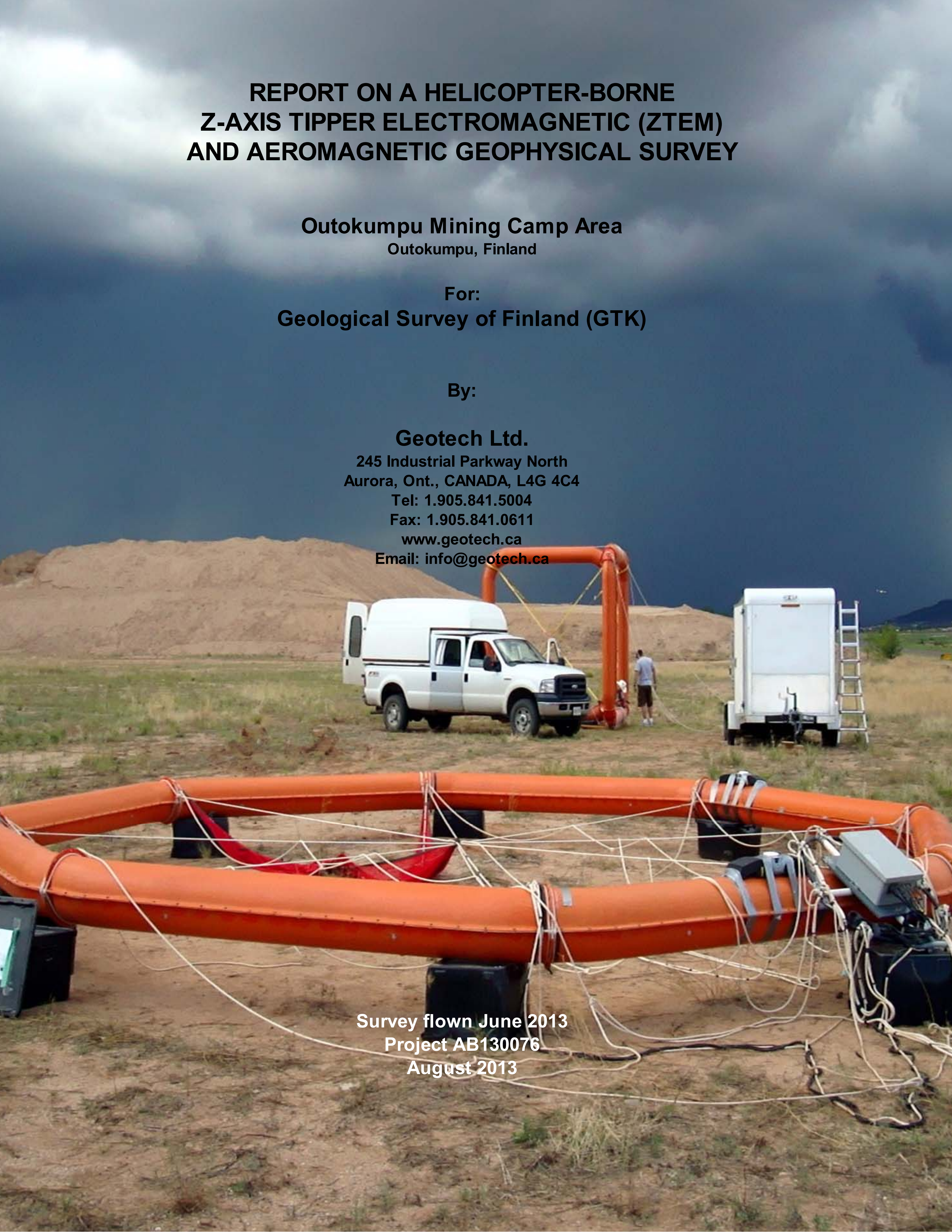

REPORT ON A HELICOPTER-BORNE Z-AXIS TIPPER ELECTROMAGNETIC (ZTEM) AND AEROMAGNETIC GEOPHYSICAL SURVEY

Outokumpu Mining Camp Area

Outokumpu, Finland

For:

Geological Survey of Finland (GTK)

By:

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Survey flown June 2013
Project AB130076
August 2013

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REPORT ON A HELICOPTER-BORNE Z-AXIS, TIPPER ELECTROMAGNETIC (ZTEM) AND AEROMAGNETIC GEOPHYSICAL SURVEY

Outokumpu Mining Camp Area
Outokumpu, Finland

Executive Summary

During June 6th to June 28th, 2013 Geotech Ltd. carried out a helicopter-borne geophysical survey for the Geological Survey of Finland over the Outokumpu Mining Camp Area situated near Outokumpu, Finland.

Principal geophysical sensors included a Z-Axis Tipper electromagnetic (ZTEM) system, and a caesium magnetometer. Ancillary equipment included a GPS navigation system and a radar altimeter. A total of 1201 line-kilometres of geophysical data were acquired during the survey.

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

The processed survey results are presented as the following maps:

- Total Magnetic Intensity
- 3D View of In-Phase Total Divergence versus Skin Depth
- In-Phase Total Divergence (25Hz, 75Hz and 300Hz)
- Tzx In-line In-Phase & Quadrature Profiles over 75Hz Phase Rotated Grid
- Tzy Cross-line In-Phase & Quadrature Profiles over 75Hz Phase Rotated Grid

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set. 2D inversions over selected lines were performed in support of the ZTEM survey results.

1. INTRODUCTION

1.1 General Considerations

These services are the result of the agreement made between Geotech Ltd. and the Geological Survey of Finland to perform a helicopter-borne geophysical survey over the Outokumpu Mining Camp Area situated near Outokumpu, Finland (Figure 1&2).

Maija Kurimo represented the Geological Survey of Finland during the data acquisition and data processing phases of this project.

The geophysical surveys consisted of helicopter borne AFMAG Z-axis Tipper electromagnetic (ZTEM) system and aero magnetics sensor using a caesium magnetometer. A total of 1201 line kilometres of geophysical data were acquired during the survey. The survey area is shown in Figure 2.

In a ZTEM survey, a single vertical-dipole air-core receiver coil is flown over the survey area in a grid pattern, similar to regional airborne EM surveys. Three orthogonal axis, air-core coils are placed close to the survey site to measure the horizontal EM reference fields. Data from the four coils are used to obtain the Tzx and Tzy Tipper (Vozoff, 1972) components at minimum six frequencies in the 25 to 600 Hz band. The ZTEM data provides useful information on geology using resistivity contrasts while magnetometer data provides additional information on geology using magnetic susceptibility contrasts.

Figure 1: Property Location

The crew was based out of Joensuu, Finland for the acquisition phase of the survey. Survey flying was started on June 6th and was completed on June 28th, 2013. Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in August, 2013.

