WINDY-MCKINLEY MEGATEM® II

Geological Survey of Canada
Magnetic and Electromagnetic Data
Geophysical Data Set 6082 and 6083

Department of Natural Resources Canada
RM 237 A

Report on Windy-McKinley MEGATEM® II Airborne Geophysical Survey
Geophysical Data Set 6082 and 6083

615 Booth Street
Ottawa, Ontario, K1A 0E9
Canada

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CREDITS

This electromagnetic and magnetic survey was funded by the Geomapping for Energy and Minerals Program of the Earth Sciences Sector, Natural Resources Canada. Project management, quality assurance and quality control were performed by the Geological Survey of Canada, Natural Resources Canada.

List of accountabilities and responsibilities:

- Regis Dumont, Geophysicist, Geological Survey of Canada, Natural Resources Canada – overall project management
- Fugro Airborne Surveys, Ottawa, Ontario - data acquisition and data compilation.

DISCLAIMER

To enable the rapid dissemination of information, this digital data has not received a technical edit. Every possible effort has been made to ensure the accuracy of the information provided; however, the Geological Survey of Canada does not assume any liability or responsibility for errors that may occur. Users may wish to verify critical information.

CITATION

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

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1) INTRODUCTION

Recognising the value of geoscience data in reducing private sector exploration risk and investment attraction, the Geological Survey of Canada and the Yukon Geological Survey funded the Windy-McKinley MEGATEM® II survey.

- Acquisition of airborne geophysics (high-resolution magnetic/electromagnetic data)
- Compilation and delivery of digital data and maps products.

The airborne survey contract was awarded through a Request for Proposal and Contractor Selection process. The system and contractor selected for the survey were judged on many criteria, including the following:

- applicability of the proposed system to the local geology and potential deposit types
- aircraft capabilities and safety plan
- experience with similar surveys

- QA/QC plan
- capacity to acquire the data and prepare final products in the allotted time
- price-performance.

2) SURVEY LOCATION AND SPECIFICATIONS

The Windy-McKinley survey area is located in south western Yukon (Figure 1).

The MEGATEM® II time-domain electromagnetic (90 Hz base frequency) and magnetic system, mounted on a fixed wing platform, was selected by the GSC to conduct the survey.

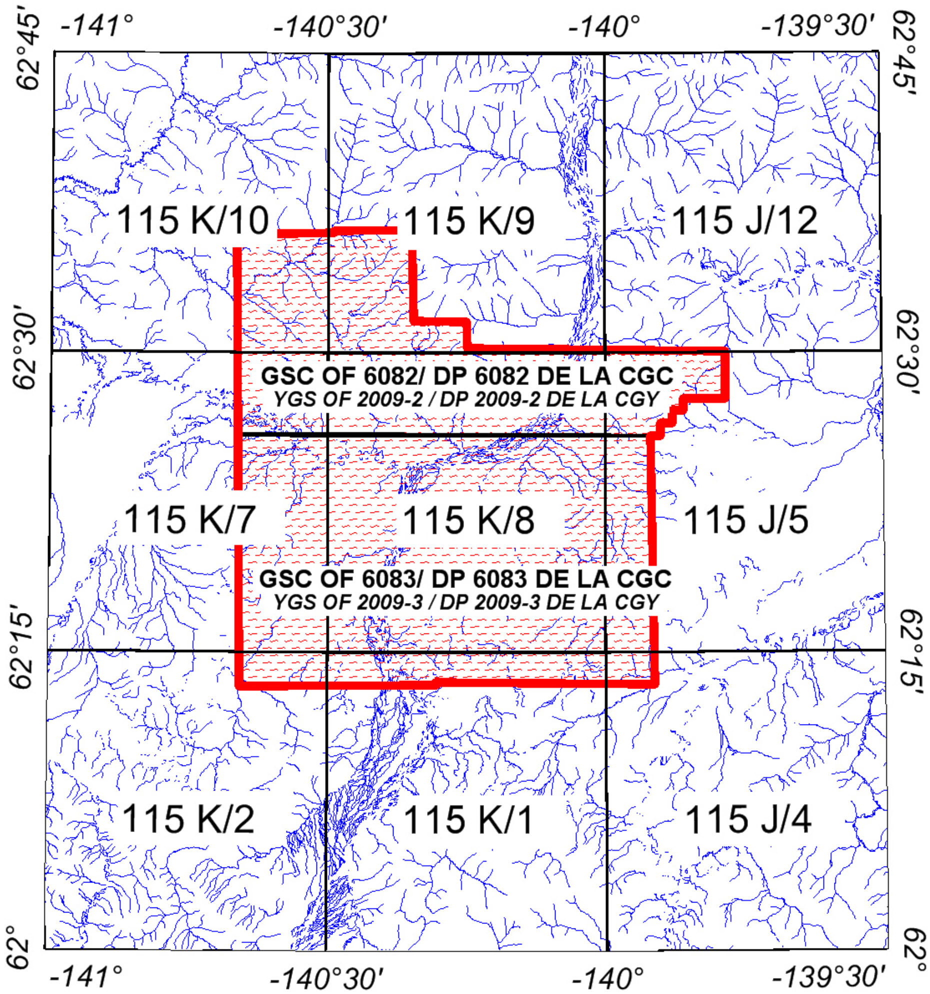

Figure 1: Windy-McKinley survey area (MEGATEM® II platform).

The airborne survey and noise specifications for the Windy-McKinley survey are as follows:

a) traverse line spacing and direction
   - flight line spacing is 400 m
   - flight line direction is 090° - 270°

- maximum deviation from the nominal traverse line location could not exceed ±50 m over a distance greater than 3000 m

b) control line spacing and direction
   - at a regular 1000 m interval, perpendicular to the flight line direction
   - along each survey boundary (if not parallel to the flight line direction)

c) terrain clearance of the EM receiver bird
   - nominal terrain clearance is 60 m
   - altitude tolerance limited to ±15 m, except in areas of severe topography

d) aircraft speed
   - nominal aircraft speed is 70 m/sec
   - aircraft speed tolerance limited to ±10.0 m/sec, except in areas of severe topography

e) magnetic diurnal variation
   - could not exceed a maximum deviation of 3 nT peak-to-peak over a 1 minute chord.

f) magnetometer noise envelope
   - in-flight noise envelope could not exceed 0.11 nT
   - base station noise envelope could not exceed 0.1 nT

g) EM receiver noise envelope
   - the noise envelope could not exceed:
     dB/dt X & Z raw channel 20 data ±3500 pT/s
     over a distance exceeding 3000 m

3) AIRCRAFT, EQUIPMENT AND PERSONNEL

Aircraft and Geophysical On-Board Equipment

Aircraft:	DeHavilland DHC-7EM (Dash-7) turbo-prop (MEGATEM® system)
Operator:	FUGRO AIRBORNE SURVEYS
Registrations:	C-GJPI
Survey Speed:	135 knots ; 157 mph ; 70m/sec.
Magnetometer:	Scintrex Cs-2 single cell cesium vapour, towed-bird installation, sensitivity of 0.01 nT, sampling rate = 0.1 sec., ambient range 20,000 to 100,000 nT. The general noise envelope was kept below 0.1 nT. Nominal sensor height of 65 metres above ground.

Electromagnetic system:	MEGATEM® II multicoil system		
	C-GJPI		
	Transmitter:	vertical axis loop of 406 m² number of turns: 6 nominal height above ground of 120 metres current of 650 amperes dipole moment of 1.58 x 10^6 Am²	
	Receiver :	multicoil system (x, y and z) with a final recording rate of 4 samples/second, for the recording of 20 channels of x, y and z-coil data; nominal height above ground of 60 metres, placed 130 m behind the centre of the transmitter loop	
		Base frequency:	90 Hz
		Pulse width:	2251 µs
		Pulse delay:	33 µs
		Off-time:	3272 µs
		Point value:	5.43 µs
		Window mean delay times in milliseconds after the end of the pulse	
		channel 1: -2.200	channel 11: 0.499
		channel 2: -1.798	channel 12: 0.621
		channel 3: -1.093	channel 13: 0.770
		channel 4: -0.388	channel 14: 0.947
		channel 5: 0.005	channel 15: 1.150
		channel 6: 0.185	channel 16: 1.394
		channel 7: 0.223	channel 17: 1.693
		channel 8: 0.271	channel 18: 2.045
		channel 9: 0.331	channel 19: 2.466
		channel 10: 0.404	channel 20: 2.984

Digital Acquisition:	FUGRO AIRBORNE SURVEYS GEODAS
Analogue Recorder:	RMS GR-33, showing the total magnetic field at 2 vertical scales, the radar and barometric altimeters, the time-constant filtered traces of the db/dt and B-field x and z-coil channels 7, 13, 18 and the on-time x-coil channel 1, the raw traces of the db/dt and b-field x and z-coil channel 20, the EM primary field, the power line monitor, the 4th difference of the magnetics, the x-coil earth's field and fiducials
Barometric Altimeter:	Rosemount 1241M, sensitivity 1 foot, 0.1 sec. recording interval

Radar Altimeter:	Sperry RT-300, accuracy 3%, sensitivity one foot, range 0 to 2,500 feet, 0.1 sec. recording interval
Camera:	Panasonic colour video, super VHS, model WV-CL302
Electronic Navigation:	NovAtel OEM4 dual-frequency GPS receiver, 1 sec. recording interval, with a resolution of 0.00001 degree and an accuracy of ±5 m. Real time differential correction was provided by Omnistar.

Base Station Equipment

Magnetometer:	Scintrex Cs-2 single cell cesium vapour, mounted in a magnetically quiet area, measuring the total intensity of the earth's magnetic field in units of 0.01 nT at intervals of 0.5 seconds, within a noise envelope of 0.10 nT
GPS Receiver:	NovAtel OEM4, measuring all GPS channels, for up to 12 satellites
Data Logger:	CF1 Single Board Base Station

Field Office Equipment

Computers:	Dell Inspiron laptops with 100 GB hard drive
Printer:	Canon Bubblejet printer

Field Personnel

The following personnel were on-site during the acquisition program.

Tim Brownrigg	Geophysicist
Francis Torres	Geophysicist
Seigfried Hypolite	Pilot
Jonathan Carpio	Pilot
Brendon Fisher	Aircraft engineer
Chas Eveson	Aircraft engineer
James McKay	Aircraft engineer
Enrique Aparicio	Electronics technician
Al Proulx	Electronics technician

The above personnel are responsible for the operation and data handling from the aircraft. All personnel are employees and contractors of Fugro Airborne Surveys.

4) DATA ACQUISITION

The town of Northway, Alaska was used as the base of operations. The survey was carried out from September 3rd, 2008 to September 23rd, 2008. The area is covered by a total of 5029.8 line kilometres of flying. A total of 106 survey lines were flown over one block. An additional 46 control lines were flown perpendicular to the traverse lines or along the survey block boundaries.

Division of flying

- Flying dates: September 3rd to September 23rd , 2008
- Production flights: 1 to 8
- Survey coverage:
  Lines 10010 to 11060, control lines 18010 to 18460

General statistics

Survey dates	September 3rd to September 23rd, 2008
Total km	5029.8 km
Total flying hours	36.9 hours
Production hours	36.7 hours
Number of production days	8 days
Number of production flights	8 flights
Bad weather days	10 days
Testing	0.2 hours
Equipment breakdown	0 days
Aircraft breakdown/maintenance	3 days
Pilot training	0 hrs
Average production per flight	629 km
Average production per hour	136 km
Average production per day	140 km

The following tests and calibrations were performed prior to the commencement of the survey flying:

- Magnetometer lag check
- EM system lag check
- GPS navigation lag and accuracy check
- Altimeter calibration
- Comparison between the base station magnetometer and aircraft magnetic sensor

These tests were flown out of either Ottawa, ON or Northway, AK, as part of the start-up procedures.

Details of these tests and their results are given in Appendix A.

After each flight, all analogue records were examined as a preliminary assessment of the noise level of the recorded data. Altimeter deviations from the prescribed flying altitudes were also closely examined as well as the magnetic diurnal activity, as recorded on the base station.

All digital data were verified for validity and continuity. The data from the aircraft and base station were transferred to the PC's hard disk. Basic statistics were generated for each parameter recorded. These included the minimum, maximum and mean values, the standard deviation and any null values located. Editing of all recorded parameters for spikes or datum shifts was done, followed by final data verification via an interactive graphics screen with on-screen editing and interpolation routines. Any of the recorded parameters could be plotted at a suitable scale on the field printer.

The quality of the GPS navigation was controlled on a daily basis by recovering the flight path of the aircraft. The correction procedure employs the raw ranges from the base station to create improved models of clock error, atmospheric error, satellite orbit, and selective availability. These models are used to improve the conversion of aircraft raw ranges to aircraft position. The GrafNav-corrected GPS was plotted back daily in the field on the laptop display and checked for speed busts.

Checking all data for adherence to specifications was carried out in the field by the Fugro Airborne Surveys field geophysicists.

