GM 64761

DATA ACQUISITION REPORT, HELICOPTER-BORNE MAGNETIC AND GAMMA-RAY SPECTROMETRY GEOPHYSICAL SURVEY, LAC ARQUES PROJECT

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Énergie et Ressources naturelles
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HELICOPTER-BORNE
MAGNETIC AND GAMMA-RAY SPECTROMETRY GEOPHYSICAL SURVEY
NEMISCAU, QUÉBEC
NTS MAP SHEETS 032O11, 032O12, 032O13 AND 032O14

DATA ACQUISITION REPORT
LAC ARQUES PROJECT

PRELIMINARY

GM 64761

Presented to:
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Potassium Concentration, (ppm)		Digital Terrain Model, (m)	

1. INTRODUCTION

During June 2009, **Geophysics GPR International Inc.** flew a helicopter-borne magnetic, time-domain electromagnetic and gamma-ray spectrometry geophysical survey for **EXPLORATION NEMASKA INC.** The survey was composed of two (2) partially superimposed blocks for a minimum coverage of 6323 line-km, located near Nemiscau, (Québec) on the NTS sheets 032O11, 032O12, 032O13 and 032O14. The magnetic and time-domain electromagnetic survey was flown from June 3rd to June 16th, 2009 for a total of **3295 line-km**. The magnetic and spectrometric survey was flown from June 19th to June 26th, 2009 for a total of **3115.4 line-km.**

The time-domain electromagnetic survey was flown first using a TDEM EMosquito II, a high resolution time-domain transient electromagnetic system with a large penetration. The gamma-ray spectrometer survey was flown afterwards. For both surveys, a radar altimeter, temperature and pressure sensor and a DGPS system were mounted onto the helicopter.

This report is intended to be read in association with the printed maps provided in Appendix B.

Data processing was carried out by Olivier Létourneau, Phys., quality control was carried out by Jean-Luc Arsenault, Eng. M.A.Sc., and this report was written by Olivier Létourneau, Phys.

2. SURVEY DETAILS

2.1 Survey Area

The survey area is located near Nemiscau, Québec, Canada (*Figure 1*). The survey consists of two (2) partially superimposed blocks on the NTS maps 032O11, 032O12, 032O13 and 032O14.

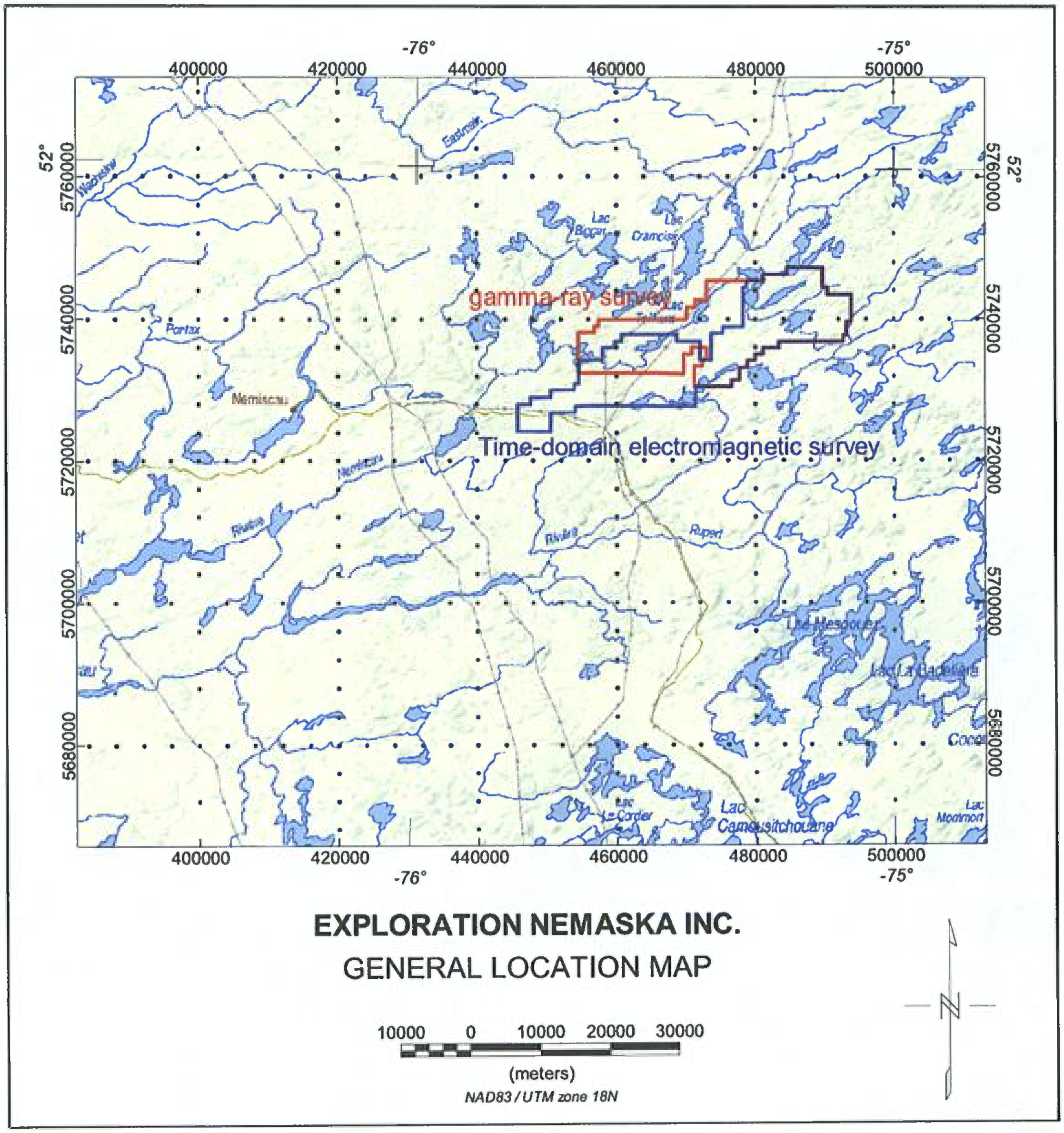

Figure 1 – General survey area

2.2 Survey block parameters

The direction of the flight lines is (0°-180°). The direction of the tie-lines is (90°-270°), with respect to UTM coordinates.