1.2 Survey Location

The Outokumpu Mining Camp Area is located at Outokumpu, Finland as shown in Figure 2.

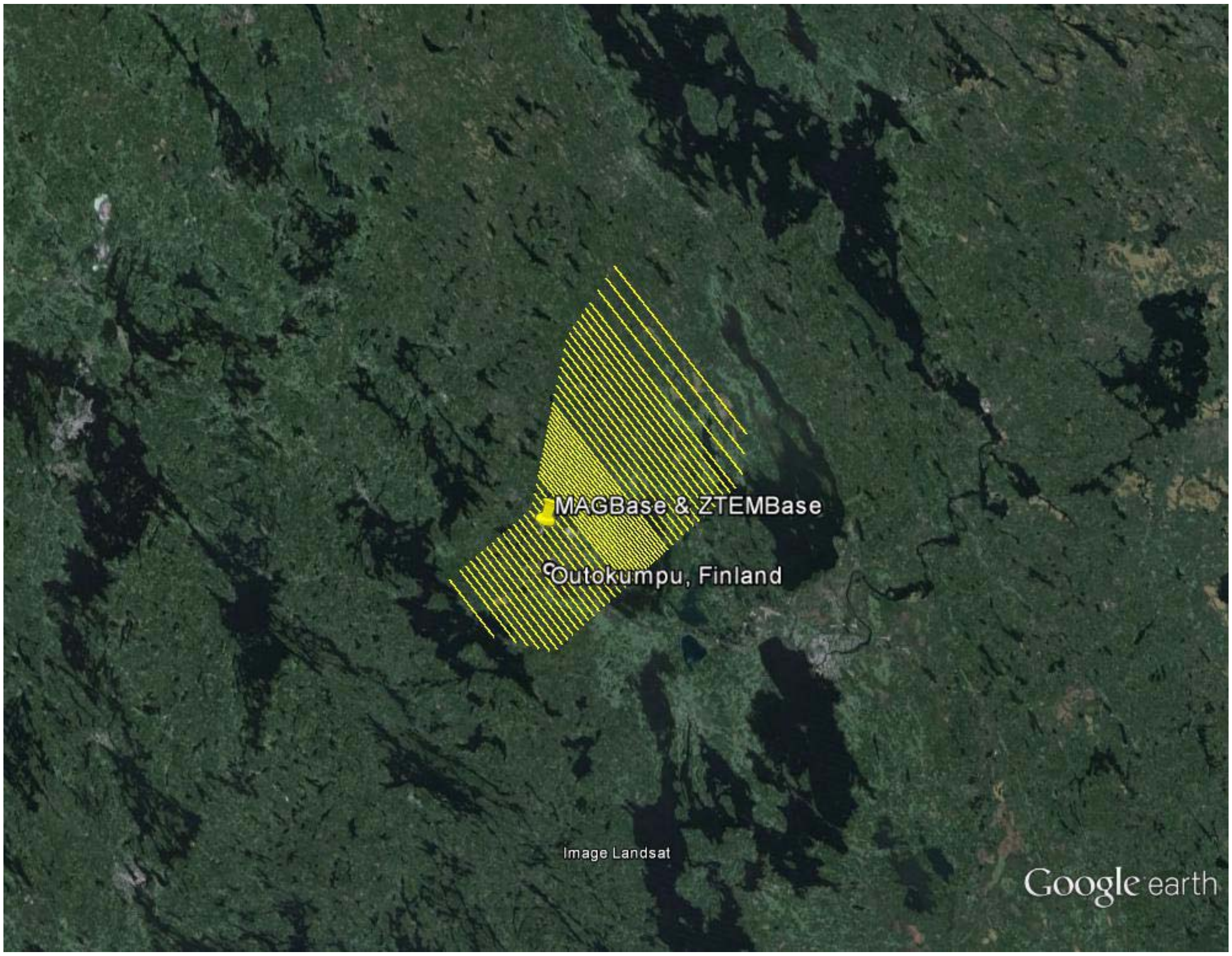

Figure 2: Survey Area with ZTEM and Magnetic Base Station Locations

The survey was flown in a northwest to southeast (N 140° E azimuth) direction, with a combination of flight line spacing of 500, 1000, and 2000 metres as depicted in Figure 3. Tie lines were neither flown nor planned for this survey. For more detailed information on the flight spacing and direction see Table 1.

1.3 Topographic Relief and Cultural Features

The Block exhibits a high relief covering 1155 square kilometres, with an elevation ranging from 68 to 255 meters above sea level (see Figure 3).

There are a number of rivers and streams which connect various lakes. There are visible signs of culture such as roads, railroads, trails, powerlines, and building infrastructure as the survey area passes through a populated town.

