REPORT ON
COMBINED HELICOPTER-BORNE
MAGNETIC AND ELECTROMAGNETIC
SURVEY
HEMLO, ONTARIO

RECEIVED
JUN. 4 1984
MINING LANDS SECTION

For
PROFLEX LIMITED
By
AERODAT LIMITED
June 1, 1984
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(Scale: 1:15,000)

Maps

1. Airborne Electromagnetic Survey Profiles
   4500 Hz (coaxial)

2. Airborne Electromagnetic Survey Profiles
   4100 Hz (coplanar)

3. Total Field VLF-EM

4. Total Field Magnetic Map

5. Interpretation Map
1. **INTRODUCTION**

During the period of March 2 to June 14, 1983, Aerodat carried out an airborne geophysical survey of approximately 1,570 square kilometers in the Hemlo area of Ontario. Equipment operated included a 3-frequency HEM and VLF electromagnetic systems, a magnetometer and a radar positioning device. At a nominal line spacing of 100 meters a total of 15,770 line kilometers of data was acquired.

This report on behalf of Proflex Limited refers to a part of the overall survey, consisting of 124 line kilometers (76 line miles), flown on May 10, 1983.
2. SURVEY AREA AND LOCATIONS

The index map below outlines the overall survey and the location of the property to which this report refers. The property outline and related mining claim numbers are indicated on the maps accompanying the report.
3. AIRCRAFT AND EQUIPMENT

3.1 Aircraft

The helicopter used for the survey was an Aerospatiale A-Star 350-D owned and operated by North Star Helicopters. Installation of the geophysical and ancillary equipment was carried out by Aerodat. The survey aircraft was flown at a nominal altitude of 60 meters.

3.2 Equipment

3.2.1 Electromagnetic System

The electromagnetic system was an Aerodat/Geonics 3 frequency system. Two vertical coaxial coil pairs were operated at 950 and 4500 Hz and a horizontal coplanar coil pair at 4100 Hz. The transmitter-receiver separation was 7 meters. In-phase and quadrature signals were measured simultaneously for the 3 frequencies with a time-constant of 0.1 seconds. The electromagnetic bird was towed 30 meters below the helicopter.

3.2.2 VLF-EM System

The VLF-EM System was a Herz 1A. This instrument measures the total field and vertical
quadrature component of the selected frequency. The sensor was towed in a bird 15 meters below the helicopter. The station used was NAA, Cutler Maine, 17.8 KHz or NLK, Jim Creek Washington, 24.8 KHz.

3.2.3 Magnetometer

The magnetometer was a Geometrics G-803 proton precession type. The sensitivity of the instrument was 1 gamma at a 0.5 second sample rate. The sensor was towed in a bird 15 meters below the helicopter.

3.2.4 Magnetic Base Station

An IFG proton precession type magnetometer was operated at the base of operations to record diurnal variations of the earth's magnetic field. The clock of the base station was synchronized with that of the airborne system.
3.2.5 Radar Altimeter

A Hoffman HRA-100 radar altimeter was used to record terrain clearance. The output from the instrument is a linear function of altitude for maximum accuracy.

3.2.6 Tracking Camera

A Geocam tracking camera was used to record flight path on 35 mm film. The camera was operated in strip mode and the fiducial numbers for cross reference to the analog and digital data were imprinted on the margin of the film.

3.2.7 Analog Recorder

A RMS dot-matrix recorder was used to display the data during the survey. A sample record with channel identification and scales is presented on the following page.
### Digital Recorder

A Perle DAC/NAV data system recorded the survey data on cassette magnetic tape. Information recorded was as follows:

<table>
<thead>
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<th>Equipment</th>
<th>Interval</th>
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<tbody>
<tr>
<td>EM</td>
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<tr>
<td>VLF-EM</td>
<td>0.5 second</td>
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<tr>
<td>magnetometer</td>
<td>0.5 second</td>
</tr>
<tr>
<td>altimeter</td>
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<tr>
<td>fiducial (time)</td>
<td>1.0 second</td>
</tr>
<tr>
<td>fiducial (manual)</td>
<td>0.2 second</td>
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</tbody>
</table>
3.2.9 Radar Positioning System

A Motorola Mini-Ranger (MRS III) radar navigation system was utilized for both navigation and track recovery. Transponders located at fixed known locations were interrogated several times per second and the ranges from these points to the helicopter measured to several meter accuracy. A navigational computer triangulates the position of the helicopter and provides the pilot with navigation information. The range/range data was recorded on magnetic tape for subsequent flight path determination.
4. DATA PRESENTATION

4.1 Base Map and Flight Path Recovery

The base map, at a scale of 1/15,000 is an enlargement of published 1/50,000 topographic maps.

