ONTARIO GEOLOGICAL SURVEY

Geophysical Data Set 1078

Ontario Airborne Geophysical Surveys
Magnetic and Gamma-Ray Spectrometric Data
Lac des Mille Lacs–Nagagami Lake Area

by

Ontario Geological Survey

2015

Ontario Geological Survey
Ministry of Northern Development and Mines
Willet Green Miller Centre, 933 Ramsey Lake Road,
Sudbury, Ontario P3E 6B5 Canada

Contents

FIGURES

CREDITS

List of accountabilities and responsibilities.

- Jack Parker, Senior Manager, Earth Resources and Geoscience Mapping Section, Ontario Geological Survey (OGS), Ministry of Northern Development and Mines (MNDM) – accountable for the geophysical survey projects, including contract management
- Edna Mueller-Markham, Senior Consulting Geophysicist, Paterson, Grant and Watson Limited (PGW), Toronto, Ontario, Geophysicist under contract to MNDM – responsible for the airborne geophysical survey project management, quality assurance (QA) and quality control (QC)
- Tom Watkins, Manager, Publication Services Unit, GeoServices Section, Ontario Geological Survey, MNDM – managed the project-related hard-copy products
- Desmond Rainsford, Geophysicist, Earth Resources and Geoscience Mapping Section, Ontario Geological Survey – responsible for final quality assurance (QA), quality control (QC) of published digital products
- Goldak Airborne Surveys, Saskatoon, Saskatchewan – data acquisition and data compilation

DISCLAIMER

CITATION

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

Ontario Airborne Geophysical Surveys, magnetic and gamma-ray spectrometric data, grid and profile data (ASCII format) and vector data, Lac des Mille Lacs–Nagagami Lake area; Ontario Geological Survey, Geophysical Data Set 1078a.

Ontario Airborne Geophysical Surveys, magnetic and gamma-ray spectrometric data, grid and profile data (Geosoft® format) and vector data, Lac des Mille Lacs–Nagagami Lake area; Ontario Geological Survey, Geophysical Data Set 1078b.

NOTE

Users of OGS products are encouraged to contact those Aboriginal communities whose traditional territories may be located in the mineral exploration area to discuss their project.

1. Introduction

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

- applicability of the proposed system to the local geology and potential deposit types
- aircraft capabilities and safety plan
- experience with similar surveys
- QA/QC plan
- capacity to acquire the data and prepare final products in the allotted time
- price performance

2. Survey Location and Specifications

2.1. SURVEY LOCATION

The Lac des Mille Lacs–Nagagami Lake survey area is located north of Thunder Bay and trends west to east for nearly 460 km. The geology of the area is mostly represented by the Quetico Subprovince, which lies within the Archean Superior Province and part of Nipigon Embayment of the Proterozoic Southern Province. The simplified geology is shown in Figure 1. The regional geological strike trends approximately east-west.

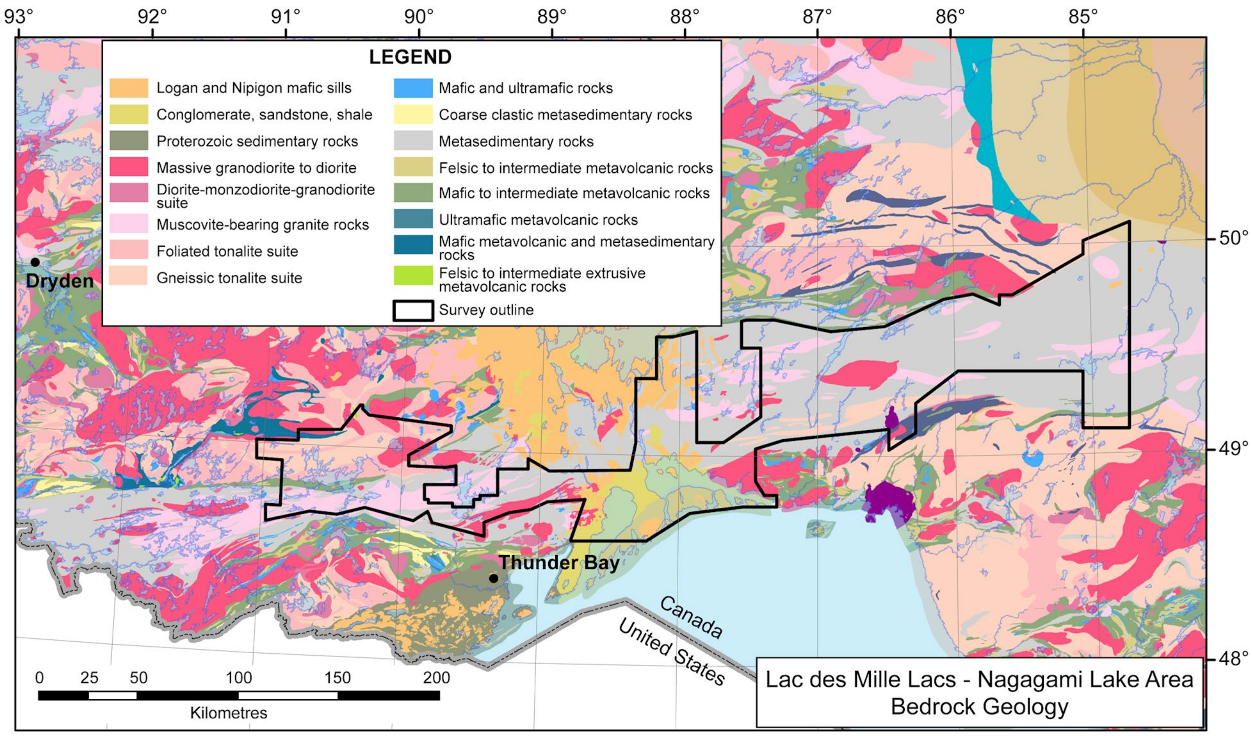


Figure 1. Geology of the Lac des Mille Lacs–Nagagami Lake survey area (*from* Ontario Geological Survey 2011); survey boundary is shown in black.

The western and eastern parts of the survey are dominated by the metasedimentary rocks of the Quetico Subprovince. The Quetico Subprovince is dominated by supracrustal sedimentary sequences mainly of turbiditic wacke and pelite metamorphosed to schist, paragneiss and migmatite with abundant S-type granites and pegmatites derived from the anatexis of sedimentary rocks. The survey also covers a portion of the Marmion terrane in the area north of Lac des Mille Lac. The Marmion terrane is dominated by the Marmion intrusive complex which is composed of tonalite-trondhjemite-granodiorite rocks with elongate greenstone belts located along the west, northern and south margins.

A narrow swath of the Nipigon Embayment is located near the center of the survey, approximately 50 km northeast of Thunder Bay. This area is dominated by the clastic sedimentary rocks of the Sibley Group.

2.2. SURVEY SPECIFICATIONS

The Lac des Mille Lacs–Nagagami Lake area survey specifications and tolerances are as follows:

a) Traverse-line spacing and direction
   - flight-line spacing is 200 m
   - the survey area was flown with lines oriented at 0°/180° (relative to UTM grid). The distance between adjacent flight lines will not exceed 1.25 times the line spacing for a distance of more than 1 km along any flight line.

b) Control-line spacing and direction
   - at regular 2000 m intervals, perpendicular to the flight-line direction
   - tie lines were flown along the 40 survey boundary vectors that were not perpendicular to the traverse lines

c) Terrain clearance of the magnetometers
   - nominal terrain clearance is 100 m and will be consistent with safety of aircraft and crew
   - altitude tolerance limited to ±15 m, except in areas of severe topography
   - altitude tolerance limited to ±10 m at flight-line–control-line intersections except in areas of severe topography

d) Aircraft speed
   - nominal aircraft speed is 55 to 75 m/s

e) Magnetic diurnal variation
   - could not exceed a maximum deviation of 3.0 nT peak-to-peak over a long chord equivalent to 1 minute

f) Magnetometer noise envelope
   - in-flight noise envelope could not exceed 0.1 nT, for straight and level flight
   - base station noise envelope could not exceed 0.1 nT

g) Reflights and turns
   - all reflights of flight-line segments intersected at least 2 control lines
   - all turns at the end of flight lines or control lines took place beyond the survey or block boundaries

3. Aircraft, Equipment and Personnel

Aircraft:

C-GJBB, C-GJBG	Piper® Navajo® PA-31
	4 m composite tail stinger
Demonstrated Figure of Merit	<0.9 nT
Sensor Separation	
Lateral:	584″ 14.783 m
Longitudinal:	384″ 9.754 m

Aircraft Magnetometers:

Manufacturer:	Geometrics
Type and Model Number:	Cesium G-822A
Range:	20 000 to 90 000 nT
Sensitivity:	0.005 nT
Sampling Rate:	10 Hz

Base Station Magnetometers:

Manufacturer:	GEM Systems, Inc.
Type and Model Number:	Overhauser GSM-19W
Range:	20 000 to 120 000 nT
Sensitivity:	0.01 nT
Sampling Rate:	1 Hz

Real-time Magnetic Compensator:

Manufacturer:	RMS Instruments Limited
Type and Model Number:	AADCII
Range:	20 000 to 100 000 nT
Resolution:	0.001 nT
Sampling Rate:	10 Hz

Digital Acquisition System:

Manufacturer:	Goldak Exploration Technology
Type and Model Number:	GEDAS
Sampling Rate:	10 Hz
Data Format:	GEDAS binary

Radiometric System:

Manufacturer:	Radiation Solutions Inc.
Type and Model Number:	RS-500 Digital Gamma Array Spectrometer
Detector Volume:	33.6 L downward, 8.4 L upward
Channels:	1024
Sample rate:	1 Hz

Positioning Cameras:

Manufacturer:	Panasonic
Model:	GPKR402 HRSV
Lens:	WV-LR4R5 4.5 mm
	FOV at 1000 feet; AGL is 1040 by 1300 feet

Barometric Altimeter:

Manufacturer:	Setra Systems, Inc.
Type and Model Number:	270
Range:	–1000 to 10 000 feet
Resolution:	1 m
Sampling Rate:	10 Hz

Radar Altimeter 1:

Manufacturer:	Thompson
Type and Model Number:	CFS 530A
Range:	0 to 8000 feet
Resolution:	1 m
Accuracy:	2%
Sampling Rate:	10 Hz

Radar Altimeter 2:

Manufacturer:	Terra
Type and Model Number:	TRA3000 – TRI40
Range:	40 to 2500 feet
Resolution:	3 m
Accuracy:	5 to 7%
Sampling Rate:	10 Hz

Positioning System:

Manufacturer:	Goldak Exploration Technology Ltd.
Type and Model Number:	GEDAS
Displays:	10″ Colour LCD graphical display Graphic LCD pilot indicator

GPS Subsystem:

Manufacturer:	NovAtel Inc.
Type and Model Number:	OEM4 dual-frequency ProPak™ (×3)
System Resolution:	1 m
Overall accuracy:	3 m in real-time; <1 m post-corrected

Goldak Personnel:

Captain:	Jay Mathieson Denys Lebrun
Co-pilot/Equipment Operator:	Lawrence Ando Darryl Sandhana
Field Processing:	Bill Heath Abbas Shaik
Project Management:	Ben Goldak
Data Processing:	Glen Carson

4. Data Acquisition

4.1. ACQUISTION SUMMARY

Goldak Airborne Surveys was selected by the MNDM to perform the Lac des Mille Lacs–Nagagami Lake area horizontal magnetic gradient and gamma-ray survey, which is centred about 100 km northwest of Thunder Bay, Ontario and covers an area of approximately 22 500 km^2.

The principal geophysical sensors were 3 high-sensitivity cesium vapour magnetometers and a gamma-ray spectrometer linked to 42 L (33.6 L downward-looking and 8.4 L upward-looking crystals) of sodium iodide detectors. Ancillary equipment included a GPS navigation system with a GPS base station, a colour video tracking camera, temperature and pressure sensors, radar and barometric altimeters and 2 base station magnetometers.

Goldak Airborne Surveys utilized 2 of its aircraft—registrations C-GJBB and C-GJBG—for this survey and based its operations out of Thunder Bay and Geraldton, Ontario.

The survey area was flown with traverse lines oriented N-S and perpendicular E-W control lines. The traverse-line spacing was 200 m, whereas the control-line spacing was 2000 m. An additional 40 control lines were flown along the off-angle survey borders. Total survey coverage was 128 344 line-kilometres (115 918 km traverse lines plus 12426 km tie lines).

Aircraft C-GJBG arrived in Thunder Bay on July 15th, 2014, and performed its first production flight on July 18th. Aircraft C-GJBB arrived on July 18th, 2014, and performed its first production flight on July 20th. After completion of the approximate western half of the survey area, on August 31st the base of operations was moved to Geraldton for the remainder of the project. To complete the project, 147 flights were required: 123 production flights and 24 calibration flights. The survey of the Lac des Mille Lacs–Nagagami Lake area was completed on October 29th, 2014.

Magnetic base stations and a GPS base station were installed at each base of operations. The real-time data from the magnetic stations were transmitted to the field office for diurnal monitoring purposes and retained for further use in the total field levelling process. The GPS data were used for post flight differential corrections which improves the accuracy of the raw positioning data to the submetre level.

The locations of the base stations for the Lac des Mille Lacs–Nagagami Lake survey are as follows:

Station	Location	Longitude	Latitude	Elevation (m)
Base Mag 1	Near Thunder Bay airport 1 km south of Airlane Hotel	89° 18’ 26.9" W	48° 22’ 28.7" N	193
Base Mag 2	Within survey block. 33 km northwest of Thunder Bay	89° 26’ 14.4" W	48° 38’ 22.8" N	465
Base GPS	Antenna on roof of Airlane Hotel, Thunder Bay	89° 17’ 57.4199" W	48° 22’ 48.4864" N	163.22
Base Mag 1A	1 km west of Geraldton, later moved	86° 57' 33.80" W	49° 43' 22.48" N	337
Base Mag 1B	1 km south of Geraldton	86° 56' 58.40" W	49° 42' 09.01" N	335
Base Mag 2	4 km southwest of Geraldton	86° 59' 07.8" W	49° 39' 53.4" N	338
Base GPS	Antenna on roof of Chateau Apartments, Geraldton	86° 57' 2.3964" W	49° 43' 28.1460 N	308.24

Field logs detailing production, status and weather conditions were kept and forwarded to the MNDM quality assurance authority on a weekly basis and are included in this document as Appendix C.

4.2. PRESURVEY TESTS AND CALIBRATIONS

The following tests and calibrations were performed prior to data acquisition:

- System lag verification (“lag test”)
- Magnetometer heading check
- Magnetometer figure of merit (“FOM”) check
- Altimeter calibration (“radar stack”)
- Stripping ratio calibration (“pad test”)
- Cosmic calibration
- Altitude attenuation and sensitivity calibration

The pad tests took place in Goldak’s Saskatoon (Saskatchewan) hangar using their set of calibrated test pads. The altitude attenuation and sensitivity calibration was flown over the Geological Survey of Canada (GSC)–approved Danielson calibration range, approximately 100 km south of Saskatoon. Radar stack and lag tests were flown in Saskatoon. The heading tests were flown over the GSC magnetic observatory site near Meanook before commencement of data collection. Several figure of merit flights were undertaken over an area of relatively low magnetic gradient centred approximately 110 km northwest of Thunder Bay.

Further details of these tests are described in the section "*7.1.1 Test and Calibrations"* and the results are provided in Appendix A.

5. Data Compilation and Processing

5.1. PERSONNEL

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

Final Processing:	Glen Carson
Field Processing:	Bill Heath, Abbas Shaikh

5.2. BASE MAPS

Base maps of the survey area were supplied by the Ministry of Northern Development and Mines.

5.2.1. PROJECT DESCRIPTION

Datum:	North American Datum 1983 (NAD83)
Local Datum:	(4 m) Canada
Ellipsoid:	Geodetic Reference System 1980 (GRS 80)
Projection:	UTM (Zone 16N)
Central Meridian:	87° W
False Northing:	0 m
False Easting:	500 000 m
Scale Factor:	0.9996

5.3. PROCESSING OF THE MAGNETIC DATA

5.3.1. INITIAL FIELD PROCESSING

Processing of the magnetic data begins in the field where the raw magnetic, positioning and altitude data from the aircraft acquisition systems is first imported into a Geosoft® Oasis montaj™ database on a line basis. The magnetic base station data, logged during the corresponding flight time, were then merged with the flight data for display and quality control checks.

A system latency correction, determined from the presurvey lag test of 0.4 seconds for the tail magnetometer data and 0.3 seconds for the wing-tip magnetometer data, is then applied.

The raw, measured magnetic gradients are normalized using the known aircraft sensor separations and aircraft direction to give consistently signed gradient values in units of nT/m. A correction matrix, derived from the attitude data, is then applied scaling them to provide true longitudinal and transverse gradient values parallel to and perpendicular to the ideal line direction.

Quality-control procedures described in the section "*7.1.2 Daily Field Quality Control"* are also performed at this time.

5.3.2. Control-Line Levelling

The intention of control-line levelling is to apply a smoothly varying function to the measured data, which results in nearly identical values at the intersections of traverse and control lines. The most significant component of the correction is to accommodate the diurnal variation of the magnetic field. Other sources of error are altitude errors, GPS positioning errors and system drift.

Levelling of the total field data consists of the following steps:

1. Calculation of the positions of the survey-line–control-line intersection points and the extraction of mismatch values of the magnetic data between the line and control lines at these points.
2. An iterative application of corrections, based on best-fit, first-order linear trends of mismatch values (with outliers removed), on the traverse and control lines until the resulting corrections approach zero.
3. An iterative application of long-wavelength corrections on traverse and control lines determined by applying median and low-pass filters to the remaining intersection mismatches (with outliers removed) and then using Akima spline interpolation between the now-filtered intersection mismatch values. This enhances and isolates correction "features" that span several intersections. The lengths of the filters are based on the traverse-line–control-line intersection separations. In this case, the initial filter lengths spanned 10 control-line intersections on survey lines and 50 survey-line intersections on control lines. The number of intersections spanned is reduced in increments to an appropriate minimum until the correction approaches zero.
4. Calculation of the first vertical derivative from the gridded data of the intermediate levelled total field using a 2-D fast Fourier transform (FFT) operator.
5. An altitude correction derived by multiplying the calculated vertical gradient by the aircraft's deviation from the planned surface height is then applied to the original unlevelled magnetic data.
6. Steps 1 to 3 are then repeated using the altitude-corrected magnetic data.
7. Manual inspection of the remaining intersection mismatches and reducing it to zero (where appropriate) by applying the necessary corrections to either the survey or tie lines. Special attention is paid to ensuring that the overall correction profiles are as smooth as possible and that there is no line-to-line correlation in the correction profiles, which implies a misapplied correction.
8. The second vertical derivative of the total field grid is analyzed to ensure that the corrections are sufficient and appropriate. Features that appear along the survey lines in the second vertical derivative may be the result of over-correction or under-correction. In either case, the solution is to revise the correction profile at those intersections.

5.3.3. Calculation and Removal of the International Geomagnetic Reference Field

The International Geomagnetic Reference Field (IGRF) was calculated using the 2005 model year with a constant date of September 7, 2014 (roughly the midpoint of the survey) as the reference date. A constant altitude of 483.93 m, the mean altitude over the course of the survey, was specified as the elevation. This value was subtracted from the tie-line levelled data to obtain the residual magnetic field data.

5.3.4. MICROLEVELLING OF THE MAGNETIC DATA

After control line levelling, any residual flight line noise or "corrugation" in the magnetic field data was further reduced using Paterson, Grant and Watson's microlevelling technique. This technique first involves the generation of line-to-line noise profiles by applying frequency domain sixth-order, high-pass Butterworth filter and a directional cosine filter perpendicular to the flight-line direction to the gridded data. This "decorrugation" grid is then sampled back into the database. The initial noise profile data are then limited to a user-defined maximum amplitude and then filtered using a Naudy–Dreyer nonlinear filter (Naudy and Dreyer 1968) to obtain the microlevelling correction. Finally, the correction and gridded microlevelled data are inspected to ensure no geological signal was removed and an overall improvement in the gridded data was achieved.

The following parameters in Paterson, Grant and Watson's "Miclev" routine were used:

- Decorrugation wavelength cutoff: 800 m
- Decorrugation grid cell size: 40 m
- Naudy filter length: 400 m
- Naudy filter tolerance: 0.0001
- Amplitude limit: 3 nT

5.3.5. GEOLOGICAL SURVEY OF CANADA DATA LEVELLING

In 1989, as part of the requirements for the contract with the Ontario Geological Survey to compile and level all existing Geological Survey of Canada (GSC) aeromagnetic data (flown prior to 1989) in Ontario, Paterson, Grant and Watson Limited developed a robust method to level the magnetic data of various base levels to a common datum provided by the GSC as 812.8 m grids. The essential theoretical aspects of the levelling methodology were fully discussed in Gupta et al. (1989) and Reford et al. (1990). The method was later applied to the remainder of the GSC data across Canada and the high-resolution airborne magnetic and electromagnetic surveys flown by the OGS (Ontario Geological Survey 1996). It has since been applied to all newly acquired OGS aeromagnetic surveys.

a) Terminology

Master grid: refers to the 200 m Ontario magnetic grid compiled and levelled to the 812.8 m magnetic datum from the Geological Survey of Canada

GSC levelling: the process of levelling profile data to a master grid, first applied to GSC data

Intrasurvey levelling or microlevelling:
refers to the removal of residual line noise described earlier in this section; the wavelengths of the noise removed are usually shorter than tie-line spacing

Intersurvey levelling or GSC levelling:
refers to the level adjustments applied to a block of data; the adjustments are the long wavelength (in the order of tens of kilometres) differences with respect to a common datum, in this case, the 200 m Ontario master grid, which was derived from all pre1989 GSC magnetic data and adjusted, in turn, by the 812.8 m GSC Canada-wide grid

b) The GSC Levelling Methodology

While the typical GSC levelling process uses a combination of nonlinear filters, the shape and magnetics of the Lac des Mille Lacs–Nagagami Lake survey block necessitated a slightly differing method using a combination of median and low-pass filters to obtain an adequate the final correction grid.

The magnetic data after control-line levelling, microlevelling and IGRF removal is used as input to the GSC levelling procedure.

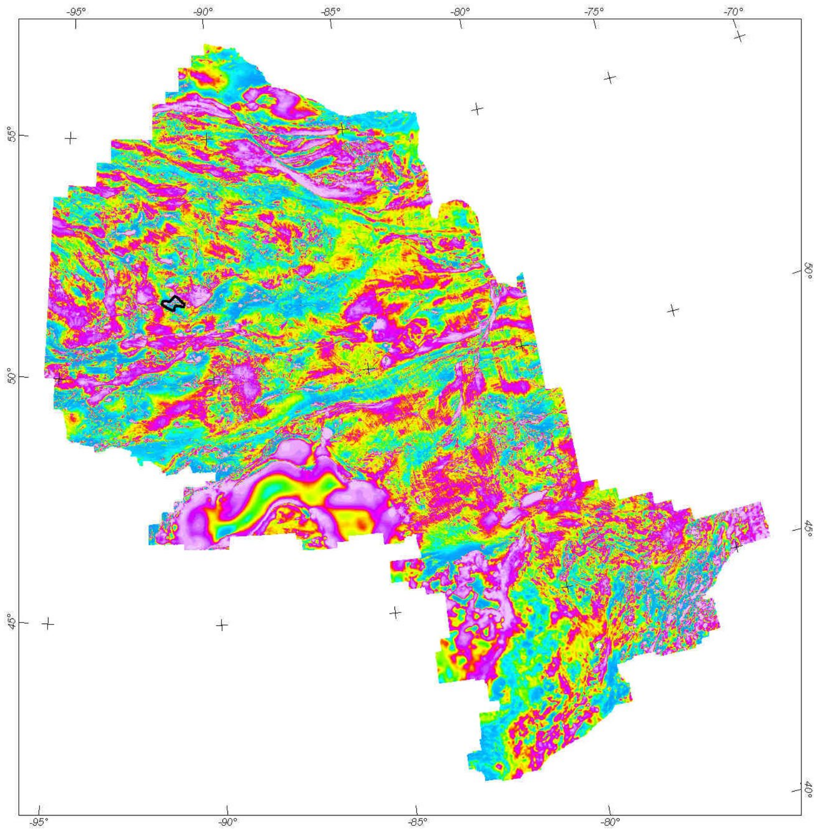


Figure 2. Ontario master aeromagnetic grid (Ontario Geological Survey 1999).

