APPENDIX A

Geophysical Survey Report

BC Geological Survey
Assessment Report
33512b

Fugro Airborne Surveys

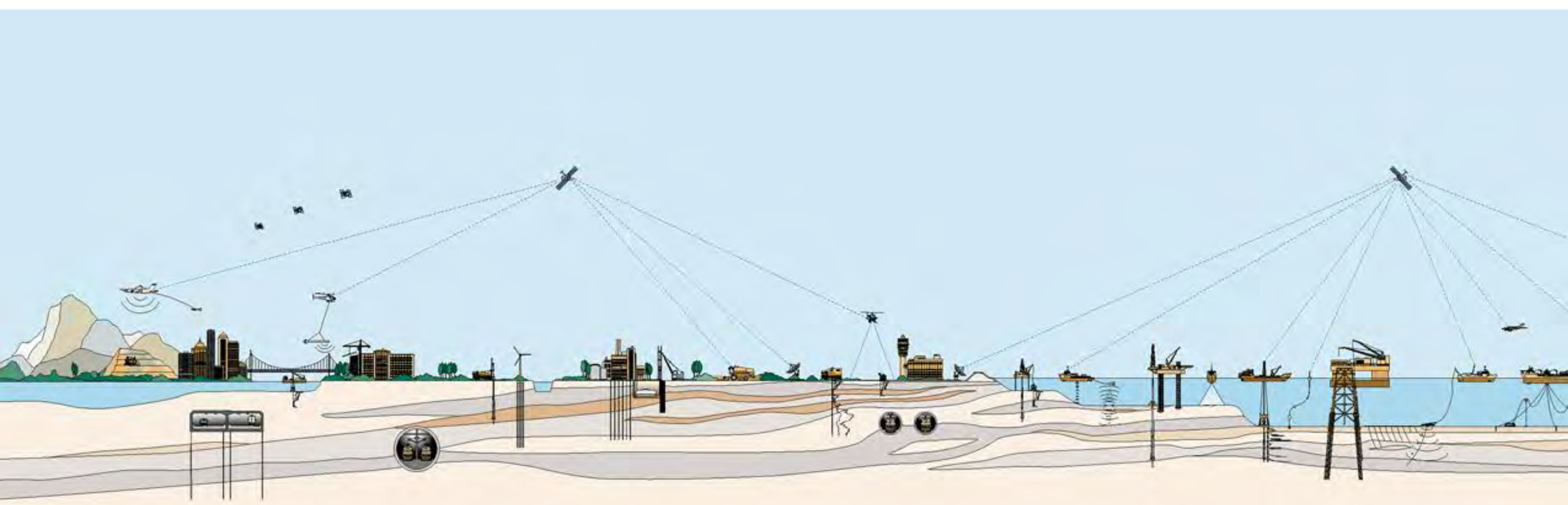
GEOPHYSICAL SURVEY REPORT

HM1 STINGER-MOUNTED MAGNETIC SURVEY

SPECTRUM AREA

PROJECT 12089

KEEWATIN CONSULTANTS (2002) INC.



December 14, 2012

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FUGRO AIRBORNE SURVEYS

Fugro Airborne Surveys was formed in early 2000 through the global merger of leading airborne geophysical survey companies: Geoterrex-Dighem, High-Sense Geophysics, and Questor of Canada; World Geoscience of Australia; and Geodass and AOC of South Africa. Sial Geosciences of Canada joined the Fugro Airborne group in early 2001, and Spectra Exploration Geosciences followed thereafter. In mid 2001, Fugro acquired Tesla 10 and Kevron in Australia, and certain activities of Scintrex. Fugro also works with Lasa-Geomag located in Brazil for surveys in South America. With a staff of over 400, Fugro Airborne Surveys now operates from 12 offices worldwide.

Fugro Airborne Surveys is a professional services company specializing in low level remote sensing technologies that collects, processes, and interprets airborne geophysical data related to the subsurface of the earth and the sea bed. The data and map products produced have been an essential element of exploration programs for the mining and petroleum industries for over 50 years. Engineers, scientists and others with a need to map the earth's subsurface geology use Fugro Airborne Surveys for environmental and engineering solutions. From mapping kimberlite pipes and oil and gas deposits to detecting water tables and unexploded ordnance, Fugro Airborne Surveys designs systems dedicated to specific targets and survey needs. State of the art geophysical systems and techniques ensure that clients receive the highest quality survey data and images.

Fugro Airborne Surveys acquires both time domain and frequency domain electromagnetic data as well as magnetic, radiometric and gravity data from a wide range of fixed wing (airplane) and helicopter platforms. Depending on the geophysical mapping needs of the client, Fugro Airborne Surveys can field airborne systems capable of collecting one or more of these types of data concurrently. The company offers all data acquisition, processing, interpretation and final reporting services for each survey.

Fugro Airborne Surveys is a founding member of IAGSA, the International Airborne Geophysics Safety Association. Our health, safety and environment management system has successfully achieved certification to the international standard *OHSAS 18001* and our quality management system has also successfully achieved certification to the international standard *ISO 9001:2000 Quality Management Systems – Requirement*s.

Disclaimer

1. The Survey that is described in this report was undertaken in accordance with current internationally accepted practices of the geophysical survey industry, and the terms and specifications of a Survey Agreement signed between the CLIENT and FUGRO. Under no circumstances does FUGRO make any warranties either expressed or implied relating to the accuracy or fitness for purpose or otherwise in relation to information and data provided in this report. The CLIENT is solely responsible for the use, interpretation, and application of all such data and information in this report and for any costs incurred and expenditures made in relation thereto. The CLIENT agrees that any use, reuse, modification, or extension of FUGRO's data or information in this report by the CLIENT is at the CLIENT's sole risk and without liability to FUGRO. Should the data and report be made available in whole or part to any third party, and such party relies thereon, that party does so wholly at its own and sole risk and FUGRO disclaims any liability to such party.

2. Furthermore, the Survey was performed by FUGRO after considering the limits of the scope of work and the time scale for the Survey.

3. The results that are presented and the interpretation of these results by FUGRO represent only the distribution of ground conditions and geology that are measurable with the airborne geophysical instrumentation and survey design that was used. FUGRO endeavours to ensure that the results and interpretation are as accurate as can be reasonably achieved through a geophysical survey and interpretation by a qualified geophysical interpreter. FUGRO did not perform any observations, investigations, studies or testing not specifically defined in the Agreement between the CLIENT and FUGRO. The CLIENT accepts that there are limitations to the accuracy of information that can be derived from a geophysical survey, including, but not limited to, similar geophysical responses from different geological conditions, variable responses from apparently similar geology, and limitations on the signal which can be detected in a background of natural and electronic noise, and geological variation. The data presented relates only to the conditions as revealed by the measurements at the sampling points, and conditions between such locations and survey lines may differ considerably. FUGRO is not liable for the existence of any condition, the discovery of which would require the performance of services that are not otherwise defined in the Agreement.

4. The passage of time may result in changes (whether man-made or natural) in site conditions. The results provided in this report only represent the site conditions and geology for the period that the survey was flown.

5. Where the processing and interpretation have involved FUGRO's interpretation or other use of any information (including, but not limited to, topographic maps, geological maps, and drill information; analysis, recommendations and conclusions) provided by the CLIENT or by third parties on behalf of the CLIENT and upon which FUGRO was reasonably entitled or expected to rely upon, then the Survey is limited by the accuracy of such information. Unless otherwise stated, FUGRO was not authorized and did not attempt to independently verify the accuracy or completeness of such information that was received from the CLIENT or third parties during the performance of the Survey. FUGRO is not liable for any inaccuracies (including any incompleteness) in the said information.

Introduction

This report describes the logistics, data acquisition, processing and presentation of results of a HM1 stinger-mounted magnetic airborne geophysical survey carried out for Keewatin Consultants (2002) Inc. over one property near Iskut, British Columbia. Total coverage of the survey block amounted to 389.6 km. The survey was flown between September 23 and September 24, 2012.

The purpose of the survey was to map the geology and structure of the area. Data were acquired using a HM1 magnetic system with a high-sensitivity cesium magnetometer. The information from these sensors was processed to produce maps and images that display the properties of the survey area. A GPS electronic navigation system ensured accurate positioning of the geophysical data with respect to the base map coordinates.

The survey data were processed and compiled in the Fugro Airborne Surveys Toronto office. Maps and data in digital format are provided with this report.

TABLE OF CONTENTS

APPENDICES

TABLE OF TABLES

TABLE OF FIGURES

Survey Area Description

Location of the Survey Area

One block near Iskut, British Columbia (Figure 1) was flown between September 23 and September 24, 2012, with Iskut, British Columbia as the base of operations. Survey coverage consisted of 352.9 km of traverse lines flown with a spacing of 100 m and 36.7 km of tie lines with a spacing of 1000 m for a total of 389.6 km.

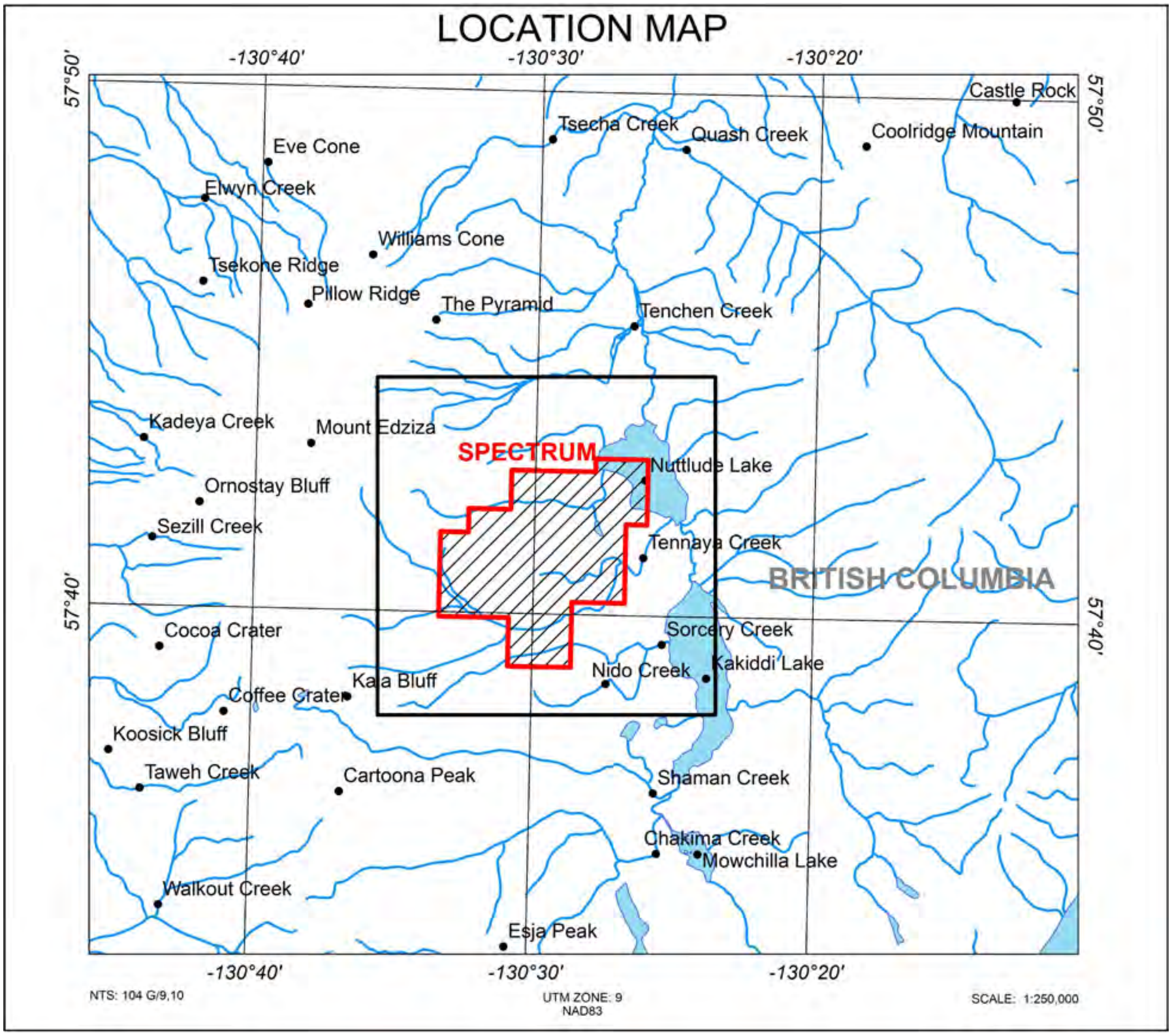


Figure 1 Spectrum Area - Location Map

Table 1 contains the coordinates of the corner points of the survey block.

Block	Corners	X-UTM (E)	Y-UTM (N)
12089-1	1	407239	6395512
Spectrum Area	2	408228	6395489
	3	408248	6396334
	4	409737	6396301
	5	409768	6397692
	6	412747	6397627
	7	412757	6398090
	8	414618	6398051
	9	414569	6395731
	10	413824	6395747
	11	413765	6392964
	12	411901	6393005
	13	411850	6390686
	14	409613	6390735
	15	409651	6392457
	16	407171	6392513

Table 1 Area Corners NAD83 UTM Zone 9N

Block	Line Numbers	Line direction	Line Spacing	Line km
1	10010 - 10740	90°/270°	100 m	352.9 km
Spectrum Area	19010 - 19080	0°/180°	1000 m	36.7 km

Table 2 Line kilometre summary

During the survey GPS base stations were set up to collect data to allow post processing of the positional data for increased accuracy. The location of the GPS base stations are shown in Table 3.