The coordinates given in *Table 1* represent the outline of the zones to be flown. **All coordinates are given in UTM zone 18N (NAD83).**

X (m)	Y (m)
445808	5724261
445842	5727961
447564	5727948
447604	5728874
450481	5728845
450479	5729895
453854	5729850
453939	5729849
453944	5730808
454503	5730787
454549	5734153
457996	5734144
457979	5735967
459780	5735964
459780	5736851
460812	5736827
460822	5737807
468525	5737787
468534	5736872
471906	5736881
471897	5734156
473540	5734156
473561	5736084
473562	5737931
475322	5737928
475317	5738882
478191	5738868
478170	5744408
478769	5744406
478791	5745344
481068	5745329
481066	5746236
484511	5746221
484501	5747162
489680	5747155
489686	5744382
490229	5744363
490267	5743459
493707,	5743441
493679	5739686
493129	5739703
493104	5737863
492543	5737863
492479	5736953
483331	5736960
483319	5736023
481047	5736057
481050	5735119
479870	5735108
479889	5734201
478729	5734200
478720	5733271
477604	5733299
477563	5731436
476439	5731444
476409	5730520
471242	5730550
471231	5727761
453904	5727874
453909	5726945
450479	5726986
450402	5724195

Block coordinates - TDEM & MAG survey

X (m)	Y (m)
485604,2	5736948,6
492536,9	5736952,5
492542,6	5737862,6
493118,7	5737863,0
493128,5	5739702,7
493128,5	5739702,7
493679,2	5739685,6
493707,1	5743441,3
490245,1	5743458,7
490240,7	5744362,2
489685,5	5744382,4

489679,9	5747155,2
484500,9	5747161,8
484510,7	5746221,3
481066,0	5746235,9
481067,6	5745329,4
473031,7	5745361,2
473044,0	5742613,4
471323,2	5742608,2
471293,0	5741668,2
470106,3	5741662,7
470123,0	5739821,0
465536,4	5739818,4
457500,8	5739894,4
457498,7	5738966,8
456890,2	5738964,5
456906,1	5738049,2
454610,9	5738063,6
454562,1	5733464,2
454551,6	5732476,0
465525,6	5732396,5
469539,5	5732366,5
469539,5	5734258,3
469529,4	5735186,4
470685,1	5735198,8
470700,5	5736112,5
472969,9	5736100,3
472946,4	5734238,7

472419,5	5734255,4
472419,8	5733333,4
471202,4	5733342,5
471211,5	5730534,2
476408,8	5730519,8
476438,8	5731443,5
477562,6	5731436,4
477582,6	5733299,7
478720,4	5733271,3
478720,7	5734200,0
479889,2	5734200,9
479869,8	5735107,7
481050,3	5735118,6
481046,6	5736057,4
483319,0	5736023,4
483331,2	5736960,3
485641,9	5736948,4
485641,9	5736948,6

Block coordinates - Spectrometry & MAG survey

Table 1: Survey block coordinates

Two (2) partially superimposed blocks were scheduled for surveying for a total of 6323 linear kilometres, based on 125 meters line spacing, and 1250 meters tie-line spacing. One survey was shifted 62.5 meters east compared to the other, resulting that the superimposed has a line spacing coverage of 62.5 meters.

2.3 Survey geodetic parameters

The DGPS data were acquired as longitude and latitude format in WGS84 coordinates system. The coordinates were re-projected as NAD83 Zone 18 North using Geosoft's Oasis Montaj software. *Table 2* below presents the geodetic parameters that were used for data processing.

Table 2 – Geodetic parameters

Datum:	NAD83
Ellipsoid:	GRS-80
Projection:	UTM
Zone:	18N
Central meridian:	-75°
False Easting:	500 000
False Northing:	0
Scale factor:	0.9996

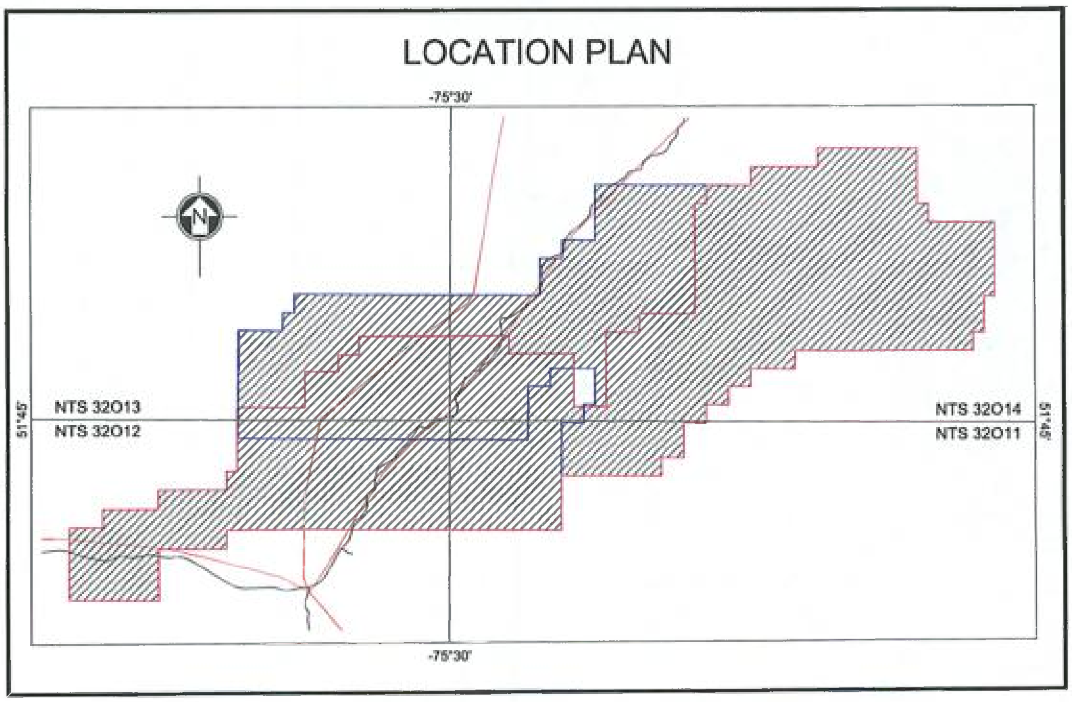

Figure 2 – Survey area and map sheets location

3. LOGISTICS

3.1 Survey helicopter

- Type : ROBINSON R-44 Raven 2
- Call sign : **C-GATM**
- Operated by: **Prospectair Geosurveys Inc.** based in Gatineau, Québec

3.2 Survey personnel

The survey personnel consisted of the following: (*Table 3)*:

Table 3 – Survey personnel

Operators	*Alain Tremblay, pilote*
Data Processing	*Olivier Létourneau, Phys.*
Report	*Olivier Létourneau, Phys.*
Quality Control	*Réjean Paul, Eng.*
Drafting	*André Beaudoin, tech.*
Project Manager	*Jean-Luc Arsenault, Eng., M.A.Sc.*
Mechanics	*Patrick Thérrien*
Pilots	*Alain Tremblay, pilote*

3.3 Preparation

The helicopter's installation was carried out in a hangar at Hydro-Québec's Nemiscau airport, located in Nemiscau, Québec. The EMosquito II™ system was assembled and a test flight was carried out.

3.4 Operating base & fuel cache

The crew was based at Camp Cree Construction in Nemiscau, Québec. The Hydro-Québec's Nemiscau airport was used for take-off and landing operations with the bird attached.

3.5 Flight dates

The crew finished mobilization on June 3th. Flying production was carried from June 3th to June 26th, 2009. The crew demobilized on June 26th.

4. DATA ACQUISITION

4.1 Planned survey parameters

Table 4 below shows the planned survey parameters for the project.

Table 4 – Planned survey parameters

Parameters	Specifications
Mag. Sampling Interval	0.1s (~2.8 m and 3.5m for spectro and TDEM survey)
Spectro. Sampling Interval	1.0s (~27.8 m)
TDEM Sampling Interval	0.1s (~3.5m)
Flight-line Spacing	62.5 and 125 m
Flight-line Direction	0°-180°
Control-line Spacing	1250 m
Control-line Direction	90°-270°
Aircraft MTC*	60m +/- 6m
Mag. Sensor MTC*	30m +/- 6m
Ground speed	100 and 125 km/h for spectro and TDEM survey

* Mean Terrain Clearance

4.2 Quality control

During data acquisition, quality control was carried out on data at the beginning by GPR's experience technician to ensure that quality remained within specifications. At the end of the planned survey, data were reviewed by the same experience technician and re-flight lines were identified. Profiles were checked to ensure correct flight path recovery and instrument noise was verified using Geosoft Oasis Montaj Software. The magnetic data on the TDEM survey was of poor quality in some areas. The area not covered by magnetic data from the spectrometric survey was reflown. The magnetic data from the spectrometric data were used otherwise.

