Report # 09035

HELICOPTER-BORNE STINGER-MOUNTED MAGNETIC AND RADIOMETRIC GEOPHYSICAL SURVEY FOR RARE EARTH METALS INC. CHAPLEAU, ONTARIO, CANADA

Fugro Airborne Surveys Corp.
Mississauga, Ontario
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SUMMARY

This report describes the logistics, data acquisition, processing and presentation of results of a Stinger-Mounted Magnetic and Radiometric airborne geophysical survey carried out for Rare Earth Metals Inc., over the Lackner property near Chapleau, Ontario. Total coverage of the survey block amounted to 670 line-km. The survey was flown from October 15th, 2009 to October 17th, 2009.

The purpose of the survey was to detect zones of mineralization and to provide information that could be used to map the geology and structure of the survey area. This was accomplished by using a high sensitivity cesium magnetometer and a 256-channel spectrometer. The information from these sensors was processed to produce maps that display the magnetic and radiometric properties of the survey areas. A GPS electronic navigation system ensured accurate positioning of the geophysical data with respect to the base maps.

The survey data were processed and compiled in the Fugro Airborne Surveys Toronto office. Map products and digital data were provided in accordance with the scales and formats specified in the Survey Agreement.

The survey properties contain several anomalous features, many of which are considered to be of moderate to high priority as exploration targets. Areas of interest may be assigned priorities on the basis of supporting geophysical, geochemical and/or geological information.

After initial investigations have been carried out, it may be necessary to re-evaluate the remaining anomalies based on information acquired from the follow-up program.

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1. INTRODUCTION

A stinger-mounted magnetic and radiometric survey was flown for Rare Earth Metals Inc., from October 15th, 2009 to October 17th, 2009, over the Lackner survey block located near Chapleau Ontario, Canada. The survey area is shown in Figure 2.

Survey coverage consisted of approximately 670 line-km, including 93 line-km of tie lines. Flight lines were flown in an azimuthal direction of 90°/270° with a line separation of 80 metres. Tie lines were flown orthogonal to the traverse lines with a line separation of 500 metres.

The survey employed the stinger-mounted magnetic system and a 256-channel spectrometer. Ancillary equipment consisted of radar and barometric altimeters, a video camera, a digital recorder, and an electronic navigation system. The instrumentation was installed in an AS350B3 turbine helicopter (Registration C-FYZF) that was provided by Great Slave Helicopters Ltd. The helicopter flew at an average airspeed of 105km/h with a nominal terrain clearance of 30 metres.

Figure 1: Fugro Airborne Surveys Stinger with AS350-B3

2. SURVEY OPERATIONS

The base of operations for the Lackner survey was established at Chapleau Airport, Ontario.

Table 2-1 lists the corner coordinates of the survey areas in NAD83 UTM Zone 17N, central meridian 81° W.

Table 2-1

Block	Corners	X-UTM (E)	Y-UTM (N)
09035-3	1	338943	5299934
Lackner	2	345434	5299934
Block	3	345434	5292826
	4	338943	5292826

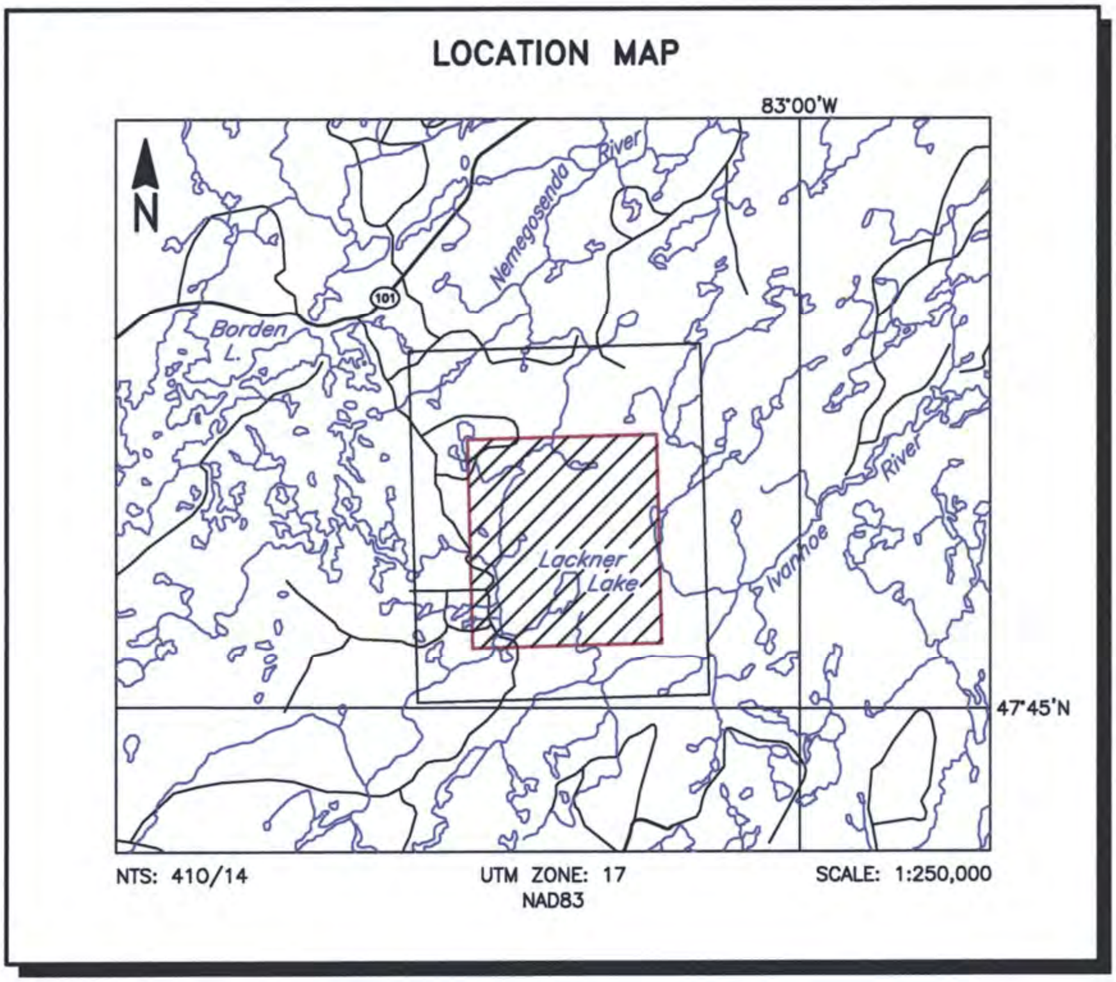

Figure 2
Survey Location Map and Sheet Layout
Lackner Block, Chapleau, Ontario
Job # 09035-3

The survey specifications for Lackner block were as follows:

Parameter	Specifications
Traverse line direction (Lackner)	90°/270°
Traverse line spacing	80 m
Tie line direction	180°/360°
Tie line spacing	500 m
Mag sample interval	10 Hz, 2.9 m @ 105 km/h
Spectrometer sample interval	1 HZ, 29 m @ 105 km/h
Aircraft mean terrain clearance	30 m
Mag sensor mean terrain clearance	30 m
Spectrometer sensor mean terrain clearance	30 m
Average speed	105 km/h
Navigation (guidance)	±5 m, Real-time GPS
Post-survey flight path	±2 m, Differential GPS

3. SURVEY EQUIPMENT

This section provides a brief description of the geophysical instruments used to acquire the survey data and the calibration procedures employed. The geophysical equipment was installed in an AS350B3 helicopter. This aircraft provides a safe and efficient platform for surveys of this type.

Airborne Magnetometer

Model:	Fugro D1344 processor with Scintrex CS3 sensor.
Type:	Optically pumped cesium vapour.
Sensitivity:	0.01 nT
Sample rate:	10 per second

The magnetometer sensor is housed in a stinger mounted on the helicopter.

Magnetic Base Station

Model:	Fugro CF1 base station with timing provided by integrated GPS	
Sensor type:	Scintrex CS-3. Optically pumped cesium vapour.	
Counter specifications:	Accuracy:	±0.1 nT
	Resolution:	0.01 nT
	Sample rate	1 Hz

GPS specifications:	Model:	Marconi Allstar
	Type:	Code and carrier tracking of L1 band, 12-channel, C/A code at 1575.42 MHz
	Sensitivity:	-90 dBm, 1.0 second update
	Accuracy:	Manufacturer's stated accuracy for differential corrected GPS is 2 metres

Environmental
Monitor specifications:

Temperature:
- Accuracy: ±1.5ºC max
- Resolution: 0.0305ºC
- Sample rate: 1 Hz
- Range: -40ºC to +75ºC

Barometric pressure:
- Model: Motorola MPX4115AP
- Accuracy: ±3.0º kPa max (-20ºC to 105ºC temp. ranges)
- Resolution: 0.013 kPa
- Sample rate: 1 Hz
- Range: 55 kPa to 108 kPa

A digital recorder is operated in conjunction with the base station magnetometer to record the diurnal variations of the earth's magnetic field. The clock of the base station is synchronized with that of the airborne system, using GPS time, to permit subsequent removal of diurnal drift. The locations of the base stations in WGS84 geographic coordinates were as follows:

Location	**Date**	**Latitude**	**Longitude**	**Height (above ellipsoid)**
Chapleau Airport	October 15th to October 17th 2009	47° 49' 07.13" N	83° 21' 28.18" W	408.0 m

A GEM Systems GSM-19 proton precession magnetometer (part of the CF-1 base station) was used as a back-up unit.

Navigation (Global Positioning System)

Airborne Receiver for Real-time Navigation & Guidance

Model:	Novatel OEM4
Type:	Code and carrier tracking of L1-C/A code at 1575.42 MHz, 12-channel
Sample rate:	10 Hz update. 2Hz recording
Accuracy:	Manufacturer's stated accuracy for differential corrected GPS is better than 1 metre.
Antenna:	Aero AT1675; Mounted on tail of aircraft.

Primary Base Station for Post-Survey Differential Correction

Model:	Novatel OEM4
Type:	Code and carrier tracking of L1-C/A code at 1575.42 MHz, 12-channel
Sample rate:	10 Hz update. 2Hz recording
Accuracy:	Manufacturer's stated accuracy for differential corrected GPS is better than 1 metre.

Secondary GPS Base Station

Model:	Marconi Allstar OEM, CMT-1200
Type:	Code and carrier tracking of L1 band, 12-channel, C/A code at 1575.42 MHz

Sensitivity: -90 dBm, 1.0 second update

Accuracy: Manufacturer's stated accuracy for differential corrected GPS is 2 metres.

The Novatel OEM4 captured the airborne positional data which were post-processed using the base station GPS to provide differentially corrected positional data. The Novatel OEM4 is operated as the primary base station and utilizes time-coded signals from at least four of the twenty-four NAVSTAR satellites. The base station raw XYZ data are recorded, thereby permitting post-survey processing for theoretical accuracies of better than 2 m. The mobile Novatel OEM4 receiver was coupled with a PNAV navigation system for real-time guidance. A Marconi Allstar GPS unit, part of the CF-1, was used as a secondary base station.

The locations of the GPS base station set-ups in WGS84 geographic coordinates were as follows:

Location	Date	Latitude	Longitude	Height (above ellipsoid)
Chapleau Airport	October 15th to October 17th 2009	47° 49' 07.05" N	83° 21' 28.15" W	413.0 m

Radar Altimeter

Manufacturer:	Honeywell/Sperry
Model:	RT 300 / AT 220
Type:	Short pulse modulation, 4.3 GHz
Sensitivity:	0.3 m
Sample rate:	2 per second

The radar altimeter measures the vertical distance between the helicopter and the ground.

Barometric Pressure and Temperature Sensors

Type:	Motorola MPX4115AP analog pressure sensor AD592AN high-impedance remote temperature sensors	
Sensitivity:	Pressure: Temperature:	150 mV/kPa 100 mV/°C or 10 mV/°C (selectable)
Sample rate:	10 per second	

The D1300 circuit is used in conjunction with one barometric sensor and up to three temperature sensors. Two sensors (baro and temp) are installed in the data acquisition system in the aircraft, to monitor pressure (kpa) and external temperatures (temp_ext).