The steps in the GSC levelling process are as follows:

1. Created an upward continuation of the survey grid to 305 m.

   Almost all recent surveys (1990 and later) to be compiled were flown at a nominal terrain clearance of 100 m or less. The first step in the levelling method is to upward continue the survey grid to 305 m, the nominal terrain clearance of the Ontario master grid (Figure 2).

   The grid cell size for the survey grids is set at 100 m. Since the wavelengths of level corrections will be greater than 10 to 15 km, working with 100 m or even 200 m grids at this stage will not affect the integrity of the levelling method. Only at the very end, when the level corrections are imported into the databases, will the level correction grids be regridded to 1/5 of line spacing.

   The unlevelled 100 m grid is extended by at least 2 grid cells beyond the actual survey boundary, so that, in the subsequent processing, all data points are covered.

2. Created a difference grid between the survey grid and the Ontario master grid.

   The difference between the upward-continued survey grid and the Ontario master grid, re-gridded at 100 m, is computed (Figure 3). The short wavelengths represent the higher resolution of the survey grid. The long wavelengths represent the level difference between the 2 grids.

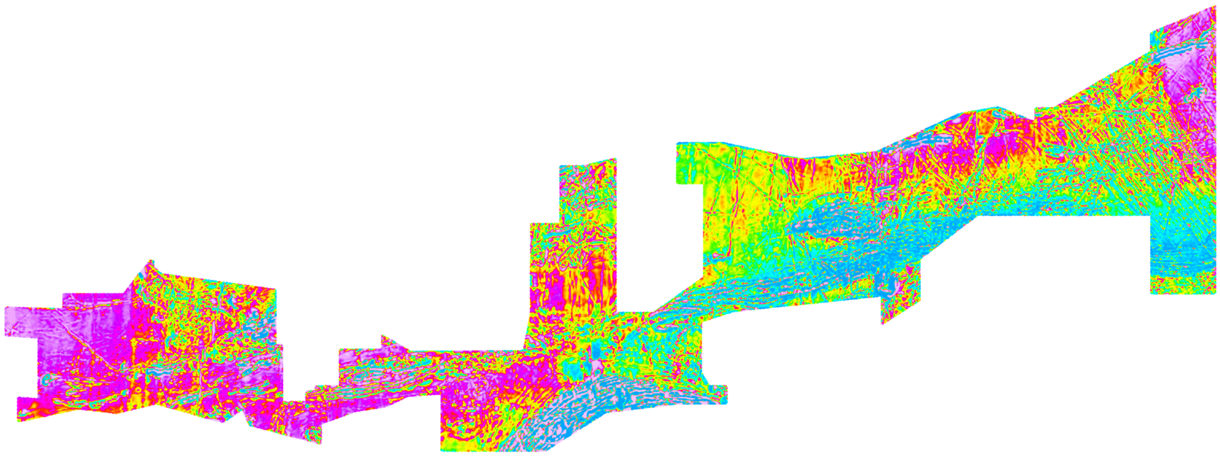


Figure 3. Difference grid (difference between survey grid and master grid).

3. Applied the first pass of a median and lowpass filter of wavelength on the order of 30 km along the flight-line direction. Reapplied the same filters across the flight-line direction.
4. Applied the second pass of median and lowpass filter of wavelength on the order of 15 km along the flight-line direction. Reapplied the same filters across the flight-line direction.

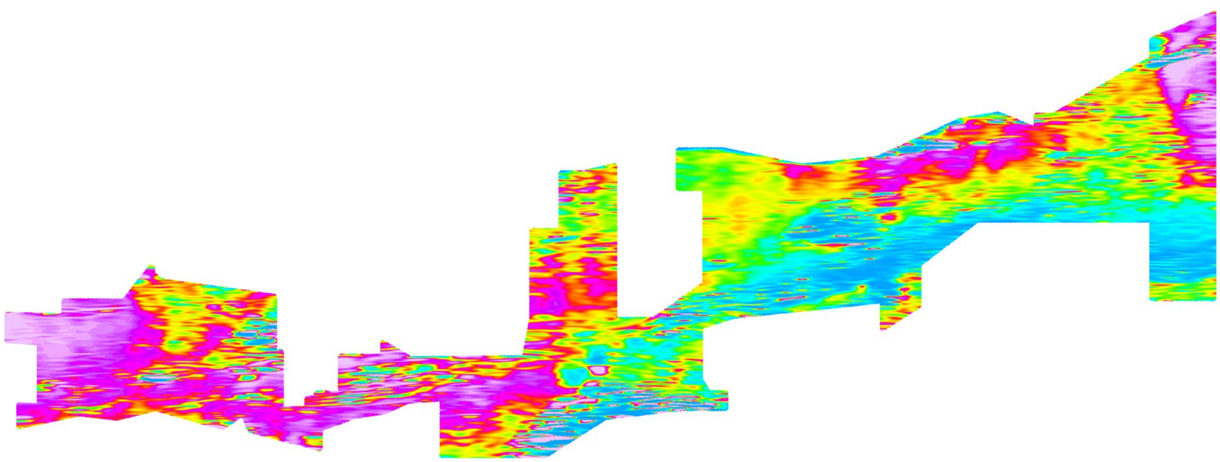


Figure 4. Difference grid after application of across-line filter.

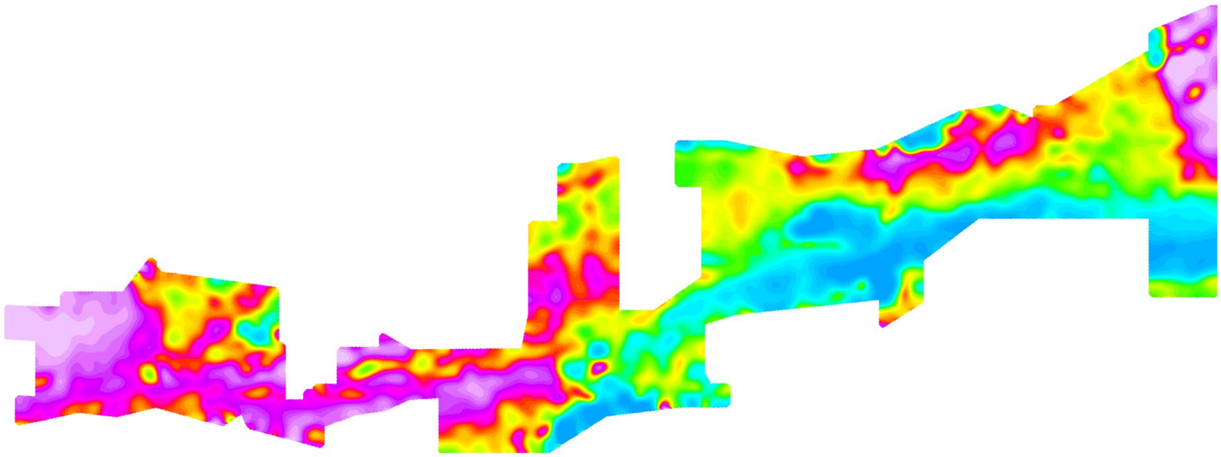


Figure 5. Level correction grid.

5. Regridded to 1/5 line spacing and imported level corrections into database.
6. Subtracted the level correction channel from the unlevelled channel to obtain the level corrected channel.
7. Final minimum curvature grid created with cell size at 1/5 of line spacing used as input to the gradient enhancement routine.

c) Parameters

The following GSC levelling parameters were used in the Lac des Mille Lacs–Nagagami Lake survey:

- Upward continuation distance: 205 m
- First pass median filter lengths: 30 000 m
- Second pass median filter lengths: 15 000 m
- Low-pass filter cut-off wavelength: 10 000 m

5.3.6. PROCESSING OF MEASURED MAGNETIC GRADIENTS

Processing of the magnetic gradient data consists of the following steps:

1. Attitude correction, as described in section 5.3.1, is performed before levelling the gradient information. The effect of attitude on a particular measurement is dependent on the magnitude of the local gradient and the degree of deviation from straight and level flight. This compound effect cannot be accounted for by tie-line levelling of the data, as it is both nonsystematic and at a much shorter wavelength than the tie-line separation. Correcting the data for attitude before levelling insures that levelling corrections are kept to a minimum.
2. Horizontal gradients are calculated from the gridded total field data, sampled into the database and subtracted from the measured, rotated gradients.
3. A 31 second median filter followed by a 31 second low-pass filter is applied to the difference and then added back to the measured gradient. This ensures that the lower wavelengths accurately represent the regional field, which is otherwise difficult to achieve.

5.3.7. GRADIENT-ENHANCED GRIDDING

Gradient enhancement of the total magnetic field grid was achieved using Goldak's Gradient Variable Trend (GVT) gridding algorithm, which utilizes the horizontal gradients to guide the between-line interpolation of the data to generate a more realistic image free of artifacts and irregularities present grids generated from minimum curvature algorithms.

5.3.8. CALCULATION OF VERTICAL DERIVATIVES OF THE RESIDUAL MAGNETIC FIELD

The final grid of the magnetic field values is then used as input to create the first and second vertical derivatives for both the tail sensor and gradient-enhanced magnetic grids. The calculation is done in the frequency domain by use of a transfer function of the first and second vertical derivatives, respectively. Additionally, a small low-pass filter (200 m, Order 5 low-pass Butterworth filter) aimed at attenuating the high frequency signal enhanced by the second derivative operator, without aliasing the geological signal was applied to the second vertical derivative grid. The second vertical derivative grid is presented on the maps because of its superior rendition of the magnetic anomalies.

5.3.9. CALCULATION OF THE KEATING COEFFICIENTS

The magnetic signatures of kimberlite pipes are approximately circular anomalies. Through pattern recognition analysis of a moving window, first-order regression between the analytic signal of the residual magnetic field grid and the theoretical signature of a magnetic vertical cylinder, correlation coefficients are derived (Keating 1995). Where the correlation meets some threshold, the location, magnitude and sign of the correlation, expressed as a percentage are retained and can be plotted on a magnetic map. Increasing values in magnitude of the coefficient signify a goodness of fit with a cylindrical model, whereas sign signifies the direction of magnetization as some kimberlite pipes acquired magnetization during a time of geomagnetic field reversal.

The Keating coefficients were calculated using the Oasis Montaj™ executable kimberlite.gx with the following parameters:

- Flying Height: 100 m
- Depth to Top 104 m
- Overburden 4 m
- Correlation Threshold: 0.75
- Grid Cell Size: 40 m
- Window Size 17 × 17 cells
- Cylinder radius 100
- Cylinder length infinite
- Magnetization 100
- Field Inclination: 74.6°
- Field Declination: –5.2°

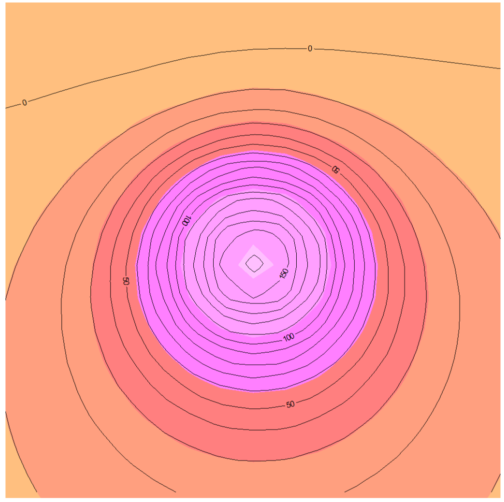


Figure 6. Keating Model

It is important to be aware that other magnetic sources may correlate well with the vertical cylinder model, whereas some kimberlite pipes of irregular geometry may not. The user should study the magnetic anomaly that corresponds with the Keating symbols, to determine whether it does resemble a kimberlite pipe signature, reflects some other type of source or even noise in the data e.g., boudinage (beading) effect of the minimum curvature gridding. All available geological information should be incorporated in kimberlite pipe target selection.

5.4. PROCESSING OF RADIOMETRIC DATA

All radiometric raw channels were background corrected from overwater background line segments, flown pre- and postflight, in the field for quality control.

The processing methodology was as described in *Airborne Gamma Ray Spectrometer Surveying Report* by the International Atomic Energy Agency (IAEA) (International Atomic Energy Agency 1991). In this case, no energy calibration or dead-time correction was done as the dead time is typically much less than 0.1% with the Radiation Solutions Inc. system.

5.4.1. SPECTRAL NOISE REDUCTION

Statistical noise reduction in the radiometric data was accomplished using Goldak's GET NASVD software. In the process, groups of observed spectra are first scaled to yield a constant variance in each channel. These adjusted groups of spectra are then factorized to component matrices using a singular value decomposition (SVD) routine such that:

$$N = USV^T$$

where,

N = adjusted data matrix of size n samples by m channels
S = m by n matrix where the diagonal elements are the ranked singular values of N
U = orthogonal n by n matrix
V = orthogonal m by m matrix the columns of which are the principle components of N

The bulk of the original signal is contained in the lower order components while the higher order components can be regarded as statistical noise. By reconstructing the data using only the lower order components, "smoothed" spectra are produced with less over-all noise. Count rates in the total count, potassium, thorium and uranium windows are then extracted from these noise-reduced spectra and imported to an Oasis montaj™ database for further processing.

5.4.2. Filtering of the Cosmic and Upward Uranium Channels

Variations in the cosmic channel are of long wavelength and usually attributed to changes in altitude or atmospheric conditions. A 200 point low-pass filter is applied on a flight-by-flight basis to the cosmic channel to allow for a smooth correction, free of statistical noise in the process described in section "*5.4.3 Cosmic Background Corrections*". Similarly, the upward uranium channel, used in the correction of atmospheric radon, is highly susceptible to statistical noise due to generally low count rates. A 30 point low-pass filter, again on a flight-by-flight basis, is applied to the upward-looking uranium channel.

5.4.3. Cosmic Background Corrections

Radiation in the 3 to 6 MeV range, the cosmic channel, is attributed to non-Earth sources and can be considered as pure noise, in that it has no relationship with the desired geological signal. As such, it can be measured independently and used to remove the cosmic component in lower energy windows.

Theory suggests that the cosmic measurement should increase linearly as altitude increases, provided there is no contamination from radon. Methodology for the removal of the cosmic background involves a cosmic calibration flight where measurements are taken at a variety of heights from 3500 to 12 000 feet altitude. Linear regressions are derived for each of the regions of interest relative to the cosmic channel. The slope yields the "cosmic stripping ratio" and the y-intercept is, in theory, the aircraft background.

The correction applied is then expressed as

$$N_i = (a_i * C) + b_i$$

where,

N_i = cosmic correction in the i'th channel;
a_i = cosmic stripping ratio in the i'th channel;
C = counts in cosmic window (3 to 6 MeV);
b_i = aircraft background in the i'th channel.

In practice, the aircraft background derived in this fashion can be unreliable.

The cosmic stripping ratios for each aircraft determined from the respective cosmic calibration flights are listed below. A complete summary of the tests are listed in Appendix A.

	C-GJBG	C-GJBB
a_{TC}	1.171	1.121
a_K	0.067	0.063
a_{Th}	0.054	0.053
a_u	0.069	0.067
a_{upu}	0.014	0.014

5.4.4. Aircraft Background Corrections

The aircraft background, derived from the cosmic calibration test described in section "*5.4.3 Cosmic Background Corrections*"., is not reliable, likely because of the small number of data points in each flight and some nonlinearity in the relationship between counts in the cosmic and ROI (region of interest) windows at lower altitudes. It is also difficult to obtain a data set that is untainted by radon contamination. As an alternative, an iterative process was used to determine the final aircraft backgrounds. Initially, a background value of zero is assumed for each channel and cosmic and radon corrections are applied. Then, the overwater repeat lines are averaged for each aircraft and added to the background. The process is repeated until the overwater values average zero.

The values below are the final backgrounds applied as determined from the above method and are not those from the cosmic calibration flight.

	C-GJBG	C-GJBB
b_{TC}	46.1	36.1
b_K	18	12.3
b_U	-0.7	-0.76
b_{Th}	-2.6	-2.4
b_{upu}	-0.2	-0.08

5.4.5. Radon Background Corrections

Radon concentrations vary from flight to flight and are affected by weather and topography. A variety of methods can be used to model and remove this signal. The upward detector, which is mostly shielded from geologic signal by being centred above 4 downward detectors, is used to estimate the contribution of atmospheric radon into the downward uranium channel, U_r, and overwater tests are used to determine the ratio between radon in the uranium window and radon contributions to the other windows.

After cosmic and background corrections have been applied, the signal detected over water is solely due to atmospheric radon. Overwater "backgrounds" are flown at the beginning and end of every flight to collect data with a variety of ambient radon concentrations.

These data are averaged and analyzed to solve the following equations by linear regressions:

$$u_r = a_U * U_r + b_U$$
$$K_r = a_K * U_r + b_K$$
$$Th_r = a_{Th} * U_r + b_{Th}$$
$$TC_r = a_{TC} * U_r + b_{TC}$$

where,

u_r =the radon component in the upward U window;

K_r , U_r , Th_r , TC_r =the radon components in the various windows of the downward detectors (where K = potassium; U = uranium; Th = thorium; TC = total count);

a_i =coefficients are the calibration constants determined by linear regression;

b_i =coefficients are now near-zero after removal of aircraft and cosmic backgrounds.

The a_i coefficients, determined by linear regression of count rates in the i'th window to downward uranium count rates of the overwater test data for each aircraft, are as follows:

	C-GJBG	C-GJBB
a_{TC}	15.423	15.128
a_K	0.870	0.873
a_{Th}	0.077	0.098
a_u	0.293	0.272

The radon contribution to the downward uranium window, U_r, can be determined from

$$U_r = \frac{(u - a_1 * U - a_2 * Th + a_2 * b_{Th} - b_U)}{(a_U - a_1 - a_2 * a_{Th})}$$

where,

u	=	count rate in the upward uranium window;
U , Th	=	count rates in the uranium and thorium windows;
a_U	=	ratio of upward uranium counts to downward uranium counts in the overwater data;
a_{Th}	=	ratio of thorium counts to downward uranium counts in the overwater data;
b_U , b_{Th}	=	the small non-zero background in the uranium and thorium channels after removal of cosmic and aircraft backgrounds;
a_1 , a_2	=	covariance coefficients that relate counts in the downward uranium and thorium channels to counts in the upward uranium channels. These are determined in the following process.

The signal measured in the upward uranium window is made up of a contribution from atmospheric radon and a geologic component due to radioactive sources in the ground. This component (u_g) has a linear relationship with the downward uranium (U_g) and thorium (Th_g) given by

$$u_g = a_1 * U_g + a_2 * Th_g$$

Values of u_g, U_g and Th_g are found by analyzing the differences in count rates in each window for adjacent sections of survey lines. Differences between count rates are found at some interval, m, in the upward and downward uranium and thorium channels. Where the overall radioactivity was decreasing, as evidenced by the difference in the total count window, the sign of the differences was reversed.

$$U_g = (U_n - U_{n+m})$$

$$Th_g = (Th_n - Th_{n+m})$$

$$u_g = (u_n - u_{n+m})$$

The differences then are accumulated over the entire survey to determine the calibration factors for upward uranium to downward uranium and thorium for sources in the ground by solving the simultaneous linear equations:

$$\sum(u_g * U_g) = a_1 * \sum(U_g)^2 + a_2 * \sum(U_g * Th_g)$$

and

$$\sum(u_g * U_g) = a_1 * \sum(U_g * Th_g) + a_2 * \sum((Th_g)^2$$

where the summation is carried out over all (n) points in the database. The following coefficients were determined for each aircraft:

	C-GJBG	C-GJBB
a_1	0.0368	0.0390
a_2	0.0522	0.0583

5.4.6. Spectral Stripping Corrections

The spectra of the potassium, uranium and thorium series overlap. Because of this, each spectral window contains counts due to each of the other windows. This can be corrected by "stripping" the data using coefficients derived by obtaining measurements over concrete pads with known radioelement concentrations. Each crystal pack was tested prior to the survey with Goldak's calibrated test pads. The first 3 coefficients vary with height above ground; the attenuation values used are standard values from the IAEA reports.

	C-GJBG			
	Average	DPU 5552	DPU 5553	Δ / m
α	0.29404	0.29107	0.29701	0.00049
β	0.43832	0.42700	0.44964	0.00065
γ	0.80901	0.79208	0.82594	0.00069
a	0.05220	0.04966	0.05475	
b	-0.00019	0.00016	-0.00053	
g	-0.00178	-0.00159	-0.00198	

	C-GJBB			
	Average	DPU 5407	DPU 5621	Δ / m
α	0.29469	0.29441	0.29498	0.00049
β	0.43896	0.43492	0.44299	0.00065
γ	0.79224	0.78270	0.80178	0.00069
a	0.05253	0.05090	0.05416	
b	-0.00058	-0.00080	-0.00037	
g	0.00730	0.00714	0.00747	

Given the background corrected count rates in the potassium, uranium and thorium windows (N) and stripping matrix (S) the stripped count rates in each window (A) can be calculated as follows:

$$A = S^{-1}N$$

or

$$\begin{bmatrix} K_{strip} \\ U_{strip} \\ Th_{strip} \end{bmatrix} = \begin{bmatrix} 1 & \gamma & \beta \\ g & 1 & \alpha \\ b & a & 1 \end{bmatrix}^{-1} * \begin{bmatrix} K_{bg} \\ U_{bg} \\ Th_{bg} \end{bmatrix}$$

which yields:

$$K_{strip} = \frac{Th_{bg} * (\alpha * \gamma - \beta) + U_{bg} * (a * \beta - \gamma) + K_{bg} * (1 - a * \alpha)}{\det(S)}$$

$$U_{strip} = \frac{Th_{bg} * (g * \beta - \gamma) + U_{bg} * (1 - b * \beta) + K_{bg} * (b * \alpha - g)}{\det(S)}$$

$$Th_{strip} = \frac{Th_{bg} * (1 - g * \gamma) + U_{bg} * (b * \gamma - a) + K_{bg} * (a * g - b)}{\det(S)}$$

where,

$$\det(S) = 1 - g * \gamma - a * (\gamma - g * \beta) - b * (\beta - \alpha * \gamma)$$

5.4.7. Calculation of Effective Height

The height of the detectors must be corrected to standard temperature and pressure (*STP*) height to account for the attenuating properties of changes in air density on count rates. This effective height, h_e, is calculated from the formula below:

$$h_e = h * \left(\frac{273.15}{T + 273.15}\right) * \left(\frac{P}{1013.25}\right)$$

where,

h = the observed height above ground level (AGL) in metres;
T = temperature in degrees Celsius;
P = barometric pressure in millibars.

5.4.8. Height Attenuation Correction and Conversion to Radioelement Concentrations

Each aircraft was flown over the Geological Survey of Canada–approved Danielson test range, located approximately 100 km south of Saskatoon, Saskatchewan, to determine its respective system sensitivities and height attenuation coefficients. These parameters are installation specific and relate to the detector crystal packs used, the aircraft and the location of the equipment within the aircraft. A calibrated meter was used to traverse the test range while the aircraft was flying over at several altitudes. The data are background corrected by immediately flying over nearby water at the same height. They are then stripped and reduced to survey height. The system sensitivities are the ratios of counts to the measured concentrations. The attenuation coefficient is then derived from the exponential relationship between the stripped counts at the various heights.