5) DATA COMPILATION AND PROCESSING

Personnel

The following personnel were involved in the compilation of data and creation of the final products:

Michael Pearson	Manager of the Compilation Dept.
David Murray	Supervising Processor
Stuart Stevenson	Geophysicist
Matt Noteboom	Geophysicist
Francis Torres	Geophysicist

Base maps

Text for the base maps of the survey area were supplied by the Geological Survey of Canada.

Projection description

Datum:	NAD83
Projection:	UTM (Zone 7N)
Central Meridian:	141° West
False Northing:	0 m
False Easting:	500,000 m
Scale factor:	0.9996

Processing of Base Station data

The recorded magnetic diurnal base station data is reformatted and loaded into the OASIS Montaj database. After initial verification of the integrity of the data from statistical analysis, the appropriate portion of the data is selected to correspond to the exact start and end time of the flight. The data is then checked and corrected for spikes using a fourth difference editing routine. Following this, interactive editing of the data is done, via a graphic editing tool, to remove events caused by man-made disturbances. A small running average filter equivalent to less than 8 sec was applied. The final processing step consists of extracting the long wavelength component of the diurnal signal through low pass filtering, to be subtracted from the airborne magnetic data as a pre-leveling step.

Post Processing of the Positioning Data (GPS)

The raw dual-frequency GPS data from both the mobile (aircraft) and base station are recovered. Using GrafNav software (differential correction software), positions are recalculated from the recorded raw range data in flight. Post-flight recalculation of the fixes from the raw ranges rather than using the fixes which are recorded directly in flight, improves on the final accuracy, as it eliminates possible time tag errors that can result during the real-time processing required to get from the range data to the fixes directly within the receiver. Differential corrections are then applied to the aircraft fixes using the recorded base station data. A point to point speed calculation is then done from the final X, Y coordinates and reviewed as part of the quality control. The flight data is then cut back to the proper survey line limits and a preliminary plot of the flight path is done and compared to the planned flight path to verify the navigation. The positioning data is then exported to the other processing files.

Processing of the Altimeter data

The altimeter data, which includes the radar altimeter, the barometric altimeter and the GPS elevation values, after differential corrections, are checked and corrected for spikes using a fourth difference editing routine. The barometric data was corrected against the corrected GPS altitude data, which was also corrected to orthometric height. Following this, a digital terrain trace is computed by subtracting the radar altimeter values from the differentially corrected orthometric GPS elevation values. All resulting parameters are then checked, in profile form, for integrity and consistency, using a graphic viewing editor.

Processing of Magnetic data

The data is reformatted and loaded into an OASIS Montaj database. After initial verification of the data by statistical analysis, the values are adjusted for system lag. The data is then checked and corrected for any spikes using a fourth difference editing routine and inspected on the screen using a graphic profile display. Interactive editing, if necessary, is done at this stage. Following this, the long wavelength component of the diurnal is subtracted from the data as a pre-leveling step. A preliminary grid of the values is then created and verified for obvious problems, such as errors in positioning or bad diurnal. Appropriate corrections are then applied to the data, as required.

GSC leveling

Next TMF processing stage was levelling, which consists in the proper statistical distribution of traverses vs. ties intersection errors, so as to obtain the smoothest possible correction model on each line. An initial simple correction model (average) is first applied on ties, and then on traverses after updating intersections on corrected ties. This process is pursued iteratively, using correction models of progressively decreasing wavelength, in order to further correct the residual errors of the previous passes. Final correction models after six iterations were based on a tensioned spline of tension=0.1 and smoothness=0.1 (traverses), as allowed by the line network.

A “final” magnetic channel is provided. This magnetic field is gridded at a cell size of 100 m using the minimum curvature algorithm. The International Geomagnetic Reference Field (IGRF) was removed from the data for a survey altitude of 819 m, using the 2005 model year extrapolated to mid September, 2008 (2008.7).

First Vertical Derivative of the Residual Magnetics

The final grid of the corrected total field values is then used as input to create the second vertical derivative. The first vertical derivative was calculated by fast Fourier transform.

Processing of the Electromagnetic Data

The data is reformatted and loaded into the OASIS Montaj database. After initial verification of the data by statistical analysis, the values are then adjusted for system lag. The next step is to check and correct each individual channel for system drift. This is done with the data in flight form, incorporating the pre and post flight high altitude background segments for zero signal reference. The response from each channel is viewed in profile form, using a graphic viewing tool, and the regions of background minima checked against the high altitude background segments. Drift problems noted are directly corrected using the interactive editing functions available from the graphic viewing tool. These corrections are either of a DC offset nature, a linear tilt or a gently varying (low order) polynomial function. Once corrected for drift, the baseline values for each individual channel allow calculation of any derived product, such as the decay constant or the apparent conductivity, free of errors.

Following the correction for drift, spheric events in the data are isolated and removed through a decay analysis of each transient. Erroneous decays, not associated with power lines, are identified during this process and removed by interpolation. This was followed by the application of a small median filter aimed at removing events of a 1 second period.

The final low pass noise filtering was done using an adaptive filter technique based on time domain triangular operators. Using a 2nd difference value to identify changes in gradient along each channel, minimal filtering (3 point convolution) is applied over the peaks of the anomalies, ranging in set increments up to a maximum amount of filtering in the resistive background areas (31 points for both the x-coil and the z-coil data).

Calculation of the Decay Constant

Calculation of the decay constant (also known as tau) is done by fitting the data from the appropriate off-time channels (mapping the decay transient) to a single exponential function of the form:

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

where A = the amplitude at time zero, t = time is seconds and τ is the decay constant.

A semi-log plot of this exponential function will be displayed as a straight line, the slope of which will reflect the rate of decay and therefore the strength of the conductor. A slow rate of decay, reflecting high conductance, will be represented by a high decay constant value. The response was calculated from channels 09 to 20 (mid times of 331 to 2984 µsec after turn-off). This is done from both the db/dt X and Z coil channels.

As a single parameter, the decay constant provides more useful information than the amplitude data of any given single channel, as it indicates not only the peak of the response but also the relative strength of the conductor. Also, unlike any quantitative value derived from the data, such as conductance or resistivity, the decay constant is the expression of a simple mathematical function which is model independent, such that it is a truer representation of the data. The only disadvantage of this parameter is that, in order to get a reliable fit of the data to the exponential function, a minimum amount of signal above the background is required. In essence, this means that the decay constant will effectively map features of moderate to high conductance, but weaker, more resistive features will best be defined by the apparent conductivity calculation.

Calculation of the Apparent Conductivity

The apparent conductivity was calculated by fitting all 20 channels of the Z-coil response of the dB/dt component to the homogeneous half space model. Prior to the fitting, the data is deconvolved to the step response in order to provide a linear relationship as the conductivity of the ground increases from the resistive limit to the inductive limit.

The apparent conductivity provides the maximum information on the near-surface conductivity of the ground which, when combined with the magnetic signature, provides good geological mapping.

EM Anomaly Selection

EM anomalies are selected and stored in the database. An automatic routine locates all the anomaly peaks from a reference channel and fits off-time dB/dt X coil data, that has been normalized to parts per million (PPM), to a vertical plate model in order to derive the conductivity-thickness-product and the depth to the top of the conductor. The conversion of unnormalized units (picoteslas per second) to PPM is obtained using the following formula:

$$PPM = \{ (X * A * G) / V \} * 10^6$$

where X = the unnormalized units, A = the area of the receiver coil (37 m^2), G = the receiver gain (1615 for MEGATEM® II), and V = half the receiver peak to peak voltage (pV) as obtained from the reference waveform.

The initial EM anomaly selection is reviewed interactively, by an experienced interpreter, using a graphic viewing/editing tool where the anomaly selections are checked against a multi-channel profile display of the data. Corrections are made (erroneous selections deleted and missing ones added) and the selected anomalies are classified as to their possible source (surficial, bedrock or culture). The resulting anomaly selection is then checked with the magnetic signature and other derived EM parameters (decay constant and conductance) for geological significance and a final revision made. Base map information and the flight video tapes are also checked, during this process, to help in the final sorting between man-made responses and geological sources.

Note on the B-Field Data

One thing to note is the data units for the B-Field data, delivered in femtoteslas (fT) and how these compare to the regular dB/dt data, delivered in pT/s (picoteslas per second). After standard processing, the resolution (mean noise envelope) of the dB/dt data is approximately 1200 – 2000 pT/s. The corresponding resolution of the B-Field data, after regular processing is approximately 2500-4000 fT or 2.5 – 4.0 picoteslas. So the amplitude ratio, based on the residual noise levels after processing, of B-Field over dB/dt is approximately 2:1. This is an important factor when trying to image or display the data.

The introduction of the B-Field data stream, as part of the GEOTEM® and MEGATEM® systems, provides the explorationist with a more effective tool for exploration in a broader range of geological environments and for a larger class of target priorities. The advantage of the B-Field data compared with the normal voltage data (dB/dt) are as follows:

- a broader range of target conductances that the system is sensitive to (the B-Field is sensitive to bodies with conductances as great as 100 000 siemens)
- enhancement of the slowly decaying response of good conductors
- suppression of rapidly decaying response of less conductive overburden
- reduction in the effect of sferics on the data
- an enhanced ability to interpret anomalies due to conductors below thick conductive overburden
- reduced dynamic range of the measured response (easier data processing and display).

Figures 2 and 3 display the calculated vertical plate response of a MEGATEM® II signal for the dB/dt and B-Field respectively. For the dB/dt response, the amplitude of the early channel peaks are about 25 siemens and the late channel peaks are about 100 siemens. As the conductance exceeds 1000 siemens the response curves quickly roll back into the noise level. For the B-Field response, the early channel amplitude peaks at about 80 siemens and the late channel at about 200 siemens. The projected extension of the graph in the direction of increasing conductance, where the response would roll back into the noise level, is close to 100 000 siemens. So, a strong conductor, having a conductance of several thousand siemens, would be difficult to interpret on the dB/dt data, since the response would be mixed in with the background noise. However, this strong conductor would stand out clearly on the B-Field data, although it would have an unusual character, being a moderate to high amplitude response, exhibiting almost no decay.

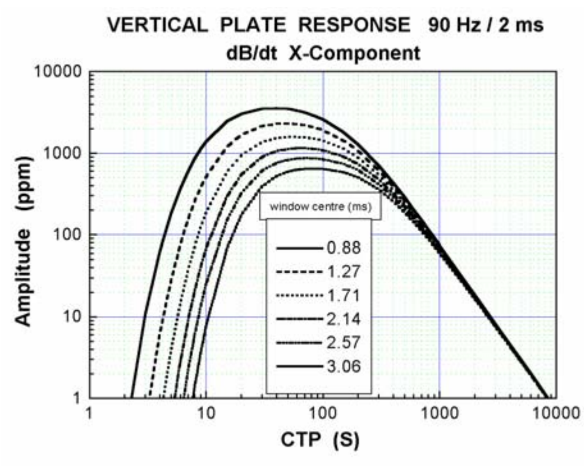

Figure 2. Vertical plate response – dB/dt

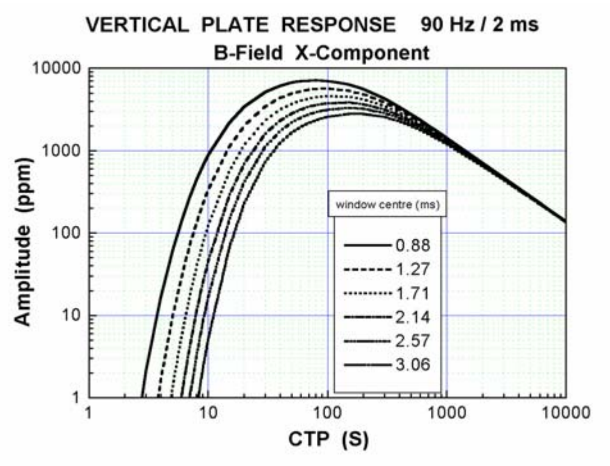

Figure 3. Vertical plate response –B-field

In theory, the response from a super conductor (50,000 to 100,000 siemens) would be seen on the B-Field data as a low amplitude, non-decaying anomaly, not visible in the off-time channels of the dB/dt stream. Caution must be exercised here, as this signature can also reflect a residual noise event in the B-Field data. In this situation, careful examination of the dB/dt on-time (in-pulse) data is required to resolve the ambiguity. If the feature is strictly a noise event, then being absent in the dB/dt off-time data stream would locate the response at the resistive limit and the mid on-pulse channel (normally identified as channel 3) would reflect little but background noise, or at best a weak negative peak. If, on the other hand, the feature does indeed reflect a superconductor, then this would locate the response at the inductive limit. In this situation, the on-time response of the dB/dt stream would mirror the transmitted pulse, giving rise to a large negative response in the mid on-pulse channel (normally identified as channel 3).

Discussion on filtering and gridding

The design of all filter parameters is controlled by power spectra analysis and by testing on selected portions of the data and graphically viewing the results pre and post filtering, to ensure that the full resolution of the geological signal is preserved while minimizing the non-geological signal.

