



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

**Turtlepond Lake, Ghost Lake, Kawene and Eva Lake,  
Kenbridge South & Kenbridge North A & B Properties  
Dryden Area, Ontario, Canada**

**For:**

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**By**

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**Survey flown in February 2008**

**Project 8015**

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REPORT ON A HELICOPTER-BORNE  
VERSATILE TIME DOMAIN ELECTROMAGNETIC SURVEY  
Turtlepond Lake, Ghost Lake, Kawene and Eva Lake, Kenbridge  
South & Kenbridge North A & B Properties,  
Dryden Area, Ontario, Canada

## Executive Summary

During February 20<sup>th</sup> to 25<sup>th</sup>, 2008 Geotech Ltd. carried out a helicopter-borne geophysical survey for Canadian Arrow Mines Ltd. over six (6) blocks near Dryden, Ontario, Canada.

Principal geophysical sensors included a versatile time domain electromagnetic (VTEM) system and a cesium magnetometer. Ancillary equipment included a GPS navigation system and a radar altimeter. A total of 1057 line-km were flown.

In-field data processing involved quality control and compilation of data collected during the acquisition stage, using the in-field processing centre established at the Holiday Inn in Dryden, Ontario. Preliminary and final data processing, including generation of final digital data products were done at the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as electromagnetic stacked profiles and the following grids;

- Total magnetic intensity
- Digital elevation model
- B-field time gate 3.286 ms

# 1. INTRODUCTION

## 1.1 General Considerations

These services are the result of the Agreement made between Geotech Ltd. Canadian Arrow Mines Ltd. to perform a helicopter-borne geophysical survey over six (6) blocks near Dryden, Ontario, Canada.

1057 line-km of geophysical data were acquired during the survey.

Todd Keast acted on behalf of Canadian Arrow Mines Ltd. during data acquisition and data processing phases of this project.

The survey area and blocks are as shown in Appendix A.

The crew was based in Dryden, Ontario for the acquisition phase of the survey, as shown in Section 2 of this report.

Survey flying was completed on February 25<sup>th</sup>, 2008. Preliminary data processing was carried out daily during the acquisition phase of the project. Final data presentation and data archiving was completed in the Aurora office of Geotech Ltd. in March, 2008.

## 1.2 Survey and System Specifications

The six survey blocks were flown at the same 100 metre traverse line spacing and at a north-south (N 0° E) direction. Tie lines were flown perpendicular to the traverse lines in an east-west (N 90° E) direction. The tie lines were flown at different line spacing's for each block; Turtlepond Lake was flown at 1050 metres, Kenbridge North A and Kenbridge South were flown at 1000 metres, Kenbridge North B was flown at 1500 metres, Kawene and Eva Lake was flown at 1100 metres and Ghost Lake was flown at 800 meters. For more detail information on the flight spacing and direction see table 1.

Where possible, the helicopter maintained a mean terrain clearance between 73 and 75 meters, which translated into an average height of 38 to 40 meters above ground for the bird-mounted VTEM system and 58 to 60 meters for the magnetic sensor.

The survey was flown using a Eurocopter Aerospatiale 350 FX-2 helicopter, registration C-FXFU. The helicopter was operated by Gateway Helicopters Ltd. Details of the survey specifications may be found in Section 2 of this report.

### **1.3 Data Processing and Final Products**

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

Databases, grids and maps of final products are presented to Canadian Arrow Mines Ltd.

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set.

### **1.4 Topographic Relief and Cultural Features**

The survey blocks are located in Northern, Ontario, Canada. The Ghost Lake block is located 10 kilometers north-east of the town of Dryden Ontario. There is access to this block via rural road off of highway 17. The north-west corner of this block is adjacent to the Dryden Regional Airport (C-YHD). Topographically, this survey area exhibits a moderate relief, with an elevation range of 384 to 454 meters above sea level. The area exhibits some lakes, rivers and marshy regions.

Turtle Lake block is located 30 kilometers south-east of the town of Dryden, Ontario and one kilometer west of Stanawan Bay, Ontario. Access to this block is via highway 502 which passes directly through the block from the north-west corner to the south-east corner. Topographically, this survey area exhibits a moderate relief, with an elevation range of 381 to 465 meters above sea level. The area exhibits several lakes, rivers and marshy regions.

Kawene and Eva Lake block is located between the town of Kawene, Ontario to the north-east and highway 17 to the south-west. Access to this block is via rural roads off of highway 17. Topographically, this survey area exhibits a shallow relief, with an elevation range of 433 to 482 meters above sea level. The area exhibits several lakes (most notably Eva Lake to the south and Kawene Lake to the North), rivers and marshy regions. Rural road 633 runs directly through the block from the south-west corner to the north.

Kenbridge South block is located 70 kilometers south-west of Dryden, Ontario. Topographically, this survey area exhibits a moderate relief, with an elevation range of 357 to 441 meters above sea level. The area exhibits several lakes (most notably Atikwa Lake to the East), rivers and marshy regions.

Kenbridge North blocks A and B are located 10 kilometers north of the Kenbridge South block and 65 kilometers south-west of Dryden, Ontario. Topographically, this survey area exhibits a moderate relief, with an elevation range of 349 to 426 meters above sea

level. The area exhibits several lakes, rivers and marshy regions.

Some power lines activity is detected by the 60 Hz power line monitor over the Ghost Lake and Kawene and Eva Lake blocks. Special care is recommended in identifying cultural features that might be detected in the survey area. Appendix A depicts the flight path over the topology.

## 2. DATA ACQUISITION

### 2.1 Survey Area

The survey block (see location map, Appendix A) and general flight specifications are as follows:

**Table 1** - Survey block

Survey block	Traverse/Tie Line spacing (m)	Area (Km <sup>2</sup> )	Line-km's	Flight direction	Line numbers
Ghost Lake	Traverse: 100	10.2	167.5	N 0° E	L7010 to L7580
	Tie: 800		17.2	N 90° E	T7910 to T7930
Turtlepond Lake	Traverse: 100	39.5	407.7	N 0° E	L1010 to L1590
	Tie: 1050		41.3	N 90° E	T1910 to T1970
Kawene & Eva Lake	Traverse: 100	15.2	185.8	N 0° E	L5010 to L5480
	Tie: 1100		18.7	N 90° E / N 81°E	T5890 to T5930
Kenbridge South	Traverse: 100	7	115.2	N 0° E	L2010 to L2360
	Tie: 1000		10.8	N 90° E	T2910 to T2930
Kenbridge North A	Traverse: 100	3.2	46.5	N 0° E	L3010 to L3150
	Tie: 1000		9.6	N 90° E	T3910 to T3930
Kenbridge North B	Traverse: 100	2.6	49.7	N 0° E	L4010 to L4160
	Tie: 1500		6.0	N 90° E	T4910 to T4920

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

### 2.2 Survey Operations

Survey operations were based in the town of Dryden, Ontario for the acquisition phase of the survey.

The following table shows the timing of the flying.

**Table 2** - Survey schedule

Date	Flight #	Flown KM	Block	Crew location	Comments
20-Feb-08	1	145.9	Ghost	Dryden, Ontario	Production
21-Feb-08				Dryden, Ontario	No Production – Due to weather, low ceiling and snow.
22-Feb-08	2	39	Ghost	Dryden, Ontario	Production
23-Feb-08	3, 4, 5	284	Kawene & Eva, Turtle	Dryden, Ontario	Production
24-Feb-08	6, 7, 8	369	Turtle	Dryden, Ontario	Production
25-Feb-08	9, 10	237.7	Kenbridge South, North A & B	Dryden, Ontario	



## 2.3 Flight Specifications

The nominal EM sensor terrain clearance was 38 to 40 meters (EM bird height above ground, i.e. helicopter is maintained 73 to 75 meters above the ground). Nominal survey speed was 80 km/hour. The data recording rates of the data acquisition was 0.1 second for electromagnetics and magnetometer, 0.2 second for altimeter and GPS. This translates to a geophysical reading about every 2 meters along flight track. Navigation was assisted by a GPS 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.

## 2.4 Aircraft and Equipment

### 2.4.1 Survey Aircraft

The survey was flown using a Euro copter Aerospatiale 350 FX-2 helicopter, registration C-FXFU. The helicopter was operated by Gateway 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 1 below.

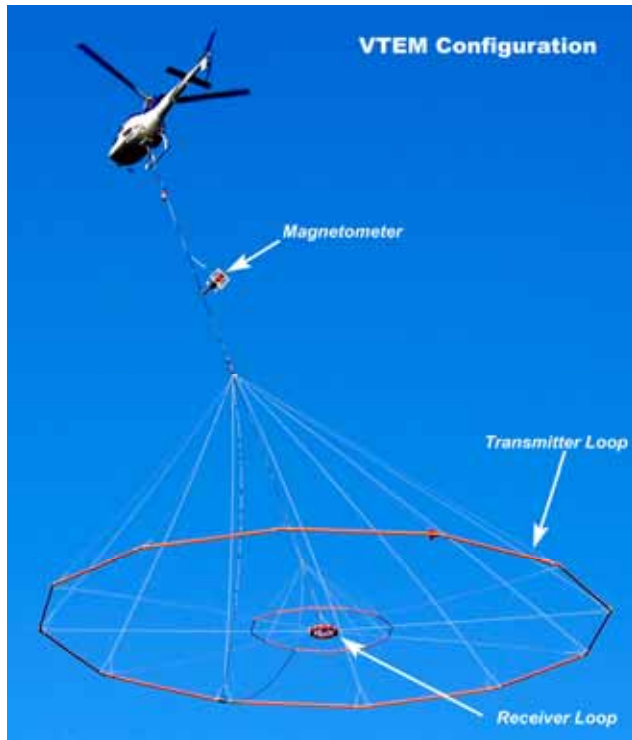


Figure 1 - VTEM Configuration

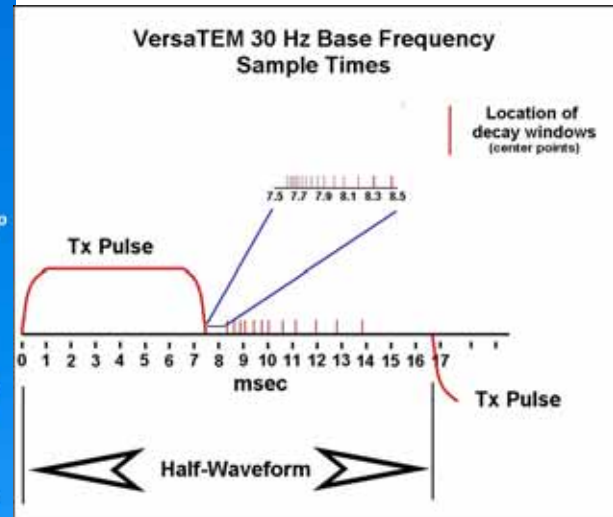


Figure 2 - VTEM Waveform & Sample Times

Receiver and transmitter coils are concentric and Z-direction oriented. The receiver decay recording scheme is shown diagrammatically in Figure 2.

