REPORT

016987

ON A
COMBINED HELICOPTER-BORNE
ELECTROMAGNETIC AND MAGNETIC SURVEY
FARO, YUKON
NTS 105 K/2,3,5,6,7

FOR

ANVIL RANGE MINING CORPORATION
POSTAL BAG #1000
FARO, YUKON
Y0B 1K0

BY

AERODAT INC.
3883 NASHUA DRIVE
MISSISSAUGA, ONTARIO
L4V 1R3
PHONE: 905 - 671-2446

October 16, 1996

J9650

R. W. Woolham, P. Eng.
Consulting Geophysicist

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF MAPS

The survey data are presented in sets of numbered maps in the following format:

I BLACK LINE MAPS: (Scale 1:24,000)

Map No. Description

1. BASE MAP; screened topographic base map plus survey area boundary, and UTM grid.

2. COMPILATION / INTERPRETATION MAP; with base map, flight path map and EM anomaly symbols with interpretation .

3. TOTAL FIELD MAGNETIC CONTOURS; with base map, EM anomaly symbols and flight lines.

4. VERTICAL MAGNETIC GRADIENT CONTOURS; with base map, EM anomaly symbols and flight lines.

5A. APPARENT RESISTIVITY CONTOURS; apparent resistivity calculated for the coplanar 4,175 Hz data, with base map, EM anomaly symbols and flight lines.

5B. APPARENT RESISTIVITY CONTOURS; apparent resistivity calculated for the coaxial 4,600 Hz data, with base map, EM anomaly symbols and flight lines.

II COLOUR MAPS: (Scale 1:24,000)

1. TOTAL FIELD MAGNETICS; with superimposed contours, flight lines and EM anomaly symbols.

2. VERTICAL MAGNETIC GRADIENT; with superimposed contours, flight lines and EM anomaly symbols.

3A. HEM OFFSET PROFILES; coaxial 935 Hz and 32,000 Hz data with flight lines and EM anomaly symbols.

3B. HEM OFFSET PROFILES; coplanar 4,175 Hz and coaxial 4,600 Hz data with flight lines and EM anomaly symbols.

3C. HEM OFFSET PROFILES; coplanar 32,000 Hz data with flight lines and EM anomaly symbols.

4A. APPARENT RESISTIVITY; calculated for the coplanar 4,175 Hz data with superimposed contours, flight lines and EM anomaly symbols.

4B. APPARENT RESISTIVITY; calculated for the coaxial 4,600 Hz data with superimposed contours, flight lines and EM anomaly symbols.

III SHADOW DERIVATIVE: (Scale 1:24,000)

1. TOTAL FIELD MAGNETICS SHADOW MAP; with suitable sun angle

REPORT ON A
COMBINED HELICOPTER-BORNE
ELECTROMAGNETIC AND MAGNETIC SURVEY
FARO, YUKON

1. INTRODUCTION

This is a report on an airborne geophysical survey carried out for Anvil Range Mining Corporation by Aerodat Inc. under a contract dated May 14, 1996. Principal geophysical sensors included a five frequency electromagnetic system and a high sensitivity cesium vapour magnetometer. Ancillary equipment included a colour video tracking camera, Global Positioning System (GPS) navigation instrumentation, a radar altimeter, a power line monitor and a base station magnetometer.

The survey covered an area of about 700 square kilometres covering Faro and environs. Total survey coverage is approximately 4132 line kilometres including 360 kilometres of tie lines. The Aerodat Job Number is J9650.

This report describes the survey, the data processing, data presentation and interpretation of the geophysical results. Identified electromagnetic anomalies appear on selected map products as EM anomaly symbols with interpreted source characteristics. The interpretation map indicates conductive areas of possible interest. It also shows prominent structural features interpreted from the magnetic results. Significant structural, conductive and/or magnetic associations are the basis for the selection of specific geophysical anomalies for further investigation.

2. SURVEY AREA

Faro is about 200 km north-northeast of Whitehorse and 65 km west-northwest of Ross River. Topography is shown on the 1:50,000 scale NTS map sheets 105 K/2, K/3, K/5, K/6 and K/7. Local relief is moderate to rugged. Elevations range from about 650 m to over 2,000 m above mean sea level. The survey area is shown in the attached index map that includes local topography and latitude - longitude coordinates. This index map also appears on all black line map products. The flight line direction is approximately North 30° East. Line spacing is 200 metres.

INDEX MAP

3. GENERAL SURVEY LOGISTICS

The survey was completed in the period June 17 to July 27, 1996. Principal personnel are listed in Appendix III. A total of 32 survey flights was required to complete the project. Aircraft ground speed is maintained at approximately 60 knots (30 metres per second) and mean terrain clearance of 60 metres consistent with the safety of the aircraft and crew.