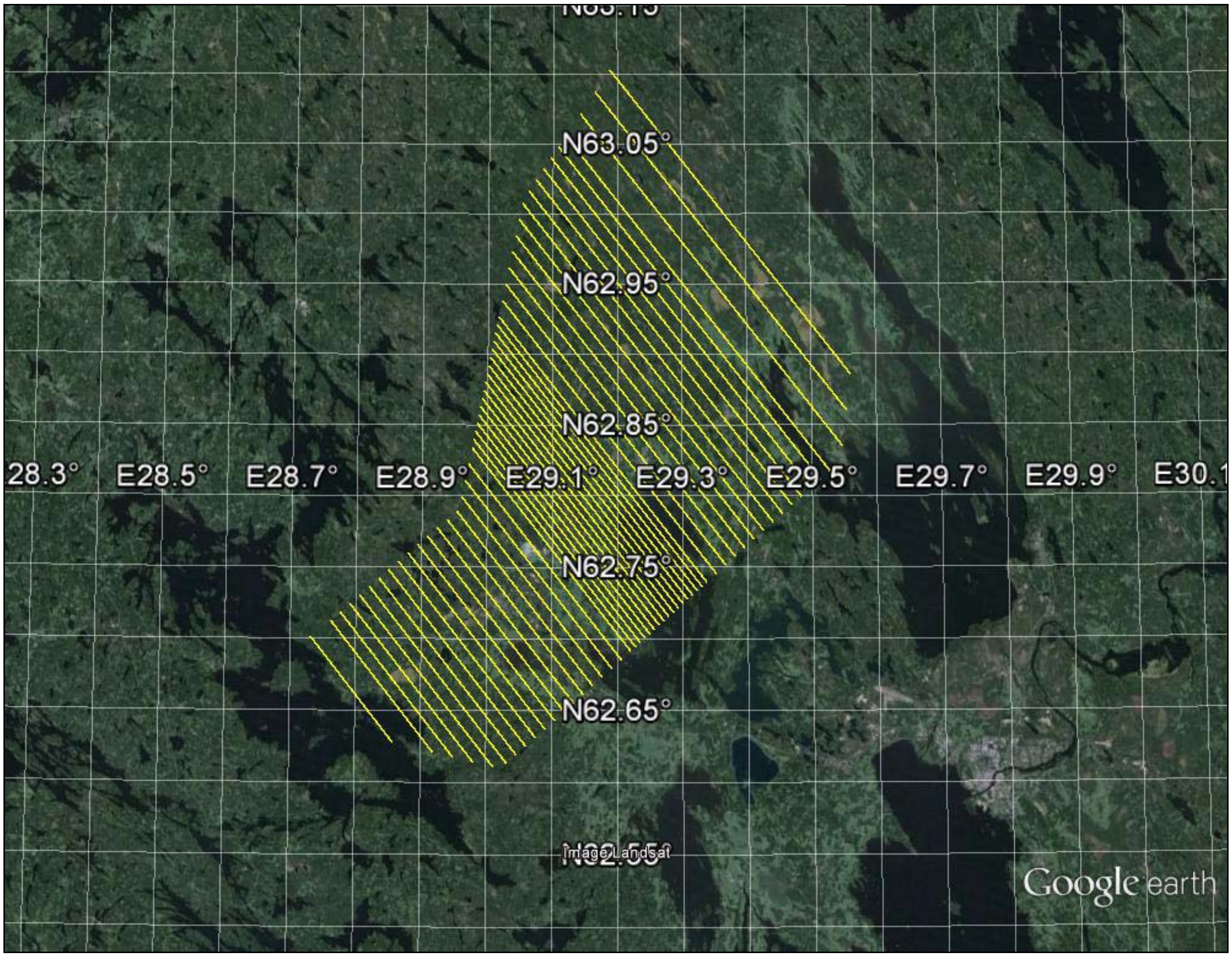

Figure 3: Google Earth image of the block

2. DATA ACQUISITION

2.1 Survey Area

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

Table 1: Survey Specifications

Survey block	Traverse Line spacing (m)	Area (Km^2)	Planned Line-km	Actual[1] Line-km	Flight direction	Line numbers
Outokumpu	Traverse: 500/1000/2000	1155	1201	1252.4	N 140° E / N 320° E	L1000 – L1230
TOTAL		**1155**	**1201**	**1252.4**		

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

2.2 Survey Operations

Survey operations were based out of Joensuu, Finland June 6th, 2013 to June 28th, 2013. The following table shows the timing of the flying.

Table 2: Survey schedule

Date	Flight #	Flow km	Crew location	Comments
6-June-2013			Joenssu, Finland	Mobillization
7-June-2013			Joenssu, Finland	Mobillization
8-June-2013			Joenssu, Finland	ZTEM BS System assembly Polarity test completed
9-June-2013			Joenssu, Finland	ZTEM BS System assembly completed
10-June-2013			Joenssu, Finland	Limited assembly – light to heavy rain
11-June-2013			Joenssu, Finland	Limited assembly – heavy rain
12-June-2013			Joenssu, Finland	Limited assembly – heavy rain
13-June-2013			Joenssu, Finland	Helicopter arrived, system assembled
14-June-2013			Joenssu, Finland	Heli install completed No further tests due to heavy rain
15-June-2013			Joenssu, Finland	No production due to technical issues
16-June-2013			Joenssu, Finland	No production due to technical issues
17-June-2013			Joenssu, Finland	No production due to technical issues
18-June-2013			Joenssu, Finland	No production due to technical issues
19-June-2013			Joenssu, Finland	No production due to technical issues
20-June-2013	1		Joenssu, Finland	Kms not accepted

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

Date	Flight #	Flow km	Crew location	Comments
21-June-2013	2,3		Joenssu, Finland	Flight aborted – didn't have enough fuel Kms not accepted
22-June-2013	4,5	279.8	Joenssu, Finland	280 is flown
23-June-2013			Joenssu, Finland	Pilot's mandatory day off
24-June-2013	6,7	263.6	Joenssu, Finland	264 km flown
25-June-2013	8,9,10	230.9	Joenssu, Finland	231 km flown
26-June-2013	11,12	262.4	Joenssu, Finland	262 km flown
27-June-2013	13,14	95.6	Joenssu, Finland	96 km flown
28-June-2013	15	68.3	Joenssu, Finland	Remaining kms were flown – flying complete

2.3 Flight Specifications

During the survey the helicopter was maintained at a mean altitude of 161 metres above the ground with a nominal survey speed of 80 km/hour for the survey block. This allowed for a nominal EM bird terrain clearance of 91 metres and a magnetic sensor clearance of 106 metres.

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

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

2.4 Aircraft and Equipment

2.4.1 Survey Aircraft

The survey was flown using an Aerospatiale SA315B Lama helicopter, registration number I-EFLY. The helicopters were owned and operated by Air Walser. Installation of the geophysical and ancillary equipment was carried out by a Geotech Ltd crew.

2.4.2 Airborne Receiver

The airborne ZTEM receiver coil measures the vertical component (Z) of the EM field. The receiver coil is a Geotech Z-Axis Tipper (ZTEM) loop sensor which is isolated from most vibrations by a patented suspension system and is encased in a fibreglass shell. It is towed from the helicopter using an 85 metre long cable as shown in Figure 4.

The coil has a 7.4 metre diameter with an orientation to the Vertical Dipole. The digitizing rate of the receiver is 2000 Hz. Attitudinal positioning of the receiver coil is enabled using 3 GPS antennas mounted on the coil. The output sampling rate is 0.4 seconds (see Section 2.4.7)