Status	Location Name	WGS84 Longitude (deg-min-sec)	WGS84 Latitude (deg-min-sec)	Orthometric Height (m)
Primary	Iskut, British Columbia	58° 25' 40.92989"	-130° 00' 56.66869"	806.538
Secondary	Iskut, British Columbia	57° 49' 05.09263"	-129° 57' 42.78221"	861.794

Table 3 GPS Base Station Location

The location of the Magnetic base stations are shown in Table 4.

Status	Location Name	WGS84 Longitude (deg-min-sec)	WGS84 Latitude (deg-min-sec)
Primary	Iskut, British Columbia	57° 49’ 05.09263”	-129° 57’ 42.78221”
Secondary	Iskut, British Columbia	57° 49’ 05.09263”	-129° 57’ 42.78221”

Table 4 Magnetic Base Station Location

System Information

Figure 2 HM1 System

The HM1 system is composed of a stinger fixed to the belly of a helicopter containing a magnetometer, fluxgate magnetometer and a GPS antenna for flight path recovery. The helicopter has a tail boom mounted GPS antenna for in-flight navigation, radar, laser and barometric altimeters, video camera and data acquisition system.

Aircraft and Geophysical On-Board Equipment

Helicopter:	AS350 B2
Operator:	Pacific Western Helicopters
Registration:	C-GPWV
Average Survey Speed:	107 km/h (30m/s)
Digital Acquisition:	Fugro Airborne Surveys HeliDAS.
Video:	Panasonic WVCD/32 Camera with Axis 241S Video Server. Camera is mounted to the exterior bottom of the helicopter between the forward skid tubes
Magnetometer:	Scintrex Cesium Vapour CS-3, mounted in the nose of the stinger; Operating Range: 15,000 to 100,000 nT Operating Limit: -40°C to 50°C Accuracy: ±0.002 nT Measurement Precision: 0.001 nT Sampling rate: 10.0 Hz
Fluxgate:	Billingsley TMF100 Triaxial fluxgate, mounted in Stinger Axial alignment: < ±1 degree Sensitivity: 100 µV per nT Sampling rate10.0 Hz
Radar Altimeter:	Honeywell Sperry Altimeter System. Radar antennas are mounted to the exterior bottom of the helicopter between the forward skid tubes Operating Range: 0 – 2500ft Operating Limit: -55°C to 70°C 0 to 55,000 ft Accuracy: ± 3% (100 – 500ft above obstacle) ± 4% (500 – 2500ft above obstacle) Measurement Precision: 1 ft Sample Rate: 10.0 Hz

Laser Altimeter: Optech G-150 mounted on the belly of the helicopter;

Operating Range: 0.2 to 250 m
Operating Limit: -10°C to 45°C
Accuracy:
±5 cm (10°C to 30°C)
±10 cm (-10°C to 45°C)
Measurement Precision: 1 cm
Sample Rate: 10.0 Hz

Aircraft Navigation: NovAtel OEM4 Card with an Aero antenna mounted on the tail *of the helicopter;*

Operating Limit: -40°C to 85°C
Real-Time Accuracy: 1.2m CEP (L1 WAAS);
Real-Time Measurement Precision: 6 cm RMS
Sample Rate: 2.0 Hz

Barometric Altimeter: Motorola MPX4115AP analog pressure sensor mounted in the helicopter

Operating Range: 55 kPa to 108 kPa
Operating Limit: -40°C to 125°C
Accuracy:
± 1.5 kPa (0°C to 85°C)
± 3.0 kPa (-20°C to 0°C, 85°C to 105°C)
± 4.5 kPa (-40°C to -20°C, 105°C to 125°C)
Measurement Precision: 0.01 kPa
Sampling Rate = 10.0 Hz

Temperature: Analog Devices 592 sensor mounted on the camera box

Operating Range: -40°C to + 75°C
Operating Limit: -40°C to + 75°C
Accuracy: ± 1.5°C
Measurement Precision: 0.03°C
Sampling Rate = 10.0 Hz

Base Station Equipment

Primary Magnetometer: Fugro CF1 using Scintrex cesium vapour sensor with Marconi GPS card and antenna for measurement synchronization to GPS. The base station also collects barometric pressure and outside temperature.

Magnetometer Operating Range: 15,000 to 100,000 nT
Barometric Operating Range: 55kPa to 108 kPa

	Temperature Operating Range: -40°C to 75°C Sample Rate: 1.0 Hz
GPS Receiver:	NovAtel OEM4 Card with an Aero antenna
	Real-Time Accuracy: 1.8m CEP (L1) Sample Rate: 1.0 Hz
Secondary Magnetometer:	GEM Systems GSM-19
	Operating Range: 20,000 to 120,000 nT Operating Limit: -40°C to 60°C Accuracy: ± 0.2 nT Measurement Precision: 0.01 nT Sample Rate: 0.33 Hz

Quality Control and In-Field Processing

Digital data for each flight were transferred to the field workstation, in order to verify data quality and completeness. A database was created and updated using Geosoft Oasis Montaj and proprietary Fugro Atlas software. This allowed the field personnel to calculate, display and verify both the positional (flight path) and geophysical data. The initial database was examined as a preliminary assessment of the data acquired for each flight.

In-field processing of Fugro survey data consists of differential corrections to the airborne GPS data, filtering of all geophysical and ancillary data, verification of the digital flight path recordings, and diurnal correction of magnetic data.

All data, including base station records, were checked on a daily basis to ensure compliance with the survey contract specifications. Re-flights were required if any of the following specifications were not met.

Navigation

A specialized GPS system provided in-flight navigation control. The system determined the absolute position of the helicopter by monitoring the range information of twelve channels (satellites). The Novatel OEM4 receiver was used for this application. In North America, the OEM4 receiver is WAAS-enabled (Wide Area Augmentation System) providing better real-time positioning.

A Novatel OEM4 GPS base station was used to record pseudo-range, carrier phase, ephemeris, and timing information of all available GPS satellites in view at a one second interval. These data are used to improve the conversion of aircraft raw ranges to differentially corrected aircraft position. The GPS antenna was set-up in a location that allowed for clear sight of the satellites above. The set-up of the antenna also considered surfaces that could cause signal reflection around the antenna that could be a source of error to the received data measurements.

Flight Path

Flight lines did not deviate from the intended flight path by more than 25% of the planned flight path over a distance of more than 1 kilometre. Flight specifications were based on GPS positional data recorded at the helicopter.

Clearance

The survey elevation is defined as the measurement of the helicopter radar altimeter to the tallest obstacle in the helicopter path. An obstacle is any structure or object which will impede the path of the helicopter to the ground and is not limited to and includes tree canopy, towers and power lines.

Survey elevations may vary based on the pilot's judgement of safe flying conditions around man-made structures or in rugged terrain.

The average survey elevation achieved for the helicopter and instrumentation during data collection was:

Helicopter	30 metres
Magnetometer	30 metres

The traverse lines and control line altitudes did not deviate by more than 20% over a distance of 2 km from the ideal flight path.

The achieved survey height average was 28.4 metres. Deviations from this average were due to the steep terrain flying.

Flying Speed

The average calculated ground speed was 107 km/h ranging between 14 to 266 km/h. This resulted in a ground sample interval of approximately 0.4 to 7.4 metres at a 10 Hz sampling rate. Variance in the survey speed was due to climbing and descending over steep terrain

Airborne High Sensitivity Magnetometer

To assess the noise quality of the collected airborne magnetic data, Fugro monitors the 4th difference results during flight which is verified post flight by the processor. The contracted specification for the collected airborne magnetic data was that the non-normalized 4th difference would not exceed 1.6 nT over a continuous distance of 1 kilometre excluding areas where this specification was exceeded due to natural anomalies. Fugro achieved an average non-normalized 4th difference result of 1.49 nT.

Magnetic Base Station

Ground magnetic base stations were set-up to measure the total intensity of the earth's magnetic field. The base stations were placed in a magnetically quiet area, away from power lines and moving metallic objects. The contracted specification for the collected ground magnetic data was the non-linear variations in the magnetic data were not to exceed 10 nT per minute. Throughout the period of the survey the earth's magnetic activity was calm. Fugro's standard of setting up the base station within 50 km from the centre of the survey block allowed for successful removal of the active magnetic events on the collected airborne magnetic data.

Compensation System

The presence of the helicopter in close proximity to the sensors causes considerable interference on the readings. The orientation of the aircraft with respect to the sensors and the motion of the aircraft through the earth's magnetic field are contributing factors. A special calibration flight is flown to record the information necessary to remove these effects.

The manoeuvre consists of flying a series of calibration lines at high altitude to gain information in each of the required line directions. During this procedure, the pitch, roll and yaw of the aircraft are varied. Each variation is conducted in succession (first vary pitch, then roll, then yaw).

A three-axis fluxgate magnetometer measures the orientation and rates of change of the aircraft's magnetic field with respect to the earth's magnetic field. A compensation algorithm is applied to generate a set of coefficients for each line direction and for each magnetometer sensor to compensate for permanent, induced and eddy current magnetic noise generated by the aircraft.

Data Processing

Flight Path Recovery

To check the quality of the positional data the speed of the bird is calculated using the differentially corrected x, y and z data. Any sharp changes in the speed are used to flag possible problems with the positional data. Where speed jumps occur, the data are inspected to determine the source of the error. The erroneous data are deleted and splined if less than two seconds in length. If the error is greater than two seconds the raw data are examined and if acceptable, may be shifted and used to replace the bad data. The gps z component is the most common source of error. When it shows problems that cannot be corrected by recalculating the differential correction, the barometric altimeter is used as a guide to assist in making the appropriate correction. The corrected WGS84 longitude and latitude coordinates were transformed to NAD83 using the following parameters.

Datum:	NAD83
Ellipsoid:	GRS 1980
Projection:	UTM Zone 9N
Central meridian:	129° West
False Easting:	500000 metres
False Northing:	0 metres
Scale factor:	0.9996
WGS84 to Local Conversion:	Molodensky
Dx,Dy,Dz:	0,0,0

Recorded video flight path may also be linked to the data and used for verification of the flight path. Fiducial numbers are recorded continuously and are displayed on the margin of each digital image. This procedure ensures accurate correlation of data with respect to visible features on the ground. The fiducials appearing on the video frames and the corresponding fiducials in the digital profile database originate from the data acquisition system and are based on incremental time from start-up. Along with the acquisition system time, UTC time is also recorded in parallel and displayed (Figure 3).

Altitude Data

Radar altimeter data are despiked by applying a 1.5 second median and smoothed using a 1.5 second Hanning filter. The radar altimeter data are then subtracted from the GPS elevation to create a digital elevation model that is gridded and used in conjunction with profiles of the radar altimeter and flight path video to detect any spurious values.

Laser altimeter data are despiked and filtered using an alpha trim filter. The laser altimeter data are then subtracted from the GPS elevation to create a digital elevation model that is examined in grid format for spurious values. The laser does a better job of piercing the tree canopy than the radar altimeter.

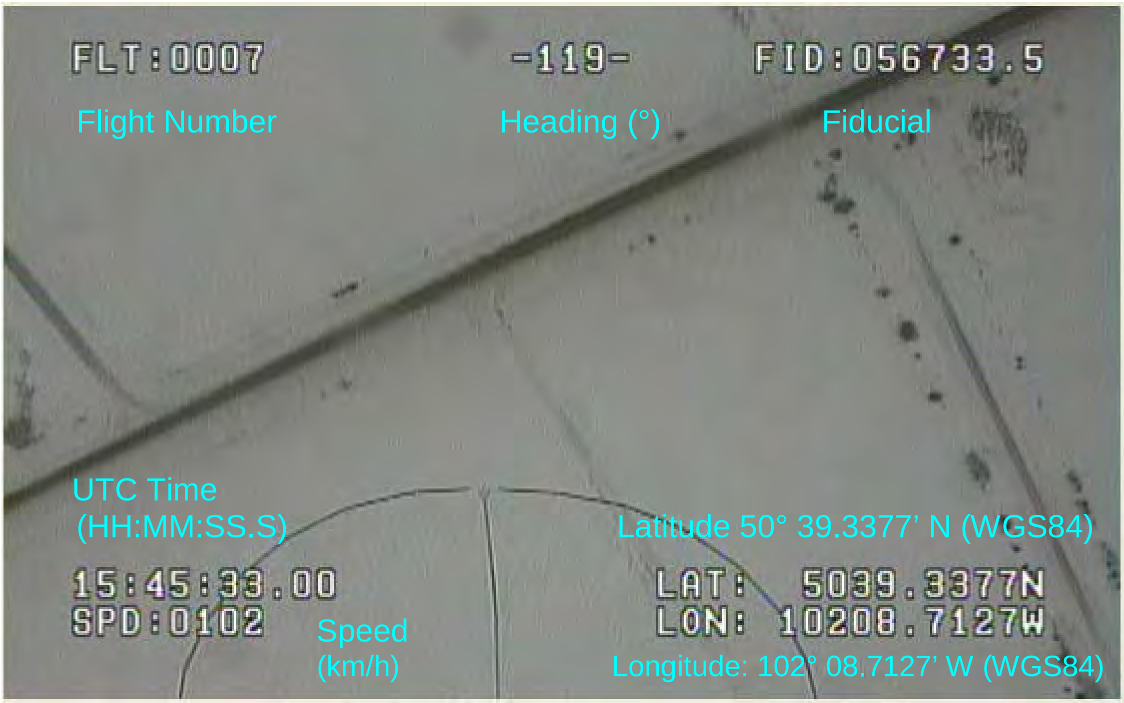


Figure 3 Flight path video

Magnetic Base Station Diurnal

The raw diurnal data are sampled at 1 Hz and imported into a database. The data are filtered with a 51 second median filter and then a 51 second Hanning filter to remove spikes and smooth short wavelength variations. A non linear variation is then calculated and a flag channel is created to indicate where the variation exceeds the survey tolerance. Acceptable diurnal data are interpolated to a 10 Hz sample rate and the local regional field value, calculated from the average of the first day's diurnal data, is removed to leave the diurnal variation. This diurnal variation is then ready to be used in the processing of the airborne magnetic data.