A global positioning system (GPS) consisting of a Magnavox MX 9212 operated in differential mode guides aircraft navigation and flight line control. Field processing of the differential GPS data in the field utilizes a PC using software supplied by the manufacturer. One system is installed in the survey helicopter. This involves mounting the receiver antenna on the tail boom. A second system acts as the base station. The published NTS maps provide the Universal Transverse Mercator (UTM) coordinates of the survey area corners. These coordinates program the navigation system. A test flight confirms if area coverage is correct. Thereafter the navigation system guides the pilot along the survey traverse lines marked on the topographic map. The operator also enters manual fiducials over prominent topographic features. Survey lines showing excessive deviation are re-flown.

The magnetic tie line navigation is visual and, where possible, traverses cover areas of low topographic and magnetic relief. Aircraft position is registered by the navigation system. The operator calibrates the geophysical systems at the start, middle (if required) and end of every survey flight. During calibration the aircraft is flown away from ground effects to record electromagnetic zero levels.

4. DELIVERABLES

The report on the results of the survey is presented in three copies. The report includes folded white print copies of all black line maps. Three copies of the colour and shadow maps are in accompanying map tube(s).

The black line maps show topography, UTM grid coordinates and the survey boundary. A full list of all map types is at the beginning of this report. A summary follows:

MAP NO.	DESCRIPTION
	BLACK LINE
1	Base Map
2	Compilation/Interpretation Map
3	Total Field Magnetic Contours
4	Vertical Magnetic Gradient Contours

5A Apparent Resistivity Contours - 4,175 Hz
5B Apparent Resistivity Contours - 4,600 Hz

COLOUR

1 Total Field Magnetics
2 Vertical Magnetic Gradient
3A HEM Offset Profiles - 865 Hz and 935 Hz
3B HEM Offset Profiles - 4,175 Hz and 4,600 Hz
3C HEM Offset Profiles - 32,000 Hz
4A Apparent Resistivity Contours - 4,175 Hz
4B Apparent Resistivity Contours - 4,600 Hz

Total Field Magnetic Shadow

The processed digital data, including both the profile and the gridded data, is on CD ROM'S (ISO 9660). Profile data is written as columnar ASCII records and the gridded data as standard Geosoft PC grids. A full description of the format is included with the package. All gridded data can be displayed on IBM compatible microcomputers using the Aerodat AXIS (Aerodat Extended Imaging System) or RTI (Real Time Imaging) software package. The complete data package includes all analog records, base station magnetometer records, flight path video tape and original map cronaflexes.

5. AIRCRAFT AND SURVEY EQUIPMENT

5.1 Aircraft

The survey aircraft was an Aerospatiale AS 315B Lama helicopter, piloted by G. Suthern, owned and operated by Turbowest Helicopters Ltd. M. Barry of Aerodat acted as navigator and equipment operator. Aerodat performed the installation of the geophysical and ancillary equipment. The survey aircraft is flown at a mean terrain clearance of 60 metres (200 feet) and speed of 60 knots.

5.2 Electromagnetic System

The electromagnetic system is an Aerodat five frequency configuration. Two vertical coaxial coil pairs operate at frequency ranges of 935 Hz and 4,600 Hz and three horizontal coplanar coil pairs at frequency ranges of 865, 4,175 Hz and 32 kHz. The actual frequencies used depend on the particular bird configuration. At the present time Aerodat has eight bird systems. This survey utilized the Hawk bird with frequencies of 919 Hz and 4,341 Hz for the coaxial coil pairs and 847 Hz, 4,737 Hz and 33,360 Hz for the coplanar coil pairs. The transmitter-receiver separation is 6.40 metres. Inphase and quadrature signals are measured simultaneously for the five frequencies with a time constant of 0.1 seconds. The HEM bird is towed 30 metres (100 feet) below the helicopter.

5.3 Magnetometer

A Scintrex H8 cesium, optically pumped magnetometer sensor, measures the earth's magnetic field. The sensitivity of this instrument is 0.001 nanoTesla at a sampling rate of 0.2 second. The sensor is towed in a bird 15 metres (50 feet) below the helicopter 45 metres (150 feet) above the ground).

5.4 Ancillary Systems

Base Station Magnetometer

A Gem Systems, Inc. GSM8 magnetometer is set up at the base of operations to record diurnal variations of the earth's magnetic field. Synchronization of the clock of the base station with that of the airborne system is checked each day to insure diurnal corrections will be accurate. Recording resolution is 1 nT with an update rate of four seconds. Magnetic field variation data are plotted on a 3" wide gridded paper chart analog recorder. Each division of the grid (0.25") is equivalent to one minute (chart speed) or five nT (vertical sensitivity). The date, time and current total field magnetic value are automatically recorded every 10 minutes. The data is also saved to digital tape.

Radar Altimeter

A King KRA-10 radar altimeter records terrain clearance. The output from the instrument is a linear function of altitude. The radar altimeter is pre-calibrated by the manufacturer and is checked after installation using an internal calibration procedure.

Tracking Camera

A Panasonic colour video camera records the flight path on VHS video tape. The camera operates in continuous mode. The video tape also shows the flight number, 24 hour clock time (to .01 second), and manual fiducial number.