Twenty-four measurement gates were used in the range from 120  $\mu$ s to 6578  $\mu$ s, as shown in Table 3.

**Table 3 – Decay Sampling Scheme**

<b>VTEM Decay Sampling scheme</b>				
<b>Array Index</b>	<b>( Microseconds )</b>			
	<b>Time Gate</b>	<b>Start</b>	<b>End</b>	<b>Width</b>
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

VTEM system parameters:

#### Transmitter Coil

- Transmitter coil diameter: 26 m
- Number of turns: 4
- Transmitter frequency: 30 Hz
- Peak current: 202 A
- Pulse width: ~7.4 ms
- Duty cycle: 44.5%
- Peak dipole moment: 430,000 NIA

#### Receiver Coil

- Receiver coil diameter: 1.2 m
- Number of turns: 100.
- Effective coil area: 113.1 m<sup>2</sup>
- Wave form shape: trapezoid.
- Sampling frequency: 10 Hz

Recording sampling rate was 10 samples per second.

A 60 Hz power line monitor data is also recorded.

EM measurements are recorded approximately 38 to 40 meters above ground level, according to flying conditions (cable length is 42 m below helicopter).

### **2.4.3 Airborne magnetometer**

The magnetic sensor utilized for the survey was a Geometrics optically pumped cesium vapour magnetic field sensor, mounted in a separated bird, towed 15 meters below the helicopter, as shown in Figure 1. 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 nanoTeslas 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.

## 2.4.5 GPS Navigation System

The navigation system used was a Geotech PC 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. 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
RadarAltimeter	0.2 sec

## 2.4.7 Base Station

A combine magnetometer/GPS base station was utilized on this project. A Geometrics Cesium 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 at the Dryden Regional Airport away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data was 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.

<u>Field:</u>	
Project Manager:	Shawn Grant
Crew chief:	Roberto Tito Calin Cosma
Operator:	Adrian Sarmasag Eric MacNeill

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Gateway Helicopters

Pilot:	Brad MacRae
Mechanical Engineer:	Andrew MacGregor

<u>Office:</u>	
QC Geophysicist:	Harish Kumar
Data Processing:	George Lev
Reporting/Mapping:	Eric Steffler

Data acquisition and processing phases were carried out under the supervision of Andrei Bagrianski, Surveys Manager. Overall management of the project was undertaken by Edward Morrison, President, Geotech Ltd.

## 4. DATA PROCESSING AND PRESENTATION

### 4.1 Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the UTM coordinate system (UTM Zone 15N) 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 eastings (x) and UTM northings (y).

### 4.2 Electromagnetic Data

A three stage digital filtering process was used to reject major spheric events and to reduce system noise. Local spheric 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 spheric 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 20 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 1.151 milliseconds after the termination of the impulse is also presented as contour colour image.

Generalized modeling results of VTEM data, written by Geophysicist Roger Barlow, are shown in Appendix E.

Graphical representation of the VTEM output voltage of the receiver coil is shown in Appendix C.

### 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.

The second order of the vertical magnetic derivative was calculated using the Fast Fourier Transformation algorithm.



## 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 a scale of 1:10,000. The coordinate/projection system used was WGS84, UTM zone 15 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 a colour magnetic contour map. The following maps are presented on paper;

- VTEM B-field profiles, Time Gates 0.234 – 6.578 ms in linear - logarithmic scale.
- VTEM dB/dt profiles, Time Gates 0.234 – 6.578 ms in linear – logarithmic scale.
- VTEM B-field late time, Time Gate 1.151 ms colour image and contours.
- Total magnetic intensity colour image and contours.

### 5.3 Digital Data

- Two copies of the data and Maps on DVD-ROM were prepared to accompany the report. Each DVD -ROM contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map format. A *readme.txt* file may be found on the DVD -ROM that describes the contents in more detail.
- Two copies of DVD-ROMs were prepared.

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

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

Channel Name	Description
SF[33]:	dB/dt 6578 microsecond time channel (pV/A/m <sup>4</sup> )
BF[10]:	B-field 120 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[11]:	B-field 141 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[12]:	B-field 167 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[13]:	B-field 198 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[14]:	B-field 234 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[15]:	B-field 281 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[16]:	B-field 339 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[17]:	B-field 406 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[18]:	B-field 484 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[19]:	B-field 573 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[20]:	B-field 682 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[21]:	B-field 818 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[22]:	B-field 974 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[23]:	B-field 1151 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
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BF[29]:	B-field 3286 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[30]:	B-field 3911 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[31]:	B-field 4620 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[32]:	B-field 5495 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
BF[33]:	B-field 6578 microsecond time channel (pV*ms)/(A*m <sup>4</sup> )
PLM:	60 Hz power line monitor

Electromagnetic B-field and dB/dt data is found in array channel format between indexes 10 – 33, as described above.

- Database VTEM\_waveform.gdb in Geosoft GDB format, containing the following channels:

Time:            Sampling rate interval, 10.416 microseconds  
 Volt:            output voltage of the receiver coil (volt)

- Grids in Geosoft GRD format, as follow,

7086_**_magF:	Total magnetic intensity (nT)
7086_**_dem:	Digital elevation model (m)
7086_**_BF1151:	B-Field Channel 23 (Time Gate 1.151 ms.)

Where \*\* represents the block name. (ie: 8015\_GHO\_MagF)

A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 10 meters was used.

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

Bfield_10K_**:	B-field profiles, Time Gates 0.234 – 6.578 ms in linear logarithmic scale.
dBdt_10K_**:	dB/dt profiles, Time Gates 0.234 – 6.578 ms in linear logarithmic scale.
BF1151_10K_**:	B-field mid time, Time Gate 1.151 ms colour image and contours.
TMI_10K_**:	Total magnetic intensity colour image and contours.

Where \*\* represents the block name. (ie: TMI\_10K\_Ken\_South.map)

1:50k topographic vectors were taken from the NRCAN Geogratis database at, <http://geogratis.gc.ca/geogratis/en/index.html>. These files are unedited and may have artefacts and inconsistencies where two adjacent map sheets join.

- Google Earth file *Flight\_Path.kmz* showing the flight path of the block.

Free version of Google Earth software can be downloaded from, <http://earth.google.com/download-earth.html>

## 6. CONCLUSIONS

A helicopter-borne versatile time domain electromagnetic (VTEM) geophysical survey has been completed over the six (6) survey blocks near Dryden, Ontario, Canada.

The total area coverage is 77.7 km<sup>2</sup>. Total survey line coverage is 1057 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.

Final data processing at the office of Geotech Ltd. in Aurora, Ontario was carried out under the supervision of Andrei Bagrianski, Surveys Manager.

Respectfully submitted,

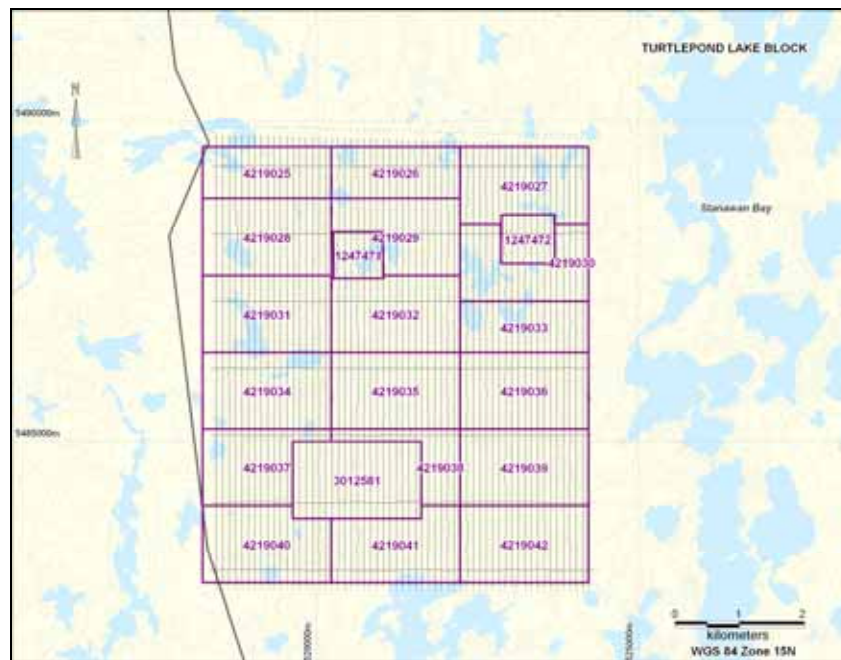
George Lev  
**Geotech Ltd.**  
March 2008