Residual Magnetic Intensity

The Total Magnetic Field (TMF) data collected in flight were profiled on screen along with a fourth difference channel calculated from the TMF. Spikes were removed manually where indicated by the fourth difference. The despiked data were then corrected for lag by 2 seconds. The diurnal variation that was extracted from the filtered ground station data was then removed from the despiked and lagged TMF and an average magnetic base value of 56845 was added back. The IGRF was calculated using the 2010 IGRF model for the specific survey location, date and altitude of the sensor and removed from the TMF to obtain the Residual Magnetic Intensity (RMI). The results were then levelled using tie and traverse line intercepts. Manual adjustments were applied to any lines that required levelling, as indicated by shadowed images of the gridded magnetic data. The manually levelled data were then subjected to a microlevelling filter.

Magnetic First Vertical Derivative

The levelled, Residual Magnetic Intensity grid was subjected to a processing algorithm that enhances the response of magnetic bodies in the upper 500 metres and attenuates the response of deeper bodies. The resulting calculated vertical gradient grid (CVG) provides better definition and resolution of near-surface magnetic units. It also identifies weak magnetic features that may not be quite as evident in the RMI data. Regional magnetic variations and changes in lithology, however, may be better defined on the Residual Magnetic Intensity.

Digital Elevation

The laser altimeter values are subtracted from the differentially corrected and de-spiked GPS-Z values to produce profiles of the height above mean sea level along the survey lines. These values are gridded to produce contour maps showing approximate elevations within the survey area. Any subtle line-to-line discrepancies are manually removed. After the manual corrections are applied, the digital terrain data are filtered with a microlevelling algorithm.

The accuracy of the elevation calculation is directly dependent on the accuracy of the two input parameters, laser altimeter and GPS-Z. The GPS-Z value is primarily dependent on the number of available satellites. Although post-processing of GPS data will yield X and Y accuracies in the order of 1-2 metres, the accuracy of the Z value is usually much less, sometimes in the ±5 metre range. Further inaccuracies may be introduced during the interpolation and gridding process.

Because of the inherent inaccuracies of this method, no guarantee is made or implied that the information displayed is a true representation of the height above sea level. Although this product may be of some use as a general reference, THIS PRODUCT MUST NOT BE USED FOR NAVIGATION PURPOSES.

Contour and Colour Map Displays

The magnetic are interpolated onto a regular grid using a modified Akima spline technique. The resulting grid is suitable for image processing and generation of contour maps. The grid cell size is 20% of the line interval.

Colour maps are produced by interpolating the grid down to the pixel size. The parameter is then incremented with respect to specific amplitude ranges to provide colour "contour" maps.

Final Products

This section lists the final maps and products that have been provided under the terms of the survey agreement. Other products can be prepared from the existing dataset, if requested. Most parameters can be displayed as contours, profiles, or in colour.

Maps

Base maps of the survey area were produced by converting published raster image topographic maps to a bitmap (.bmp) format. This process provides a relatively accurate, distortion-free base that facilitates correlation of the navigation data to the map coordinate system. The topographic files were combined with geophysical data for plotting some of the final maps. All maps were created using the following parameters:

Projection Description:

Datum:	NAD83
Ellipsoid:	GRS80
Projection:	UTM Zone 9N
Central meridian:	129° West
False Easting:	500000 metres
False Northing:	0 metres
Scale factor:	0.9996
WGS84 to Local Conversion:	Molodensky
Dx,Dy,Dz:	0, 0, 0

Maps depicting the survey results have been plotted and provided as a PDF (or .MAP) at a scale of 1:20,000 as listed in Table 5. Each parameter is plotted on one map sheet.

Final Map Products	No. of Map Sets Plotted
Residual Magnetic Intensity	2
Calculated Vertical Magnetic Gradient	2

Table 5 Final Map Products

Digital Archives

Line and grid data in the form of a Geosoft database (*.gdb) and XYZ file and Geosoft grids (*.grd) have been written to DVD. The formats and layouts of these archives are further described in Appendix B (Data Archive Description).

Report

Two paper copies of this Geophysical Survey Report plus a digital copy in PDF format.

Flight Path Videos

All survey flights in BIN/BDX format with a viewer.

CONCLUSIONS AND RECOMMENDATIONS

This report provides a very brief description of the survey results and describes the equipment, data processing procedures and logistics of the airborne survey over the Spectrum Area, near Iskut, British Columbia. The various maps included with this report display the magnetic properties of the survey area.

There are four areas of interest within the survey block. The most prominent is the active gradient region centered on the high ridge at the west-center area of the block that could indicate a possible intrusive formation. The second is an arch of high positive magnetic gradient outlined with negative magnetic gradient that traces the valley to the south of the prominent ridge that may have been a result emplacement of the possible intrusive-like feature. The third active area is located at the very southern end of the block as the grid approaches the peak of the next ridge, which could indicate a similar geological environment to that of the prominent ridge. North of this ridge is plateau that is coincident with an area of moderately high magnetic gradient. The fourth area of interest is the most northern ridge in the block which is characterized by a high positive magnetic signature on the south flank and peak that has a rapid transition to a negative magnetic gradient on the north face.

It is recommended that the survey results be assessed and fully evaluated in conjunction with all other available geophysical, geological, and geochemical information. In particular, structural analysis of the data should be undertaken and areas of interest should be selected. An attempt should be made to determine the geophysical “signatures” over any known zones of mineralization in the survey areas or their vicinity.

It is also recommended that image processing of existing geophysical data be considered, in order to extract the maximum amount of information from the survey results. Current software and imaging techniques often provide valuable information on structure and lithology, which may not be clearly evident on the contour and colour maps. These techniques can yield images that define subtle, but significant, structural details.

Respectfully submitted,

FUGRO AIRBORNE SURVEYS CORP.

R12089

Appendix A List of Personnel

List of Personnel:

The following personnel were involved in the acquisition, processing, interpretation and presentation of data, relating to a HM1 magnetic airborne geophysical survey carried out for Keewatin Consultants (2002) Inc. over the Spectrum Area near Iskut, British Columbia.

Duane Griffith	Manager, Geophysical Services
Lesley Minty	Project Manager
Chris Sawyer	Flight Planner
Urbano Jaimes	Field Data Processor
Shane Seddon	Operator
Muhammed Farooqui	Operator
Steven Tanaka	Pilot (Pacific Western Helicopters)
Sean Plener	Data Processor

All personnel were employees of Fugro Airborne Surveys, except where indicated.

Appendix B Data Archive Description

Data Archive Description:

Survey Details:

Survey Area Name:	Spectrum Area
Project number:	12089
Client:	Keewatin Consultants (2002) Inc.
Survey Company Name:	Fugro Airborne Surveys
Flown Dates:	September 23 to September 24, 2012
Archive Creation Date:	December 14, 2012

Geodetic Information for map products:

Datum:	NAD83
Ellipsoid:	GRS80
Projection:	UTM Zone 9N
Central meridian:	129° West
False Easting:	500000 metres
False Northing:	0 metres
Scale factor:	0.9996
WGS84 to Local Conversion:	Molodensky
Dx,Dy,Dz:	0, 0, 0

Grid Archive:

Geosoft Grids:

File	Description	Units
mag	Residual Magnetic Intensity	nT
cvg	Calculated Magnetic Vertical Gradient	nT/m

kmz:

File	Description	Units
mag	Residual Magnetic Intensity	nT
cvg	Calculated Magnetic Vertical Gradient	nT/m

Disclaimer: Google Earth Accuracy
Fugro provides images of geophysical data in .KML or .KMZ format for viewing in Google Earth as a convenient product to our clients. It is important to recognize that the horizontal and vertical positional accuracy of Google Earth is not sufficient for close location of targets for drilling, verifying outcrop, etc. Fugro makes no warranty as to the accuracy of apparent positioning of Fugro data when converted and displayed in Google Earth.

Linedata Archive:
Geosoft Database Layout:

Field	Variable	Description	Units
1	X	Easting NAD83	m
2	Y	Northing NAD83	m
3	fid	fiducial	-
4	longitude	Longitude WGS84	degrees
5	latitude	Latitude WGS84	degrees
6	flight	Flight number	-
7	date	Flight date	ddmmyy
8	altrad_heli	Helicopter height above surface from radar altimeter	m
9	altlas_heli	Helicopter height above surface from laser altimeter	m
10	gpsz	Helicopter height above geoid	m
11	dem	Digital elevation model (above geoid)	m
12	diurnal	Measured ground magnetic intensity	nT
13	diurnal_cor	Diurnal correction – base removed	nT
14	mag_raw	Total magnetic field – spike rejected	nT
15	mag_comp	Total magnetic field - compensated	nT
16	mag_lag	Total magnetic field - corrected for lag	nT
17	mag_diu	Total magnetic field – diurnal variation removed	nT
18	igrf	international geomagnetic reference field	nT
19	mag_rmi	Residual magnetic intensity	nT
20	fx	Fluxgate magnetometer, component 1	nT
21	fy	Fluxgate magnetometer, component 2	nT
22	fz	Fluxgate magnetometer, component 3	nT

Note – The null values in the GDB and XYZ archives are displayed as *.

Maps:

PDF files of final maps at a scale of 1:20,000. One map set consists of one sheet.

File	Description	Units
mag	Residual Magnetic Intensity	nT
cvg	Calculated Vertical Magnetic Gradient	nT/m

Report:

A logistics and processing report for Project #12089 in PDF format:

R12089.pdf

Video:

Digital video in BIN/BDX format are archived for all survey flights. To view the files, two video viewers are included. The first viewer is a standalone program and can be used by everyone. The second viewer requires Oasis Montaj and is version specific. Documentation is included with more information.

Digital Flight Path.pdf

FASSurveyReplay (Stand alone)
FugroDVD_MontajViewer72 (Oasis Montaj)