Global Positioning System (GPS)

The Global Positioning System is a U.S. Department of Defense program that will provide worldwide, 24 hour, all weather position determination capability. GPS consists of three segments:

- a constellation of satellites
- ground stations that control the satellites
- a receiver

The receiver takes in coded data from satellites in view and there after works out the range to each satellite. The coded data must therefore include the instantaneous position of the satellite relative to some agreed earth-fixed coordinate system. The satellite constellation consists of 24 satellites with a proportion of the satellites acting as standby spares.

Analog Recorder

An RMS dot matrix recorder displays the data during the survey. Record contents are as follows:

LABEL	PARAMETER	CHART SCALE
MAGF	Total Field Magnetics, Fine	2.5 nT/mm
MAGC	Total Field Magnetics, Coarse	25 nT/mm
L9XI	935 Hz, Coaxial, Inphase	2.5 ppm/mm
L9XQ	935 Hz,Coaxial,Quadrature	2.5 ppm/mm
M4XI	4,600 Hz, Coaxial, Inphase	2.5 ppm/mm
M4XQ	4,600 Hz, Coaxial, Quadrature	2.5 ppm/mm
L8PI	865 Hz, Coplanar, Inphase	2.5 ppm/mm
L8PQ	865 Hz, Coplanar, Quadrature	2.5 ppm/mm
M4PI	4,175 Hz, Coplanar, Inphase	10 ppm/mm
M4PQ	4,175 Hz, Coplanar, Quadrature	10 ppm/mm
H3PI	32,000 Hz, Coplanar, Inphase	20 ppm/mm
H3PQ	32,000 Hz, Coplanar, Quadrature	20 ppm/mm
BARO	Barometer	10 ft/mm
RALT	Radar Altimeter	10 ft/mm
PWRL	60 Hz Power Line Monitor	-

Data is recorded with positive - up, negative - down. The analog zero of the radar altimeter is 5 cm from the top of the analog record. A helicopter terrain clearance of 60 m (200 feet) should therefore be seen some 3 cm from the top of the analog record.

Chart speed is 2 mm/second. The 24-hour clock time is printed every 20 seconds. The total magnetic field value is printed every 30 seconds. The ranges from the radar navigation system are printed every minute.

Vertical lines crossing the record are manual fiducial markers activated by the operator. The start of any survey line is identified by two closely spaced manual fiducials. The end of any survey line is identified by three closely spaced manual fiducials. Manual fiducials are numbered in order. Every tenth manual fiducial is indicated by its number, printed at the bottom of the record.

Calibration sequences are located at the start and end of each flight and at intermediate times where needed.

Digital Recorder

A DGR-33 data system records the digital survey data on magnetic media. Contents and update rates are as follows:

DATA TYPE	RECORDING INTERVAL	RECORDING RESOLUTION
Magnetometer	0.1 second	0.001 nT
VLF-EM (4 Channels)	0.2 second	0.03%
HEM, (8 or 10 Channels)	0.1 second	
HEM, coaxial		0.03 ppm
HEM, coplanar- 865 Hz/4,175 Hz		0.06 ppm
HEM, coplanar- 32,000 Hz		0.125 ppm
Position (2 Channels)	0.2 second	0.1 m
Altimeter	0.2 second	0.05 m
Power Line Monitor	0.2 second	
Manual Fiducial		
Clock Time		

6. DATA PROCESSING AND PRESENTATION

6.1 Base Map

The base map is taken from a photographic enlargement of the NTS topographic maps. A UTM reference grid (grid lines usually every kilometre) and the survey area boundaries are added. After registration of the flight path to the topographic base map, some topographic detail and the survey boundary are added digitally. This digital image forms the base for the colour and shadow maps.

6.2 Flight Path Map

Global Positioning System

The GPS receiver takes in coded data from satellites in view and there after calculates the range to each satellite. The coded data must therefore include the instantaneous position of the satellite relative to some agreed earth-fixed coordinate system.

A further calculation using ranges to several satellites gives the position of the receiver in that coordinate system (eg. UTM, lat/long.). The elevation of the receiver is given with respect to a model ellipsoidal earth.

Normally the receiver must see four satellites for a full positional determination (three space coordinates and time). If the elevation is known in advance, only three satellites are needed. These are termed 3D and 2D solutions.

The position of the receiver is updated every tenth of a second. The accuracy of any one position determination is described by the Circular Error Probability (CEP). Ninety-five percent of all position determinations will fall within a circle of a certain radius. If the horizontal position accuracy is 25 m CEP, for example, 95% of all trials will fall within a circle of 25 m radius centred on the mean. The system may be degraded for civilian use and the autonomous accuracy is then 100 m CEP. This situation is called selective availability (SA). Much of this error (due principally to satellite position/time errors and atmospheric delays) can be removed using two GPS receivers operating simultaneously. One receiver acting as the base station, is at a known position. The second remote receiver is in the unknown position. Differential corrections determined for the base station may then be applied to the remote station. Differential positions are accurate to five m CEP (for a one second sample). Averaging will reduce this error further.