The flight path was derived from the Mini Ranger radar positioning system. The distance from the helicopter to two established reference locations was measured several times per second and the position of the helicopter mathematically calculated by triangulation. It is estimated that the flight path is generally accurate to about 30 meters, with respect to the topographic detail of the base map.
4.2 Electromagnetic Profile Maps

The electromagnetic data was recorded digitally at a high sample rate of 10/second with a small time constant of 0.1 second. A two-stage digital filtering process was carried out to reject major sferic events, and reduce system noise.

Local atmospheric activity can produce sharp, large amplitude events that cannot be removed by conventional filtering procedures. Smoothing or stacking will reduce their amplitude but leave a broader residual response that can be confused with a geological phenomenon. To avoid this possibility, a computer algorithm searches out and rejects the major "sferic" events.

The signal to noise was further enhanced by the application of a low pass filter. The filter was applied digitally. It has zero phase shift which prevents any lag or peak displacement from occurring and it suppresses only variation with a wavelength less than about 0.25 seconds. This low effective time constant permits maximum profile shape resolution.

Following the filtering processes, a base level correction was made. The correction applied is a linear function of time that ensures that the corrected amplitude of the various inphase and quadrature components
is zero when no conductive or permeable source is present. This filtered and levelled data was then presented in profile map form.

The in-phase and quadrature responses of the coaxial 4500 Hz and the coplanar 4100 Hz configuration are presented with flight path on the topographic base map.

4.3 Magnetic Contour Maps

The aeromagnetic data was corrected for diurnal variations by subtraction of the digitally recorded base station magnetic profile. No correction for regional variation is applied.

The corrected profile data was interpolated onto a regular grid at a 2.5 mm interval using a cubic spline technique. The grid provided the basis for threading the presented contours at a 10 gamma interval.

4.5 VLF-EM Contour Maps

The VLF-EM signal, was compiled in map form. The mean response level of the total field signal was removed and the data was gridded and contoured at an interval of 2%.
5. INTERPRETATION

The electromagnetic profile maps and VLF contour map were analysed and conductor axes interpreted. The axes identified are divided into 2 classifications: "probable bedrock conductors" and "possible bedrock conductors".

In the first category are those conductors that display relatively clear characteristics of a thin, steeply dipping conductive source. A discussion of the HEM response shape is provided in the Appendix. Anomalies with less distinctive characteristics were also included in this category if associated with a magnetic feature.

The second category, "possible bedrock conductor" were not adequately distinguished by HEM response shape or magnetic association to rule out a conductive overburden source.
6. RECOMMENDATIONS

The "Hemlo" gold deposit is a very weak electromagnetic conductor. Cultural interference along the road prevented reliable evaluation of electromagnetic data over the main zone; however, weak HEM and VLF-EM responses are noted along strike. The magnetic contour map clearly showed an associated linear magnetic anomaly of about 150 gammas amplitude.

Gold mineralization, disseminated in the rock cannot be expected to produce a measurable electromagnetic anomaly. The associated geologic formation may become measureably conductive due to accessory sulphide or graphite mineralization or even electrolytic conduction within faults and shears.
Interpreted bedrock conductor axes indicate zones potentially favourable to gold mineralization and deserve ground follow-up investigation. Those most familiar with the detailed geology of the area can best evaluate the potential significance of the conductors and magnetic features and assign relative follow up priority.

Respectfully submitted,

August 24, 1983
APPENDIX I

GENERAL INTERPRETIVE CONSIDERATIONS

Electromagnetic

The Aerodat 3 frequency system utilizes 2 different transmitter-receiver coil geometries. The traditional coaxial coil configuration is operated at 2 widely separated frequencies and the horizontal coplanar coil pair is operated at a frequency approximately aligned with the higher frequency.