Appendix C Map Product Grids

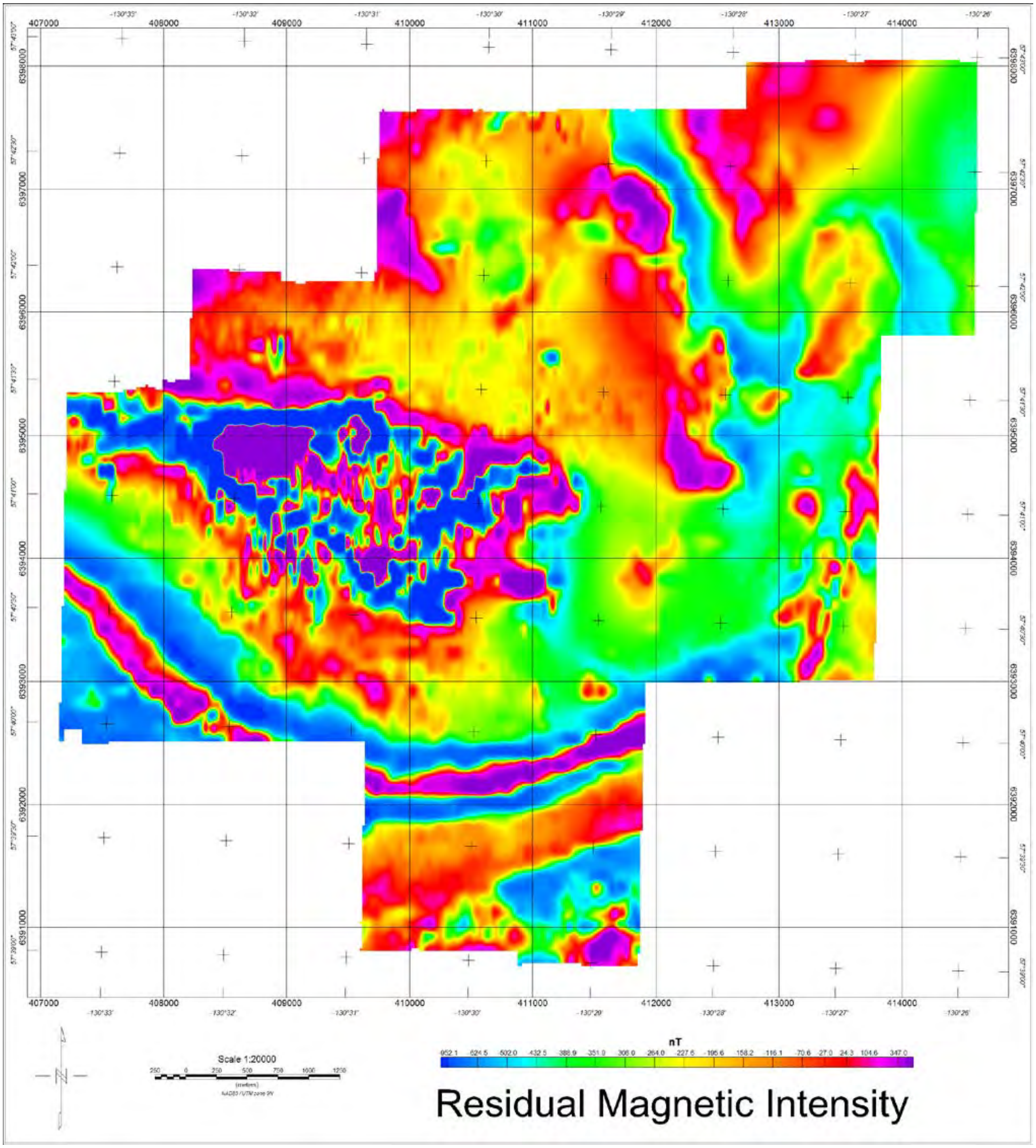


Figure 4 Residual Magnetic Intensity

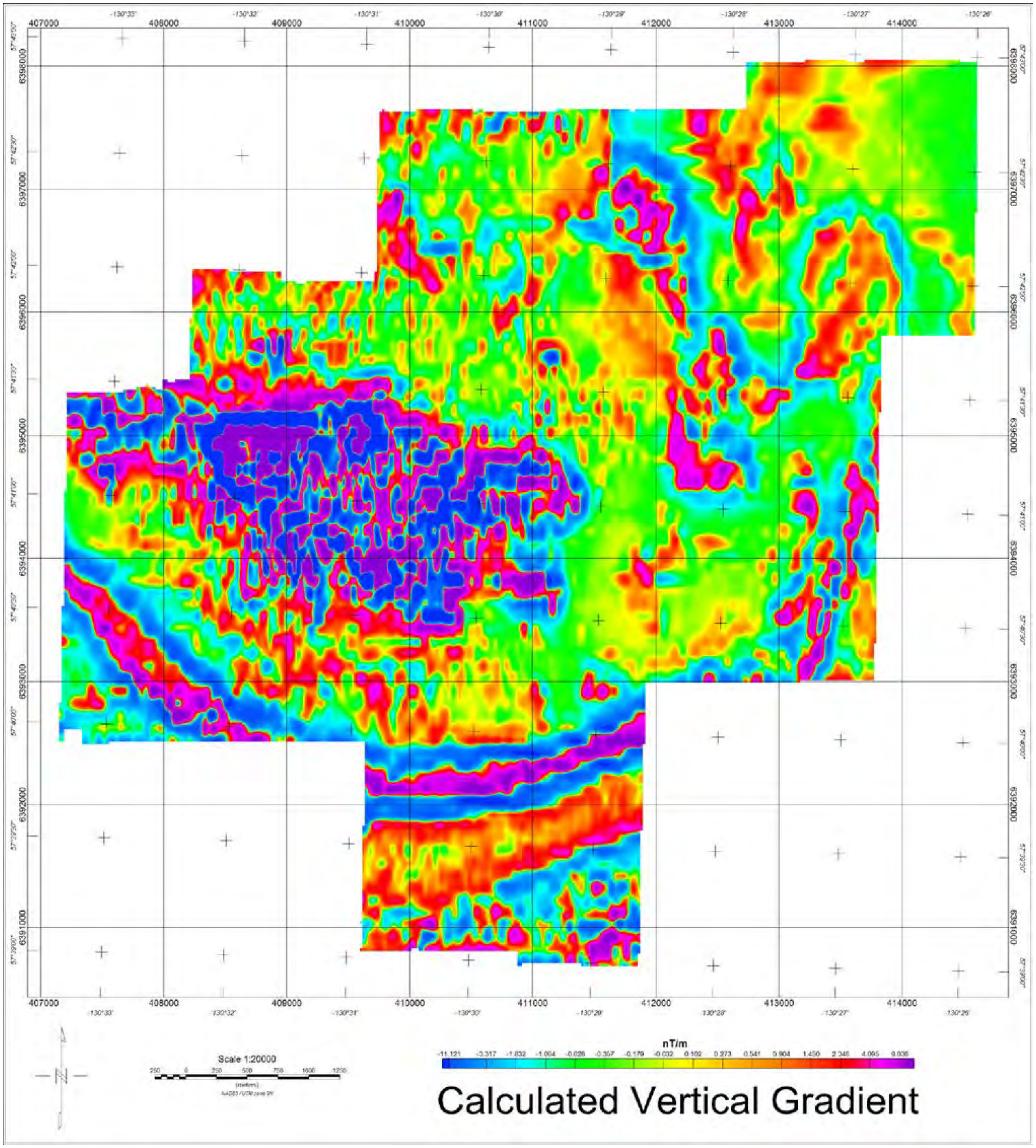


Figure 5 Calculated Vertical Magnetic Gradient

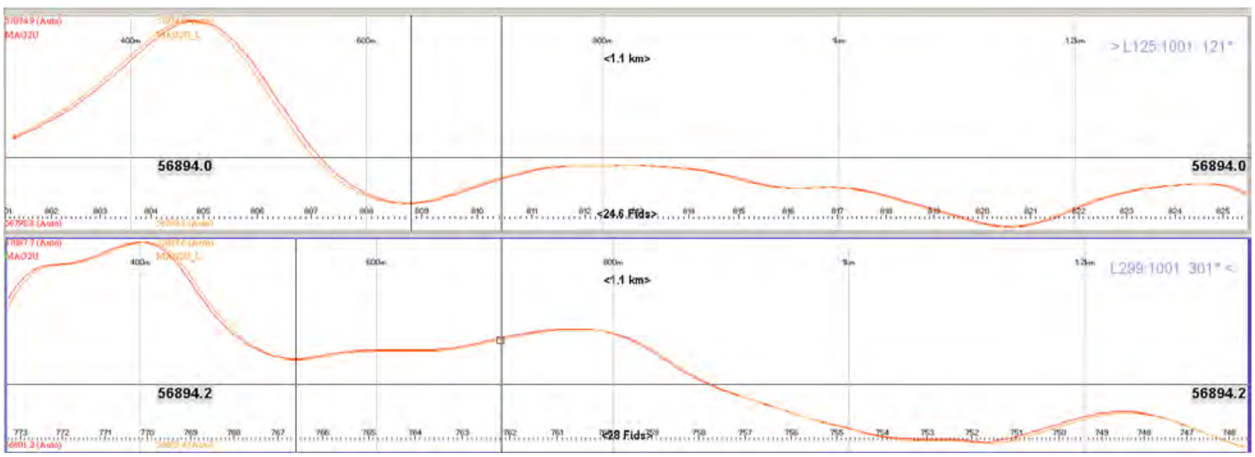
Appendix D Calibration and Tests

Magnetics Lag Test

Project Number: 12089
Date Flown: 15-Sept-12
Flight Number:1001

Survey Type: HM1 Stinger
Aircraft Registration: C-GPWV
Location: Stewart

Correction Lag Applied: 2 seconds

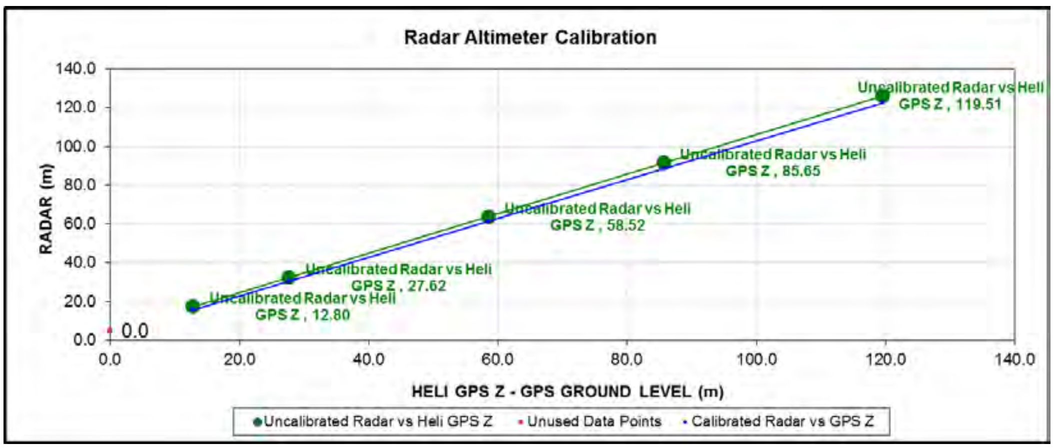


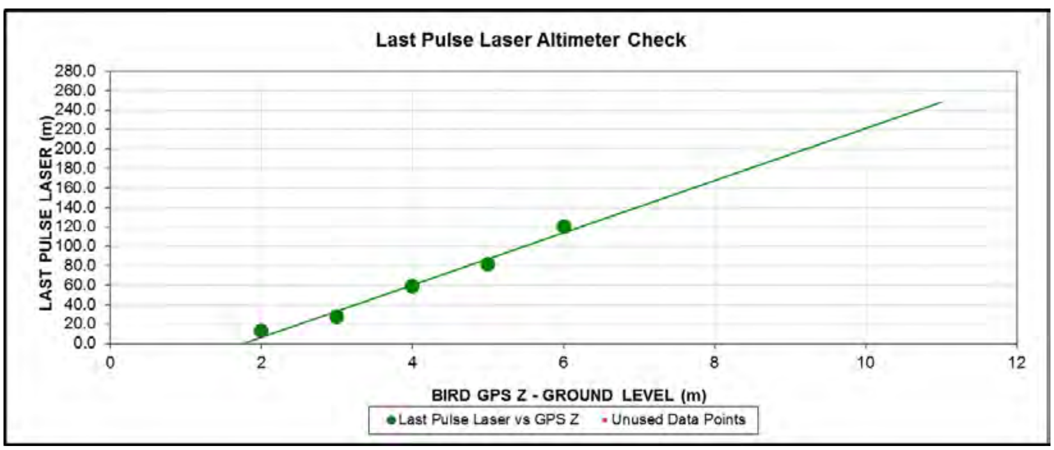
ALTIMETER CALIBRATION

Project Number: 12089
Date Flown: 15-Sept-12
Flight Number: 1001

Survey Type: HM1 Stinger
Aircraft Registration:C-GPWV
Location: Stewart

TARGET RADAR (ft)	ZHG_HELI	ALTRAD_FT	ALTLASLP_M	ALTBAR_M
0	807.5	15.4	0.1	680.4
50	820.3	57.0	13.0	696.4
100	835.1	106.6	27.9	710.3
200	866.0	208.9	58.9	742.1
300	893.2	300.5	82.1	769.8
400	927.0	413.6	120.2	805.2





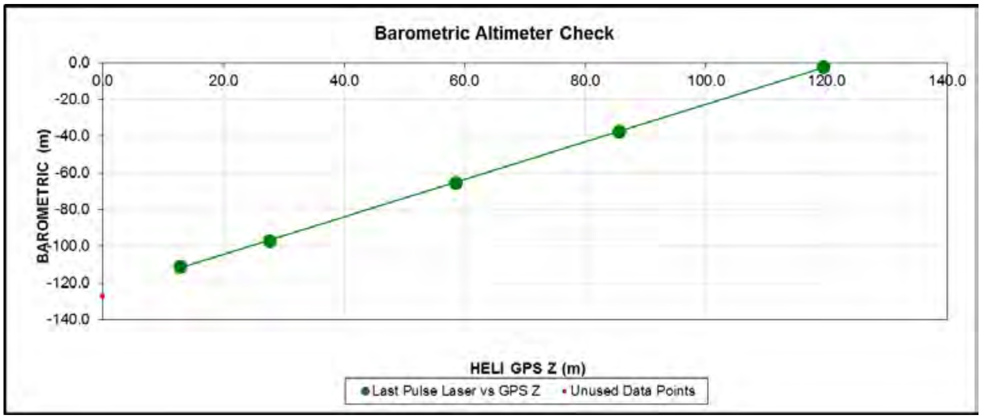

Barometric Altimeter Check
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
-120.0
-140.0
BAROMETRIC (m)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
HELI GPS Z (m)
Last Pulse Laser vs GPS Z
Unused Data Points

Figure of Merit

Project Number:		Survey Type:	
Date Flown:		Aircraft Registration:	
Flight Number:		Location:	

BOX 1	Sensor Position:		Pitch	Roll	Yaw	Total	Figure of Merit
	Raw Mag Channel:		Residual Peak to Peak	Residual Peak to Peak	Residual Peak to Peak		
	Line Number	Heading					
Direction 1:	1045.00	045	0.12	0.11	0.12	0.35	1.49
Direction 2:	1135.00	135	0.10	0.08	0.10	0.28	
Direction 3:	1225.00	225	0.15	0.11	0.17	0.43	
Direction 4:	1315.00	315	0.15	0.12	0.15	0.42	

BOX 2	Sensor Position:		Pitch	Roll	Yaw	Total	Figure of Merit
	Raw Mag Channel:		Residual Peak to Peak	Residual Peak to Peak	Residual Peak to Peak		
	Line Number	Heading					
Direction 1:	2045.00	045	0.25	0.23	0.13	0.60	1.78
Direction 2:	2135.00	135	0.10	0.16	0.12	0.37	
Direction 3:	2225.00	225	0.11	0.14	0.16	0.41	
Direction 4:	2315.00	315	0.15	0.12	0.13	0.40	

Appendix E Background Information

Magnetic Responses

The measured total magnetic field provides information on the magnetic properties of the earth materials in the survey area. The information can be used to locate magnetic bodies of direct interest for exploration, and for structural and lithological mapping.

The total magnetic field response reflects the abundance of magnetic material in the source. Magnetite is the most common magnetic mineral. Other minerals such as ilmenite, pyrrhotite, franklinite, chromite, hematite, arsenopyrite, limonite and pyrite are also magnetic, but to a lesser extent than magnetite on average.

In some geological environments, an EM anomaly with magnetic correlation has a greater likelihood of being produced by sulphides than one which is non-magnetic. However, sulphide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Canada).

Iron ore deposits will be anomalously magnetic in comparison to surrounding rock due to the concentration of iron minerals such as magnetite, ilmenite and hematite.

Changes in magnetic susceptibility often allow rock units to be differentiated based on the total field magnetic response. Geophysical classifications may differ from geological classifications if various magnetite levels exist within one general geological classification. Geometric considerations of the source such as shape, dip and depth, inclination of the earth's field and remanent magnetization will complicate such an analysis.

In general, mafic lithologies contain more magnetite and are therefore more magnetic than many sediments which tend to be weakly magnetic. Metamorphism and alteration can also increase or decrease the magnetization of a rock unit.