Digital Data Acquisition System

Manufacturer:	Fugro
Model:	HeliDAS
Recorder:	Compact Flash Card (PCMCIA)

The stored data are downloaded to the field workstation PC at the survey base for verification, backup and preparation of in-field products.

Compensation System

Manufacturer:	Fugro
Model:	HeliDAS, with Billingsley TFM100G2-1E fluxgate magnetometer

The presence of the helicopter in close proximity to the sensors causes considerable deviations 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). This provides a complete picture of the effects of the aircraft at designated headings in all orientations.

The HeliDAS compensation system derives a set of coefficients for each line direction and for each magnetometer sensor. The coefficients can be applied real-time or in a post-processing environment.

Video Flight Path Recording System

Type:	Axis 2420 Digital Network Camera
Recorder:	Axis 241S Video Server and Fujitsu Tablet Computer
Format:	NTSC

Fiducial numbers are recorded continuously and are displayed on the margin of each image. This procedure ensures accurate correlation of data with respect to visible features on the ground.

Spectrometer

Manufacturer:	Radiation Solutions Inc.
Series:	RS-500
Model:	RSX-5

Type:	1024 Multichannel, Automatic Multi-Peak Stabilization
Accuracy:	1 count/sec.
Update:	1 integrated sample/sec.

The RSX-5 Airborne Spectrometer employs four downward looking crystals (1024 cu.in.- 16.8 L) and one upward looking crystal (256 cu.in.- 4.2 L). The downward crystal records the radiometric spectrum from 410 KeV to 3 MeV over 256 discrete energy windows, as well as a cosmic ray channel that detects photons with energy levels above 3.0 MeV. From these 256 channels, the standard Total Count, Potassium, Uranium and Thorium channels are extracted. The upward crystal is used to measure and correct for Radon.

The shock-protected Sodium Iodide (Thallium) crystal package is unheated, and is automatically stabilized through full-spectrum-fitting with respect to each element peak. The RSX-5 provides raw or Compton stripped data that has been automatically corrected for gain, base level, ADC offset and dead time.

The RSX-5 system is automatically calibrated before each flight using calibration spectra stored in its memory which was derived from calibration pads – Potassium (K), Uranium (U), Thorium (Th). Additionally, repeat test lines are flown to determine if there are any differences in background. This procedure allows corrections to be applied to each survey flight to eliminate any differences that might result from changes in temperature or humidity.

4. 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 on a screen or printer. Records were 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, spike rejection and filtering of all geophysical and ancillary data, verification of flight videos, diurnal correction, and preliminary leveling of magnetic data.

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

Navigation	-	Positional (x,y) accuracy of better than 10 m, with a CEP (circular error of probability) of 95%.
Flight Path	-	No lines to exceed ±25% departure from nominal line spacing over a continuous distance of more than 1 km, except for reasons of safety.

Clearance - Mean terrain sensor clearance of 30 m, ±6 m, except where precluded by safety considerations, e.g., restricted or populated areas, severe topography, obstructions, tree canopy, aerodynamic limitations, etc.

Airborne Mag - The magnetometer noise envelope of ± 0.1 nT is exceeded intermittently over a cumulative total of 10 percent or more of any flight line or continuously over 1 kilometre or more.

Base Mag - Diurnal variations not to exceed 10 nT over a straight line time chord of 1 minute. The base station recorded magnetometer instrument noise levels are in excess of 0.5 nT for periods longer than 5 minutes or where the base station has ceased to function for periods of 5 minutes or more.

Airborne Spec - The response of the thorium and uranium hand samples in the thorium and uranium windows respectively should not differ from the average response of the hand sample checks recorded on previous flights during this survey by more than plus or minus 10 percent. The Total Count response of corrected radiometric data recorded on a test line will not differ from the average count rate recorded in the Total Count channel for corresponding parts of previous test lines flown during this survey by more than plus or minus 15 percent.

5. DATA PROCESSING

Flight Path Recovery

The raw range data from at least four satellites are simultaneously recorded by both the base and mobile GPS units. The geographic positions of both units, relative to the model ellipsoid, are calculated from this information. Differential corrections, which are obtained from the base station, are applied to the mobile unit data to provide a post-flight track of the aircraft, accurate to within 2 m. Speed checks of the flight path are also carried out to determine if there are any spikes or gaps in the data.

The corrected WGS84 Latitude/Longitude coordinates are transformed to the UTM coordinate system used on the final maps. Images or plots are then created to provide a visual check of the flight path.

Residual Magnetic Field

The magnetic data were corrected to produce a final leveled residual field product by the application of the following sequence of procedures:

- Data quality check on the raw and compensated magnetic data
- Lag correction
- Loading, checking and application of the measured diurnal data
- Removal of the IGRF
- Leveling of residual magnetic intensity (RMI) data

The data quality check was accomplished in the field by applying a fourth difference filter to all raw compensated magnetic data after it had been loaded into the Oasis montaj™ database. Plotting the raw and compensated data together permitted tracking the performance of the magnetometer sensor as well as monitoring the noise levels that were superimposed on the data during survey activities. Magnetometer noise levels were maintained within stated specifications.

The aeromagnetic data from the magnetic sensor was inspected in both grid and profile format. Spikes were removed manually with the aid of a fourth difference calculation and small gaps were interpolated using an Akima spline.

A lag correction was applied to remove the effects of temporal delay inherent in the data acquisition system. A correction of 1.2 seconds was applied to the data.

The diurnal variations recorded by the base station were edited for any cultural contamination and filtered to remove high-frequency noise. This diurnal magnetic data was then subtracted from the despiked, lagged total magnetic field to provide a first order diurnal correction. The diurnal-removed magnetic field data were then gridded and compared to a grid of the despiked, lagged magnetic data to ensure that the data quality was improved by diurnal removal.

The International Geomagnetic Reference Field (IGRF) was calculated for the survey area using the flight date, height above the WGS spheroid, and the latitude and longitude of each survey point. The IGRF was removed from the diurnally corrected data.

Once the lagged, diurnal and IGRF-removed grids were created and examined, the results were then levelled using tie and traverse line intercepts. Manual adjustments were applied to any lines that required further leveling, as indicated by shadowed images of the gridded magnetic data.

After the application of tie-line or manual levelling, a procedure known as microleveling was applied. This technique is designed to remove any persistent, low-amplitude component of flight line noise remaining after tie-line levelling. Directional filters were then applied to the magnetic grid to produce a decorrugated “noise” grid. This grid was then re-sampled back into the database where the resultant “noise” channel was filtered to remove any remaining short wavelength responses that could be due to geologic sources. The amplitude of the “noise” channel was also limited to restrict the effect that the microleveling might have on strong geologic response. Finally, the “noise” channel was subtracted from the leveled channel created earlier in the processing sequence, resulting in the final levelled IGRF-removed magnetic field channel.

It should be noted that tie-line leveling does not always produce favourable results because of the significant differences in magnetic gradients at intersection points. In these instances manual and microleveling techniques can be applied to the data. There are also several areas where the topography changed rapidly and the pilot was unable to maintain the aircraft height above ground consistently from line to line. Where these altitude differences have occurred in high gradient areas, differences in magnetic values from line to line can sometimes be seen. Care has been taken to remove these problems where possible, but because the wavelength of these differences can be very short, and the amplitudes of the anomalies can be quite high, it is difficult to remove them entirely without risking the removal of real geological features of similar characteristics.

IGRF Removal

The International Geomagnetic Reference Field (IGRF) was calculated at a 1 Hz interval for all survey data based on flight date, the latitude and longitude for each survey point and the value of the GPS height above the spheroid. Information on the model used for the calculation can be found at http://www.ngdc.noaa.gov/seg/geomag .

The IGRF was calculated using the 2005 IGRF model and interpolated to 10 Hz before being subtracted from the final lagged, diurnally corrected total magnetic field. The IGRF corrected channel was used in the magnetic levelling procedure. The final levelled magnetic data, with IGRF removed, were archived as residual magnetic intensity (mag_rmi).

Calculated Vertical Magnetic Gradient

The final residual magnetic field data were subjected to a processing algorithm that enhances the response of magnetic bodies in the upper 500 m and attenuates the response of deeper bodies. The resulting vertical gradient map provides better definition and resolution of near-surface magnetic units. It also identifies weak magnetic features that may not be evident on the residual field map. However, regional magnetic variations and changes in lithology may be better defined on the residual magnetic field map.

Digital Elevation (Optional)

The laser altimeter values (altlas_heli) are subtracted from the differentially corrected and de-spiked GPS-Z values (gpsz) to produce profiles of the height above the ellipsoid along the survey lines. These values are gridded to produce contour maps showing approximate elevations within the survey area. The digital terrain data are filtered with a microleveling algorithm.

The accuracy of the elevation calculation is directly dependent on the accuracy of the two input parameters, altlas_heli and gpsz. The laser altimeter value may be erroneous in areas of heavy tree cover, where the altimeter reflects the distance to the tree canopy rather than the ground. 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 ±10 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, Colour and Shadow Map Displays

The geophysical data 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 for the magnetic grids (16m) and 25% of the shortest line interval for the radiometric grids (20m).

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.

Radiometrics

All radiometric data reductions performed by Fugro rigorously follow the procedures described in the IAEA Technical Report[1].

All processing of radiometric data was undertaken at the natural sampling rate of the spectrometer, i.e., one second.

The following sections describe each step in the process.

Pre-filtering

The laser altimeter data were processed with a 15-point Median filter to remove spikes.

Reduction to Standard Temperature and Pressure

The laser altimeter data were converted to effective height (h_e) in feet using the acquired temperature and pressure data, according to the following formula:

$$h_e = h * \frac{273.15}{T + 273.15} * \frac{P}{1013.25}$$

where: *h* is the observed crystal to ground distance in feet

T is the measured air temperature in degrees Celsius

P is the barometric pressure in millibars

Live Time Correction

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[1] Exploranium, I.A.E.A. Report, Airborne Gamma-Ray Spectrometer Surveying, Technical Report No. 323, 199

The spectrometer, a Radiation Solutions RSX-5, uses the notion of "live time" to express the relative period of time the instrument was able to register new pulses per sample interval. This is the opposite of the traditional "dead time", which is an expression of the relative period of time the system was unable to register new pulses per sample interval.

The RSX-5 measures the live time electronically, and outputs the value in milliseconds. The live time correction is applied to the total count, potassium, uranium, thorium, upward uranium and cosmic channels. The formula used to apply the correction is as follows:

$$C_{lt} = C_{raw} * \frac{1000.0}{L}$$

where: C_{lt} is the live time corrected channel in counts per second

C_{raw} is the raw channel data in counts per second

L is the live time in milliseconds

Intermediate Filtering

Two parameters were filtered, but not returned to the database:

- Radar altimeter was smoothed with a 15-point Hanning filter (h_{ef}).
- The Cosmic window was smoothed with a 9-point Hanning filter (Cos_f).

Aircraft and Cosmic Background

Aircraft background and cosmic stripping corrections were applied to the total count, potassium, uranium, thorium and upward uranium channels using the following formula:

$$C_{ac} = C_{lt} - (a_c + b_c * \mathrm{Cos}_f)$$

where: C_{ac} is the background and cosmic corrected channel

C_{lt} is the live time corrected channel

a_c is the aircraft background for this channel

b_c is the cosmic stripping coefficient for this channel

Cos_f is the filtered Cosmic channel

Radon Background

The determination of calibration constants that enable the stripping of the effects of atmospheric radon from the downward-looking detectors through the use of an upward-looking detector is divided into two parts:

1) Determine the relationship between the upward- and downward-looking detector count rates for radiation originating from the ground.

2) Determine the relationship between the upward- and downward-looking detector count rates for radiation due to atmospheric radon.