5. SURVEY EQUIPMENT

5.1 The EMosquito™ TDEM system

The TDEM EMosquito II is a high resolution time-domain transient electromagnetic helicopter-borne system developed by T.H.E.M Geophysics of Gatineau, Québec. This powerful light-weight system employs a transient or time-domain electromagnetic transmitter that drives an alternating current through an insulated electrical coil system. The system uses a 4 KW generator and a large condenser to transmit alternating 2.75-ms half sine pulses with intervening off-times of 13.916 ms electric pulse, 60 pulses per second. The current in the coil produces an electromagnetic field. Termination of the current flow is not instantaneous, but occurs over a very brief period of time (a few microseconds) known as the ramp time, during which the magnetic field is time-varient. The time-varient nature of the primary electromagnetic field creates a secondary electromagnetic field in the ground beneath the coil, in accordance with Faraday's Law. This secondary field immediately begins to decay in the process, generating additional eddy currents that propagate downward and outward into the subsurface. Measurements of the secondary currents are made only during the time-off period by a vertical component receiver located almost half way between the helicopter and the transmitter loop. It is placed with the magnetometer taped to a horizontal boom which supports the receiving coils tear-drop shape vessel at its end. The boom has an elastic suspension. A proprietary suspension system protects the orthogonal coils assembly and limits the total field excursions. The tear-drop vessel acts as a vane and maintains the mast in the line of flight.

Depth of investigation depends on the time interval after shutoff of the current, since at later times the receiver is sensing eddy currents at progressively greater depths. The intensity of the eddy currents at specific times and depths is determined by the bulk conductivity of subsurface rock units and their contained fluids.

Table 5: Technical specifications of the EMosquito II EM system

Item	Specification
Transmitter:	
Loop Diameter:	7.5 meters
Current Waveform:	Half-Sine
Turns:	2
Pulse Length	2 ms
Frequencies	30, 45, 90 Hz (programmable)
Loop Area	50 m^2
Peak Current	2000A
Tow Cable Length	65 meters
Self-Powered	9HP Honda coupled with 28 Volts Alternator
Receiver:	
Coil axis	X, Y and Z orthogonal coils assembly
Configuration	Coaxial (Z)
Four channels	Current, X, Y and Z
Max Sampling rate	1024 points per half cycle at 90 Hz
Survey sampling rate	1024 or 2048 per half cycle at 30Hz
Sampling	Full waveform
Gates	Programmable (max 256)
On time signal	Recorded and processed
Mechanical:	
Maximum survey speed:	**110 km per hour**
Transmitter height	30 meters AGL
Receiver height	60 meters
Weight (Total)	200 kg

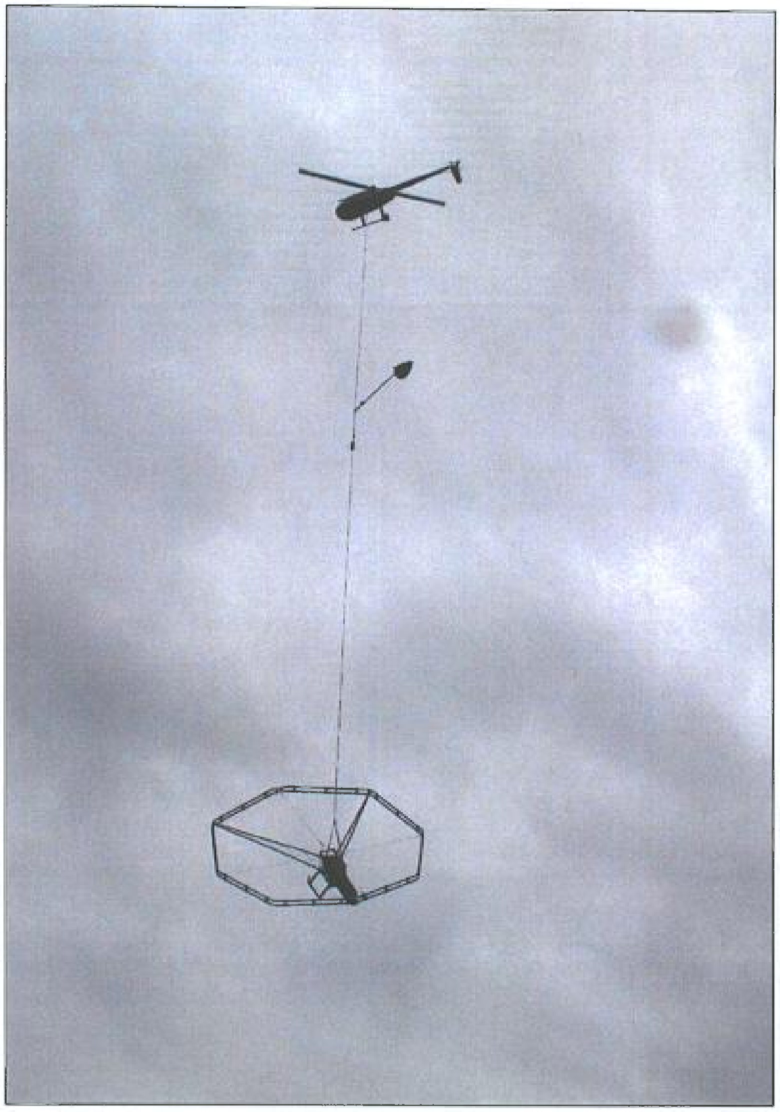

Figure 3 – EMosquito II™ in flight with a ROBINSON R44

5.2 Helicopter-borne magnetometer

Airborne magnetometers are used to detect magnetic anomalies in the Earth's local magnetic field. The anomalies may be an indication of concentrations of ferromagnetic minerals in the Earth's crust and may be used to visualize the geological structure of the upper crust in the subsurface, particularly the spatial geometry of bodies of rock and the presence of faults and folds. This is a particularly useful tool for geological mapping for the areas where bedrock is obscured by overburden or water.

A helicopter-borne magnetometer was used to record magnetic data of the anomalies in the Earth's local magnetic field.

For this survey, one (1) Geometrics G-823A (optically pumped caesium vapour) total magnetic field sensor with a sampling interval of 0.1 second was installed in the bird, 28 meters below a 55 meter cable under the helicopter half was between the helicopter and TDEM loop system. The magnetometers include the well proven high performance G-822A. The magnetometer sends the signal to the Pico Envirotec's data acquisition system which converted it to measured magnetic field strength units, nanoTesla (nT), using a Larmor counter. It provides unmatched versatility of performance, size, function, and cost effectiveness.

Both the ground and heliborne systems used a non-oriented (strap-down) optically-pumped Cesium split-beam sensor. These magnetometers have a sensitivity of 0.005 nT and a range of 15,000 to 100,000 nT with a sensor noise of less than 0.02 nT. The heliborne sensor was mounted in a bird made of non-magnetic material located 15 m below the helicopter when flying. Total magnetic field measurements were recorded at 10 Hz in the aircraft. The ground system was recording magnetic data at 1 sample every 3 seconds.

