REPORT ON
COMBINED HELICOPTER-BORNE
MAGNETIC, ELECTROMAGNETIC,
AND VLF-EM SURVEY
SANTOY LAKE, ONTARIO

RECEIVED
MINING LANDS SECTION

for
OREQUEST CONSULTANTS LIMITED - BLOCK A
by
AERODAT LIMITED
December 14, 1983
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1. INTRODUCTION

This report describes an airborne geophysical survey carried out by Aerodat Limited. Equipment operated included a 3-frequency electromagnetic system, a VLF-EM system, a magnetometer, and a radar positioning system.

The survey area near Terrace Bay, Ontario was flown from August 23 to August 28, 1983. A total of 202 line miles were flown at a nominal line spacing of 100 meters.

This report on behalf of OreQuest Consultants Ltd., Block A, refers to a part of the overall survey consisting of 25 line miles (40.2 line kilometers).
2. SURVEY AREA LOCATION

The survey area is indicated on the index map below. The flight lines were flown in an east/west direction at a nominal spacing of 100 meters.
3. AIRCRAFT AND EQUIPMENT

3.1 Aircraft

The aircraft used for the survey was an Aerospatiale A-Star 350D helicopter owned and operated by Maple Leaf Helicopters. Installation of the geophysical and ancillary equipment was carried out by Aerodat. The helicopter 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 946 Hz and 4575 Hz, and a horizontal coplanar coil pair at 4175 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 NLK (24.8 kHz, Jim Creek, Washington).

3.2.3 Magnetometer

The proton precession magnetometer used was a Geometrics G-803. The sensitivity of the instrument was 0.5 gamma at a 0.8 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. In addition to manual and time fiducials, the following data was recorded:

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<th>Scale</th>
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</thead>
<tbody>
<tr>
<td>00</td>
<td>altimeter (500 ft. at 10 ft./mm top of chart)</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>high freq. quadrature</td>
<td>2 ppm/mm</td>
</tr>
<tr>
<td>05</td>
<td>high freq. in-phase</td>
<td>2 ppm/mm</td>
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<tr>
<td>04</td>
<td>mid freq. quadrature</td>
<td>4 ppm/mm</td>
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<tr>
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<td>02</td>
<td>low freq. quadrature</td>
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<tr>
<td>01</td>
<td>low freq. in-phase</td>
<td>2 ppm/mm</td>
</tr>
<tr>
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<td>magnetometer</td>
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<td>14</td>
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<td>07</td>
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<tr>
<td>08</td>
<td>VLF-EM Quadrature</td>
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### 3.2.8 Digital Recorder

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

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<td>fiducial (manual)</td>
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</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 meters accuracy. A navigational computer triangulates the position of the helicopter and provides the pilot with navigational 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 1:10,000, is a photomosaic assembled from available aerial photography.

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.
4.2 Electromagnetic Profile Maps

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

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 ratio was further enhanced by the application of a low pass digital filter. It has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations 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 in-phase and quadrature components is zero when no conductive or permeable source is present. The filtered and levelled data was then presented in profile map form.

The in-phase and quadrature responses of the 946 Hz coaxial configuration were presented with flight path and electromagnetic anomaly information on the base map.
4.3 Total Field Magnetic Contours

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

The aeromagnetic data was presented with electromagnetic anomaly information on the base map.
4.4 VLF-EM Total Field Contours

The VLF-EM signal from NLK (Jim Creek, Washington) 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%. The VLF-EM data was presented with electromagnetic anomaly information on the base map.
5. INTERPRETATION AND RECOMMENDATIONS

The electromagnetic profile maps were analyzed to identify those responses typical of bedrock conductors. As discussed in the Appendix, the profile shape can indicate the general geometry of the conductive source. Anomalies with characteristics of a thin, steeply dipping conductive sheet were interpreted to be of bedrock origin.

