Ontario

ONTARIO GEOLOGICAL SURVEY

Geophysical Data Set 1244

Ontario Airborne Geophysical Surveys
Magnetic and Electromagnetic Data
Bull Lake Area

Purchased Data

by

Ontario Geological Survey

2015

Ontario Geological Survey
Ministry of Northern Development and Mines
Willet Green Miller Centre, 933 Ramsey Lake Road,
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CREDITS

List of accountabilities and responsibilities.

- Jack Parker, Senior Manager, Earth Resources and Geoscience Mapping Section, Ontario Geological Survey (OGS), Ministry of Northern Development and Mines (MNDM) – accountable for the geophysical survey projects, including contract management
- Steve Munro, Senior Geophysicist, Scott Hogg & Associates Ltd. (SHA), Toronto, Ontario – responsible for the reprocessing of this data set
- Tom Watkins, Manager, Publication Services Unit, GeoServices Section, Ontario Geological Survey, MNDM – managed the project-related hard-copy products
- Desmond Rainsford, Geophysicist, Earth Resources and Geoscience Mapping Section, Ontario Geological Survey – responsible for initial quality assurance (QA), quality control (QC) and project-related digital products
- Geotech Ltd., Aurora, Ontario – data acquisition and original products

DISCLAIMER

Every possible effort has been made to ensure the accuracy of the information presented in this report and the accompanying data; however, the Ministry of Northern Development and Mines does not assume liability for errors that may occur. Users should verify critical information.

The geophysical data were purchased from the private sector. The original data acquisition was neither supervised by the Ontario Geological Survey (OGS) nor carried out to OGS technical specifications. However, the purchased data do meet a pre-defined valuation criteria set out by the OGS. Some quality assurance and quality control checks have been carried out on the digital data.

CITATION

Parts of this publication may be quoted if credit is given. It is recommended that reference to this publication be made in the following form:

Ontario Geological Survey 2015. Survey report on Bull Lake area, 19p. [PDF document]; *in* Ontario airborne geophysical surveys, magnetic and electromagnetic data, grid and profile data (ASCII and Geosoft® formats) and vector data, Bull Lake area—Purchased data; Ontario Geological Survey, Geophysical Data Set 1244.

NOTE

Users of OGS products are encouraged to contact those Aboriginal communities whose traditional territories may be located in the mineral exploration area to discuss their project.

1. Introduction

As part of an ongoing program to acquire high-quality, high-resolution airborne geophysical data across the Province of Ontario, the Ministry of Northern Development and Mines (MNDM) does, from time to time, issue Requests For Data (RFD) in order to purchase existing proprietary data held by mining companies. Purchase of existing data complements new surveys commissioned by the MNDM. The purchase of data is attractive due to the low cost of acquisition relative to flying new surveys.

The money used to purchase the data can be reinvested in exploration. The data are assessed for quality prior to purchase and are reprocessed to meet the common formats and standards of other Ontario geophysical data. Once reprocessed, these data are then made public.

Ranking and valuation of submitted airborne geophysical survey data sets were based on the following criteria:

- date of survey: recent surveys were favoured over older surveys because of improved acquisition technology, greater data density and improved final products
- survey method: magnetometer surveys, without supplementary radiometric or very low frequency (VLF) survey data, were given the lowest rating in this category; airborne electromagnetic (AEM) and magnetometer surveys were given the highest; the objective was to acquire data that complements what is already available in the public domain, with emphasis on exploration rather than mapping
- location of area
- data sets covering areas already surveyed or scheduled for survey were only selected if they added significantly to the acquired data sets
- proximity or coincidence of the survey block with areas having restricted land use designations affected the value assigned to that survey
- consideration was given to data sets that were collected in remote areas where logistical costs are very high
- line spacing: detailed surveys were normally accorded a higher rating than reconnaissance surveys
- quality of data: data quality, processed products and adherence to correct survey specifications had to be up to normal industry standards
- survey size: data sets comprising less than 1000 line-kilometres were selected only if they fell in very strategic locations
- other criteria: factors such as apparent mineral significance, previous exploration activity and land availability were also considered in making the final selection

2. Survey Location and Specifications

2.1. SURVEY LOCATION

This report describes a helicopter-borne geophysical survey located near Elliot Lake, Ontario (Orta 2007). The survey was flown on behalf of Mustang Minerals Corp. The survey was conducted by Geotech Ltd., Aurora, Ontario, using their VTEM versatile time-domain electromagnetic (EM) and magnetic system. The survey was flown during the period May 26 to June 1, 2007.

The survey block was located approximately 30 km east of Elliot Lake, Ontario (Figure 1).

2.1.1. NAME OF SURVEYED AREA

The survey was conducted over the East Bull Lake property of Mustang Minerals Corp. "East Bull Lake", which had been named in 1952 so as to distinguish it from another Bull Lake to the west, also in Algoma District, was changed by the Ontario Geographic Names Board in 1978 to "Bull Lake". The East Bull Lake intrusion was named prior to 1978, and that name remains unchanged as per the conventions of the North American Stratigraphic Code. Furthermore, the lake continues to be referred to as "East Bull Lake" 1) in local usage, 2) in a local business name, and 3) in a geological context, the latter primarily as a reference to the aforementioned nickel-copper-platinum group elements mineralized intrusion.

2.2. SURVEY SPECIFICATIONS

The survey was flown using a north-south line direction with a 100 m line spacing. Tie-lines were flown in an east-west direction, with a 1000 m spacing. Total survey coverage was 935 line-kilometres. Throughout the survey, the helicopter maintained a nominal altitude of 80 m. This provided a nominal 40 m terrain clearance for the EM receiver and a 65 m terrain clearance for the magnetometer.

