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Report on Drone Magnetic Geophysics and 3D inversions at the Northway Project, Ontario

Hogg Township,
Porcupine Mining Division,
Northeast Region, Ontario
Map Sheet: 42I05

Claims: 640970, 640971, 640972, 640974, 640975, 640980, 640981, 640982,640984, 640986, 640987, 640988, 640989, 640990, 640992, 640993, 640994, 640995, 640996, 640997, 641001, 641002, 641007, 641009, 641010, 641011, 641012, 641015

Author:
Justin J. Daley, MSc, PGeo
VP Exploration
VR Resources Ltd.

April 2023

VR RESOURCES LTD.
1500 – 409 Granville Street
Vancouver, BC, Canada, V6C1G8
Web: www.vrr.ca

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Appendix B

Summary

During the period of March 22-24, 2022 Pioneer Exploration carried out a drone magnetic survey over the Northway property, located near Otter Rapids, Ontario. The work was performed for VR Resources Ltd. of Vancouver, BC in order to help map high and low density features in the basement geology in search of Iron-oxide Copper-Gold mineralization within the Hecla-Kilmer Alkali Complex and carbonatite. The flown area is in the Hecla and Kilmer Townships, Porcupine Mining Division, Northeast Region, Ontario. Map sheet 42I05

Principal geophysical sensors included a GEM System's UAV GSMP-35U mounted below a Matrice M600 Pro UAV. Ancillary equipment included a DGPS navigation system and a radar altimeter. The survey covers 114 line-km and an area of approximately 1.8 x 2.8 km's, for 5.10 km^2.

In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Pioneer Exploration in Saskatoon, SK.

Subsequently, final magnetic survey results were sent to Condor North Consulting of Vancouver, BC for modelling of magnetic susceptibility inversion and magnetic intensity inversion (MVI). These inversion models were used to better understand the three dimensional nuances of the magnetic data at Northway and to provide targets for first-pass drill testing.

All maps, figures and coordinates are in UTM WGS84 Zone 17

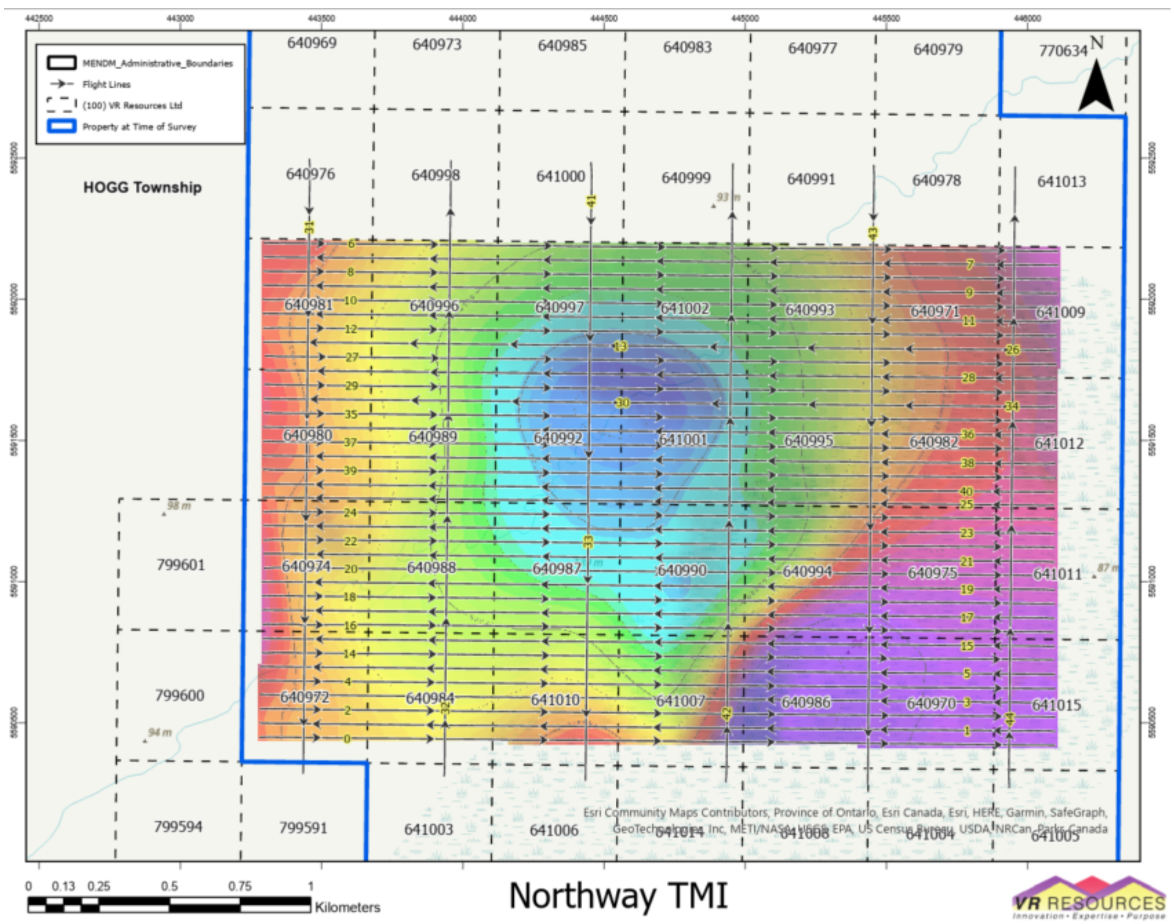

Figure 1A: Claims and Flight lines of Northway Drone Magnetic Survey, March 2022

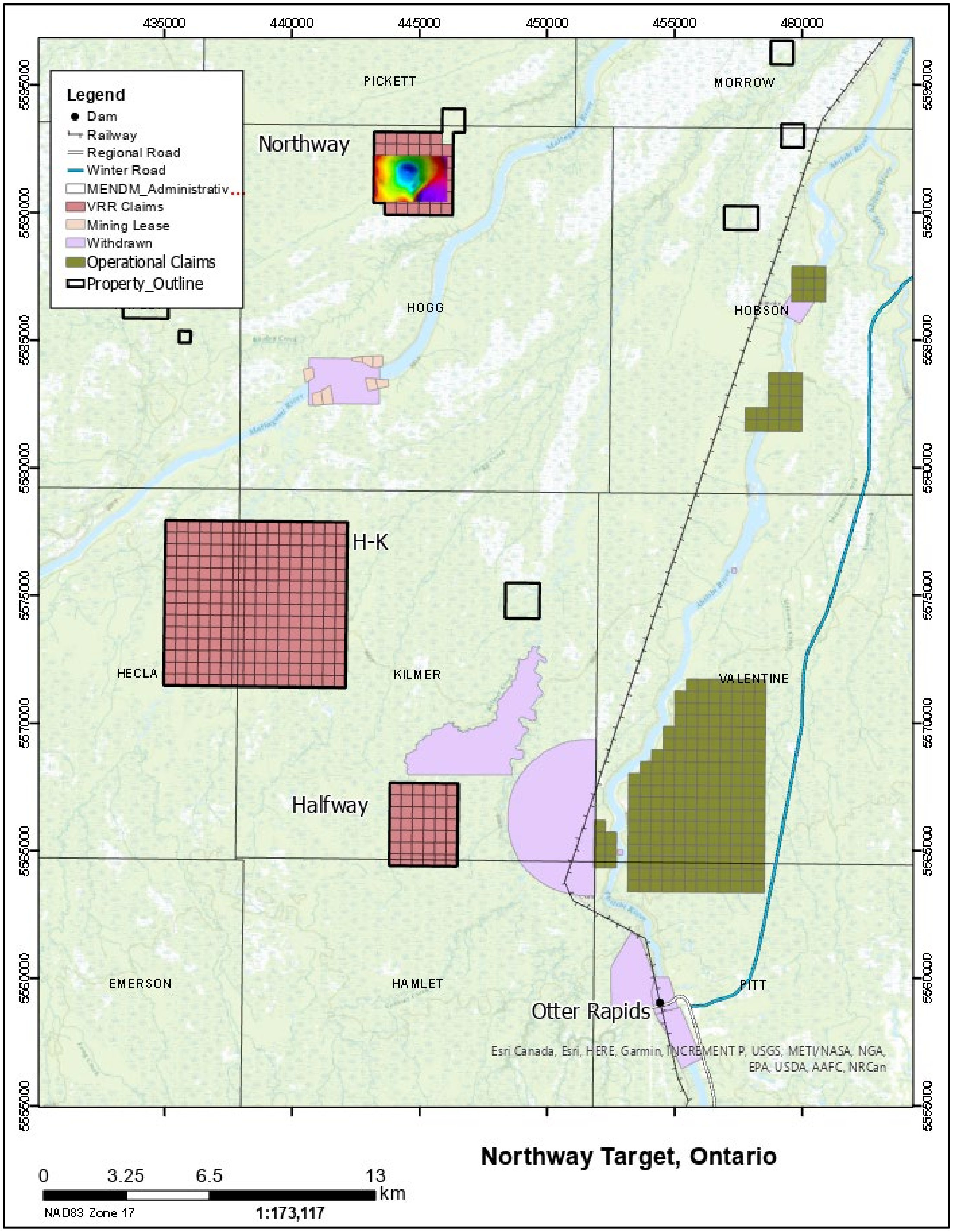

Figure 1B: Location and access to the Northway Property

Location and Access

The Northway property is in the Moose River basin in northern Ontario, Canada. It is located just north of the Mattagami river. The nearest town is Kapuskasing located on the Trans-Canada Highway (Provincial HWY 11) some 110 kilometres to the southwest. Cochrane is the regional services hub and is located 150 kilometres to the southeast,. The property is 15 kilometers west of the active ONR railway line which connects the town of Moosonee with Cochrane on the Trans Canada Highway, thus providing port access to the James Bay region (Figure 1).

Otter Rapids Dam is an Ontario hydroelectric facility located on the Abitibi River about 50 kilometres to the south of the property. Provincial Highway 634 provides road access to Otter Rapids from Smooth Rock Falls, located at the junction of HWY 634 with the Trans-Canada Highway. Private ground just behind the ONR bunk house was rented from Villeneuve Construction and served as camp and helicopter base for crews during the survey. Helicopter access to the property from camp is about 50km each way

The Northway property is located in a boreal region of lowland muskeg, with black spruce and pine forest along river drainages. Topographic relief is minimal, and there is no outcrop in the lowland region; Northway is tens of kilometres north of the northern limit of exposed Archean Superior Province shield in northern Ontario.

Regional Geology and Exploration History

Both the Northway and Hecla-Kilmer properties are centered on large magnetic anomalies associated with regional gravity features which occur along the western margin of the Kapuskasing Structural Zone (Figure 2), a long-lived, crustal-scale fault zone with bisects the Archean Superior craton between James Bay and Lake Superior, and hosts numerous alkaline, ultrabasic and carbonatite intrusions and kimberlites which span more than 1.6 billion years of activity. This tectonic setting is prospective for the development of large IOCG or carbonatite-hosted copper-gold hydrothermal breccia systems.

Northway is a large, roughly circular magnetic low or reversal approximately 1.2 km across. There is no historically documented drilling or geology described at this location, however diamond exploration drilling occurred in the vicinity and documented roughly 100m of Paleozoic stratigraphy. On either side of the Archean Suture that skirts the edge of Northway are volcanic/intrusive-dominated Wabigoon province to the south, and the sediment-dominated English River province to the north (Figure 3).

In 1981, Selco Exploration Company completed a drill hole on peripheral magnetic high of the complex as part of a regional diamond exploration program, and intersected ultra-basic rocks and mafic breccia.

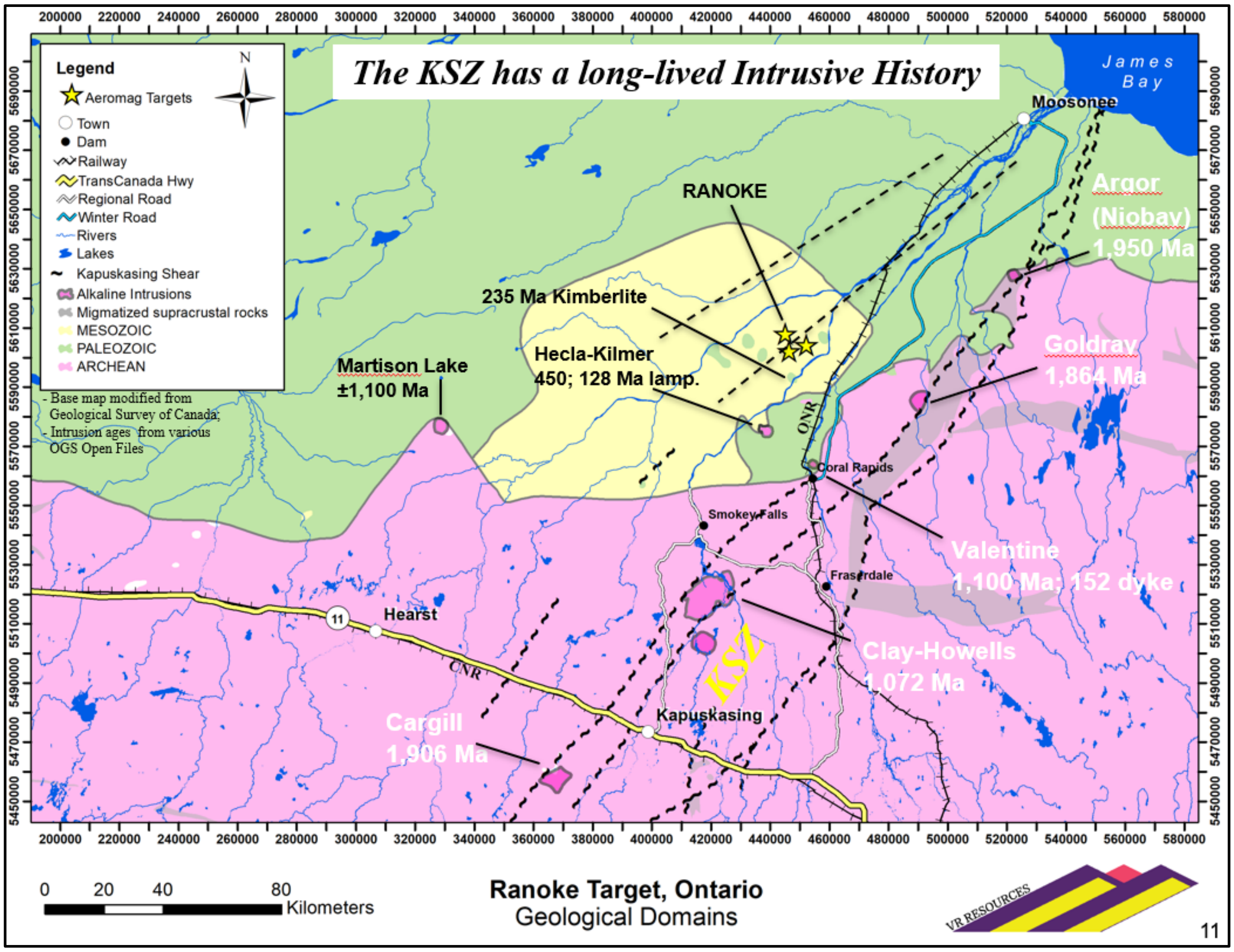

Figure 2: Regional geology map of Kapuskasing structural zone (KSZ) and James Bay Lowlands with alkaline and ultrabasic intrusions and their ages highlighted. The Northway target is noted by 3 gold stars indicating magnetic targets.

Table 2: Summary of major geological/tectonic events shaping the study region. (Darbyshire et al., 2017)

Date	Event
3–2.6 Ga	Assembly of Superior Craton
2.8–2.6 Ga	Kenoran Orogen completes assembly process
2.49–2.45 Ga	Hotspot influence and rifting on SE Superior margin leads to emplacement of Matachewan dyke swarm
2.2 Ga	Age of Southern Province; Nipissing Sills fed by distant Ungava plume
1.9–1.6 Ga	Penokean Orogen on southern margin of Superior Province; likely age of major uplift in Kapuskasing Structural Zone
~1.8 Ga	Trans-Hudson Orogen on northwest Superior margin
~1.1 Ga	Keweenawan Mid-Continent Rift on southern Superior margin
1.1–1.0 Ga	Grenville Orogen on southeast Superior margin
Late Proterozoic - Early Cambrian	Opening of Ottawa-Bonnechere Graben and Lake Timiskaming structural zone (Ontario/Quebec border region)
Phanerozoic	Development of Hudson Bay and Moose River intracratonic basins
180–134 Ma	Emplacement of kimberlites along track of Great Meteor hotspot

Property Exploration History

There are no known exploration efforts documented over the Northway target within the OGS Assessment Work database. However, in 1981, Selco Exploration Company completed a drill hole on peripheral magnetic highs of the complex as part of a regional diamond exploration program, and intersected ultra-basic rocks and mafic breccia.

Property Geology

The geology at time of survey is unknown. The Northway target geology is inferred to include a sequence of Paleozoic strata that includes Devonian Sextant Formation arenite, overlain by Kwataboahegan Carbonate Reef and Packstone and Cretaceous mudstone (Lavoie et al. 2011). The basement geology is unknown but is inferred from magnetics to be an intrusive stock.

Exploration Model

Northway is located immediately north of a robust copper-gold-fluorite heavy mineral anomaly evident in several rivers in the Coral Rapids area, based on a regional alluvium survey completed by the Ontario Geological Survey in 2001 and 2002. The unique mineral assemblage underscores the potential for a buried carbonatite or IOCG deposit (iron oxide copper-gold) as the source of the geochemical anomaly.

The Northway property covers a well defined, magnetic anomaly approximately 1.2 kilometres in size and evident on regional-scale Geological Survey of Canada (GSC) aeromagnetic maps that is a candidate for an intrusive source or alteration footprint related to such an IOCG system.

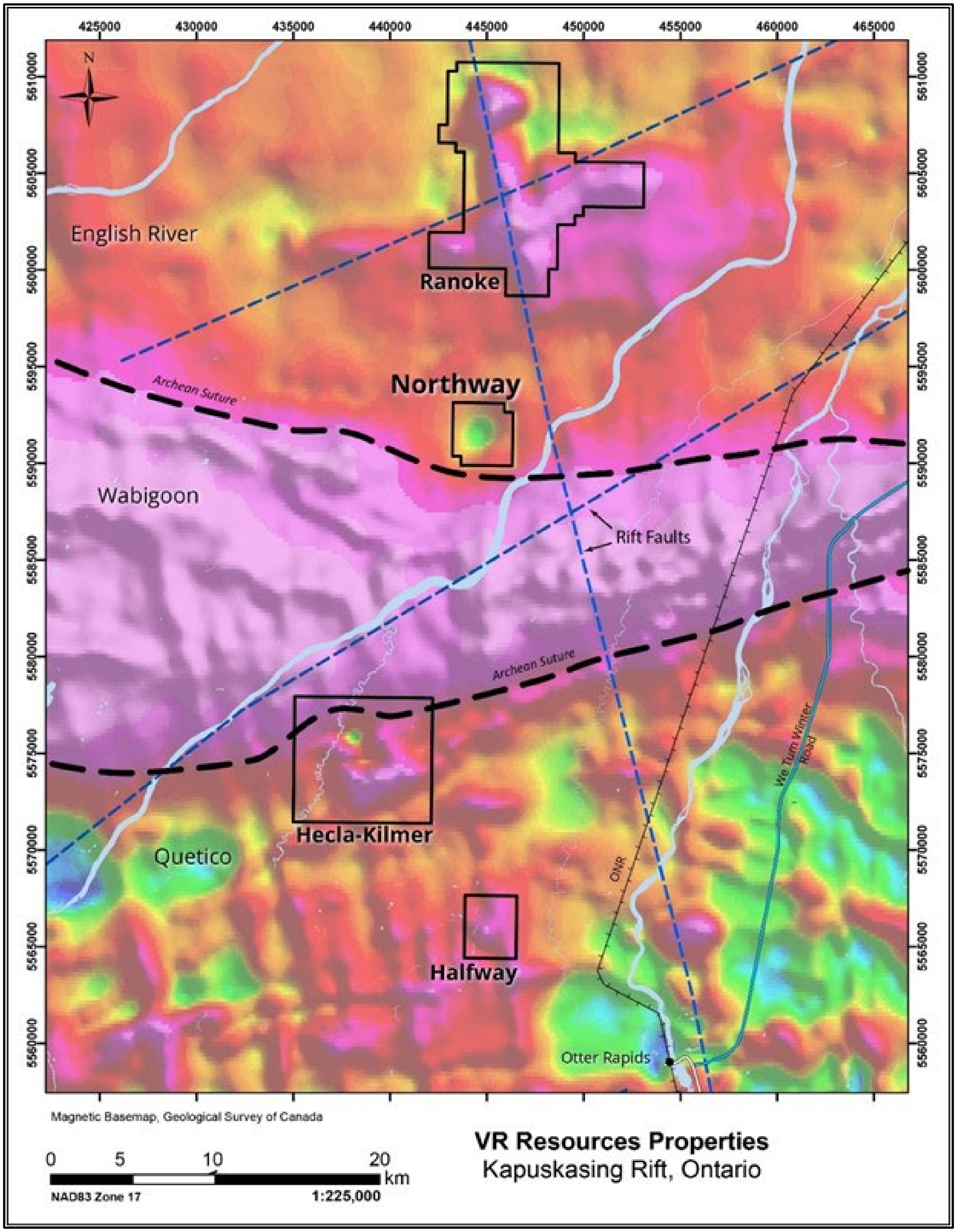

Figure 3*: Regional RTP magnetic data from the OGS showing a large circular magnetic low between the Hecla-Kilmer Alkaline intrusive complex and VR's Ranoke property centered on a large magnetic domain. The Northway anomaly is also found along the Archean suture of the East Wabigoon and English River subprovinces, a deep seated structural zone.*