The process of conductor identification was based entirely on profile shape with no consideration given to the estimated conductance. However, this parameter was calculated by application of the coaxial in-phase and quadrature responses to the phasor diagram for the vertical half-plane model. This was carried out by computer and the results are presented on the interpretation map in symbolized form.

The estimated conductance is a measure of the conductive properties of the source. A low conductance of say 4 mhos or less is indicative of electrolytic conduction in faults or shears or possibly minor disseminated mineralization.

Higher conductances indicate that electronic conduction is a factor and that significant sulphide or graphite mineralization is present.
Gold, as a result of its low concentration, and certain base metal sulphides due to poor electrical conduction, cannot be expected to produce a high conductance anomaly. Accessory conductive mineralization may produce a recognizable response, and indirectly provide an electromagnetic signature. Similarly, a fault or shear zone, favourable to mineral emplacement, may be identified by electrolytic, as opposed to mineral, conductivity.

The overall survey in the Terrace Bay area has identified a large number of conductors interpreted to be of bedrock origin. The conductivity anomalies are often associated with magnetic features. These relationships may provide an indication as to the nature of the conductive source. It is for this reason that the interpreted bedrock electromagnetic conductor axes have been coded to indicate the nature of magnetic association.

Numerous bedrock conductors have been identified in this block. Those in the northern half of the block are of higher conductance, indicative of sulphide or graphite mineralization. All of the axes identified deserve ground follow-up consideration as zones potentially favourable to gold mineralization, while those of higher conductance noted warrant additional investigation as potential base metal sulphide targets.
The relative prioritization of the electromagnetic conductors for further investigation is best left to those most familiar with the geology.

Respectfully submitted,

Glenn A. Boustead

December 15, 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 one of the coaxial frequencies.

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 conductor's 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 accompanying phasor diagram. Other physical models will show the same trend but different quantitative relationships.

The phasor diagram for the vertical half-plane model, as presented, is for the coaxial coil configuration with the amplitudes in ppm as measured at the response peak over the conductor. To assist the interpretation of the survey results the computer is used to identify the apparent conductance and depth at selected anomalies. The results of this calculation are presented in table form in Appendix II and the conductance and in-phase amplitude are presented in symbolized form on the map presentation.

The conductance and depth values as presented 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 is the depth estimate, but both should be considered as relative rather than absolute guides to the anomaly's 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.*

Overburden anomalies often produce broad poorly defined anomaly profiles. In most cases the response of the coplanar coils closely follows that of the coaxial coils with a relative amplitude ratio of 4.*

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 coils in the $X, Y, Z$ configuration 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
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 determines 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.
**Type of Survey(s):**
AIRBORNE GEOPHYSICAL SURVEY (VLF, HEM, MAG.)

**Claim Holder(s):**
K.A. GRACEY

**Address:**
401 - 595 HOME STREET, VANCOUVER B.C. V6T 2T5

**Survey Company:**
AERODAT LTD.

**Name and Address of Author (of Geo-Technical report):**
AERODAT LTD. 3883 NASHUA DRIVE, MISSISSAUGA ONTARIO

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

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**Expenditures (excludes power stripping)**

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**Instructions**

Total Days Credits may be apportioned at the claim holder's choice. Enter number of days credits per claim selected in columns at right.

**Date:**
FEBRUARY 25, 84

**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.

**For Office Use Only**

Total number of mining claims covered by this report of work: 24

**RECEIVED**
MINING LANDS SECTION

**Date Recorded:**
FEBRUARY 29, 1984

**Certified by:**
[Signature]

**Name and Postal Address of Person Certifying:**
D. HOWE c/o OREQUEST CONSULTANTS LTD. 404 - 595 HOME STREET, VANCOUVER B.C. V6C 2T5

**Recorded Holder or Agent (Signature):**
[Signature]

**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.

**Date Recorded:**
FEBRUARY 25, 1984

**Certified by:**
[Signature]
To: Geophysics

Mr. Belew

Comments

Approved

Date

Signature

To: Geology - Expenditures

Comments

Approved

Date

Signature

To: Geochemistry

LD

Comments

Approved

Date

Signature

To: Mining Lands Section, Room 6462, Whitney Block. (Tel: 5-1380)
Mrs. Audrey Hayes  
Mining Recorder  
Ministry of Natural Resources  
P.O. Box 5000  
Thunder Bay, Ontario  
P7C 5G6  

Dear Sir:

We have received reports and maps for an Airborne Geophysical (Electromagnetic, Magnetometer and VLF) Survey submitted on Mining Claims TB 731501 et al in the Area of Santoy Lake.

