Ontario

ONTARIO GEOLOGICAL SURVEY

Geophysical Data Set 1247

Ontario Airborne Geophysical Surveys
Magnetic, Electromagnetic and Gamma-Ray Spectrometric Data
Scadding Township Area

Purchased Data

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

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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
- Terraquest Ltd., Markham, Ontario – responsible for data reprocessing, compilation and digital products
- 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 quality assurance (QA), quality control (QC) and project-related digital products
- Terraquest Ltd., Markham, Ontario – data acquisition and data compilation — for True Claim Exploration Inc., Vancouver, British Columbia

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 Geological Survey 2015. Survey report on the Scadding Township area, 31p. [PDF document]; *in* Ontario airborne geophysical surveys, magnetic, electromagnetic and gamma-ray spectrometric data, grid and profile data (ASCII and Geosoft® formats) and vector data, Scadding Township area—Purchased data; Ontario Geological Survey, Geophysical Data Set 1247.

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.

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1. Introduction

As part of an ongoing program to acquire high-quality, high-resolution airborne geophysical data across the Province of Ontario, the Ministry of Northern Development and Mines (MNDM) does, from time to time, issue Requests For Data (RFD) in order to purchase existing proprietary data held by mining companies. Purchase of existing data complements new surveys commissioned by the MNDM. The purchase of data is attractive due to the low cost of acquisition relative to flying new surveys.

The money used to purchase the data can be reinvested in exploration. The data are assessed for quality prior to purchase and are reprocessed to meet the common formats and standards of other Ontario geophysical data. Once reprocessed, these data are then made public.

Ranking and valuation of submitted airborne geophysical survey data sets were based on the following criteria:

- date of survey: recent surveys were favoured over older surveys because of improved acquisition technology, greater data density and improved final products
- survey method: magnetometer surveys, without supplementary radiometric or very low frequency (VLF) survey data, were given the lowest rating in this category; airborne electromagnetic (AEM) and magnetometer surveys were given the highest; the objective was to acquire data that complements what is already available in the public domain, with emphasis on exploration rather than mapping
- location of area
- data sets covering areas already surveyed or scheduled for survey were only selected if they added significantly to the acquired data sets
- proximity or coincidence of the survey block with areas having restricted land use designations affected the value assigned to that survey
- consideration was given to data sets that were collected in remote areas where logistical costs are very high
- line spacing: detailed surveys were normally accorded a higher rating than reconnaissance surveys
- quality of data: data quality, processed products and adherence to correct survey specifications had to be up to normal industry standards
- survey size: data sets comprising less than 1000 line-kilometres were selected only if they fell in very strategic locations
- other criteria: factors such as apparent mineral significance, previous exploration activity and land availability were also considered in making the final selection

2. Survey Location and Specifications

2.1. SURVEY LOCATION

This survey is located in northern Ontario south east of Lake Wanapitei, 30 km northeast of Sudbury (Figure 1). The survey outline is irregular in shape with 43 corners; centred at approximately 532716E 5165612N (WGS84 UTM Zone 17N). The total survey is 2950 line-kilometres, covering an area of 240 km^2.

2.2. SURVEY SPECIFICATIONS

Table 1. Summary of survey specifications for the Scadding Township area.

Parameter	Specification	Instrument Precision
Aircraft speed	78.0 m/sec (281 km/hr)	
Sampling interval	7–8 m (10 Hz)	
Flight-line interval	100 m	±3 m
Flight-line direction	0° and 180°	
Control-line interval	1000 m	±3 m
Control-line direction	90° and 270°	
Aircraft mean terrain clearance	80 m	±5 m

Table 2. Summary of survey kilometres.

Survey Kilometres	
Traverse	2661 km
Control	288.96 km
Total	2949.9 km

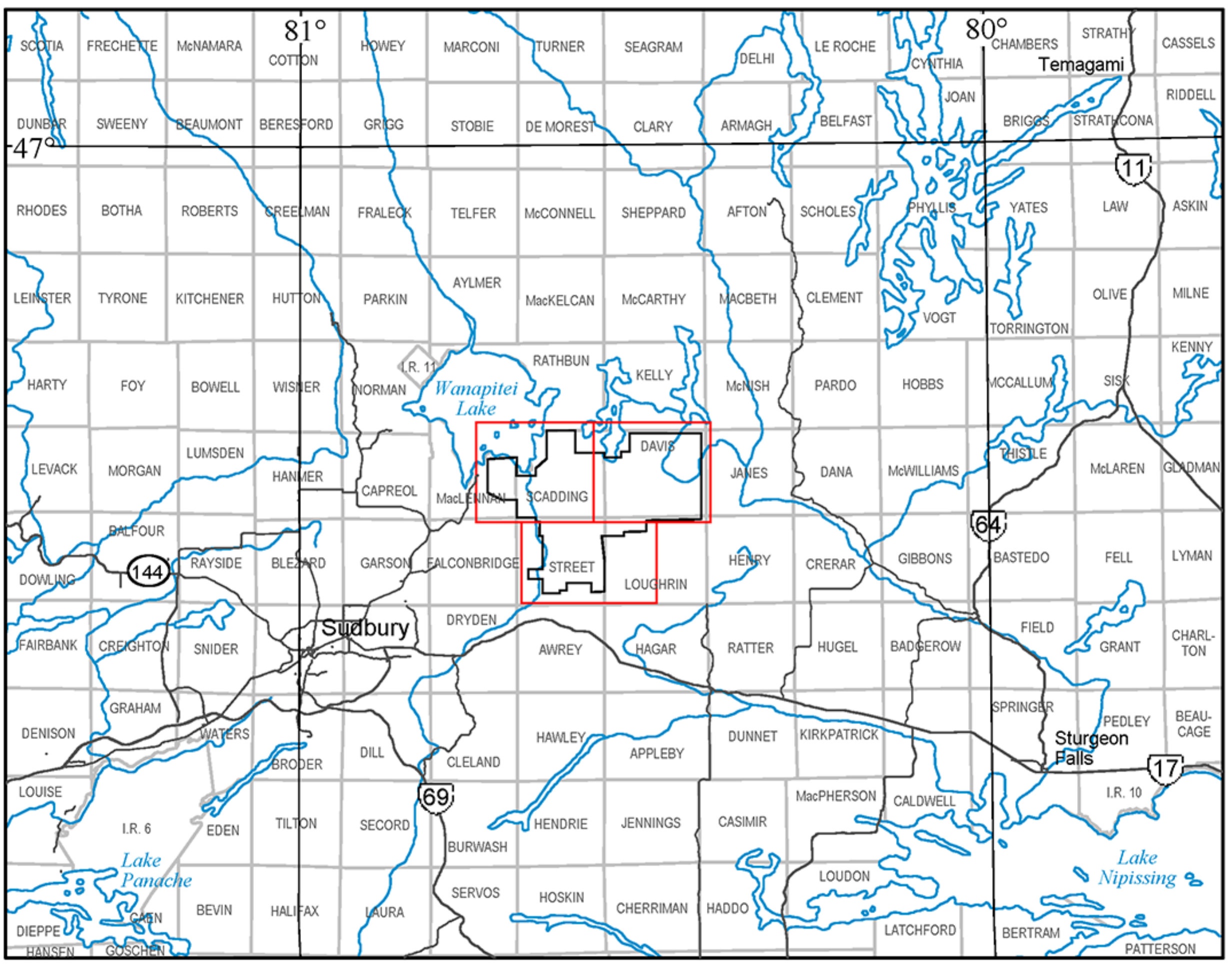


Figure 1. Location of the Scadding Township survey area (outlined in red).

3. Aircraft, Equipment and Personnel

3.1. SURVEY AIRCRAFT

The survey aircraft for this project was a Beechcraft® King Air® 90, leased and operated by Dynamic Aviation on behalf of Terraquest Ltd. Its aircraft Identifier is N41J. The aircraft has been specifically modified with long-range fuel cells and an array of sensors to carry out airborne geophysical surveys.

3.2. EQUIPMENT

3.2.1. MAGNETOMETER SYSTEMS

3.2.1.1. HIGH-SENSITIVITY MAGNETOMETERS

Three high-resolution cesium vapour magnetometers, manufactured by Scintrex, were installed in the tail stinger and 2 wing-tip extensions; the transverse separation was 16.2 m and the longitudinal separation was 10.3 m.

Table 3. Geometrics Limited magnetometer specifications.

Type of Magnetometer Sensor:	cesium vapour
Model:	G822A
Manufacturer:	Geometrics Ltd.
Resolution:	0.001 nT counting at 0.1 per second
Sensitivity:	±0.005 nT
Dynamic Range:	20 000 to 100 000 nT
Fourth Difference:	0.02 nT
Recorded Sample Rate:	0.1 seconds
Noise Envelope:	0.10 nT (tail magnetometer)
Sampling Rate:	10 Hz

3.2.1.2. TRI-AXIAL FLUXGATE MAGNETIC SENSOR

The fluxgate tri-axial magnetometer was mounted in the rear of the aircraft cabin to monitor aircraft manoeuver and magnetic interference. This was used to compensate the high sensitivity data in real time.

Table 4. Billingsley Magnetics fluxgate magnetometer specifications.

Tri-Axial Fluxgate Magnetic Sensor:	(for compensation, mounted in mid-section of tail stinger)
Model:	W/FM100G2-1F
Manufacturer:	Billingsley Magnetics
Description:	low noise miniature triaxial fluxgate magnetometer
Axial Alignment:	> orthogonality > ±1 degree
Accuracy:	< ±0.75% of full scale (0.5% typical)
Field Measurement:	±100 000 nT
Linearity:	< ±0.015% of full scale
Sensitivity:	100 microvolt/nanotesla
Noise:	<12 picotesla RMS/–Hz @ 1 Hz
Sampling Rate:	10 Hz

3.2.1.3. DATA ACQUISITION AND MAGNETOMETER PROCESSOR SYSTEM

Table 5. RMS Instruments DAARC 500 (data acquisition and adaptive aeromagnetic) real-time compensator specifications.