C-GJBG				
Altitude Attenuation Coeff.			Sensitivities	
Total Counts (c/s/m)	-0.00705		Total Counts (c/s/nGy/h)	23.1730
Potassium (c/s/m)	-0.00895		Potassium (c/s/%)	66.2274
Uranium (c/s/m)	-0.00756		Uranium (c/s/ppm)	6.5866
Thorium (c/s/m)	-0.00711		Thorium (c/s/ppm)	3.9680

C-GJBB				
Altitude Attenuation Coeff.			Sensitivities	
Total Counts (c/s/m)	-0.00719		Total Counts (c/s/nGy/h)	23.1384
Potassium (c/s/m)	-0.00920		Potassium (c/s/%)	64.0440
Uranium (c/s/m)	-0.00728		Uranium (c/s/ppm)	6.5332
Thorium (c/s/m)	-0.00719		Thorium (c/s/ppm)	3.9255

The survey data in each window are first reduced to the observed count rate at standard temperature and pressure (*STP*) height and then scaled by the sensitivity to determine the final ground concentration, C, using the following equation

$$C = \frac{n_0 e^{-\mu(H-h)}}{S}$$

where,

n_0	=	stripped count rate;
e	=	Euler's constant
μ	=	window attenuation coefficient;
H	=	nominal survey terrain clearance;
h	=	standard temperature and pressure (STP) height above ground of observation;
S	=	sensitivity.

5.4.9. MICROLEVELLING OF THE RADIOELEMENT CONCENTRATION DATA

As a final step to enhance the data for display purposes, any remaining line noise in the dose rate and equivalent uranium channels were removed through microlevelling. No microlevelling adjustment was applied to the equivalent thorium and percent potassium channels as they contained little to no line noise.

The following parameters in Paterson, Grant and Watson's "Miclev" routine were used:

- Decorrugation wavelength cutoff: 800 m
- Decorrugation grid cell size: 40 m
- Naudy filter length: 400 m
- Naudy filter tolerance: 0.0001
- Dose rate amplitude limit: 1.25 nGy per hour
- Uranium amplitude limit: 0.3 ppm

5.4.10. CALCULATION OF THE ELEMENTAL RATIOS

Because corrected count rates frequently go to zero or even negative values over water, a simple mathematical ratio is not meaningful and is not useful in the calculation of elemental ratios. The standard procedure is to sum neighbouring points until some threshold, equivalent to 100 counts, is met in both the numerator and denominator and then calculate the ratio. If the threshold isn't reached within 50 samples, then the point is ignored. This minimizes the statistical error in the data and cleans up the "blow-ups" that would occur when the denominator went to zero. Additionally, no ratio is calculated at locations where the potassium concentration is less than 0.25%.

The ratio grid was derived in a similar fashion from the grids of elemental concentrations. In this case, the values are summed at an increasing radius from the centre point until the threshold is met or a maximum radius of 1000 m is reached. At each step, 4 more points were added to the sum, to account for the circular symmetry. No ratio was calculated where the potassium counts were less than 100.

5.4.11. GENERATION OF THE TERNARY RADIOELEMENT IMAGE

The ternary map is produced by scaling the distribution of uranium, potassium and thorium against cyan, magenta and yellow, respectively. In this case, the data were processed using the GSC's S-Tergen utility, which normalizes the data and applies an optimum colour distribution. The algorithm used is as described in Broome et al. (1987).

5.5. PROCESSING OF THE POSITIONING AND ALTITUDE DATA

Processing of the positioning data takes place in the field and is performed on a postflight basis.
The following procedures are included in positioning and altitude data processing:

1. The raw airborne GPS data are corrected using the corresponding GPS base station data and NovAtel® Inc.'s Waypoint® GrafNav® GNSS Post-Processing software suite.

2. The corrected GPS World Geodetic System 1984 (WGS84) longitude, latitude and altitude are merged into a Geosoft® database with aircraft flight data and reprojected to the local UTM datum (NAD83). Velocity is then calculated from the corrected positions. Corrected UTM co-ordinates are trimmed to online.
3. The primary radar altimeter data are lagged by 0.9 seconds and the secondary radar altimeter data are lagged by 3.0 seconds.
4. The digital elevation model is calculated by subtracting the radar altimeter data from the GPS altitude data.
5. Attitude information is derived from 3 GPS receivers mounted on the tail, cabin and right wingtip. Moving baseline software by Waypoint® is used to compute the relative positions of the antennas. By determining the relative apparent positions of the front–right and front–tail antenna pairs and comparing to the known reference geometry of the aircraft, the pitch, roll, azimuth and yaw of the aircraft are calculated to better than 0.5° precision.

In addition, all quality-control checks, described in section "*7.1.2 Daily Field Quality Control*, are performed at this time.

Note that because of the shape of the survey block, there are several areas of over-flight between boundaries directly north and south of each other, flown for the sake of survey efficiency. While data over these overflight zones have been retained, the magnetic data in these areas have not been levelled. Final UTM northing and easting co-ordinates have been windowed to the actual survey extents. The over-flight co-ordinates are retained in the final longitude and latitude channels, should users wish to work with data in these regions.

6. Final Products

The following products were delivered to MNDM.

a) Profile Databases
Databases, in both Geosoft® *gdb* and ASCII format, of the following, were provided:
- Magnetic line data archive
- Radiometric line data archive
- Keating coefficient archive

b) Gridded Data
Grids, in both Geosoft® *grd* and *gxf* formats, gridded from co-ordinates in UTM Zone 16N, NAD83, of the following data:
- digital elevation model
- total magnetic field from the tail sensor
- first vertical derivative of the total magnetic field from the tail sensor
- second vertical derivative of the total magnetic field from the tail sensor
- GSC-levelled, gradient-enhanced residual magnetic field
- calculated first vertical derivative of the GSC-levelled gradient-enhanced residual magnetic field
- calculated second vertical derivative of the GSC-levelled gradient-enhanced residual magnetic field
- measured lateral horizontal gradient
- measured longitudinal horizontal gradient
- total air-absorbed dose rate

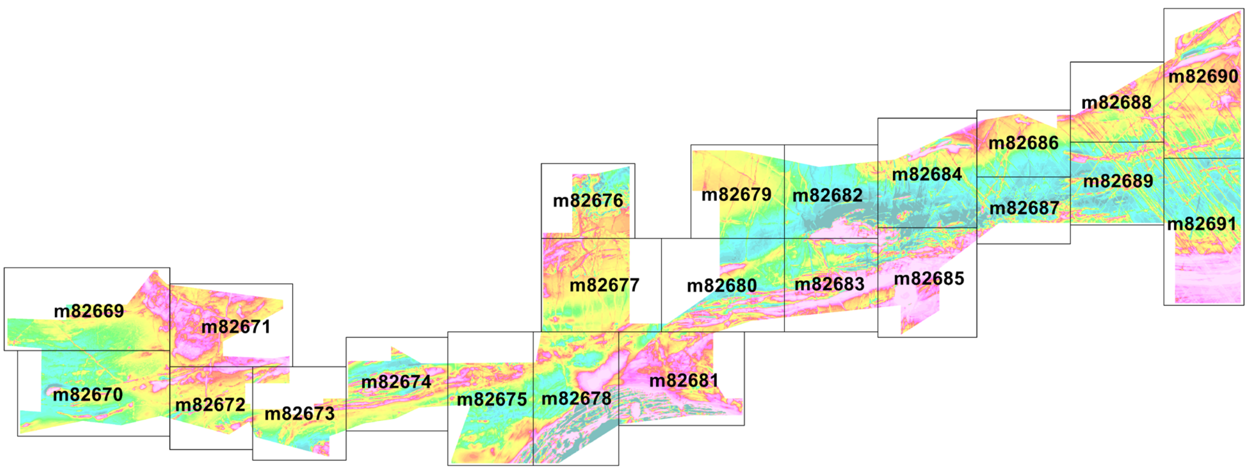
- percent potassium
- equivalent ppm uranium
- equivalent ppm thorium
- ratio of potassium to thorium

c) Project Report
Provided in portable document format (*pdf*)

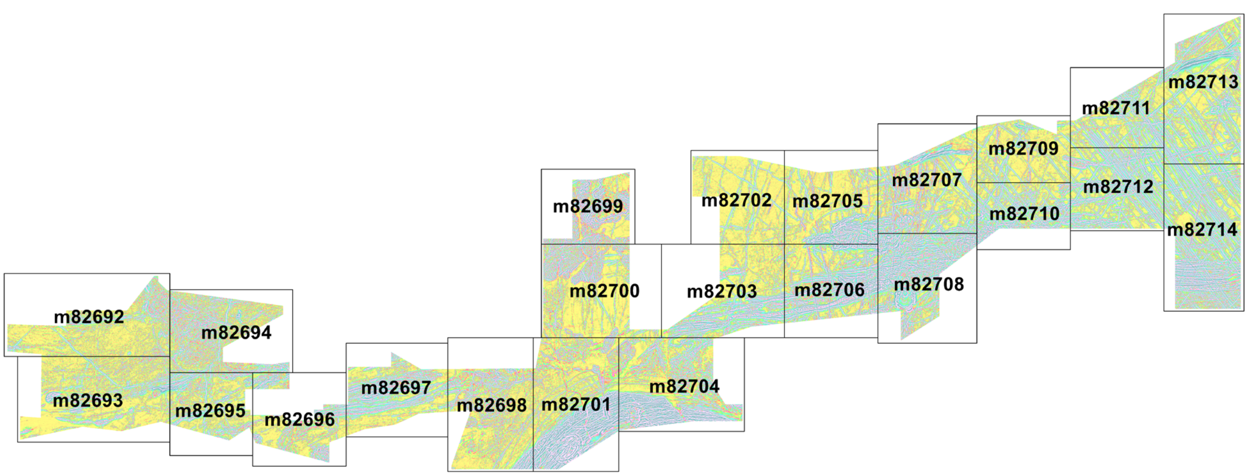
d) Flight Videos
The digitally recorded video from each survey flight are provided (upon request) in a compressed binary format on an external hard drive.

e) Maps
Digital 1:50 000 scale maps (NAD83 UTM Zone 16N) in Geosoft® MAP format, with a topographic layer, of the following:

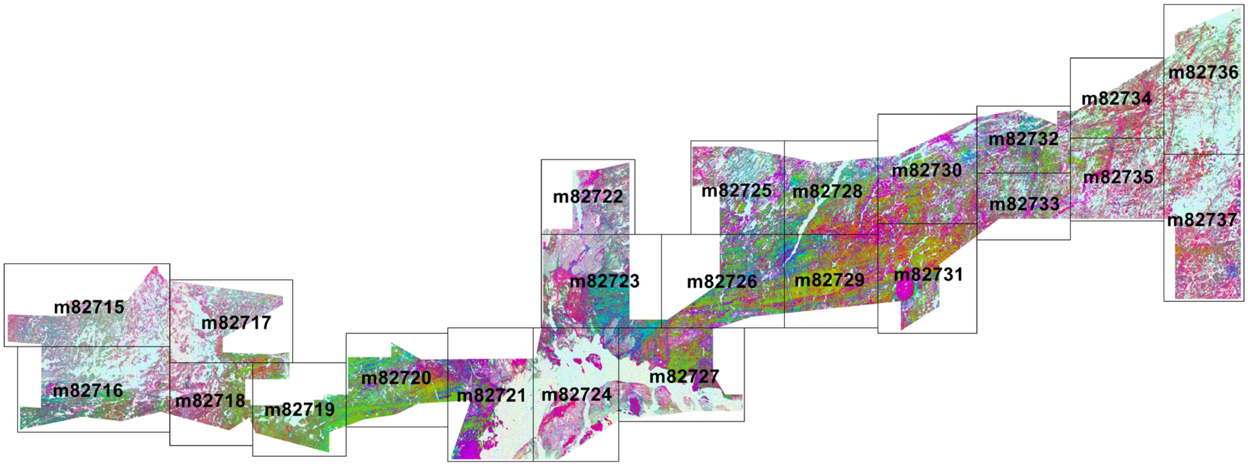
- colour-filled contours of gradient-enhanced residual magnetic field and flight lines (with the following tile names and layout, where "m82xxx" indicates OGS Map 82xxx):



- shaded colour image of the second vertical derivative of the the GSC-levelled gradient-enhanced total magnetic intensity with Keating coefficients (with the following tile names and layout, where "m82xxx" indicates OGS Map 82xxx):



- histogram-equalized ternary RGB (converted from cyan-magenta-yellow) radioelement image and flight lines, with inset images of percent potassium, equivalent uranium, equivalent thorium (with the following tile names and layout, where "m82xxx" indicates OGS Map 82xxx):



f) Georeferenced Image Files

Geographically referenced colour images (NAD83 UTM Zone 16N) of the survey area divided in to 4 sections, incorporating a base map, in GeoTIFF format:

- "GSC levelled" gradient-enhanced residual magnetic field grid + planimetric base
- shaded second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field grid + planimetric base
- total count grid + planimetric base
- potassium grid + planimetric base
- equivalent uranium grid + planimetric base
- equivalent thorium grid + planimetric base
- potassium, uranium, thorium ternary image + planimetric base

g) Vector Files

Vector line files in *dxf* (v.12) ASCII format, in NAD83 UTM Zone 16N coordinates, of the following:

- flight path
- Keating coefficients
- magnetic contours

7. Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) were undertaken by the survey contractor Goldak Airborne Surveys, by Paterson, Grant and Watson Limited (QA/QC Geophysicist), and by MNDM. Stringent QA/QC is emphasized throughout the project so that the optimal geological signal is measured, archived and presented.

7.1. SURVEY CONTRACTOR

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

7.1.1. TESTS AND CALIBRATIONS

The full results of the tests and calibrations described below can be found in Appendix A.

a) Compensation Figure of Merit

Aircraft movements induce spurious magnetic fields, which are removed from the magnetic data by the compensator. The efficiency of this removal can be evaluated by conducting a test called a Figure of Merit (FOM). The aircraft flies a series of 3 manoeuvres of ±10° rolls, ±5° pitches and ±5° yaws in each of the traverse- and control-line directions in a magnetically quiet zone (low magnetic gradient). The peak-to-peak amplitudes of the responses obtained on the magnetometer compensated channel are determined for each of the 3 manoeuvre types and for each of the 4 directions. The 12 values are then summed giving the Figure of Merit.

Compensation figure of merit tests were performed by both aircraft after their initial arrival on site and before survey operations commenced. In addition, the calibration and tests were repeated after any significant change to the aircraft or its systems which may have altered its magnetic properties.

In all calibration and subsequent tests performed by the aircraft, the resultant figures of merit for the tail and wing-tip sensors were below the specified threshold of 1.5 nT.

b) Heading Test

To verify system accuracy and acceptable heading error, heading tests were performed over the GSC magnetic observatory at Meanook, Alberta, both prior to commencement and after completion of the survey. The aircraft performed 3 passes in each cardinal direction directly over the observatory and the aircraft measured total field was compared against the observatory data.

For all tests performed the calculated heading errors were minimal and the absolute accuracies were within the contract threshold of 10 nT.

c) Lag Tests

To verify the magnetic system latency, the survey aircraft conducted lag tests. These tests involve flying multiple passes in each of the 4 cardinal headings over a known magnetic feature and comparing the position of the observed magnetic peaks with the known position of the target.

Both aircraft flew this test over a tower located 22 km southwest of Saskatoon, Saskatchewan prior to survey commencement and after completion.

The calculated system latencies from these tests were determined to be consistent between the pre- and postsurvey values and were consistent with previous tests performed by these aircraft.

d) Radar Altimeter Calibration

The radar altimeter calibration and verification were performed by acquiring altitude data from several passes of increasing altitude over the runway at the Saskatoon airport. The radar altimeters of both aircraft were confirmed to have a linear relationship with and within acceptable range of the GPS height.

e) Cosmic Calibration

High-altitude cosmic calibration flights were performed by both aircraft prior to the survey. In this test, the aircraft climbed from 1500 m to 3600 m in increments of 300 m and accumulated approximately 10 minutes of data at each altitude. The resultant data determined the linear relationship between counts in the cosmic window and each region of interest window.

f) Radiometric Test Range

Each aircraft performed a calibration flight over Goldak's radiometric test range at Danielson, Saskatchewan, to determine the radiometric system sensitivities and altitude attenuation factors. The aircraft repeated a 10 km test line and an adjacent overwater line (for background corrections) at altitudes of 60 to 270 m in 30 m increments.

Simultaneously, actual ground concentrations were measured by a ground crew equipped with a calibrated hand-held RSI™ RS-230 BGO spectrometer. At 8 predetermined stations along the survey test line, four 180-second sample accumulations were acquired, each approximately 20 m apart. The processed measurements are then averaged giving the ground concentrations in each window for the test line.

g) Radiometric Pad Test

To determine the stripping ratios of each detector, calibrations were done at Goldak's hangar using pads calibrated by Bob Grasty (Grasty and Hovgaard 1996). Four concrete pads, 3 embedded with the ROI radioelements and one "bare" pad for background corrections, were placed beneath detector packs installed in the aircraft. Data were then accumulated for approximately 20 minutes. The averaged count rates are then used to compute the 6 stripping ratios for each spectrometer.

7.1.2. DAILY FIELD QUALITY CONTROL

a) Positioning Data

In a Geosoft® Oasis montaj™ database, the corrected GPS data are inspected for gaps and positioning error as indicated by anomalous velocity changes or vertical offsets. The real-time positions are compared to the post-corrected positions for integrity check.

Flight path is examined to detect horizontal deviations that exceed tolerances. Computed velocity is inspected and confirmed to be within tolerances.

The radar altimeter and barometric altimeter data are inspected for anomalous conditions. The computed digital elevation model is compared against known topographical data. Vertical navigation is checked for deviations from the predetermined flight surface that exceed tolerances.

b) Magnetic Data

Goldak Airborne Surveys' data acquisition system is designed to allow the second pilot to monitor data quality at all times. Both pilots have been trained to operate the equipment and recognize data problems. Automated systems are also in place to draw their attention to anomalous conditions. In addition, the field processor is continually monitoring the magnetic base station via radio link to be on the alert for poor diurnal conditions. The field processor maintains scheduled communication with the aircraft for flight-following purposes and to update the flight crew on weather and diurnal conditions.

After a survey flight, the magnetic and measured gradient data are inspected on a line-by-line basis for gaps, spikes and other anomalous conditions. Magnetic noise levels are monitored using the fourth digital difference and visually. The magnetic base station data are examined for deviations that exceed the contract stated peak-to-peak magnitude and chord lengths. Reflights are assigned where necessary.

A frequency domain plot of the uncompensated and compensated magnetic data is generated through fast Fourier transform on a line-by-line basis and inspected. Through this, the general ongoing performance of the magnetic compensation can be evaluated and any aircraft system-induced magnetic noise can be easily discerned.

Grids of the total field and horizontal gradient data, along with flight path plots, are examined daily to visually compare the correlation of data between lines and across flights.

c) Radiometric Data

Onsite, weather conditions were continuously monitored to ensure that no radiometric survey took place within 4 hours after measurable precipitation or 12 hours after heavy precipitation.

Prior to each survey flight, the field crew performed 2 system verification tests. The results of these system verification tests are plotted in Appendix A.

1. Source Tests:
   While the aircraft sat stationary, a ^{232}Th source was placed in a cradle and attached to the aircraft beneath the spectrometer detector pack and data were collected for 2 minutes. The sample was then removed and data were again collected for 2 minutes for background determination. The results analyzed and plotted to ensure consistent sensitivities throughout the survey.
2. System Resolution Test:
   A ^{232}Th source was used determine the full width–half amplitude (FWHM) of the 2615 keV photopeak, expressed as a percentage, as a measure of system performance. In all tests performed, FWHM of the photopeak remained below the contract specified threshold of 6%.

Before and after each radiometric survey flight, a repeat line was flown as an additional measure of system consistency throughout the survey as well as consistency between aircraft.

During a survey flight, the flight crew is presented with a diagnostic display of the of the radiometric acquisition system showing a combined spectra and status of each detector crystal. In the event of anomalous system state or error, a visual alert is displayed.

Post flight, the radiometric data are imported into a Geosoft® Oasis Montaj™ database and viewed in profile format. The data are checked for any gaps, erroneous detector crystal states or stabilization errors. Any records that show an error in detector state are removed and scheduled for reflight if needed. Rough background correction estimates are removed from the ROI channels and the data are displayed in grid format to check for coherence.

A complete archive of the spectra is maintained from the spectrometer console data. An RSI software package can be used with these archives to correct any stabilization problems that may be subsequently found.

7.1.3. Near-Final Field Products

Near-final products of the profile and gridded magnetic and radiometric data were made available to the QA/QC Geophysicist during visits to the survey site, for review and approval, prior to demobilization.

7.1.4. Quality Control in the Office

a) Review of field processed data

At the home office, the results of the field processing are reviewed at regular intervals throughout the survey and following completion.

b) Review of the final processed data

The results of the levelling of the magnetic data are reviewed on a line-by-line basis through inspection of the total correction profile and intersection mismatch values. Final grid products are visually and statistically inspected for overall quality and validity.

The final radiometric processing is reviewed on a line-by-line basis through inspection of the numerous correction profiles and final processed channels. Statistical plots of the overwater test line and repeat line data are generated to ensure proper background correction coefficients. Final grids are again inspected for quality and validity.

7.1.5. Interim Products

Archive files containing the raw and interim processed profile data and the gridded data were provided to the QA/QC Geophysicist for review and approval.

7.2. QA/QC GEOPHYSICIST

The QA/QC Geophysicist received data directly from field operations during data acquisition, focussing initially on the data acquisition procedures, base station monitoring and instrument calibration. As data were collected, they were reviewed for adherence to the survey specifications and completeness. Any problems encountered during data acquisition were discussed and resolved.

The QA/QC checks included the following:

a) Navigation Data

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

b) Magnetic Data

- appropriate location of the magnetic base station, and adequate sampling of the diurnal variations
- heading error and lag tests are satisfactory
- magnetometer noise levels are within specifications
- magnetic diurnal variations remain within specifications
- magnetometer drift is minimal once diurnal and IGRF corrections are applied

- spikes and/or drop-outs are minimal to non-existent in the raw data
- filtering of the profile data is minimal to non-existent
- in-field levelling produces image-quality grids of total magnetic field and higher order products (e.g., second vertical derivative)

c) Radiometric data
- consistency between daily test lines
- consistency between daily fixed source and static background measurements
- shifts in radioelement concentrations between flights
- precipitation limitations are observed
- The energy resolution is confirmed daily with ^{232}Th and, using the 2615 keV photopeak of ^{232}Th, a total system resolution better than 12% is maintained

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

7.3. MINISTRY OF NORTHERN DEVELOPMENT AND MINES

MNDM worked with the QA/QC Geophysicist to ensure that the digital files adhered to the specified ASCII and binary file formats, that the file names and channel names were consistent, and that all required data were delivered on schedule.

In addition, the MNDM worked with the contractor and the QA/QC Geophysicist to ensure that map products were complete, contained the appropriate legend information and complied with the cartographic specifications.

8. References

Broome, J., Carson, J.M., Grant, J.A. and Ford, K. 1987. A modified ternary radioelement mapping technique and its application to the south coast of Newfoundland; Geological Survey of Canada, Paper 87-14, scale 1:500 000.

Grasty, R.L. and Hovgaard, J. 1996. The calibration of upward looking detectors in gamma ray surveys; *in* Expanded Abstracts, Society of Exploration Geophysicists, 66th Annual International Meeting, San Francisco, v.15, p.1422-1425, DOI:10.1190/1.1826379.

Gupta, V., Paterson, N., Reford, S., Kwan, K., Hatch, D. and Macleod, I. 1989. Single master aeromagnetic grid and magnetic colour maps for the province of Ontario; *in* Summary of Field Work and Other Activities 1989, Ontario Geological Survey, Miscellaneous Paper 146, p.244-250.

International Atomic Energy Agency 1991. Airborne gamma ray spectrometer surveying; International Atomic Energy Agency, Vienna, Austria, Technical Reports Series 323, 97p.

Keating, P.B. 1995. A simple technique to identify magnetic anomalies due to kimberlite pipes; Exploration and Mining Geology, v.4, no.2, p.121-125.

Naudy, H. and Dreyer, H. 1968. Essai de filtrage nonlinéaire appliqué aux profiles aeromagnétiques; Geophysical Prospecting, v.16, p.171-178.

Ontario Geological Survey 1996. Ontario airborne magnetic and electromagnetic surveys, processed data and derived products: Archean and Proterozoic “greenstone” belts—Matachewan area; Ontario Geological Survey, Geophysical Data Set 1014.