5.3 Base-station magnetometer

As the aircraft flies, the magnetometer records tiny variations in the amplitude of the ambient magnetic field due to the temporal effects of the constantly varying solar wind and spatial variations in the Earth's magnetic field (diurnal), the latter being due both to the regional magnetic field, and the local effect of magnetic minerals in the Earth's crust. By subtracting the diurnal effects, one obtains the spatial distribution and relative abundance of ferromagnetic minerals in the upper levels of the crust alone.

A GEM's GSM 19 Overhauser magnetometers (proton precession) total magnetic field sensor, with a sampling interval of 3 seconds was used to record the diurnal variation of the magnetic field at the base-station's location. The GSM-19 magnetometer has resolution of 0.01 nT, and 0.2 nT accuracy over its operating range of 20,000- to 100,000 nT at a recording rate of 3 Hz. The base-station was set up at a location away from power lines and main roads to avoid interference from traffic. It was located a few hundred meters from the helipads in a nearby wooden area.

5.4 Airborne Gamma-ray Spectrometer

Airborne Gamma-ray spectrometry surveys consist of mapping the occurrence of naturally occurring Potassium^{40} (K) concentration and equivalent Uranium^{238} (U) and Thorium^{232} (Th) concentration on the survey's surface.

The 256-channel gamma-ray spectrometer detects gamma-rays originating from the disintegration of radioactive element's nuclide. Out of the three main geological radioactive elements, only the Potassium^{40} emits gamma-rays directly. The Uranium^{238} and Thorium^{232} emit gamma-rays through their decay series. It is the 1.76MeV gamma-ray emitted by Bi^{214} which is considered diagnostic of U^{238} and the 2.61MeV gamma-ray emitted by Tl^{208} that is considered diagnostic for the Th^{232}. The reason for this is that neither U^{238} nor Th^{232} emit gamma-ray and those given off by the daughters between U^{238} and Bi^{214} or Th^{232} and Tl^{208} in their decay series are of lower energy and are difficult to resolve.

This is the reason why the concentrations of Uranium and Thorium are considered equivalent assuming the U^{238} and Th^{232} and their daughters are in equilibrium, which happens after 2 million years for U^{238} and after 100 years for Th^{232}, if none of the decay series' elements are removed during that time.

The gamma-ray spectrometer chosen for this survey is the RSX-5 from Radiation Solutions. It is an intelligent, self calibrating gamma-ray spectrometer using NaI (Tl) large volume detector. All dedicated electronics modules are housed within the detector's container. The RSX-5 series of gamma-ray spectrometers are widely used in geological and geophysical exploration and mapping as well as environmental and nuclear surveillance.

Individual, independent, detector processing provides real time gain and linearity correction. The system's stabilization algorithm makes these spectrometer systems fully automated and self-stabilizing on natural radioactive elements. This eliminates the requirement for regular, time consuming, and frequent system checking and re-calibration. Furthermore, it provides excellent accuracy and reliability of the gamma-ray measurements. New design techniques for the peak detection electronics almost completely eliminate 'pulse pile up' and 'Dead Time' effects.

System specifications:

- Resolution: 256 channels
- Five NaI crystal detectors, each with individual electronics, for a total of 16.8 litres (1025 in^3) of downward looking crystals and 4.2 litres of upward looking crystal (256.25 in^3)
- Individual detector tracking and linearity correction
- Energy spectra from 36 keV to 3 MeV with adjustable threshold
- Data sampling rate: 1 Hz
- Signal sampling: 25 MHz by internal 12 bit ADC for each detector
- Pulse rate per detector : > 60000 pulses per second with no dead time
- Channel capacity : 65500 counts/sampling period
- Operating temperature range: -10° to +55° Celsius

5.5 DGPS positioning

A Novatel Pro-pak V3 DGPS receiver that offers many differential correction options for various environments and worldwide coverage was used for in-flight navigation, with a sampling interval of 1 second. The antenna was mounted directly on the helicopter. The DGPS system provides an accurate positioning as well as the height above the WGS-84 ellipsoid for the Agis on-board navigation system. The differential data set was relayed to the helicopter via the Omnistar network appropriate geosynchronous satellite for the survey location. The receiver optimizes the corrections for the current location.

5.6 Radar altimeter

A FreeFlight TRA3000 radar altimeter, combined with a TRI40 Indicator unit mounted on the helicopter provides the pilot with highly accurate altitude-above-ground-level (AGL) information with a resolution of 0.5 m and an accuracy of 5% over a range up to 2,500 ft. The radar altimeter data is recorded and sampled at 10 Hz.

5.7 Helicopter Data Acquisition and Recording System

The Airborne Geophysical Information System (AGIS-XP) is advanced, software driven instrument specifically designed for mobile aerial or ground geophysical survey work. The AGIS instrumentation package includes an advanced Satellite navigation (GPS), real-time flight path information that is displayed over a map image (BMP format) of the area, and reliable data acquisition software. Thanks to simple interfacing, the radar and barometric altimeters and the Geometrics magnetometer are easily integrated into the system and digitally recorded. Automatic synchronization to the GPS position and time provides very close correlation between data and geographical position. The AGIS is equipped with a software suite allowing easy maintenance, upgrades, data QC, and project and survey area layout planning.

For the purpose of the TDEM recording, PicoEnvirotec designed for Prospectair a TDEM data acquisition and synchronization system perfectly compatible with the existing AGIS-XP package.

Data were recorded on hard disk and backed up after each flight.

5.8 Survey helicopter

PROSPECTAIR flew the survey using Prospectair's Robinson R44 (registration C-GATM) helicopter that handles efficiently the equipment load and the required survey range. Table 2 presents the helicopter technical specifications and capacity.

Table 6: Technical specifications of the R44 Robinson Helicopter

Item	Specification
Powerplant	One 195kW (260hp) Textron Lycoming O-540
Rate of climb	1000 ft/min Rate of climb 1000 ft/min
Cruising speed at 75%	power 209 MPH
Service ceiling	14,000 ft
Range with no reserve	645 km
Empty weight	635 kg
Maximum take-off	1,090 kg

5.9 Data Processing Hardware and Software

Processing was performed on high performance desktop computers optimized for quick daily QC and processing tasks. Geosoft software Oasis Montaj version 7.1 was used for data processing.

5.10 Field computer workstation

A dedicated laptop computer was used on-site for the purpose of displaying geophysical data for quality control, calculating and displaying the navigation, producing preliminary maps, and backing up digital data.

6. DATA PROCESSING

6.1 Magnetic data

1) Data checking, editing, reformatting and flight path recovery

Data recorded were transferred after each flight to the processing computer for verification and quality control. All measured data were compiled by Pico Envirotec's data acquisition and upload in Geosoft's binary database formatted data aRaw GPS data (longitude, latitude and height) were recorded in the WGS-84 geodetic system. These coordinates were transformed into the NAD83 datum, UTM projection, Zone 18 North by the navigation software and compared in real-time to the theoretical coordinates of the flight paths to provide a correction to the pilot.

The DGPS data were recorded at 1 Hz and interpolated at (0.1 s interval) and exported for flight path recovery and quality control.