Routinely three different gridding algorithms are used: a modified Akima spline routine for regular gridding; a linear routine, for gridding of parameters limited to a constant background value, to prevent “overshoots”; and a minimum curvature routine, usually for undersampled data. The minimum curvature gridding is used on this project for the magnetic data to better represent small, single line features in the data that are not adequately sampled by the 400 metre line spacing. The linear routine is used for the gridding of the x and z decay constants, and the Akima spline routine is used for the gridding of the apparent conductance and the digital terrain model.

Gridding is normally done by interpolating the data at right angles to the line direction. Geological features which are orthogonal to the survey line direction will be best represented in this manner, but features which trend at an oblique angle to the line direction will often be poorly represented, appearing as broken-up segments.

Fixed-wing TDEM systems exhibit an asymmetry in the response due to the system's geometry (i.e. physical separation between the transmitter loop and the receiver coils). The amount of asymmetry in the response also varies with the geometry of the conductor itself. A system lag correction is applied during the processing to align the responses, from one survey line to the next, over narrow vertical conductors, such that these will be displayed as straight axes. However, this will leave the edges of broad flat-lying conductors displaying a line-to-line oscillation or "herringbone" pattern. This, in itself, is a useful interpretation aid, as it helps to distinguish between vertical and flat-lying conductors but as a regional mapping presentation, it presents an unappealing image. This asymmetry, associated with the edges of flat-lying conductors, can be removed by applying a de-corrugation technique directly to the gridded values. This step is often referred to as "de-herringboning". All final EM grids are prepared in both the regular and "de-herringboned" versions, for comparison. The de-herringboned grids are used for the map presentation.

6) FINAL PRODUCTS

Map products at 1:50 000

- Residual magnetic field in colour with contours, plotted with EM anomalies on a planimetric base
- Shaded colour image of the first vertical derivative of the magnetics, plotted with EM anomalies on a planimetric base
- Colour EM Z -coil decay constant with contours, plotted with EM anomalies on a planimetric base
- Apparent conductivity with a profile of B Field X Coil Channel 08, plotted with EM anomalies on a planimetric base

Profile databases

- EM database at 5 samples/sec in both Geosoft® GDB and ASCII format
- Magnetic database at 10 samples/sec in both Geosoft® GDB and ASCII format

EM anomaly database

EM anomaly database in both Geosoft® GDB and ASCII format

Data grids

Geosoft® data grids, in GRD, gridded from coordinates in NAD83 datum of the following parameters:

- Digital Terrain Model
- Residual Magnetic Intensity (regular gridding)
- First Vertical Derivative of Magnetics (regular gridding)
- EM X-Coil Decay Constant (regular grid)
- EM X-Coil Decay Constant (de-herringboned grid)
- EM Z-Coil Decay Constant (regular grid)
- EM Z-Coil Decay Constant (de-herringboned grid)
- Apparent Conductance (regular grid)
- Apparent Conductance (de-herringboned grid)

Halfwave files

These are compressed ASCII files, covering one flight of data per file, delivered on separate DVDs. These files contain the 1024 points of the TDEM waveform, stacked to 4 Hz sampling, for the four components T (primary transmitted electromagnetic field), X (X-component of the secondary electromagnetic field), Y (Y-component of the secondary electromagnetic field) and Z (Z-component of the secondary electromagnetic field).

RAW data files

These files contain the 1024 points of the TDEM waveform, unstacked, delivered as binary files with an executable for converting to ASCII.

Waveform parameter table files

These are the TDEM reference waveform files delivered as standard ASCII text files, one for each survey flight. These files provide information on the system geometry, the window (channel) positions, the conversion factors and the waveform itself.

Project report

Provided in MS Word format.

7) QUALITY ASSURANCE AND QUALITY CONTROL

Quality assurance and quality control (QA/QC) were undertaken by the survey contractor (Fugro Airborne Surveys), and by the GSC. Stringent QA/QC is emphasized throughout the project so that the optimal geological signal is measured, archived, and presented.

Survey Contractor

Important checks are required during the data acquisition stage to ensure that the data quality is kept within the survey specifications. The following lists in detail the standard data quality checks that were performed during the course of the survey.

Daily quality control

Navigation data

- The differentially corrected GPS flight track is recovered and matched against the theoretical flight path to ensure that any deviations are within the specifications (i.e. deviations not greater than 50 metres from the nominal line spacing over a 3 km distance).

- All altimeter data (radar, barometric and GPS elevation) is checked for consistency and deviations in terrain clearance were monitored closely. The survey is flown in a smooth drape fashion maintaining a nominal terrain clearance of 120 metres, whenever possible. Altitude corrections are done in a smoothly controlled manner, rather than forcing the return to nominal, to avoid excessive motion of the towed-bird which would impact on the quality of the data. A digital elevation trace, calculated from the radar altimeter and the GPS elevation values, is also generated to further control the quality of the altimeter data.

- The synchronicity of the GPS time and the acquired time of the geophysical data is checked by matching the recorded time fields.

- A final check on the navigation data is computing the point-to-point speed from the corrected UTM X and Y values. The computed values should be free of erratic behavior showing a nominal ground speed of 70 m/s with point-to-point variations not exceeding +/- 10 m/s.

Magnetometer data

- The diurnal variation is examined for any deviations that exceed the specified 3 nT peak-to-peak over a 1 minute chord. Data was re-flown when this condition is exceeded, with any re-flown line segment crossing a minimum of two control lines. A further quality control done on the diurnal variation is to examine the data for any man-made disturbances. When noted, these artifacts are graphically removed by a polynomial interpolation so that they are not introduced into the final data when the diurnal values are subtracted from the recorded airborne data.

- The integrity of the airborne magnetometer data is checked through statistical analysis and graphically viewed in profile form to ensure that there are no gaps and that the noise specifications are met.

- A fourth difference editing routine is applied to the raw data to locate and correct any small steps and/or spikes in the data.

- Any effects of filtering applied to the data are examined by displaying in profile form the final processed results against the original raw data, via a graphic screen. This is done to ensure that any noise filtering applied has not compromised the resolution of the geological signal.

- On-going gridding and imaging of the data is also done to control the overall quality of the magnetic data.

Electromagnetic data

- The high altitude calibration sequences, recorded pre- and post-flight, are closely examined. These background data segments, which are free of ground conductive response, are checked to ensure that the baseline positions for each channel are good, that the noise levels are within specified limits and that the system has been well compensated for excessive motion of the towed-bird.

- The reference waveform, collected during the calibration sequence and used for the compensation of the primary field, is closely examined for consistency from flight to flight. Diagnostic parameters, such as the peak voltages for each coil set and the transmitter current are noted and entered in the daily processing log for future reference.

- All recorded EM channels are examined and adjusted for system drift. This is done by graphically displaying each channel data in profile for the entire flight as a continuous segment and checking the high altitude background segments and local minima against a zero baseline value. This check also provides a good overall view of the response from each channel for any unusual behavior.

- Level of spheric activity is assessed during the processing, through a decay analysis. The percentage of bad decays detected that are not associated with power lines, are tabulated and reported. Under normal conditions, this is kept to 1 % or less.

- The "streamed" data is checked for continuity and its integrity assessed by statistical analysis. A viewing tool is also used to display the transient/waveform response from each of the four measured components: Tx, Rx, Ry and Rz.

- After processing, the final results are displayed in profile form, via a graphic screen and compared with the raw data, to ensure that the data has not been over filtered. A multi-channel profile display of the data, at this stage, also provides a visual check on the character of the decay information. This is followed by the calculation of the decay constant itself, which is gridded and imaged on an on-going basis throughout the survey, to further control the quality of the electromagnetic data.

Near-final field products

Near-final products of the profile and gridded navigation, magnetic and electromagnetic data were made available to the GSC Geophysicist during visits to the survey site, for review and approval, prior to demobilization.

Quality control in the office

Review of field processing of Magnetic & Electromagnetic data.

The general results of the field processing are reviewed in the profile database by producing a multi-channel stacked display of the data (raw and processed) for every line, using a graphic viewing tool. The magnetic and altimeter data are checked for spikes and residual noise. The electromagnetic channel data is checked for baseline positions, decay character and the effect of filtering.

Review of leveling of magnetics.

The results of the field levelling of the magnetics are reviewed, using imaging and shadowing techniques. Any residual errors noted are corrected.

Creation of first vertical derivative

The first vertical derivative is created from the final gridded values of the total field magnetic data and checked for any residual errors using imaging and shadowing techniques.

Creation of final EM grids

EM grids of the x and z-coil decay constant (tau) and the apparent conductance values are created, reviewed for residual drift/leveling errors and the necessary corrections applied. At this stage, the option of using either the regular dB/dT coil data or the B-Field components, to generate the required parameter grids, is reviewed to ensure the best definition of the targets sought. Necessary material is provided to the GSC Geophysicist for this evaluation.

Correction of EM grids for asymmetry

The selected EM derived parameter grids are corrected for asymmetry (de-herringboned) and checked against the original grids to ensure that there is no loss or misrepresentation of geological features.

EM anomaly selection.

The automated EM anomaly selection is reviewed interactively against the profile data, via a graphic display tool and edited to ensure that all valid anomalies are represented in the database. The final selection is then checked against the base maps (and in-flight videos, as required) to properly separate and label man-made responses from geological sources.

Interim products

Archive files containing the raw and processed profile data, the EM anomaly database and the final gridded parameters are provided to the GSC Geophysicist for review and approval.

Creation of 1:50 000 maps

After approval of the interim data, the 1:50 000 maps were created and verified for registration, labeling, dropping weights, general surround information, etc. The hard copy and corresponding digital files were provided to the GSC Geophysicist for review and approval.

GSC Geophysicist

The GSC Geophysicist conducted on-site inspections during data acquisition, focusing initially on the data acquisition procedures, base station monitoring and instrument calibration. As data was collected, it was reviewed for adherence to the survey specifications and completeness. Any problems encountered during data acquisition were discussed and resolved.

The QA/QC checks included the following:

Navigation Data

- appropriate location of the GPS base station
- flight line and control line separations are maintained, and deviations along lines are minimized
- verify synchronicity of GPS navigation and flight video
- all boundary control lines are properly located
- terrain clearance specifications are maintained
- aircraft speed remained within the satisfactory range
- area flown covers the entire specified survey area
- differentially-corrected GPS data does not suffer from satellite-induced shifts or dropouts
- GPS height and radar/laser altimeter data are able to produce an image-quality DEM
- GPS and geophysical data acquisition systems are properly synchronized
- GPS data are adequately sampled

Magnetic Data

- appropriate location of the magnetic base station, and adequate sampling of the diurnal variations
- heading error and lag tests are satisfactory
- magnetometer noise levels are within specifications
- magnetic diurnal variations remain within specifications
- magnetometer drift is minimal once diurnal and IGRF corrections are applied
- spikes and/or drop-outs are minimal to non-existent in the raw data
- filtering of the profile data is minimal to non-existent
- in-field leveling produces image-quality grids of total magnetic field and higher-order products (e.g. second vertical derivative)

Time-domain Electromagnetic Data

- selected receiver coil orientations, base frequency, primary field waveform and secondary field sampling are appropriate for the local geology
- raw "streaming" data are recorded and archived
- data behaves consistently between channels (i.e. consistent signal decay)
- noise levels are within specifications, and system noise is minimized
- bird swing and orientation noise is not evident
- sferics and other spikes are minimal (after editing)
- cultural (60 Hz) noise is not excessive
- regular tests are conducted to monitor the reference waveform and system drift, and to ensure proper zero levels
- filtering of the profile data is minimal

- in-field processing produces image-quality images of apparent conductivity and decay constant (tau).

The GSC Geophysicist reviewed interim and final digital and map products throughout the data compilation phase, to ensure that noise was minimized and that the products adhered to the GSC specifications. This typically resulted in several iterations before all digital products were considered satisfactory. Considerable effort was devoted to specifying the data formats, and verifying that the data adhered to these formats.

The GSC provided the text and planimetric base required for the digital and hard copy maps.

The GSC Geophysicist ensured that the digital files adhered to the specified ASCII and binary file formats, that the file names and channel names were consistent, and that all required data were delivered on schedule. The map products were carefully reviewed in digital and hard copy form to ensure legibility and completeness.

