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Technical report, heliborne magnetic and TDEM survey

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Technical Report

Heliborne Magnetic and TDEM Survey

Nisk Project, Nemiscau Area,
Eeyou Istchee Baie-James Region, Québec, 2023

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Dynamic Discovery Geoscience

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May 2023

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Table of Contents

FIGURES

TABLES

I. INTRODUCTION

Prospectair Geosurveys conducted a high-resolution heliborne magnetic (MAG) and time-domain electromagnetic (TDEM) survey for the mineral exploration company Power Nickel Inc. on its Nisk Property, located in the Nemiscau area, Eeyou Istchee Baie-James region, Province of Québec (Figure 1). The survey was flown from April 4 to 7, 2023.

Two survey blocks, referred to as Main and West, were flown for a total of 508 l-km (Table 1). A total of 7 production flights were performed using Prospectair's Airbus H125, registration C-GATM. The helicopter and survey crew operated out of the Relais routier Nemiscau, at km 291 of the Route du Nord, located about 20 km to the west of the West block (Figure 2).

Table 1: **Survey blocks particulars**

Block	NTS Mapsheet	Line-km flown	Flight numbers	Dates Flown
Main	032O12	484 l-km	Flt 1 to 7	April 4 to 7
West	032O12	24 l-km	Flt 1 and 3	April 4 and 5

Figure 1: **General survey location**

Both blocks were flown with traverse lines at 100 m spacing and control lines spaced every 1000 m. The survey lines were oriented N154 for both blocks, and the control lines were oriented perpendicular to traverse lines. The nominal survey height for the MAG-TDEM survey was 85 m, but the several high-tension powerlines found in the area resulted in an average height above ground of the helicopter of 98 m, with the mag sensor and receiver coil at 73 m, and the transmitter loop at 48 m above the ground. The average survey flying speed (calculated equivalent ground speed) was 26.9 m/s. The survey area is covered by forest, lakes and a few wetlands. The topography is mostly gently undulating, with a few hills to the south of the Main block. The elevation is ranging from 280 to 424 m above mean sea level (MSL). The Main block is approximately located in between the Voirdye Lake to the southeast and the large Nemiscau River to the northwest. From the ground, the West block can be easily accessed via the Route du Nord, while the Main block can be accessed by the main road servicing the high-tension power lines extending towards the northeast from Hydro-Québec's Albanel Sub-station, found to the south of the Main block. Coordinates outlining the survey blocks are given in Appendix A, with respect to NAD-83 datum, UTM projection zone 18N. The location of the Nisk Property claims (in red) and of the survey lines is shown on Figure 3.

Figure 2: **Survey location and base of operation**

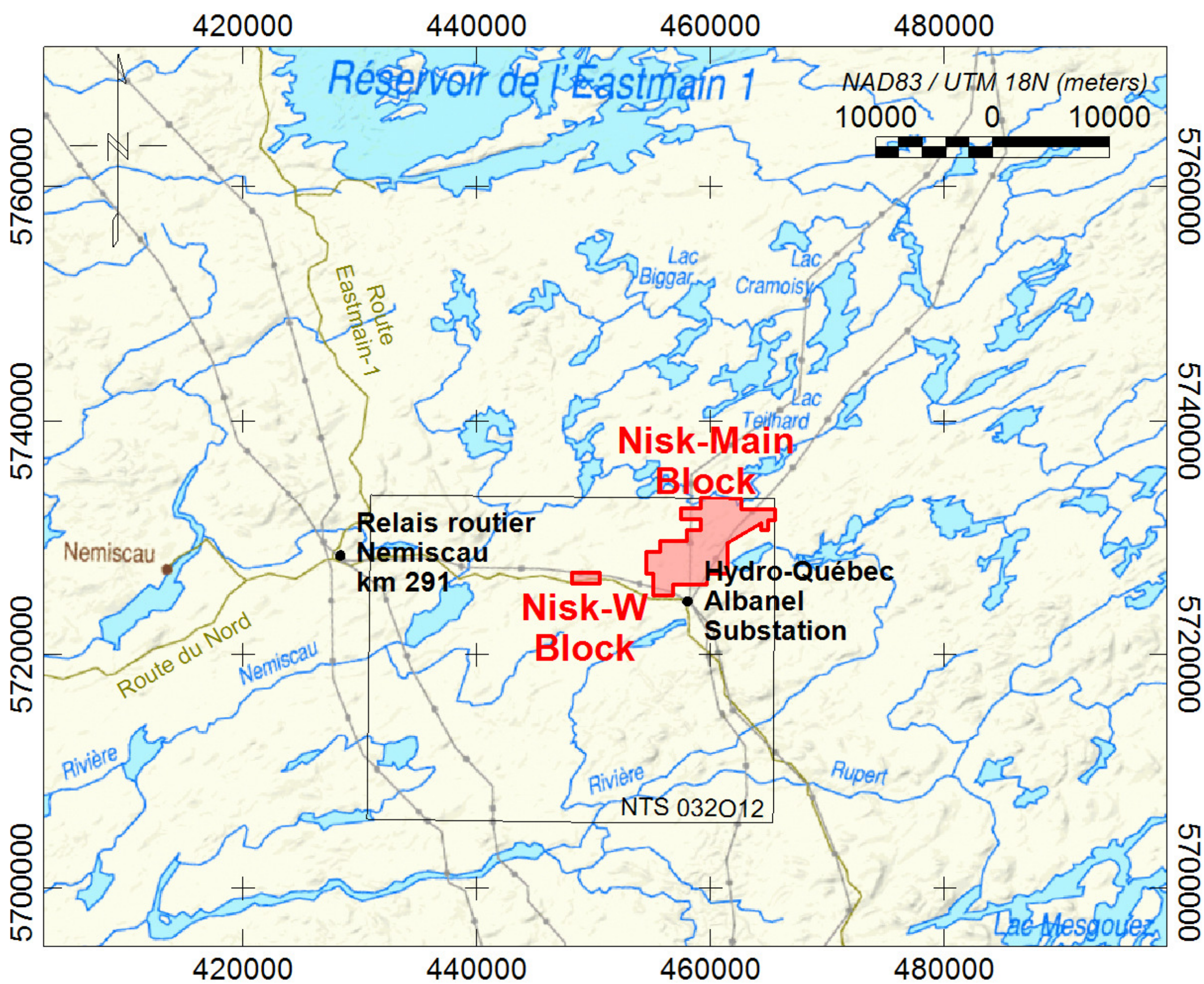
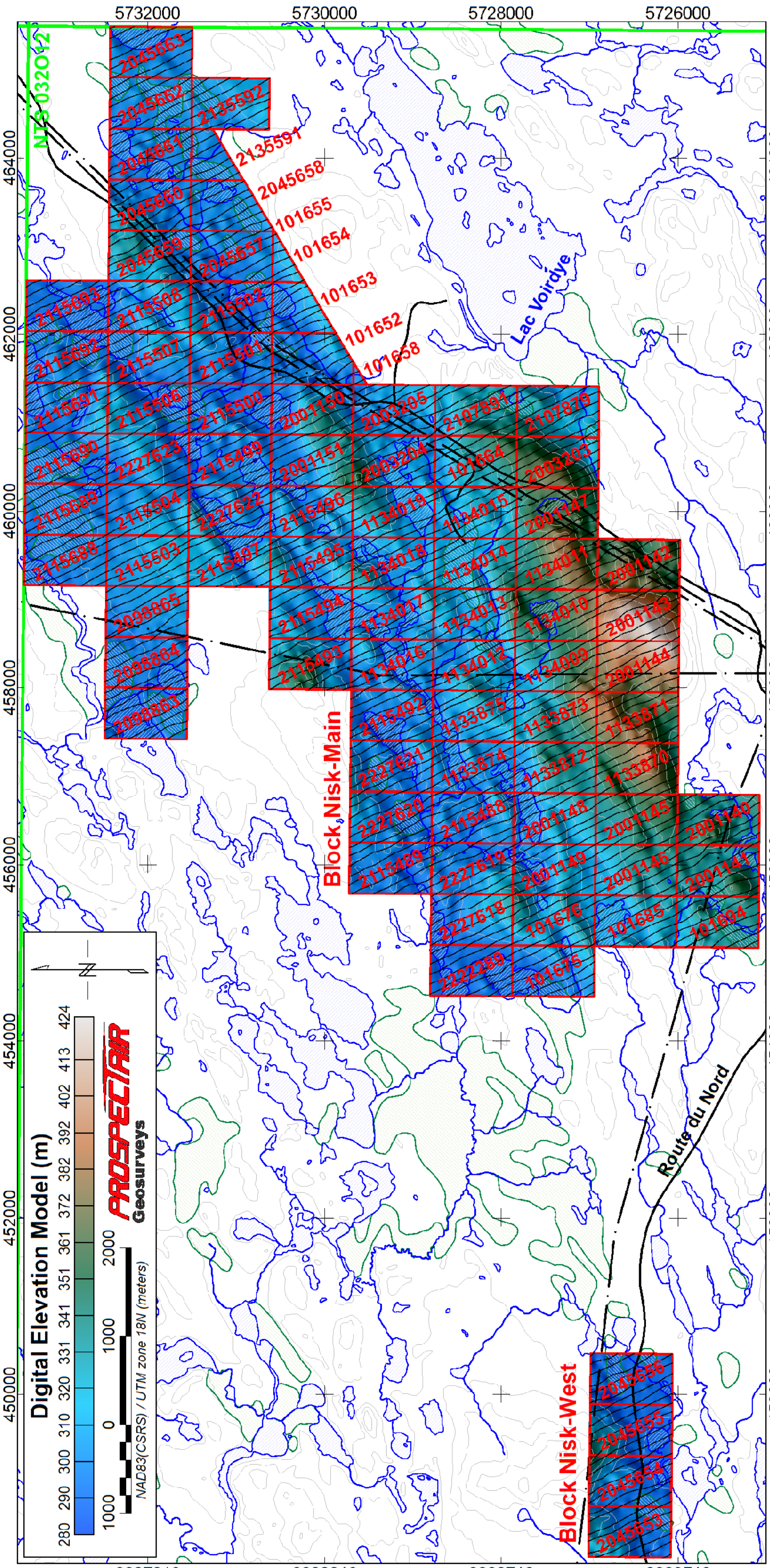


Figure 3: **Survey lines and Nisk Property claims**



II. SURVEY EQUIPMENT

Prospectair provided the following instrumentation for this survey.