The electromagnetic response measured by the helicopter system is a function of the "electrical" and "geometrical" properties of the conductor. The "electrical" property of a conductor is determined largely by its conductivity and its size and shape; the "geometrical" property of the response is largely a function of the conductors shape and orientation with respect to the measuring transmitter and receiver.

Electrical Considerations

For a given conductive body the measure of its conductivity or conductance is closely related to the measured phase shift between the received and transmitted electromagnetic field. A small phase shift indicates a relatively high conductance, a large phase shift lower conductance. A small phase shift results in a large in-phase to quadrature
ratio and a large phase shift a low ratio. This relationship is shown quantitatively for a vertical half-plane model on the phasor diagram. Other physical models will show the same trend but different quantitative relationships.

The conductance and depth values as determined are correct only as far as the model approximates the real geological situation. The actual geological source may be of limited length, have significant dip, its conductivity and thickness may vary with depth and/or strike and adjacent bodies and overburden may have modified the response. In general the conductance estimate is less affected by these limitations than the depth estimate but both should be considered a relative rather than absolute guide to the anomalies' properties.
Conductance in mhos is the reciprocal of resistance in ohms and in the case of narrow slab-like bodies is the product of electrical conductivity and thickness.

Most overburden will have an indicated conductance of less than 2 mhos; however, more conductive clays may have an apparent conductance of say 2 to 4 mhos. Also in the low conductance range will be electrolytic conductors in faults and shears.

The higher ranges of conductance, greater than 4 mhos, indicate that a significant fraction of the electrical conduction is electronic rather than electrolytic in nature. Materials that conduct electronically are limited to certain metallic sulphides and to graphite. High conductance anomalies, roughly 10 mhos or greater, are generally limited to sulphide or graphite bearing rocks.

Sulphide minerals with the exception of sphalerite, cinnabar and stibnite are good conductors; however, they may occur in a disseminated manner that inhibits electrical conduction through the rock mass. In this case the apparent conductance can seriously underrate the quality of the conductor in geological terms. In a similar sense the relatively non-conducting sulphide minerals noted above may be present in significant concentration in association with minor conductive
sulphides, and the electromagnetic response only relate to the minor associated mineralization. Indicated conductance is also of little direct significance for the identification of gold mineralization. Although gold is highly conductive it would not be expected to exist in sufficient quantity to create a recognizable anomaly, but minor accessory sulphide mineralization could provide a useful indirect indication.

In summary, the estimated conductance of a conductor can provide a relatively positive identification of significant sulphide or graphite mineralization; however, a moderate to low conductance value does not rule out the possibility of significant economic mineralization.

**Geometrical Considerations**

Geometrical information about the geologic conductor can often be interpreted from the profile shape of the anomaly. The change in shape is primarily related to the change in inductive coupling among the transmitter, the target, and the receiver.

In the case of a thin, steeply dipping, sheet-like conductor, the coaxial coil pair will yield a near symmetric peak over the conductor. On the other hand the coplanar coil pair will pass through a null couple relationship and yield a minimum over the conductor, flanked by positive side lobes. As the dip of the conductor decreases from vertical, the coaxial
anomaly shape changes only slightly, but in the case of
the coplanar coil pair the side lobe on the down dip side
strengthens relative to that on the up dip side.

As the thickness of the conductor increases, induced
current flow across the thickness of the conductor becomes
relatively significant and complete null coupling with the
coplanar coils is no longer possible. As a result, the
apparent minimum of the coplanar response over the conductor
diminishes with increasing thickness, and in the limiting
case of a fully 3 dimensional body or a horizontal layer
or half-space, the minimum disappears completely.

A horizontal conducting layer such as overburden will produce
a response in the coaxial and coplanar coils that is a
function of altitude (and conductivity if not uniform). The
profile shape will be similar in both coil configurations
with an amplitude ratio (coplanar/coaxial) of about 4/1.*

In the case of a spherical conductor, the induced currents
are confined to the volume of the sphere, but not relatively
restricted to any arbitrary plane as in the case of a sheet-
like form. The response of the coplanar coil pair directly
over the sphere may be up to 8* times greater than that of
the coaxial coil pair.
In summary a steeply dipping, sheet-like conductor will display a decrease in the coplanar response coincident with the peak of the coaxial response. The relative strength of this coplanar null is related inversely to the thickness of the conductor; a pronounced null indicates a relatively thin conductor. The dip of such a conductor can be inferred from the relative amplitudes of the side-lobes.

