ONTARIO GEOLOGICAL SURVEY

Geophysical Data Set 1243

Ontario Airborne Geophysical Surveys
Magnetic and Electromagnetic Data
Matachewan–Timmins 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,
Sudbury, Ontario P3E 6B5 Canada

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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 and Associates Ltd. (SHA), Toronto, Ontario, responsible for the reprocessing data
- 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
- Aeroquest International, Mississauga, 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 the Matachewan–Timmins area, 20p. [PDF document]; *in* Ontario airborne geophysical surveys, magnetic and electromagnetic data, grid and profile data (ASCII and Geosoft® formats) and vector data, Matachewan–Timmins area—Purchased Data; Ontario Geological Survey, Geophysical Data Set 1243.

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 on-going program to acquire high-quality, high-resolution airborne geophysical data across the Province of Ontario, the Ontario 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 occurring within 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 the compilation of 7 helicopter-borne geophysical surveys located in northern Ontario, carried out on behalf of Mustang Minerals Corp. The surveys were flown by Aeroquest Ltd. in 2004, using their AeroTEM™ time domain electromagnetic system, in conjunction with a high-sensitivity cesium vapour magnetometer. Details of the system are included within this report.

The blocks were located south of the city of Timmins, Ontario and west and northwest of Matachewan, Ontario, Figure 1. The survey blocks are outlined in red polygons and labeled with the original survey block names.

2.2. SURVEY SPECIFICATIONS

The 7 survey blocks comprise a total of 4694 line kilometers. Table 1 summarizes some of the details for the individual blocks. For the purposes of this data compilation, the blocks were ultimately combined into a single database. To avoid line numbering conflicts, a numerical prefix was added to the line numbers of each block. For each survey, the helicopter maintained a nominal terrain clearance of 70 m. The terrain clearance of the EM receivers was 30 m and the terrain clearance of the magnetic sensor was 51 m.

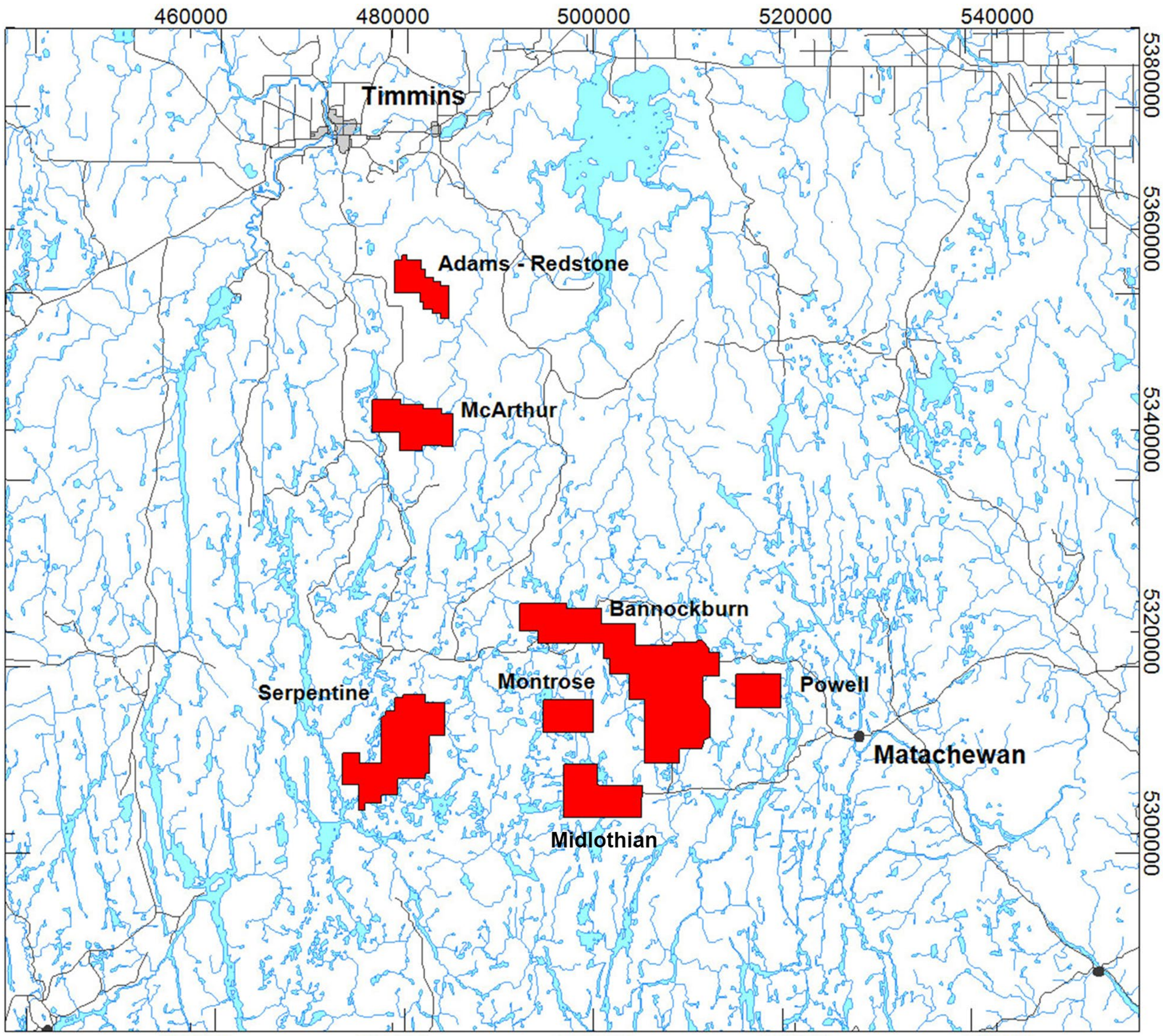

Figure 1. Map showing location of survey blocks in the Matachewan–Timmins survey area, northern Ontario.

