REPORT ON A HELICOPTER-BORNE VERSATILE TIME DOMAIN ELECTROMAGNETIC (VTEM) GEOPHYSICAL SURVEY

BOB Project

Yukon, Canada

For:

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By

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Survey flown during July, 2008

Project 8077

November, 2008

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

REPORT ON A HELICOPTER-BORNE VERSATILE TIME DOMAIN ELECTROMAGNETIC SURVEY

BOB Project
Yukon, Canada

Executive Summary

During July 20th to July 22nd, 2008 Geotech Ltd. carried out a helicopter-borne geophysical survey for Archer Cathro & Associates Ltd. over one (1) block of the Bob Project situated in the Yukon, Canada.

Principal geophysical sensors included a versatile time domain electromagnetic (VTEM) system, and a caesium magnetometer. Ancillary equipment included a GPS navigation system and a radar altimeter. A total of 112 line-kilometres were flown.

The survey operations were based out of Ross River, Yukon. In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as electromagnetic stacked profiles, and as a colour grid of the B-field EM late time channels and total magnetic intensity.

Digital data includes all electromagnetic and magnetic products, plus ancillary data including the waveform.

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set. No formal interpretation is included.

1. INTRODUCTION

1.1 General Considerations

These services are the result of the Agreement made between Geotech Ltd. and Archer Cathro & Associates Ltd. to perform a helicopter-borne geophysical survey over the Bob property block located near Ross River, Yukon, Canada (Figure 1).

Matt Dumala acted on behalf of Archer Cathro & Associates Ltd. during the data acquisition and data processing phases of this project.

The geophysical surveys consisted of helicopter borne EM using the versatile time-domain electromagnetic (VTEM) system and aeromagnetics using a caesium magnetometer. A total of 112 line-km of geophysical data were acquired during the survey. The survey area is shown in Figure 2.

The crew was based out of Ross River, Yukon for the acquisition phase of the survey. Survey flying started on July 20th and was completed on July 22nd, 2008

Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final data processing followed immediately after the end of the survey. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in November, 2008.

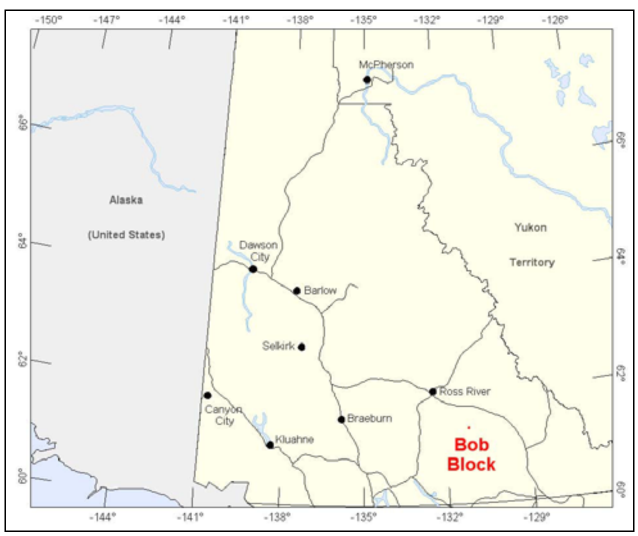

Figure 1 - Property Location

1.2 Survey Location and Specifications

The Bob block (61°19'18.83"N, 131°11'48.94"W) is located approximately 100 kilometres south-east of Ross River, Yukon, the base of operations for the survey.

The survey block was flown in a north-east (N 40° E) direction with a traverse line spacing of 100 metres, as depicted in Figure 2. Tie lines were flown perpendicular to the traverse lines at a spacing of 980 metres in the direction of N 130° E. For more detailed information on the flight spacing and direction see Table 1.

1.3 Topographic Relief and Cultural Features

Topographically, the property exhibits large relief, with elevations ranging from 1207 to 1861 metres above sea level (see Figure 2). There are many small rivers and streams that run throughout the block. There are no roads leading to the block, making it accessible only by air. The survey block is covered by NTS (National Topographic Survey) of Canada sheet 105G06.

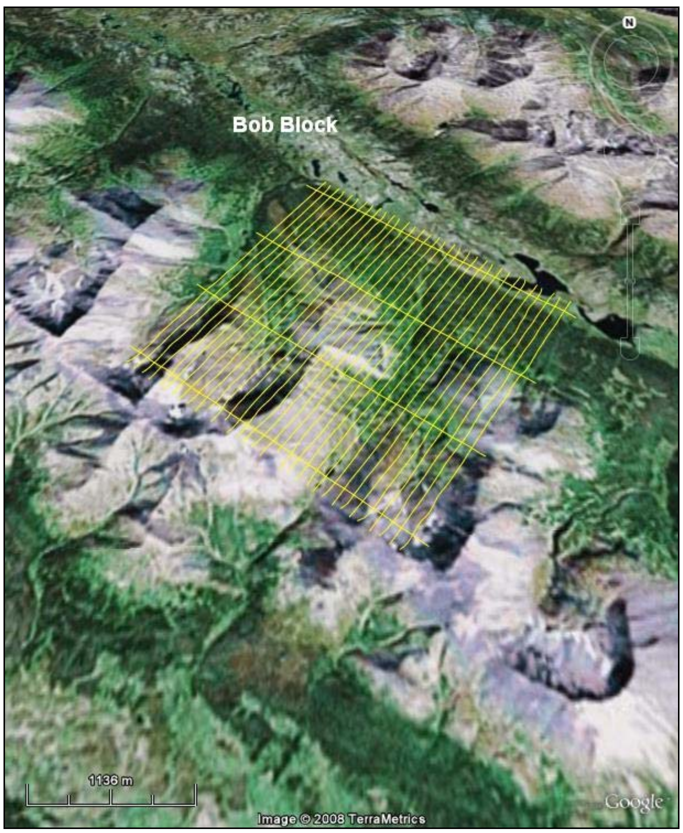

Figure 2 - Google Earth Image with Flight Paths

2. DATA ACQUISITION

2.1 Survey Area

The survey block (see Location map, Figure 2) and general flight specifications are as follows:

Table 1 - Survey blocks

Survey block	Line spacing (m)	Area (Km^2)	Planned Line-km	Actual Line-km[1]	Flight direction	Line number
Bob	Traverse: 100	11	99	108	N 40°E	L3700 - 4020
	Tie: 980		13	14	N 130°E	T4100 - 4130
TOTAL		11	112	122		

Survey block boundaries co-ordinates are provided in Appendix B.

2.2 Survey Operations

Survey operations were based out of Ross River, Yukon from July 20th to July 22nd, 2008. The following table shows the timing of the flying.

Table 2 - Survey schedule

Date	Flight #	Flown KM	Block	Crew location	Comments
20-July-08	48	48	BOB	Ross River, Yukon	Limited production – low ceiling and rain
21-July-08				Ross River, Yukon	No production – low ceiling, rain
22-July-08	49, 50	61	BOB	Ross River, Yukon	Production aborted – low ceiling, rain

[1]NOTE: Actual line-km represents the total line-km contained in the final databases. These line-km normally exceed the Planned line-km, as indicated in the survey NAV files.

2.3 Flight Specifications

The helicopter was maintained at a mean height of 72 metres above the ground with a nominal survey speed of 80 km/hour. This allowed for a nominal EM sensor terrain clearance of 41 metres and a magnetic sensor clearance of 63 metres. The data recording rates of the data acquisition was 0.1 second for electromagnetics, magnetometer and 0.2 second for altimeter and GPS. This translates to a geophysical reading about every 2 metres along flight track. Navigation was assisted by a CDGPS receiver and data acquisition system, which reports GPS co-ordinates as latitude/longitude and directs the pilot over a pre-programmed survey grid.

The operator was responsible for monitoring of the system integrity. He also maintained a detailed flight log during the survey, tracking the times of the flight as well as any unusual geophysical or topographic feature.

On return of the aircrew to the base camp the survey data was transferred from a compact flash card (PCMCIA) to the data processing computer. The data were then uploaded via ftp to the Geotech office in Aurora for daily quality assurance and quality control by qualified personnel, operating remotely.

2.4 Aircraft and Equipment

2.4.1 Survey Aircraft

The survey was flown using a Eurocopter Aerospatiale (Astar) 350 B3 helicopter, registration C-GTRK. The helicopter was operated by TRK Helicopters Ltd. Installation of the geophysical and ancillary equipment was carried out by Geotech Ltd.

2.4.2 Electromagnetic System

The electromagnetic system was a Geotech Time Domain EM (VTEM) system. The configuration is as indicated in Figure 3 below.

Receiver and transmitter coils are concentric and Z-direction oriented. The coils were towed at a mean distance of 35 metres below the aircraft as shown in Figure 5. The receiver decay recording scheme is shown diagrammatically in Figure 4.