Massive conductors that could be approximated by a conducting sphere will display a simple single peak profile form on both coaxial and coplanar coils, with a ratio between the coplanar to coaxial response amplitudes as high as 8.*

Occasionally if the edge of an overburden zone is sharply defined with some significant depth extent, an edge effect will occur in the coaxial coils. In the case of a horizontal conductive ring or ribbon, the coaxial response will consist of two peaks, one over each edge; whereas the coplanar coil will yield a single peak.
It should be noted at this point that Aerodat's definition of the measured ppm unit is related to the primary field sensed in the receiving coil without normalization to the maximum coupled (coaxial configuration). If such normalization were applied to the Aerodat units, the amplitude of the coplanar coil pair would be halved.
Magnetics

The Total Field Magnetic Map shows contours of the total magnetic field, uncorrected for regional variation. Whether an EM anomaly with a magnetic correlation is more likely to be caused by a sulphide deposit than one without depends on the type of mineralization. An apparent coincidence between an EM and a magnetic anomaly may be caused by a conductor which is also magnetic, or by a conductor which lies in close proximity to a magnetic body. The majority of conductors which are also magnetic are sulphides containing pyrrhotite and/or magnetite. Conductive and magnetic bodies in close association can be, and often are, graphite and magnetite. It is often very difficult to distinguish between these cases. If the conductor is also magnetic, it will usually produce an EM anomaly whose general pattern resembles that of the magnetics. Depending on the magnetic permeability of the conducting body, the amplitude of the inphase EM anomaly will be weakened, and if the conductivity is also weak, the inphase EM anomaly may even be reversed in sign.
VLF Electromagnetics

The VLF-EM method employs the radiation from powerful military radio transmitters as the primary signals. The magnetic field associated with the primary field is elliptically polarized in the vicinity of electrical conductors. The Herz Totem uses three orthogonal coils to measure the total field and vertical quadrature component of the polarization ellipse.

The relatively high frequency of VLF 15-25 kHz provides high response factors for bodies of low conductance. Relatively "disconnected" sulphide ores have been found to produce measurable VLF signals. For the same reason, poor conductors such as sheared contacts, breccia zones, narrow faults, alteration zones and porous flow tops normally produce VLF anomalies. The method can therefore be used effectively for geological mapping. The only relative disadvantage of the method lies in its sensitivity to conductive overburden. In conductive ground the depth of exploration is severely limited.

The effect of strike direction is important in the sense of the relation of the conductor axis relative to the energizing electromagnetic field. A conductor aligned along a radius drawn from a transmitting station will be
in a maximum coupled orientation and thereby produce a stronger response than a similar conductor at a different strike angle. Theoretically it would be possible for a conductor, oriented tangentially to the transmitter to produce no signal. The most obvious effect of the strike angle consideration is that conductors favourably oriented with respect to the transmitter location and also near perpendicular to the flight direction are most clearly rendered and usually dominate the map presentation.

The total field response is an indicator of the existence and position of a conductivity anomaly. The response will be a maximum over the conductor, without any special filtering, and strongly favour the upper edge of the conductor even in the case of a relatively shallow dip.

The vertical quadrature component over steeply dipping sheet like conductor will be a cross-over type response with the cross-over closely associated with the upper edge of the conductor.

The response is a cross-over type due to the fact that it is the vertical rather than total field quadrature component that is measured. The response shape is due largely to geometrical rather than conductivity considerations and the distance between the maximum and minimum on either side of the cross-over is related to target depth. For a given target geometry, the larger this distance the greater the
depth.

The amplitude of the quadrature response, as opposed to shape, is a function of target conductance and depth as well as the conductivity of the overburden and host rock. As the primary field travels down to the conductor through conductive material, it is both attenuated and phase shifted in a negative sense. The secondary field produced by this altered field at the target also has an associated phase shift. This phase shift is positive and is larger for relatively poor conductors. This secondary field is attenuated and phase shifted in a negative sense during return travel to the surface. The net effect of these 3 phase shifts determine the phase of the secondary field sensed at the receiver.