Table 1. Survey block details (Fiset 2004a-g).

Prefix	Survey Name	Line Orientation	Line Spacing	Line Kilometers
1	Adams-Redstone	N-S	50 m and 100 m	388
2	McArthur	N-S	100 m	318
3	Serpentine	N-S and E-W	100 m	948
4	Bannockburn	N-S and E-W	50 m and 100 m	2319
5	Montrose	N-S	100 m	186
6	Midlothian	N-S	100 m	366
7	Powell	N-S	100 m	169

3. Aircraft, Personnel And Equipment

3.1. AIRCRAFT

Helicopter: Aerospatiale AS350B2 A Star

Registration: C-FAVI

Owner-Operator: Abitibi Helicopters Ltd., La Sarre, QC

3.2. PERSONNEL

The following personnel were involved with the survey.

Field Personnel

Party Chief: Bert Simon

Field Data Processing: Chris Balch

Field Operators: Marcus Watson, Chris Kosak

Pilot: Kevin Jackson (Abitibi)

Office Personnel

Data Processing and Reporting: Neil Fiset, Chris Balch, Steve Balch

3.3. EQUIPMENT

3.3.1. MAGNETOMETER

The Aeroquest airborne survey system employed a Geometrics® G-823A cesium vapour magnetometer sensor installed in a 2 m towed bird airfoil attached to the main tow line, 19 m below the helicopter (Figure 2). The sensitivity of the magnetometer is 0.001 nanoteslas (nT) at a 0.1 second sampling rate. The nominal ground clearance of the magnetometer bird was 51 m. The magnetic data are recorded at 10 Hz by the RMS DGR-33 data acquisition system.

3.3.2. EM SYSTEM

The electromagnetic system was an Aeroquest AeroTEM™ time domain towed-bird system. The AeroTEM bird is towed 40 m below the helicopter (*see* Figure 2).

The wave-form is triangular with a symmetric transmitter on-time pulse of 1150 µs and a base frequency of 150 Hz (Figure 3). The current alternates polarity every on-time pulse. During every Tx on-off cycle (300 per second), 120 contiguous channels of raw X- and Z-component (and a transmitter current monitor, itx) of the received waveform are measured. These 120 channel data are referred to as the raw streaming data. The AeroTEM system has 2 separate EM data recording streams, the conventional RMS DGR-33 and the MDAS system which records the full waveform.

3.3.3. MDAS Acquisition System

The 128 channels of raw streaming data were recorded by the MDAS acquisition system onto a removable hard drive. The streaming data were processed post-survey to yield 33 stacked and binned on-time and off-time channels at a 10 Hz sample rate. The channels are represented graphically in Figure 3. The timing of the final processed EM channels is described in Table 2.