Textural differences on a total field magnetic contour, colour or shadow map due to the frequency of activity of the magnetic parameter resulting from inhomogeneities in the distribution of magnetite within the rock, may define certain lithologies. For example, near surface volcanics may display highly complex contour patterns with little line-to-line correlation.

Rock units may be differentiated based on the plan shapes of their total field magnetic responses. Mafic intrusive plugs can appear as isolated "bulls-eye" anomalies. Granitic intrusives appear as sub-circular zones, and may have contrasting rings due to contact metamorphism. Generally, granitic terrain will lack a pronounced strike direction, although granite gneiss may display strike.

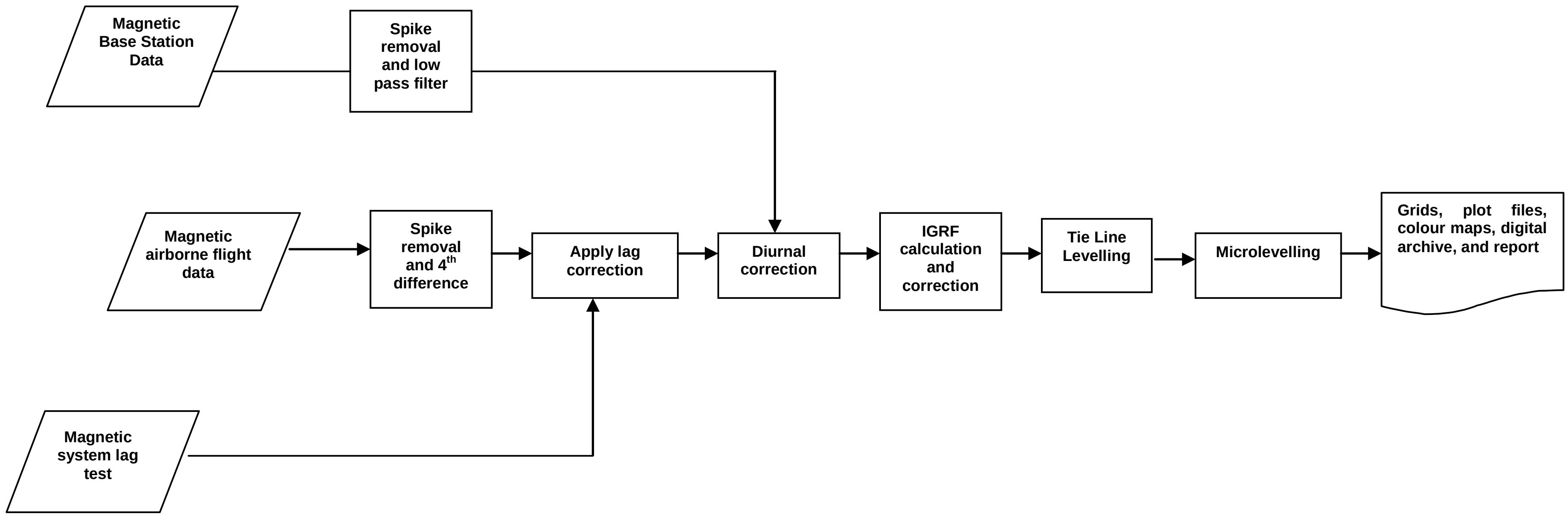
Linear north-south units are theoretically not well-defined on total field magnetic maps in equatorial regions due to the low inclination of the earth's magnetic field. However, most stratigraphic units will have variations in composition along strike that will cause the units to appear as a series of alternating magnetic highs and lows.

Faults and shear zones may be characterized by alteration that causes destruction of magnetite (e.g., weathering) that produces a contrast with surrounding rock. Structural breaks may be filled by magnetite-rich, fracture filling material as is the case with diabase dikes, or by non-magnetic felsic material.

Faulting can also be identified by patterns in the magnetic total field contours or colours. Faults and dikes tend to appear as lineaments and often have strike lengths of several kilometres. Offsets in narrow, magnetic, stratigraphic trends also delineate structure. Sharp contrasts in magnetic lithologies may arise due to large displacements along strike-slip or dip-slip faults.

Appendix F Data Processing Flowcharts

Magnetic Data Processing Flow Chart



Appendix G Glossary

FUGRO GLOSSARY OF AIRBORNE GEOPHYSICAL TERMS

accelerometer: an instrument that measures both acceleration (due to motion) and acceleration due to ***gravity***.

altitude attenuation: the absorption of gamma rays by the atmosphere between the earth and the detector. The number of gamma rays detected by a system decreases as the altitude increases.

AGG: Airborne ***gravity gradiometer.***

AGS: Airborne ***gamma-ray spectrometry***.

amplitude: The strength of the total electromagnetic field. In ***frequency domain*** it is most often the sum of the squares of ***in-phase*** and ***quadrature*** components. In multi-component electromagnetic surveys it is generally the sum of the squares of all three directional components.

analytic signal: The total amplitude of all the directions of magnetic ***gradient***. Calculated as the sum of the squares.

anisotropy: Having different ***physical parameters*** in different directions. This can be caused by layering or fabric in the geology. Note that a unit can be anisotropic, but still **homogeneous**.

anomaly: A localized change in the geophysical data characteristic of a discrete source, such as a conductive or magnetic body: something locally different from the **background**.

apparent- : the ***physical parameters*** of the earth measured by a geophysical system are normally expressed as apparent, as in "apparent ***resistivity*"**. This means that the measurement is limited by assumptions made about the geology in calculating the response measured by the geophysical system. Apparent resistivity calculated with ***HEM***, for example, generally assumes that the earth is a ***homogeneous half-space*** – not layered.

attitude: the orientation of a geophysical system relative to the earth. Some surveys assume the instrument attitudes are constant, and other surveys measure the attitude and correct the data for the changes in response because of attitude.

B-field: In time-domain **electromagnetic** surveys, the magnetic field component of the (electromagnetic) **field**. This can be measured directly, although more commonly it is calculated by integrating the time rate of change of the magnetic field **dB/dt**, as measured with a receiver coil.

background: The "normal" response in the geophysical data – that response observed over most of the survey area. **Anomalies** are usually measured relative to the background. In airborne gamma-ray spectrometric surveys the term defines the **cosmic**, radon, and aircraft responses in the absence of a signal from the ground.

base-level: The measured values in a geophysical system in the absence of any outside signal. All geophysical data are measured relative to the system base level.

base frequency: The frequency of the pulse repetition for a ***time-domain electromagnetic*** system. Measured between subsequent positive pulses.

base magnetometer: A stationary magnetometer used to record the ***diurnal*** variations in the earth's magnetic field; to be used to correct the survey magnetic data.

bird: A common name for the pod towed beneath or behind an aircraft, carrying the geophysical sensor array.

bucking: The process of removing the strong ***signal*** from the ***primary field*** at the ***receiver*** from the data, to measure the ***secondary field***. It can be done electronically or mathematically. This is done in ***frequency-domain EM***, and to measure ***on-time*** in ***time-domain EM***.

calibration: a procedure to ensure a geophysical instrument is measuring accurately and repeatably. Most often applied in ***EM*** and ***gamma-ray spectrometry***.

calibration coil: A wire coil of known size and dipole moment, which is used to generate a field of known ***amplitude*** and ***phase*** or ***decay constant*** in the receiver, for system calibration. Calibration coils can be external, or internal to the system. Internal coils may be called Q-coils.

coaxial coils: **[CX]** Coaxial coils in an HEM system are in the vertical plane, with their axes horizontal and collinear in the flight direction. These are most sensitive to vertical conductive objects in the ground, such as thin, steeply dipping conductors perpendicular to the flight direction. Coaxial coils generally give the sharpest anomalies over localized conductors. (See also ***coplanar coils***)

coil: A multi-turn wire loop used to transmit or detect electromagnetic fields. Time varying ***electromagnetic*** fields through a coil induce a voltage proportional to the strength of the field and the rate of change over time.

compensation: Correction of airborne geophysical data for the changing effect of the aircraft. This process is generally used to correct data in ***fixed-wing time-domain electromagnetic*** surveys (where the transmitter is on the aircraft and the receiver is moving), and magnetic surveys (where the sensor is on the aircraft, turning in the earth's magnetic field.

component: In ***frequency domain electromagnetic*** surveys this is one of the two **phase** measurements – ***in-phase or quadrature***. In "multi-component" electromagnetic surveys it is also used to define the measurement in one geometric direction (vertical, horizontal in-line and horizontal transverse – the Z, X and Y components).

Compton scattering: gamma ray photons will bounce off electrons as they pass through the earth and atmosphere, reducing their energy and then being detected by ***radiometric*** sensors at lower energy levels. See also ***stripping***.

conductance: See ***conductivity thickness***

conductivity: [σ] The facility with which the earth or a geological formation conducts electricity. Conductivity is usually measured in milli-Siemens per metre (mS/m). It is the reciprocal of ***resistivity***.

conductivity-depth imaging: see ***conductivity-depth transform***.

conductivity-depth transform: A process for converting electromagnetic measurements to an approximation of the conductivity distribution vertically in the earth, assuming a ***layered earth***. (Macnae and Lamontagne, 1987; Wolfgram and Karlik, 1995)

conductivity thickness: [**σt**] The product of the ***conductivity***, and thickness of a large, tabular body. (It is also called the "conductivity-thickness product") In electromagnetic geophysics, the response of a thin plate-like conductor is proportional to the conductivity multiplied by thickness. For example a 10 metre thickness of 20 Siemens/m mineralization will be equivalent to 5 metres of 40 S/m; both have 200 S conductivity thickness. Sometimes referred to as conductance.

conductor: Used to describe anything in the ground more conductive than the surrounding geology. Conductors are most often clays or graphite, or hopefully some type of mineralization, but may also be man-made objects, such as fences or pipelines.

continuation: mathematical procedure applied to ***potential field*** geophysical data to approximate data collected at a different altitude. Data can be continued upward to a higher altitude or downward to a lower altitude.

coplanar coils: **[CP]** In HEM, the coplanar coils lie in the horizontal plane with their axes vertical, and parallel. These coils are most sensitive to massive conductive bodies, horizontal layers, and the ***halfspace***.

cosmic ray: High energy sub-atomic particles from outer space that collide with the earth's atmosphere to produce a shower of gamma rays (and other particles) at high energies.

counts (per second): The number of ***gamma-rays*** detected by a gamma-ray ***spectrometer*****.** The rate depends on the geology, but also on the size and sensitivity of the detector.

culture: A term commonly used to denote any man-made object that creates a geophysical anomaly. Includes, but not limited to, power lines, pipelines, fences, and buildings.

current channelling: See current gathering.

current gathering: The tendency of electrical currents in the ground to channel into a conductive formation. This is particularly noticeable at higher frequencies or early time channels when the formation is long and parallel to the direction of current flow. This tends to enhance anomalies relative to inductive currents (see also ***induction***). Also known as current channelling.

daughter products: The radioactive natural sources of gamma-rays decay from the original "parent" element (commonly potassium, uranium, and thorium) to one or more lower-energy "daughter" elements. Some of these lower energy elements are also radioactive and decay further. ***Gamma-ray spectrometry*** surveys may measure the gamma rays given off by the original element or by the decay of the daughter products.

dB/dt: As the ***secondary electromagnetic field*** changes with time, the magnetic field [**B**] component induces a voltage in the receiving ***coil***, which is proportional to the rate of change of the magnetic field over time.

decay: In ***time-domain electromagnetic*** theory, the weakening over time of the ***eddy currents*** in the ground, and hence the ***secondary field*** after the ***primary field*** electromagnetic pulse is turned off. In ***gamma-ray spectrometry***, the radioactive breakdown of an element, generally potassium, uranium, thorium, into their ***daughter*** products.

decay constant: see time constant.

decay series: In ***gamma-ray spectrometry***, a series of progressively lower energy ***daughter products*** produced by the radioactive breakdown of uranium or thorium.

depth of exploration: The maximum depth at which the geophysical system can detect the target. The depth of exploration depends very strongly on the type and size of the target, the contrast of the target with the surrounding geology, the homogeneity of the surrounding geology, and the type of geophysical system. One measure of the maximum depth of exploration for an electromagnetic system is the depth at which it can detect the strongest conductive target – generally a highly conductive horizontal layer.

differential resistivity: A process of transforming ***apparent resistivity*** to an approximation of layer resistivity at each depth. The method uses multi-frequency HEM data and approximates the effect of shallow layer ***conductance*** determined from higher frequencies to estimate the deeper conductivities (Huang and Fraser, 1996)

dipole moment: [NIA] For a transmitter, the product of the area of a ***coil***, the number of turns of wire, and the current flowing in the coil. At a distance significantly larger than the size of the coil, the magnetic field from a coil will be the same if the dipole moment product is the same. For a receiver coil, this is the product of the area and the number of turns. The sensitivity to a magnetic field (assuming the source is far away) will be the same if the dipole moment is the same.

diurnal: The daily variation in a natural field, normally used to describe the natural fluctuations (over hours and days) of the earth's magnetic field.

dielectric permittivity: **[ε]** The capacity of a material to store electrical charge, this is most often measured as the relative permittivity [ε_r], or ratio of the material dielectric to that of free space. The effect of high permittivity may be seen in HEM data at high frequencies over highly resistive geology as a reduced or negative ***in-phase***, and higher ***quadrature*** data.

dose rate: see **exposure rate**.

drape: To fly a survey following the terrain contours, maintaining a constant altitude above the local ground surface. Also applied to re-processing data collected at varying altitudes above ground to simulate a survey flown at constant altitude.

drift: Long-time variations in the base-level or calibration of an instrument.

eddy currents: The electrical currents induced in the ground, or other conductors, by a time-varying ***electromagnetic field*** (usually the ***primary field***). Eddy currents are also induced in the aircraft's metal frame and skin; a source of ***noise*** in EM surveys.

electromagnetic: **[EM]** Comprised of a time-varying electrical and magnetic field. Radio waves are common electromagnetic fields. In geophysics, an electromagnetic system is one which transmits a time-varying ***primary field*** to induce ***eddy currents*** in the ground, and then measures the ***secondary field*** emitted by those eddy currents.

energy window: A broad spectrum of ***gamma-ray*** energies measured by a spectrometric survey. The energy of each gamma-ray is measured and divided up into numerous discrete energy levels, called windows.

equivalent (thorium or uranium): The amount of radioelement calculated to be present, based on the gamma-rays measured from a **daughter** element. This assumes that the ***decay series*** is in equilibrium – progressing normally.

exposure rate: in radiometric surveys, a calculation of the total exposure rate due to gamma rays at the ground surface. It is used as a measurement of the concentration of all the **radioelements** at the surface. Sometimes called "dose rate".See also: **natural exposure rate**.

fiducial, or fid: Timing mark on a survey record. Originally these were timing marks on a profile or film; now the term is generally used to describe 1-second interval timing records in digital data, and on maps or profiles.