The procedures to determine these calibration factors are documented in IAEA Report #323 on airborne gamma-ray surveying. The calibrations for the first part were determined as outlined in the report.

The latter case normally requires many over-water measurements where there is no contribution from the ground. Where this is not possible, it is standard procedure to establish a test line over which a series of repeat measurements are acquired. From these repeat flights, any change in the downward uranium window due to variations in radon background would be directly related to variations in the upward window and the other downward windows.

The validity of this technique rests on the assumption that the radiation from the ground is essentially constant from flight to flight. Inhomogeneities in the ground, coupled with deviations in the flight path between test runs, add to the inaccuracy of the accumulated results. Variations in flying heights and other environmental factors also contribute to the uncertainty.

A test site was established in or near the survey area. The tests were carried out at the start and end of each day, and at the end of each flight. Data were acquired over a four-minute period at the nominal survey altitude. The data were then corrected for live time, aircraft background and cosmic activity.

Once the survey was completed, the relationships between the counts in the downward uranium window and in the other four windows due to atmospheric radon were determined using linear regression for each of the hover sites. The following equations were used:

$$u_r = a_u Ur + b_u$$

$$K_r = a_K U_r + b_K$$

$$T_r = a_T U_r + b_T$$

$$I_r = a_I U_r + b_I$$

where: u_r is the radon component in the upward uranium window

K_r, U_r, T_r and I_r are the radon components in the various windows of the downward detectors

the various "a" and "b" coefficients are the required calibration constants

In practice, only the "a" constants were used in the final processing. The "b" constants, which are normally near zero for over-water calibrations, were of no value as they reflected the local distribution of the ground concentrations measured in the five windows.

The thorium, uranium and upward uranium data for each line were copied into temporary arrays, then smoothed with 21, 21 and 51 point Hanning filters to product Th_f, U_f, and u_f respectively. The radon component in the downward uranium window was then determined using the following formula:

$$U_r = \frac{u_f - a_1 * U_f - a_2 * Th_f + a_2 * b_{Th} - b_u}{a_u - a_1 - a_2 * a_{Th}}$$

where: U_r is the radon component in the downward uranium window

u_f is the filtered upward uranium

U_f is the filtered uranium

Th_f is the filtered thorium

a_1, a_2, a_u and a_{Th} are proportionality factors and

b_u and b_{Th} are constants determined experimentally

The effects of radon in the downward uranium are removed by simply subtracting U_r from U_{ac}. The effects of radon in the total count, potassium, thorium and upward uranium are then removed based upon previously established relationships with U_r. The corrections are applied using the following formula:

$$C_{rc} = C_{ac} - (a_c * U_r + b_c)$$

where: C_{rc} is the radon corrected channel

C_{ac} is the background and cosmic corrected channel

U_r is the radon component in the downward uranium window

a_c is the proportionality factor and

b_c is the constant determined experimentally for this channel

Compton Stripping

Following the radon correction, the potassium, uranium and thorium are corrected for spectral overlap. First, α,β and γ the stripping ratios, are modified according to altitude. Then an adjustment factor based on a, the reversed stripping ratio, uranium into thorium, is calculated. (Note: the stripping ratio altitude correction constants are expressed in change per metre. A constant of 0.3048 is required to conform to the internal usage of height in feet):

$$\alpha_h = \alpha + h_{ef} * 0.00049$$

$$\alpha_r = \frac{1.0}{1.0 - a * \alpha_h}$$

$$\beta_h = \beta + h_{ef} * 0.00065$$

$$\gamma_h = \gamma + h_{ef} * 0.00069$$

where: α, β, γ are the Compton stripping coefficients

α_h, β_h, γ_h are the height corrected Compton stripping coefficients

h_{ef} is the height above ground in metres

α_r is the scaling factor correcting for back scatter

a is the reverse stripping ratio

The stripping corrections are then carried out using the following formulas:

$$Th_c = (Th_{rc} - a * U_{rc}) * \alpha_r$$

$$K_c = K_{rc} - \gamma_h * U_c - \beta_h * Th_c$$

$$U_c = (U_{rc} - \alpha_h * Th_{rc}) * \alpha_r$$

where: U_c, Th_c and K_c are corrected uranium, thorium and potassium

α_h,β_h,γ_h are the height corrected Compton stripping coefficients

U_{rc}, Th_{rc} and K_{rc} are radon-corrected uranium, thorium and potassium

α_r is the backscatter correction

Attenuation Corrections

The total count, potassium, uranium and thorium data are then corrected to a nominal survey altitude, in this case 100 feet. This is done according to the equation:

$$C_a = C * e^{\mu(h_{ef} - ho)}$$

where: C_a is the output altitude corrected channel

C is the input channel

e^{μ} is the attenuation correction for that channel

h_{ef} is the effective altitude

h_0 is the nominal survey altitude to correct to

6. 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. These include magnetic enhancements or derivatives, digital terrain, or radioelement ratios. Most parameters can be displayed as contours, profiles, or in colour.

Base Maps

Base maps of the survey area were produced by scanning 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 the final maps. All maps were created using the following parameters:

Projection Description:

Datum:	NAD83
Ellipsoid:	GRS80
Projection:	UTM (Zone: 17N)
Central Meridian:	81° W
Latitude of Origin:	0°
False Northing:	0
False Easting:	500000
Scale Factor:	0.9996
WGS84 to Local Conversion:	Molodensky
Datum Shifts:	DX: 0 DY: 0 DZ: 0

Final Products

The following parameters are presented on 2 map sets at a scale of 1:20,000. All maps include flight lines and topography, unless otherwise indicated. Preliminary products are not listed.

Hardcopy Products

2 copies: Final color maps (1:20,000)

- a) Residual Magnetic Intensity (nT)
- b) Calculated Vertical Magnetic Gradient (nT/m)
- c) Uranium Counts (cps)
- d) Thorium Counts (cps)
- e) Potassium Counts (cps)
- g) Total Counts (cps)

2 copies: Logistics and Processing Report

Digital Archive (see Archive Description)

Line data archives (Magnetic, Gamma Ray and Ancillary) in Geosoft GDB format
Line data archive (Magnetics, Gamma Ray and Ancillary) in ASCII XYZ format
Grid archives in Geosoft format
Final color maps (1:20,000) in Adobe PDF formats
Logistics and Processing Report in Adobe PDF format
Digital Flight Path Video in .Bin/.BDX format with Viewer

7. SURVEY RESULTS

Magnetic Data

A Fugro CF-1 cesium vapour magnetometer was operated at the survey base to record diurnal variations of the earth's magnetic field. The clock of the base station was synchronized with that of the airborne system to permit subsequent removal of diurnal drift.

The residual magnetic field data has been presented as a colour map with contours on the planimetric base map using a contour interval of 20 nT where gradients permit. The map shows the magnetic properties of the rock units underlying the survey area.

The residual magnetic field data has been subjected to a processing algorithm to produce a map of the calculated vertical gradient. This procedure enhances near-surface magnetic units and suppresses regional gradients. It also provides better definition and resolution of magnetic units and displays weak magnetic features that may not be clearly evident on the residual field map.

There is strong evidence on the magnetic map that suggests the survey area has been subjected to deformation and/or alteration. These structural complexities are evident on the contour map as variations in magnetic intensity, irregular patterns, and as offsets or changes in strike direction.

If a specific magnetic intensity can be assigned to the rock type that is believed to host the target mineralization, it may be possible to select areas of higher priority on the basis of the magnetic data. This is based on the assumption that the magnetite content of the host rocks will give rise to a limited range of contour values that will permit differentiation of various lithological units.

The magnetic results, in conjunction with the other geophysical parameters, have provided valuable information that can be used to effectively map the geology and structure in the survey areas.

Radiometric Data

The radiometric data have been included in the data archive, and have been presented as grids and colour map products for the following parameters: Total Counts, Potassium, Uranium, and Thorium. The results exhibit similar patterns, and appear to have delineated areas of higher radioelement concentrations.

In the Lackner area, the anomalous radiometric values are associated with a large, circular, ring-like magnetic unit (the Lackner Lake Carbonatite) that dominates the centre of the property. This complex is about 5.5 km in diameter. A second, smaller, plug like feature which is also magnetic, abuts the NNE flank of the main unit. This latter unit is about 1.1 km in diameter.

8. 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 survey.

The various maps included with this report display the magnetic and radiometric properties of the survey areas. It is recommended that a complete assessment and detailed evaluation of the survey results be carried out, in conjunction with all available geophysical, geological and geochemical information.

It is also recommended that additional 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.

APPENDIX A

LIST OF PERSONNEL

The following personnel were involved in the acquisition, processing, and presentation of data, relating to a magnetometer and radiometric airborne geophysical survey carried out for RARE EARTH METALS INC, near CHAPLEAU, ONTARIO, CANADA.

David Miles	Manager, Geophysical Projects
Emily Farquhar	Manager, Geophysical Services
Graham Konieczny	Manager, Data Processing and Interpretation
Paul Smith	Supervisor, Geophysical Interpretation
Lesley Minty	Project Manager
Stephen Harrison	Geophysicist
Yuri Mironenko	Geophysicist
Tim Nykolaichuk	Geophysical Operator
Ed Ashie	Pilot (Great Slave Helicopters Ltd.)
Kevin Coldwell	AME (Great Slave Helicopters Ltd.)
Lyn Vanderstarren	Drafting Supervisor
Susan Pothiah	Expeditor

The survey consisted of 670 line-km of coverage, flown from October 15th to October 17th, 2009.

All personnel are employees of Fugro Airborne Surveys, except for the pilot and the AME, who are employees of Great Slave Helicopters Ltd.

APPENDIX B

BACKGROUND INFORMATION

APPENDIX B

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.

Gamma Ray Spectrometry

Radioelement concentrations are measures of the abundance of radioactive elements in the rock. The original abundance of the radioelements in any rock can be altered by the subsequent processes of metamorphism and weathering.

Gamma radiation in the range that is measured in the thorium, potassium, uranium and total count windows is strongly attenuated by rock, overburden and water. Almost all of the total radiation measured from rock and overburden originates in the upper .5 metres. Moisture in soil and bodies of water will mask the radioactivity from underlying rock. Weathered rock materials that have been displaced by glacial, water or wind action will not reflect the general composition of the underlying bedrock. Where residual soils exist, they may reflect the composition of underlying rock except where equilibrium does not exist between the original radioelement and the products in its decay series.

Radioelement counts (expressed as counts per second) are the rates of detection of the gamma radiation from specific decaying particles corresponding to products in each radioelements decay series. The radiation source for uranium is bismuth (Bi-214), for thorium it is thallium (Tl-208) and for potassium it is potassium (K-40).

The uranium and thorium radioelement concentrations are dependent on a state of equilibrium between the parent and daughter products in the decay series. Some daughter products in the uranium decay are long lived and could be removed by processes such as leaching. One product in the series, radon (Rn-222), is a gas which can easily escape. Both of these factors can affect the degree to which the calculated uranium concentrations reflect the actual composition of the source rock. Because the daughter products of thorium are relatively short lived, there is more likelihood that the thorium decay series is in equilibrium.

Lithological discrimination can be based on the measured relative concentrations and total, combined, radioactivity of the radioelements. Feldspar and mica contain potassium. Zircon, sphene and apatite are accessory minerals in igneous rocks that are sources of uranium and thorium. Monazite, thorianite, thorite, uraninite and uranothorite are also sources of uranium and thorium which are found in granites and pegmatites.

In general, the abundance of uranium, thorium and potassium in igneous rock increases with acidity. Pegmatites commonly have elevated concentrations of uranium relative to thorium. Sedimentary rocks derived from igneous rocks may have characteristic signatures that are influenced by their parent rocks, but these will have been altered by subsequent weathering and alteration.