## APPENDIX A

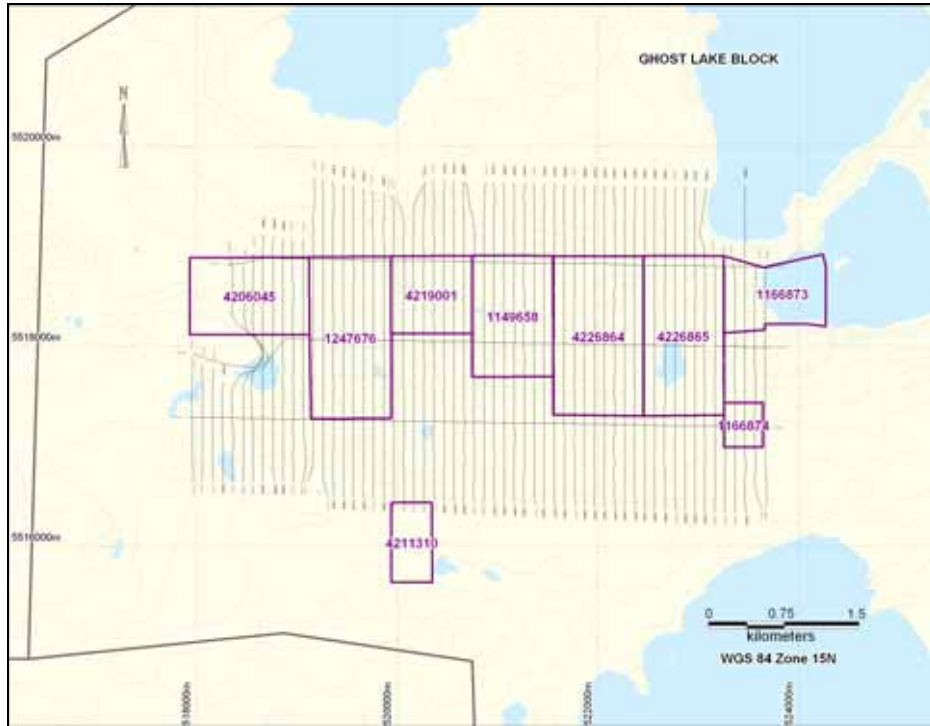
### SURVEY BLOCK LOCATION MAPS



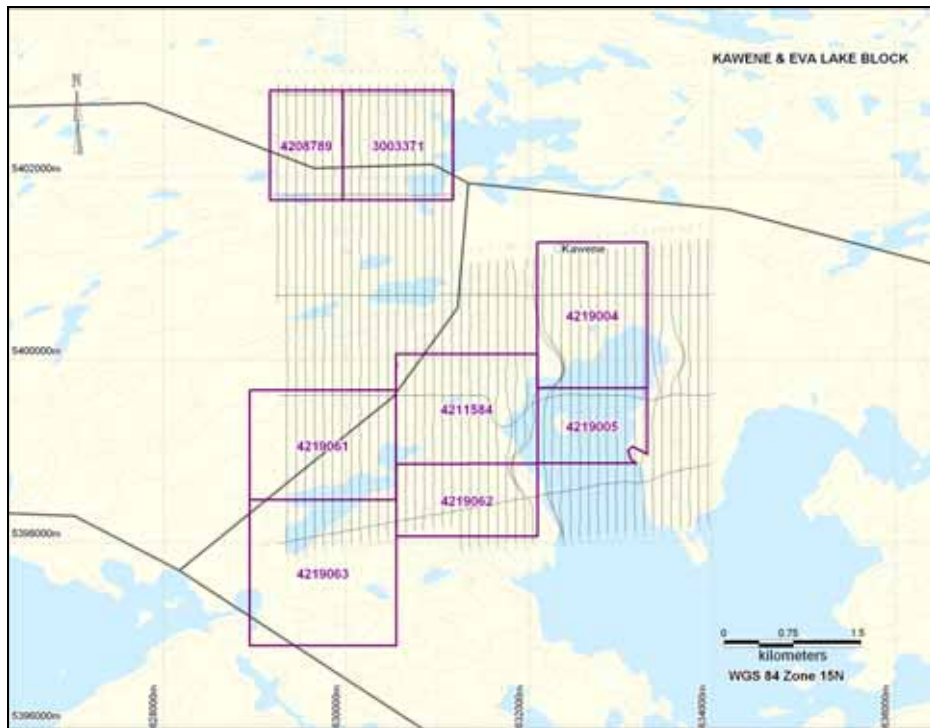
Canadian Arrow Mines Ltd. survey blocks overview.



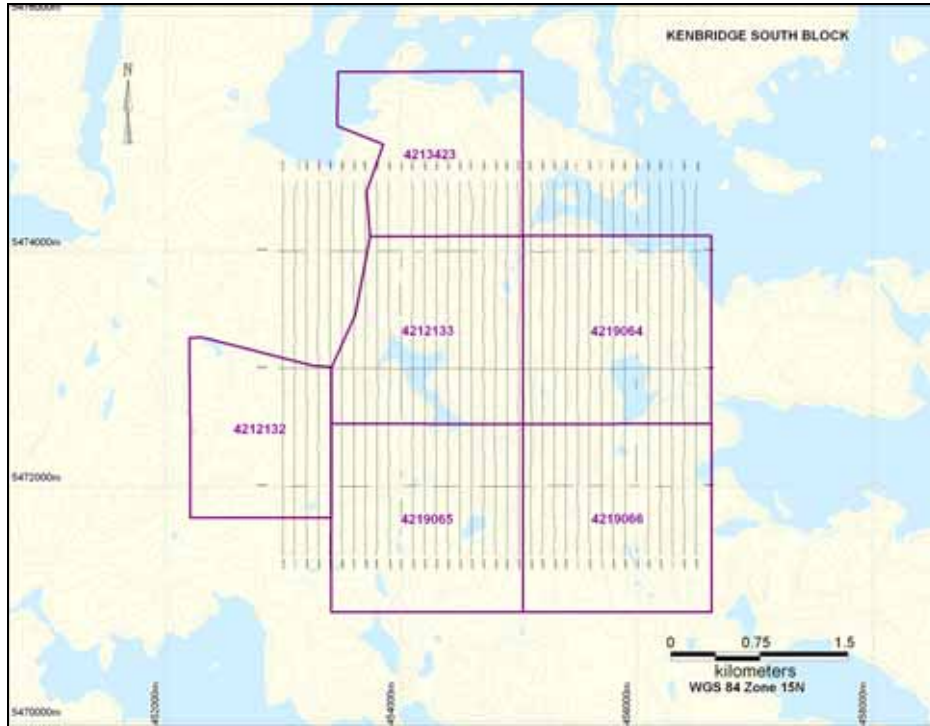
Turtlepond Lake survey block with Ontario Mining Claims.



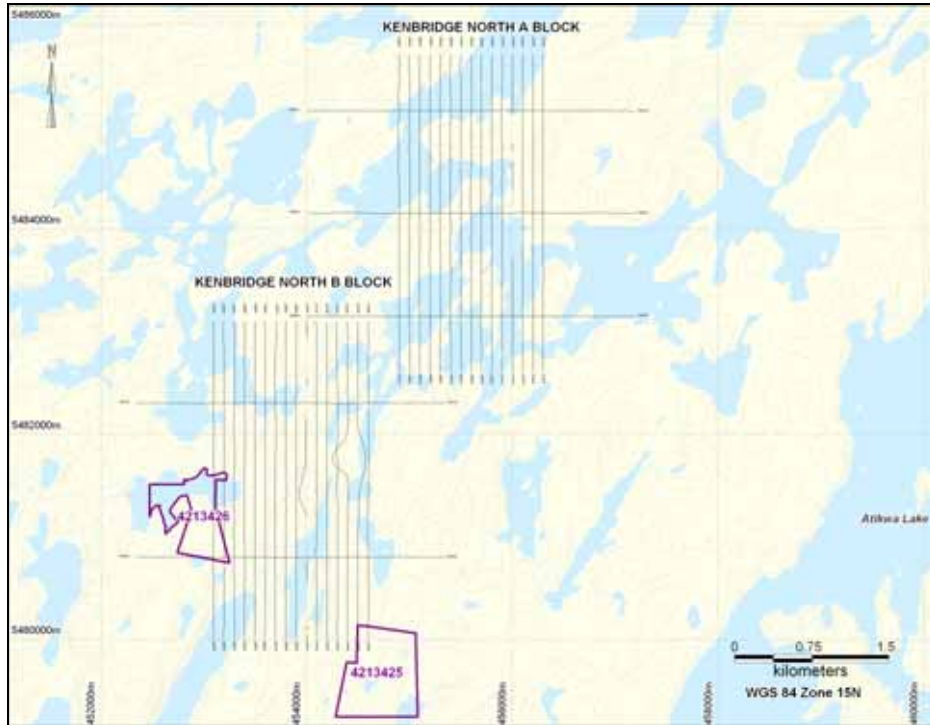
**Ghost Lake survey block with Ontario Mining Claims.**



**Kawene and Eva Lake survey block with Ontario Mining Claims.**



**Kenbridge South survey block with Ontario Mining Claims.**



**Kenbridge North A & B survey blocks with Ontario Mining Claims.**



## APPENDIX B

### SURVEY BLOCK COORDINATES

(WGS 84, UTM zone 15 north)

<b>Turtlepond Lake</b>	
<b>X</b>	<b>Y</b>
524135	5489551
524256	5482796
518380	5482843
518417	5489715

<b>Ghost Lake</b>	
<b>X</b>	<b>Y</b>
523736	5518928
523680	5517000
517964	5517283
517935	5518890

<b>Kenbridge South</b>	
<b>X</b>	<b>Y</b>
456500	5474000
456500	5472000
453000	5472000
453000	5474000