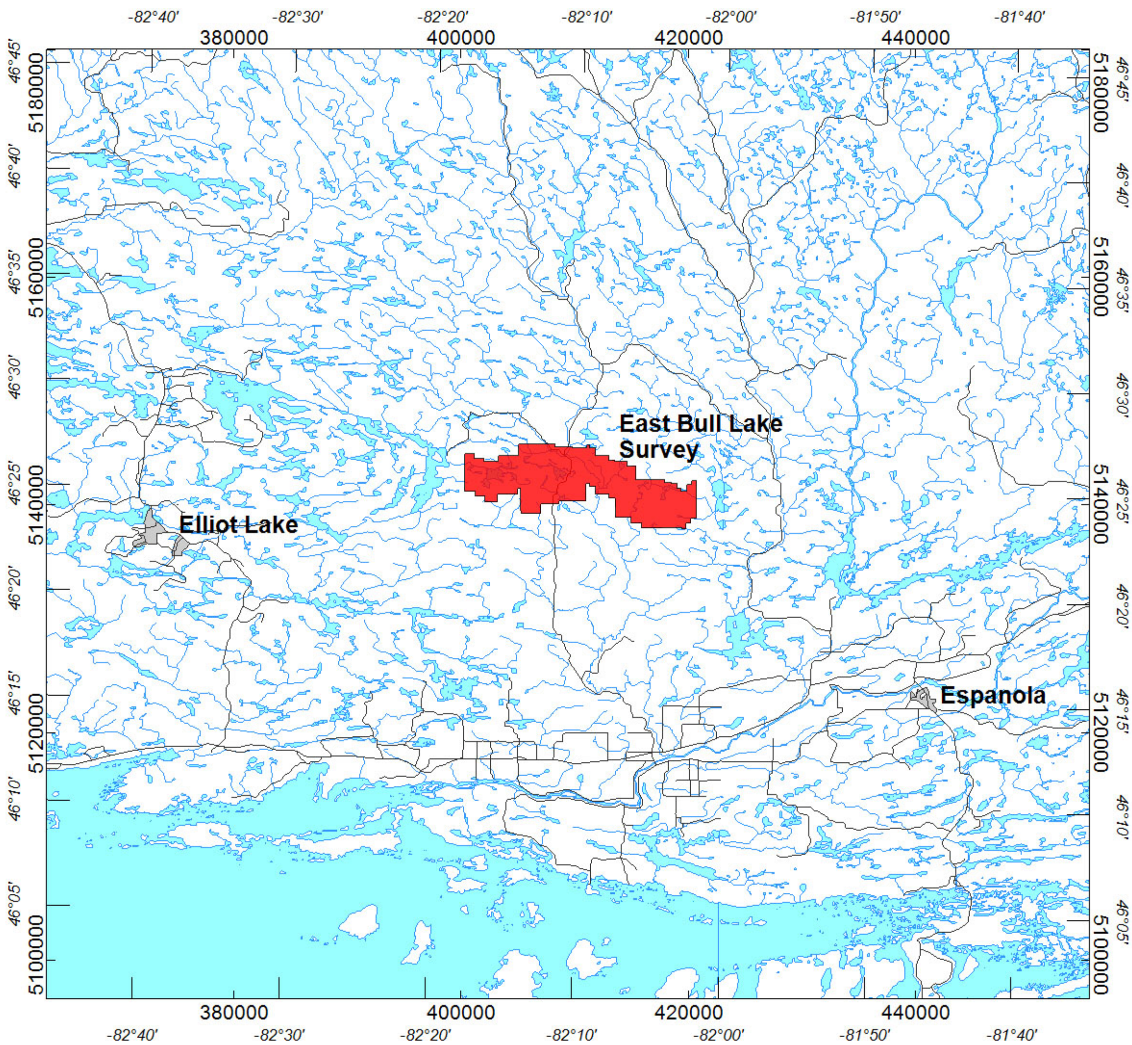

Figure 1. Location of the Bull Lake survey area (shown in red; also referred to as "East Bull Lake" area: *see* text for explanation).

3. Aircraft, Equipment and Personnel

3.1. AIRCRAFT

Helicopter:	Aerospatiale 350-FX2
Registration:	C-FHAU
Owner-Operator:	Abitibi Helicopters Ltd.

Installation of the geophysical and ancillary equipment was carried out by Geotech Ltd.

3.2. PERSONNEL

The following personnel were involved with the survey.

3.2.1. FIELD PERSONNEL

Project Manager:	Harish Kumar
Field Operation Manager:	Shawn Grant
Crew Chief:	Kyle Corriveau
Operators:	Ioan Serbu
Pilots:	Jonathan Filion
	Pierre Michaude
Engineer:	Lawrence Ando

3.2.2. OFFICE PERSONNEL

Data Processing:	Jennifer Zhu
Data Processing / Reporting:	Marta Orta
QC Geophysicist:	Nick Venter

3.3. EQUIPMENT

3.3.1. MAGNETOMETER

The VTEM system included a Geometrics optically pumped cesium vapour magnetometer contained in a towed bird, 15 m below the helicopter (Figure 2). The mean height above terrain for the magnetometer was 65 m. The sensitivity of the magnetic sensor is 0.02 nanotesla (nT) at a sampling interval of 0.1 seconds.

3.3.2. ELECTROMAGNETIC SYSTEM

The VTEM system uses a superimposed dipole configuration with the receiver located within the transmitter loop. The system was towed 40 m below the helicopter (*see* Figure 2) at a mean terrain clearance of 40 m. A summary of the system configuration details for the survey is provided in Table 1. The transmitter axis is vertical (Z). The receiver has a single vertical (Z) axis. The transmitter current waveform was trapezoid shaped, repeated with reversing polarity, at a base frequency of 30 Hz. The receiver measures the secondary field at intervals after the termination of the transmitter current pulse (Figure 3).