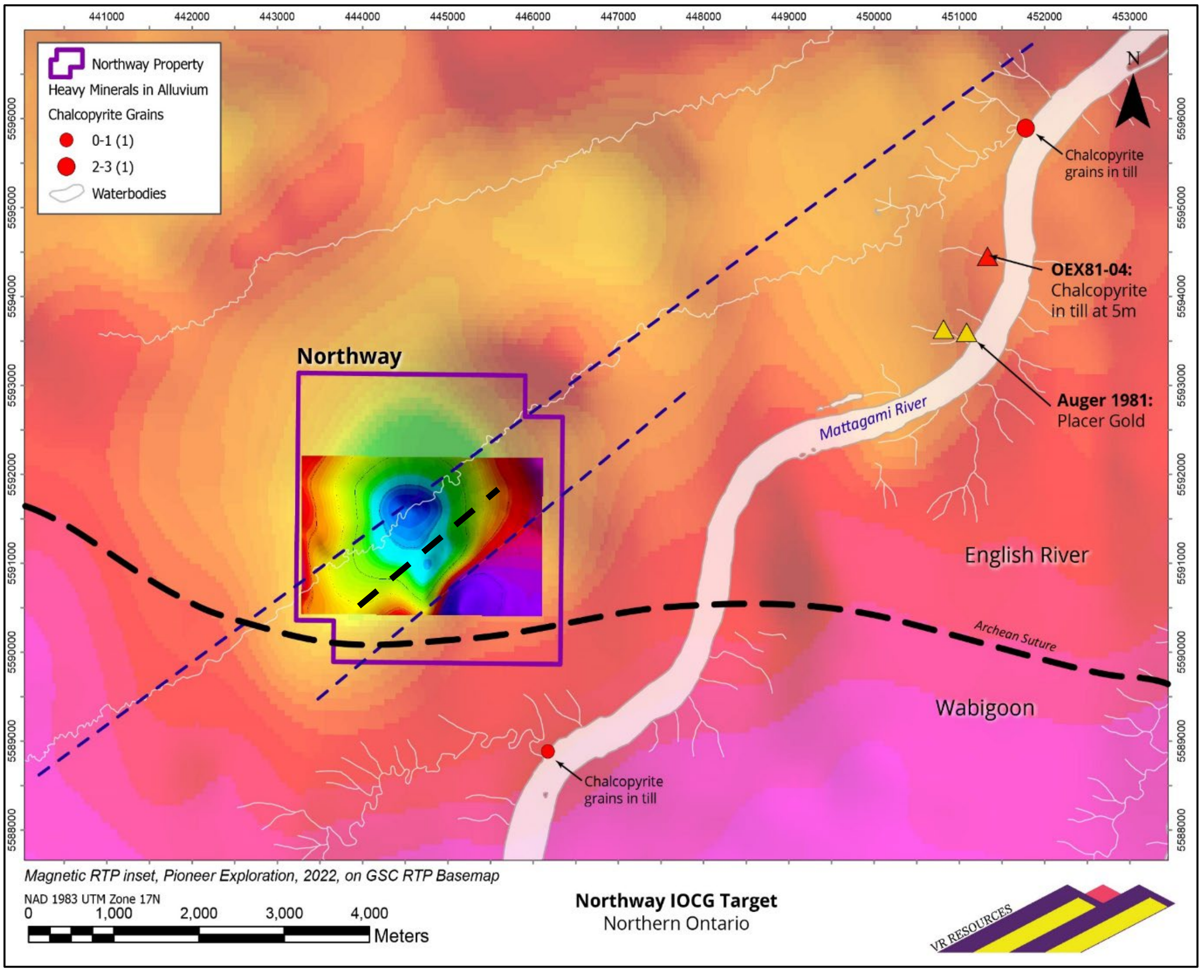

Figure 4*: Plan map of RTP magnetic survey results on regional RTP basemap with heavy minerals in alluvial sediments nearby at the exploration target at Northway.*

The plan map in Figure 4 shows the heavy minerals gold and chalcopyrite found in historic alluvial sample surveys and drill logs in the region for which there are no known sources. This magnetic anomaly is potentially the near-surface but till-covered source to copper and gold grains observed in the unconsolidated overburden in nearby auger drill holes completed in the early 1980's during a reconnaissance evaluation of Cretaceous-aged coal seams in the Moose River Basin.

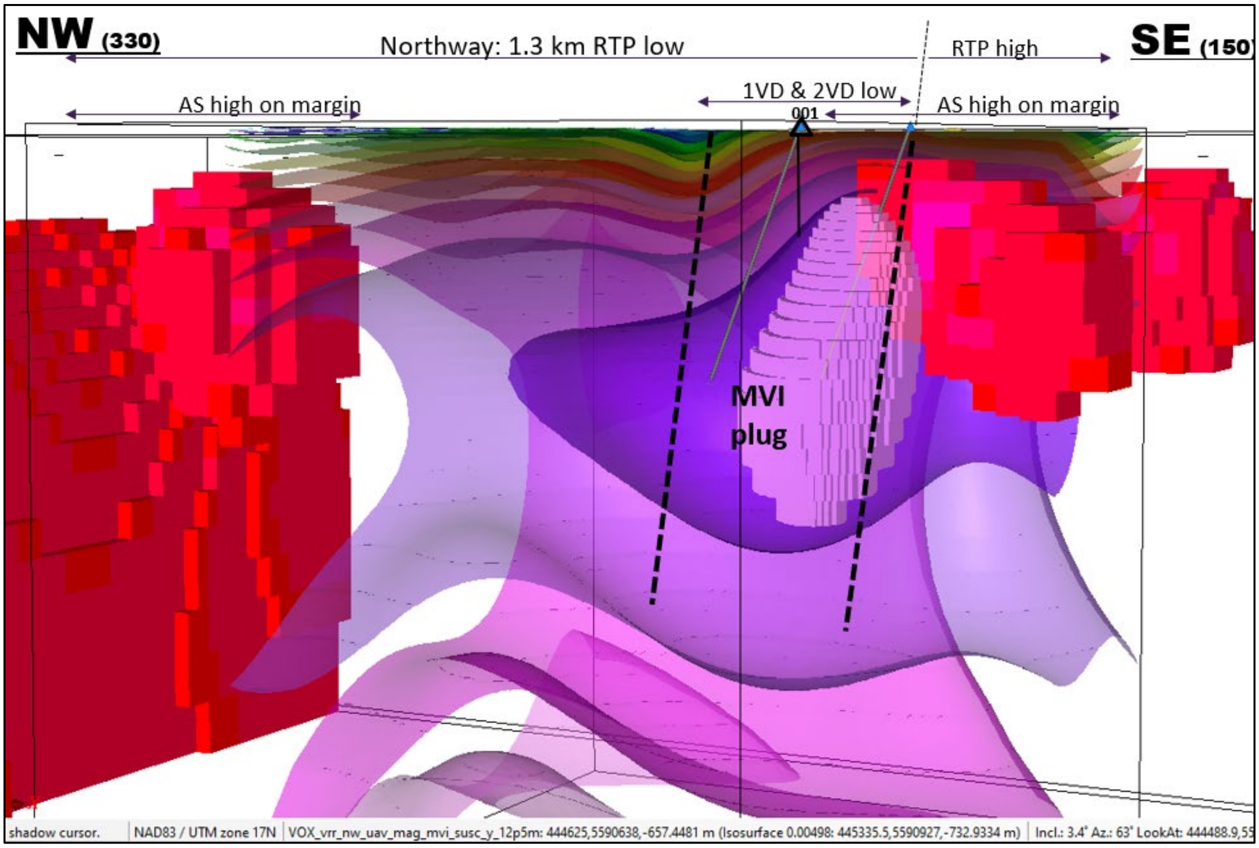

Figure 5*: View to Northeast of magnetic vector intensity data in 3D supplied by Condor Consulting. The pink bodies at centre show a mostly vertical interpreted magnetic response that is interpreted to be an intrusive body along a NE trending normal fault. Field of view is roughly 1.5km across.*

Certificate

1. I, Justin J. Daley, reside at 451 Kingswood Rd., Toronto, Ontario, M4E3P4

2. I have a B.Sc. Honours in Geological Sciences from Queen's University in Kingston, ON (2012) and a M.Sc. in Geology (Mineral Exploration) from Laurentian University in Sudbury, ON (2017).

3. I am a registered Professional Geoscientist in the Province of Ontario and have been for five years.

4. I have been involved in all aspects of mineral exploration for 10 years in the United States, Mexico, Chile, Peru, and across Canada in British Columbia, Saskatchewan, Yukon Territory and Ontario.

5. I have primarily worked within magmatic-hydrothermal systems, such as Cu-Mo-Au porphyries, Au-Ag epithermal deposits and iron-oxide copper gold deposits, for the last 10 years.

6. I am not aware of any material fact or of any material change with respect to the subject matter of this technical report, which has not been reviewed and might make the report misleading.

7. I am a non-independent person with respect to VR Resources, I own shares and have received option agreements with respect to my work with the company as "Principal Geologist" from 2017 to 2022 and VP Exploration from 2022-present.

Dated at Toronto, Ontario on Apr 6, 2023

Justin J. Daley, PGeo

PROFESSIONAL GEOSCIENTIST
JUSTIN DALEY
PRACTISING MEMBER
3344
ONTARIO

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APPENDIX A

VR Resources Ltd.
UAV Aeromagnetic Survey
Logistics Report

Pioneer Exploration Consultants Ltd.

info@pioneerexploration.ca
t. 1-306-715-6802

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Introduction

On March 22^{nd}, 23^{rd} and 24^{th} , 2022 Pioneer Exploration Consultants Ltd. (Pioneer) completed an airborne magnetic survey using an Unmanned Aerial Vehicle (UAV) over and area close to Otter Rapids, Ontario. The survey was flown at the request of VR Resources Ltd.

This report covers data acquisition, instrument descriptions, data processing and presentations. The digital data delivery is described later in this report. This report does not include any geological interpretations of the geophysical dataset. Key survey personnel are listed in Table 1.

Table 1: Personnel involved with the project.

Pilot in Command	Andrew Gagnon-Nandram
Ground Crew	Mackenzie Evenden
Data Processing and QA/QC	Kiyavash Parvar (M.A.Sc. Geophysics), Andrew Gagnon-Nandram (M.A.Sc. Geophysics)

Location

The project area is located approximately 25km north west of Otter Rapids, Ontario, Canada. The staging locations were accessed by a helicopter. The completed survey lines are illustrated in Figure 1.

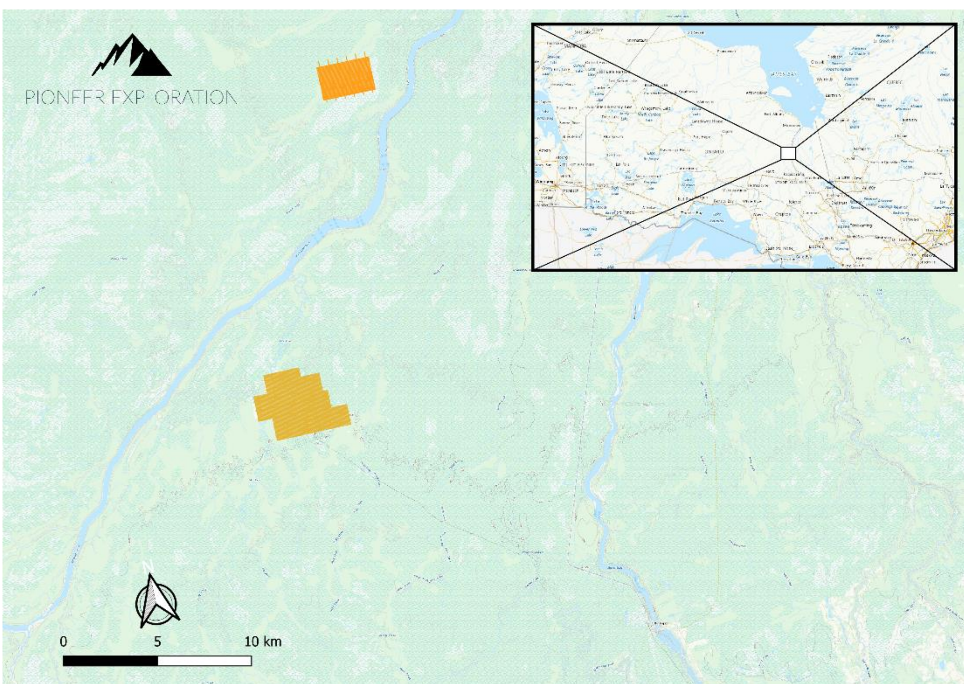

Figure 1: Flight lines are shown in red in relation to the nearby town of Otter Rapids, ON.

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info@pioneerexploration.ca
t. 1-306-715-6802

Survey Specifications and Procedures

Data collection for this survey area was conducted at 50m spaced lines with 500 m spaced tie lines. The nominal magnetic sensor altitude above ground level (AGL) was set to 50 m. Elevation from the terrain may vary depending on the treeline and obstacles on the flight route. Satellite imagery was used to create a high resolution DSM to assist the UAV terrain following procedure and to minimize the possible topographic effects on the magnetic data. The nominal production groundspeed is 9 m/s for flat topography with no wind. The survey speed may vary depending on the terrain and environmental conditions.

The ground crews performed daily safety meetings and pre-flight checks prior to the start of drone flight operations. The Pilot in Command (PIC) is responsible for the safety of the crew and equipment during the survey operations. Each survey flight is pre-planned using ground control software, then the flight plans are uploaded to the UAV prior to takeoff. The UAV system flies the pre-defined waypoint-based flight plans while the ground crew maintains visual line of sight with the craft and the flight telemetry information. Flights are terminated and the UAV returns for landing when the battery voltage reaches a certain limit, or when the flight plan is complete. The survey flights can be manually terminated and taken over with full manual pilot control at anytime. Upon landing, the flight batteries are exchanged and the sensor is downloaded for data QAQC. The average distance covered by each flight is approximately 6-10-line kms of data acquisition.

Addition details on the completed survey can be found in Table 2.

Table 2: Survey details.

Area Name	Line Spacing (m)	Line Direction (deg)	Tie Line Spacing (m)	Total Line Kilometres (km)
Extension Grid	50	000	500	221.011
North Grid	50	090	500	114.305

Instrumentation and Software

The principal airborne sensor used was a Gem Systems Canada GSMP-35U potassium vapor sensor mounted on a UAV platform. Ancillary equipment included a laser altimeter with range of 130m, Global

Positioning Satellite (GPS) system antenna and Inertial Measurement Unit (IMU). A stationary GSM-19 Overhauser magnetometer was used as a base station. Raw aerial magnetometer data was collected at a rate of 10 Hz while base station data was collected at a rate of 0.16 Hz. Total field and GPS UTC time were recorded with each data point, enabling diurnal correction to be applied during final data processing.

Magnetic Base Station

A GSM-19 Overhauser Magnetometer base station was placed in a location of low magnetic gradient, away from electrical transmission lines and moving metallic objects, such as motor vehicles and aircrafts. The data collected from this base station was used to diurnally correct the aeromagnetic data. The GSM-19 Overhauser Magnetometer is supplied by GEM systems of Markham, Ontario. General specifications of the magnetometer are included in Appendix 1: Instrument Specification.

Unmanned Aerial Vehicle – Matrice 600

Pioneer used the Matrice M600 Pro UAV to complete this survey. The Matrice 600 (M600) is DJI's platform designed for professional aerial photography and industrial applications. It is built to closely integrate with a host of powerful DJI technologies, including the A3 flight controller, Lightbridge 2 transmission system, Intelligent Batteries and Battery Management system, for maximum performance and quick setup. As stated by the manufacturer, some of the advantages to using this type of multirotor systems are:

Total Integration: The modular design makes the M600 easy to set up and ready to use in just minutes. Its dust proof propulsion systems simplify maintenance while actively cooled motors make for reliable operation during extended use.

Smart Flight Safety: The M600 uses sine-wave driven, intelligent ESCs to ensure it performs accurately, safely and efficiently while A3's self-adaptive flight systems adjust flight parameters automatically based on different payloads. The A3 can be upgraded with two additional GNSS and IMU units to A3 Pro or with D-RTK GNSS for enhanced accuracy.

Extended Flight Time and Transmission Range: The M600 features an extended flight time and a 5 km long-range, ultra-low latency HD image transmission for accurate image composition and capture. The system uses 6 small DJI Intelligent Batteries, allowing it to be shipped easily to wherever it is needed. A customized battery management system and power distribution board allows all six batteries to be turned on with the press of a single button and keeps the system in flight in the event of a battery failure. It also allows users to check the battery status in real-time during flight.

Powerful App Control: The M600 supports a live HD view, battery status, redundancy status, transmission strength and much more, straight from the tablet application.

UAV Aeromagnetic Configuration

GEM System's UAV GSMP-35U is a potassium magnetometer providing unmatched sensitivity in addition to a low heading error effect. The GSMP-35U operates similarly to other alkali vapor magnetometers while benefiting from the unique spectral properties of potassium. Each GSMP-35U system has 0.0002 nT sensitivity combined with +/- 0.1 nT absolute accuracy over its full operating range. More details on the

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info@pioneerexploration.ca
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instrument can be found in Appendix 1: Instrument Specification. The UAV aeromagnetic setup consists of a towed bird configuration with a sensor-aircraft separation distance of either 3 or 5m. The sensor is flown along the survey lines with a fixed heading to maximize the signal amplitude and provide the best sensor orientation for the local conditions. This action minimizes heading errors. The data is both stored on board during acquisition and transmitted in real-time back to the ground control station to monitor the collection during flight and ground clearance of the sensor from the laser altimeter data.

Data Deliverables and Channel Descriptions

All data is typically delivered in either Geosoft Database (GDB) or simple formats such as .txt or csv. The data deliverables are client specific to best suit their needs and software requirements. Regardless of software, a database is supplied to the client with channel descriptions as described in Table 3.

Table 3: Database channel descriptions.

Parameter	Explanation	Units/Format
Date	Flight Date	Yyyy/mm/dd
Time	GNSS time stamp	hhmmss.ss
lat	Latitude (WGS84)	Decimal degrees
lon	Longitude (WGS84)	Decimal degrees
alt	GPS altitude above the average sea level	metres
utmE	UTM easting (WGS84)	metres
utmN	UTM northing (WGS84)	metres
sat	Number of locked satellites	metres
zone	UTM zone	-
yaw	IMU yaw reading	Degrees
pitch	IMU pitch reading	Degrees
roll	IMU roll reading	Degrees
nT	Magnetic field readings (Raw)	Nanotesla
nT2	Diurnal correction has been applied on the nT channel (Diurnal datum: 55500 nT)	Nanotesla
Final	Final Total Magnetic Intensity	Nanotesla
Levelled	Levelled data based on tie line intersections	Nanotesla
VD1	1st Vertical derivative	nT/m
AS	Analytic Signal	nT/m

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Magnetic Maps and Derived Data Products

The final magnetic data has been presented in the form of several different magnetic maps (Appendix 2: Final Maps). Each of these different data presentations is a useful tool for identifying geological structures and other features.

Total Magnetic Intensity

Based on the flight lines covered by the drone, the total magnetic field map grid was created by interpolating the filtered magnetic data. The purpose of this data presentation is to highlight geological structures that may be visible in the survey area by their magnetic signature or their magnetic contrast to their surroundings.

First Vertical Derivative

The first order vertical derivative quantifies the rate of change of the magnetic field as a function of elevation. It is an approximation of the vertical magnetic gradient, which could be directly measured with separate magnetometers vertically spaced apart. The purpose of this type of filter is to eliminate the long wavelength signatures and make sharp features more detectable, such as the edges of magnetic bodies. This filter also increases the noise level, which limits the use of higher order derivatives (n=2 for example). The vertical derivative is used to delineate the contacts between large-scale magnetic domains because its value is zero over vertical contacts.

3D Analytic Signal

The analytic signal is the square root of the sum of the squares of the derivatives in the x, y, and z directions:

$$Analytical\ Signal = \sqrt{dx * dx + dy * dy + dz * dz}$$

The analytic signal is useful in locating the edges of magnetic source bodies, particularly where remanent magnetic signals and/or low magnetic latitude complicates interpretation.

