Airborne and Ground Gravity Geophysics

Thunder Bay North Project
Thunder Bay Mining Division
Northwestern Ontario
2010-2011

Magma Metals (Canada) Limited
P.O. Box 10628, Thunder Bay, Ontario P7B 6V1
1004 Alloy Dr., Thunder Bay Ontario P7B 6A5

Overview

During 2010 and 2011 Magma Metals (Canada) Limited [Magma Metals] had two gravity geophysical surveys completed on their Thunder Bay North project area. Included within this report are the logistic reports and interpretations produced by the contracted companies as well as an additional interpretation report done by an independent geophysical consulting company. This cover page is meant as a brief summary of the results, for detailed information refer to the individual attached reports.

During 2010 Magma Metals contracted Furgo Airborne Surveys Pty Ltd to fly a Falcon airborne gravity gradiometer survey over the Thunder Bay North Project area. The survey was flown as follow up to a small ground gravity test survey that was preformed over the Thunder Bay North deposit. The test survey indicated that it may be possible to detect an ultramafic body at depth via gravity. Initial interpretation of the airborne data indicated that detection of the ultramafic bodies was not possible by airborne gravity methods. To verify this Condor Consulting Inc. was contracted to verify the quality of the data and to independently interpret the results of the airborne geophysical survey. It was concluded that while airborne gravity could not detect the ultramafic bodies it was able to detect large, regional changes in lithology. It was proposed that a more detailed, lower altitude survey may have success, either a helicopter gravity gradiometry survey or a ground based gravity survey.

During the winter of 2011, 83.3km of lines were cut over Escape Lake and Beaver Lake, covering a portion of the Thunder Bay North deposit. The lines were subsequently surveyed by Eastern Geophysics Limited using a LaCoste & Romberg model G gravity meter. Interpretation of the data indicated clearly showed the ultramafic body, defined by previous diamond drilling, at Beaver Lake.

Conclusion

Interpretation and comparison of both airborne and ground gravity geophysics returned mixed results. The ground gravity survey indicated that while it is possible to detect large (>100m wide), thick (>80m thick), ultramafic bodies it is prohibitively expensive as a regional exploration tool. The fixed wing airborne gravity survey did not detect the ultramafic body but does illustrate changes in regional geology. It may be possible to detect an ultramafic body via an airborne survey flown both slower and lower, such as from a helicopter, but at this time such a survey is not warranted.

Attached

Falcon Airborne Gravity Gradiometer Survey, Processing Report – Furgo Airborne Surveys Pty Ltd

Report on Processing & analysis of Falcon AGG and Magnetic Data Thunder Bay North Project – Condor Consulting Inc.

Logistics Report – Eastern Geophysics Limited
Escape Lake Bouger Gravity Map

350,000 mE
355,000 mE
360,000 mE
365,000 mE
5,405,000 mN
5,400,000 mN
0 500 1,000
metres
Scale 1:25,000
4242141 0.3
4208965 11.429
4208969 19.954
4208973 17.941
4208977 10.065
4208978 23.892
4221369 4.62
4221370 17.028
4208966 26.895
4208970 27.511
4208974 25.223
4208979 25.597
4221368 0.209
4221367 2.046
4240538 16.379
4240537 26.389
4208984 20.713
1248241 26.246
1248240 13.035
4205432 7.227
4208980 25.619
4242774 8.833
4242775 18.535
4242148 7.37
4221364 25.245
4221366 10.857
4240539 21.065
4240536 26.686
4240541 4.598
1248244 11.209
842189 17.787
1248239 15.224
4205378 8.613
4208981 26.059
4240540 9.163
4225216 14.806
4225975 14.806
4225974 14.663
4216374 10.747
4242773 9.328
4221363 28.886
4214273 30.58
4225211 28.402
4225215 10.263
4208971 11.363
842186 18.656
4210157 25.003
4222631 18.414
4222632 11.88
4222633 27.753
4229975 11.539
4225973 15.873
4211163 19.624
4229972 0.726
4221361 19.822
4225212 19.063
4225213 20.867
4225214 7.59
4225972 17.523
4211637 5.269
3005105 20.042
4211638 5.313
1246796 21.824
4222636 15.906
4222635 10.12
4222634 25.707
4222637 1.551
3005106 5.28
4221362 25.179
4221365 23.408
4242805 21.78
4242808 8.096
4242811 16.819
4242812 21.043
4243631 28.127
4243637 27.544
4243638 27.511
4243643 21.296
4243649 2.123
4218927 2.123
4243632 27.874
4243635 25.927
4243639 9.988
4243642 1.562
4214076 3.223
4444444 - Claim Number
99.99 - Flight Line km's on Claim
4243633 9.592
4243634 1.793

Thunder Bay, Ontario

FALCON™ Airborne Gravity Gradiometer Survey

for

Magma Metals (Canada) Limited

Processing Report

Survey Flown: August, 2010

By

FUGRO AIRBORNE SURVEYS Pty Ltd
U3/435 Scarborough Beach Rd
Osborne Park, WA, 6017
AUSTRALIA

FASP Job# 2152
FASO Job# 10811

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1 INTRODUCTION

Fugro Airborne Surveys conducted a high-sensitivity aeromagnetic and **FALCON**™ Airborne Gravity Gradiometer (AGG) survey over the Thunder Bay survey area under contract with Magma Metals (Canada) Limited.

1.1 Survey Location

The Thunder Bay survey area is centred on longitude 88°57' W, latitude 48º 45' N (see the location map in *Figure 1*).

The production flights took place during August 2010 with the first production flight taking place on 14th August and the final flight taking place on 26th August. To complete the survey area coverage a total of 6 production flights were flown, for a combined total of 1491 line kilometres of data acquired.

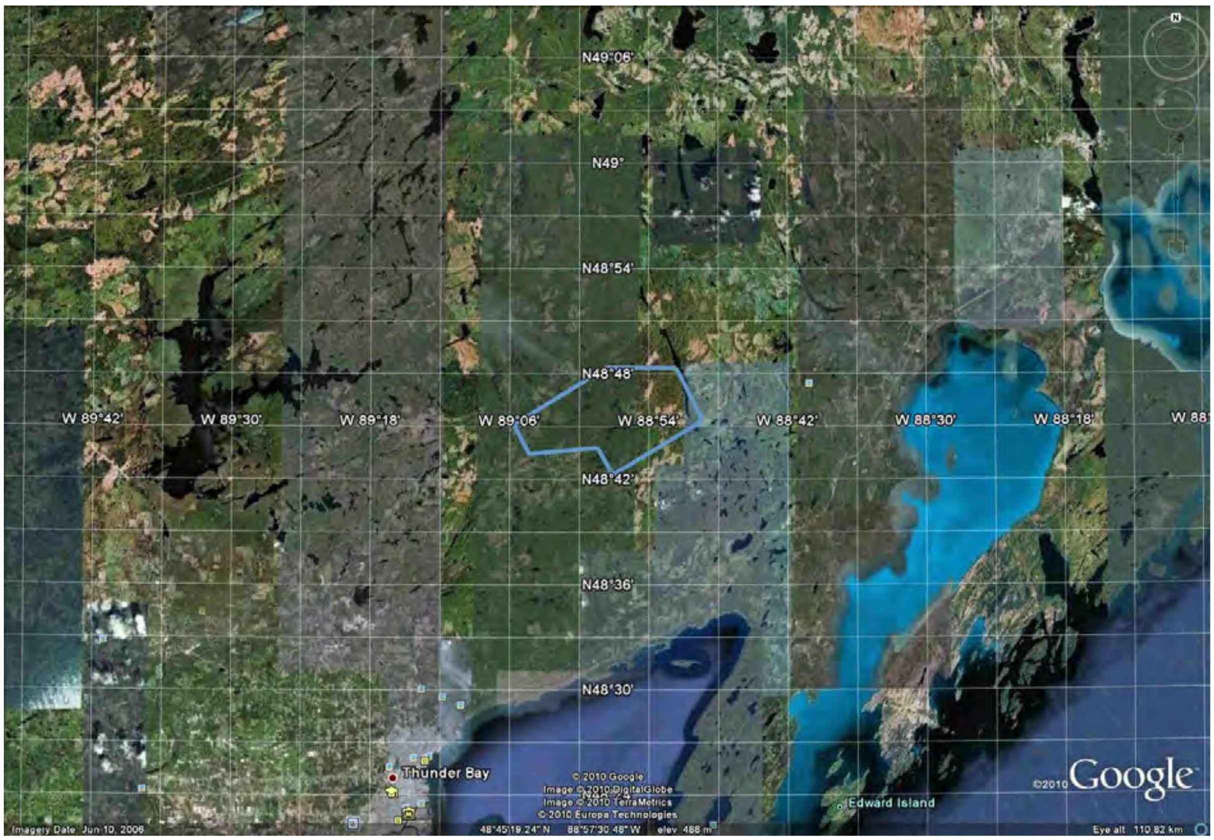

Figure 1: Thunder Bay - *Survey Area Location*

2 SUMMARY OF SURVEY PARAMETERS

2.1 Survey Area Specifications

Thunder Bay

Total kilometres (km)	1491
Terrain Clearance (m)	80
Clearance Method	Drape
Traverse Line Direction (deg.)	060 / 240
Traverse Line Spacing (m)	100
Tie Line Direction (deg.)	150 / 330
Tie Line Spacing (m)	1200

The survey block is defined by the coordinates in *Table 1*, in UTM zone 16N projection, referenced to the WGS84 datum.

Corner Number	Easting	Northing
1	347443	5402814
2	356080	5407759
3	363356	5407535
4	366054	5401924
5	356400	5396450
6	354850	5399324
7	347599	5398890
8	346050	5402010
9	347443	5402801
10	347443	5402814

Table 1: Thunder Bay - *Survey Boundary Coordinates*

2.2 Data Recording

The following parameters were recorded during the course of the survey:

- **FALCON™ AGG data**: recorded at different intervals.
- **Airborne total magnetic field**: recorded with a 0.1 s sampling rate.
- **Aircraft altitude**: measured by the barometric altimeter at intervals of 0.1 s.
- **Terrain clearance**: provided by the radar altimeter at intervals of 0.1 s.
- **Airborne GPS positional data** (latitude, longitude, height, time and raw range from each satellite being tracked): recorded at intervals of 1 s.
- **Time markers**: in digital data.
- **Ground total magnetic field**: recorded with a 1 s sampling rate.
- **Ground based GPS positional data** (latitude, longitude, height, time and raw range from each satellite being tracked): recorded at intervals of 1 s.
- **Aircraft distance to ground**: measured by the laser scanner system, scanning at 20 times per second (when in range of the instrument and in the absence of thick vegetation).

2.3 Job Safety Plan, HSE Summary

A Job Safety Plan and Job Safety Analysis was prepared and implemented in accordance with the Fugro Airborne Surveys Occupational Safety and Health Management System.

3 FIELD OPERATIONS

3.1 Operations

The survey was based out of Thunder Bay in North-western Ontario. The survey aircraft was operated from Thunder Bay Airport using aircraft fuel available on site. A temporary office was set up in Thunder Bay where all survey operations were run and the post-flight data verification was performed.

3.2 Base Stations

The dual frequency GPS base, backup dual frequency station and magnetometer base stations were set up away from any cultural interference as detailed below.

The differentially corrected WGS-84 coordinates of the GPS ground station were:

GPS Base Station

Date:	07 Aug., 2010
Location:	Thunder Bay Airport
Latitude:	48º 22' 28.1638" N
Longitude:	89º 18' 29.6635" W
Height:	158 m

Magnetometer Base Station (CF1)

Location:	Thunder Bay Airport
Base:	56928 nT

3.3 Field Personnel

The following technical personnel participated in field operations:

Crew Leader:	D. MacDonald
Pilots:	S. Cowan and T. Gaillot
Technicians:	D. MacDonald and J. Carr
Project Manager:	D. Grenier
Final QC and Processing	W.Irvine, K. Zawadzki, T. Brownrigg

4 QUALITY CONTROL RESULTS

4.1 Survey acquisition issues

During the course of the survey there were no data quality issues with:

AGG instrumentation
Mag and GPS base stations
Airborne magnetometer system
Data acquisition systems
Radar altimeter
Laser scanner

4.2 Flight Path Map

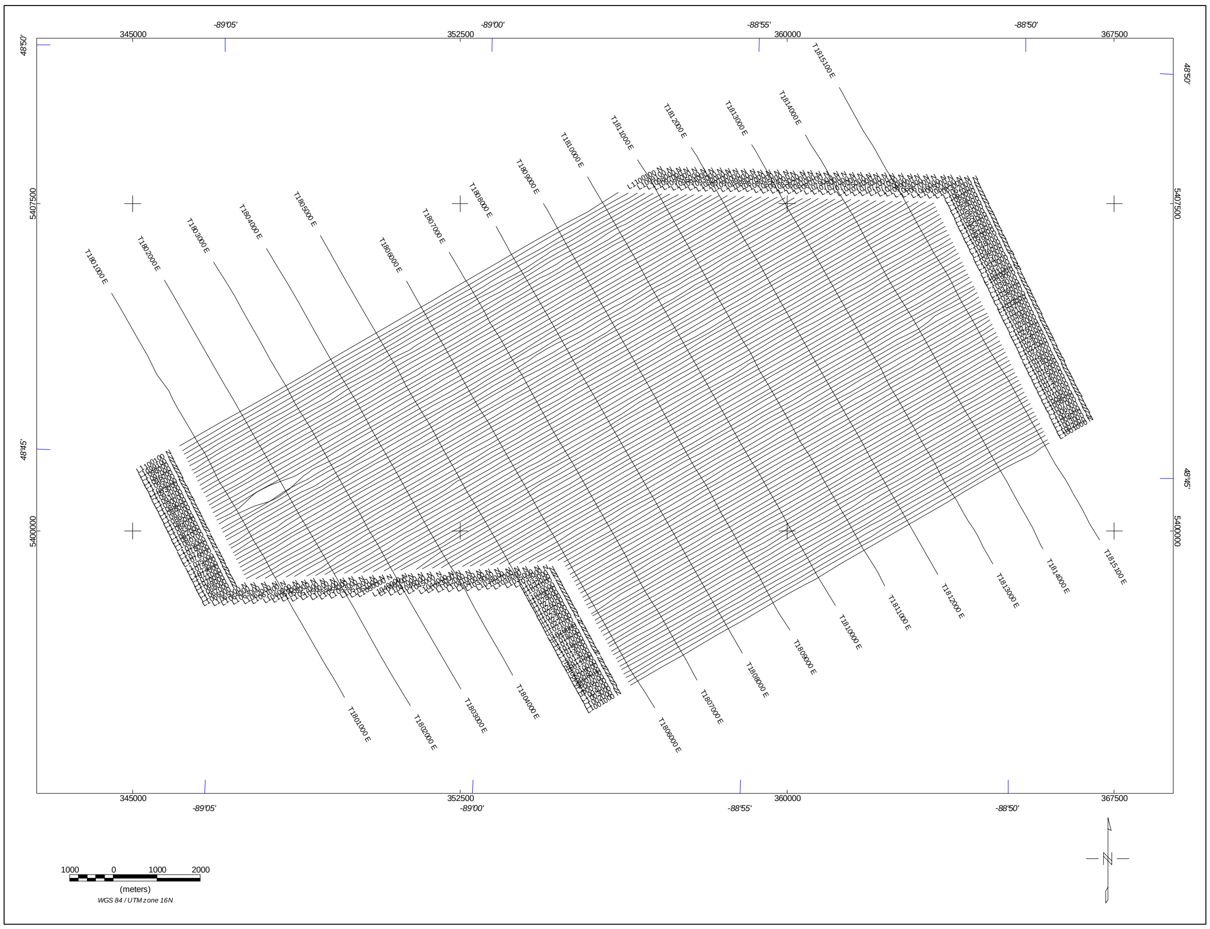

Figure 2: Thunder Bay - *Flight Path map*

4.3 Turbulence

The mean turbulence recorded in the Thunder Bay survey area was 46.4 milli g (where g = 9.80665 m/sec/sec.).Turbulence was variable ranging from very low to high. The typical pattern for a given flight was for turbulence to commence at a very low level and then increase throughout the flight. The turbulence pattern across the survey area is shown in *Figure 3*.

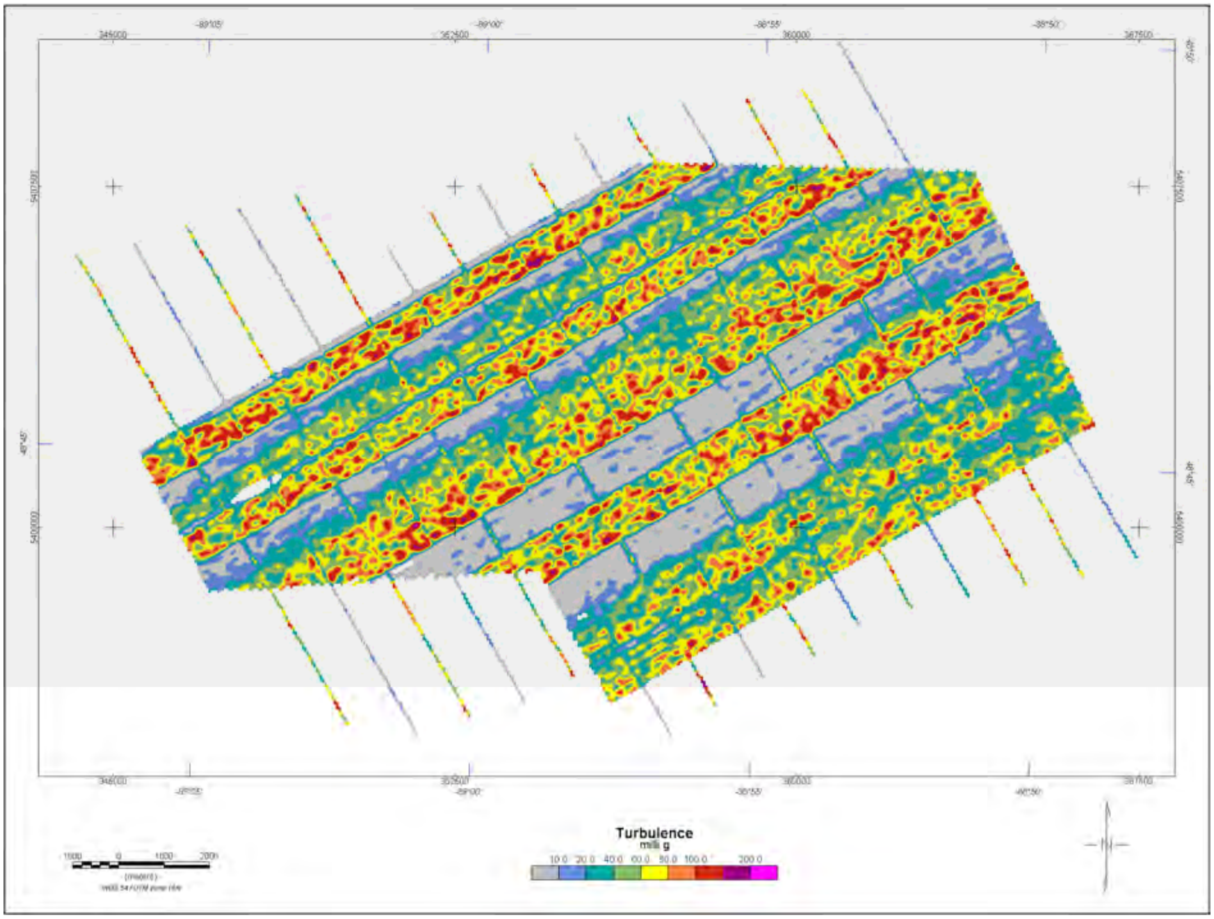

Figure 3: Thunder Bay - *Turbulence (milli g (where g = 9.80665 m/sec/sec))*

4.4 AGG System Noise

The system noise is defined to be the standard deviation of half the difference between the A & B complements, for each of the NE and UV curvature components. The results for this survey are very good with values of 3.66 Eö and 3.64 Eö for NE and UV respectively.

The system noise for each of the curvature components are shown below in *Figure 4* and *Figure 5*.

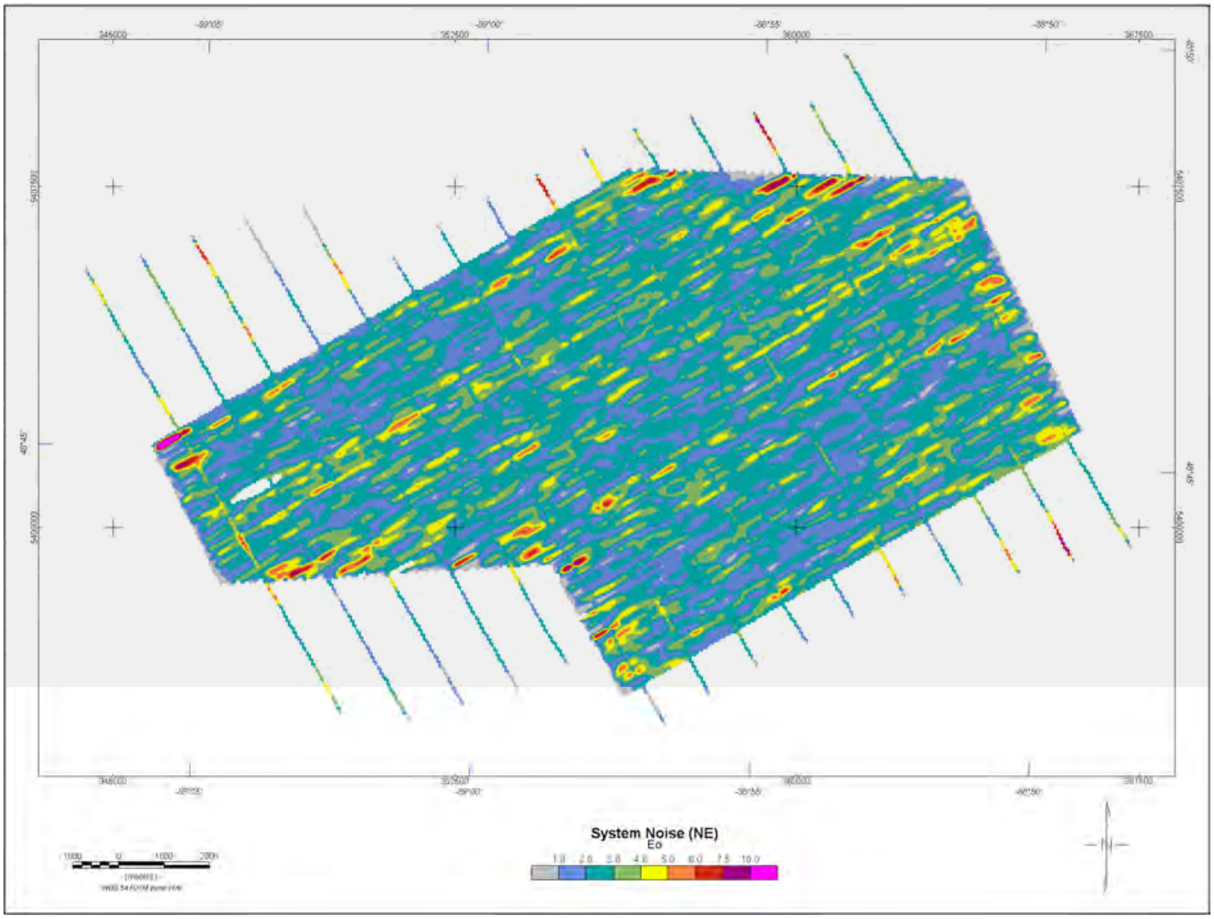

Figure 4: Thunder Bay – *System Noise (NE) (*Eö*)*

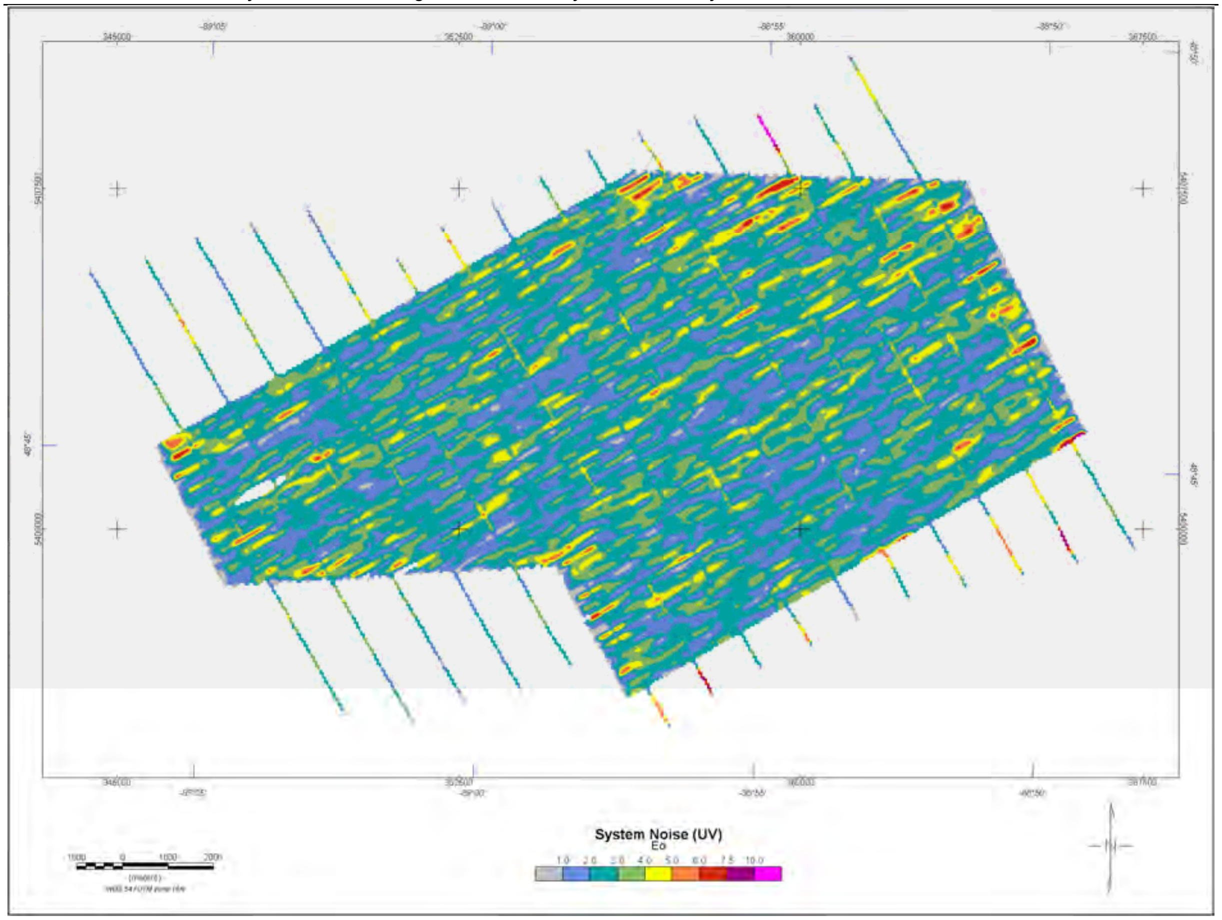

Figure 5: Thunder Bay – *System Noise (UV) (*Eö*)*

4.5 Digital Terrain Model

Laser scanner range data were combined with GPS position and height data (adjusted from height above the WGS84 ellipsoid to height above the geoid by applying the Earth Gravitational Model 1996 (EGM96)). The output of this process is a “swath” of terrain elevations extending either side of the aircraft flight path. Width and sample density of this swath varies with aircraft height. Typical values are 100 to 150 metres and five to ten metres respectively.

Because terrain correction of AGG data requires knowledge of the terrain at distances up to at least 10 km from the data location, laser scanner data collected only along the survey line path must be supplemented by data from another source. For this purpose, Shuttle Radar Topography Mission (SRTM) v2 data are usually chosen.

Laser scanner data were good with scan density generally above 65%. Laser scanner data were gridded at 25m with a 1 cell maximum extension beyond data limits then filled and buffered out to 15km beyond the survey boundary using the SRTM data. The stitching operation was carried out using a proprietary ERMapper batch process. This process uses the Laser scanner data to locally adjust the SRTM prior to stitching.

Figure 6 shows the final Digital Terrain Model resulting from the laser scanner and SRTM data processing.

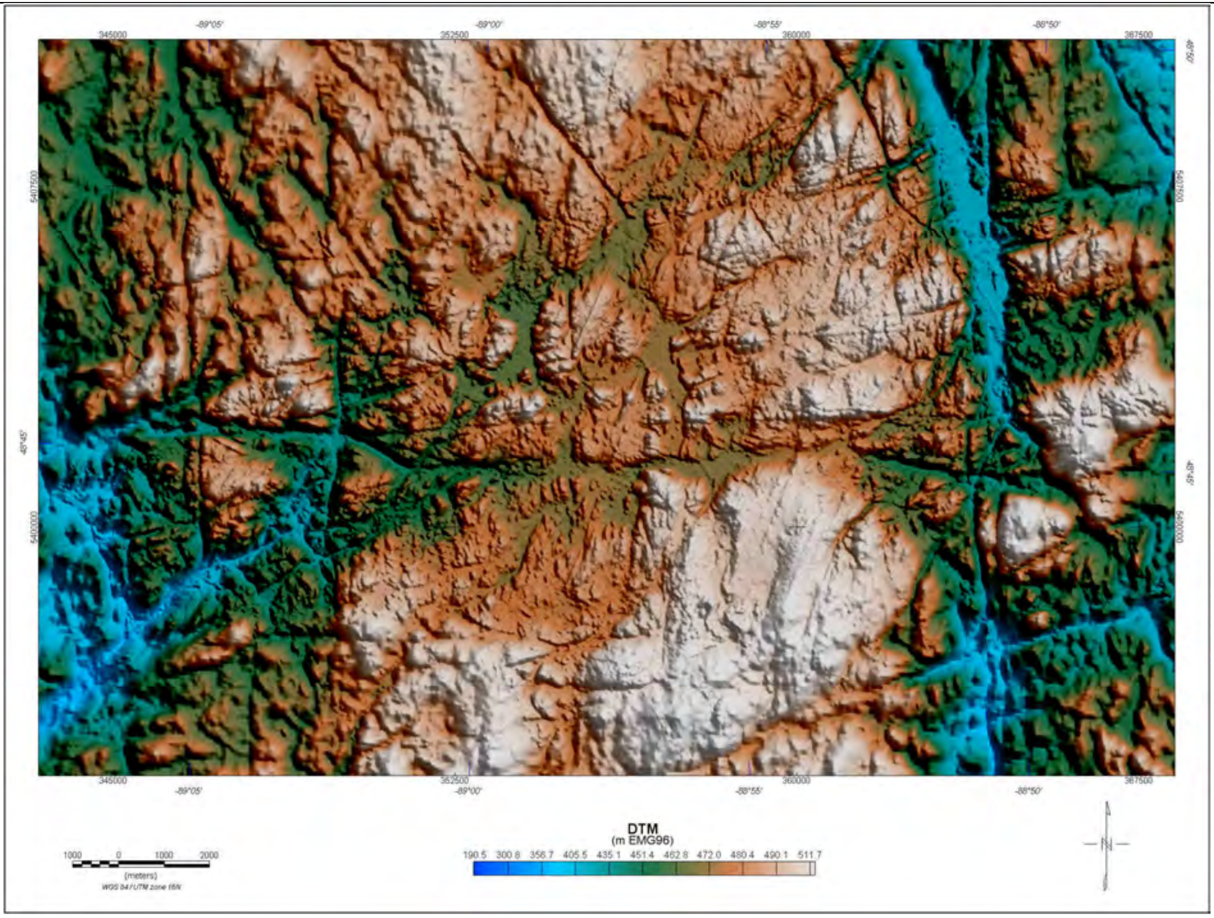

Figure 6: Thunder Bay: *Final Digital Terrain Model (metres above WGS84 ellipsoid with EGM96 geoid correction)*

4.6 Terrain Clearance

Terrain clearance for the Thunder Bay survey averaged slightly above the nominal clearance of 80m having a mean value of 105.4m across the survey area. The terrain clearance is shown below in *Figure 7*.