Airborne Magnetometers

Geometrics G-822A

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 25 m below the helicopter when flying. Total magnetic field measurements were recorded at 10 Hz in the aircraft.

Time-Domain Electromagnetic Transmitter and Receiver

ProspecTEM

Prospectair Geosurveys significantly modified and improved the *Emosquito II* that was built by THEM Geophysics of Gatineau (Québec) to develop ProspecTEM. It is a powerful light-weight system adapted for small size helicopters and easy manoeuvrability enabling the system to be flown as close to the ground as safely possible and ensuring maximum data resolution. Advanced signal processing technique and a full processing package was developed in house to optimize the ProspecTEM data. The technical specifications are listed below in Table 2.

ProspecTEM system employs a transient or time-domain electromagnetic transmitter that drives an alternating current through an insulated electrical coil system. The towing bridle is constructed from a Kevlar rope and multi-paired shielded cables. It is attached to the helicopter by a weak link assembly. An onboard harness with outboard connectors mounted on a plate allows for quick disconnection or connection of the exterior elements. 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.

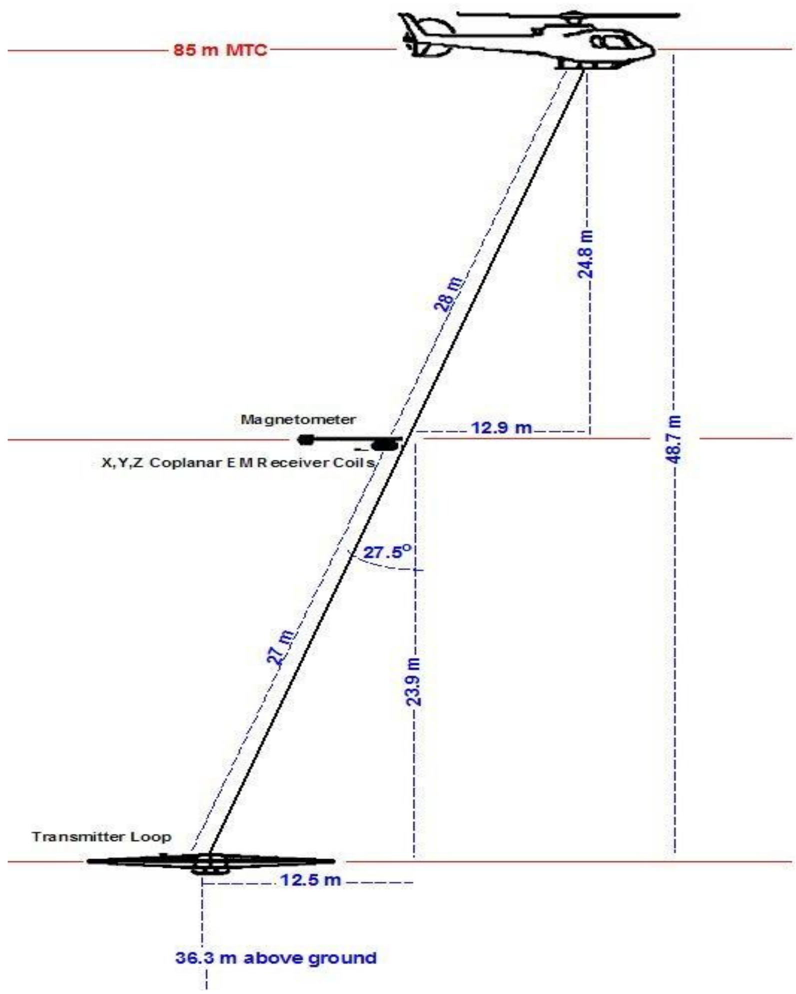
The current in the coil produces an electromagnetic field. Termination of the current flow is not instantaneous, but occurs over a very brief period of time (a few microseconds) known as the ramp time, during which the magnetic field is time-variant. The time-variant nature of the primary electromagnetic field, which propagates downward and outward into the subsurface, induces eddy currents which characteristics are governed by rocks conductivity distribution. These eddy currents generate a secondary electromagnetic field, in accordance with Faraday's Law. This secondary field immediately begins to decay in the process. Measurements of the secondary field 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 2: **Technical specifications of the ProspecTEM Time-Domain system**

Item	Specification
Transmitter:	
Loop Diameter:	5.6 meters
Current Waveform:	Half-Sine
Turns:	2
Pulse Length	2.75 ms
Frequency	30 Hz
Loop Area	25 m^2
Peak Current	3000A
Tow Cable Length	65 meters
Self-Powered	13HP Honda coupled with 28 Volts Alternator
Receiver:	
Coils axis	Z
Configuration	Coaxial (Z)
Two channels	Current and Z
Max Sampling rate	1000 points per half cycle at 90 Hz
Survey sampling rate	1000 per half cycle at 30Hz
Sampling	Full waveform
Gates	Programmable
On time signal	Recorded
Mechanical:	
Maximum survey speed:	120 km per hour
Transmitter height	30 meters AGL
Receiver height	60 meters
Weight (Total)	200 kg

Figure 4: **ProspecTEM system configuration**



Real-Time Differential GPS

Omnistar DGPS

Prospectair uses an OmniStar differential GPS navigation system to provide real-time guidance for the pilot and to position data to an absolute accuracy of better than 5 m. The *Omnistar* receiver provides real-time differential GPS for the IMPAC on-board navigation system. The differential correction data set was relayed to the helicopter via the appropriate Omnistar network satellite for the survey location. The receiver optimizes the corrections for the current location.

Airborne Navigation and Data Acquisition System

Nuvia IMPAC system

The airborne geophysical information system (IMPAC) is advanced, software driven instrument specifically designed for mobile aerial or ground geophysical survey work. The IMPAC instrumentation package includes a GPS based navigation system, real-time flight path information that is displayed over a map image of the area, and reliable data acquisition software. Thanks to simple interfacing, the radar and barometric altimeters, the TDEM system 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 IMPAC is equipped with a software suite allowing easy maintenance, upgrades, data QC, and project and survey area layout planning.

Magnetic Base Station

GEM GSM-19

A GEM GSM-19 Overhauser magnetometer, a computer workstation and a complement of spare parts and test equipment serve as the base station. Prospectair establish the base station in a secure location with low magnetic noise. 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. The ground system was recording magnetic data at 1 Hz.

Altimeters

Free Flight Radar Altimeter

The Free Flight radar altimeter measures height above ground to 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.

Prospectair Digital Barometric Pressure Sensor

The barometric pressure sensor measures static pressure to an accuracy of ± 4 m and resolution of 2 m over a range up to 30,000 ft above sea level. The barometric altimeter data are sampled at 10 Hz.

Survey helicopter

Airbus H125 (registration C-GATM)

The survey was flown using Prospectair's H125 helicopter that handles efficiently the equipment load and the required survey range. Table 3 presents the H125 technical specifications and capacity, and the aircraft is shown in Figure 5.

Table 3: **Technical specifications of the H125 Airbus helicopter**

Item	Specification
Powerplant	One 710kW (952shp) Safran Helicopter Arriel 2D
Rate of climb	1,959 ft/min
Cruise speed	260 km/h – 140 kts
Service ceiling	7,010 m
Range with no reserve	630 km
Empty weight	1,305 kg
Maximum takeoff weight	2,800 kg

Figure 5: **C-GATM Airbus H125**

III. SURVEY SPECIFICATIONS

Data Recording

The following parameters were recorded during the course of the survey:

In the helicopter:

- GPS positional data: time, latitude, longitude, altitude, heading and accuracy (PDOP) recorded at intervals of 0.1 s.
- Total magnetic field: recorded at intervals of 0.1 s.
- Terrain clearance as measured by the radar altimeter at intervals of 0.1 s.
- Z and Current TDEM channels at 90000Hz.

At the base and remote magnetic ground stations:

- Total magnetic field: recorded at intervals of 1 s.
- GPS time recorded every 1 s to synchronize with airborne data.

Technical Specifications

The data quality control was performed on a daily basis. The following technical specifications were adhered to:

- *Height* – 85m target terrain clearance for the MAG-TDEM survey except in areas where Transport Canada regulations prevent flying at this height, or as deemed necessary by the pilot to ensure safety. Traverse lines and control lines must be flown at the same altitude at points of intersection; the altitude tolerances are limited to no more than 30 m difference between traverse lines and control lines.
- *Airborne Magnetometer Data* - The noise envelope not to be exceeded 0.5 nT more than 500 m line-length without a reflight.
- *Diurnal Specifications* – A maximum tolerance of 5.0 nT (peak to peak) deviation from a long chord of one minute at the base station.
- *EM data* – No spikes on Z channel and constant current confirmed.
- *Flying Speed* – The average ground speed for the survey aircraft shall be 120 kph. The acceptable high limit is 160 kph over flat topography.
- *Radar Altimeter* – minimal accuracy of 5%, minimum range of 0-2500 m.
- *Barometer* – Absolute air pressure to 0.1 kPa.
- *Flight Path Following* – Maximum deviation of 30% of line spacing allowed over a maximum line distance of 300 m.