——— 1999. Single master gravity and aeromagnetic data for Ontario—Geosoft® format; Ontario Geological Survey, Geophysical Data Set 1036.

——— 2011. 1:250 000-scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release—Data 126–Revision 1.

Reford, S.W., Gupta, V.K., Paterson, N.R., Kwan, K.C.H. and Macleod, I.N. 1990. Ontario master aeromagnetic grid: A blueprint for detailed compilation of magnetic data on a regional scale; *in* Expanded Abstracts, Society of Exploration Geophysicists, 60th Annual International Meeting, San Francisco, p.617-619, DOI:10.1190/1.1890282.

Appendix A. Test and Calibration Results

1. RADAR ALTIMETER CALIBRATIONS

Radar Altimeter Calibration Analysis

Project	OMNDM LdML-LN
Flight	7
Aircraft	C-GJBB
Date	2014-07-04
Julian Day	185

Pilot	Mathieson
Copilot	Lebrun
Processor	Carson

Radar Stack Summary

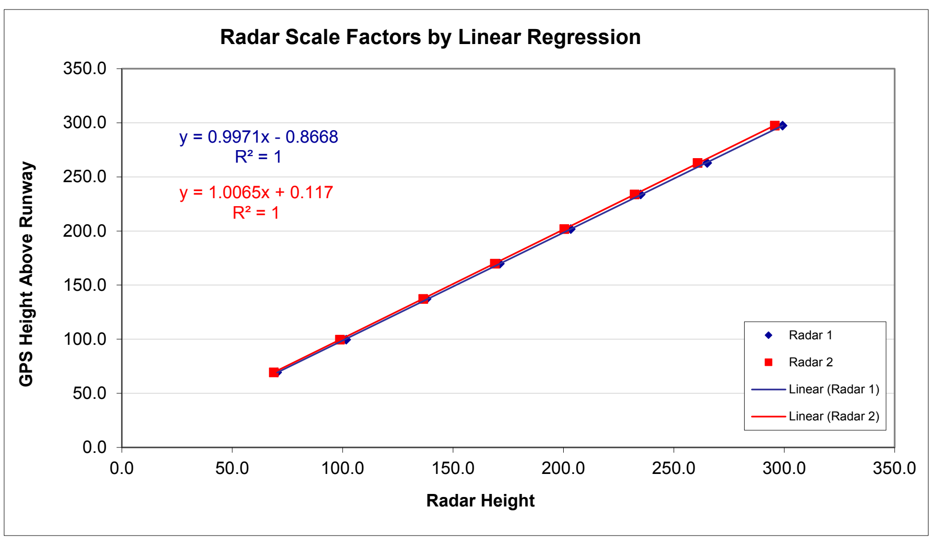
Runway Height	502
Tail Height	3.5

Test Location	Saskatoon Airport
Radar 1 Type	Thompson-CFS ERT160
Radar 2 Type	Terra TRA-30

Radar 1 Scale Factor	0.991
Radar 2 Scale Factor	1.007

Radar Stack Analysis

PASS (ft)	GPSAlt	RAlt 1	RAlt 2	Hgt AGL	RAlt 1 Scale	RAlt 2 Scale
100	575.0	70.4	68.8	69.5	0.99	1.01
200	605.2	101.6	98.7	99.7	0.98	1.01
300	642.8	138.0	136.5	137.3	1.00	1.01
400	675.4	171.1	168.9	169.9	0.99	1.01
500	707.3	203.3	200.4	201.8	0.99	1.01
600	739.3	235.0	232.2	233.8	0.99	1.01
700	768.4	265.1	260.7	262.9	0.99	1.01
800	803.1	299.2	295.7	297.6	0.99	1.01



Radar Altimeter Calibration Analysis

Project	OMNDM LdML-LN
Flight	9
Aircraft	C-GJBG
Date	2014-07-08
Julian Day	189

Pilot	Lebrun
Copilot	
Processor	Carson

Radar Stack Summary

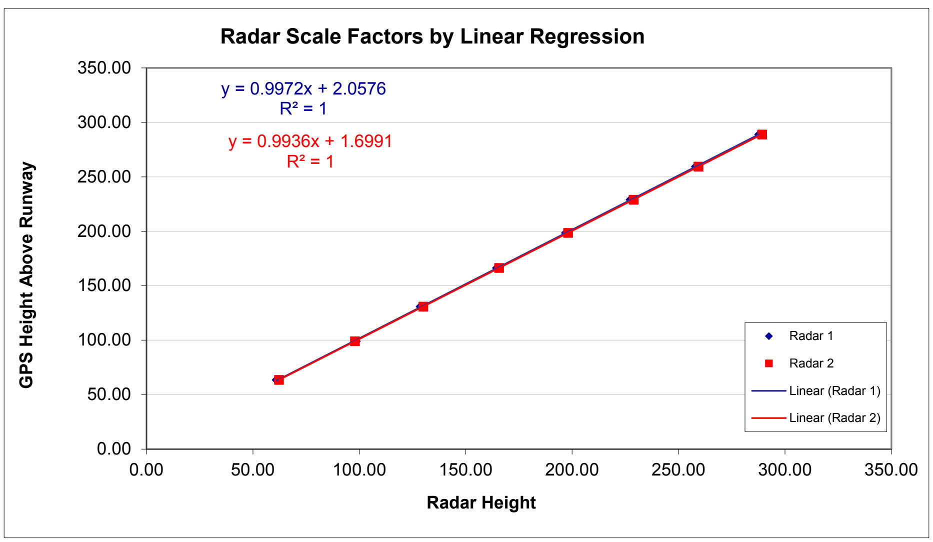
Runway Height	502
Tail Height	3.5

Test Location	Saskatoon Airport
Radar 1 Type	Thompson-CFS ERT160
Radar 2 Type	Terra TRA-30

Radar 1 Scale Factor	1.012
Radar 2 Scale Factor	1.006

Radar Stack Analysis

PASS (ft)	GPSAlt	RAlt 1	RAlt 2	Hgt AGL	RAlt 1 Scale	RAlt 2 Scale
100	569.04	61.14	62.25	63.54	1.04	1.02
200	604.52	98.35	97.97	99.02	1.01	1.01
300	636.45	128.77	130.05	130.95	1.02	1.01
400	671.79	164.67	165.69	166.29	1.01	1.00
500	704.11	197.09	198.10	198.61	1.01	1.00
600	734.53	227.38	228.87	229.03	1.01	1.00
700	764.90	258.13	259.30	259.40	1.00	1.00
800	794.50	287.87	289.21	289.00	1.00	1.00



Radar Altimeter Calibration Analysis

Project	OMNDM LdML-LN
Flight	157
Aircraft	C-GJBB
Date	2014-11-03
Julian Day	307

Pilot	Mathieson
Copilot	Saldanha
Processor	Carson

Radar Stack Summary

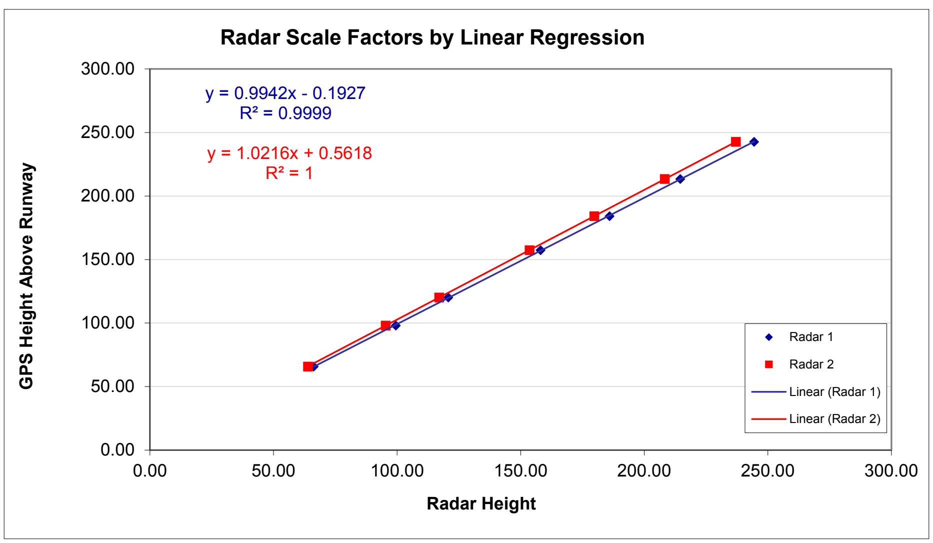
Runway Height	501
Tail Height	3.5

Test Location	Saskatoon, SK
Radar 1 Type	Thompson-CFS ERT160
Radar 2 Type	Terra TRA-30

Radar 1 Scale Factor	0.993
Radar 2 Scale Factor	1.026

Radar Stack Analysis

PASS (ft)	GPSAlt	RAlt 1	RAlt 2	Hgt AGL	RAlt 1 Scale	RAlt 2 Scale
200	570.29	66.22	63.95	65.79	0.99	1.03
300	602.50	99.46	95.32	98.00	0.99	1.03
400	624.70	120.66	117.05	120.20	1.00	1.03
500	661.93	158.05	153.54	157.43	1.00	1.03
600	688.62	185.96	179.74	184.12	0.99	1.02
700	717.95	214.52	208.31	213.45	1.00	1.02
800	747.13	244.42	237.03	242.63	0.99	1.02



Radar Altimeter Calibration Analysis

Project	OMNDM LdML-LN
Flight	163
Aircraft	C-GJBG
Date	2014-12-02
Julian Day	336

Pilot	Lebrun
Copilot	
Processor	Heath

Radar Stack Summary

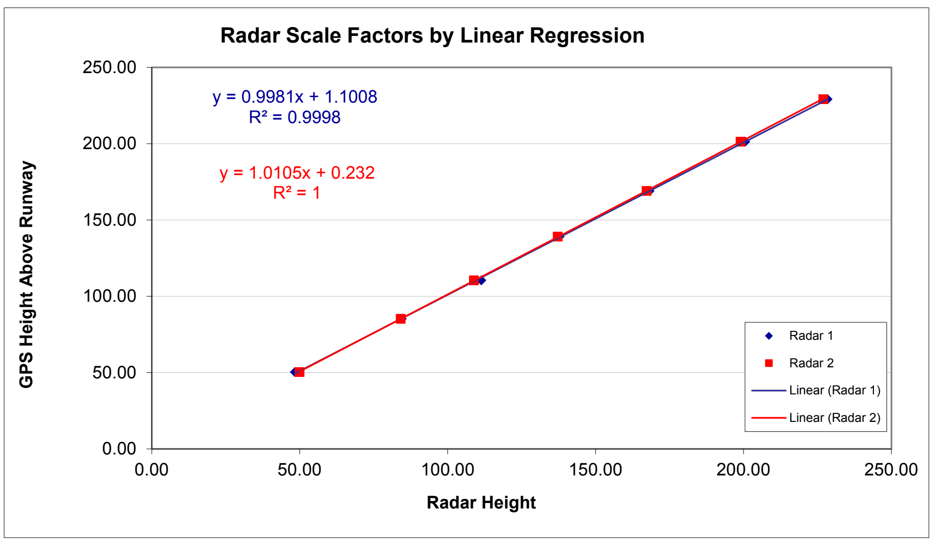
Runway Height	502
Tail Height	3.5

Test Location	Saskatoon 09-27
Radar 1 Type	Thompson-CFS ERT160
Radar 2 Type	Terra TRA-30

Radar 1 Scale Factor	1.009
Radar 2 Scale Factor	1.012

Radar Stack Analysis

PASS (ft)	GPSAlt	RAlt 1	RAlt 2	Hgt AGL	RAlt 1 Scale	RAlt 2 Scale
200	555.84	48.40	49.92	50.34	1.04	1.01
300	590.82	84.48	84.16	85.32	1.01	1.01
400	615.98	111.37	108.90	110.48	0.99	1.01
500	644.66	137.87	137.23	139.16	1.01	1.01
600	674.69	168.25	167.22	169.19	1.01	1.01
700	706.92	200.56	198.98	201.42	1.00	1.01
800	734.75	228.37	226.95	229.25	1.00	1.01



2. LAG TESTS

Lag Test Analysis

Project	OMNDM LdML-LN
Flight	159
Aircraft	C-GJBB
Date	2014-11-01
Julian Day	305

Pilot	Mathieson
Copilot	Saldanha
Processor	Carson

Lag Test Summary

MB Average Lag	0.38
MR Average Lag	0.30
ML Average Lag	0.30

Test Location	Near Saskatoon, SK
Feature Easting	370600
Feature Northing	5767237

Air Time	4
Test Time	0.3
Ferry Time	

Lag Test Analysis

Bottom Tail Magnetometer (MB)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	E	370632.2	5767227.3	79.8	33.65	0.42
2	W	370573.7	5767246.9	73.9	28.12	0.38
3	E	370630.2	5767237.8	79.5	30.40	0.38
4	W	370573.1	5767247.1	73.4	28.66	0.39
5	S	370594.6	5767207.7	78.8	29.41	0.37
6	N	370603.7	5767260.7	73.2	24.31	0.33
7	S	370591.7	5767204.6	80.2	33.11	0.41
8	N	370599.6	5767261.2	74.0	24.58	0.33

Right Wing Magnetometer (MR)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	E	370625.6	5767232.4	80.2	26.11	0.33
2	W	370575.4	5767237.1	75.5	24.43	0.32
3	E	370624.4	5767229.0	79.8	25.69	0.32
4	W	370580.8	5767245.0	73.9	20.80	0.28
5	S	370584.3	5767210.8	77.2	30.16	0.39
6	N	370603.8	5767253.7	73.3	17.45	0.24
7	S	370596.3	5767215.4	78.8	21.53	0.27
8	N	370602.1	5767253.5	73.1	17.01	0.23

Left Wing Magnetometer (ML)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	E	370625.6	5767232.4	80.2	26.11	0.33
2	W	370575.4	5767237.1	75.5	24.43	0.32
3	E	370624.4	5767229.0	79.8	25.69	0.32
4	W	370580.8	5767245.0	73.9	20.80	0.28
5	S	370584.3	5767210.8	77.2	30.16	0.39
6	N	370603.8	5767253.7	73.3	17.45	0.24
7	S	370596.3	5767215.4	78.8	21.53	0.27
8	N	370602.1	5767253.5	73.1	17.01	0.23

Lag Test Analysis

Project	OMNDM LdML-LN
Flight	164
Aircraft	C-GJBG
Date	2014-12-02
Julian Day	336

Pilot	Lebrun
Copilot	
Processor	Heath

Lag Test Summary

MB Average Lag	0.36
MR Average Lag	0.24
ML Average Lag	0.24

Test Location	Tower SW of YXE
Feature Easting	370603
Feature Northing	5767237

Air Time	
Test Time	
Ferry Time	

Lag Test Analysis

Bottom Tail Magnetometer (MB)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	S	370598.8	5767211.2	76.0	25.7	0.34
2	N	370606.8	5767261.4	66.7	25.1	0.38
3	S	370597.7	5767212.0	72.1	25.2	0.35
4	N	370607.8	5767261.7	66.7	25.5	0.38
5	E	370627.8	5767231.4	74.8	24.8	0.33
6	W	370582.6	5767240.2	66.7	21.2	0.32
7	E	370629.7	5767230.9	80.0	26.8	0.33
8	W	370576.6	5767243.4	61.2	27.7	0.45

Right Wing Magnetometer (MR)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	S	370600.5	5767218.6	76.0	18.1	0.24
2	N	370603.6	5767248.4	66.6	11.9	0.18
3	S	370599.2	5767219.0	72.0	18.0	0.25
4	N	370606.2	5767255.2	66.7	18.9	0.28
5	E	370620.0	5767233.5	80.0	16.8	0.21
6	W	370588.6	5767238.8	61.2	15.1	0.25
7	E	370621.9	5767232.9	79.8	18.8	0.24
8	W	370588.5	5767240.4	61.0	15.5	0.25

Left Wing Magnetometer (ML)						
Pass	Direction	Peak X	Peak Y	Velocity	From Tower	Lag
1	S	370600.5	5767218.6	76.0	18.1	0.24
2	N	370603.6	5767248.4	66.6	11.9	0.18
3	S	370599.2	5767219.0	72.0	18.0	0.25
4	N	370606.2	5767255.2	66.7	18.9	0.28
5	E	370620.0	5767233.5	80.0	16.8	0.21
6	W	370588.6	5767238.8	61.2	15.1	0.25
7	E	370621.9	5767232.9	79.8	18.8	0.24
8	W	370588.5	5767240.4	61.0	15.5	0.25

3. HEADING TESTS

Heading Test

Project	OMNDM LdML-LN
Flight	2
Aircraft	C-GJBB
Date	2014-03-24
Julian Day	83

Pilot	Lebrun
Copilot	Mathieson
Processor	Rotheram

Heading Test Summary

MB Mean Offset	-4.13
MB Mean N/S Error	0.58
MB Mean E/W Error	0.04
MB Mean Error	0.31
MR Mean Offset	-11.94
MR Mean N/S Error	0.54
MR Mean E/W Error	0.50
MR Mean Error	0.52
ML Mean Offset	-10.99
ML Mean N/S Error	0.12
ML Mean E/W Error	0.74
ML Mean Error	0.43

Test Location	Meanook, AB
Station Offset	

Air Time	1.2
Test Time	0.4
Ferry Time	0.8

Heading Test Analysis

Bottom Tail Magnetometer (MB)							
Pass	Direction	Time	Meas TF	Base TF	Offset (nT)	Heading Error (nT)	Heading
1	N	60609.1	57542.54	57546.36	-3.82	0.52	N-S
2	S	60736.5	57541.15	57545.49	-4.34		
3	N	60866.6	57540.88	57544.72	-3.84	0.60	N-S
4	S	60969.3	57540.64	57545.08	-4.44		
5	N	61100.7	57541.10	57544.95	-3.86	0.62	N-S
6	S	61199.9	57540.71	57545.19	-4.48		
7	E	61383.0	57541.14	57545.19	-4.05	0.05	E-W
8	W	61484.1	57541.37	57545.47	-4.10		
9	E	61593.7	57540.68	57544.81	-4.13	0.02	E-W
10	W	61692.2	57539.27	57543.42	-4.16		
11	E	61802.7	57542.83	57547.02	-4.19	0.06	E-W
12	W	61894.5	57539.47	57543.60	-4.13		

Right Wing Magnetometer (MR)							
Pass	**Direction**	**Time**	**Meas TF**	**Base TF**	**Offset (nT)**	**Heading Error (nT)**	**Heading**
1	N	60609.10	57534.59	57546.36	-11.77	0.50	N-S
2	S	60736.50	57533.22	57545.49	-12.27		
3	N	60866.60	57532.93	57544.72	-11.79	0.52	N-S
4	S	60969.30	57532.76	57545.08	-12.31		
5	N	61100.70	57533.19	57544.95	-11.76	0.59	N-S
6	S	61199.90	57532.84	57545.19	-12.35		
7	E	61383.00	57533.25	57545.19	-11.94	0.28	E-W
8	W	61484.10	57533.81	57545.47	-11.66		
9	E	61593.70	57532.67	57544.81	-12.14	0.60	E-W
10	W	61692.20	57531.88	57543.42	-11.55		
11	E	61802.70	57534.86	57547.02	-12.16	0.62	E-W
12	W	61894.50	57532.05	57543.60	-11.55		

Left Wing Magnetometer (ML)							
Pass	**Direction**	**Time**	**Meas TF**	**Base TF**	**Offset (nT)**	**Heading Error (nT)**	**Heading**
1	N	60609.10	57535.35	57546.36	-11.00	0.01	N-S
2	S	60736.50	57534.49	57545.49	-11.00		
3	N	60866.60	57533.72	57544.72	-10.99	0.15	N-S
4	S	60969.30	57533.93	57545.08	-11.15		
5	N	61100.70	57534.01	57544.95	-10.94	0.21	N-S
6	S	61199.90	57534.04	57545.19	-11.15		
7	E	61383.00	57534.07	57545.19	-11.12	0.47	E-W
8	W	61484.10	57534.82	57545.47	-10.66		
9	E	61593.70	57533.37	57544.81	-11.44	0.91	E-W
10	W	61692.20	57532.89	57543.42	-10.53		
11	E	61802.70	57535.63	57547.02	-11.39	0.85	E-W
12	W	61894.50	57533.06	57543.60	-10.54		

Heading Test Analysis

Project	OMNDM LdML-LN
Flight	1
Aircraft	C-GJBG
Date	2014-03-27
Julian Day	86

Pilot	Mathieson
Copilot	Rotheram
Processor	Rotheram

Heading Test Summary

MB Mean Offset	-5.57
MB Mean N/S Error	0.44
MB Mean E/W Error	0.07
MB Mean Error	0.25
MR Mean Offset	-7.48
MR Mean N/S Error	0.41
MR Mean E/W Error	0.21
MR Mean Error	0.31
ML Mean Offset	-5.71
ML Mean N/S Error	0.42
ML Mean E/W Error	0.18
ML Mean Error	0.30

Test Location	Meanook, AB
Station Offset	

Air Time	1.2
Test Time	0.4
Ferry Time	0.8

Heading Test Analysis

Bottom Tail Magnetometer (MB)							
Pass	Direction	Time	Meas TF	Base TF	Offset (nT)	Heading Error (nT)	Heading
1	N	60678.70	57517.30	57522.52	-5.22	0.51	N-S
2	S	60812.20	57516.92	57522.65	-5.73		
3	N	60956.30	57518.07	57523.31	-5.24	0.38	N-S
4	S	61067.60	57516.90	57522.52	-5.62		
5	N	61214.20	57517.95	57523.28	-5.33	0.42	N-S
6	S	61334.50	57517.20	57522.95	-5.75		
7	W	61557.90	57516.07	57521.60	-5.53	0.15	E-W
8	E	61679.90	57514.78	57520.46	-5.68		
9	W	61806.20	57513.76	57519.43	-5.67	0.01	E-W
10	E	61931.60	57513.41	57519.09	-5.68		
11	W	62061.50	57513.55	57519.20	-5.65	0.04	E-W
12	E	62200.30	57514.26	57519.95	-5.69		

Right Wing Magnetometer (MR)							
Pass	Direction	Time	Meas TF	Base TF	Offset (nT)	Heading Error (nT)	Heading
1	N	16:51:18.7	57515.33	57522.52	-7.19	0.52	N-S
2	S	16:53:32.2	57514.95	57522.65	-7.70		
3	N	16:55:56.3	57516.06	57523.31	-7.24	0.33	N-S
4	S	16:57:47.6	57514.96	57522.52	-7.57		
5	N	17:00:14.2	57516.02	57523.28	-7.27	0.38	N-S
6	S	17:02:14.5	57515.31	57522.95	-7.65		
7	W	17:05:57.9	57514.06	57521.60	-7.54	0.09	E-W
8	E	17:07:59.9	57513.01	57520.46	-7.45		
9	W	17:10:06.2	57511.74	57519.43	-7.69	0.30	E-W
10	E	17:12:11.6	57511.70	57519.09	-7.39		
11	W	17:14:21.5	57511.52	57519.20	-7.69	0.25	E-W
12	E	17:16:40.3	57512.51	57519.95	-7.43		

Left Wing Magnetometer (ML)							
Pass	Direction	Time	Meas TF	Base TF	Offset (nT)	Heading Error (nT)	Heading
1	N	16:51:18.7	57517.17	57522.52	-5.34	0.61	N-S
2	S	16:53:32.2	57516.69	57522.65	-5.96		
3	N	16:55:56.3	57517.92	57523.31	-5.39	0.34	N-S
4	S	16:57:47.6	57516.79	57522.52	-5.73		
5	N	17:00:14.2	57517.69	57523.28	-5.59	0.32	N-S
6	S	17:02:14.5	57517.04	57522.95	-5.91		
7	W	17:05:57.9	57515.86	57521.60	-5.74	0.06	E-W
8	E	17:07:59.9	57514.79	57520.46	-5.68		
9	W	17:10:06.2	57513.50	57519.43	-5.93	0.19	E-W
10	E	17:12:11.6	57513.36	57519.09	-5.74		
11	W	17:14:21.5	57513.29	57519.20	-5.91	0.29	E-W
12	E	17:16:40.3	57514.32	57519.95	-5.62		

