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# **REPORT ON AN**

# AIRBORNE MAGNETIC AND VLF-EM SURVEY

### **CUNNINGHAM TOWNSHIP**

# SUDBURY MINING DISTRICT, ONTARIO

for

# INGAMAR EXPLORATIONS LIMITED

by: TERRAQUEST LTD.

Toronto, Canada August 24, 1988

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MINING LANDS SECTION



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## 1. Introduction

This report describes the specifications and results of a geophysical survey carried out for Ingamar Explorations Limited of Cedar Hill, Connaught, Ontario, PON 1A0 by Terraquest Ltd., 240 Adelaide Street West, Toronto, Canada. The field work was completed on July 1, 1988 and the data processing, interpretation and reporting from July 2 to August 24, 1988.

The purpose of a survey of this type is two-fold. First to prospect directly for anomalously conductive and magnetic areas in the earth's crust which may be caused by, or at least related to, mineral deposits. A second is to use the magnetic and conductivity patterns derived from the survey results to assist in mapping geology, and to indicate the presence of faults, shear zones, folding, alteration zones and other structures potentially favourable to the presence of gold and base-metal concentration. To achieve this purpose the survey area was systematically traversed by an aircraft carrying geophysical instruments along parallel flight lines spaced at even intervals, 100 metres above the terrain surface, and aligned so as to intersect the regional geology in a way to provide the optimum contour patterns of geophysical data.

### 2. The Property

The property is located in the northeast corner of Cunningham township, in the Sudbury Mining Division of Ontario about 128 kilometres southwest of the town of Timmins. The property can be approached by bush roads to the east in Garnet township and to the west on the west side of Ransom Lake.

The latitude and longitude are 47 degrees 45 minutes, and 82 degrees 37 minutes respectively, and the N.T.S. reference is 410/10 and 15.

The claim numbers are shown in figure 2 and listed below:

P-987226	to	P-987234	Inc.	(9)
P-1036517				(1)
P-1036520	to	P-103527	Inc.	(8)
Total Clai	18			
				$\sim$

# 3. Geology

#### Map References

1.	Map 51F:	Cunningham-Garnet Area
		Scale 1:63,360 O.D.M. 1942
2.	Map 2503:	Cunningham and Gamet Townships Scale 1:31,680 O.G.S. 1967
3.	Map P.2339:	Cunningham Township Scale 1:15,840 O.G.S. 1980

The survey area is underlain predominantly by mafic metavolcanics that trend to the west and northwest. Minor intermediate and felsic metavolcanics occur in the central part of the survey area north of Allan Lake. At least three iron formations associated with chemical metasediments occur along the eastern part of the survey area.

Three gold occurrences around the eastern and northern edges of Allan Lake indicate that gold mineralization is associated with both the mafic and intermediate metavolcanics.

Regionally, faults trend to the north-northwest.

## 4. Survey Specifications

#### 4.1 Instruments

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The survey was carried out using a Cessna 206 aircraft, registration C-GGLS, which carries a magnetometer and a VLF electromagnetic detector.

The magnetometer is a high sensitivity, optically pumped cesium vapour magnetometer mounted in a stinger attached to the tail of the aircraft. It's specifications are as follows:

Working range:	20,000-100,000 gammas
Sensitivity:	0.001 gemmas
Sampling rate:	0.2 seconds
Model:	BIW 2321H8
Manufacturer:	Scintrex, Concord Ontario,

The magnetometer processor is a PMAG 3000 and the data acquisition system is a PDAS 1000, both manufactured by Picodas Group Inc.

The signal to noise ratio of the magnetic response is improved by a real time compensation technique provided by Picodas Limited. The seconds of com-





sated noise are permanent, induced and petty current effects of the airframe and the heading effects. The system uses three fluxgate magnetometers to measure the aircraft attitude with respect for the earth magnetic field vector. A mathematical model is used to solve this interference effect.

The VLF-EM unit uses three orthogonal detector coils to measure (a) the total field strength of the time-varying EM field and (b) the phase between the vertical coil and both the "along line" coil (LINE) and the "cross-line" coil (ORTHO). The LINE coil is tuned to a transmitter station that is ideally positioned at right angles to the flight lines, while the ORTHO coil transmitter should be in line with the flight lines. It's specifications are:

Accuracy:	1%
Reading Interval:	1/2 second
Model:	TOTEM 2A
Manufacturer:	Herz Industries, Toronto, Canada

The VLF sensor is mounted in the left wing tip extension.

Other instruments are:

- King KRA-10A radar altimeter
- UDAS-100 data processor with Digidata nine track tape recorder, manufatured by Urtec Ltd., Markham, Ontario.
- Geocam video camera and recorder for flight path recovery, manufactured by Geotech Ltd., Markham, Ontario.