Metamorphism and alteration will cause variations in the abundance of certain radioelements relative to each other. For example, alterative processes may cause uranium enrichment to the extent that a rock will be of economic interest. Uranium anomalies are more likely to be economically significant if they consist of an increase in the uranium relative to thorium and potassium, rather than a sympathetic increase in all three radioelements.

Faults can exhibit radioactive highs due to increased permeability which allows radon migration, or as lows due to structural control of drainage and fluvial sediments which attenuate gamma radiation from the underlying rocks. Faults can also be recognized by sharp contrasts in radiometric lithologies due to large strike-slip or dip-slip displacements. Changes in relative radioelement concentrations due to alteration will also define faults.

Similar to magnetics, certain rock types can be identified by their plan shapes if they also produce a radiometric contrast with surrounding rock. For example, granite intrusions will appear as sub-circular bodies, and may display concentric zonations. They will tend to lack a prominent strike direction. Offsets of narrow, continuous, stratigraphic units with contrasting radiometric signatures can identify faulting, and folding of stratigraphic trends will also be apparent.

APPENDIX C

DATA ARCHIVE DESCRIPTION

APPENDIX C

ARCHIVE DESCRIPTION

These DVDs contain final data archives of an airborne survey conducted by Fugro Airborne Surveys on behalf of RARE EARTH METALS INC., near CHAPLEAU, ONTARIO, CANADA, from October 15th to October 17th, 2009.

Project #: 09035

1. LineData: Magnetometer, Gamma Ray and Auxiliary Data

2. Grids: Grids in Geosoft format for the following parameters:
   1. Digital Elevation Model (meters above ellipsoid)
   2. Residual Magnetic Intensity (nT)
   3. Calculated Vertical Magnetic Gradient (nT/m)
   4. Uranium Counts (cps)
   5. Thorium Counts (cps)
   6. Potassium Counts (cps)
   7. Total count (cps)

3. Maps: Final maps at 1:20,000 in PDF format
   1. Colour RMI map
   2. Colour CVG map
   3. Colour Uranium Counts map
   4. Colour Thorium Counts map
   5. Colour Potassium Counts map
   6. Colour Total Counts map

5. Report: Technical and Logistics report in Adobe PDF format

6. Software: Software for viewing digital flight videos

Projection Description:

Datum:	NAD83
Ellipsoid:	GRS80
Projection:	UTM (Zone: 17N)
Central Meridian:	81° W
Latitude of Origin:	0°
False Northing:	0
False Easting:	500000
Scale Factor:	0.9996
WGS84 to Local Conversion:	Molodensky
Datum Shifts:	DX: 0 DY: 0 DZ: 0

APPENDIX D

GLOSSARY

APPENDIX D

GLOSSARY OF AIRBORNE GEOPHYSICAL TERMS

Note: The definitions given in this glossary refer to the common terminology as used in airborne geophysics.

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.

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.

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**.

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.

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 coil: A wire coil of known size and dipole moment, which is used to generate a field of known ***amplitude*** and ***phase*** 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: [σ**t**] 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.

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, or one of 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.

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. 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.

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 ***primary field*** that oscillates smoothly over time (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.

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 is often 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***.

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***).

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.

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**.

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***.

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***.

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***.

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 ***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.

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***.

Version 1.5, November 29, 2005
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, normal unit for measurement of B-Field
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
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/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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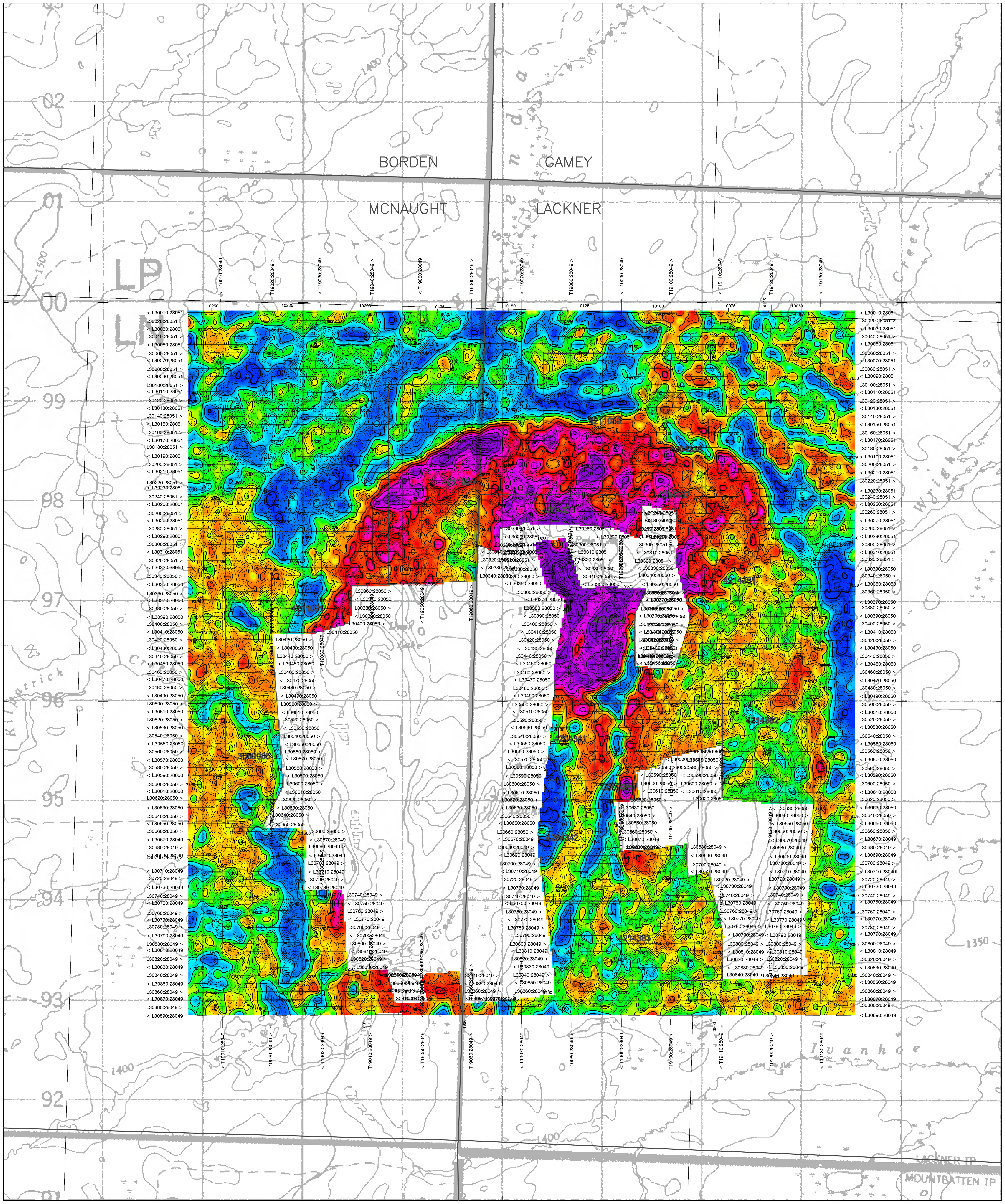
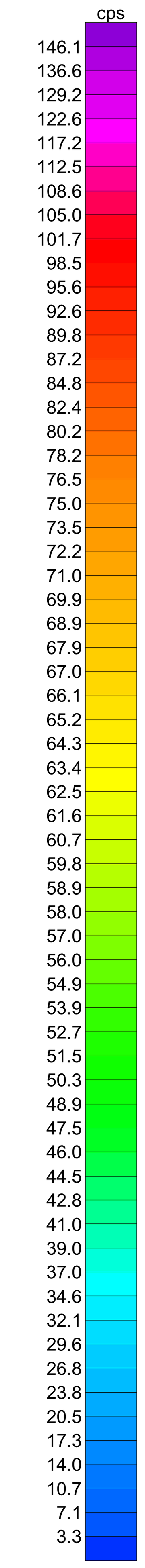
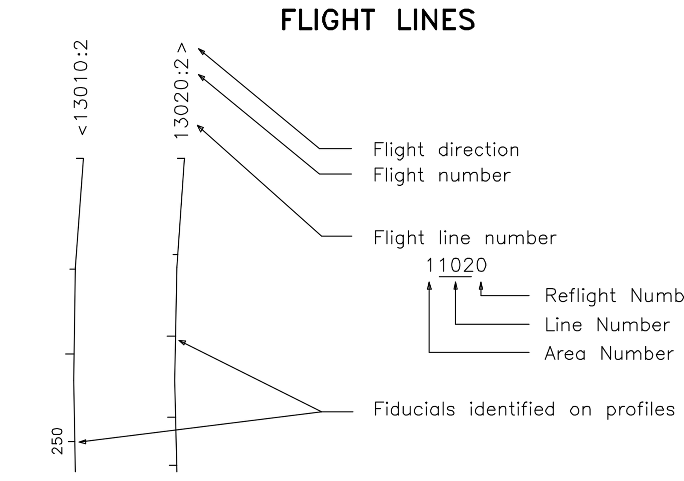


TECHNICAL SUMMARY

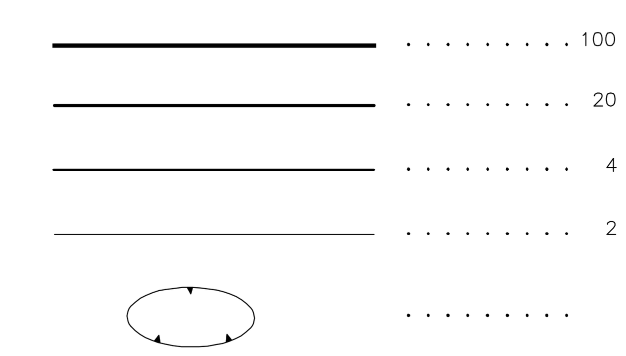
Navigation	Differentially-corrected GPS
Data reduction grid interval	20 metres
Terrain clearance	Helicopter, Spectrometer 30 m Magnetometer 30 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Cesium / 0.01 nT
Spectrometer	RS-500
Spectrometer data sampling	1.0 second