Raw line data was in Oasis Montaj .GDB and .GBN format. Data coordinates were re-projected in NAD83 datum, UTM projection Zone 18 North using Oasis Montaj.

2) Lag corrections

Residual errors of positioning, generated by the delay of time (lag) between the magnetometer and GPS readings generate a systematic position shift between reading values. For this particular system, no lag correction was applied since the original seemed to have a lag less than the sampling intervals (~2.0 m). The results of this test can be found in Appendix A.

3) Diurnal corrections

The magnetic data recorded at the base-station were synchronized, using the GPS time and merged with the helicopter-borne data. Subsequently, the diurnal corrections obtained by subtracting the mean value of the base-station readings were applied to the data after low-pass filtering.

4) Heading corrections

No heading correction was applied to the magnetic data since the original data were of sufficient quality.

5) Tie-line levelling

Classical tie-line levelling was performed on the original TMF data. The LevTieLine module in Oasis Montaj was used to carry out these operations.

6) Microlevelling

The obtained TMF was micro-levelled using a standard combination of a Butterworth high-pass filter followed by a directional cosine filter, used to obtain the residual error grid, which was imported in the Oasis Montaj database, filtered and subtracted from the original to obtain the smooth de-corrugated TMF data.

7) First Vertical Derivative (FVD).

The first vertical derivative was obtained with the help of the 2D-FFT first vertical derivative calculated from the total magnetic field.

Figure 4 presents a summary of the processing sequence used to obtain the final magnetic grid.

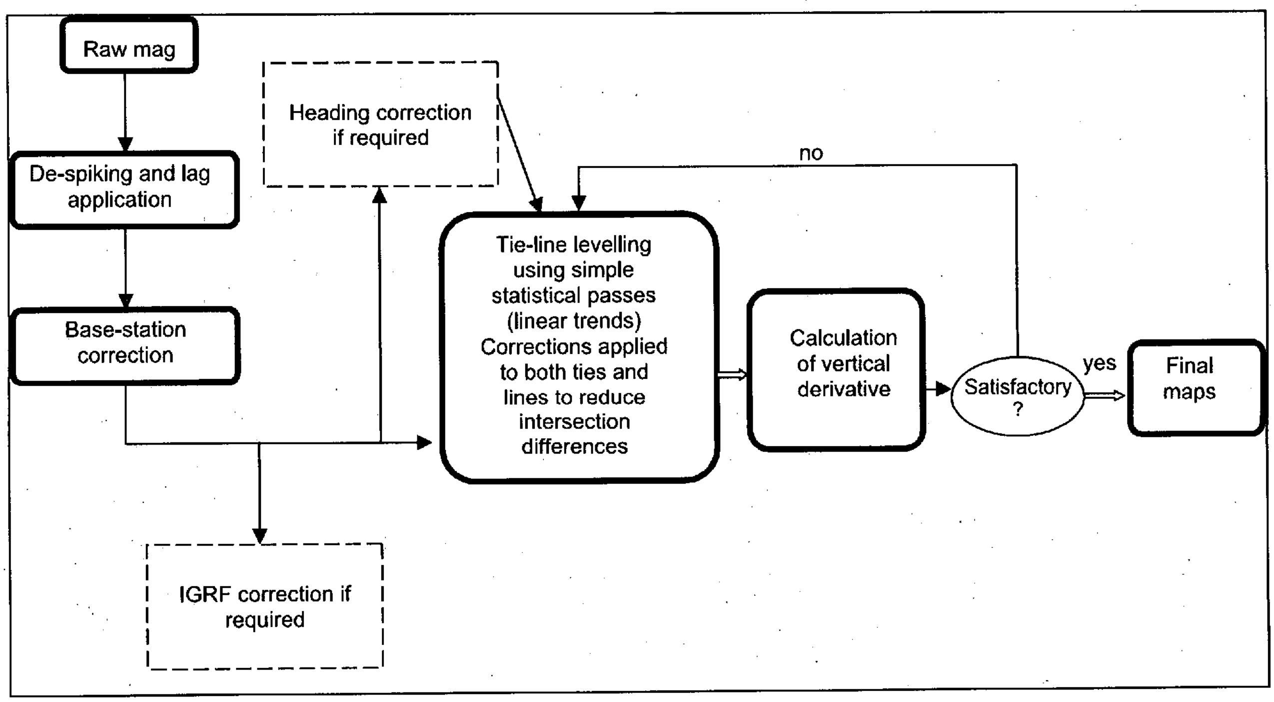

Figure 4 – Standard magnetic data processing flow

6.2 Digital Terrain Model (DTM) data processing

The Digital Terrain Model was obtained by subtracting the radar altimeter readings (helicopter mounted) from the DGPS height (helicopter mounted). The radar altimeter was corrected, for a lag estimated to be 4 seconds.

The obtained DTM was micro-levelled using a standard combination of a Butterworth high-pass filter followed by a directional cosine filter, used to obtain the residual error grid, which was imported in the Oasis Montaj database, filtered and subtracted from the original to obtain the smooth de-corrugated DTM data.

6.3 Gamma-ray Spectrometry

The preliminary data processing and quality control of airborne gamma-ray spectrometry was performed using the Geosoft Oasis Montaj RPS suite.

The following checks were performed in the field:

1) Careful verification of each profile (and spectra) to spot spikes, jumps or interruptions in the readings.
2) Lag correction (none was apparent)
3) Statistical calculation of the mean spectra at each line to ensure peak stability.
4) Gridding windowed elements (K, U, Th) and total count to evaluate data coherence and consistence.
5) A background over lakes flight was flown at the beginning and at the end of the flight to check daily variations in the radon content.

The final processing of the gamma-ray spectrometry data was performed with the RPS extension software. This program is specially designed to process spectrometer acquired data and interfaces directly with Geosoft Oasis Montaj.

The following resumes the final processing.

1) Principal component NASVD noise reduction

To reduce the spectrometer's noise, NASVD noise reduction filter was used on the actual dataset. The spectrum is converted into a 256x256 covariance matrix from which 256 spectrum components (eigenvectors) were extracted and ordered by variance. The last 245 eigenvectors are eliminated, which are considered as statistical and instrumental noise components. Finally, the filtered spectrum is reconstructed based on the 11 first eigenvectors less theoretical noise expected to be Poisson distributed.

2) Deadtime correction

Spectrometers require a finite time to process each pulse from the detector. While one pulse is being processed, all other incoming pulses are automatically rejected. The total counting time available is thus reduced by the time taken to process all pulses (the "dead time"). The time during which the spectrometer is receptive to incoming pulses is the "live time". The dead time is therefore the difference between the sample accumulation time and the live time. The correction is usually small, but can be significant in areas of high radioactivity. For this case, the live time was 999 msec for each second.

3) Energy calibration

The RSX-5 is a self calibrating gamma-ray spectrometer. It uses the natural occurring gamma-ray radiation to calibrate itself. The stability of the spectrum and its alignment with the normal element window was verified.

4) Aircraft & background removal

The aircraft spectrum is constant. The cosmic spectrum at each observation point is estimated by scaling a normalized cosmic spectrum by the cosmic window count rate. The aircraft and cosmic background spectra are then subtracted from the live time and energy-calibrated observed spectra. The background factors can be found in Appendix A.

