REPORT ON AN
AIRBORNE MAGNETIC AND VLF-EM SURVEY
AFTON AND SCHOLES TOWNSHIPS
SUDBURY MINING DIVISION, ONTARIO

for
EMERALD LAKE RESOURCES INC.

RECEIVED
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by
MAPPING LANDS SECTION

TERRAQUEST LTD.
Toronto, Canada

July 9, 1986
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No. A-625-2, Vertical Magnetic Gradient
No. A-625-3, VLF-EM Survey
No. A-625-4, Interpretation

TERRAQUEST LTD.
1. INTRODUCTION

This report describes the specifications and results of a geophysical survey carried out for Emerald Lake Resources Inc. of 1275 Main Street West, North Bay, Ontario P1B 2W7 by Terraquest Ltd., 905 - 121 Richmond St. W., Toronto, Canada. The field work was performed on June 9, 1986 and the data processing, interpretation and reporting from June 10 to July 9, 1986.

The purpose of a survey of this type is two-fold. One is 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 meters 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 Afton and Scholes townships, in the Sudbury Mining Division of Ontario about 70 kilometres north of the town of Sudbury. The survey area lies on the east side of Afton township and the west side of Scholes township. It is readily accessible by roads from the south.

The latitude and longitude are 46 degrees 56 minutes, and 80 degrees 23 minutes respectively, and the N.T.S. reference is 411/16.

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

| WD 184-185    | (2) |
| S 91249-91250 | (2) |
| S 111764-111765 | (2) |
| S 470249-470278 | (30) |
| S 482959-482963 | (5) |

**total 41 claims**

3. GEOLOGY

Map References

1. Map 2361: Sudbury-Cobalt geological compilation series. scale
FIGURE 1. General Location Map
FIGURE 2. Property Location Map, Afton and Scholes Townships

The property is underlain by a sequence of east-northeast trending, Early Precambrian mafic to intermediate metavolcanics, felsic to intermediate metavolcanics and to the north, sediments of the Gowganda Formation. Iron formations are associated with the mafic volcanics and commonly host sulphide and gold mineralization.

The Middle Precambrian Nipissing Diabase occurs extensively in this area with a predominantly gabbroic composition.

Fault sets trend to the north-northwest, north, northeast and less frequently to the east-northeast.

4. SURVEY SPECIFICATIONS

4.1 Instruments

The survey was carried out using a Cessna 182 aircraft, registration C-FAKK, which carries a magnetometer and a VLF electromagnetic detector.

The magnetometer is a proton precession type with the sensor element mounted in an extension of the right wing tip. It's specifications are as follows:

- Resolution: 0.5 gamma
- Accuracy: One gamma
- Cycle time: One second
- Range: 20000 - 100000 gammas in 23 overlapping steps
- Gradient tolerance: Up to 5000 gammas per meter
- Model: GSM-8BA

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 relationship 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
FIGURE 3. SAMPLE OF ANALOGUE DATA
FIGURE 4

TERRAQUEST CLASSIFICATION OF VLF-EM CONDUCTOR AXES

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Correlation</th>
<th>Association: Possible Origins</th>
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<tbody>
<tr>
<td>a</td>
<td>Coincident with magnetic stratigraphy</td>
<td>Magnetic horizons: stratabound mineralogic origin or shear zone</td>
</tr>
<tr>
<td>b</td>
<td>Parallel to magnetic stratigraphy</td>
<td>Non-magnetic horizons: stratabound mineralogic origin or shear zone</td>
</tr>
<tr>
<td>c</td>
<td>No correlation with magnetic stratigraphy</td>
<td>Association not known: stratabound mineralogic origin, fault or shear zone, overburden</td>
</tr>
<tr>
<td>d</td>
<td>Coincident with magnetic dyke</td>
<td>Dyke or possible fault: mineralogic or electrolytic</td>
</tr>
<tr>
<td>f</td>
<td>Coincident with topographic lineament or parallel to fault system</td>
<td>Fault zone: mineralogic or electrolytic</td>
</tr>
<tr>
<td>ob</td>
<td>Total field contours conform to topographic depression</td>
<td>Most likely overburden: Clayey sediments, swampy mud</td>
</tr>
<tr>
<td>cul</td>
<td>Coincident with cultural sources</td>
<td>Electrical, pipe or railway lines</td>
</tr>
</tbody>
</table>