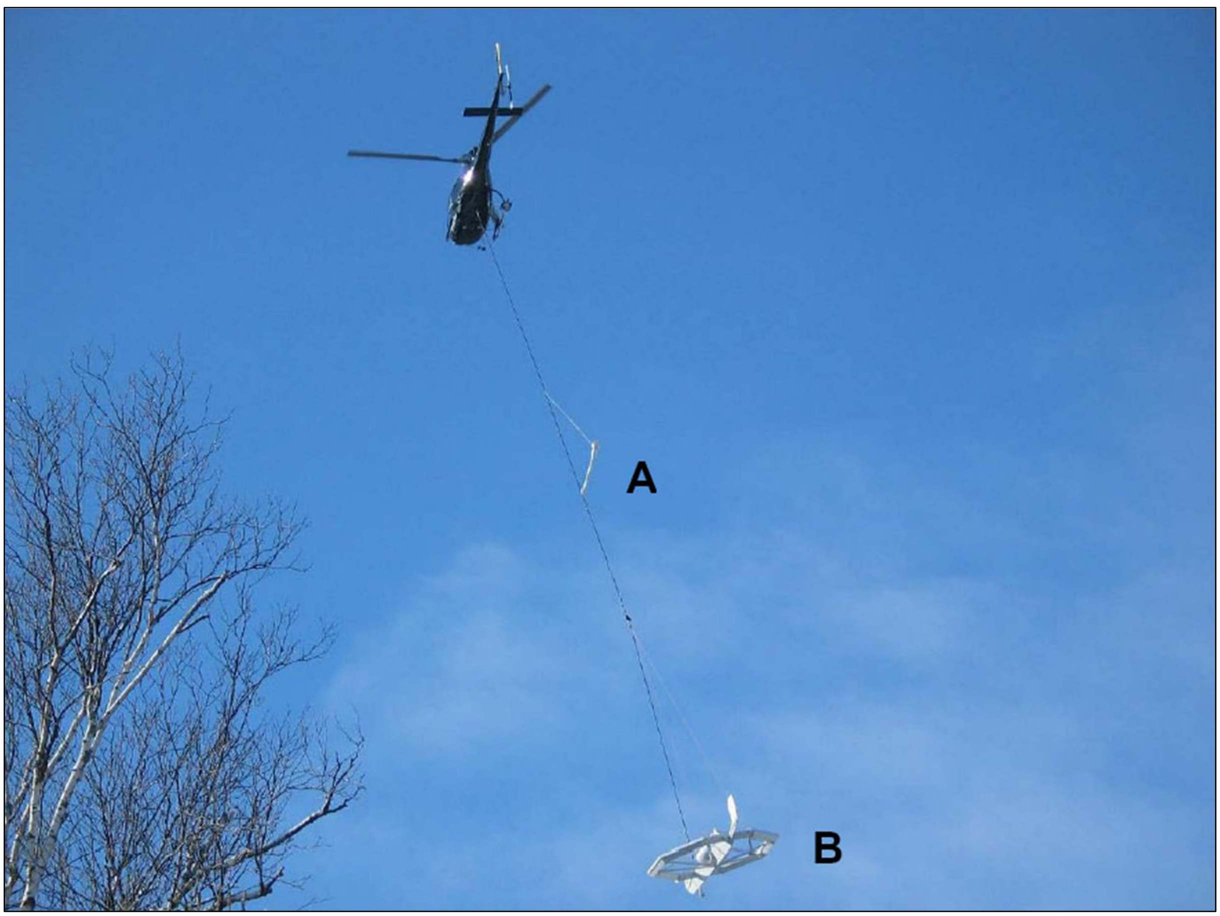

Figure 2. The Aeroquest airborne survey system configuration with magnetometer bird (A) and AeroTEM™ EM Bird (B).

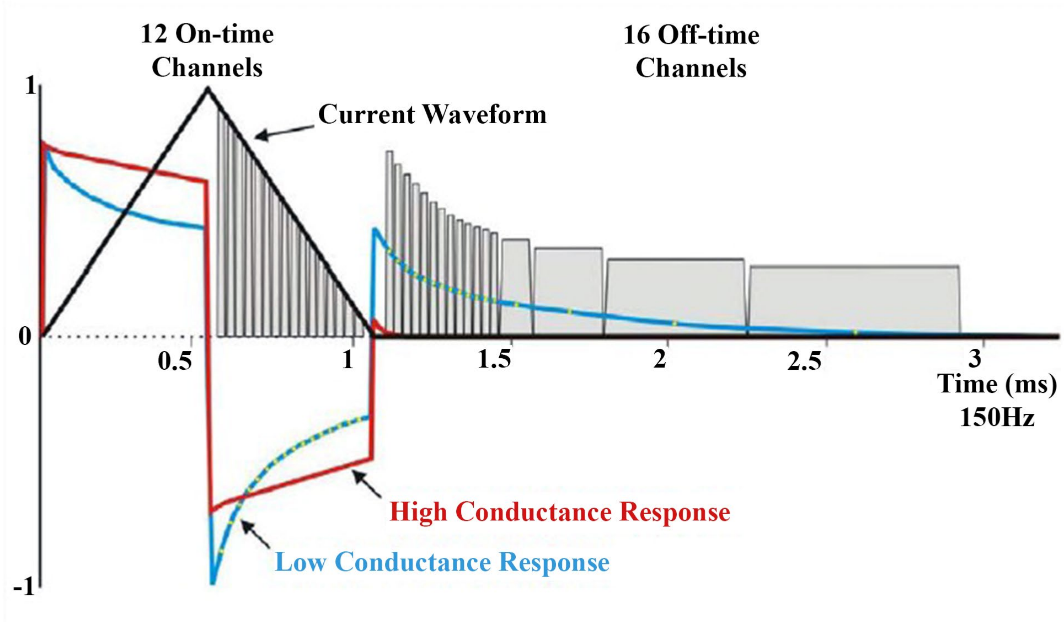

Figure 3. Diagram of transmitter and receiver waveforms, and receiver windows.

3.3.4. RSM DGR-33 DIGITAL ACQUISITION SYSTEM

The RMS Instruments' DGR33A data acquisition system was used to collect and record magnetics, radar altimeter, GPS position, and time. The system also recorded 6 channels of real-time processed off-time EM decay in the Z direction and one in the X direction and plotted the data in real-time on the analogue chart recorder. These channels are derived by a binning, stacking and filtering procedure on the raw streaming data. The primary use of the RMS EM data (channels Z1 to Z6, X1) is to provide for real-time QA/QC on board the aircraft.

3.3.5. RADAR ALTIMETER

A Terra TRA 3500/TRI-30 radar altimeter was used to record terrain clearance. The antenna was mounted on the outside of the helicopter, beneath the cockpit. Therefore, the recorded data reflect the height of the helicopter above the ground. The Terra altimeter has an altitude accuracy of +/-1.5 m.

3.3.6. GPS NAVIGATION SYSTEM

The navigation system consisted of an Ag-Nav Inc. AG-NAV2 GPS navigation system comprising a PC-based acquisition system, navigation software, a deviation indicator in front of the aircraft pilot to direct the flight, a full screen display with controls in front of the operator, a Trimble® AgGPS132 WAAS-enabled GPS receiver mounted on the instrument rack and a Trimble antenna mounted on the magnetometer bird.

WAAS (Wide Area Augmentation System) consists of approximately 25 ground reference stations positioned across the United States that monitor GPS satellite data. Two master stations located on the east and west coasts collect data from the reference stations and create a GPS correction message. This correction accounts for GPS satellite orbit and clock drift plus signal delays caused by the atmosphere and ionosphere. The corrected differential message is then broadcast through one of 2 geostationary satellites (satellites with a fixed position over the equator). The corrected position has a published accuracy of less than 3 m.