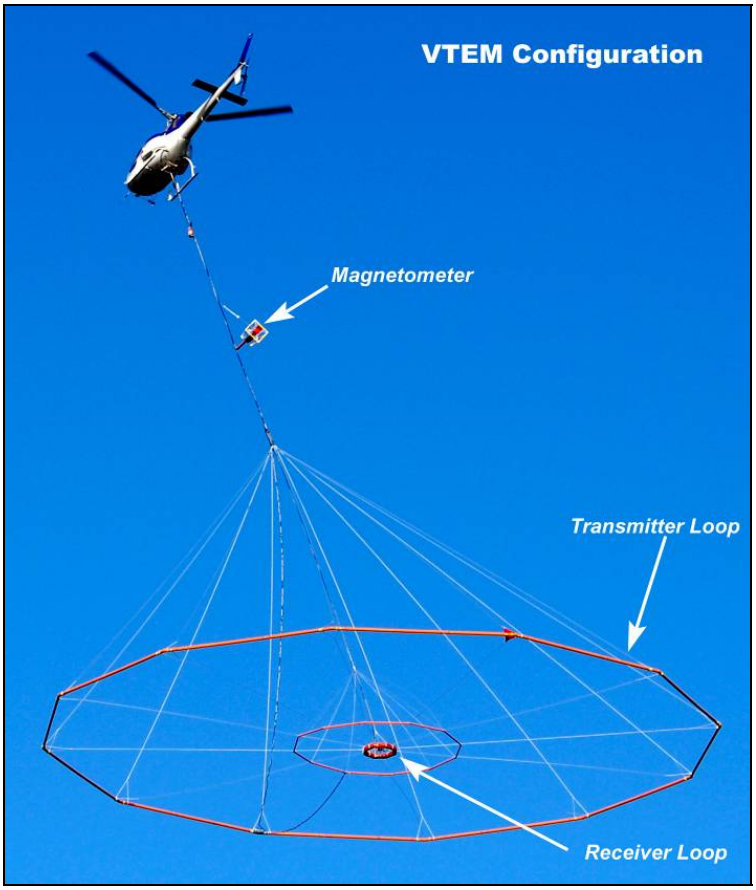

Figure 3 - VTEM Configuration

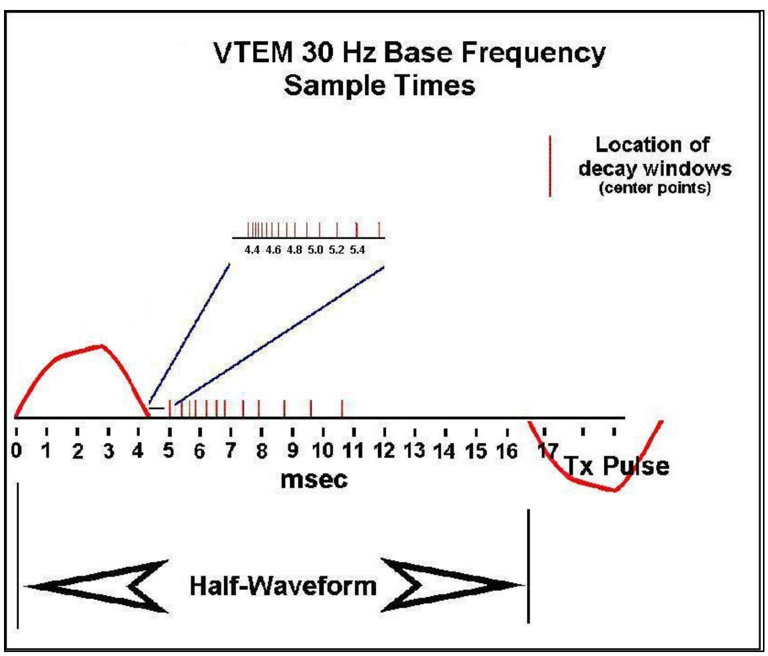

Figure 4 – VTEM Short Pulse Waveform & Sample Times

The VTEM decay sampling scheme is shown in Table 3 below. Twenty six measurement gates (ch 10-35) were used for the final data processing in the range from 120 ms to 9245 ms, as shown in Table 5.

Table 3 – Decay Sampling Scheme

VTEM Decay Sampling scheme				
Array	(Microseconds)			
Index	Time Gate	Start	End	Width
0	0			
1	10	10	21	11
2	21	16	26	11
3	31	26	37	11
4	42	37	47	11
5	52	47	57	10
6	62	57	68	11
7	73	68	78	11
8	83	78	91	13
9	99	91	110	19
10	120	110	131	21
11	141	131	154	24
12	167	154	183	29
13	198	183	216	34
14	234	216	258	42
15	281	258	310	53
16	339	310	373	63
17	406	373	445	73
18	484	445	529	84
19	573	529	628	99
20	682	628	750	123
21	818	750	896	146
22	974	896	1063	167
23	1151	1063	1261	198
24	1370	1261	1506	245
25	1641	1506	1797	292
26	1953	1797	2130	333
27	2307	2130	2526	396
28	2745	2526	3016	490
29	3286	3016	3599	583
30	3911	3599	4266	667
31	4620	4266	5058	792
32	5495	5058	6037	979
33	6578	6037	7203	1167
34	7828	7203	8537	1334
35	9245	8537	10120	1584

VTEM system parameters:

Transmitter Section
- Transmitter coil diameter: 26 m
- Number of turns: 4
- Transmitter base frequency: 30 Hz
- Peak current: 179 A
- Pulse width: 4.2 ms
- Pulse width: Duty cycle: 44%
- Peak dipole moment: 556,400 nIA
- Nominal terrain clearance: 39 m

Receiver Section
- Receiver coil diameter: 1.2 m
- Number of turns: 100.
- Effective coil area: 113.1 m^2
- Wave form shape: trapezoid
- Power Line Monitor: 60 Hz

Magnetometer
- Nominal terrain clearance: 61 m

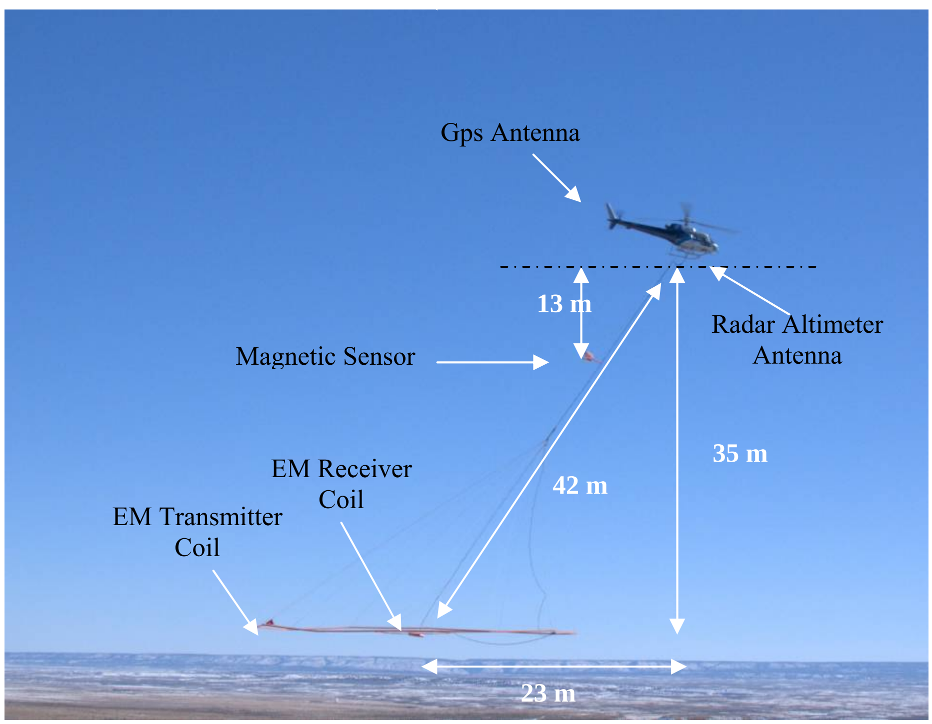

Figure 5 - VTEM system configuration

2.4.3 Airborne magnetometer

The magnetic sensor utilized for the survey was a Geometrics optically pumped caesium vapour magnetic field sensor, mounted in a separate bird, 13 metres below the helicopter, as shown in Figure 5. The sensitivity of the magnetic sensor is 0.02 nanoTesla (nT) at a sampling interval of 0.1 seconds. The magnetometer sends the measured magnetic field strength as nanoTesla to the data acquisition system via the RS-232 port.

2.4.4 Radar Altimeter

A Terra TRA 3000/TRI 40 radar altimeter was used to record terrain clearance. The antenna was mounted beneath the bubble of the helicopter cockpit (Figure 5).

2.4.5 GPS Navigation System

The navigation system used was a Geotech PC104 based navigation system utilizing a NovAtel's CDGPS (Canada-Wide Differential Global Positioning System Correction Service) enable OEM4-G2-3151W GPS receiver, Geotech navigate software, a full screen display with controls in front of the pilot to direct the flight and an NovAtel GPS antenna mounted on the helicopter tail (Figure 5). As many as 11 GPS and two CDGPS satellites may be monitored at any one time. The positional accuracy or circular error probability (CEP) is 1.8 m, with CDGPS active, it is 1.0 m. The co-ordinates of the block were set-up prior to the survey and the information was fed into the airborne navigation system.

2.4.6 Digital Acquisition System

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 4.

Table 4 – Acquisition Sampling Rates

DATA TYPE	SAMPLING
TDEM	0.1 sec
Magnetometer	0.1 sec
GPS Position	0.2 sec
Radar Altimeter	0.2 sec

2.4.7 Base Station

A combined magnetometer/GPS base station was utilized on this project. A Geometrics Caesium vapour magnetometer was used as a magnetic sensor with a sensitivity of 0.001 nT. The base station was recording the magnetic field together with the GPS time at 1 Hz on a base station computer.

The base station magnetometer sensor was installed on the apron at the airport in Ross River, Yukon (61°58'21.77"N, 132°25'37.56"W), away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.

3. PERSONNEL

The following Geotech Ltd. personnel were involved in the project.

Field:

Project Manager:	Les Moschuk (office)
Data QC/QA:	Nick Venter (office)
Crew chief:	Ryan MacIver
System Operator:	Jason McKinnon

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Guardian Helicopters Inc.

Pilot:	Randy Marks
Mechanical Engineer:	Chris Ward

Office:

Preliminary Data Processing:	Nick Venter
Final Data Processing:	Neil Fiset
Mapping/Reporting:	Kyle Orlowski

Data acquisition phase was carried out under the supervision of Andrei Bagrianski, P. Geo, Surveys Manager. Processing phase was carried out under the supervision of Jean Legault, P. Geo, Manager of Processing and Interpretation. The overall contract management and customer relations were by Paolo Berardelli.

4. DATA PROCESSING AND PRESENTATION

Data compilation and processing were carried out by the application of Geosoft OASIS Montaj and programs proprietary to Geotech Ltd.

4.1 Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the NAD83 Datum, UTM Zone 9 North coordinate system in Oasis Montaj.

The flight path was drawn using linear interpolation between x, y positions from the navigation system. Positions are updated every second and expressed as UTM easting's (x) and UTM northing's (y).

4.2 Electromagnetic Data

A three stage digital filtering process was used to reject major sferic events and to reduce 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. The filter used was a 16 point non-linear filter.

The signal to noise ratio was further improved by the application of a low pass linear digital filter. This filter has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations with a wavelength less than about 1 second or 15 metres. This filter is a symmetrical 1 sec linear filter.

The results are presented as stacked profiles of EM voltages for the time gates, in linear - logarithmic scale for both B-field and dB/dt response. B-field time channel recorded at 1.641 milliseconds after the termination of the impulse is also presented as contour colour image.

Graphical representations of the VTEM transmitter current waveform and the output voltage of the receiver coil are shown in Appendix C.

Generalized modeling results of VTEM data, written by consultant Roger Barlow and Nasreddine Bournas, P. Geo., are shown in Appendix E.

4.3 Magnetic Data

The processing of the magnetic data involved the correction for diurnal variations by using the digitally recorded ground base station magnetic values. The base station magnetometer data was edited and merged into the Geosoft GDB database on a daily basis. The aeromagnetic data was corrected for diurnal variations by subtracting the observed magnetic base station deviations.

Tie line levelling was carried out by adjusting intersection points along traverse lines. A micro-levelling procedure was applied to remove persistent low-amplitude components of flight-line noise remaining in the data.

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of approximately 0.2 cm at the mapping scale. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.

5. DELIVERABLES

5.1 Survey Report

The survey report describes the data acquisition, processing, and final presentation of the survey results.

The survey report is provided in two paper copies and digitally in PDF format.

5.2 Maps

Final maps were produced at scale of 1:10,000. The coordinate/projection system used was NAD 83, UTM Zone 9 North. All maps show the flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as EM profiles, a late-time gate gridded EM channel, and color magnetic TMI contour maps. The following maps are presented on paper;

- VTEM B-field profiles, Time Gates 0.234 – 9.245 ms in linear - logarithmic scale over total magnetic intensity colour grid and.
- VTEM dB/dt profiles, Time Gates 0.234 – 9.245 ms in linear – logarithmic scale.
- VTEM B-field late time, Time Gate 1.641 ms colour image.
- Total magnetic intensity (TMI) colour image and contours.

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5.3 Digital Data

- Two copies of the data and maps on DVD were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map and PDF format.