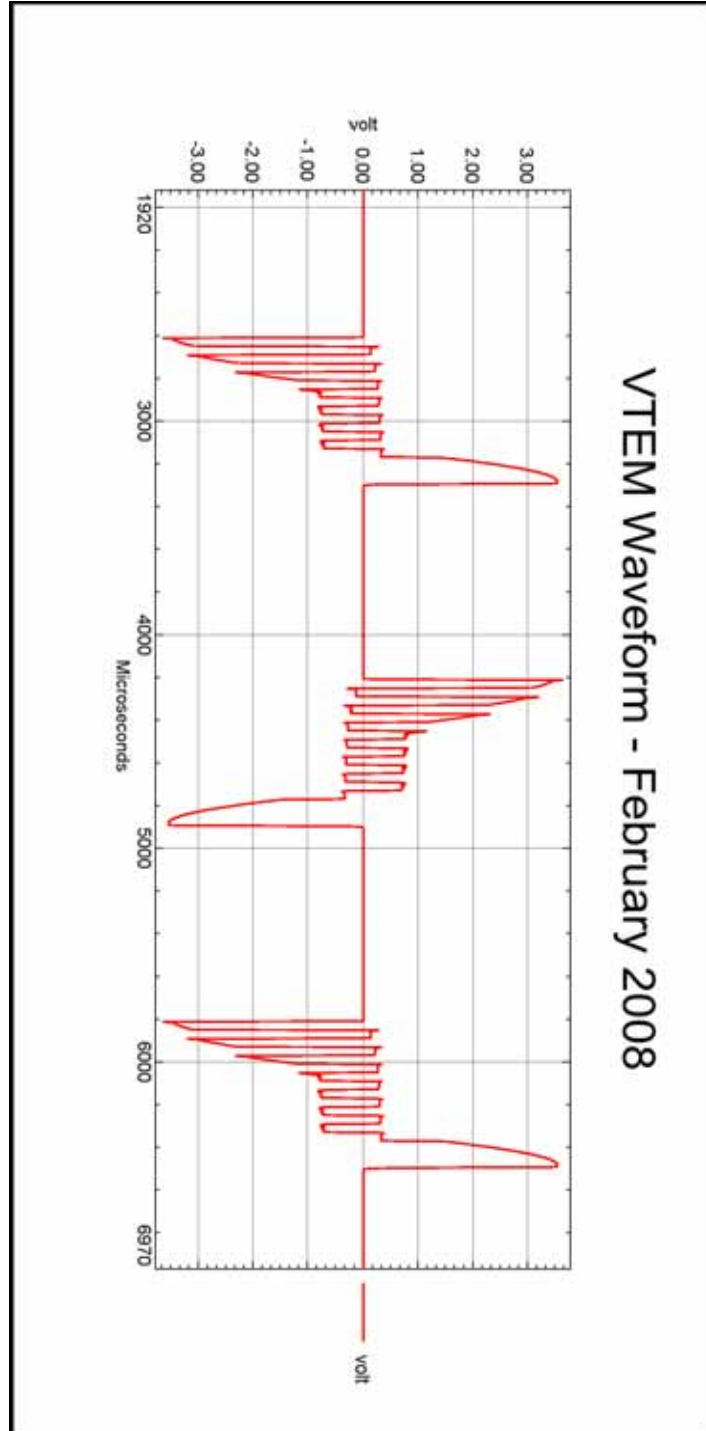
<b>Kenbridge North A</b>	
<b>X</b>	<b>Y</b>
454900	5485300
456300	5485300
456300	5483000
454900	5483000

<b>Kenbridge North B</b>	
<b>X</b>	<b>Y</b>
454600	5482400
454600	5480700
453100	5480700
453100	5482400

<b>Kawene &amp; Eva Lake</b>	
<b>X</b>	<b>Y</b>
631172	5402949
631174	5400711
633950	5400711
633950	5398800
629325	5397900
629325	5401734
629170	5401734
629172	5402937