IV. SYSTEM TESTS

Magnetometer System Calibration

The survey configuration using a bird towed 25 m below any magnetic piece of the helicopter allows the simplification of the magnetic calibration requirement. Consequently, heading error and aircraft movement noise was considered negligible and no correction was applied to the data.

Instrumentation Lag

The data lag is a combination of two factors: 1) the time difference between when a reading is sensed, and when that value is recorded by the acquisition system, and 2) the time taken for the sensor to arrive at the location of the GPS antenna. The second factor is defined by the physical distance between the GPS antenna and any given sensor, and the speed of the aircraft. The total magnetic lag value for the IMPAC acquisition system has been calculated to 2.12 s for this survey. The TDEM lag has been calculated to 0.63 s.

V. FIELD OPERATIONS

The survey operations were conducted out of the Relais routier Nemiscau from April 4 to 7, 2023. The MAG-TDEM data acquisition required 7 flights. At the end of each production day, the data were sent to Dynamic Discovery Geoscience's office via internet. The data were then checked for Quality Control to ensure they fulfilled contractual specifications. The full dataset was inspected prior to provide authorization for the field crew to demobilize. The GEM-19 magnetic base station was set up in a magnetically quiet area close to the helicopter pad, at latitude 51.6995971°N, longitude 76.0446081°W. The survey pilot was Claude Gay and the survey system technician was Laurent Huard.

Figure 6: **Example of a magnetic base station setup**

VI. DIGITAL DATA COMPILATION

Data compilation including editing and filtering, quality control, and final data processing was performed by Joël Dubé, P.Eng. Processing was performed on high performance desktop computers optimized for quick daily QC and processing tasks. Geosoft software Oasis Montaj version 2022.2 and Matlab R2018a were used.

Magnetometer Data

The airborne magnetometer data, recorded at 10 Hz, were plotted and checked for spikes and noise on a flight basis. A 2.12 second lag correction was applied to all data to correct for the time delay between detection and recording of the airborne data.

Ground magnetometer data were recorded at 1 sample per second and interpolated by a spline function to 10 Hz to match airborne data. Data were inspected for cultural interference and edited where necessary. Some low-pass filtering was deemed necessary on the ground station magnetometer data to remove minor high frequency noise. The diurnal variations were removed by subtracting the ground magnetometer data from the airborne data and then adding back the average magnetic field value of the ground magnetometer.

The levelling corrections were applied in several steps. First, a correction for altitude was applied by multiplying the First Vertical Derivative of the pre-levelled data by the difference between the actual survey altitude and the average survey altitude. Standard levelling corrections were then performed using intersection statistics from traverse and tie lines. After statistical levelling was considered satisfactory, decorrugation was applied on the data to remove any remaining subtle non-geological features oriented in the direction of the traverse lines.

Once the Total Magnetic Intensity (TMI) was gridded, its First Vertical Derivative (FVD) and Second Vertical Derivative (SVD) were calculated to enhance narrower geological features. Finally, the component of the normal Earth’s magnetic field, described by the International Geomagnetic Reference Field (IGRF), has been removed from the TMI to yield the residual TMI. This ensures that the very long wavelength signal within the block is indeed originating from the local geology and not from the Earth’s expected regional gradient.

In order to enhance the subtle magnetic features some more, the Tilt Angle Derivative (TILT) was also computed for this project.

It has been shown that it is possible to use the Tilt Angle Derivative to estimate both the location and depth of magnetic sources (Salem et al., 2007).

When two bodies of different magnetic susceptibility are in contact, the vertical and horizontal gradients along a horizontal line perpendicular to the vertical contact are governed by the following equations:

$\delta M/\delta h=2KFc(z_c/(h^2+z_c^2))$
$\delta M/\delta z=2KFc(h/(h^2+z_c^2))$

where
K = susceptibility contrast
F = magnetic field's strength
c = 1-$\cos^2$(field Inclination)$\sin^2$(field Declination)
h = location along an horizontal axis perpendicular to the contact
z_c = contact depth
$\delta M/\delta h$ = sqrt(($\delta M/\delta x)^2$+($\delta M/\delta y)^2$)

The Tilt Angle (θ) is defined as
$\theta = \tan^{-1}[(\delta M/\delta z)/(\delta M/\delta h]$

By substitution of the gradients we get
$\theta = \tan^{-1} [h/z_c]$

This has two main implications for any given anomaly:

1- The 0° angle line is located directly above the contact between a magnetic source and the surrounding rock. This allows for accurate estimation of source location.
2- The distance between the 0° and the +45° lines as well as the distance between the -45° and the 0° lines are equal to the depth of the source at the contact. This allows for a direct estimation of the depth of the source of the anomaly. The depth estimated with this method is actually the distance between the magnetic sensor and the top of the source. Knowing that the sensor was 73m above the ground in average enables direct depth estimates.

In practice, the signal originating from multiple sources at different depth within a same area will cause juxtaposition of the Tilt Angle values, and complicate location and depth estimation. Nevertheless, the method remains an excellent tool for rapid assessment of sources characteristics, without the need for complex assumptions to be made or heavy computer requirements, as is the case with 3D Euler deconvolution or 3D data inversions.

Radar Altimeter Data

The terrain clearance measured by the radar altimeter in metres was recorded at 10 Hz. The data were filtered to remove high frequency noise using a 1 sec low pass filter. The final data were plotted and inspected for quality.

Positional Data

Real time DGPS correction provided by Omnistar was applied to the recorded GPS positional data.

Positional data (Lat, long, UTM X, UTM Y, geoid height) were recorded at 10 Hz sampling rate and all data processing was performed in the WGS-84 datum. The delivered data are provided in X, Y locations in UTM projection zone 18 North, with respect to the NAD-83 (CSRS) datum. Altitude data were initially recorded relative to the GRS-80 ellipsoid, but are delivered as orthometric heights (MSL elevation).

Terrain Data

Terrain elevation data (also referred to as digital elevation model, or DEM) are computed from the altitude of the helicopter, given by DGPS recordings, and the radar altimeter data.

TDEM Data

The PicoEnvirotec EM Digital Acquisition System records the vertical component (Z) of the receiver coils at a sampling rate of 90000Hz. 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 11 correspond to the ON-time measurements and channels 12 to 40 correspond to the OFF-time. Channel 12 isn't used for interpretation and mapping as some 'ramp-off' effects remain 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 lag correction of 0.63 sec was applied to the data after being empirically determined by flying a sharp anomaly in two opposite directions.

Table 4: **Setting used in the windowing of the full waveform**

Channel #	Starting time (msec)	Width (msec)	Pulse	Channel #	Starting time (msec)	Width (msec)	Pulse
1	0.16667	0.01667	**ON**	**21**	3.15000	0.53333	**OFF**
2	0.25000	0.01667	**ON**	**22**	3.26667	0.53333	**OFF**
3	0.33333	0.01667	**ON**	**23**	3.40000	0.53333	**OFF**
4	1.30000	0.01667	**ON**	**24**	3.40000	1.10000	**OFF**
5	1.31667	0.01667	**ON**	**25**	3.45000	1.10000	**OFF**
6	1.33333	0.01667	**ON**	**26**	3.65000	1.10000	**OFF**
7	2.58333	0.01667	**ON**	**27**	3.88333	1.10000	**OFF**
8	2.66667	0.01667	**ON**	**28**	4.13333	1.10000	**OFF**
9	2.80000	0.08333	**ON**	**29**	4.43333	1.10000	**OFF**
10	2.81667	0.08333	**ON**	**30**	4.76667	1.10000	**OFF**
11	2.83333	0.08333	**ON**	**31**	5.16667	1.10000	**OFF**
12	2.85000	0.16667	**RAMP**	**32**	5.20000	2.20000	**OFF**
13	2.86667	0.18333	**OFF**	**33**	5.55000	2.20000	**OFF**
14	2.86667	0.25000	**OFF**	**34**	6.13333	2.20000	**OFF**
15	2.86667	0.36667	**OFF**	**35**	6.78333	2.20000	**OFF**
16	2.91667	0.36667	**OFF**	**36**	7.51667	2.20000	**OFF**
17	2.91667	0.53333	**OFF**	**37**	8.36667	2.20000	**OFF**
18	2.95000	0.53333	**OFF**	**38**	9.33333	2.20000	**OFF**
19	3.00000	0.53333	**OFF**	**39**	10.4500	2.20000	**OFF**
20	3.03333	0.53333	**OFF**	**40**	11.7000	2.20000	**OFF**

As for the magnetic data, levelling corrections were applied to the TDEM data using intersection statistics from traverse and tie lines, as well as light decorrugation based on gridded information, in order to remove base line offsets. The levelled TDEM data are delivered in the database.

Gridding

The magnetic, early off-time TDEM (channel 13), mid off-time TDEM (channel 20), and late off-time TDEM (channel 27) data were interpolated onto a regular grid using a bi-directional gridding algorithm to create a two-dimensional grid equally incremented in x and y directions.