4. MAGNETOMETER FIGURE OF MERIT TESTS

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	15
Aircraft	C-GJBB
Date	2014-07-18
Julian Day	199

Pilot	Mathieson
Copilot	Ando
Processor	Shaikh/Bello

Test Summary

MB FOM	0.74
MR FOM	1.55
ML FOM	1.41

Test Location	Thunder Bay
Reason for Comp / FOM	Intial Comp

Air Time	1.2
Test Time	0.3
Ferry Time	0.9

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	1.17E+00	3.37E-02	34.8	32.5
Right Wing M2	1.10E+00	3.32E-02	333.2	31.6
Tail Top M3				
Tail Lower M4	1.88E-01	1.86E-02	10.1	13.3
Lateral Grad G1	1.27E+00	6.21E-02	20.3	30.8
Long Grad G2	3.98E+00	6.64E-02	59.9	35.9
Vert Grad G3				
Memory Slot	1			

FOM Analysis

Bottom Tail Magnetometer (MBc)

	North	East	South	West	Sum
Pitch	0.11	0.1	0.12	0.08	0.41
Roll	0.04	0.04	0.04	0.04	0.16
Yaw	0.03	0.04	0.03	0.07	0.17
Sum	0.18	0.18	0.19	0.19	0.74

Right Wing Magnetometer (MRc)

	North	East	South	West	Sum
Pitch	0.16	0.18	0.16	0.1	0.60
Roll	0.16	0.14	0.09	0.07	0.46
Yaw	0.13	0.16	0.09	0.11	0.49
Sum	0.45	0.48	0.34	0.28	1.55

Left Wing Magnetometer (MLc)

	North	East	South	West	Sum
Pitch	0.11	0.1	0.1	0.14	0.45
Roll	0.17	0.16	0.08	0.08	0.49
Yaw	0.1	0.13	0.09	0.15	0.47
Sum	0.38	0.39	0.27	0.37	1.41

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	16
Aircraft	C-GJBG
Date	2014-07-18
Julian Day	199

Pilot	Mathieson
Copilot	Saldanha
Processor	Shaikh

Test Summary

MB FOM	0.73
MR FOM	1.53
ML FOM	1.49

Test Location	Thunder Bay
Reason for Comp / FOM	Initial comp

Air Time	1.4
Test Time	0.4
Ferry Time	1

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	1.17E+00	3.60E-02	32.6	33.8
Right Wing M2	1.04E+00	3.74E-02	27.6	33.7
Tail Top M3				
Tail Lower M4	2.36E-01	1.96E-02	12.1	14.1
Lateral Grad G1	2.20E+00	6.55E-02	33.6	33.2
Long Grad G2	3.61E+00	6.88E-02	52.4	36.2
Vert Grad G3				
Memory Slot	12			

FOM Analysis

Bottom Tail Magnetometer (MBc)					
	North	East	South	West	Sum
Pitch	0.09	0.09	0.09	0.07	0.34
Roll	0.04	0.04	0.06	0.04	0.18
Yaw	0.04	0.07	0.05	0.05	0.21
Sum	0.17	0.20	0.20	0.16	0.73

Right Wing Magnetometer (MRc)					
	North	East	South	West	Sum
Pitch	0.12	0.19	0.14	0.11	0.56
Roll	0.2	0.11	0.1	0.09	0.50
Yaw	0.12	0.14	0.08	0.13	0.47
Sum	0.44	0.44	0.32	0.33	1.53

Left Wing Magnetometer (MLc)					
	North	East	South	West	Sum
Pitch	0.1	0.1	0.09	0.2	0.49
Roll	0.2	0.13	0.12	0.15	0.60
Yaw	0.08	0.15	0.09	0.08	0.40
Sum	0.38	0.38	0.30	0.43	1.49

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	87
Aircraft	C-GJBG
Date	2014-09-13
Julian Day	256

Pilot	Saldhana
Copilot	Lebrun
Processor	Heath / Bello

Test Summary

MB FOM	0.41
MR FOM	1.1
ML FOM	1.55

Test Location	Geraldton
Reason for Comp / FOM	Scheduled recomp

Air Time	0.8
Test Time	0.4
Ferry Time	0.4

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	1.27E+00	4.09E-02	31.1	36.1
Right Wing M2	9.55E-01	2.61E-02	36.6	34.5
Tail Top M3				
Tail Lower M4	1.86E-01	1.16E-02	16	13.9
Lateral Grad G1	2.91E+00	9.78E-02	30.5	38.3
Long Grad G2	3.87E+00	6.59E-02	58.9	37.1
Vert Grad G3				
Memory Slot	1			

FOM Analysis

Bottom Tail Magnetometer (MBc)					
	North	East	South	West	Sum
Pitch	0.02	0.03	0.06	0.05	0.16
Roll	0.04	0.04	0.04	0.04	0.16
Yaw	0.03	0.03	0.02	0.01	0.09
Sum	0.09	0.10	0.12	0.10	0.41

Right Wing Magnetometer (MRc)					
	North	East	South	West	Sum
Pitch	0.03	0.08	0.09	0.08	0.28
Roll	0.13	0.11	0.16	0.07	0.47
Yaw	0.1	0.09	0.08	0.08	0.35
Sum	0.26	0.28	0.33	0.23	1.10

Left Wing Magnetometer (MLc)					
	North	East	South	West	Sum
Pitch	0.12	0.11	0.06	0.08	0.37
Roll	0.18	0.14	0.18	0.21	0.71
Yaw	0.17	0.13	0.1	0.07	0.47
Sum	0.47	0.38	0.34	0.36	1.55

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	88
Aircraft	C-GJBB
Date	2014-09-13
Julian Day	256

Pilot	Lebrun
Copilot	Pelletier
Processor	Heath / Bello

Test Summary

MB FOM	0.9
MR FOM	1.28
ML FOM	1.3

Test Location	Geraldton
Reason for Comp / FOM	Scheduled recomp

Air Time	0.8
Test Time	0.4
Ferry Time	0.4

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	1.07E+00	4.48E-02	24	30.2
Right Wing M2	1.18E+00	3.88E-02	30.3	33.1
Tail Top M3				
Tail Lower M4	1.99E-01	3.40E-02	5.9	14.2
Lateral Grad G1	7.29E-01	7.41E-02	9.8	34.9
Long Grad G2	3.74E+00	6.81E+00	54.9	36.6
Vert Grad G3				
Memory Slot	4			

FOM Analysis

Bottom Tail Magnetometer (MBc)					
	North	East	South	West	Sum
Pitch	0.05	0.11	0.14	0.1	0.40
Roll	0.08	0.08	0.03	0.06	0.25
Yaw	0.1	0.05	0.09	0.01	0.25
Sum	0.23	0.24	0.26	0.17	0.90

Right Wing Magnetometer (MRc)					
	North	East	South	West	Sum
Pitch	0.12	0.17	0.16	0.05	0.50
Roll	0.09	0.09	0.09	0.09	0.36
Yaw	0.07	0.19	0.11	0.05	0.42
Sum	0.28	0.45	0.36	0.19	1.28

Left Wing Magnetometer (MLc)					
	North	East	South	West	Sum
Pitch	0.09	0.15	0.09	0.08	0.41
Roll	0.1	0.16	0.11	0.1	0.47
Yaw	0.05	0.17	0.12	0.08	0.42
Sum	0.24	0.48	0.32	0.26	1.30

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	150
Aircraft	C-GJBB
Date	2014-10-26
Julian Day	299

Pilot	Mathieson
Copilot	Pelletier
Processor	Shaikh/Bello

Test Summary

MB FOM	0.47
MR FOM	1.4
ML FOM	1.29

Test Location	Geraldton
Reason for Comp / FOM	Project close out

Air Time	3.9
Test Time	0.4
Ferry Time	3.5

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	8.91E-01	3.53E-02	25.3	24.1
Right Wing M2	9.61E-01	3.31E-02	29.1	30.8
Tail Top M3				
Tail Lower M4	2.09E-01	1.27E-02	16.4	13.7
Lateral Grad G1	6.61E-01	8.41E-02	7.9	29.8
Long Grad G2	3.13E+00	5.66E-02	55.3	33
Vert Grad G3				
Memory Slot	9			

FOM Analysis

Bottom Tail Magnetometer (MBc)					
	North	East	South	West	Sum
Pitch	0.05	0.04	0.08	0.05	0.22
Roll	0.04	0.02	0.03	0.02	0.11
Yaw	0.04	0.04	0.04	0.02	0.14
Sum	0.13	0.10	0.15	0.09	0.47

Right Wing Magnetometer (MRc)					
	North	East	South	West	Sum
Pitch	0.11	0.07	0.09	0.06	0.33
Roll	0.1	0.08	0.13	0.09	0.40
Yaw	0.15	0.16	0.17	0.19	0.67
Sum	0.36	0.31	0.39	0.34	1.40

Left Wing Magnetometer (MLc)					
	North	East	South	West	Sum
Pitch	0.09	0.1	0.11	0.16	0.46
Roll	0.11	0.1	0.07	0.1	0.38
Yaw	0.07	0.16	0.1	0.12	0.45
Sum	0.27	0.36	0.28	0.38	1.29

Compensation / Figure of Merit Test Analysis

Project	OMNDM LdML-LN
Flight	165
Aircraft	C-GJBG
Date	2014-12-04
Julian Day	338

Pilot	Smith
Copilot	Lebrun
Processor	Heath

Test Summary

MB FOM	0.37
MR FOM	0.92
ML FOM	1.27

Test Location	Saskatoon
Reason for Comp / FOM	Project close out

Air Time	1.2
Test Time	0.4
Ferry Time	0.8

RMS AADCII Compensator Statistics

	Uncomp Std Dev	Comp Std Dev	IR	Solution Norm
Left Wing M1	1.27E+00	3.83E-02	33.1	36.5
Right Wing M2	9.33E-01	2.62E-02	35.6	33
Tail Top M3				
Tail Lower M4	2.74E-01	1.35E-02	20.3	23.4
Lateral Grad G1	2.91E+00	8.47E-02	34.3	36
Long Grad G2	3.55E+00	6.31E-02	56.3	40.7
Vert Grad G3				
Memory Slot	5			

FOM Analysis

Bottom Tail Magnetometer (MBc)					
	North	East	South	West	Sum
Pitch	0.03	0.04	0.04	0.03	0.14
Roll	0.02	0.03	0.03	0.03	0.11
Yaw	0.02	0.04	0.03	0.03	0.12
Sum	0.07	0.11	0.10	0.09	0.37

Right Wing Magnetometer (MRc)					
	North	East	South	West	Sum
Pitch	0.05	0.07	0.07	0.06	0.25
Roll	0.05	0.09	0.07	0.09	0.30
Yaw	0.1	0.1	0.09	0.08	0.37
Sum	0.20	0.26	0.23	0.23	0.92

Left Wing Magnetometer (MLc)					
	North	East	South	West	Sum
Pitch	0.06	0.12	0.04	0.07	0.29
Roll	0.16	0.12	0.09	0.14	0.51
Yaw	0.17	0.12	0.1	0.08	0.47
Sum	0.39	0.36	0.23	0.29	1.27

5. COSMIC CALIBRATIONS

Cosmic Calibration

Project	OMNDM LdML-NL
Flight	12
Aircraft	C-GJBB
Date	2013-07-17

Pilot	Lebrun
Copilot	Ando
Processor	Carson

Calibration Results

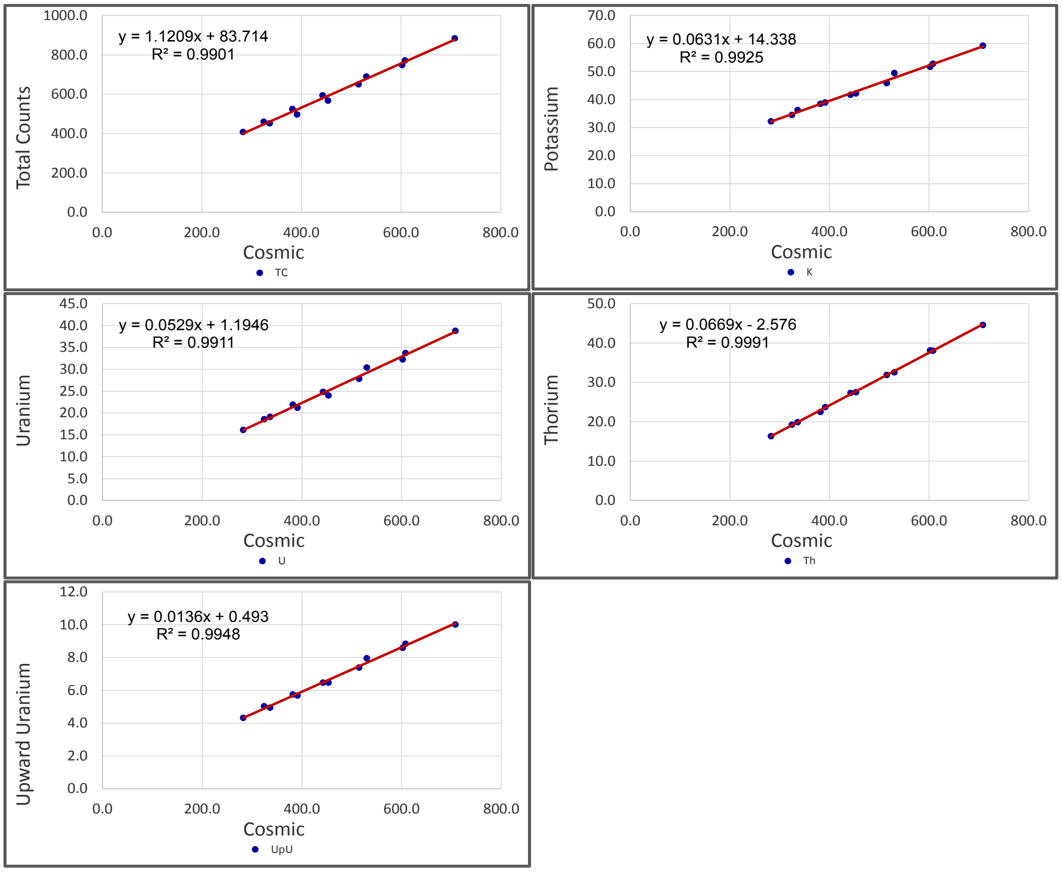
Cosmic Correction Ratios

	Slope	Intercept	R^2
TC	1.1209	83.7142	0.9901
K	0.0631	14.3380	0.9925
U	0.0529	1.1946	0.9911
Th	0.0669	-2.5760	0.9991
UpU	0.0136	0.4930	0.9948

Test Data

Line	Order	Cosmic	TC	K	U	Th	UpU
6000	1	282.4	408.2	32.2	16.1	16.3	4.3
7000	2	324.2	460.6	34.5	18.6	19.3	5.0
8000	3	381.7	525.2	38.5	21.9	22.5	5.8
9000	4	442.3	594.8	41.8	24.8	27.3	6.5
10000	5	514.7	650.4	45.9	27.8	31.9	7.4
11000	6	602.0	748.5	51.7	32.3	38.1	8.6
12000	7	707.8	884.3	59.3	38.8	44.6	10.0
11001	8	607.7	772.1	52.8	33.7	38.1	8.8
10001	9	530.2	689.9	49.5	30.4	32.6	8.0
9001	10	453.1	567.6	42.2	24.0	27.5	6.5
8001	11	391.1	497.4	39.0	21.2	23.7	5.7
7001	12	335.9	452.2	36.3	19.1	19.9	4.9

Graphs - TC, K, U, Th, UpU vs Cosmic Counts



Cosmic Calibration

Project	OMNDM LdML-NL
Flight	11
Aircraft	C-GJBG
Date	2013-07-17

Pilot	Mathieson
Copilot	Salanda
Processor	Carson

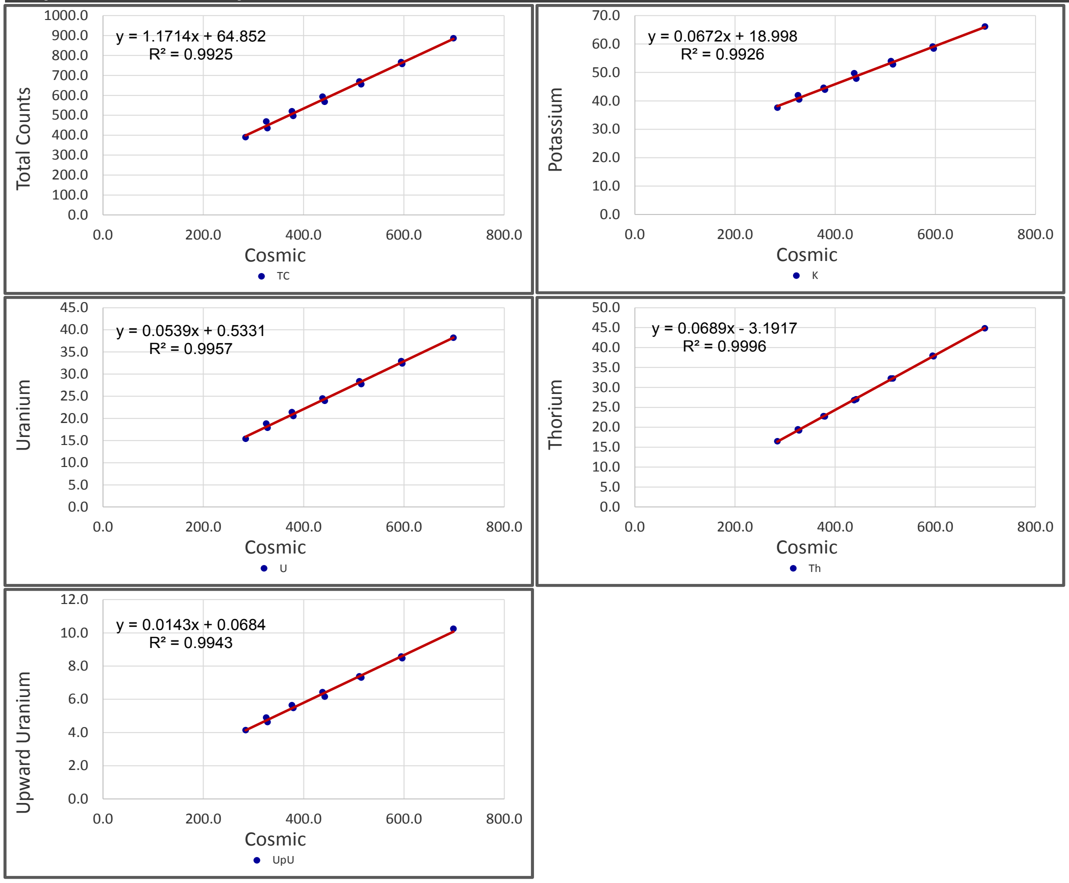
Calibration Results

Cosmic Correction Ratios			
	Slope	Intercept	R^2
TC	1.1714	64.8522	0.9925
K	0.0672	18.9975	0.9926
U	0.0539	0.5331	0.9957
Th	0.0689	-3.1917	0.9996
UpU	0.0143	0.0684	0.9943

Test Data

Line	Order	Cosmic	TC	K	U	Th	UpU
6000	1	284.4	390.3	37.6	15.4	16.5	4.1
7000	2	327.8	435.6	40.5	17.9	19.2	4.6
8000	3	379.5	496.8	44.0	20.6	22.7	5.5
9000	4	442.0	567.5	47.8	24.0	27.1	6.2
10000	5	514.9	655.6	52.8	27.8	32.2	7.3
11000	6	596.5	757.3	58.5	32.4	37.8	8.5
12000	7	698.8	886.5	66.2	38.2	44.8	10.3
11001	8	594.6	766.9	59.2	32.9	38.0	8.6
10001	9	511.2	669.4	54.0	28.4	32.2	7.4
9001	10	437.7	593.1	49.7	24.5	26.8	6.4
8001	11	376.8	520.7	44.6	21.4	22.8	5.7
7001	12	325.5	469.2	42.0	18.9	19.5	4.9

Graphs - TC, K, U, Th, UpU vs Cosmic Counts



6. RADIOMETRIC TEST RANGE

Radiometric Calibration Range

Project	OMNDM LdML-NL
Flight	3
Aircraft	C-GJBB
Date	2013-07-03

Pilot	Lebrun
Copilot	
Processor	Carson

Calibration Summary

Alititude Attenuation Coefficients	
Total Counts (c/s/m)	-0.007191
Potassium (c/s/m)	-0.009204
Uranium (c/s/m)	-0.007278
Thorium (c/s/m)	-0.007192

Sensitivities	
Total Counts (c/s/nGy/h)	23.1
Potassium (c/s/%)	64.0
Uranium (c/s/ppm)	6.5
Thorium (c/s/ppm)	3.9

Test Data

Background Line Data

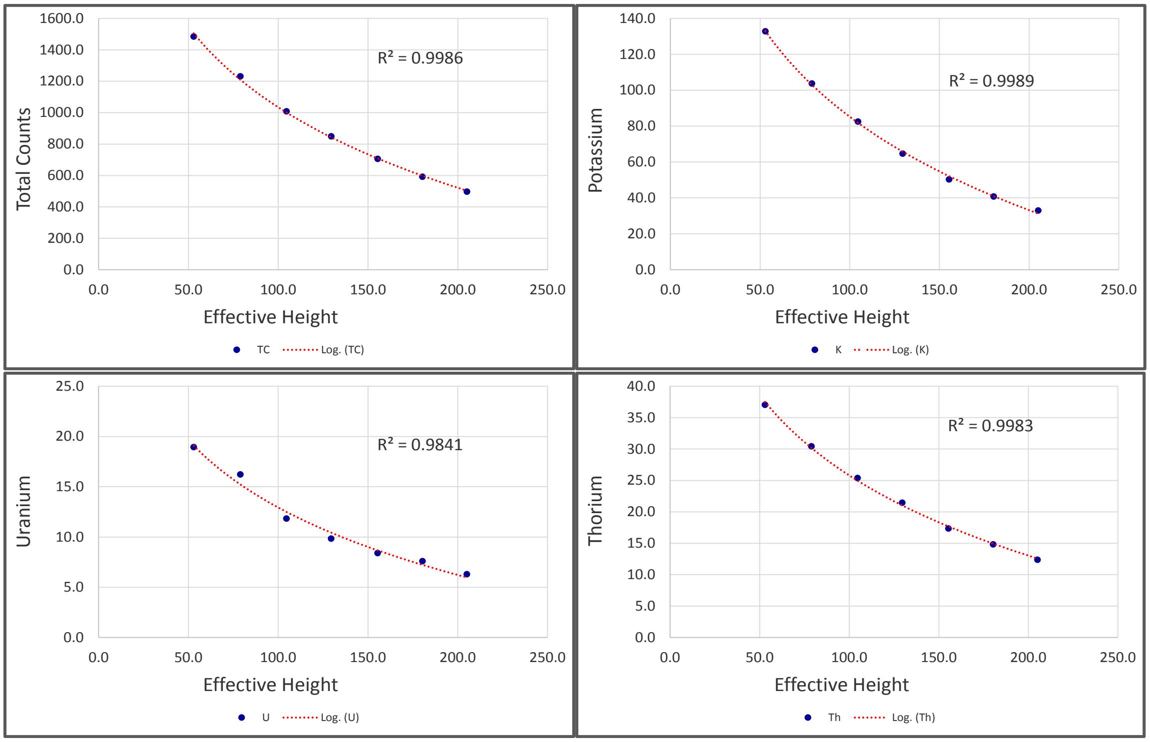
Radar Alt (m)	Effective Height (m)	GPS Alt (m)	TC (c/s)	K (c/s)	U (c/s)	Th (c/s)
92.2	79.1	650.7	280.2	25.5	11.5	9.3
122.3	104.6	681.1	286.2	25.7	12.3	9.3
153.2	130.5	711.7	292.9	26.4	12.2	9.9
183.1	155.6	740.8	299.0	26.7	12.8	10.3
213.1	180.6	770.7	302.5	26.8	13.0	10.2
243.6	205.8	801.0	310.4	27.9	13.4	10.7
274.5	231.2	830.8	314.0	27.4	13.3	10.5
307.1	257.8	863.9	320.0	27.5	13.8	10.6