Data Processing

All general magnetic QA/QC and data processing techniques have been applied to the data. All post-field data processing was carried out using Geosoft Oasis Montaj, Python and Microsoft Excel software/ programming languages. Presentation of final maps used ESRI ArcMap and/or Geosoft Oasis Montaj. Results were gridded using minimum curvature method and a grid cell size of approximately 1/3 of flight line spacing.

The geophysical images accompanying this report are positioned using the WGS 1984 datum. The survey geodetic GPS positions have been map-projected using the Universal Transverse Mercator (UTM) projection. A summary of the map datum and projection specifications are as follows:

- Datum: WGS 1984 UTM Zone 17 U
- Scale Factor: 1:7500 and 1 :15000
- Linear Unit: Metre (1)

The magnetic data was first quality checked in the field and any points lacking sufficient georeferenced data or which were excessively noisy were removed. The resulting data was processed as mosaics throughout the survey area as data was collected daily. The final result is a combination of all collected data, including lines that were re-flown due to weak or insufficient magnetic signal.

The base station readings were initially processed and filtered to remove high frequency noise. The filtered base station dataset was then used to perform a diurnal correction on the magnetic survey data. The diurnally corrected profile data were interpolated into a grid using the minimum curvature technique with a grid size of approximately 1/3 of flight line spacing. All final maps have a normalized color interval.

After finishing interpolation, initial processing subjected the data to a non-linear filter with a wavelength limit of 3-4 fiducials and tolerance of 0.001. This filter removes high frequency noise which mostly occur because the sensor is in the dead zone due to sudden changes in sensor orientation, effect of ferro-metallic objects, or the influence of weather conditions on the sensor. This filter smooths out noise and high frequency features.

After leveling the data using the tie lines, the data was micro-levelled. This step is performed to mitigate the corrugation effect associated with gaps between the data lines and is completed by applying a high-pass butterworth filter with the threshold of 400 metres (line spacing x 4) followed by a directional cosine filter perpendicular to the line direction. The resulted noise channel was then subtracted from the leveled values to microlevel the data. The final result of the leveling and micro-leveling processes was then put in "Final" Channel of the database.

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info@pioneerexploration.ca
t. 1-306-715-6802

The following corrections were applied to the airborne magnetic data:

- Correction for diurnal variation using the digitally recorded ground base station magnetic values as described above
- Lag was measured by a lag test prior to the operation. Only a minor lag correction is applied to final data (0.2s)
- Heading biases were applied based on clover leaf data collected
- Micro-leveling
- Analytic Signal calculation
- General Horizontal Derivative
- First Vertical Derivative calculation
- 2nd Vertical Derivative calculation

The final maps are included in Appendix 2: Final Maps.

Data Comments

Pioneer's UAV aeromagnetic surveys result in a high quality, high resolution data product. The increased flight line density and lower flight elevation possible with the use of a UAV platform results in superior resolution data products when compared to conventional airborne magnetic data. Using an auto-controlled UAV platform also allows for minimal deviation from pre-planned flight lines, and greatly reduces the impact of human errors during data acquisition.

Logistics remains a major challenge of UAV surveying. In order to operate legally within the guidelines set by Transport Canada, line of sight must be maintained to the UAV and surrounding airspace at all times. This often results in the necessity of several staging locations for covering the survey area, and sometimes requires the employment of additional equipment such as an aerial platform or scissor lift to achieve unobstructed line of sight beyond surrounding buildings or vegetation. The smaller flight sorties are typical in UAV-based surveys and require greater attention in post processing.

Pioneer makes every effort to identify potential sources of noise in order to mitigate their impact on our collected survey data. The magnetic noise envelope of our UAVs has been mapped in 3D prior to use. Our flight lines are planned with a minimum of 50 m overlap past the survey boundaries so that the magnetic sensor has time to stabilize itself after the UAV has completed its turns. Additionally, weather is carefully monitored and when excessive data inconsistency is noted due to weather conditions, flights are suspended until conditions improve.

Pioneer is very pleased with the results from this survey and confirms that the level of error and noise in the dataset falls below our threshold, which is set based on the Geological Survey of Canada guidelines for airborne magnetometer survey data.

Respectfully submitted,

Kiyavash Parvar, M.A.Sc. UAV Geophysics
Vice President of Geophysics
Pioneer Exploration Consultants Ltd.
Ottawa, Ontario

PIONEER EXPLORATION

Pioneer Exploration Consultants Ltd.

info@pioneerexploration.ca
t. 1-306-715-6802

Appendix 1: Instrument Specification

GSM-19 Overhauser Magnetometer

Performance

Sensitivity: Standard
GSM-19 0.022 nT @ 1 Hz
GSM-19PRO 0.015 nT @ 1 Hz
Resolution: 0.01 nT
Absolute Accuracy: 0.1 nT
Dynamic Range: 20,000 to 120,000 nT
Gradient Tolerance: up to 10,000 nT/m
Samples at: 60+, 5, 3, 2, 1, 0.5, 0.2 sec
Operating Temperature: -40°C to +50°C

Operating Modes

Manual: Coordinates, time, date and reading stored automatically at up to 0.2 sec.
Base Station: Time, date and reading stored at 1 to 60 second intervals.
Remote Control: Optional remote control using RS-232 interface.
Input / Output: Input/Output: RS-232 using 6-pin weatherproof connector with USB adapter.

Memory - (# of Readings in millions)

Mobile: 1.4M,
Base Station: 5.3M,
Gradiometer: 1.2M,
Walking Mag: 2.6M

Dimensions

Console: 223mm x 69mm x 240 mm(8.7x2.7x9.5in)
Sensor: 175mm x 75mm diameter cylinder (6.8in long by 3 in diameter)

Weights

Console with Belt: 2.1 kg
Sensor and Staff Assembly: 1.0 kg

Matrice 600

Structure

Diagonal Wheelbase: 1133 mm
Aircraft Dimensions: 1668 mm x 1518 mm x 759 mm (Propellers, frame arms and GPS mount unfolded)
640 mm x 582 mm x 623 mm (Frame arms and GPS mount folded)
Package Dimensions : 620 mm x 320 mm x 505 mm
Intelligent Flight Battery Quantity: 6
Weight (with six TB47S batteries): 9.1 kg
Weight (with six TB48S batteries): 9.6 kg
Max Takeoff Weight: 15.1 kg

Performance

Hovering Accuracy (P-Mode, with GPS) Vertical: ±0.5 m, Horizontal: ±1.5 m
Max Angular Velocity: Pitch: 300°/s, Yaw: 150°/s
Max Pitch Angle: 25°
Max Speed of Ascent: 5 m/s
Max Speed of Descent: 3 m/s
Max Wind Resistance: 8 m/s
Max Flight Altitude above Sea Level: 2500 m
Max Speed: 18 m/s (No wind)
Hovering Time (with six TB47S batteries)* No payload: 35 min, 6 kg payload: 16 min
Hovering Time (with six TB48S batteries)* No payload: 40 min, 5.5 kg payload: 18 min

* The hovering time is based on flying at 10 m above sea level in a no-wind environment and landing with 10% battery level.

Remote Controller

Operating Frequency:

- 920.6 MHz to 928 MHz (Japan)
- 5.725 GHz to 5.825 GHz
- 2.400 GHz to 2.483 GHz

Max Transmission Distance (unobstructed, free of interference) :

- FCC Compliant: 3.1 miles (5 km)
- CE Compliant: 2.1 miles (3.5 km)

Pioneer Exploration Consultants Ltd.

info@pioneerexploration.ca
t. 1-306-715-6802

EIRP:

- 10 dBm @ 900 M/li>
- 13 dBm @ 5.8 G
- 20 dBm @ 2.4 G

Video Output Port: HDMI, SDI, USB
Dual Users Capability: Master-and-Slave control
Mobile Device Holder: Supports smartphones and tablets
Output Power: 9 W
Operating Temperature: 14° to 104° F (-10° to 40° C)
Storage Temperature:
Less than 3 months: -4° to 113° F (-20° to 45° C)
More than 3 months: 72° to 82° F (22° to 28° C)

Charge Temperature: 32° to 104° F (0° to 40° C)
Built-in Battery: 6000 mAh, 2S LiP
Max Tablet Width: 170 m

Propulsion System

Motor Model: DJI 6010
Propeller Model: DJI 2170

Battery

Model: TB48S
Capacity: 5700 mAh
Voltage: 22.8 V
Type: LiPo 6S
Energy: 129.96 Wh
Net Weight: 680 g
Operating Temperature: 14° to 104° F (-10° to 40° C)
Storage Temperature: Less than 3 months: -4° to 113° F (-20° to 45° C)
More than 3 months: 72° to 82° F (22° to 28° C)
Charge Temperature: 41° to 104° F (5° to 40° C)
Max Charging Power: 180 W

Charger

Model: A14-100P1A
Voltage: Output26.3 V
Power Rating: 100 W

GEM GSMP-35UA: Ultra Light-Weight Potassium Magnetometer

Magnetometer Specifications

Sensitivity: 0.0002 nT @ 1 Hz
Resolution: 0.0001 nT
Absolute Accuracy: +/- 0.1 nT
Heading Error: + / – 0.05 nT
Dynamic Range: 15,000 to 120,000 nT
Gradient Tolerance: 50,000 nT/m
Sampling Intervals: 1, 2, 5, 10, 20 Hz
Operating Temperature: -40°C to +55°C

Orientation

Sensor Angle: optimum angle 35° between sensor head axis & field vector.
Proper Orientation: 10° to 80° & 100° to 170
Heading Error: +/- 0.05 nT between 10° to 80°and 360° full rotation about axis.

Environmental

Operating Temperature: -40°C to +55°C
Storage Temperature: -70°C to +55°C
Humidity:0 to 100%, splashproof

Dimensions & Weight

Sensor: 161mm x 64mm (external dia) with 2m cabling ; 0.43 kg
Electronics Box: 236mm x 56mm x 39mm; 0.46 kg
Option 1 cabling; .125kg
Option 3 light weight battery; .250kg

Power

Power Supply:18 to 32 V DC
Power Requirements: approx. 50 W at start up, dropping to 12 W after warm-up
Power Consumption:12 W typical at 20°C
Warm-up Time: <15 minutes at -40°C

Outputs

20 Hz RS-232 output with comprehensive Windows Personal Computer (PC) software for data acquisition and display.

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t. 1-306-715-6802

Outputs UTC time, magnetic field, lock indication, heater, field reversal, GPS position (latitude, longitude altitude, number of satellites)

Components

Sensor, pre-amplifier box, 2m sensor /pre-amplifier cable (optional cable 3-5m), manual & shipping case

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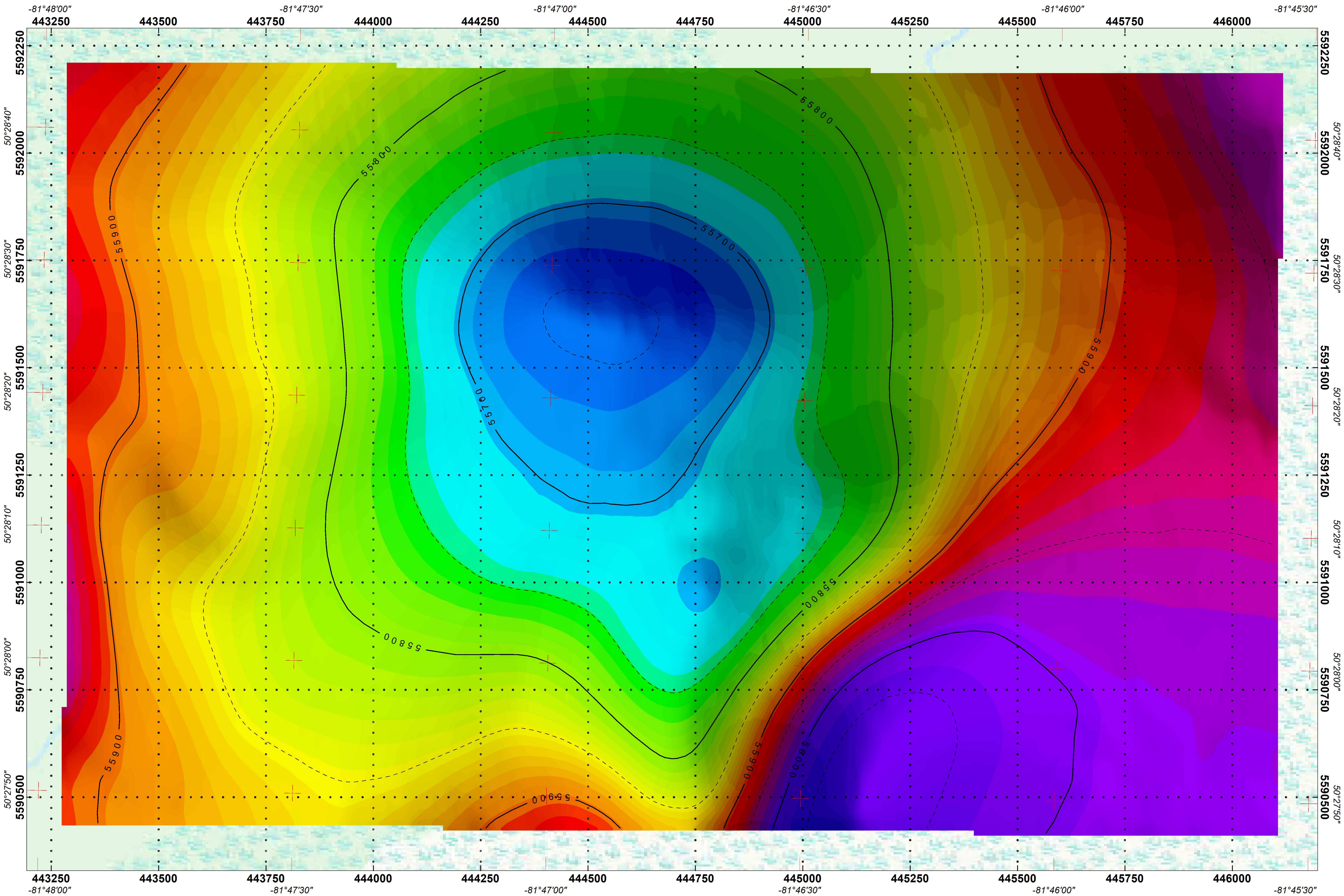
t. 1-306-715-6802

Appendix 2: Final Maps

PIONEER EXPLORATION

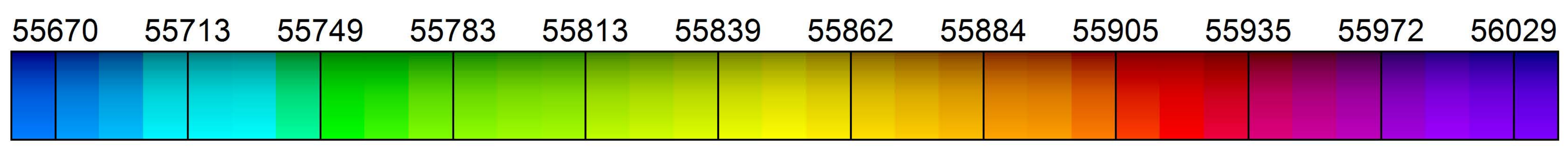


Scale 1:7500

100 0 100 200

metres

NAD83(CSRS) / UTM zone 17N



TMI_RTP

nT

Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 000°N
Tie-line spacing: 500 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 40m

Instrumentation:

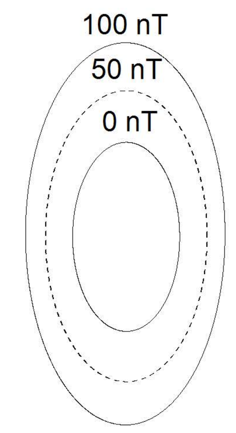
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

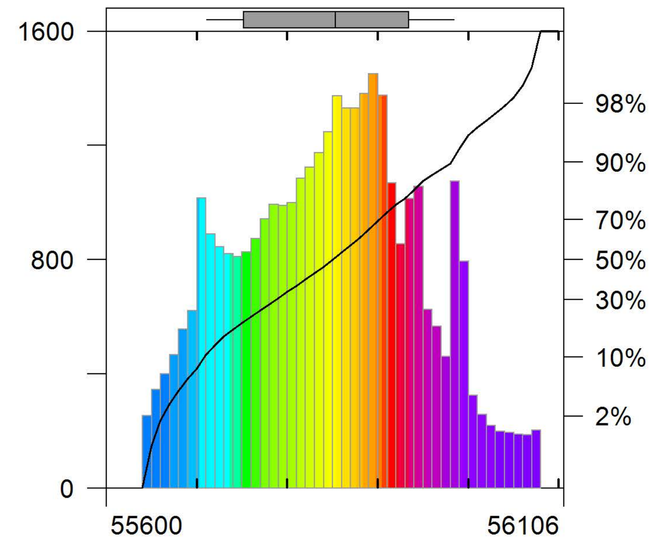
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 17U)

Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

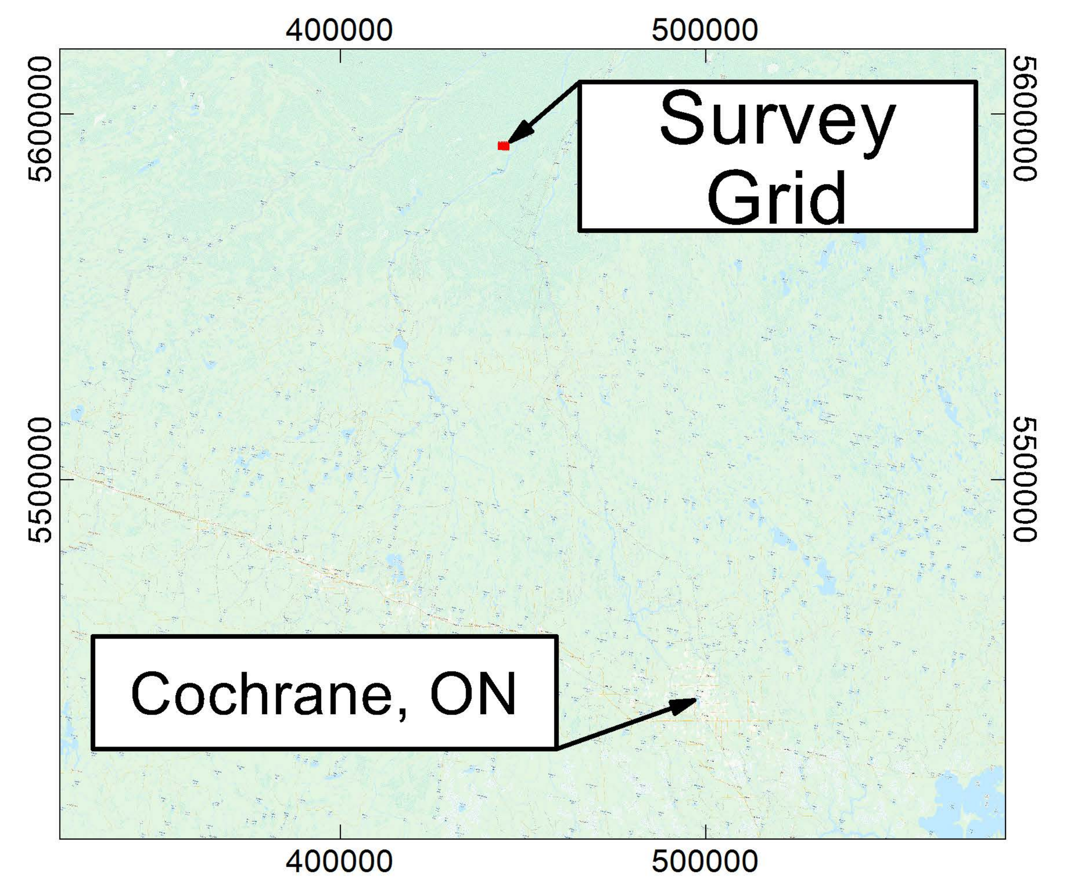
Contour Legend:





Data Distribution

Samples:	34810
Minimum:	55640
Maximum:	56080
Mean:	55850
Geo.Mean:	55850
Median:	55850
Mode:	55990
Std.Dev.:	98.66
Std.Err.:	0.5288
Skew:	0.01526
Kurtosis:	-0.7232