- DVD structure.

There are two (2) main directories;

Data contains databases, grids and maps, as described below.
Report contains a copy of the report and appendices in PDF format.

Databases in Geosoft GDB format, containing the channels listed in Table 5.

Table 5 – Geosoft GDB Data Format.

Channel Name	Description
X:	X positional data (metres – NAD83, UTM zone 9 north)
Y:	Y positional data (metres – NAD83, UTM zone 9 north)
Z:	GPS antenna elevation (metres - ASL)
Lon:	Longitude data (degree – WGS84)
Lat:	Latitude data (degree – WGS84)
Radar:	Helicopter terrain clearance from radar altimeter (metres - AGL)
RadarB:	EM Bird terrain clearance from radar altimeter (metres - AGL)
DEM:	Digital elevation model (metres)
Gtime:	GPS time (seconds of the day)
Mag1:	Raw Total Magnetic field data (nT)
Basemag:	Magnetic diurnal variation data (nT)
Mag2:	Diurnal corrected Total Magnetic field data (nT)
Mag3:	Leveled Total Magnetic field data (nT)
SF[10]:	dB/dt 120 microsecond time channel pV/(A*m^4)
SF[11]:	dB/dt 141 microsecond time channel pV/(A*m^4)
SF[12]:	dB/dt 167 microsecond time channel pV/(A*m^4)
SF[13]:	dB/dt 198 microsecond time channel pV/(A*m^4)
SF[14]:	dB/dt 234 microsecond time channel pV/(A*m^4)
SF[15]:	dB/dt 281 microsecond time channel pV/(A*m^4)
SF[16]:	dB/dt 339 microsecond time channel pV/(A*m^4)
SF[17]:	dB/dt 406 microsecond time channel pV/(A*m^4)
SF[18]:	dB/dt 484 microsecond time channel pV/(A*m^4)
SF[19]:	dB/dt 573 microsecond time channel pV/(A*m^4)
SF[20]:	dB/dt 682 microsecond time channel pV/(A*m^4)
SF[21]:	dB/dt 818 microsecond time channel pV/(A*m^4)
SF[22]:	dB/dt 974 microsecond time channel pV/(A*m^4)
SF[23]:	dB/dt 1151 microsecond time channel pV/(A*m^4)
SF[24]:	dB/dt 1370 microsecond time channel pV/(A*m^4)
SF[25]:	dB/dt 1641 microsecond time channel pV/(A*m^4)
SF[26]:	dB/dt 1953 microsecond time channel pV/(A*m^4)
SF[27]:	dB/dt 2307 microsecond time channel pV/(A*m^4)
SF[28]:	dB/dt 2745 microsecond time channel pV/(A*m^4)
SF[29]:	dB/dt 3286 microsecond time channel pV/(A*m^4)
SF[30]:	dB/dt 3911 microsecond time channel pV/(A*m^4)
SF[31]:	dB/dt 4620 microsecond time channel pV/(A*m^4)
SF[32]:	dB/dt 5495 microsecond time channel pV/(A*m^4)
SF[33]:	dB/dt 6578 microsecond time channel pV/(A*m^4)
SF[34]:	dB/dt 7828 microsecond time channel pV/(A*m^4)

Channel Name	Description
SF[35]:	dB/dt 9245 microsecond time channel pV/(A*m^4)
BF[10]:	B-field 120 microsecond time channel (pV*ms)/(A*m^4)
BF[11]:	B-field 141 microsecond time channel (pV*ms)/(A*m^4)
BF[12]:	B-field 167 microsecond time channel (pV*ms)/(A*m^4)
BF[13]:	B-field 198 microsecond time channel (pV*ms)/(A*m^4)
BF[14]:	B-field 234 microsecond time channel (pV*ms)/(A*m^4)
BF[15]:	B-field 281 microsecond time channel (pV*ms)/(A*m^4)
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BF[33]:	B-field 6578 microsecond time channel (pV*ms)/(A*m^4)
BF[34]:	B-field 7828 microsecond time channel (pV*ms)/(A*m^4)
BF[35]:	B-field 9245 microsecond time channel (pV*ms)/(A*m^4)
PLM:	Power Line monitor (60Hz)
Distance:	Distance between observations (metres)

Electromagnetic B-field and dB/dt data is found in array channel format between indexes 10 – 35, as described above.

- Database of the VTEM Waveform "VTEM_waveform.gdb" in Geosoft GDB format, containing the following channels:

Time:	Sampling rate interval, 10.416 microseconds
Rx_Volt:	Output voltage of the receiver coil (Volt)
Tx_Curr:	Output current of the transmitter (Amp)

- Grids in Geosoft GRD format, as follows:

BF25_Bob:	B-Field Channel 25 (Time Gate 1.641 ms)
Mag3_Bob:	Total magnetic intensity (nT)

  A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 25 metres was used.

- Maps at 1:10,000 in Geosoft MAP format, as follows:

8077_Bfield_Bob:	B-field profiles, Time Gates 0.234 – 9.245 ms in linear logarithmic scale over TMI.
8077_dBdt_Bob:	dB/dt profiles, Time Gates 0.234 – 9.245 ms in linear logarithmic scale.
8077_BF_Bob:	B-field Time Gate 1.641 ms colour image.
8077_TMI_Bob:	Total magnetic intensity colour image and contours.

  Maps are also presented in PDF and MapInfo format.

  1:50,000 topographic vectors were taken from the NRCAN Geogratis database at; http://geogratis.gc.ca/geogratis/en/index.html.

- Google Earth files *8077_Bob_fltpath.kml* showing the flight path of each block. Free versions of Google Earth software from: http://earth.google.com/download-earth.html

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

A helicopter-borne versatile time domain electromagnetic (VTEM) geophysical survey has been completed over the Bob Project, in the Yukon Territory, Canada.

The total area coverage is 11 km^2. Total survey line coverage is 112 line kilometres. The principal sensors included a Time Domain EM system and a magnetometer. Results have been presented as stacked profiles and contour colour images at a scale of 1:10,000. No formal interpretation is included in this report.

6.2 Recommendations

Based on the geophysical results obtained, a large number of interesting EM and magnetic anomaly groupings were identified across the property. We therefore recommend a detailed interpretation of the EM and magnetic data in conjunction with the known geology including EM anomaly picking, as well as 3D inversion and modelling techniques to further characterize the observed anomalies and to more accurately determine their parameters (depth, conductance, dip, etc.) prior to ground follow up and drill testing.

Respectfully submitted[6],

Kyle Orlowski
Geotech Ltd.

Jean Legault, P. Geo, P. Eng
Geotech Ltd.

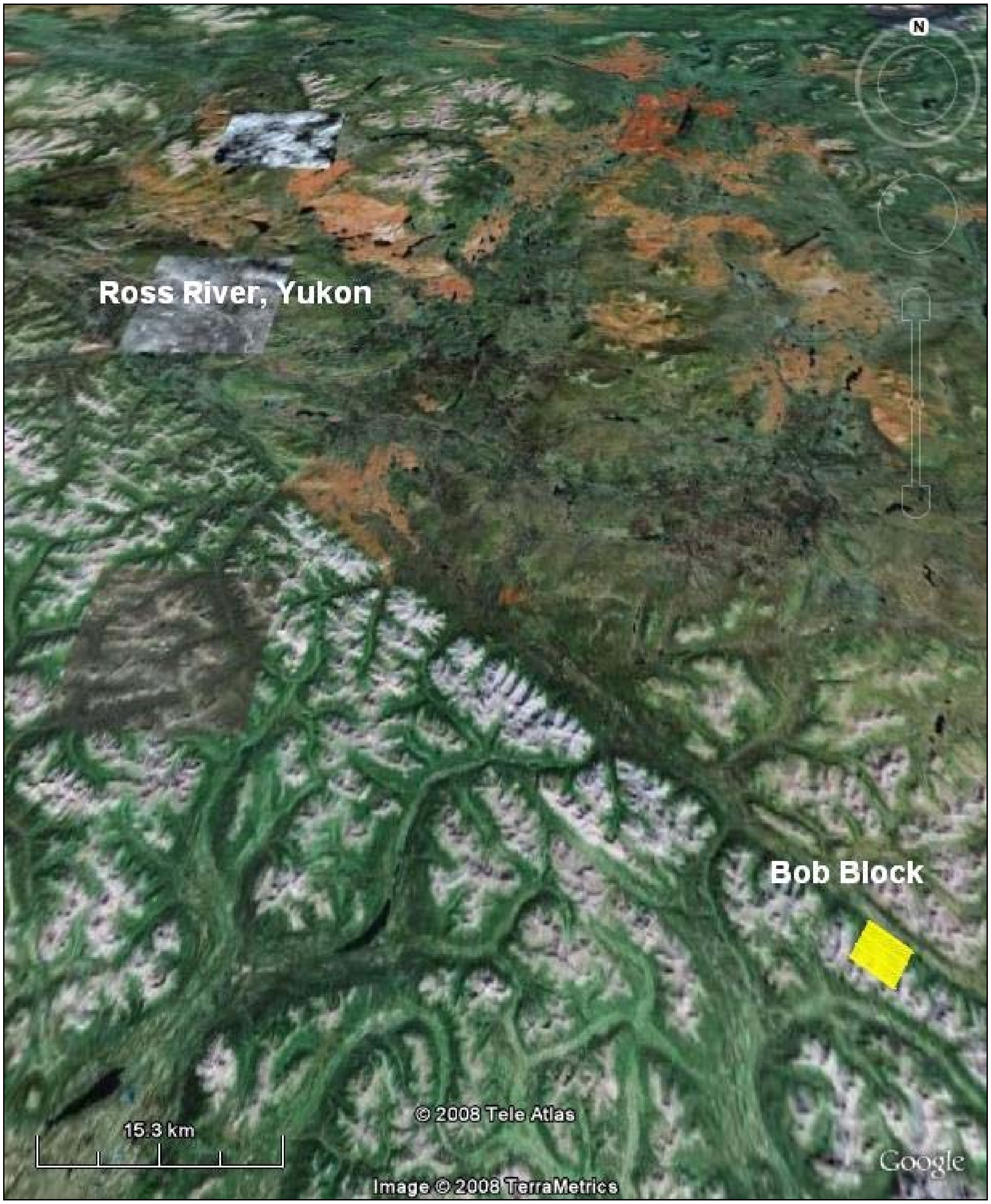
Neil Fiset
Geotech Ltd.