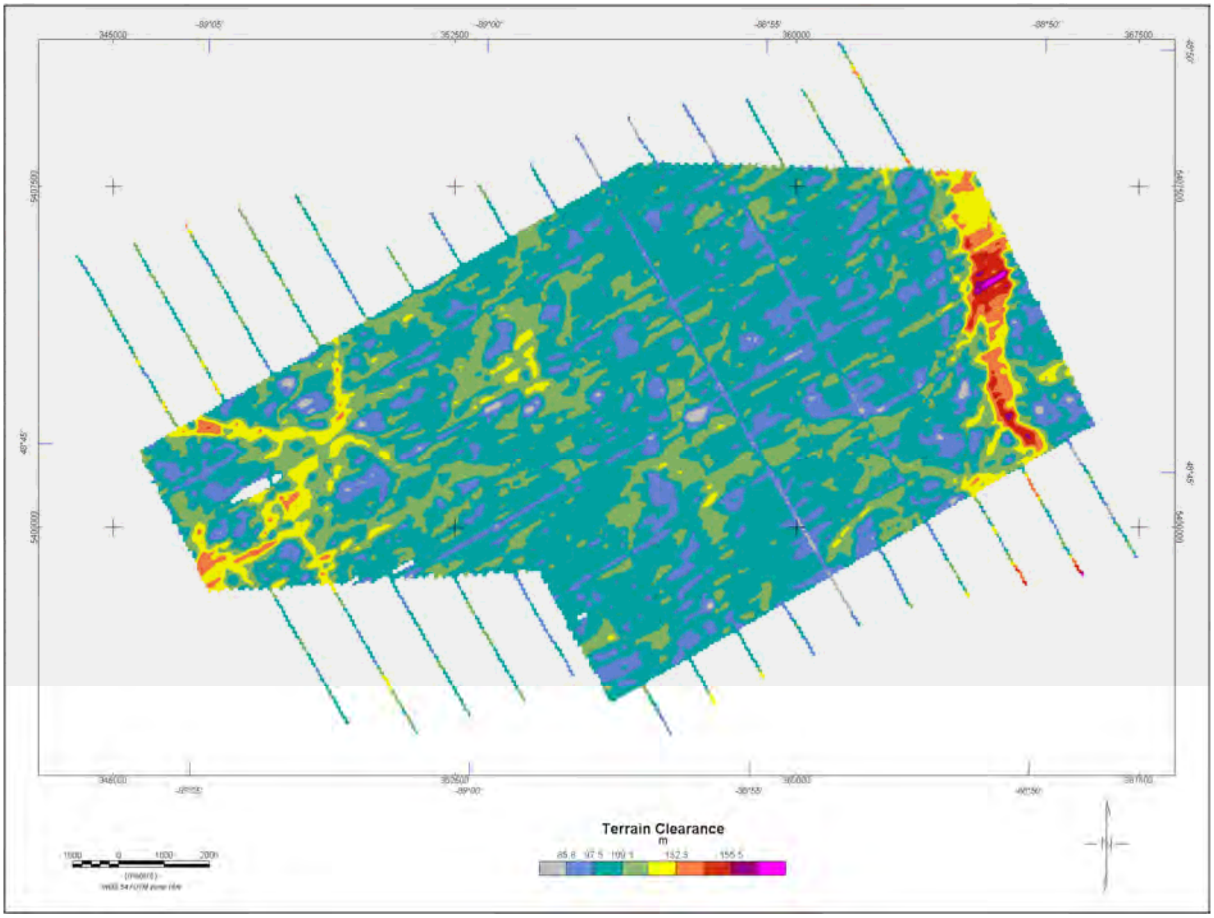

Figure 7: Thunder Bay - *Ground clearance (from laser scanner) (metres above ground surface)*

5 FALCON™ AIRBORNE GRAVITY GRADIENT (AGG) RESULTS

5.1 Processing Summary

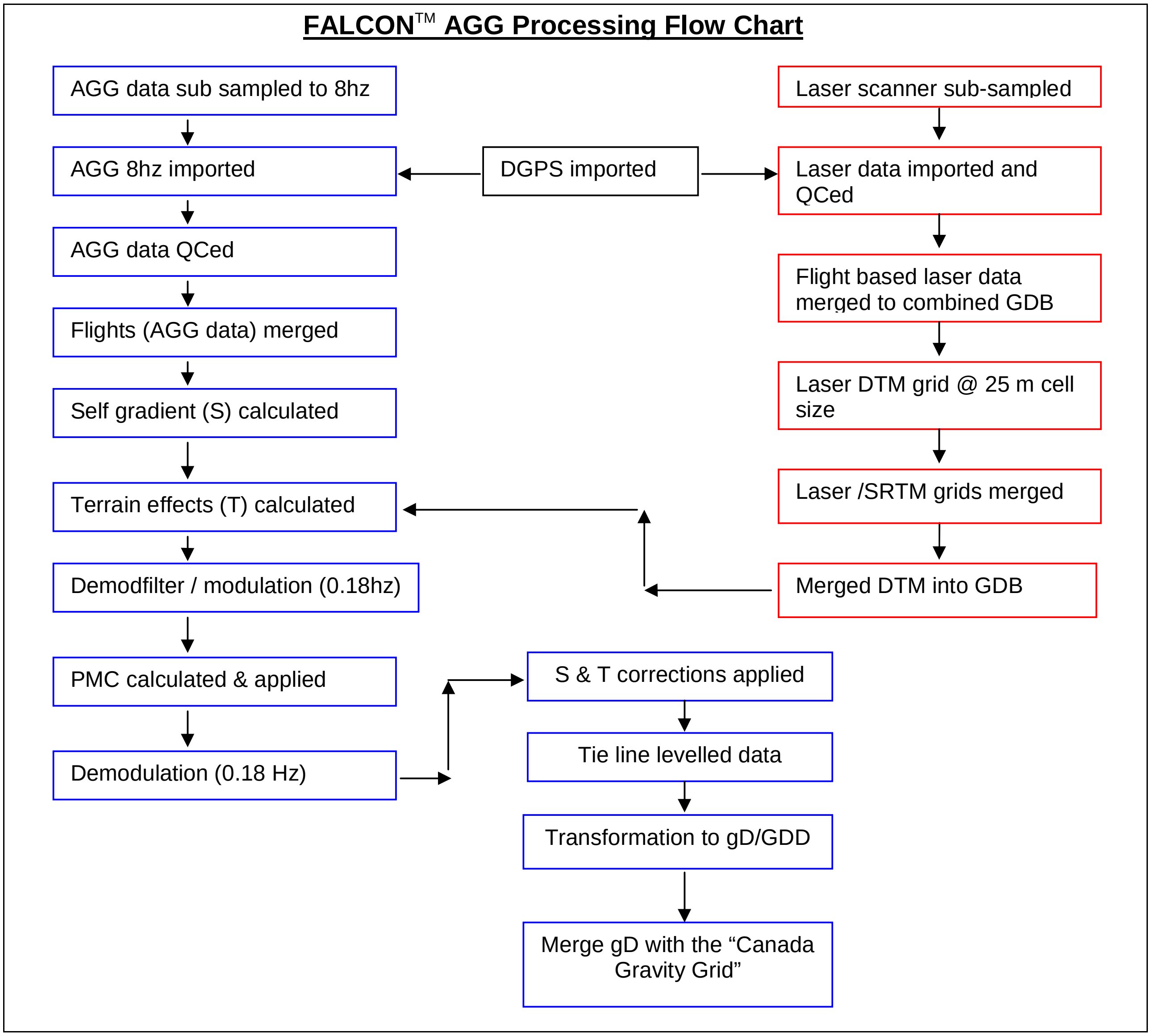

Figure 8: *FALCON™ AGG Data Processing*

5.2 FALCON™ Airborne Gravity Gradiometer Data

Figure 8 summarises the steps involved in processing the AGG data obtained from the survey.

The **FALCON**™ Airborne Gravity Gradiometer data were digitally recorded by the ADAS on removable hard drives. The raw data were then copied on to the field processing laptop, backed up twice onto DVD+R media and shipped to Fugro Perth using a secure courier service.

Preliminary processing and QC of the **FALCON™** AGG data was completed on-site using Fugro's DiAGG software.

Further QC and Final **FALCON™** AGG data processing was performed by the office based data processor.

5.3 Radar Altimeter Data

The terrain clearance measured by the radar altimeter in metres was recorded at 10 Hz. The data were plotted and inspected for quality.

5.4 Laser Scanner Data

The terrain clearance measured by the laser scanner in metres was recorded at 20 scans/sec with 276 data points per scan, and was then sub-sampled using a window width of 0.25 sec. The sub-sampled laser scanner data were edited for spikes prior to gridding.

5.5 Positional Data

A number of programs were executed for the compilation of navigation data in order to reformat and recalculate positions in differential mode. Waypoint's GrafNav GPS processing software was used to calculate DGPS positions from raw range data obtained from the moving (airborne) and stationary (ground) receivers.

The GPS ground station position was determined by logging GPS data continuously for 24 hours prior to survey flights commencing. The GPS data were processed and quality controlled completely in the field.

Positional data (longitude, latitude, Z) were output in the WGS84 datum. The longitude and latitude data were then projected into UTM16N coordinates.

Parameters for the WGS84 datum are:

Ellipsoid:	WGS84
Semi-major axis:	6378137.0 m
1/flattening:	298.257

All processing was performed using WGS84/UTM16N co-ordinates. Final line data and final grid data was supplied in this projection.

5.6 Additional Processing

For the terrain correction, the standard density of 2.67g/cc which appears to closely approximate the terrain density in the survey area was applied. The data were tie line and micro-levelled.

5.7 FALCON™ Airborne Gravity Gradient Data - G_{DD} & g_D

The transformation into G_{DD} and g_D was accomplished using two methods: Fourier domain transformation and the Method of Equivalent Sources. The G_{DD} result produced by the Fourier domain transformation displays slightly greater frequency content when compared to the Equivalent Sources produced G_{DD}.

At longer wavelengths and in the g_D data, the results produced by both methods are comparable.

Fourier

The Fourier domain transformation method uses a low-pass filter to improve the signal to noise ratio by removing processing artefacts and other information which is known to be beyond the sampling resolution. A cut-off wavelength of 200 m was used in the low-pass filter.

Equivalent Source

The equivalent source transformation utilises a smooth model inversion to calculate the density of a surface of sources followed by a forward calculation to produce g_D and G_{DD}. It was possible to closely match the wavelength characteristics of the Fourier results by placing the sources at a depth of 100 metres.

Drape Surfaces

Both transformations use a smoothed surface onto which the output data is projected. These surfaces are smoother equivalents of the actual flying surface.

The Fourier and Equivalent Source G_{DD} (density 2.67g/cc) maps are shown in *Figure 9* and *Figure 10* respectively.

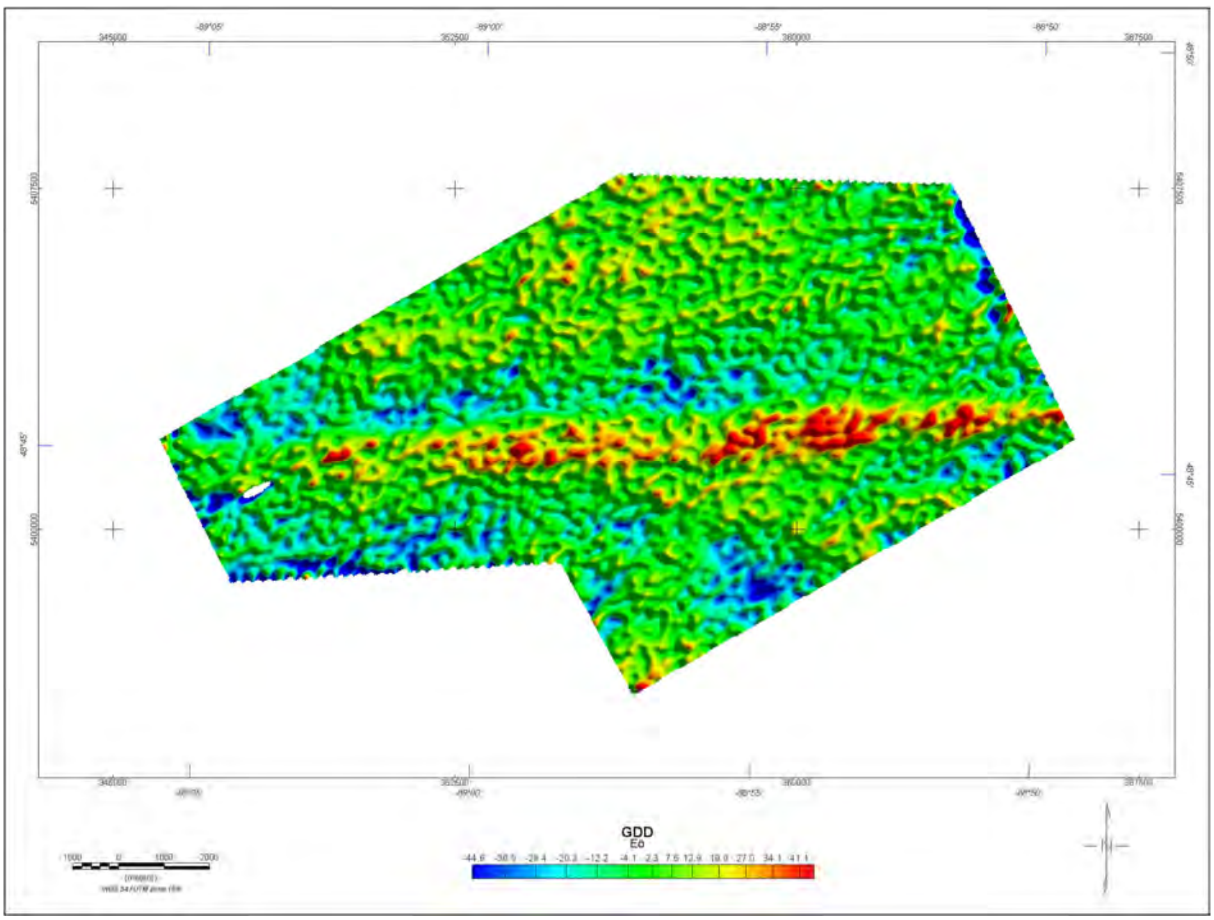

Figure 9: Thunder Bay – *Fourier Domain G_{DD} (Eö)*

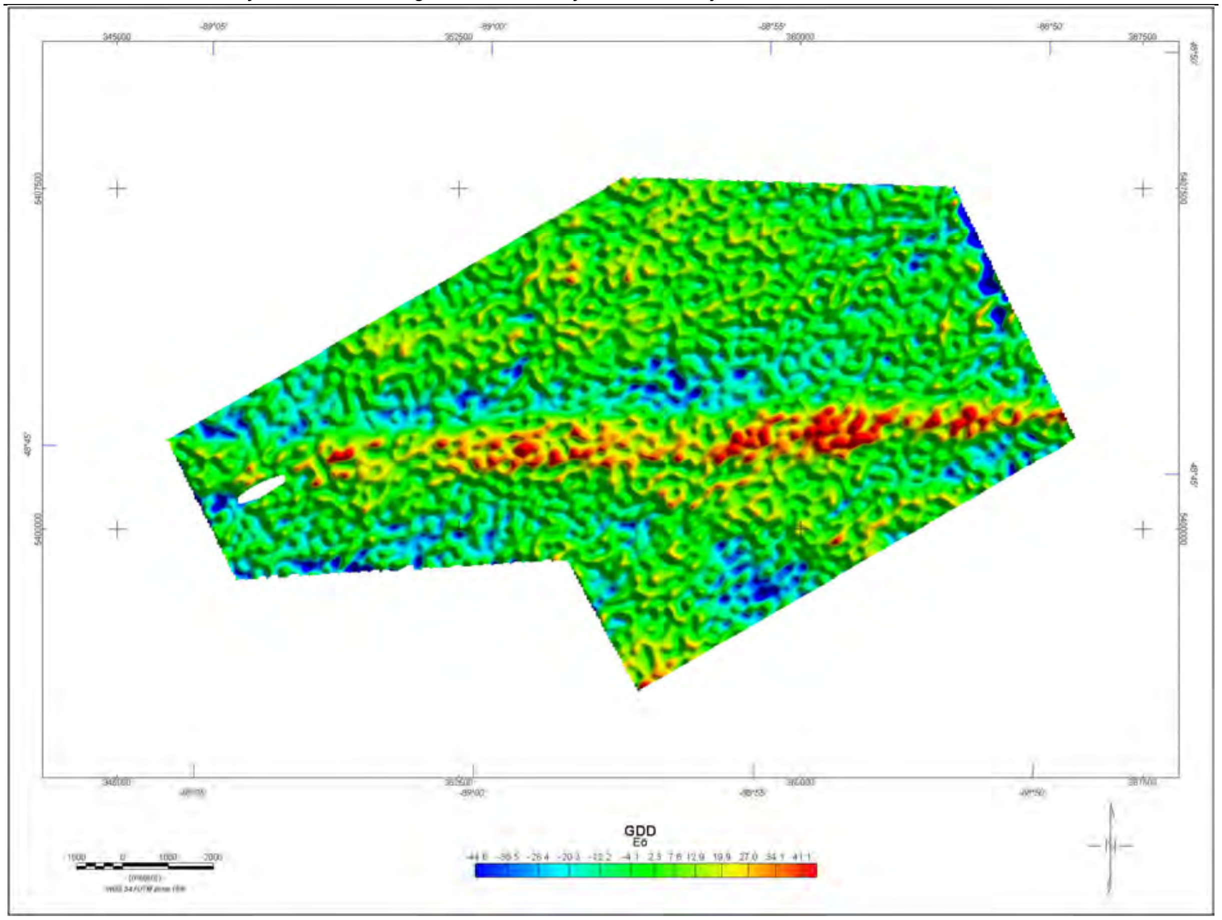

Figure 10: Thunder Bay – *Equivalent Source G_{DD} (Eö)*

Two versions of vertical gravity (g_D) are presented: Fourier, derived by integrating the G_{DD}; and Equivalent Source, derived directly from the modelled sources. The (density 2.67g/cc) Fourier result is presented in *Figure 11* and the (density 2.67g/cc) Equivalent Source result is presented in *Figure 12*.

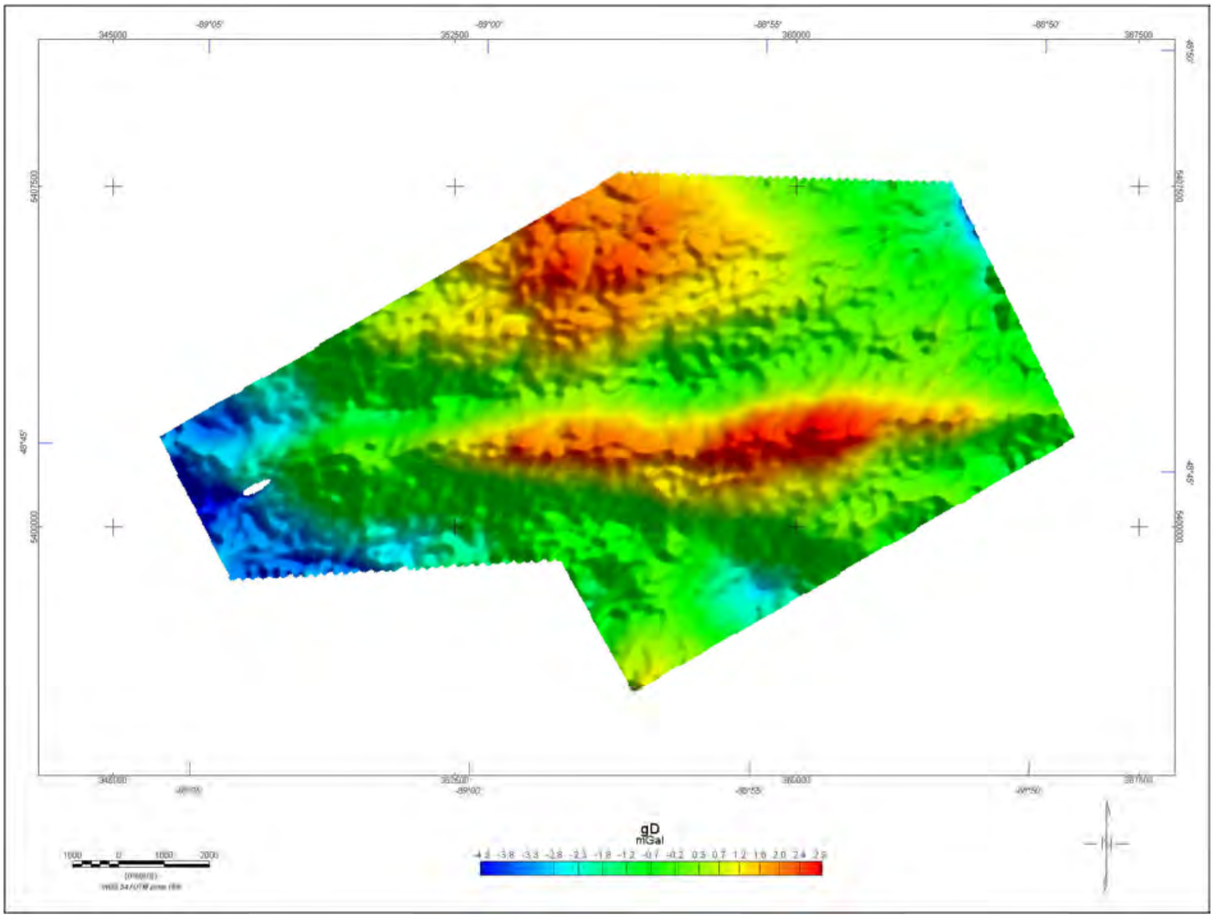

Figure 11: Thunder Bay – *Vertical Gravity (g_D) from Fourier processing (mGal)*

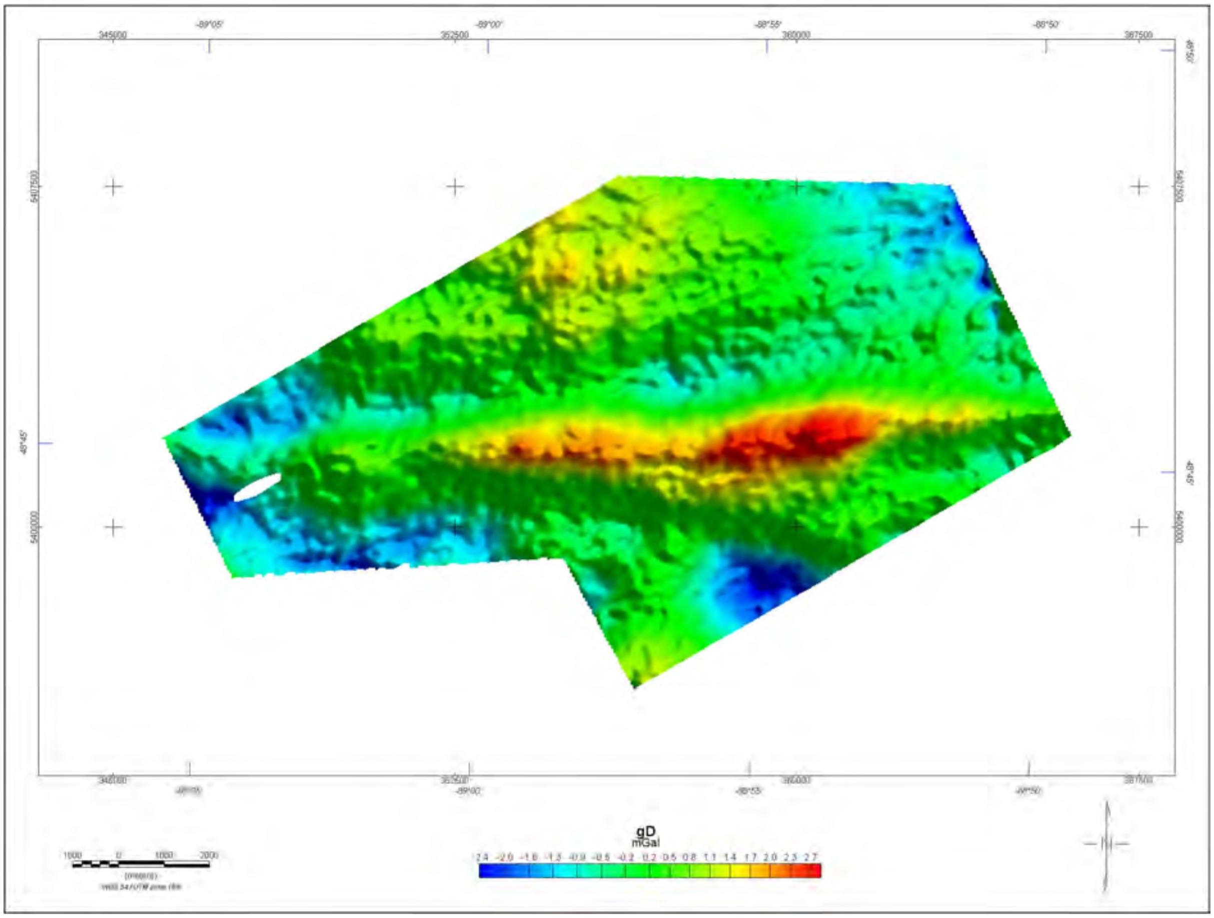

Figure 12: Thunder Bay – *Vertical Gravity (g_D) from Equivalent Source (mGal)*

5.8 Conforming g_D to regional gravity

As discussed in section 9.3, the long wavelength information in g_D (both the Fourier and Equivalent Source versions) can be improved by incorporating ancillary information.

To improve this, the g_D grids were conformed to the Canadian Gravity data. The steps to make the conformed g_D grids are given below. The (density 2.67g/cc) results are presented in *Figure 13* and *Figure 14.*

- Low pass filter the regional data using a cosine squared filter with cut-off at 30km, tapering to 20km.
- High pass filter the g_D data (Fourier and Equivalent Source) cosine squared filter with cut-off at 30 km, tapering to 20km.
- Conform the Fourier and Equivalent Source data to the regional data by addition of the filtered grids. The filter design is such that this method provides uniform frequency response across the overlap frequencies.

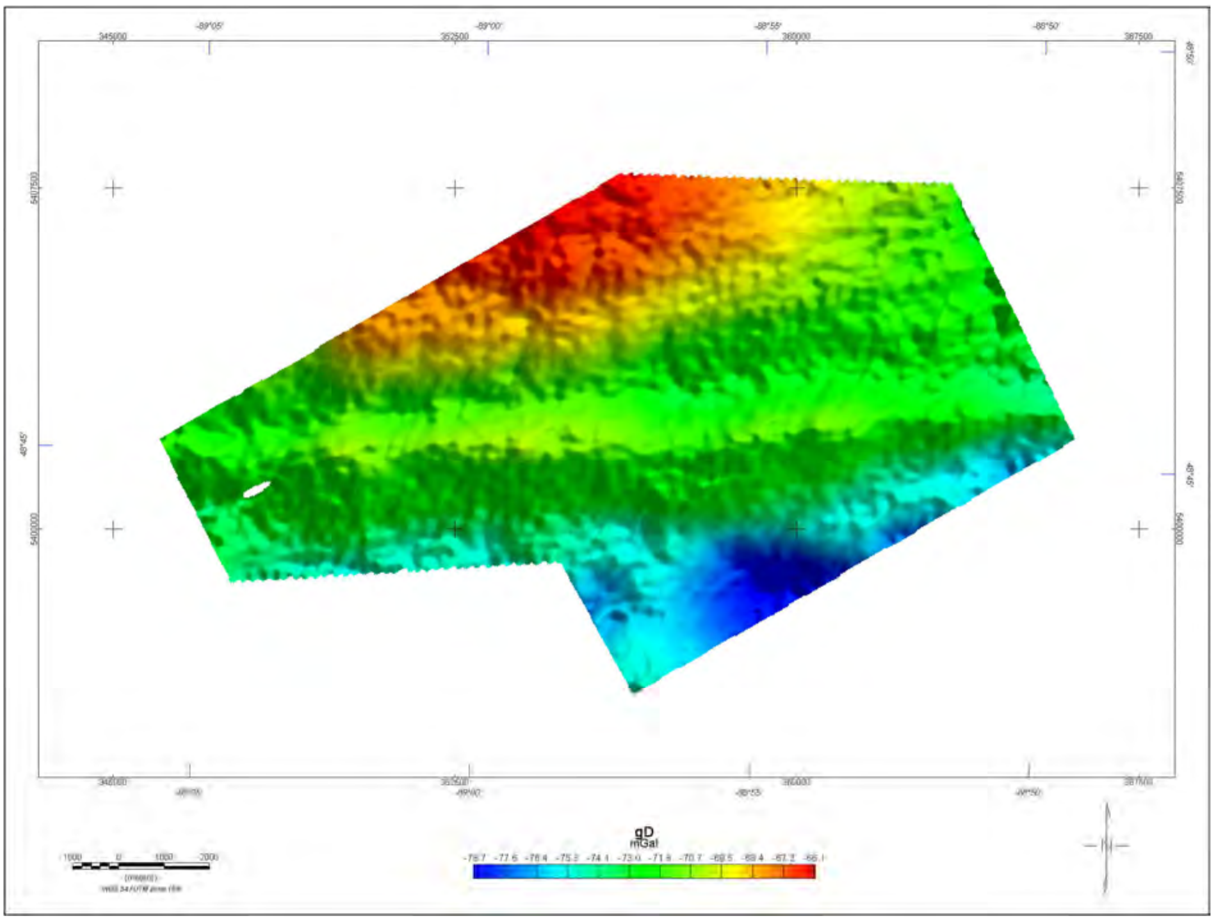

Figure 13: Thunder Bay – *Vertical Gravity (g_D) from Fourier processing conformed with regional gravity data (mGal)*

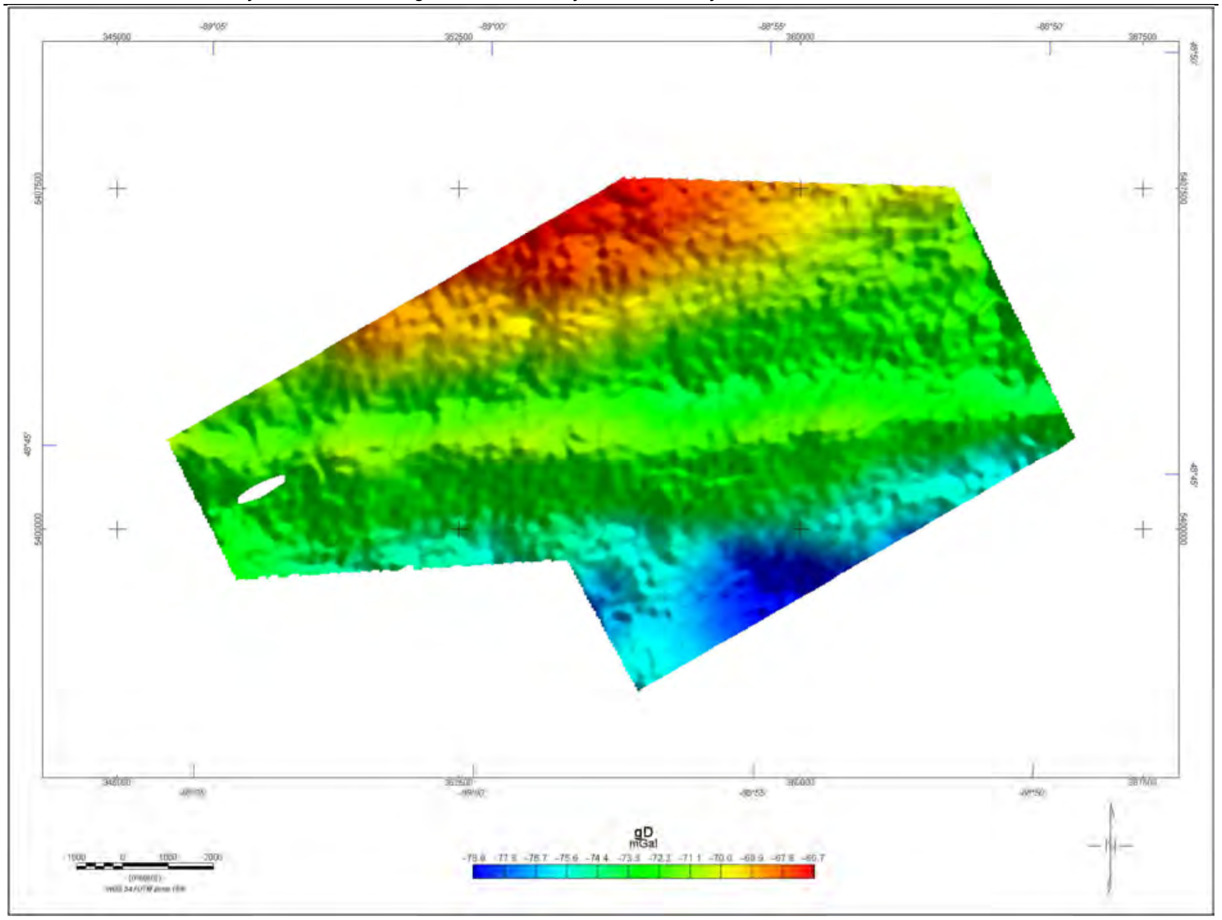

Figure 14: Thunder Bay – *Vertical Gravity (g_D) from Equivalent Source conformed with regional gravity data (mGal).*

6 AEROMAGNETIC RESULTS

6.1 Processing Summary

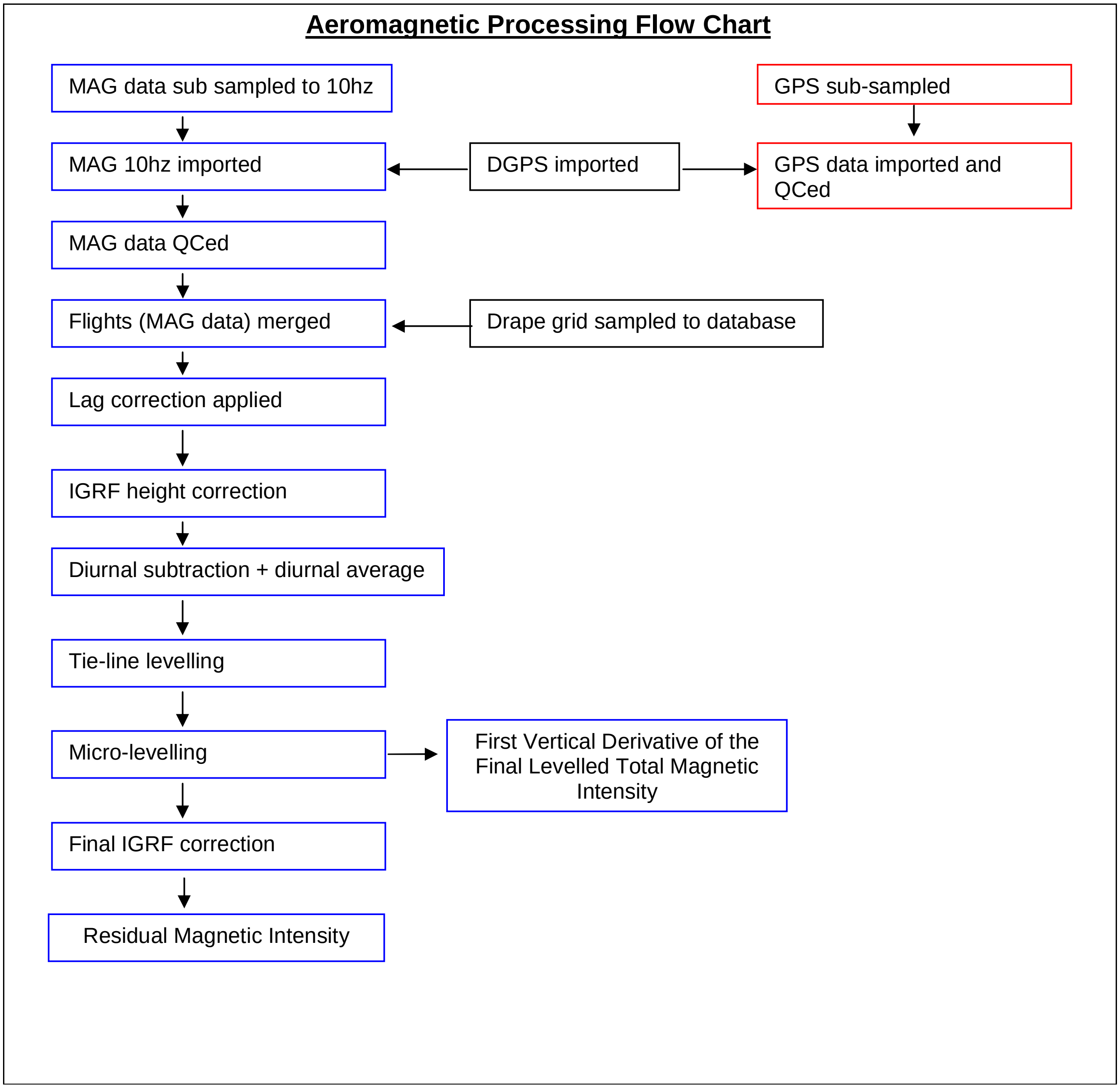

Figure 15: *Aeromagnetic Data Processing*

6.2 Aeromagnetic Data

Figure 15 summarises the steps involved in processing the aeromagnetic data obtained from the survey.

The aeromagnetic data were digitally recorded by the FASDAS on removable hard drives. The raw data were then copied onto the field processing laptop, backed up twice onto hard drive media and ftped to Fugro's secure server.

Preliminary processing and QC of the aeromagnetic data were completed on-site using Fugro's proprietary ATLAS software.

Further QC and Final aeromagnetic data processing were performed by the office based data processor.

6.3 Radar Altimeter Data

The terrain clearance measured by the radar altimeter in metres was recorded at 10 Hz. The data were plotted and inspected for quality.

6.4 Positional Data

A number of programs were executed for the compilation of navigation data in order to reformat and recalculate positions in differential mode. Waypoint's GrafNav GPS processing software was used to calculate DGPS positions from raw range data obtained from the moving (airborne) and stationary (ground) receivers.

The GPS ground station position was determined by logging GPS data continuously for 24 hours prior to survey flights commencing. The GPS data were processed and quality controlled completely in the field.

Positional data (longitude, latitude, Z) were output in the WGS84 datum. The longitude and latitude data were then projected into UTM16N coordinates.

Parameters for the WGS84 datum are:

Ellipsoid:	WGS84
Semi-major axis:	6378137.0 m
1/flattening:	298.257

All processing was performed using WGS84/UTM16N co-ordinates. Final line and grid data were supplied in this projection.