DAS & Compensation:	combined
Model:	DAARC 500
Manufacturer:	RMS Instruments
Operating System:	QNX 6.3
Time:	104 MHz temperature-compensated crystal clock
Front-End Magnetic Processing:	resolution 0.32 pT; system noise <0.1 pT; sample rate 160, 640, 800 or 1280 Hz
Front-End - Fluxgate:	I/F module; oversampling, self-calibrating 16 bit A/D converter
Compensation:	improvement ratio (total field) 10-20 typical
Input Serial:	8 isolated RS232 channels; ASCII and Binary formats
Input Analog:	16 bit, self-calibrating A/D converter
Input Events:	4 latched event inputs
Raw Data Logging:	at front end sampling rate, 1 MB buffer
Output/Recording:	rate 10, 20 or 40 Hz; Serial up to 115.2 kbps; recording media 1 GB Flash; 80 GB hard drive; flash disk via USB; display
Front Panel Indicators:	8 LEDs for magnetometer input; 2 LEDs for front-end status

3.2.2. RADIOMETRIC SYSTEM

Table 6. Pico Envirotec Inc. GRS 510 gamma-ray spectrometer specifications.

Type:	gamma-ray spectrometer
Model:	GRS 510
Manufacturer:	Pico Envirotec Inc.
Downwards Volume:	3075.5 in^3 (50.4 L) Downward (12 crystals)
Upwards Volume:	512.6 in^3 (8.4 L) Upward (2 crystals)
Software:	real-time data collection
Energy Detection Range:	50 KeV to 3 MeV
Count Rate:	up to 1 000 000 pps communication
Collected Spectrum:	256 Channels
Spectra Tracking:	individual detectors with recorded status of tuning
Sampling Rate:	1 Hz
Time Stabilization:	automatic on natural radionuclei
Spectra Stabilization:	automatic after system calibration
Windows (ROI):	additional to full spectra up to 22 special windows
Peak Detector:	digital – time resolution 50 nsec
Dead Time:	negligible for up to 60 000 pulses/sec/detector

Abbreviation: ROI, region of interest.

3.2.3. TERRAQUEST XDS BROADBAND VLF–EM SYSTEM

The proprietary XDS broadband VLF–EM system has been developed by Terraquest Ltd. It employs 3 orthogonal, air-core coils mounted in the pod of the tail stinger that are coupled with a receiver–console. The receiver–console is tuned to a half-power bandwidth of 22 to 26 kHz, which includes the following frequencies: Cutler, Maine (NAA) signal at 24 kHz, La Moure, North Dakota (NML) signal at 25.2 kHz and Seattle, Washington (NLK) signal at 24.8 kHz. Depending on the orientation of each orthogonal coil, the coil will measure either X, Y, or Z directions of the total VLF field.

Table 7. Terraquest Limited XDS Broadband VLF–EM specifications.

Model:	XDS Broadband
Manufacturer:	Terraquest Ltd.
Primary Source:	magnetic field component radiated from government VLF radio transmitters
Parameters Measured:	X, Y and Z components, absolute field
Frequency Range:	half power 22.0 to 26.0 kHz
Gain:	constant gain setting
Filtering:	no filtering
Sampling Rate:	10 Hz

3.2.4. Navigation and Ancillary Systems

3.2.4.1. NAVIGATION SYSTEM

Table 8. AgNav Inc. navigation system specifications.

Navigation and Guidance:	stand-alone module
Model:	LiNav P151
Manufacturer:	AgNav Inc.
Main Display:	LCD moving map display
Pilot Display:	2 line shows left/right, distance to end of line/survey
Line:	generates and follows survey lines
Input:	GPS with corrections; up to 10 Hz
Media:	USB memory stick
Sampling Rate:	1 Hz

3.2.4.2. GLOBAL POSITIONING SYSTEM DIFFERENTIAL RECEIVER

Table 9. Trimble GPS specifications.

Model:	AG-132
Manufacturer:	Trimble
Channels:	12
Position Update:	0.2 second for navigation
Correction Service:	real-time correction subscription: Omnistar
Sample Rate:	1 second
Accuracy:	~3 m

3.2.4.3. BAROMETRIC SENSOR

Table 10. Barometric sensor information.

Sensors:	pressure (millibars (mB))
Model:	LX18001AN
Manufacturer:	SenSym
Source:	coupled to aircraft barometric (pitot static) system
Output:	serial output to DAARC 500

3.2.4.4. RADAR ALTIMETER

Table 11. FreeFlight Systems radar altimeter specifications.

Altimeter:	radar
Model:	RA 3500
Manufacturer:	FreeFlight Systems
Accuracy:	±5% at 50 to 500 feet
Output:	digital for pilot and data acquisition
Sampling Rate:	10 Hz

3.2.4.5. FLIGHT PATH CAMERA

Table 12. Sony® camera specifications.

Camera:	(mounted in belly of aircraft)
Model:	DFW-SX910
Manufacturer:	Sony
Serial Number:	100140
Specifications:	½″, 1.3 LX, 12 VDC, C/CS, EI/ES, backlit compensation
Lens:	Fujinon $^{2}/_{3}$″, 2.7 mm, auto iris
Output:	Video
Sampling Rate:	1 Hz

3.2.5. BASE STATION MAGNETOMETER AND GPS RECEIVER

The base station magnetometer was a CS-2 cesium vapour instrument manufactured by Scintrex. The magnetometer processor was a KMAG manufactured by Kroum VS Instruments and the data logger was an iPAQ PDA by Hewlett Packard. The counter was powered by a 10VAC (50/60hz) to 30VDC 3.0 amp power supply with an internal 12VDC fan. The logging software SDAS-1 was written by Kroum VS Instrument Ltd. specifically for the pocket PC hardware. It supports real-time graphics with selectable windows (uses 2 user selectable scales: coarse and fine). The time record was obtained from the base GPS receiver. Magnetic data were logged at 1 Hz. Data collection was by an RS232 link recording in ASCII string format onto a flash memory card.

Table 13. Ground magnetometer specifications.

Ground Magnetometer:	cesium vapour
Model:	CS-2
Manufacturer:	Scintrex
Sensitivity:	0.01 nT
Noise Envelope:	0.05 nT
Sampling Interval:	1 second
Minimum Range:	50 to 3500 feet
GPS Model:	12 channel GPS
Manufacturer:	Deluo
Type:	L1, C/A code
Antenna:	built in patch
Logging Rate:	1 per second
Power:	5 VCD taken from iPAQ power supply

3.3. PERSONNEL

The contractor supplied the following qualified and experienced personnel to carry out the survey and to complete the re- processing for MNDM.

Table 14. Personnel for the survey and re-processing.

FIELD		OFFICE PROCESSING	
Geophysicists:	Brendan Purchase, Carolyn Boone	Geophysicist (Magnetics):	Brendan Purchase
Captain:	Dan Landis, Dwight Monk	Geophysicist (Keating):	Allen Duffy
First Officer:	Tim Wescott, Jessica Jackson	Geophysicist (Radiometric):	Allen Duffy
Equipment Operator:	Mark Andrews	Geophysicist (XDS VLF–EM):	Brendan Purchase

Project Management was the responsibility of Charles Barrie, Terraquest Ltd., operations manager in Markham, Ontario.

4. Contractor Data Acquisition and Field Processing

On April 18, 2010, the crew arrived and set up operations in Sudbury. The following day, the crew successfully completed calibrations (“Appendix G: Calibrations”). The acquisition period was 9 days: 5 of those days were allocated to survey, 2 for weather/standby and 1 each for set up and calibrations. The calibration results can be found in “Appendix G: Calibrations”.

Table 15. Survey schedule.

Calibrations:	April 19
Survey Period:	April 20–26
Flight Numbers:	2, 4-7, 9
Number of Production Flights:	6

Average production per flight and day: 485 km and 727 km, respectively

During the survey, the pilot maintained daily personal, aircraft and preflight safety reports. The operator set up the base station and monitored the airborne data during calibrations and/or survey and kept precise notes of each flight. After the flight, the operator would forward the flight report and data to the project geophysicist. The project geophysicist performed quality control on the raw and compensated survey data. Additionally, the geophysicist would transcribe the operator notes and enter quality control notes into a Microsoft® Excel® spreadsheet. From this spreadsheet, daily, weekly and summary reports were automatically generated.

4.1. FLIGHT PATH

The satellite navigation system was used to ferry to the survey sites and to survey along each line. The survey co-ordinates were supplied by the client and were used to establish the survey boundaries and the flight lines. The flight-path guidance accuracy was variable depending upon the number and condition (health) of the satellites employed. With Omnistar real-time correction, the accuracy was, for the most part, better than 3 m. The flight path was recorded as WGS 84 latitude/longitude and converted into UTM co-ordinates (North American Datum 1983, Zone 17N) in Geosoft® Oasis montaj™. The flight-path maps can be viewed in “Appendix F: Flight Path Maps”.

4.2. MAGNETIC DATA

The field data were examined in the evening after each flight by a geophysicist who inspected the data for quality control and tolerances. Magnetic data from the diurnal base station were scrutinized for spurious readings (data spikes) and any obvious cultural interference. Any such features were manually removed and the data re-interpolated (Akima spline) to maintain a continuous record. The data were then subsequently used to correct measured airborne magnetic readings.