Index to Relative Amplitudes of Conductor Axes

- Total field conductor axis
- Strong total field conductor axis
- Total field conductor axis with strong quadrature response

Notes

1. Mineralogic origins include sulphides, graphite, and in fault or shear zones gouge
2. Electrolytic origins imply conductivity related to porosity or high moisture content
Model: TOTEM 2A
Manufacturer: Herz Industries, Toronto

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, manufactured 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

a) Line spacing: 100 meters
b) Line direction: 350 degrees
c) Terrain clearance: 100 meters
d) Average ground speed: 156 km/hr.
e) Data point interval:
   Magnetic: 42 meters
   VLF-EM: 21 meters
f) Tie Line interval: 2 kilometers
g) Channel 1 (LINE): NLK Seattle, 24.8 kHz
h) Channel 2 (ORTHO): NSS Annapolis, 21.4 kHz
i) Line km over total survey area: 185
j) Line km over claim groups: 160

4.3 Tolerances

a) 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.
b) Terrain clearance: Portions of line which were flown above 125 meters for more than one km were reflown if safety considerations were acceptable.
c) Diurnal magnetic variation: Less than twenty gammas deviation from a smooth background over a period of two minutes or less as seen on the base station analogue record.
d) Manoeuvre noise: Approximately +/-5 gammas.

4.4 Photomosaics

For navigating the aircraft and recovering the flight path, mosaics of aerial photographs were made from existing air photos. In order to provide a semi-controlled base the photos were laid down on a topographic map which had been photographically adjusted to the photo scale. The laydown was then photographed and printed at the final map scale.
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 1/4 the flight line spacing.

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 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.

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

Grant, F.S.; Review of Data Processing and Interpretation Methods in Gravity and Magnetics; Geophysics, August 1972.
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.

Areas showing a smooth 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.

6.2 Interpretation

The total magnetic field is dominated by a strong anomaly of about 9,500 gammas centered primarily over the western half of the survey area. This compares with a relief of approximately 7,000 gammas for the same anomaly on the regional magnetic survey by the Geological Survey of Canada. The large, smooth pattern of this anomaly suggests a very strong magnetic source at considerable depth. It is recommended that this anomaly be modelled using iterative computer techniques to provide the shape of the source and its depth, dip, width and iron content.

The vertical magnetic gradient shows a dramatic improvement in the resolution of near surface magnetic trends and has been used as a basis for magnetic mapping.

Exposures of the iron formation correlate well with very strong magnetic responses permitting good delineation of this unit. The very intense magnetic activity creates significantly exaggerated widths of these horizons.
Moderately strong magnetic horizons occur within the mafic to intermediate volcanics and have been interpreted as a subunit, Unit 1m. The magnetic activity is probably related to increased proportions of mafic minerals including magnetite, and to disseminated to concentrated sulphides, particularly pyrrhotite. Where Unit 1m approaches the iron formation it is overwhelmed by the intense magnetic activity and difficult to resolve.

Exposures of mafic to intermediate volcanics (Unit 1), felsic to intermediate volcanics (Unit 2), sediments (Unit 3) and Gowganda Formation sediments (Unit 6) all coincide with lower magnetic activity. Together they comprise the quiet magnetic background.

Exposures of the Nipissing Diabase (Unit 7) coincide with variable magnetic responses, probably depending upon the concentration of magnetic minerals and/or the thickness or total mass of the unit. The Nipissing Diabase in the centre of the property has very little influence on the magnetic pattern which reflects the underlying, east-west trending volcanics. There is only minor attenuation. The Nipissing Diabase to the east appears to create slightly greater attenuation of the magnetic responses from the underlying volcanics.