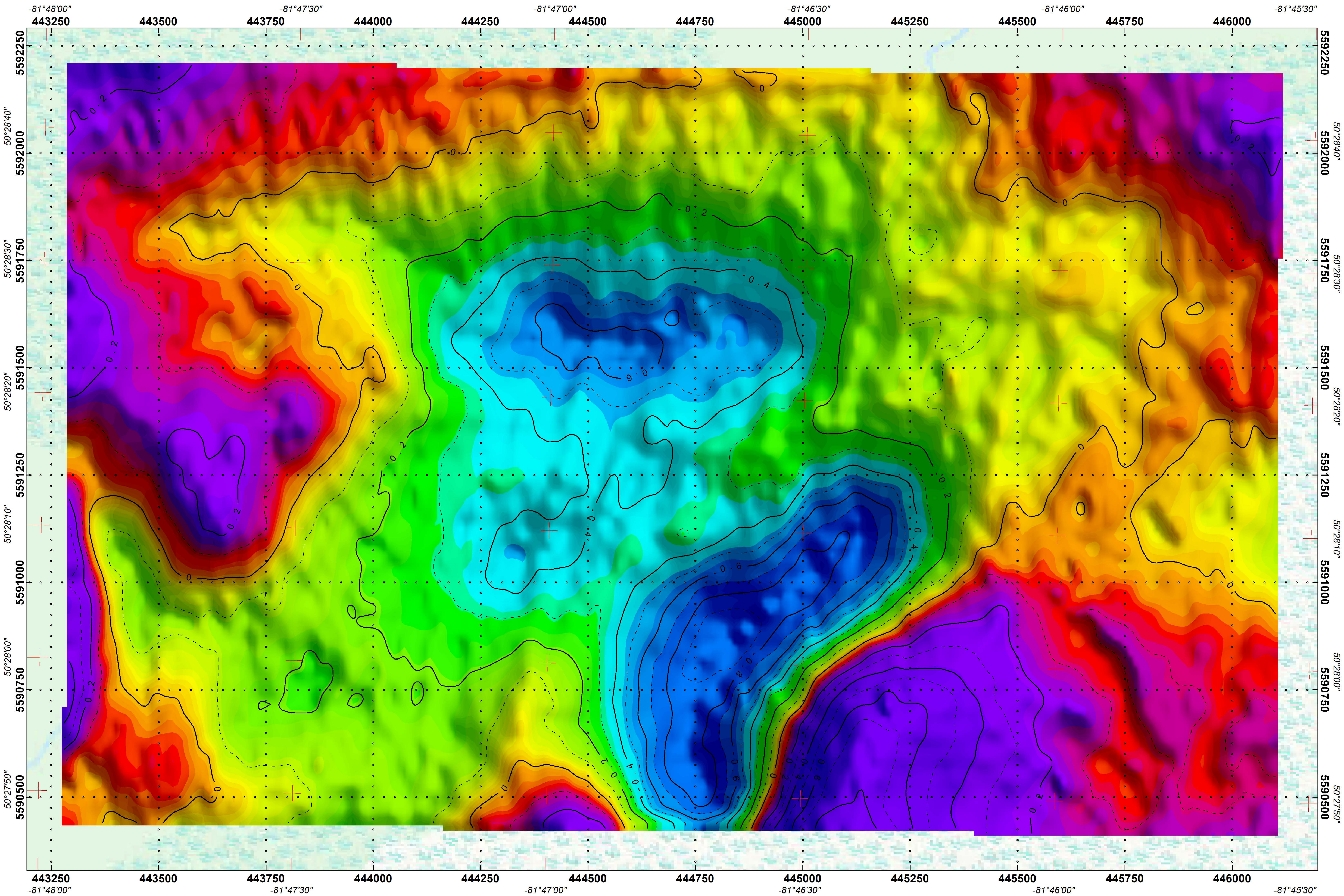
Pioneer Exploration Consultants Ltd.

Levelled and Micro-Levelld Drone Magnetic Survey
Total Magnetic Intensity- Reduced to Pole(TMI-RTP)
Units: nT

Survey Date: March 2022

Map Author: Kiyavash Parvar M.A.Sc Geophysics

PIONEER EXPLORATION



Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 000°N
Tie-line spacing: 500 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 40m

Instrumentation:

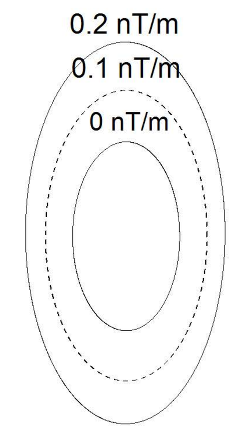
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

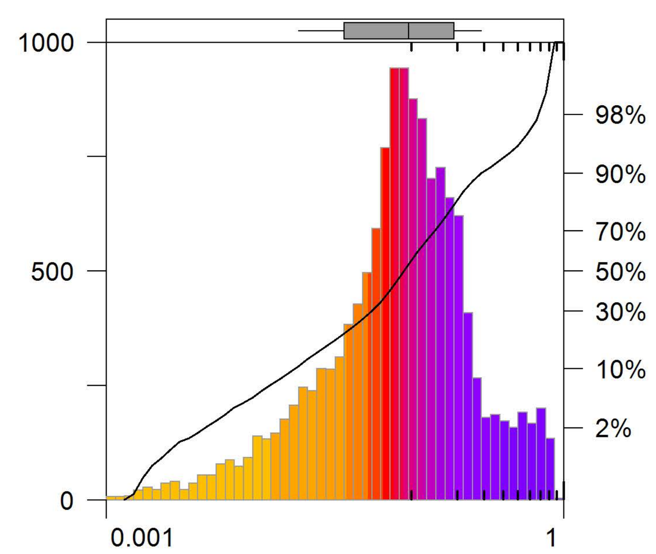
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 17U)

Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

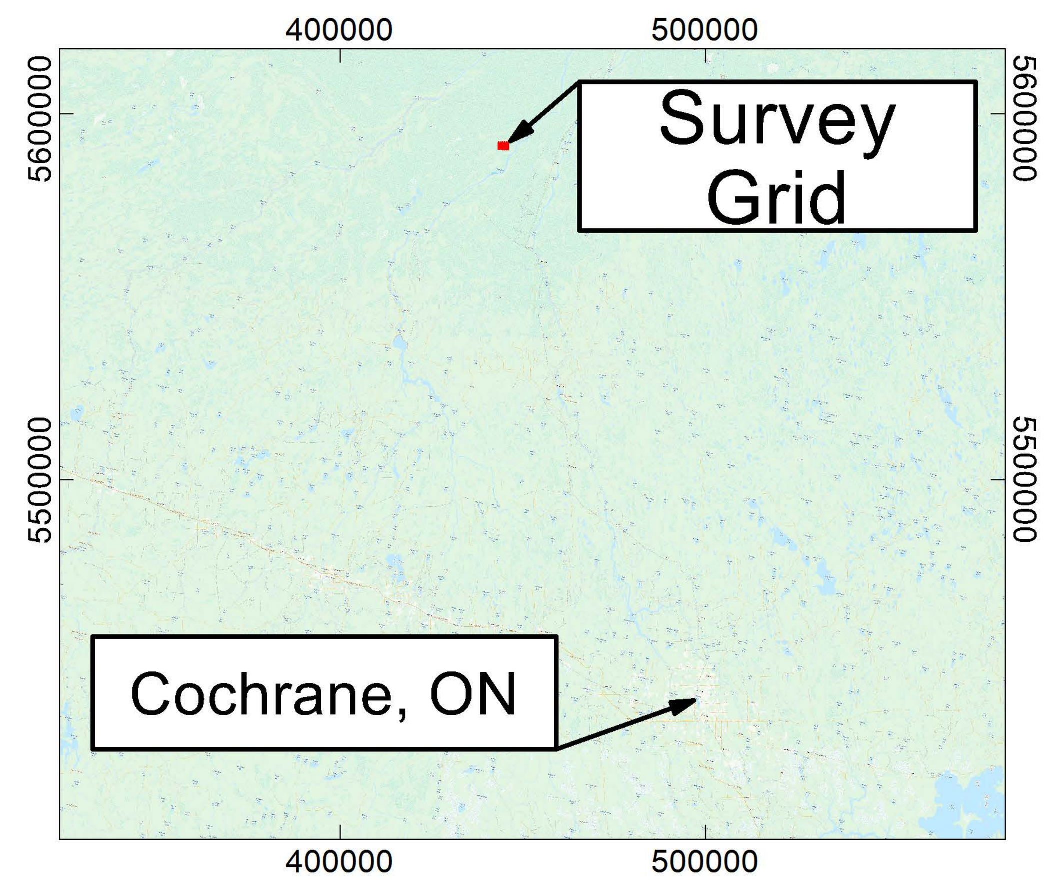
Contour Legend:

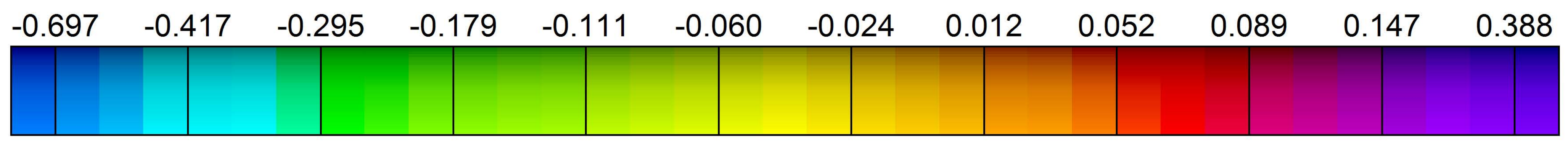




Data Distribution

Samples:	34810
Minimum:	-0.9824
Maximum:	0.8882
Mean:	-0.08808
Geo.Mean:	0.07684
Median:	-0.04105
Mode:	-0.5509
Std.Dev.:	0.265
Std.Err.:	0.00142
Skew:	-0.3886
Kurtosis:	1.372
Log:	
Mean:	-1.1
Median:	-1.048
Skew:	-0.6509





1VD
nT/m

Scale 1:7500
100 0 100 200
metres
NAD83(CSRS) / UTM zone 17N

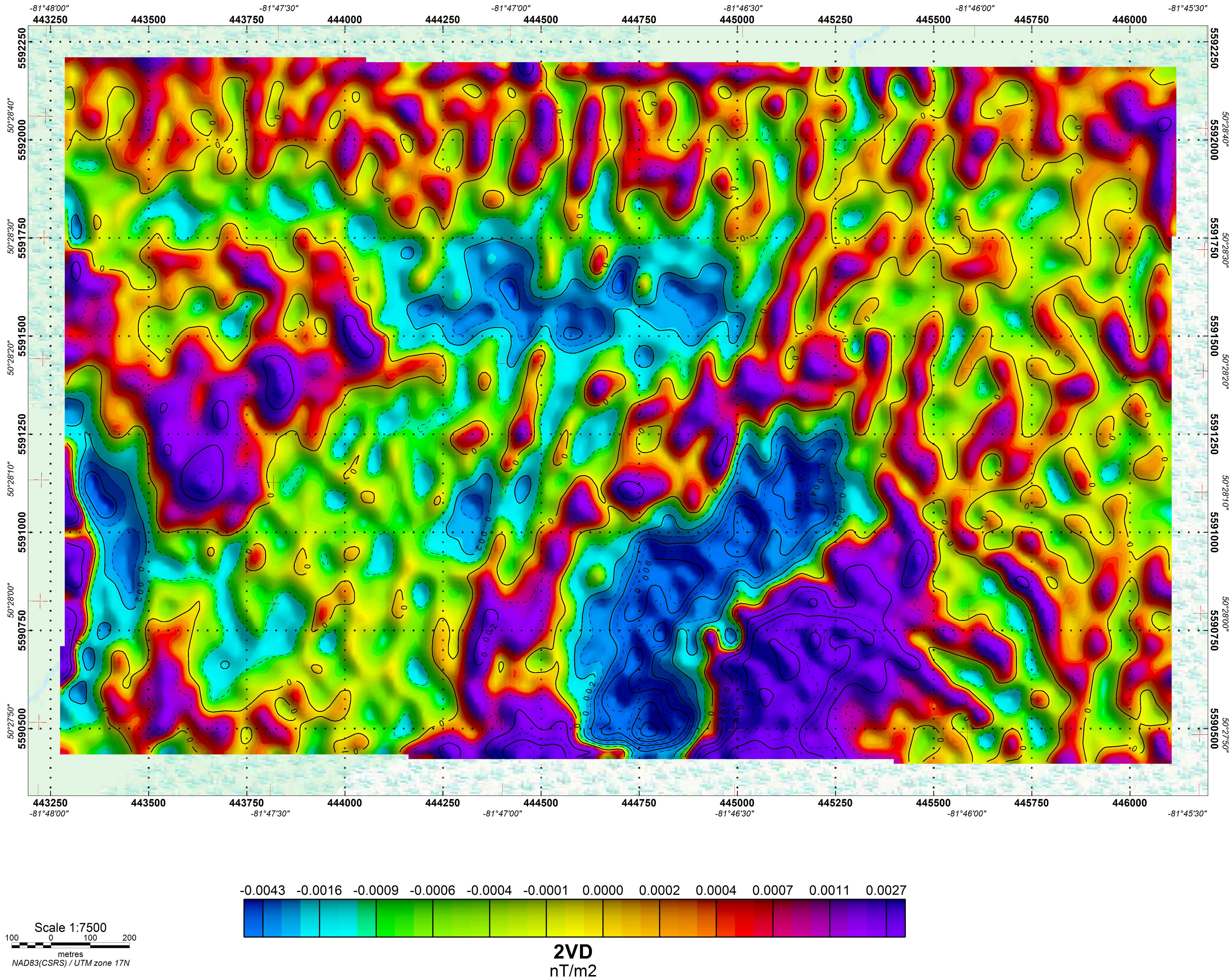
Pioneer Exploration Consultants Ltd.

Levelled and Micro-Levelld Drone Magnetic Survey
1st Vertical Derivative (1VD)
Units: nT/m

Survey Date: March 2022

Map Author: Kiyavash Parvar M.A.Sc Geophysics

PIONEER EXPLORATION



Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 000°N
Tie-line spacing: 500 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 40m

Instrumentation:

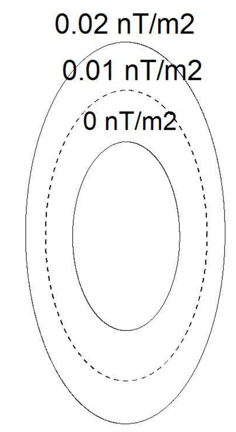
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

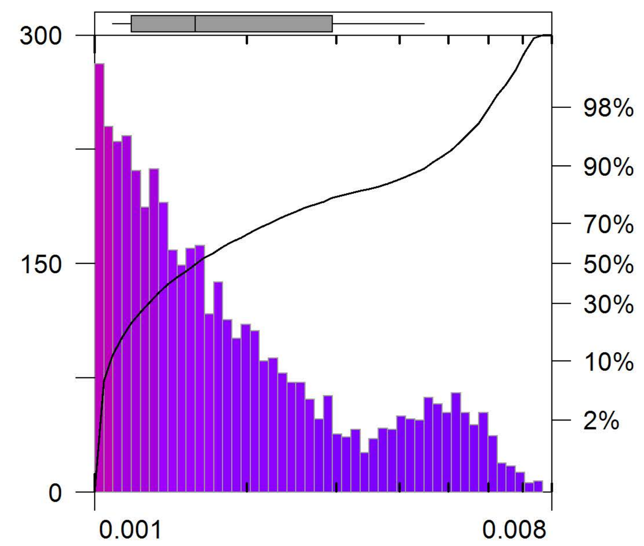
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 17U)

Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

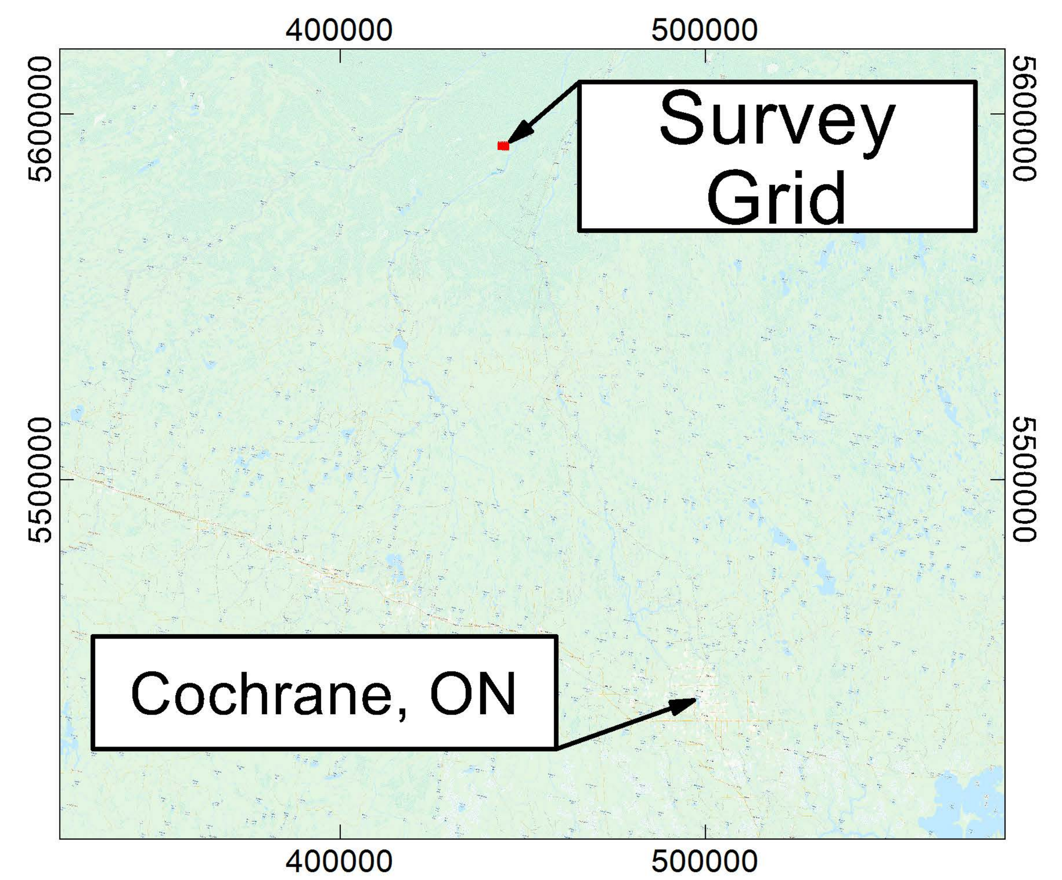
Contour Legend:





Data Distribution

Samples:	34810
Minimum:	-0.01079
Maximum:	0.007655
Mean:	-0.000197
Geo.Mean:	0.0004819
Median:	-0.0000424
Mode:	-0.002345
Std.Dev.:	0.001667
Std.Err.:	0.00000894
Skew:	-0.7529
Kurtosis:	5.259
Log:	
Mean:	-2.732
Median:	-2.799
Skew:	0.8791



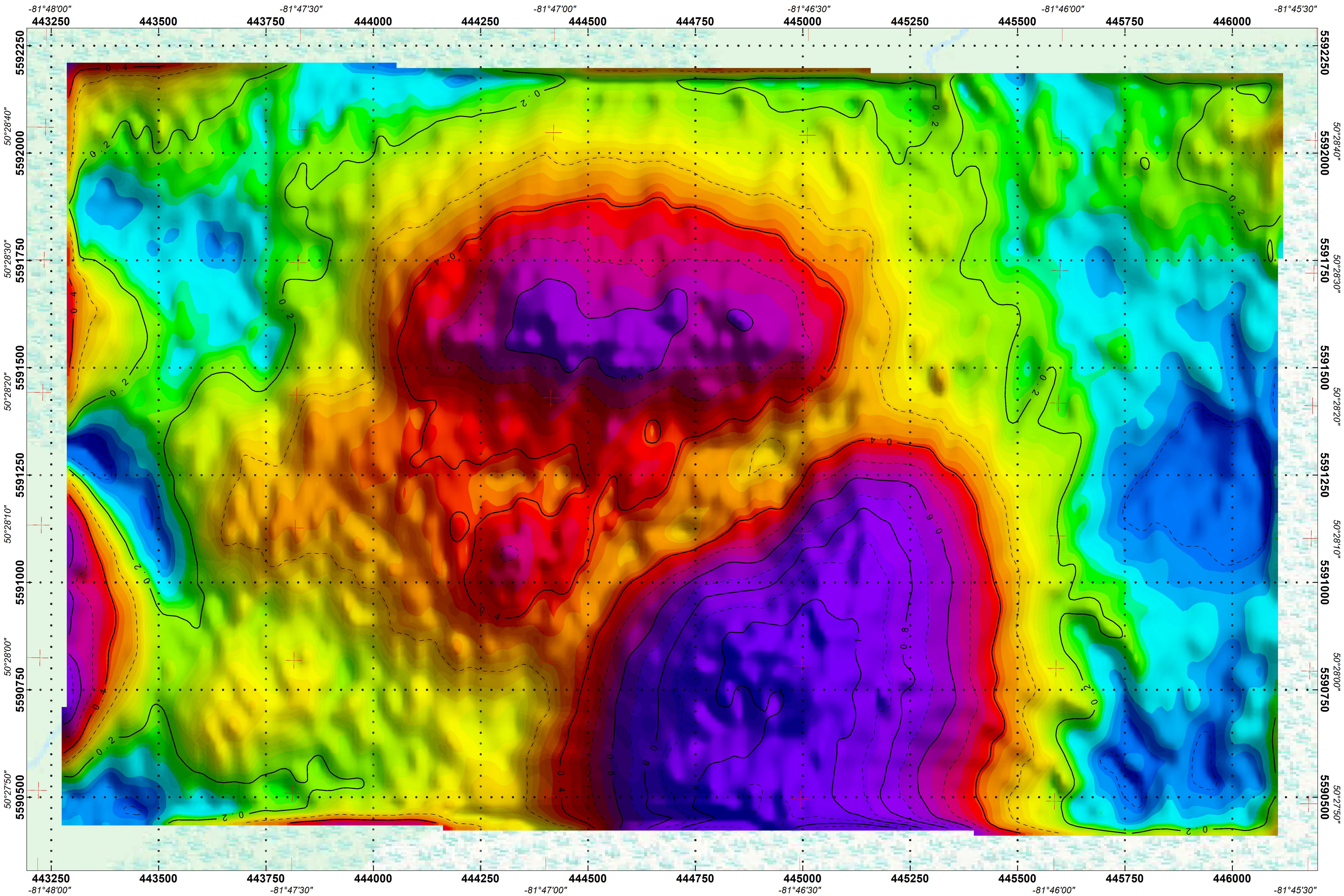
Pioneer Exploration Consultants Ltd.