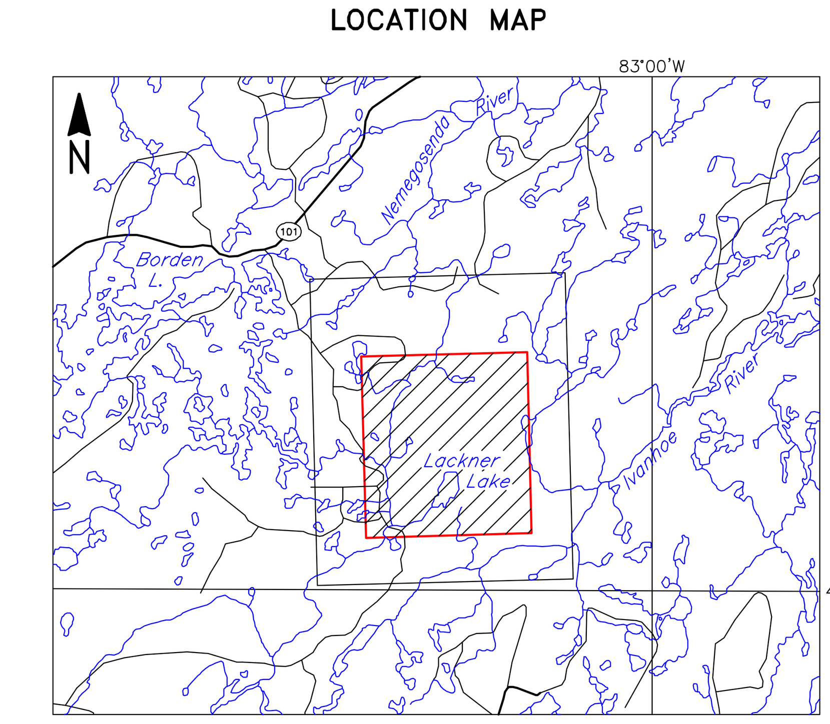
FLIGHT LINES



CONTOUR INTERVALS



LOCATION MAP



NTS: 410/14 — UTM ZONE: 17 NAD83 — SCALE: 1:250,000

RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

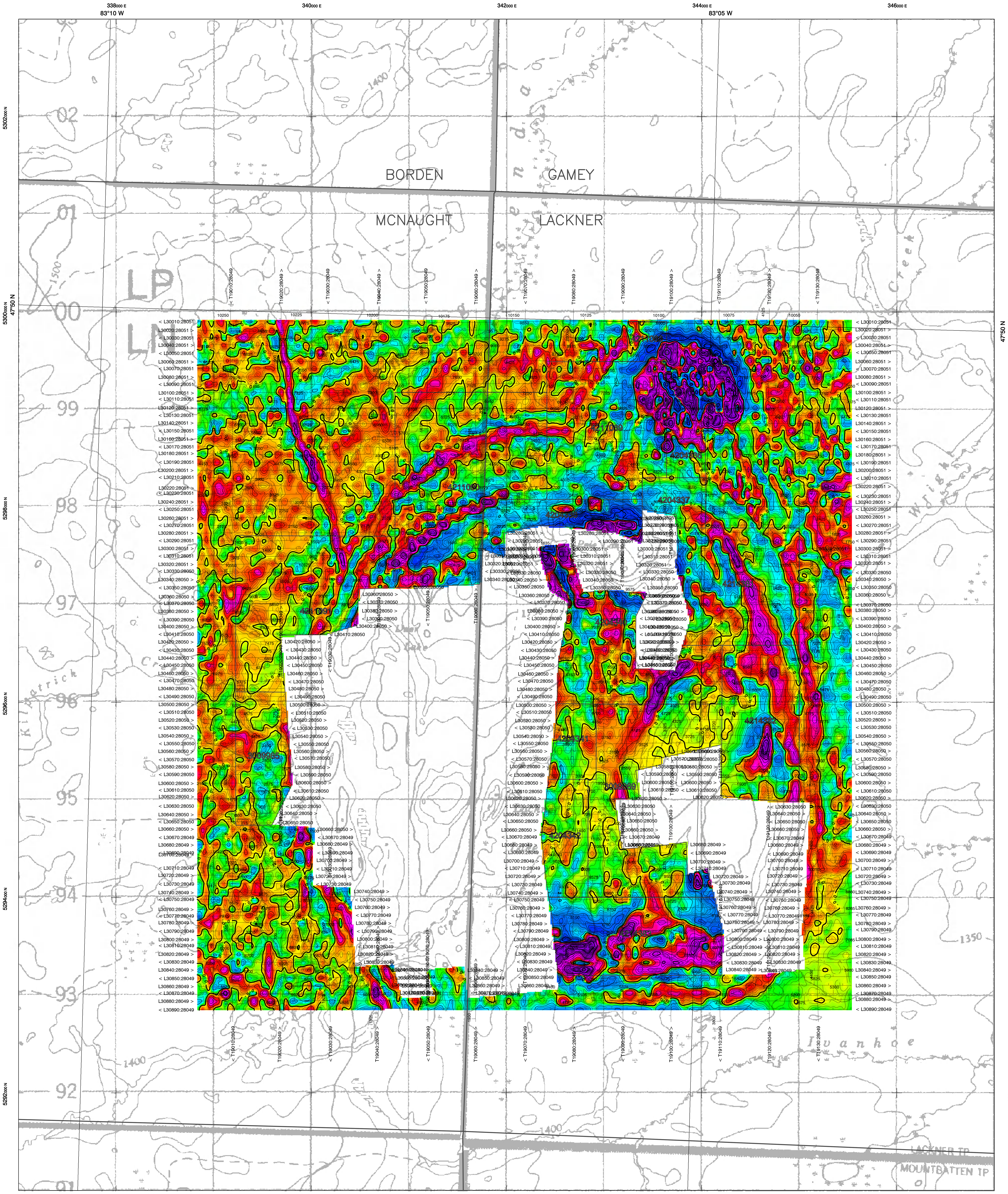
RADIOMETRIC POTASSIUM COUNTS

FUGRO MAG/RAD SURVEY	NTS: 410/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

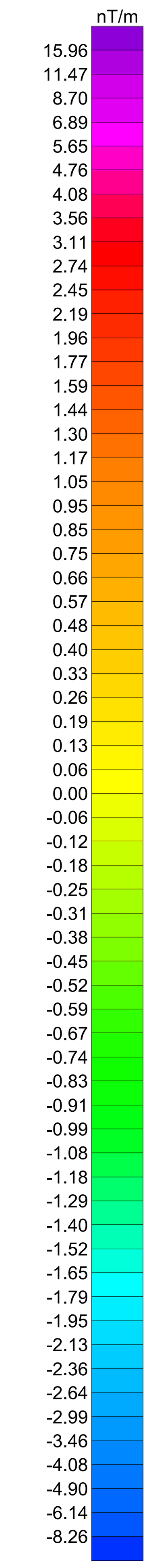
0 1 2 Km
0 1 Mi
Scale 1:20 000

FUGRO AIRBORNE SURVEYS

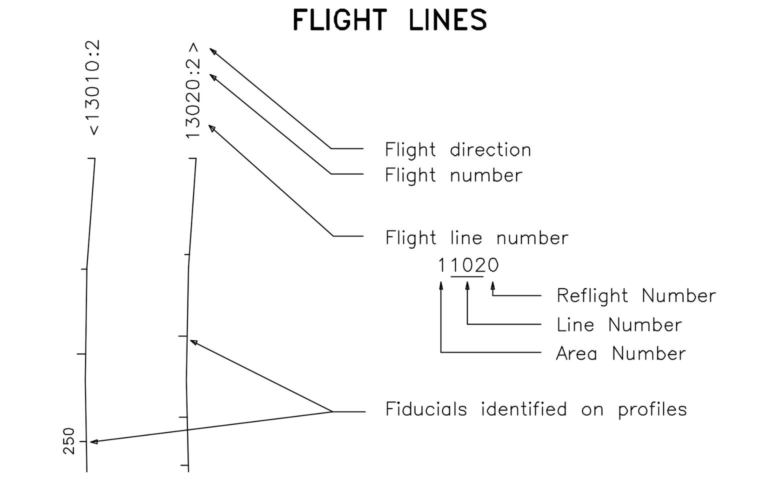


TECHNICAL SUMMARY

Navigation	Differentially-corrected GPS
Data reduction grid interval	16 metres
Terrain clearance	Helicopter, Spectrometer 30 m Magnetometer 30 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Cesium / 0.01 nT
Spectrometer	RS-500
Spectrometer data sampling	1.0 second



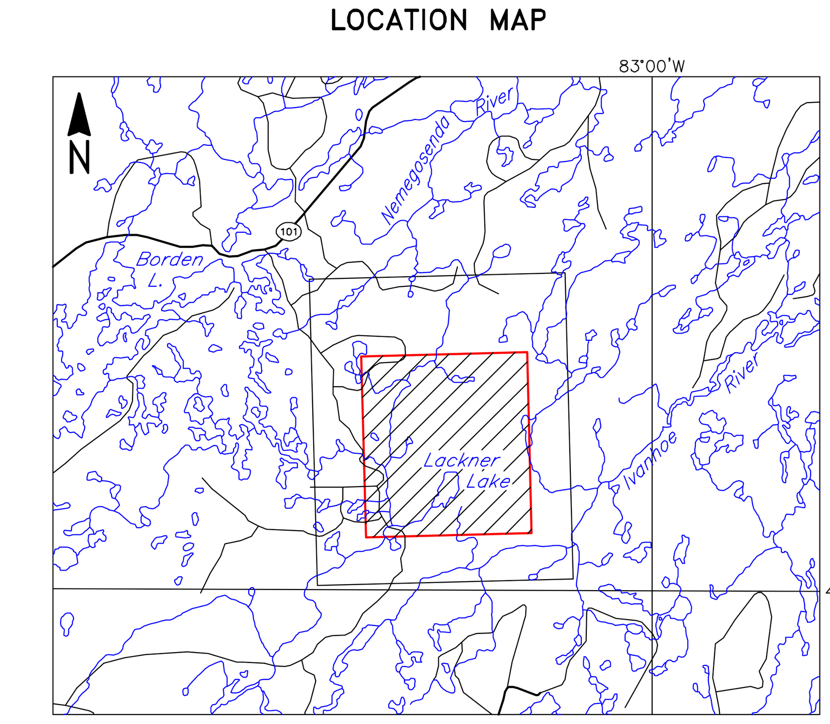
FLIGHT LINES



CALCULATED VERTICAL GRADIENT CONTOURS

....	50 nT/metre
....	10 nT/metre
....	2 nT/metre
....	0.4 nT/metre
....	0.2 nT/metre

LOCATION MAP



NTS: 41O/14 UTM ZONE: 17 NAD83 SCALE: 1:250,000

RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

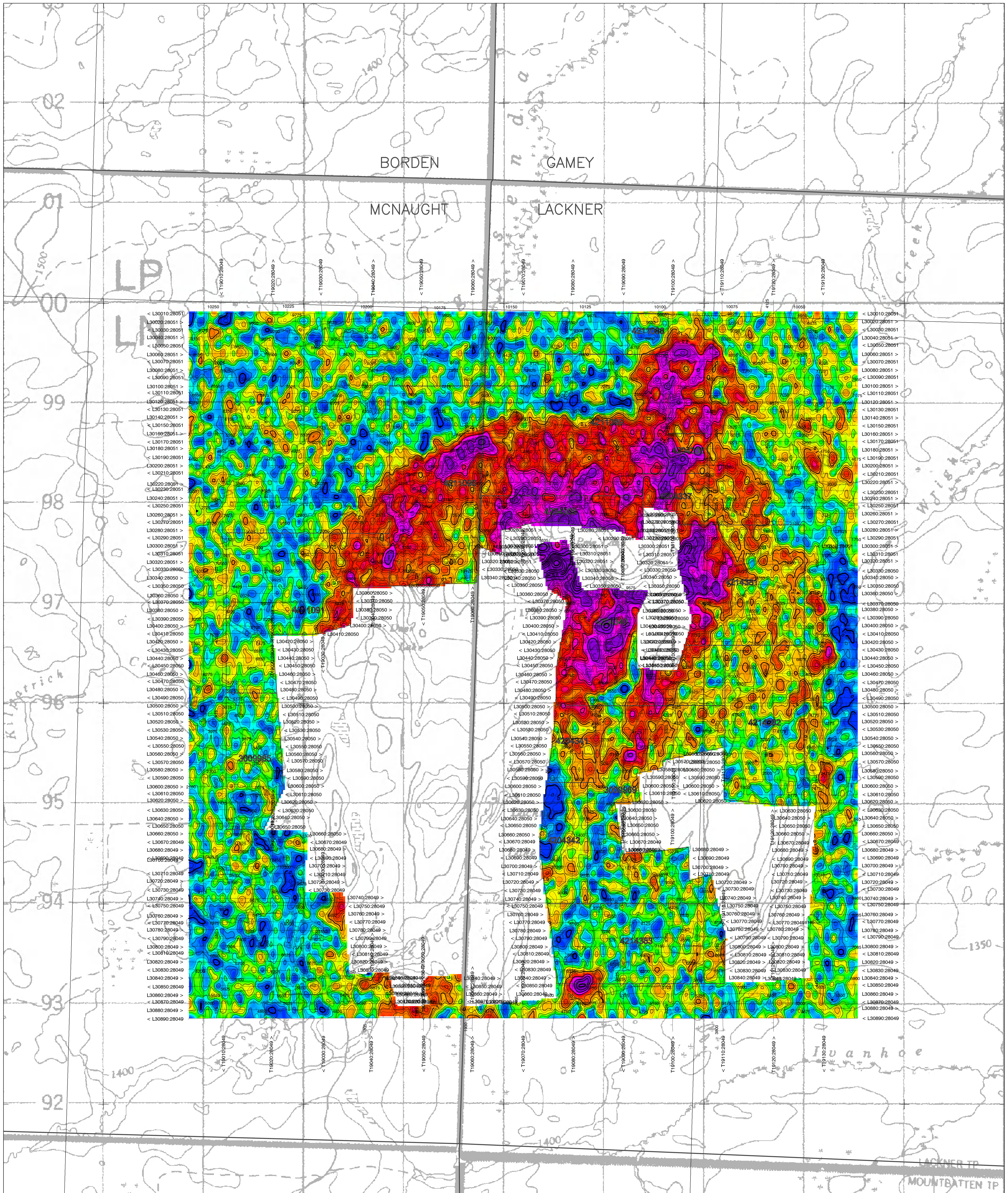
CALCULATED VERTICAL MAGNETIC GRADIENT

FUGRO MAG/RAD SURVEY	NTS: 41O/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