Survey co-ordinates were set up prior to the survey and the information was fed into the airborne navigation system. The co-ordinate system employed in the survey design was NAD27 Canada Mean UTM, zone 17N projection. The real-time differentially corrected GPS positional data were recorded by the RMS DGR-33 in geodetic coordinates (latitude and longitude using WGS84) at 0.2 s intervals. For this subsequent re-compilation, the UTM and latitude/longitude coordinate data were re-projected to NAD83.

3.3.7. VIDEO TRACKING AND RECORDING SYSTEM

A high resolution digital colour 8 mm video camera was used to record the helicopter ground flight path along the survey lines. The video was digitally annotated with GPS position and time and can be used to verify ground positioning information and cultural causes of anomalous geophysical responses.

Table 2. AeroTEM™ receiver recording times.

Channel	Measured Channels	Start Time (µs)	Stop Time (µs)	Mid Time (µs)	Width (µs)
On 1	24	634.9	661.4	648.1	26.5
On 2	25	661.4	687.8	674.6	26.5
On 3	26	687.8	714.3	701.1	26.5
On 4	27	714.3	740.7	727.5	26.5
On 5	28	740.7	767.2	754.0	26.5
On 6	29	767.2	793.7	780.4	26.5
On 7	30	793.7	820.1	806.9	26.5
On 8	31	820.1	846.6	833.3	26.5
On 9	32	846.6	876.0	859.8	26.5
On 10	33	876.0	899.5	886.2	26.5
On 11	34	899.5	925.9	912.7	26.5
On 12	35	925.9	952.4	939.2	26.5
On 13	36	952.4	978.8	965.6	26.5
On 14	37	978.8	1005.3	992.1	26.5
On 15	38	1005.3	1031.7	1018.5	26.5
On 16	39	1031.7	1058.2	1045.0	26.5
Off 0	44	1164.0	1190.5	1177.2	26.5
Off 1	45	1190.5	1216.9	1203.7	26.5
Off 2	46	1216.9	1243.4	1230.2	26.5
Off 3	47	1243.4	1269.8	1256.6	26.5
Off 4	48	1269.8	1296.3	1283.1	26.5
Off 5	49	1296.3	1322.8	1309.5	26.5
Off 6	50	1322.8	1349.2	1336.0	26.5
Off 7	51	1349.2	1375.7	1362.4	26.5
Off 8	52	1375.7	1402.1	1388.8	26.5
Off 9	53	1402.1	1428.6	1415.3	26.5
Off 10	54	1428.6	1455.0	1441.8	26.5
Off 11	55	1455.0	1481.5	1468.3	26.5
Off 12	56	1481.5	1507.9	1494.7	26.5
Off 13	57-60	1507.9	1613.8	1574.1	104.2
Off 14	61-68	1613.8	1825.4	1719.6	208.3
Off 15	69-84	1825.4	2248.7	2037.0	416.6
Off 16	85-116	2248.7	3095.2	2672.0	677.0

3.3.8. BASE STATION

The base magnetometer used in the project was a Scintrex® CS-2 cesium vapour magnetometer, coupled with a Picodas MEP-710 frequency counter/decoupler. The base GPS was a Leica® Mx9212 12-channel receiver. The base magnetometer and GPS receiver were positioned away from potential noise sources. Since the aircraft employed a real-time differential GPS receiver, the GPS positional data from the ground station was not logged. The base GPS was used solely for the GPS clock, to synchronize the base station magnetometer data with the survey data.

4. Contractor Data Processing

4.1. FLIGHT PATH AND TERRAIN CLEARANCE

The position of the survey helicopter was directed by use of the Global Positioning System (GPS). Positions were updated 5 times per second (5 Hz) and expressed as NAD27 latitude and longitude calculated from the raw pseudo range derived from the C/A code signal. The instantaneous GPS flight path, after conversion to UTM co-ordinates, is drawn using linear interpolation between the x/y positions. The terrain clearance was maintained with reference to the radar altimeter. The raw Digital Terrain Model (DTM) was derived by taking the GPS survey elevation and subtracting the radar altimeter terrain clearance values. The calculated topography elevation values are relative and are not tied in to surveyed geodetic heights. Each flight included at least two high elevation ‘background’ checks. These high elevation checks are to ensure that the gain of the system remained constant and within specifications.

4.2. ELECTROMAGNETIC DATA

The raw streaming data, sampled at a rate of 38 400 Hz (126 channels, 300 times per second) was reprocessed using a proprietary software algorithm developed and owned by Aeroquest Limited. Processing began with a segmenting and synchronization procedure that isolates the relevant portion of the flight and pre-processes the time series to ensure data synchronization is maintained. The pre-processed segment was then partially stacked and tested for high noise events, including sferics, which are skipped during the main stacking procedure.

During the main processing algorithm, data were stacked for 30 full cycles or 0.2 seconds. Deconvolution of the system waveform, primary field removal during the on-time, and system transient removal during the off-time were preformed ahead of the stacking. The data were then binned into the 16 on-time and 17 off-time channels and their base levels corrected. The resulting profiles were then filtered using a filter with 11 coefficients. An overburden stripped response was generated by subtracting the off-time response from the on-time response for the X1 to X16 and Z1 to Z16 channels.

The final processing step was to merge the processed EM data back into the Geosoft® database file (GDB) with the GPS position, altimeter, magnetics, etc. The EM fiducial was used to synchronize the data.