Flight Path

The flight path is drawn using linear interpolation between x,y positions from the navigation system. These positions are updated every second (or about 1.25 mm at a scale of 1:24,000). Occasional dropouts occur when the optimum number of satellites are not available for the GPS to make accurate positional determinations. Interpolation is used to cover short flight path gaps. The navigator's flight path and/or the flight path recovered from the video tape may be stitched in to cover larger gaps. Such gaps may be recognized by the distinct straight line character of the flight path.

The manual fiducials are shown as a small circle and labelled by fiducial number. The 24-hour clock time is shown as a small square, plotted every 30 seconds. Small tick marks are plotted every two seconds. Larger tick marks are plotted every 10 seconds. The line and flight numbers are given at the start and end of each survey line.

The aircraft position is expressed in geographic latitude and longitude coordinates, using the international WGS84 spheroid. Any particular survey area located on the globe has a specific reference ellipsoid or projection zone. A further refinement for a better fit to the earth's surface at the survey location is applied by adding or subtracting slight x, y and/or z datum shifts (a few metres to hundreds of metres) to the origin of the ellipsoid. The geographic coordinates are converted to fit this ellipsoid before calculating the UTM coordinates. The UTM coordinates are expressed as UTM eastings (x) and UTM northings (y).

The flight path map is merged with the base map by matching UTM coordinates from the base maps and the flight path record. The match is confirmed by checking the position of prominent topographic features as recorded by manual fiducial marks or as seen on the flight path video record.

6.3 Electromagnetic Survey Data

The electromagnetic data are recorded digitally at a sample rate of 10 per second with a time constant of 0.1 seconds. A two stage digital filtering process rejects major sferic events and reduces system noise. Local sferic 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 geological phenomena. To avoid this possibility, a computer algorithm searches out and rejects the major sferic events. This is referred to as a "surgical mute" in signal processing terms. The signal to noise ratio is further enhanced by the application of a low pass digital filter. This filter has zero phase shift that 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 gives minimal profile distortion.

Following the filtering process, a base level correction is made using EM zero levels determined during high altitude calibration sequences. The correction applied is a linear function of time that ensures the corrected amplitude of the various inphase and quadrature components is zero when no conductive or permeable source is present. The filtered and levelled data are the basis for the determination of apparent resistivity (see following section). The inphase and quadrature responses along the flight line are presented in profile form offset along the flight lines. Differentiation of the various profiles is achieved using two colours (coaxial and coplanar) and two line weights (inphase and quadrature). For interpretation purposes the coaxial and coplanar data sets for a similar frequency range are presented together on one map (865/935 and 4,175/4,600).

6.4 Total Field Magnetics

The aeromagnetic data is corrected for diurnal variations by adjustment with the recorded base station magnetic values. No corrections for regional variations are applied. The corrected profile data are interpolated on to a regular grid using an Akima spline technique. The grid provided the basis for threading the presented contours. The minimum contour interval is 2 nT with a grid cell size of 50 m. Magnetic high areas are assigned warm colours (orange/red) while magnetic low areas show as cool colours (blue).

6.5 Calculated Vertical Magnetic Gradient

The vertical magnetic gradient is calculated from the gridded total field magnetic data. The calculation is based on a 17 x 17 point convolution in the space domain. The results are contoured using a minimum contour interval of 0.05 nT/m. Grid cell sizes are the same as those used in processing the total field data. The high and low amplitude responses are give the same colour representation as the total field contours.

6.6 Colour Relief or Shadow Map of Total Field Magnetics

A useful manipulation of the magnetic data is the production of a colour shadow map. It is an aid in the interpretation and presentation of the magnetic information. The shadow map displays two independent variables simultaneously on the same map. The two variables are the amplitude and the gradient of the quantity measured over the mapping region. At every point or grid cell on the map the hue represents the amplitude of the magnetic value and the lightness/darkness of the hue is varied according to the slope or gradient of the data at the cell location. The gradient is translated into a reflectance parameter with respect to a chosen illumination direction. Subtle magnetic structures having a specific trend are enhanced or attenuated depending on the position and angle to the horizon of the light source relative to the trend. If the light source is orthogonal to the trend there will be maximum shadow relief. Regional discontinuities representing fault structures are easily recognized with shadow enhancement.

6.7 Apparent Resistivity

The apparent resistivity is calculated by assuming a 200 metre thick conductive layer over resistive bedrock. The computer determines the resistivity that would be consistent with the sensor elevation and recorded inphase and quadrature response amplitudes at the selected frequency. The apparent resistivity profile data is re-interpolated onto a regular grid at a 50 metres true scale interval using an Akima spline technique and contoured using logarithmically arranged contour intervals. The minimum contour interval depends on the selected frequency and is in units of log(ohm.m) in logarithmic intervals of 0.05, 0.25, 1.0, 5.0 etc. The colour presentation assigns warmer colours (reds) to low resistivity or very conductive responses and cooler colours (blues) to high resistivity or poor conductivity responses.