The final grids were created with 20 m grid cell size, appropriate for the survey lines spaced at 100 m. Traverse lines were used in the gridding process.

VII. RESULTS AND DISCUSSION

Magnetic data

The Residual Total Magnetic Intensity (TMI) of the Nisk blocks, presented in Figure 7 together with TDEM anomalies, is relatively active and varies over a range of 2,510 nT, with a standard deviation of 166 nT and an average value of -42 nT. The Main block is slightly more active than the West block.

The survey blocks are characterized by several strong, lens-shaped, magnetic anomalies generally trending ENE-WSW and extending over more than 1 km each, which are dispersed within wider areas depicting mostly subdued magnetic signal. These magnetically settled areas with weaker background values are typical of meta-sedimentary or felsic to intermediate volcanic/intrusive rocks, while the stronger magnetic anomalies are likely related to mafic or ultramafic intrusive rocks. Other weaker magnetic anomalies could also pertain to mafic volcanics or sedimentary horizons locally enriched in magnetic minerals. The strong magnetic anomalies depict longer wavelength characteristics, indicating that the postulated mafic/ultramafic intrusions are rooted at depth. Stronger anomalies are best seen on Figure 8 which shows the residual TMI data with a linear color distribution.

Magnetic lineaments are generally trending ENE-WSW in the area, gradually varying from E-W in the west block, to NE-SW at the northeast end of the Main block. One relatively strong curvilinear feature globally striking NE-SW extends for almost 10 km within the Main block and likely pertains to a mafic dyke. Some lineaments appear curved, either by shearing or folding structures, or possibly also at the contact zone with some possible intrusions in the area. These evidences are attesting that the area underwent strong deformation events in the past. In general terms, magnetic lineaments are related to rock formations that are enriched in magnetic minerals (magnetite and/or pyrrhotite).

In some areas, it is possible to detect structural features offsetting observed magnetic lineaments and causing abrupt interruption or changes of the magnetic response. These features are typically caused by faults, fractures and shear zones, which could also be of interest for gold exploration. If they are thought to be favorable structures in the exploration context of the Nisk project, they should be paid particular attention and should be the object of a comprehensive structural interpretation, which is beyond the scope of this report.

Shorter wavelength anomalies are greatly enhanced on the FVD (Figure 9) and on the TILT (Figure 10) products. Since the FVD attenuates longer wavelength anomalies, and the TILT enhances very weak amplitude anomalies, they are the preferred products for structural interpretation. As well, a joint analysis of these results with the topography data (Figure 11) can help in the interpretation process of geological structures.

Regarding cultural interference, the major high-tension powerlines crossing both blocks are known to be evident sources of non-geological noise in the magnetic data. As a consequence, high frequency anomalies located near such infrastructures are likely to originate from cultural sources and should be treated with caution when planning ground investigations of magnetic anomalies.

In addition, when the helicopter had to steeply climb up above these infrastructures for obvious safety reasons, the magnetic response can appear somewhat blurred, with geological anomalies being attenuated in amplitude and increased in wavelength because of the greater sensor distance from the ground. This can also result in local stripes parallel to survey lines in the data. This effect is really local and quickly fades out on either sides of the overflown obstacle, but must be nevertheless considered when following-up on the results.