November 2008

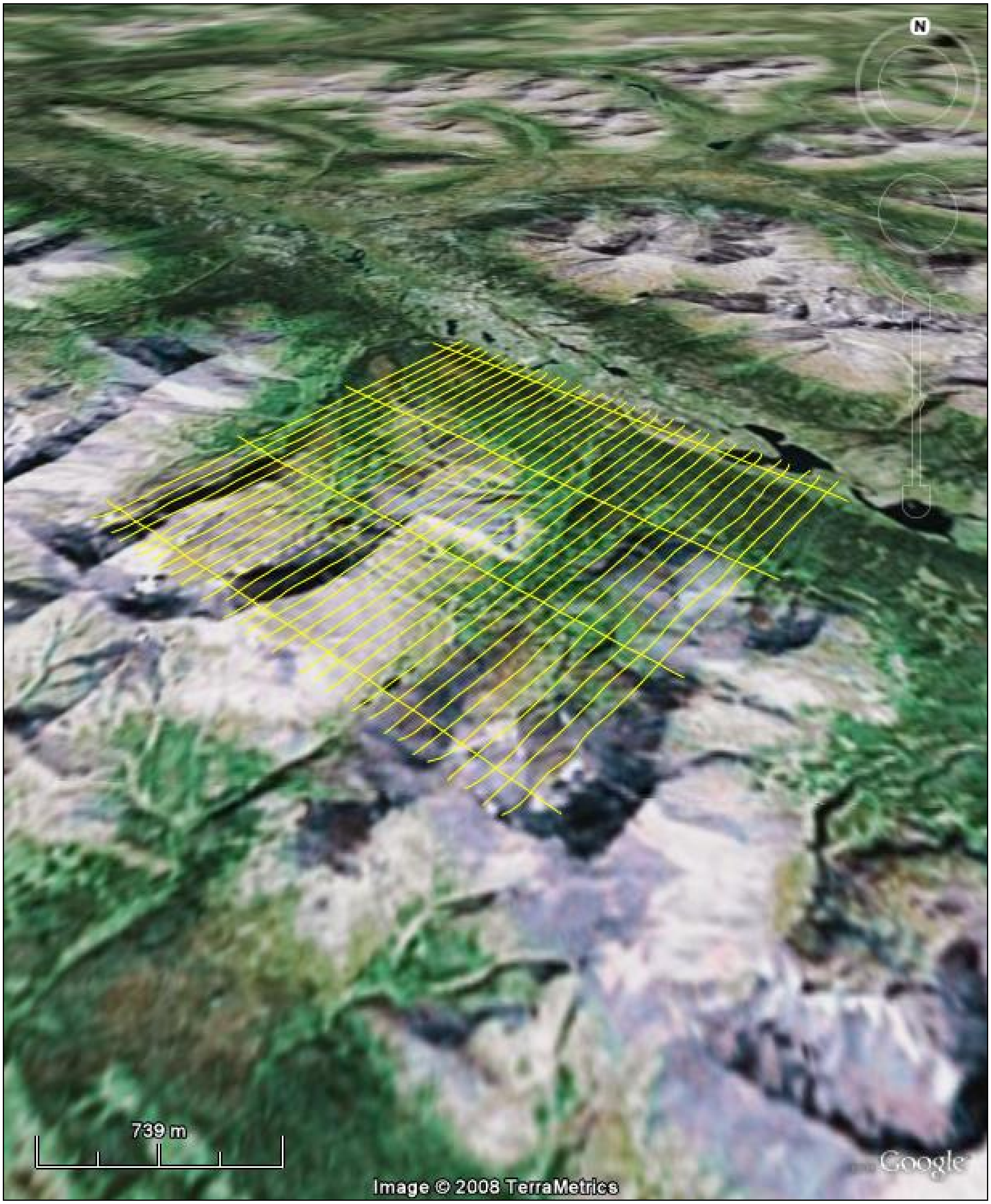
[6]Final data processing and interpretation of the EM and magnetic data were carried out by Neil Fiset, from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Jean Legault, P. Geo, Manager of Data Processing and Interpretation.

APPENDIX A

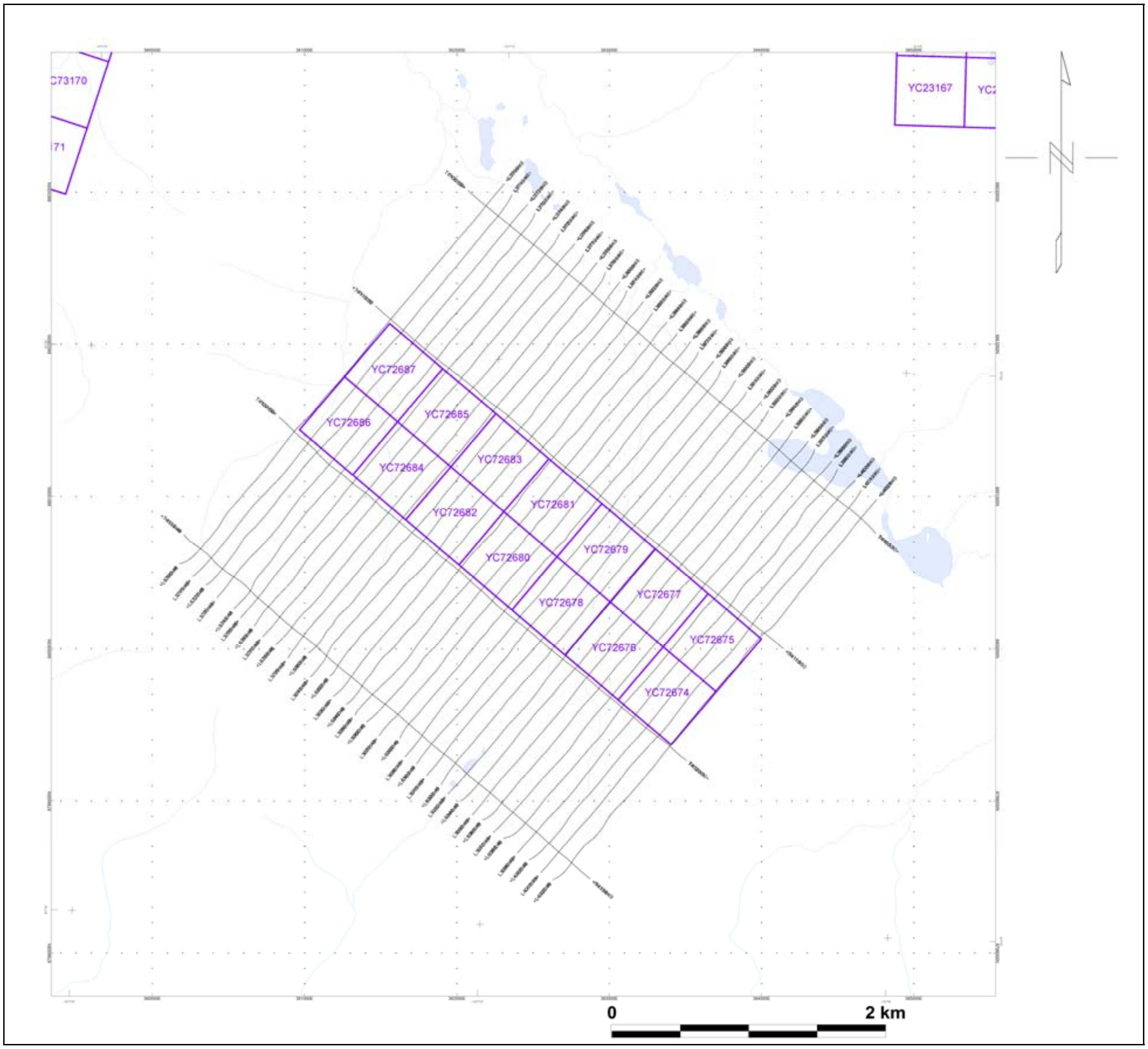
SURVEY BLOCK LOCATION MAPS



Google Earth Image: Bob Project



Google Earth Image: Bob Block



Mining Claims Map: Bob Block

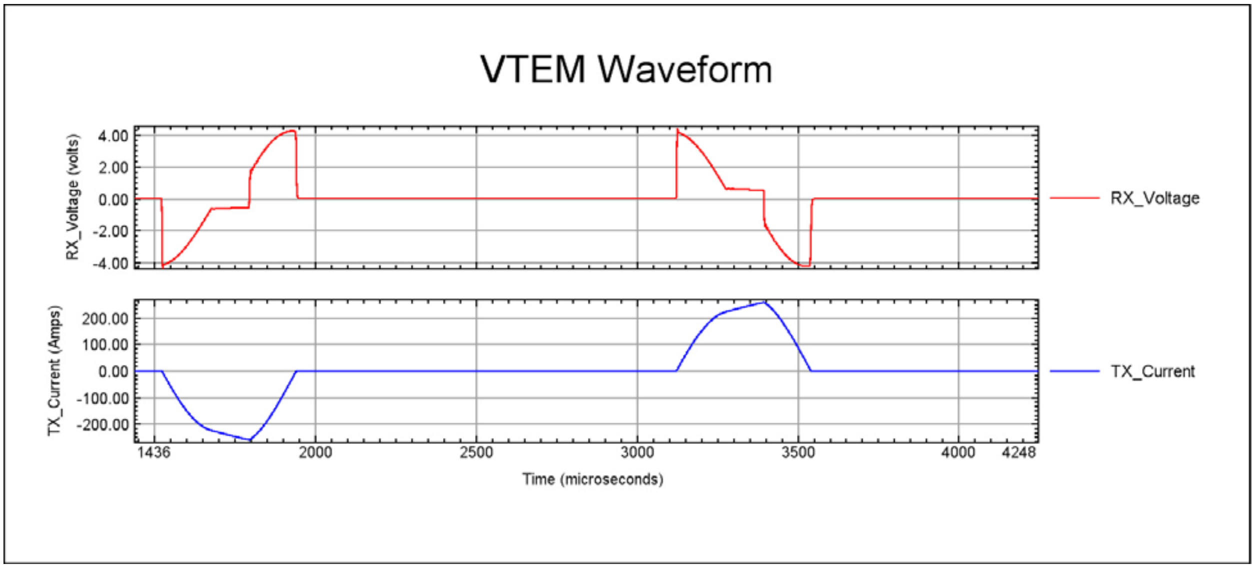
APPENDIX B

SURVEY BLOCK COORDINATES
(NAD83, UTM Zone 9 North)