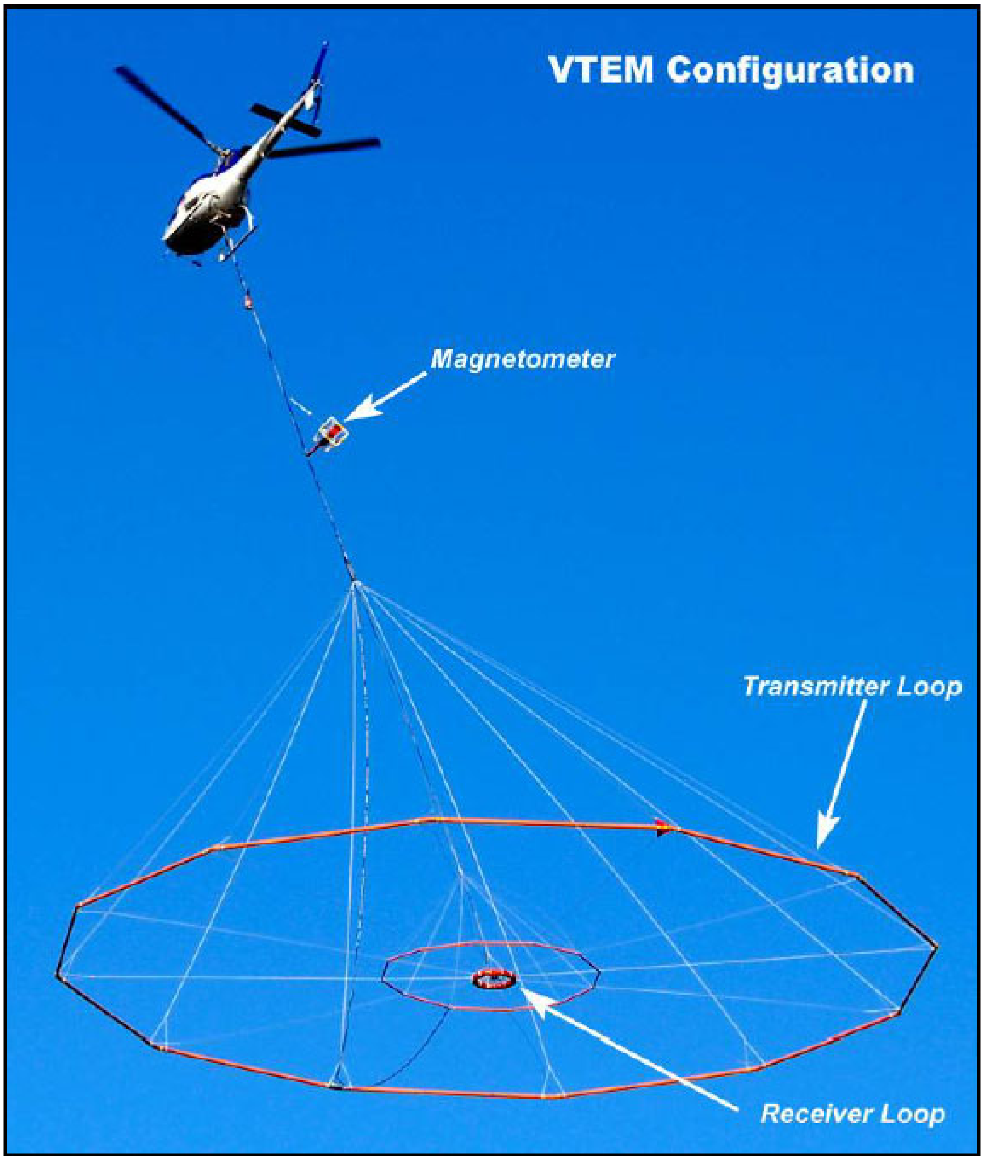

Figure 2. VTEM system.

Table 1. System configuration details.

Parameter	Value
Transmitter diameter	26 m
Number of turns	4
Peak current	193 A
Pulse width	7200 µs
Peak dipole moment (NIA)	409 800
Receiver diameter	1.2 m
Number of turns	100
Effective area	113 m^2

Figure 3 shows the VTEM current waveform for the 30Hz system, with locations of the receiver coil sample windows in the first half-cycle. The current in the transmitter coil generates the primary field. This field will induce a voltage in the receiver coil that is a function of the time rate of change of the primary field (i.e., dB/dt). Figure 4 shows the voltage response to the primary field in the receiver coil.

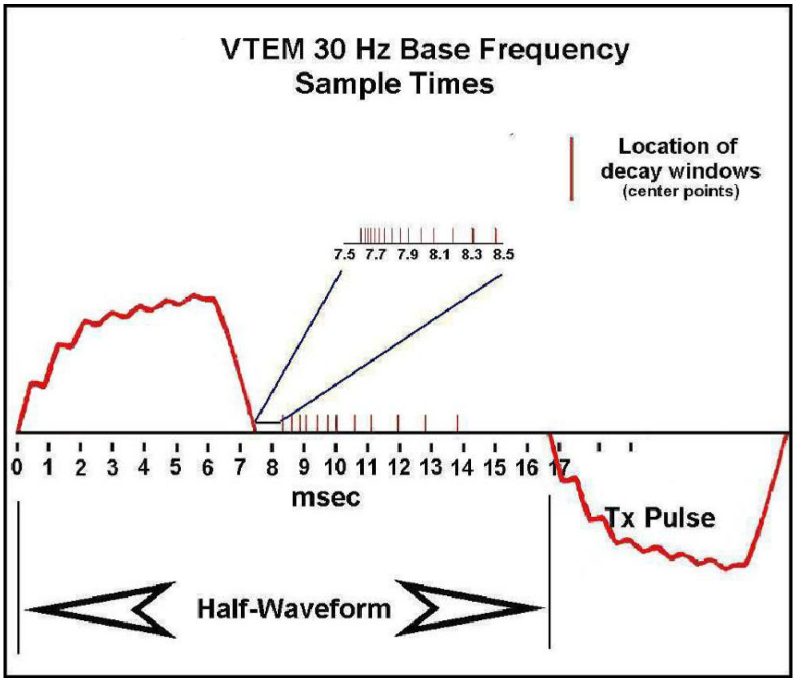

Figure 3. VTEM current waveform and off-time recording scheme.