4.3. MAGNETIC DATA

Prior to any levelling, the magnetic data were subjected to a lag correction of -0.1 seconds and a spike removal filter. The filtered aeromagnetic data were then corrected for diurnal variations using the magnetic base station and the intersections of the tie lines.

5. Final Data Compilation and Processing

5.1. BASE MAPS

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

Projection Description

Datum:	NAD83 (Canada)
Ellipsoid:	GRS80
Projection:	UTM Zone 17N (Central Meridian=81° W)
False Northing:	0 m
False Easting:	500 000 m
Scale Factor:	0.9996

5.2. EDITING AND INSPECTION OF CONTRACTOR MAGNETIC PROFILE DATA

The contractor provided 3 fields of magnetic profile data; de-spiked raw magnetic data (*mag_raw*), lagged, filtered and diurnally-corrected magnetic data (*mag_diurn*) and a tie-line levelled magnetic data (*mag_lev_orig*).

Some residual spikes were noted in the raw mag channel. These spikes were deleted from *mag_raw* and the edited profile was stored as *mag_edit*. These spikes produced noise events in the filtered and diurnally corrected mag channel as well. These events were edited out of *mag_diurn* in place. The resulting gaps and both *mag_edit* and *mag_diurn* were spanned using an Akima interpolation algorithm.

Ordinarily, the contractor's final, levelled profile channel would be used as the starting point for final processing. To test the levelling procedure, a difference channel was calculated by subtracting the final channel from *mag_diurn*. It was noted that insufficient care was taken to control the tie line levelling procedure. In areas of active magnetic gradient, positional errors of the intersection resulted in large level corrections being applied that were not valid. It was decided that the *mag_diurn* channel would be chosen as the starting point for further processing. The contractor's levelled channel was thus named *mag_lev_orig*. A *mag_lev* channel was also created, that was simply populated with *mag_diurn*.

5.3. IGRF 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 2000 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 57 280 nT was removed from the channel *igrf*. The resultant correction (*igrf_cor*) was subtracted from *mag_diurn* and stored as *mag_igrf*.

5.4. MAGNETIC MICROLEVELLING

Each of the 7 surveys was processed individually. The Serpentine block (Block 3) and Bannockburn block (Block 4) had both north-south oriented lines and east-west oriented lines. These perpendicular lines were treated separately. The profile data of channel *mag_igrf* were gridded using a bi-cubic spline algorithm and 9 separate grids were produced.

Microlevelling is the process of removing residual flight line noise that remains after conventional levelling using base station diurnal correction and control lines (or in the case of this survey diurnal correction only). 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 real anomalies, the flight path was 'threaded' through the filtered grid and a database profile channel was created from each 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 one kilometre or longer. This microlevel correction profile was applied to the *mag_igrf* profile and a final magnetic profile channel, *mag_final* was created.

5.5. GEOLOGICAL SURVEY OF CANADA LEVELLING

The final step in the magnetic processing was to level the data set to the 200 m Ontario Master grid (Ontario Geological Survey 1999), which has been compiled and levelled to the 812.8 m magnetic datum from the Geological Survey of Canada (GSC). 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 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. 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, for each database, using a bi-cubic spline and a 20 m cell size.

5.6. SECOND VERTICAL DERIVATIVE GRIDS

The second vertical derivative of each of the total magnetic field grids 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.

5.7. 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 magnetised sources. It was found that the best results were obtained by sub-sampling the magnetic grids to a 40 m cell size and using corresponding 40 m model grids.

The cylinder model parameters are as follows:

Cylinder diameter:	200 m
Cylinder length:	infinite
Overburden thickness:	Table 3 (Drill hole data provided by MNDM)
Magnetic inclination:	74.3° N
Magnetic declination:	11.2° W
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 4.

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 bi-cubic spline gridding. All available geological information should be incorporated in kimberlite pipe target selection.

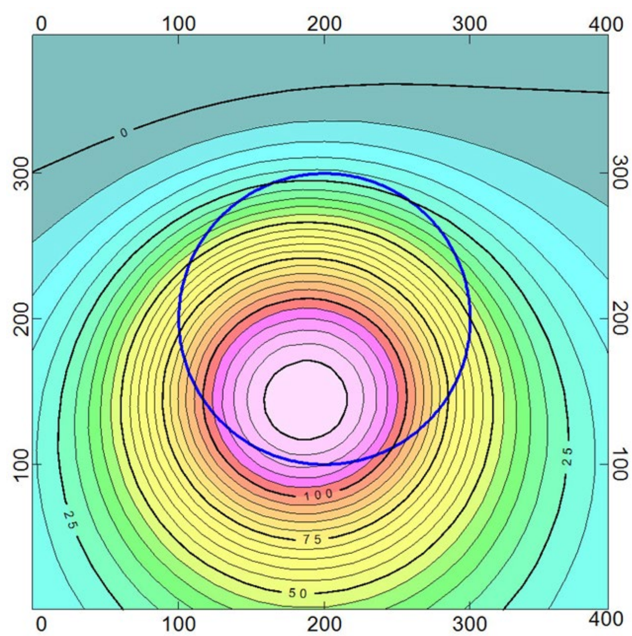

Figure 4. Total field response of the model used in the Keating correlation.

Table 3. Overburden thickness for each survey block area.