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Test & Calibration Results

MEGATEM Aircraft

C-GJPI

Fugro Airborne Surveys

July & September 2008

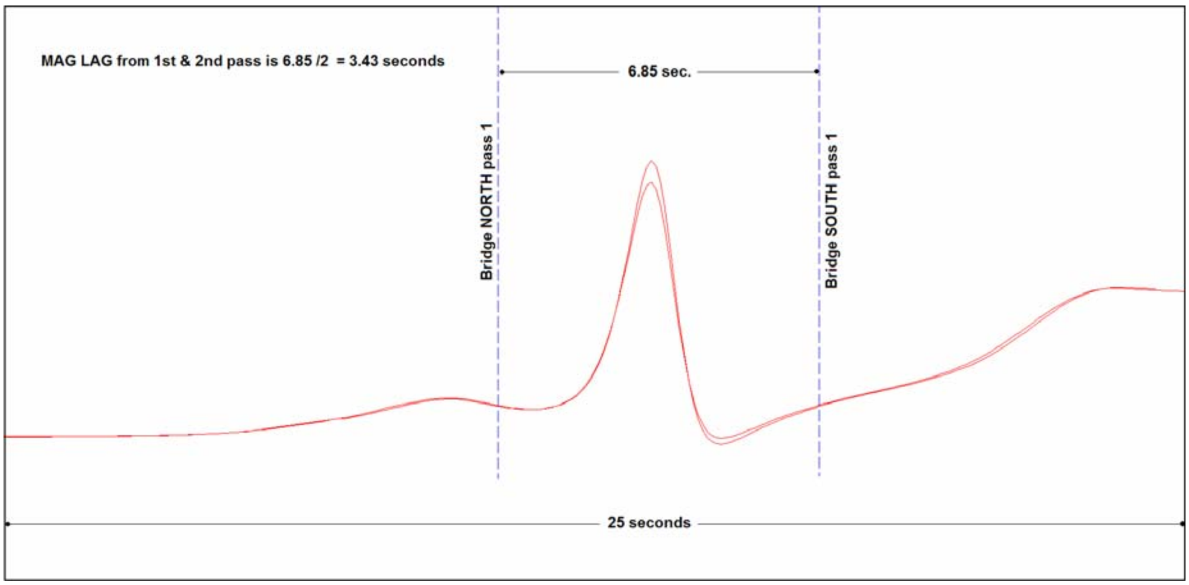
The following Tests & Calibrations were performed on the MEGATEM aircraft (registration C-GJPI).

- Time offset (lag) between the magnetometer and the video, flown in Fitzroy Harbour (railroad bridge), Ontario on July 21st, 2008.
- Time offset (lag) between the MEGATEM response and the video, flown in Fitzroy Harbour (railroad bridge), Ontario on July 21st, 2008.
- Altimeter calibration, flown over Ottawa River, Ontario on July 21st, 2008.
- Heading error with the magnetometer, flown over Bourget, Ontario on July 21st, 2008.
- GPS Lag and Accuracy check, flown over Northway, Alaska on September 2nd, 2008.

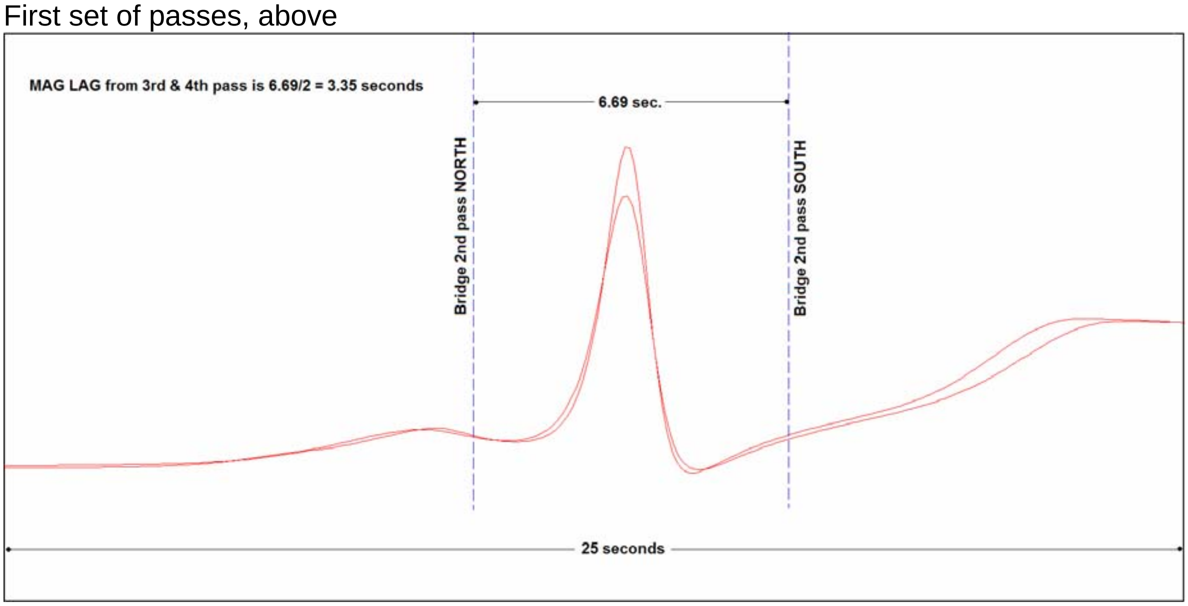
Results of the Magnetometer and MEGATEM Lag tests:
Location: Fitzroy Harbour Railroad Bridge, ON
Date: July 21st, 2008
Job: 08418

Magnetometer: Cesium vapour, towed bird installtion, sampling at 10 Hz Cable at 400 ft
MEGATEM: Set-up for 90 Hz with a with a 2 msec. Pulse, sampling at 4 Hz Cable at 450 ft

Pass	Video (Fid)	Radar
1 N	57585.80	117.6 m
2 S	57770.05	124.8 m
3 N	57967.80	113.4 m
3 S	58175.25	127.1 m



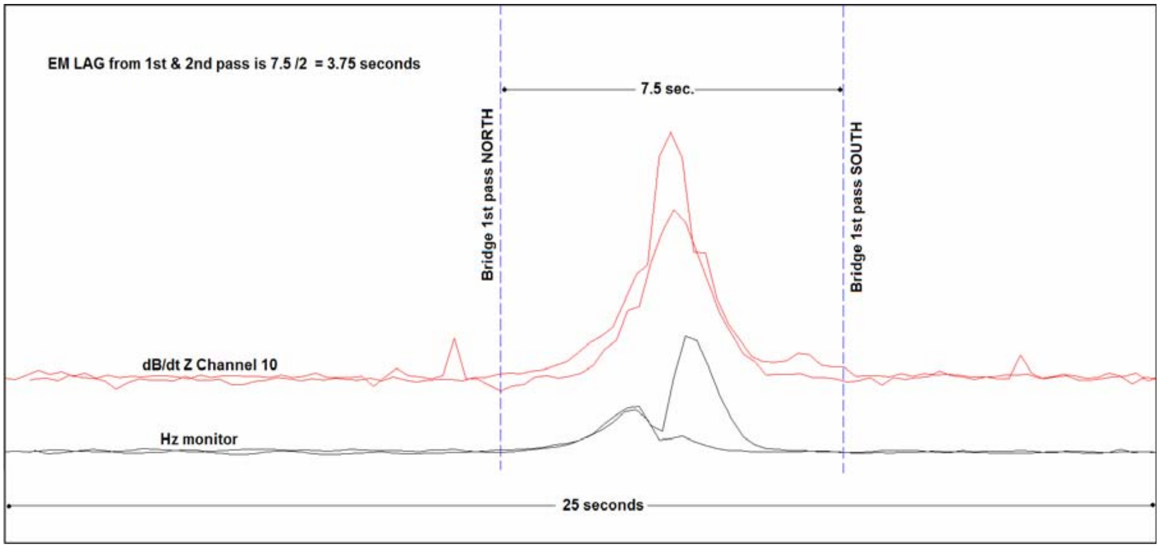
First set of passes, above



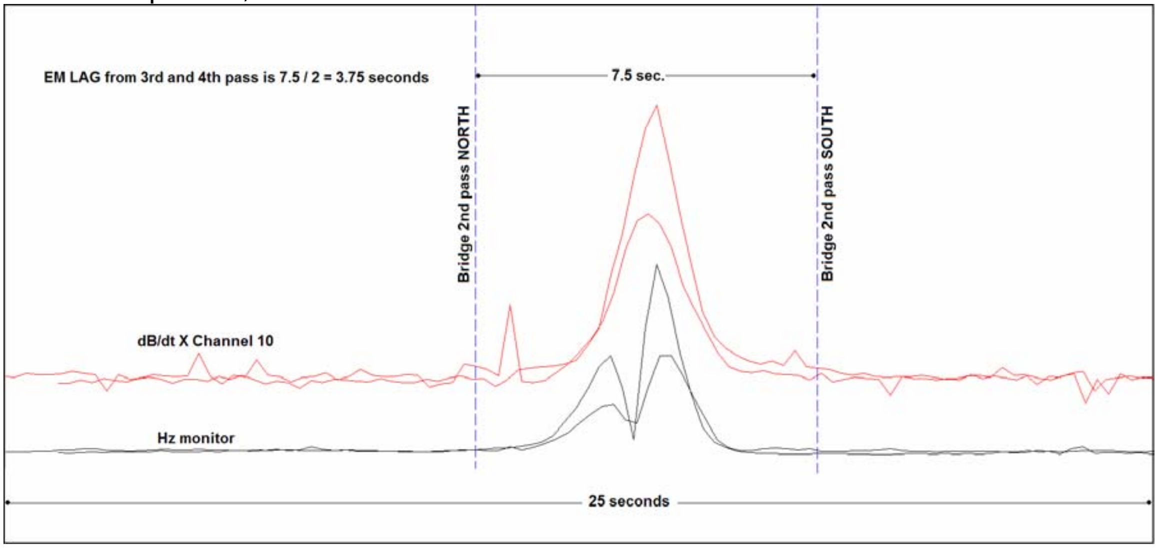
Second set of passes, above

Magnetometer LAG value calculated from the 1st set of passes = 3.43 seconds
Magnetometer LAG value calculated from the 2nd set of passes = 3.35 seconds
Average of 3.39 seconds

LAG value: Use 3.4 seconds or 34 samples



First set of passes, above



Second set of passes, above

LAG value for the MEGATEM from the 1st set of passes = 3.75 seconds
LAG value for the MEGATEM from the 2nd set of passes = 3.75 seconds
Average of 3.75 seconds

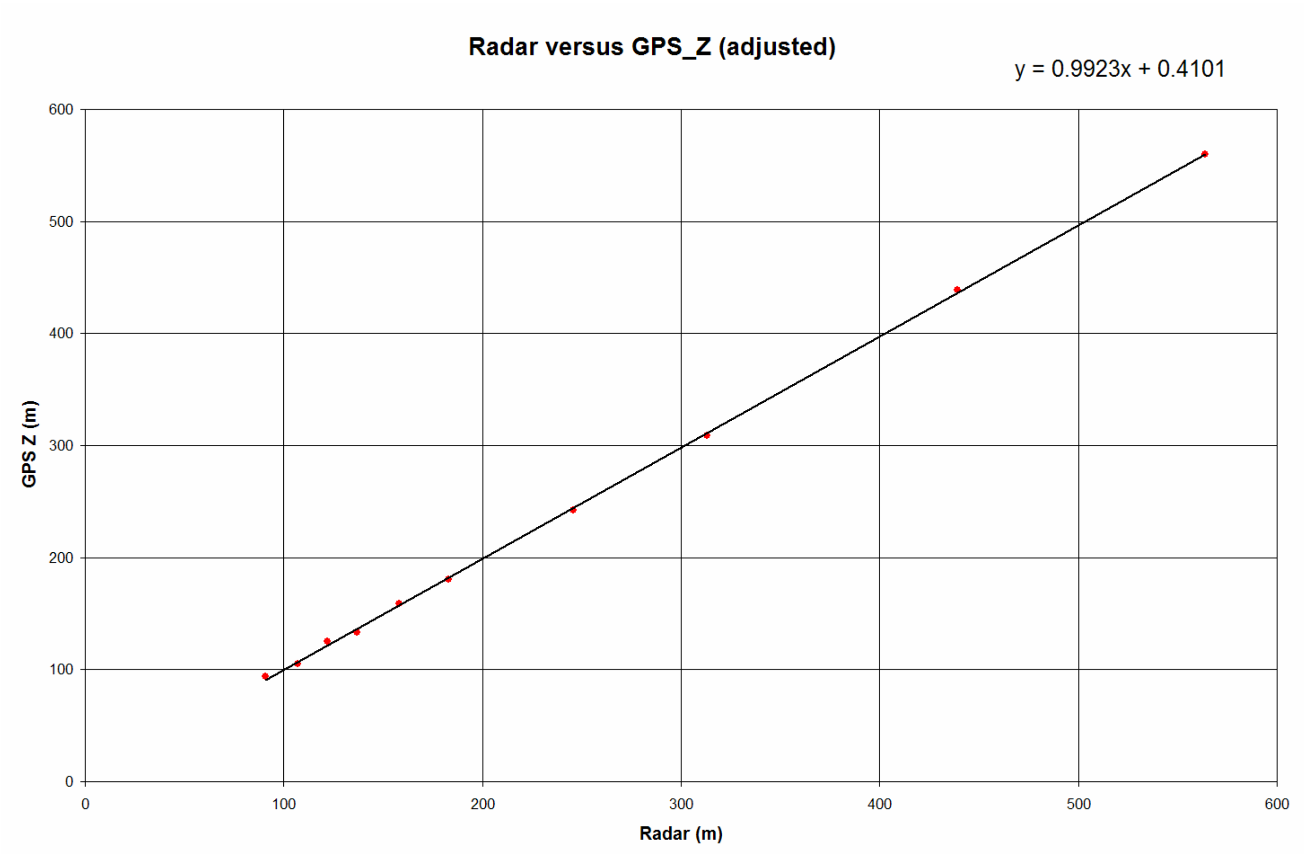
LAG value: Use 3.75 seconds or 15 samples