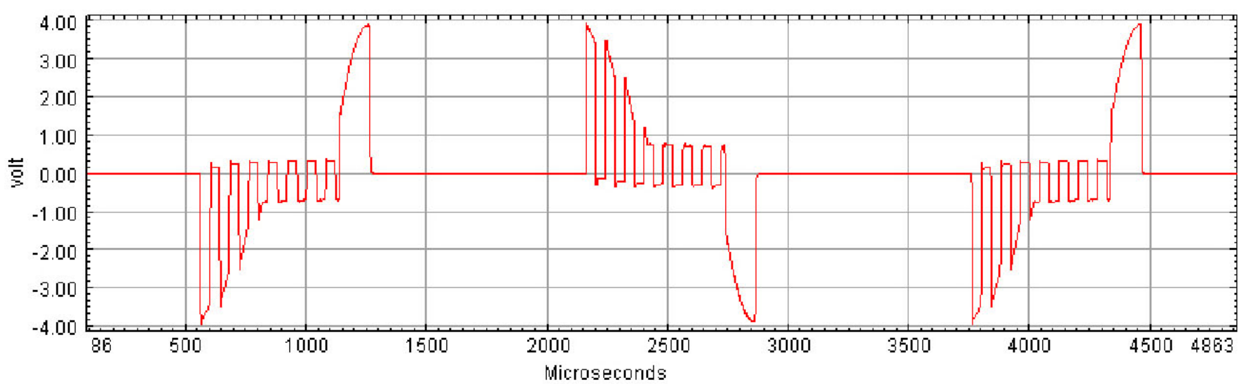

Figure 4. Voltage response to waveform in receiver coil.

3.3.2.1. SAMPLE TIME WINDOWS

Table 2 summarizes the off-time receiver recording window times for the VTEM survey.

Table 2. VTEM receiver recording time.

Array Index	Time (µs)	Start (µs)	End (µs)	Width (µs)
0	120	110	131	21
1	141	131	154	24
2	167	154	183	29
3	198	183	216	34
4	234	216	258	42
5	281	258	310	53
6	339	310	373	63
7	406	373	445	73
8	484	445	529	84
9	573	529	628	99
10	682	628	750	123
11	818	750	896	146
12	974	896	1063	167
13	1151	1063	1261	198
14	1370	1261	1506	245
15	1641	1506	1797	292
16	1953	1797	2130	333
17	2307	2130	2526	396
18	2745	2526	3016	490
19	3286	3016	3599	583
20	3911	3599	4266	667
21	4620	4266	5058	792
22	5495	5058	6037	979
23	6578	6037	7203	1167

3.3.3. RADAR ALTIMETER

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

3.3.4. GPS NAVIGATION SYSTEM

The system employed a proprietary Geotech personal computer (PC)–based navigation system, with a screen display and controls in front of the pilot. The GPS receiver was a NovAtel® Wide Area Augmentation System (WAAS)–enabled OEM4-G2-3151W. The GPS antenna was mounted on the helicopter tail.

3.3.5. DIGITAL ACQUISITION SYSTEM

The Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data are displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. Data sampling intervals are summarized in Table 3.

Table 3. Data sampling rates.

Data Type	Sample Rate
TDEM	0.1 s
Magnetometer	0.1 s
GPS	0.2 s
Radar altimeter	0.2 s

3.3.6. BASE STATION

The base station consisted of a Geometrics cesium vapour magnetometer recorded magnetic field. Diurnal variation, together with GPS time, was logged on a computer at a 1 Hz sample rate. The base station was located 80 m from the Elliot Lake Airport.

4. Contractor Data Processing

4.1. FLIGHT PATH

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the UTM co-ordinate system (UTM Zone 17N, NAD83) in Geosoft® Oasis montaj™.

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 that 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 second linear filter.

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 were edited and merged into the Geosoft® Oasis montaj™ database (*.gdb*) on a daily basis. The aeromagnetic data were 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.

5. Data Compilation and Processing

5.1. BASE MAPS

Base maps of the survey area were supplied by the Ministry of Northern Development and Mines.

5.1.1. PROJECT DESCRIPTION

Datum:	North American Datum 1983 (NAD83)
Ellipsoid:	Geodetic Reference System 1980 (GRS 80)
Projection:	UTM Zone 17N (CM=81°W)
False Northing:	0 m
False Easting:	500 000 m
Scale Factor:	0.9996

5.2. INTERNATIONAL GEOMAGNETIC REFERENCE FIELD CORRECTION

Before final levelling, the data were corrected for the International Geomagnetic Reference Field (IGRF). A channel of IGRF field amplitude was generated using the latitude, longitude and GPS altitude data. The 2005 model year was chosen and extrapolated to the actual date stored in the database line headers. To create a correction channel, a median value of 56 390 nT was removed from the channel *igrf*. The resultant correction (*igrf_cor*) was subtracted from the levelled contractor data channel (*mag_lev*) and stored as *mag_igrf*.

5.3. MAGNETIC MICROLEVELLING

Microlevelling is the process of removing residual flight-line noise that remains after conventional levelling using control lines. It has become increasingly important as the resolution of aeromagnetic surveys has improved and the requirement of interpreting subtle geophysical anomalies has increased.

To isolate and remove this noise, the following procedure was employed. An elliptical reject filter, aligned with the flight lines, was first applied to the gridded total magnetic field. This filter removes features with a long wavelength in the flight-line direction, but a short wavelength in the transverse direction. While removing the unwanted residual levelling errors, it also significantly distorts higher amplitude anomalies.

In order to minimize the effect on geological anomalies, the flight path was "threaded" through the filtered grid and a database profile channel was created from the filtered grid. The difference between the *mag_igrf* and this filtered profile was calculated. The difference profile was clipped to the amplitude of the observed noise in the grid. A half cosine roll-off filter was then applied to this channel and a final correction profile was derived with wavelengths on the order of 1 km or longer. This microlevel correction profile was applied to the *mag_igrf* profile and a final magnetic profile channel (*mag_final*) was created.