Prefix	Survey Name	Average OB Depth	No. DDH
1	Adams-Redstone	24.0	388
2	McArthur	11.7	318
3	Serpentine	14.7	948
4	Bannockburn	13.3	2319
5	Montrose	12.8	186
6	Midlothian	4.9	366
7	Powell	6.5	169

(OB, overburden thickness, depth in metres, from *Ontario Geological Survey 2013)*

5.8. 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 amplitude at time=0 , 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 5).

The voltage in the receiver coil is a function of dB/dt, which behaves in a similar way (Figure 6):

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

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

$$Tau = -\ (t_1\text{-}t_2)\ /\ \log\ (Ampliude_1/Amplitude_2)$$

The actual signal measured by a time domain EM system, surveying a nonuniform 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 twenty-one point Hanning filter and stored as *tau_z*. In some instances, a weak response (likely caused by mild conductivity of the overburden) was noted on some flight lines but not on adjacent lines. This would cause an undesirable streaking in the final map. For these regions, the tau profile data was DC adjusted to match the data on adjacent lines. The edited tau channel was called *tau_z_alt*. and was gridded for each survey database using a bi-cubic spline and a 20 m cell size.

5.9. PROFILE DATABASE AND GRID MERGE

The gridded and profile data were combined into single master data sets. For each of the grid varieties (GSC levelled magnetic data, 2VD and Tau) 2 final grids were created. Grids from the east-west oriented lines of the Serpentine and Bannockburn blocks were merged as one set, and the north-south data of all 7 blocks were combined as a second set.

The profile data was also merged into a single database. The numeric prefix in Table 3 was added to the line numbers of each respective database to conflicts.

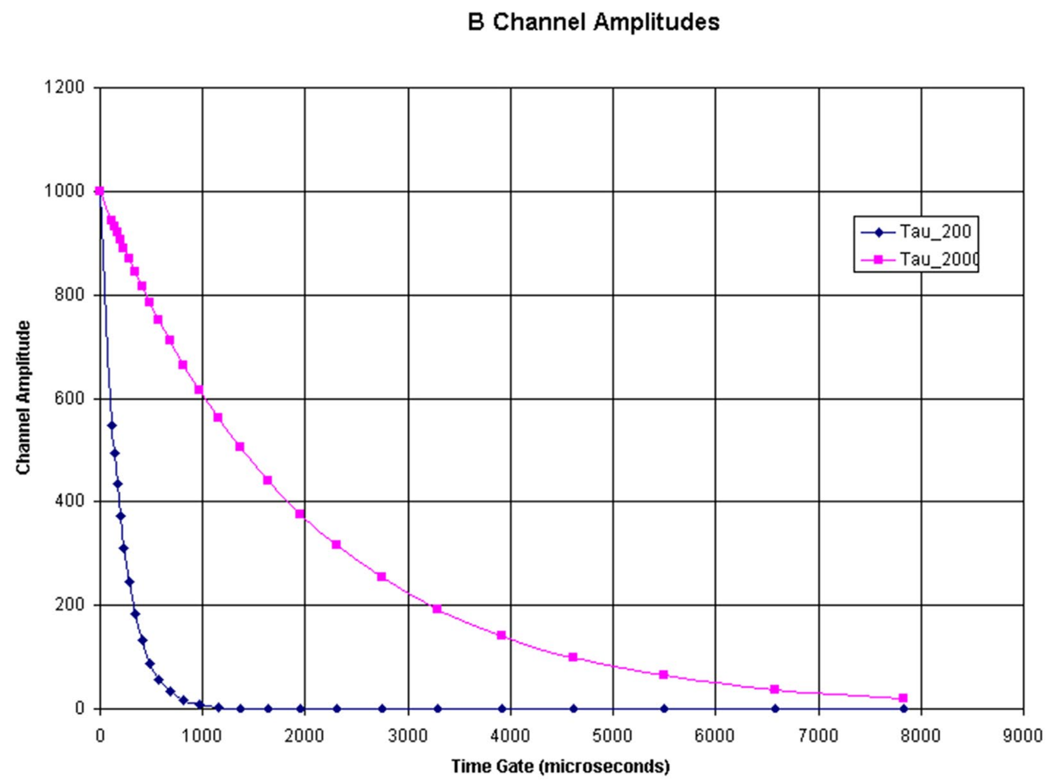

Figure 5. B-field decay with 2 different time constants.