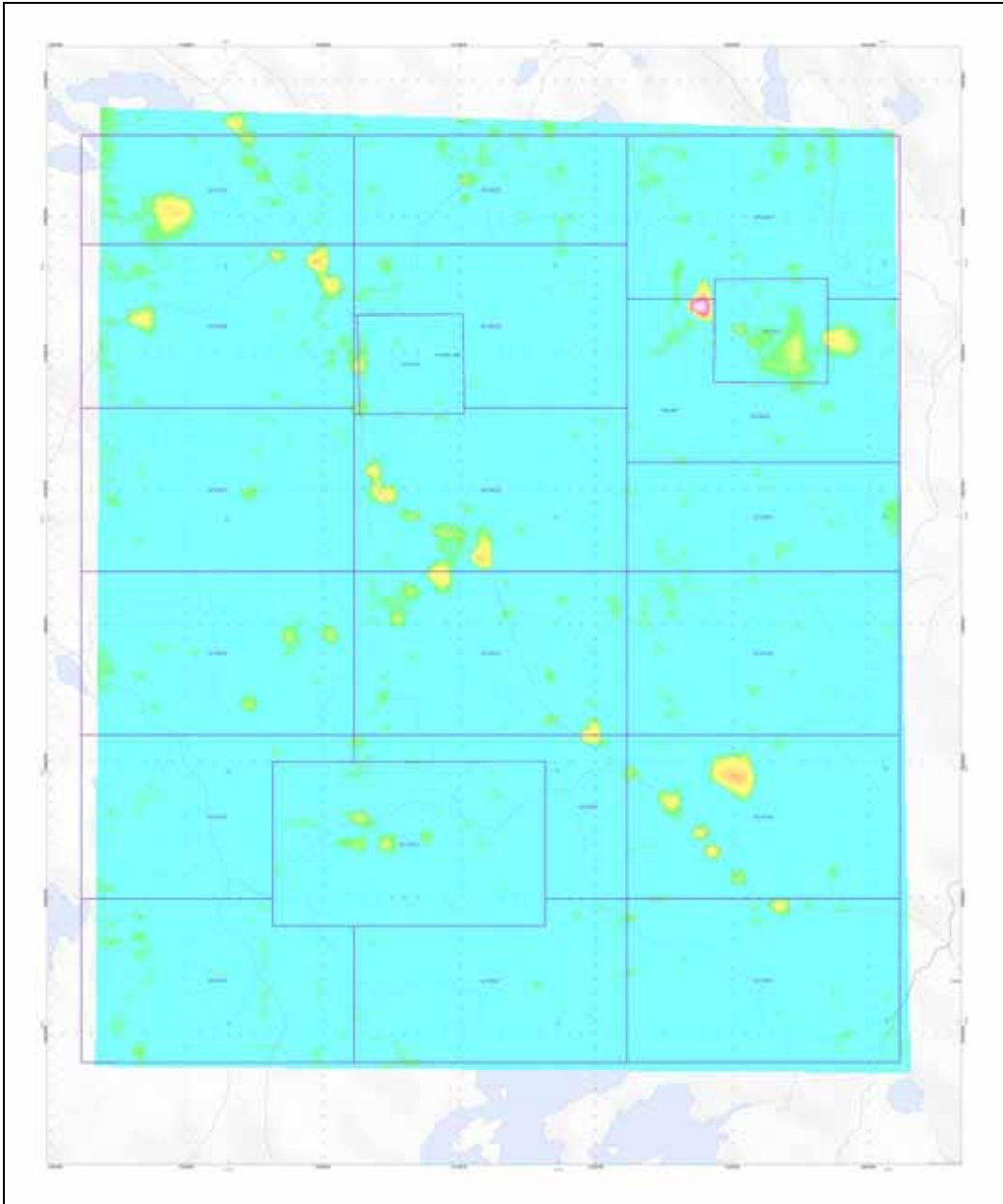
## APPENDIX C

### VTEM WAVEFORM

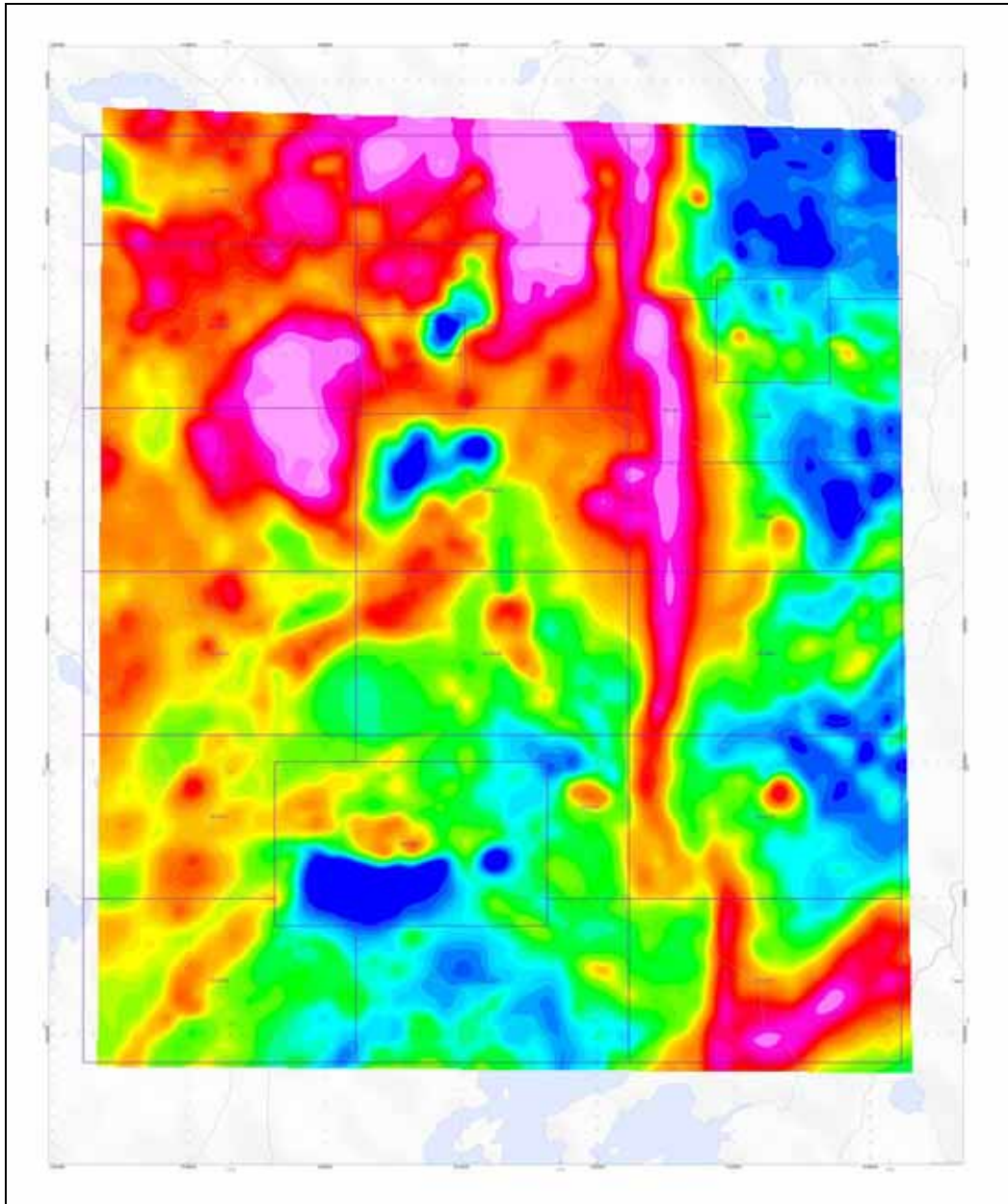


**APPENDIX D**

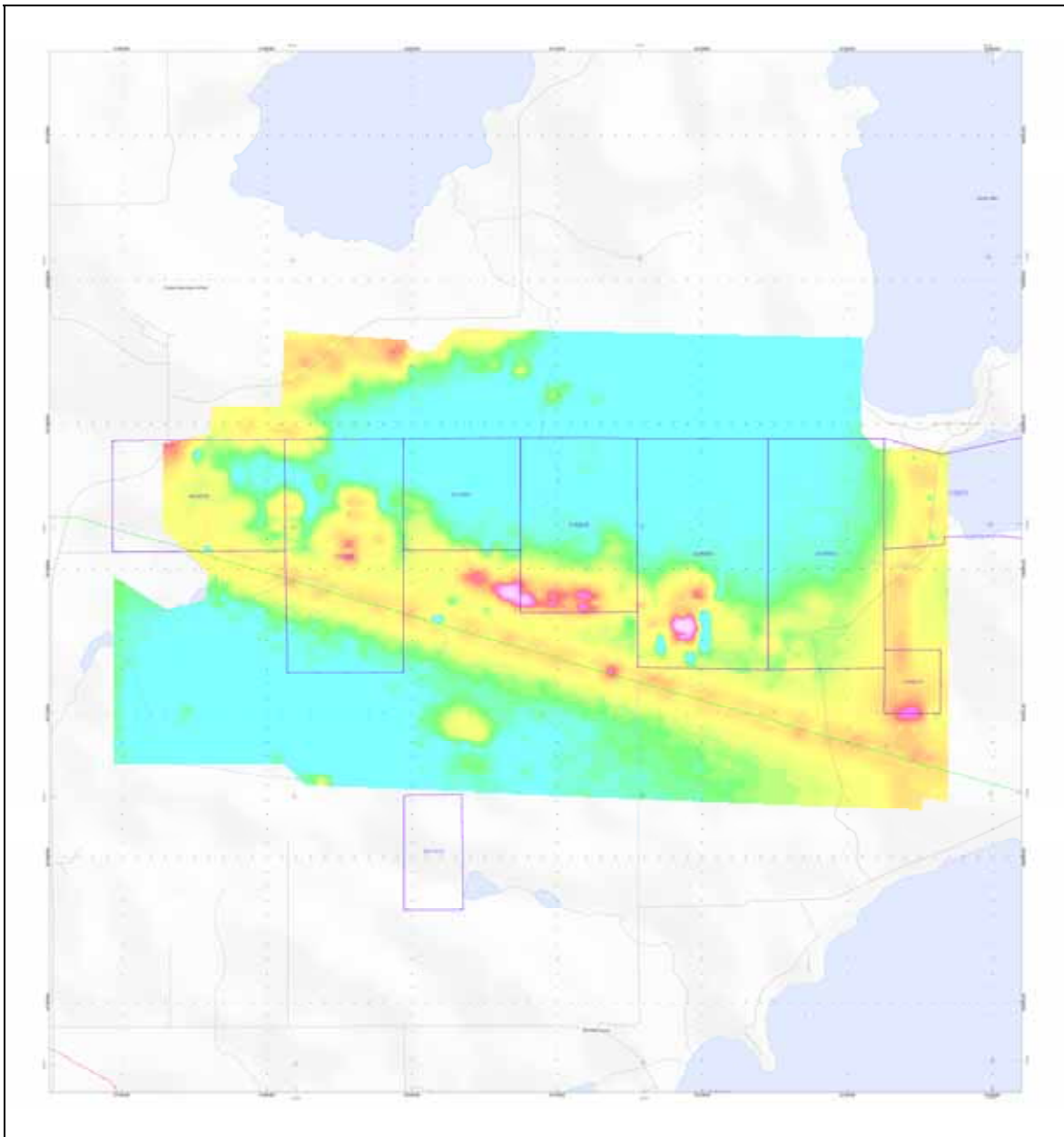
**GEOPHYSICAL MAPS**



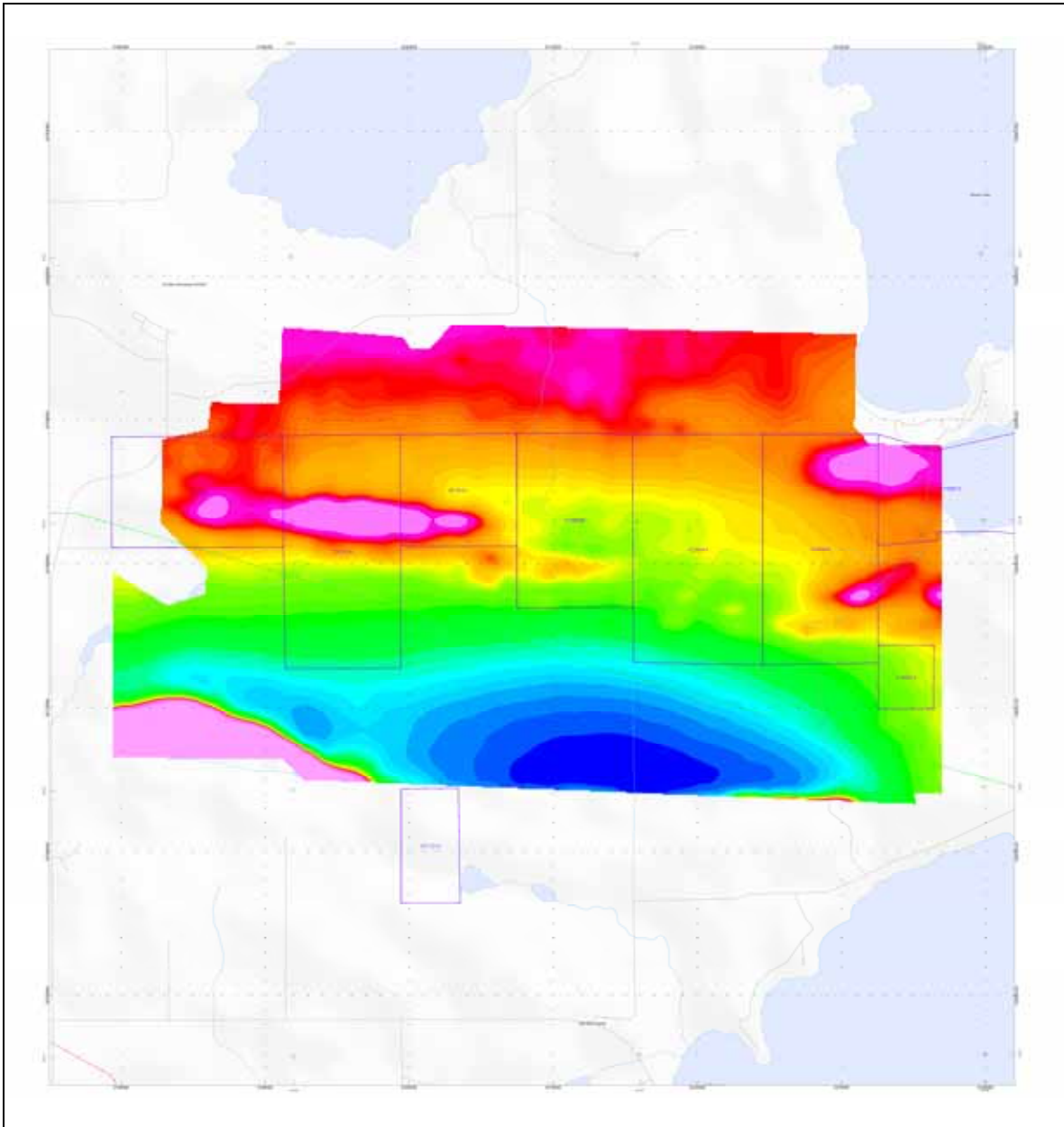
**Turtlepond Lake Block VTEM B-Field Time Gate 1.151 ms**