5.4. GEOLOGICAL SURVEY OF CANADA DATA LEVELLING

The final step in the magnetic processing was to level the data set to the 200 m Ontario magnetic master grid, which has been compiled and levelled to the 812.8 m magnetic datum from the Geological Survey of Canada. The levelling process must retain all the detail of the newer low-altitude survey and only make corrections on the order of 10 km or more. To accomplish this, a variation on a method developed by Patterson, Grant and Watson (Reford et al. 1990) was used. The procedure was as follows:

The final total magnetic data were gridded at a 200 m cell size and upward continued to a height of 305 m, to match the nominal terrain clearance of the Ontario master grid (Ontario Geological Survey 1999). The difference between the upward continued grid and the Ontario master grid was calculated. An FFT 2-D low-pass filter was applied to a grid of the difference, which retained wavelengths longer than 10 km. This filtered grid was re-gridded at a 20 m cell size and the flight path was threaded through the grid to create a correction profile. This long wavelength correction profile was subtracted from the final magnetic channel to create a "GSC-levelled" (*mag_gsclevel*) channel.

The levelled magnetic profile data were gridded using a bi-cubic spline.

5.5. SECOND VERTICAL DERIVATIVE GRID

The second vertical derivative of the residual magnetic field was computed to enhance small and weak near-surface anomalies and as an aid to delineate the contacts of the lithologies having contrasting susceptibilities. The location of contacts or boundaries is usually traced by the zero contour of the second vertical derivative map.

The calculation was done in the frequency domain by combining the transfer function of the second vertical derivative and a half cosine roll-off filter with a 100 m cut-off wavelength to minimize grid aliasing effects in the total magnetic field, which are emphasized by the second vertical derivative.

5.6. KEATING CORRELATION COEFFICIENTS

Possible kimberlite targets are identified from the residual magnetic intensity data, based on the identification of roughly circular anomalies. This procedure is automated by using a known pattern recognition technique (Keating 1995), which consists of computing, over a moving window, a first-order regression between a vertical cylinder model anomaly and the gridded magnetic data. Only the results where the absolute value of the correlation coefficient is above a threshold of 75% were retained. On the magnetic maps, the results are depicted as circular symbols, scaled to reflect the correlation value. The most favourable targets are those that exhibit a cluster of high amplitude solutions. Correlation coefficients with a negative value correspond to reversely magnetized sources. It was found that the best results were obtained by subsampling the final magnetic grid to a 40 m cell size and using a corresponding 40 m model grid.

The cylinder model parameters are as follows:

- Cylinder Diameter: 200 m
- Cylinder Length: infinite
- Overburden Thickness: 3 m
- Magnetic Inclination: 72.90° N
- Magnetic Declination: 9.23° W
- Magnetization Scale Factor: 100
- Model Window Size: 10 × 10 cells (400 m × 400 m)
- Model Window Grid Cell Size: 40 m

The model's magnetic response is shown in Figure 5. The model body is shown as a blue circle. For the purpose of the illustration, the grid cell size was set to a finer size than the 40 m used in the Keating correlation algorithm.

It is important to be aware that other magnetic sources may correlate well with the vertical cylinder model, whereas some kimberlite pipes of irregular geometry may not. The user should study the magnetic anomaly that corresponds with the Keating symbols, to determine whether it does resemble a kimberlite pipe signature, reflects some other type of source or even noise in the data (e.g., boudinage (beading) effect of the gridding). All available geological information should be incorporated in kimberlite pipe target selection.

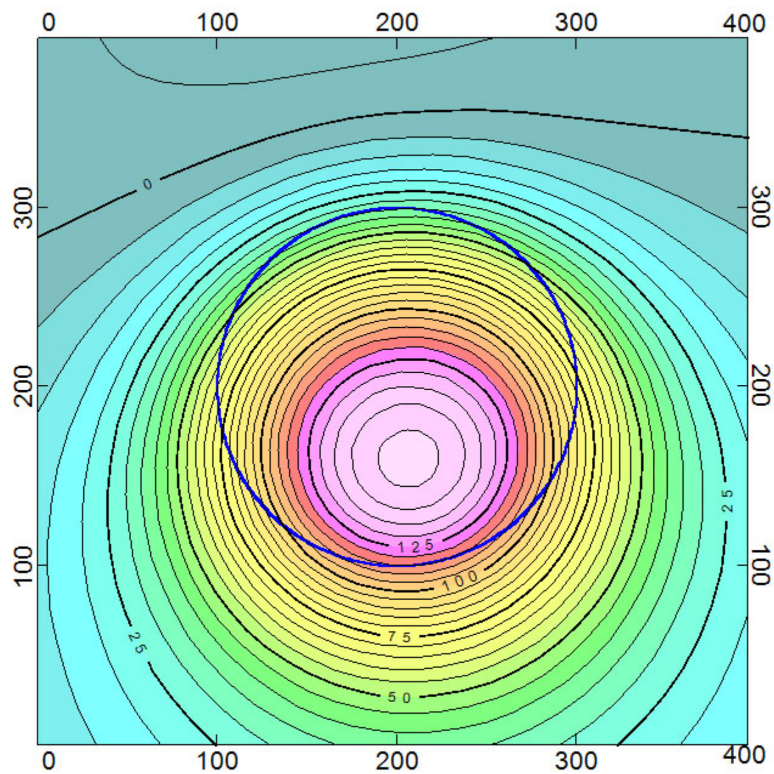

Figure 5. Total field response of the model used in the Keating correlation.

5.7. DECAY CONSTANT CALCULATION AND GRIDDING

The theoretical decay constant of a uniform half-space is given by the following exponential:

$$B = Ae^{-t/\tau}$$

where **B** is the secondary field amplitude, **A** is the time=0 amplitude, **t** is the time and **τ** is the decay constant (tau). A large conductive body will have a large tau and, thus, the signal will decay slowly. A small poor conductor will have a small tau and, thus, decay quickly (Figure 6).

The voltage in the receiver coil is a function of dB/dt (Figure 7), which behaves in a similar way:

$$dB/dt = (-A/\tau)\, e^{-t/\tau}$$

The time constant, Tau can be calculated using any 2 channels in the dB/dt decay.

$$Tau = -(t1-t2) / \log(Amplitude1/Amplitude2)$$

The actual signal measured by a time-domain EM system, surveying a non-uniform geological setting, is a sum of exponentials. A time constant calculated using early channels would predominantly reflect the shorter time constants and one based on late channels would predominantly reflect the longer time constants.