The diurnal and lag corrected data were further refined using tie-line levelling. Using the Geosoft® Oasis montaj™ implementation of this procedure, an initial table of tie-traverse line intersection differences was compiled (together with supporting ancillary parameters such as local gradient, etc.) and intersection data were loaded into the processing database. In a series of iterative levelling passes, outlier intersection values were either disabled or modified to refine and finalize the overall result.

5. Final Data Compilation and Processing

5.1. FINAL MAGNETIC PROCESSING

Prior to beginning the reprocessing, it was discovered that the database provided was not the original 10 Hz database, but instead an incorrectly sampled 1 Hz database. Terraquest was the original contractor for acquisition and successfully recovered the original 10 Hz database before beginning the final microlevelling. Microlevelling is a process that uses a directional filter to identify and remove residual noise along the traverse line direction. These imperfections could be due to incomplete removal of diurnal or heading influences in sections of adjacent lines. The resulting corrections were limited to the maximum amplitude of 4 nT for the survey to avoid removing geologic responses.

The total magnetic intensity (TMI) was corrected using the tenth generation of the International Geomagnetic Reference Field (IGRF), valid for the period of 2010–2015, to produce the residual magnetic field. The average terrain elevation for the survey was 364 m.

5.1.1. LEVELLING MAGNETIC DATA TO MASTER MAGNETIC DATUM

This levelling procedure drapes the microlevelled magnetic data onto the GSC 812.8 m regional grid to produce a levelled product that maintains the resolution of the unleveled data (Reford 1990; Gupta et al. 1989).

The final residual magnetic field (RMI) was gridded to 1/5 of the line spacing using bi-directional gridding. The grid was then upward continued by 220 m to bring the survey data to that of the nominal terrain clearance of the Ontario regional grid (305 m in height). The Ontario regional grid was then subtracted from the upward continued residual magnetic field to create a difference grid containing high frequency geology and error. The difference grid was filtered using a non-linear and low pass filters. The resultant difference grid was then saved to a database and subtracted from the unlevelled (RMI) grid to produce a final residual magnetic product leveled to the Ontario Regional datum.

The following GSC levelling parameters were used in the Scadding Township survey:

distance to upward continue: 220 m
first pass non-linear filter length: 25 000 m
second pass non-linear filter length: 2500 m
low-pass filter cut-off wavelength: 10 000 m

5.1.2. SECOND VERTICAL DERIVATIVE OF THE RESIDUAL MAGNETIC FIELD

The final residual magnetic field levelled to the magnetic master datum (Ontario Geological Survey 1999) was then used to create the second vertical derivative. The second vertical derivative was calculated using a 2-D FFT operator that contained a mild Butterworth low-pass filter of 150 m that limited high frequency aliasing. The second vertical derivative optimizes shallow surface anomalies and its zero contour outlines boundaries or contacts.

5.2. KEATING CORRELATION COEFFICIENTS

Possible kimberlite targets are identified from the residual magnetic intensity data, based on the identification of roughly circular anomalies. This procedure is automated by using a known pattern recognition technique (Keating 1995), which consists of computing, over a moving window, a first-order regression between a vertical cylinder model anomaly and the gridded magnetic data. Only the results where the absolute value of the correlation coefficient is above a threshold of 75% were retained. On the magnetic maps, the results are depicted as circular symbols, scaled to reflect the correlation value. The most favourable targets are those that exhibit a cluster of high amplitude solutions. Correlation coefficients with a negative value correspond to reversely magnetized sources.

First, an artificial kimberlite anomaly grid was prepared using parameters provided by MNDM. The cylinder model parameters are as follows:

- Cylinder diameter: 200.0 m
- Mean data acquisition clearance: 70.0 m
- Average overburden depth: 0.7 m
- Depth to top of cylinder: 70.7 m
- Depth to bottom of cylinder : infinite
- Magnetic inclination: 74.8° N
- Magnetic declination: -3.5° W
- Window size: 31 × 31 cells (620 m × 620 m)
- Magnetization scale factor: 100
- Model window grid cell size: 20 m

The model's magnetic response is shown in Figure 2.

The model was cross-correlated with the final microlevelled, IGRF-corrected, gradient-enhanced grid and a database of coefficients created. These were plotted in a symbol format and reviewed for correctness. The databases have been provided in Geosoft® *.gdb* format (uncompressed) and comma delimited ASCII *.csv* format. The database fields are described in the Appendixes.

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 gridding). All available geological information should be incorporated in kimberlite pipe target selection.

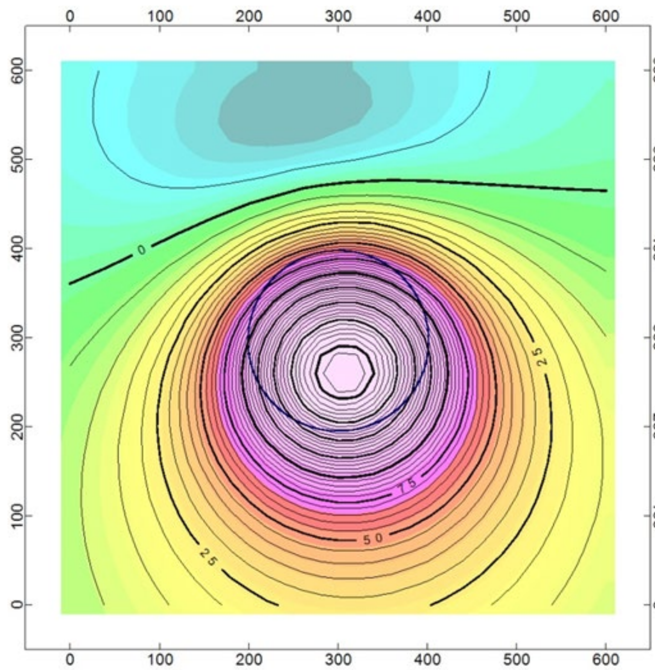


Figure 2. Vertical cylinder model anomaly used for Keating correlation on the Scadding Township survey area. Grid cell size is 20 m and contour interval is 10 nT. Top of cylinder outlined in blue.

5.3. FINAL RADIOMETRIC PROCESSING

The radiometric data were processed according to guidelines established in the definitive IAEA Technical Report “Airborne Gamma Ray Spectrometer Surveying” (International Atomic Energy Agency 1991). Below is a generalized description of the data reduction process.

5.3.1. ENERGY WINDOWS

The radiometric data were recorded as a 256-channel spectrum and integrated into 5 elemental energy windows (region of interest (ROI): total count, potassium, uranium, thorium and cosmic).

Table 16. Energy windows.

Window (“ROI”)	Energy Range (keV)		Channel Range*	
Total Count	410	2810	034	234
Potassium	1370	1570	114	131
Uranium	1660	1860	138	155
Thorium	2410	2810	201	234
Cosmic	>3000		255	

**Overall channel number range is indexed 0–255.*

5.3.2. AIRCRAFT AND COSMIC BACKGROUND CORRECTION

Removal of cosmic background was completed from a linear equation containing the raw cosmic component and an aircraft intercept for each measured element (total count, potassium, uranium and thorium). The results can be found in “Appendix G: Calibrations” “Radiometric Cosmic Calibration”.

5.3.3. ATMOSPHERIC BACKGROUND CORRECTION

The airborne radon background was removed by subtracting background readings that were collected over large bodies of water before each survey flight. The over-water background data contained only airborne radon daughter products present in the radioelement windows as the ground radiation had been effectively screened. The over-water data were compiled into a table and were subtracted on a flight by flight basis from the cosmic corrected data to produce radon background corrected regions of interest.

5.3.4. COMPTON STRIPPING

The data were corrected for Compton scattering. This is caused by gamma-ray photons colliding with electrons, transferring some of its energy and scattering down as a lower energy photon. This phenomenon will cause some incident photons to be wrongly classified as lower energy events. Pad calibrations are completed to experimentally derive “Compton stripping” ratios. The Compton stripping ratios are used to correct each elemental window count rate for the effects of the other elements. The Compton stripping ratios can be found in “Appendix G: Calibrations” “Radiometric Pad Tests: Compton Coefficients”.

Special Reprocessing Note:

Upon initial examination of the data, there appeared to be excessive coherence in the variation of thorium and uranium data channels as expressed in the gridded data. This was considered to be suspicious and prompted a step-by-step check in the original data reduction procedure chain. This check revealed that the Compton stripping operation had most probably been originally misapplied resulting in, essentially, no stripping of the uranium channel (and reduced adjustment of the potassium data). The data were subsequently completely reprocessed using atmospheric background corrected data as a starting point. Reprocessing of the data included fresh application of micro-level corrections—with resulting corrections limited to ±1 SD (one standard deviation) to avoid excessive influence on important anomalous geologic features.

5.3.5. ALTITUDE ATTENUATION CORRECTION

The regions of interest were then corrected for attenuation effects due to varying terrain clearances. Altitude attenuation coefficients were experimentally determined based on terrain clearances corrected to standard temperature and pressure. Measured count rates were adjusted to a constant terrain clearance of 80 m. The altitude attenuation coefficients can be found in “Appendix G: Calibrations” “Radiometric Altitude Attenuation Calibration”.

5.3.6. CONVERSION TO GROUND UNITS

As a final step, the altitude attenuated counts were converted to equivalent ground concentration units through the application of sensitivity factors developed during a calibration flight over an approved radiometric test range. The system was calibrated at the Geologic Survey of Canada’s calibration facility (Breckenridge test line) located outside Ottawa, Ontario. The results can be found in “Appendix G: Calibrations” “Radiometric Sensitivities Breckenridge”.