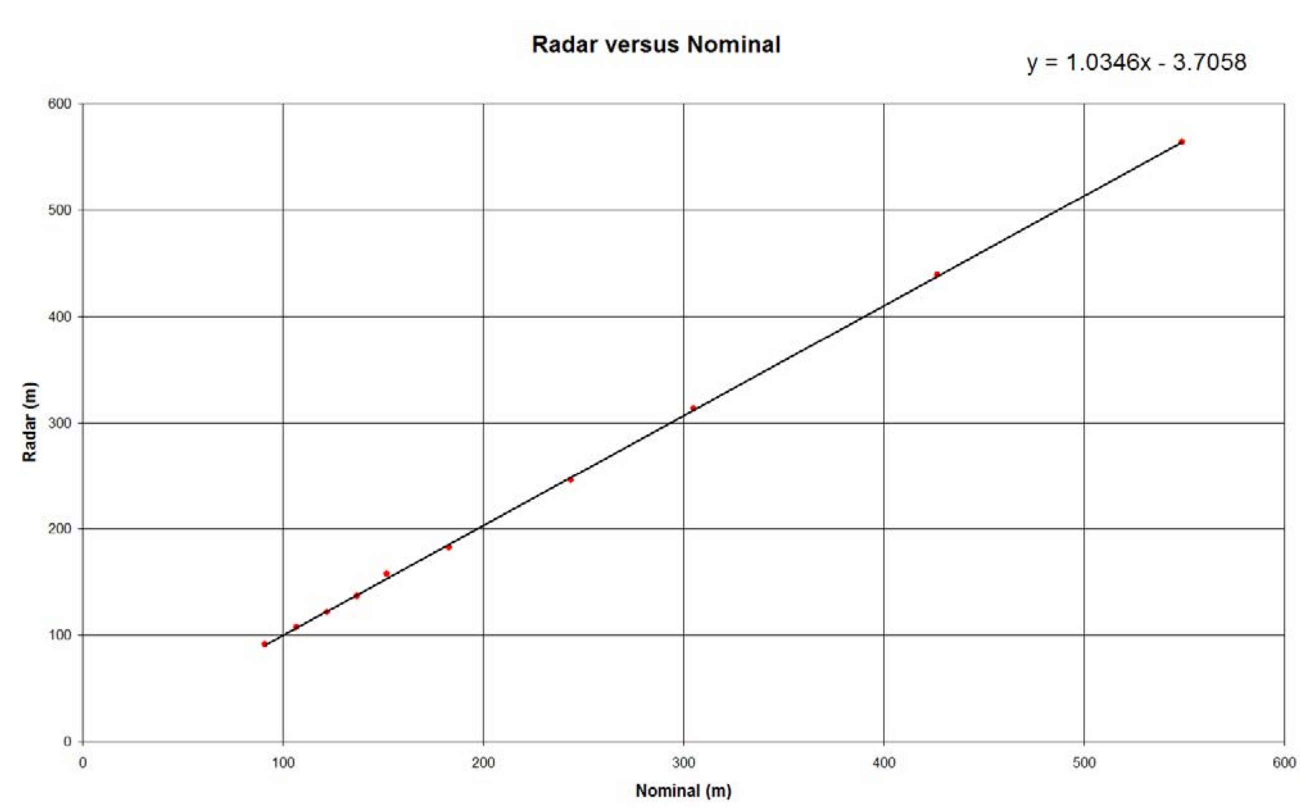
Results of the Altimeter Calibration:
Location: Ottawa River, ON
Date: July 21st, 2008
Job: 08418

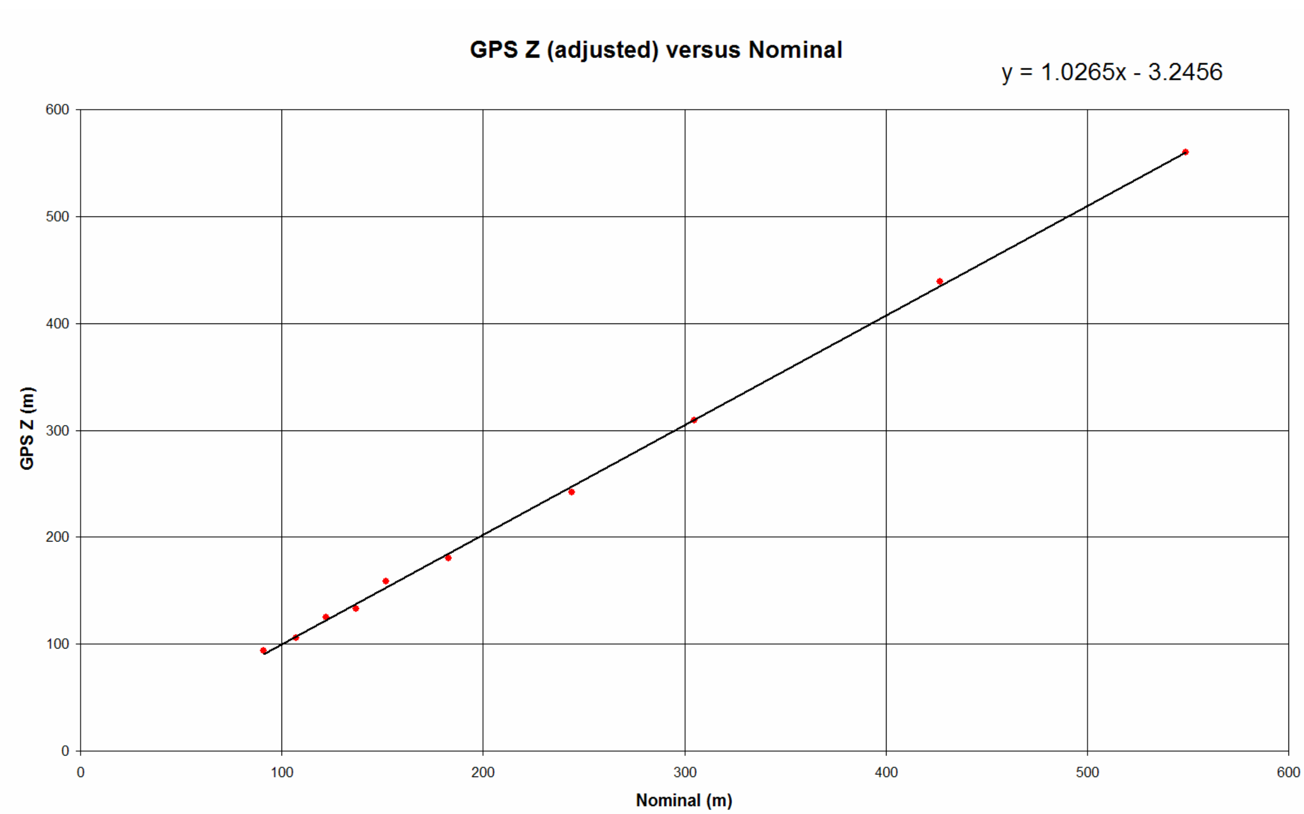
Elevation of river is 45 m a.s.l.

Nominal (m)	Radar (m)	GPS Z adjusted (m)
91	91	93.6
107	107	105.4
122	122	124.9
137	137	133.2
152	158	158.6
183	183	180.6
244	246	241.9
305	313	308.9
427	439	438.6
549	564	560.2

Both radar and GPS Z are linear across the entire range (300 to 1800 ft).
Regression line equations are:
- For Radar versus GPS Z (selected points): y = 1.0346x - 3.71
- For Radar versus Nominal : y = 1.0265x – 3.24
- For GPS Z versus Nominal : y = 0.9923x + 0.41




Radar versus Nominal
y = 1.0346x - 3.7058
Radar (m)
Nominal (m)
0
100
200
300
400
500
600


GPS Z (adjusted) versus Nominal
y = 1.0265x - 3.2456
GPS Z (m)
Nominal (m)
0
100
200
300
400
500
600

AEROMAGNETIC SURVEY SYSTEM CALIBRATION AT BOURGET TEST RANGE, ONTARIO

AIRCRAFT TYPE & REGISTRATION: Dash-7, C-GJPI
DATE: 21/07/2008
ORGANIZATION: FUGRO AIRBORNE SURVEYS
HEIGHT FLOWN: 1270 feet
MAGNETOMETER TYPE: Cesium vapor
SAMPLE RATE: 10 Hz

Direction of Flight Across the Bourget crossroads	Time over the crossroads is seconds after midnight UTC	Total Field value recorded in the survey aircraft over the crossroads **T1**	Observatory diurnal value adjusted to the time over the crossroads **T2**	Calculated Bourget value **T3 = T2-C**	Error value **T4 = T1 – T3**
North	53027.05	53675.27 nT	55217,83 nT	54671.07 nT	4.20 nT
South	52475.00	54678.01 nT	55217.10 nT	54670.34 nT	7.67 nT
East	53309.50	54677.59 nT	55220.00 nT	54673.24 nT	4.35 nT
West	52728.40	54674.43 nT	55217.60 nT	54670.84 nT	3.59 nT
North	54196.00	54675.82 nT	55218.06 nT	54671.30 nT	4.52 nT
South	53584.00	54677.80 nT	55218.00 nT	54671.24 nT	6.56 nT
East	54490.65	54675.82 nT	55218.18 nT	54671.42 nT	4.40 nT
West	53887.55	54673.49 nT	55216.98 nT	54670.22 nT	3.27 nT

TOTAL = 38.56 nT

Number of passes for Average: 8 Average = 4.82 nT

The correction constant C is the difference in the total field between the Blackburn Observatory value (O) and the value B at the point above the Bourget crossroads at a given height. At 1000 feet, C is (O-B) = 550 nT; and at 500 feet, C = 556 feet.

The magnetic gradient over the Bourget crossroads is 0.012 nT/ft.

NOTE: The present test was flown at a mean altitude of 1270 feet above ground. The correction constant C used for this nominal flying height, was adjusted based on the magnetic gradient value. This was calculated to be 546.76 nT.

Average North – South heading error = 2.76 nT

Average East – West heading error = 0.95 nT

Results of the GPS Lag & Accuracy check:
Location: Northway, AK
Date: September 2nd, 2008
Job: 08418

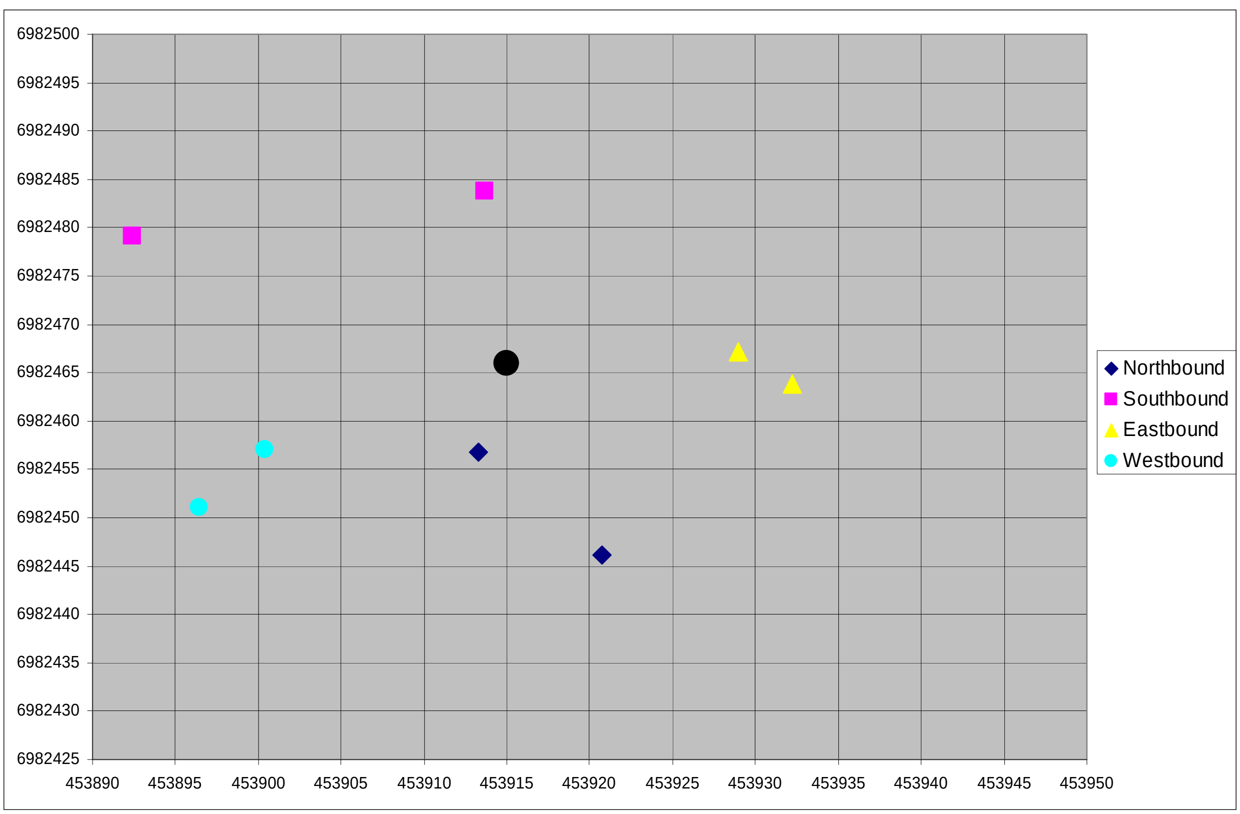
GPS Lag & Accuracy check over BOURGET, 21/07/2008