The highest measurable resistivity is approximately equal to the transmitter frequency. The lower limit on apparent resistivity is rarely reached.

7. INTERPRETATION

7.1 Area Geology

A 1:50,000 scale geology map of the survey block was made available and the following comments relate to this map. Late Hadrynian to early Ordovician metasediments of the Vangorda and Mount Mye Formations consisting of metabasite and phyllite as well as basalt and phyllite of the Menzies Creek Formation dominate the main survey area. This suite of rocks is bounded to the south by Devonian to Permian age basalt of the Anvil Range Group rocks as well as ultramafic rocks and the Tintina Fault Zone. Cretaceous age quartz monzonite and granodiorite felsic intrusives are present to the north of the survey area.

The area is well known for its zinc-lead deposits which are hosted by the Vangorda and Mount Mye formations. There are presently seven known sulphide deposits forming a line stretching for over 30 km from the Faro deposit in the west to the Sea deposit in the east. These are shown on the interpretation maps. Three deposits, Dy, Grum and Vangorda, totalling approximately 35 million tonnes and averaging 5.1% zinc and 3.5 % lead, are presently under development or are being mined (Canadian Mines Handbook 1995-96).

In such a prospective and well explored area very detailed analysis of the magnetic and conductive responses with respect to all previous exploration information is a definite requirement. It is not the mandate of this report, however, to carry out such a study. The 1:50,000 scale supplied geological map forms a useful base from which to evaluate the gross geophysical features detected by the airborne survey. In this respect the fault structures and sulphide deposits shown on the geology map are indicated on the interpretation map for reference purposes.

7.2 Magnetic Interpretation

The total field magnetic responses reflect major changes in the magnetite content of the underlying rock units. The amplitude of the magnetic responses relative to the regional background help to assist in identifying specific magnetic and nonmagnetic units related to, for example, mafic flows or tuffs, mafic to ultramafic intrusives, felsic intrusives, felsic volcanics and/or sediments etc. Obviously, several geological sources can produce the same magnetic response. These ambiguities can be reduced considerably if basic geological information on the area is available to the geophysical interpreter.

In addition to amplitude variations, magnetic patterns related to the geometry of the particular rock unit also help in determining the probable source of the magnetic response. For instance, long narrow magnetic linears usually reflect mafic tuff/flow horizons or mafic intrusive dyke structures while semi-circular features with complex magnetic amplitudes may be produced by local plug-like intrusive sources such as pegmatites, carbonatites or kimberlites.

The calculated vertical magnetic gradient assists considerably in mapping weaker magnetic linears that are partially masked by nearby higher amplitude magnetic features. The broad zones of higher magnetic amplitude, however, are severely attenuated in the vertical magnetic gradient results. These higher amplitude zones reflect rock units having magnetic susceptibility signatures. For this reason both the total and gradient magnetic data sets must be evaluated.

Theoretically the magnetic gradient zero contour line marks the contacts or limits of large magnetic sources. This applies to wide sources, greater than 50 metres, having simple slab geometries and shallow depth.(See discussion in Appendix I) Thus the gradient map also aids in the more accurate delineation of contacts between differing magnetic rock units.

The cross cutting structures, shown on the interpretation map as faults, are based on interruptions and discontinuities in the magnetic trends. Generally, sharp folding of magnetic units will produce a magnetic pattern indistinguishable from a fault break. Thus, if anomaly displacements are small such fault structures, where they mark an anomaly interruption, may actually represent a deformation node rather than faulting.

7.3 Magnetic Survey Results and Conclusions

To facilitate the following discussion of the magnetic results it is suggested the interpretation map be compared with the total field and vertical gradient magnetic colour contour maps either as overlays or side by side.

The magnetic background is interpreted to be approximately 57,950 nanoTesla (nT). Amplitudes range from about 750 nT below background to 2,800 nT above background. Relatively high amplitude magnetic trends, more than about 300 nT above background, are shown with a thick line while lower amplitude responses are shown with thinner lines on the interpretation map. Below background magnetic areas are outlined with a thick dashed line and shown with pointed depression symbols.

The highest amplitude minimums and maximums are only present in the extreme south part of the map sheets. These anomalies map a belt of ultramafic rocks striking southeast-northwest. The high amplitude negative flank on the north side of this magnetic horizon and gentle gradient south flank indicates the source has a gentle south dip. Most of the other magnetic responses are only about 25 to 150 nT above background and form sinuous, contorted and complex anomaly patterns. The source of these responses are probably thin lenses of basalt or metabasite associated with the Anvil Range Group, Vangorda Formation and Mount Mye Formation rocks. In a few locations there are isolated high amplitude anomalies with characteristics suggestive of intrusive plug-like bodies. The best example is the circular anomaly in the northeast corner of map sheet D6. These types of signatures may reflect late stage mafic intrusive sources associated with Cretaceous age tectonic activity.

