desired, where the depth of overburden limits the use of other methods or where appreciable topographic relief occurs.

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Appendix I

SUMMARY OF COSTS

	Wages (Schedule 'A')	Expenses (Schedule 'B')	Total
Linecutting		7,544.50	
Geology	2,275.96		
Geophysics	493.06	12,462.28	
Assays		1.62	
Camp		2,595.44	
Misc. Freight & Transport.		646.29	
Rotary-Wing		3,897.09	
	2,769.02	27,147.22	$29,916.24
District Expense - 5%			$ 1,495.81
			$31,412.05
Administration @ 10%			$ 3,141.21
TOTAL COSTS			$34,553.26

Appendix II

TELEPHONE 685-4331

DYNASTY EXPLORATIONS LIMITED

330 MARINE BUILDING
355 BURRARD STREET
VANCOUVER 1, B.C.

AFFIDAVIT SUPPORTING SUMMARY OF COSTS

I, CLIFFORD MALISH, Accountant, Dynasty Explorations Limited, of Vancouver, British Columbia, do hereby state that, to the best of my knowledge and belief, the statement of costs attached hereto with reference to geophysical surveys conducted on the Lorna, Gran, Roto, Aro Mineral Claims, is correct and true.

Clifford Malish

Date

Notary Publis for the
Province of British Columbia.