A value for Tau was calculated by analysis of all of the dB/dt time gates with emphasis given to later channels and larger values. The Tau profile was smoothed using a 21 point Hanning filter. The data were gridded using a bi-cubic spline. The final grid was smoothed with 2 passes of a 3 × 3 Hanning filter.

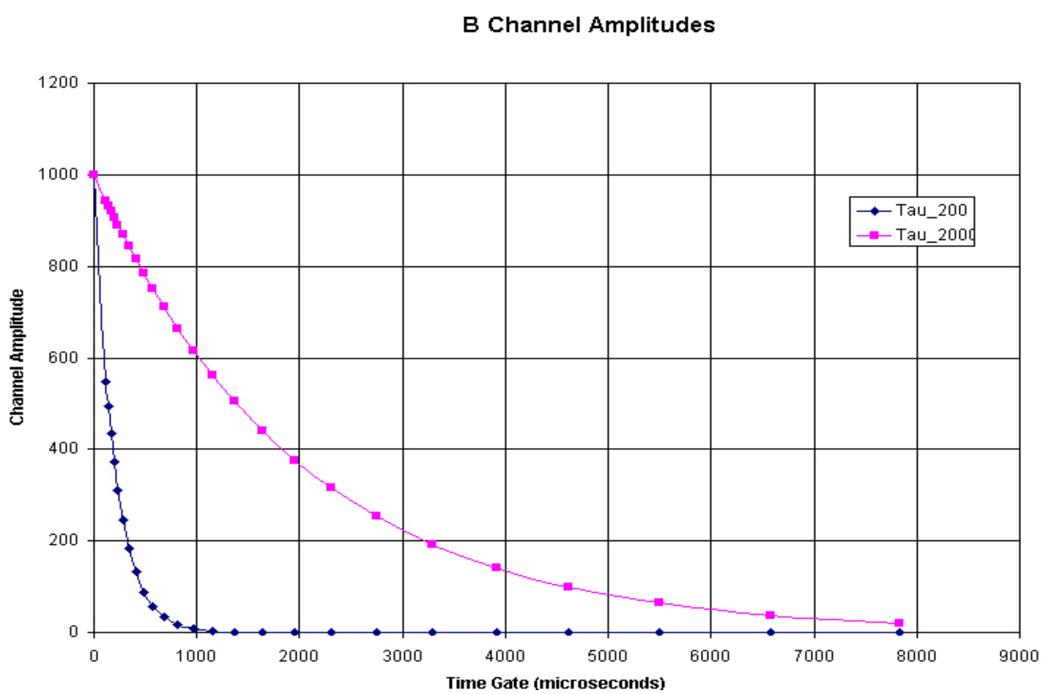

Figure 6. B field decay with 2 different time constants.

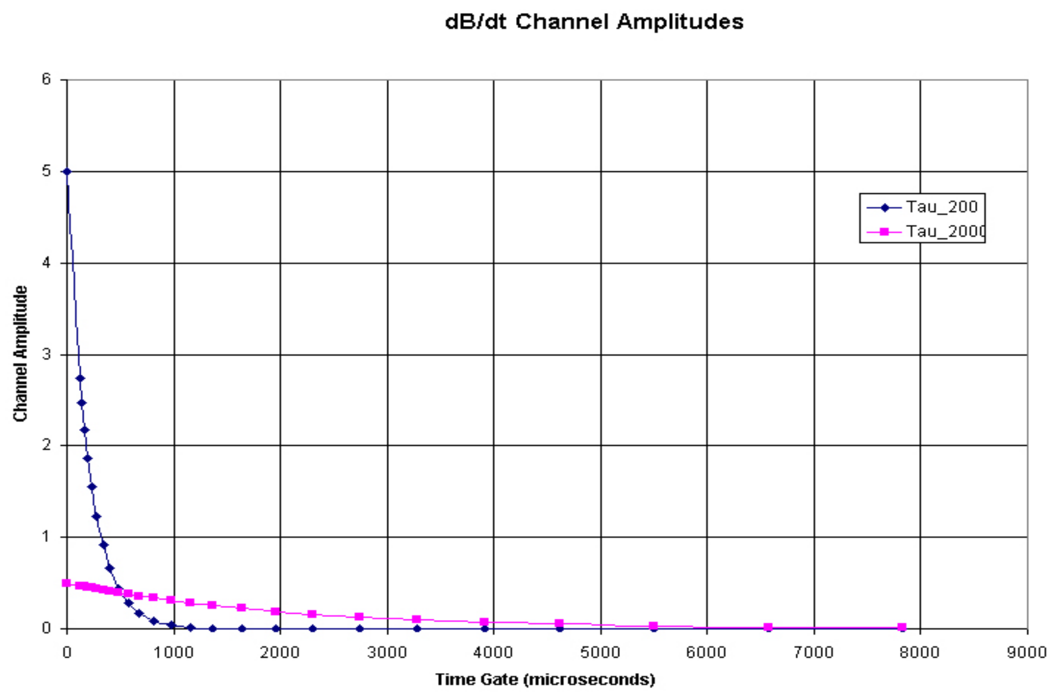

Figure 7. dB/dt field decay with 2 different time constants.

5.8. ELECTROMAGNETIC ANOMALY SELECTION AND ARCHIVING

The VTEM system will respond to conductive overburden, near-surface horizontal conducting layers, man-made sources and bedrock conductors. Identification of natural conductors is based on the rate of transient decay, magnetic correlation and response shape, together with the response pattern and topography. Man-made responses may be identifiable by examining the power-line monitor.