The following comments relate to the 1:50,000 scale supplied geology map. In the west half of the survey area (maps C6, D6 and E6), where magnetic activity is relatively subdued, the metabasite and basalt units within the Vangorda and Menzie Creek Formations either contain very little magnetite or phyllite is the dominate rock type. Towards the east, however, the magnetic levels increase forming erratic patterns and complex magnetic centres along a belt hosting the six sulphide deposits east of the Faro deposit (maps F6 and G6). The complex magnetic patterns in this area suggest the geological structure is much more complex than displayed by the geology map.

The Swim, SB and Sea deposits correlate with specific magnetic anomalies and the other three sulphide bodies have a spatial association with magnetic anomalies. This suggests they may contain magnetite or pyrrhotite mineralization. Investigation of some of the other significant magnetic anomalies in this region is suggested. Specific examples are the large anomaly southeast of the Swim deposit and the anomaly southwest of the Sea deposit. Some of the conductive zones recommended for investigation, to be discussed in a following section, flank magnetic centres and this may be a favourable association when evaluating the other conductive responses in more detail.

To the north and east of the aforementioned deposits magnetic levels increase and form broad generally northeast striking anomalies. The broader anomaly characteristics suggest some depth of burial of the source of the responses. This may be related to overburden cover or overlying non-magnetic rocks. This area is dominated by phyllite rocks of the Mount Mye Formation which probably do not contain magnetic minerals. The two underlying phyllite and schist units of the Mount Mye Formation are probably not magnetic. Therefore the phyllite rocks in this area may be intercalated with metabasite units of the Mount Mye or Vangorda Formations.

7.4 Electromagnetic Anomaly Selection/Interpretation

Usually two sets of stacked colour coded profile maps of one coaxial and one coplanar inphase and quadrature responses are used to select conductive anomalies of interest. Selection of anomalies is based on conductivity as indicated by the inphase to quadrature ratios of the 935 Hz and/or 4,600 Hz coaxial data, anomaly shape, and anomaly profile characteristics relative to coaxial and corresponding coplanar responses.(see discussion and figure in Appendix I) It is difficult to differentiate between responses associated with the edge effects of flat lying conductors and actual poor conductivity bedrock conductors on the edge of or overlain by flat lying conductors. Poor conductivity bedrock conductors having low dips will also exhibit responses that may be interpreted as surficial overburden conductors. In such cases, where the source of the conductive response appears to be ambiguous, the anomaly is still selected for plotting. In some situations the conductive response has line to line continuity and some magnetic association thus providing possible evidence that the response is related to an actual bedrock source.

In some areas the inphase profile component exhibits a negative anomaly response usually over obvious magnetic areas. This is produced by local concentrations of magnetite and usually occurs when the sensor is flying close to the ground surface. If only magnetite is present there will be no quadrature response associated with the negative inphase response. If conductive material is present, however, such as graphite or sulphides, a positive quadrature response will be evident with the negative inphase response. In this case the anomaly is selected for plotting and evaluation and designated as a magnetic/conductive response. An example is present on the north central part of sheet D6 as conductor 4.

The calculation of the depth to the conductive source and its conductivity is based on the 4,600 Hz data assuming a thin vertical sheet model. The amplitude of the inphase and quadrature responses are used for the calculations which are automatically determined by computer. These data are listed in Appendix II and the depth and conductivity values are shown with each plotted anomaly. Further detailed discussion and illustration of the determination of these values is contained in Appendix I.

The selected anomalies are automatically categorized according to their conductivity and amplitude. The calculation of the conductivity of low amplitude anomalies can be very inaccurate. Therefore, anomalies having amplitudes below a certain level and/or low conductivity value are given a zero rating with the category increasing for increasing conductivity values that are statistically reliable.

7.5 Electromagnetic Survey Results and Conclusions

Very conductive flat lying to gently dipping material is contributing to the electromagnetic responses in various degrees throughout the survey block. The flat lying responses are characterized by identically shaped coaxial and coplanar response profiles while gently dipping responses show a slight offset of the coaxial peak from the coplanar peak. These response shapes are illustrated in Appendix I, in the figure entitled "HEM Response Profile Shapes ....." profiles B, C and I. Vertical and dipping tabular bodies have profile shapes as illustrated in Appendix I in the same figure profiles A, B and C. For dipping bodies the main coplanar peak is down dip from the coaxial peak. The coaxial peak related to near vertical to vertical dipping tabular conductive bodies is picked for digitizing and plotting on all map products. These peaks mark the top edge of the body and line to line continuity of the intercepts will indicate the strike of the conductors.

Flat lying type, but more limited width, conductive responses are present in some locations. These responses are characterized by a "M" shaped coaxial anomaly with a single peaked coplanar anomaly centred in the trough between the two coaxial peaks. This is illustrated in Appendix I in the same figure as previously mentioned (see profile shape E or G). The actual geometry of the source of these ribbon type responses is difficult to determine but probably reflects thin, limited width, flat lying graphitic sediments if the anomaly has a formational character. Short strike length ribbon type anomalies having good conductivity are more prospective as they could reflect a flat tabular sulphide deposit. Examples of such responses are conductors 7 and 29 on sheets D6 and F6/G6 respectively.