Figure 7: **Residual TMI with equal area color distribution and TDEM anomalies**

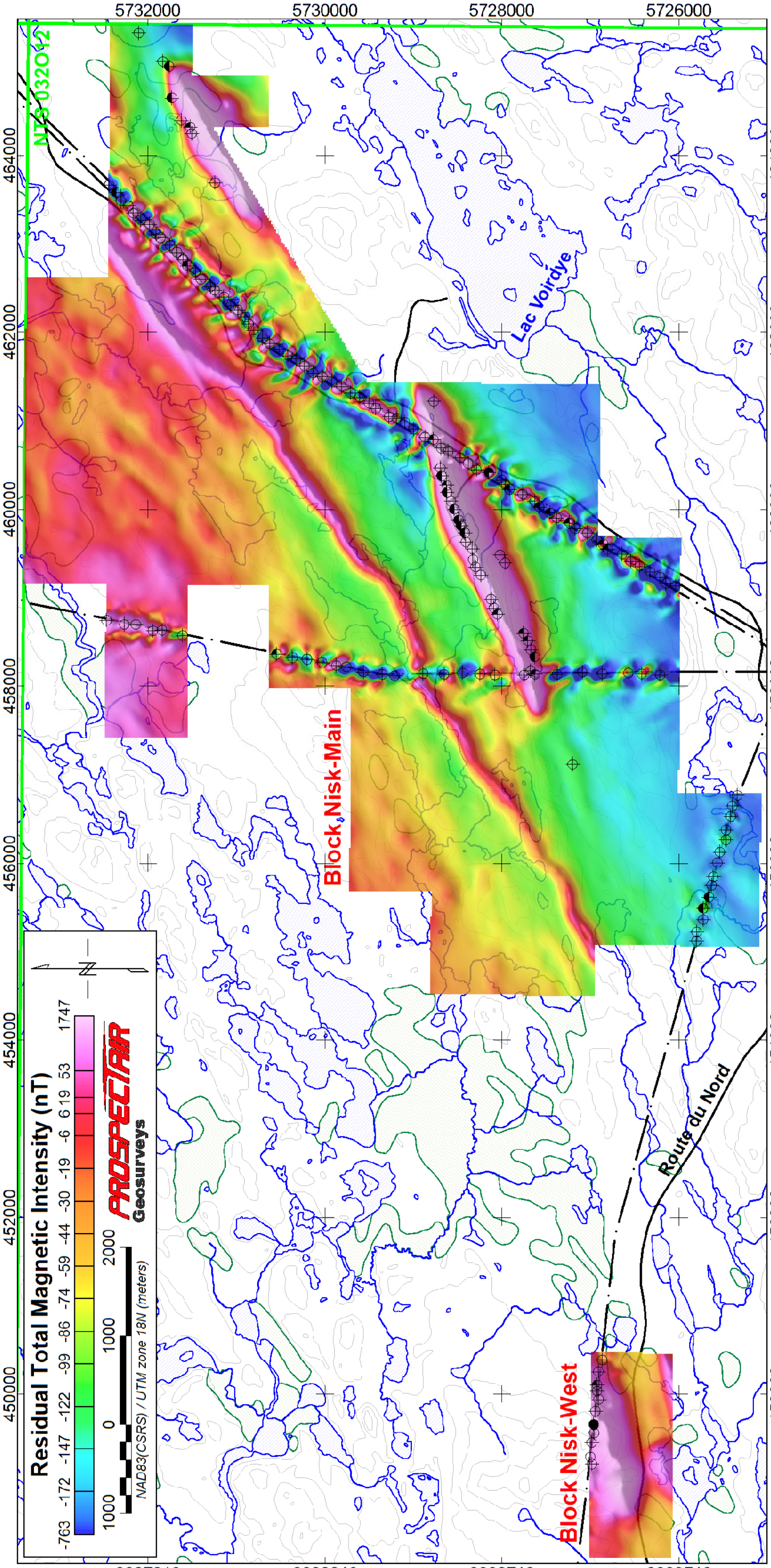


Figure 8: **Residual TMI with linear color distribution and TDEM anomalies**

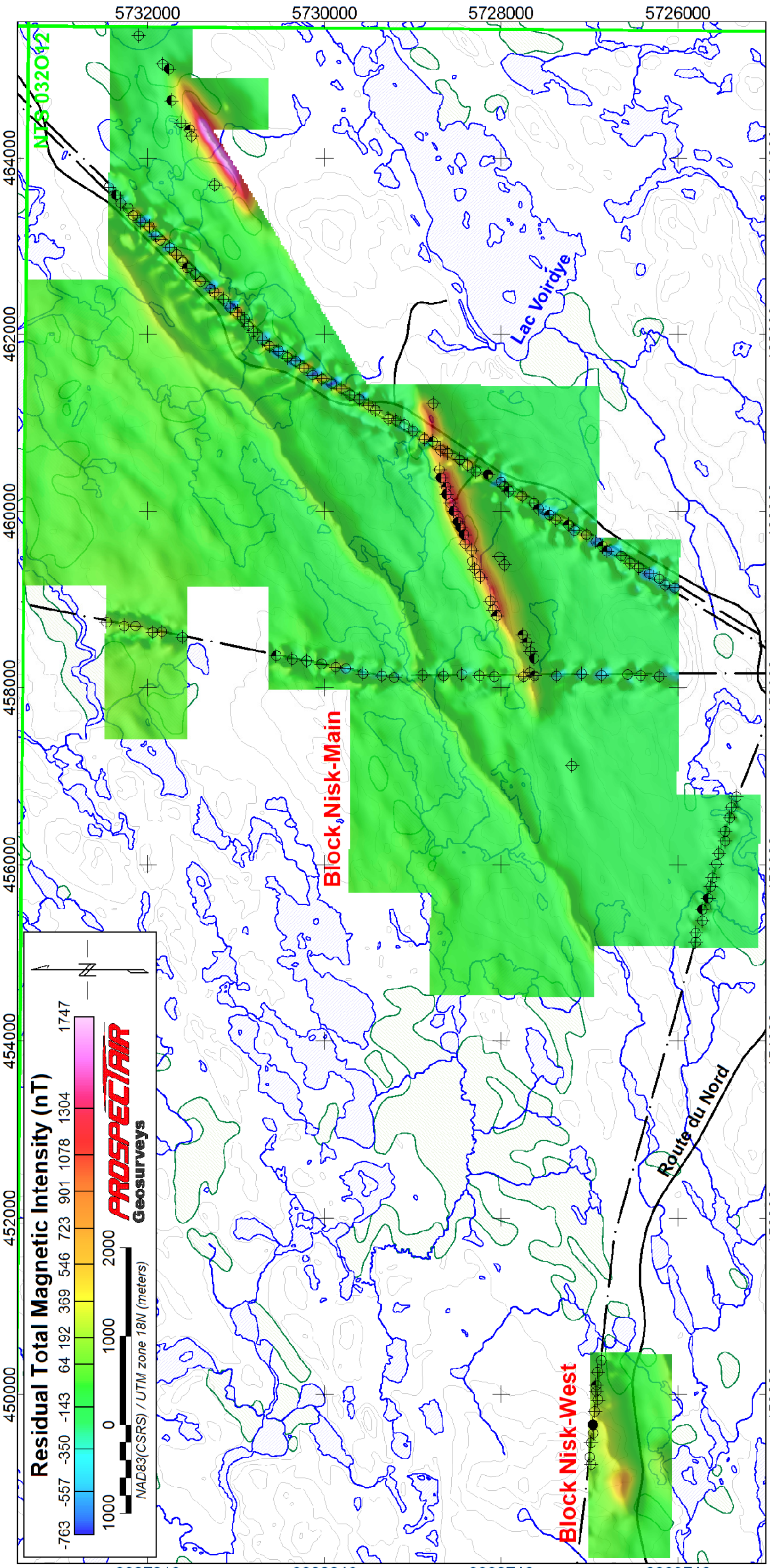


Figure 9: **First vertical derivative of TMI and TDEM anomalies**

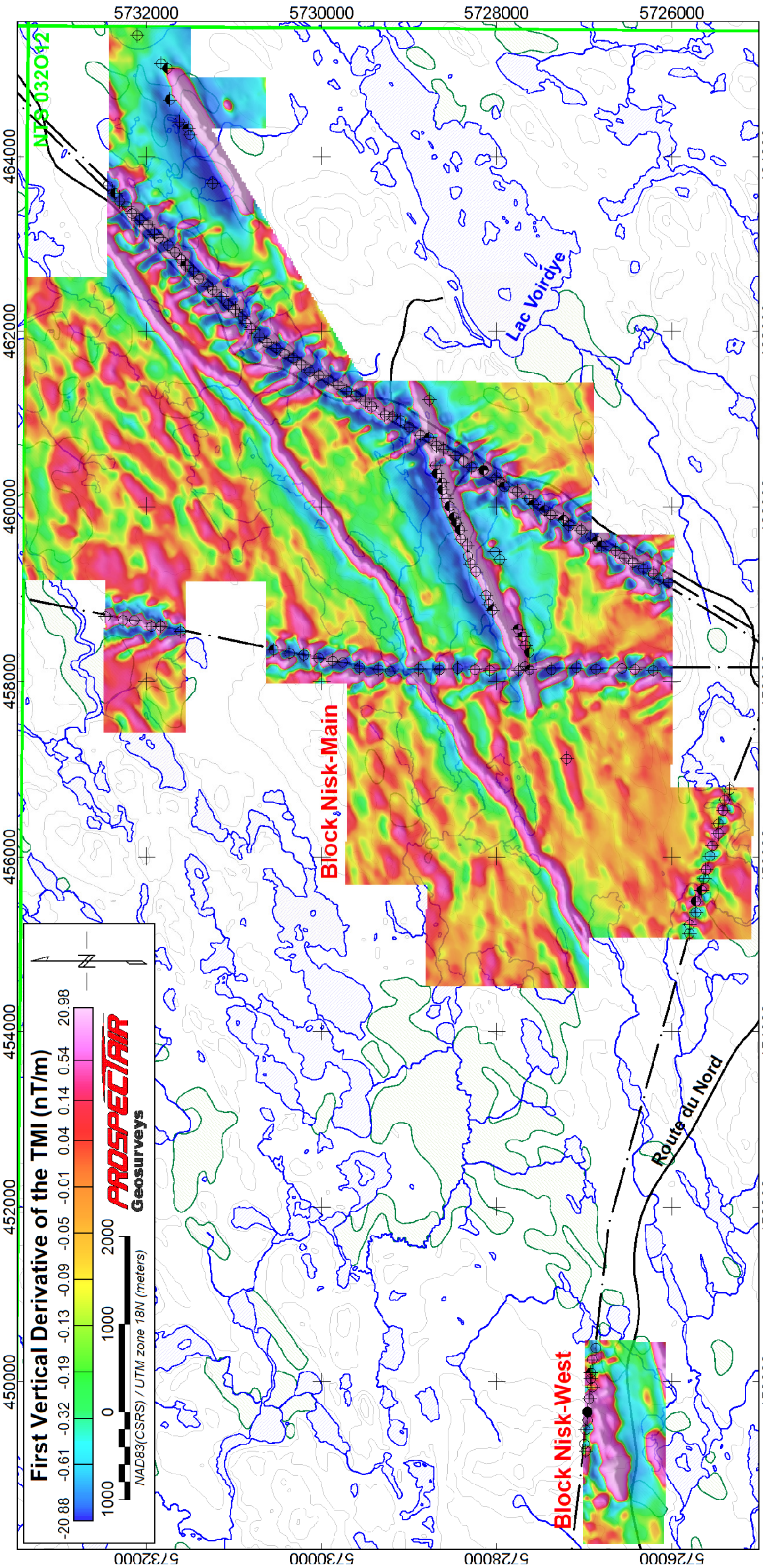


Figure 10: **Magnetic tilt angle derivative and TDEM anomalies**

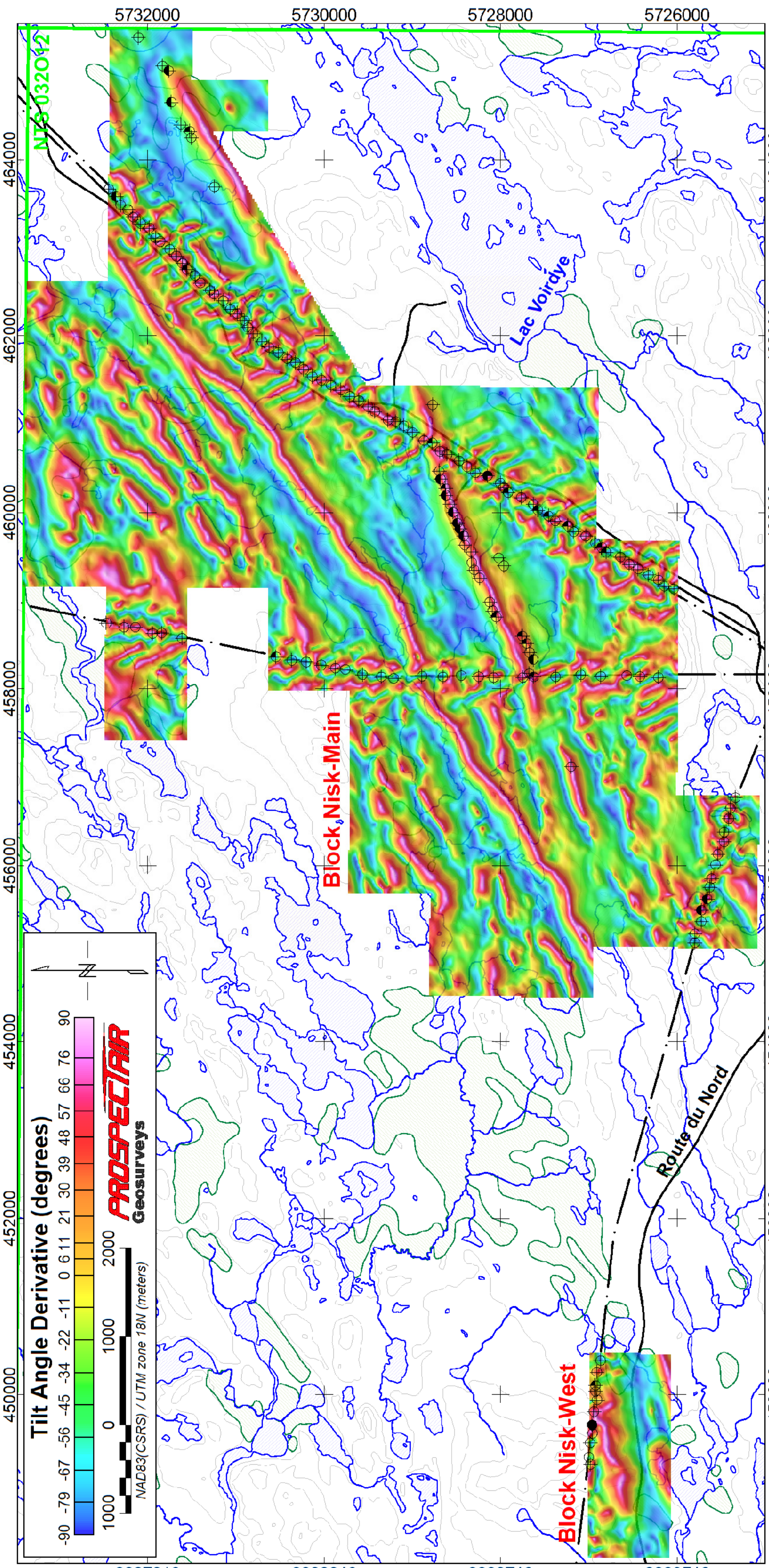
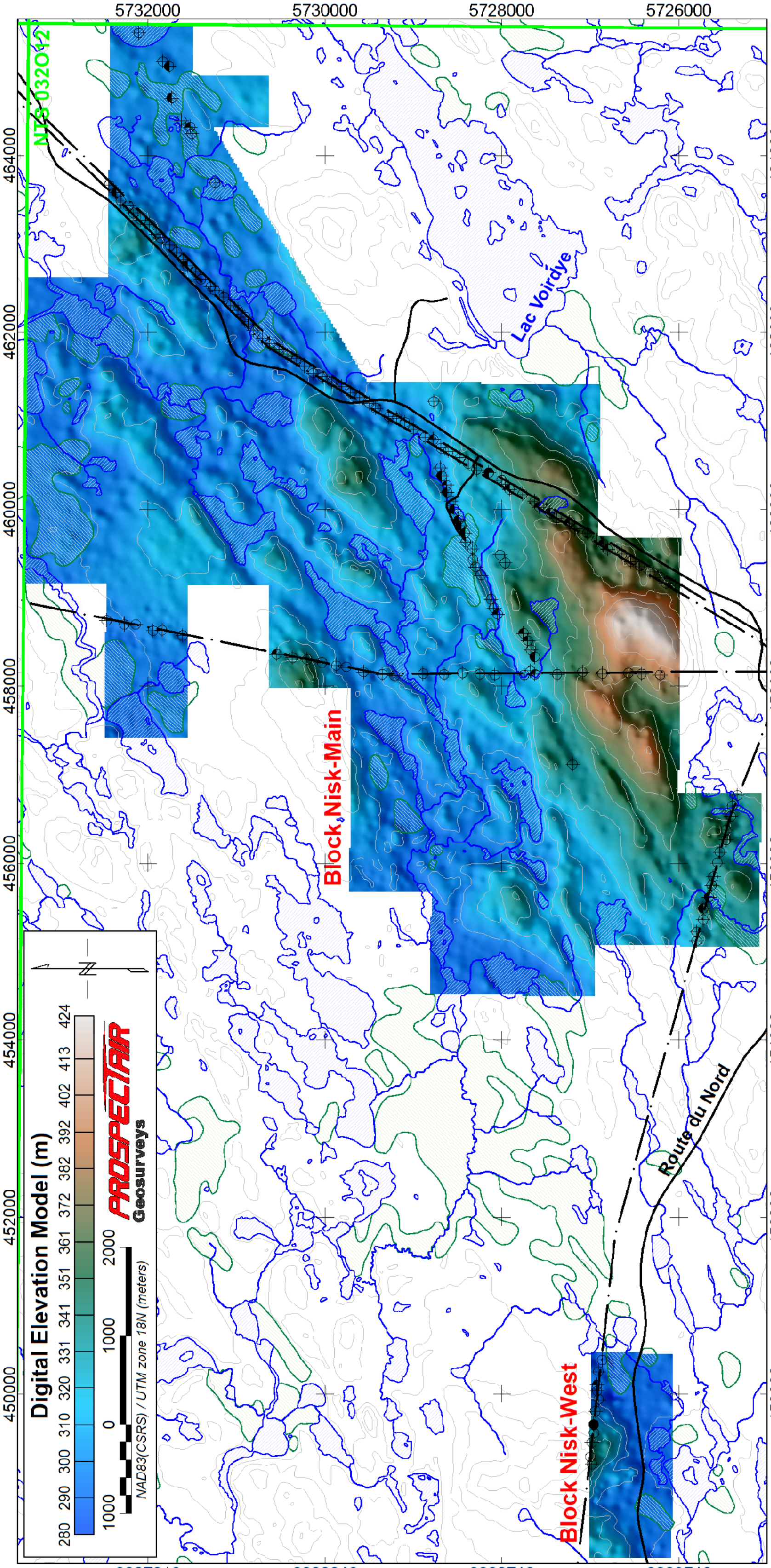


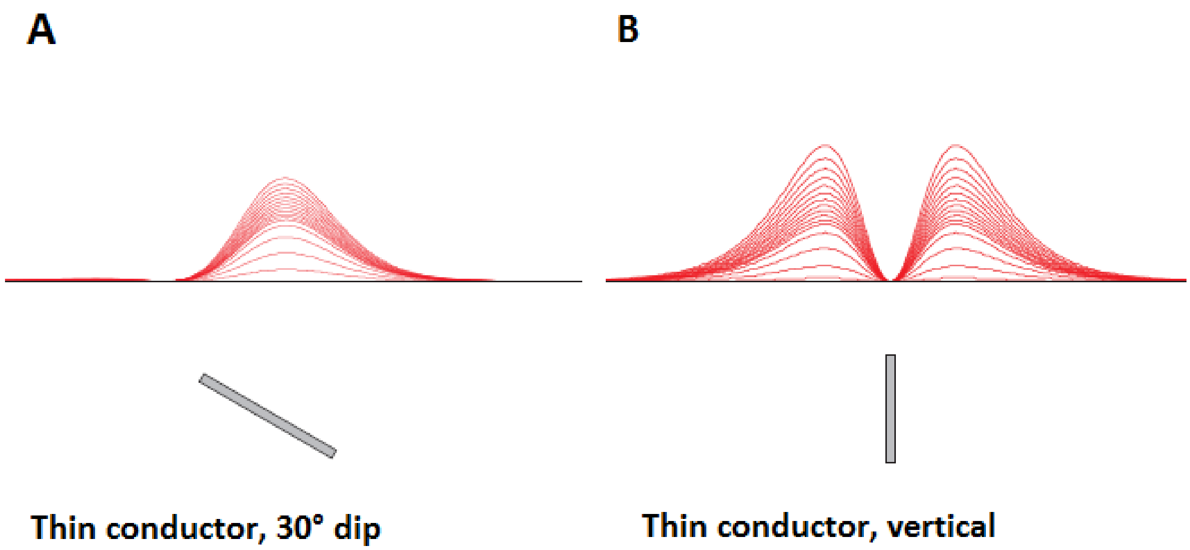
Figure 11: **Digital elevation model and TDEM anomalies**



Time-Domain Electromagnetic data

There is no automatic picking program involved in the interpretation procedures of the ProspecTEM system. Identification of the EM anomalies is made from the EM profiles. Most of the time, the location of anomalies is based on the assumption that the causative source is a somewhat thick or flat lying conductor, which would generate an anomaly mostly centered over the conductor (Figure 12, A). It is important to understand that some other conductive bodies could generate a strong EM response that is offset from the mass centre of the source. For instance, a thin conductor with a steep dip would generate an "M" shape anomaly (Figure 12, B), with the stronger shoulder on the dip side. Therefore, caution must be taken when planning work at the location of an anomaly. It is recommended to combine other available geoscientific information and to review the EM anomaly location before to investigate an anomaly of interest.

Figure 12: **Example of EM response over thin conductors**



The classification of anomalies is based on the calculated time constant (TAU). The EM time constant is a general measure of the speed of decay of the electromagnetic response and reflects the "conductance quality" of a source. The decay rate of the secondary EM field recorded by the TDEM system is a function of the conductivity and geometry of conductors detected. A