5.3.7. Ternary Image and Ratios

A radioelement ternary map was created using the red–green–blue intensity (RGBI) colour model. To clarify and better display the relative concentrations of the 3 principal radioelements (potassium, uranium and thorium), the grids were sum-normalized using the following formulae:

$$K_{norm} = \frac{K}{K + eU + eTh}$$

$$eU_{norm} = \frac{eU}{K + eU + eTh}$$

$$eTh_{norm} = \frac{eTh}{K + eU + eTh}$$

At each individual grid node, a display colour was formed by combining the 3 primary colour components (red, green and blue) weighted according to the sum-normalized K, eU and eTh components (which now vary from 0.0 to 1.0). Prior to combination to generate the final colour mix, each colour (or radioelement) plane was redistributed using an equal area histogram algorithm.

The intensity of the resulting colour was then altered according to the overall total count activity level, again normalized to vary from 0.0 to 1.0. The intensity weighting is applied logarithmically and has the effect of bleaching out colour where the overall activity is low to insignificant. This ensures that the resulting ternary image does not contain amplified colour noise over low count rate areas such as lakes, rivers and swamps.

To get around limitations in commercially available processing software, which can have problems in the proper application of the intensity (total count) grid, custom software was written and used to generate the ternary image as a standard Geosoft® colour grid. The software reads the input data in their native % K, ppm eU and ppm eTh unit-based grids and directly calculates and images the sum-normalized data. The total count grid (nGy/h) is also input and normalized prior to being used for intensity weighting. The same software is used to generate the ternary index legend, which results in improved clarification of the cyan, magenta and yellow transition zones when using red–green–blue as the primary colour model.

In summary, the RGBI colouring scheme was applied using the following colour transforms:

Colour:	Normalized	Unit	Data Limits	Transform
Red (R):	K_{norm}	%	0 to 1	equal area histogram
Green (G):	eU_{norm}	ppm	0 to 1	equal area histogram
Blue (B):	eTh_{norm}	ppm	0 to 1	equal area histogram
Intensity (I):	total count	nGy/h	99% of data values	logarithmic transform

Finally, the potassium–thorium ratio was calculated as an interpretation tool for identifying potassium alteration zones. In calculating the ratio, minimum thresholds of K = 0.3% and Th = 0.3 ppm eTh were specified. Both regions of interest were pretreated with a 7 fiducial low-pass filter prior to ratio calculation with the below-threshold regions masked out.

5.4. FINAL TERRAQUEST XDS VLF–EM PROCESSING

The Terraquest proprietary XDS VLF–EM system is a passive broadband system that captures secondary EM signals from geologic bodies in line, orthogonal and vertical directions (equivalent to y, x and z components, respectively) in the half-power range of 22.0 to 26.0 kHz. This data set contained some line-to-line and flight variations as there were variabilities in the primary fields. This was particularly evident in the “Orthogonal” channel.

The raw data from each of the 3 XDS components were edited for off-times (during radio calls), spikes and level shifts. Additionally, the data were mildly low-pass filtered, normalized on a line-by-line basis and underwent polynomial trend removal. The vertical component required the use of a Fraser filter as the anomaly signatures were crossovers and not peak-centric. To reduce the high frequency noise, the vertical and orthogonal components of the data were also upward continued by 100 m (vertical) and 20 m (orthogonal) and de-corrugated to eliminate noise in the line direction.

5.5. REFORMATTING OF LINE ARCHIVE DATABASE

The original magnetic and VLF–EM line archive was recovered to preserve the 10 Hz integrity. The line archive databases required only minor reformatting from the original contractor-supplied data set. These reformats include creation of ancillary channels, renaming of existing channels and deleting any redundant lines. The line databases were saved as 2 formats: Geosoft® (*.gdb*) format (uncompressed) and ASCII (*.xyz*) format.

5.6. FINAL MAP PRODUCTS

Base maps of the survey area were supplied by the MNDM and were used to create the following digital Geosoft® map products:

1. 1:20 000 scale colour-filled contours of the gradient-enhanced residual magnetic field with flight path and MNDM supplied planimetric base and map surround in 3 map sheets (Maps 60 454 to 60 456)
2. 1:20 000 scale shaded colour image of the second vertical derivative of the residual magnetic field with flight path and Keating (1995) kimberlite pipe correlation coefficients, and MNDM supplied planimetric base and map surround in 3 map sheets (Maps 60 457 to 60 459)
3. 1:20 000 scale ternary radioelement image and flight path, and MNDM supplied planimetric base and map surround in 3 map sheets (Maps 60 460 to 60 462)
4. 1:20 000 scale colour-filled contours of the VLF–EM vertical component and flight path, and MNDM supplied planimetric base and map surround, in 3 map sheets (Maps 60 463 to 60 465)

These digital maps were supplied to the MNDM for the creation of hard-copy and *.pdf* map products and are not part of the geophysical data set.

5.7. CREATION OF GEOREFERENCED IMAGES

Seamless 150 DPI resolution georeferenced GeoTIFF images of the 4 map themes described in section 5.6 were prepared. The GeoTIFFs show all the map elements except for the map surround information, co-ordinate graticule and co-ordinate annotations and are available in Geophysical Data Set (GDS) 1247.

5.8. CREATION OF LINE WORK (VECTOR) ARCHIVES

Seamless AutoCad® (*.dxf*) format files were created containing flight path, Keating coefficient symbols, and magnetic and XDS VLF-EM contours .

6. References

Barrie, C. 2010. Operations report, gradient-magnetic, radiometric and XDS VLF–EM survey, Scadding Township property, Sudbury, Ontario, prepared for True Claim Exploration Inc. by Terraquest Ltd.; unpublished report, True Claim Exploration Inc., Sudbury Resident Geologist’s office, assessment file AFRO# 2.45173, AFRI# 20000005511, 47p.

Gupta, V.K., Paterson, N.R., Reford, S.W., Kwan, K., Hatch, D. and MacLeod, I.N. 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, No.323.

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.

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

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; abstract *in* Society of Exploration Geophysicists, 60th Annual Meeting, San Francisco, California, SEG Technical Program, Expanded Abstracts 1990, p.617-619, DOI:10.1190/1.1890282.

Appendix A. Data Files Description

1. ARCHIVE LAYOUT

The files for the Scadding Township Geophysical Survey are archived on a single DVD-ROM and provided as single product, as outlined below:

Type of Data	Magnetic, Electromagnetic and Gamma-Ray Spectrometric
Format	Grid and Profile Data (DVD-R)
ASCII and Geosoft® Binary	Geophysical Data Set (GDS) 1247

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

Geophysical Data Set 1247 (DVD)

a) ASCII (GXF) grids
- total (residual) magnetic field
- second vertical derivative of the total magnetic field
- total count (natural air absorbed dose rate) (nGy per hour)
- digital elevation model
- potassium concentration (%)
- equivalent thorium concentration (ppm)
- equivalent uranium concentration (ppm)
- potassium–equivalent thorium ratio
- ternary
- VLF–EM vertical component (volts)
- VLF–EM in-line component (volts)
- VLF–EM orthogonal component (volts)

b) ASCII (CSV) data
- database of Keating correlation (kimberlite) coefficients in ASCII CSV (comma-separated values) format

c) Vector (DXF) files
- flight path
- Keating correlation (kimberlite) anomalies
- total field magnetic contours

d) GeoTIFF (150 dpi) images
   - colour total magnetic field with planimetric base
   - colour-shaded relief of second vertical derivative of the total magnetic field with planimetric base
   - total count grid with planimetric base
   - potassium grid with planimetric base
   - equivalent uranium grid with planimetric base
   - equivalent thorium grid with planimetric base
   - ternary with planimetric base
   - VLF–EM vertical component with planimetric base
   - VLF–EM in-line component with planimetric base
   - VLF–EM orthogonal component with planimetric base

e) Geosoft® binary (GRD) grids
   - total (residual) magnetic field
   - second vertical derivative of the total magnetic field
   - total count (natural air absorbed dose rate) (nGy per hour)
   - potassium concentration (%)
   - equivalent thorium concentration (ppm)
   - equivalent uranium concentration (ppm)
   - potassium–equivalent thorium ratio
   - ternary
   - VLF–EM vertical component (volts)
   - VLF–EM in-line component (volts)
   - VLF–EM orthogonal component (volts)

f) Geosoft® (GDB) binary data
   - profile database of magnetic and VLF–EM data (10 Hz sampling) in Geosoft® GDB format
   - profile database of gamma-ray spectrometric (radiometric) data (1 Hz sampling) in Geosoft® GDB format
   - database of Keating correlation (kimberlite) coefficients in Geosoft® GDB format

g) ASCII (XYZ) data
   - profile database of magnetic and VLF–EM data (10 Hz sampling) in ASCII XYZ format
   - profile database of gamma-ray spectrometric (radiometric) data (1 Hz sampling) in ASCII XYZ format

h) Survey report in Adobe® Acrobat® (PDF) format

2. CO-ORDINATE SYSTEMS

The profile and Keating coefficient data are provided in 2 co-ordinate systems:

- Universal Transverse Mercator (UTM) projection, Zone 17N, 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 17N, NAD83, Canada local datum

3. DATA FILES

The survey data files are provided as follows:

- SCADDING.GDB Geosoft® Oasis montaj™ uncompressed binary database file of the magnetic and electromagnetic data, sampled at 10 Hz
- SCADDING.XYZ ASCII file of the magnetic and electromagnetic data, sampled at 10 Hz
- SCADDING_SPEC.GDB Geosoft® Oasis Montaj™ uncompressed binary database file of the gamma-ray spectrometric data, sampled at 1 Hz
- SCADDING_SPEC.XYZ ASCII file of the gamma-ray spectrometric data, sampled at 1 Hz
- SCAKC.GDB Geosoft® Oasis montaj™ uncompressed binary database file of the Keating coefficients
- SCAKC.CSV ASCII file of the Keating coefficients