For this survey area most of the conductors are related to flat lying to gently dipping bodies associated with the graphitic phyllite. The peak of the anomalies tends to mark the centre of the flat lying source rather than marking an edge. As a result, a better representation of the extent of the conductors are the resistivity map products. The mid frequency coaxial 4,600 Hz resistivity maps have been used to show the extent and trend of major conductive zones. The 100 ohm metre contour line is shown on the interpretation maps as a dashed line with depression symbols pointing to the centre of the anomaly. Within the larger conductive zones the trend of major conductive horizons is indicated with a dashed-dotted line and other conductive trends associated with selected HEM anomaly intercepts are joined together with line segments. The contour outline that marks the 50 ohm metre contour line has been reproduced on the colour magnetic map products for reference purposes.

Many of the higher resistivity anomalies may also be less conductive graphitic sediments but it is not possible to differentiate such responses from possible slightly conductive alluvials, talus or conductive lake bottom sediments. The lakes in the east part of the survey area on sheets H5, G6 and H6 have a significant conductivity signature as does the northwest trending Blind River to the west.

Some of the conductors may be produced by man-made sources such as mine infrastructures, tailings ponds, buildings, bridges, culverts, highway guard rails, irrigation pipes, disused power lines, grounded metal fences etc. The location of the anomalies relative to these features or suspected features gives a clue to a possible cultural source for the anomaly. As an example, the tailings pond area produces a high conductivity response. It is suspected many of the HEM intercepts with a vertical type profile signature are related to man-made sources. Some intercepts form a straight line further confirming their cultural origin. Other anomalies produced by operating power lines are sometimes difficult to recognize without reference to the power line monitor record. A contour map of the response from the power line channel showed two corridors of power line interference one running between the Faro and Grum deposits and the other south to the town of Faro.

The electromagnetic profile maps and resistivity maps have been examined together and compared with the geology and known sulphide deposit locations. The graphitic phyllite units of the Mount Mye and Vangorda Formations are, of course, very conductive and are mapped by the very low resistivity contours. The most conductive response, however, is present as a southern wide belt of low resistivity stretching from sheet D6 in the west to sheet G6 in the east. This conductive belt correlates with sediments of the Earn and Anvil Range Groups containing shale, chert and chert conglomerate. In order to explain the high conductivity of this Group, at least in this region, the main rock type must be graphitic shales.

Note the Menzie Creek Formation, consisting of basalt and carbonaceous phyllite immediately north of the Anvil Range Group rocks also has some very conductive zones along its strike length. This is very evident on sheet F6 where there are two bulges in the main conductive zones in the south part of the sheet. No doubt conductive phyllite rocks are present in this zone whereas basalt is probably dominate to the west.

To the south of the Anvil Range Group rocks and abutting the ultramafic horizon there are several high resistivity zones. These correlate with basalt of the Anvil Range Group. The ultramafic horizon is also reflected by a high resistivity signature for most of its strike length. Just to the south of this ultramafic rocks there are two long conductive horizons. The north one correlates with the Vangorda Fault and the south one with the Tintina Trench.

The remaining rock types, schist, phyllite and metabasite of the Mount Mye and Vangorda Formations tend to have resistive signatures with a few conductive responses probably related to slightly graphitic schist or phyllite units.

The six sulphide deposits east of the Faro orebody do not have a unique conductive expression but do have a spatial association with larger conductive zones. The Faro deposit area has a specific conductive response but this is probably related to past mining activity. The Vangorda deposit is part of a large conductive zone partly related to a graphitic phyllite horizon just to the south. The Grum and SB deposits have higher conductive responses at their east ends and the Sea deposit is associated with the south fork of a two pronged low resistivity zone.

As a first pass at selecting conductive targets for investigation both the resistivity and electromagnetic profile maps are examined. Unique and/or isolated high conductivity signatures as well as conductive responses apparently additional to a larger conductive zone have been designated for investigation. No anomalies have been selected in the vicinity of the Faro deposit because of the probable presence of cultural sources. In this respect some of the anomalies selected near the Dy, Grum and Vangorda deposits, presently under development, may have cultural sources. In all, 43 anomalies are indicated on the interpretation maps with numbering increasing from west to east. The Mount Mye and Vangorda Formations are probably the only rocks hosting Faro type deposits. Nevertheless, a few conductors are selected outside these rock formations. The following table lists the pertinent geological information and comments on the selected anomalies.