weak conductor, such as shallow conductive overburden, will show rapid response decay, thus a small value of the time constant. Conversely, a good conductor, such as a graphite or sulphide orebody, will have a response decaying slowly, relating to a large TAU value. The TAU is calculated using proprietary software and is derived from the best exponential least squares fit for channels Z13 to Z27. Calculating TAU for low amplitude anomalies that have their first off-time channel (channel 13) amplitude smaller than 75 nT/s can yield unreliable results given the weak response. As well, in some rare cases, despite stronger response of the first off-time channel, noise in the mid to late channels can cause the TAU estimation to be unreliable. No best fit were tried on these noisy or low signal anomalies and an arbitrary minimal time constant of 0.10 msec was attributed. Moreover, the resulting exponential best fit of the decay curve is extrapolated to the zero-delay time, which can be used to compare the amplitude of anomalies.

On the Main block, 146 EM anomalies are identified, classified and listed (Appendix B). All marginal anomalies with TAU lower than 0.25 msec are included in a group represented by an empty circle on the anomaly map. In total, 118 anomalies are reported in this class. The remaining anomalies are classified in 4 other groups, with time-constant considered small (0.25 to 0.50 msec, 15 anomalies), intermediate (0.50 to 0.75 msec, 12 anomalies), strong (0.75 to 1.00 msec, 1 anomaly) and very strong (over 1.00 msec, 0 anomalies). On the West block, 11 EM anomalies are identified (Appendix C). In total, 9 anomalies are reported as marginal, 1 as weak, none as intermediate, none as strong and 1 as very strong for this block. These anomalies are reported on all the figures of this section, and the symbols used are similar to the legend on the maps. The early off-time map and figure (Figure 13) provide a good overview of the TDEM response amplitude distribution.