Test Line Data

Radar Alt (m)	Effective Height (m)	GPS Alt (m)	TC (c/s)	K (c/s)	U (c/s)	Th (c/s)
61.8	53.0	659.5	1766.9	191.7	43.6	47.4
92.4	78.9	688.2	1518.6	158.4	39.2	40.8
122.9	104.7	719.1	1302.4	131.9	33.6	35.8
152.6	129.5	748.2	1148.0	111.2	30.7	32.0
183.6	155.4	777.9	1010.6	94.2	28.2	28.0
213.6	180.3	807.6	902.3	83.3	26.8	25.6
243.8	205.1	837.1	812.3	73.6	25.0	23.3
275.7	231.2	867.6	735.8	66.6	23.1	21.5

Ground Truth Concentrations	
Total Counts (nGy/h)	45.5
Potassium (%)	1.3
Uranium (ppm)	2.0
Thorium (ppm)	6.7

Graphs - Stripped Counts per Second vs Effective Height



Radiometric Calibration Range

Project	OMNDM LdML-NL
Flight	4
Aircraft	C-GJBG
Date	2013-07-03

Pilot	Lebrun
Copilot	
Processor	Carson

Calibration Summary

Alititude Attenuation Coefficients	
Total Counts (c/s/m)	-0.007052
Potassium (c/s/m)	-0.008952
Uranium (c/s/m)	-0.007562
Thorium (c/s/m)	-0.007112

Sensitivities	
Total Counts (c/s/nGy/h)	23.2
Potassium (c/s/%)	66.2
Uranium (c/s/ppm)	6.6
Thorium (c/s/ppm)	4.0

Test Data

Background Line Data

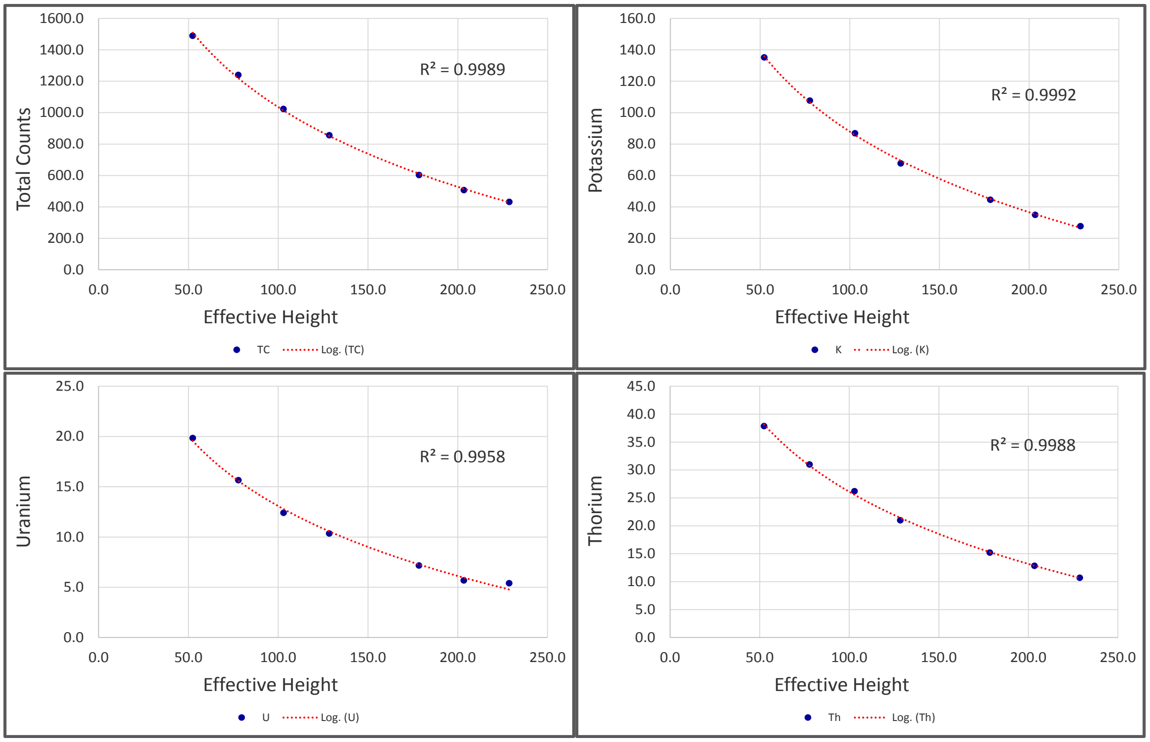
Radar Alt (m)	Effective Height (m)	GPS Alt (m)	TC (c/s)	K (c/s)	U (c/s)	Th (c/s)
91.0	77.3	650.5	290.4	32.3	11.3	9.3
122.6	103.9	683.2	299.8	31.6	11.9	9.7
152.7	129.0	713.0	305.4	32.3	12.2	10.0
182.8	154.0	742.3	309.5	33.1	13.0	9.9
213.3	179.2	773.1	311.9	33.5	12.9	10.3
244.1	204.6	803.7	315.6	33.2	13.2	10.3
274.7	229.6	833.4	320.1	33.0	13.1	10.9
305.8	254.9	865.1	321.8	33.4	13.3	10.6

Test Line Data

Radar Alt (m)	Effective Height (m)	GPS Alt (m)	TC (c/s)	K (c/s)	U (c/s)	Th (c/s)
61.7	52.4	660.2	1787.3	201.8	43.6	48.5
92.0	77.8	689.0	1541.5	168.5	37.9	41.6
122.0	103.0	719.5	1328.9	143.5	33.6	36.8
152.6	128.5	749.7	1165.1	120.6	30.3	31.6
182.7	153.4	778.5	1028.8	103.7	26.9	28.7
213.1	178.4	808.7	919.4	92.8	25.9	26.0
243.5	203.4	838.7	826.7	81.1	24.0	23.7
274.4	228.7	868.4	754.4	72.9	23.2	21.7

Ground Truth Concentrations	
Total Counts (nGy/h)	45.5
Potassium (%)	1.3
Uranium (ppm)	2.0
Thorium (ppm)	6.7

Graphs - Stripped Counts per Second vs Effective Height



7. PAD CALIBRATIONS

Ground Pad Calibration

Project	OMNDM LdML-NL
Flight	N/A
Aircraft	C-GJBB
Detectors	5407 / 5621
Date	2014-06-12

Pilot	N/A
Copilot	
Processor	Carson

Calibration Results

DPU 5407 Stripping Ratios	
α	0.2950
β	0.4430
Ɣ	0.8018
a	0.0542
b	-0.0004
g	0.0075

DPU 5621 Stripping Ratios	
α	0.2944
β	0.4349
Ɣ	0.7827
a	0.0509
b	-0.0008
g	0.0071

Test Data

	Known Pad Concentrations			
Window	BG (Bare)	K	U	Th
K (%)	0.86	9.77	1.02	0.82
U (ppm)	0.99	0.9	53.7	2.15
Th (ppm)	2.64	2.57	3.43	121

	DPU 5407			
Window	BG (Bare)	K	U	Th
K (c/s)	162.9	353.3	245.4	217.2
U (c/s)	23.1	24.3	121.4	60.7
Th (c/s)	26.2	26.1	32.3	146.7
TC (c/s)	1134.3	1832.8	2725.3	2802.3

	DPU 5621			
Window	BG (Bare)	K	U	Th
K (c/s)	144.4	323.5	219.1	190.2
U (c/s)	21.9	23.0	113.1	54.3
Th (c/s)	25.1	24.9	30.4	128.7
TC (c/s)	1054.8	1721.0	2530.4	2472.9

Ground Pad Calibration

Project	OMNDM LdML-NL
Flight	N/A
Aircraft	C-GJBG
Detectors	5552 / 5553
Date	2014-07-03

Pilot	N/A
Copilot	
Processor	Carson

Calibration Results

DPU 5552 Stripping Ratios	
α	0.2911
β	0.4270
ϒ	0.7921
a	0.0497
b	0.0002
g	-0.0016

DPU 5621 Stripping Ratios	
α	0.2970
β	0.4496
ϒ	0.8259
a	0.0548
b	-0.0005
g	-0.0020

Test Data

	Known Pad Concentrations			
Window	BG (Bare)	K	U	Th
K (%)	0.86	9.77	1.02	0.82
U (ppm)	0.99	0.9	53.7	2.15
Th (ppm)	2.64	2.57	3.43	121

	DPU 5552			
Window	BG (Bare)	K	U	Th
K (c/s)	167.3	335.3	243.8	215.2
U (c/s)	23.7	23.2	116.2	57.8
Th (c/s)	27.0	26.9	32.3	137.3
TC (c/s)	1154.7	1753.9	2635.7	2655.7

	DPU 5553			
Window	BG (Bare)	K	U	Th
K (c/s)	149.3	323.4	217.5	193.8
U (c/s)	22.1	21.6	100.7	52.8
Th (c/s)	24.9	24.7	29.8	122.6
TC (c/s)	1065.0	1701.9	2363.6	2413.0

8. RADIOMETRIC SYSTEM RESOLUTION TESTS

Radiometric System Resolution Test

Project	OMNDM LdML-NL
Flight	N/A
Aircraft	C-GJBB
Detectors	5407 / 5621
Date	2014 07-20 to 10-29

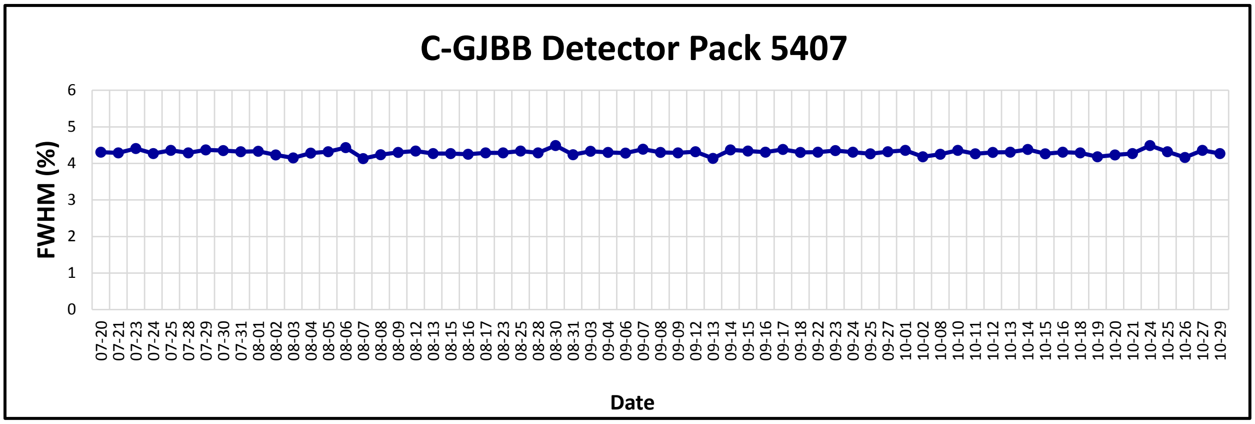
Pilot	N/A
Copilot	N/A
Processor	Carson

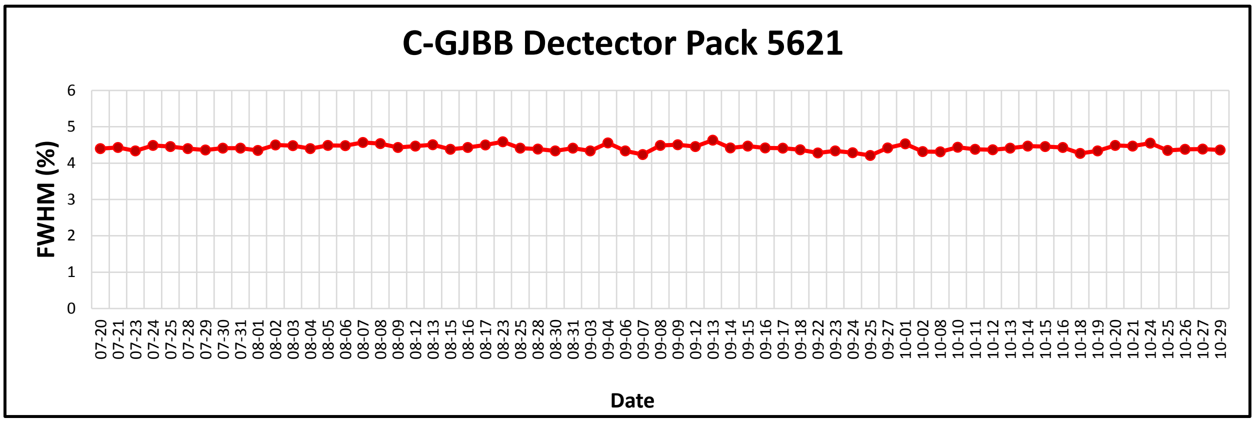
Test Data

Date	DPU1 FWHM	Err	DPU2 FWHM	Err
2014-07-20	4.31	0.59	4.40	0.57
2014-07-21	4.29	0.63	4.43	0.66
2014-07-23	4.41	0.79	4.34	0.65
2014-07-24	4.27	0.59	4.49	0.62
2014-07-25	4.36	0.61	4.46	0.66
2014-07-28	4.29	0.54	4.40	0.55
2014-07-29	4.37	0.72	4.36	0.54
2014-07-30	4.35	0.61	4.41	0.64
2014-07-31	4.32	0.55	4.41	0.72
2014-08-01	4.33	0.76	4.35	0.66
2014-08-02	4.23	0.57	4.50	0.53
2014-08-03	4.15	0.50	4.48	0.70
2014-08-04	4.28	0.56	4.40	0.61
2014-08-05	4.32	0.56	4.49	0.56
2014-08-06	4.43	0.65	4.48	0.69
2014-08-07	4.13	0.58	4.57	0.64
2014-08-08	4.24	0.70	4.54	0.61
2014-08-09	4.30	0.57	4.43	0.67
2014-08-12	4.34	0.60	4.47	0.58
2014-08-13	4.27	0.50	4.51	0.58
2014-08-15	4.27	0.64	4.38	0.58
2014-08-16	4.25	0.60	4.43	0.65
2014-08-17	4.29	0.65	4.50	0.56
2014-08-23	4.29	0.54	4.59	0.67
2014-08-25	4.34	0.66	4.41	0.66
2014-08-28	4.29	0.54	4.39	0.64
2014-08-30	4.49	0.69	4.34	0.58
2014-08-31	4.24	0.60	4.41	0.66
2014-09-03	4.33	0.64	4.34	0.64
2014-09-04	4.30	0.68	4.56	0.61
2014-09-06	4.28	0.76	4.34	0.70
2014-09-07	4.39	0.64	4.24	0.61
2014-09-08	4.30	0.65	4.49	0.59

Date	DPU1 FWHM	Err	DPU2 FWHM	Err
2014-09-09	4.29	0.52	4.51	0.68
2014-09-12	4.32	0.68	4.46	0.59
2014-09-13	4.14	0.62	4.63	0.63
2014-09-14	4.37	0.62	4.42	0.75
2014-09-15	4.34	0.72	4.47	0.62
2014-09-16	4.31	0.66	4.42	0.79
2014-09-17	4.38	0.64	4.41	0.55
2014-09-18	4.30	0.57	4.37	0.47
2014-09-22	4.31	0.56	4.28	0.54
2014-09-23	4.35	0.61	4.34	0.65
2014-09-24	4.31	0.63	4.29	0.58
2014-09-25	4.26	0.67	4.21	0.59
2014-09-27	4.32	0.61	4.42	0.64
2014-10-01	4.36	0.64	4.53	0.64
2014-10-02	4.18	0.59	4.32	0.60
2014-10-08	4.25	0.66	4.31	0.59
2014-10-10	4.36	0.69	4.44	0.66
2014-10-11	4.26	0.60	4.38	0.50
2014-10-12	4.30	0.65	4.37	0.51
2014-10-13	4.31	0.68	4.41	0.60
2014-10-14	4.38	0.62	4.47	0.68
2014-10-15	4.26	0.58	4.46	0.63
2014-10-16	4.31	0.70	4.43	0.63
2014-10-18	4.29	0.46	4.27	0.61
2014-10-19	4.18	0.63	4.34	0.52
2014-10-20	4.23	0.67	4.49	0.64
2014-10-21	4.27	0.58	4.47	0.56
2014-10-24	4.49	0.69	4.55	0.66
2014-10-25	4.32	0.72	4.35	0.57
2014-10-26	4.16	0.57	4.38	0.65
2014-10-27	4.36	0.69	4.39	0.56
2014-10-29	4.27	0.57	4.36	0.68

Graphs C-GJBB DPU 5407 & 5621 FWHM





Radiometric System Resolution Test

Project	OMNDM LdML-NL
Flight	N/A
Aircraft	C-GJBG
Detectors	5407 / 5621
Date	2014 07-18 to 10-26

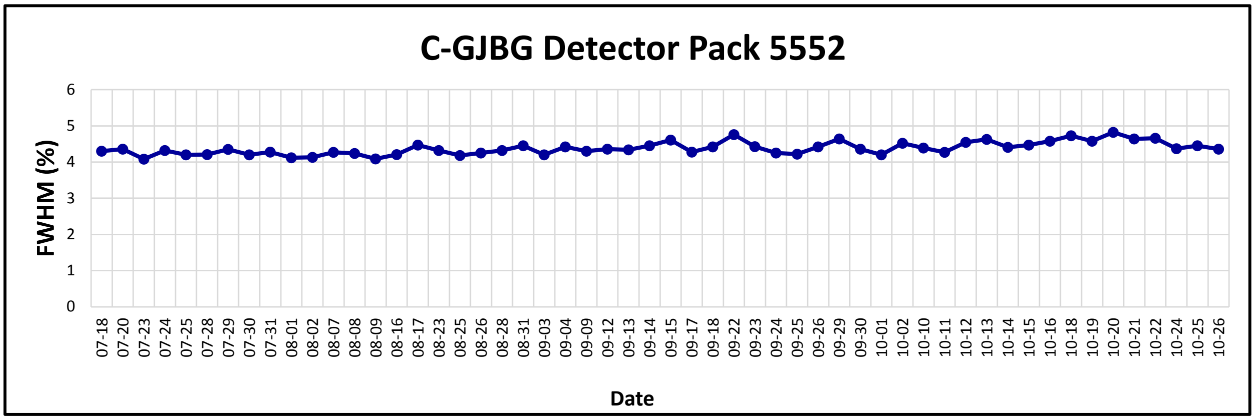
Pilot	N/A
Copilot	N/A
Processor	Carson

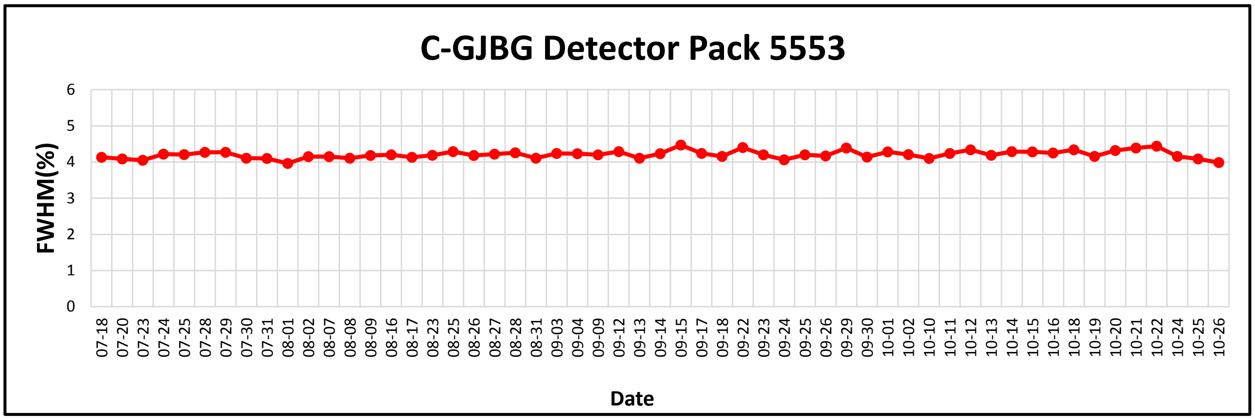
Test Data

Date	DPU1 FWHM	Err	DPU2 FWHM	Err
2014-07-18	4.30	0.75	4.13	0.62
2014-07-20	4.36	0.58	4.09	0.55
2014-07-23	4.08	0.52	4.05	0.57
2014-07-24	4.32	0.69	4.22	0.63
2014-07-25	4.20	0.51	4.21	0.63
2014-07-28	4.21	0.70	4.27	0.79
2014-07-29	4.35	0.64	4.27	0.51
2014-07-30	4.20	0.60	4.11	0.60
2014-07-31	4.28	0.71	4.10	0.61
2014-08-01	4.12	0.59	3.96	0.63
2014-08-02	4.13	0.54	4.15	0.74
2014-08-07	4.27	0.62	4.15	0.59
2014-08-08	4.24	0.66	4.11	0.49
2014-08-09	4.09	0.45	4.18	0.64
2014-08-16	4.21	0.66	4.20	0.55
2014-08-17	4.47	0.58	4.13	0.49
2014-08-23	4.32	0.67	4.19	0.60
2014-08-25	4.18	0.56	4.29	0.61
2014-08-26	4.25	0.62	4.18	0.61
2014-08-28	4.22	0.66	4.32	0.59
2014-08-31	4.26	0.55	4.45	0.60
2014-09-03	4.11	0.63	4.20	0.54
2014-09-04	4.24	0.65	4.42	0.62
2014-09-09	4.23	0.58	4.30	0.69
2014-09-12	4.20	0.44	4.36	0.60
2014-09-13	4.29	0.60	4.34	0.61
2014-09-14	4.11	0.60	4.45	0.52

Date	DPU1 FWHM	Err	DPU2 FWHM	Err
2014-09-15	4.23	0.60	4.61	0.62
2014-09-17	4.47	0.62	4.28	0.56
2014-09-18	4.24	0.67	4.42	0.57
2014-09-22	4.16	0.63	4.76	0.82
2014-09-23	4.40	0.55	4.43	0.72
2014-09-24	4.20	0.63	4.25	0.62
2014-09-25	4.06	0.57	4.22	0.66
2014-09-26	4.20	0.59	4.42	0.56
2014-09-29	4.17	0.65	4.64	0.64
2014-09-30	4.39	0.63	4.36	0.62
2014-10-01	4.14	0.62	4.20	0.71
2014-10-02	4.28	0.55	4.52	0.64
2014-10-10	4.21	0.63	4.39	0.52
2014-10-11	4.10	0.60	4.27	0.64
2014-10-12	4.24	0.65	4.55	0.81
2014-10-13	4.34	0.68	4.63	0.68
2014-10-14	4.19	0.61	4.41	0.58
2014-10-15	4.29	0.59	4.47	0.58
2014-10-16	4.28	0.56	4.58	0.57
2014-10-18	4.25	0.48	4.73	0.68
2014-10-19	4.34	0.59	4.58	0.75
2014-10-20	4.16	0.60	4.82	0.74
2014-10-21	4.32	0.66	4.64	0.71
2014-10-22	4.39	0.66	4.66	0.65
2014-10-24	4.44	0.74	4.37	0.62
2014-10-25	4.16	0.56	4.45	0.60
2014-10-26	4.09	0.57	4.36	0.66