Bob	
X	Y
380291	6800642
382211	6802940
384671	6800861
382741	6798563

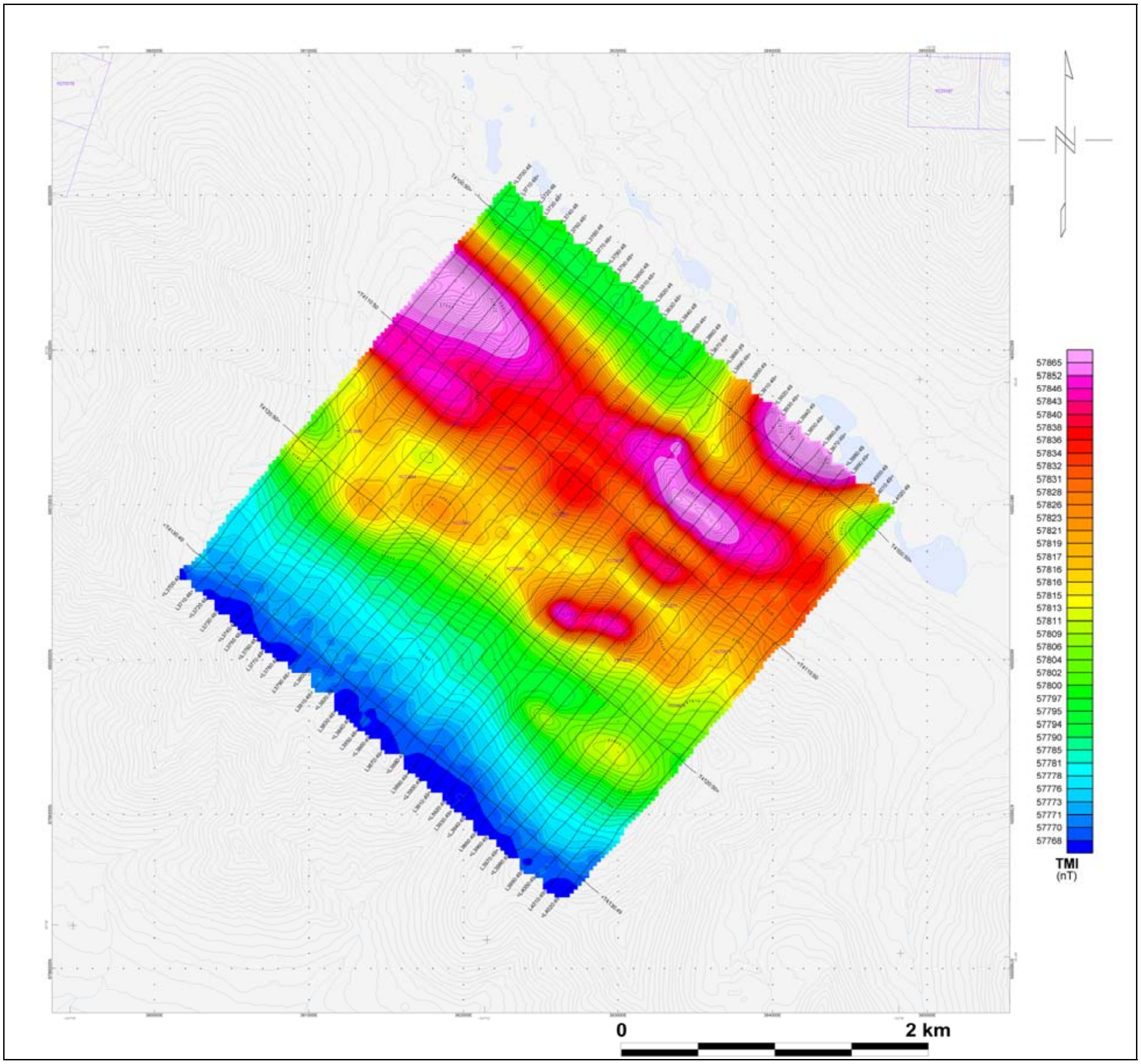
APPENDIX C

VTEM WAVEFORM



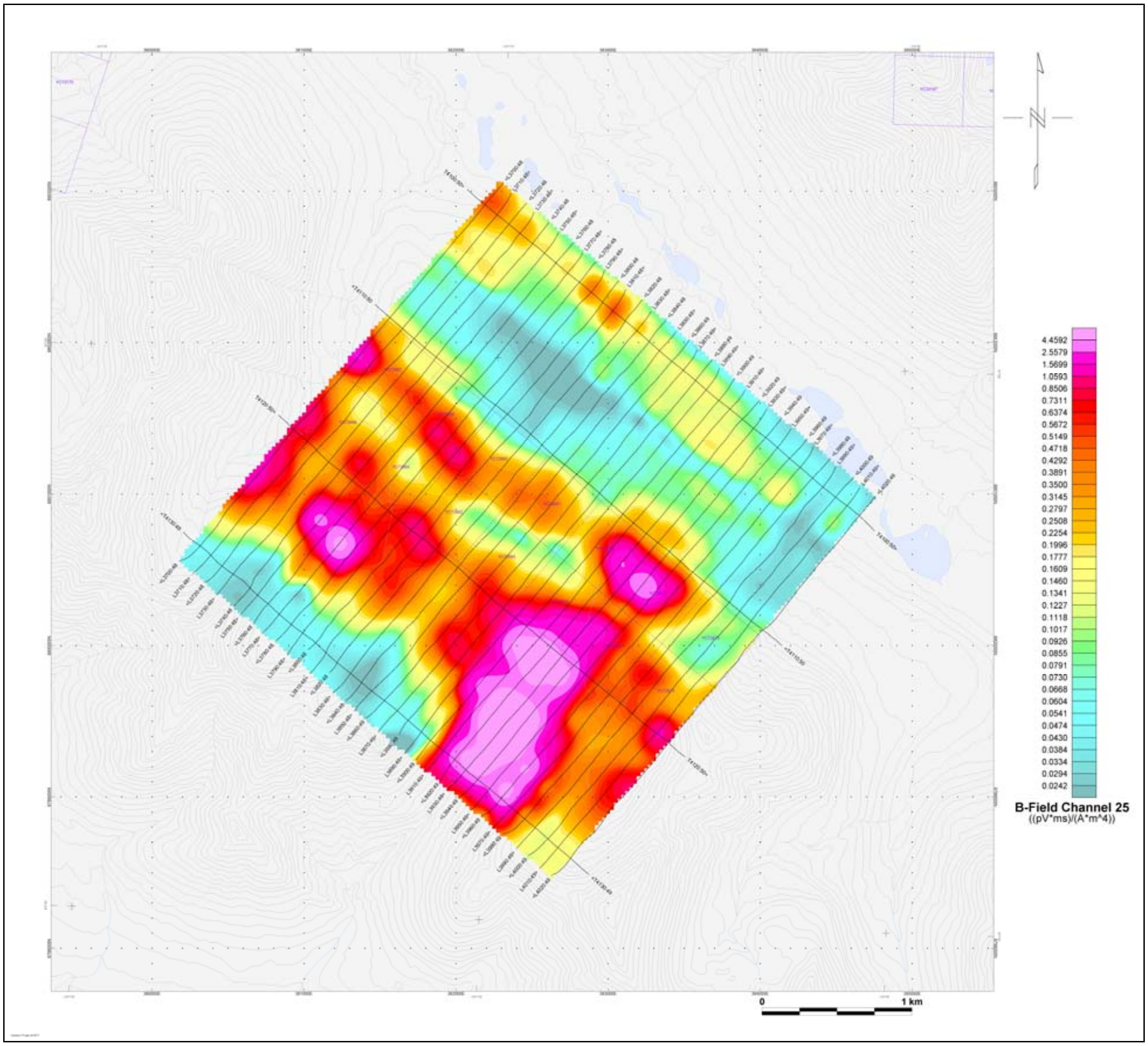
APPENDIX D

GEOPHYSICAL MAPS[1]

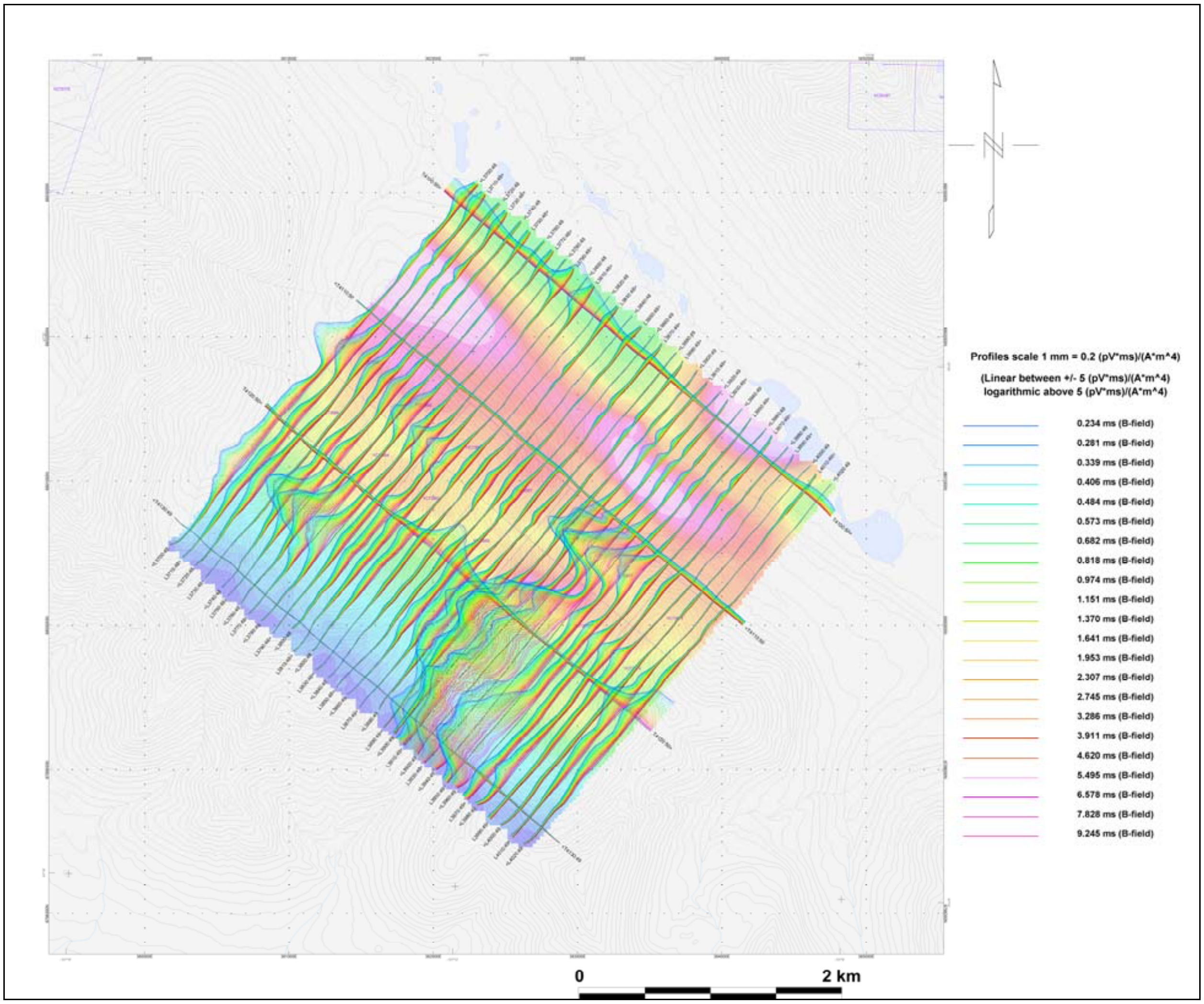


Bob Property: Total Magnetic Intensity (TMI)