Levelled and Micro-Levelld Drone Magnetic Survey
2nd Vertical Derivative(2VD)
Units: nT/m2

Survey Date: March 2022

Map Author: Kiyavash Parvar M.A.Sc Geophysics

PIONEER EXPLORATION



Scale 1:7500

100 0 100 200

metres

NAD83(CSRS) / UTM zone 17N

0.109 0.149 0.173 0.194 0.217 0.243 0.278 0.331 0.389 0.463 0.601 1.000

AS

nT/m

Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 000°N
Tie-line spacing: 500 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 40m

Instrumentation:

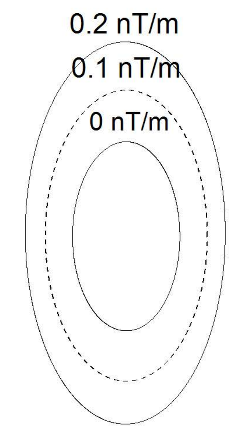
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

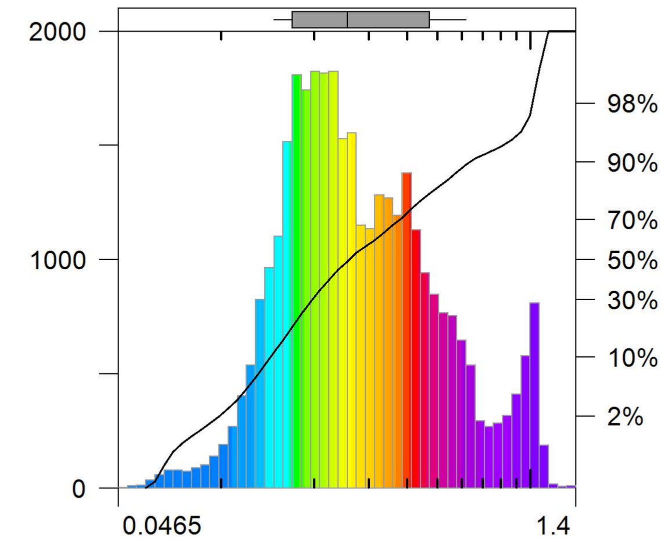
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 17U)

Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

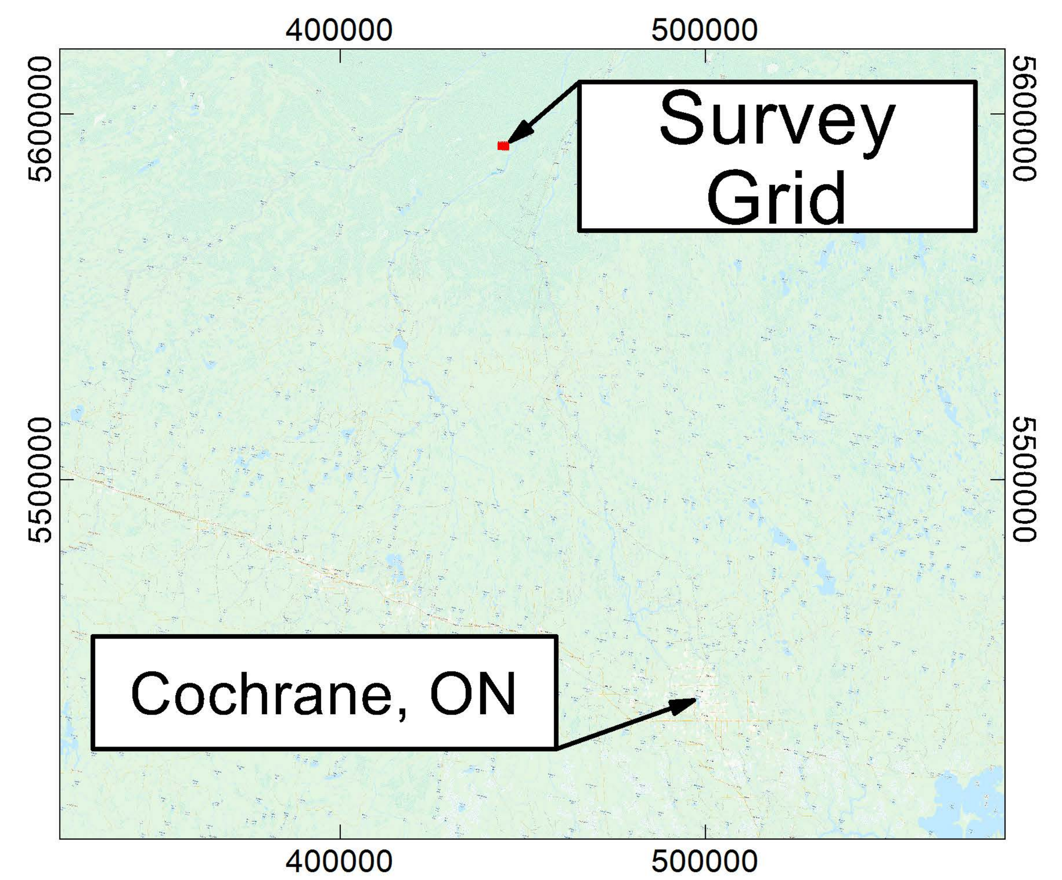
Contour Legend:





Data Distribution

Samples:	34810
Minimum:	0.04655
Maximum:	1.393
Mean:	0.3386
Geo.Mean:	0.2828
Median:	0.2593
Mode:	0.1388
Std.Dev.:	0.2252
Std.Err.:	0.001207
Skew:	1.631
Kurtosis:	2.281
Log:	
Mean:	-0.5485
Median:	-0.5862
Skew:	0.3514



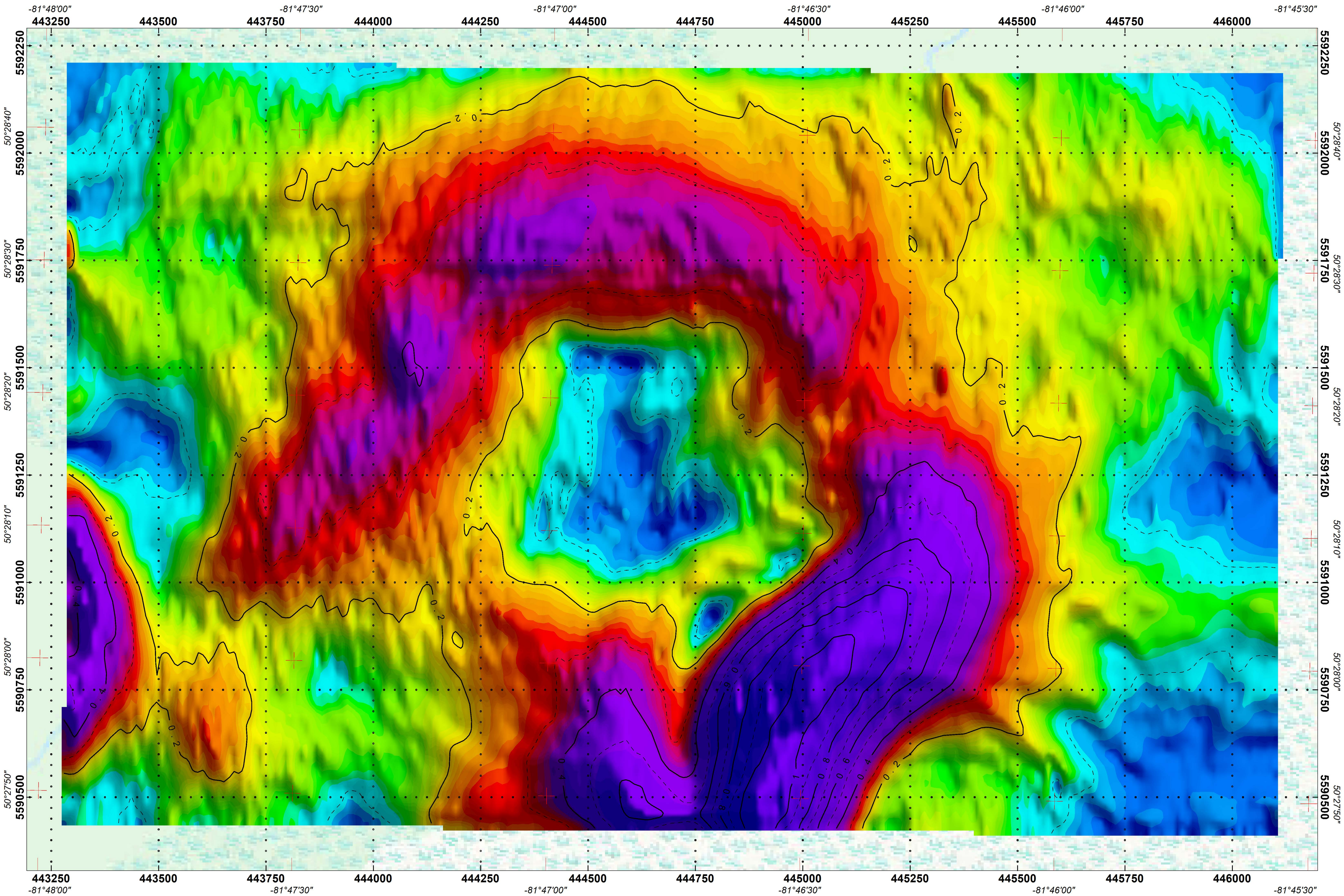
Pioneer Exploration Consultants Ltd.

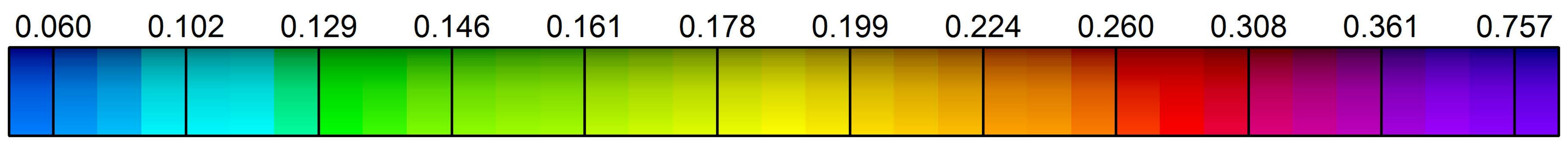
Levelled and Micro-Levelld Drone Magnetic Survey
Analytic Signal (AS)
Units: nT/m

Survey Date: March 2022

Map Author: Kiyavash Parvar M.A.Sc Geophysics

PIONEER EXPLORATION





HD

nT/m

Scale 1:7500

100 0 100 200

metres

NAD83(CSRS) / UTM zone 17N

Flight Parameters:

Flight line spacing: 50 m
Flight line azimuth: 000°N
Tie-line spacing: 500 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 40m

Instrumentation:

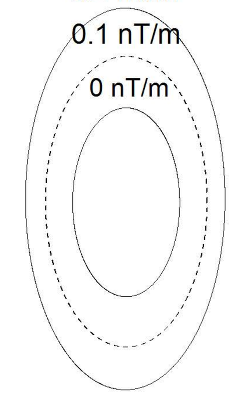
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

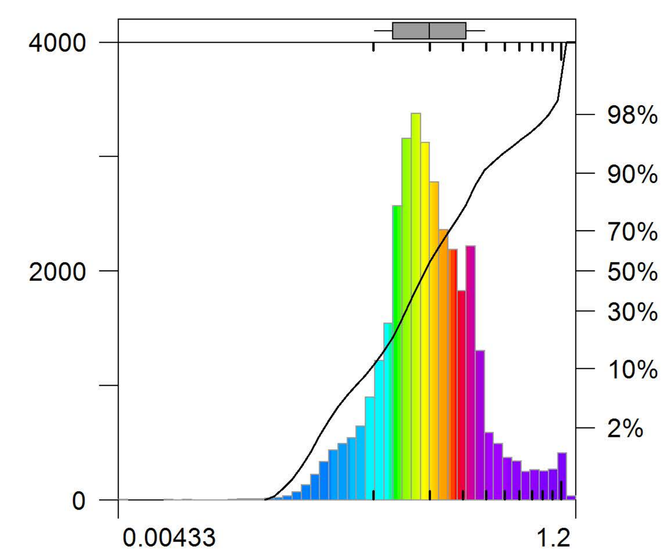
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 17U)

Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

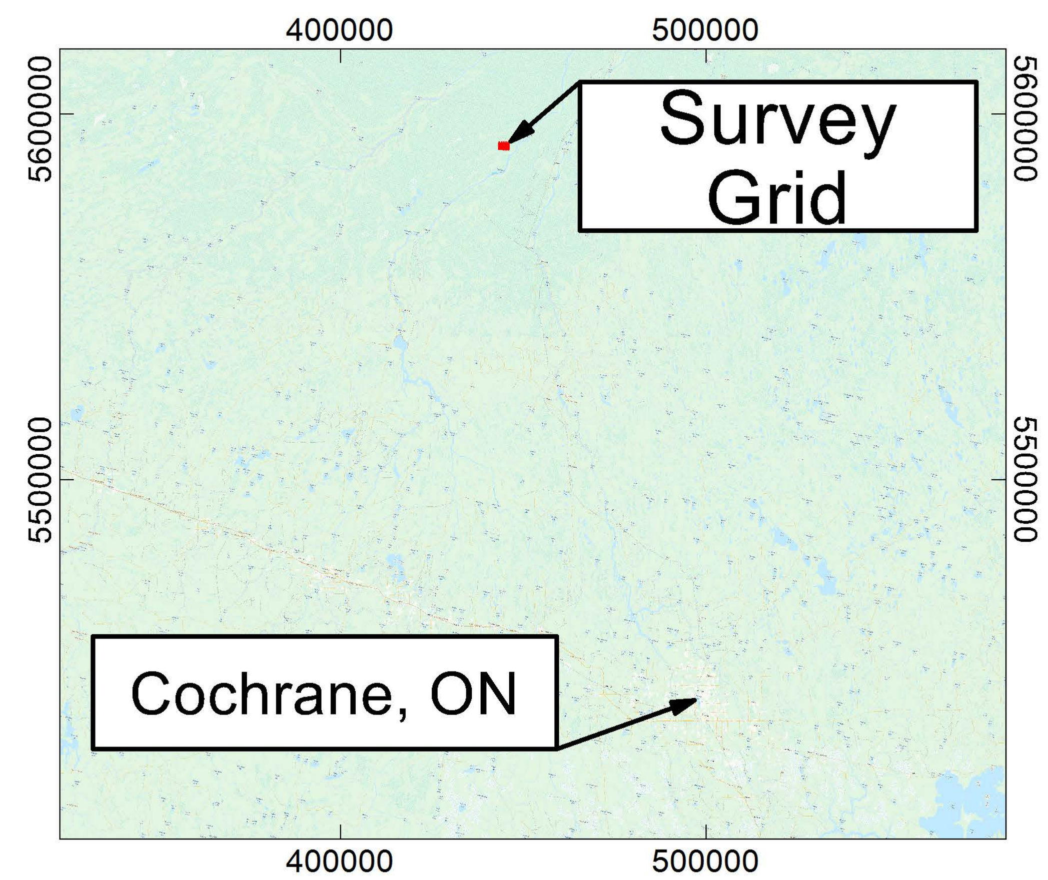
Contour Legend:





Data Distribution

Samples:	34810
Minimum:	0.004335
Maximum:	1.104
Mean:	0.2338
Geo.Mean:	0.1945
Median:	0.1881
Mode:	0.05598
Std.Dev.:	0.1665
Std.Err.:	0.0008924
Skew:	2.53
Kurtosis:	7.901
Log:	
Mean:	-0.711
Median:	-0.7255
Skew:	0.1277



Pioneer Exploration Consultants Ltd.

Levelled and Micro-Levelld Drone Magnetic Survey
Generalized Horizontal Derivative (HD)
Units: nT/m

Survey Date: March 2022

Map Author: Kiyavash Parvar M.A.Sc Geophysics

Memorandum

From: Francis Moul, Principal Geophysicist
Condor North Consulting ULC

Condor·North·Consulting·ULC

Date: Sept. 15, 2022

RE: Magnetic susceptibility smooth model inversion and magnetic vector inversion of UAV magnetic data at the Northway project, Ontario

Summary

This memorandum outlines details of a magnetic vector inversion (MVI) (Ellis et al., 2012; MacLeod and Ellis, 2013) and magnetic susceptibility inversion modelling exercise carried out on a unmanned airborne vehicle (UAV, drone) total magnetic intensity (TMI) dataset acquired at 50 m line spacing by Pioneer Exploration Consultants Ltd. (Pioneer) for VR Resources Ltd. (VRR) at the Northway project, Ontario. The inversion AOI was defined by the area of the gridded survey magnetic data. An additional set of coarse, regional inversions were undertaken using data from the public Otter Rapids 250 m line spaced survey (OGS, 2005). Condor North Consulting ULC (Condor) generated unconstrained, smooth model, magnetic susceptibility inversions and magnetic vector inversions (MVIs) using the Geosoft VOXI software.The OGS data were inverted at a 100 m x 100 m horizontal cell size and the drone data were inverted at 12.5 m x 12.5 m horizonal cell size. Delivered susceptibility inversion results are for regional magnetic data (coarse mesh), drone magnetic data (fine mesh), drone magnetic data using the regional magnetic susceptibility as a reference (fine mesh). Delivered magnetic vector inversion results are for drone magnetic data (fine mesh) unconstrained by the regional data only; no acceptable solution was obtained using the regional (coarse mesh) results. Inversion parameters are appended to this document; all data files are included as a digital archive.

Magnetic Modelling

Source Data

In all cases, the coordinate system used is NAD83 UTM Zone 17N. The source data for the inversions were: 1) 12.5m cell size grids generated from the delivered Pioneer drone magnetic database, and 2) 62.5 m cell size grids generated from the delivered OGS magnetic database. The survey line paths are shown in Figure 1 and the parameters are listed in Table 1.

The levelled, microlevelled, and regional conformed residual total magnetic intensity (RMI) data in the “mag_gsclev” channel of the OR1_mag.gdb database were gridded at a 62.5 m cell size allowing interpolation to fill all internal gaps due to line path wander (Figure 2). The final levelled, and microlevelled, total magnetic intensity (TMI) drone data in the “final” channel of the VR_Northgrid_Final.gdb database were gridded at 12.5 m cell size (Figure 3).

The drone laser altimeter data were unprocessed and poor quality making accurate estimate of the terrain clearance difficult without knowledge of the vertical datum for the GPS receiver. The mean clearance for the laser (54 m) was assumed to represent a reasonable clearance value. The mean clearance from the “radar_raw” in the regional database was 81 m.

The drone inversion AOI was defined as the area of the gridded data. The regional AOI was defined by the drone inversion AOI plus a buffer adequate to capture the regional magnetic response in the area of the drone AOI.

The surface elevation was defined by the Shuttle Radar Topography Mission 1 arcsecond (SRTM1) digital elevation model (DEM) (Figure 4). The terrain in the drone AOI is very flat with a total elevation change of 11 m (maximum 80 m and minimum 69 m). The terrain in the regional AOI is flat with a total elevation change of 52 m (maximum 92 and minimum 40 m). A single, assumed, constant terrain clearance was used rather than the measured or calculated terrain clearance for each survey. The vertical datum for the sensor clearance is acquired from the datum from the SRTM1 DEM and defined as mean sea level based on the EGM96 geoid.