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)965-6918

A. Barr:mc

cc:  K.A. Gracey  
Suite 401  
591 Howe Street  
Vancouver, B.C.  
V6T 2T5

cc:  D. Howe  
c/o Orequest Consultants Ltd  
Suite 404  
595 Howe Street  
Vancouver, B.C.  
V6C 2T5
**Ministry of Natural Resources**

**GEOPHYSICAL - GEOLOGICAL - GEOCHEMICAL TECHNICAL DATA STATEMENT**

TO BE ATTACHED AS AN APPENDIX TO TECHNICAL REPORT
FACTS SHOWN HERE NEED NOT BE REPEATED IN REPORT
TECHNICAL REPORT MUST CONTAIN INTERPRETATION, CONCLUSIONS ETC.

---

**Type of Survey(s)**: AIRBORNE GEOPHYSICAL SURVEY (VLF, HEM, MAG.)

**Township or Area**: SANTOY LAKE AREA G 612

**Claim Holder(s)**: K.A. GRACEY

---

**Survey Company**: AERODAT LTD.

**Author of Report**: AERODAT LTD.

**Address of Author**: 3833 NASHUA DRIVE, MISSISSAUGA, ONT.

**Covering Dates of Survey**: 23/08/83 - 28/08/83 (linecutting to office)

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**Total Miles of Line Cut**: ——

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**SPECIAL PROVISIONS CREDITS REQUESTED**

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**Geological**

**Geochemical**

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**AIRBORNE CREDITS (Special provision credits do not apply to airborne surveys)**

- Magnetometer: 40
- Electromagnetic: 20
- Radiometric: 20 (VLF)

**DATE**: Feb 28 1983

**SIGNATURE**: 

Author of Report or Agent

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**MINING CLAIMS TRAVERSED**

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**TOTAL CLAIMS**: 24

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**MINING LANDS SECTION**

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**Res. Geol. Qualifications**: 2.4871

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**RECEIVED**

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**MINING LANDS SECTION**
SELF POTENTIAL

Instrument ___________________________ Range __________________

Survey Method ______________________________________________________

Corrections made ____________________________________________________

RADIOMETRIC

Instrument __________________________________________________________

Values measured _____________________________________________________

Energy windows (levels) _______________________________________________

Height of instrument ___________________________ Background Count ______

Size of detector _____________________________________________________

Overburden __________________________________________________________

(Re, 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) AIRBORNE GEOPHYSICAL SURVEY (VLF, HEM, MAG.)

Instrument(s) VLF - HERZ 1A, HEM - GEONICS 3 Freq., MAGNETICS - GEOMETRICS G803

(Aspecify for each type of survey)

Accuracy __________________________________________________________

(Aspecify for each type of survey)

Aircraft used HELICOPTER ASTAR 350 D

Sensor altitude 30 METRES

Navigation and flight path recovery method RADAR POSITIONING SYSTEM, GEOCAM TRACKING CAMERA, RADAR ALTIMETER

Aircraft altitude 60 METRES Line Spacing 100 METRES

Miles flown over total area 202 LINE MILES Over claims only 25 MILES (40.2 KM.)
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Total number of mining claims covered by this report of work: 24
BLOCK A

VLF-EM TOTAL FIELD CONTOURS

TEHRACE BAY AREA

AERODAT LIMITED

42D15NW08118 2.6503 SANTOY LAKE

August 1983