5) Radon correction using spectral ratio method

Other non-terrestrial gamma-rays detected by the spectrometer which need to be removed are emitted by $Radon^{222}$. The upward looking crystal method (IAEA, 1991) uses an additional crystal pack that is partially shielded from radiation from below to give the system a directional sensitivity and the ability to discriminate from the atmosphere and from the ground. The radon correction factor can be found in Appendix A.

6) **Extracting window for radioelement (K, U, Th) and TC, stripping corrections and height attenuation corrections**

The full-spectrum was windowed for (K, U, Th and TC) and Total Counts.

The stripping correction is used to correct each of the K, U and Th window count rates for those gamma rays not originating from their particular radioelement or decay series. For example, thorium, series gamma-rays appear in both the uranium and potassium windows, and uranium series gamma rays appear in the potassium window. This is caused by the Comptons effect. The stripping factors can be found in Appendix A.

In airborne surveying, the height of the detector changes continuously as the aircraft proceeds along a flight line, and the window data must be corrected to a nominal survey height. Window count rates vary approximately exponentially with height for the range of 60 m. The count rate attenuation factors can be found in Appendix A.

7) **Convert to concentrations using calibration pads and range results**

Airborne instruments are calibrated using international standards developed by the Geological Survey of Canada, to ensure consistent, accurate estimates of K, eU and eTh. This calibration procedure yields the sensitivity of the spectrometer (count rate per unit of potassium, uranium & thorium concentration) measured in cps/ppm or cps/%, which can be found in Appendix A.

The following diagram summarizes the processing of the airborne gamma-ray spectrometry data.

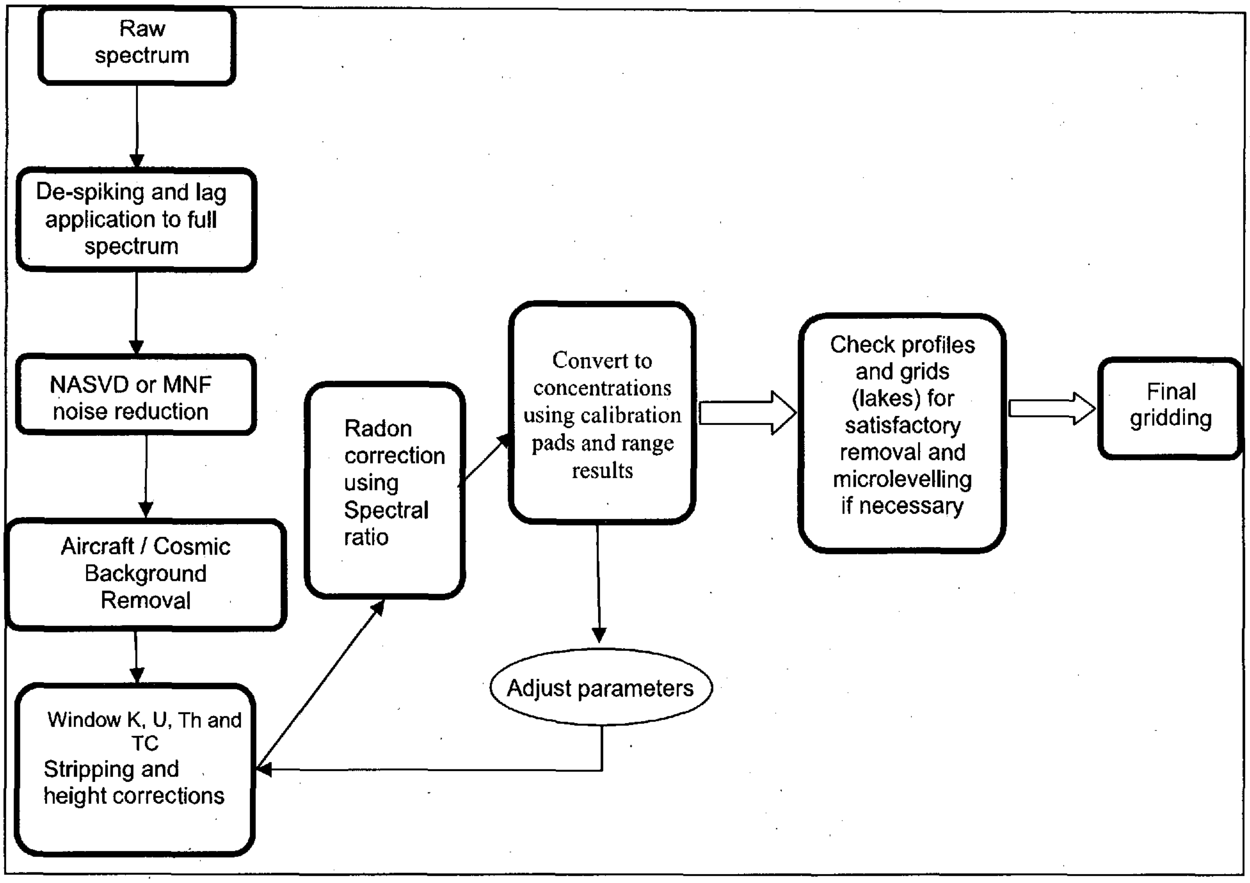

Figure 5 – Gamma-ray spectrometry processing flow

6.4 TDEM processing

Data compilation, including editing and filtering, quality control, and final data processing of the Time-Domain ElectroMagnetic survey was performed by Marc Boivin, P.Geo.

The PicoEnvirotec EM Digital Acquisition System records the vertical component (Z) of the receiver coils at a sampling rate of 60000Hz. There is 30 full cycles (60 half cycles) of the full waveform (Tx ON and OFF time) every second.

The first data manipulation involves a stacking procedure where each half cycle is weighted with respect to the previous cycle (±¼), the next cycle (±¼) and its own value (±½). The positive and negative signs of the respective multiplication coefficients are used to make positive all negative half cycles.

The next step is the half cycle averaging corresponding to the desired sampling rate. In the present case, from the 60 stacked positive half cycles per second, 6 consecutive half cycles are averaged to produce one sample every 0.1 sec.

The windowing settings for the 40 different channels are presented in table 4. Channels 1 to 10 correspond to the ON-time measurements and channels 11 to 40 correspond to the OFF-time. Channel 11 isn't used for interpretation and mapping as it exists some 'ramp-off' effect that alters the data quality. Each window is filtered with a median filter removing spikes and with a finite impulse response (FIR) selective filter of the 251th order improving the signal to noise ratio.

A ±125 metres wave length was identified on the EM signal. The source of the noise was not clearly resolved. A band pass filter was applied to the data in order to improve the results. The original data (Z_RAW channel) and the filtered data (Z channel) are provided in the final database.

Settings used in the windowing of the full waveform

Channel #	Starting time (msec)	Width (msec)	Channel #	Starting time (msec)	Width (msec)
1	0.16667	0.01667	21	3.15000	0.53333
2	0.25000	0.01667	22	3.26667	0.53333
3	0.33333	0.01667	23	3.40000	0.53333
4	1.30000	0.01667	24	3.26667	1.10000
5	1.31667	0.01667	25	3.45000	1.10000
6	1.33333	0.01667	26	3.65000	1.10000
7	2.58333	0.01667	27	3.88333	1.10000
8	2.66667	0.01667	28	4.13333	1.10000
9	2.80000	0.08333	29	4.43333	1.10000
10	2.81667	0.08333	30	4.76667	1.10000
11	2.83333	0.08333	31	5.16667	1.10000
12	2.85000	0.16667	32	5.05000	2.20000
13	2.86667	0.18333	33	5.55000	2.20000
14	2.86667	0.25000	34	6.13333	2.20000
15	2.86667	0.36667	35	6.78333	2.20000
16	2.91667	0.36667	36	7.51667	2.20000
17	2.91667	0.53333	37	8.36667	2.20000
18	2.95000	0.53333	38	9.33333	2.20000
19	3.00000	0.53333	39	10.4500	2.20000
20	3.03333	0.53333	40	11.7000	2.20000

6.5 TDEM interpretation

General

The following basic interpretation is solely based on the helicopter-borne EM data acquired in this project and there was no match with the geology. Further interpretation works should include the determination of specific geological target type and the correlation between other data sources.