					RAW		After LAG	
Pass	**Video Fid**	**Offset**	**Speed (m/s)**	**Radar (m)**	**Easting**	**Northing**	**Easting**	**Northing**
1N	86942.9	8m east	78.26	85	453921	6982446	453920	6982461
1S	87169.3	2m west	75.54	89	453914	6982484	453914	6982469
2N	87386.4	2m east	73.93	83	453913	6982457	453914	6982472
2S	87608.8	6m west	76.68	103	453892	6982479	453893	6982464
1E	87863.6	2m south	76.6	85	453932	6982464	453917	6982464
1W	88042.4	5m north	75.61	92	453900	6982457	453916	6982457
2E	88207.9	4m south	75.5	84	453929	6982467	453914	6982467
2W	88371.9	7m north	73.53	96	453896	6982451	453911	6982451

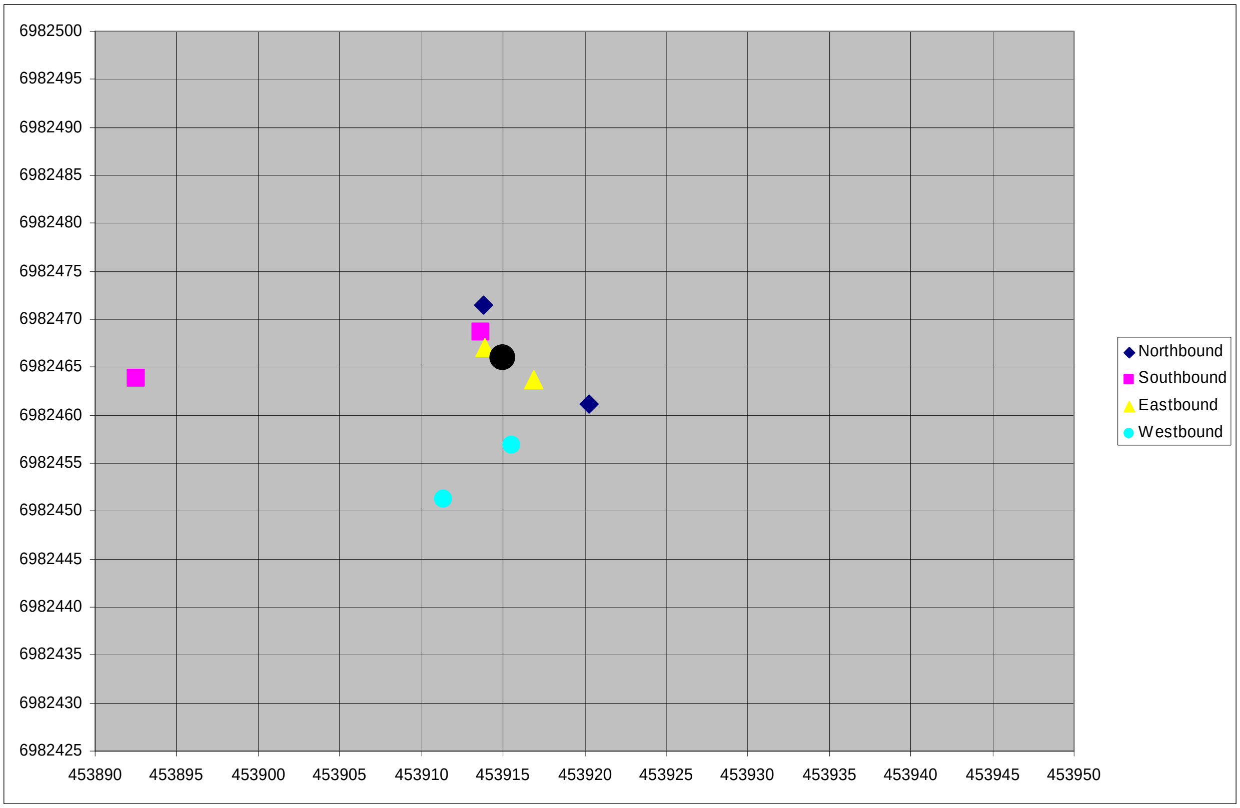
Reference GPS position of the base station is 453915,6982467 (WGS84 UTM Zone 7N)

GPS Lag value calculated: -0.2 second
** Negative lag indicates a lead.

Before Lag Correction



After Lag Correction



APPENDIX B PROFILE ARCHIVE DEFINITION

Geophysical Data Sets 6082 and 6083 were carried out using the time-domain MEGATEM® II electromagnetic and magnetic system mounted on a fixed wing platform. Transmitter base frequency of 90 Hz was used.

Data File Layout

02/02/2009	01:20 PM	<DIR>	digital_video
02/02/2009	01:21 PM	<DIR>	flight_logs
13/02/2009	03:23 PM	<DIR>	geosoft_databases
13/02/2009	03:17 PM	<DIR>	geosoft_grids
09/03/2009	02:35 PM	<DIR>	hwa_files
24/02/2009	11:29 AM	<DIR>	packed_geosoft_maps
24/02/2009	09:56 AM	<DIR>	pdf_maps
23/02/2009	12:48 PM	<DIR>	prameter_tables
03/02/2009	10:39 AM	<DIR>	raw_stream
09/03/2009	02:16 PM	<DIR>	report
24/02/2009	11:57 AM	<DIR>	unpacked_geosoft_maps

The files for the Windy McKinley area MEGATEM® Geophysical Data Set 6082 and 6083 are archived as one external USB hard disk with the file content divided as follows:

- ASCII (GXF) grids
- EM Anomaly database (ASCII format)
- Project report (Word® and Adobe® PDF formats)

- Geosoft® Binary (GRD) grids
- EM Anomaly database (GDB format)
- Project report (Word® and Adobe® PDF formats)

- Profile database of magnetic data (10Hz sampling) in ASCII (XYZ) format.
- Profile database of electromagnetic data (5Hz sampling) in ASCII (XYZ) format
- Parameter table files PTAxxx.OUT
- EM Anomaly database (ASCII format)
- Project report (Word® 2003 and Adobe® PDF formats)
- Profile database of magnetic data (10 Hz sampling) in Geosoft® OASIS montaj (GDB) format.
- Profile database of electromagnetic data (5Hz sampling) in Geosoft® OASIS montaj (GDB) format for block 1,2 and 3
- Parameter table files PTAxxx.OUT
- EM Anomaly database (GDB format)
- Project report (Word® 2003 and Adobe® PDF formats)

The content of the ASCII and binary file types are identical. They are provided in both forms to suit the user's available software.

- Half wave data (5Hz sampling) in compressed ASCII format (WinZip®). Coverage ??
- Half wave data (5Hz sampling) compressed ASCII format (WinZip®). Coverage ??
- Readme file with half wave data description (Word® 97 and Adobe® PDF formats)

- Half wave data (5Hz sampling) in compressed ASCII format (WinZip®).
- Parameter table files PTAxxx.OUT
- Project report (Word® 97 and Adobe® PDF formats)
- Vector files (Geosoft Map® and DXF format) illustrating the half wave data coverage
- Readme file with half wave data description (Word® 97 and Adobe® PDF formats)

Coordinate Systems

The profile, electromagnetic anomaly data is provided in two coordinate systems:
- Universal Transverse Mercator (UTM) projection, Zone 7N, NAD83 datum, North American local datum
- Latitude/longitude coordinates, NAD83 datum, North American local datum

The gridded data are provided in one UTM coordinate systems:
- Universal Transverse Mercator (UTM) projection, Zone 7N, NAD83 datum

Line Numbering

Each traverse and control line has a unique line number with the segment number incorporated as the last digit.

Profile Data

The profile data are provided in two formats, one ASCII and one binary:

ASCII
Directory structure: geosoft_databases/xyz_files/
- Windy_McKinley_5hz.xyz - ASCII XYZ file, sampled at 5 Hz
- Windy_McKinley_mag.xyz - ASCII XYZ file, sampled at 10 Hz.

Binary
Directory structure: geosoft_databases/
- Windy_McKinley_5hz.gdb – Geosoft® OASIS montaj binary database file (no compression), sampled at 5 Hz
- Windy_McKinley_mag.gdb – Geosoft® OASIS montaj binary database file (no compression) , sampled at 10 Hz.

The files Windy_McKinley_5hz.xyz/gdb contain the bulk of the data, including the final magnetic channel, sampled at 5 Hz, the acquisition sampling rate of the electromagnetic data. The contents of Windy_McKinley_5hz.xyz/.gdb (both file types contain the same set of data channels) are summarized as follows (import template for ascii data in the xyz_files directory):

Channel Name	Description	Units

line_number	full flightline number (flightline and part numbers)	
fiducial	fiducials	seconds after midnight
flight	flight number	
date	local date	YYYYMMDD
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
long_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
gps_z_real	real-time GPS Z (NAD83)	metres
gps_z_final	differentially corrected GPS Z (NAD83 datum)	metres above sea level
radar_raw	raw radar altimeter	metres above terrain
radar_final	corrected radar altimeter	metres above terrain
baro_raw	raw barometric altimeter	metres above sea level
baro_final	corrected barometric altimeter	metres above sea level
dem	digital elevation model	metres above sea level
time_utc	UTC time	seconds after midnight
height_mag	magnetometer height	metres above terrain
mag_base_raw	raw magnetic base station data	nanoteslas
mag_base_final	corrected magnetic base station data	nanoteslas
mag_raw	raw magnetic field	nanoteslas
mag_edit	edited magnetic field	nanoteslas
mag_diurn	diurnally corrected magnetic field	nanoteslas
igrf	local IGRF field	nanoteslas
mag_final	final tie line levelled magnetic field	nanoteslas
mag_res	final residual magnetic field	nanoteslas
height_em	electromagnetic receiver height	metres above terrain
em_x_raw_on	raw (stacked) dB/dT, X-component, on-time (5 channels)	picoteslas per second
em_x_raw_off	raw (stacked) dB/dT, X-component, off-time (15 channels)	picoteslas per second
em_y_raw_on	raw (stacked) dB/dT, Y-component, on-time (5 channels)	picoteslas per second
em_y_raw_off	raw (stacked) dB/dT, Y-component, off-time (15 channels)	picoteslas per second
em_z_raw_on	raw (stacked) dB/dT, Z-component, on-time (5 channels)	picoteslas per second
em_z_raw_off	raw (stacked) dB/dT, Z-component, off-time (15 channels)	picoteslas per second
em_x_drift_on	drift-corrected dB/dT, X-component, on-time (5 channels)	picoteslas per second
em_x_drift_off	drift-corrected dB/dT, X-component, off-time (15 channels)	picoteslas per second
em_y_drift_on	drift-corrected dB/dT, Y-component, on-time (5 channels)	picoteslas per second
em_y_drift_off	drift-corrected dB/dT, Y-component, off-time (15 channels)	picoteslas per second
em_z_drift_on	drift-corrected dB/dT, Z-component, on-time (5 channels)	picoteslas per second
em_z_drift_off	drift-corrected dB/dT, Z-component, off-time (15 channels)	picoteslas per second
em_x_final_on	filtered dB/dT, X-component, on-time (5 channels)	picoteslas per second
em_x_final_off	filtered dB/dT, X-component, off-time (15 channels)	picoteslas per second
em_y_final_on	filtered dB/dT, Y-component, on-time (5 channels)	picoteslas per second
em_y_final_off	filtered dB/dT, Y-component, off-time (15 channels)	picoteslas per second
em_z_final_on	filtered dB/dT, Z-component, on-time (5 channels)	picoteslas per second
em_z_final_off	filtered dB/dT, Z-component, off-time (15 channels)	picoteslas per second
em_bx_raw_on	raw (stacked) B-field, X-component, on-time (5 channels)	femtoteslas
em_bx_raw_off	raw (stacked) B-field, X-component, off-time (15 channels)	femtoteslas
em_by_raw_on	raw (stacked) B-field, Y-component, on-time (5 channels)	femtoteslas
em_by_raw_off	raw (stacked) B-field, Y-component, off-time (15 channels)	femtoteslas
em_bz_raw_on	raw (stacked) B-field, Z-component, on-time (5 channels)	femtoteslas
em_bz_raw_off	raw (stacked) B-field, Z-component, off-time (15 channels)	femtoteslas
em_bx_drift_on	drift-corrected B-field, X-component, on-time (5 channels)	femtoteslas
em_bx_drift_off	drift-corrected B-field, X-component, off-time (15 channels)	femtoteslas
em_by_drift_on	drift-corrected B-field, Y-component, on-time (5 channels)	femtoteslas
em_by_drift_off	drift-corrected B-field, Y-component, off-time (15 channels)	femtoteslas
em_bz_drift_on	drift-corrected B-field, Z-component, on-time (5 channels)	femtoteslas
em_bz_drift_off	drift-corrected B-field, Z-component, off-time (15 channels)	femtoteslas
em_bx_final_on	filtered B-field, X-component, on-time (5 channels)	femtoteslas

em_bx_final_off	filtered B-field, X-component, off-time (15 channels)	femtoteslas
em_by_final_on	filtered B-field, Y-component, on-time (5 channels)	femtoteslas
em_by_final_off	filtered B-field, Y-component, off-time (15 channels)	femtoteslas
em_bz_final_on	filtered B-field, Z-component, on-time (5 channels)	femtoteslas
em_bz_final_off	filtered B-field, Z-component, off-time (15 channels)	femtoteslas
power	60 Hz power line monitor	microvolts
primary	electromagnetic primary field	microvolts
tau_x	decay constant (tau) for X-component	microseconds
tau_z	decay constant (tau) for Z-component	microseconds
conductivity	apparent conductivity from dB/dT Z channels 01-20	siemens per metre

In Windy_McKinley_5hz.xyz, the electromagnetic channel data are provided in individual channels with numerical indices (e.g. em_x_final_on[0] to em_x_final_on[4], and em_x_final_off[0] to em_x_final_off[14]). Windy_McKinley_5hz.gdb, the electromagnetic channel data are provided in array channels with 5 elements (on-time) or 15 elements (off-time).