6.5 Lag Correction

All aeromagnetic data were lagged prior to final processing. A lag of 0.30 seconds was applied

6.6 IGRF Height Correction

The IGRF is calculated using the drape height and using the GPS height to produce a height corrected total magnetic intensity. A full IGRF correction was applied during a later step.

6.7 Diurnal Subtraction

The base station magnetics (diurnal) were filtered using a long wavelength filter to retain wavelengths longer than 71 seconds. This value was subtracted from the height corrected total magnetic intensity. Next, based upon the average magnetic value calculated from running the base station for 24 hours, a base value of 56928 nT was added back to the magnetics. This produced the diurnally corrected total magnetic intensity.

6.8 Tie-line Levelling

At this stage the total magnetic intensity were tie-line levelled using the standard Oasis tie-line levelling process.

6.9 Micro-levelling

At this stage the total magnetic intensity data were micro-levelled using Fugro's proprietary ATLAS software.

6.10 Total Magnetic Intensity

The total magnetic intensity had a minimum value of 56608 nT and a maximum value of 57683 nT across the survey area presented in *Figure 16*.

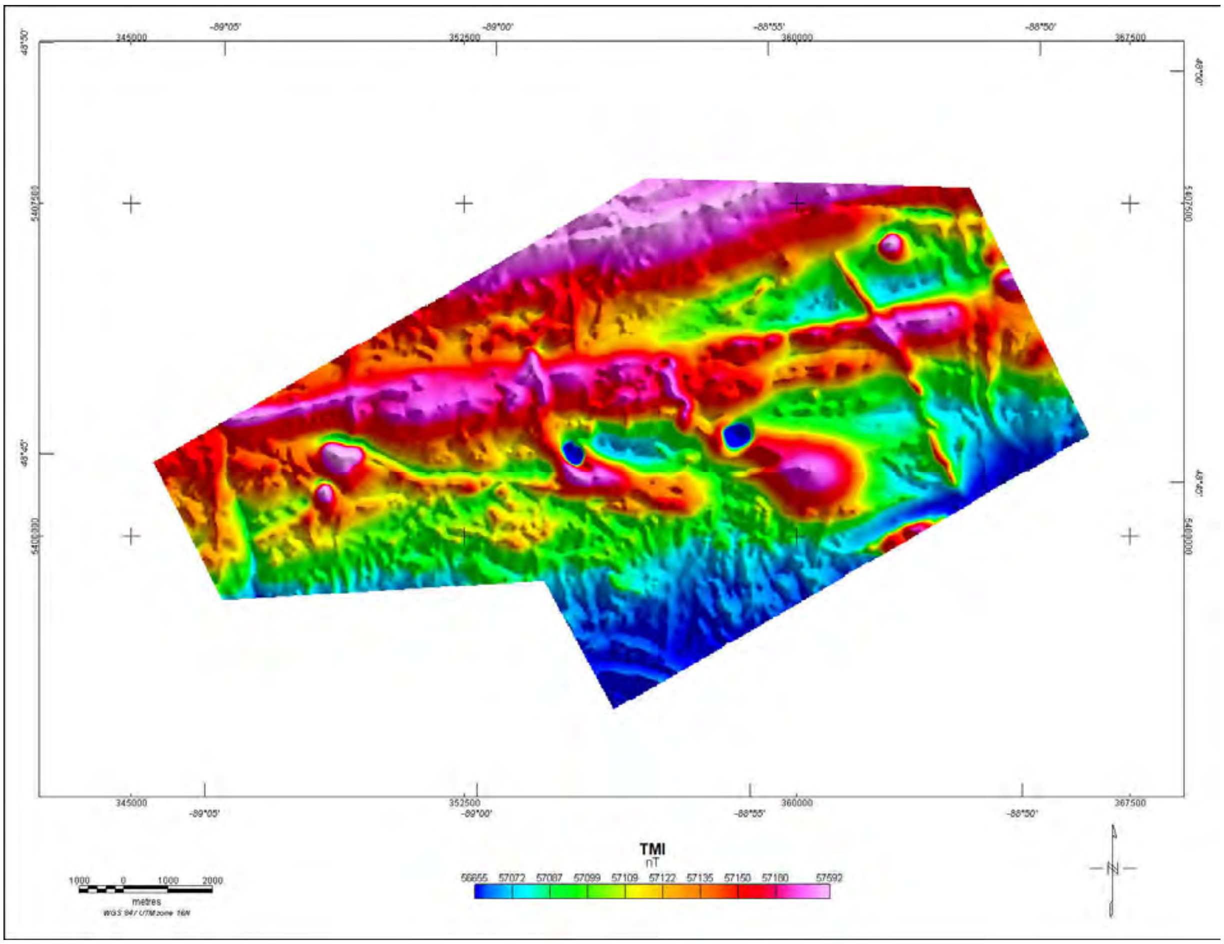

Figure 16: Thunder Bay – *Total Magnetic Intensity (nT)*

6.11 First Vertical Derivative of the Total Magnetic Intensity

The first vertical derivative of the total magnetic intensity had a minimum value of -6.824 nT/m and a maximum value of 5.717 nT/m across the survey area presented in *Figure 17.*

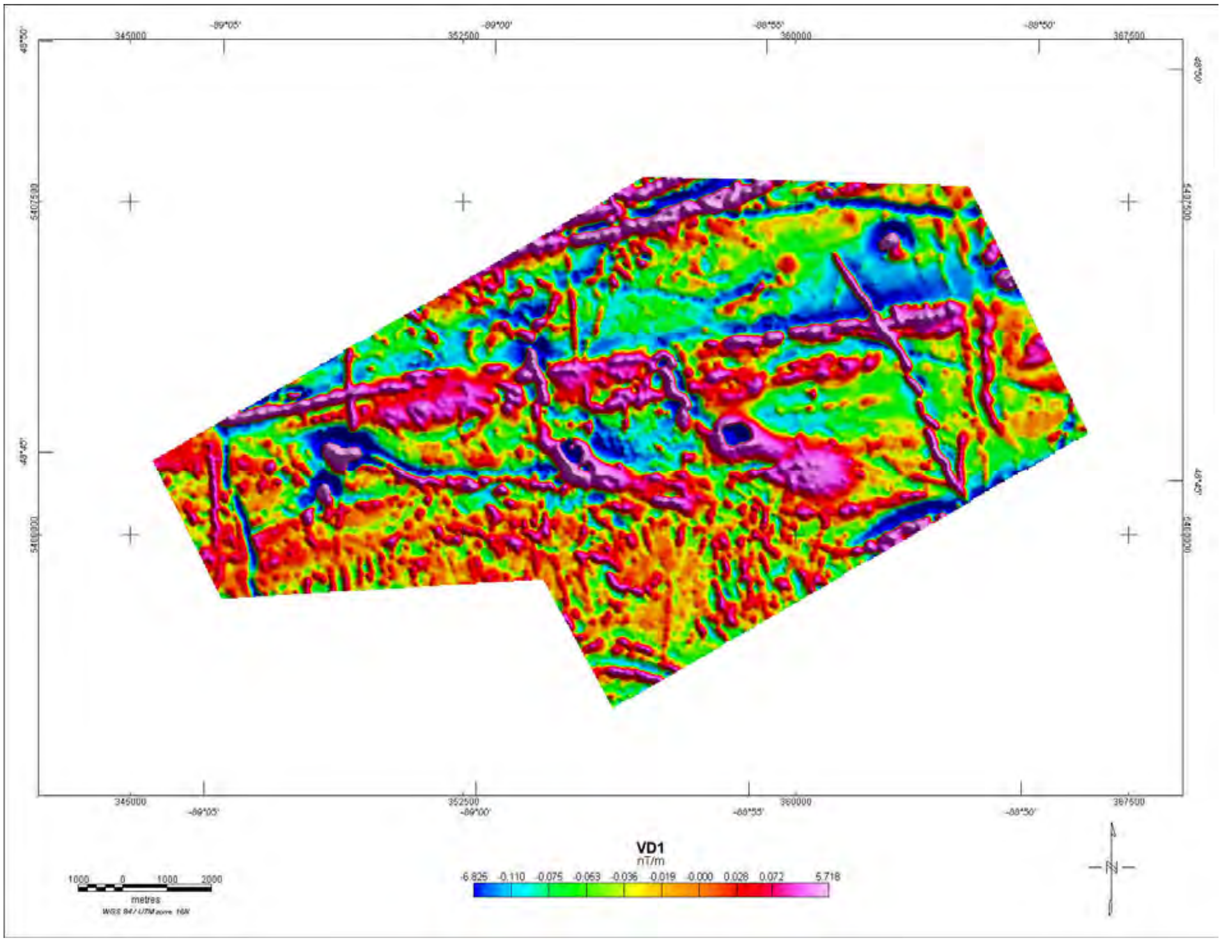

Figure 17: Thunder Bay – *First Vertical Derivative of the Total Magnetic Intensity (nT/m)*

6.12 IGRF Correction

The levelled total magnetic intensity was then IGRF corrected using the 2010 model, 2010/08/15 as the removal date and a constant elevation of 580m above the WGS84 ellipsoid. The output from this correction is the residual magnetic intensity.

6.13 Residual Magnetic Intensity

The residual magnetic intensity had a minimum value of -697 nT and a maximum value of 387 nT across the survey areas.

7 APPENDIX I - SURVEY EQUIPMENT

7.1 Survey Aircraft

A Fugro Airborne Surveys Cessna C208B turbo prop, Canadian registration C-GGRD (Newton), was used to fly the survey area. The following instrumentation was used for this survey.

7.2 FALCON™ Airborne Gravity Gradiometer

FALCON™ *AGG System*
The **FALCON**™ AGG System is based on current state-of-the-art airborne gravity gradiometer technology and has been optimized for airborne broad band geophysical exploration. The system is capable of supporting surveying activities in areas ranging from 1,000 ft below sea level to 13,000 ft above sea level with aircraft speeds from 70 to 130 knots. The **FALCON**™ AGG data streams were digitally recorded at different rates on removable drives installed in the **FALCON**™ AGG electronics rack.

7.3 Airborne Data Acquisition Systems

Fugro Digital Acquisition System (FASDAS)
The Fugro FASDAS is a data acquisition system executing propriety software for the acquisition and recording of location, magnetic and ancillary data. Data are presented both numerically and graphically in real time on the VGA display providing on-line quality control capability.

The FASDAS is also used for real time navigation. A pre-programmed flight plan containing boundary coordinates, line start and end coordinates, the altitude values calculated for a theoretical drape surface, line spacing and cross track definitions is loaded into the computer prior to each flight. The WGS-84 latitude and longitude and altitude received from the real-time corrected, dual frequency Novatel OEMV L1/l2-Band Positioning receiver, is transformed to the local coordinate system for cross track and distance to go values. This information, together with ground heading and speed, is displayed to the pilot numerically and graphically on a two line LCD display. It is also presented on the operator LCD screen in conjunction with a pictorial representation of the survey area, survey lines and ongoing flight path.

FALCON™ *AGG Data Acquisition System (ADAS)*
The Fugro DAS provides control and data display for the **FALCON**™ AGG system. Data is displayed real time for the operator and warnings displayed should system parameters deviate from tolerance specifications. All **FALCON**™ AGG and laser scanner data are recorded to a removable hard drive.

7.4 Aerial and Ground Magnetometers

The airborne Caesium magnetometer was a Scintrex CS-2 having a noise envelope of 0.002nT pk-pk in 0.01-1Hz bandwidth. The ground magnetometers are a Scintrex CS2 Caesium sensor sampling at 1Hz.

7.5 Real-Time Differential GPS

Novatel OEMV L-Band Positioning
The Novatel OEMV L-band Positioning receiver provides real-time differential GPS for the onboard navigation system. The differential data set was relayed via a geo-synchronous satellite to the aircraft where the receiver optimized the corrections for the current location.

7.6 GPS Base Station Receiver

Novatel OEM4 L1/L2
The Novatel GPS receiver is a 12 channel dual frequency GPS receiver. It provides raw range information of all satellites in view sampled every 1s and recorded on a computer laptop. This data is post-processed with the rover data to provide differential GPS (DGPS) corrections for the flight path.

7.7 Altimeters

King KRA405 Radar Altimeter
Fugro Digital Barometric Pressure Sensor
The radar altimeter has a resolution of 1m, an accuracy of 2%, a range of 1-2,500 ft and a measurement rate of 10 Hz. The barometric pressure is measured with an on board pressure module (Rosemount 1241M) with a suitable pneumatic connection to a Pitot-static system.

7.8 Laser Scanner

Riegl LMS-Q140I-80
The laser scanner is designed for high speed line scanning applications. The system is based upon the principle of time-of-flight measurement of short laser pulses in the infrared wavelength region and the angular deflection of the laser beam is obtained by a rotating polygon mirror wheel. The measurement range is up to 400 m with a minimum range of 2 m and an accuracy of 50mm. The laser beam is eye safe, the laser wavelength is 0.9 µm, the scan angle range is +/- 40° and the scan speed is 20 scans/s.

7.9 Data Processing Hardware and Software

The following equipment was used in the field office:

Hardware
- One 2.0 GHz (or higher) laptop computer
- External USB hard drive reader for ADAS removable drives
- External USB hard drive for data backup
- HP DeskJet All-In-One printer, copier, scanner

Software
- Oasis Montaj data processing and imaging software
- GrafNav Differential GPS processing software
- Fugro - Atlas data processing software
- Fugro - DiAGG Processing software

8 APPENDIX II - SYSTEM TESTS

8.1 Instrumentation Lag

Due to the relative position of the magnetometer, altimeters and GPS antenna on the aircraft and to processing/recording time lags, raw readings from each data stream vary in position. To correct for this and to align selected anomaly features on lines flown in opposite directions, the magnetic and altimeter data are 'parallaxed' with respect to the position information. The lags were applied to the data during processing.

8.2 Radar Altimeter Calibration

The radar altimeter is checked for accuracy and linearity every 12 months, or when any change in a key system component requires this procedure to be carried out. This calibration allows the radar altimeter data to be compared and assessed with the other height data (GPS, barometric and laser) to confirm the accuracy of the radar altimeter over its operating range. The calibration is performed by flying a number of 30 second lines at preselected terrain clearances over an area of flat terrain and using the results of the radar altimeter, differentially corrected GPS heights in mean sea level (MSL) and laser scanner were used to derive slope and offset information.

8.3 FALCON™ AGG Noise Measurement

At the commencement of the survey, 20 minutes of data were collected with the aircraft in straight level flight at 3500 ft AGL. This data was processed as a survey line to check the AGG noise levels.

Daily flight debriefs incorporating FALCON™ AGG performance statistics for each flight line are prepared using output from Fugro DiAGG software. These are sent daily to Fugro office staff for performance evaluation.

8.4 Daily Calibrations

A set of daily calibrations were performed each survey day as follows:
- Magnetic base station time check
- AGG Quiescent Calibration

8.4.1 Magnetic Base Station Time Check

Prior to each days survey all magnetic base stations were synchronised using broadcast GPS time signals.

8.4.2 FALCON™ AGG Calibration

A calibration was performed at the beginning of each flight and the results monitored by the operator. The coefficients obtained from each of the calibrations were used in the processing of the data.

9 APPENDIX III - FALCON™ AGG DATA & PROCESSING

9.1 Nomenclature

The Falcon airborne gravity gradiometer (AGG) system adopts a North, East, and Down coordinate sign convention and these directions (N, E, and D) are used as subscripts to identify the gravity gradient tensor components. Lower case is used to identify the components of the gravity field and upper case to identify the gravity gradient tensor components. Thus the parameter usually measured in a normal exploration ground gravity survey is $\mathbf{g_D}$ and the vertical gradient of this component is $\mathbf{G_{DD}}$.

9.2 Units

The vertical component of gravity ($\mathbf{g_D}$) is delivered in the usual units of mGal. The gradient tensor components are delivered in Eötvös, which is usually abbreviated to "Eö". By definition **1 Eö = 10^{-4} mGal/m.**

9.3 FALCON Airborne Gravity Gradiometer Surveys

In standard ground gravity surveys, the component measured is "$\mathbf{g_D}$", which is the *vertical component of the acceleration due to gravity*. In airborne gravity systems, since the aircraft is itself accelerating, measurement of "$\mathbf{g_D}$" cannot be made to the same precision and accuracy as on the ground. Airborne gravity gradiometry uses a differential measurement to remove the aircraft motion effects and delivers gravity data of a spatial resolution and sensitivity comparable with ground gravity data.

The Falcon gradiometer instrument acquires two curvature components of the gravity gradient tensor namely $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ where $\mathbf{G_{UV}} = (\mathbf{G_{EE}} - \mathbf{G_{NN}})/2$. Since these curvature components cannot easily and intuitively be related to the causative geology, they are transformed into the vertical gravity gradient ($\mathbf{G_{DD}}$), and integrated to derive the vertical component of gravity ($\mathbf{g_D}$). Interpreters display, interpret and model both $\mathbf{G_{DD}}$ and $\mathbf{g_D}$. The directly measured $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ data are appropriate for use in inversion software to generate density models of the earth. The vertical gravity gradient, $\mathbf{G_{DD}}$, is more sensitive to small or shallow sources and has greater spatial resolution than $\mathbf{g_D}$ (similar to the way that the vertical gradient provides greater spatial resolution and increased sensitivity to shallow sources of the magnetic field). In the integration of $\mathbf{G_{DD}}$ to give $\mathbf{g_D}$, the very long wavelength component, at wavelengths comparable to or greater than the size of the survey area, cannot be fully recovered. Long wavelength gravity are therefore incorporated in the $\mathbf{g_D}$ data from other sources. This might be regional ground, airborne or marine gravity if such data are available. The Danish National Space Centre global gravity data of 2008 (DNSC08) are used as a default if other data are not available.

9.4 Gravity Data Processing

The main elements and sequence of processing of the gravity data are as follows:

1. Dynamic corrections for residual aircraft motion (called Post Mission Compensation or PMC) are calculated and applied.
2. Self Gradient corrections are calculated and applied to reduce the time-varying gradient response from the aircraft and platform.
3. A Digital Terrain Model (DTM) is created from the laser scanner range data, the AGG inertial navigation system rotation data and the DGPS position data.
4. Terrain corrections are calculated and applied.

5. $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ are levelled and transformed into the full gravity gradient tensor, including $\mathbf{G_{DD}}$, and into $\mathbf{g_D}$.

9.5 Aircraft dynamic corrections

The design and operation of the FALCON AGG results in very considerable reduction of the effects of aircraft acceleration but residual levels are still significant and further reduction is required and must be done in post-processing.

Post-processing correction relies on monitoring the inertial acceleration environment of the gravity gradiometer instrument (GGI) and constructing a model of the response of the GGI to this environment. Parameters of the model are adjusted by regression to match the sensitivity of the GGI during data acquisition. The modelled GGI output in response to the inertial sensitivities is subtracted from the observed output. Application of this technique to the output of the GGI, when it is adequately compensated by its internal mechanisms, reduces the effect of aircraft motion to acceptable levels.

Following these corrections, the gradient data are demodulated and filtered along line with a 6-pole Butterworth low-pass filter with a cut-off frequency of 0.18 Hz (for fixed-wing operations; a higher frequency may be used for helicopter operations).

9.6 Self Gradient Corrections

The GGI is mounted in gimbals controlled by an inertial navigation system which keeps the GGI pointing in a fixed direction whilst the aircraft and gimbals rotate around it. Consequently, the GGI measures a time-varying gravity gradient due to these masses moving around it as the heading and attitude of the aircraft changes during flight. This is called the self-gradient.

Like the aircraft dynamic corrections, the self-gradient is calculated by regression of model parameters against measured data. In this case, the rotations of the gimbals are the input variables of the model. Once calculated, the modelled output is subtracted from the observed output.

9.7 Laser Scanner Processing

The laser scanner measures the range from the aircraft to the ground in a swathe of angular width ±40 degrees below the aircraft. The aircraft attitude (roll, pitch and heading) data provided by the AGG inertial navigation system are used to adjust the range data for changes in attitude and the processed differential GPS data are used to reference the range data to located ground elevations referenced to the WGS 84 datum. Statistical filtering strategies are used to remove anomalous elevations due to foliage or built up environment. The resulting elevations are gridded to form a digital terrain model (DTM).

9.8 Terrain Corrections

An observation point above a hill has excess mass beneath it compared to an observation point above a valley. Since gravity is directly proportional to the product of the masses, uncorrected gravity data have a high correlation with topography.

It is therefore necessary to apply a terrain correction to gravity survey data. For airborne gravity gradiometry at low survey heights, a detailed DTM is required. Typically, immediately below the aircraft, the digital terrain will need to be sampled at a cell size roughly one-third to one-half of the survey height and with a position accuracy of better than 1 metre. For these accuracies, LIDAR data are required and each FALCON survey aircraft comes equipped with LIDAR (laser scanner).

If bathymetric data are used then these form a separate terrain model for which terrain corrections are calculated at a density chosen to suit the water bottom – water interface. Once the DTM has been merged, the terrain corrections for each of the $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ data streams are calculated. In the calculation of terrain corrections, a density of 1 gm/cc is used. The calculated corrections are stored in the database allowing the use of any desired terrain correction density by subtracting the product of desired density and correction from the measured $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ data. The terrain correction density is chosen to be representative of the terrain density over the survey area. density Sometimes more than one density is used with input from the client.

Typically, the terrain corrections are calculated over a distance 10 km from each survey measurement point.

9.9 Tie-line Levelling

The terrain- and self gradient-corrected $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ data are tie-line levelled across the entire survey using a least-squares minimisation of differences at survey line intersections. Occasionally some micro-levelling might be performed.

9.10 Transformation into G_{DD} & g_D

The transformation of the measured, corrected and levelled $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ data into gravity and components of the full gravity gradient tensor is accomplished using two methods:

- Fourier domain transformation and
- Equivalent source transformation.

The Fourier method relies on the Fourier transform of Laplace's equation. The application of this transform to the complex function $\mathbf{G_{NE} + i\, G_{UV}}$ provides a stable and accurate calculation of each of the full tensor components and gravity. The Fourier method performs piece-wise upward and downward continuation to work with data collected on a surface that varies from a flat horizontal plane. For stability of the downward continuation, the data are low-pass filtered. The cut-off wavelength of this filter depends on the variations in altitude and the line spacing. It is set to the smallest value that provides stable downward continuation.

The equivalent source method relies on a smooth model inversion to calculate the density of a surface of sources and from these sources, a forward calculation provides the $\mathbf{G_{DD}}$ and $\mathbf{g_D}$ data. The smoothing results in an output that is equivalent to the result of the low-pass filter in the Fourier domain method.

The Fourier method generates all tensor components but the equivalent source method only generates $\mathbf{G_{DD}}$ and $\mathbf{g_D}$ (and $\mathbf{G_{NE}}$ and $\mathbf{G_{UV}}$ for comparison with the inputs).

The limitations of gravity gradiometry in reconstructing the long wavelengths of gravity can lead to differences in the results of these two methods at long wavelength. The merging of the $\mathbf{g_D}$ data with externally supplied regional gravity such as the DNSC08 gravity removes these differences.

9.11 Noise & Signal

With all the Falcon AGG instruments, there are two measurements made of both the NE and UV curvature components during acquisition. This gives a pair of independent readings at each sample point.

The standard deviation of half the difference between these pairs is a good estimate of the survey noise. This is calculated for each line, and the average of all the survey lines is the figure quoted for the survey as a whole.

This difference error has been demonstrated to follow a 'normal' or Gaussian statistical distribution, with a mean of zero. Therefore, the bulk of the population (95%) will lie between -2σ and +2σ of the mean. For a typical survey noise estimate of, say, 3 Eö, 95% of the noise will be between -6 Eö and +6 Eö.

These typical errors in the curvature gradients translate to errors in $\mathbf{G_{DD}}$ of about 5 Eö and in $\mathbf{g_D}$ (in the shorter wavelengths) in the order of 0.1 mGal.

9.12 Risk Criteria in Interpretation

The risks associated with a Falcon AGG survey are mainly controlled by the following factors.

- **Survey edge anomalies** – the transformation from measured curvature gradients to vertical gradient and vertical gravity gradient is subject to edge effects. Hence any anomalies located within about 2 x line spacing of the edge of the survey boundaries should be treated with caution.
- **Single line anomalies** – for a wide-spaced survey, an anomaly may be present on only one line. Although it might be a genuine anomaly, the interpreter should note that no two-dimensional control can be applied.
- **Low amplitude (less than 2σ) anomalies** – Are within the noise envelope and need to be treated with caution, if they are single line anomalies and close in diameter to the cut-off wavelengths used.
- **Residual topographic error anomalies** – Inaccurate topographic correction either due to inaccurate DTM or local terrain density variations may produce anomalies. Comparing the DTM with the G_{DD} map terrain-corrected for different densities is a reliable way to confirm the legitimacy of an anomaly.
- **The low density of water and lake sediments** (if present) can create significant gravity and gravity gradient lows which may be unrelated to bedrock geology. It is recommended that all anomalies located within lakes or under water be treated with caution and assessed with bathymetry if available.

9.13 References

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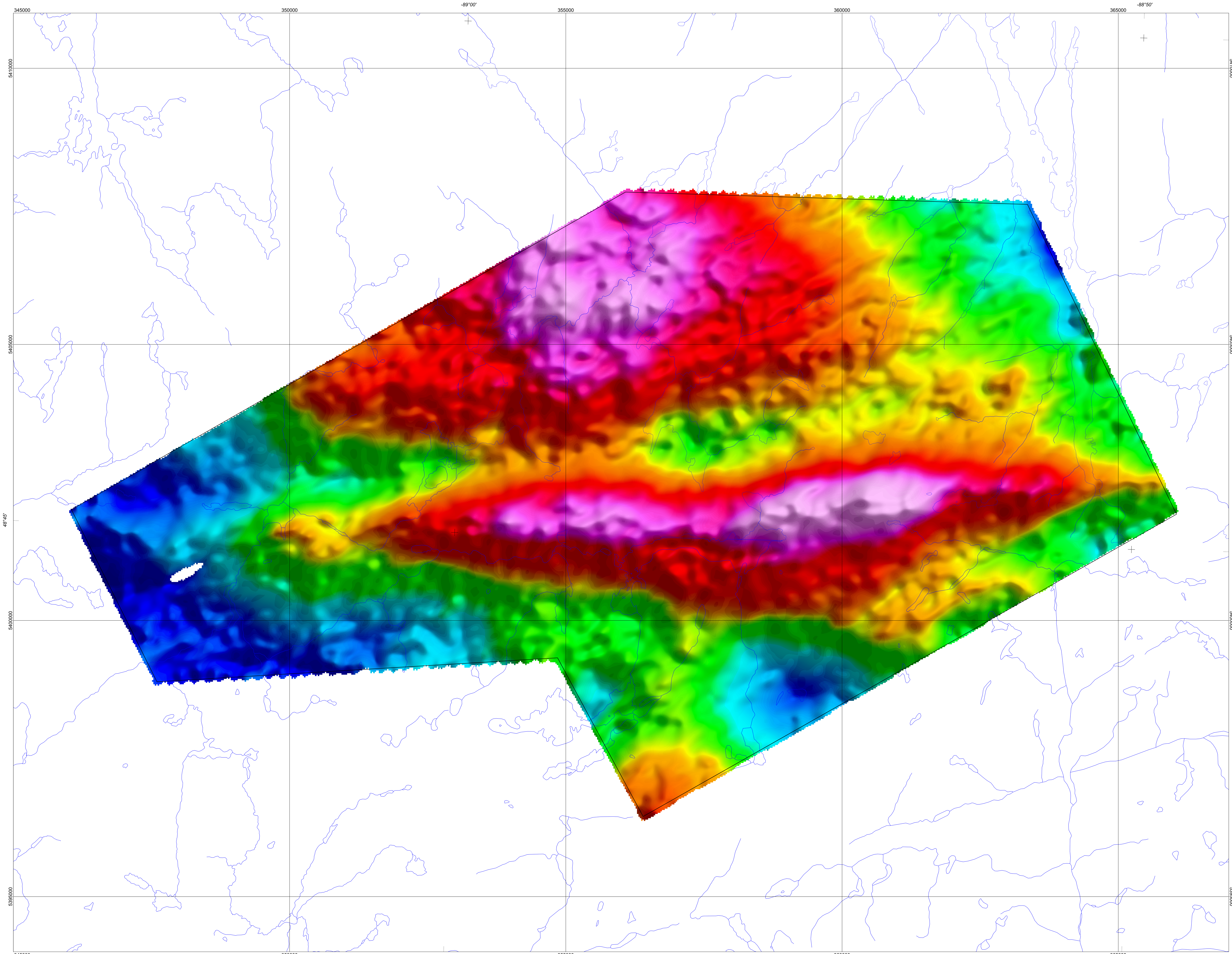


CLIENT LOGO HERE

FALCON Airborne Gravity Gradiometer

and High Resolution Magnetic Survey For

Magma Metals (Canada) Limited

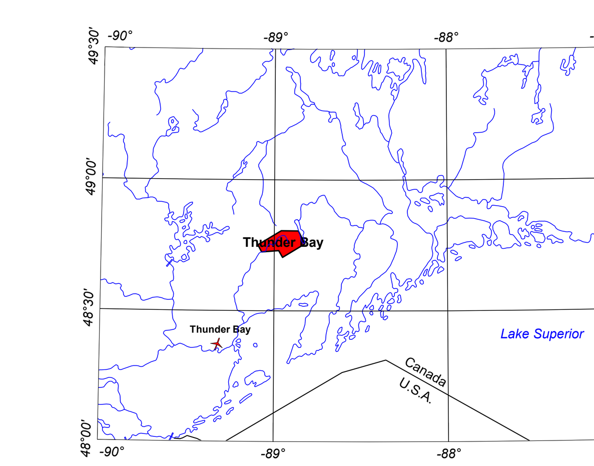
Thunder Bay

Ontario

Fourier Derived Vertical Gravity

Preliminary Map

mGal



Survey Specifications

Line Spacing	100m
Line Azimuth	60°-240°
Tie-Line Spacing	500m
Tie-Line Azimuth	150°-330°

Geodetic Specifications

Map Projection	UTM
Datum	WGS84
UTM Zone	16 North
Central Meridian	87° West
False Easting	500000m
False Northing	0m
Scale Factor	0.9996

Line Direction
Line Version
<10010
Line Number
Fiducials

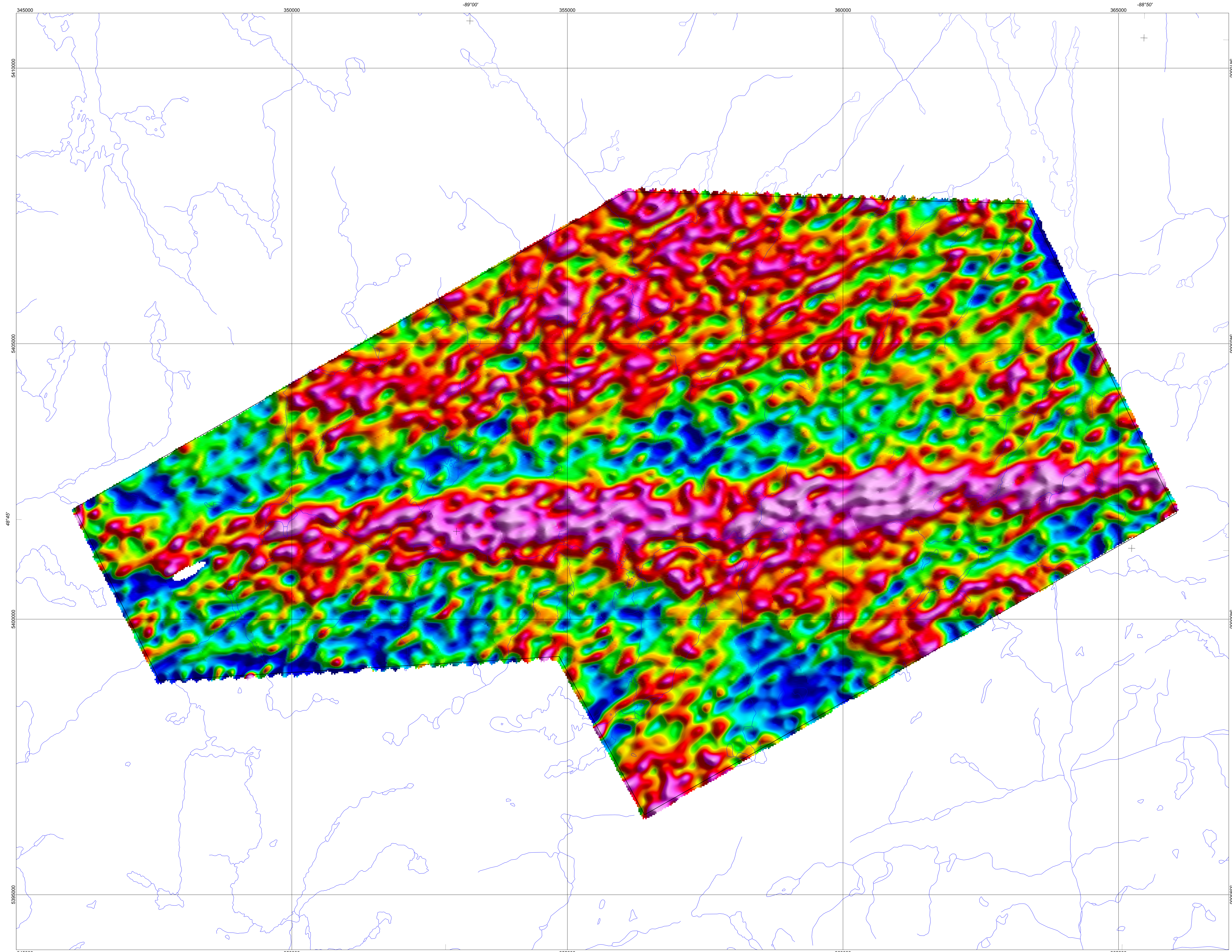
Inclination 74 degrees
Declination -11 degrees

Scale 1:25000

metres

Fugro Project 10811
Map Creation 09.08.10

FUGRO AIRBORNE SURVEYS



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FALCON Airborne Gravity Gradiometer

and High Resolution Magnetic Survey For

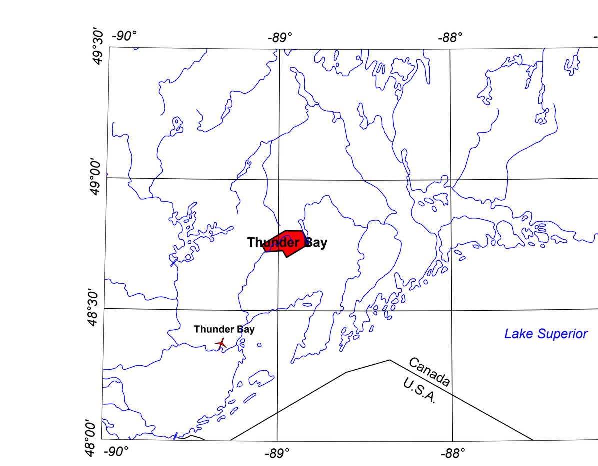
Magma Metals (Canada) Limited

Thunder Bay

Ontario

Fourier Derived Gdd Gradient

Preliminary Map



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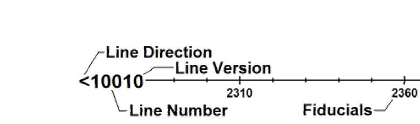


Inclination 74 degrees
Declination -11 degrees

Scale 1:25000

500 0 500 1000 1500

metres

WGS 84 / UTM zone 16N

Fugro Project 10811
Map Creation 09.08.10

FUGRO AIRBORNE SURVEYS

REPORT ON PROCESSING & ANALYSIS OF

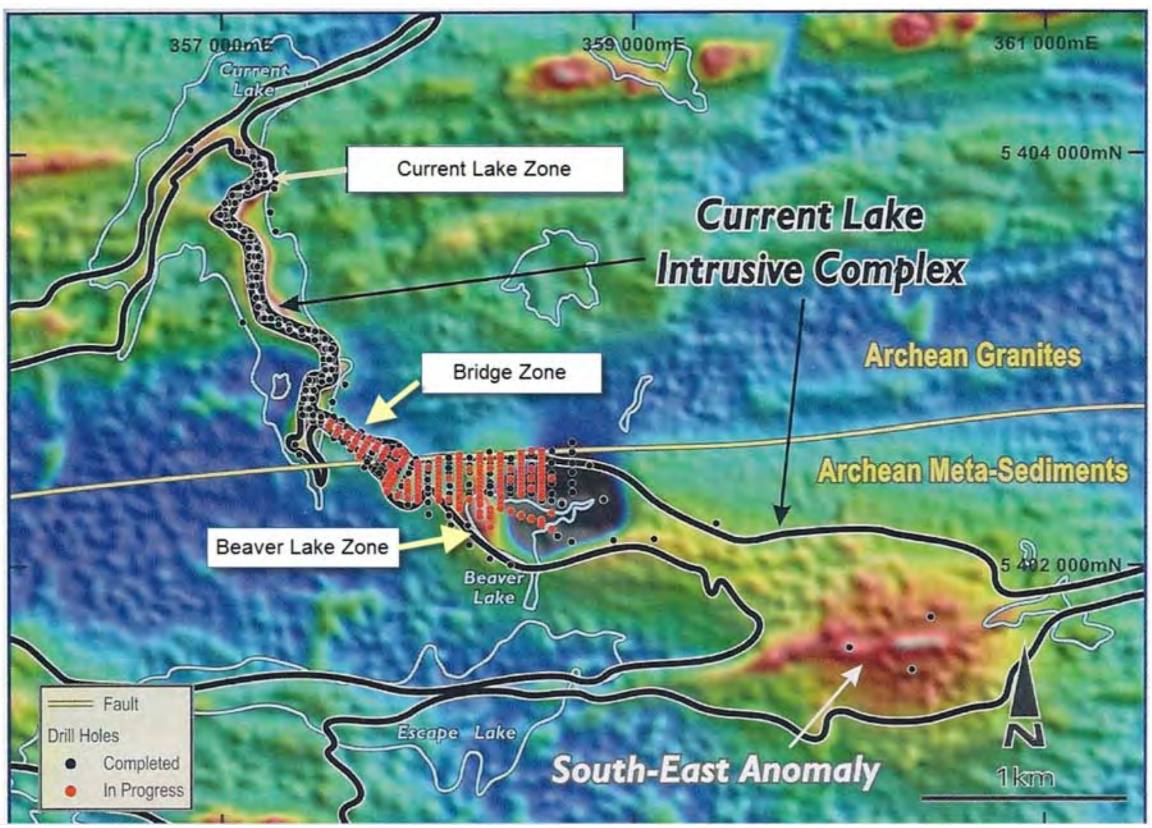
FALCON AGG AND MAGNETIC DATA

THUNDER BAY NORTH PROJECT, ONTARIO

FOR

MAGMA METALS (CANADA) LIMITED

JANUARY 2011



Condor Consulting
Lakewood Colorado
USA

Contents

1. SUMMARY

The main purpose of this work is to help map the distribution of mafic and ultramafic rocks of the TBN (TBN) igneous complex based on inversion and modeling of airborne magnetic and gravimetric data. Data was obtained from two high resolution surveys: a fixed-wing Falcon survey flown at 100 m line separation and a low level (20 m) helicopter borne mag survey flown at 50 m line separation.