Table 1: Survey parameters and references

Year	System	Project Area	Survey Block	Line Spacing (m)	Nominal Clearance (m)	Reference
1981	Unkown	N/A	Otter Rapids Block 1 (Corral Rapids)	250	81	OGS, 2005
2022	UAV	Northway	Northgrid	50	54	None[1]

[1] No survey logistics and processing report for the 2022 survey was available at the time of writing

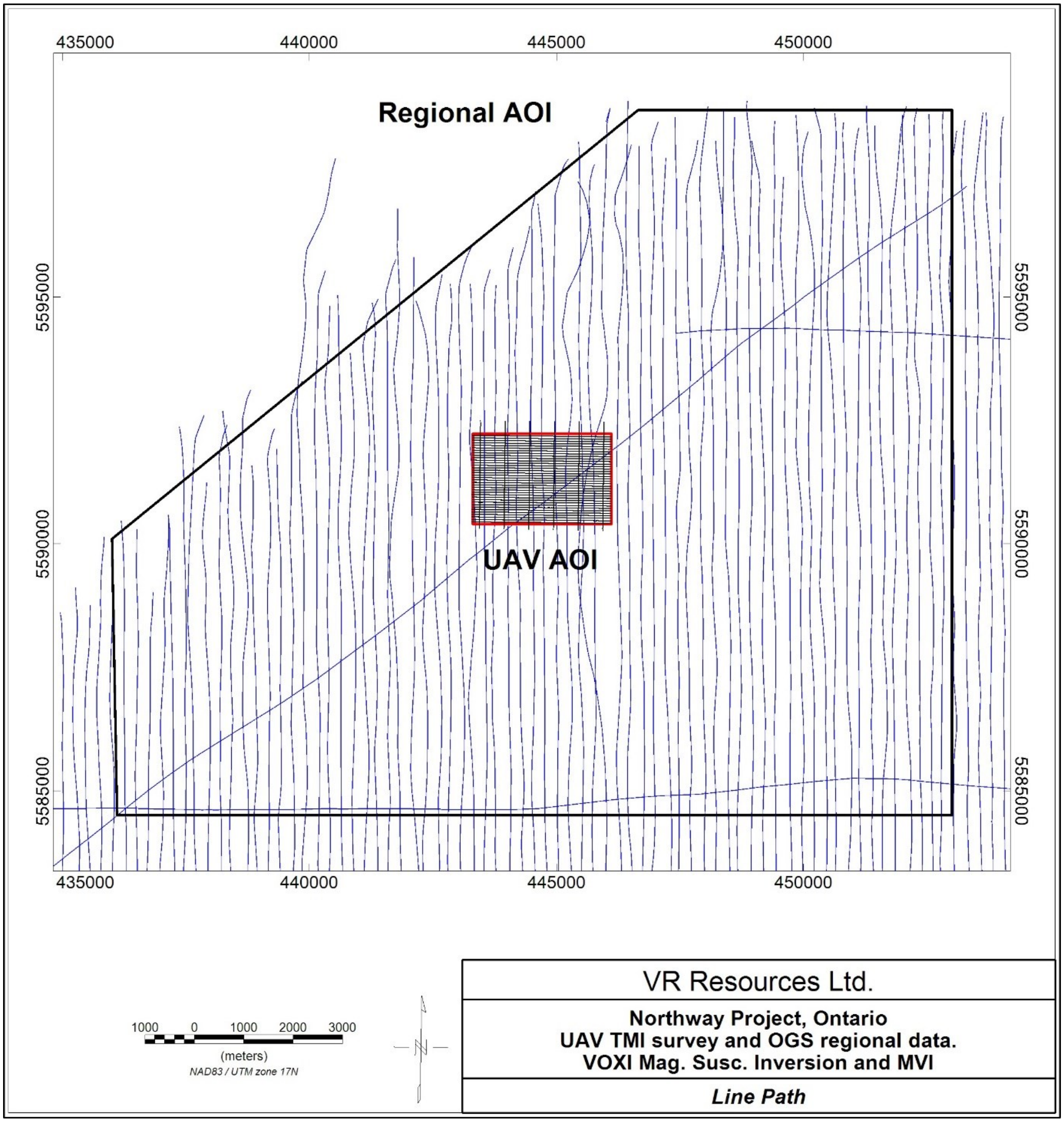


Figure 1: The linepath for the surveys (blue is regional and black is UAV) and the AOIs (black is regional and red is detailed UAV) .

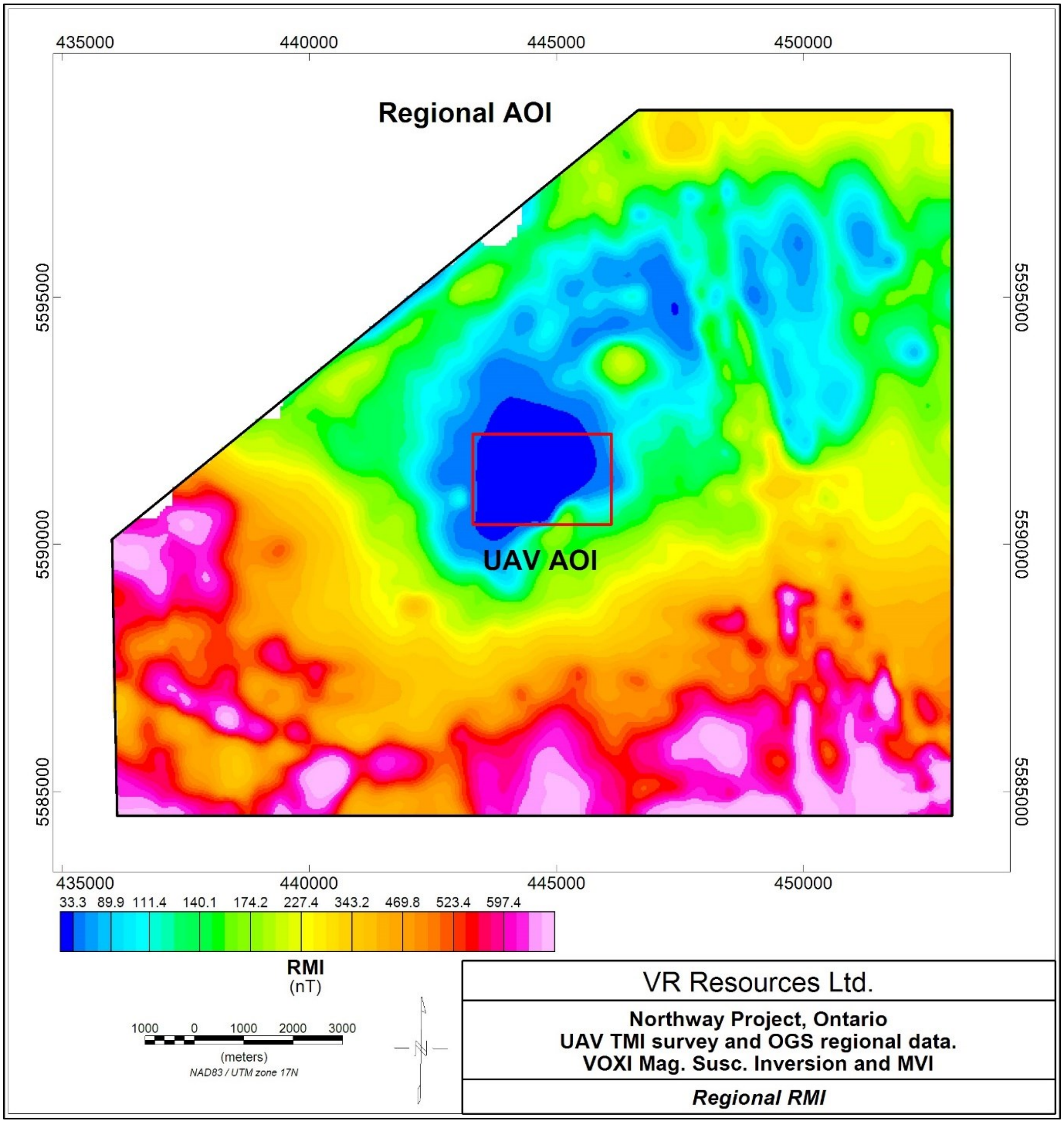


Figure 2: The RMI magnetic grid from the OGS database trimmed to the regional AOI (black).

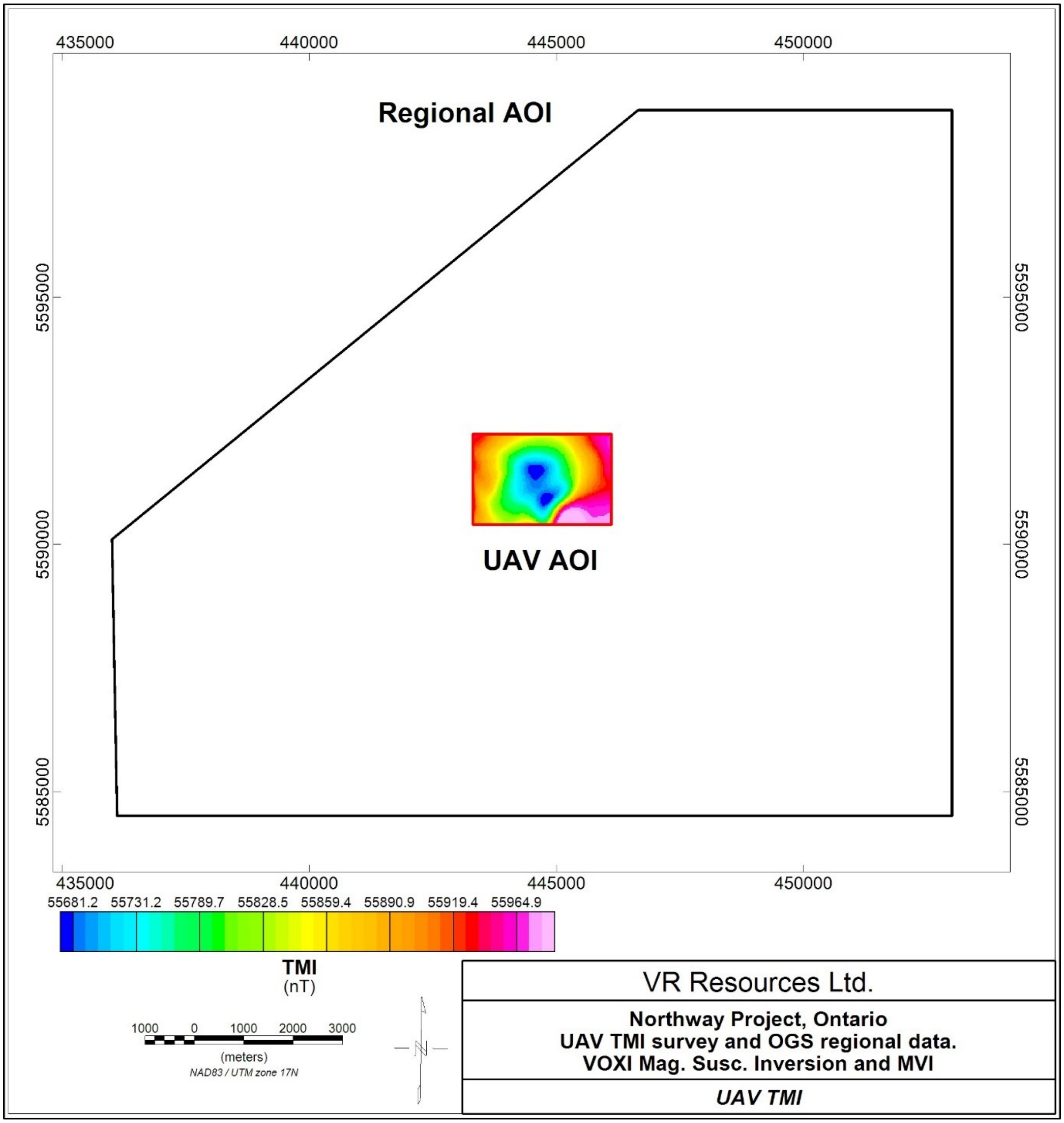


Figure 3: The TMI magnetic grid from the UAV database trimmed to the UAV AOI (red).

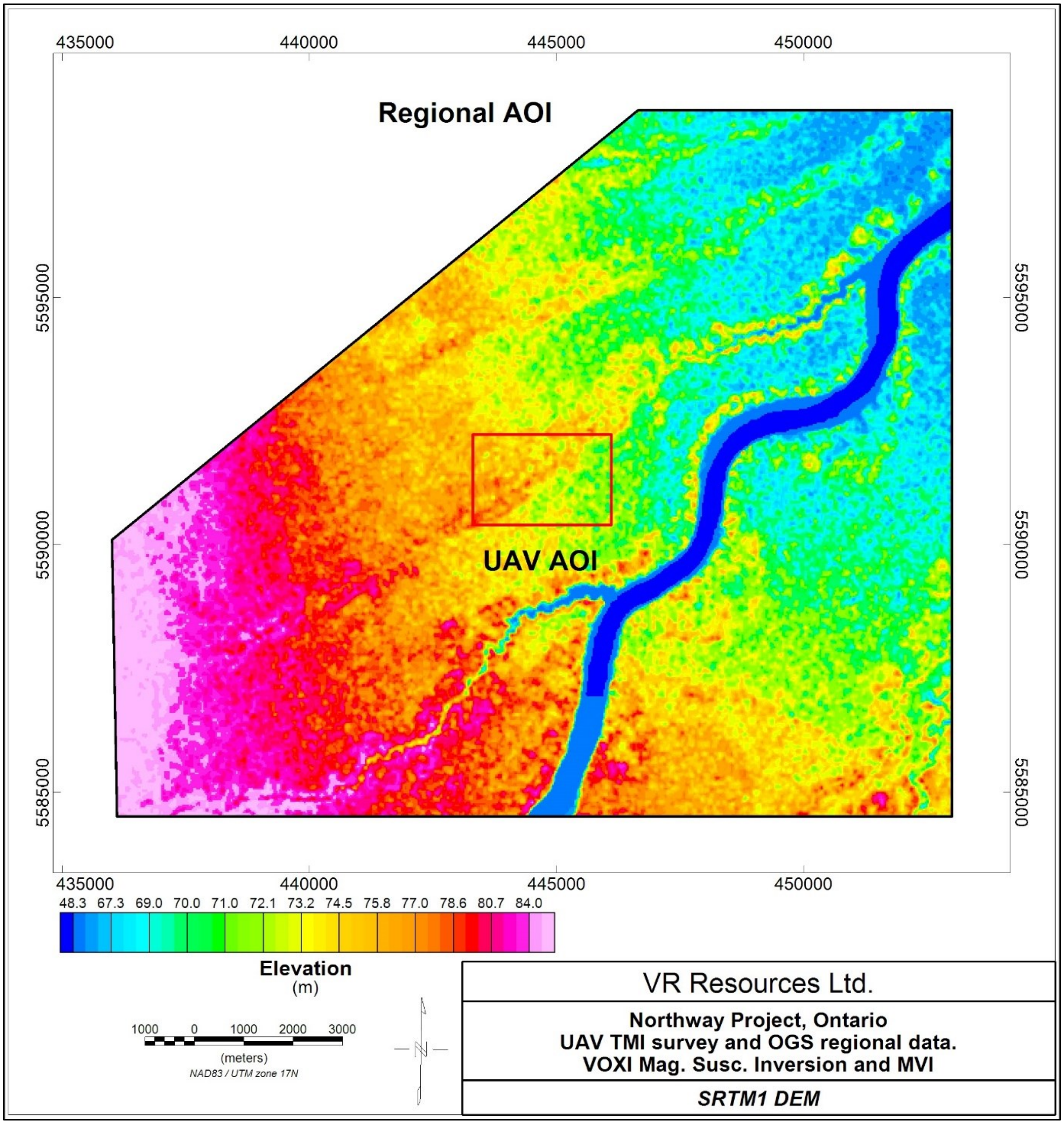


Figure 4: DEM. The inversion AOIs (black and red) are overlain.

Data preparation and inversion parameters – Regional AOI

Coarse Susceptibility Inversion

The coarse inversion was generated using a single tile without a reference model. An active mesh was generated using 100 m x 100 m lateral cells and minimum 50 m vertical cells with a 1.08 expansion ration for the vertical cell size. The mesh was padded with 9 cells in each direction expanding in size at a 1.2 ratio.

The RMI grid (or1_tmi_gsclev.grd) was trimmed to the regional AOI (or1_tmi_gsclev-taoi-rev.grd). A 1st order polynomial surface was removed resulting in a residual grid (or1_tmi_gsclev-taoi-rev-detrend1e.grd) (Figure 5). The residual was resampled to a single value per horizontal inversion cell and a constant background value of -94.36 nT was removed resulting in a mean of 0 nT for the input data (Figure 6, Table 2). An International Geomagnetic Reference Field (IGRF) of 77.4° inclination, -11.1° declination, and 60,027 nT suitable for the acquisition date in 1981 was assumed.

Sensor elevation was assumed to be a constant 80 m above the terrain as defined by the SRTM1 DEM.

An absolute error level of 6.464 nT was assumed for all magnetic values. All other inversion parameters were left as default except: the computational error factor was adjusted from 0.002 to 0.0002 (reducing stripping present at depth with the higher error factor), and Iterative Reweighting Inversion (IRI) Focussing was not used.

The standard deviation of the misfit was 6.3 nT; the inversion misfit is shown in Figures 7 and 8. The residual and predicted data for each tile are included in the tile .gdb databases.

The Geosoft VOXI susceptibility model parameters and process are documented in the .html and .log files included in the digital appendix. The log files for each inversion are included in the data archive.

Table 2: Mesh and error parameters for each inversion tile and combined model.

Name	Voxel Dimensions	Absolute Error (nT)	Background (nT)	Residual Average (nT)
Tile1	172 x 143 x 26	6.464	-94.36	0

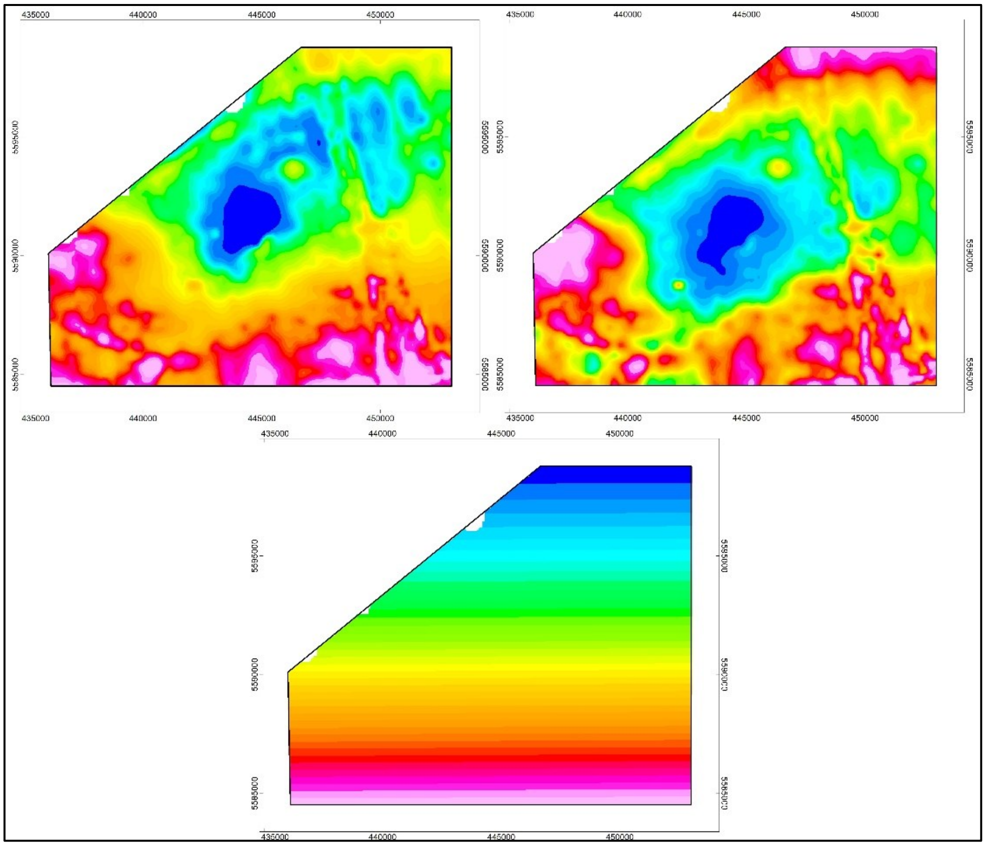


Figure 5: RMI (upper left), RMI after removal of a 1st order polynominal surface (upper right), trend removed (bottom). The detrended RMI was the input for magnetic inversion.