Graphs C-GJBG DPU 5552 & 5553 FWHM

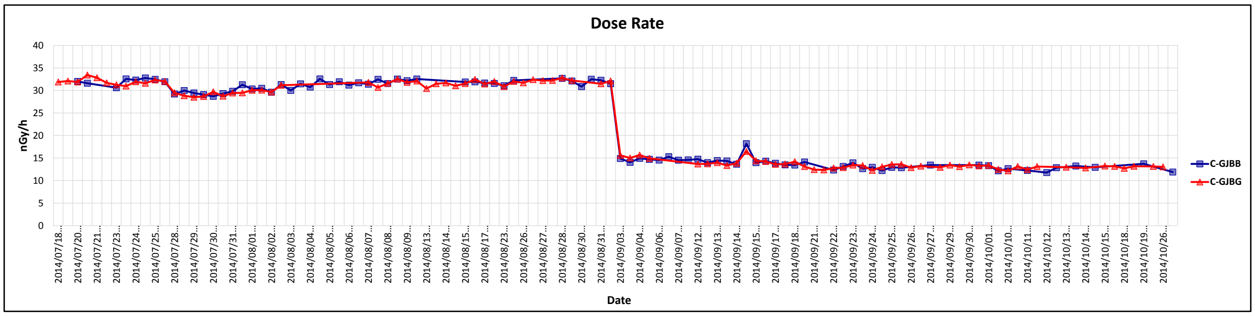


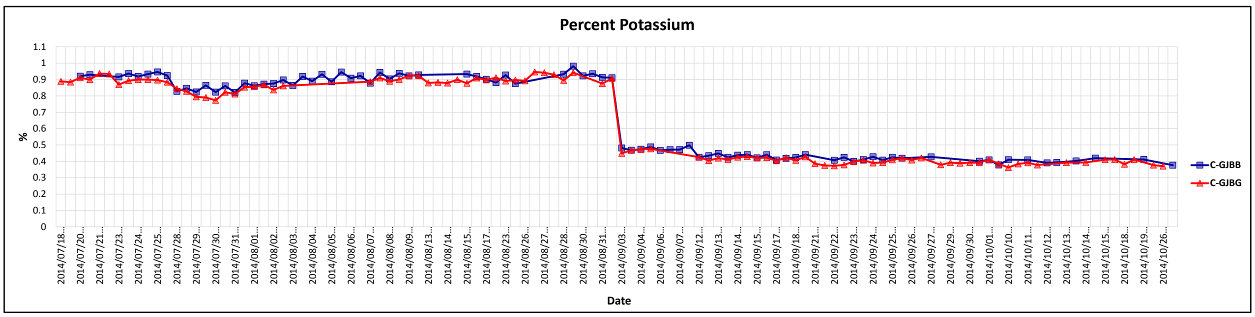


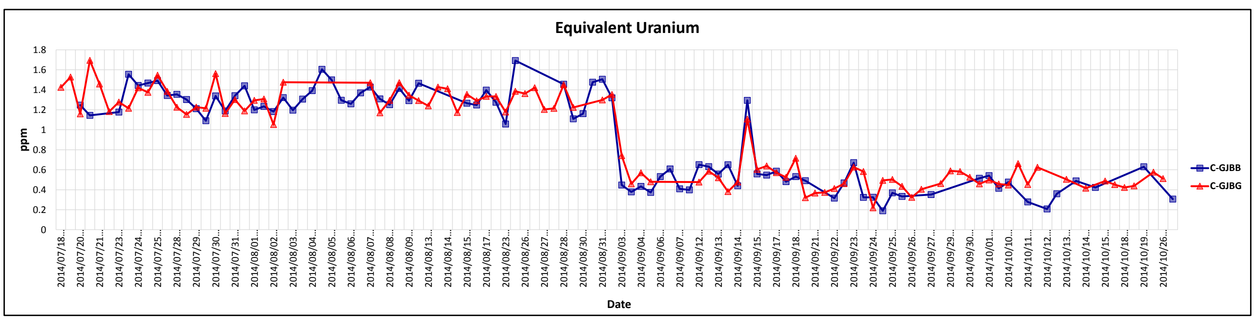
9. DAILY REPEAT LINES

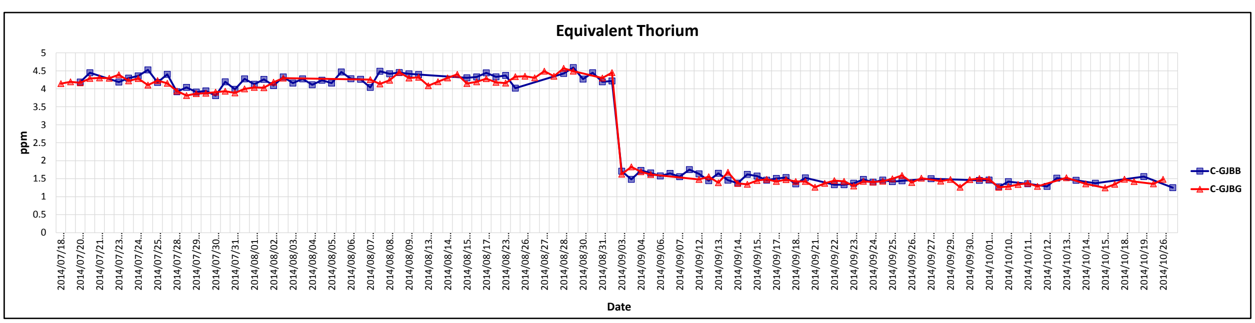
Note: The following graphs contain the results of the test lines from both bases of operations. From July 18th to August 31st, the averages are from the test line near Thunder Bay, ON. From September 1st onward, the test line near Geraldton, ON is used.

Graphs - Final Average Test Line Concentrations (C-GJBG in Blue, C-GJBB in Red)



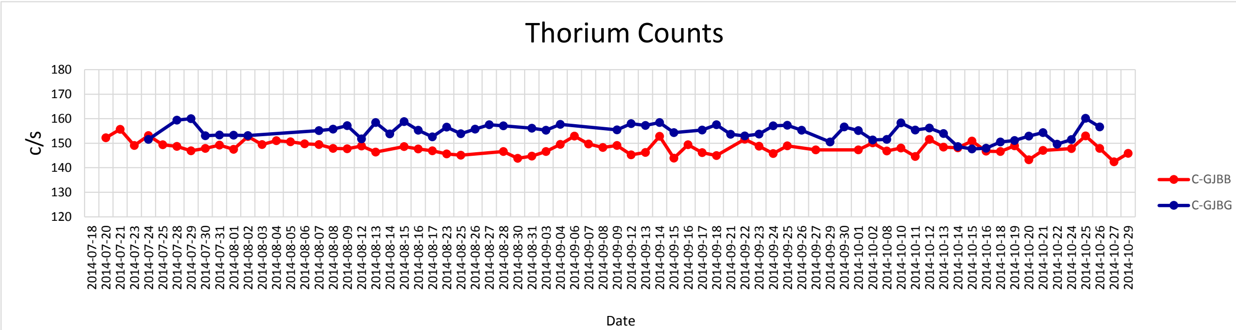






10. DAILY SOURCE TESTS

Graph - Daily Source Test Average Thorium Count per Second



Appendix B. Archive Definitions

Geophysical Data Set 1078 is derived from surveys using a magnetic gradiometry and gamma-ray spectrometric systems mounted on fixed-wing platforms conducted by Goldak Airborne Surveys.

1. ARCHIVE LAYOUT

The files for the Lac des Mille Lacs–Nagagami Lake Geophysical Survey are archived on 2 DVDs and sold as separate products, as outlined below:

Type of Data	Magnetic and Gamma-Ray Spectrometric
Format	Grid and Profile Data (DVD)
ASCII	Geophysical Data Set (GDS) 1078a
Geosoft® Binary	Geophysical Data Set (GDS) 1078b

The content of the ASCII and Geosoft® binary file types are identical. The data are provided in both formats to suit the user's available software. The survey data are divided as follows.

Geophysical Data Set 1078a (DVD)

a) ASCII (*gxf*) grids
- digital elevation model
- total magnetic field
- first vertical derivative of the total magnetic field
- second vertical derivative of the total magnetic field
- "GSC levelled" gradient-enhanced total magnetic field
- first vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- measured lateral (across line) horizontal magnetic gradient
- measured longitudinal (along line) horizontal magnetic gradient
- natural air absorbed dose rate (nGy per hour)
- potassium (%)
- equivalent thorium (ppm)
- equivalent uranium (ppm)
- potassium/equivalent thorium ratio (%/ppm)

b) Vector (*dxf*) files
- flight path
- total field magnetic contours
- Keating coefficients

d) GeoTIFF seamless map images
- "GSC levelled" gradient-enhanced residual magnetic field with planimetric base
- shaded second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field with planimetric base
- total count grid with planimetric base

- percent potassium grid with planimetric base
- equivalent uranium grid with planimetric base
- equivalent thorium grid with planimetric base
- potassium, uranium, thorium ternary image with planimetric base

f) ASCII (*xyz*) data
- profile database of magnetic data (10 Hz sampling) in ASCII *xyz* format
- profile database of gamma-ray spectrometric data (1 Hz sampling) in ASCII *xyz* format
- profile database of the 1024 channel gamma-ray spectra (1 Hz sampling) in ASCII *xyz* format
- database of Keating coefficients in ASCII *csv* (comma-separated values) format

h) Survey report in portable document format (*pdf*)

Geophysical Data Set 1078b (DVD)

a) Geosoft® binary (*grd*) grids
- digital elevation model
- total magnetic field
- first vertical derivative of the total magnetic field
- second vertical derivative of the total magnetic field
- “GSC levelled” gradient-enhanced residual magnetic field
- first vertical derivative of the “GSC levelled” gradient-enhanced residual magnetic field
- second vertical derivative of the “GSC levelled” gradient-enhanced residual magnetic field
- measured lateral (across line) horizontal magnetic gradient
- measured longitudinal (along line) horizontal magnetic gradient
- natural air absorbed dose rate (nGy per hour)
- potassium (%)
- equivalent thorium (ppm)
- equivalent uranium (ppm)
- potassium/equivalent thorium ratio (%/ppm)

c) Vector (*dxf*) files
- flight path
- total field magnetic contours
- Keating coefficients

d) GeoTIFF seamless map images
- “GSC levelled” gradient-enhanced residual magnetic field with planimetric base
- shaded second vertical derivative of the “GSC levelled” gradient-enhanced residual magnetic field with planimetric base
- total count grid with planimetric base
- percent potassium grid with planimetric base
- equivalent uranium grid with planimetric base
- equivalent thorium grid with planimetric base
- potassium, uranium, thorium ternary image with planimetric base

e) Geosoft® (*gdb*) binary data
- profile database of magnetic data (10 Hz sampling) in Geosoft® *gdb* format
- profile database of gamma-ray spectrometric data (1 Hz sampling) in Geosoft® *gdb* format
- profile database of the 1024 channel gamma-ray spectra (1 Hz sampling) in Geosoft® *gdb* format
- Keating coefficients in Geosoft® *gdb* format

h) Survey report in portable document format (*pdf*)

2. CO-ORDINATE SYSTEMS

The profile data are provided in 2 co-ordinate systems:
- Universal Transverse Mercator (UTM) projection, Zone 16N, NAD83, Canada local datum
- latitude/longitude co-ordinates, NAD83, Canada local datum

The gridded data are provided in 1 co-ordinate system:
- Universal Transverse Mercator (UTM) projection, Zone 16N, NAD83, Canada local datum

3. LINE NUMBERING

The line numbering convention for survey data provided in GDS 1078 is as follows:
- Line numbers are 2 to 4 digits with the last digit indicating part or revision number i.e., line 10 is the first line of the survey followed by line 20; should line 10 be in 2 parts, the first is 10 and the second is 11. Similarly, should line 220 have been reflown, it will be in the database as line 221.
- Standard control line numbers begin with 80000, while boundary control line numbers begin with 90000 but both are otherwise organized under the same scheme.
- In the Geosoft® Oasis montaj™ binary database, survey lines are designated with a leading character "L" and control lines are designated with a leading character "T".

4. DATA FILES

The survey data files are provided as follows:
- LNMAG.GDB Geosoft® Oasis montaj™ uncompressed binary database file of the magnetic data, sampled at 10 Hz
- LNMAG.XYZ ASCII file of the magnetic data, sampled at 10 Hz
- LNSPEC.GDB Geosoft® Oasis Montaj™ uncompressed binary database file of the gamma-ray spectrometric data, sampled at 1 Hz
- LNSPEC.XYZ ASCII file of the gamma-ray spectrometric data, sampled at 1 Hz
- LNSPEC1024.GDB Geosoft® Oasis Montaj™ uncompressed binary database file of the 1024 channel gamma-ray spectra , sampled at 1 Hz
- LNSPEC1024(1-23).XYZ
  ASCII file of the 1024 channel gamma-ray spectra, sampled at 1 Hz
- LNKC.GDB Geosoft® Oasis montaj™ uncompressed binary database file of the Keating coefficients
- LNKC.CSV ASCII file of the Keating coefficients

The contents of LNMAG.XYZ/LNMAG.GDB (both file types contain the same set of data channels) are summarized as follows:

Channel Name	Description	Units
gps_x_raw	raw GPS X	metres
gps_y_raw	raw GPS Y	metres
gps_z_raw	raw GPS Z	metres
gps_base_x	GPS base station X	decimal-degrees
gps_base_y	GPS base station Y	decimal-degrees
gps_base_z	GPS base station Z	metres
gps_x_final	differentially corrected GPS X (NAD83 datum)	decimal-degrees
gps_y_final	differentially corrected GPS Y (NAD83 datum)	decimal-degrees
gps_z_final	differentially corrected GPS Z (NAD83 datum)	metres above sea level
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
radar1_raw	raw radar altimeter 1	metres above terrain
radar2_raw	raw radar altimeter 2	metres above terrain
radar_final	corrected radar altimeter	metres above terrain
dem	digital elevation model	metres above sea level
fiducial	fiducial	
flight	flight number	
line_number	full flightline number (flightline and part numbers)	
line	flightline number	
line_part	flightline part number	
time_utc	UTC time	seconds
time_local	local time	seconds after midnight
date	local date	YYYY/MM/DD
height_mag	magnetometer height	metres above terrain
mag_base1_raw	raw magnetic base station 1 data	nanoteslas
mag_base2_raw	raw magnetic base station 2 data	nanoteslas
mag_base1_final	corrected magnetic base station 1 data	nanoteslas
mag_base2_final	corrected magnetic base station 2 data	nanoteslas
fluxgate_x	X-component field from the compensation fluxgate magnetometer	nanoteslas
fluxgate_y	Y-component field from the compensation fluxgate magnetometer	nanoteslas
fluxgate_z	Z-component field from the compensation fluxgate magnetometer	nanoteslas
mag_raw_left	raw magnetic field from left wingtip sensor	nanoteslas
mag_comp_left	compensated magnetic field from left wingtip sensor	nanoteslas
mag_lag_left	comp'd, edited and lag corrected magnetic field from left wingtip	nanoteslas
mag_raw_right	raw magnetic field from right wingtip	nanoteslas
mag_comp_right	compensated magnetic field from right wingtip	nanoteslas
mag_lag_right	comp'd, edited and lag corrected mag. field from right wingtip	nanoteslas
mag_raw_tail	raw magnetic field from tail sensor	nanoteslas
mag_comp_tail	compensated magnetic field from tail sensor	nanoteslas
mag_lag_tail	compensated, edited and lag corrected magnetic. field from tail sensor	nanoteslas

Channel Name	Description	Units
mag_diurn1_tail	diurnally corrected magnetic field from tail sensor	nanoteslas
mag_diurn2_tail	Diurnally corrected magnetic field from tail sensor	nanoteslas
igrf	local IGRF field	nanoteslas
mag_igrf_tail	IGRF-corrected magnetic field from tail sensor	nanoteslas
mag_lev_tail	levelled magnetic field from tail sensor	nanoteslas
mag_final_tail	microlevelled magnetic field from tail sensor	nanoteslas
mag_gsclevel_tail	GSC levelled magnetic field from tail sensor	nanoteslas
mag_grad_lat_raw	raw lateral horizontal mag. gradient (from wingtip sensors)	nanoteslas/metre
mag_grad_lat_cor	attitude corrected lateral horizontal mag. gradient	nanoteslas/metre
mag_grad_lat_final	levelled lateral horizontal mag. gradient	nanoteslas/metre
mag_grad_long_raw	raw longitudinal horizontal mag. gradient (from wingtip sensors)	nanoteslas/metre
mag_grad_long_cor	attitude corrected longitudinal horizontal mag. gradient	nanoteslas/metre
mag_grad_long_final	levelled longitudinal horizontal magnetic gradient	nanoteslas/metre
pitch	aircraft pitch	degrees
roll	aircraft roll	degrees
yaw	aircraft yaw	degrees
azimuth	aircraft azimuth	degrees
aircraft	aircraft registration	

The contents of LNSPEC.XYZ/ LNSPEC.GDB (both file types contain the same set of data channels) are summarized as follows:

Channel Name	Description	Units
gps_x_final	differentially corrected GPS X (NAD83 datum)	decimal-degrees
gps_y_final	differentially corrected GPS Y (NAD83 datum)	decimal-degrees
gps_z_final	differentially corrected GPS Z (NAD83 datum)	metres above sea level
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
radar_raw	raw radar altimeter	metres above terrain
radar_final	corrected radar altimeter	metres above terrain
dem	digital elevation model	metres above sea level
baro_press	barometric pressure	millibars
air_temp	outside air temperature	degrees Celsius
air_temp_f	low-pass filtered outside air temperature	degrees Celsius
fiducial	fiducial	
flight	flight number	
line_number	full flightline number (flightline and part numbers)	
line	flightline number	
line_part	flightline part number	
time_utc	UTC time	seconds after midnight
time_local	local time	seconds
date	local date	YYYYMMDD
height_rad	gamma-ray spectrometer height at STP	metres above terrain

Channel Name	Description	Units
live_time_down	downward looking gamma-ray spectrometer live time	microseconds
live_time_up	upward looking gamma-ray spectrometer live time	microseconds
cosmic_raw	raw cosmic window	counts per second
radon_raw	raw upward-looking uranium window	counts per second
radon_nasvd	upward-looking uranium from smoothed spectrum	counts per second
radon_final	lag corrected upward-looking uranium window	counts per second
total_count_raw	raw total counts	counts per second
potassium_raw	raw potassium	counts per second
uranium_raw	raw uranium	counts per second
thorium_raw	raw thorium	counts per second
total_count_nasvd	total counts from smoothed spectrum	counts per second
potassium_nasvd	potassium from smoothed spectrum	counts per second
uranium_nasvd	uranium from smoothed spectrum	counts per second
thorium_nasvd	thorium from smoothed spectrum	counts per second
total_count_corr	corrected total air-absorbed dose rate	nanograys per hour
potassium_corr	corrected potassium	percent
euranium_corr	corrected equivalent uranium	parts per million
ethorium_corr	corrected equivalent thorium	parts per million
dose_rate	natural air absorbed dose rate	nanograys per hour
total_count_final	final micro-levelled total air-absorbed dose rate	nanograys per hour
potassium_final	final potassium	percent
euranium_final	final micro-levelled equivalent uranium	parts per million
ethorium_final	final equivalent thorium	parts per million
k_over_th	ratio of potassium over equivalent thorium	percent/parts per million
aircraft	aircraft registration	

The contents of LNSPEC1024.XYZ/ LNSPEC1024.GDB (both file types contain the same set of data channels) are summarized as follows:

Channel Name	Description	Units
x_nad83	GPS X in UTM co-ordinates using NAD83 datum	metres
y_nad83	GPS Y in UTM co-ordinates using NAD83 datum	metres
lon_nad83	differentially corrected GPS X (longitude - NAD83 datum)	decimal-degrees
lat_nad83	differentially corrected GPS Y (latitude - NAD83 datum)	decimal-degrees
fiducial	fiducial	seconds
flight	flight number	
line_number	full flight line number (flight line and part numbers)	
line	flight line number	
line_part	flight line part number	
date	local date	YYYY/MM/DD
time_utc	utc time	seconds after midnight
spec_dn	raw 1024-channel downward gamma-ray spectrum (array channel)	counts per second
spec_up	raw 1024-channel upward gamma-ray spectrum (array channel)	counts per second

The contents of LNKC.CSV/LNKC.GDB (both file types contain the same set of data channels) are summarized as follows:

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83 datum	metres
y_nad83	northing in UTM co-ordinates using NAD83 datum	metres
lon_nad83	longitude using NAD83 datum	decimal-degrees
lat_nad83	latitude using NAD83 datum	decimal-degrees
corr_coeff	correlation coefficient	percent
pos_coeff	positive correlation coefficient	percent
neg_coeff	negative correlation coefficient	percent
norm_error	standard error normalized to amplitude	percent
amplitude	peak-to-peak anomaly amplitude within window	nanoteslas

5. GRID FILES

The gridded data are provided in 2 formats:

- **.gxf* Geosoft® uncompressed ASCII grid exchange format (revision 3.0)
- **.grd* Geosoft® Oasis montaj™ uncompressed binary grid file

All grids are NAD83 UTM Zone 16N co-ordinates with a grid cell size of 40 m × 40 m and are summarized as follows:

- LNDEM83.gxf/.grd digital elevation model
- LNMAG83.gxf/.grd total magnetic field
- LN1VD83.gxf/.grd first vertical derivative of the total magnetic field
- LN2VD83.gxf/.grd second vertical derivative of the total magnetic field
- LNGMAGGSC83.gxf/.grd "GSC levelled" gradient-enhanced residual magnetic field
- LNG1VDMAGGSC83.gxf/.grd first vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- LNG2VDMAGGSC83.gxf/.grd second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- LNLAG.gxf/.grd measured lateral (across line) horizontal magnetic gradient
- LNLOG.gxf/.grd measured longitudinal (along line) horizontal magnetic gradient
- LNTC83.gxf/.grd natural air absorbed dose rate (nGy per hour)
- LNK83.gxf/.grd percent potassium (%)
- LNTH83.gxf/.grd equivalent thorium (ppm)
- LNU83.gxf/.grd equivalent uranium (ppm)
- LNKTHRATIO83.gxf/.grd percent potassium/equivalent thorium ratio (%/ ppm)

6. GEOREFERENCED IMAGE FILES

Geographically referenced colour images of the survey area divided in to 4 sections, incorporating a base map, are provided in GeoTIFF format for use in GIS applications:

- LNGMAGGSC83(1-4).TIF — "GSC levelled" gradient-enhanced residual magnetic field grid + planimetric base
- LNG2VDMAGGSC83(1-4).TIF — shaded second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field grid + planimetric base
- LNTC83(1-4).TIF — total count grid + planimetric base
- LNK83(1-4).TIF — potassium grid + planimetric base
- LNU83(1-4).TIF — equivalent uranium grid + planimetric base
- LNTH83(1-4).TIF — equivalent thorium grid + planimetric base
- LNTERN83(1-4).TIF — potassium, uranium, thorium ternary image + planimetric base

7. VECTOR FILES

Vector line work from the maps is provided in DXF (v.12) ASCII format using the following naming convention:

- LNPATH83.DXF — flight path
- LNKC83.DXF — Keating coefficients
- LNMAG83.DXF — magnetic contours

The layers within the DXF files correspond to the various object types found therein and have intuitive names.

8. MAP FILES

Digital 1:50 000 scale maps (NAD83 UTM Zone 16N) in Geosoft® MAP format, with a topographic layer, of the following:

- colour-filled contours of gradient-enhanced residual magnetic field and flight lines with the following tile names:
  m82669 – m82691
- shaded colour of the second vertical derivative of the GSC-levelled gradient-enhanced total magnetic intensity with Keating:
  m82692 – m82714
- histogram-equalized ternary RGB (converted from cyan-magenta-yellow) radioelement image with inset images of percent potassium, equivalent uranium, equivalent thorium, and flight lines :
  m82715 – m82737

Note: map file products were used to create hardcopy and *pdf* maps and do not form part of this digital data set. Hardcopy maps may be ordered through Publication Sales office (call toll free: 888-415-9845) and digital copies download free of charge from the Geology Ontario website (www.geologyontario.mndm.gov.on.ca).