The Falcon survey data itself was briefly reviewed and found to exhibit typical noise levels, though high turbulence was noted on lines flown later in the survey days. This is typical of noise driven by turbulence which in turn is related to thermal effects encountered during summer operations. The Falcon data was also compared to a small ground gravity survey. From this it is possible to deduce that several noise spikes are related to elevation errors in the ground survey and to estimate an upper limit for the noise in the Falcon survey of approximately 0.38 mGal RMS which is similar to expectations from published Falcon data. The Falcon DEM and terrain corrections seem appropriate for the area. The data were presented using a 200 m cut-off wavelength to preserve the highest possible frequency content. This also includes a considerable amount of noise and images might be improved by applying a low pass filter with a longer cut-off wavelength.

Processing here involved inverting the mag and gravity data independently using unconstrained UBC-style smooth model voxel inversions. The following models were calculated covering the entire extent of the Falcon or UTS surveys:

- susceptibility derived from total field Falcon mag,
- susceptibility derived from the UTS mag survey,
- density derived from Falcon vertical gravity (Gd) and
- density derived from the Falcon gravity gradient (Gdd).

In addition the two higher resolution models were prepared for the Current Lake-Bridge Zone-Beaver Lake –Southeast anomaly area.

- susceptibility derived from the UTS mag survey and
- density derived from Falcon vertical gravity (Gd).

The Falcon susceptibility and density models were used to generate a classified model with seven classes, each defining a non-overlapping portion of the density-susceptibility parameter space. These classes appear to reflect the main geologic units. A “classification error” model was also

generated which highlights features which fit poorly into their respective classes. This model emphasizes areas which are statistically anomalous, without consideration of the cause of the anomalism.

Gravity data for three lines selected by Magma Metals (Canada) Limited (Magma) were modeled in 2.5D using Encom's ModelVision Pro v 10.0 (MVP). This allows complex shapes to be modeled in either section or plan. The interpreted footprint of the TBN complex rocks and two geologic sections along with selected densities from core were provided by Magma and these were used to constrain the ModelVision models. In all three cases most of the local gravity anomaly is explained by dense metasedimentary host rocks and the response from the TBN igneous rocks is demonstrated to be a very small fraction of the local gravity anomaly, particularly for the Southeast anomaly. This results from several factors including large volume of high density metasedimentary rock, weakly anomalous density for a large fraction of the TBN rocks (particularly the hybrid unit), flat-lying geometry of the TBN rocks in the area which was modeled and the large depth to top (~925 m) of the dense part of the target.

The modeling and available data do not suggest that there would be much merit in completing a constrained density model but a constrained susceptibility model, using the body outline developed from image interpretation and drilling as reference model, may be both feasible and effective.

2. INTRODUCTION

Exploration Scenario

The target model is a PGM deposit hosted in Proterozoic age mafic-ultramafic rocks which are hosted by Archean age metasediments and granitoids. While the possibility exists for a highly conductive Ni-Cu deposit within the study area, to date the zones described as massive sulfide are quite limited in size.

Mapping the distribution of UM rocks in 3D based on their susceptibility and density character is the primary purpose of this program of work. While not likely to generate targets *per se*, this information will hopefully aid in directing drilling into the more favorable areas.

Much of the exploration effort to date has been directed towards the Current lake – Bridge Zone – Beaver Lake area where extensive drilling has been completed. Here the mafic to ultramafic rocks of the TBN intrusive complex vary from outcropping in the north near Current Lake to shallow (~150 m) in the Beaver Lake zone (Figure 1). Sparse, deep drilling in the area of the South-East Anomaly demonstrated the presence of TBN intrusive rocks at depths below 650 m.

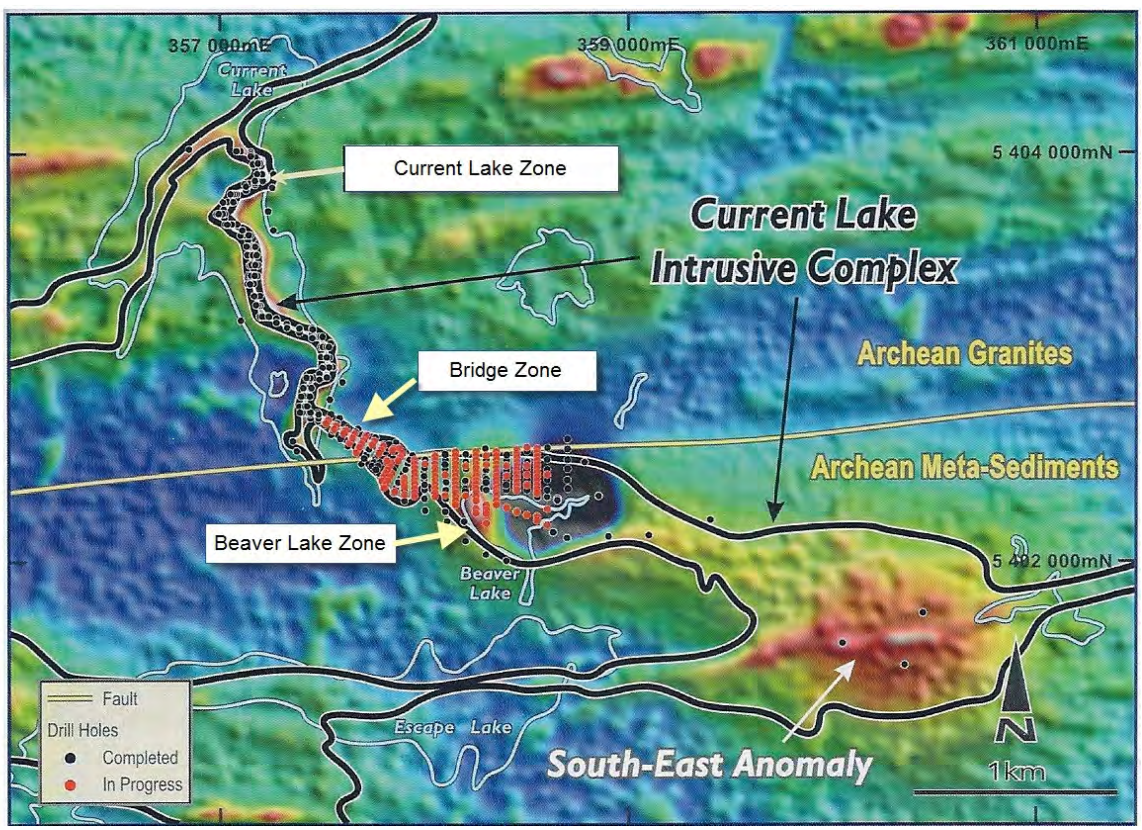


Figure 1 Location of mineralized zones and anomalies (after Magma 2010)

Geophysical Surveys Data

Two detailed airborne geophysical surveys cover the project area and are used here (Figure 2). A 1500 line-km Falcon airborne gravity gradiometry survey was flown in August 2010 at a mean clearance of 105 m with 100 m line separation. Part of this same area was covered with a detailed helicopter mag survey flown at a mean clearance of 20 m and 50 m line separation. A small ground gravity survey was also provided for comparison with the Falcon data.

Datum and Projection

All input data and all models and images in this report use WGS84 and UTM16N

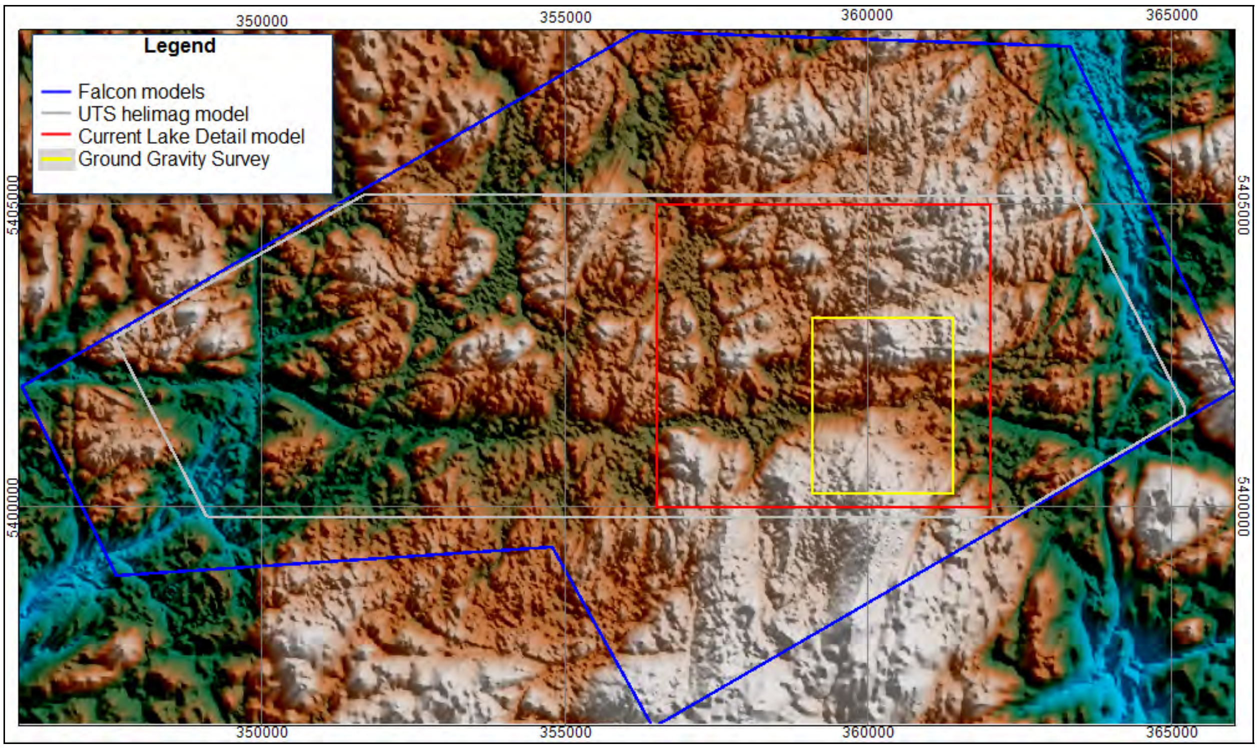


Figure 2 Location and extent of geophysical surveys and 3D models.

3. ASSESSMENT OF FALCON DATA AND PROCESSING

At the request of Magma we include a brief assessment of the Falcon data and processing parameters. Below we consider statistical measures of noise compared to published data, the accuracy of the DEM used for terrain correction and compare the Falcon-derived gravity data to a small ground gravity grid which was over-flown by the Falcon survey.

Data Acquisition

As is commonplace in modern airborne surveys the flight path is very good with only one obvious deviation, presumably to avoid a tower or other obstacle. The only parameter that is noticed to be inconsistent with the specification is the clearance above ground. The mean altitude is 105 m whereas the specification was 80 m. This difference might be attributed to tree cover in the area and the writer is not familiar with the exact wording of the contract specifications.

Statistical Measures of Noise

Noise in a Falcon survey is determined by a number of factors and can be described by a lower noise limit, which is achieved only under perfect operating conditions, plus noise which increases with aircraft acceleration, mainly due to turbulence.

The Falcon system consists of two independent gradiometers (called complements) mounted on the same rotating wheel. The curvature gradient data for each of two tensor components (Gne and Guv) is the *average* of the output from these two complements. The *difference* of these two complements provides a measure of uncorrelated system noise for each component. The system noise is defined as the standard deviation of half the difference between the complements, for each of the Gne and Guv components. From the Falcon survey report (Fugro 2010) the noise is estimated at 3.66 Eö and 3.64 Eö for Gne and Guv respectively. In Figure 3 we can compare the noise from the TBN survey to historical data and can see that it is fairly typical for data collected during the most recently published period, particularly since it was collected during summer when turbulence at low altitude can be a problem. We note that the turbulence conditions varied from low to high during the survey with rather high turbulence encountered in the latter part of each day (See Figure 3 in Fugro 2010). This will have some negative impact on the final noise for the survey but it appears to be within the norms for the system.

Short bursts of uncorrelated noise are observed near the edges of the survey on several lines (See Figure 4 and 5 in Fugro 2010) and these may be related to instability arising after turns, however this is speculative and these events have not been traced back to source. In the experience of the writer such features are uncommon but should not be a major problem.

Processing

Processing appears to have used standard Falcon signal processing, details of which are not published by Fugro, followed by self gradient, terrain correction and conversion from measured curvature gradients to all five independent components of the tensor field. The transformation was completed using two independent methodologies (Fourier and Equivalent Source). The fact that these very different methodologies give very similar results is re-assuring though, because they have identical input, only limited conclusions can be drawn from such agreement.

The processing parameters appear to be appropriate for the survey specification. However, a short cut-off wavelength has been used, 200 m, which is commensurate with the 100 m line separation. Such a short wavelength is adopted to maintain the highest possible resolution in the final data. However the gradient data shows very low signal to noise and it may be desirable to sacrifice resolution and reduce the high frequency noise by applying a low pass filter of say 300 to 600 m to the Gdd data. This often produces images which are more readily interpretable. A reasonable alternative is to use a mid-level slice from the inverted Gdd density model for image interpretation rather than the Gdd data. See, for example, the lower panels on Figure 12.

DEM and Terrain Corrections

The Falcon DEM is an extremely important input to airborne gravity gradient processing and, since airborne gravity data cannot be corrected using Bouguer correction, accurate terrain corrections are absolutely critical to providing a useful result. The Falcon DEM was only examined in detail in the area where there was independent data from the ground gravity survey and the Falcon DEM generally compares favorably to the ground GPS data. In fact the comparison actually highlights some significant errors in the *ground* data (see below). We note that Magma have apparently flown a LIDAR survey over the project area and this could be used to independently evaluate the Falcon DEM, though no concerns regarding the Falcon DEM have been raised at this time.

Terrain corrections were completed using a density of 2.67 g/cc which seems appropriate considering the densities of near-surface rocks. Sufficient information is supplied in the database to apply terrain corrections using a different density, if required.

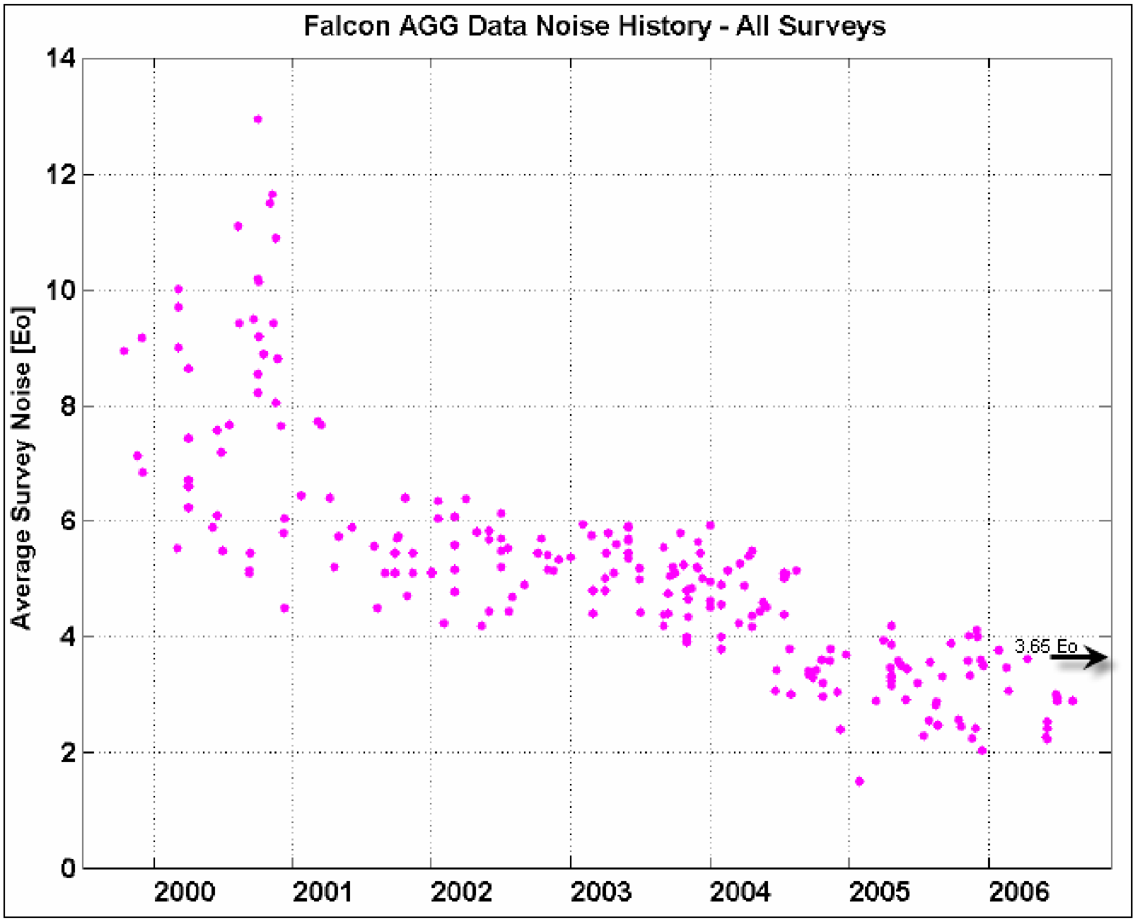


Figure 3 Falcon noise history. Each point on the figure is the average RMS noise for each completed Falcon survey plotted at the completion date of that survey. (From Dransfield 2007) For comparison the arrow shows the average noise level for the TBN survey.

Comparison between Falcon and Ground Gravity Data

A dataset from a small (2.5 x 3.7 km) ground gravity survey collected over part of the area known as the Southeast Anomaly (Figure 1 and 2) is used as an independent benchmark against which the Falcon data is assessed. The ground data was provided as Bouguer corrected data along with station coordinates, including elevations. Neither survey specification nor processing procedures were supplied for the ground survey and it is assumed that the data were collected using differential GPS and a state-of-the-art gravimeter. It is not clear if any terrain corrections have been applied to the ground data, though considering the limited relief the effect should be small in most parts of this grid.

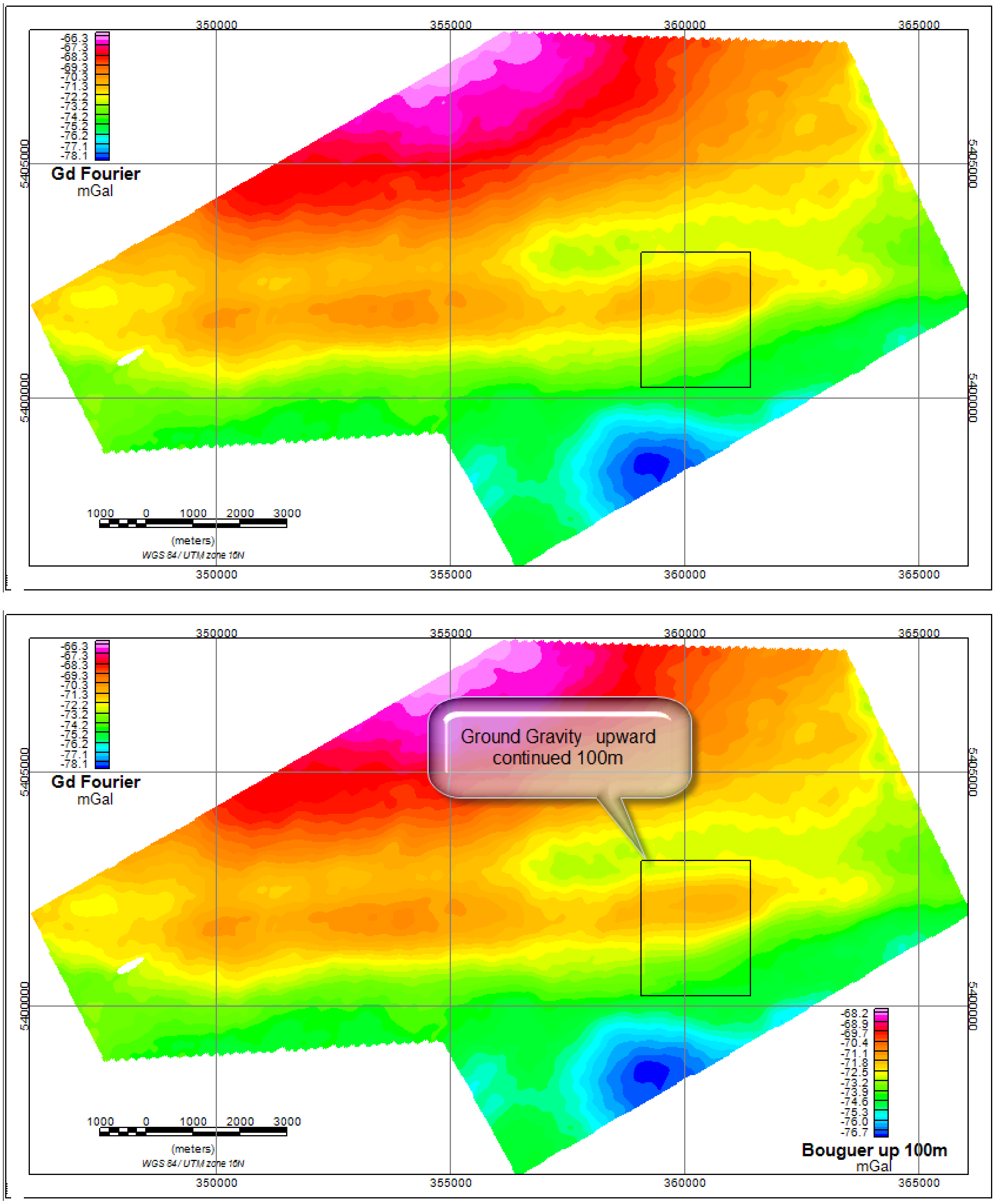


Figure 4 Comparison of Falcon Gravity (upper panel) with Bouguer ground Gravity upward continued 100 m (inset lower panel). Note that systematic ground gravity coverage was limited to the inset region and that different linear color bars were used for the Falcon and Bouguer gravity, as shown.

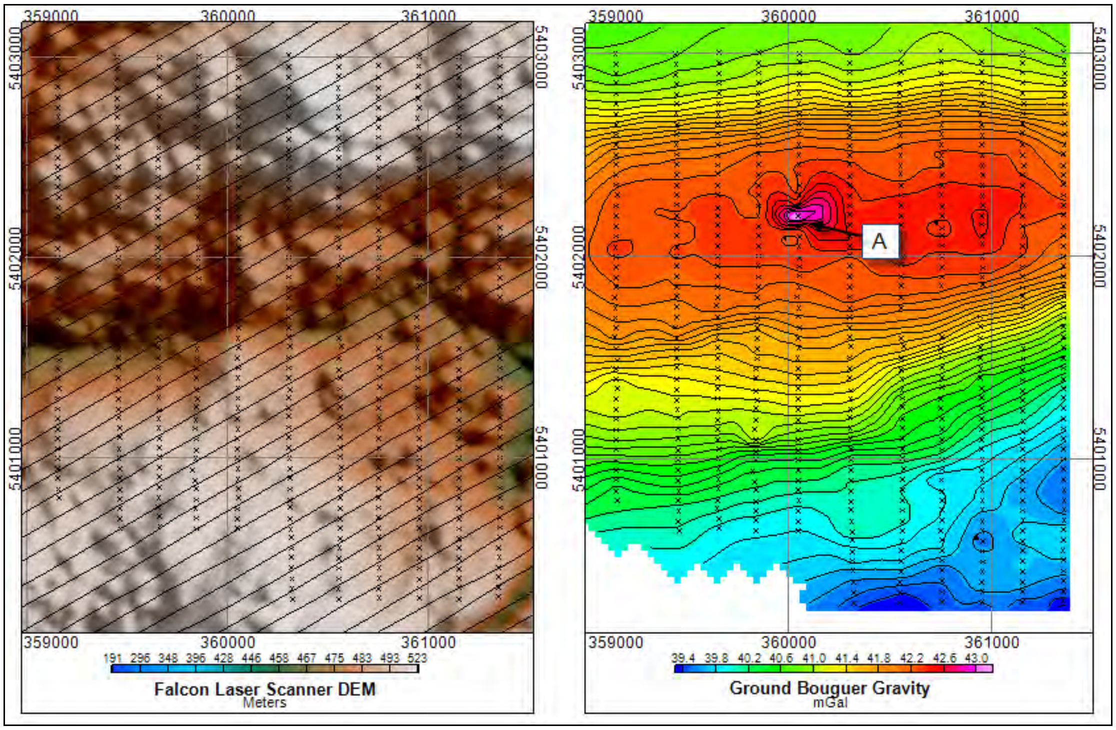


Figure 5 DEM from the Falcon laser scanner (left) and Ground gravity (right). Station locations are shown by the symbols and Falcon flight lines are shown by the NE-SW lines.

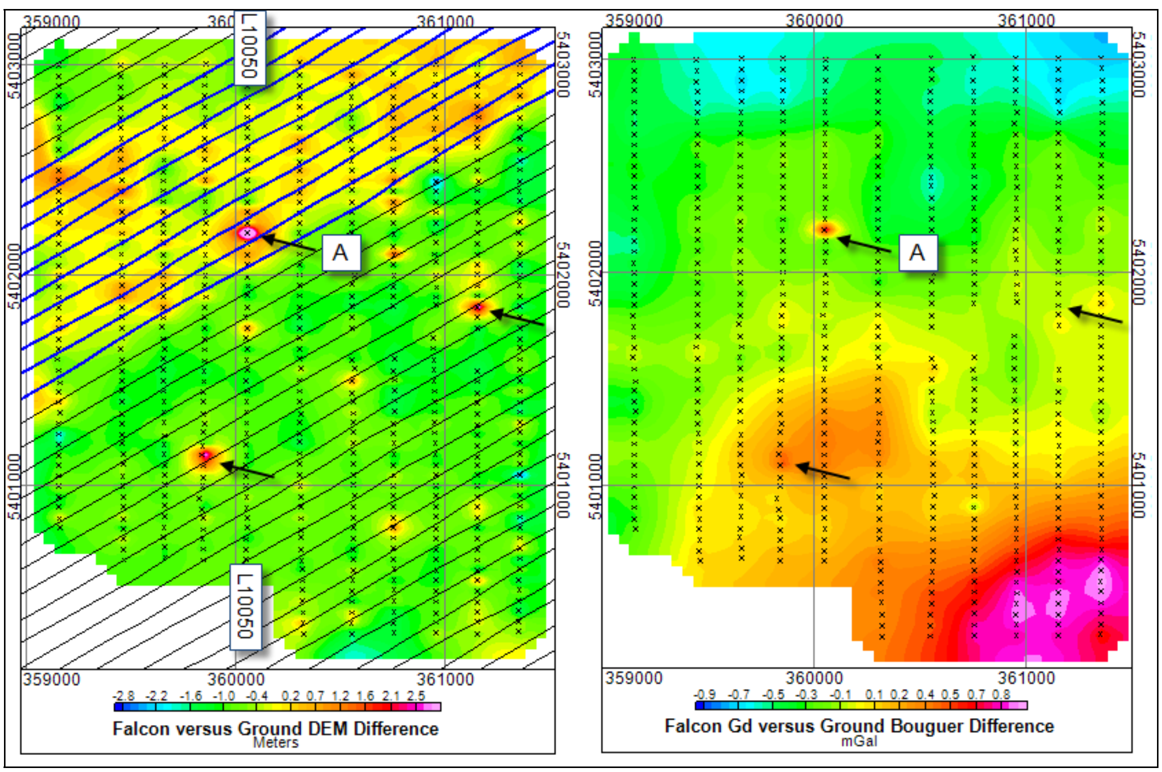


Figure 6 The difference between Falcon laser DEM and Elevations from the ground survey (left) and the difference between the Falcon Gd and Bouguer gravity. These illustrate the combined errors for both the ground and airborne surveys.

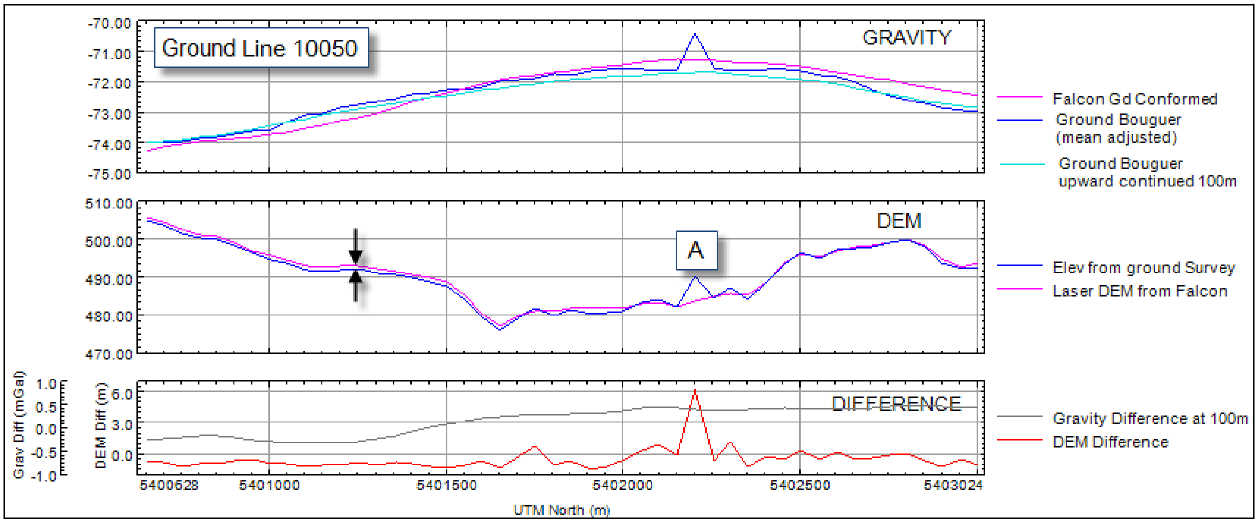


Figure 7 Comparison Elevation and Gd from the ground and airborne surveys for L10050 from the ground survey. See Figure 6 for location. "A" shows a 6m error in elevation which can almost certainly be attributed to the ground survey. The arrows in the middle panel show the systematic offset of about 1m attributable to the aircraft GPS altitude.

Figure 4 (upper panel) shows the conformed Falcon Gd data terrain corrected with a density of 2.67 g/cc. The rectangle marks the extent of the ground gravity survey but only Falcon data is shown on the upper panel. In the lower panel the ground gravity data, upward continued by 100m, is shown within this rectangle. This provides visual confirmation that the Bouguer gravity and Falcon gravity are providing similar qualitative information.

Figure 5, 6, 7 and 8 provide quantitative comparisons between the between the two DEMs and gravity maps from the two surveys.

The digital elevation model and station elevations are, in general, as important as the gravity measurements in determining the quality of the final corrected gravity data. Here we can look at the differences between the DEMs to assess the combined error contributions. Usually, when comparing two data sets in this manner it is impossible to attribute errors to one data set or the other however in this case, we can draw some reasonable conclusions about the source of some of the errors. For example, there are a number of single-point anomalies evident in the DEM difference image (Figure 6, left). These represent errors of up to 6 m in elevation. In this case we can almost certainly attribute these spikes to error in the ground survey since similar spikes can be seen in the ground gravity data at exactly these locations. Some of these are quite large. For example the station labeled “A” in Figure 5, 6 and 7 reflects a 6 m difference in elevation between the two DEMs and this is accompanied by a 1.2 mGal spike in the ground gravity with no noticeable spike in the terrain corrected Falcon gravity. On the other hand Figure 6 (left) shows a band of slightly elevated differences (yellow) in the northwest part of the area. This band appears to run parallel to the Falcon flight lines and further investigation showed that this was associated with a single flight, shown by the heavier blue flight lines on Figure 6 (left). These systematic errors have amplitudes of ~1 m and are almost certainly associated with the aircraft GPS elevation for that flight. This is within specification for the Falcon DEM and does not result in visible band in the Gd data, which may possibly have been removed by leveling.