Figure of Merit: **(FOM)** A sum of the 12 distinct magnetic noise variations measured by each of four flight directions, and executing three aircraft attitude variations (yaw, pitch, and roll) for each direction. The flight directions are generally parallel and perpendicular to planned survey flight directions. The FOM is used as a measure of the **manoeuvre noise** before and after **compensation.**

fixed-wing: Aircraft with wings, as opposed to "rotary wing" helicopters.

flight: a continuous interval of survey data collection, generally between stops at base to refuel.

flight-line: a single line of data across the survey area. Surveys are generally comprised of many parallel flight lines to cover the survey area, with wider-spaced ***tie lines*** perpendicular. Flight lines are generally separated by ***turn-arounds*** when the aircraft is outside the survey area.

footprint: This is a measure of the area of sensitivity under the aircraft of an airborne geophysical system. The footprint of an ***electromagnetic*** system is dependent on the altitude of the system, the orientation of the transmitter and receiver and the separation between the receiver and transmitter, and the conductivity of the ground. The footprint of a ***gamma-ray spectrometer*** depends mostly on the altitude. For all geophysical systems, the footprint also depends on the strength of the contrasting ***anomaly***.

frequency domain: An ***electromagnetic*** system which transmits a harmonic ***primary field*** that oscillates over time (e.g. sinusoidal), inducing a similarly varying electrical current in the ground. These systems generally measure the changes in the ***amplitude*** and ***phase*** of the ***secondary field*** from the ground at different frequencies by measuring the **in-phase** and **quadrature** phase components. See also ***time-domain***.

full-stream data: Data collected and recorded continuously at the highest possible sampling rate. Normal data are stacked (see ***stacking***) over some time interval before recording.

gamma-ray: A very high-energy photon, emitted from the nucleus of an atom as it undergoes a change in energy levels.

gamma-ray spectrometry: Measurement of the number and energy of natural (and sometimes man-made) gamma-rays across a range of photon energies.

GGI: gravity gradiometer instrument. An airborne gravity gradiometer (AGG) consists of a GGI mounted in an inertial platform together with a temperature control system.

gradient: In magnetic surveys, the gradient is the change of the magnetic field over a distance, either vertically or horizontally in either of two directions. Gradient data can be measured, or calculated from the total magnetic field data because it changes more quickly over distance than the ***total magnetic field***, and so may provide a more precise measure of the location of a source. See also ***analytic signal***.

gradiometer, gradiometry: instrument and measurement of the gradient, or change in a field with location usually for ***gravity*** or ***magnetic*** surveys. Used to provide higher resolution of ***targets***, better ***interpretation*** of ***target*** geometry, independence from drift and absolute field and, for ***gravity***, accelerations of the aircraft.

gravity: Survey collecting measurements of the earth's gravitational field strength. Denser objects in the earth create stronger gravitational pull above them.

ground effect: The response from the earth. A common ***calibration*** procedure in many geophysical surveys is to fly to altitude high enough to be beyond any measurable response from the ground, and there establish ***base levels*** or ***backgrounds***.

half-space: A mathematical model used to describe the earth – as infinite in width, length, and depth below the surface. The most common halfspace models are ***homogeneous*** and ***layered earth***.

heading error: A slight change in the magnetic field measured when flying in opposite directions.

HEM: Helicopter ElectroMagnetic, This designation is most commonly used for helicopter-borne, ***frequency-domain*** electromagnetic systems. At present, the transmitter and receivers are normally mounted in a ***bird*** carried on a sling line beneath the helicopter.

herringbone pattern: A pattern created in geophysical data by an asymmetric system, where the **anomaly** may be extended to either side of the source, in the direction of flight. Appears like fish bones, or like the teeth of a comb, extending either side of centre, each tooth an alternate flight line.

homogeneous: This is a geological unit that has the same ***physical parameters*** throughout its volume. This unit will create the same response to an HEM system anywhere, and the HEM system will measure the same apparent ***resistivity*** anywhere. The response may change with system direction (see ***anisotropy***).

HFEM: Helicopter Frequency-domain ElectroMagnetic, This designation is used for helicopter-borne, **frequency-*domain*** electromagnetic systems. Formerly most often called HEM.

HTEM: Helicopter Time-domain ElectroMagnetic, This designation is used for the new generation of helicopter-borne, ***time-domain*** electromagnetic systems.

in-phase: the component of the measured ***secondary field*** that has the same phase as the transmitter and the ***primary field***. The in-phase component is stronger than the ***quadrature*** phase over relatively higher ***conductivity***.

induction: Any time-varying electromagnetic field will induce (cause) electrical currents to flow in any object with non-zero ***conductivity***. (see ***eddy currents***)

induction number: also called the "response parameter", this number combines many of the most significant parameters affecting the ***EM*** response into one parameter against which to compare responses. For a ***layered earth*** the response parameter is $\mu\omega\sigma h^2$ and for a large, flat, ***conductor*** it is $\mu\omega\sigma th$, where μ is the ***magnetic permeability***, ω is the angular ***frequency***, σ is the **conductivity**, t is the thickness (for the flat conductor) and h is the height of the system above the conductor.

inductive limit: When the frequency of an EM system is very high, or the **conductivity** of the target is very high, the response measured will be entirely **in-phase** with no **quadrature** (**phase** angle =0). The in-phase response will remain constant with further increase in conductivity or frequency. The system can no longer detect changes in conductivity of the target.

infinite: In geophysical terms, an "infinite' dimension is one much greater than the ***footprint*** of the system, so that the system does not detect changes at the edges of the object.

International Geomagnetic Reference Field: **[IGRF]** An approximation of the smooth magnetic field of the earth, in the absence of variations due to local geology. Once the IGRF is subtracted from the measured magnetic total field data, any remaining variations are assumed to be due to local geology. The IGRF also predicts the slow changes of the field up to five years in the future.

inversion, or **inverse modeling**: A process of converting geophysical data to an earth model, which compares theoretical models of the response of the earth to the data measured, and refines the model until the response closely fits the measured data (Huang and Palacky, 1991)

layered earth: A common geophysical model which assumes that the earth is horizontally layered – the ***physical parameters*** are constant to ***infinite*** distance horizontally, but change vertically.

lead-in: approach to a ***flight line*** outside of survey area to establish proper track and stabilize instrumentations. The lead-in for a helicopter survey is generally shorter than required for fixed-wing.

line source, or line current: a long narrow object that creates an ***anomaly*** on an ***EM*** survey. Generally man-made objects like fences, power lines, and pipelines (***culture***).

mag: common abbreviation for ***magnetic.***

magnetic: ("**mag**") a survey measuring the strength of the earth's magnetic field, to identify geology and targets by their effect on the field.

magnetic permeability: **[μ]** This is defined as the ratio of magnetic induction to the inducing magnetic field. The relative magnetic permeability [μ_r] is often quoted, which is the ratio of the rock permeability to the permeability of free space. In geology and geophysics, the ***magnetic susceptibility*** is more commonly used to describe rocks.

magnetic susceptibility: **[k]** A measure of the degree to which a body is magnetized. In SI units this is related to relative ***magnetic permeability*** by $k=\mu_r-1$, and is a dimensionless unit. For most geological material, susceptibility is influenced primarily by the percentage of magnetite. It is most often quoted in units of 10^{-6}. In HEM data this is most often apparent as a negative ***in-phase*** component over high susceptibility, high ***resistivity*** geology such as diabase dikes.

manoeuvre noise: variations in the magnetic field measured caused by changes in the relative positions of the magnetic sensor and magnetic objects or electrical currents in the aircraft. This type of noise is generally corrected by magnetic **compensation**.

model: Geophysical theory and applications generally have to assume that the geology of the earth has a form that can be easily defined mathematically, called the model. For example steeply dipping **conductor**s are generally modeled as being **infinite** in horizontal and depth extent, and very thin. The earth is generally modeled as horizontally layered, each layer infinite in extent and uniform in characteristic. These models make the mathematics to describe the response of the (normally very complex) earth practical. As theory advances, and computers become more powerful, the useful models can become more complex.

natural exposure rate: in radiometric surveys, a calculation of the total exposure rate due to natural-source gamma rays at the ground surface. It is used as a measurement of the concentration of all the natural **radioelements** at the surface. See also: **exposure rate**.

natural source: any geophysical technique for which the source of the energy is from nature, not from a man-made object. Most commonly applied to natural source ***electromagnetic*** surveys.

noise: That part of a geophysical measurement that the user does not want. Typically this includes electronic interference from the system, the atmosphere (***sferics***), and man-made sources. This can be a subjective judgment, as it may include the response from geology other than the target of interest. Commonly the term is used to refer to high frequency (short period) interference. See also ***drift***.

Occam's inversion: an ***inversion*** process that matches the measured ***electromagnetic*** data to a theoretical model of many, thin layers with constant thickness and varying resistivity (Constable et al, 1987).

off-time: In a ***time-domain electromagnetic*** survey, the time after the end of the ***primary field pulse***, and before the start of the next pulse.

on-time: In a ***time-domain electromagnetic*** survey, the time during the ***primary field pulse***.

overburden: In engineering and mineral exploration terms, this most often means the soil on top of the unweathered bedrock. It may be sand, glacial till, or weathered rock.

Phase, phase angle: The angular difference in time between a measured sinusoidal electromagnetic field and a reference – normally the primary field. The phase is calculated from $\tan^{-1}$(***in-phase / quadrature***).

physical parameters: These are the characteristics of a geological unit. For electromagnetic surveys, the important parameters are ***conductivity, magnetic permeability*** (or ***susceptibility***) and ***dielectric permittivity***; for magnetic surveys the parameter is magnetic susceptibility, and for gamma ray spectrometric surveys it is the concentration of the major radioactive elements: potassium, uranium, and thorium.

permittivity: see ***dielectric permittivity***.

permeability: see ***magnetic permeability***.

potential field: A field that obeys Laplace's Equation. Most commonly used to describe ***gravity*** and ***magnetic*** measurements.

primary field: the EM field emitted by a transmitter. This field induces ***eddy currents*** in (energizes) the conductors in the ground, which then create their own ***secondary* fields**.

pulse: In time-domain EM surveys, the short period of intense ***primary*** field transmission. Most measurements (the ***off-time***) are measured after the pulse. **On-time** measurements may be made during the pulse.

quadrature: that component of the measured ***secondary field*** that is phase-shifted 90° from the ***primary field***. The quadrature component tends to be stronger than the ***in-phase*** over relatively weaker ***conductivity***.

Q-coils: see ***calibration coil***.

radioelements: This normally refers to the common, naturally-occurring radioactive elements: potassium (K), uranium (U), and thorium (Th). It can also refer to man-made radioelements, most often cobalt (Co) and cesium (Cs)

radiometric: Commonly used to refer to ***gamma ray*** spectrometry.

radon: A radioactive daughter product of uranium and thorium, radon is a gas which can leak into the atmosphere, adding to the non-geological background of a gamma-ray spectrometric survey.

receiver: the ***signal*** detector of a geophysical system. This term is most often used in active geophysical systems – systems that transmit some kind of signal. In airborne ***electromagnetic*** surveys it is most often a ***coil***. (see also, ***transmitter***)

resistivity: **[ρ]** The strength with which the earth or a geological formation resists the flow of electricity, typically the flow induced by the ***primary field*** of the electromagnetic transmitter. Normally expressed in ohm-metres, it is the reciprocal of ***conductivity***.

resistivity-depth transforms: similar to ***conductivity depth transforms***, but the calculated ***conductivity*** has been converted to ***resistivity***.

resistivity section: an approximate vertical section of the resistivity of the layers in the earth. The resistivities can be derived from the ***apparent resistivity***, the ***differential resistivities***, ***resistivity-depth transforms***, or ***inversions***.

response parameter: another name for the **induction number**.

secondary field: The field created by conductors in the ground, as a result of electrical currents induced by the ***primary field*** from the ***electromagnetic*** transmitter. Airborne ***electromagnetic*** systems are designed to create and measure a secondary field.