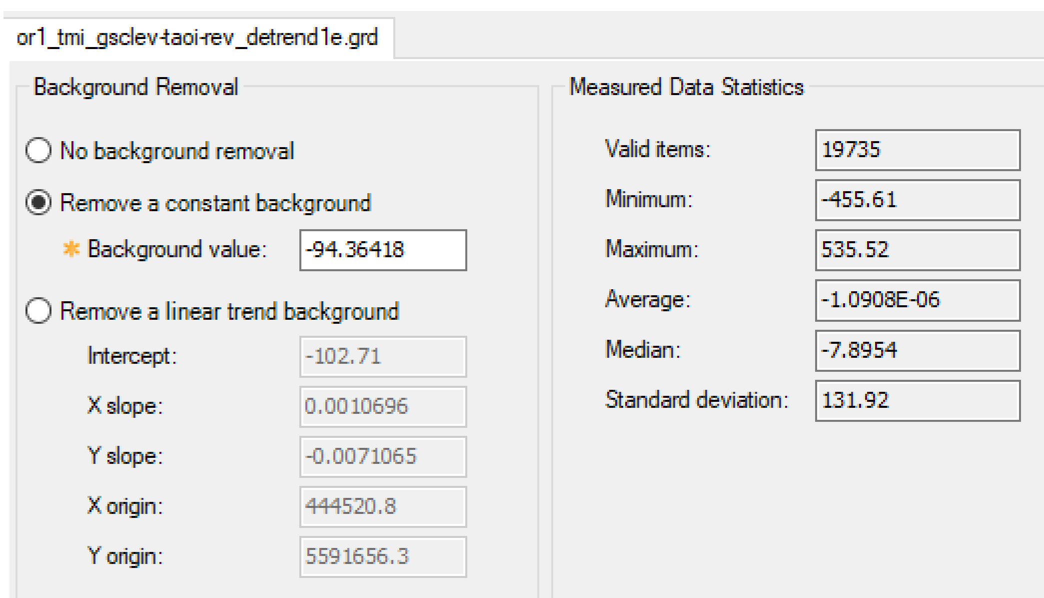


Figure 6: VOXI data preparation for susceptibility inversion in AOI (coarse inversion).

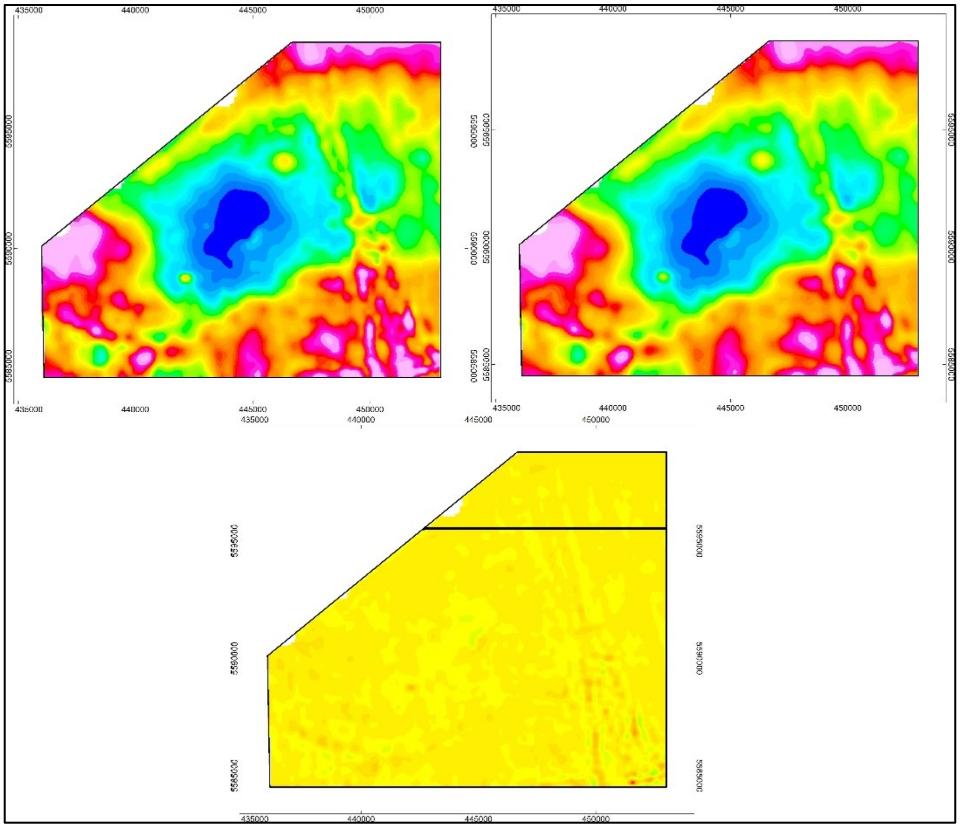
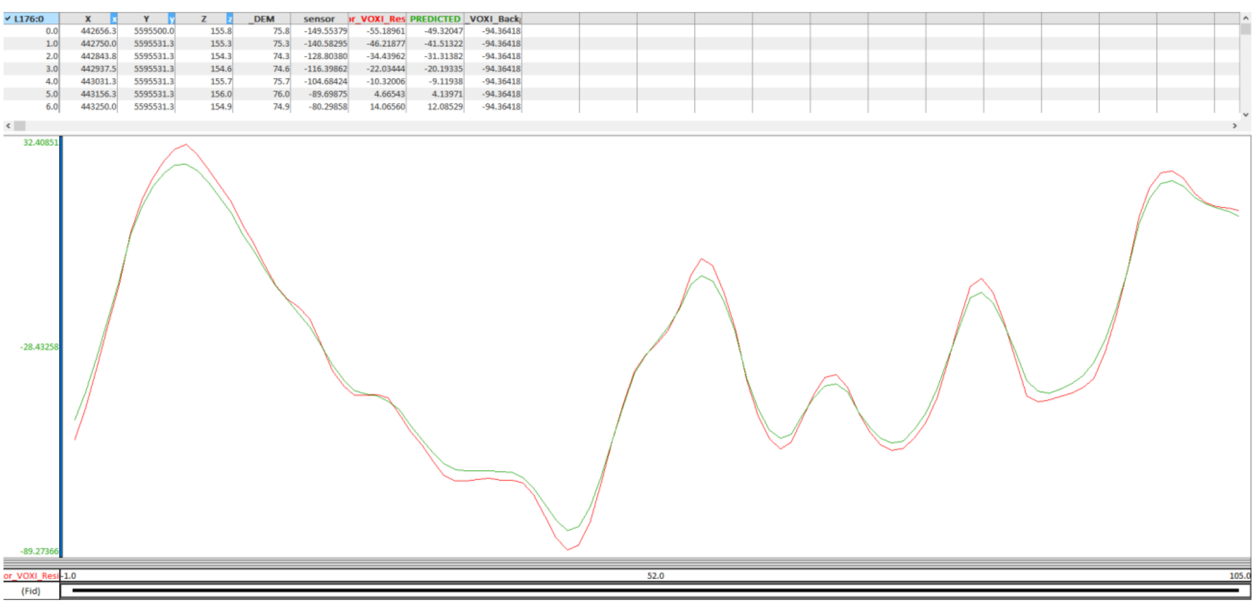


Figure 7: Residual input (upper left), predicted (upper right), misfit (bottom). Common histogram equalization colour scale in all panels.



L176:0	X	Y	Z	_DEM	sensor	or_VOXI_Res	PREDICTED	_VOXI_Back
0.0	442656.3	5595500.0	155.8	75.8	-149.55379	-55.18961	-49.32047	-94.36418
1.0	442750.0	5595531.3	155.3	75.3	-140.58295	-46.21877	-41.51322	-94.36418
2.0	442843.8	5595531.3	154.3	74.3	-128.80380	-34.43962	-31.31382	-94.36418
3.0	442937.5	5595531.3	154.6	74.6	-116.39862	-22.03444	-20.19335	-94.36418
4.0	443031.3	5595531.3	155.7	75.7	-104.68424	-10.32006	-9.11938	-94.36418
5.0	443156.3	5595531.3	156.0	76.0	-89.69875	4.66543	4.13971	-94.36418
6.0	443250.0	5595531.3	154.9	74.9	-80.29858	14.06560	12.08529	-94.36418

Figure 8: Residual (red) and predicted (green) for line indicated in preceeding figure.

Data preparation and inversion parameters – Drone AOI

Fine Susceptibility Inversion (no reference model)

The fine inversion was generated using a single with no reference model.

An active mesh was generated using 12.5 m x 12.5 m lateral cells and minimum 6.25 m vertical cells with a 1.08 expansion ration for the vertical cell size. The mesh was padded with 9 cells in each direction expanding in size at a 1.2 ratio.

The TMI grid (northway_uav_tmi_final.grd) was trimmed to the AOI (northway_uav_tmi_final.grd). A 1st order polynomial surface was removed resulting in a residual grid (northway_uav_tmi_final_detrend1e.grd) (Figure 9). The residual was resampled to a single value per horizontal inversion cell and the same constant background value as used for the coarse model was removed. A background value of -77.1753 nT was removed resulting in a mean of 0 nT for the input data (Figure 10, Table 3). An International Geomagnetic Reference Field (IGRF) of 74.4° inclination, -10.4° declination, and 56,258 nT was assumed.

Sensor elevation was assumed to be a constant 54 m above the terrain as defined by the SRTM1 DEM.

An absolute error level of 2.5 nT was assumed for all magnetic values. All other inversion parameters were left as default except: the computational error factor was adjusted from 0.002 to 0.0002 (reducing stripping present at depth with the higher error factor), and Iterative Reweighting Inversion (IRI) Focussing was not used.

The standard deviation of the misfit was 2.5 nT; the inversion misfit is shown in Figures 11 and 12. The residual and predicted data for each tile are included in the tile .gdb databases.

The Geosoft VOXI susceptibility model parameters and process are documented in the .html and .log files included in the digital appendix. The log files for each inversion are included in the data archive.

Table 3: Mesh and error parameters for each inversion tile and combined model.

Name	Voxel Dimensions	Absolute Error (nT)	Background (nT)	Residual Average (nT)
Tile1	225 x 148 x 59	2.5	-77.1753	0

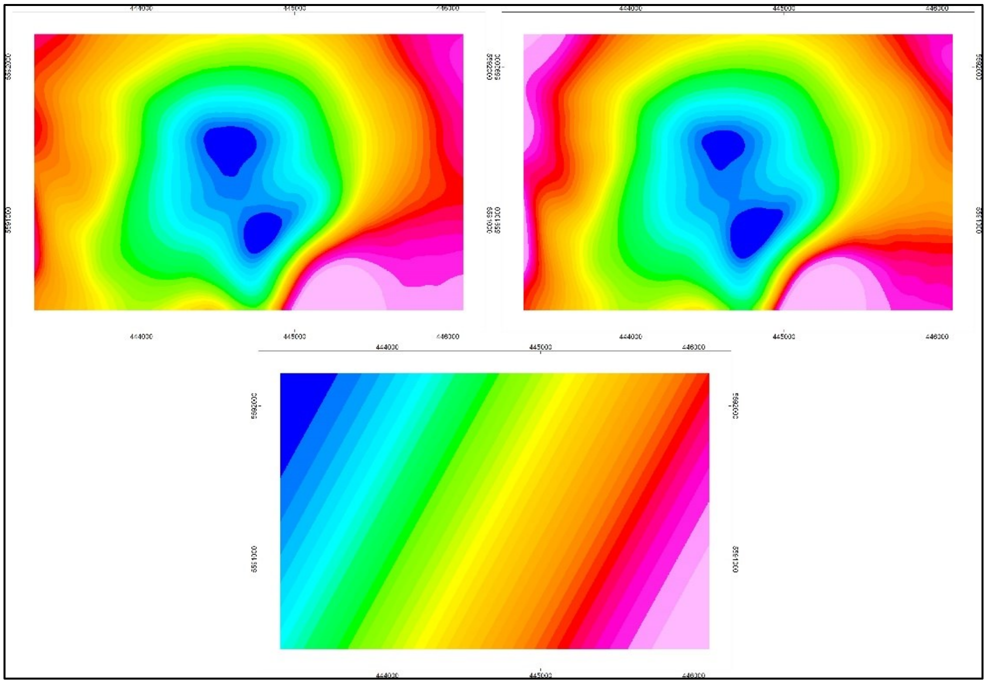


Figure 9: TMI (upper left), TMI after removal of a 1st order polynominal surface (upper right), trend removed (bottom). The detrended TMI was the input for magnetic inversion.

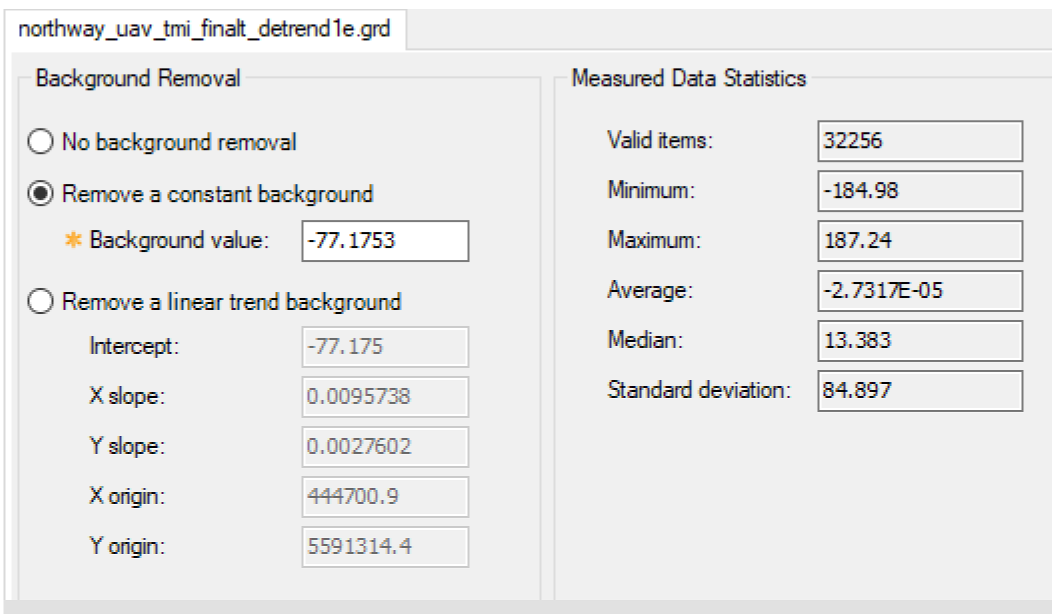


Figure 10: VOXI data preparation for susceptibility inversion in AOI (fine inversion – no reference model).

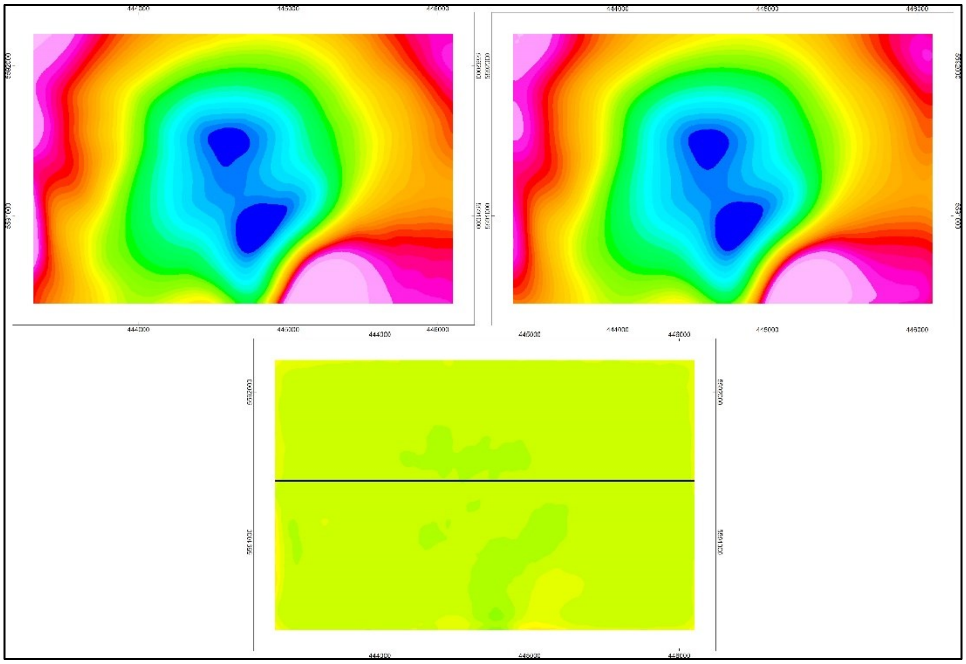


Figure 11: Residual input (upper left), predicted (upper right), misfit (bottom). Common histogram equalization colour scale in all panels.

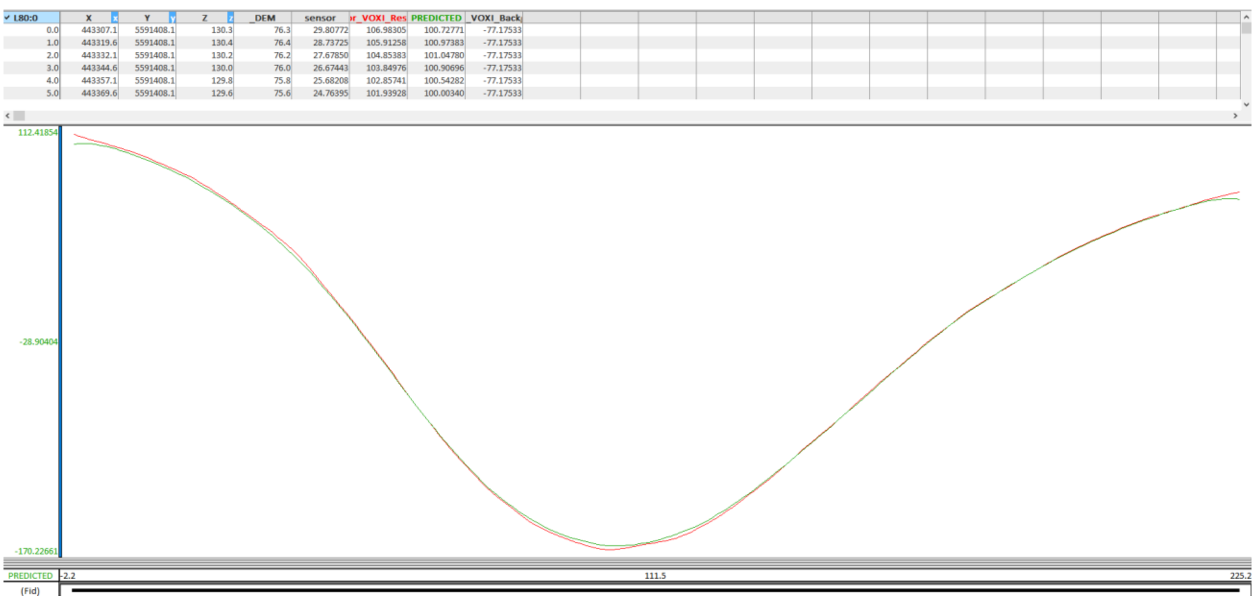


Figure 12: Residual (red) and predicted (green) for line indicated in preceeding figure.

Fine Susceptibility Inversion (regional reference model)

The fine inversion was generated using a single tile and the regional coarse susceptibility model as a reference.

An active mesh was generated using 12.5 m x 12.5 m lateral cells and minimum 6.25 m vertical cells with a 1.08 expansion ration for the vertical cell size. The mesh was padded with 9 cells in each direction expanding in size at a 1.2 ratio.

The TMI grid (northway_uav_tmi_final.grd) was trimmed to the AOI (northway_uav_tmi_final.grd). A 1st order polynomial surface was removed resulting in a residual grid (northway_uav_tmi_final_detrend1e.grd). An additional 1st order polynomial surface was removed in order to produce an RMI grid (northway_uav_tmi_finalt_detrend1e_detrend1e2regional.grd) conformed to the regional RMI grid (or1_tmi_gsclev-taoi-rev_detrend1e.grd). (Figure 13). The residual was resampled to a single value per horizontal inversion cell and a background value of -250 nT nT was removed resulting in a mean of -165 nT for the input data (Figure 14, Table 4). An International Geomagnetic Reference Field (IGRF) of 74.4° inclination, -10.4° declination, and 56,221 nT was assumed.

Sensor elevation was assumed to be a constant 54 m above the terrain as defined by the SRTM1 DEM.

An absolute error level of 2.5 nT was assumed for all magnetic values. All other inversion parameters were left as default except: the computational error factor was adjusted from 0.002 to 0.0002 (reducing stripping present at depth with the higher error factor), and Iterative Reweighting Inversion (IRI) Focussing was not used. Reference model parameter weighting was set at 0.001.

The standard deviation of the misfit was 2.5 nT; the inversion misfit is shown in Figures 15 and 16. The residual and predicted data for each tile are included in the tile .gdb databases.

The Geosoft VOXI susceptibility model parameters and process are documented in the .html and .log files included in the digital appendix. The log files for each inversion are included in the data archive.

Table 4: Mesh and error parameters for each inversion tile and combined model.