The files Windy_McKinley_mag.xyz/.gdb contain all of the magnetic and related data, sampled at 10 Hz, the acquisition sampling rate of the magnetic data. The contents of Windy_McKinley_mag.xyz/.gdb (both file types contain the same set of data channels) are summarized as follows (import template for ascii data in the xyz_files directory):

Channel Name	**Description**	**Units**
line_number	flightline and part number	
x_nad83	Easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	Northing in UTM co-ordinates using NAD83 datum	metres
long_nad83	Longitude using NAD83 datum	decimal-degrees
lat_nad83	Latitude using NAD83 datum	decimal-degrees
gps_z_real	Real-time GPS Z (NAD83)	metres
gps_z_final	Differentially corrected GPS Z (NAD83 datum)	metres above sea level
radar_raw	Raw radar altimeter	metres above terrain
radar_final	Corrected radar altimeter	metres above terrain
baro_raw	Raw barometric altimeter	metres above sea level
baro_final	Corrected barometric altimeter	metres above sea level
dem	digital elevation model	metres above sea level
fiducial	fiducials	seconds after midnight
flight	flight number	
time_utc	UTC time	seconds after midnight
date	local date	YYYY/MM/DD
height_mag	magnetometer height	metres above terrain
mag_base_raw	raw magnetic base station data	nanoteslas
mag_base_final	corrected magnetic base station data	nanoteslas
mag_raw	raw magnetic field	nanoteslas
mag_edit	edited magnetic field	nanoteslas
mag_diurn	diurnally-corrected magnetic field	nanoteslas
mag_final	final tie line levelled magnetic field	nanoteslas
igrf	local IGRF field	nanoteslas
mag_res	final residual magnetic field	nanoteslas

APPENDIX C ANOMALY ARCHIVE DEFINITION

Electromagnetic Anomaly Data

The electromagnetic anomaly data are provided in two formats, one ASCII and one binary:
ASCII space-delimited format – geosoft_databases/xyz_files/Windy_McKinley_anomalies.xyz

Geosoft® OASIS montaj binary database file -
geosoft_databases/Windy_McKinley_anomalies.gdb

Both file types contain the same set of data channels, summarized as follows (import template for ascii data in the xyz_files directory):

Channel Name	Description	Units
line_number	full flightline number	
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
long_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
height_em	electromagnetic receiver height	metres above terrain
dem	digital elevation model	metres above sea level
anomaly_id	unique anomaly identifier (see below)	
anomaly_letter	anomaly letter identifier (see below)	
anomaly_type_letter	anomaly classification (see below)	
no_chan	number of off-time channels deflected	
em_x_final_on	filtered dB/dT, X-component, on-time (5 channels)	picoteslas per second
em_x_final_off	filtered dB/dT, X-component, off-time (15 channels)	picoteslas per second
em_y_final_on	filtered dB/dT, Y-component, on-time (5 channels)	picoteslas per second
em_y_final_off	filtered dB/dT, Y-component, off-time (15 channels)	picoteslas per second
em_z_final_on	filtered dB/dT, Z-component, on-time (5 channels)	picoteslas per second
em_z_final_off	filtered dB/dT, Z-component, off-time (15 channels)	picoteslas per second
em_bx_final_on	filtered B-field, X-component, on-time (5 channels)	femtoteslas
em_bx_final_off	filtered B-field, X-component, off-time (15 channels)	femtoteslas
em_by_final_on	filtered B-field, Y-component, on-time (5 channels)	femtoteslas
em_by_final_off	filtered B-field, Y-component, off-time (15 channels)	femtoteslas
em_bz_final_on	filtered B-field, Z-component, on-time (5 channels)	femtoteslas
em_bz_final_off	filtered B-field, Z-component, off-time (15 channels)	femtoteslas
tau_x	decay constant (tau) for X-component	microseconds
tau_z	decay constant (tau) for Z-component	microseconds
conductance	apparent conductivity from dB/dT Z channels 01-20	siemens per metre
conductance_vert	conductance of vertical plate model	siemens
depth	depth of vertical plate model	metres
heading	direction of flight	degrees
flight	flight number	
fiducial	fiducial	seconds after midnight
time_utc	UTC time	seconds after midnight
date	local date	YYYY/MM/DD

The unique anomaly identifier (anomaly_id) is a ten digit integer in the format 1LLLLLLAAA where 'LLLLLL' holds the line number (and leading zeroes pad short line numbers to six digits). The 'AAA' represents the numeric anomaly identifier (anomaly_no) for that line padded with leading zeroes to three 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.

The codes for anomaly_type and anomaly_type_number are as follows:

N	1	Normal (bedrock) response
N?	2	Normal (bedrock) response, questionable
S	3	Surficial response
S?	4	Surficial response, questionable
C	5	Cultural (man-made) response
C?	6	Cultural (man-made) response, questionable

The (?) does not question the existence of the anomaly, but denoted some uncertainty as to the possible origin of the source.

N: Bedrock (normal) - an anomaly whose response matches that of a bedrock conductor, using a thin vertical plate model. This anomaly type might include other shapes of conductors: roughly pod-shaped, thick dykes, short strike length bodies, or conductors sub-parallel to the flight path.

S: Flat lying conductors - generally surficial. Typical geologic anomalies might be conductive overburden, swamps or clay layers. They would not appear to be conductive at depth.

C: Line current - an anomaly with the shape typical of line currents - typically cultural (man-made sources) such as power lines, train tracks, fences, etc.

APPENDIX D GRID ARCHIVE DEFINITION

Gridded Data

The gridded data are provided in binary format:
*.grd - Geosoft® OASIS montaj binary grid file (no compression)

The grids are summarized as follows:

Windy_McKinley_mag_res	IGRF-corrected residual magnetic field in nanoteslas (UTM coordinates, NAD83 datum)
Windy_McKinley_mag_vd1	first vertical derivative of the IGRF-corrected magnetic field in nanoteslas per metre-squared (UTM coordinates, NAD83 datum)
Windy_McKinley_dem	digital elevation model in metres above sea level (UTM coordinates, NAD83 datum)
Windy_McKinley_cond_hs	apparent conductivity in siemens per metre (UTM coordinates, NAD83 datum)
Windy_McKinley_cond_hs_deh	de-herringboned apparent conductance in siemens per metre (UTM coordinates, NAD83 datum)
Windy_McKinley_taux09	x-coil decay constant (tau) in microseconds (ms) (UTM coordinates, NAD83 datum),
Windy_McKinley_taux09_deh	de-herringboned x-coil decay constant (tau) in ms (UTM coordinates, NAD83 datum)
Windy_McKinley_tauz09	z-coil decay constant (tau) in microseconds (UTM coordinates, NAD83 datum)
Windy_McKinley_tauz09_deh	de-herringboned z-coil decay constant (tau) in ms (UTM coordinates, NAD83 datum)

APPENDIX E TDEM PARAMETER TABLE DEFINITION

A parameter table file exists for each survey flight. This file represents the TDEM reference waveform used by the system to compensate the received signal for the contribution by the primary field generated at the transmitter.

Each file is stored as "ptaxxx.out", where xxx identifies the corresponding flight number.

The files are archived as standard ASCII text files and contain the following information:

- System geometry/configuration.
- Window (channel) positions, given in samples along the waveform.
- Conversion factors from listed values to PPM.
- Each point of the waveform for the following 7 components:
  - Transmitter response in units of Am^2
  - dB/dT X-coil response in units of nT/s
  - dB/dT Y-coil response in units of nT/s
  - dB/dT Z-coil response in units of nT/s
  - B-Field X-coil response in units of fT
  - B-Field Y-coil response in units of fT
  - B-Field Z-coil response in units of fT

<u>A sample of a parameter table follows</u>

```
GEOTEM Calibration Data - Version 31 July 1998
 'D0080112.002' = Name of original saved parameter table file
     125.000000000000000 = Horizontal TX-RX separation in metres
      50.000000000000000 = Vertical   TX-RX separation in metres
      90.000000000000000 = Base Frequency in Hertz
      43.402777777777780 = Sample Interval in micro-seconds
        20 Time Gates:  First and Last Sample number, RMS chart position:
             1          4        10        1
             2         11        23        2
             3         24        36        3
             4         37        49        4
             5         50        53        5
             6         54        55        6
             7         56        58        7
             8         58        61        8
             9         62        64        9
             10        65        68       10
             11        69        72       11
             12        73        76       12
             13        77        81       13
             14        82        86       14
             15        87        91       15
             16        92        97       16
             17        98       103       17
             18       104       110       18
             19       111       118       19
             20       119       128       20
```

Component:	TX	dBx/dt	dBy/dt	dBz/dt	Bx	By	Bz
IndivPPM:		16.97154	852.8368	32.88570	24.99176	1302.157	48.35992
TotalPPM:		15.07923	15.07923	15.07923	22.19901	22.19901	22.19901
SI_Units:		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
DataUnits:	A*m^2	nT/s	nT/s	nT/s	pT	pT	pT
128 Samples:							
1	7729.282	15.96003	-3.930862	25.94668	-113.2370	-.2736754	-53.69548
2	1024.003	24.50268	1.026651	13.67564	-112.3589	-.3367008	-52.83562
3	398.5879	317.5182	16.88734	198.6653	-104.9366	.5205769E-01	-48.22753
4	15695.36	3616.584	119.4898	2086.784	-19.56110	3.011632	1.369888
5	67698.08	14473.86	379.0306	7872.654	373.0266	13.83022	217.5035
6	134235.2	30133.23	732.3142	15838.12	1341.062	37.94794	732.0602
7	198690.4	43453.41	1017.253	22496.55	2937.995	75.91598	1563.976
8	261714.8	51975.27	1164.056	26779.31	5008.929	123.2534	2633.330
9	323187.0	56594.40	1207.164	29131.60	7365.042	174.7122	3846.675
10	382890.4	58589.26	1196.222	30170.94	9864.688	226.8690	5133.622
11	440686.7	58926.92	1161.745	30367.83	12414.95	278.0401	6447.398
12	496231.2	58214.87	1118.357	30021.63	14957.09	327.5215	7757.933
13	549314.6	56810.41	1071.185	29312.33	17453.30	375.0376	9045.562
14	599686.2	54918.71	1021.773	28345.43	19877.98	420.4577	10296.82
15	647069.8	52657.67	969.9995	27182.63	22212.53	463.6819	11501.85
16	691302.4	50094.17	915.6895	25860.95	24442.39	504.6040	12652.97
17	732240.1	47272.43	857.8681	24404.12	26555.38	543.0926	13743.79
18	769640.8	44222.05	796.7552	22827.58	28540.94	579.0003	14768.79
19	803450.5	40966.94	731.9139	21144.64	30389.66	612.1745	15723.04
20	833346.6	37527.52	663.6411	19366.39	32093.10	642.4600	16602.19
21	859323.9	33922.85	592.5283	17502.52	33643.67	669.7206	17402.30
22	881209.9	30170.38	518.8977	15562.19	35034.58	693.8401	18119.85
23	898976.3	26288.71	442.1611	13555.16	36259.82	714.6964	18751.73
24	912502.6	22297.01	364.2277	11491.54	37314.20	732.1962	19295.28
25	921742.5	18214.65	284.6580	9381.562	38193.36	746.2779	19748.26
26	926662.2	14060.86	204.0446	7234.495	38893.78	756.8834	20108.85
27	927364.1	9854.848	122.9833	5060.035	39412.79	763.9804	20375.66
28	923746.7	5615.631	41.92896	2869.674	39748.52	767.5592	20547.74
29	915895.0	1362.764	-39.14478	671.1644	39899.96	767.6196	20624.58
30	903873.7	-2884.436	-121.0489	-1523.952	39866.93	764.1432	20606.08
31	887685.5	-7103.616	-201.4232	-3703.113	39650.18	757.1451	20492.64
32	867399.8	-11277.36	-280.4637	-5859.924	39251.29	746.6875	20285.11
33	843172.9	-15386.93	-357.6422	-7983.167	38672.64	732.8397	19984.70
34	815163.6	-19412.59	-433.1687	-10062.68	37917.44	715.6780	19593.08
35	783413.8	-23336.08	-506.9882	-12089.16	36989.73	695.2753	19112.35
36	748179.8	-27139.86	-578.1486	-14054.79	35894.33	671.7263	18544.99
37	709579.2	-30807.27	-647.4260	-15948.87	34636.80	645.1296	17893.87
38	667809.9	-34320.21	-712.1000	-17762.84	33223.44	615.6260	17162.28
39	623115.9	-37664.14	-773.0846	-19489.75	31661.28	583.3955	16353.85
40	575678.5	-40823.00	-830.5354	-21120.95	29958.00	548.5947	15472.54
41	525725.8	-43783.54	-884.4982	-22649.47	28121.92	511.3761	14522.66
42	473492.1	-46532.31	-933.8410	-24068.54	26161.94	471.9156	13508.81
43	419244.9	-49057.47	-978.6750	-25371.42	24087.51	430.4113	12435.90
44	363220.0	-51347.62	-1018.960	-26553.29	21908.58	387.0599	11309.06
45	305690.8	-53393.00	-1054.490	-27608.78	19635.57	342.0632	10133.67
46	247003.6	-55184.48	-1085.077	-28533.00	17279.28	295.6316	8915.313
47	187352.1	-56715.41	-1110.876	-29322.47	14850.90	247.9763	7659.769
48	127010.4	-57979.32	-1131.085	-29974.13	12361.87	199.3227	6372.951
49	65108.98	-58917.41	-1137.950	-30448.89	9825.045	150.0814	5061.687
50	8325.732	-58320.01	-1086.630	-30032.90	7280.830	101.8049	3749.149
51	-14672.06	-51573.19	-916.9132	-26305.74	4895.995	58.32526	2526.522