Figure 7 shows the result of subtracting the conformed Falcon Gd from the Ground Bouguer data after upward continuation to the flight altitude and manually removing the most obvious noise spikes in the ground data. Although the differences are small in the northern part of this image, we note considerable variation in the southern part of the grid where differences exceed 1 mgal over distances of approximately 1 km. It is not possible to assign these errors unequivocally to one dataset or the other, but it is prudent to assume that much of the error should be assigned to the Falcon Gd data. This difference image has a standard deviation of 0.38 mGal giving us a maximum RMS error estimate for the Falcon survey (albeit over a small area). This should be considered an upper limit since the ground data are demonstrably not devoid of noise or error and this measure also includes all difference in the two data sets including terrain correction and any error associated with conforming the Falcon data to the regional ground gravity. This is consistent with the conclusion drawn by Boggs and Dransfield (2004) that the RMS error in Falcon survey data is roughly 0.3 mGal for wavelengths below 10 km.

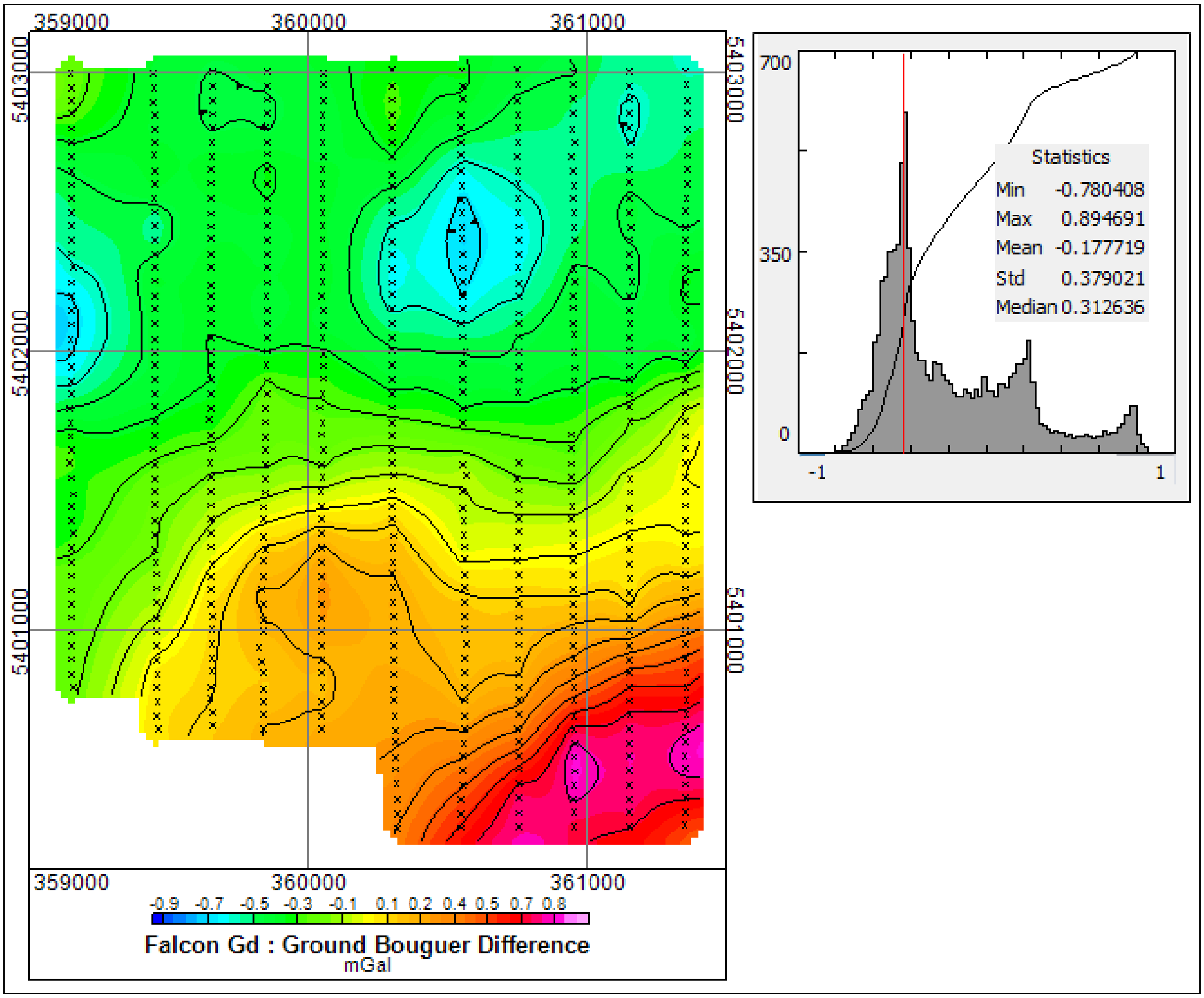


Figure 8 Difference between Falcon Gd and Bouguer Gravity upward continued by 102 m and histogram showing the statistics of this difference image.

4. 3D VOXEL INVERSIONS

Potential field models (i.e. magnetic and gravity) are inherently non-unique. It can be shown that an infinite number of arbitrarily complex models can be constructed which will fit potential field data. This is illustrated in Figure 9 where for a given gravity field, all of the solutions below will fit the observed data.

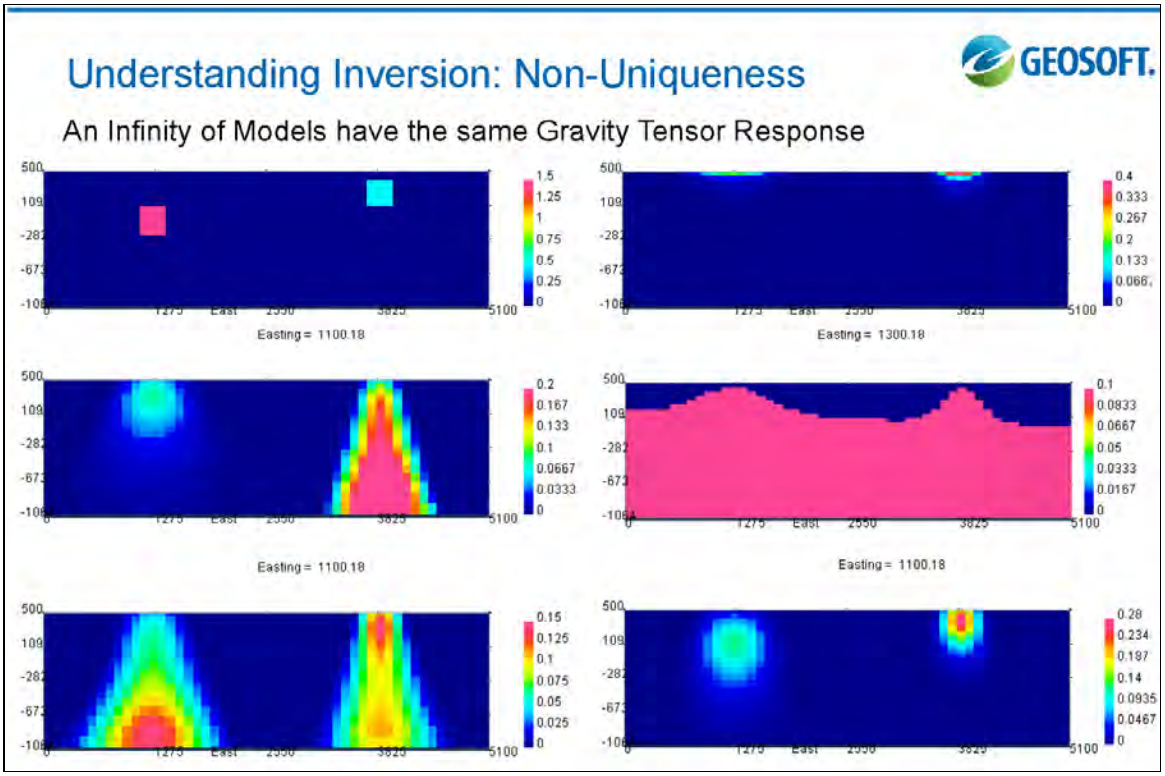


Figure 9 All of the outcomes shown above are derived from the same gravity response (courtesy R Ellis, Geosoft).

It is only by using independent information such as other independent geophysical data or geological data to provide external control (sometimes called constraints) that a greater degree of uniqueness can be superimposed. In the case of the models derived here a unique solution is achieved by demanding that the resulting model be the smoothest possible model that fits the data to the noise level of the data. These are generally referred to as "smooth model" inversions.

Inversions of potential field data were completed using UBC-style voxel inversions for Falcon Vertical Gravity (Gd), Falcon Vertical gravity gradient (Gdd) and Total Field Magnetics. These were completed using 50 m x 50 m x 25 m cells (X,Y,Z) with cell dimensions increasing gradually in the vertical direction in the customary manner.

A detailed model (15 m x 15 m x 7.5 m cells) was also completed over the Current Lake Complex using UTS helimag data. For convenience of display the Falcon Gd data was also inverted at greater detail for this same volume.

The actual error level in processed geophysical data is an important input to the inversion but it is usually quite difficult to estimate and the inversions were run using a variety of noise levels. For the density models derived from gravity (Gd) the model using an error level of 0.1 mGal is favored here, though a higher resolution model using 0.04 mGal error is included in the data delivery. The density model derived from the vertical gravity gradient data (Gdd) used a noise level of 4 Eö. This gives somewhat better resolution than the lowest noise level Gd model, but has a very noisy appearance in the shallower levels of the model and these shallow levels should generally be ignored. Inversions for Gdd using lower assigned error levels were also completed but these showed a progressively nosier appearance and are not included here (see for example Figure 12 and Figure 11).

Magnetic data from the fixed-wing Falcon survey was inverted using a noise level of 2 nT. A noise level of 4 nT was used for the low level UTS survey.

Model files are included in both UBC format and ASCII XYZ format. File names for these files are listed in Appendix 1.

Systematic interpretation of the models is outside the scope of this report but several features in the Current Lake-Southeast anomaly area are discussed by way of illustration. Figure 13 shows two 3D views of density and susceptibility isosurfaces (3D contours) extracted from the models. Only a few isosurfaces are shown to minimize clutter. Red and blue show positive and negative susceptibility bodies respectively while grey and green show positive and negative density bodies. In general the TBN rocks can be seen cross cutting the major formations outlined by the density isosurfaces. The sinuous Current Lake zone is shown wrapping around a small, low density zone (a green "sphere"). The latter also corresponds to reverse magnetic response but this is not captured in the image due to the limited number of susceptibility isosurfaces shown. Note that the gravity data have NOT been bathymetrically corrected and this may have significant implications for the apparent negative density contrast in this zone (i.e. it may arise from deep water). The Beaver Lake zone and Southeast Anomaly appear as prominent susceptibility bodies of opposite signs. The tube-like connection between the Beaver Lake zone and the Southeast anomaly can be readily inferred from the two panels.

As previously discussed these are unconstrained smooth inversions, and as a result, they tend to smear or overemphasize strongly anomalous features to greater depth, so this should be kept in mind when interpreting these results.

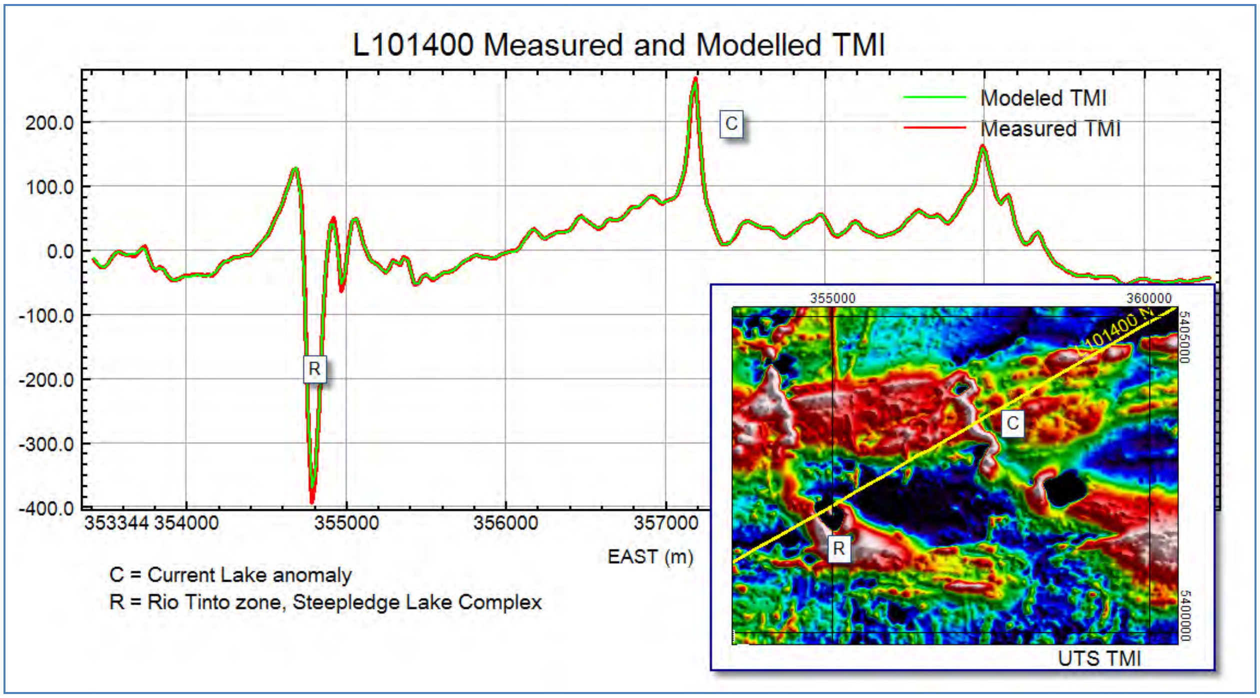


Figure 10 Measured (red) and modelled (green) mag profile from the Current Lake detailed susceptibility model.

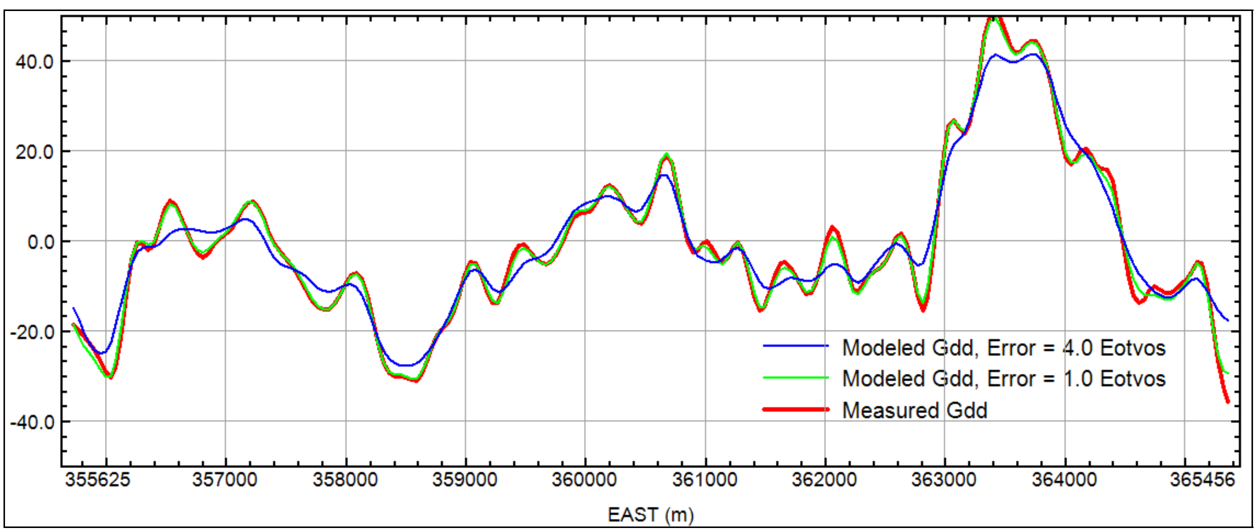


Figure 11 Measured versus model data for the two different models shown in Figure 12.

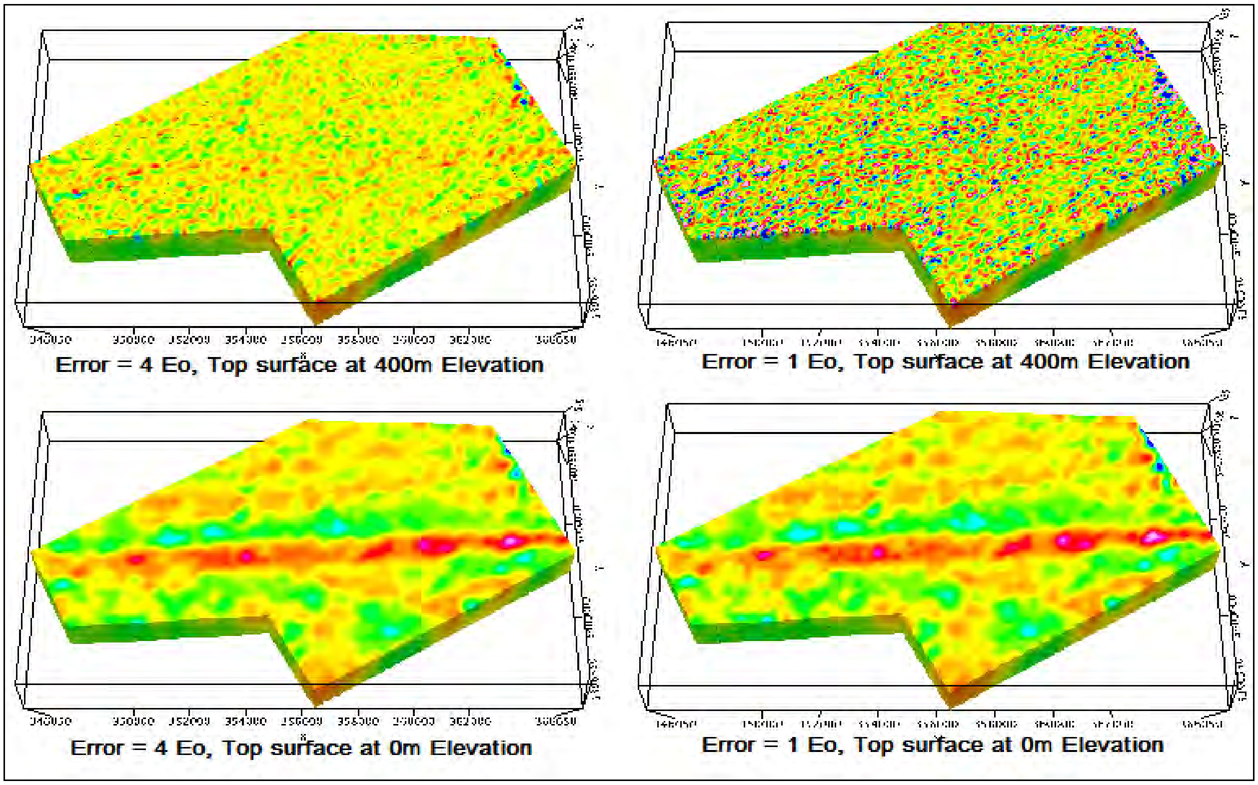


Figure 12 Density models from Gdd data. The left panels were inverted using an assigned error of 4 Eö while the right panels used an assigned error of 1.0 Eö. Top panels are sliced near the surface and the bottom panels were sliced at 0 m elevation.

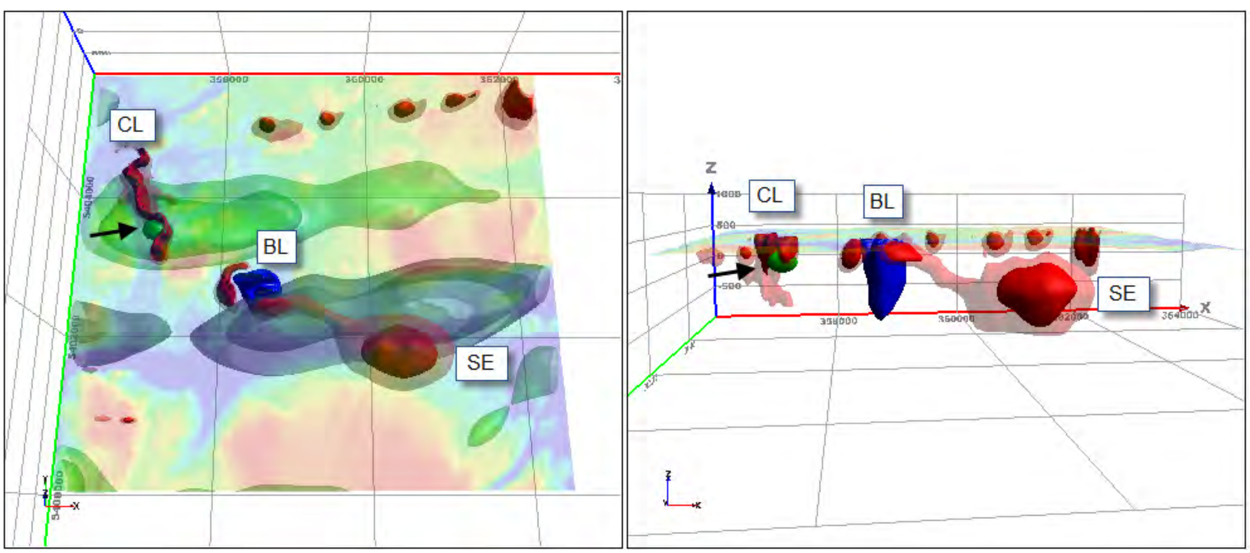


Figure 13 Susceptibility and density isosurfaces from the Current Lake detailed models are shown beneath a transparent image of the topography. The left panel is looking steeply north while the right panel is looking north at a shallow angle. [CL]=Current Lake zone, [BL]= Beaver Lake zone and [SE]=Southeast anomaly. Susceptibility Isosurfaces: Red =.008 , .006 SI and blue = -0.01 SI. Density Isosurfaces: Green = Grey= -0.04, -0.06 ,-0.09 g/cc and Grey = +0.06, 0.08 g/cc. On the right panel only the -0.09 gravity isosurface is shown. The arrow points to a very low density zone that the Current Lake chonolith seems to deviate around.

5. 3D CLASSIFICATION OF MODELED SUSCEPTIBILITY AND DENSITY

The 3D density and susceptibility models derived by inverting the Falcon survey data were classified based on their physical properties to produce a combined 3D model of the area.

Figure 14 show a cross plot of the density and susceptibility data[1]. Note that this plot actually shows a subset representing about 1% of the total dataset, simply to reduce visual clutter. Aside from the elliptical cluster centered on density and susceptibility contrast of (0, 0) it is difficult to recognize well bounded clusters in this dataset. As a result the boundaries of these classes are rather arbitrary. The number of classes is also arbitrary and this was tested with various trials ranging from 4 to 15 classes. Too many classes invariably resulted in output with a “contoured” or “terraced” appearance while having too few classes resulted in distinct geological / geophysical units being lumped into the same class. In the end we selected seven classes, which is a compromise, and this seems to do a reasonable job of splitting out most of the recognizable units without resulting in excessive clutter. Table 1 and Figure 15 show the statistical characteristics of the seven classes in terms of their susceptibility and density.

The visual impact of the classification model depends considerably on how colors are assigned to each class. This color assignment is, of course, entirely arbitrary and colors may be re-assigned at will by changing the color look-up table. As an intuitive starting point the classes have been sorted and colors assigned so that the lowest susceptibilities have the coldest colors and highest susceptibilities have warm colors. Two different color keys are shown on Figure 16 (upper). The familiar color bar shows just the cluster number while the bubble diagram on the right shows the relationship between class number, color, mean susceptibility and mean density. Horizontal slices at 100 m intervals through the classification model are shown in Figure 17.

[1] Except in rather special circumstances, such as where the density contrast and susceptibility are both related *mostly* to variation in the concentration of magnetite (e.g. an iron formation province), we do not expect high correlation between density and susceptibility.

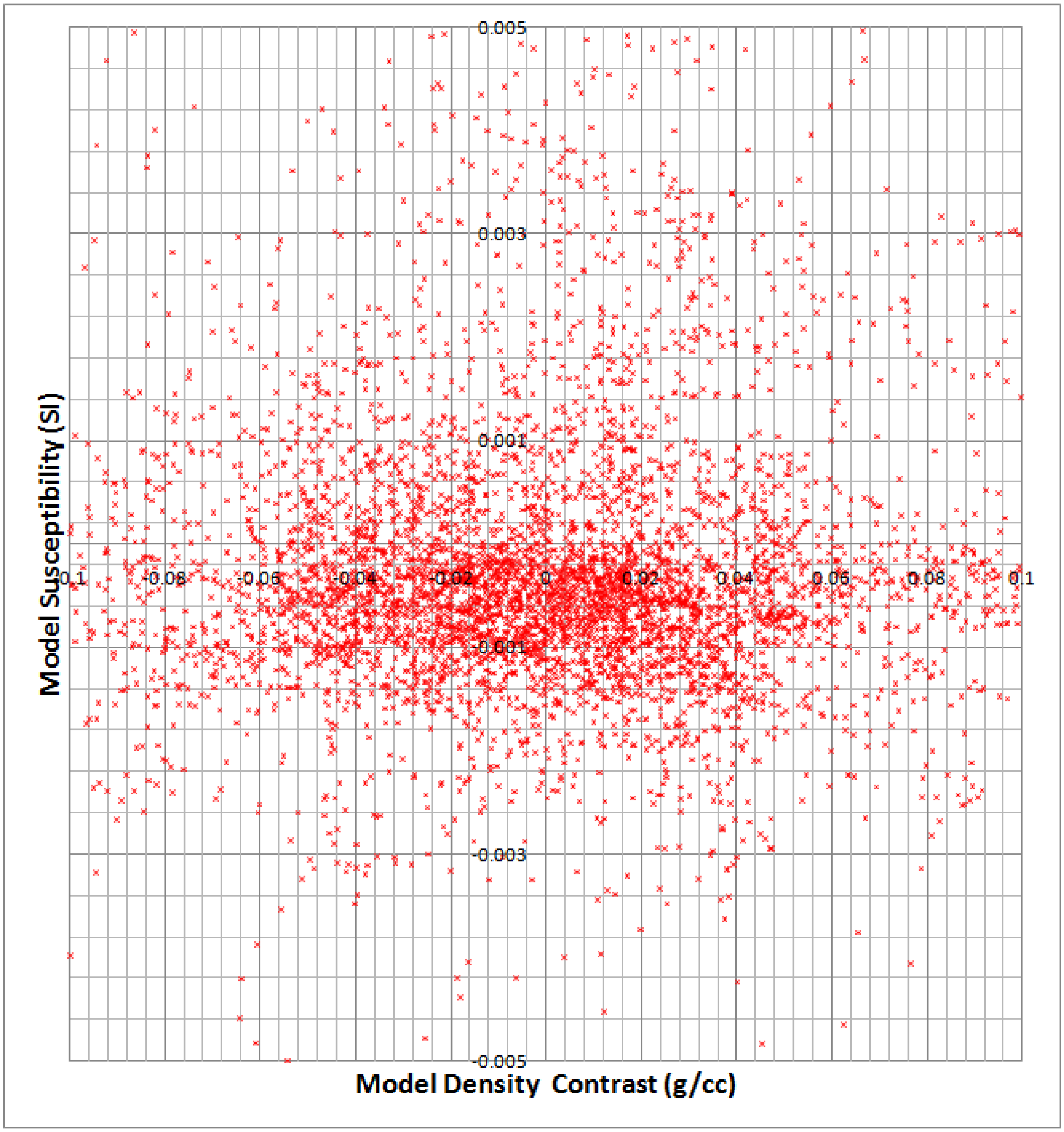


Figure 14 Susceptibility versus Density cross plot from the Falcon 3D models. This data shown is a tiny fraction of the more than 1.4 million cells in the entire model and illustrates that well defined clusters are not obvious in the data.

Cluster Number	Mean Susc	Std.Dev. Susc	Mean Density	Std. Dev. Density
0	-0.00182	0.00177	0.007	0.012
1	-0.00124	0.0007	-0.023	0.015
2	-0.00081	0.0007	0.039	0.025
3	-0.00026	0.00054	-0.044	0.024
4	0.00155	0.00111	-0.03	0.02
5	0.00153	0.00145	0.038	0.027
6	0.00417	0.00346	0.005	0.017

Table 1 Class Statistics

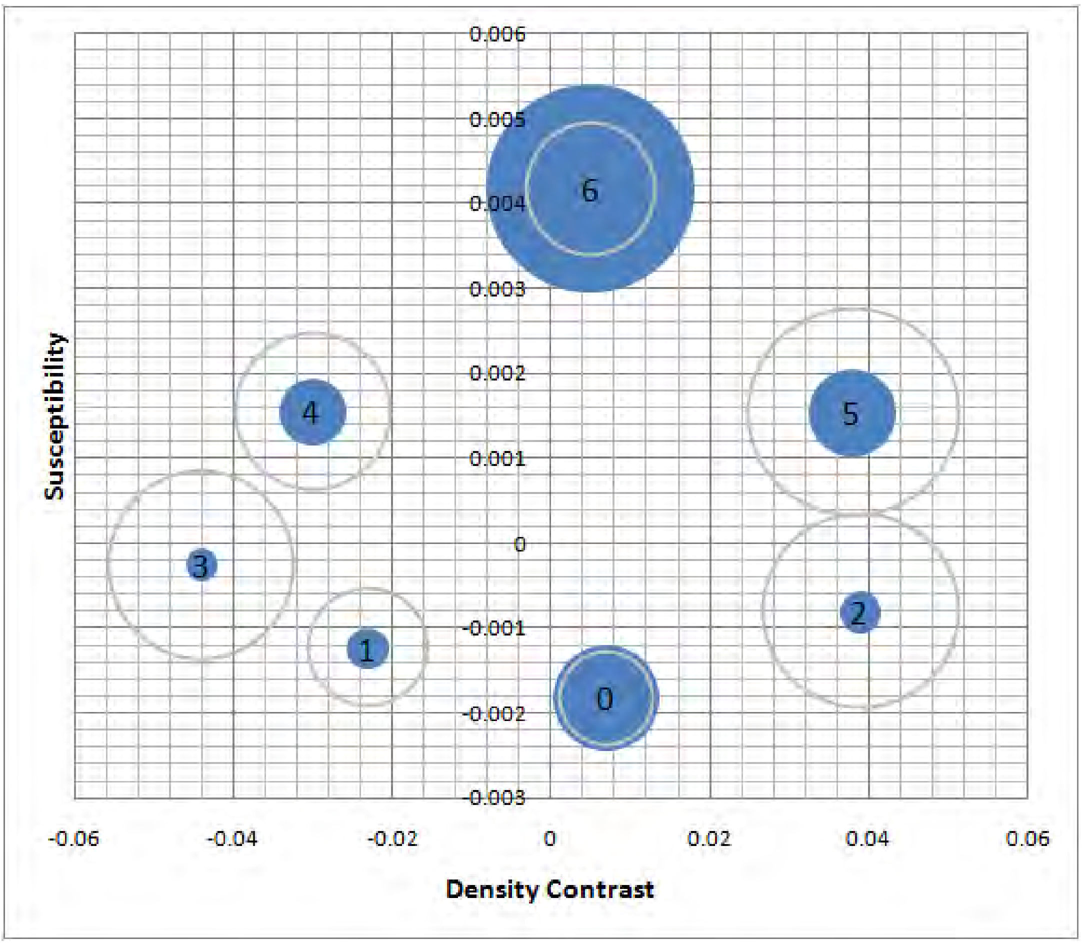


Figure 15 Susceptibility: Density classes from Table 1. The center of the circles shows the mean of each class in susceptibility-density space. The diameter of the solid circle is proportional to the standard deviation of the susceptibility for each class and the open circles show the same information for density.

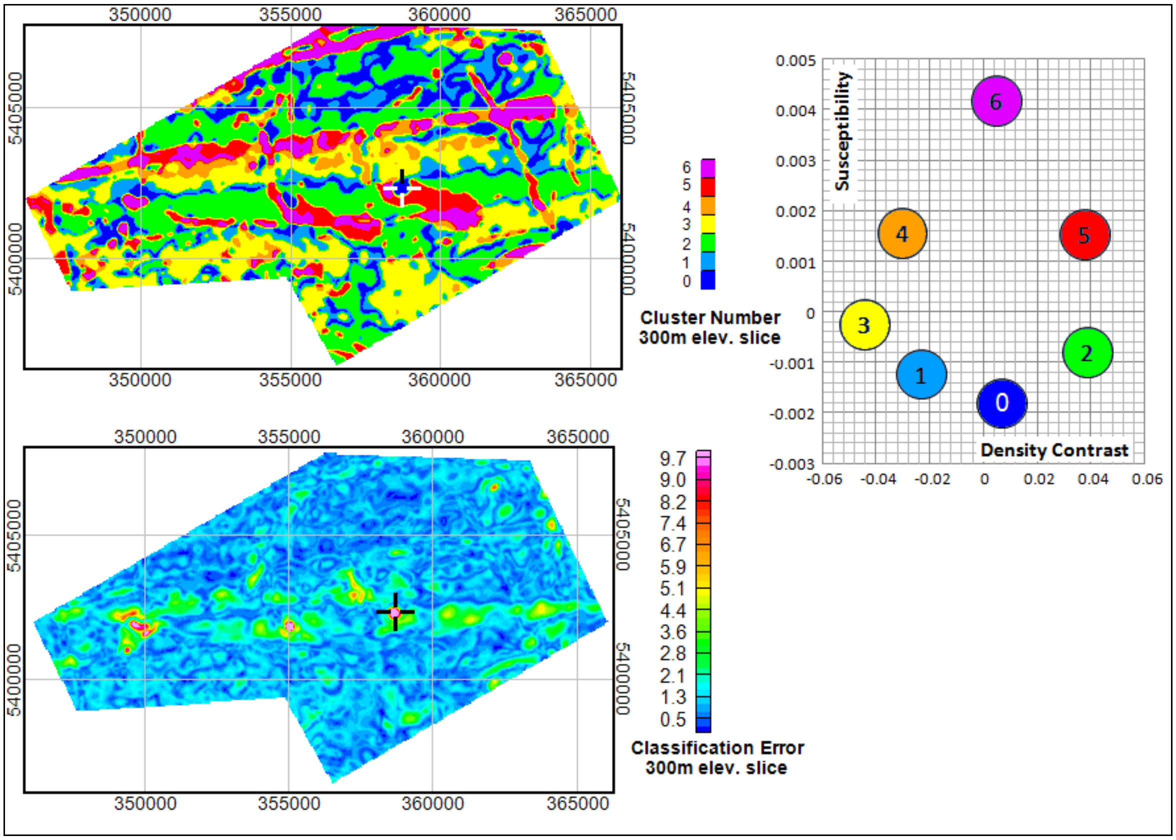


Figure 16 A slice through the classified model (upper left) and the "classification error" model (lower left). The slice is at 300 m elevation (roughly 200 m below ground surface and the cursor on both images marks the location of the Beaver Lake zone, for visual reference.. Clusters with low susceptabilities are shown with cold colors and those with high susceptibilities are shown with warm colors. The mean susectpibility and density for each cluster is shown on the upper right.