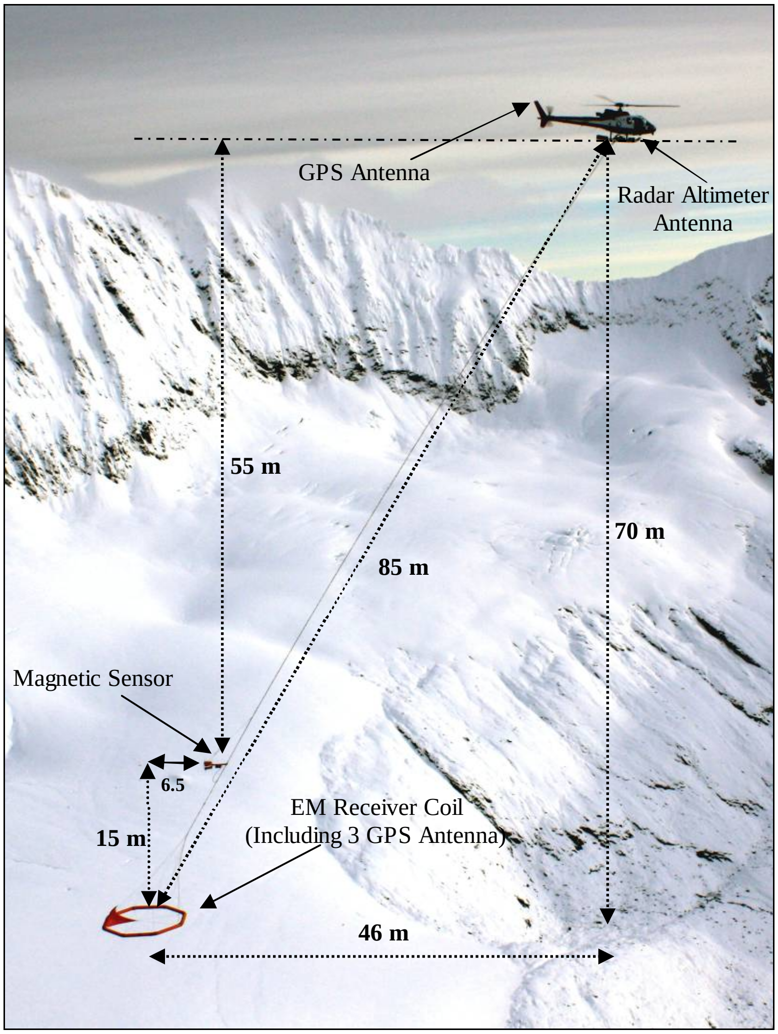

Figure 4: ZTEM System Configuration

2.4.3 Base Station Receiver

The Geotech ZTEM base station deployed on this survey was consisted of three orthogonal coils as shown in Figure 5. The measured field by these coils provide horizontal X and Y components of the EM reference field which is further used with the airborne coil data to calculate the in-line and cross-line component of the Tzx and Tzy field. One side of each coil is 3.04 metres.

The base station for the survey was installed in a flat area, surrounded by high trees and deep forest (62°45.4962"N, 28°59.0038"W) away from any cultural sources. The azimuth of the reference coil was N203^{o}E (named as A) and for the orthogonal component it was N293^{o}E (named as B). Angles A and B are taken into account together with the survey lines azimuth to calculate the in-line (Tzx) and cross-line (Tzy) field utilizing a proprietary software.

Figure 5: ZTEM base station receiver coils.

2.4.4 Airborne magnetometer

The magnetic sensor utilized for the survey was a Geometrics split-beam optically pumped caesium vapour magnetic field sensor, mounted in a separate bird, and towed on a cable at a mean distance of 55 metres below the helicopter (Figure 4). The sensitivity of the magnetic sensor is 0.02 nanoTesla (nT) at a sampling interval of 0.1 seconds. The magnetometer will perform continuously in areas of high magnetic gradient with the ambient range of the sensor approximately 20k-100k nT. The Aerodynamic magnetometer noise is specified to be less than 0.5 nT. The magnetometer sends the measured magnetic field strength as nanoTesla to the data acquisition system via the RS-232 port.

2.4.5 Radar Altimeter

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

2.4.6 GPS Navigation System

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

2.4.7 Digital Acquisition System

The power supply and the data acquisition system are mounted on an equipment rack which is installed into the helicopter. Signal and power wires are run through the helicopter to connect on to the tow cable outside. The tow cable supports the ZTEM and magnetometer birds during flight via a safety shear pin connected to the helicopter hook. The major power and data cables have a quick disconnect safety feature as well. The installation was undertaken by the Geotech Ltd. crew and was certified before surveying.

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 3.

Table 3: Acquisition and Processing Sampling Rates

DATA TYPE	ACQUISITION SAMPLING	PROCESSING SAMPLING
ZTEM Receiver	0.0005 sec	0.4 sec
Magnetometer	0.1 sec	0.4 sec
GPS Position	0.2 sec	0.4 sec
Radar Altimeter	0.2 sec	0.4 sec
ZTEM Base station	0.0005 sec	– –

2.4.8 Mag Base Station

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

The base station magnetometer sensors for the block (62°45.4962'N, 28°59.0038'W) were installed next to the ZTEM base station away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.

3. PERSONNEL

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

Field:

Project Manager:	Jerome Vidal (Office)
Data QA/QC:	Nick Venter (Office)
Crew chief:	Werner Hilla
System Operators:	Werner Hilla

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Air Walser.

Pilot:	Emanuel Bertoldi
Mechanical Engineer:	Fabrizzio Mordenti

Office:

Preliminary Data Processing:	Nick Venter
Final Data Processing:	Carlos Izarra
Final Data QC:	Geoffrey Plastow
2D Inversions:	Shengkai Zhao
Reporting/Mapping:	Karl Monje/Wendy Acorn

Data acquisition was carried out under the supervision of Andrei Bagrianski, P. Geo, Chief Operating Officer. Processing was under the supervision of Geoffrey Plastow, ZTEM Processing Manager and 2D inversions under the supervision of Jean Legault, P. Geo, P. Eng, Chief Geophysicist (Interpretation). The overall contract management and customer relations were by Doug Pitcher.

4. DATA PROCESSING AND PRESENTATION

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

4.1 Flight Path

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the KKJ, Finland Uniform Coordinate System (KKJ-3) in Oasis Montaj.

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

4.2 In-field Processing and Quality Control

In-Field data processing and quality control are done on a flight by flight basis by a qualified data processor (see Section 3.0). Processing steps and check-up procedures are designed to assure the best possible final quality of ZTEM survey data. A general overview of those steps is presented in the following paragraphs.

The In-Field quality control can be separated into several phases:

a. GPS Processing Phase: GPS Data are first examined and evaluated during the GrafMov processing.
b. Raw data, ZTEM viewer phase:
   Data can be viewed, examined for consistency, individual channel spectra examined and overall noise estimated in the viewer provided by the ZTEM proprietary software, on the raw flight data and raw base station data separately, on the merged data, and finally on the data that have undergone ZTEM processing.
c. Field Geosoft phase:
   Magnetic data, Radar altimeter data, GPS positioning data are re-examined and processed in this phase. Prior to splitting the lines EM data are examined flight by flight and the effectiveness of applying the attitude correction evaluated. After splitting the lines, a set of grids are generate for each parameter and their consistency evaluated. Data profiles are also re-evaluated on a line to line basis. A power line monitor channel is available in order to identify power line noise.

4.3 GPS Processing

Three GPS sensor (mounted on the airborne receiving loop) measurements were differentially corrected using the Waypoint GrafMov^{TM} software in order to yield attitude corrections to recorded EM data.