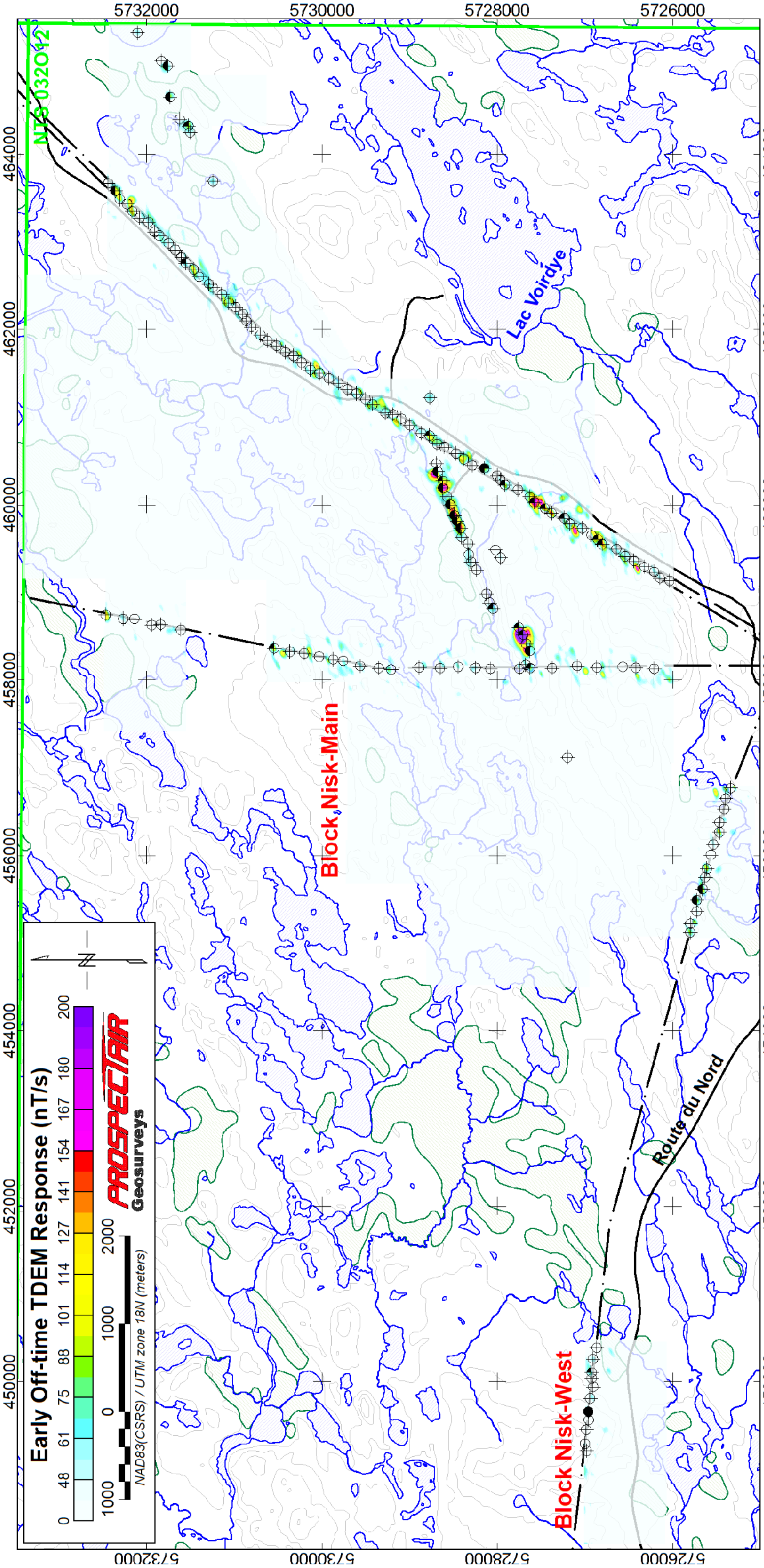
Two main types of anomalies can be identified on the basis of their location and the characteristics of their EM responses.

The first type consists in EM anomalies that are dispersed near human infrastructures, namely along the several high-tension powerlines found in both blocks. Some contribution to these EM anomalies could actually partly come from conductive geological sources, but most really appear as cultural interference.

The second type of EM anomalies is typical of graphite and sulphide conductors. They are most often narrow, of variable amplitudes, and locally with larger TAU values compared to typical conductive overburden EM responses, which is denoting better quality conductors. The orientation of the conductive lineaments of this group is clearly aligned with magnetic trends, which suggests that the conductive sources are indeed embedded in the bedrock. Many conductive lineaments actually show a positive correlation to magnetic lineaments (Figures 7 to 10) at least locally. In these instances, the good correlation of EM and magnetic anomalies suggest that sulphides, including pyrrhotite, are likely to compose at least part of the anomalies' sources. EM anomalies of this type are considered as prospective targets in the Nisk exploration context. The most magnetic conductors are likely related to sulphides rich magmatic layers, while the less magnetic ones could pertain to mineralized veins, smaller size sulphides occurrences with less pyrrhotite or graphitic horizons.

Finally, it is important to point that the TDEM response amplitude is governed by three main factors: the conductivity of the source, the volume of the conductive source, and the distance between the source and the TDEM sensor. The anomaly shape is also dependant on the geometry of the conductive source, as exemplified in Figure 12. The connectivity between the conductive minerals is also critical for a source to be highly conductive. As a result, disseminated sulphides occurrences of economic interest are not necessarily responding to EM techniques. On the other hand, sulphide rich zones (in stringer, semi-massive or massive form) that are devoid of economic base metals will nevertheless respond strongly to TDEM.

Figure 13: **Early off-time TDEM response and anomalies**



VIII. WORK RECOMMENDATION

The discussion on the geological implication of the survey data is minimal in this report. A more general study including information regarding the local geology and all other geoscience data available in the area would be necessary to extract the full potential of the geophysical data and help to confirm and prioritize exploration targets.

EM anomalies detected by this survey could be investigated with basic ground prospection methods at first. If interesting results are obtained, or if overburden proves too thick for prospecting, it is recommended to use ground resistivity/IP or EM techniques, depending on the nature of the sources, to accurately define targets for stripping and/or drilling. The implementation of a geochemical soil sampling program or of a till sampling program could also help further prioritize outlined anomalies.

In addition, given the geological context that may be considered prospective for disseminated, non-conductive, sulphides mineralization, the magnetic data can also be used on its own to guide exploration efforts.

IX. FINAL PRODUCTS

Digital line data

The Geosoft databases are provided with the channels detailed in Table 5. Note that the MAG and TDEM data are supplied as two separate databases, one for each survey block.

Table 5: **MAG-TDEM line data channels**

No.	Name	Description	Units
1	UTM_X	UTM Easting, NAD-83, Zone 18N	m
2	UTM_Y	UTM Northing, NAD-83, Zone 18N	m
3	Lat_deg	Latitude in decimal degrees (WGS-84)	Deg
4	Long_deg	Longitude in decimal degrees (WGS-84)	Deg
5	GPS_Z	Helicopter altitude (w.r.t. MSL)	m
6	Gtm_sec	Second since midnight GMT	Sec
7	Radar	Ground clearance given by the radar altimeter	m
8	Terrain	Digital Elevation Model calculated from GPS and Radar	m
9	Mag_Raw	Raw magnetic data	nT
10	Mag_Lag	Lagged magnetic data	nT
11	Gnd_mag	Base station magnetic data	nT
12	Mag_Cor	Magnetic data corrected for diurnal variation	nT
13	TMI	Fully levelled Total Magnetic Intensity	nT
14	TMIres	Residual TMI (IGRF removed)	nT
15	OFF_TIME	Amplitude of Off-time channels (13 to 36)	nT/s

Maps

All maps are referenced to NAD-83 in the UTM projection Zone 18 North, with coordinates in metres. Maps are at a 1:20,000 scale. They are provided in PDF, PNG, Geotiff and Geosoft MAP formats for the products detailed in Table 6.

Table 6: **Maps delivered**

No.	Name	Description
1	DEM+FlightPath_Claims	Digital Elevation Model with flight path and properties claims
2	TMI	Residual Total Magnetic Intensity
3	FVD	First Vertical Derivative of the TMI
4	TILT	Tilt Angle Derivative of the TMI
5	Early_OffTime	Early_Off-Time TDEM response (Channel 13)
6	TDEM_Profiles+Anomalies	TDEM profiles with anomalies
7	FVD +TDEM_Anomalies	First Vertical Derivative of the TMI with TDEM anomalies

Grids

Two separate sets of digital grids are delivered, one for each survey block. All grids are referenced to NAD-83 in the UTM projection Zone 18 North, with coordinates in metres. Grids are provided in Geosoft GRD format, with a 20 m grid cell size, as well as in the Geotiff format for the products listed in Table 7.

Table 7: **Grids delivered**

No.	Name	Description	Units
1	TERRAIN	Digital Elevation Model measured by helicopter	m
2	TMI	Total Magnetic Intensity	nT
3	FVD	First Vertical Derivative of TMI	nT/m
4	SVD	Second Vertical Derivative of TMI	nT/m^2
5	TMIres	Residual TMI (IGRF removed)	nT
6	TILT	Tilt Angle Derivative of the TMI	Degree
7	Early_Off-Time	Early Off-Time TDEM response (Channel 13)	nT/s
8	Mid_Off-Time	Mid Off-Time TDEM response (Channel 20)	nT/s
9	Late_Off-Time	Late Off-Time TDEM response (Channel 27)	nT/s

Project report

The report is submitted in PDF format. The anomaly table presented in annex is also provided as a separate Excel spreadsheet.

Respectfully submitted,

Joël Dubé, P.Eng.
May 9, 2023

X. Statement of Qualifications

Joël Dubé
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I, Joël Dubé, P.Eng., do hereby certify that:

1. I am a Professional Engineer specialized in geophysics, President of Dynamic Discovery Geoscience Ltd., registered in Canada.