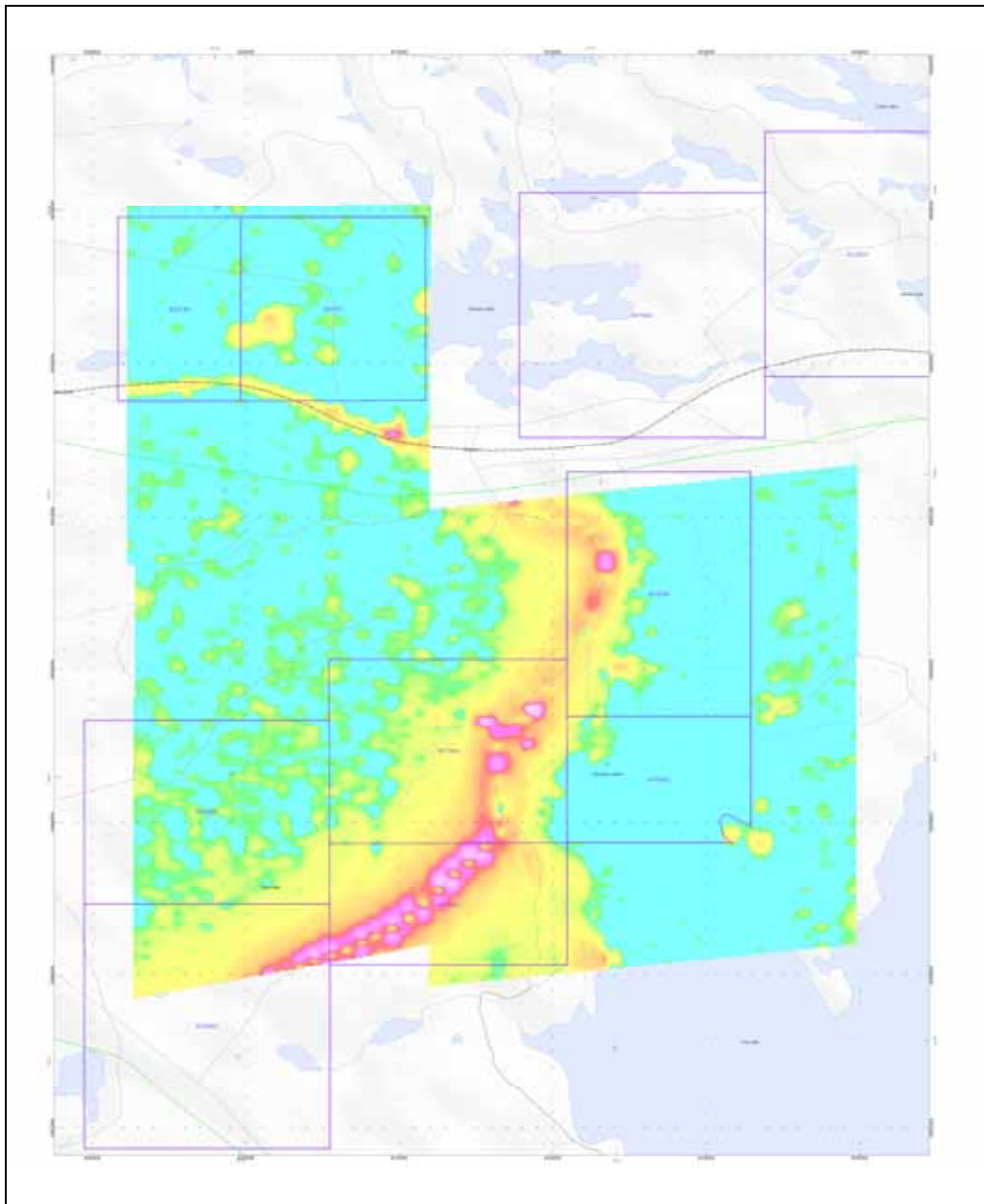
**Turtlepond Lake Block Total Magnetic Intensity**



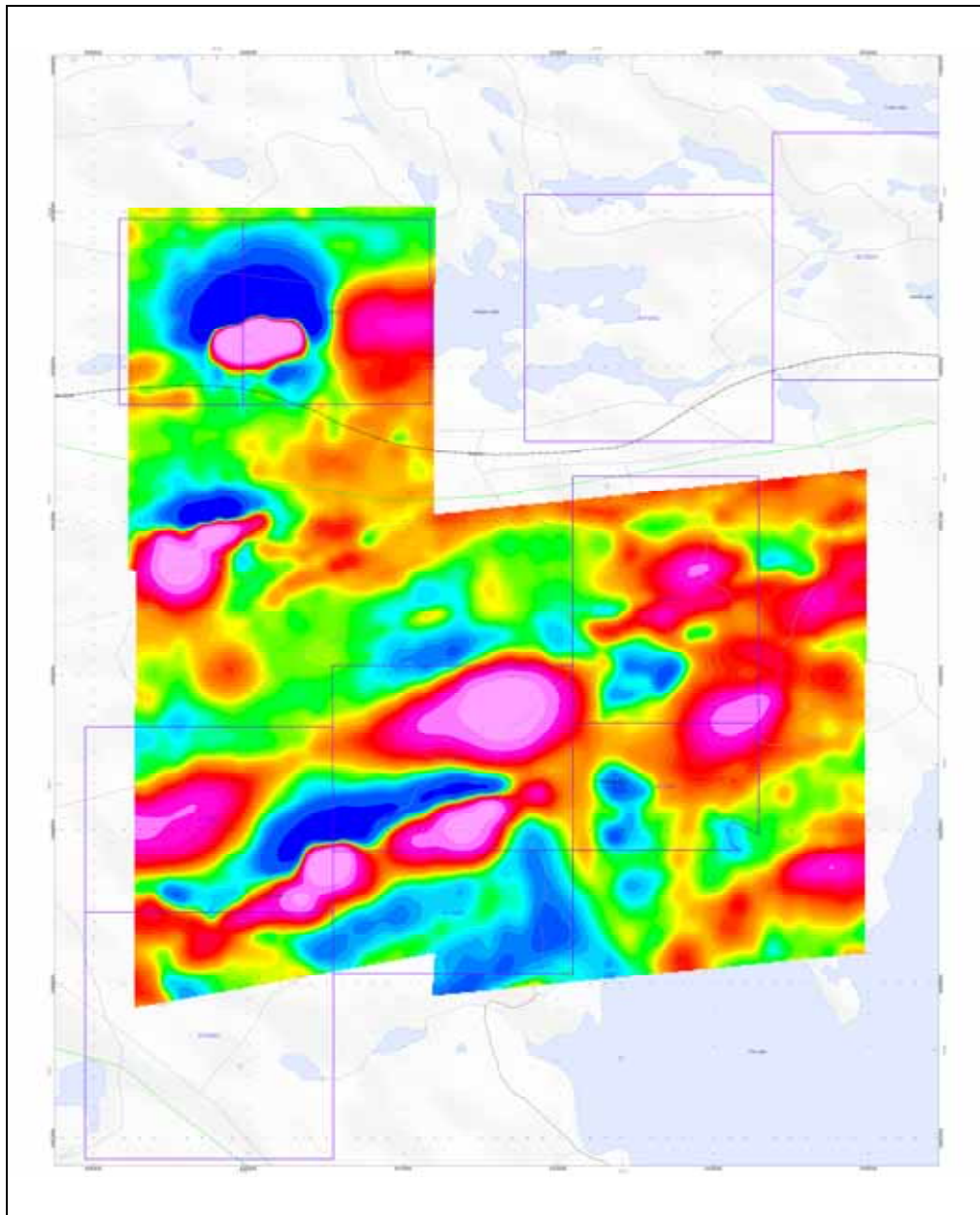
**Ghost Lake Block VTEM B-Field Time Gate 1.151 ms**