Overview of the electromagnetic data

There is actually no automatic picking program involved in the interpretation procedures of the EMosquito system. Identification of the EM anomalies is made on the EM profiles and classification is based on the calculated time constant (TAU). The EM Time-Constant (TAU) is a general measure of the speed of decay of the electromagnetic response and reflects the "conductance quality" of a source.

The time rate of the secondary EM field recorded by the TDEM system is a function of the conductivity and geometry of conductors detected. A large resistivity conductivity will show a small value of the time constant (TAU) and conversely, a small resistivity will show a large value of the time constant (TAU).

The time constants (Tau) were calculated using the MAXWELL V4.14 software of EMIT. The value was obtained by the best least squares fit between channels Z19 and Z36.

Four hundred sixty nine (469) EM anomalies were identified, classified and listed in Appendix A. On the 469 anomalies, 240 show low amplitudes close to noise level. They were classified as "possible anomaly". No time-constant (TAU) were calculated for these possible anomalies. The 229 remaining anomalies were classified in 5 groups, from a small time-constant (< 1ms) to large time-constant (> 5ms).

6.6 Presentation

The Total Magnetic Field, First Vertical Derivative, DTM and spectrometric data were gridded using a 15 meters size cell. Oasis Montaj's Minimum Curvature was used for all griddings.

7. FINAL PRODUCTS

7.1 Paper products

A standard set of geophysical maps was produced at a scale of **1: 50 000** (Appendix B). The flight path is presented on a separate map. The claims boundaries and their numbers are displayed on this map. The name and direction of the lines are indicated at the beginning and end of each line.

The maps were drawn in the UTM projection Zone 18 North, NAD83 datum. Coordinate units are in meters, unless indicated otherwise.

The final paper products consist of ten (10) maps.

The final maps produced for each map sheet are as follows:

1) Flight path recovery and property limits map
2) Colour contour map of the Total Magnetic Field
3) Colour contour map of the First Vertical Derivative
4) Colour contour map of the Potassium concentration
5) Colour contour map of the Equivalent Uranium concentration
6) Colour contour map of the Equivalent Thorium concentration
7) Colour contour map of the Air absorbed dose rate derived from total counts
8) Colour contour map of the Digital Terrain Model
9) Profile map of the TDEM
10) Interpretation map

The digital data are included on a CD-ROM along with the printed maps. *Table 5* below lists each map type and its associated drawing number.

Table 7 – Drawing titles and numbers

Drawing title	Drawing number
Flight path Recovery and property limits	09-07-352-PRE
Total Magnetic Field, (nT)	09-07-353-PRE
First Vertical Derivative (nT/m)	09-07-354-PRE
Potassium concentration, (%)	09-07-355-PRE
Equivalent Uranium concentration, (ppm)	09-07-356-PRE
Equivalent Thorium concentration, (ppm)	09-07-357-PRE
Air absorbed dose rate derived from total counts, (nGy/h)	09-07-358-PRE
Digital Terrain Model, (m)	09-07-359-PRE
Profile map, (nT/sec)	09-07-360-PRE
Interpretation map	09-07-361-PRE

7.2 Digital products

Below is a list of the products delivered on CD-ROM (More detailed in Appendix C).

There are two (2) main directories:

Data/Block/

Contains for Mag. and Spectro.:

• Databases	(Oasis Montaj™ .GDB and ASCII.XYZ)
• Grids	(Montaj™ .GRD binary grid format)
• Projection information files	(MapInfo and other .GI)
• Maps	(Oasis Montaj™ .MAP)
• Files used in the MapInfo software to distinguish a Geosoft map file from a MapInfo file	(MapInfo and other .GM)
• PDF	

Report/

Contains:

• Copy of the report	(Adobe Acrobat .PDF)
• Description of the database's Channel	(Adobe Acrobat .PDF)

8. CONCLUSION

A helicopter-borne time-domain electromagnetic and gamma-ray spectrometric geophysical survey was flown for **Exploration Nemaska Inc.** The survey was composed of two (2) partially superimposed blocks, Nemiscau, Québec. For both surveys, the total magnetic field were recorded. A total linear distance of **~~3115.4~~ km** 3295 Km was flown from June 3rd to June 16th, 2009 for the TDEM survey, and a total linear distance of ~~3295~~ km was flown from June 19th to June 26th, 2009 for the gamma-ray spectrometric survey. → 3115,4 Km

The total magnetic field, gamma-ray spectrum and TDEM responses' windows were measured by the helicopter-borne system. DGPS positioning and radar altitude data were collected.

The final paper products consist of maps at a scale of 1:50 000. A total of ten (10) maps was produced. The digital products consist of final databases, maps, metadata files and final grid files. Digital data are included on the CD-ROM and the content is described in Appendix C.

It is hoped that the information presented in this report and on the accompanying maps will be useful both in planning subsequent exploration efforts and interpretation of related exploration data.

This report was written by Olivier Létourneau, Phys., verified and approved by Réjean Paul, Eng., Geoph.

Olivier Létourneau, Phys.

Réjean Paul, Eng., Geoph.
President
(O.I.Q. No.: 23848)

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<u>**CERTIFICATE OF QUALIFICATION**</u>

1. I, the undersigned, Réjean Paul, graduated with a B. Sc. A. in Physics from École Polytechnique de Montréal in 1972 and the cofounder of Geophysics GPR International Inc. since 1974. I have worked in airborne geophysics since the year 1978.
2. I am a member of l'Ordre des ingénieurs du Québec (O.I.Q. No.: 23848) and also of the Society of Exploration Geophysicists.
3. I have no direct or indirect interests in the mining claims owned by **Exploration Nemaska.**, nor in the securities of this company and have no interest in receiving such interest.