4.4 ZTEM Electromagnetic Data

The ZTEM data were processed using proprietary software. Processing steps consist of the following preliminary and final processing steps:

4.4.1 Preliminary Processing

a. Airborne EM, Mag, radar altimeter and GPS data are first merged with EM base station data into one file.
b. Merged data are viewed and examined for consistency in an incorporated viewer
c. In the next, processing phase, the following entities are taken into account:
   - the Base station coils orientation with respect to the Magnetic North,
   - the Local declination of the magnetic field,
   - Suggested direction of the X coordinate (North or line direction),
   - Sensitivity coefficient that compensates for the difference in geometry between the base station and airborne coils.
   - Rejection filters for the 60 Hz and helicopter generated frequencies.
d. six frequencies (25, 37, 75, 150, 300 and 600 Hz) are extracted from the airborne EM time-series coil response using windows of 0.4 seconds and the base station coils using windows of 1.0 seconds.
e. The real (In-Phase) and imaginary (Quadrature) parts of the tipper transfer functions are derived from the In-line (X or Tzx) and Cross-line (Y or Tzy) components.
f. Such processed EM data are then merged with the GPS data, magnetic base station data and exported into a Geosoft xyz file.

4.4.2 Geosoft Processing

Next stage of the preliminary data processing is done in a Geosoft ™ environment, using the following steps:

a. Import the output xyz file from the AFMAG processing, as well as the base Mag data into one database.
b. Split lines according to the recorded line channel,
c. GPS processing, flight path recovery (correcting, filtering, calculating Bird GPS coordinates, line splitting)
d. Radar altimeter processing, yielding the altitude values in metres.
e. Magnetic spike removal, filtering (applied to both airborne and base station data). Calculation of a base station corrected mag.
f. Apply preliminary attitude corrections to EM data (In phase and Quadrature), filter and make preliminary grids and profiles of all channels.

4.4.3 Final Processing

Final data processing and quality control were undertaken by Geotech Ltd headquarters in Aurora, Ontario by qualified senior data processing personnel.

A quality control step consisted of re-examining all data in order to validate the preliminary data processing and to allow for final adjustments to the data.

Attitude corrections were re-evaluated, and re-applied, on component by component, flight by flight, and frequency by frequency bases. Any remaining line to line system noise was removed by applying a mild additional levelling correction.

4.4.4 ZTEM Profile Sign Convention

Tzx and Tzy tipper components do not exhibit maxima or minima above conductors, resistors or at contacts; in fact they produce cross-over type anomalies (Ward, 1959; Vozoff, 1972; Labson, 1985). The sign of the cross-over (positive-to-negative or neg-to-pos) or its polarity (normal or reversed) depends on the line direction and follows a well-defined convention. The crossover polarity sign convention for ZTEM is according to the right hand Cartesian rule (Z positive –up) that is commonly used for multi-component transient electromagnetic methods.

For the southeast to northwest lines of the block the sign convention for the In-phase Tzx in-line component crossover is positive-negative pointing N 320° E for tabular conductors' perpendicular to the profile (Figure 6). The corresponding Tzy component in-phase cross-over polarity is positive-negative pointing N 230° E (90 degrees counter clockwise to Tzx) according to the right hand Cartesian rule.

Conversely, tabular resistive bodies produce In-Phase cross-overs for the In-line Tzx and Cross-line Tzy components that are opposite in sign to conductors, i.e., negative to positive cross-overs.

On the other hand, the Quadrature part of the tipper transfer function can produce cross-overs in Tzx and Tzy that are of either polarity over a conductor or resistor. For this reason, the ZTEM profile sign convention only applies to the In-phase part of the tipper response. A brief discussion of ZTEM and AFMAG, along with selected forward model responses is presented in Appendix D.

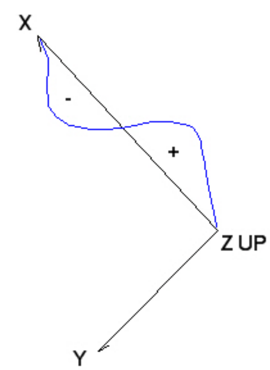

Figure 6: ZTEM Crossover Polarity Convention for Tzx and Tzy for survey lines

4.4.5 ZTEM Quadrature Sign Dependence

One important note regarding the sign of the ZTEM Quadrature, relative to the In-Phase component, particularly with regards to computer modeling and inversion.

The sign of the magnetotelluric Quadrature relative to the In-Phase tipper transfer function component pertains to the Fourier transformation of the time series to give frequency domain spectra. There are two widely used conventions for time dependence in the transformations, **exp(+iωt)** and **exp(-iωt).** That which is implemented largely is a matter of personal preference and precedent. The importance of the In-Phase and Quadrature sign convention is not critical, provided that it is known and documented.

In ZTEM, the data processing code used for the Fourier transformation the time-series data to frequency domain spectra adopts a **exp(-iωt)** time dependence (J. Dodds, Geo Equipment Manufacturing, pers. comm., Nov-2009). Whereas in the forward modeling and inversion program Zvert2d, the sign of the Quadrature relative to the In-Phase transfer function assumes an **exp(+iωt)** dependence[2].

As a result, for users interested in computer modeling and inversion of ZTEM data, the sign of the Quadrature will need to be reversed, relative to the In-Phase component, in order to provide a proper result (Figure 7). Indeed this reverse Quadrature polarity convention is assumed in all forward modeling and inversion of ZTEM data, as described in Figures 5-7 in Appendix D.

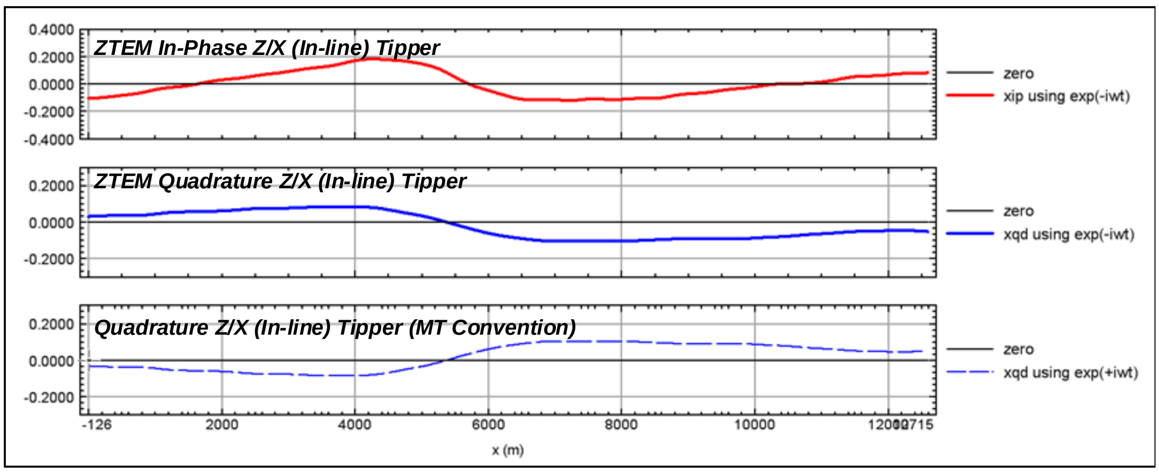

Figure 7: Illustration of ZTEM In-Phase & Quadrature Tipper transfer function polarity convention (e-iωt) relative to equivalent MT Tipper Quadrature polarity convention (e+iωt) for a graphitic conductor in Athabasca Basin, SK.