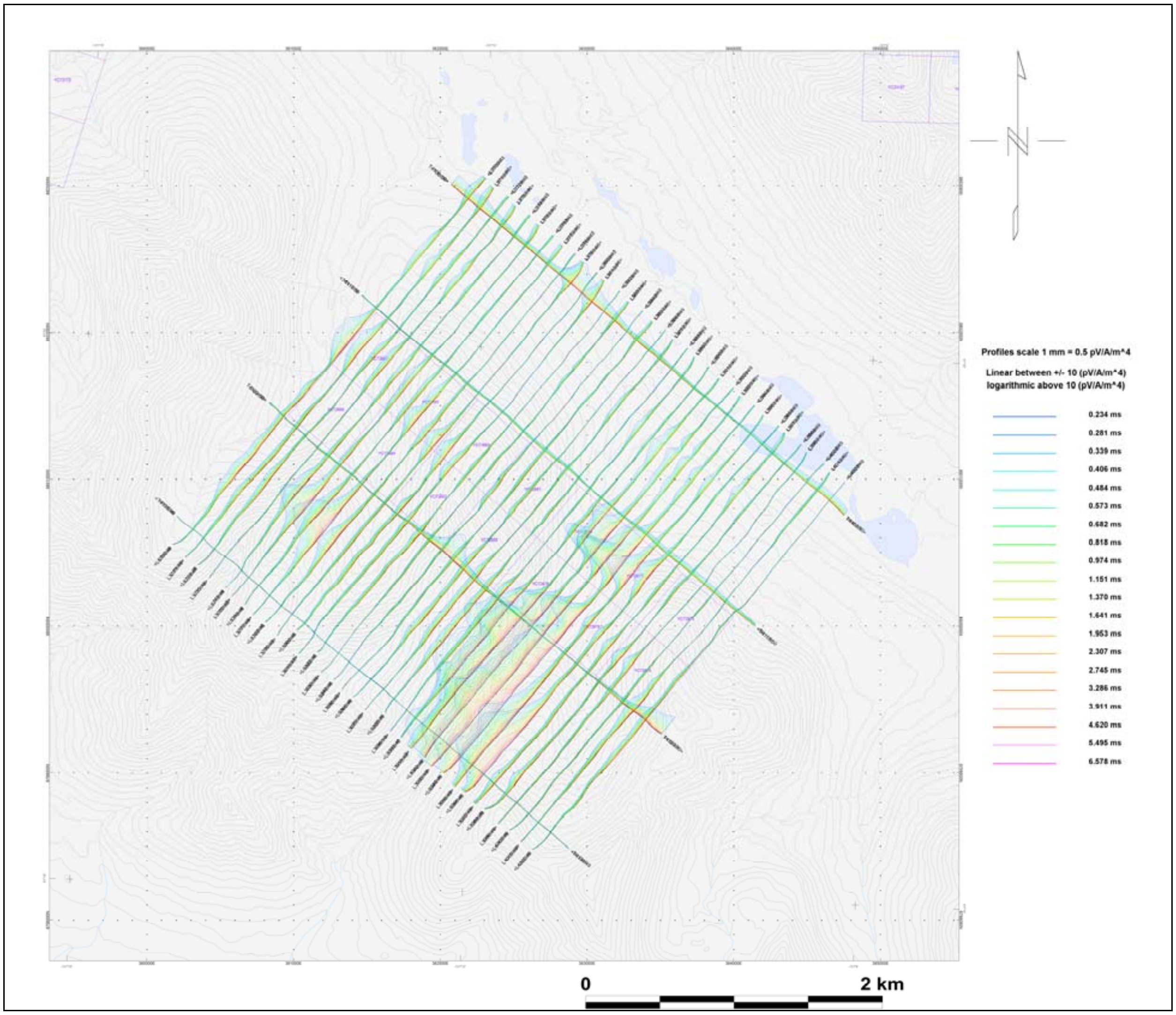
1 Note: Present maps are a selection of the final geophysical maps. Full size geophysical maps are also available in PDF format on the final DVD.



Bob Property: VTEM B-Field Contours
- Time Gate 1.641 ms



Bob Property: VTEM B-Field Profiles
– Time Gates 0.234 to 9.245 ms, over TMI



Bob Property: VTEM dB/dt Profiles
- Time Gates 0.234 to 9.245 ms

APPENDIX E

GENERALIZED MODELING RESULTS OF THE VTEM SYSTEM

Introduction

The VTEM system is based on a concentric or central loop design, whereby, the receiver is positioned at the centre of a 26.1 metres diameter transmitter loop that produces a dipole moment up to 384,000 nIA at peak current. The wave form is a bi-polar, modified square wave with a turn-on and turn-off at each end. With a base frequency of 30 Hz, the duration of each pulse is approximately 7.4 milliseconds followed by an off time where no primary field is present.

During turn-on and turn-off, a time varying field is produced (dB/dt) and an electro-motive force (emf) is created as a finite impulse response. A current ring around the transmitter loop moves outward and downward as time progresses. When conductive rocks and mineralization are encountered, a secondary field is created by mutual induction and measured by the receiver at the centre of the transmitter loop.

Measurements are made during the on and off-time, when only the secondary field (representing the conductive targets encountered in the ground) is present.

Efficient modeling of the results can be carried out on regularly shaped geometries, thus yielding close approximations to the parameters of the measured targets. The following is a description of a series of common models made for the purpose of promoting a general understanding of the measured results.

General Modeling Concepts

A set of models has been produced for the Geotech VTEM® system with explanation notes (see models C1 to C18). The reader is encouraged to review these models, so as to get a general understanding of the responses as they apply to survey results. While these models do not begin to cover all possibilities, they give a general perspective on the simple and most commonly encountered anomalies.

When producing these models, a few key points were observed and are worth noting as follows:

- For near vertical and vertical plate models, the top of the conductor is always located directly under the centre low point between the two shoulders in the classic **M** shaped response.

- As the plate is positioned at an increasing depth to the top, the shoulders of the **M** shaped response, have a greater separation distance.

- When faced with choosing between a flat lying plate and a prism model to represent the target (broad response) some ambiguity is present and caution should be exercised.

- With the concentric loop system and Z-component receiver coil, virtually all types of conductors and most geometries are most always well coupled and a response is generated (see model H). Only concentric loop systems can map this type of target.

The Maxwell ™ modeling program (Fullagar and Reid, 2001) used to generate the following responses assumes a resistive half-space.

Variation of Plate Depth

Geometries represented by plates of different strike length, depth extent, dip, plunge and depth below surface can be varied with characteristic parameters like conductance of the target, conductance of the host and conductivity/thickness and thickness of the overburden layer.

Diagrammatic models for a vertical plate are shown in Figures C-1 & C-2 and C-5 & C-6 at two different depths, all other parameters remaining constant. With this transmitter-receiver geometry, the classic **M** shaped response is generated. Figures C-1 and C-2 show a plate where the top is near surface. Here, amplitudes of the duel peaks are higher and symmetrical with the zero centre positioned directly above the plate. Most important is the separation distance of the peaks. This distance is small when the plate is near surface and widens with a linear relationship as the plate (depth to top) increases. Figures C-5 and C-6 show a much deeper plate where the separation distance of the peaks is much wider and the amplitudes of the channels have decreased.

Variation of Plate Dip

As the plate dips and departs from the vertical position, the peaks become asymmetrical. Figures C-3 & C-4 and C-7 and C-8 show a near surface plate dipping 80º at two different depths. Note that the direction of dip is toward the high shoulder of the response and the top of the plate remains under the centre minimum.

As the dip increases, the aspect ratio (Min/Max) decreases and this aspect ratio can be used as an empirical guide to dip angles from near 90º to about 30º. The method is not sensitive enough where dips are less than about 30º. For example, for a plate dipping 45º, the minimum shoulder starts to vanish. In Figures C-9 & C-10 and C-11 & C-12, a flat lying plate is shown, relatively near surface. Note that the twin peak anomaly has been replaced by a symmetrical shape with large, bell shaped, channel amplitudes which decay relative to the conductance of the plate.

In the special case where two plates are positioned to represent a synclinal structure. Note that the main characteristic is that the centre amplitudes are higher (approximately double) compared to the high shoulder of a single plate. This model is very representative of tightly folded formations where the conductors where once flat lying.

Variation of Prism Dip

Finally, with thicker, prism models, another algorithm is required to represent current on the plate. A plate model is considered to be infinitely thin with respect to thickness and incapable of representing the current in the thickness dimension. A prism model is constructed to deal with this problem, thereby, representing the thickness of the body more accurately.

Figures C-13 & C-14 and C-15 & C-16 show the same prism at the same depths with variable dips. Aside from the expected differences asymmetry prism anomalies show a characteristic change from a double-peaked anomaly to single peak signatures.

I. THIN PLATE

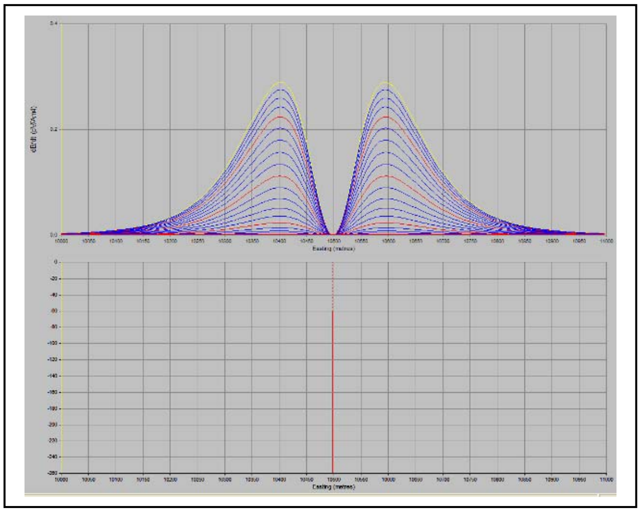


Figure C-1: dB/dt response of a shallow vertical thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

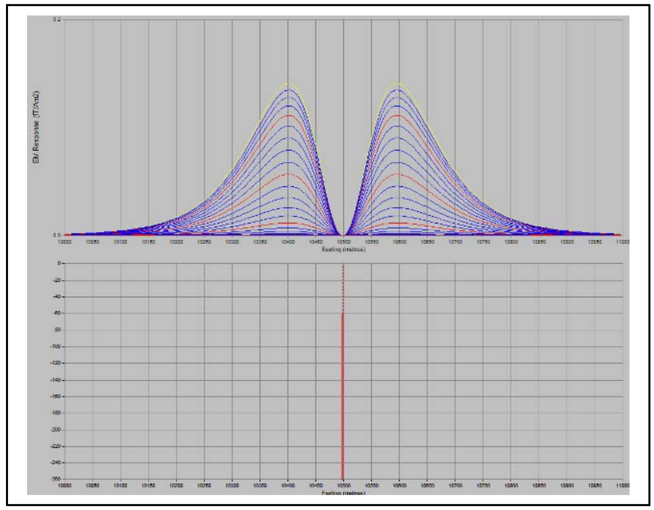


Figure C-2: B-field response of a shallow vertical thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.