**Ghost Lake Block Total Magnetic Intensity**

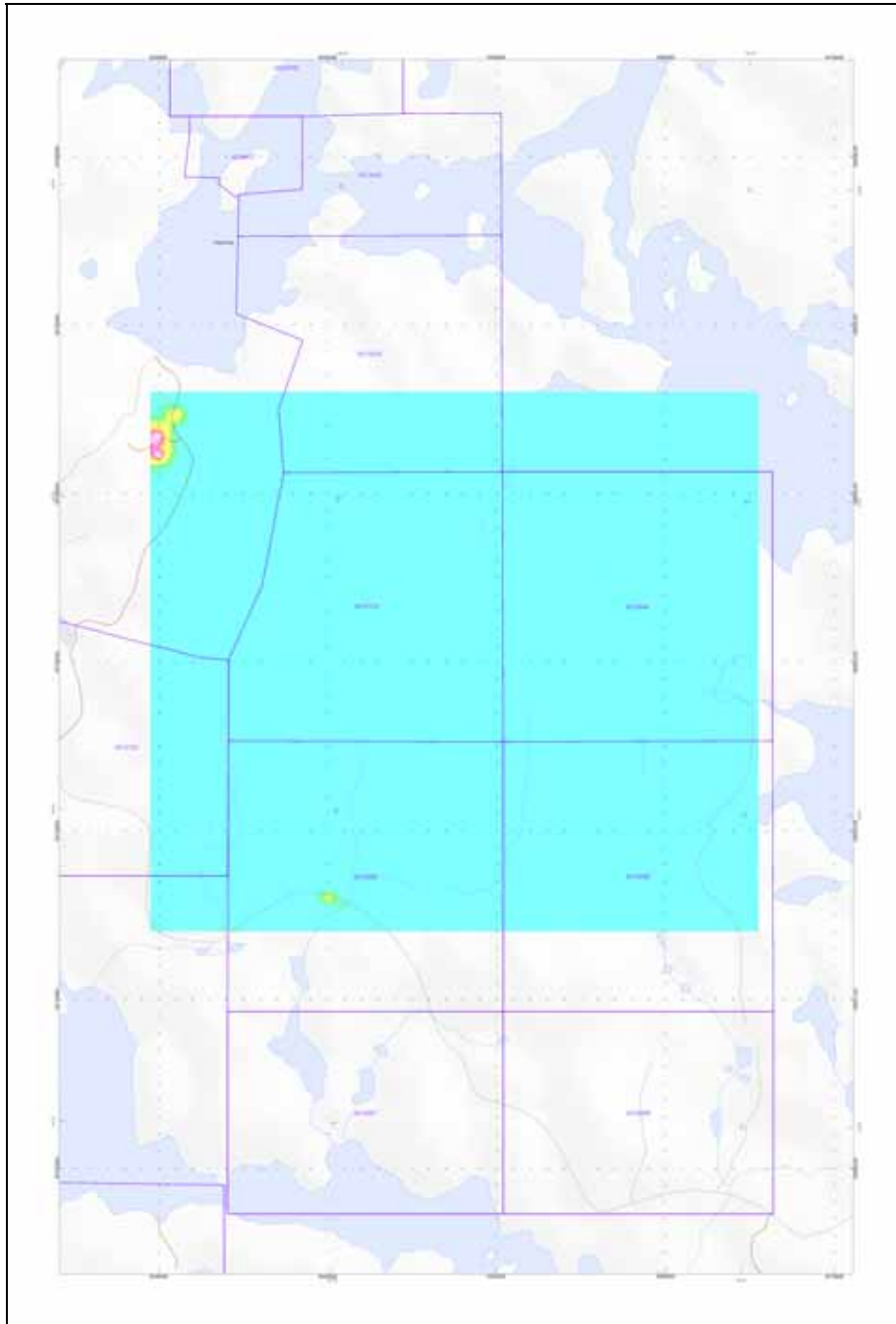


**Kawene and Eva Lake Blocks VTEM B-Field Time Gate 1.151 ms**

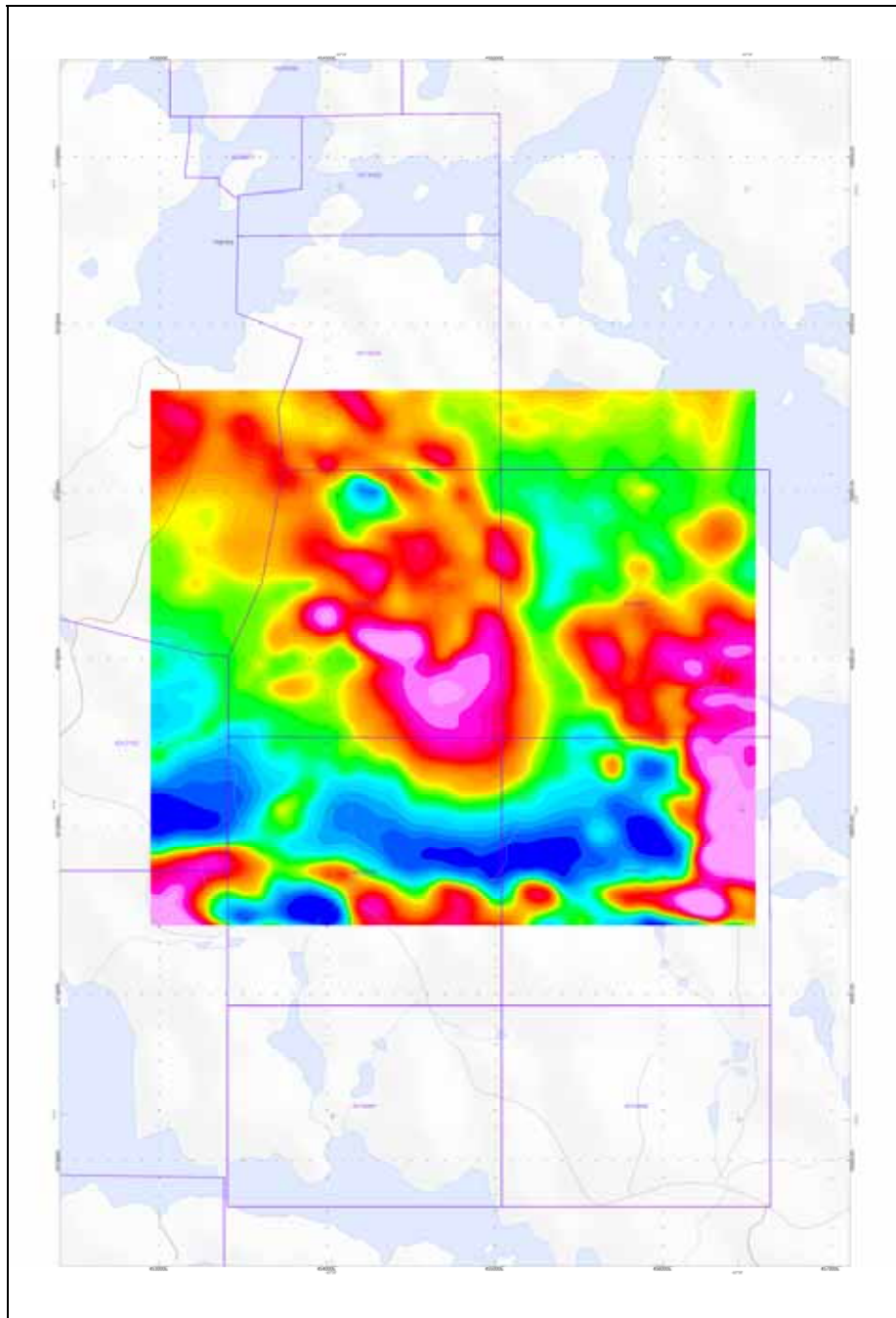


**Kawene and Eva Lake Blocks Total Magnetic Intensity**

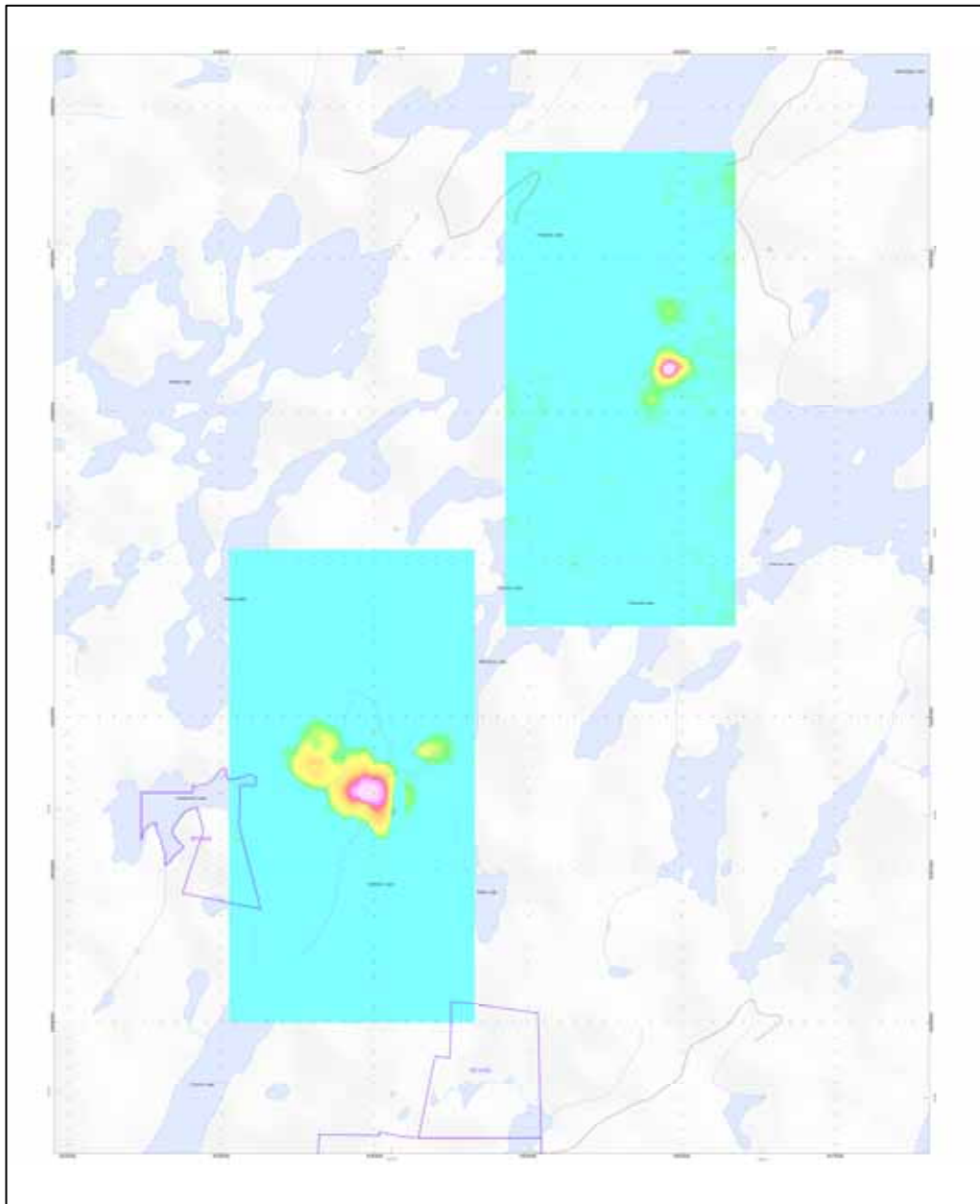




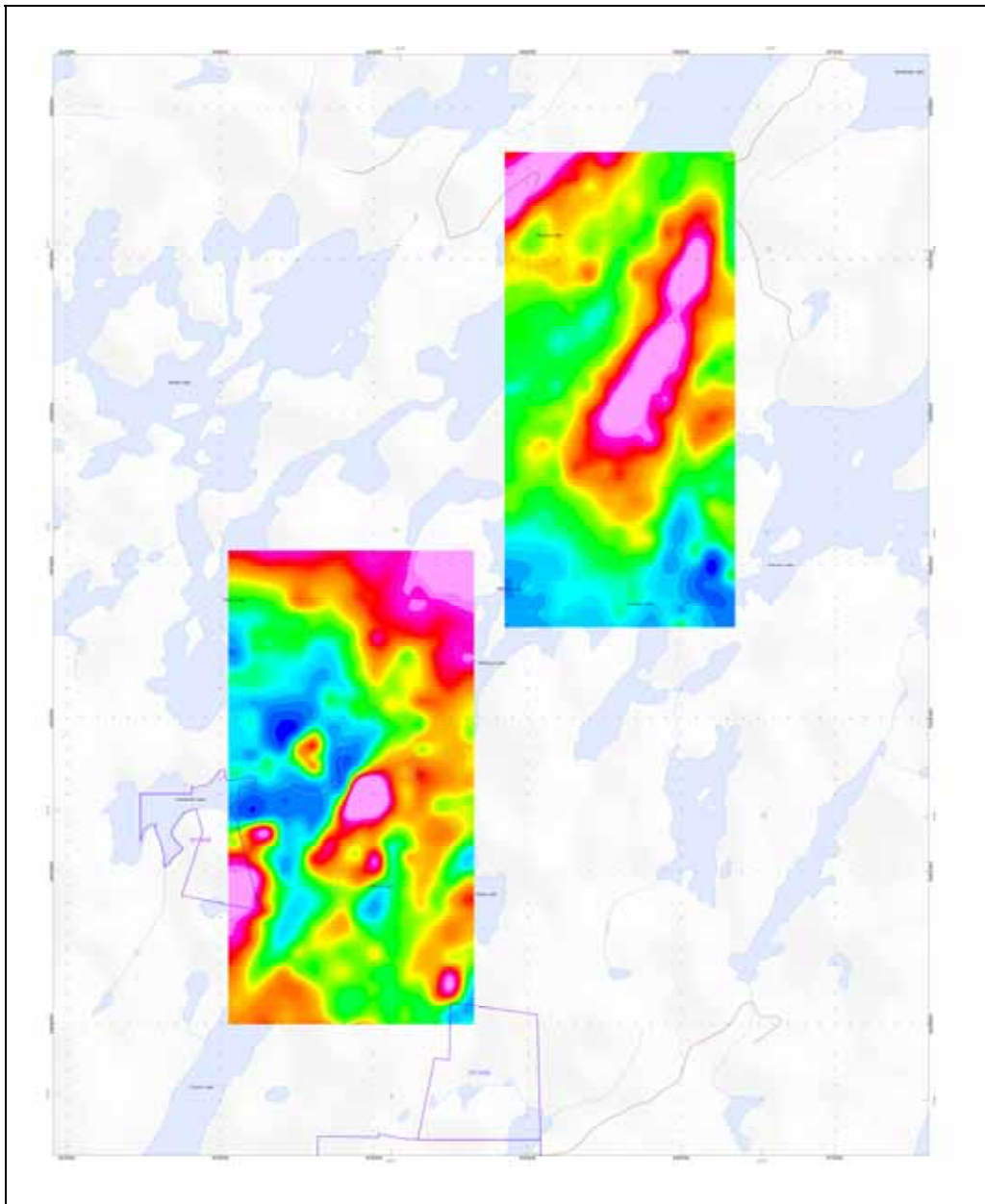
**Kenbridge South Block VTEM B-Field Time Gate 1.151 ms**



**Kenbridge South Block Total Magnetic Intensity**



**Kenbridge North Blocks VTEM B-Field Time Gate 1.151 ms**



**Kenbridge North Blocks Total Magnetic Intensity**

## 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 meters diameter transmitter loop that produces a dipole moment up to 625,000 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 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.

#### 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 A and G at two different depths, all other parameters remaining constant. With this transmitter-receiver geometry, the classic M shaped response is generated. Figure A shows a plate where the top is near surface. Here, amplitudes of the dual 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. Figure G shows 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. Figure B shows a near surface plate dipping  $80^\circ$ . 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  $90^\circ$  to about  $30^\circ$ . The method is not sensitive enough where dips are less than about  $30^\circ$ . Figure E shows a plate dipping  $45^\circ$  and, at this angle, the minimum shoulder starts to vanish. In Figure D, 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.

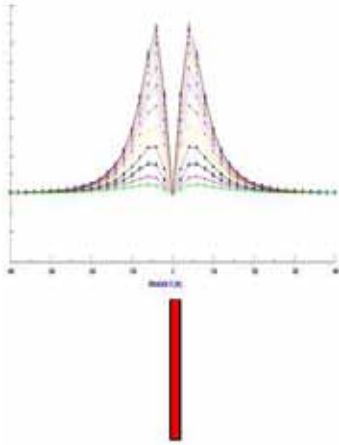