[2] Phillip E. Wannamaker (2009): Two-dimensional Inversion of ZTEM data: Synthetic Model Study and Test Profile Images, Internal Geotech technical report by Emblem Exploration Services Inc., January 22, 2009, 32 pp.

4.4.6 Total Divergence and Phase Rotation Processing

In a final processing step DT (Total Divergence) and PR (Phase Rotation) processing are applied to the multi-frequency In-phase and Quadrature ZTEM data. This is due to the crossover nature of the Tipper Responses; these additional processing steps are applied to convert them into local maxima for easier interpretation.

To present the data from both tipper components into one image, the Total Divergence parameter, termed the DT is calculated from the horizontal derivatives of the Tzx and Tzy tippers (Lo and Zang, 2008). It is analogous to the "Peaker" parameter in VLF (Pedersen, 1998).

Total Divergence DT: ***DT = DIV (Tzx, Tzy)***
= d(Tzx)/dx+d(Tzy)/dy

This DT parameter was introduced by Petr Kuzmin (Milicevic, 2007, p. 13) and is derived for each of the In Phase and Quadrature components at individual frequencies. These in turn allow for minima over conductors and maxima over resistive zones. DT grids for each of the extracted frequencies were generated accordingly, using a reverse colour scheme with warm colours over conductors and cool colours over resistors.

The DT gives a clearer image of conductor's location and shape but, as a derivative, it does not preserve some of the long wavelength information and is also sensitive to noise.

As an alternative, a 90 degree Phase Rotation (PR) technique is also applied to the grids of each individual component (Tzx and Tzy). It transforms bipolar (cross over) anomalies into single pole anomalies with a maximum over conductors, while preserving long wavelength information (Lo et al., 2009). The two orthogonal grids are then usually added to obtain a Total Phase Rotated (TPR) grid for the In-Phase and Quadrature.

Total Phase-Rotation TPR: ***= PR (Tzx) + PR (Tzy)***

A presentation of the ZTEM test survey results over unconformity uranium deposits that illustrates DT and TPR examples, as documented by Lo et al. (2009) is provided in Appendix E.

4.4.7 2D EM Inversion

2d inversions of the ZTEM results were performed over selected lines using the Geotech Av2dtopo software developed by Phil Wannamaker, U. of Utah, for Geotech Ltd. The inversion algorithm is based on the 2D inversion code with Jacobians of de Lugao and Wannamaker (1996), the 2D forward code of Wannamaker et al (1987), and the Gauss-Newton parameter step equations of Tarantola (1987). Av2dtopo has been developed/modified for use with our ZTEM platform by taking into account the ground topography and the air-layer between the receiver bird and the ground surface. It also implements a depth-of-investigation (DOI) index, using the 1.5x MT maximum skin depth and integrated 1D conductance method of Spies (1989). This is shown using a dashed DOI line and opaque coloring in the 2d inversion sections of Appendix F.

The 2D code only considers the In-Line (Tzx) data and assumes that the strike lengths of bodies are infinite and orthogonal to the profile. The code is designed to account for the ZTEM vertical coil receiver and fixed base station reference measurements. The inversion uses a model-mesh consisting of 440 cells laterally and 112 cells vertically. Typically the ZTEM data are de-sampled to 192 pts, in order to allow the inversion to run in 20 minutes or less. Typically, between 1-2% errors are added to the In-line in-phase (XIP) and Quadrature (XQD) data obtained at 25, 37, 75, 150, 300 and 600 Hz. Errors are adjusted until numerical convergence (<1.0 rms) is attained in 5 iterations or less. All inversions are based on an apriori homogeneous starting half-space model, usually between 100 – 1000ohm metres, as determined by the interpreter, based on model testing, as described in Appendix F.

4.5 Magnetic Data

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

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of 150 metres. The Minimum Curvature algorithm was used to interpolate values onto a rectangular regular spaced grid.

5. DELIVERABLES

5.1 Survey Report

The survey report describes the data acquisition, processing, and final presentation of the survey results. The survey report is provided in two paper copies and digitally in PDF format.

5.2 Maps

Final maps were produced at scale of 1:50,000. The coordinate/projection system used was KKJ, Finland Uniform Coordinate System. All maps show the flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as profile plans for the EM data that were generated for individual real (In-Phase) and imaginary parts (Quadrature) of the Tzx and Tzy components. Colour contour maps of the corresponding DT (Total Divergence) or TPR (Total Phase Rotated) grids for three of the six frequencies, (25, 37, 75, 150, 300 and 600Hz), as well as for corresponding Phase Rotated Grids for individual components.

3D views have been constructed by plotting the either DT or TPR grids at their respective penetration depths using a 2000 ohm-m half space, using the Bostick skin depth rule (Bostick, 1977) see Appendix D.

Final maps were chosen, in consultation with the client, to represent all collected data, are listed in Section 5.3.

Sample maps of the related 3D view, Magnetic and Total Phase Rotated are included in this report and presented in Appendix C.

5.3 Digital Data

- Two copies of the data and maps on 2 DVDs were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map and PDF format.

- DVD structure.

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

Databases in Geosoft GDB format, containing the channels listed in Table 4.