Sengpiel section: a ***resistivity section*** derived using the ***apparent resistivity*** and an approximation of the depth of maximum sensitivity for each frequency.

sferic: Lightning, or the ***electromagnetic*** signal from lightning, it is an abbreviation of "atmospheric discharge". These appear to magnetic and electromagnetic sensors as sharp "spikes" in the data. Under some conditions lightning storms can be detected from hundreds of kilometres away. (see ***noise***)

signal: That component of a measurement that the user wants to see – the response from the targets, from the earth, etc. (See also ***noise***)

skin depth: A measure of the depth of penetration of an electromagnetic field into a material. It is defined as the depth at which the primary field decreases to 1/e of the field at the surface. It is calculated by approximately 503 x √(resistivity/frequency). Note that depth of penetration is greater at higher ***resistivity*** and/or lower ***frequency***.

spec: common abbreviation for *gamma-ray spectrometry*.

spectrometry: Measurement across a range of energies, where ***amplitude*** and energy are defined for each measurement. In gamma-ray spectrometry, the number of gamma rays are measured for each energy ***window***, to define the ***spectrum***.

spectrum: In ***gamma ray spectrometry***, the continuous range of energy over which gamma rays are measured. In ***time-domain electromagnetic*** surveys, the spectrum is the energy of the **pulse** distributed across an equivalent, continuous range of frequencies.

spheric: see ***sferic***.

stacking: Summing repeat measurements over time to enhance the repeating ***signal***, and minimize the random ***noise***.

stinger: A boom mounted on an aircraft to carry a geophysical sensor (usually ***magnetic***). The boom moves the sensor farther from the aircraft, which might otherwise be a source of ***noise*** in the survey data.

stripping: Estimation and correction for the gamma ray photons of higher and lower energy that are observed in a particular ***energy window***. See also ***Compton scattering***.

susceptibility: See ***magnetic susceptibility***.

tau: [τ] Often used as a name for the ***decay time constant***.

TDEM: ***time domain electromagnetic***.

thin sheet: A standard model for electromagnetic geophysical theory. It is usually defined as a thin, flat-lying conductive sheet, ***infinite*** in both horizontal directions. (see also ***vertical plate***)

tie-line: A survey line flown across most of the ***traverse lines***, generally perpendicular to them, to assist in measuring ***drift*** and ***diurnal*** variation. In the short time required to fly a tie-line it is assumed that the drift and/or diurnal will be minimal, or at least changing at a constant rate.

time constant: The time required for an ***electromagnetic*** field to decay to a value of 1/e of the original value. In ***time-domain*** electromagnetic data, the time constant is proportional to the size and ***conductance*** of a tabular conductive body. Also called the decay constant.

Time channel: In ***time-domain electromagnetic*** surveys the decaying ***secondary field*** is measured over a period of time, and the divided up into a series of consecutive discrete measurements over that time.

time-domain: ***Electromagnetic*** system which transmits a pulsed, or stepped ***electromagnetic*** field. These systems induce an electrical current (***eddy current***) in the ground that persists after the ***primary field*** is turned off, and measure the change over time of the ***secondary field*** created as the currents ***decay***. See also ***frequency-domain***.

total energy envelope: The sum of the squares of the three ***components*** of the ***time-domain electromagnetic secondary field***. Equivalent to the ***amplitude*** of the secondary field.

transient: Time-varying. Usually used to describe a very short period pulse of ***electromagnetic*** field.

transmitter: The source of the ***signa***l to be measured in a geophysical survey. In airborne ***EM*** it is most often a **coil** carrying a time-varying electrical current, transmitting the ***primary field***. (see also ***receiver***)

traverse line: A normal geophysical survey line. Normally parallel traverse lines are flown across the property in spacing of 50 m to 500 m, and generally perpendicular to the target geology. Also called a **flight line**.

turn-arounds: The time the aircraft is turning between one ***traverse*** or ***tie line*** and the next. Turn-arounds are generally outside the survey area, and the data collected during this time generally are not useable, because of aircraft ***manoeuvre noise***.

vertical plate: A standard model for electromagnetic geophysical theory. It is usually defined as thin conductive sheet, ***infinite*** in horizontal dimension and depth extent. (see also ***thin shee***t)

waveform: The shape of the ***electromagnetic pulse*** from a ***time-domain*** electromagnetic transmitter.

window: A discrete portion of a ***gamma-ray spectrum*** or ***time-domain electromagnetic decay***. The continuous energy spectrum or ***full-stream*** data are grouped into windows to reduce the number of samples, and reduce ***noise***.

zero, or zero level: The ***base level*** of an instrument, with no ***ground effect*** or ***drift***. Also, the act of measuring and setting the zero level.

Version 1.8, February, 2012
Greg Hodges,
Chief Geophysicist
Fugro Airborne Surveys, Toronto

Common Symbols and Acronyms

k	Magnetic susceptibility
ε	Dielectric permittivity
μ, μ_r	Magnetic permeability, relative permeability
ρ, ρ_a	Resistivity, apparent resistivity
σ,σ_a	Conductivity, apparent conductivity
σt	Conductivity thickness
τ	Tau, or time constant
Ωm	ohm-metres, units of resistivity
AGS	Airborne gamma ray spectrometry.
CDT	Conductivity-depth transform, conductivity-depth imaging (Macnae and Lamontagne, 1987; Wolfgram and Karlik, 1995)
CPI, CPQ	Coplanar in-phase, quadrature
CPS	Counts per second
CTP	Conductivity thickness product
CXI, CXQ	Coaxial, in-phase, quadrature
FOM	Figure of Merit
fT	femtoteslas, common unit for measurement of B-Field in time-domain EM
EM	Electromagnetic
keV	kilo electron volts – a measure of gamma-ray energy
MeV	mega electron volts – a measure of gamma-ray energy 1MeV = 1000keV
NIA	dipole moment: turns x current x Area
nT	nanotesla, a measure of the strength of a magnetic field
nT/s	nanoteslas/second; standard unit of measurement of secondary field dB/dt in time domain EM.
nG/h	nanoGreys/hour – gamma ray dose rate at ground level
ppm	parts per million – a measure of secondary field or noise relative to the primary or radioelement concentration.
pT	picoteslas: standard unit of measurement of B-Field in time-domain EM
pT/s	picoteslas per second: Units of decay of secondary field, dB/dt
S	siemens – a unit of conductance
x:	the horizontal component of an EM field parallel to the direction of flight.
y:	the horizontal component of an EM field perpendicular to the direction of flight.
z:	the vertical component of an EM field.

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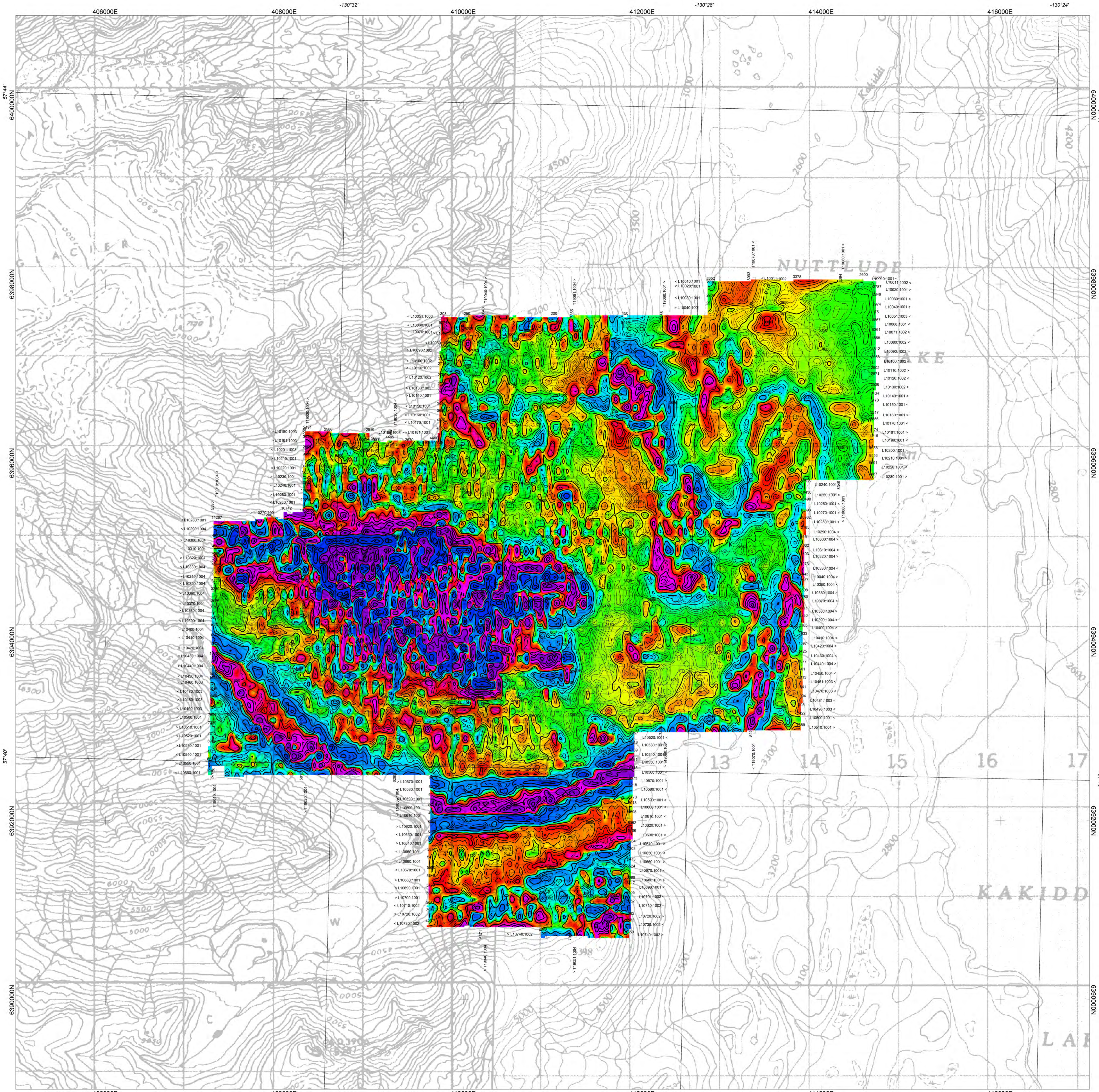
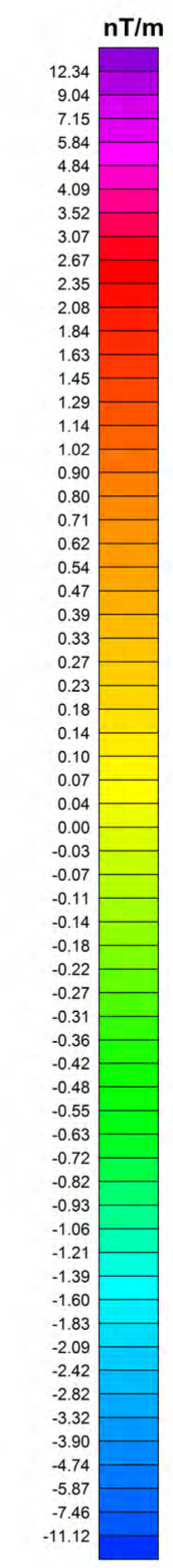
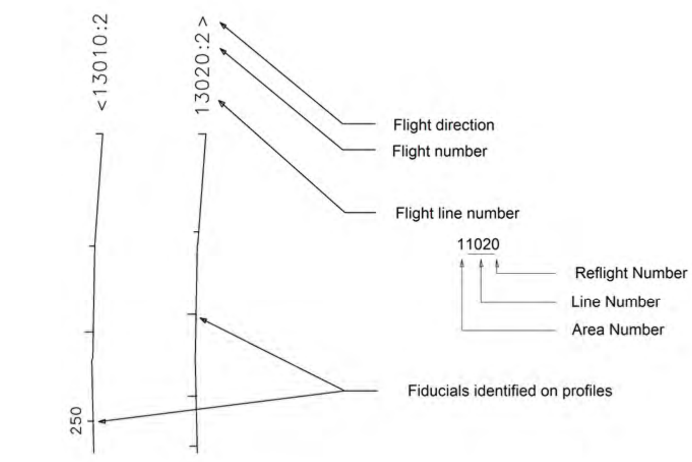


TECHNICAL SUMMARY

Navigation	Differentially-corrected GPS
Data reduction grid interval	20 metres
Terrain Clearance..........................	Magnetometer 30m Helicopter 30m
Data sampling interval...................	0.1 second
Magnetometer / sensitivity.............	Cesium / 0.01nT



FLIGHT LINES

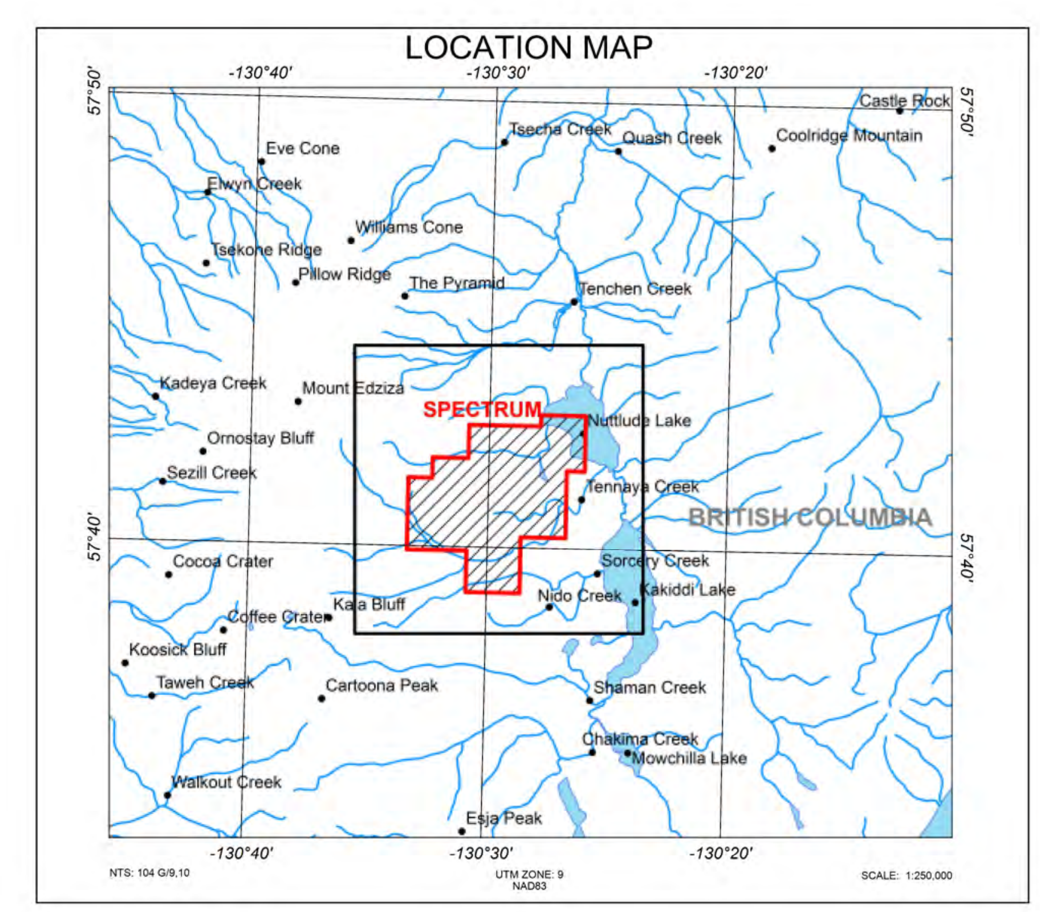


CALCULATED VERTICAL MAGNETIC GRADIENT CONTOURS

2.50 nT/m
0.50 nT/m
0.10 nT/m
0.05 nT/m

Magnetic inclination within the survey area: 75 degrees N
Magnetic declination within the survey area: 21 degrees E