A relatively poor conductor in resistive ground will yield a net positive phase shift. A relatively good conductor in more conductive ground will yield a net negative phase shift. A combination is possible whereby the net phase shift is zero and the response is purely in-phase with no quadrature component.

A net positive phase shift combined with the geometrical cross-over shape will lead to a positive quadrature response on the side of approach and a negative on the side of departure. A net negative phase shift would produce the reverse. A further sign reversal occurs with a 180 degree
change in instrument orientation as occurs on reciprocal line headings. During digital processing of the quadrature data for map presentation this is corrected for by normalizing the sign to one of the flight line headings.
Mining Lands Section

Control Sheet

File No 24830

TYPE OF SURVEY

GEOPHYSICAL

GEOLGICAL

GEOCHEMICAL

EXPENDITURE

MINING LANDS COMMENTS:

____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________
____________________________________________________

LD 89

Signature of Assessor

Aug 7/84

Date
Type of Survey(s) Airborne Electromagnetic-Magnetic-VLF EM
Township or Area: McCron Twp. Areas of Oskabukuta &
Claim Holder(s): A. Nabigon, E. Nabigon, L. Halverson
2/o Gallo Expl'n Services, 148 Allanhurst Dr.,
Islington, Ont., M9A 4K7
Survey Company Aerodat Ltd.
Author of Report: R. L. S. Hogg
Address of Author: 3883 Nashua Dr. Mississauga, Ont.
Covering Dates of Survey: May 10, 1983
Total Miles of Line Cut: 0

SPECIAL PROVISIONS
CREDITS REQUESTED
ENTER 40 days (includes
line cutting) for first
survey.
ENTER 20 days for each
additional survey using
same grid.

AIRBORNE CREDITS (Special provision credits do not apply to airborne surveys)
Magnetometer 30 Electromagnetic 30 Radiometric 20

DATE: May 31/84 SIGNATURE: Author of Report or Agent

RECEIVED
JUN 1 1984
MINING LANDS SECTION

TOTAL CLAIMS 77
SELF POTENTIAL
Instrument_________________________ Range_________________________
Survey Method________________________
Corrections made________________________

RADIOMETRIC
Instrument_________________________
Values measured________________________
Energy windows (levels)________________________
Height of instrument________________________ Background Count________
Size of detector________________________
Overburden__________________________
(type, depth – include outcrop map)

OTHERS (SEISMIC, DRILL, WELL, LOGGING ETC.)
Type of survey_________________________
Instrument_________________________
Accuracy_________________________
Parameters measured________________________
Additional information (for understanding results)_________________________

AIRBORNE SURVEYS
Type of survey(s) Electromagnetic, Magnetic, and VLF EM
Instrument(s) Aerodat/Geonics 3-Frequency EM, Geometrics G-803 Proton Mag.
Aircraft Gamma (Mag)
Accuracy 1 (specify for each type of survey) Herz 1A VLF EM
Aircraft used Aerospiaile A-Star 350-D Helicopter
Sensor altitude 30 Meters (EM) 45 Meters (Mag)
Aircraft altitude 60 Meters Line Spacing 100 Meters
Miles flown over total area 9,777 linemiles Over claims only 76 linemiles
**Ontario Ministry of Natural Resources**

### Type of Survey

Geophysical (Airborne) HEM, VLF EM, MAG

### Claim holder(s)

Alfred Nabigon, Edward Nabigon, Lloyd Halverson. E29321, E29105. D18249

c/o Gallo Exploration Services Inc. 148 Allanhurst Dr. Islington, Ont. M9A 4K7

### Survey Company

Aerodat Limited.