2. I earned a Bachelor of Engineering in Geological Engineering in 1999 from the École Polytechnique de Montréal.

3. I am an Engineer registered with the Ordre des Ingénieurs du Québec, No. 122937, and a Professional Engineer with Professional Engineers Ontario, No. 100194954 (CofA No. 100219617), with the Association of Professional Engineers and Geoscientists of New Brunswick, No. L5202 (CofA No. F1853), with the Association of Professional Engineers of Nova Scotia, No. 11915 (CofC No. 51099), with Engineers Geoscientists Manitoba, No. 43414. (CofA No. 6897), with Professional Engineers & Geoscientists Newfoundland & Labrador, No. 10012 (PtoP No. N1134) and with the Northwest Territories & Nunavut Association of Professional Engineers & Geoscientists, No. L4447 (PtoP No. P1414).

4. I have practised my profession for 24 years in exploration geophysics.

5. I have not received and do not expect to receive a direct or indirect interest in the properties covered by this report.

Dated this 9th day of May, 2023

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Joël Dubé, P.Eng. #122937

XI. Appendix A – Survey blocks outline

Nisk Main Block

Easting	Northing
456786	5725075
455052	5725091
455069	5726944
454493	5726949
454509	5728808
455661	5728798
455669	5729724
457972	5729705
457980	5730631
459131	5730622
459138	5731544
457412	5731558
457420	5732490
459146	5732476
459153	5733402
462610	5733376
462603	5732449
465480	5732428
465474	5731496
464898	5731500
464892	5730624
464311	5730629
464316	5731263
461430	5729520
461410	5726892
459682	5726905
459674	5725978
456794	5726002

Nisk West Block

Easting	Northing
450457	5726060
448147	5726083
448157	5727015
450466	5726992

XII. Appendix B – Nisk Main block TDEM anomaly table

Line	UTM_X (m)	UTM_Y (m)	ID	Time Constant (msec)	Amplitude at zero delay (nT/s)
50	455120	5725801	50.01	0.09	1429
60	455221	5725799	60.01	0.10	0
70	455363	5725725	70.01	0.10	0
80	455490	5725725	80.01	0.71	137
91	455615	5725659	91.01	0.59	161
100	455752	5725630	100.01	0.10	0
110	455847	5725611	110.01	0.11	1114
120	456006	5725565	120.01	0.10	0
131	456123	5725538	131.01	0.10	0
140	456261	5725466	140.01	0.18	509
150	456376	5725466	150.01	0.10	0
160	456529	5725413	160.01	0.10	0
170	456647	5725396	170.01	0.10	0
181	456765	5725341	181.01	0.10	0
290	457118	5727201	290.01	0.10	0
340	458126	5726213	340.01	0.10	0
350	458137	5726422	350.01	0.10	0
360	458148	5726571	360.01	0.10	0
371	458140	5726865	371.01	0.10	0
381	458157	5727091	381.01	0.10	0
390	458133	5727377	390.01	0.10	0
401	458135	5727627	401.01	0.37	169
410	458172	5727677	410.01	0.12	710
410	458126	5727748	410.02	0.10	0
420	459129	5726038	420.01	0.10	0
420	458332	5727630	420.02	0.61	123
420	458126	5728080	420.03	0.10	0
430	459161	5726147	430.01	0.10	0
430	458409	5727672	430.02	0.17	344
430	458136	5728248	430.03	0.10	0
440	459232	5726212	440.01	0.10	0
440	458512	5727706	440.02	0.30	1433
440	458149	5728447	440.03	0.16	479
450	459290	5726324	450.01	0.10	0
450	458597	5727756	450.02	0.34	197
450	458132	5728654	450.03	0.10	0
461	459355	5726441	461.01	0.10	0
461	458141	5728891	461.02	0.10	0
471	459411	5726544	471.01	0.10	0
471	458117	5729213	471.02	0.10	0
481	459493	5726642	481.01	0.10	0
481	458814	5728050	481.02	0.37	139
481	458133	5729353	481.03	0.10	0
491	459544	5726806	491.01	0.43	238
491	458883	5728090	491.02	0.10	0
491	458158	5729565	491.03	0.10	0
500	459601	5726854	500.01	0.27	264
500	458981	5728124	500.02	0.10	0
500	458219	5729759	500.03	0.05	11854
510	459649	5726927	510.01	0.10	0
510	458233	5729873	510.02	0.10	0
520	459729	5727034	520.01	0.10	0
520	458267	5730034	520.02	0.10	0
530	459779	5727173	530.01	0.10	0

530	459394	5727964	530.02	0.10	0
530	459254	5728238	530.03	0.10	0
530	458305	5730202	530.04	0.10	0
541	459845	5727237	541.01	0.40	157
541	459482	5728022	541.02	0.10	0
541	459347	5728300	541.03	0.10	0
541	458322	5730367	541.04	0.10	0
550	459900	5727382	550.01	0.19	638
550	459428	5728326	550.02	0.10	0
550	458360	5730548	550.03	0.26	345
560	459956	5727458	560.01	0.48	284
560	459553	5728334	560.02	0.10	0
570	460025	5727579	570.01	0.32	426
570	459628	5728409	570.02	0.10	0
580	460088	5727630	580.01	0.22	285
580	459731	5728420	580.02	0.65	224
590	460167	5727766	590.01	0.10	0
590	459809	5728460	590.02	0.63	167
600	460222	5727916	600.01	0.50	141
600	459876	5728490	600.02	0.74	224
610	460277	5727966	610.01	0.10	0
610	459998	5728539	610.02	0.66	153
620	460328	5728003	620.01	0.10	0
620	460089	5728577	620.02	0.10	0
620	458571	5731609	620.03	0.10	0
630	460414	5728149	630.01	0.88	149
630	460188	5728620	630.02	0.68	256
630	458633	5731842	630.03	0.10	0
640	460445	5728287	640.01	0.10	0
640	460268	5728624	640.02	0.33	187
640	458626	5731943	640.03	0.10	0
650	460518	5728381	650.01	0.08	2001
650	460375	5728682	650.02	0.64	94
650	458699	5732139	650.03	0.10	0
660	460583	5728470	660.01	0.10	0
660	460467	5728697	660.02	0.10	0
660	458697	5732268	660.03	0.10	0
670	460656	5728607	670.01	0.10	0
670	458744	5732469	670.02	0.10	1546
680	460689	5728688	680.01	0.10	0
690	460784	5728774	690.01	0.36	236
700	460811	5728869	700.01	0.10	0
710	460903	5728999	710.01	0.10	0
720	460978	5729096	720.01	0.10	0
730	461217	5728771	730.01	0.10	0
730	461026	5729189	730.02	0.10	0
740	461043	5729276	740.01	0.10	0
750	461140	5729425	750.01	0.10	0
760	461196	5729502	760.01	0.10	0
770	461264	5729607	770.01	0.10	0
780	461311	5729709	780.01	0.10	0
790	461382	5729814	790.01	0.10	0
800	461437	5729921	800.01	0.10	0
810	461496	5730030	810.01	0.10	0
820	461538	5730133	820.01	0.10	0
830	461620	5730232	830.01	0.10	0
840	461697	5730325	840.01	0.10	0
850	461737	5730419	850.01	0.10	0
860	461811	5730519	860.01	0.10	0
870	461868	5730625	870.01	0.10	0
880	461930	5730704	880.01	0.10	0

890	462022	5730806	890.01	0.10	0
900	462091	5730865	900.01	0.10	0
910	462172	5730901	910.01	0.10	0
920	462251	5730986	920.01	0.10	0
930	462299	5731061	930.01	0.10	0
940	462396	5731142	940.01	0.24	224
950	462474	5731247	950.01	0.10	0
960	462512	5731291	960.01	0.10	0
970	462597	5731403	970.01	0.10	0
980	462681	5731464	980.01	0.24	325
990	462754	5731556	990.01	0.44	169
1002	462819	5731604	1002.01	0.10	0
1010	462901	5731673	1010.01	0.10	0
1020	462979	5731751	1020.01	0.10	0
1030	463067	5731858	1030.01	0.10	0
1040	463105	5731910	1040.01	0.10	0
1051	463219	5731982	1051.01	0.10	0
1060	463686	5731244	1060.01	0.10	0
1060	463269	5732081	1060.02	0.10	0
1070	463344	5732165	1070.01	0.07	4216
1080	463427	5732223	1080.01	0.10	0
1090	463481	5732306	1090.01	0.24	292
1100	463579	5732358	1100.01	0.55	162
1110	463661	5732440	1110.01	0.10	0
1120	464242	5731506	1120.01	0.10	0
1131	464315	5731524	1131.01	0.49	149
1140	464391	5731624	1140.01	0.10	0
1170	464645	5731733	1170.01	0.64	122
1201	465001	5731761	1201.01	0.66	106
1210	465058	5731833	1210.01	0.10	0
1250	465378	5732105	1250.01	0.10	0

XIII. Appendix C – Nisk West block TDEM anomaly table

Line	UTM_X (m)	UTM_Y (m)	ID	Time Constant (msec)	Amplitude at zero delay (nT/s)
151	449212	5726982	151.01	0.10	0
161	449291	5727001	161.01	0.10	0
170	449453	5726988	170.01	0.10	0
181	449564	5726958	181.01	0.10	0
190	449659	5726963	190.01	1.05	120
200	449810	5726944	200.01	0.10	0
210	449941	5726907	210.01	0.10	0
220	450035	5726925	220.01	0.10	0
230	450104	5726925	230.01	0.32	164
240	450257	5726910	240.01	0.10	0
250	450386	5726867	250.01	0.10	0