The EM profile response of the Z-Coil receiver was examined on a line by line basis and conductor locations were noted. This was done in consideration of the magnetic field and decay constant profile data as well. A thin, vertically oriented source produces a double-peak anomaly in the z-component response, with a diminished or null response over the axis of the conductor. This response becomes asymmetrical if the body dips, with a greater response on the down-dip side. A thick source will show a single peak response. In either case, a single position was noted for the anomaly that represented the interpreted centre of the body.

Conductors having direct association with magnetic anomalies, as well as conductors interpreted to be steeply or moderately dipping were classified as being bedrock in origin. Interpreted broad conductors, with no correlation to the magnetic data were classified as surficial in origin. For each picked EM anomaly, the maximum decay constant value, associated with the anomaly, was assigned to the location of the conductor axis. Each anomaly was numbered sequentially as it occurred along each line (i.e., 1, 2, 3, etc.). A sequential alphabetical reference was also assigned (i.e., a, b, c, etc.). An additional identifier, unique to each anomaly in the data set, was also assigned to each anomaly. The format of this identifier is described in Appendix C in this report. A subset database was created from the main database that contained all channels described in Appendix C in this report.

5.9. REFORMATTING OF ELECTROMAGNETIC AND MAGNETIC LINE ARCHIVE DATABASE

The contractor-supplied line archive data, plus newly created channels, were reformatted to the MNDM specifications in Geosoft® (*.gdb*) format (uncompressed) and ASCII (*.xyz*) format. The electromagnetic channel data have been provided in multi-element array channels in the *.gdb* file, and as individual channels in the *.xyz* file. A description of the profile database contents is provided in Appendix B.

Note: EM bird height was not available for this data set.

5.10. FINAL MAP PRODUCTS

The following 3 digital maps (in Geosoft® Oasis montaj™ packed map format) were created for the Bull Lake area:

1. 1:20 000 scale colour-filled contours of the residual magnetic field with flight lines and MNDM supplied planimetric base and map surround in 1 map sheet (Map 60 438)
2. 1:20 000 scale shaded colour image of the second vertical derivative of the residual magnetic field with flight lines and Keating (1995) kimberlite pipe correlation coefficients, and MNDM supplied planimetric base and map surround in 1 map sheet (Map 60 439)
3. 1:20 000 scale colour-filled contours of Z-component decay constant with EM anomalies, flight lines and MNDM supplied planimetric base and map surround, in 1 map sheet (Map 60 440)

5.11. CREATION OF GEOREFERENCED IMAGES

Seamless 200 DPI resolution georeferenced GeoTIFF images of the 3 map themes described in section 5.10 were prepared. The GeoTIFFs show all the map elements except for the map surround information, co-ordinate graticule and co-ordinate annotations and are available in Geophysical Data Set (GDS) 1244.

5.12. CREATION OF LINE WORK (VECTOR) ARCHIVES

Seamless AutoCad® (*.dxf*) format files have been prepared of the flight lines, EM anomalies, Keating coefficient symbols, and contours of residual magnetic field and EM decay constant.

6. References

Keating, P.B. 1995. A simple technique to identify magnetic anomalies due to kimberlite pipes; Exploration and Mining Geology, v.4, no.2, p.121-125.

Ontario Geological Survey 1999. Single master gravity and aeromagnetic data for Ontario; Ontario Geological Survey, Geophysical Data Set 1036.

Orta, M. 2007. Report on a helicopter-borne versatile time domain electromagnetic (VTEM) geophysical survey, East Bull Lake property, Ontario, prepared for Mustang Minerals Corp. by Geotech Ltd.; unpublished report, Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.35221, AFRI# 20000002196, 36p.

Reford, S.W., Gupta, V.K., Paterson, N.R., Kwan, K.C.H. and Macleod, I.N. 1990. Ontario master aeromagnetic grid: A blueprint for detailed compilation of magnetic data on a regional scale; abstract *in* Society of Exploration Geophysicists, 60th Annual Meeting, San Francisco, California, SEG Technical Program, Expanded Abstracts 1990, p.617-619, DOI:10.1190/1.1890282.

Appendix A. Data Files Description

The files for the Bull Lake area geophysical survey are archived on DVD-ROM and sold as single product, as outlined below:

Type of Data	Magnetic and Electromagnetic
Format	Grid and Profile Data (DVD-R)
ASCII and Geosoft® Binary	Geophysical Data Set (GDS) 1244

The content of the ASCII and Geosoft® binary file types are identical. They are provided in both forms to suit the user's available software. The survey data are divided as follows.

Geophysical Data Set 1244 (DVD)

a) ASCII (GXF) grids
- total (residual) magnetic field
- second vertical derivative of the total magnetic field
- EM decay constant

b) Geosoft® binary (GRD) grids
- total (residual) magnetic field
- second vertical derivative of the total magnetic field
- EM decay constant

c) Vector (DXF) files
- flight path
- EM anomalies
- Keating correlation (kimberlite) anomalies
- total field magnetic contours
- EM decay constant contours

d) GeoTIFF seamless map images
- colour total magnetic field with planimetric base
- colour shaded-relief of second vertical derivative of the total magnetic field with planimetric base
- colour EM decay constant with planimetric base

e) Geosoft® (GDB) binary data
- profile database of magnetic and electromagnetic data (10 Hz sampling) in Geosoft® GDB format
- database of electromagnetic (EM) anomalies in Geosoft® GDB format
- database of Keating coefficients (kimberlite) in Geosoft® GDB format
- waveform database in Geosoft® GDB format

f) ASCII (XYZ) data
- profile database of magnetic and electromagnetic data (10 Hz sampling) in ASCII XYZ format
- database of electromagnetic (EM) anomalies in ASCII CSV (comma-separated values) format
- database of Keating coefficients in ASCII CSV (comma-separated values) format

g) Survey report in Adobe® Acrobat® (PDF) format

1. CO-ORDINATE SYSTEMS

The profile, electromagnetic anomaly and Keating coefficient data are provided in 2 co-ordinate systems:

- Universal Transverse Mercator (UTM) projection, Zone 17N, NAD83, Canada local datum
- latitude/longitude co-ordinates, NAD83, Canada local datum

The gridded data are provided in 1 co-ordinate system:

- Universal Transverse Mercator (UTM) projection, Zone 17N, NAD83, Canada local datum

2. NAMING OF FILES

In keeping with the original survey of the “East Bull Lake property”, the files will retain the following designations: “East Bull” or “EB”.