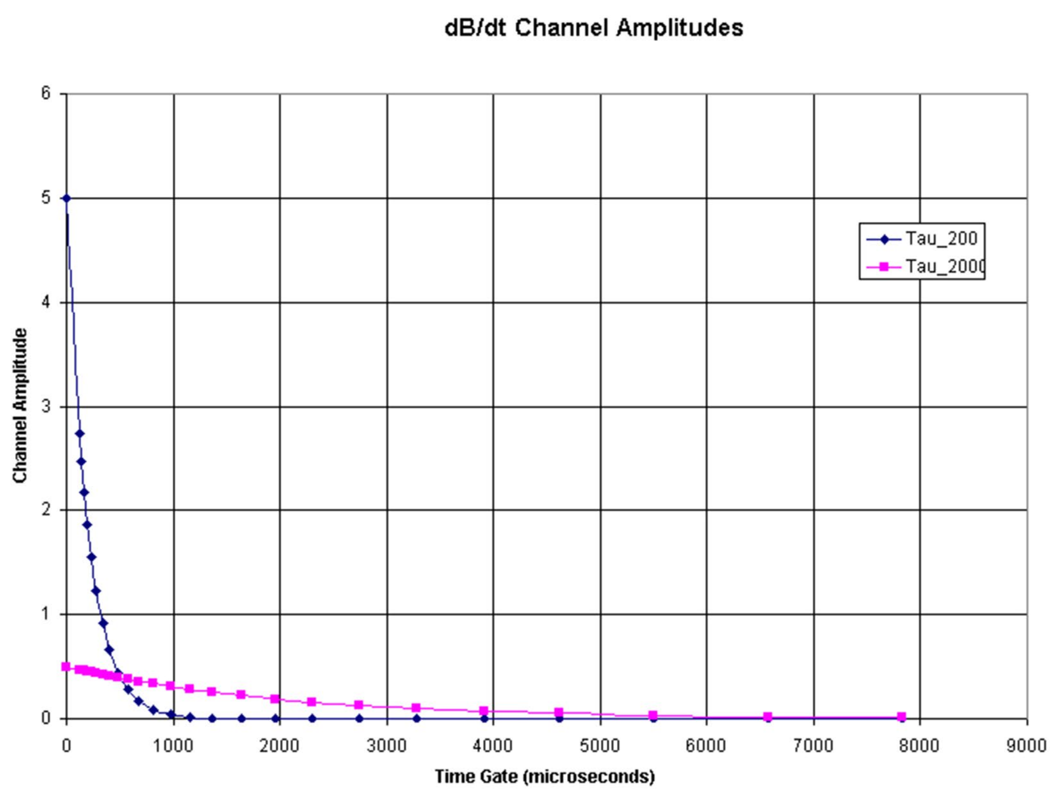

Figure 6. dB/dt field decay with 2 different time constants.

5.10. EM ANOMALY SELECTION AND ARCHIVING

The AeroTEM 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.

The EM profile responses of both the X-coil and Z-coil receivers were 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 orientated 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. The AeroTEM system included a 60 Hz power monitor, which was used to identify cultural anomalies. One set of conductors worth particular note occurred in the Bannockburn block. Conductor axes were observed on the 50 m infill lines (41525 to 41555) but not in the main survey lines, or the series of east-west lines that cross the area. It is likely that a ground EM transmitter loop was present when the infill lines were flown, but not when the other survey lines were flown. These conductors have been designated as cultural.

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.

5.11. REFORMATTING OF EM 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 given in Appendix B.

5.12. FINAL MAP PRODUCTS

The following 18 digital maps (in Geosoft® packed map format) were created for Matachewan–Timmins area in order to produce the following 18 hard-copy maps (Map numbers 60 420 to 60 437).

- 1:20 000 scale colour-filled contours of the residual magnetic field and electromagnetic anomalies with flightlines and MNDM supplied planimetric base and map surround in 6 map sheets (60 420 to 60 425)
- 1:20 000 scale shaded colour image of the second vertical derivative of the residual magnetic field with flight lines and Keating kimberlite pipe correlation coefficients, and MNDM supplied planimetric base and map surround in 6 map sheets (60 426 to 60 431)

- 1:20 000 scale colour-filled contours of the EM decay constant and electromagnetic anomalies, flightlines and MNDM supplied planimetric base and map surround, in 6 map sheets (60 432 to 60 437)

5.13. CREATION OF GEOREFERENCED GEOTIFF IMAGES

Seamless 150 dpi resolution georeferenced geotiff images of the 3 map themes described above 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 1243 (GDS 1243).

5.14. CREATION OF LINEWORK (VECTOR) ARCHIVES

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

6. References

Fiset, N. 2004a. Report on a helicopter-borne magnetic and electromagnetic survey, featuring the Aeroquest AeroTEM™ system, Redstone Property, Adams Township, Timmins area, Ontario; unpublished report for Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.28796, AFRI# 42A06SE2024, 45p.

——— 2004b. Report on a helicopter-borne magnetic and electromagnetic survey, featuring the Aeroquest AeroTEM™ system, Bannockburn Property, Bannockburn Township, Matachewan area, Ontario; unpublished report for Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.29671, AFRI# 41P15NW2014, 42p.

——— 2004c. Report on a helicopter-borne magnetic and electromagnetic survey, featuring the Aeroquest AeroTEM™ system, McArthur Property, McArthur Township, Timmins area, Ontario; unpublished report for Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.29089, AFRI# 42A03NE2010, 41p.

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——— 2004f. Report on a Helicopter-borne magnetic and electromagnetic survey, featuring the Aeroquest AeroTEM™ system, Powell Property, Powell Township, Matachewan area, Ontario; unpublished report for Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.29869, AFRI# 20000000457, 41p.

——— 2004g. Report on a helicopter-borne magnetic and electromagnetic survey, featuring the Aeroquest AeroTEM™ system, Serpentine Property, Semple and Sothman townships, Matachewan area, Ontario; unpublished report for Mustang Minerals Corp., Sudbury Resident Geologist's office, assessment file AFRO# 2.28603, AFRI# 41P14NE2014, 52p.

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

——— 2013. Ontario Drill Hole Database—2013; Ontario Geological Survey.

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; *in* Expanded Abstracts, Society of Exploration Geophysicists, 60th Annual International Meeting, San Francisco, v.1., p.617-619.