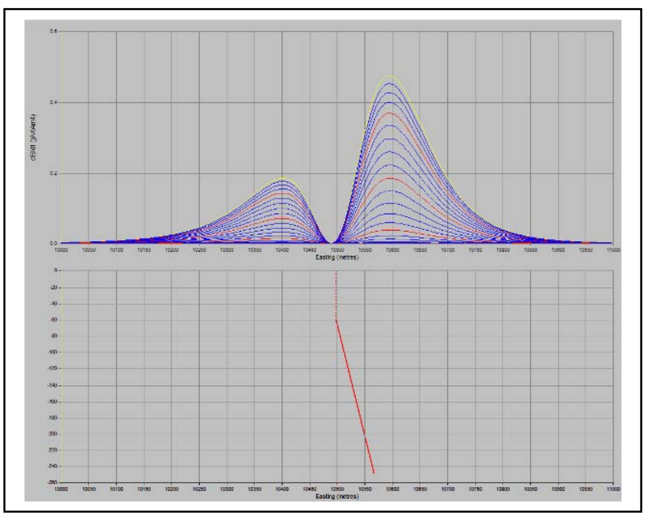


Figure C-3: dB/dt response of a shallow skewed thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

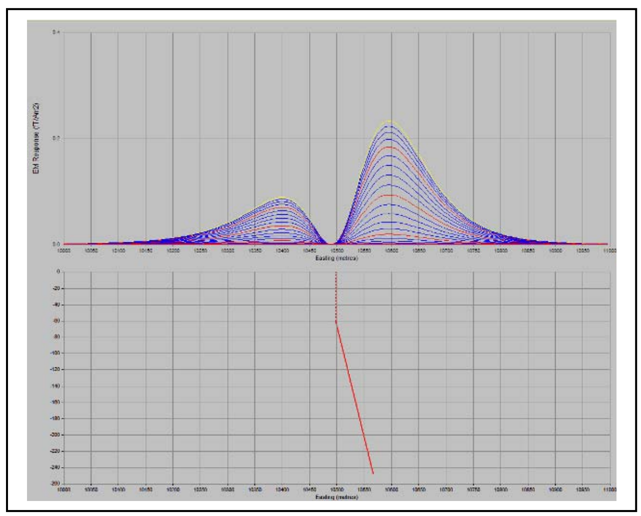


Figure C-4: B-field response of a shallow skewed thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.

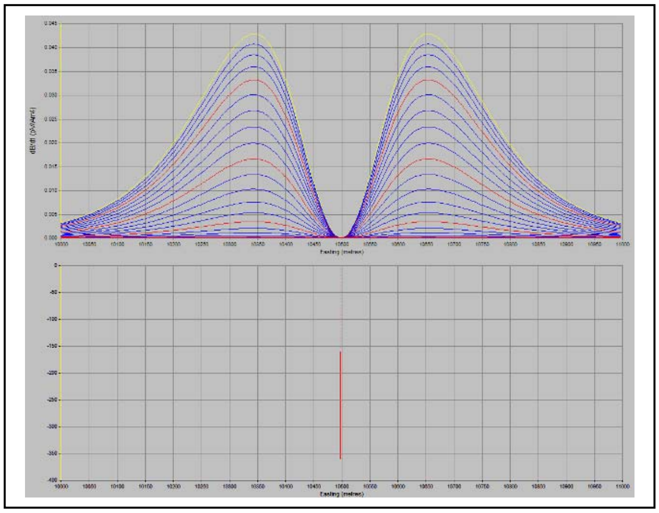


Figure C-5: dB/dt response of a deep vertical thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

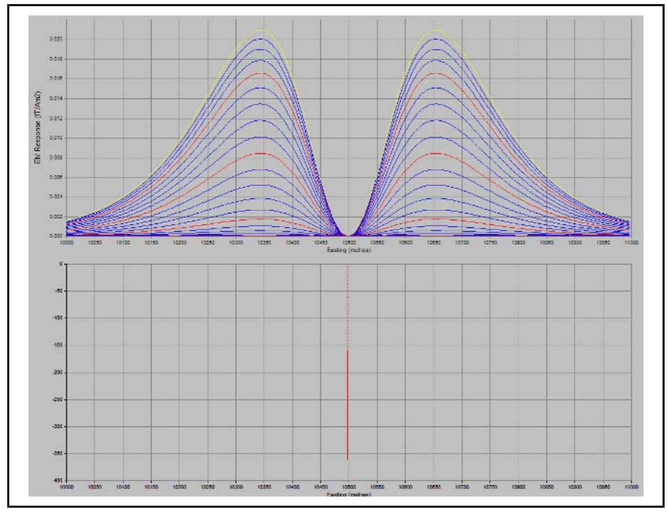


Figure C-6: B-Field response of a deep vertical thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.

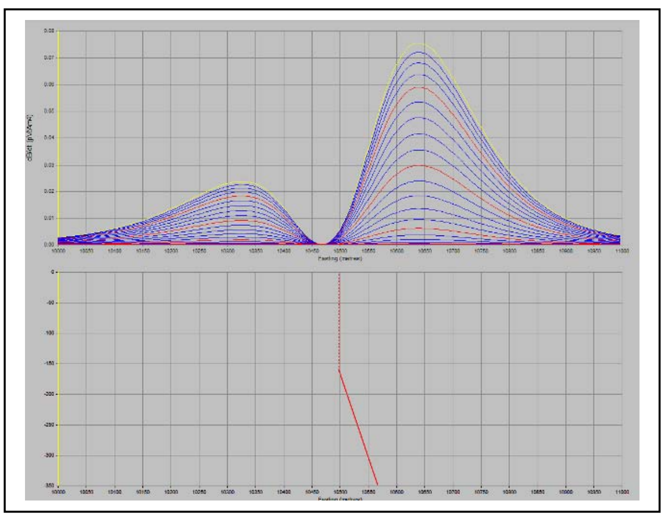


Figure C-7: dB/dt response of a deep skewed thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

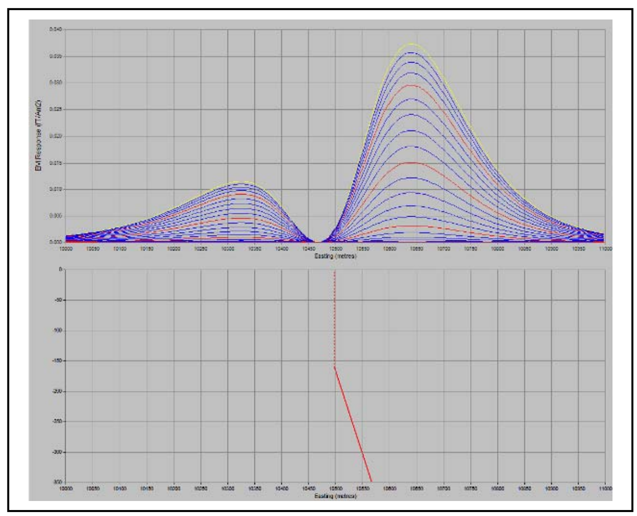
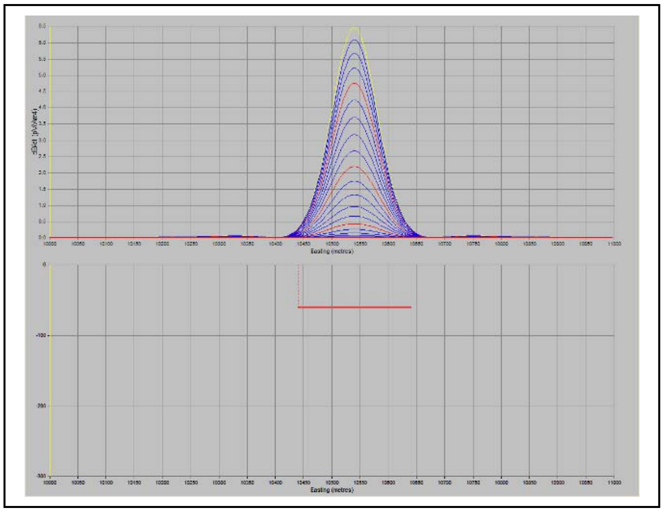


Figure C-8: B-field response of a deep skewed thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.



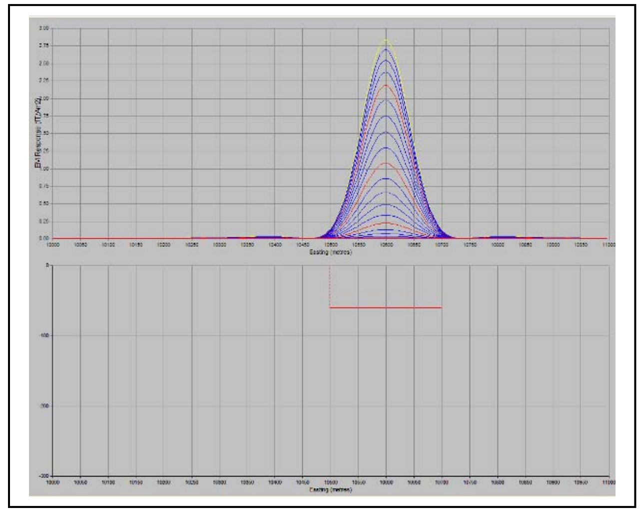
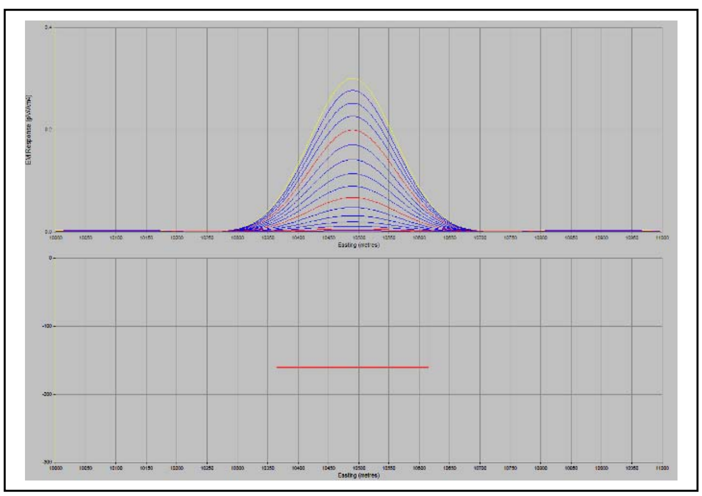


Figure C-9: dB/dt response of a shallow horizontal thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

Figure C-10: B-Field response of a shallow horizontal thin plate. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.



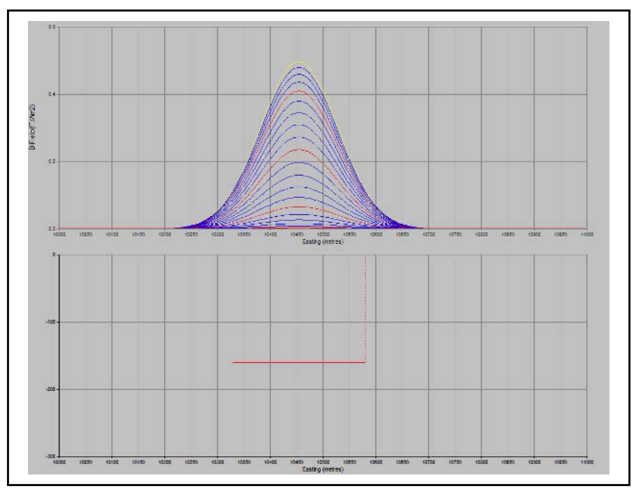


Figure C-11: dB/dt response of a deep horizontal thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

Figure C-12: B-Field response of a deep horizontal thin plate. Depth=200 m, CT=20 S. The EM response is normalized by the dipole moment.