Classification Error

The classification model appears to map the regional lithology but it is easy to recognize that some highly anomalous features do not appear as distinct classes. This is a consequence of having relatively few classes. For example the rare, intense negative susceptibility anomalies such as the one associated with part of the Beaver Lake Zone (sus <-0.01), are included in Class 0 which has the lowest susceptibility and has a mean of -.0018 SI. See the crosshairs on Figure 16. To help understand this, and as an adjunct to the classification model, we calculate a separate model which estimates the how *anomalous* each model point is with respect to the mean physical properties for its class. For example, any point which falls within Class 6 and has the same mean susceptibility and density as that shown in Table 1 for Class 6 will have a classification error of 0.0. A point which falls within Class 6 but plots several standard deviations away from the mean will have a large

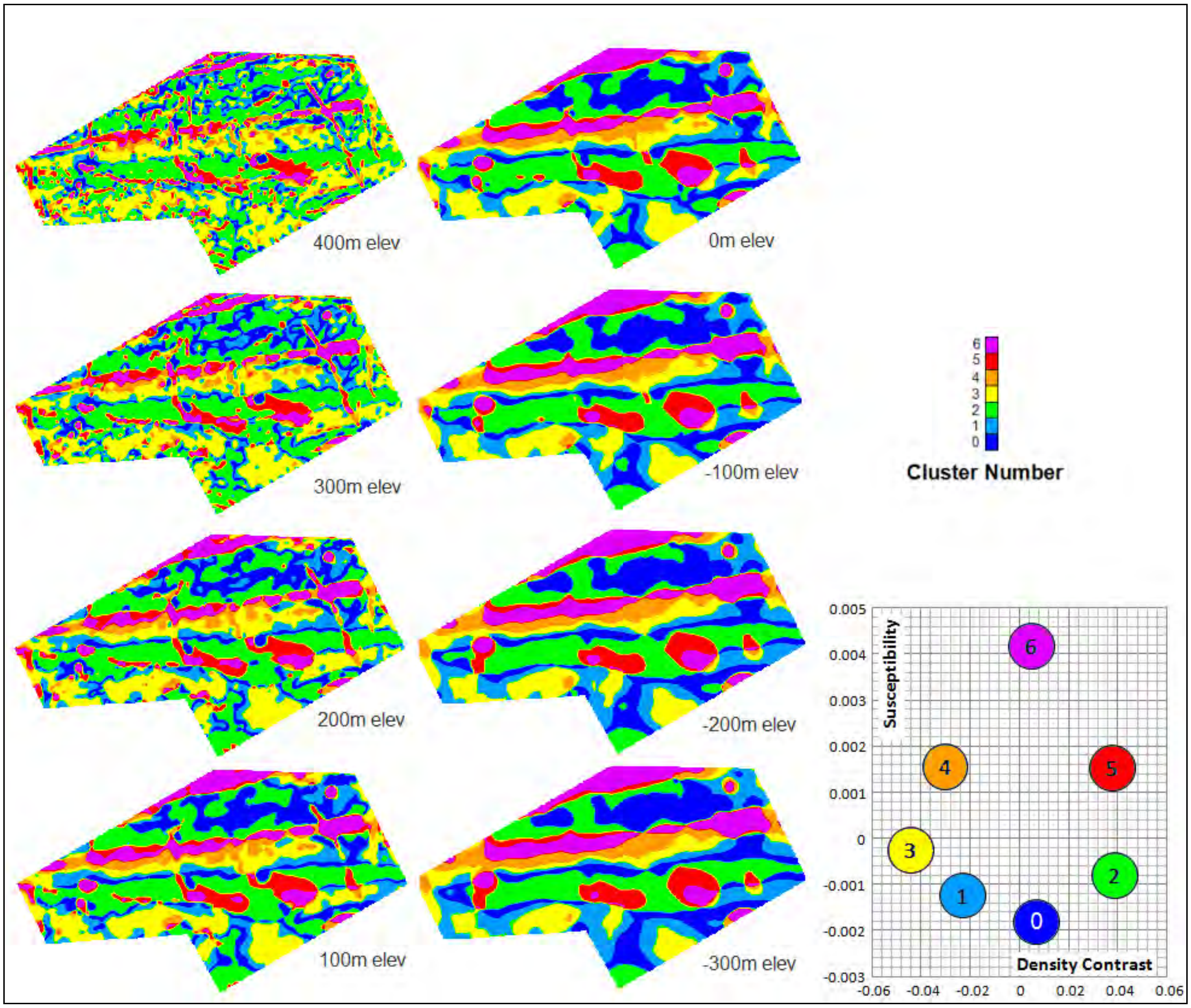


Figure 17 Horizontal slices through the 3D Classification model at elevations as shown.

classification error indicating that it is a highly anomalous member of Class 6. This classification error is analogous to the quantization error defined in digital signal processing and can be used to highlight parts of the model that are highly anomalous without consideration of the cause of the anomalism.

6. 2.5D MODELING

Three sections were selected by Magma for 2.5D modeling of the gravity using ModelVision Pro. The geological constraints for the models were provided with two sections (Figure 20, Figure 23) and by the orange outline of the TBN intrusive complex shown on Figure 19. Additional density data was provided from drill holes SEA10-06 and SEA08-02.

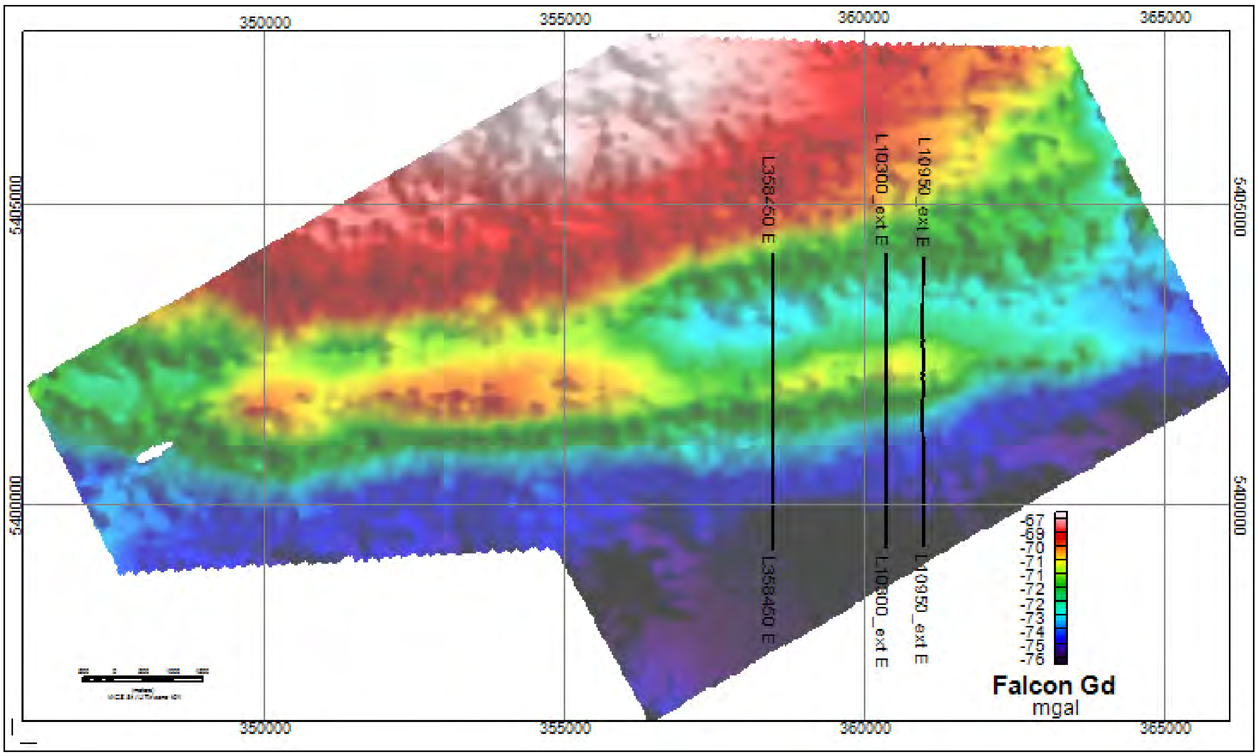


Figure 18 Location of three lines selected by Magma for gravity modeling using ModelVision.

Density statistics for various units were compiled by Magma (Heggie 2010) and those averages were used, where deemed appropriate in this study.

As is all too common in exploration programs most physical property measurements are restricted to within the target horizon and density data outside the target horizon is sparse or absent. This is particularly important for gravity modeling since the measured data are sensitive only to *contrasts* in the physical property and the background density is never zero so, for example, accurate estimate of the density of both the target and surrounding host rocks is required in order to build a model with geologic constraints.

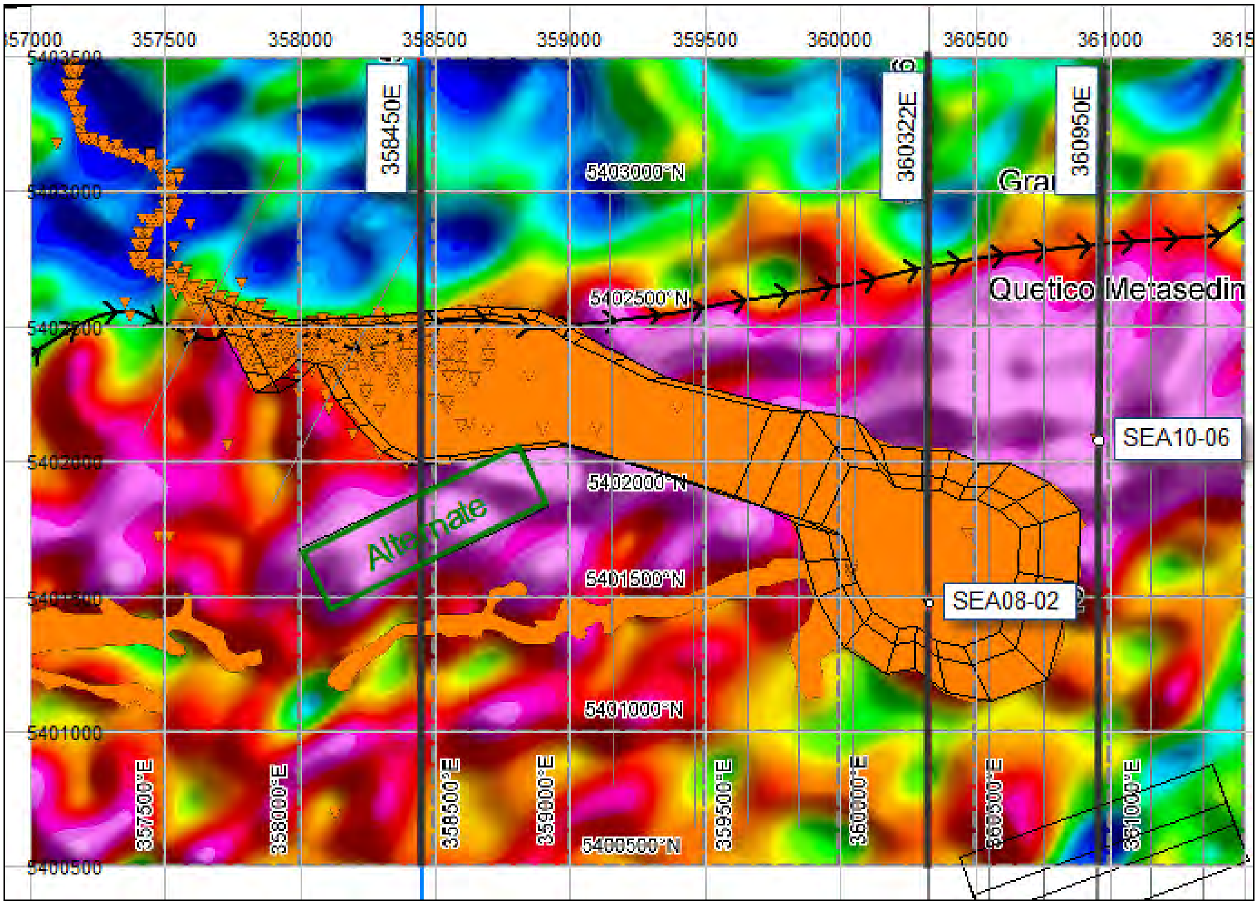


Figure 19 Plan view of gravity models. The orange polygon is the plan extent of the TBN igneous complex provided by Magma and is shown on a backdrop image of gravity gradient data (Gdd). The black wireframe bodies show the outline of the TBN Complex bodies used for the gravity model. For clarity the metasedimentary bodies are not shown. The green body marked “alternate” was used only for the scenario illustrated in Figure 22.

Pertinent to this exercise the physical property data is mostly limited to the vicinity of the western most modeled section (358450E), within and slightly north of the TBN complex. There is very little host rock data in the vicinity of the eastern two sections. One notable exception is the detailed core densities provided for SEA10-06, which was drilled entirely outside the TBN complex. SEA08-02 contains some host rock densities but these are available for only two very short sections above the TBN complex, as well as many points within the complex.

Encom’s ModelVision Pro version 10 was used for gravity modeling. Although this allows one to model complex 3D shapes by importing, say, an ore body model, and such a model is static i.e. it cannot be edited or inverted within this modeling environment. In general the program allows you to create, edit and invert for shapes that are complex in two dimensions (plan or section) but the shape must be relatively simple in the third dimension. For the modeling here the complex footprint of the TBN intrusive complex was digitized in plan and was allowed to have sloping sides but its top, bottom and internal layers are horizontal. The eastern lobe of the TBN complex, centered on section L100300 (Section 360322E), is comprised of three horizontal layers as shown in Figure 24. The western part of the complex was modeled (Section 358450E) as a single horizontal slab of peridotite, with other units in the immediate vicinity of the modeled section apparently insignificant volumetrically.

Gravity Model Section 358450E

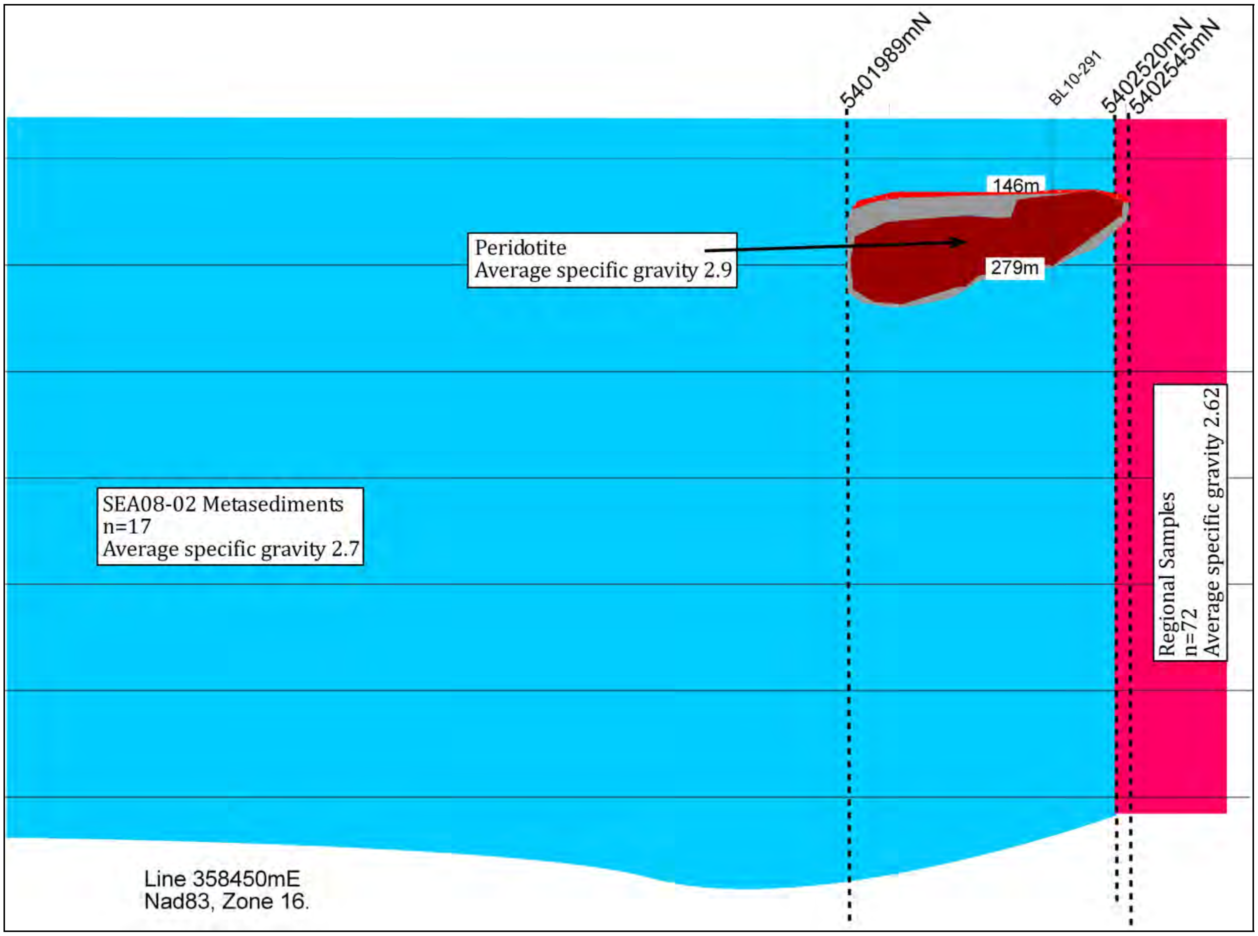


Figure 20 Background information for Section 358450E provided by Magma Metals. The TBN body was modeled in this region with a slab a peridotite 133 m thick.

The modeled section for 358450E can be seen in Figure 21 and in plan in Figure 19. Where densities were fixed using *a priori* information, they are noted as such on Figure 21. Other densities were determined by inversion. The fit to the data is quite good, with less the 2% error.

Note that a high density band of metasediments was arbitrarily added at about 5401750N in order to account for a small residual discrepancy centered at that location. An alternate, more optimistic, model is shown in Figure 22 and this illustrates the fundamental ambiguity in this situation. In this second scenario the fit to the data is even better but two points should be kept in mind. Firstly, the improved fit should not weigh heavily in choosing between these two models since either model fits the data to within the noise level and secondly there is no supporting evidence from the mag that peridotite extends into this area.

The contribution of the TBN body to the gravity anomaly for this section is illustrated by the difference between the solid and dotted red lines in Figure 21. The anomalous response of the body in question is small compared to the background geologic variability and noise and without *a priori* information from mag or drilling such small, rather broad anomalies can be easily accommodated in the model by varying the density and dimension of units within the Archean host rocks.

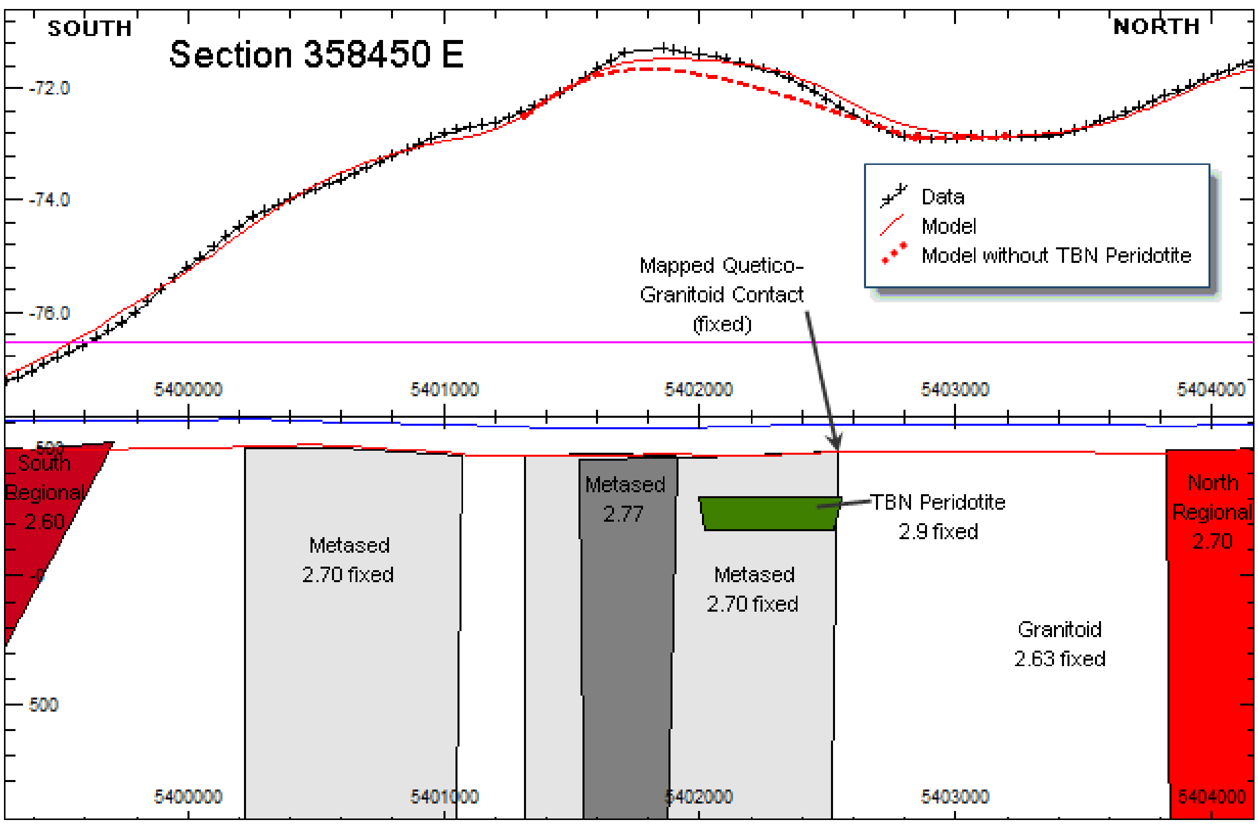


Figure 21 Section 358450 through the Beaver lake zone. See Figure 19 for plan view of the peridotite. The dotted red line shows the same model without the peridotite.

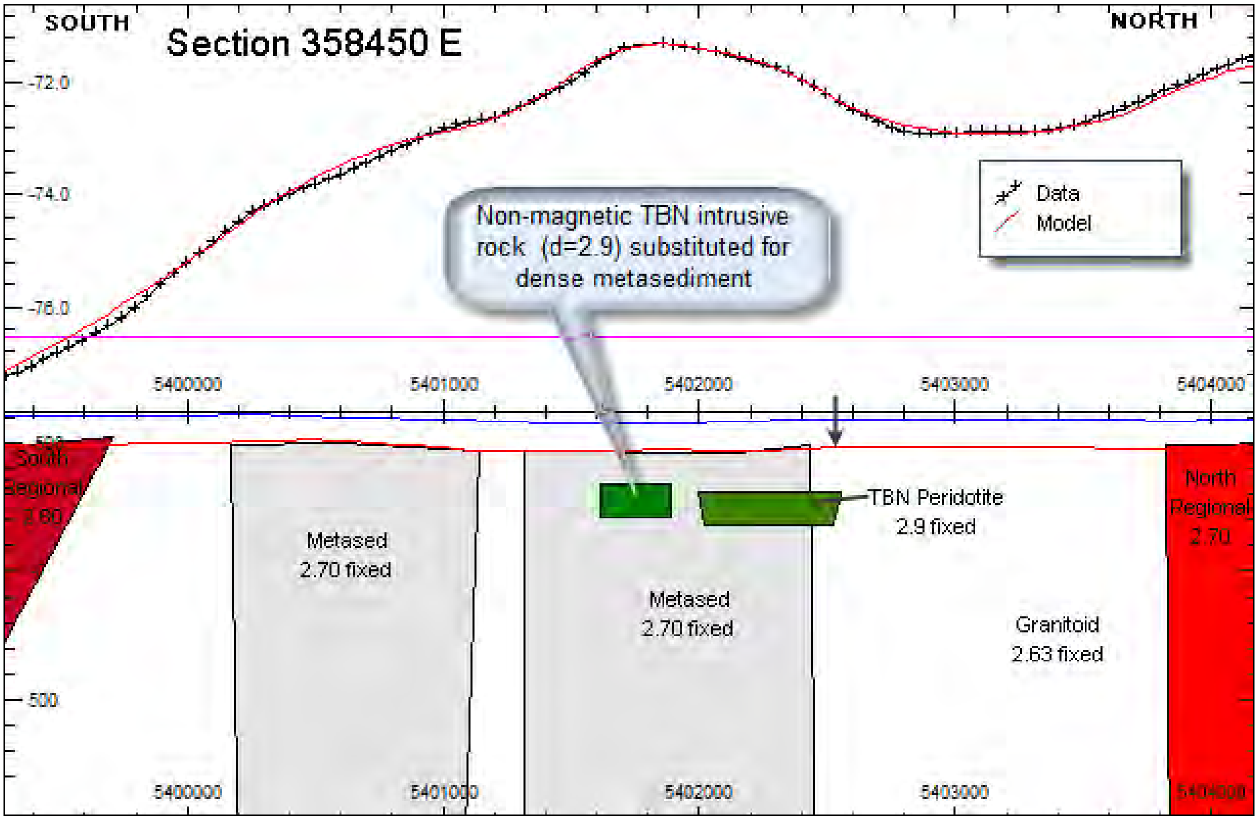


Figure 22 An alternate model for section 358450E where a spur of peridotite (D=2.90) is substituted for the dense metasediment shown on Figure 21 (see Figure 19 for plan view of this body). The boundary between granitoid and metasediment has also been arbitrarily shifted about 100 m south of its mapped location at 5402550N.

The results of gravity modeling both with, and without the TBN complex can be seen in the following four figures illustrating that the contribution of the TBN complex at these depths is very small indeed.

A final model (Figure 28) was completed by forcing a 3.00 g/cc "peridotite" body into the section in place of the dense metasediments. Only the strike length, density and regional parameters were fixed, the cross section geometry and depth to top of the peridotite were determined by inversion. This scenario fits the gravity data very well but, of course, ignores the rock type and density observed in SEA10-06.

Gravity Model Sections 360332E and 360950E

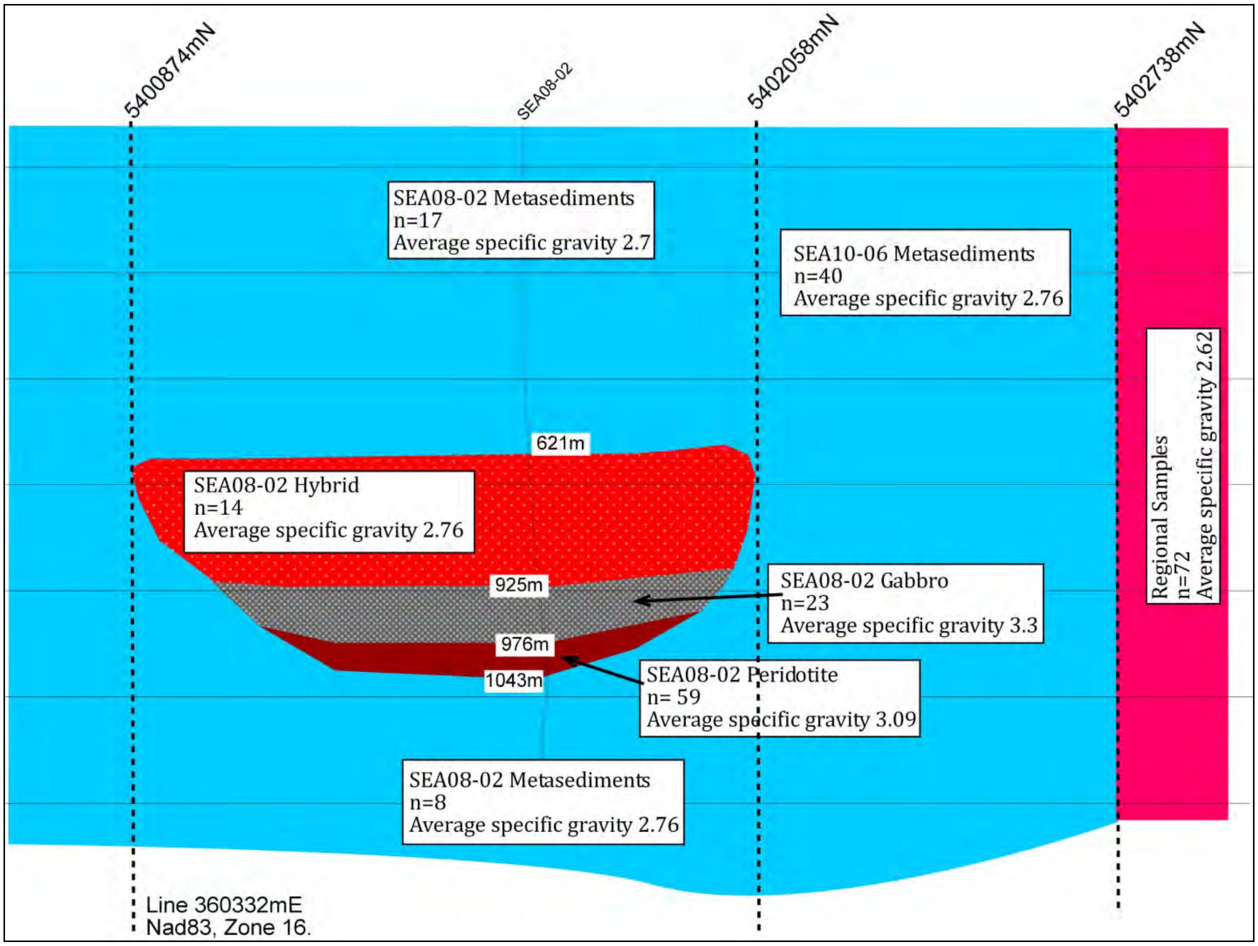


Figure 23 Background data for section 360332E provided by Magma. Note that section is not to scale.

Sections 360332E and 360950E were modeled simultaneously. Figure 23 shows the input data (from Magma) which was used to constrain the TBN model. Note that this section is not to scale and the uppermost 300 m of the TBN complex has a density of 2.76 g/cc, which is very similar to the density of the Quetico metasedimentary host rocks observed in SEA10-06 and thus is essentially invisible to the gravity survey. The gabbro and basal peridotite, while dense, are only 120 m thick and buried more than 925 m below the surface. This makes for a very challenging gravity target! Note that both model sections were generated with a hypothetical background density of 2.67 g/cc. Using a background of 2.63 g/cc as suggested from “background” rocks which were mostly acquired in the Current Lake and Bridge Zone areas, would simply have the effect of reducing all densities by 0.04 g/cc.

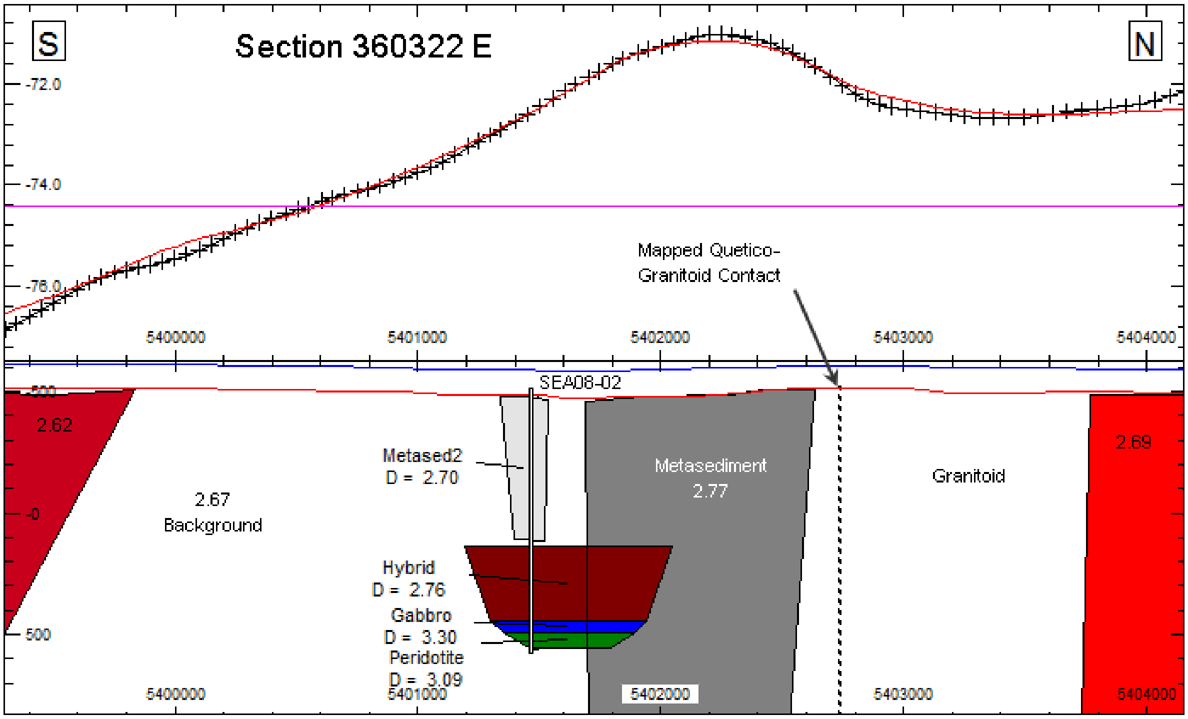


Figure 24 Falcon Gd section 360322E through the Southeast zone. See Figure 19 for plan view.

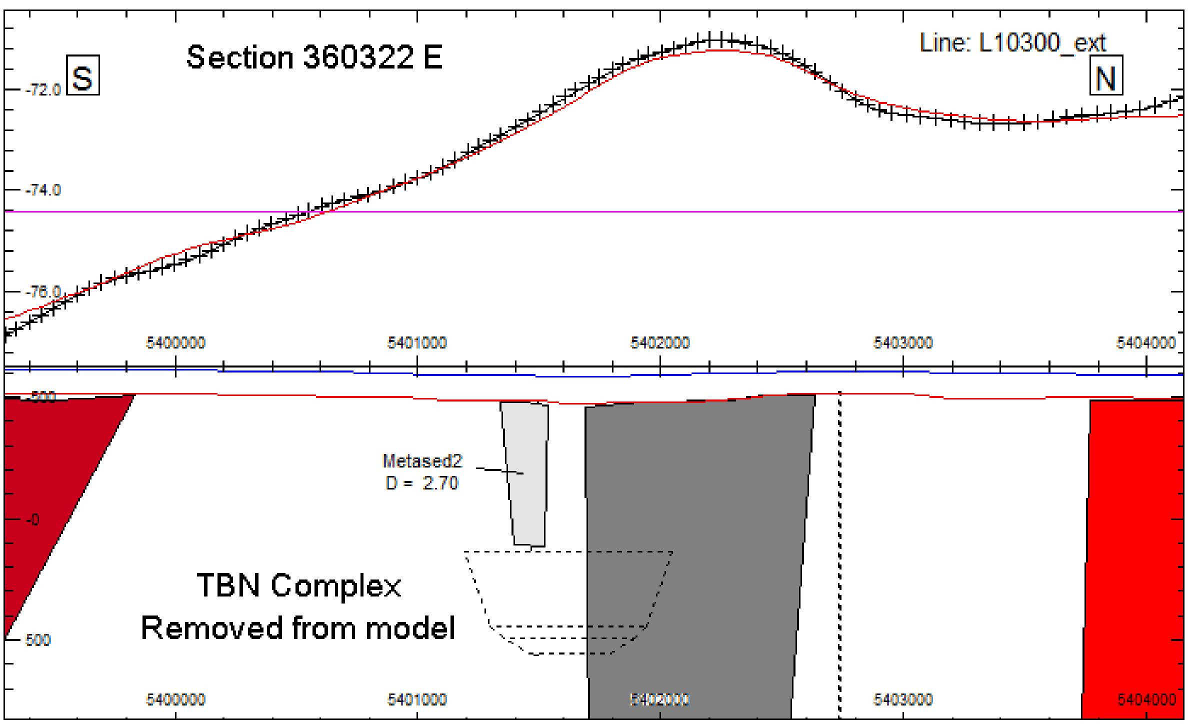


Figure 25 This modeled section is identical to Figure 24 except the contribution from the deep, southeast TBN body has been removed.