Appendix B. Profile Archive Definition

The profile data are provided in 2 formats:

- SCADDING.XYZ — ASCII file of the profile data
- SCADDING.GDB — Geosoft® uncompressed binary database file of the profile data, sampled at 10 Hz
- SCADDING_SPEC.XYZ — ASCII file of the radiometric (gamma-ray spectrometric) data, sampled at 1 Hz
- SCADDING_SPEC.GDB — Geosoft® Oasis Montaj™ uncompressed binary database file of the radiometric (gamma-ray spectrometric) data, sampled at 1 Hz

The contents of SCADDING.XYZ/SCADDING.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	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
long_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
gps_z_final	differentially corrected GPS elevation (NAD83)	metres above sea level
drape	drape surface	metres above sea level
radar_final	corrected radar altimeter	metres above terrain
dem	digital elevation model	metres above sea level
fiducial	fiducial	seconds
flight	flight number	
line_number	full flight-line number (flight line and part numbers)	
time_utc	UTC time	seconds
date	local date	YYYY/MM/DD
mag_base_raw	raw magnetic base station data	nanoteslas
mag_base_final	corrected magnetic base station 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 wing-tip sensor	nanoteslas
mag_comp_left	compensated magnetic field from left wing-tip sensor	nanoteslas
mag_lag_left	compensated, edited and lag corrected magnetic field from left wing-tip sensor	nanoteslas
mag_raw_right	raw magnetic field from right wing-tip sensor	nanoteslas
mag_comp_right	compensated magnetic field from right wing-tip sensor	nanoteslas
mag_lag_right	compensated, edited and lag corrected magnetic field from right wing-tip sensor	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
mag_diurn_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
igrf_cor	IGRF correction profile	nanoteslas

Channel Name	Description	Units
mag_grad_lat_final	levelled lateral horizontal magnetic gradient (from wing-tip sensors)	nanoteslas/metre
mag_grad_long_final	levelled longitudinal horizontal magnetic gradient	nanoteslas/metre
linetotal	raw XDS line component	volts
orthototal	raw XDS ortho component	volts
verttotal	raw XDS vertical component	volts
line_final	processed XDS line component	volts
ortho_final	processed XDS ortho component	volts
vert_final	processed XDS vert component	volts
baro_raw	raw barometric pressure	volts
OMGCOR	levelling correction	nanoteslas

The contents of SCADDING_SPEC.XYZ/SCADDING_SPEC.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	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
long_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
gps_z_final	differentially corrected GPS elevation (NAD83)	metres above sea level
fiducial	fiducial	seconds
flight	flight number	
line_number	full flight-line number (flight line and part numbers)	
time_utc	UTC time	seconds
date	local date	YYYY/MM/DD
radar_final	corrected radar altimeter	metres above terrain
radar_STP	corrected radar altimeter for standard temp and pressure	metres above terrain
Spc_rawd	downward-looking 256-channel gamma-ray spectrum	counts
Spc_rawu	upward-looking 256-channel gamma-ray spectrum	counts
cosmic_raw	raw cosmic window	counts per second
radon_raw	raw upward-looking uranium window	counts per second
total_count_win	windowed total count	counts per second
potassium_win	windowed potassium	counts per second
uranium_win	windowed uranium	counts per second
thorium_win	windowed thorium	counts per second
total_count_final	microlevelled total air-absorbed dose rate	nanograys per hour
potassium_final	microlevelled potassium	percent
euranium_final	microlevelled equivalent uranium	parts per million
ethorium_final	microlevelled equivalent thorium	parts per million
u_over_th	ratio of equivalent uranium over equivalent thorium	
k_over_th	ratio of potassium over equivalent thorium	

Appendix C. Keating Correlation Archive Definition

1. KIMBERLITE PIPE CORRELATION COEFFICIENTS

The Keating kimberlite pipe correlation coefficient data are provided in 2 formats:

- SCAKC.CSV ASCII file of the Keating correlation coefficient data
- SCAKC.GDB Geosoft® uncompressed binary database file of the Keating correlation coefficient data

Both file types contain the same set of data channels, summarized as follows:

Channel Name	Description	Units
x_nad83	easting in UTM co-ordinates using NAD83	metres
y_nad83	northing in UTM co-ordinates using NAD83	metres
lon_nad83	longitude using NAD83	decimal-degrees
lat_nad83	latitude using NAD83	decimal-degrees
corr_coeff	correlation coefficient	percent ×10
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

Appendix D. Grid Archive Definition

1. GRIDDED DATA

The gridded data are provided in 2 formats:

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

All grids are NAD83 UTM Zone 17N, with a grid cell size of 20 m × 20 m. The grids are summarized as follows:

- SCAMAG83.gxf/.grd residual of the total magnetic field
- SCAGMAG83.gxf/.grd residual of the gradient-enhanced total magnetic field
- SCA2VD83.gxf/.grd second vertical derivative of the gradient-enhanced total magnetic field
- SCADEM83.gxf/.grd digital elevation model
- SCATC83.gxf/.grd total count (nGy/hr)
- SCAK83.gxf/.grd potassium (%)
- SCATH83.gxf/.grd equivalent thorium (ppm)
- SCAU83.gxf/.grd equivalent uranium (ppm)
- SCAKTH83.gxf/.grd potassium over equivalent thorium ratio
- SCATERN83.gxf/.grd radioelement ternary (potassium, uranium and thorium RGBI image)
- SCAVLFV83.gxf/.grd VLF–EM vertical component (volts)
- SCAVLFI83.gxf/.grd VLF–EM in-line component (volts)
- SCAVLFO83.gxf/.grd VLF–EM orthogonal component (volts)

Appendix E. GeoTIFF and Vector Archive Definition

1. GEOTIFF IMAGES

Geographically referenced colour images, incorporating a base map, are provided in GeoTIFF format for use in GIS applications:

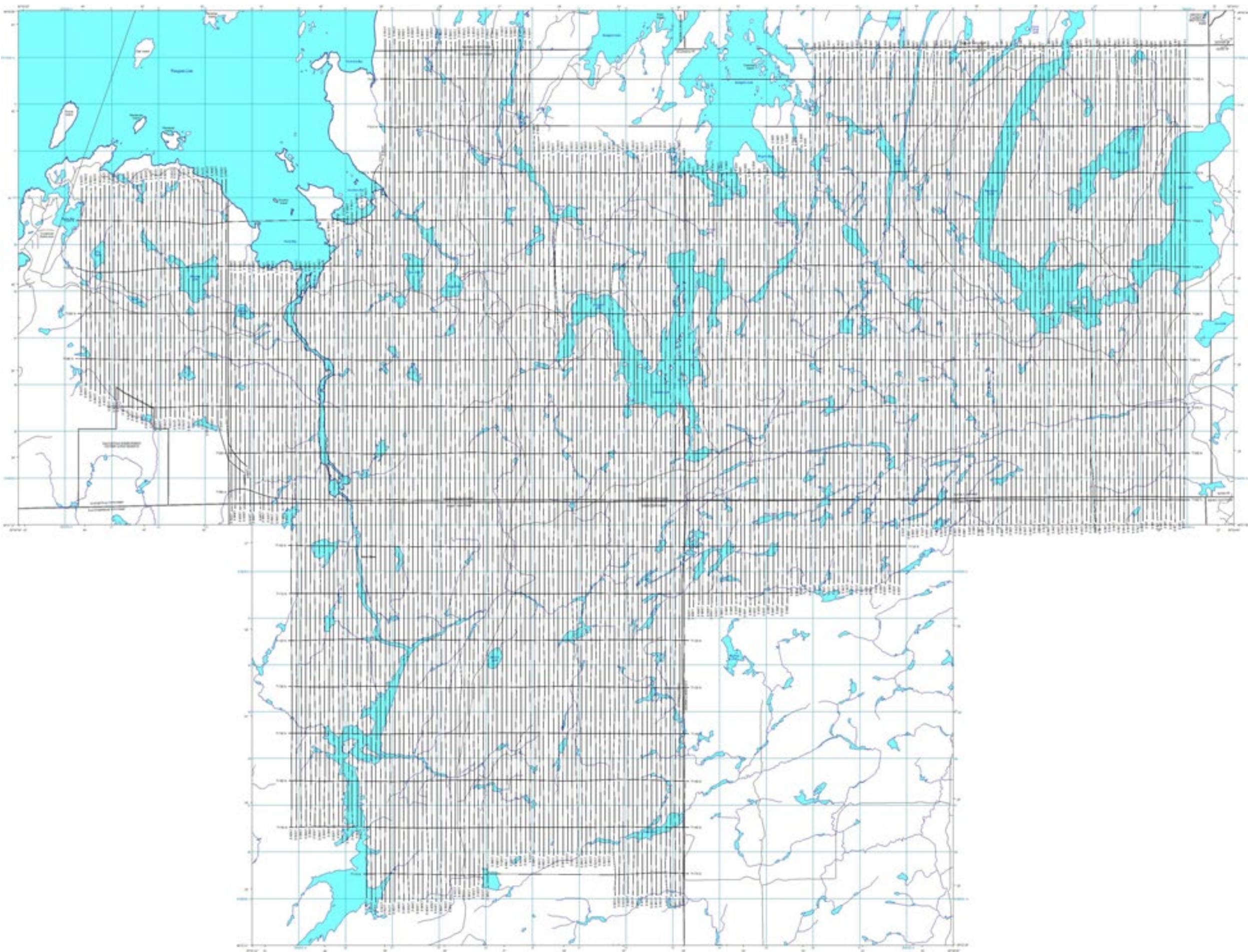
- SCAMAG83.TIF — colour-filled contours of gradient-enhanced residual magnetic field with flight path
- SCA2VD83.TIF — colour-filled contours of the second vertical derivative of the residual magnetic field with Keating coefficients and flight path
- SCATC83.TIF — total count with flight path
- SCAK83.TIF — potassium with flight path
- SCAU83.TIF — equivalent uranium with flight path
- SCATH83.TIF — equivalent thorium with flight path
- SCATERN83.TIF — radioelement ternary (potassium, uranium and thorium RGBI image) with flight path
- SCAVLFV83.TIF — colour-filled contours of the VLF-EM vertical component and flight path
- SCAVLFI83.TIF — colour-filled contours of the VLF-EM in-line component and flight path
- SCAVLFO83.TIF — colour-filled contours of the VLF-EM orthogonal component and flight path