0 1 2 Km
0 1 Mi
Scale 1:20 000

FUGRO AIRBORNE SURVEYS



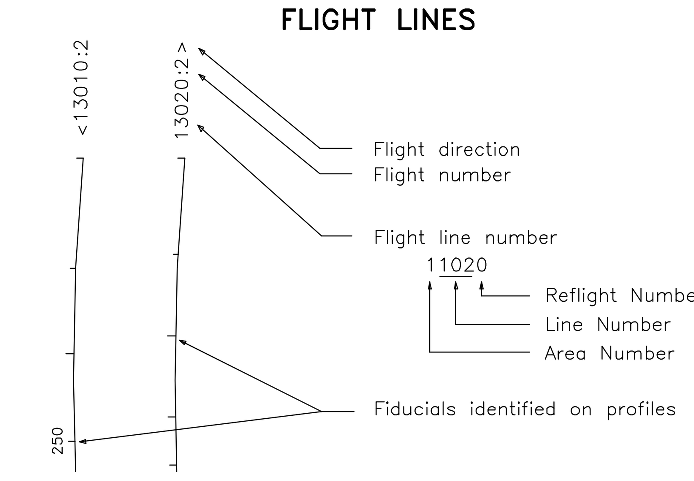
TECHNICAL SUMMARY

Navigation . . . . Differentially-corrected GPS
Data reduction grid interval . . . . 20 metres
Terrain clearance . . . . Helicopter, Spectrometer 30 m
Magnetometer 30 m
Data sampling interval . . . . . . 0.1 second
Magnetometer / sensitivity . . . . . Cesium / 0.01 nT
Spectrometer RS-500
Spectrometer data sampling . . . . 1.0 second

cps

32.0, 27.8, 25.0, 22.8, 21.0, 19.6, 18.3, 17.2, 16.2, 15.3, 14.4, 13.6, 12.8, 12.1, 11.4, 10.8, 10.3, 9.7, 9.3, 8.9, 8.5, 8.1, 7.8, 7.5, 7.3, 7.0, 6.8, 6.5, 6.3, 6.1, 5.9, 5.7, 5.6, 5.4, 5.2, 5.0, 4.8, 4.7, 4.5, 4.3, 4.1, 3.9, 3.7, 3.5, 3.3, 3.1, 2.8, 2.6, 2.3, 2.0, 1.6, 1.2, 0.6

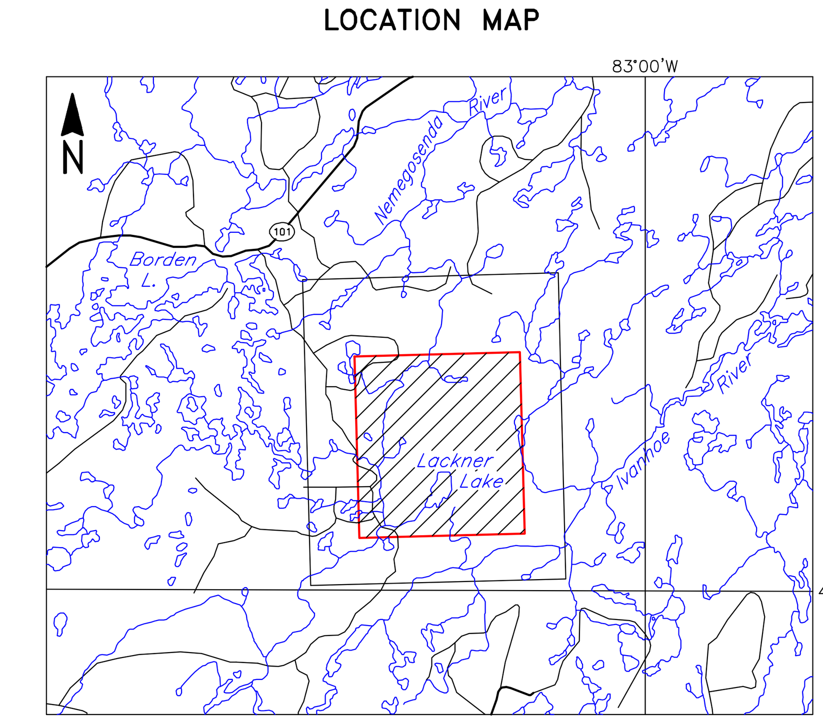
FLIGHT LINES



CONTOUR INTERVALS

. . . .	50 cps
. . . .	10 cps
. . . .	2 cps
. . . .	1 cps
. . . .	low

LOCATION MAP



NTS: 410/14 UTM ZONE: 17 NAD83 SCALE: 1:250,000

RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

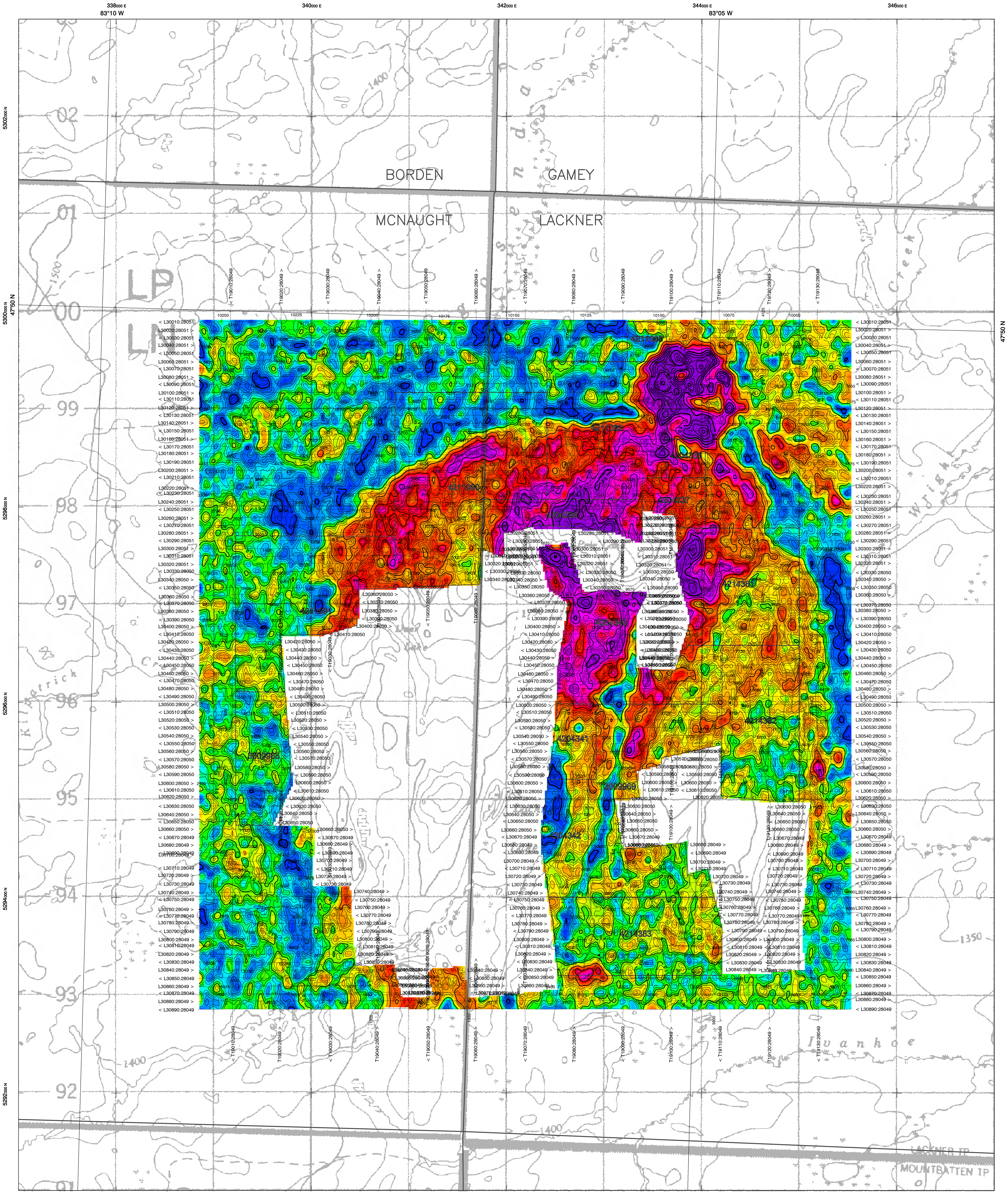
RADIOMETRIC URANIUM COUNTS

FUGRO MAG/RAD SURVEY	NTS: 410/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

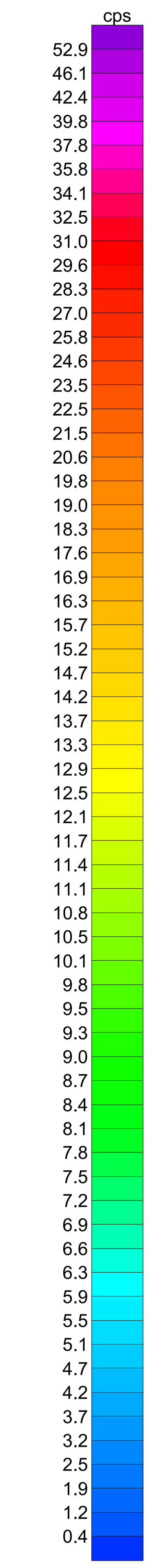
0 1 2 Km
0 1 Mi
Scale 1:20 000

FUGRO AIRBORNE SURVEYS

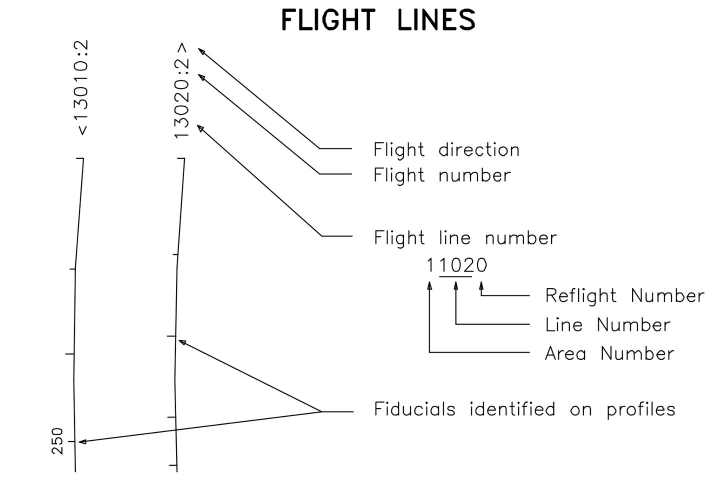


TECHNICAL SUMMARY

Navigation	Differentially-corrected GPS
Data reduction grid interval	20 metres
Terrain clearance	Helicopter, Spectrometer 30 m Magnetometer 30 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Cesium / 0.01 nT
Spectrometer	RS-500
Spectrometer data sampling	1.0 second