Signed in Longueuil, on July 27th, 2009

Respectfully submitted,

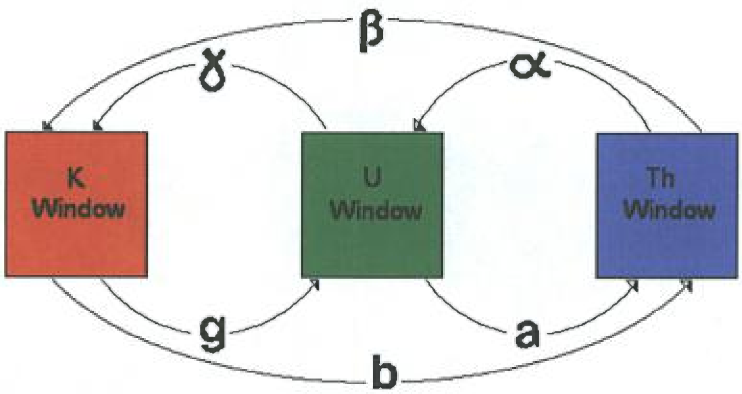
Réjean Paul, Eng., Geoph.
President
(O.I.Q. No.: 23848)

APPENDIX A

Equipment Calibration and Tests

CALIBRATION RESULTS OF K-U-TH AND TC WINDOW COUNTS FROM PAD MEASUREMENTS

Spectrometer: GRS-10 from Pico Envirotec
Stripping Ratios



Th into U	α (alpha)	0.272
Th into K	β (beta)	0.413
U into K	γ (gamma)	0.757
U into Th	a	0.043
K into Th	b	0.000
K into U	g	0.000

System Sensitivities (60 m ground clearance)

Window	Sensitivity	Attenuation
TC	15.93 cps/nGy/h	-0.0068 /m
K	44.24 cps/e%K	-0.0100 /m
U	4.46 cps/ppm eU	-0.0063 /m
Th	2.45 cps/ppm eTh	-0.0072 /m

Cosmic background

Window	Background (cps)	Vs comics
TC	7.482	1.2782
K	2.153	0.1099
U	0	0.0544
Th	0	0.0659
U_up	0.689	0.0095

Upward looking coefficient (Radon removal)

	Window	Background (cps)	Vs comics
A1		A_{tc}	45.311
A2		A_k	4.3508
B_k,B_u,B_{th},B_{tc}	0	A_u	0.642
		A_{th}	1.0789

APPENDIX B
Maps

Drawing number: 09-07-352-PRE to 09-07-361-PRE

NUMÉRIQUE

PAGE(S) DE DIMENSION HORS STANDARD NUMÉRISÉE ET POSITIONNÉE À LA SUITE DES PRÉSENTES PAGES STANDARDS.

APPENDIX C

Digital Data on CD-ROM

CD contents

File Name	Description	Format
REPORT		
M09678_Report.pdf	Data acquisition report	Acrobat
Database_Channel_Description.pdf	List of database channels of magnetic and spectrometric databases and corresponding units	Acrobat

DATA\MAG		
M09678_MAG.XYZ M09678_MAG.GDB	Magnetic database	Geosoft .XYZ and .GDB
TMF.grd	Total Magnetic Field grid	Geosoft .GRD
FVD.grd	First Vertical Derivative	Geosoft .GRD
GIs	Including all projection information files	MapInfo and other .GI
M09678_TMF -(09-07-353-PRE).map	Total Magnetic Field map, (nT)	Geosoft .MAP
M09678_FVD-(09-07-354-PRE).map	First Vertical Derivative map, (nT/m)	Geosoft .MAP
M09678_BASE-(09-07-352-PRE).map	Flight path Recovery and Property limits	Geosoft .MAP
TIFFs	Geo referenced images	.TIFF
GMs	Including all GM files used in the MapInfo software to distinguish a Geosoft map file from a MapInfo file	Geosoft .GM

\Spectro		
M09678_RAD.GDB M09678_RAD.XYZ	Spectrometric database	Geosoft .XYZ and .GDB
U.grd	Processed equivalent uranium concentration grid	Geosoft .GRD
TH.grd	Processed equivalent thorium concentration grid	Geosoft .GRD
K.grd	Processed equivalent potassium concentration grid	Geosoft .GRD
TC.grd	Processed air absorbed dose rate derived from total count grid	Geosoft .GRD
DTM.grd	Digital Terrain Model	Geosoft .GRD
GIs	Including all projection information files	MapInfo and other .GI
M09678_U-(09-07-356-PRE).map	Equivalent Uranium concentration map, (ppm)	Geosoft .MAP
M09678_Th-(09-07-357-PRE).map	Equivalent Thorium concentration map, (ppm)	Geosoft .MAP
M09678_K-(09-07-355-PRE).map	Potassium concentration map, (%)	Geosoft .MAP
M09678_TC-(09-07-358-PRE).map	Air absorbed dose rate derived from total count map (nGy/h)	Geosoft .MAP
M09678_DTM-(09-07-359-00).map	Digital Terrain Model map, (m)	Geosoft .MAP
TIFFs	Geo referenced images	.TIFF
GMs	Including all GM files used in the MapInfo software to distinguish a Geosoft map file from a MapInfo file	Geosoft .GM

MAGNETIC DATABASE CHANNEL DESCRIPTION

Channel name	Unit	Description
X	m	UTM Northing (NAD 83 zone 18N)
Y	m	UTM Northing (NAD 83 zone 18N)
Z	m	GPS height (in helicopter)
Lat	Dec. degrees	Latitude WGS84
Lon	Dec. degrees	Longitude WGS84
Time_GPS	HH:MM:SS.SS	GPS time
MAG_raw	nT	Despiked mag
MAG_raw_lagged	nT	Despiked and lag mag
MAG_levelled	nT	Diurnal corrected mag
MAG_final	nT	Final magnetic data
Basemag	nT	base station magnetic readings
TMF	nT	Total Magnetic Field

SPECTROMETRY DATABASE CHANNEL DESCRIPTION

Channel name	Unit	Description
X	m	UTM Easting (NAD 83 zone 18N)
Y	m	UTM Northing (NAD 83 zone 18N)
Z	m	GPS height (in helicopter)
Lat	Dec. degrees	Latitude WGS84
Lon	Dec. degrees	Longitude WGS84
Time_GPS	HH:MM:SS.SS	GPS time
Temperature	celsius	Temperature converted to Celsius
Altitude	m	Radar Altimeter (in helicopter)
Pressure	mBar	Pressure
Spectro_Down	256 channel	Measured spectrum raw but lagged and despiked (database only) in 256 channel vector array format
Spectro_Up	256 channel	Measured spectrum raw but lagged and despiked (database only) in 256 channel vector array format
SVD_Down	256 channel	Processed spectrum using NASVD (database only) in 256 channel vector array format
SVD_Up	256 channel	Processed spectrum using NASVD (database only) in 256 channel vector array format
TC	nGy/h	Absorbed Dose rate derived from total count readings
K	%	Potassium concentration reading
U	ppm	Equivalent Uranium concentration reading
Th	ppm	Equivalent Thorium concentration reading
DTM	Meters	Digital Terrain Model

EM_anomaly.gdb, Listing of all identified EM anomalies

No.	Name	Description	Units
1	X	UTM Easting, NAD83, Zone 18N	m
2	Y	UTM Easting, NAD83, Zone 18N	m
3	NAME	Anomaly ID	
4	Class1_possible	Group of very weak anomalies	N/A
5	Class2	Group of anomaly with TAU <1	millisecond
6	Class3	Group of anomaly with TAU ≥1 and <2	millisecond
7	Class4	Group of anomaly with TAU ≥2 and <3.5	millisecond
8	Class5	Group of anomaly with TAU ≥3.5 and <5	millisecond
9	Class6	Group of anomaly with TAU >5	millisecond

EM_final.gdb

No.	Name	Description	Units
1	X	UTM Easting, NAD83, Zone 18N	m
2	Y	UTM Easting, NAD83, Zone 18N	m
3	Lat_deg	Latitude in decimal degrees	deg
4	Long_deg	Longitude in decimal degrees	deg
6	Z_RAW (array channel)	Raw Z channels (Z13-Z40)	nT/sec
7	Z (array channel)	Filtred Z channels (Z13-Z40)	nT/sec