LOCATION MAP



EILAT EXPLORATION LTD.
SPECTRUM BLOCK, ISKUT AREA, BRITISH COLUMBIA

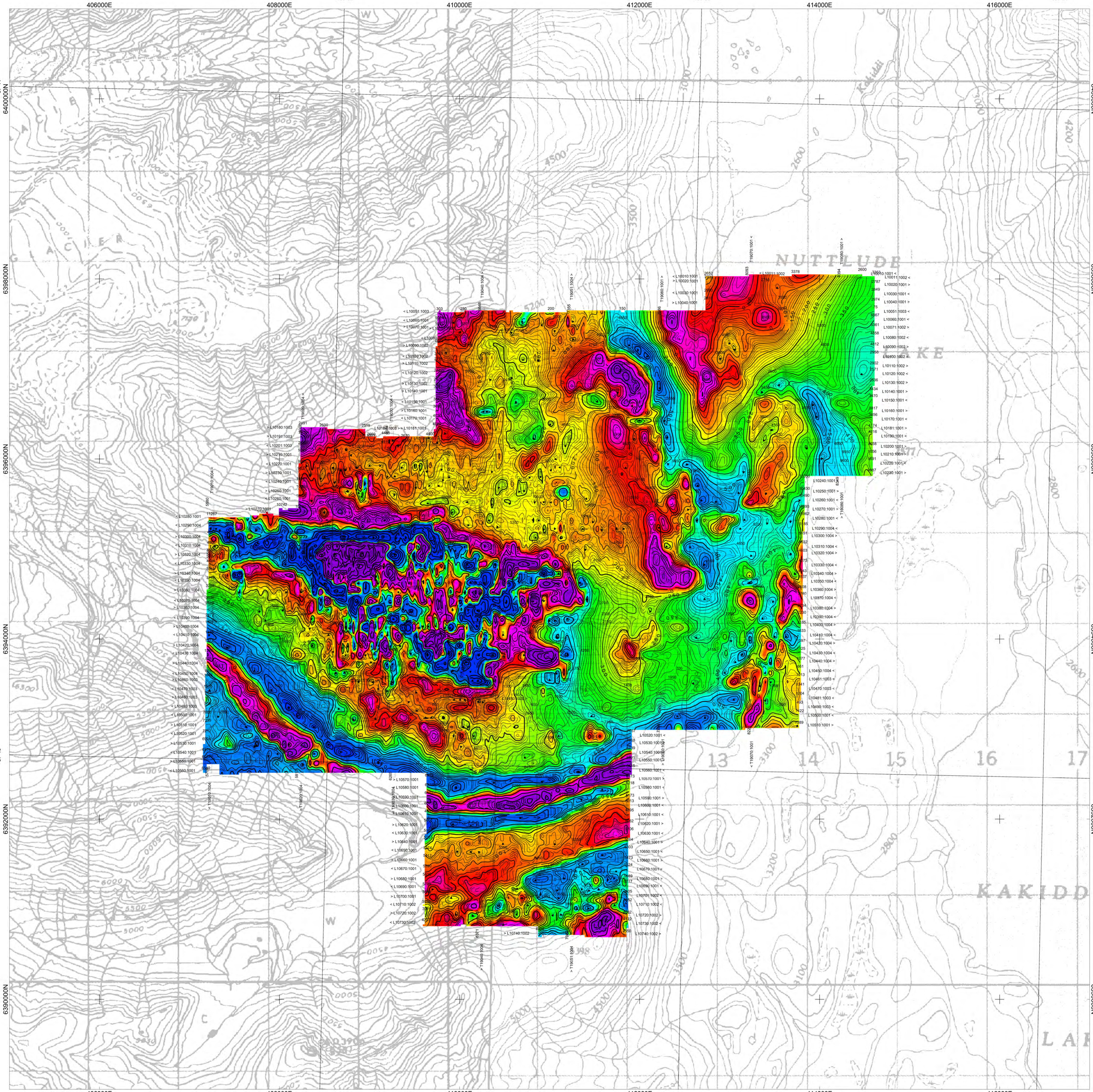
CALCULATED VERTICAL MAGNETIC GRADIENT

FUGRO MAG SURVEY	NTS: 104 G/9,10	GEOPHYSICIST:
DATE: DECEMBER 2012	JOB: 12089	SHEET: 1

FUGRO AIRBORNE SURVEYS

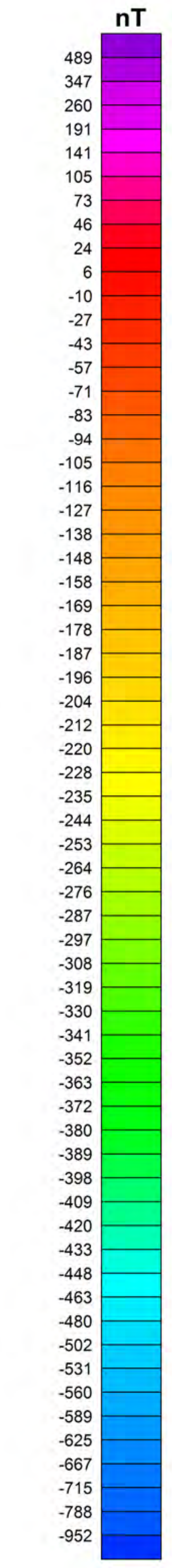
Scale 1:20000
250 0 250 500 750 1000 1250 1500
(metres)
NAD83 / UTM zone 9N

FUGRO AIRBORNE SURVEYS

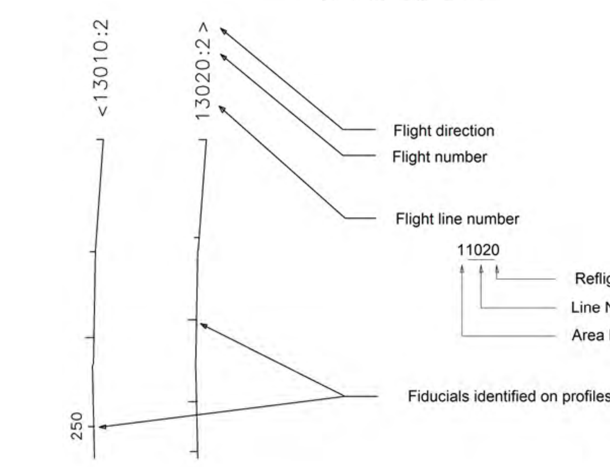


TECHNICAL SUMMARY

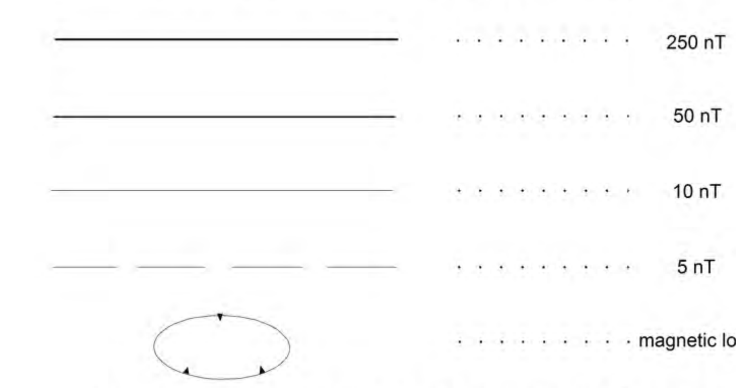
Navigation .... Differentially-corrected GPS
Data reduction grid interval .... 20 metres
Terrain Clearance........................ Magnetometer 30m
Helicopter 30m
Data sampling interval................ 0.1 second
Magnetometer / sensitivity........... Cesium / 0.01nT



FLIGHT LINES

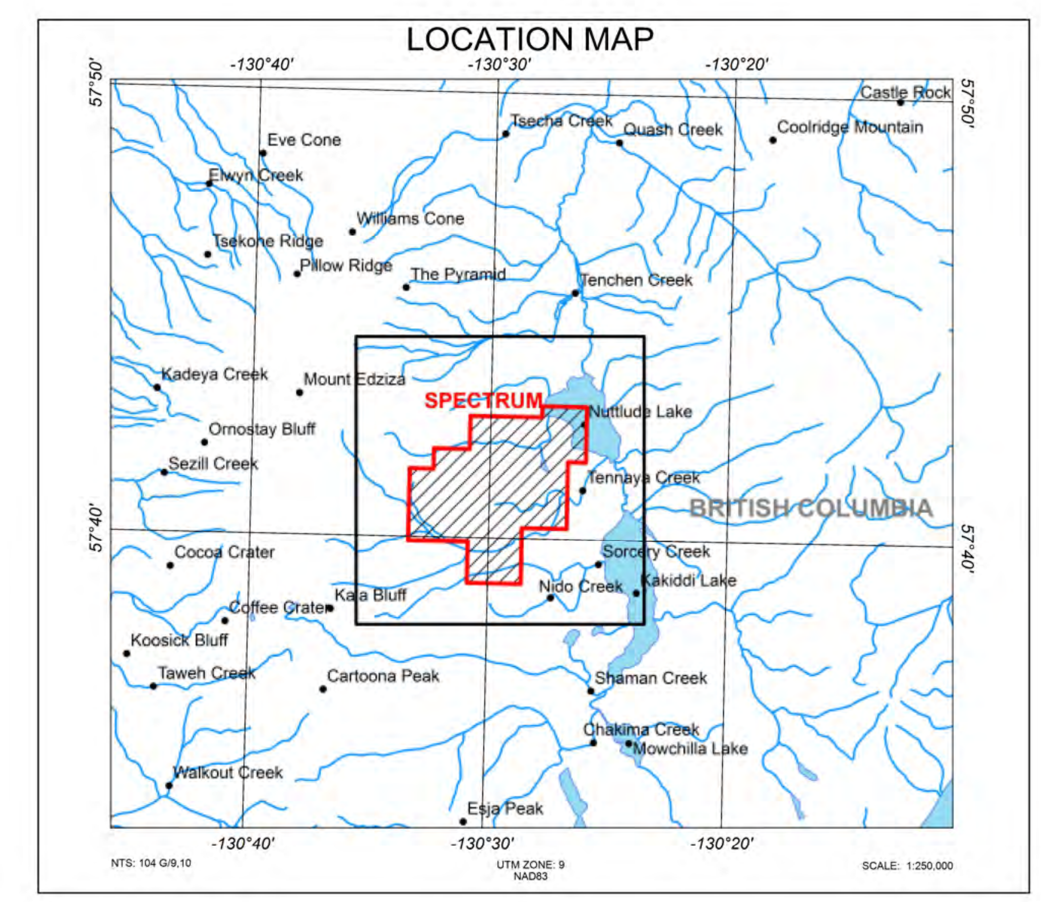


RESIDUAL MAGNETIC INTENSITY CONTOURS



Magnetic inclination within the survey area: 75 degrees N
Magnetic declination within the survey area: 21 degrees E

LOCATION MAP



EILAT EXPLORATION LTD.
SPECTRUM BLOCK, ISKUT AREA, BRITISH COLUMBIA

RESIDUAL MAGNETIC INTENSITY

IGRF Removed

FUGRO MAG SURVEY	NTS: 104 G/9,10	GEOPHYSICIST:
DATE: DECEMBER 2012	JOB: 12089	SHEET: 1

FUGRO AIRBORNE SURVEYS

Scale 1:20000

250 0 250 500 750 1000 1250 1500

(metres)

NAD83 / UTM zone 9N

FUGRO AIRBORNE SURVEYS

Eilat Exploration Ltd.

SPECTRUM PROJECT
Archaeological Impact Assessment
Final Report *Heritage Inspection Permit 2011-0296*

DRAFT

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December 2012

SPECTRUM PROJECT

ARCHAEOLOGICAL IMPACT ASSESSMENT, FINAL REPORT

HERITAGE INSPECTION PERMIT 2011-0296

DRAFT

December 2012
Project #1088-001

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Prepared for:

Eilat Exploration Ltd.

Prepared by:

Rescan Tahltan Environmental Consultants
Dease Lake

July 18, 2014

Archaeological Impact Assessment (AIA) reports received and reviewed by the Geological Survey Branch that are found to be acceptable for exploration and development work credit will remain on file and kept confidential. If an AIA report is submitted as part of a larger technical assessment report, the section of the report pertaining to the AIA report will remain on file, kept confidential and excluded from the version of the report that is uploaded to ARIS.

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