Appendix C. Operational Reports

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

July 14 to July 20

2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Lebrun	Methieson
Copilot:	Ando	Saldanha
Processor:	Shaikh	Bello
Base:	Room 204 Airlane Hotel, Thunder Bay, ON	
Contact:		

Summary	
Project Total	127358
Remaining	125125
Flown this week	2233
Flown to date	2233

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon July 14		C-GJBB												
		C-GJBG												
Tues July 15		C-GJBB												Crew Arrived, JBG arrived
		C-GJBG												
Wed July 16		C-GJBB												Setup the base Mags and Base GPS
		C-GJBG												
Thurs July 17	10	C-GJBG	0.8	0.5		1.3								Comp Flight - Comp Rejected
		C-GJBG												
Fri July 18	11	C-GJBG	0.8	3.3		4.1								Cosmic test Flight
	12	C-GJBB	4.5			4.5								Cosmic test Flight
	13	C-GJBB	0.9	0.3		1.2								Comp flight - Comp rejected
	14	C-GJBG	1.4		3.4	4.8	672	432	240					
	15	C-GJBB	0.9	0.3		1.2								Comp flight in new comp block - Comp Passed
	16	C-GJBG	1.0	0.4		1.4								Comp flight in new comp block- Comp Passed
Sat July 19		C-GJBB								100				Turbulance in Survey block
		C-GJBG												
Sun July 20	17	C-GJBG	0.3		5.8	6.1	938	938						
	18	C-GJBB	1.1		5.4	6.5	1207	863	344					Left sensor failed during flight

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	11.7	4.8	14.6	31.1	2817	2233	584
Total to Date	12.37	5.6	14.6	33.2	2817	2233	584

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

July 21 to July 27
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Mathieson	Lebrun
Copilot:	Ando	Saldanha
Processor:	Shaikh	Bello
Base:	Room # 204, Airlane Hotel, Thunder Bay ON	
Contact:	807-473-1600	

Summary	
Project Total	127358
Remaining	117926
Flown this week	7199
Flown to date	9432

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	19	C-GJBG	0.2		5.9	6.1	1083	1073	10					
July 21	20	C-GJBB	0.8	0.4		1.2								Comp flight - rejected
	21	C-GJBB	1.2	0.4		1.6								Comp flight - passed
Tues		C-GJBB								100				Rain / thunderstorm
July 22		C-GJBG								100				Rain / thunderstorm
Wed	22	C-GJBB	1.8		4.3	6.1	1018	685	333					JBB left mag dropouts
July 23	23	C-GJBG	1.1		5.1	6.2	720	720						
Thurs	24	C-GJBB	0.9	0.4		1.3								Comp flight - Passed (Left mag changed)
July 24	25	C-GJBG	0.9		5.6	6.5	1196	1186	10					
	26	C-GJBB	1.0		5.3	6.3	1236	1208	28					
Fri	27	C-GJBG	0.7		5.5	6.2	1130	1130						
July 25	28	C-GJBB	0.9		5.7	6.6	1197	1197						
Sat		C-GJBB								100				Rain in survey block
July 26		C-GJBG								100				Rain in survey block
Sun		C-GJBB								100				Rain in survey block
July 27		C-GJBG								100				Rain in survey block

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	9.5	1.2	37.4	48.1	7580	7199	381
Total to Date	21.87	6.8	52	81.3	10397	9432	965

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

July 28 to August 03
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Mathieson	Saldanha
Copilot:	Ando	Pelletier
Processor:	Shaikh	
Base:	Room # 204, Airlane Hotel, Thunder Bay	
Contact:	807-473-1600	

Summary	
Project Total	127358
Remaining	103670
Flown this week	14256
Flown to date	23688

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	29	C-GJBG	0.9		5.4	6.3	1145	1145						
July 28	30	C-GJBB	0.7		5.8	6.5	1296	1296						
Tues	31	C-GJBG	1.0		1.7	2.7	336	336		70				Flight terminated due to rain in block
July 29	32	C-GJBB	0.7		1.5	2.2	335	335		70				Flight terminated due to rain in block
Wed	33	C-GJBG	0.8		5.5	6.3	1200	1200						
July 30	34	C-GJBB	1.0		5.5	6.5	1326	1326						
Thurs	35	C-GJBG	0.8		5.6	6.4	1109	1109						
July 31	36	C-GJBB	0.8		5.8	6.6	1345	1345						
Fri	37	C-GJBG	0.6		5.8	6.4	1260	1260						
August 01	38	C-GJBB	0.8		6.0	6.8	1380	1380						
Sat	39	C-GJBG	0.7		5.7	6.4	1223	1202	21					
August 02	40	C-GJBB	0.8		6.0	6.8	1323	1312	11					
Sun	41	C-GJBB	0.8		4.7	5.5	1010	1010						
August 03		C-GJBG										100		JBG exaust manifold broken ,waiting on parts

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	10.4	0	65	75.4	14288	14256	32
Total to Date	32.27	6.8	117	156.7	24685	23688	997

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

August 04 to **August 10**
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Matieson	Saldanha
Copilot:	Ando	Pelletier
Processor:	Shaikh	
Base:	Room # 204, Airlane Hotel, Thunder Bay	
Contact:	807-473-1600	

Summary	
Project Total	127358
Remaining	92841
Flown this week	10829
Flown to date	34517

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	42	C-GJBB	0.6		4.5	5.1	782	782						
August 04		C-GJBG												JBG exahust problem waiting to replace
Tues	43	C-GJBB	0.8		5.8	6.6	1222	1222						
August 05		C-GJBG												JBG exahust problem waiting to replace
Wed	44	C-GJBB	0.7		6.0	6.7	1296	1296						
August 06	45	C-GJBB	0.9		4.2	5.1	940	940						
														JBG exahust problem waiting to replace
Thurs	46	C-GJBB	0.8		5.7	6.5	1261	1261						
August 07	47	C-GJBG	1.0		4.0	5.0	828	828						
Fri	48	C-GJBB	1.0		5.5	6.5	1172	1172						
August 08	49	C-GJBG	1.0		5.6	6.6	1079	1079						
Sat	50	C-GJBB	1.1		5.5	6.6	1223	1223						
August 09	51	C-GJBG	0.9		5.5	6.4	1026	1026						
Sun		C-GJBB								100				Thunderstorm
August 10		C-GJBG												

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	8.8	0	52.3	61.1	10829	10829	0
Total to Date	41.07	6.8	169.3	217.8	35514	34517	997

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

August 11 to August 17

2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Mathieson	Saldanha
Copilot:	Pelletier	Ando
Processor:	Shaikh	
Base:	Room # 204, Airlane Hotel, Thunder Bay	
Contact:	807-473-1600	

Summary	
Project Total	127358
Remaining	85783
Flown this week	7058
Flown to date	41575

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon August 11		C-GJBB								100				Rain in survey block
		C-GJBG								100				Rain in survey block
Tues August 12		C-GJBB										100		JBB flap problem, fixed in late evening
		C-GJBG										100		JBG left engine oil temperature gauge problem, fixed in late evening
Wed August 13	52	C-GJBG	0.9		3.3	4.2	409	310	99					
		C-GJBG										100		JBB right engine oil temperature gauge failure
Thurs August 14	53	C-GJBG	1.0		5.0	6.0	1069	1055	14					
	54	C-GJBG	0.7		5.5	6.2	1165	1165						
Fri August 15	55	C-GJBG	0.7		5.9	6.6	1333	1333						
	56	C-GJBB	1.0		5.3	6.3	1177	1177						
Sat August 16	57	C-GJBB	0.7			0.7				100				Flight terminated due to light rain and low clouds
		C-GJBG								100				Low Clouds and light rain in survey block
Sun August 17	58	C-GJBB	0.9		5.5	6.4	1175	1175						
	59	C-GJBG	1.2		5.1	6.3	843	843						

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	7.1	0	35.6	42.7	7171	7058	113
Total to Date	48.17	6.8	204.9	260.5	42685	41575	1110

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

August 18 to **August 24**
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Mathieson	Saldanha
Copilot:	Ando	Pelletier
Processor:	Shaikh	
Base:	Room # 204, Airlane Hotel, Thunder Bay	
Contact:	807-473-1600	

Summary	
Project Total	127358
Remaining	83295
Flown this week	2488
Flown to date	44063

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon August 18		C-GJBB								100				Low clouds / rain in block
		C-GJBG								100				Low clouds / rain in block
Tues August 19		C-GJBB								100				Low clouds / rain in block
		C-GJBG								100				Low clouds / rain in block
Wed August 20		C-GJBB								100				Fog / Low clouds / Rain
		C-GJBG								100				Fog / Low clouds / Rain
Thurs August 21		C-GJBB								100				Fog / Low clouds / Rain
		C-GJBG								100				Fog / Low clouds / Rain
Fri August 22		C-GJBB								100				Fog / Low clouds / Rain
		C-GJBG								100				Fog / Low clouds / Rain
Sat August 23	60	C-GJBB	1.0		5.6	6.6	1272	1272						
	61	C-GJBG	0.6		5.7	6.3	1216	1216						
Sun August 24		C-GJBB								100				Rain and low clouds
		C-GJBG								100				Rain and low clouds

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	1.6	0	11.3	12.9	2488	2488	0
Total to Date	49.77	6.8	216.2	273.4	45173	44063	1110

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

August 25 to August 31
2014

Aircraft and Crew			
Aircraft:	C-GJBB	C-GJBG	
Pilot:	Mathieson	Saldanha	Lebrun
Copilot:	Pelletier	Ando	
Processor:	Shaikh		
Base:	Room # 204, Airlane Hotel, Thunder Bay		
Contact:	807-473-1600		

Summary	
Project Total	127358
Remaining	74900
Flown this week	8395
Flown to date	52458

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon August 25	62	C-GJBB	1.3			1.3				100				Flight terminated due to very low clouds
	63	C-GJBG	0.9		1.1	2.0	99	99		100				Flight terminated due to very low clouds
Tues August 26	64	C-GJBG	0.7		5.5	6.2	1203	1203						
		C-GJBG											100	Waiting on crew replacement
Wed August 27	65	C-GJBG	1.1		5.0	6.1	1070	1070						
		C-GJBG											100	JBB pilot arrived late evening
Thurs August 28	66	C-GJBB	1.0		5.5	6.5	1207	1207						
	67	C-GJBG	1.3		5.4	6.7	1145	1145						
Fri August 29		C-GJBB								100				Rain in block
		C-GJBG								100				Rain in block
Sat August 30	68	C-GJBB	1.2		5.4	6.6	1294	1294						JBG under scheduled maintenance
		C-GJBG												
Sun August 31	69	C-GJBG	1.2		5.4	6.6	1105	1105						
	70	C-GJBB	1.4		5.1	6.5	1272	1272						

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	10.1	0	38.4	48.5	8395	8395	0
Total to Date	59.87	6.8	254.6	321.9	53568	52458	1110

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

September 01 to September 07
2014

Aircraft and Crew

Aircraft:	C-GJBB	C-GJBG
Pilot:	Lebrun	Saldanha
Copilot:	Pelletier	Ando
Processor:	Heath	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary

Project Total	127358
Remaining	67504
Flown this week	7396
Flown to date	59854

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon September 01		C-GJBB								100				Rain in block
		C-GJBG								100				Rain in block
Tues September 02		C-GJBB											100	Crew moved from Thunder Bay to Geraldton
		C-GJBG											100	
Wed September 03	71	C-GJBG	1.1		5.8	6.9	1226	1226						
	72	C-GJBB	1.0		5.5	6.6	1159	1159						
Thurs September 04	73	C-GJBG	1.0		5.8	6.8	1229	1229						
	74	C-GJBB	0.7		6.2	6.9	1283	1283						
Fri September 05		C-GJBB												Extreme High Wind
		C-GJBG												Extreme High Wind
Sat September 06	75	C-GJBB	1.2		5.1	6.3	1246	1246						
		C-GJBG												Hydraulic Failure
Sun September 07	76	C-GJBB	1.2		5.1	6.3	1253	1253						
		C-GJBG												Hydraulic Failure

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	6.2	0	33.5	39.8	7396	7396	0
Total to Date	66.07	6.8	288.1	361.7	60964	59854	1110

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

September 08 to September 14
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Lebrun	Saldhana
Copilot:	Pelleitier	Ando
Processor:	Heath	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	56136
Flown this week	11368
Flown to date	71222

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon September 08	77	C-GJBB	0.6		4.7	5.3	1115	1115						
		C-GJBG												Hydraulic Failure
Tues September 09	78	C-GJBB	0.7		1.3	1.8	206	206						MAG ONLY Terminated rain in the survey block
	79	C-GJBG	1.3		0.6	1.9	111	111						MAG ONLY Terminated rain in the survey block
Wed September 10		C-GJBB								100				Heavy rain all day
		C-GJBG								100				Heavy rain all day
Thurs September 11	80	C-GJBB	0.6		6.0	6.6	1469	1469						MAG Only Ground still wet from previous days rain
	81	C-GJBG	0.6		6.3	6.9	1131	1131						MAG Only Ground still wet from previous days rain
Fri September 12	82	C-GJBB	0.9		5.5	6.4	1369	1277	92					
	83	C-GJBG	0.9		5.6	6.5	1250	1158	92					
Sat September 13	84	C-GJBB	0.9			0.9								Comp - failed
	85	C-GJBG	0.7			0.7								Comp - failed
	86	C-GJBB	0.5			0.5								Comp - failed
	87	C-GJBG	0.8			0.8								Comp - passed
	88	C-GJBB	0.6			0.6								Comp - passed
	89	C-GJBG	1.1		4.0	5.1	960	960						
Sun September 14	90	C-GJBB	0.5		5.5	6.0	1321	1321						
	91	C-GJBG	1.0		5.4	6.4	1249	1249						
	92	C-GJBB	0.4		6.0	6.4	1371	1371						

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	12.1	0	50.9	62.8	11552	11368	184
Total to Date	78.17	6.8	339	424.5	72516	71222	1294

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

September 15 to September 21
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Lebrun	Saldanha
Copilot:	Ando	Pelletier
Processor:	Heath	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	47867
Flown this week	8269
Flown to date	79491

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	93	C-GJBG	0.9		2.2	3.1	478	478						
September 15	94	C-GJBB	0.8		5.6	6.4	1015	1015						
Tues	95	C-GJBB	0.7		1.5	2.2	330	330		66				Terminated due to poor Wx
September 16		C-GJBG								66		33		Scheduled Maintenance not complete before weather turned
Wed	96	C-GJBB	0.9		5.4	6.3	1262	1250	12					
September 17	97	C-GJBG	1.0		4.7	5.7	981	981						
Thurs	98	C-GJBG	0.9		4.7	5.6	1193	1193						
September 18	99	C-GJBG	0.9		4.9	5.8	1169	1169						
	100	C-GJBB	0.8		3.2	4.0	788	788						
	101	C-GJBG	1.0		3.7	4.7	869	869						
Fri		C-GJBB								100		100		JBB undergoing scheduled maintenance; heavy rain all day
September 19		C-GJBG								100				Heavy rain all day
Sat		C-GJBB								100		100		JBB undergoing scheduled maintenance; heavy rain all day
September 20		C-GJBG								100		30		Heavy rain all day
Sun	102	C-GJBG	1.2		1.0	2.2	196	196		80				Flight terminated due to rain
September 21		C-GJBG								80		20		Scheduled maintenace complete

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	9.1	0	36.9	46	8281	8269	12
Total to Date	87.27	6.8	375.9	470.5	80797	79491	1306

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

September 22 to September 28
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Lebrun	Saldanha
Copilot:	Pelletier	Ando
Processor:	Heath	
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	35311
Flown this week	12556
Flown to date	92047

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	103	C-GJBG	1.0		5.5	6.5	950	950						
September 22	104	C-GJBB	0.5		5.9	6.4	1430	1430						
Tues	105	C-GJBG	1.0		5.5	6.5	1219	1219						
September 23	106	C-GJBB	0.5		6.0	6.5	1428	1428						
Wed	107	C-GJBG	0.9		5.3	6.2	1197	1197						
September 24	108	C-GJBB	0.6		0.2	0.8								
	109	C-GJBG	0.4		6.1	6.5	1428	1428						
Thurs	110	C-GJBB	0.5		6.0	6.5	1428	1428						
September 25	111	C-GJBG	1.0		5.6	6.6	1304	1304						
Fri	112	C-GJBG	0.8		5.4	6.2	1265	1265						
September 26		C-GJBG											100	Aircraft JBB - Crew time ex
Sat	113	C-GJBB	0.7		4.6	5.3	1019	907	112					Flown by JBG normal crew
September 27		C-GJBG										100		Aircraft requires scheduled maintenance.
Sun		C-GJBB								100			100	Rain all day
September 28		C-GJBG								100		100		

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	7.9	0	56.1	64	12668	12556	112
Total to Date	95.17	6.8	432	534.5	93465	92047	1418

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

September 29 to October 05
2014

Aircraft and Crew		
Aircraft:	C-GJBG	C-GJBB
Pilot:	Lebrun	Saldanha
Copilot:	Pelletier	Ando
Processor:	Heath/ Shaikh	
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	30984
Flown this week	4327
Flown to date	96374

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon September 29	114	C-GJBG	0.8		3.7	4.5	869	869		25		25		Low cloud until noon
		C-GJBB											100	Aircraft JBB - Crew time ex
Tues September 30	115	C-GJBG	0.8		5.3	6.1	1186	1186						
		C-GJBB											100	Aircraft JBB - Crew time ex
Wed October 01	116	C-GJBB	0.7		5.7	6.4	1338	1227	111					
	117	C-GJBG	1.1		4.8	5.9	1045	1045						
Thurs October 02	118	C-GJBB	0.2		0.1	0.3				100				Flight terminated due to low clouds
	119	C-GJBG	0.3			0.3				100				Flight terminated due to low clouds
Fri October 03		C-GJBG								100				Rain/Low clouds
		C-GJBB								100				Rain/Low clouds
Sat October 04		C-GJBG								100				Wet snow/Low cloud
		C-GJBB								100				Wet snow/Low cloud
Sun October 05		C-GJBG								100				Fluries/Low vis
		C-GJBB								100				Fluries/Low vis

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	3.9	0	19.6	23.5	4438	4327	111
Total to Date	99.07	6.8	451.6	558	97903	96374	1529

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

October 06 to October 12

2014

Aircraft and Crew		
Aircraft:	C-GJBG	C-GJBB
Pilot:	Mathieson	Saldanha
Copilot:	Pelletier	Ando
Processor:	Shaikh	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	21254
Flown this week	9730
Flown to date	106104

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon		C-GJBG								100				Wet Snow/Low clouds
October 06		C-GJBB								100				
Tues		C-GJBG								100				Rain and snow mixed/ Low clouds
October 07		C-GJBB								100				
Wed	120	C-GJBB	0.2			0.2				100				Wet snow/rain/Low clouds
October 08		C-GJBB								100				Flight terminated due to low clouds
Thurs		C-GJBG								100				Wet flurries/rain/low clouds
October 09		C-GJBB								100				
Fri	121	C-GJBG	0.9		4.7	5.6	1065	1065						
October 10	122	C-GJBB	1.4		5.1	6.5	1449	1449						
Sat	123	C-GJBG	0.7		4.4	5.1	1026	1026						
October 11	124	C-GJBB	0.5		4.4	4.9	1033	1033						
	125	C-GJBG	0.6		4.2	4.8	909	909						
	126	C-GJBB	0.5		4.9	5.4	1155	1155						
Sun	127	C-GJBG	1.1		5.4	6.5	1241	1241						
October 12	128	C-GJBB	0.6	0.4		1.0								JBB Comp flight - Right mag replaced
	129	C-GJBG	0.8		2.5	3.3	523	523						
	130	C-GJBB	0.6		5.9	6.5	1329	1329						

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	7.9	0.4	41.5	49.8	9730	9730	0
Total to Date	107	7.2	493.1	607.8	107633	106104	1529

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

October 13 to October 19

2014

Aircraft and Crew		
Aircraft:	C-GJBG	C-GJBB
Pilot:	Mathieson	Saldanha
Copilot:	Pelletier	Ando
Processor:	Shaikh	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	**127358**
Remaining	**6766**
Flown this week	**14488**
Flown to date	**120592**

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	131	C-GJBG	1.0		5.2	6.2	1189	1189						
October 13	132	C-GJBB	0.8		5.6	6.4	1302	1302						
	133	C-GJBG	0.8		2.3	3.1	537	537						
	134	C-GJBB	0.4		3.2	3.6	777	777						
Tues	135	C-GJBG	0.8		5.5	6.3	1200	1200						
October 14	136	C-GJBB	0.6		5.7	6.3	1364	1364						
Wed	137	C-GJBG	0.9		5.3	6.2	1187	1187						
October 15	138	C-GJBB	1.1		5.4	6.5	1268	1268						
Thurs	139	C-GJBG	0.9		5.1	6.0	1120	1120						
October 16	140	C-GJBB	1.5		4.8	6.3	1092	1092						
Fri		C-GJBG								100				Rain/Low clouds
October 17		C-GJBB								100				
Sat	141	C-GJBG	1.2		5.2	6.4	1062	1062						
October 18		C-GJBB										100		JBB right engine magneto failure
Sun	142	C-GJBB	1.0		5.2	6.2	1196	1196						
October 19	143	C-GJBG	0.8		5.6	6.4	1194	1194						

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	**11.8**	**0**	**64.1**	**75.9**	**14488**	**14488**	**0**
Total to Date	**118.8**	**7.2**	**557.2**	**683.7**	**122121**	**120592**	**1529**

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

October 20 to **October 26**
2014

Aircraft and Crew		
Aircraft:	C-GJBG	C-GJBB
Pilot:	Mathieson	Saldanha
Copilot:	Pelletier	Ando
Processor:	Shaikh	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	1085
Flown this week	5681
Flown to date	126273

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon October 20		C-GJBG								100	60			Rain/Low clouds, unsettled mag
		C-GJBB								100	60			Rain/Low clouds, unsettled mag
Tues October 21	144	C-GJBG	0.9		2.0	2.9	457	457		50				Flt terminated due to Fog in area
		C-GJBB										100		JBB engine magneto failure
Wed October 22	145	C-GJBG	0.6		5.7	6.3	1178	1178						
		C-GJBB										100		JBB problem fixed in late evening.
Thurs October 23		C-GJBG								100				Low clouds/ rain
		C-GJBB								100				Low clouds/ rain
Fri October 24		C-GJBG								100				Low clouds/Rain
		C-GJBB								100				Low clouds/Rain
Sat October 25	146	C-GJBB	1.0		5.2	6.2	1225	1225						
	147	C-GJBG	0.8		4.2	5.0	903	903						
Sun October 26	148	C-GJBB	1.2		3.7	4.9	894	894						
	149	C-GJBG	0.7		4.7	5.4	1024	1024						
	150	C-GJBB	1.2		2.7	3.9								JBB Mag reflights
	150	C-GJBB	1.2		2.7	3.9								JBB Comp flight

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	7.6	0	30.9	38.5	5681	5681	0
Total to Date	126.4	7.2	588.1	722.2	127802	126273	1529

Goldak Airborne Surveys Operations Report

OMNDM Thunder Bay

October 27 to November 02
2014

Aircraft and Crew		
Aircraft:	C-GJBB	C-GJBG
Pilot:	Mathieson	Saldanha
Copilot:	Pelletier	Ando
Processor:	Shaikh	Bello
Base:	Suit 8 203 3rd Ave SW Geraldton Ontario	
Contact:	780-903-4599	

Summary	
Project Total	127358
Remaining	-1432
Flown this week	2517
Flown to date	128790

			Flight Times (h)				Production (km)			Unservicability (%)				
	Flight	Aircraft	Ferry	Test	Survey	Total	Flown	Accepted	Rejected	Weather	Diurnal	Equipent	Crew	Notes
Mon	151	C-GJBB	0.9		5.7	6.6	1360	1360						
October 27	152	C-GJBB	1.0		2.0	3.0	490	490						
														JBG is down for schduled maintenance
Tues		C-GJBB								100				Low clouds/rain
October 28		C-GJBG								100				Low clouds/rain
Wed	153	C-GJBB	1.0		2.7	3.7	667	667						Survey operations complete
October 29		C-GJBG												JBG is down for schduled maintenance
Thurs		C-GJBB												
October 30		C-GJBG												
Fri		C-GJBB												
October 31		C-GJBG												
Sat	158	C-GJBB		0.3		4.0								
November 01	159	C-GJBB		0.3		4.0								
Sun		C-GJBB												
November 02		C-GJBG												

	Ferry	Test	Survey	Total	Flown	Accepted	Rejected
Weekly Total	2.9	0.6	10.4	21.3	2517	2517	0
Total to Date	129.3	7.8	598.5	743.5	130319	128790	1529