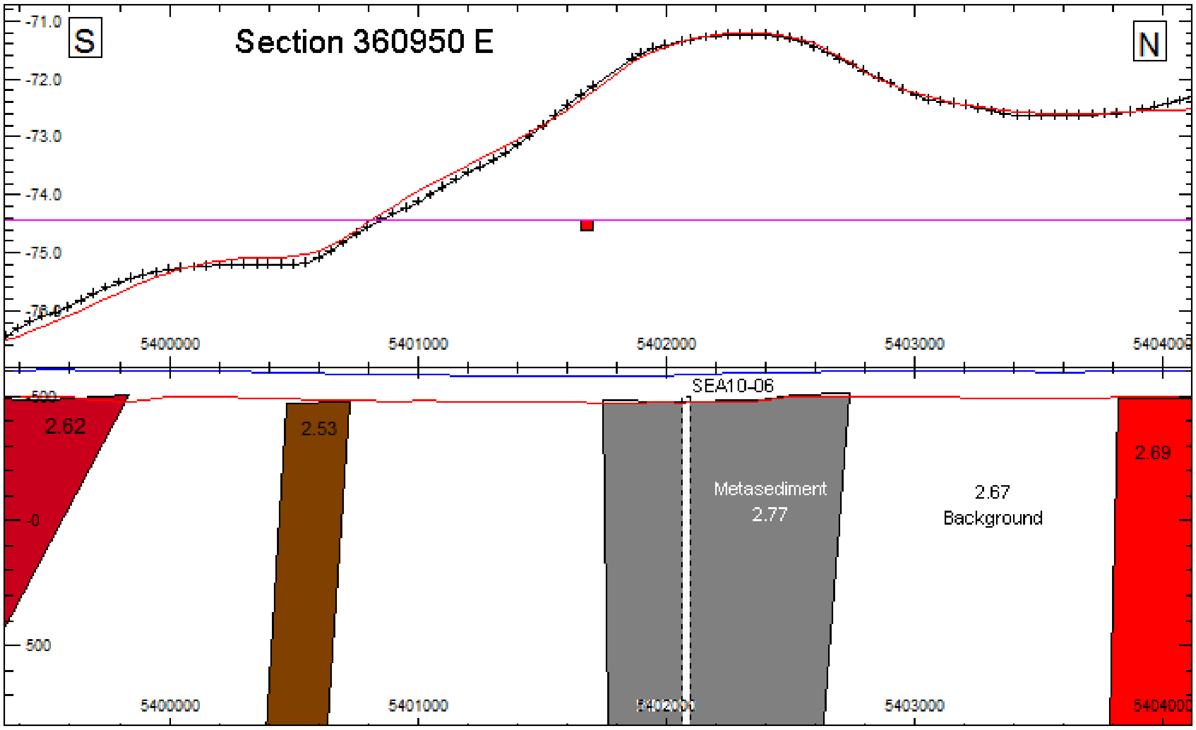


Figure 26 The deep, south east TBN body is interpreted from the mag to be off-section to the west (see Figure 19).

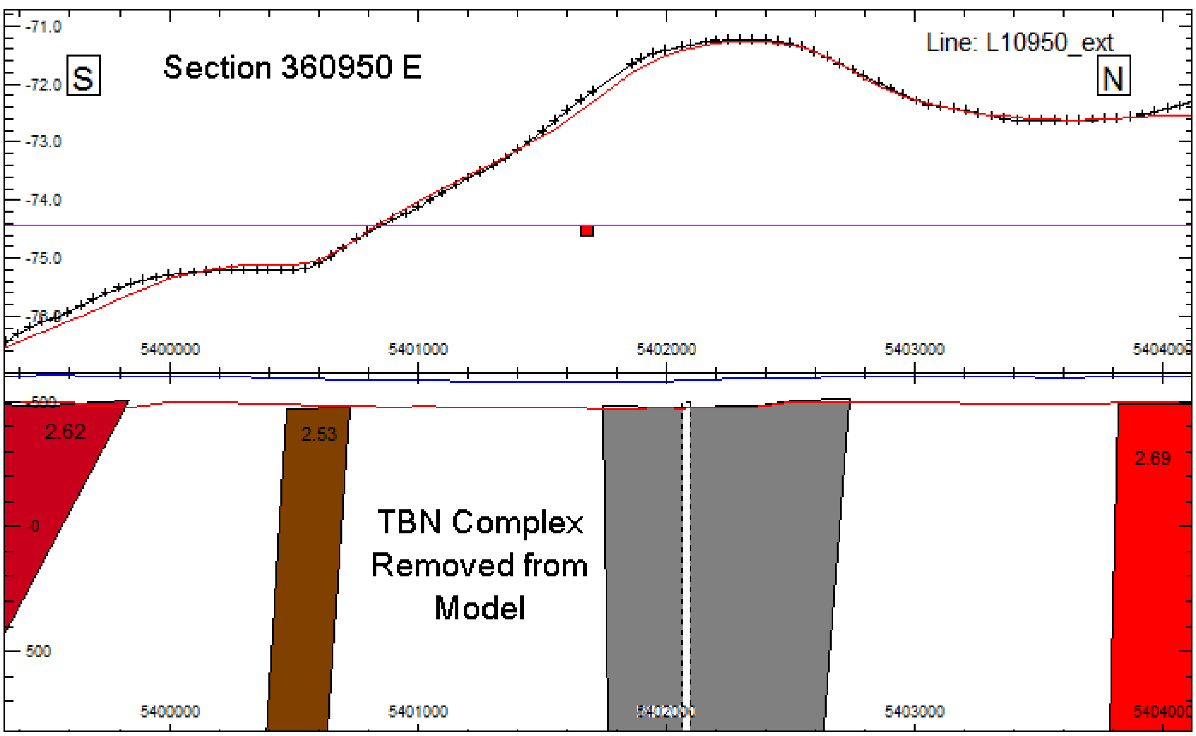


Figure 27 This modeled section is identical to Figure 26 except the contribution from TBN body has been removed.

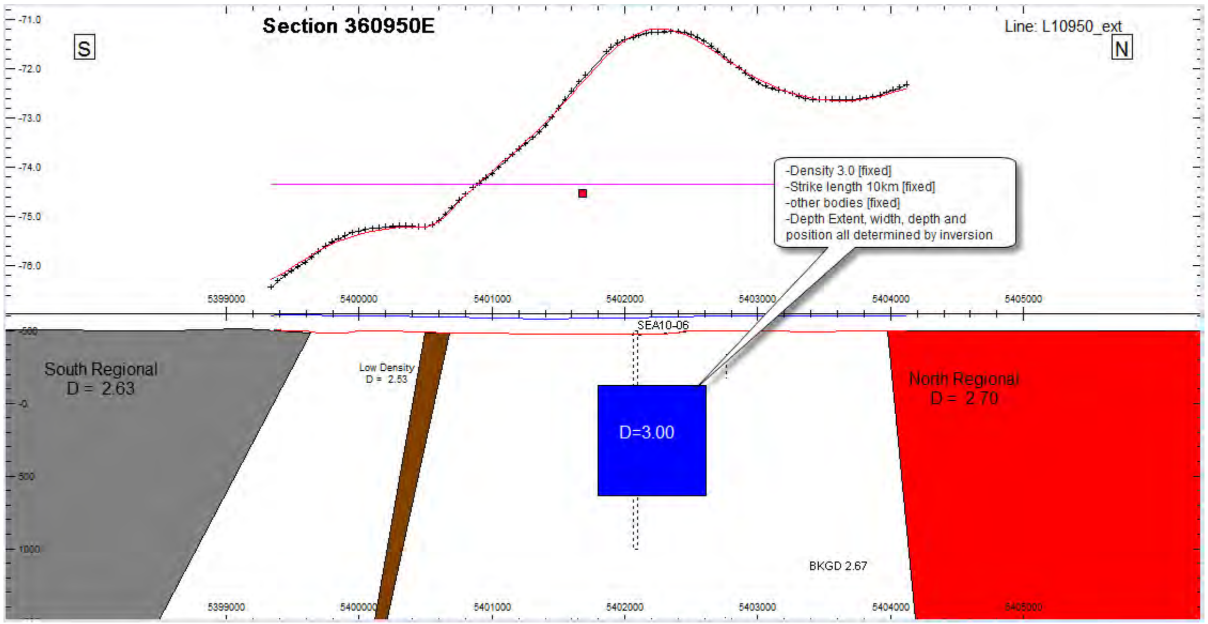


Figure 28 This section, completed at the suggestion of Magma, shows an alternate scenario where a body with a fixed density of 3.00 g/cc is introduced instead of dense metasediments observed in SEA10-06. The density is fixed, as is its strike length but the depth to top, vertical extent and north-south width are all determined by inversion. The fit to the gravity data is very good but this ignores the physical property measurements observed in SEA10-06 which indicate an average density of 2.77 g/cc through the entire length of the hole.

7. CONCLUSIONS AND RECOMMENDATIONS

Falcon data were reviewed and data acquisition, processing and noise levels appear to be normal despite troubling high turbulence encountered in some flights. The most significant deviation from specification is the flight altitude which averaged 105 m and compares poorly with the specification of 80m. This will have a negative impact on signal levels particularly for small, shallow bodies.

Comparing the Falcon gravity (Gd) to similar data collected on a small ground grid shows that the two surveys provide similar qualitative information and gives an RMS difference of 0.38mGal, which provides an upper limit for the noise estimate for the Falcon survey. Comparing the DEMs from the ground and airborne surveys revealed several suspicious GPS elevations in the ground survey data which have almost certainly propagated as errors in the ground Bouguer data.

The Falcon gravity and gradiometry data have been terrain corrected but no bathymetric corrections have been applied. Depending on the water depth this can significantly affect the gravity results. We note that the Current Lake and Beaver Lake zones are both mainly located under lakes. Bathymetry data should be collected and bathymetric corrections should be applied to gravity data.

3D voxel models for Falcon magnetic, gravity (Gd) and vertical gravity gradient (Gdd) were prepared using smooth model inversion. The UTS helimag survey was inverted over the entire survey and also a subset of this survey was inverted at higher resolution over a block covering the Current Lake-Bridge-Beaver Lake-Southeast Anomaly. Isosurfaces have been extracted from the models and are provided for viewing and interpretation as ".DXF" files. These models should be integrated with other geoscience data and interpreted.

A 3D classified model was prepared using the inverted Falcon magnetic and gravity models as input. This seems to do a reasonable job of mapping the main geophysical units. A companion 3D model maps the classification error and this highlights areas which are highly anomalous, regardless of the cause of the anomalism. Any such areas warrant consideration for follow-up, unless readily explained.

Density has been measured by Magma on many core samples within the TBN intrusive rocks but host rock samples are rare, particularly away from the Current Lake-Beaver Lake corridor. Systematic collection and measurement of spatially located host rock density (not just averages) could significantly improve the quality and confidence of gravity models.

Based on geologically constrained ModelVision gravity models the response from the TBN igneous rocks is small and, particularly in the case of the deep Southeast Anomaly it is indistinguishable from minor geologic background variations. This is mainly attributed to the depth to the anomalously dense part of the target which is more than 925 m below the surface. Such a target may be amenable to detection with new borehole gravity probe (GRAVILOG) recently developed by Scintrex and we recommend assessing the merits of surveying SEA10-06 with this instrument.

Although no ModelVision modeling was completed over the Current Lake zone its small cross section make it an unlikely target for fixed-wing gravity gradiometry. Instead, features such as this might be detectable with a low level helicopter gravity gradiometry survey. This scenario can readily be assessed with forward modeling. As alluded to above, care would be required to remove the effects of water depth, if present.

Respectfully Submitted,

Peter Diorio P.Geo.
Geophysics*One* Inc.

Ken Witherly
Condor Consulting, Inc.

January 14, 2011

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9. APPENDIX- PRODUCTS

A variety of digital products were created as part of this project. This are provided on the archive DVD and are outlined in the following Appendices.

APPENDIX 1: File Descriptions

- ## 3D models in UBC format

Directory: UBC_Format

File	Area	Input Data	Cell sizes	Notes
CurrentL_detail_Gd_0p04mGal.den	Current L to SEA	Falcon Vertical Gravity	25x25x12.5	Error = 0.04 mGal
CurrentL_detail_Gd_0p10mGal.den	Current L to SEA	Falcon Vertical Gravity	25x25x12.5	Error = 0.10 mGal
CurrentL_detail_UTSmag_4p0nT.sus	Current L to SEA	UTS HeliMag MicroLev TMI	20x20x10	Error =4.0 nT
TBN_Falc_Gdd_4p0Eo.den	TBN	Falcon Vertical Gravity Gradient	50x50x25	Error=4.0 Eö
TBN_Falc_Gd_p04mgal.den	TBN	Falcon Vertical Gravity	50x50x25	Error=0.04 mGal
TBN_Falc_Gd_p10mgal.den	TBN	Falcon Vertical Gravity	50x50x25	Error=0.10 mGal
TBN_UTS_MAG_4p0nT.sus	TBN	UTS HeliMag MicroLev TMI	25x25x10	Error =4.0 nT
TBN_3D_Classification_sort_by_susc.mod	TBN	Falcon Mag and Gd	50x50x25	Class numbers sorted from low to high susceptibility
TBN_3D_ClassErr.mod	TBN	Falcon Mag and Gd	50x50x25	Emphasizes Class Outliers

- ## 3D models in XYZ format

Directory: XYZ_Format

File	Area	Survey Data	Notes
CurrentL_detail_Gd_0p04mGal.xyz	Current L to SEA	Falcon Vertical Gravity	Error = 0.04 mGal
CurrentL_detail_Gd_0p10mGal.xyz	Current L to SEA	Falcon Vertical Gravity	Error = 0.10 mGal
CurrentL_detail_UTSmag_4p0nT.xyz	Current L to SEA	UTS microlev TMI	Error =4.0 nT
TBN_Falc_Gdd_4p0Eo.xyz	TBN	Falcon Vertical Gravity Gradient	Error=4.0 Eö
TBN_Falc_Gd_p04mgal.xyz	TBN	Falcon Vertical Gravity	Error=0.04 mGal
TBN_Falc_Gd_p10mgal.xyz	TBN	Falcon Vertical Gravity	Error=0.10 mGal
TBN_UTS_MAG_4p0nT.XYZ	TBN	UTS HeliMag MicroLev TMI	Error =4.0 nT
TBN_3D_Classification_sort_by_susc.xyz	TBN	Falcon Mag and Gd	Class numbers sorted from low to high susceptibility
TBN_3D_ClassErr.xyz	TBN	Falcon Mag and Gd	Emphasizes class outliers

APPENDIX 2: Isosurfaces in DXF format

Directory: DXFs\CurrentL_detail

File	Area	Model	Isosurface
CurrentL_detail_Gd_0p10mGal_iso+0p000.dxf	Current L to SEA	Falcon 3D density Model from Gd with 0.1mGal error	0 mGal
CurrentL_detail_Gd_0p10mGal_iso+0p020.dxf			0.02 mGal
CurrentL_detail_Gd_0p10mGal_iso+0p040.dxf			0.04 mGal
CurrentL_detail_Gd_0p10mGal_iso+0p060.dxf			0.06 mGal
CurrentL_detail_Gd_0p10mGal_iso+0p080.dxf			0.08 mGal
CurrentL_detail_Gd_0p10mGal_iso+0p090.dxf			0.09mGal
CurrentL_detail_Gd_0p10mGal_iso-0p020.dxf			-0.02 mGal
CurrentL_detail_Gd_0p10mGal_iso-0p040.dxf			-0.04 mGal
CurrentL_detail_Gd_0p10mGal_iso-0p060.dxf			-0.06 mGal
CurrentL_detail_Gd_0p10mGal_iso-0p080.dxf			-0.08 mGal
CurrentL_detail_Gd_0p10mGal_iso-0p090.dxf			-0.09mGal
Current_L_detail_4p0nT_iso+0p000.dxf	Current L to SEA	UTS 3D susc Model with 4nT error	0.00 SI
Current_L_detail_4p0nT_iso+0p0004.dxf			0.0004 SI
Current_L_detail_4p0nT_iso+0p001.dxf			0.001 SI
Current_L_detail_4p0nT_iso+0p002.dxf			0.002 SI
Current_L_detail_4p0nT_iso+0p004.dxf			0.004 SI
Current_L_detail_4p0nT_iso+0p006.dxf			0.006 SI
Current_L_detail_4p0nT_iso+0p008.dxf			0.008 SI
Current_L_detail_4p0nT_iso-0p001.dxf			-0.001 SI
Current_L_detail_4p0nT_iso-0p002.dxf			-0.002 SI
Current_L_detail_4p0nT_iso-0p004.dxf			-0.004 SI
Current_L_detail_4p0nT_iso-0p01.dxf			-.010 SI

Directory: DXFs\TNB_Project

File	Area	Model	Isosurface
TBN_Falc_Gd_p10mgal_iso+p00.dxf	TBN falcon survey	Falcon 3D density from Gd , 0.1mGal error	0.0 mGal
TBN_Falc_Gd_p10mgal_iso+p01.dxf			0.01 mGal
TBN_Falc_Gd_p10mgal_iso+p02.dxf			0.02 mGal
TBN_Falc_Gd_p10mgal_iso+p04.dxf			0.04 mGal
TBN_Falc_Gd_p10mgal_iso+p08.dxf			0.08 mGal
TBN_Falc_Gd_p10mgal_iso+p10.dxf			0.10 mGal
TBN_Falc_Gd_p10mgal_iso-p01.dxf			-0.010 mGal
TBN_Falc_Gd_p10mgal_iso-p02.dxf			-0.20 mGal
TBN_Falc_Gd_p10mgal_iso-p04.dxf			-0.04 mGal
TBN_Falc_Gd_p10mgal_iso-p08.dxf			-0.08 mGal
TBN_Falc_Gd_p10mgal_iso-p10.dxf			-0.10 mGal
TBN_UTS_mag_4p0nT_iso+0p000.dxf		UTS 3D susceptibility , 4nT error	0.000 SI
TBN_UTS_mag_4p0nT_iso+0p002.dxf			0.002 SI
TBN_UTS_mag_4p0nT_iso+0p004.dxf			0.004 SI
TBN_UTS_mag_4p0nT_iso+0p006.dxf			0.006 SI
TBN_UTS_mag_4p0nT_iso+0p008.dxf			0.008 SI
TBN_UTS_mag_4p0nT_iso+0p010.dxf			0.010 SI
TBN_UTS_mag_4p0nT_iso-0p001.dxf			-0.001 SI
TBN_UTS_mag_4p0nT_iso-0p002.dxf			-0.002 SI
TBN_UTS_mag_4p0nT_iso-0p003.dxf			-0.003 SI
TBN_UTS_mag_4p0nT_iso-0p004.dxf			-0.004 SI
TBN_UTS_mag_4p0nT_iso-0p006.dxf			-0.006 SI
TBN_UTS_mag_4p0nT_iso-0p012.dxf			-0.012 SI

APPENDIX 3: AVI Files

Directory: AVI

CurrentL_Susc_Dens_combined.AVI - Isosurfaces for the CurrentL to SEA detailed area extracted from the UTS susceptibility and Falcon density (Gd) models. Susceptibility Isosurfaces: Red =.008 and .006 SI; Blue = -0.01 SI. Density Isosurfaces: Green = -0.04, -0.06 and -0.09 g/cc and Grey = +0.06 and +0.08 g/cc.

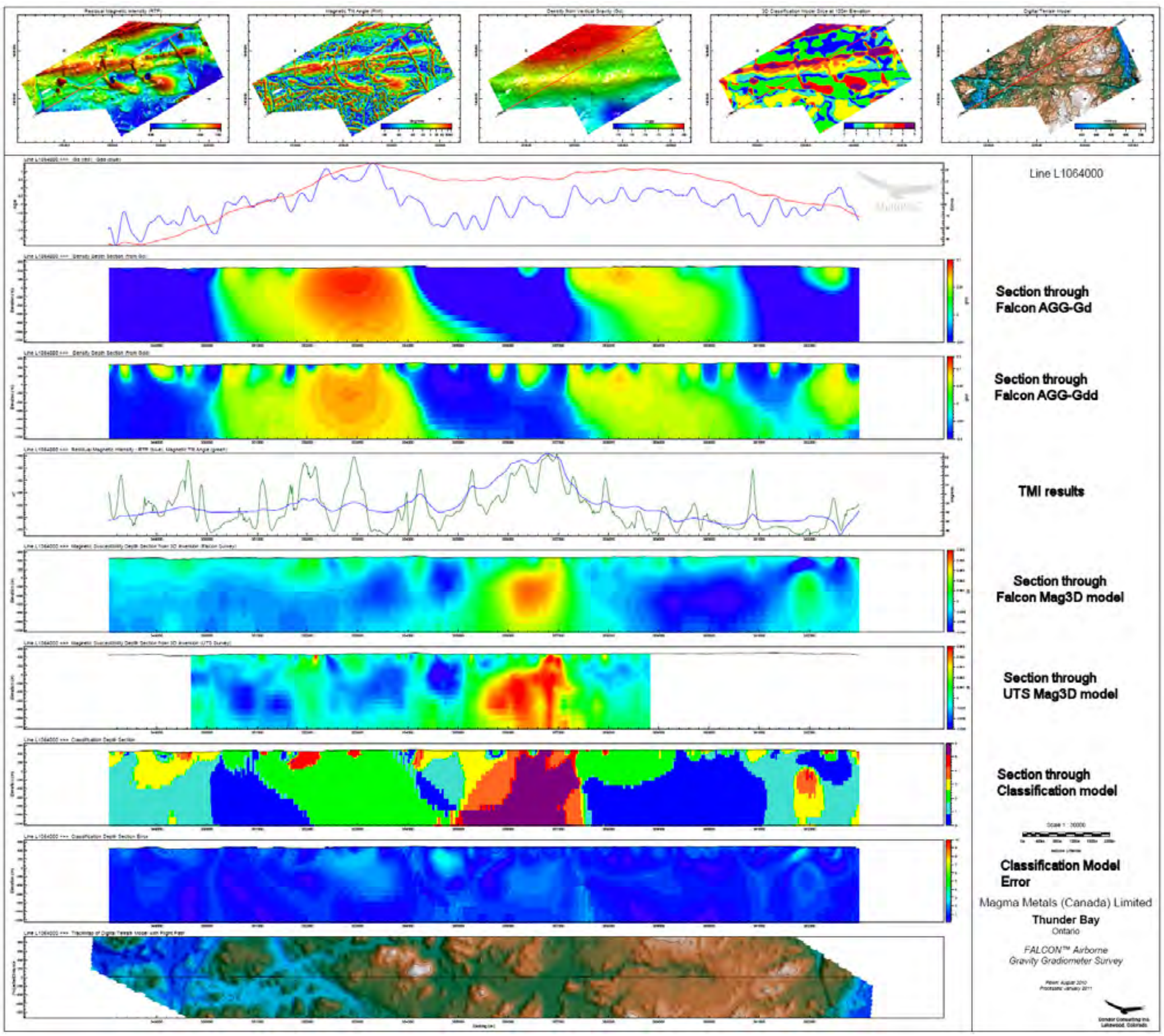
Falcon_Susc_Dens_combined.AVI –Isosurfaces extracted from the Falcon mag and gravity (gd) 3D models. Red transparent = density high, Blue transparent = density low. Red opaque = susceptibility high. Green Opaque = susceptibility low.

UTS_susc.AVI – Isosurfaces extracted from the entire UTS helimag susceptibility model. Susceptibility Isosurfaces: Red Opaque =.006 and Red transparent = .004; Blue= -0.01 SI. Green = -.10 g/cc from the Falcon density (Gd) model

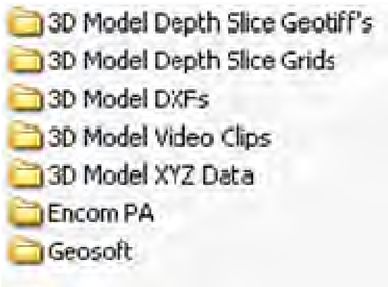
APPENDIX 4: Encom PA Session Files

Session files have been prepared for MultiPlot produced for the project as well as the various voxel models created. These files can all be viewed using then Encom PA viewer software included on the archive DVD.

- **Example of MultiPlot**



- **Encom PA Directories**



LOGISTICS REPORT

Magma Metals (Canada) Limited

Gravity Survey

Beaver Lake & Escape Lake Properties, Thunder Bay, ON

NTS: 52 A/15 & 52 A/10

Geophysicist: Warren Hughes

Project #1020-1 Ref: 1020-1grv

Introduction

This field report covers the survey procedures and parameters for the detailed gravity survey carried out for Magma Metals (Canada) Limited on the Beaver Lake Property, North Thunder Bay, Ontario NTS: 52 A/15 & 52A/10. This logistics report deals with the field work portion of this contract.

Survey Equipment

2 - LaCoste & Romberg model G gravity meter, Ser. # 789 & # 451
1 - Leica\System 1230 Dual Frequency GPS Base Station
2 - Leica\System 1230 Dual Frequency GPS Rovers
2 – Laptop computers
Registered users of Geosoft™ geophysical software
Registered users of Leica Geo-Office™ GPS software

Survey Specifications

- This project will cover 2 grids - Escape Lake Grid & Beaver Lake Grid.
- Detailed gravity survey with 92% at 25 meter station interval, 8% 50 meters, 18 % ice stations at 25 meter intervals.
- Grid line spacing of 100 m.
- Gravity survey not tied-in to the National Gravity network but tied to Eastern Geophysics' previous gravity surveys in this area for Magma.
- Gravity readings reduced to Bouguer mgal. values
- All coordinates are in NAD83 Datum using UTM zone 16 format.
- Elevations are in height above mean sea level (MSL)
- Maximum elevation tolerance of +/- 5 cm./station
- Maximum gravity tolerance of 0.05 mgal./station

Survey Procedure

A gravity and elevation observation were obtained every 25m or 50m on cut lines. All the gravity data has been calculated or reduced to Bouguer mgal. values. These calculations correct for the following parameters (1) elevation, free- air correction, instrument height; (2) latitude correction; (3) tide correction on a daily basis; (4) instrument drift; and, if required (5) terrain corrections, (6) water depth, and (7) Ice thickness where necessary. In order to verify the accuracy of these corrections, 1.5 to 2% of the readings were observed again as random repeat readings. This contract specifies repeat readings to be no greater than 0.05 mgal.

Local gravity base station: The base station was used for this was located 160cm at about 40° from surveyors X on outcrop. at 5402411.008 N, 357881.706 E.
Gravity base value: 980900.00 mgal. (Not tied-in to National Gravity Network).
DGPS Control: Horizontal and vertical control was established on a surveyors X marked on outcrop using the "HERE" position (UTM NAD83, Zone 16)
Our untied value = 5402411.008 N, 357881.706 E, orthometric (MSL) elevation = 508.109 meters. These coordinates were used for this test survey.
Control Point: We setup a GPS base check point on top of a nearby outcrop on the east side of the road. It consists of a black marker X in the middle of an orange painted circle with a NAD83 value = 5402446.289 N, 357892.379 E with an ortho height of 506.786 meters.

We later obtained a value on the X marked on outcrop completed by a local surveyor = 5402408.489 N, 357881.958 E, orthometric (MSL) elevation = 508.160 meters. The surveyors ran a base for 4 hours on the X and sent the file to Ottawa to be post processed to obtain this value.

Personnel

Mike Tatlock, Eldon Norman, Noland Nippard, Jared Wick, Brian Sutton, and Chris Bell.

Operator Journal:

Project # 1020-1 February 7 to March 16, 2011

Monday, February 7, 2011
Day-1-: Travel: Eldon Norman and Noland Nippard drove from Antigonish, NS to Edmundston, NB and stayed there for the night.

Tuesday, February 8, 2011
Day-2-: Travel: Eldon and Noland drove to Val d'Or, PQ and stayed there for the night.

Wednesday, February 9, 2011
Day-3-: Travel: Eldon and Noland drove to Thunder Bay and stay there for the night.

Thursday, February 10, 2011
Day-4-: Travel: We went to the Magma Office and picked up some grid maps. We then picked up supplies for the job and drove to the Magma camp.

Friday, February 11, 2011
Day-5-: Operating: Gravity Crew E: Read 60 stations + 2 repeats. Eldon read L-79E from 2000N to 1475N, L-78E from 1475N to 2000N and L-77E from 2000N to 1600N.

Operating: DGPS: Read 63 stations + 2 repeats. Noland read L-79E from 2000N to 1475N, L-78E from 1475N to 2000N and L-77E from 2000N to 1525N.
The cold weather caused the batteries to die faster than normal so we had to go back to camp to get extra ones. All readings today were on the Escape Lake Grid.
(Running gravity total = 60 stn. + 2 repeats, DGPS = 63 + 2 repeats)

Saturday, February 12, 2011
Day-6-: Operating: Gravity Crew E: Read 76 stations + 2 repeats. Eldon read L-77E from 1600N to 1450N, L-76E from 1450N to 1725N this line stopped at camp L-75E from 2000N to 1475N, L-74E from 1500N to 2000N and L-73E from 2000N to 1650N.

Operating: DGPS: Read 155 stations + 2 repeats. Noland read L-77E from 1500N to 1450N, L-76E from 1450N to 1725N this line stopped at camp L-75E from 2000N to 1475N, L-74E from 1500N to 2000N, L-73E from 2000N to 1550N, L-72E from 1575N to 2000N, L-71E from 2000N to 1550N, L-70E from 1500N to 2000N, and L-69E from 2000N to 1525N. All readings today were on the Escape Lake Grid.
(Running gravity total = 136 stn. + 4 repeats, DGPS = 218 + 4 repeats)
Used 2 snowmobiles today = 2 rental days to date

Sunday, February 13, 2011
Day-7-: <u>Operating</u>: Gravity Crew E: Read 83 stations + 2 repeats. Eldon read L-73E from 1650N to 1550N, L-72E from 1575N to 2000N, L-71E from 2000N to 1550N, L-70E from 1500N to 2000N, L-69E from 2000N to 1525N and L-68E from 1500N.

<u>Operating</u>: DGPS: Read 145 stations + 2 repeats. Noland read L-68E from 1500N to 2000N, L-67E from 2000N to 1475N, L-66E from 1425N to 2000N, L-65E from 2000N to 1400N, L-64E from 1375N to 2000N and L-63E from 2000N to 1350N. All readings on the Escape Lake Grid. Note: Mike arrived today with 2 local helpers, Jared Wick and Chris Bell.

(Running gravity total = 219 stn. + 6 repeats, DGPS = 363 + 6 repeats)

Used 2 snowmobiles today = 4 rental days to date

Monday, February 14, 2011
Day-8-: <u>Operating</u>: Gravity Crew E: Read 91 stations + 2 repeats. Eldon read L-68E from 1500N to 2000N, L-67E from 2000N to 1475N, L-66E from 1425N to 2000N, and L-65E from 2000N to 1400N.

<u>Operating</u>: DGPS: Read 100 stations + 2 repeats. Noland read L-62E from 1250N to 2000N, L-63E from 900N to 0 and L-64E from 0 to 1000N. All readings on the Escape Lake Grid.

<u>Operating</u>: Gravity Crew M: Read 32 stations. Mike read L-6300E from 900N to 125N. He read 10 ice stations on ice with one very close to shore. All ice stations seem to be in shallow water. L6100E was not cut to the north of the lake due to a cabin and private land beside the lake.

(Running gravity total = 342 stn. + 8 repeats, DGPS = 463 + 8 repeats)

Used 2 snowmobiles today = 6 rental days to date

Tuesday, February 15, 2011.
Day-9-: <u>Operating</u>: Gravity Crew E: Read 82 stations + 2 repeats. Eldon read L-64E from 1375N to 2000N, L-63E from 2000N to 1350N, and L-62E from 1250N to 2000N.

<u>Operating</u>: DGPS: Read 93 stations + 2 repeats. Noland read L-65E from 1050N to 0, and L-66E from 0 to 1225N. All readings on the Escape Lake Grid.

<u>Operating</u>: Gravity Crew M: Read 53 stations. Mike read L-64E from 1000N to 0, L-63E from 100N to 0, and L-65E from 0 to 400N. It was a mild day.

(Running gravity total = 477 stn. + 10 repeats, DGPS = 556 + 10 repeats)

Used 2 snowmobiles today = 8 rental days to date

Wednesday, February 16, 2011
Day10-: <u>Operating</u>: Gravity Crew E: Read 90 stations + 2 repeats. Eldon read L-79E from 1100N to 0, and L-78E from 0 to 1100N.

<u>Operating</u>: DGPS: Read 127 stations + 2 repeats. Noland read L-79E from 1100N to 0, L-78E from 0 to 1100N, and L-77E from 1100N to 200N. All readings on the Escape Lake Grid.

<u>Operating</u>: Gravity Crew M: Read 75 stations + 3 repeats. Mike read L-65E from 1025N to 400N and L-66E from 0 to 1225N. It was a sunny and warm day of about 6 degrees with basically no wind. We tried to read the lake in the morning and in the evening but the drill is on the lake and creating too much noise.
(Running gravity total = 642 stn. + 15 repeats, DGPS = 683 + 12 repeats)
Used 2 snowmobiles today = 10 rental days to date

Thursday, February 17, 2011
Day-11-: <u>Operating</u>: Gravity Crew E: Read 45 stations + 1 repeat. Eldon read L-77E from 1100N to 0.

<u>Operating</u>: DGPS: Read 53 stations + 1 repeat. Noland read L-76E from 1100N to 0, and L-77E from 0 to 200N. All readings on the Escape Lake Grid.

<u>Bad Weather</u>: Gravity Crew M: It was drizzling steady and getting heavier as we were going to head in so we went on standby. Mike went to town to get 2 more snowmobiles and some more snowshoes. He returned to the camp at 8pm.
(Running gravity total = 687 stn. + 16 repeats, DGPS = 736 + 13 repeats)
Used 2 snowmobiles today = 12 rental days to date

Friday, February 18, 2011.
Day-12-: <u>Operating</u>: Gravity Crew E: Read 98 stations + 2 repeats. Eldon read L-67E from 1200N to 0 and L-68E from 0 to 1200N.