Appendix B. Profile Archive Definition

The profile data are provided in 2 formats:

- EASTBULL.XYZ ASCII file of the profile data
- EASTBULL.GDB Geosoft® uncompressed binary database file of the profile data, sampled at 10 Hz

The contents of EASTBULL.XYZ/EASTBULL.GDB (both file types contain the same set of data channels) are summarized as follows:

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
lon_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
gps_z_final	differentially corrected GPS Z (NAD83)	metres above sea level
radar_final	corrected radar altimeter	metres above terrain
dem	digital elevation model	metres above sea level
fiducial	fiducial	
flight	flight number	
line	flight line number	
time_gps♦	GPS time	seconds
date	local date	YYYY/MM/DD
mag_base_final	corrected magnetic base station data	nanoteslas
mag_raw	raw magnetic field	nanoteslas
mag_diurn	diurnally corrected magnetic field	nanoteslas
igrf	local IGRF field	nanoteslas
igrf_cor	IGRF correction profile	nanoteslas
mag_igrf	IGRF-corrected magnetic field	nanoteslas
mag_lev	levelled magnetic field	nanoteslas
mag_final	micro-levelled magnetic field	nanoteslas
mag_gsclevel	“GSC-levelled” magnetic field	nanoteslas
em_z_final	final dB/dt, Z-component	$pV/A/m^4$
em_z_B_final	final B field, Z-component	$pV*ms/A/m^4$
power	60 Hz power line monitor	microvolts
tau_z	decay constant (tau) for Z-component	microseconds

♦*Note: There appears to have been an error while recording or archiving the GPS time data for survey line 2690. Although the time channel for this line runs backward, into negative values, the magnetic and EM profile data seem correctly aligned with the GPS co-ordinate data.*

Appendix C. Anomaly Archive Definition

1. ELECTROMAGNETIC ANOMALY DATA

The electromagnetic anomaly data are provided in 2 formats:

- EBANOMALY.CSV — ASCII file of the electromagnetic anomalies
- EBANOMALY.GDB — Geosoft® uncompressed binary database file of the electromagnetic anomalies

Both file types contain the same set of data channels, summarized as follows:

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
lon_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
dem	digital elevation model	metres above sea level
fiducial	fiducial	
line	flight-line number	
time_gps	GPS time	seconds
em_z_final	final dB/dt, Z-component, off-time	$pV/A/m^4$
em_z_B_field	final B field, Z-component, off-time	$pV*ms/A/m^4$
tau_z	decay constant (tau) for Z-component	microseconds
radar_final	helicopter height	metres above terrain
anomaly_no	nth anomaly along the survey line	
anomaly_no_letter	alphabetical reference for nth anomaly along the survey line	
anomaly_id	unique anomaly identifier	
anomaly_type_letter	anomaly classification Bedrock=B, Surficial=S, Cultural=C	
heading	direction of flight	degrees
survey_number	survey number	

The unique anomaly identifier (anomaly_id) is a 10 digit integer in the format

1LLLLLLAAA

where
"LLLLLL" holds the line number (and leading zeroes pad short line numbers to 6 digits).
"AAA" represents the numeric anomaly identifier (anomaly_no) for that line padded with leading zeroes to 3 digits.

The leading 1 indicates that the anomaly was identified as likely having a normal or surficial source. For example, 1000101007 represents the seventh anomaly on Line 101.

Anomalies identified as likely having a cultural source do not include the leading 1, and take the format LLLLLLAAA. For example, 101007 represents the seventh cultural anomaly on Line 101.

When combined with the survey number (*survey_no*), the anomaly identifier provides an electromagnetic anomaly number unique to all surveys archived by the Ontario Geological Survey.

Appendix D. Keating Correlation Archive Definition

1. KIMBERLITE PIPE CORRELATION COEFFICIENTS

The Keating kimberlite pipe correlation coefficient data are provided in 2 formats:

- EBKC.CSV — ASCII file of the Keating correlation coefficient data
- EBKC.GDB — Geosoft® uncompressed binary database file of the Keating correlation coefficient data

Both file types contain the same set of data channels, summarized as follows:

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
lon_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
corr_coeff	correlation coefficient	percent ×10
pos_coeff	positive correlation coefficient	percent
neg_coeff	negative correlation coefficient	percent
norm_error	standard error normalized to amplitude	percent
amplitude	peak-to-peak anomaly amplitude within window	nanoteslas

Appendix E. Grid Archive Definition

1. GRIDDED DATA

The gridded data are provided in 2 formats:

- *.gxf — Geosoft® uncompressed ASCII grid exchange format (revision 3.0)
- *.grd — Geosoft® uncompressed binary grid file

All grids are NAD83 UTM Zone 17N, with a grid cell size of 20 m × 20 m. The grids are summarized as follows:

- EBMAG83.gxf/.grd — "GSC-levelled" residual magnetic intensity
- EB2VD83.gxf/.grd — second vertical derivative of residual magnetic intensity
- EBDCZ83.gxf/.grd — decay constant

Appendix F. GeoTIFF and Vector Archive Definition

1. GEOTIFF IMAGES

Geographically referenced colour images, incorporating a base map, are provided in GeoTIFF format for use in GIS applications:

- EBMAG83.TIF "GSC-levelled" residual magnetic intensity
- EB2VD83.TIF second vertical derivative of "GSC-levelled" residual magnetic intensity
- EBDCZ83.TIF decay constant

2. VECTOR ARCHIVES

Vector line work from the maps is provided in DXF ASCII format using the following naming convention:

- EBPATH83.DXF flight path of the survey area
- EBANOM83.DXF electromagnetic anomalies
- EBKC83.DXF Keating correlation targets
- EBMAG83.DXF contours of the residual magnetic intensity in nanoteslas
- EBDC83.DXF contours of the decay constant in microseconds