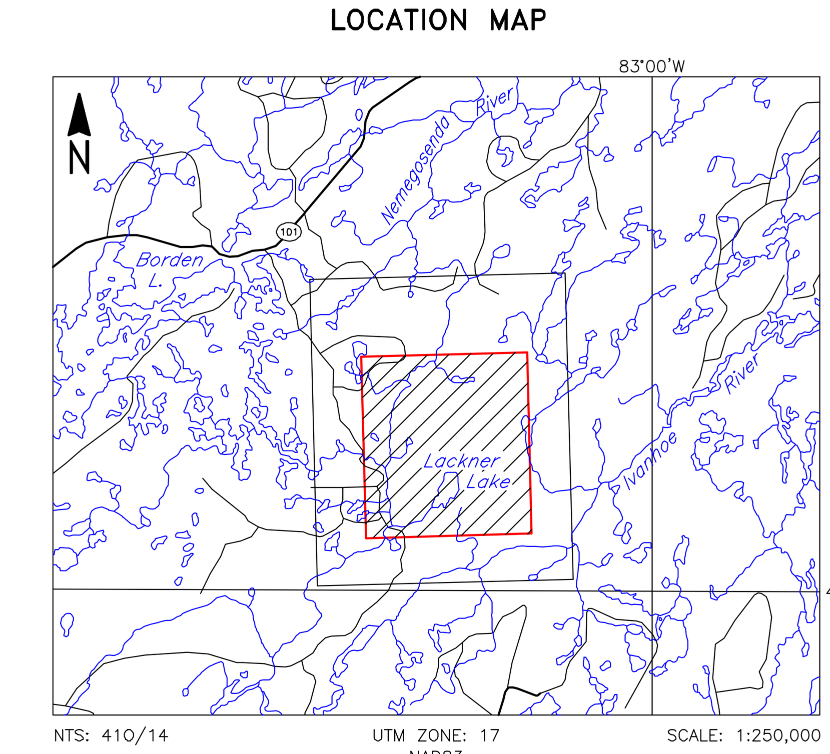
FLIGHT LINES



CONTOUR INTERVALS

. . . .	50 cps
. . . .	10 cps
. . . .	2 cps
. . . .	1 cps
. . . .	low

LOCATION MAP



NTS: 410/14 UTM ZONE: 17 NAD83 SCALE: 1:250,000

RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

RADIOMETRIC THORIUM COUNTS

FUGRO MAG/RAD SURVEY	NTS: 410/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

0 1 2 Km

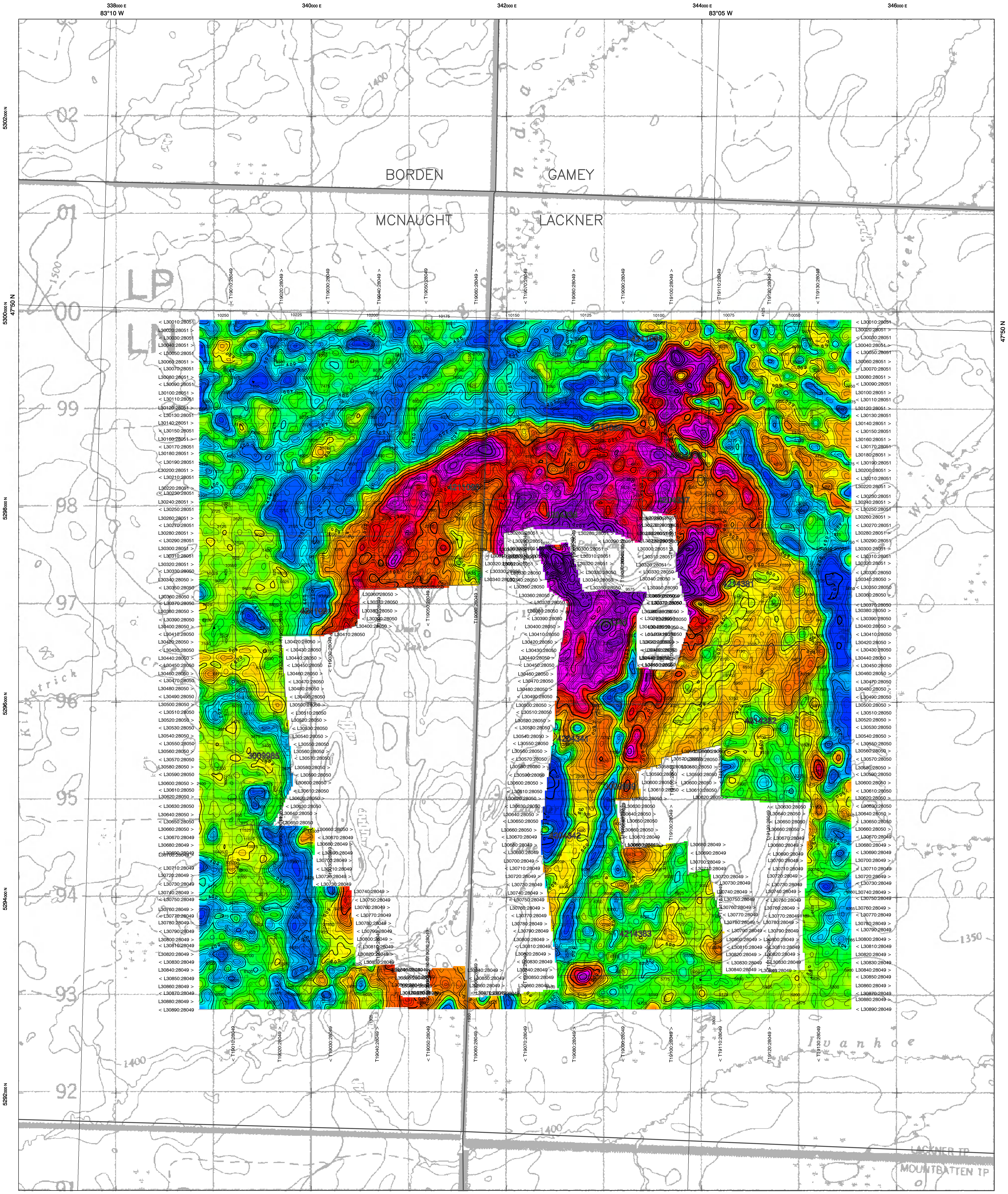
0 1 Mi

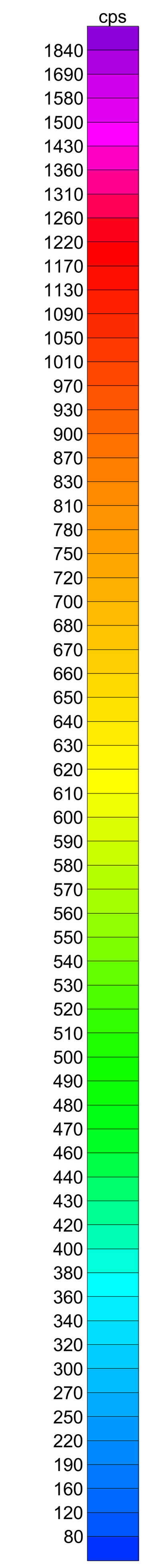
Scale 1:20 000

FUGRO AIRBORNE SURVEYS

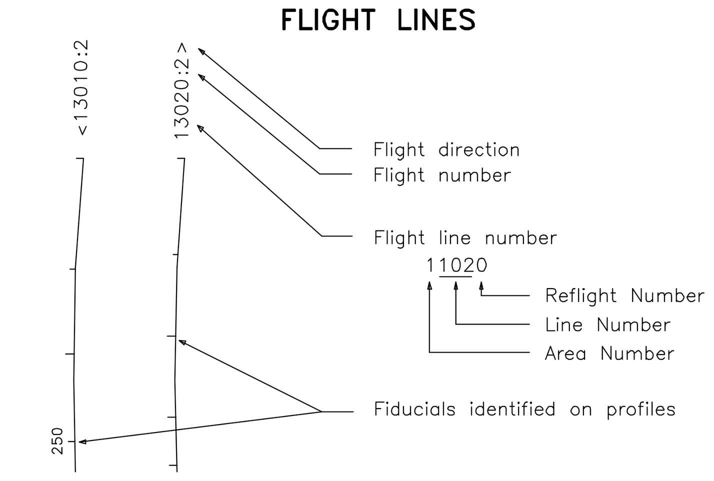
TECHNICAL SUMMARY

Navigation	Differentially-corrected GPS
Data reduction grid interval	20 metres
Terrain clearance	Helicopter, Spectrometer 30 m Magnetometer 30 m
Data sampling interval	0.1 second
Magnetometer / sensitivity	Cesium / 0.01 nT
Spectrometer	RS-500
Spectrometer data sampling	1.0 second