<u>Operating</u>: DGPS: Read 167 stations + 2 repeat. Noland read L-74E from 1225N to 0, L-75E from 0 to 1150N, L-73E from 1300N to 0, and L-72E from 0 to 400N. All readings on the Escape Lake Grid

<u>Operating</u>: DGPS M: Read 98 stations. Mike read L-67E from 1200N to 0 and L-68E from 0 to 1200N. The GPS was not very far ahead of the gravity stations so Mike read GPS today. It was a very windy and cold day but 100m north of the lake there was a wood harvested zone so the few swaying trees in the area did not slow down the GPS or gravity readings.
(Running gravity total = 785 stn. + 18 repeats, DGPS = 1001 + 15 repeats)
Used 4 snowmobiles today = 16 rental days to date

Saturday, February 19, 2011

Day-13-: <u>Operating</u>: **Gravity Crew E:** Read 92 stations + 2 repeats. Eldon read L-76E from 1100N to 0 and L-75E from 0 to 1150N.

<u>Operating</u>: DGPS: Read 109 stations + 2 repeat. Noland read L-67E from 1275N to 1225N, L-68E from 1225N to 1300N, L-69E from 1300N to 0, and L-70E from 0 to 1250N. All readings on the Escape Lake Grid.

<u>Operating</u>: Gravity Crew M: Read 60 stations. Mike read some rugged terrain correction stations at the south side of the lake on L-67E from 1275N to 1225N, L-68E from 1225N to 1300N, and L-69E from 1300N to 1225N. He also read lake stations on L-68E from 1325N to 1500N, L-67E from 1450N to 1300N, L-66E from 1250N to 1400N, L-65E from 1375N to 1075N, and L-64E from 1000N to 1325N. Noland was Mike's flashlight man on the lake from 9:15pm to 11:45pm.

(Running gravity total = 937 stn. + 20 repeats, DGPS = 1110 + 17 repeats)

Used 4 snowmobiles today = 20 rental days to date

Sunday, February 20, 2011

Day-14-: <u>Operating</u>: **Gravity Crew E:** Read 94 stations + 2 repeats. Eldon read L-74E from 1225N to225N and L-73E from 0 to 1300N. Could not reads lake at end of L-74E.

<u>Operating</u>: DGPS: Noland augered holes and measured water depths and ice thickness. All readings on the Escape Lake Grid

<u>Operating</u>: Gravity Crew M: Read 25 stations. Mike read L-70E from 1275N to 1125N and read L-69E from 1200N to 775N. These were in rough areas.

(Running gravity total = 1056 stn. + 22 repeats, DGPS = 1110 + 17 repeats)

Used 4 snowmobiles today = 24 rental days to date

Monday, February 21, 2011

Day-15-: <u>Operating</u>: **Gravity Crew E:** Read 106 Stations + 2 repeats. Eldon read L-71E from 0 to 1300N and L-72E from 1300N to 0.

<u>Operating</u>: DGPS: Read 166 stations + 2 repeat. Noland read L-70E from 1275N to 1175N, L-71E from 0 to 1300N, L-72E from 1300N to 400N, L-68E from 1325N to 1500N, L-67E from 1450N to 1300N, L-66E from 1250N to 1400N, L-65E from 1375N to 1050N, L-64E from 1000N to 1325N and L-80E from 1025N to 450N. GPS started on the Beaver Lake grid this afternoon.

<u>Operating</u>: Gravity Crew M: Read 20 stations + 1 repeat. Mike read L-70E from 1100N to 800N and L-69E from 750N to 600N. Mike had to pickup Brian Sutton at the airport. He also tried to read ice stations but it was too noisy.

Mike tried a gravity reading on the lake at 1030pm but could not get one.

(Running gravity total = 1182 stn. + 25 repeats, DGPS = 1276 + 19 repeats)

Used 4 snowmobiles today = 28 rental days to date

Tuesday, February 22, 2011

Day-16-: **Operating**: **Gravity Crew E:** Read 105 stations + 2 repeats. Eldon read L-80E from 1025N to 0, L-81E from 0 to 925N, L-82E from 1075N to 0 and L-83 from 0 to 500N. Eldon started Beaver Lake Grid today and read all day on it.

Operating: DGPS: Read 170 stations + 2 repeat. Noland read L-80E from 450N to 0, L-81E from 0 to 925N, L-82E from 1075N to 0, L-83E from 0 to 950N, L-84E from 1000N to 0, and L-85E from 0N to 1175N. All readings on Beaver Lake Grid.

Operating: Gravity Crew M: Read 57 stations + 2 repeats. Mike and Brian read L-69E from 575N to 0 and L-70E from 0 to 775N then they drove over to L-65E and read 1050N on the south side of the lake. Mike went to bed at midnight and awoke at 3:30am and tried to take readings on the lake but could not. He got back to bed at 4:55am and awoke at 8:00 am.

(Running gravity total = 1344 stn. + 29 repeats, DGPS = 1446 + 21 repeats)

Used 4 snowmobiles today = 32 rental days to date

Wednesday, February 23, 2011

Day-17-: **Operating**: **Gravity Crew E:** Read 87 Stations + 2 repeats. Eldon read L-83E from 500N to 950N, L-84E from 1000N to 0 and L-85E from 0 to 1175N, all on Beaver Lake Grid.

Operating: DGPS: Read 186 stations + 2 repeat. Noland read L-86E from 1225N to 0, L-87E from 0 to 1475N, L-88E from 1400N to 0, and L-89E from 0 to 1450N. All readings on Beaver Lake Grid.

Operating: Gravity/DGPS Crew M: Read 51 stations + 1 repeat with gravity and DGPS on each stations read today. Mike and Brian read L61E from 875N to 825N, 750N to 600, 525N, and 200N to 0. They also read L-62E from 0 to 750N. They read some on the south west inlet of the lake. This completed all of the land portion of the Escape Lake Grid since L-61E was stopped at 1175N on the north edge of the lake by a cabin due to private property.

(Running gravity total = 1482 stn. + 32 repeats, DGPS = 1683 + 23 repeats)

Used 4 snowmobiles today = 36 rental days to date

Thursday, February 24, 2011

Day-18-: <u>Operating</u>: Gravity Crew E: Read 90 stations + 2 repeats. Eldon read L-86E from 1225N to 0, and L-87E from 0 to 1475N. All readings on Beaver Lake Grid.

<u>Operating</u>: DGPS: Read 196 stations + 2 repeat. Noland read L-90E from 2100N to 0, L-91E from 0 to 2100N, L-80E from 1625N to 2100N, and L-81E from 2100N to 1475N.

<u>Operating</u>: Gravity Crew M: Read 51 stations + 1 repeat. Mike and Brian read L-80E on the north side of Escape Lake from 1625N to TL2100, L-81E from 2100N to 1475N, and L-82E from 1500N to 1600N. Mike and Brian tried to read the small 200m long pond at the south end of L-74E this morning, but could not. We read all day on the Beaver Lake Grid.

(Running gravity total = 1623 stn. + 35 repeats, DGPS = 1879 + 25 repeats)

Used 4 snowmobiles today = 40 rental days to date

Friday, February 25, 2011.

Day-19-: <u>Operating</u>: Gravity Crew E: Read 112 stations + 2 repeats. Eldon read L-88E from 1400N to 0, and L-87E from 0 to 1450N. All readings on Beaver Lake Grid. We read 18 stations on the lake this evening, L-70E from 1475N to 1300N and L-72E from 1325N to1550N on Escape Lake.

<u>Operating</u>: DGPS: Read 151 readings + 2 repeat. Noland read L-82E from 1500N to 2100N, L-83E from 2100N to 1575N, L-84E from 1650N to 2100N, L-85E from 2100N to 1725N, L-86E from 1650N to 2100N, L-87E from 2100N to 1675N, L-88E from 1650N to 2100N and L-89E from 2100N to 1575N. Noland assisted Eldon with the night lake readings.

<u>Operating</u>: Gravity Crew M: Read 86 stations + 1 repeat. Mike and Brian read L-82E from 1625N to 2100N, L-83E from 2100N to 1575N, L-84E from 1650N to 2100N, and L-85E from 1950N to 1700N and 1700N was in the lake. At night they read Escape Lake from L-69E from 1500N to 1325N and L-71E from 1325N to 1525N.

(Running gravity total = 1821 stn. + 38 repeats, DGPS = 2030 + 27 repeats)

Used 4 snowmobiles today = 44 rental days to date

Saturday, February 26, 2011.

Day-20-: <u>Operating</u>: Gravity Crew E: Read 56 stations. Eldon read L-73E from 1525N to 1325N, L-75E from 1175N to 1450N, L-78E from 1450N to 1150N, L-64E from 725N to 500N and L-61E from 500N to 300N, 550N, 575N, and 775N. All readings were ice stations on Escape Lake Grid.

<u>Operating</u>: DGPS: Read 100 stations + 2 repeat. Noland read L-91E from 2100N to 3500N, L-90E from 3500N to 2100N and L-69E from 1500N to 1325N. Noland and Brian augered and measured depths for the ice stations on L-69E.

<u>Operating</u>: Gravity Crew M: Read 53 stations. Mike got up at 2:45am and read ice stations on L-76E from 1400N to 1125N and returned to camp at 5am. Mike and Brian read ice stations on L-74E from 1475N to 1250N, L-77E from 1125N to 1425N, L-79E from 1425N to 1125N, and L-61E from 200N to 275N and 800N. We tried without success to read on the small lake at the south end of L-74E.

(Running gravity total = 1930 stn. + 38 repeats, DGPS = 2130 + 29 repeats)

Used 4 snowmobiles today = 48 rental days to date

Sunday, February 27, 2011

Day-21-: <u>Operating</u>: Gravity Crew E: Read 63 stations + 4 repeats. Eldon read L-90E from 1525N to 0, and L-91E from 0 to 500N. All readings were on Beaver Lake Grid.

<u>Operating</u>: DGPS crew: Noland and Jared augered 69 holes and measured ice and water depths.

<u>Operating</u>: Gravity Crew M: Read 37 stations + 1 repeat. Mike read L-86E from 1650N to 2100N and L-87E from 2100N to 1675N. Mike awoke at 4am and went down to try a gravity reading on the lake since it was still calm. After 15 minutes he was unable to get an accurate reading. He got back to camp at 5:20am.

(Running gravity total = 2030 stn. + 43 repeats, DGPS = 2130 + 29 repeats)

Used 4 snowmobiles today = 52 rental days to date

Monday, February 28, 2011.

Day-22-: <u>Operating</u>: Gravity Crew E: Read 41 stations plus redid 37 stations on L-73E. Eldon reread L-73E from 400N to 1300N, then read L-88E from 1650N to 2100N and L-89E from 2100N to 1525N. All readings were on Beaver Lake Grid.

<u>Operating</u>: DGPS: Noland had to drive Mike and Brian to Thunder Bay.

(Running gravity total = 2071 stn. + 43 repeats, DGPS = 2130 + 29 repeats)

Used 2 snowmobiles today = 54 rental days to date

Tuesday, March 01, 2011

Day-23-: Operating: **Gravity Crew E:** Read 86 stations + 1 repeat. Eldon read L-91E from 500N to 2100N, L-90E from 2100N to 1550N and L-76E at 1425N. All readings were on Beaver Lake Grid.

Operating: DGPS: Noland had to redo L-73E from 400N to 1300N. Read 111 readings on L70E form 1475N to 1300N, L-71E from 1325N to 1525N, L72E from 1550N to 1325N, L73E from 1325N to 1525N, L-74E from 1250N to 1475N, L-75E from 1450N to 1200N, L-76E from 1425N to 1125N, L-77E from 1125N to 1425N, L-78E from 1125N to 1425N, and L-79E from 1450N to 1125N. They also augered the holes and done ice thickness and water depths.

(Running gravity total = 2157 stn. + 44 repeats, DGPS = 2241 + 29 repeats)

Used 2 snowmobiles today = 56 rental days to date

Wednesday, March 02, 2011

Day-24-: Operating: **Gravity Crew E:** Read 92 stations + 1 repeat. Eldon read L-91E from 2100N to 3500N, and L-90E from 3500N to 2100N. All readings were on Beaver Lake Grid.

Operating: DGPS: Read 93 stations + 3 repeats. Noland read L-89E from 2100N to 3500N, and L-88E from 3500N to 2100N plus L-85E 1700N. Then Eldon and Noland ran the other lines with the skidoo to make them easier to walk.

(Running gravity total = 2249 stn. + 45 repeats, DGPS = 2334 + 32 repeats)

Used 2 snowmobiles today = 58 rental days to date

Thursday, March 03, 2011

Day-25-: Operating: **Gravity Crew E:** Read 92 stations + 1 repeat. Eldon read L-89E from 2100N to 3500N, and L-88E from 3500N to 2100N. All readings were on Beaver Lake Grid.

Operating: DGPS: Read 148 stations + 4 repeats. Noland read L-87E from 2100N to 3500N, L-86E from 3500N to 2100N, L-85E from 2525N to 3500N and L-84E from 3500N to 2625N.

(Running gravity total = 2341 stn. + 46 repeats, DGPS = 2482 + 36 repeats)

Used 2 snowmobiles today = 60 rental days to date

Friday, March 04, 2011

Day-26-: <u>Operating</u>: Gravity Crew E: Read 67 stations. Eldon read L-89E from 1475N to 1550N, L-88E from 1625N to 1425N, L-87E from 1500N to 1650N, L-86E from 1625N to 1250N, L-85E from 1200N to 1675N, and L-84E from 1625N to 1350N. All reading were on the lake, when the wind picked up and we couldn't read anymore, Eldon helped the guys auger the holes. All readings were on Beaver Lake Grid.

<u>Operating</u>: DGPS: Read 94 stations + 4 repeats. Noland read L-61E from 800N, 775N, 575N, 550N, 500N to 200N, L-64E from 725N to 500N, L-89E from 1475N to 1550N, L-88E from 1625N to 1425N, L-87E from 1500N to 1650N, L-86E from 1625N to 1250N, L-85E from 1200N to 1675N, and L-84E from 1625N to 1350N. L-85E from 2525N to 3500N and L-84E from 3500N to 2625N. Then we augered holes and measured water depths and ice thickness.
(Running gravity total = 2408 stn. + 46 repeats, DGPS = 2576 + 40 repeats)
Used 2 snowmobiles today = 62 rental days to date

Saturday, March 05, 2011

Day-27-: <u>Operating</u>: Gravity Crew E: Read 75 stations + 1 repeat. Eldon read L-87E from 2100N to 2225N, 2300N to 3300N, and L-86E from 3150N to 2275N, 2150N to 2125N. All readings were on Beaver Lake Grid.

<u>Operating</u>: DGPS: Read 137 readings + 6 repeats. Noland read L-84E from 2625N to 2050N, L-85E from 1975N to 2525N, L-83E from 2100N to 3500N and L-82E from 3500N to 2100N.
(Running gravity total = 2483 stn. + 47 repeats, DGPS = 2713 + 46 repeats)
Used 2 snowmobiles today = 64 rental days to date

Sunday, March 06, 2011

Day-28-: <u>Operating</u>: Gravity Crew E: Read 74 stations + 1 repeat. Eldon read L-74E 200N and 175N, L-85E from 2300N to 3200N plus 3300N, and L-84E from 3500N to 2325N. All readings were on Beaver Lake Grid. Eldon was able to get 2 reading on a small lake, wind was too bad on the others. We tried 3 other lakes with no luck.

<u>Operating</u>: DGPS: Read 92 stations + 4 repeats. Noland read L-80E from 2100N to 3500N and L-81E from 3500N to 2100N. This completes the GPS for land.
(Running gravity total = 2557 stn. + 48 repeats, DGPS = 2805 + 50 repeats)
Used 2 snowmobiles today = 66 rental days to date

Monday, March 07, 2011.

Day-29-: <u>Operating</u>: Gravity Crew E: Read 29 stations. Eldon read L-84E 1325N to 1025N and L-83E from 975N to 1350N. All readings were on Beaver Lake Grid. We read all 29 stations on the ice but the wind picked up so we augered hole and measured ice thickness and water depths.

<u>Operating</u>: DGPS: 29 readings. Noland read L-84E 1325N and 1025N and L-83E from 975N to 1350N.

(Running gravity total = 2586 stn. + 48 repeats, DGPS = 2834 + 50 repeats)

Used 2 snowmobiles today = 68 rental days to date

Tuesday, March 08, 2011

Day-30-: <u>Operating</u>: Gravity Crew E: Read 75 ice stations. Eldon read from L-83E 1375N to 1550N, L-82E from 1475N to 1100N, L-81E from 950N to 1450N, L- 80E from 1600N to 1050N and L-74E from 150N to 0.

<u>Operating</u>: DGPS: Read 68 stations. Noland read L-83E 1375N to 1550N, L-82E from 1475N to 1100N, L-81E from 950N to 1450N, and L- 80E from 1600N to 1050N.

(Running gravity total = 2661 stn. + 48 repeats, DGPS = 2902 + 50 repeats)

Used 2 snowmobiles today = 70 rental days to date

Wednesday, March 09, 2011

Day-31-: <u>Operating</u>: Gravity Crew E: Read 58 ice stations. Eldon read L-63E from 1325N to 925N, L-62E from 775N to 1225N and 1300N to 1325N, L-61E from 1375N to 900N, L- 85E 3250N and from 3350N to 35000N and L-86E from 3500N to 3400N. Then the wind was too strong to read any more.

<u>Operating</u>: DGPS: 48 readings + 2 repeats. Noland read L-63E from 1325N to 925N, L-62E from 775N to 1225N and 1300N to 1325N, and L-61E from 1375N to 900N. This completes the DGPS for job.

(Running gravity total = 2719 stn. + 48 repeats, DGPS = 2950 + 50 repeats)

Used 2 snowmobiles today = 72 rental days to date

Thursday, March 10, 2011

Day-32-: <u>Operating</u>: Gravity Crew E: Read 97 readings + 1 repeat. Eldon read L-86E from 3350N to 3200N and 2250N to 2175N, L-87E from 3350N to 3500N and 2250N to 2275N, L-85E from 1975N, L- 83E from 2350N to 35000N and L-82E from 3500N to 2125N. Then the wind became too strong to read any more ice stations. All readings were on Beaver Lake Grid.

<u>Operating</u>: Noland augered 61 holes and measured ice thickness and water depths.

(Running gravity total = 2816 stn. + 49 repeats, DGPS = 2950 + 50 repeats)

Used 2 snowmobiles today = 74 rental days to date

Friday, March 11, 2011

Day-33-: <u>Operating</u>: Gravity Crew E: Read 32 stations + 6 redos. Eldon read L-84E from 2300N to 2050N, L-85E from 2000N to 2275N, L-83E from 2175N to 2325N, and redone L-90E from 2425N to 2300N because the original readings were out of specs. The effects of multi earthquakes off Japan caused us to stop reading. Then Eldon and Noland auger holes. All ice stations are now complete. All readings were on Beaver Lake Grid.

<u>Operating</u>: Noland augered 98 holes and measured ice thickness and water depths.

(Running gravity total = 2848 stn. + 49 repeats, DGPS = 2950 + 50 repeats)

Used 2 snowmobiles today = 76 rental days to date

Saturday, March 12, 2011

Day-34-: <u>Operating</u>: Gravity Crew E: Read 92 stations + 1 repeat. Eldon read L-80E from 2125N to 3500N, and L-81E from 3500N to 2125N. All gravity complete. All readings were on Beaver Lake Grid.

<u>Operating</u>: Noland augered 20 holes and measured ice thickness and water depths plus redid DGPS on L-90E from 2600N to 2100N.

(Final gravity total = 2940 stn. + 49 repeats, DGPS = 2949 + 50 repeats)

Used 2 snowmobiles today = 78 rental days total

Sunday, March 13, 2011

Day-35-: <u>Travel</u>: Eldon Norman and Noland Nippard packed up equipment and shipped some to Wabush, Labrador then we drove to Kirkland Lake ON, and stayed there for the night.

Monday, March 14, 2011

Day-36-: <u>Travel</u>: Eldon Norman and Noland Nippard drove from Kirkland Lake to Riviere-du-Loup, and stayed there for the night.

Tuesday, March 15, 2011

Day-37-: <u>Travel</u>: Eldon Norman and Noland Nippard drove from Riviere-du-Loup to North Sydney and took the ferry to NL.

Wednesday, March 16, 2011

Day-38-: <u>Travel</u>: Eldon Norman and Noland Nippard drove from Port Aux Basque to home.

PROJECT SUMMARY

8.0 - Travel days
30.0 - Operating days gravity
0.0 - Operating day for tie-in
0.0 - Bad Weather days
0.0 - Standby days
0.0 - Days Off
38.0 - Total days   February 7 to March 16, 2011

2940 gravity stations read + 49 repeat readings = 2989 total stations.
485 ice stations included in total

2940 DGPS stations + 51 repeat readings, 0 stations leveled.
Note: Every gravity station read has a DGPS position, therefore it is complete.
78 snowmobile rental days

Escape Lake Grid – L-6100E, from 0 to 1175N = 48 stations
L-6200E, from 0 to 2000N = 81 stations
L-6300E, from 0 to 2000N = 81 stations
L-6400E, from 0 to 2000N = 81 stations
L-6500E, from 0 to 2000N = 81 stations
L-6600E, from 0 to 2000N = 81 stations
L-6700E, from 0 to 2000N = 81 stations
L-6800E, from 0 to 2025N = 82 stations
L-6900E, from 0 to 2000N = 81 stations
L-7000E, from 0 to 2000N = 81 stations
L-7100E, from 0 to 2000N = 81 stations
L-7200E, from 0 to 2000N = 81 stations
L-7300E, from 0 to 2000N = 81 stations
L-7400E, from 0 to 2000N = 81 stations
L-7500E, from 0 to 2000N = 81 stations
L-7600E, from 0 to 1725N = 69 stations
L-7700E, from 0 to 2000N = 81 stations
L-7800E, from 0 to 1975N = 80 stations
L-7900E, from 0 to 2000N = 81 stations

Total gravity stations = 1494 - Escape Lake Grid

Beaver Lake Grid – L-8000E, from 0 to 3500N = 121 stations
L-8100E, from 0 to 3500N = 121 stations
L-8200E, from 0 to 3500N = 120 stations
L-8300E, from 0 to 3500N = 121 stations
L-8400E, from 0 to 3500N = 121 stations
L-8500E, from 0 to 3500N = 121 stations
L-8600E, from 0 to 3500N = 120 stations
L-8700E, from 0 to 3500N = 121 stations
L-8800E, from 0 to 3500N = 119 stations
L-8900E, from 0 to 3500N = 121 stations
L-9000E, from 0 to 3500N = 121 stations
L-9100E, from 0 to 3500N = 119 stations
Total gravity stations = 1446 - Beaver Lake Grid

Escape Lake Grid = 1494 stations
Beaver Lake Grid = 1446 stations
Project Total = 2940 stations

For further information concerning this logistics report or for archived data, please contact Brian d'Entremont or Bennett d'Eon at:

EASTERN GEOPHYSICS LIMITED
819, Hwy. 335, P.O. Box 119
West Pubnico, NS B0W 3S0
PHONE (902) 762-3037
FAX (902) 762-3434
E-mail: brian.d@ns.sympatico.ca

EASTERN GEOPHYSICS LIMITED
(Newfoundland Office)
33 PRATT STREET
CORNER BROOK, NF A2H 7E1
PHONE: (709) 634-8512
FAX: (709) 634-8515
E-mail: b.deon@nl.rogers.com

Gravity Data Processing Terms:
The data was reduced to Bouguer Gravity Anomaly values in milligals, mGal. The Sunday Lake grid is tied to a common gravity base at the provincial courthouse in Thunder Bay. The density used and reported in the digital files are 2.67 g/cc. Other terms, as used in the processing, are defined below:

Observed Gravity:
Field observations corrected for Scale Factor, tides due to the Sun and Moon, instrument drift during the time between base readings, and instrument height.

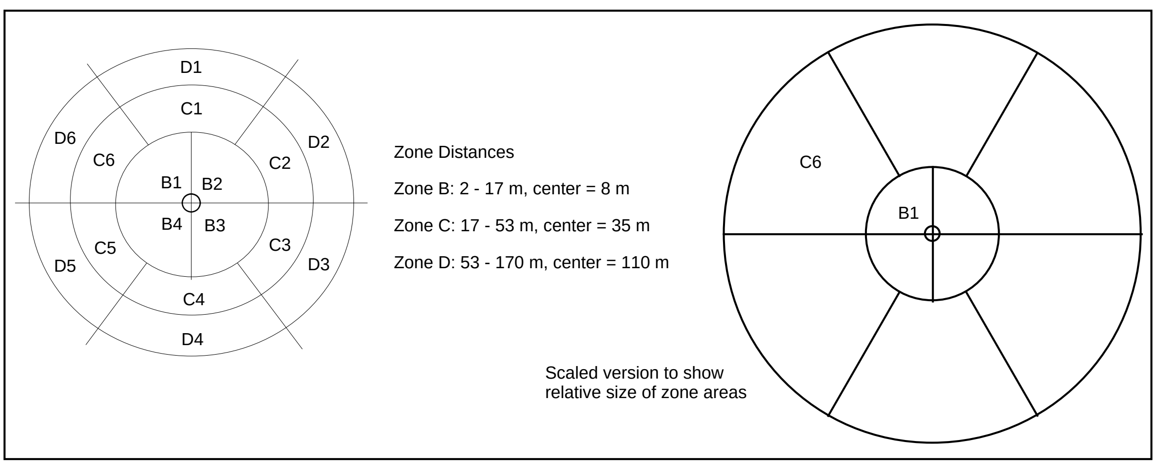
Theoretical Gravity (Latitude Correction):
A correction applied to account for the effect of latitude, due to the Earths rotation and change in radius from the center of mass. This survey used the IGF1967 formula

$$Gt = 9.78031846 * \left(1 + 0.0053024 \sin^2 \varphi - 0.0000058 \sin^2 2\varphi\right)$$

Free Air Correction:
A correction applied to account for station readings taken at various elevations above a common datum, in this case, Mean Sea Level. All GPS heights above the ellipsoid have been converted to Mean Sea Level by applying the Geoidal Separation.
Gfa = -0.3086 mGal / m * elevation (MSL)

Bouguer Slab Correction:
A correction applied to the rock layer between the station and datum, Mean Sea Level. The equation can handle water and ice layers as well but not required on this project.

Inner Terrain Correction, ITC:
A correction applied to the variable ground elevation in the near vicinity of the station. The outer radius of the C-zone is 53.3 meters. Terrain effects beyond this distance are insignificant for this region and this survey. The method used follows the Modified Hammer Zones B and C formulae.



Description of Data Channels in Bouguer Data Spreadsheet:

Column A: Line number oriented E.

Column B: Station number oriented N.

Column C: Grid Northing in meters, NAD83 UTM Zone 16

Column D: Grid Easting in meters, NAD83 UTM Zone 16

Column E: Elevation in meters Above Mean Sea Level (Orthometric), NAVD 1988

Column F: Free Air Correction, mGal

Column G: Observed Gravity in milligals

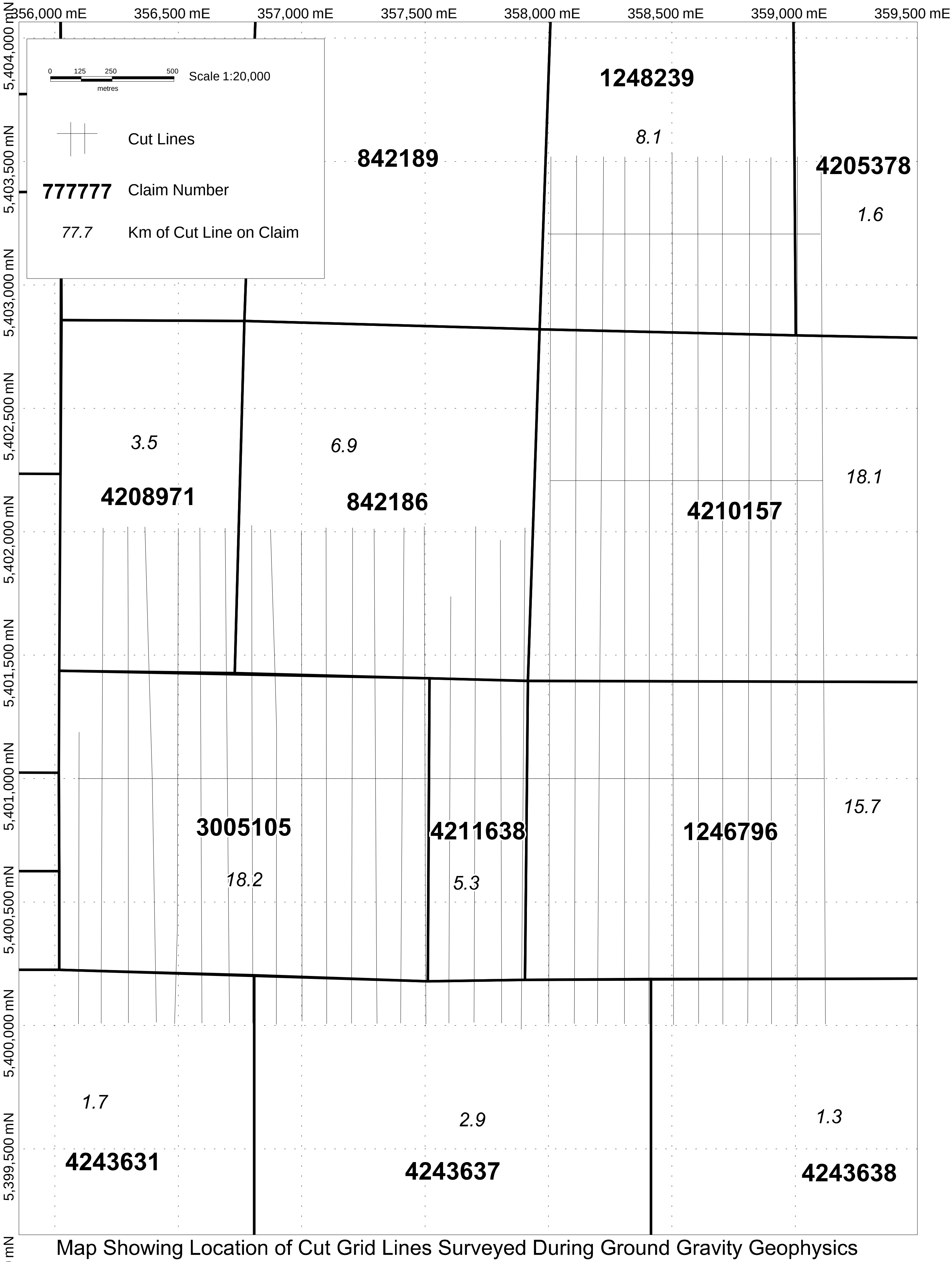
Column H: Dep_W - Water depth at 1.0 g/cc3

Column I: Dep_I - Ice thickness at 0.9 g/cc3

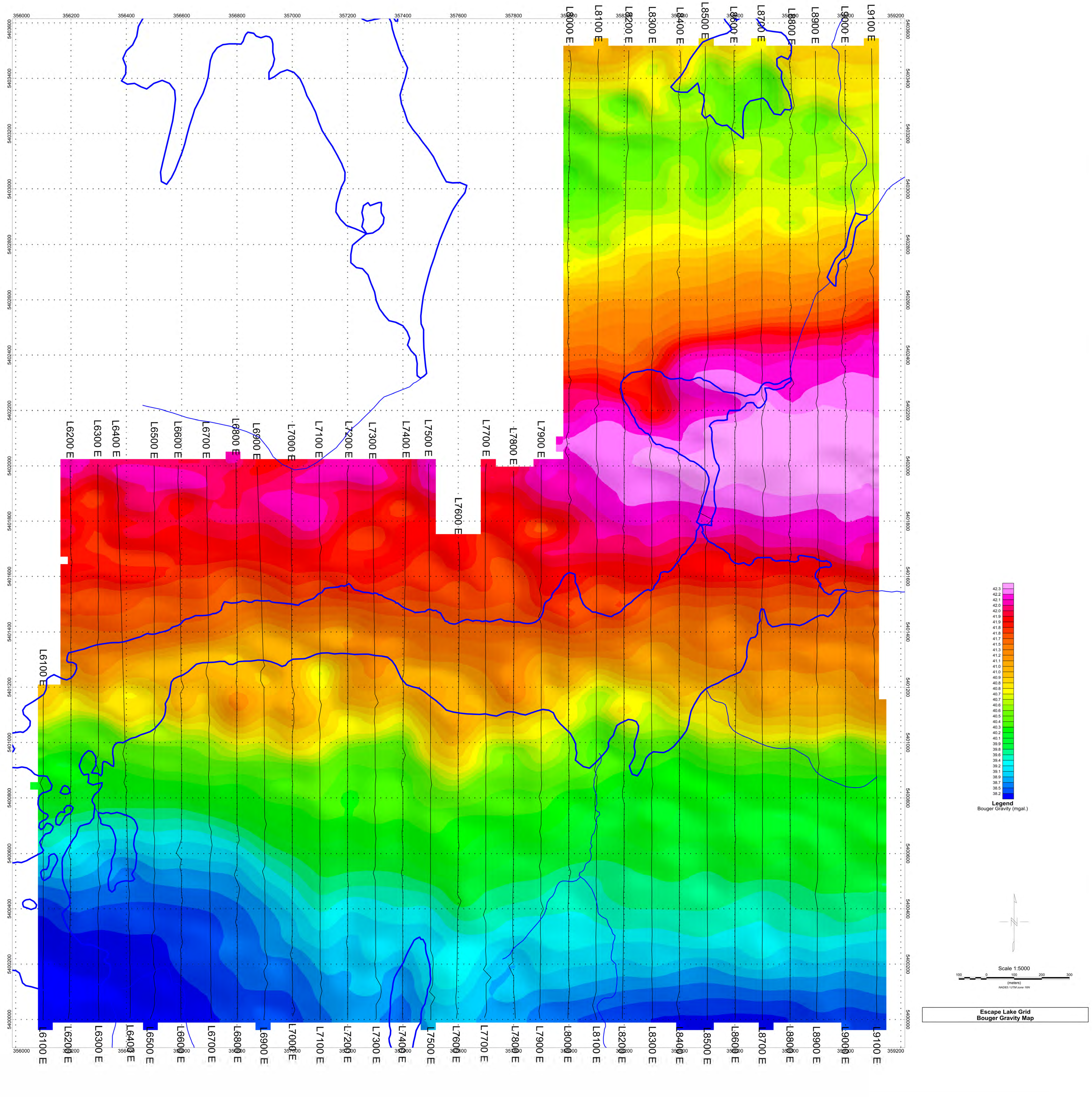
Column J: Inner Terrain Correction ITC – B and C zones, mGal

Column K: Bouguer Slab Correction for rock, mGal

Column L: Final Bouguer Gravity including ITC if available using rock density of 2.67 g/cc, mGal



Map Showing Location of Cut Grid Lines Surveyed During Ground Gravity Geophysics


L6100 E
L6200 E
L6300 E
L6400 E
L6500 E
L6600 E
L6700 E
L6800 E
L6900 E
L7000 E
L7100 E
L7200 E
L7300 E
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5402800
5403000
5403200
5403400
5403600
42.3
42.2
42.1
42.0
42.0
41.9
41.9
41.8
41.8
41.7
41.5
41.3
41.2
41.1
41.0
41.0
40.9
40.8
40.8
40.7
40.7
40.6
40.6
40.5
40.4
40.3
40.2
40.1
39.9
39.8
39.6
39.4
39.2
39.1
38.9
38.7
38.5
38.2
Legend
Bouger Gravity (mgal.)
Scale 1:5000
100 0 100 200 300
(meters)
NAD83 / UTM zone 16N
Escape Lake Grid
Bouger Gravity Map