Table 4: Geosoft GDB Data Format

Column	Description
X	KKJ Uniform Coordinate System Easting, (Centre of the ZTEM loop) (meters)
Y	KKJ Uniform Coordinate System Northing, (Centre of the ZTEM loop) (meters)
Longitude	Longitude – WGS84 (Centre of the ZTEM loop) (Decimal degree)
Latitude	Latitude – WGS84 (Centre of the ZTEM loop) (Decimal degree)
Z	Elevation- WGS84 (Centre of the ZTEM loop) (metres)
Radar	Helicopter terrain clearance from radar altimeter (metres - AGL)
Alt_B	Calculated ZTEM Bird terrain clearance (metres)
DEM	Digital Elevation Model (above mean sea level, meters)
Gtime	UTC Time (seconds of the day)
basemag	Magnetic base station data, nT
Mag1	Measured total magnetic field, nT
Mag2	Diurnally-corrected total magnetic field, nT
Mag3	Levelled total magnetic field, nT
IGRF	International Geomagnetic Reference Field
IGRF_INCL	IGRF Inclination
IGRF_DECL	IGRF Declination
TMI_IGRF	IGRF corrected TMI
xIp_025Hz	Tzx In-Phase 25 Hz final corrected
xIp_037Hz	Tzx In-Phase 37 Hz final corrected
xIp_075Hz	Tzx In-Phase 75 Hz final corrected
xIp_150Hz	Tzx In-Phase 150 Hz final corrected
xIp_300Hz	Tzx In-Phase 300 Hz final corrected
xIp_600Hz	Tzx In-Phase 600 Hz final corrected
xQd_025Hz	Tzx Quadrature 25 Hz final corrected
xQd_037Hz	Tzx Quadrature 37 Hz final corrected
xQd_075Hz	Tzx Quadrature 75 Hz final corrected
xQd_150Hz	Tzx Quadrature 150 Hz final corrected
xQd_300Hz	Tzx Quadrature 300 Hz final corrected
xQd_600Hz	Tzx Quadrature 600 Hz final corrected
yIp_025Hz	Tzy In-Phase 25 Hz final corrected
yIp_037Hz	Tzy In-Phase 37 Hz final corrected
yIp_075Hz	Tzy In-Phase 75 Hz final corrected
yIp_150Hz	Tzy In-Phase 150 Hz final corrected
yIp_300Hz	Tzy In-Phase 300 Hz final corrected
yIp_600Hz	Tzy In-Phase 600 Hz final corrected
yQd_025Hz	Tzy Quadrature 25 Hz final corrected
yQd_037Hz	Tzy Quadrature 37 Hz final corrected
yQd_075Hz	Tzy Quadrature 75 Hz final corrected
yQd_150Hz	Tzy Quadrature 150 Hz final corrected
yQd_300Hz	Tzy Quadrature 300 Hz final corrected
yQd_600Hz	Tzy Quadrature 600 Hz final corrected
PLM	Power Line Monitor (50Hz)

- Grids in Geosoft GRD format, as follows:

TMI:	Total Magnetic Intensity (TMI)
DEM:	Digital Elevation Model
PLM:	Power Line Monitor
IGRF:	International Geomagnetic Reference Field
TMI_IGRF:	IGRF corrected TMI
RTP_TMI_IGRF:	IGRF corrected RTP TMI
XIP_25Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 25 Hz
XIP_37Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 37 Hz
XIP_75Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 75 Hz
XIP_150Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 150 Hz
XIP_300Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 300 Hz
XIP_600Hz_PR:	Tzx In-Phase Component Phase Rotated grid at 600 Hz
XQd_25Hz_PR:	Tzx Quadrature component Phase Rotated grid at 25 Hz
XQd_37Hz_PR:	Tzx Quadrature component Phase Rotated grid at 37 Hz
XQd_75Hz_PR:	Tzx Quadrature component Phase Rotated grid at 75 Hz
XQd_150Hz_PR:	Tzx Quadrature component Phase Rotated grid at 150 Hz
XQd_300Hz_PR:	Tzx Quadrature component Phase Rotated grid at 300 Hz
XQd_600Hz_PR:	Tzx Quadrature component Phase Rotated grid at 600 Hz
YIP_25Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 25 Hz
YIP_37Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 37 Hz
YIP_75Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 75 Hz
YIP_150Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 150 Hz
YIP_300Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 300 Hz
YIP_600Hz_PR:	Tzy In-Phase Component Phase Rotated grid at 600 Hz
YQd_25Hz_PR:	Tzy Quadrature component Phase Rotated grid at 25 Hz
YQd_37Hz_PR:	Tzy Quadrature component Phase Rotated grid at 37 Hz
YQd_75Hz_PR:	Tzy Quadrature component Phase Rotated grid at 75 Hz
YQd_150Hz_PR:	Tzy Quadrature component Phase Rotated grid at 150 Hz
YQd_300Hz_PR:	Tzy Quadrature component Phase Rotated grid at 300 Hz
YQd_600Hz_PR:	Tzy Quadrature component Phase Rotated grid at 600 Hz
IP_25Hz_DT:	Total Divergence grid from In-phase components at 25 Hz
IP_37Hz_DT:	Total Divergence grid from In-phase components at 37 Hz
IP_75Hz_DT:	Total Divergence grid from In-phase components at 75 Hz
IP_150Hz_DT:	Total Divergence grid from In-phase components at 150 Hz
IP_300Hz_DT:	Total Divergence grid from In-phase components at 300 Hz
IP_600Hz_DT:	Total Divergence grid from In-phase components at 600 Hz
QD_25Hz_DT:	Total Divergence grid from Quadrature components at 25 Hz
QD_37Hz_DT:	Total Divergence grid from Quadrature components at 37 Hz
QD_75Hz_DT:	Total Divergence grid from Quadrature components at 75 Hz
QD_150Hz_DT:	Total Divergence grid from Quadrature components at 150 Hz
QD_300Hz_DT:	Total Divergence grid from Quadrature components at 300 Hz
QD_600Hz_DT:	Total Divergence grid from Quadrature components at 600 Hz
IP_25Hz_TPR:	Total Phase Rotated grid from In-phase components at 25 Hz
IP_37Hz_TPR:	Total Phase Rotated grid from In-phase components at 37 Hz
IP_75Hz_TPR:	Total Phase Rotated grid from In-phase components at 75 Hz
IP_150Hz_TPR:	Total Phase Rotated grid from In-phase components at 150 Hz
IP_300Hz_TPR:	Total Phase Rotated grid from In-phase components at 300 Hz

IP_600Hz_TPR: Total Phase Rotated grid from In-phase components at 600 Hz
QD_25Hz_TPR: Total Phase Rotated grid from Quadrature components at 25 Hz
QD_37Hz_TPR: Total Phase Rotated grid from Quadrature components at 37 Hz
QD_75Hz_TPR: Total Phase Rotated grid from Quadrature components at 75 Hz
QD_150Hz_TPR: Total Phase Rotated grid from Quadrature components at 150 Hz
QD_300Hz_TPR: Total Phase Rotated grid from Quadrature components at 300 Hz
QD_600Hz_TPR: Total Phase Rotated grid from Quadrature components at 600 Hz

A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 150 metres was used.

- Maps at 1:50,000 scale in Geosoft MAP format, as follows:

AB130076_50K_3D_IP_DT: 3D view of In-Phase Total Divergence versus Skin Depth (25-600Hz)
AB130076_50K_TMI: Total Magnetic Intensity (TMI_
AB130076_50K_25Hz_IP_DT: 25Hz In-Phase Total Divergence Grid
AB130076_50K_75Hz_IP_DT: 75Hz In-Phase Total Divergence Grid
AB130076_50K_300Hz_IP_DT: 300Hz In-Phase Total Divergence Grid
AB130076_50K_XIP_profiles_XIP_PR: Tzx (In-line) In-Phase Profiles over 75Hz Phase Rotated In-Phase Grid
AB130076_50K_XQD_profiles_XQD_PR: Tzx (In-line) Quadrature Profiles over 75Hz Phase Rotated Quadrature Grid.
AB130076_50K_YIP_profiles_YIP_PR: Tzy (Cross-line) In-Phase Profiles over 75Hz Phase Rotated In-Phase Grid
AB130076_50K_YQD_profiles_YQD_PR: Tzy (Cross-line) Quadrature Profiles over 75Hz Phase Rotated Quadrature Grid.