Sheet	No.	Geology	Comments
C6	1	Anvil Range Group	Probably same source as 2, 3, 6
	2	Anvil Range Group	Part of large conductive zone
D6	3	Anvil Range Group	Part of large conductive zone
	4	Vangorda Formation	Flanks magnetic anomaly
	5	Menzie Creek Form.	Within felsic intrusive suite
	6	Anvil Range Group	Part of large conductive zone
	7	Vangorda Formation	Part of formational horizon
	8	Vangorda Formation	
	9	Vangorda Fault	Part of formational horizon
E6	10	Vangorda Formation	
	11	Vangorda Formation	Part of formational horizon

Sheet	No.	Geology	Comments
	12	Mount Mye Formation	Possible power line effect
	13	Vangorda Formation	
	14	Vangorda Formation	Part of formational horizon?
	15	Vangorda Fault	On same horizon as 9
	16	Vangorda Formation	Flanks magnetic anomaly and is part of zone related to graphitic phyllite
	17	Vangorda Fault	On same horizon as 9 and 15
F6	18	Vangorda Formation	Flanks magnetic anomaly and just south of Grum deposit
	19	Mount Mye Formation	Near contact with Anvil Range Plutonic Suite
	20	Mount Mye Formation	These anomalies flank a major magnetic zone associated with the Vangorda deposit
	21	Mount Mye Formation	
	22	Mount Mye Formation	Near contact with Anvil Range Plutonic Suite
	23	Mount Mye Formation	Same as 20 and 21
	24	Vangorda Formation	
	25	Vangorda Formation	North of DY deposit
	26	Vangorda Formation	Southwest of DY deposit
	27	Vangorda Formation	Flanks magnetic anomaly
	28	Vangorda Formation	Flanks magnetic anomaly

Sheet	No.	Geology	Comments
G6	29	Vangorda Formation	
	30	Vangorda Formation	
	31	Mount Mye Formation	Flanks magnetic anomaly but may be graphitic phyllite source
	32	Menzie Creek Formation	
	33	Vangorda Formation	Flanks magnetic anomaly
	34	Vangorda Formation	Correlates with magnetic anomaly
	35	Vangorda Formation	
	36	Vangorda Formation	
	37	Vangorda Formation	May part of graphitic phyllite unit
H6	38	Mount Mye Formation	Correlates with magnetic anomaly
	39	Mount Mye Formation	Correlates with magnetic anomaly
G5	40	Mount Mye Formation	
	41	?	Flanks magnetic anomaly
H5	42	Mount Mye Formation	Large, very conductive zone
	43	Mount Mye Formation	Flanks magnetic anomaly

8. RECOMMENDATIONS

Selection of geophysical anomalies for further investigation is based on the structural and magnetic associations of the designated conductors as well as their relative conductivity. The conductors are prioritized as first, second or third priority investigation targets depending on their anomaly characteristics and geological and magnetic associations. They are tabulated following:

Sheet	First Priority	Second Priority	Third Priority
C6	None	None	1, 2
D6	None	4, 7, 8	3, 5, 6, 9
E6	16	10, 11, 13, 14	12, 15, 17
F6	28	18 to 27 inclusive	None
G6	29, 30, 33, 34	35, 36	31, 32, 37
H6	38, 39	None	None
G5	40	41	None
H5	42	43	None

The conductive anomalies recommended for investigation represent a first phase exploration program. As mentioned previously, detailed analysis of the geophysical results with respect to previous exploration efforts is required. Where no explanation for specific anomalies is forthcoming then further ground investigations will be necessary. Many of the conductive targets selected for evaluation are probably already explained by previous work. In fact, the more subtle poorer conductivity responses, not selected in this first pass, may be reflecting the disseminated less conductive surface expression of a massive sulphide deposit at depth. Thus the need for careful examination of the data sets.

Respectfully submitted,

R. W. Woolham, P.Eng.
Consulting Geophysicist

for

AERODAT INC.

J9650

October 16, 1996

APPENDIX I

GENERAL INTERPRETIVE CONSIDERATIONS

APPENDIX II

ANOMALY LISTINGS

APPENDIX III

PERSONNEL

FIELD

Flown	June 17 to July 27, 1996
Pilot(s)	G. Suthern
Operator(s)	M. Barry

OFFICE

Processing	Andrei Lambert George McDonald
Report	R. W. Woolham

APPENDIX IV

CERTIFICATE OF QUALIFICATION

I, Roderick W. Woolham of the town of Pickering, Province of Ontario, do hereby certify that:-

1. I am a geophysicist and reside at 1463 Fieldlight Blvd., Pickering, Ontario, L1V 2S3

2. I graduated from the University of Toronto in 1961 with a degree of Bachelor of Applied Science, Engineering Physics, Geophysics Option. I have been practising my profession since graduation.

3. I am a member in good standing of the following organizations: Professional Engineers Ontario (Mining Branch); Society of Exploration Geophysicists; South African Geophysical Association; Prospectors and Developers Association of Canada.

4. I have not received, nor do I expect to receive, any interest, directly or indirectly, in the properties or securities of Anvil Range Mining Corporation or any affiliate.

5. The statements contained in this report and the conclusions reached are based upon evaluation and review of maps and information supplied by Aerodat.

6. I consent to the use of this report in submissions for assessment credits or similar regulatory requirements.

REGISTERED PROFESSIONAL ENGINEER
R. W. WOOLHAM
PROVINCE OF ONTARIO

R. W. Woolham, P.Eng.

Pickering, Ontario

October 16, 1996