52	-10537.82	-37103.35	-593.0906	-18811.49	2971.591	25.55608	1547.415
53	-5599.680	-21897.11	-243.9040	-11197.24	1691.199	7.392134	896.1842
54	-3335.518	-11422.98	-34.09738	-5971.165	968.1067	1.359118	523.6060
55	-2195.035	-5555.815	40.83756	-2999.166	599.6433	1.505389	328.9374
56	-1650.604	-2597.416	46.96001	-1462.370	422.7069	3.410719	232.1159
57	-1394.167	-1207.738	31.18607	-714.3275	340.1297	5.106597	184.8785
58	-1290.904	-587.9979	14.44187	-364.0430	301.1598	6.096787	161.4764
59	-1259.885	-325.6664	2.467782	-205.2027	281.3320	6.463750	149.1229
60	-1249.743	-219.5141	-4.727469	-135.2952	269.5008	6.414712	141.7337
61	-1236.130	-178.4729	-7.894109	-105.1228	260.8640	6.140806	136.5163
62	-1228.445	-162.4722	-8.681833	-91.96437	253.4650	5.781085	132.2392
63	-1228.072	-154.7766	-8.449795	-85.45306	246.5802	5.409305	128.3890
64	-1235.436	-149.0760	-7.719331	-81.20456	239.9862	5.058412	124.7723
65	-1239.135	-143.7213	-6.716692	-77.92262	233.6321	4.745131	121.3190
66	-1228.420	-138.4068	-5.746719	-75.17229	227.5095	4.474657	117.9966
67	-1230.271	-132.8315	-5.199392	-72.73333	221.6233	4.237111	114.7869
68	-1230.279	-127.4344	-4.822192	-69.75897	215.9752	4.019629	111.6946
69	-1232.587	-121.9220	-4.375208	-66.75803	210.5638	3.820033	108.7320
70	-1231.816	-116.5951	-3.843931	-64.03566	205.3876	3.641666	105.8936
71	-1230.655	-111.5820	-3.492133	-61.65565	200.4359	3.482463	103.1659
72	-1240.686	-106.7221	-3.285778	-59.28498	195.6984	3.335373	100.5413
73	-1230.556	-102.1274	-2.788408	-56.58284	191.1660	3.203555	98.02684
74	-1224.671	-97.80101	-2.555312	-54.35416	186.8273	3.087589	95.61935
75	-1242.676	-93.79646	-2.602747	-52.20010	182.6694	2.975652	93.30698
76	-1221.913	-90.06383	-2.423037	-49.80333	178.6794	2.866585	91.09336
77	-1224.827	-86.67500	-2.085020	-47.63036	174.8439	2.768754	88.97892
78	-1223.877	-83.54163	-2.145144	-45.92556	171.1499	2.676954	86.94862
79	-1224.360	-80.37018	-2.181369	-43.74102	167.5928	2.583062	85.00273
80	-1216.329	-77.45803	-2.054077	-42.29580	164.1677	2.491147	83.13562
81	-1216.461	-74.63999	-1.909674	-41.02884	160.8670	2.405128	81.32736
82	-1219.590	-71.84667	-1.952082	-39.22677	157.6880	2.321323	79.58570
83	-1217.326	-69.29994	-1.722317	-37.73324	154.6250	2.241583	77.91556
84	-1208.074	-66.98568	-1.702209	-36.93633	151.6674	2.167266	76.29512
85	-1204.960	-64.85393	-1.863035	-35.93988	148.8063	2.089895	74.71361
86	-1212.486	-62.79464	-1.811555	-34.36544	146.0361	2.010152	73.18789
87	-1197.069	-61.05624	-1.531892	-33.37806	143.3484	1.937594	71.71776
88	-1200.950	-59.26998	-1.342465	-32.39280	140.7371	1.875217	70.29044
89	-1207.054	-57.18716	-1.143159	-31.13019	138.2098	1.821275	68.91190
90	-1204.022	-55.12002	-1.410749	-29.84234	135.7726	1.765852	67.58871
91	-1208.568	-53.75584	-1.293131	-28.49288	133.4099	1.707174	66.32276
92	-1199.583	-52.40686	-1.289343	-27.83346	131.1060	1.651131	65.10040
93	-1202.806	-50.86095	-1.529696	-27.22848	128.8649	1.589954	63.90548
94	-1199.792	-49.30663	-1.576225	-26.20628	126.6912	1.522551	62.74587
95	-1199.316	-47.86020	-1.543451	-25.17110	124.5825	1.454850	61.63091
96	-1192.981	-46.37361	-1.681621	-24.67046	122.5375	1.384861	60.54928
97	-1202.529	-45.03350	-1.735938	-24.19844	120.5538	1.310695	59.48876
98	-1201.134	-43.87226	-1.298038	-23.61783	118.6245	1.244854	58.45108
99	-1196.000	-42.72894	-.9459133	-23.08331	116.7451	1.196157	57.43760
100	-1193.117	-41.36467	-1.104402	-22.57521	114.9201	1.151662	56.44674
101	-1188.970	-40.08990	-1.055567	-21.90611	113.1525	1.104788	55.48144
102	-1191.844	-39.20676	-.9711572	-21.28362	111.4316	1.060805	54.54416
103	-1187.353	-38.35579	-.9610370	-20.83961	109.7484	1.018874	53.63003
104	-1182.623	-37.58065	-1.107444	-19.57735	108.1005	.9739849	52.75292
105	-1185.573	-36.67272	-1.140099	-18.58970	106.4891	.9252101	51.92465
106	-1192.319	-35.65127	-.9681687	-18.88900	104.9195	.8794578	51.11131
107	-1181.724	-34.75552	-.9804116	-18.50845	103.3916	.8371709	50.29973
108	-1186.438	-34.17176	-1.026308	-17.45993	101.8958	.7936223	49.51917

109	-1199.872	-33.28027	-.9290356	-17.02904	100.4320	.7511886	48.77071
110	-1188.594	-32.43866	-.9026078	-16.96322	99.00581	.7114394	48.03303
111	-1179.076	-31.71388	-1.017675	-16.18233	97.61361	.6697666	47.31372
112	-1182.215	-30.66168	-.9334908	-15.89610	96.25997	.6274236	46.61758
113	-1180.092	-29.68911	-.8826723	-16.25654	94.95028	.5880103	45.91982
114	-1187.398	-29.09322	-.9129155	-15.74467	93.67462	.5490436	45.22535
115	-1177.059	-28.75610	-1.009828	-14.67370	92.41921	.5073174	44.56523
116	-1174.586	-28.25669	-.9648259	-14.49814	91.18195	.4644646	43.93216
117	-1183.997	-27.73846	-.9766050	-14.75480	89.96678	.4223329	43.29733
118	-1167.828	-27.23595	-1.118851	-14.37880	88.77376	.3768586	42.66509
119	-1173.520	-26.52897	-1.165315	-13.72234	87.60698	.3272890	42.05526
120	-1169.221	-25.98087	-.8165336	-13.67054	86.46745	.2842801	41.46079
121	-1175.950	-25.32296	-.5975554	-13.33578	85.35408	.2535924	40.87472
122	-1171.817	-24.59286	-.8683287	-12.00767	84.27084	.2217807	40.32473
123	-1179.774	-24.14219	-.8897683	-11.37691	83.21322	.1836276	39.81725
124	-1171.686	-23.78949	-.2847956	-11.95205	82.17304	.1581379	39.31098
125	-1164.672	-23.16276	-.2341293	-11.92169	81.15411	.1468765	38.79289
126	-1174.168	-22.62722	-.9565273	-11.68826	80.16040	.1210376	38.28052
127	-1169.698	-22.20212	-.9646375	-11.90825	79.18754	.7934567E-01	37.76844
128	-1175.490	-21.84364	-.6305303	-11.79718	77.75765	.3104493E-01	36.99799

APPENDIX F HALFWAVE ARCHIVE DEFINITION

Each ASCII file is a continuous data stream representing the acquisition for one complete flight. Each line of the ASCII file contains 4109 data values, namely the fiducial ***[F]***, and for each of the four components [T, X, Y, and Z], the primary electromagnetic field ***[PEM]***, the powerline monitor ***[PLM]***, the earth's field monitor (ambient electromagnetic noise) ***[EFM]*** and the 1024 waveform points stored in that order. The four waveform components are:

T - PEM_T, PLM_T, EFM_T and the amplitude of the transmitted electromagnetic field $[T_1 \ldots T_{1024}]$

X - PEM_X, PLM_X, EFM_X and the amplitude of the secondary electromagnetic field as seen by the X coil $[X_1 \ldots X_{1024}]$

Y - PEM_Y, PLM_Y, EFM_Y and the amplitude of the secondary electromagnetic field as seen by the Y coil $[Y_1 \ldots Y_{1024}]$

Z - PEM_Z, PLM_Z, EFM_Z and the amplitude of the secondary electromagnetic field as seen by the Z coil $[Z_1 \ldots Z_{1024}]$

All data values are stored in scientific format (exponential notation), as volts. The format allows storage of the waveform as 1024 points. The halfwave sampling rate of 4 Hz is a forty five-fold stack from the original sampling rate of 90 Hz.

The fiducials mark the number of seconds after midnight for the day of the flight. Each fiducial represents a 0.25 second sample. As such, although the fiducials repeat for four lines of data, they actually increment by 0.25 seconds. For example, the second occurrence of fiducial 74087 is actually 74087.25 seconds, the third is 74087.50 seconds and the fourth is 74087.75 seconds.

The following table illustrates the ASCII data structure:

column												
1	**2**	**3**	**4**	**5**		**1028**	**1029**	**1030**	**1031**	**1032**		**2055**
F	PEM_T	PLM_T	EFM_T	T_1	…	T_{1024}	PEM_X	PLM_X	EFM_X	X_1	…	X_{1024}
	volts											
74087	1.0012530E+00	9.7377970E-04	6.5032010E-04				9.9598440E-01	1.7564380E-03	-3.3043160E-03			
74087	1.0012400E+00	8.6172720E-05	7.1580250E-04				9.9651290E-01	1.7200990E-03	-6.0959600E-02			
74087	1.0012840E+00	8.7328300E-05	7.0525570E-04				9.9891420E-01	1.6912790E-03	-8.5706660E-02			
74087	1.0011300E+00	9.2401830E-05	7.4590280E-04				1.0005320E+00	2.5104030E-03	-4.9193540E-02			
	column											
	2056	**2057**	**2058**	**2059**		**3082**	**3083**	**3084**	**3085**	**3086**		**4109**
	PEM_Y	PLM_Y	EFM_Y	Y_1	…	Y_{1024}	PEM_Z	PLM_Z	EFM_Z	Z_1	…	Z_{1024}
	volts											
	-1.4667880E+00	1.9064400E-03	1.9168430E-01				1.0075570E+00	1.3699210E-03	-6.2297300E-03			
	-1.4890710E+00	4.5591580E-03	-2.0755340E-03				1.0058710E+00	1.4081860E-03	7.7472150E-03			
	-1.3149210E+00	1.9930260E-03	-1.6909430E-01				1.0018460E+00	1.5687660E-03	9.7720830E-03			
	-1.0673150E+00	1.8790290E-03	-1.8799610E-01				9.9887660E-01	1.7389310E-03	-5.1124900E-03			