- 2D Resistivity Inversion maps:

L1030_inv_res: resistivity inversion of line L1030
L1140_inv_res: resistivity inversion of line L1140

- Maps are also presented in PDF format.

- The topographic data base was derived from Geocommunities (www.geocomm.com)

- A Google Earth file *"AB130076_GTK.kml"* is included, showing the flight path of each block. Free versions of Google Earth software from: http://earth.google.com/download-earth.html

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

A helicopter-borne ZTEM and aeromagnetic geophysical survey has been completed over the Outokumpu Mining Camp Area located near Outokumpu, Finland.

The total area coverage is 1,155 km^2. Total survey line coverage is 1,201 line kilometres. The principal sensors included a Z-Axis Tipper electromagnetic (ZTEM) system and a caesium magnetometer. Results have been presented as stacked profiles and contour colour images at a scale of 1:50,000.

There is no summary interpretation included in this report; however 2D inversions over selected lines were performed in support of the ZTEM survey results.

6.2 Recommendations

Based on the geophysical results obtained, a number of interesting conductive structures were identified across the property. The magnetic results also contain worthwhile information in support of exploration targets of interest. We therefore recommend a more detailed interpretation of the available geophysical data, including additional 2D or 3D inversions and ground follow-up, in conjunction with the geology, prior to ground follow up and drill testing.

Respectfully submitted[3],

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[3] Final data processing of the EM and magnetic data were carried out by Nick Venter and Carlos Izarra and 2D Inversions by Shengkai Zhao from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Geoffrey Plastow, Data Processing Manager and Jean Legault, P. Geo, P. Eng, Chief Geophysicist (Interpretation)

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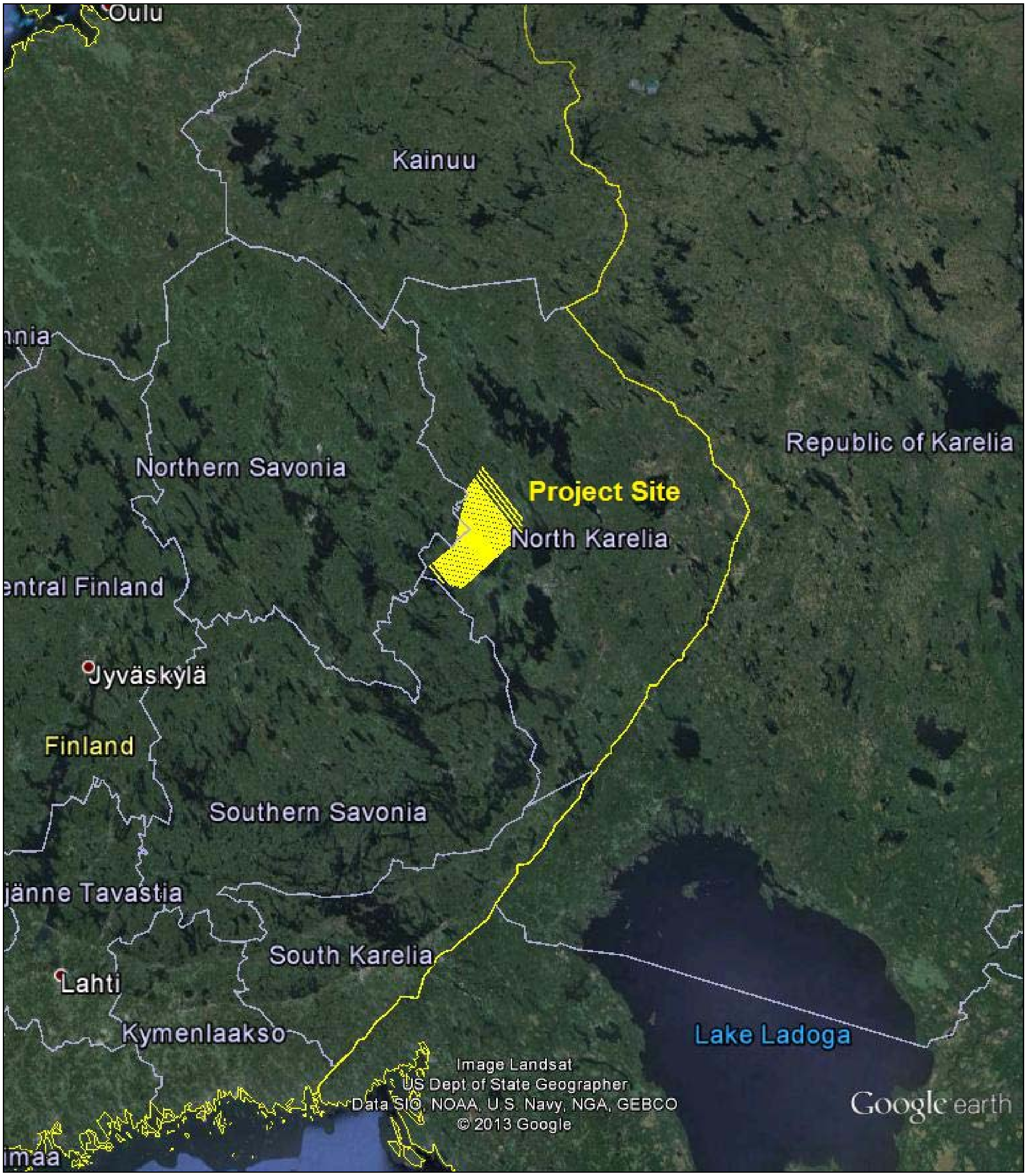
APPENDIX A

SURVEY BLOCK LOCATION MAP



Survey Overview Location Map

APPENDIX B

SURVEY BLOCK COORDINATES
(WGS84 Zone 35N)

X	Y
610409.9	6999017
607114.4	6993613.8
604368.2	6989111.1
603900.7	6988113.2
603683.5	6986816.9
602380.3	6979039.4
600642.9	6968669.3
600425.7	6967373
599991.3	6964780.5
599621.4	6963666.3
590081.5	6954819.2
588550	6953500
595270	6945490
598467.8	6944824.9
603238.2	6943805.1
604279.3	6944119.4
612933.5	6952467
613654.7	6953162.6
619424.1	6958727.6
620145.3	6959423.2
628799.5	6967770.7
629725.9	6969776.8
630179.6	6975456.5
610409.9	6999017