II. THICK PLATE

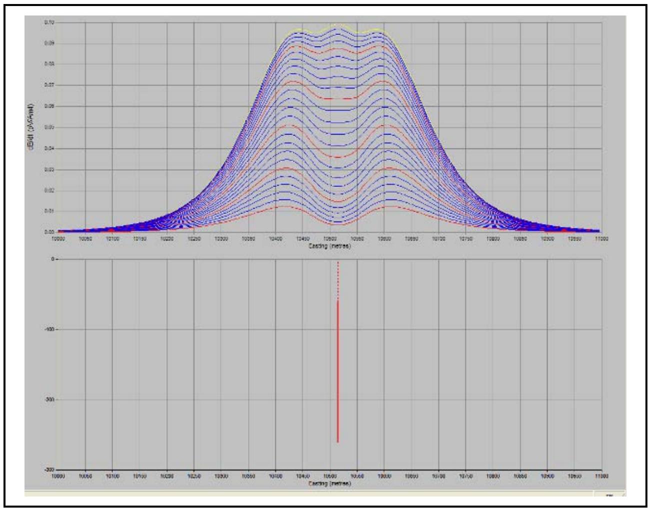


Figure C-13: dB/dt response of a shallow vertical thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment and the Rx area.

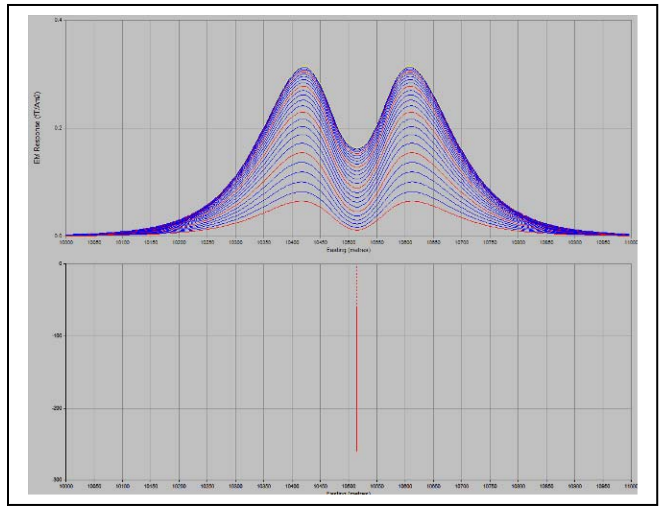


Figure C-14: B-Field response of a shallow vertical thick plate. Depth=100 m, C=12 S/m, thickness= 20 m. The EM response is normalized by the dipole moment.

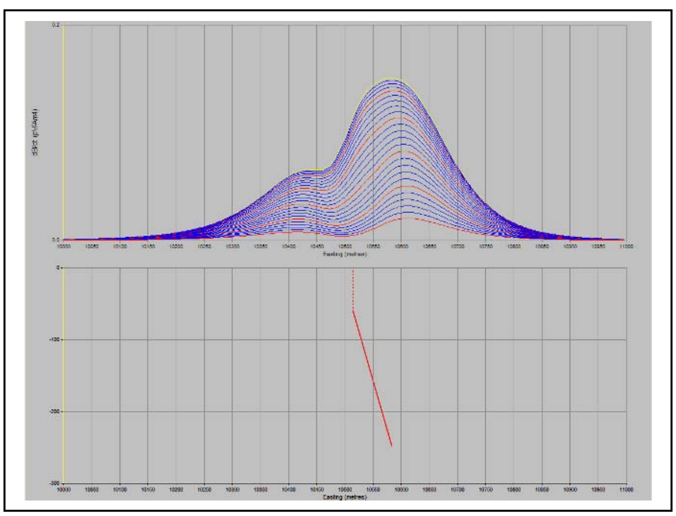


Figure C-15: dB/dt response of a shallow skewed thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment and the Rx area.

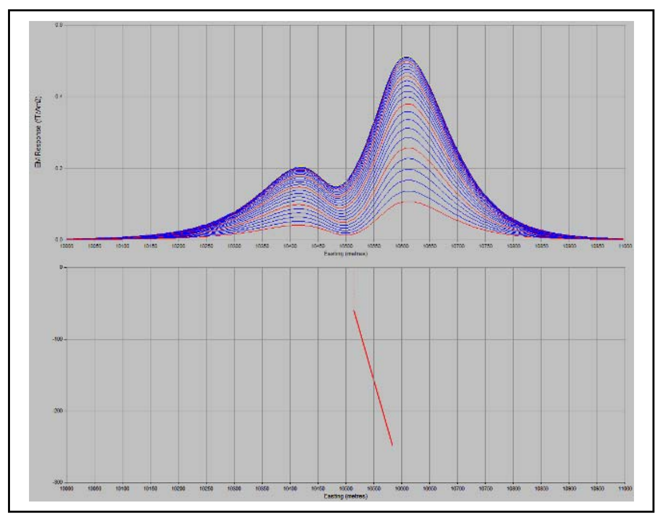


Figure C-16: B-Field response of a shallow skewed thick plate. Depth=100 m, C=12 S/m, thickness=20 m. The EM response is normalized by the dipole moment.

III. MULTIPLE THIN PLATES

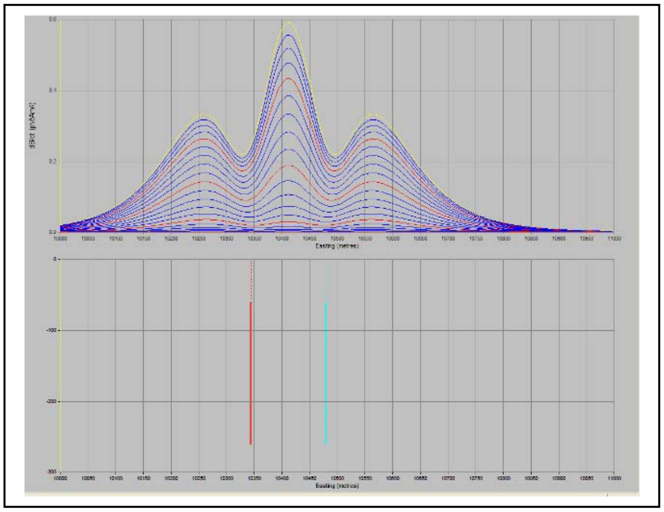


Figure C-17: dB/dt response of two vertical thin plates. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment and the Rx area.

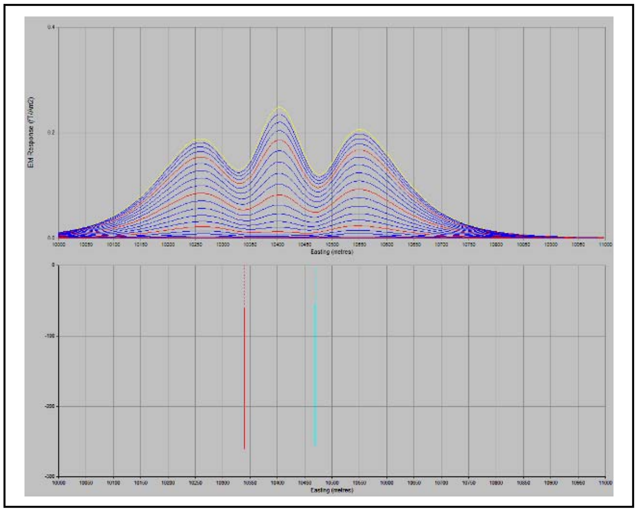


Figure C-18: B-Field response of two vertical thin plates. Depth=100 m, CT=20 S. The EM response is normalized by the dipole moment.

General Interpretation Principals

Magnetics

The total magnetic intensity responses reflect major changes in the magnetite and/or other magnetic minerals content in the underlying rocks and unconsolidated overburden. Precambrian rocks have often been subjected to intense heat and pressure during structural and metamorphic events in their history. Original signatures imprinted on these rocks at the time of formation have, it most cases, been modified, resulting in low magnetic susceptibility values.

The amplitude of magnetic anomalies, relative to the regional background, helps to assist in identifying specific magnetic and non-magnetic rock units (and conductors) related to, for example, mafic flows, 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 simple amplitude variations, the shape of the response expressed in the wave length and the symmetry or asymmetry, is used to estimate the depth, geometric parameters and magnetization of the anomaly. For example, long narrow magnetic linears usually reflect mafic flows or intrusive dyke features. Large areas with complex magnetic patterns may be produced by intrusive bodies with significant magnetization, flat lying magnetic sills or sedimentary iron formation. Local isolated circular magnetic patterns often represent plug-like igneous intrusives such as kimberlites, pegmatites or volcanic vent areas.

Because the total magnetic intensity (TMI) responses may represent two or more closely spaced bodies within a response, the second derivative of the TMI response may be helpful for distinguishing these complexities. The second derivative is most useful in mapping near surface linears and other subtle magnetic structures that are partially masked by nearby higher amplitude magnetic features. The broad zones of higher magnetic amplitude, however, are severely attenuated in the vertical derivative results. These higher amplitude zones reflect rock units having strong magnetic susceptibility signatures. For this reason, both the TMI and the second derivative maps should be evaluated together.

Theoretically, the second derivative, zero contour or color delineates the contacts or limits of large sources with near vertical dip and shallow depth to the top. The vertical gradient map also aids in determining contact zones between rocks with a susceptibility contrast, however, different, more complicated rules of thumb apply.

Concentric Loop EM Systems

Concentric systems with horizontal transmitter and receiver antennae produce much larger responses for flat lying conductors as contrasted with vertical plate-like conductors. The amount of current developing on the flat upper surface of targets having a substantial area in this dimension, are the direct result of the effective coupling angle, between the primary magnetic field and the flat surface area. One therefore, must not compare the amplitude/conductance of responses generated from flat lying bodies with those derived from near vertical plates; their ratios will be quite different for similar conductances.

Determining dip angle is very accurate for plates with dip angles greater than 30º. For angles less than 30º to 0º, the sensitivity is low and dips can not be distinguished accurately in the presence of normal survey noise levels.

A plate like body that has near vertical position will display a two shoulder, classic **M** shaped response with a distinctive separation distance between peaks for a given depth to top.

It is sometimes difficult to distinguish between responses associated with the edge effects of flat lying conductors and poorly conductive bedrock conductors. Poorly conductive bedrock conductors having low dip angles will also exhibit responses that may be interpreted as surficial overburden conductors. In some situations, the conductive response has line to line continuity and some magnetic correlation providing possible evidence that the response is related to an actual bedrock source.

The EM interpretation process used, places considerable emphasis on determining an understanding of the general conductive patterns in the area of interest. Each area has different characteristics and these can effectively guide the detailed process used.

The first stage is to determine which time gates are most descriptive of the overall conductance patterns. Maps of the time gates that represent the range of responses can be very informative.

Next, stacking the relevant channels as profiles on the flight path together with the second vertical derivative of the TMI is very helpful in revealing correlations between the EM and Magnetics.

Next, key lines can be profiled as single lines to emphasize specific characteristics of a conductor or the relationship of one conductor to another on the same line. Resistivity Depth sections can be constructed to show the relationship of conductive overburden or conductive bedrock with the conductive anomaly.

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Consultant

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Geotech Ltd.

October 2008