2. VECTOR ARCHIVES

Vector line work from the maps is provided in DXF ASCII format using the following naming convention:

- SCAPATH83.DXF — flight path of the survey area
- SCAKC83.DXF — Keating correlation coefficients
- SCAMAG83.DXF — contours of the residual magnetic intensity
- SCAVLF83.DXF — VLF–EM contours

Appendix F. Flight Path Map



Appendix G. Calibrations

1. FIGURE OF MERIT (FOM) CALIBRATIONS

FOM INDEX :N41J - FLIGHT N41J001 19 APR 2010 / BASE:Sudbury, ON

FOM TEST #1 (MAT1.x)-50pt

MAG 1													
DIR	TRAV	LINE	PITCH		ROLL		YAW			P	R	Y	SUM
	FLG		MAX	MIN	MAX	MIN	MAX	MIN					
N	*	9000	0.05	-0.05	0.05	-0.04	0.06	-0.03		0.10	0.09	0.09	0.28
E		9090	0.04	-0.05	0.03	-0.04	0.05	-0.06		0.09	0.07	0.11	0.27
S	*	9180	0.03	-0.06	0.05	-0.03	0.05	-0.03		0.09	0.08	0.08	0.25
W		9270	0.05	-0.05	0.05	-0.04	0.05	-0.05		0.10	0.09	0.10	0.29
									SUM	0.38	0.33	0.38	1.09
									FOM	1.09			
							FOM TRAVERSE ONLY			0.53	(x2 :	1.06	)

MAG 2													
DIR	TRAV	LINE	PITCH		ROLL		YAW			P	R	Y	SUM
	FLG		MAX	MIN	MAX	MIN	MAX	MIN					
N	*	9000	0.11	-0.05	0.08	-0.10	0.09	-0.09		0.16	0.18	0.18	0.52
E		9090	0.06	-0.09	0.05	-0.10	0.12	-0.12		0.15	0.15	0.24	0.54
S	*	9180	0.06	-0.10	0.05	-0.08	0.09	-0.07		0.16	0.13	0.16	0.45
W		9270	0.04	-0.09	0.04	-0.05	0.09	-0.05		0.13	0.09	0.14	0.36
									SUM	0.60	0.55	0.72	1.87
									FOM	1.87			
							FOM TRAVERSE ONLY			0.97	(x2 :	1.94	)

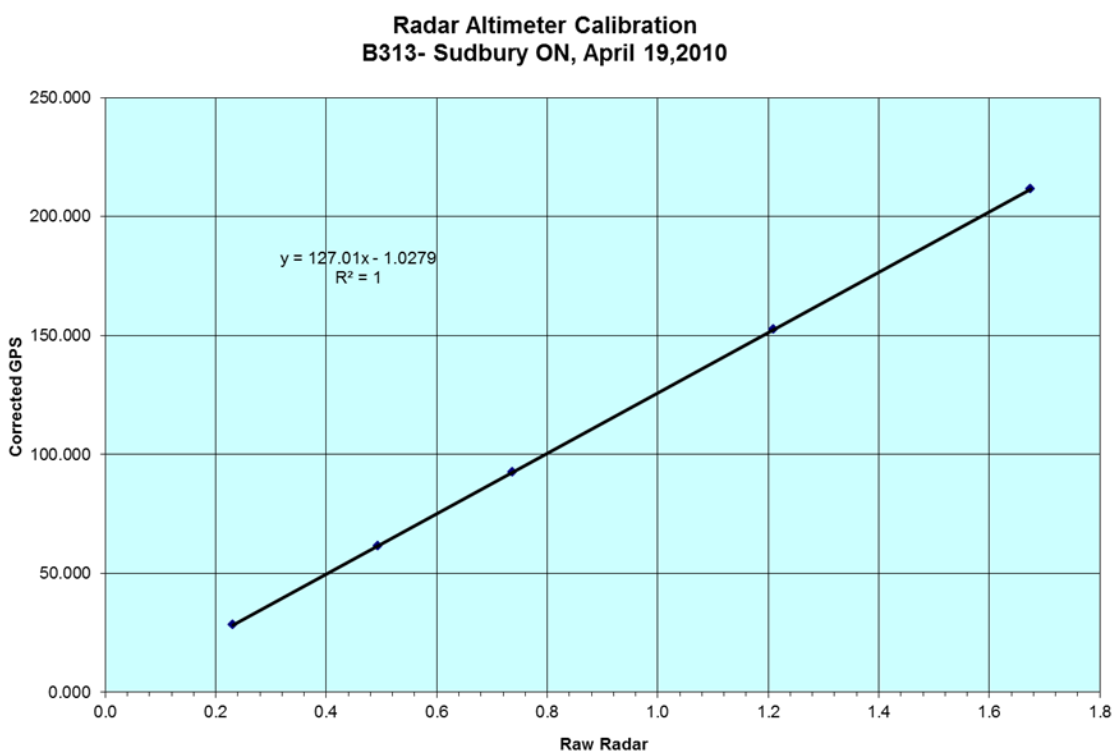
MAG 3													
DIR	TRAV	LINE	PITCH		ROLL		YAW			P	R	Y	SUM
	FLG		MAX	MIN	MAX	MIN	MAX	MIN					
N	*	9000	0.05	-0.03	0.02	-0.01	0.03	-0.02		0.08	0.03	0.05	0.16
E		9090	0.04	-0.03	0.03	-0.04	0.03	-0.05		0.07	0.07	0.08	0.22
S	*	9180	0.01	-0.05	0.03	-0.05	0.05	-0.02		0.06	0.08	0.07	0.21
W		9270	0.04	-0.03	0.02	0.02	0.02	-0.03		0.07	0.00	0.05	0.12
									SUM	0.28	0.18	0.25	0.71
									FOM	0.71			
							FOM TRAVERSE ONLY			0.37	(x2 :	0.74	)

2. RADAR ALTIMETER CALIBRATION

B313: RADAR CALIBRATION DATA SUMMARY *Calibration performed 19 APR 2010, Sudbury, ON- N41J*						
					INTERCEPT	-1.0279
					SLOPE	127.008579
LINE	RAW RADAR	GPGGA_ALT	CORRECTED GPS ALT	RAW RADAR	CALIBRATED RADAR	ERROR *
Hold		351.100	0.000			
100	0.231	379.400	28.300	0.231	28.298	-0.002
200	0.493	412.500	61.400	0.493	61.638	0.238
300	0.736	443.800	92.700	0.736	92.476	-0.224
500	1.210	503.900	152.800	1.210	152.652	-0.148
700	1.674	562.600	211.500	1.674	211.635	0.135
900	2.1	618.4				

* Error estimated as (Calibrated Radar) - (Corrected GPS Alt)

Imperial Units		
LINE	GPS_ALT	CAL_RAD
100.0	92.8	92.8
200.0	201.4	202.2
300.0	304.1	303.4
500.0	501.3	500.8
700.0	693.8977	694.341392



3. RADIOMETRIC ALTITUDE ATTENUATION CALIBRATION

TERRAQUEST N41J / SDAS/PicoEnvirotec

RADIOMETRIC ALTITUDE ATTENUATION CALIBRATION

Performed : 28 April 2010, Breckenridge Test Range, Ottawa, Canada

LINE	Average Clearance (metres)	TC (cor. CPS)	K (cor. CPS)	U (cor. CPS)	TH (cor. CPS)
L200:10	60.5	1991.7	209.4	29.5	45.3
L300:10	89.6	1629.5	160.4	24.0	38.2
L400:10	122.6	1310.9	120.7	19.9	30.4
L500:10	149.9	1081.8	96.7	16.0	25.2
L600:10	182.9	888.5	75.7	13.6	20.6
L700:10	216.2	712.1	56.9	11.4	17.1
L800:10	242.7	599.8	45.4	8.1	14.3

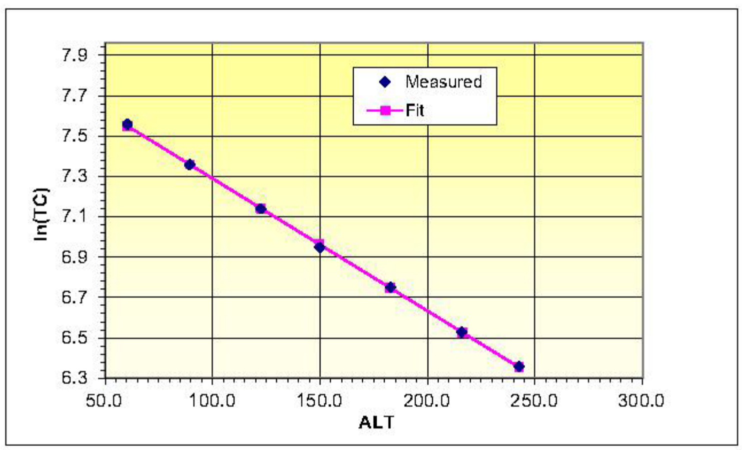
ALTITUDE ATTENUATION COEFFICIENTS

Calculated by LSQ fit to : $\ln(N) = ALT^*\mu + \ln(N_0)$ relation

TC	μ_{TC} =	-0.006562	$\ln(N_0)_{TC}$ =	7.9853					
K	μ_K =	-0.008286	$\ln(N_0)_K$ =	5.8269					
U	μ_U =	-0.006665	$\ln(N_0)_U$ =	3.7934	U (Select)	μ_U =	-0.006697	$\ln(N_0)_U$ =	3.7889
Th	μ_{Th} =	-0.006333	$\ln(N_0)_{Th}$ =	4.1953					