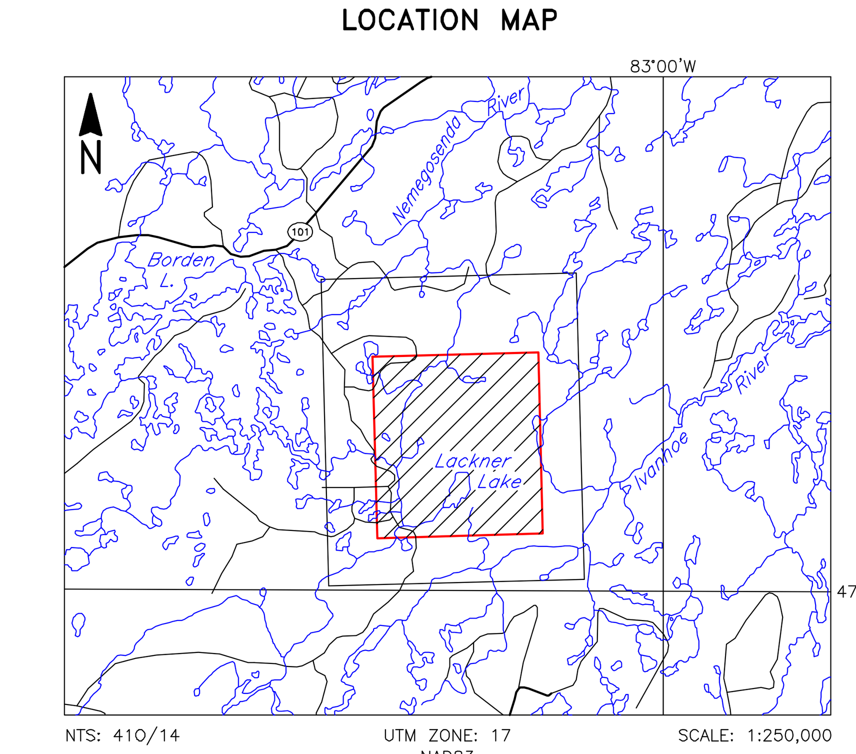
FLIGHT LINES



CONTOUR INTERVALS

	1000 cps
	200 cps
	40 cps
	20 cps
	low

LOCATION MAP



RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

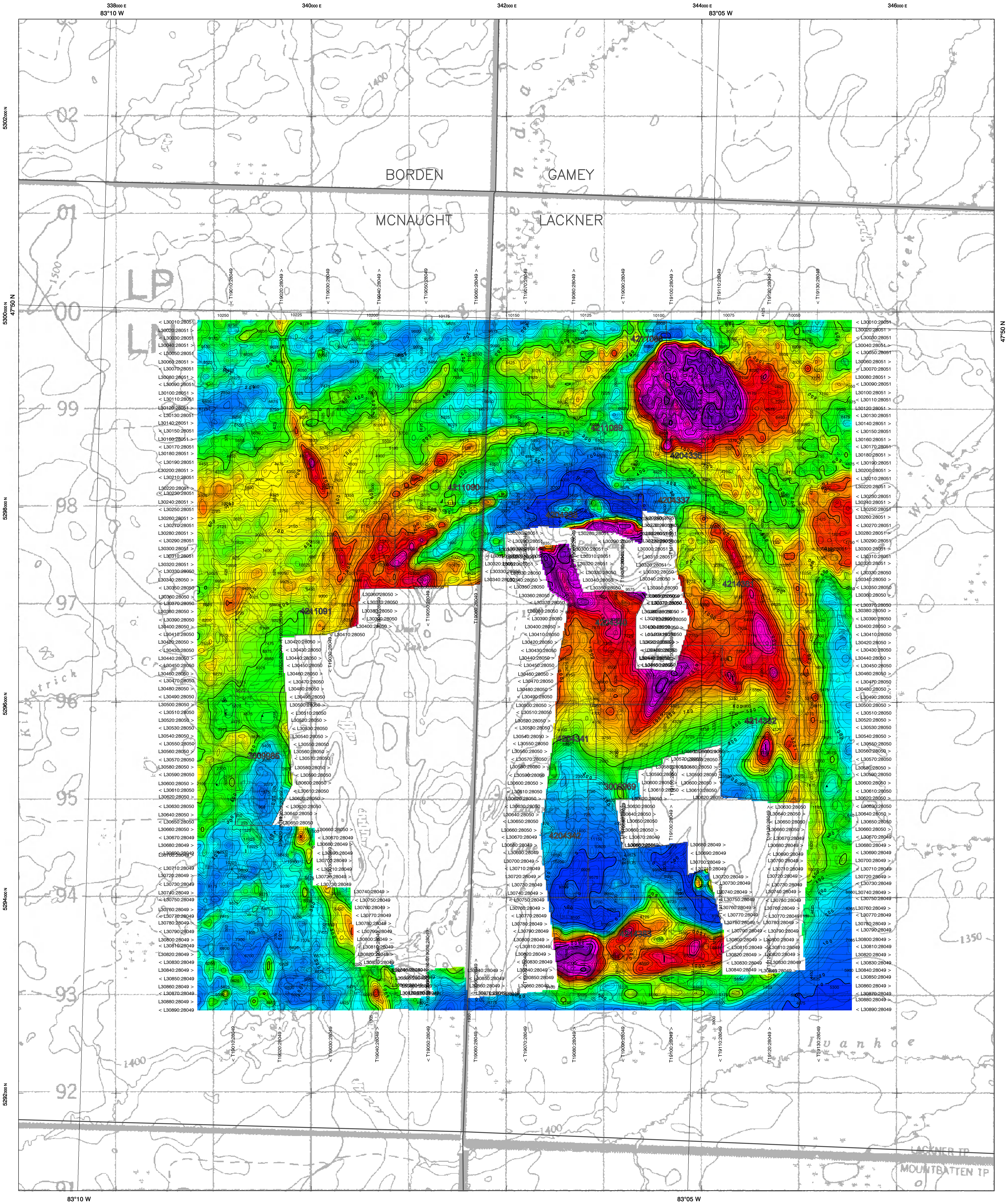
RADIOMETRIC TOTAL COUNT

FUGRO MAG/RAD SURVEY	NTS: 41O/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

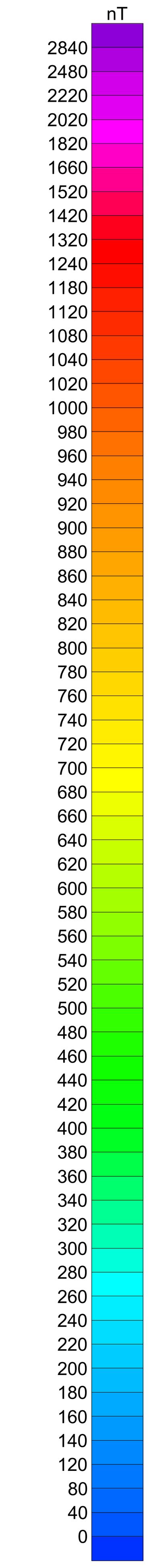
Scale 1:20 000

FUGRO AIRBORNE SURVEYS

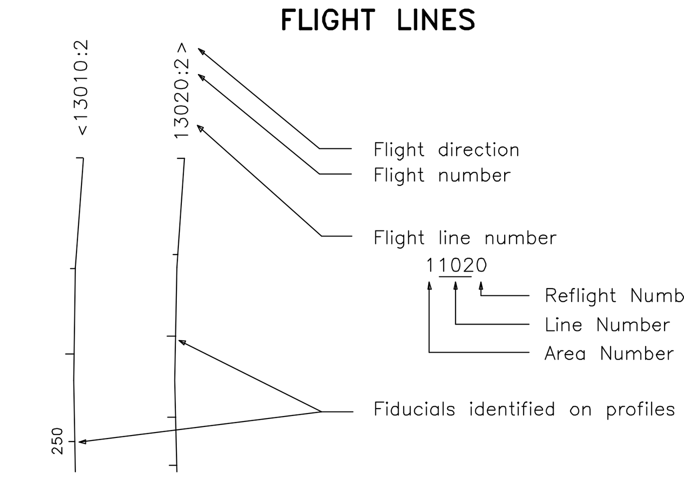


TECHNICAL SUMMARY

Navigation . . . . Differentially–corrected GPS
Data reduction grid interval . . . . 16 metres
Terrain clearance . . . . Helicopter, Spectrometer 30 m
Magnetometer 30 m
Data sampling interval 0.1 second
Magnetometer / sensitivity . . . . . Cesium / 0.01 nT
Spectrometer RS–500
Spectrometer data sampling . . . . 1.0 second



FLIGHT LINES

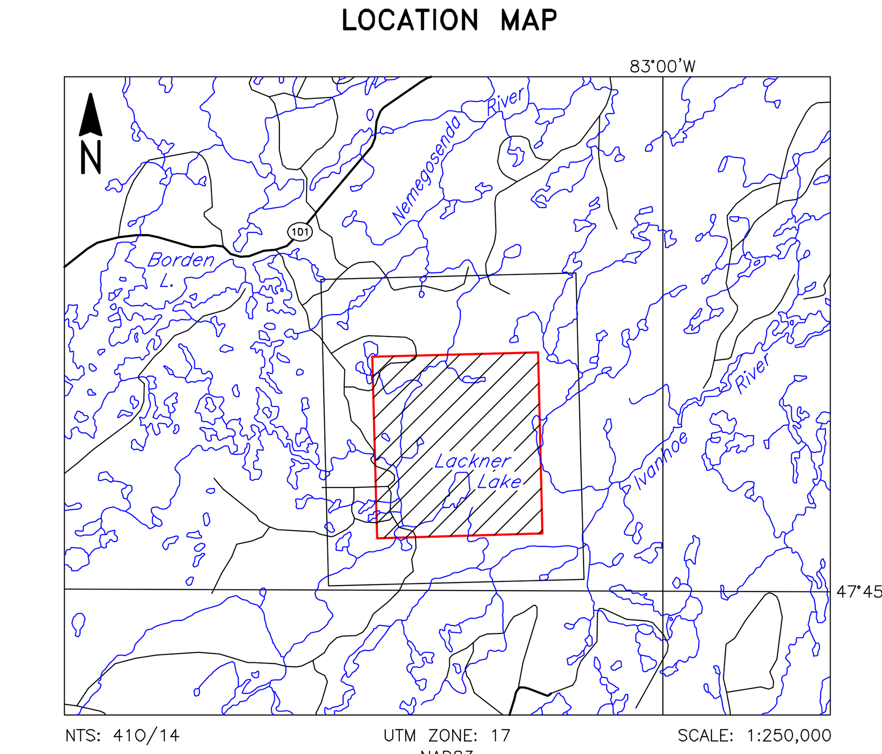


RESIDUAL MAGNETIC FIELD CONTOURS

. . . . 2500 nT
. . . . 500 nT
. . . . 100 nT
. . . . 20 nT
. . . . magnetic low

Magnetic inclination within the survey area: 74 degrees N
Magnetic declination within the survey area: 9 degrees W

LOCATION MAP



RARE EARTH METALS INC.

LACKNER BLOCK, CHAPLEAU, ONTARIO

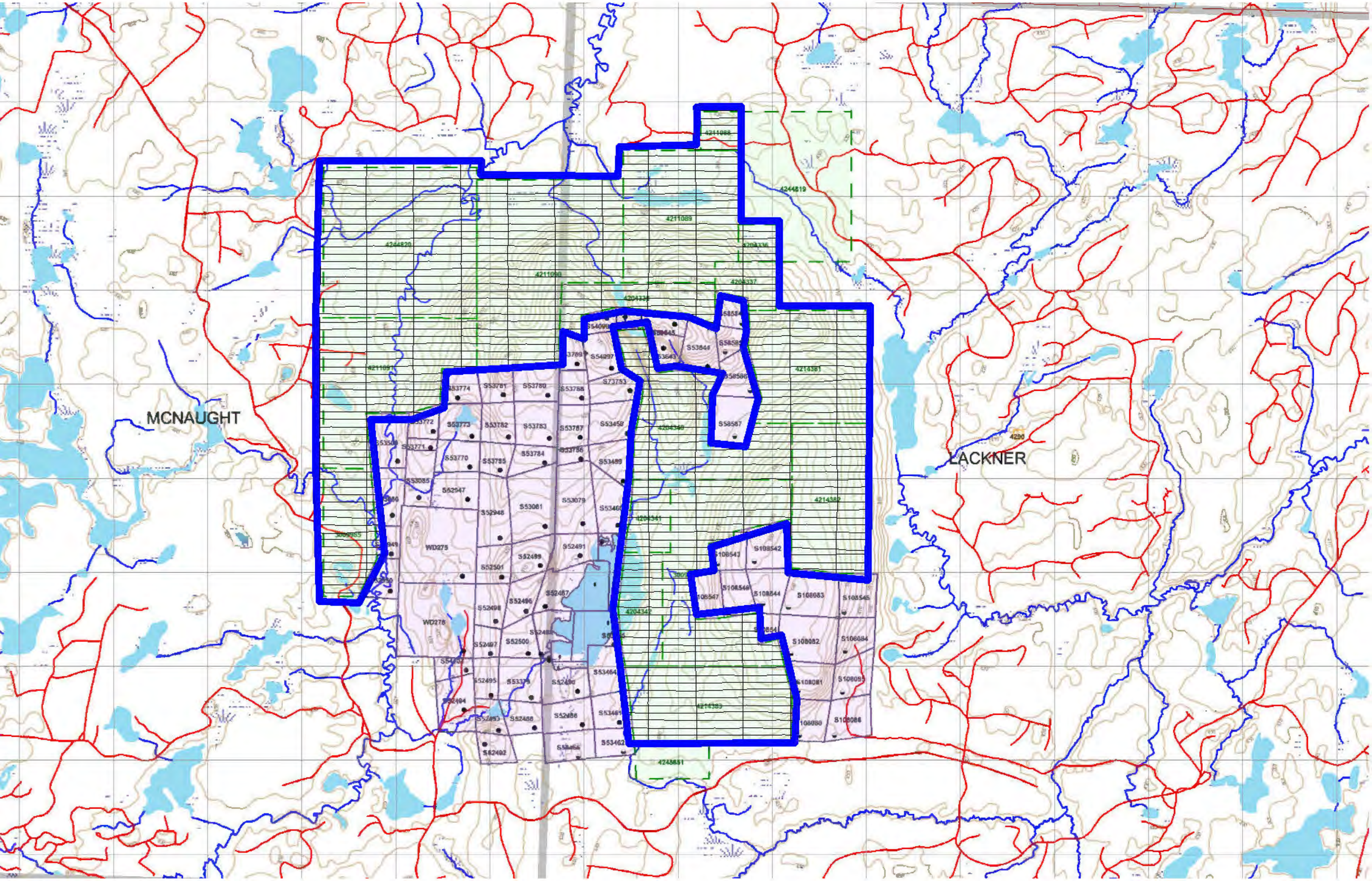
RESIDUAL MAGNETIC FIELD

IGRF Removed

FUGRO MAG/RAD SURVEY	NTS: 410/14	GEOPHYSICIST:
DATE: OCTOBER 2009	JOB: 09035	SHEET: 1

Fugro Airborne Surveys

FUGRO AIRBORNE SURVEYS


MCNAUGHT
LACKNER