In contrast the Nipissing Diabase to the west coincides with substantially greater magnetic responses although the apparent "magnetic contact" with the sediments (Unit 6) is further west than indicated by surface exposures. This may be related to variable magnetic susceptibility of the Nipissing Diabase, increasing to the west. Alternatively there may be another magnetic source beneath the Nipissing Diabase creating this effect. This is consistent with the total field magnetic data.

Several faults have been interpreted with northwest, north and northeast trends, many coinciding with air photo lineaments. The interpretation of faults from magnetic data is somewhat subjective. Reinterpretation by a different individual, preferably with ground data is often informative.

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

A substantial number of medium to strong, well defined conductor axes coincide with or parallel magnetic stratigraphy, particularly with the iron formation (types a and b). These possess increased potential for bedrock mineralogic sources and should be investigated on the ground by EM or IP techniques. In particular the strong
conductor axis that coincides with the iron formation in the northeast corner of the survey has a strong normal quadrature with a secondary reversal. These features suggest a conductor with a sharp contrast in conductance with respect to its host rock and a considerable depth extent.

7. SUMMARY

An airborne combined magnetic and VLF-EM survey has been done on the property at line intervals of 100 metres. The total field and vertical gradient magnetic data, VLF-EM data and interpretation maps are produced 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. The extensive Nipissing Diabase creates only minor attenuation of the magnetic responses from the underlying volcanic sequence. A number of VLF-EM conductor axes were found of which some are believed to have potential sulphide origins and have been recommended for additional investigation.

TERRAQUEST LTD.

Charles Q. Barrie, M.Sc.
Geologist
**Report of Work**

(Geophysical, Geologic, Geochemical and Expenditures)

**The Mining Act** 2.928

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**Ontario**

**Ministry of Natural Resources**

**Name and Address of Author (of Geo-Technical Report)**

C.Q. Barrie, 905 - 121 Richmond St. West, Toronto, Ontario

---

**Type of Survey(s)**

- Mag & VLF/EM

---

**Name of Surveyor**

R. J. WRIGHT

**Addrt$$M**

P.O. BOX 10 1st CANADIAN PLACE TORONTO M5X 1A2

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**Survey Company**

Terraquest Ltd.

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**Date of Survey**

Day \( \text{Day} \), \( \text{Month} \), \( \text{Year} \)

---

**Claim Holders**

- **Type of Survey (i)**
  - Electromagnetic
  - Magnetometer
  - Radiometric
  - Other
  - Geological
  - Geochemical

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**Geophysical**

- Days per Claim

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**Man Days**

- Days per Claim

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**Airborne Credits**

- Days per Claim

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**Expenditures (Excludes Power Stripping)**

- Total Expenditure

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**Total Number of Mining Claims Traveled**

- List in numerical sequence

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**Certification Verifying Report of Work**

I hereby certify that I have a personal and intimate knowledge of the facts set forth in the Report of Work annexed hereto, having performed the work or witnessed same during and/or after its completion and the annexed report is true.

---

**Certified**

P. A. R. BROWN RR7 CORBEIL ONTARIO POH 1KO

**Date**

24 July, 1986
**Report of Work**

(Geophysical, Geological, Geochemical and Expenditures)

The Mining Act

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Expenditures (excludes power stripping)

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For Office Use Only

Certification Verifying Report of Work

I hereby certify that I have a personal and intimate knowledge of the facts set forth in the Report of Work annexed hereto, having performed the work or witnessed same during and/or after its completion and the annexed report is true.

Name and Postal Address of Person Certifying

P. A. R. BROWN RR# 1 CORBEIL ONTARIO P0H 1K0

Date Certified

24 July, 1986
SEE ACCOMPANYING MAP(S) IDENTIFIED AS

AFTON - 0025  #1-3

LOCATED IN THE MAP CHANNEL IN THE FOLLOWING SEQUENCE (X)
For additional information see maps:

AFTON-0025 # 4