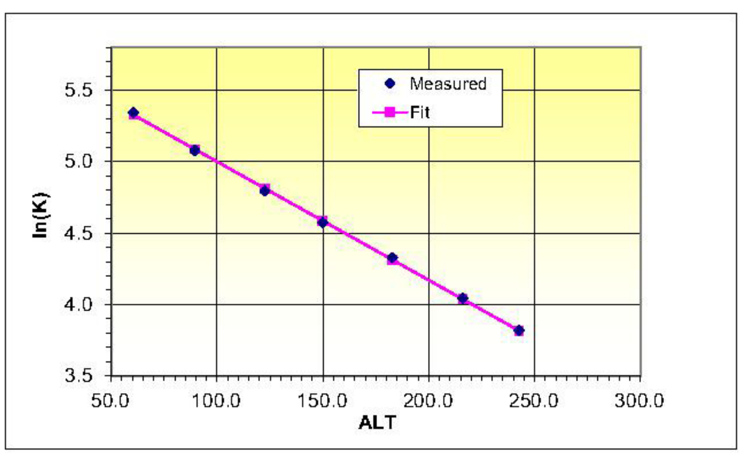
ALTITUDE DEPENDENCE: TOTAL COUNT

ALT	ln(N)	FIT
60.5	7.5968	7.5881
89.6	7.3960	7.3974
122.6	7.1785	7.1807
149.9	6.9863	7.0013
182.9	6.7895	6.7853
216.2	6.5683	6.5668
242.7	6.3966	6.3924



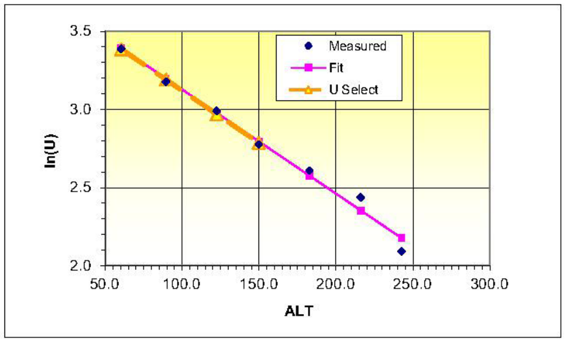
ALTITUDE DEPENDENCE: POTASSIUM

ALT	ln(N)	FIT
60.5	5.3440	5.3254
89.6	5.0774	5.0846
122.6	4.7936	4.8110
149.9	4.5713	4.5845
182.9	4.3265	4.3118
216.2	4.0411	4.0358
242.7	3.8146	3.8156



ALTITUDE DEPENDENCE: URANIUM

ALT	ln(N)	FIT
60.5	3.3854	3.3900
89.6	3.1764	3.1963
122.6	2.9892	2.9762
149.9	2.7738	2.7941
182.9	2.6079	2.5747
216.2	2.4362	2.3527
242.7	2.0906	2.1756

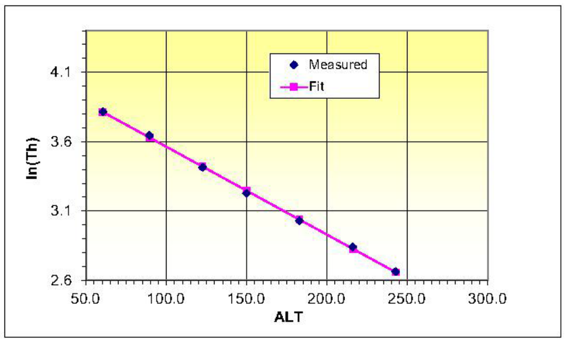


ALTITUDE DEPENDENCE: URANIUM (SELECT)

ALT	ln(N)	FIT
60.5	3.3854	3.3835
89.6	3.1764	3.1889
122.6	2.9892	2.9677
149.9	2.7738	2.7847

ALTITUDE DEPENDENCE: THORIUM

ALT	ln(N)	FIT
60.5	3.8135	3.8120
89.6	3.6434	3.6280
122.6	3.4144	3.4188
149.9	3.2257	3.2457
182.9	3.0272	3.0373
216.2	2.8397	2.8264
242.7	2.6624	2.6581



4. RADIOMETRIC COSMIC CALIBRATION

N41J : COSMIC CALIBRATION							
-performedApril 19th, 2010 / Sudbury / Flight N41J001							
LINE	GPS ALT metres	TC cps	K cps	U cps	TH cps	U UP	COSMIC cps
S2000:1	606.3	204.0	16.0	6.0	6.0	1.0	67.0
S3000:1	908.2	219.0	17.0	8.0	7.0	1.0	78.0
S4000:1	1218.9	242.0	17.0	8.0	8.0	1.0	92.0
S5000:1	1528.3	271.0	19.0	9.0	9.0	1.0	107.0
S6000:1	1815.6	303.0	20.0	11.0	11.0	1.0	121.0
S7000:1	2139.1	309.0	20.0	11.0	11.0	1.0	132.0
S8000:1	2436.6	387.0	24.0	14.0	14.0	2.0	168.0
S9000:1	2743.5	443.0	26.0	16.0	17.0	2.0	201.0
S10000:1	3042.0	511.0	30.0	18.0	20.0	3.0	237.0

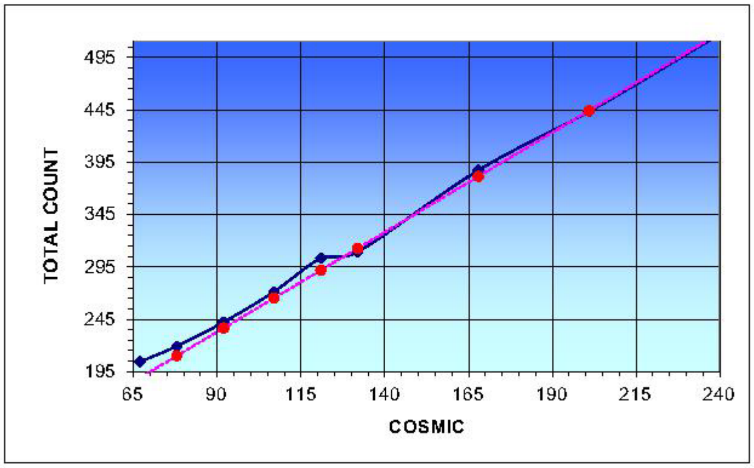
COSMIC COEFFICIENTS

$COS\_COMPONENT_n = a_n COSMIC + b_n$

	Slope (a_n)	Intercept (b_n)
Total Count	1.9034	61.3195
Potassium	0.0921	8.0030
Uranium	0.0661	2.5505
Thorium	0.0862	0.0000
Uranium UP	0.0116	-0.1082

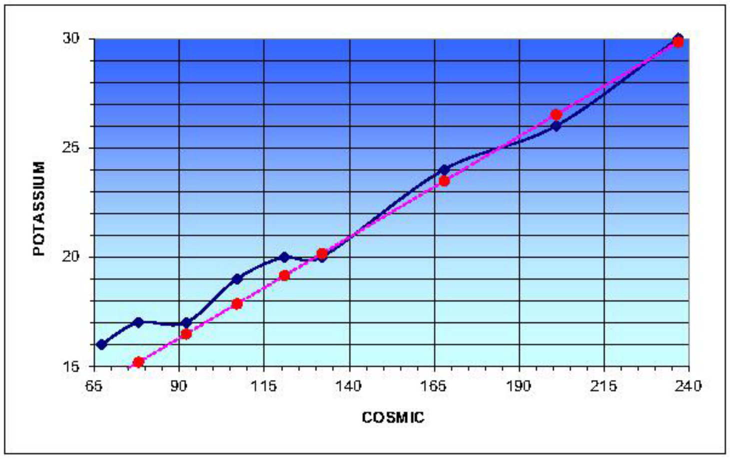
TOTAL COUNT COSMIC DEPENDENCE

COSMIC	TC	TC FIT
67.0	204.0	188.8
78.0	219.0	209.8
92.0	242.0	236.4
107.0	271.0	265.0
121.0	303.0	291.6
132.0	309.0	312.6
168.0	387.0	381.1
201.0	443.0	443.9
237.0	511.0	512.4