APPENDIX A DATA FILES DESCRIPTION

The files for the Matachewan-Timmins Geophysical Survey 1243 are archived on DVD. 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:

- ASCII (GXF) grids
  - total (residual) field magnetics
  - second vertical derivative of the total field magnetics
  - decay constant
- EM anomaly database (ASCII CSV format)
- Keating correlation (kimberlite) database (ASCII CSV format)
- DXF files:
  - flight path
  - EM anomalies
  - Keating correlation (kimberlite) anomalies
  - total field magnetic contours
  - decay constant contours
- GEOTIFF images
  - colour total field magnetics with base map
  - colour shaded relief of second vertical derivative with base map
  - colour decay constant with base map
- Geosoft® Binary (GRD) grids
  - total (residual) field magnetics
  - second vertical derivative of the total field magnetics
  - decay constant
- EM anomaly database (Geosoft® GDB format)
- Keating correlation (kimberlite) database (Geosoft® GDB format)
- ASCII Profile data
  - Profile database of electromagnetic and magnetic data (10 Hz sampling) in ASCII (XYZ) format
- Binary Profile data
  - Profile database of electromagnetic and magnetic data (10 Hz sampling) in Geosoft® GDB format
- Survey report (PDF format)

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 datum, Canada local datum
- Latitude/longitude coordinates, NAD83 datum, Canada local datum

The gridded data are provided in one UTM co-ordinate system:

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

APPENDIX B PROFILE ARCHIVE DEFINITION

The profile data are provided in 2 formats: ASCII (MATACHEWAN-TIMMINS.XYZ) and Geosoft® binary (MATACHEWAN-TIMMINS.GDB).

The contents of the databases *.xyz/.gdb* are summarized as follows.

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
radar_final	corrected radar altimeter (helicopter)	metres above terrain
gps_z_final	differentially corrected GPS Z (NAD83 datum)	metres above sea level
dem	digital elevation model	metres above sea level
fiducial	fiducial	
flight	flight number	
line	flightline number	
time_utc	UTC time	seconds
time_local	Local time	decimal hours
date	date	YYYY/MM/DD
mag_base_final	corrected magnetic base station data	nanoteslas
mag_raw	raw magnetic field	nanoteslas
mag_edit	edited raw magnetic field	nanoteslas
mag_diurn	diurnally corrected and filtered 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_lev_orig	original contractor-levelled magnetic field	nanoteslas
mag_final	micro-levelled magnetic field	nanoteslas
mag_gsclevel	GSC levelled magnetic field	nanoteslas
height_em	electromagnetic receiver height	metres above ground
power	60 Hz power line monitor	microvolts
em_x_final_on	filtered dB/dt, on-time, X-component	nT/s
em_x_final_off	filtered dB/dt, off-time, X-component	nT/s
em_z_final_on	filtered dB/dt, on-time, Z-component	nT/s
em_z_final_off	filtered dB/dt, off-time, Z-component	nT/s
em_x_final_obr	filtered dB/dT, off-time X-component, overburden response removed	nT/s
em_z_final_obr	filtered dB/dT, off-time Z-component, overburden response removed	nT/s
tau_z	decay constant (tau) for Z-component	microseconds
tau_z_alt	decay constant (tau) for Z-component edited for gridding	microseconds

APPENDIX C ANOMALY ARCHIVE DEFINITION

Electromagnetic Anomaly Data

The electromagnetic anomaly data are provided in 2 formats; ASCII (MTANOMALY.CSV) and Geosoft® binary (MTANOMALY.GDB).

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 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
dem	digital elevation model	metres above sea level
fiducial	fiducial	
line	flightline number	
time_utc	UTC time	seconds
em_x_final_on	filtered dB/dT, X-component, on-time	nT/s
em_x_final_off	filtered dB/dT, X-component, off-time	nT/s
em_z_final_on	filtered dB/dT, Z-component, on-time	nT/s
em_z_final_off	filtered dB/dT, Z-component, off-time	nT/s
tau_z	decay constant (tau) for Z-component	microseconds
height_em	electromagnetic receiver 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). The '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

Kimberlite Pipe Correlation Coefficients

The Keating kimberlite pipe correlation coefficient data are provided in 2 formats: ASCII (MTKC.CSV) and Geosoft® binary (MTKC.GDB).

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 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
corr_coeff	correlation coefficient	percent x 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

The gridded data are provided in 2 formats: ASCII (GXF) and Geosoft® binary (GRD).

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

North-south data

- MTMAG83.GRD/.GXF – GSC Levelled Residual Magnetic Intensity
- MT2VD83.GRD/.GXF – Second Vertical Derivative of Residual Magnetic Intensity
- MTDCZ83.GRD/.GXF – Decay Constant

East-west data

- MTEMAG83.GRD/.GXF – GSC Levelled Residual Magnetic Intensity
- MTE2VD83.GRD/.GXF – Second Vertical Derivative of Residual Magnetic Intensity
- MTEDCZ83.GRD/.GXF – Decay Constant

APPENDIX F GEOTIFF AND VECTOR ARCHIVE DEFINITION

GeoTIFF Images

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

- MTMAG83.TIF – GSC Levelled Residual Magnetic Intensity
- MT2VD83.TIF – Second Vertical Derivative of GSC Levelled Residual Magnetic Intensity
- MTDCZ83.TIF – Decay Constant

Vector Archives

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

- MTPATH83.DXF – Flight Path of the Survey Area
- MTANOM83.DXF – Electromagnetic Anomalies
- MTKC83.DXF – Keating Correlation Targets
- MTMAG83.DXF – Contours of the Residual Magnetic Intensity in nanoteslas
- MTDC83.DXF – Contours of the Decay Constant (micro-seconds)