### Name and Address of Person Certifying (of technical report)

Scott Hogg, 3883 Nashua Dr. Mississauga, Ont. L4V 1R3

### Credits Requested per Each Claim in Columns at right

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### Mining Claims Traversed (List in numerical sequence)

See Attached List

### Tain Miles of Line Cut

25 04 1983 | 31 05 83

### Expenditures (excludes power stripping)

**Type of Work Performed**

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<th>Days Cr.</th>
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</thead>
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### Total number of mining claims covered by this report of work

77

### Certification Verifying Report of Work

E. A. Gallo

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

E. A. Gallo. 148 Allanhurst Drive

Islington, Ont. M9A 4K7

April 4/84

Certified by Signature

[Signature]

For Office Use Only

Certification Verifying Report of Work

June 7 FWM

Instructions:

- Please type or print.
- If number of mining claims traversed exceeds space on this form, write a list. Only days credits calculated in the "Expenditure" section may be entered in the "Exp. Days Cr." columns.
- Do not use shaded area below.

Twp. of Areas Oskabukuta & Tarpon Lakes

address

McCron Twp., Area of Oskabukuta & Tarpon Lakes

Claim holder(s)

Alfred Nabigon, Edward Nabigon, Lloyd Halverson. E29321, E29105. D18249

c/o Gallo Exploration Services Inc. 148 Allanhurst Dr. Islington, Ont. M9A 4K7

Survey Company

Aerodat Limited.

Credit requested per each claim in columns at right

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<td>Mining Claim</td>
<td>Exp. Days Cr.</td>
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<td>Prefix</td>
<td>Number</td>
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</tbody>
</table>

List of Mining Claims Traversed (List in numerical sequence)

See Attached List

Total miles of line cut

25 04 1983 | 31 05 83

Expenditures (excludes power stripping)

**Type of Work Performed**

<table>
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Calculation of Expenditure Days Credits

<table>
<thead>
<tr>
<th>Total Expenditure</th>
<th>Days Cr.</th>
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</thead>
</table>

Total number of mining claims covered by this report of work

77

Certification Verifying Report of Work

E. A. Gallo

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

E. A. Gallo. 148 Allanhurst Drive

Islington, Ont. M9A 4K7

April 4/84

Certified by Signature

[Signature]
List of Mining Claims
Traversed by Airborne HEM, VLF EM, and Mag Surveys
To Accompany Report of Work Dated April 4, 1984

SSM 593101
" 593155
" 593156
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" 703217
Mrs. M.V. St. Jules
Mining Recorder
Ministry of Natural Resources
875 Queen Street East
P.O. Box 669
Sault Ste. Marie, Ontario
P6A 5N2

Dear Madam:

We have received reports and maps for an Airborne Geophysical (Electromagnetic & Magnetometer) Survey submitted on Mining Claims SSM 593101 et al in the Township of McCron and the Area of Oskabukuta and Tarpon Lakes.

This material will be examined and assessed and a statement of assessment work credits will be issued.

Yours sincerely,

S.E. Yundt
Director
Land Management Branch
Whitney Block, Room 6643
Queen's Park
Toronto, Ontario
M7A 1W3
Phone: (416) 965 1380

A. Barriso

c/o Alfred Nabigon
Edward Nabigon
Lloyd Halverson
Gall Exploration Services Inc
148 Allanhurst Drive
Islington, Ontario
M9A 4K7
For additional information see maps:

42C/125E-0010 #1-5
HELICOPTER ELECTROMAGNETIC SYSTEM

Colt Configuration - Coplanar
Separation - 7 metres
Frequency - 400 Hz.
Mean Sensor Altitude - 30 metres
Horizontal Positioning - MRSHI radar positioning

In-phase
Quadrature

HEMLO PROJECT
PROFLEX LIMITED
AIRBORNE ELECTROMAGNETIC SURVEY
PROFILES COPLANAR
SCALE 1/15,000

DATE March-June 1983

AERODAT LIMITED
MAGNETOMETER

Instrument: 0*om*trics G-803
Mean Sensor Attitude: 45 metres
Horizontal Positioning: MRS Ut radar positioning

250 gammas
500 gammas
1,000 gammas
contour interval 10 gammas

TOTAL MAGNETIC FIELD

HEMLO PROJECT

PROFLEX LIMITED

TOTAL FIELD MAGNETIC MAP

SCALE 1/15,000

March-June 1983

IM.T.S. NO: 42 C
/ILC/12

WAERODAT LIMITED

42C/2SE-0010 DENIS LAKE

230"