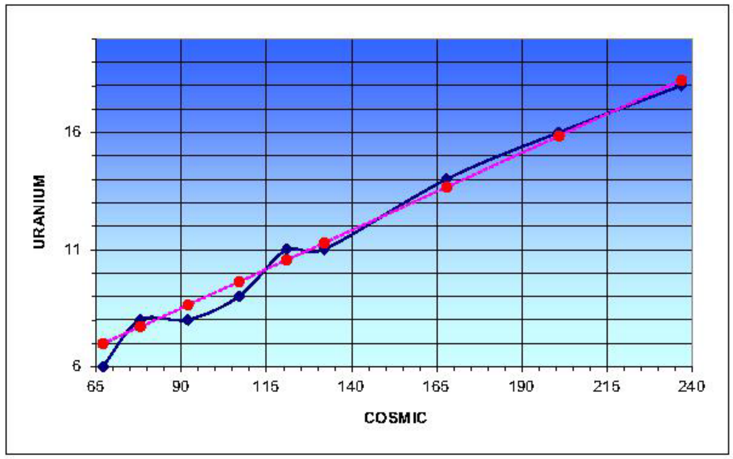
POTASSIUM COSMIC DEPENDENCE

COSMIC	K	K FIT
67.0	16.0	14.2
78.0	17.0	15.2
92.0	17.0	16.5
107.0	19.0	17.9
121.0	20.0	19.2
132.0	20.0	20.2
168.0	24.0	23.5
201.0	26.0	26.5
237.0	30.0	29.8



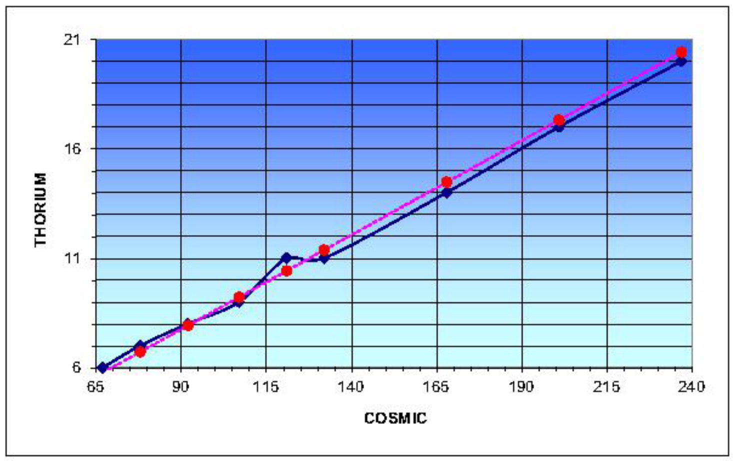
URANIUM COSMIC DEPENDENCE

COSMIC	U	U FIT
67.0	6.0	7.0
78.0	8.0	7.7
92.0	8.0	8.6
107.0	9.0	9.6
121.0	11.0	10.6
132.0	11.0	11.3
168.0	14.0	13.7
201.0	16.0	15.8
237.0	18.0	18.2



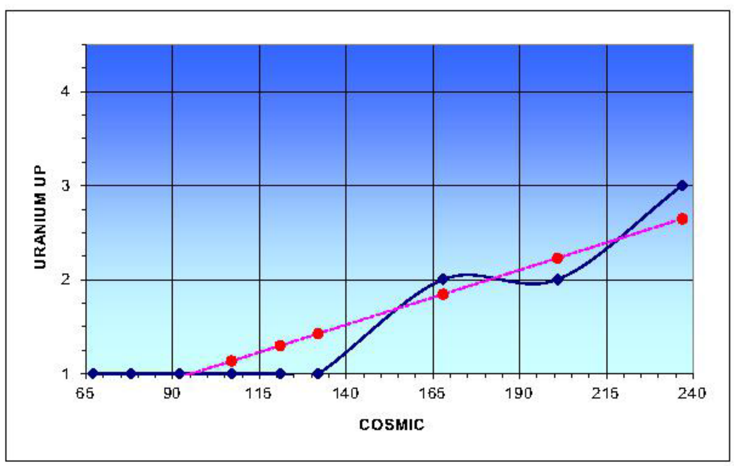
THORIUM COSMIC DEPENDENCE

COSMIC	TH	TH FIT
67.0	6.0	5.8
78.0	7.0	6.7
92.0	8.0	7.9
107.0	9.0	9.2
121.0	11.0	10.4
132.0	11.0	11.4
168.0	14.0	14.5
201.0	17.0	17.3
237.0	20.0	20.4



URANIUM UP COSMIC DEPENDENCE

COSMIC	UUP	UUP FIT
67.0	1.0	0.7
78.0	1.0	0.8
92.0	1.0	1.0
107.0	1.0	1.1
121.0	1.0	1.3
132.0	1.0	1.4
168.0	2.0	1.8
201.0	2.0	2.2
237.0	3.0	2.6



5. RADIOMETRIC PAD TESTS: COMPTON COEFFICIENTS

""" CALIBRATION OF K-U-TH WINDOW COUNTS FROM PAD MEASUREMENTS """

PROGRAM PADWIN

Concentrations of Transportable Pads - Holland Landing - PEI Pads (Keith)

NUMBER OF PADS = 4

PAD CONCENTRATIONS:

	PCT K	PPM EU	PPM TH
B Pad	1.410 (0.010)	0.97 (0.03)	2.26 (0.10)
K Pad	8.710 (0.090)	0.32 (0.02)	0.74 (0.10)
U Pad	1.340 (0.020)	52.90 (0.10)	3.40 (0.14)
T Pad	1.340 (0.020)	2.96 (0.06)	136.00 (2.10)

GEOMETRIC CORRECTION FACTORS:

POTASSIUM	URANIUM	THORIUM
1.17	1.17	1.19

""" B313 C-GGLS (Single Pack) 13APR2010 Holland Landing """

WINDOW COUNTS:

	TIME (M)	K COUNTS	U COUNTS	TH COUNTS
B Pad	758.0	128860.0	15160.0	13644.0
K Pad	778.0	625512.0	10892.0	10892.0
U Pad	640.0	269440.0	226560.0	28800.0
T Pad	610.0	200690.0	103700.0	311100.0

A-MATRIX FROM NONLINEAR REGRESSION:

8.753E+01 (1.098E+00)	4.926E+00 (4.319E-02)	1.161E+00 (2.438E-02)
-3.757E-02 (4.808E-02)	6.409E+00 (1.982E-02)	1.026E+00 (1.696E-02)
2.559E-01 (7.841E-02)	4.397E-01 (1.362E-02)	3.672E+00 (5.817E-02)

INVERSE A-MATRIX:

1.142E-02 (1.432E-04)	-8.699E-03 (1.284E-04)	-1.182E-03 (5.403E-05)
1.982E-04 (7.953E-05)	1.589E-01 (4.806E-04)	-4.447E-02 (2.760E-04)
-8.197E-04 (2.425E-04)	-1.842E-02 (6.521E-04)	2.777E-01 (4.410E-03)

WINDOW SENSITIVITIES FOR SMALL SOURCES:

K SENSITIVITY	(A11)	= 8.753E+01 (1.098E+00) COUNTS/M PER PCT K
U SENSITIVITY	(A22)	= 6.409E+00 (1.982E-02) COUNTS/M PER PPM EU
TH SENSITIVITY	(A33)	= 3.672E+00 (5.817E-02) COUNTS/M PER PPM TH

WINDOW SENSITIVITIES FOR INFINITE SOURCES:

K SENSITIVITY	(A11)	= 1.024E+02 (1.284E+00) COUNTS/M PER PCT K
U SENSITIVITY	(A22)	= 7.499E+00 (2.320E-02) COUNTS/M PER PPM EU
TH SENSITIVITY	(A33)	= 4.370E+00 (6.922E-02) COUNTS/M PER PPM TH

STRIPPING RATIOS:

TH INTO U	**(ALPHA = A23/A33) :**	**0.2794 (0.0015)**
TH INTO K	**(BETA = A13/A33) :**	**0.3163 (0.0044)**
U INTO K	**(GAMMA = A12/A22) :**	**0.7686 (0.0068)**
U INTO TH	**(A = A32/A22) :**	**0.0686 (0.0021)**
K INTO TH	**(B = A31/A11) :**	**0.0029 (0.0009)**
K INTO U	**(G = A21/A11) :**	**-0.0004 (0.0005)**

BACKGROUND COUNT RATES:

K WINDOW :	3.918E+01 (1.982E+00) COUNTS/M
U WINDOW :	1.152E+01 (3.409E-01) COUNTS/M
TH WINDOW :	8.913E+00 (5.185E-01) COUNTS/M

---------------NUMBERS IN PARENTHESES ARE ESTIMATED STANDARD DEVIATIONS (Stop - Program terminated)-------------------

Abbreviations Used: E = exponent: M = minutes; PCT = percent; PPM = parts per million.

6. RADIOMETRIC SENSITIVITIES: BRECKENRIDGE

N41J: Ottawa Calibration, Breckendridge Test Line 28 April 2010

Measured Ground Values:	
Dose Rate (TC) : nGy/hr	51.730
%K	1.935
ppm U	1.001
ppm Th	7.804

Line	Clearance (metres)	TC (cps)	K (cps)	U (cps)	Th (cps)	STC (cps/unit)	SK (cps/unit)	SU (cps/unit)	STH (cps/unit)
L200:10	60.5	1991.72	209.35	29.53	45.31	38.50	108.22	29.51	5.81
L300:10	89.6	1629.52	160.36	23.96	38.22	31.50	82.89	23.95	4.90
L400:10	122.6	1310.88	120.74	19.87	30.40	25.34	62.41	19.86	3.90
L500:10	149.9	1081.76	96.67	16.02	25.17	20.91	49.97	16.01	3.23
L600:10	182.9	888.49	75.68	13.57	20.64	17.18	39.12	13.56	2.64
L700:10	216.2	712.13	56.89	11.43	17.11	13.77	29.41	11.42	2.19
L800:10	242.7	599.83	45.36	8.09	14.33	11.60	23.45	8.09	1.84

		"m"	"b"
Exponential Fit Parameters:	TC	0.9935	56.7818
	K	0.9917	175.4029
	U	0.9934	44.3812
	TH	0.9937	8.5044

Calculated Sensitivities	
CLEARANCE:	80
TC	33.59
K	90.40
U	26.04
TH	5.12