#### 4.2 Lines and Data

Line spacing:	100 metres
Line direction:	360 degrees
Terrain clearance:	100 m
Average ground speed:	193 km/hr
Data point interval:	
Magnetic:	11 metres
VLF-EM:	11 metres
Tie Line interval:	2 km
Channel 1 (LINE):	NAA Cutler, 24.0 kHz
Channel 2 (ORTHO):	NSS Annapolis, 21.4 kHz
Line km over total survey area:	94 line km

Line km over claim 72 line km groups:

#### 4.3 Tolerances

Line spacing: Any gaps wider than twice the line spacing and longer than 10 times the line spacing were filled in by a new line.

**Terrain clearance:** Portions of line which were flown above 125 metres for more than one km were reflown if safety considerations were acceptable.

**Diurnal magnetic variation:** Less than ten gammas deviation from a smooth background over a period of two minutes or less as seen on the base station analogue record.

Manoeuvre noise: nil

#### 4.4 Photomosaics

For navigating the aircraft and recovering the flight path, semi-controled mosaics of aerial photographs were made from existing air photos. Each photograph forming the mosaic was adjusted to conform to the NTS map system before the mosaic was assembled.

#### 5. Data Processing

Flight path recovery was carried out in the field using a video tape viewer to observe the flight path as recorded by the Geocam video camera system. The flight path recovery was completed daily to enable reflights to be selected where needed for the following day.

The magnetic data was levelled in the standard manner by tying survey lines to the tie lines. The IGRF has not been removed. The total field was contoured by computer using a program provided by Dataplotting Services Inc. To do this the final levelled data set is gridded at a grid cell spacing of 1/10th of an inch at map scale.

The vertical magnetic gradient is computed from the total field data using a method of transforming the data set into the frequency domain, applying a transfer function to calculate the gradient, and then transforming back into the spatial domain. The method is described by a number of authors including Grant, 1972 and Spector, 1968. The computer program for this purpose is provided by Paterson, Grant and Watson Ltd. of Toronto.



• VLF data was treated automatically so as to normalize the non conductive background areas to 100 (total field strength) and zero (quadrature). The algorithms to do this were developed by Terraquest and will be provided to anyone interested by application to the company.

All of these dataprocessing calculations and map contouring were carried out by Dataplotting Services Inc. of Toronto.

- Grant, F.S. and Spector A., 1970: Statistical Models for Interpreting Aeromagnetic Data; Geophysics, Vol 35
- Grant, F.S., 1972: Review of Data Processing and Interpretation Methods in Gravity and Magnetics; Geophysics Vol 37-4
- Spector, A., 1968: Spectral Analysis of Aeromagnetic maps; unpublished thesis; University of Toronto.

### 6. Interpretation

#### 6.1 General Approach

To satisfy the purpose of the survey as stated in the introduction, the interpretation procedure was carried out on both the magnetic and VLF data. On a local scale the magnetic gradient contour patterns were used to outline geological units which have different magnetic intensity and patterns or "signatures". Where possible these are related to existing geology to provide a geological identity to the units. On a regional scale the total field contour patterns were used in the same way.

Faults and shear zones are interpreted mainly from lateral displacements of otherwise linear magnetic anomalies but also from long narrow "lows". The direction of regional faulting in the general area is taken into account when selecting faults. Folding is usually seen as curved regional patterns. Alteration zones can show up as anomalously quiet areas, often adjacent to strong, circular anomalies that represent intrusives. Magnetic anomalies that are caused by iron deposits of ore quality are usually obvious owing to their high amplitude, often in tens of thousands of gammas.

VLF anomalies are categorized according to whether the phase response is normal, reverse, or no phase at all. The significance of the differing phase responses is not completely understood although in general reverse phase indicates either overburden as the source or a conductor with considerable depth extent, or both. Normal phase response is theoretically caused by surface conductors with limited depth extent. In some cases, a change in the orientation of the conductor appears to affect the sense of the phase response.

Areas showing a smooth VLF-EM response somewhat above background (ie. 110 or so) are likely caused by overburden which is thick enough and conductive enough to saturate at these frequencies. In this case no response from bedrock is seen.

The VLF-EM conductor axes have been identified and evaluated according to the Terraquest classification system (Figure 4). This system correlates the nature and orientation of the conductor axes with stratigraphic, structural and topographic features to obtain an association from which one or more origins may be selected. Alternate associations are indicated in parentheses.

#### 6.2 Interpretation

The magnetic and VLF-EM data are shown in contoured format on maps at a scale of 1:10,000 in the back pocket. An interpretation map is also provided. The following notes are intended to supplement these maps.