Figure H shows a special case where two plates are positioned to represent a synclinal structure. Note that the main characteristic to remember is the centre amplitudes are higher (approximately double) compared to the high shoulder of a single plate. This model is very representative of tightly folded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

### **Variation of Prism Depth**

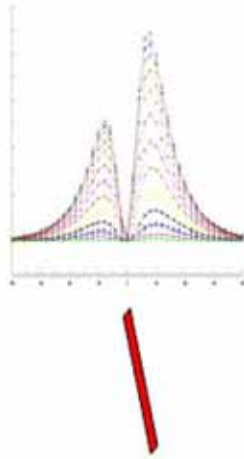
Finally, with prism models, another algorithm is required to represent current on the plate. A plate model is considered to be infinitely thin with respect to thickness and incapable of representing the current in the thickness dimension. A prism model is constructed to deal with this problem, thereby,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

Figures C, F and I show the same prism at increasing depths. Aside from an expected decrease in amplitude, the side lobes of the anomaly show a widening with deeper prism depths of the bell shaped early time channels.

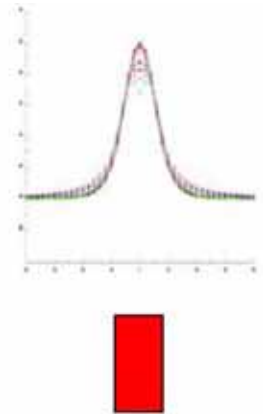
**A**



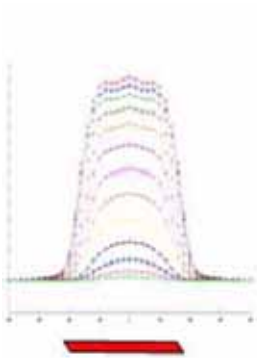
**B**



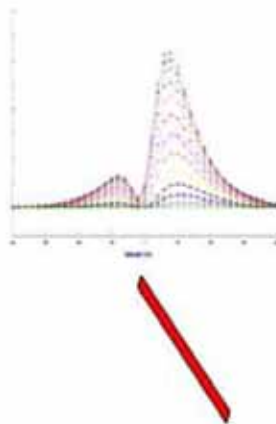
**C**



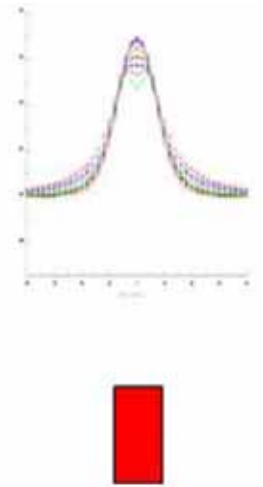
**D**

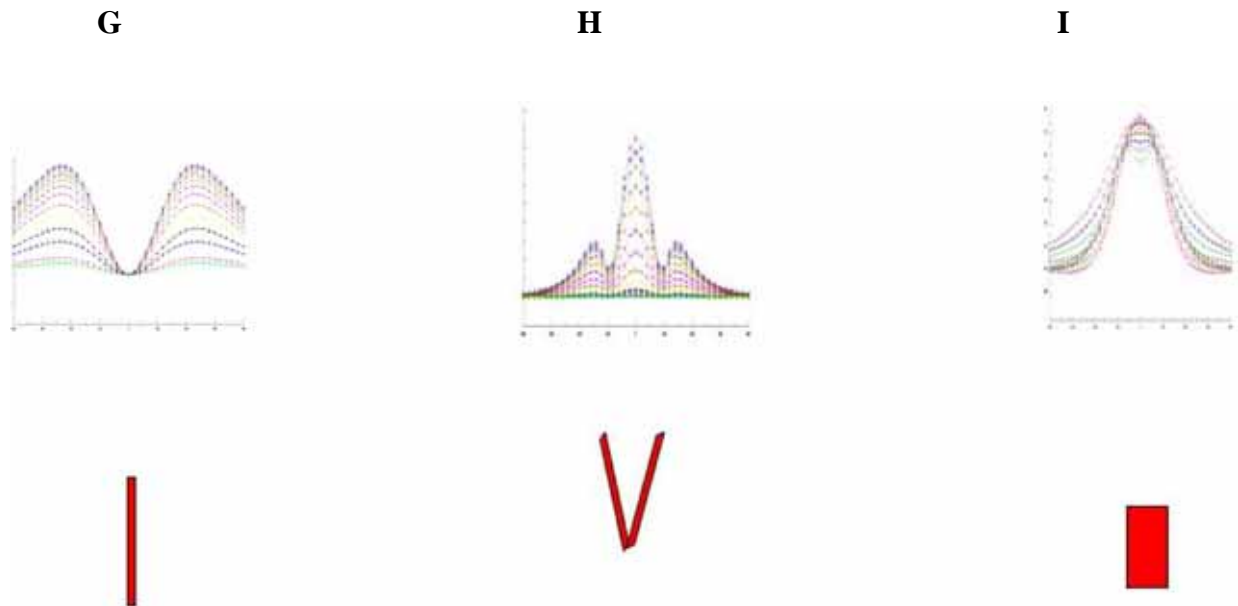


**E**



**F**





### General Modeling Concepts

A set of models has been produced for the Geotech VTEM® system with explanation notes (see models A to I above). 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 modeling program used to generate the responses was prepared by PetRos Eikon Inc. and is one of a very few that can model a wide range of targets in a conductive half space.

## General Interpretation Principles

### 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, in 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 30°. For angles less than 30° to 0°, 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.