The total magnetic field has a relief of approximately 2,000 gammas and shows strong responses along the eastern half of the survey area, and moderate to weak responses that trend to the west and northwest over the western half of the survey area. The vertical magnetic gradient is particularly useful in improving the resolution of the strong magnetic anomalies to the east and has been used to delineate the stratigraphy and structure.

The strong magnetic responses to the east are interpreted as iron formation consistent with the geological mapping. Magnetic mapping of this unit suggests that some of these horizons may be connected by folding whereas others may be truncated by north-northwest trending faults. Note that the interpreted widths may be exaggerated due to the overwhelming effect often associated with strong magnetic susceptibilities.

The mafic metavolcanics (Unit 1) correlate with moderate magnetic responses. Horizons with increased magnetic activity (Unit 1m) may be derived from more mafic compositions or possibly higher concentrations of magnetite or pyrrhotite.

	FIGURE 4	
	TERRAQUEST CLASSIFICATION OF	LF-EM CONDUCTOR AXES
SYMBOL C(	ORRELATION	ASSOCIATION: Possible Origins
<b>a</b> , <b>A</b> co	vincident with magnetic stratigraphy	Bedrock magnetic horizons: stratabound mineralogic origin or shear zone
<b>D</b> <b>D</b>	Irallel to magnetic stratigraphy	Bedrock non-magnetic horizons: stratabound mineralogic origin or shear zone
C U	o correlation with magnetic stratigraphy	Association not known: possible small scale stratabound mineralogic origin, fault or shear zone, overburden
° و	oincident with magnetic dyke	Dyke or possible fault: mineralogic or electrolytic
<b>н</b> Со Со	<pre>Dincident with topographic lineament or arallel to fault system</pre>	Fault zone: mineralogic or electrolytic
ob, OB	ontours of total field response conform o topographic depression	Most likely overburden: clayey sediments, swampy mud
	oincident with cultural sources	Electrical, pipe or railway lines
NOTES		· · · · · · · · · · · · · · · · · · ·
1 - Upper case symbols	s denote a relatively strong total field s	rength
2 - Underlined symbols	s denote a relatively strong quadrature re	bonse .
3 - Mineralogic origir 4 - Electrolytic origi	ns include sulphides, graphite, and in fau ins imply conductivity related to porosity	t zones, gouge · · · or high moisture content
	•	
		240 Adelaide Street West, Toronto, Canada M5H•1W7, Telephone (416) 971-5400, Fax (416) 971-1

: felsic (Unit 3) and intermediate (Unit 2) metavolcanics correlate with weak magnetic responses and in general cannot be discriminated, and form the quiet magnetic background.

Exposures of the gabbro correlate with moderate (Unit 5) to strong (Unit 5m) magnetic responses. This variability may be related to the initial composition or possibly to alteration. It is difficult to discriminate the 5m horizon magnetic unit from the iron formation and 1m units. For example the strong anomaly north of Allan Lake lies amongst prominent 1m horizons to the west, iron formation to the southeast, and gabbro to the northeast. It is possibly that this anomaly has many sources. However, it is speculated that the major source is an intrusive at depth, possibly part of the 5m unit. This is based on the northeast trend of the anomaly.

Numerous northeast trending faults have been interpreted, some of which correlate well with topographic lineaments. Several north trending faults in the central part of the survey area appear to possess considerable lateral displacement.

The VLF-EM survey has identified numerous VLF-EM conductive zones. The strongest ones coincide with lakes and topographic depressions and are probably related to conductive overburden.

Several strong conductor axes coincide with magnetic stratigraphy and therefore probably possess stratabound origins such as sulphides or graphite. Note that two of the major iron formations and one of the magnetic members of the mafic metavolcanics coincide with strong VLF conductor axes. These should be followed up on the ground using IP or EM methods. A few conductor axes cross the magnetic stratigraphy have been interpreted to possess structural associations, either faults or shear zones. This type of conductivity may be related to (a) minerals such as sulphides, graphite or gouge within the structure, or (b) an ionic effect created by water or porosity along the structure or to conductive overburden in an overlying topographic depression. Structures identified by either VLF-EM or magnetic methods possess potential for epithermal mineralization and should be investigated on the ground.

### 7. Summary

An airborne combined magnetic and VLF-EM survey has been carried out at 100 metre line intervals with data reading stations at 11 metres along the flight lines. All data is produced on maps at a scale of 1:10,000.

The magnetic data has been used to modify and update the existing geology and has shown a number of new contacts and faults. Numerous VLF-EM conductor axes have been identified, three of which coincide with magnetic stratigraphy and are believed to have potential sulphide origins and have been recommended for additional investigation. Several conductor axes are associated with structural sources and should be investigated for possible epithermal type mineralization.



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