Name	Voxel Dimensions	Absolute Error (nT)	Background (nT)	Residual Average (nT)
Tile1	225 x 148 x 59	2.5	-250	-165.19

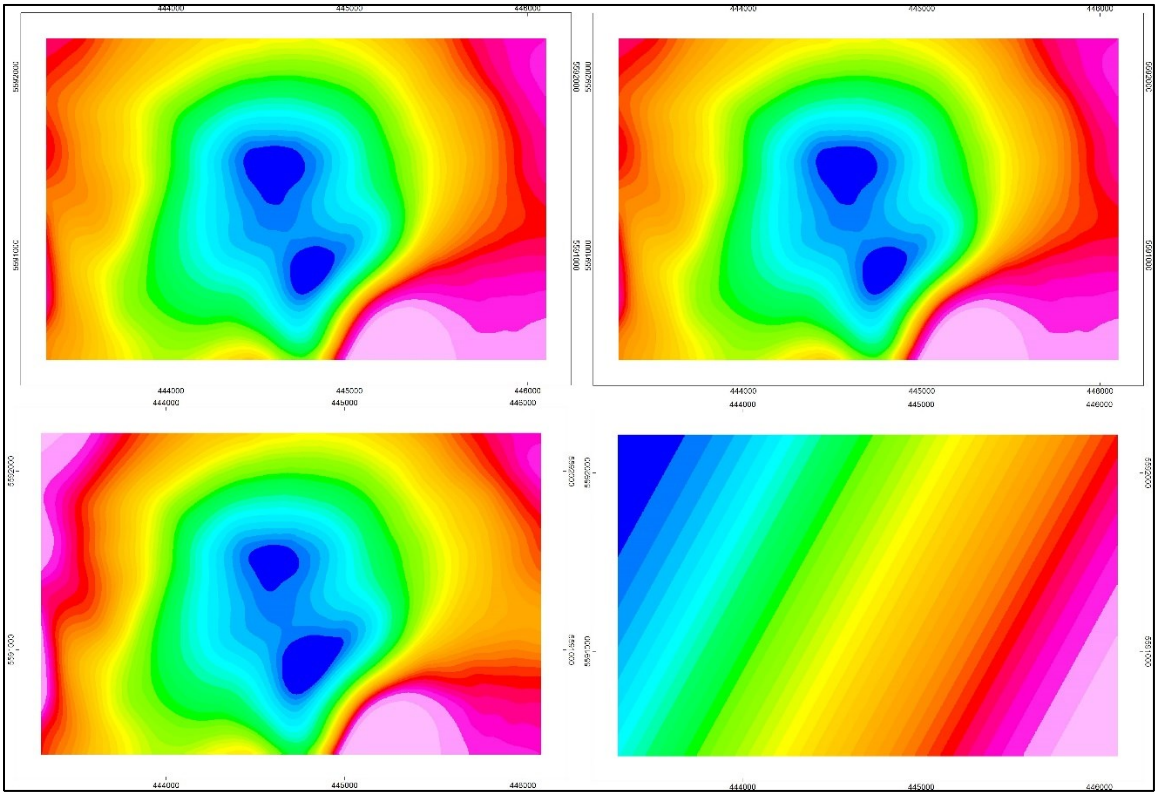


Figure 13: TMI (upper left), RMI after removal of a 1st order polynominal surface (upper right), RMI after removal of additional 1st order polynominal surface to level the UAV data to the regional data (lower left), additional trend removed (lower right). The detrended RMI was the input for magnetic inversion.

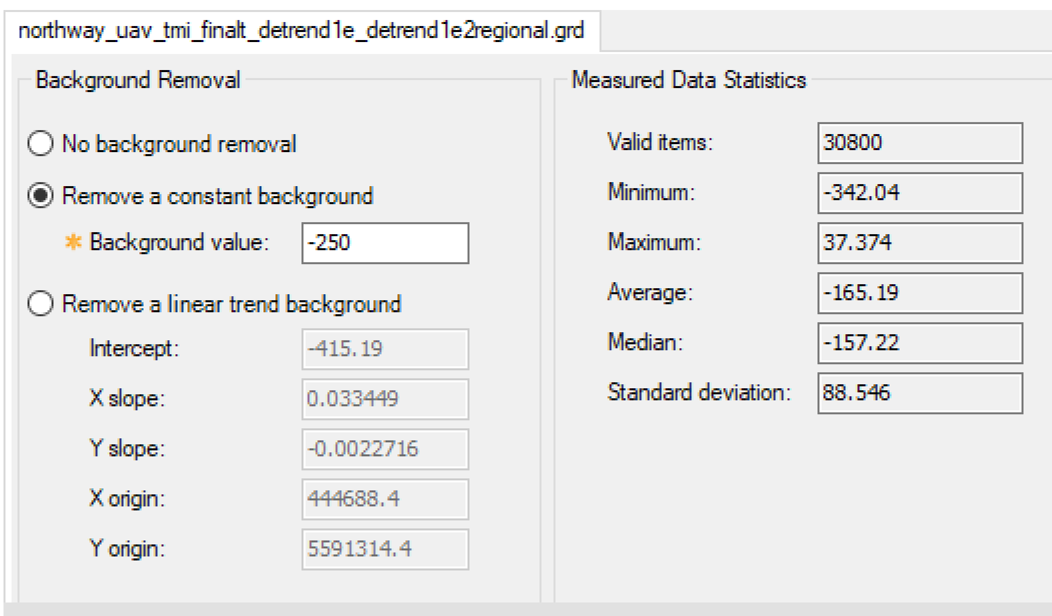


Figure 14: VOXI data preparation for susceptibility inversion in AOI (fine inversion – regional reference model).

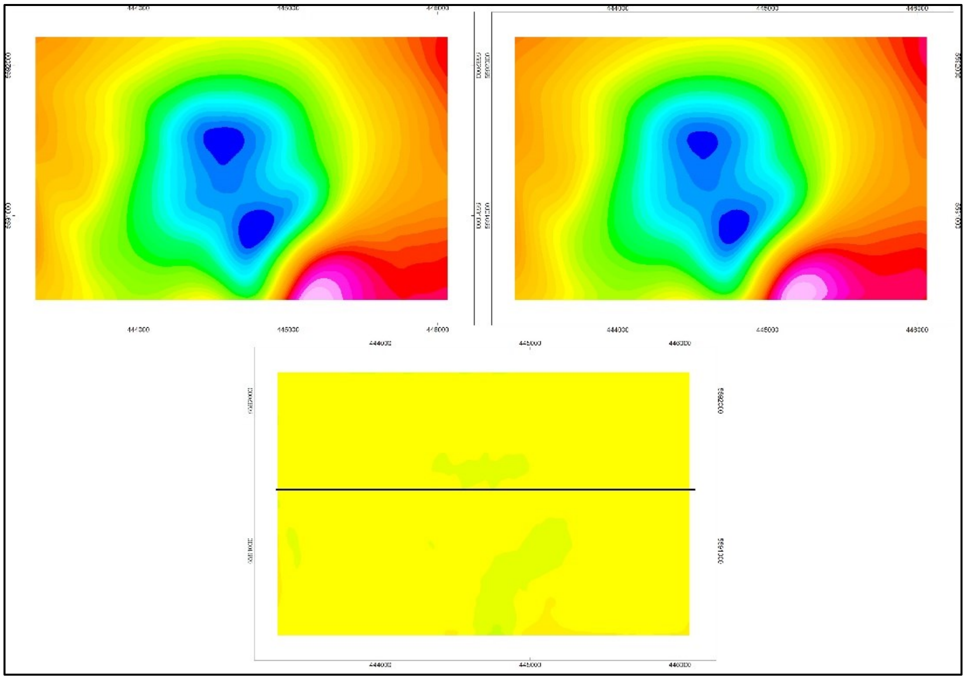


Figure 15: Residual input (upper left), predicted (upper right), misfit (bottom). Common histogram equalization colour scale in all panels.

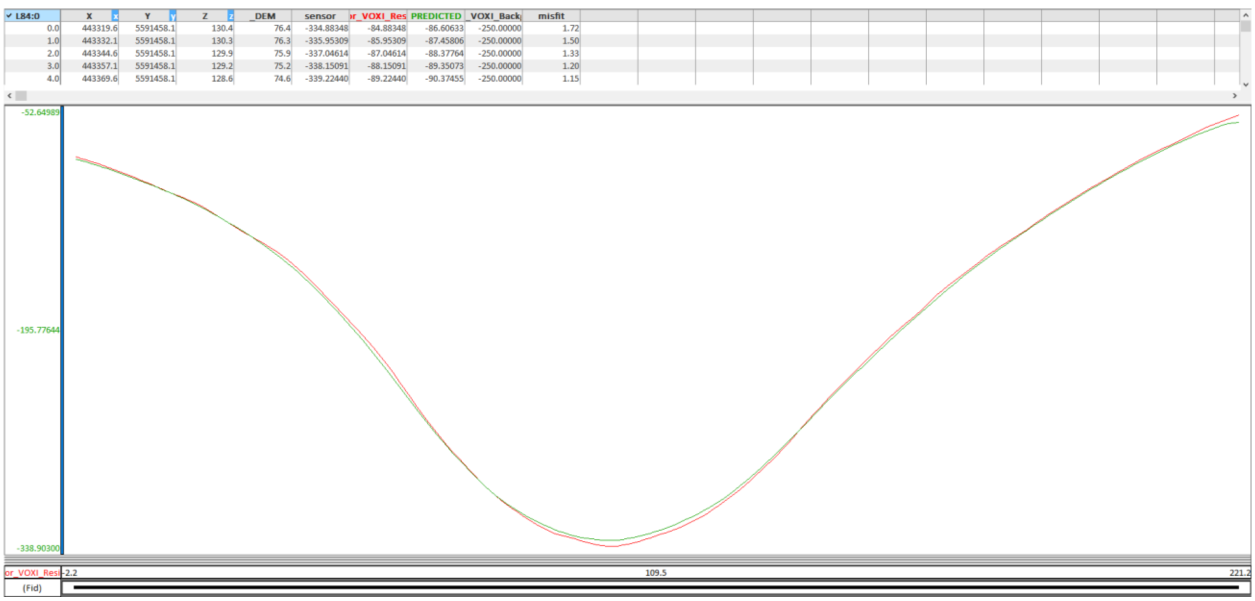


Figure 16: Residual (red) and predicted (green) for line indicated in preceeding figure.

Fine MVI Inversion (no reference model)

The fine inversion was generated using a single with no reference model. The same parameters were used for the MVI inversion as for the fine susceptibility model with no reference model.

The standard deviation of the misfit was 2.5 nT; the inversion misfit is shown in Figures 17 and 18. The residual and predicted data for each tile are included in the tile .gdb databases.

The Geosoft VOXI MVI model parameters and process are documented in the .html and .log files included in the digital appendix. The log files for each inversion are included in the data archive.

Table 5: Mesh and error parameters for each inversion tile and combined model.

Name	Voxel Dimensions	Absolute Error (nT)	Background (nT)	Residual Average (nT)
Tile1	225 x 148 x 59	2.5	-77.1753	0

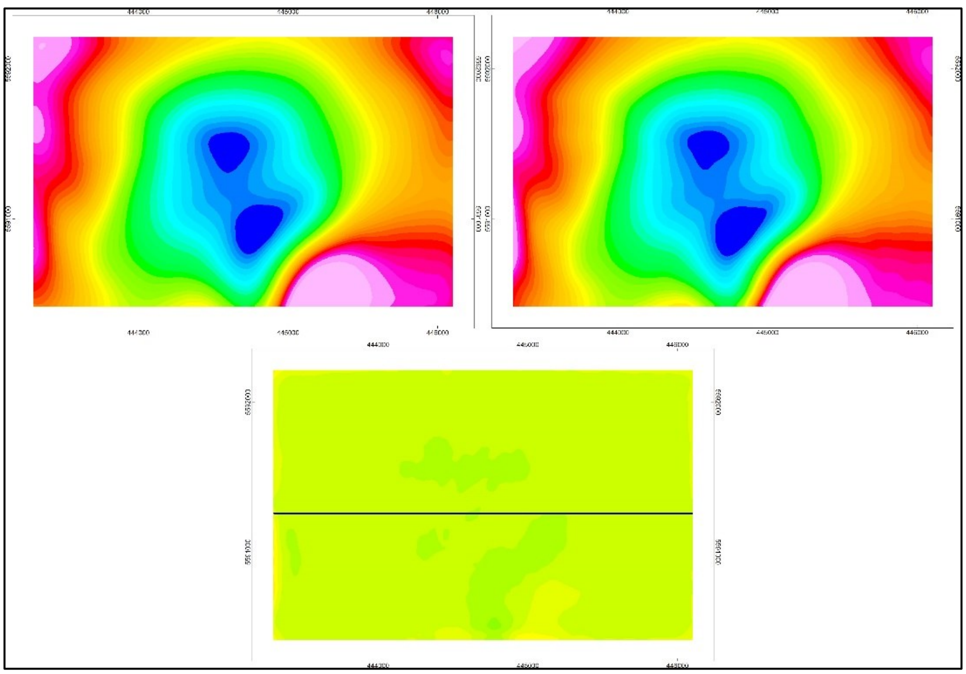


Figure 17: Residual input (upper left), predicted (upper right), misfit (bottom). Common histogram equalization colour scale in all panels.

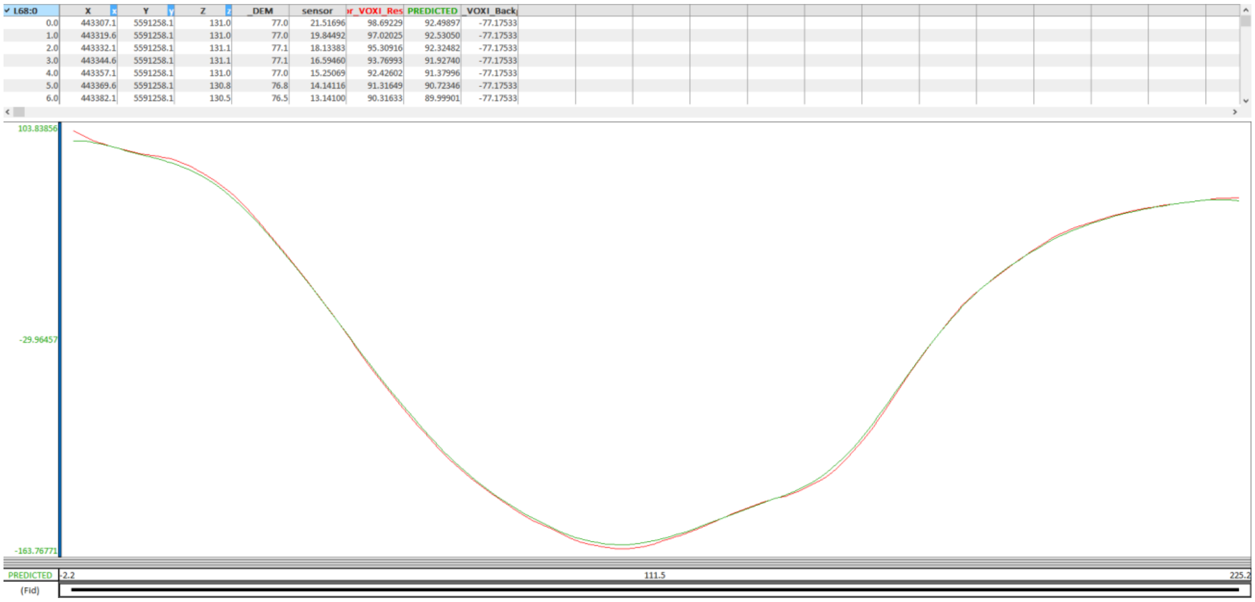


Figure 18: Residual (red) and predicted (green) for line indicated in preceeding figure.

Products

The products generated by the VOXI susceptibility inversions and magnetic vector inversion are summarised in below. Example of the products for the area are shown in Figures 19 to 31. The models are in SI units.

The voxel model is converted to generate both a UBC format voxel and a Geosoft format voxel. Geosoft format voxels are binary files with the .geosoft_voxel extension or geosoft_vectorvoxel extensions. UBC format voxels consist of a pair of ASCII files defining the mesh (.msh) and the data (.mod) and null values are defined as -1. There is no UBC equivalent to the Geosoft vector voxel format.

Products list: Regional AOI

Input grids: “SRTM1.grd”, “or1_tmi_gsclev-taoi-rev_detrend1e.grd”
Clipping polygons: “AOI-rev.ply”

VOXI Susceptibility

VOXI Susc. Voxel: VRR_NW_Regional_Mag_Susc_100m.geosoft_voxel

Isosurfaces: VRR_NW_Regional_Mag_Susc_100m-linear.dxf,
VRR_NW_Regional_Mag_Susc_100m-log.dxf

VOXI Susc depth sections:
VRR_NW_Regional_Mag_Susc_100m-Drape[DEPTH]below.grd,
VRR_NW_Regional_Mag_Susc_100m-Z[ELEVATION].grd

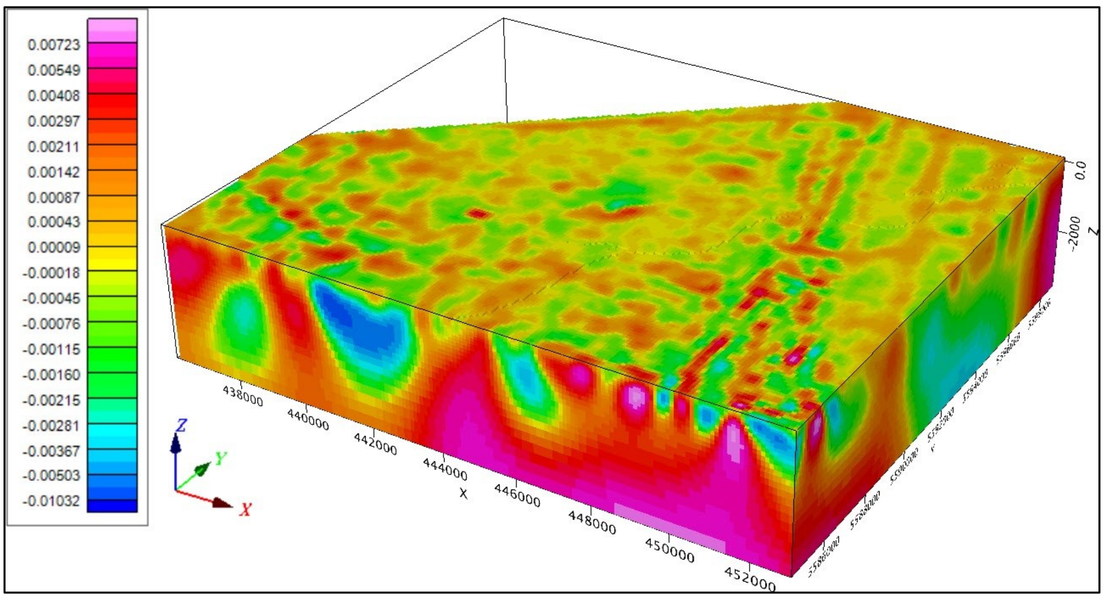


Figure 19: VOXI Regional Coarse Susc. Model

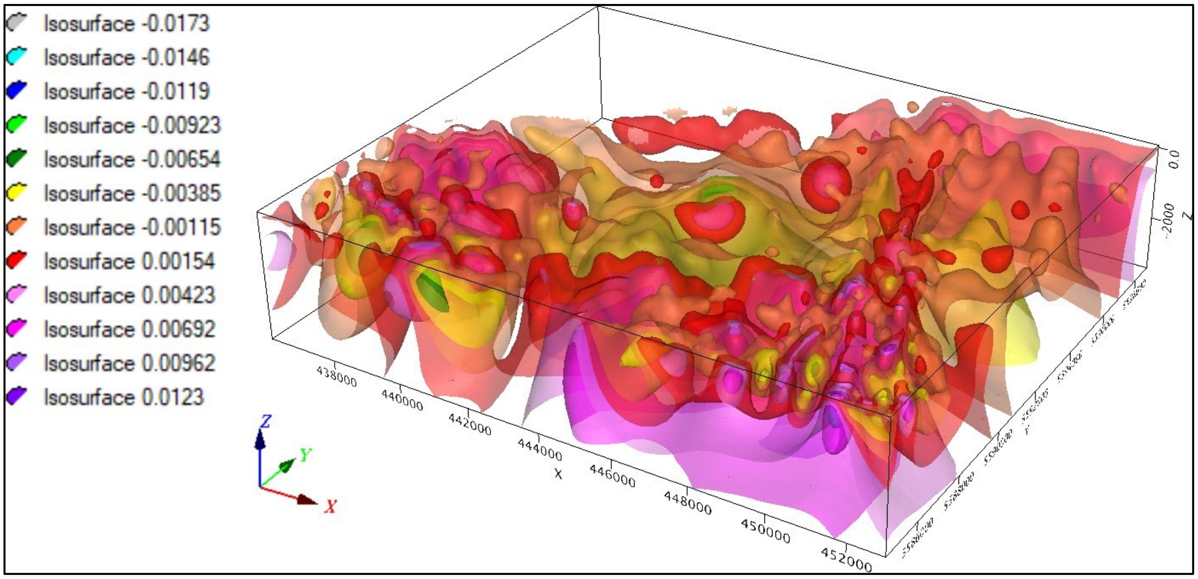


Figure 20: Isosurfaces (linear scale) generated from VOXI Regional Coarse Susc. Model

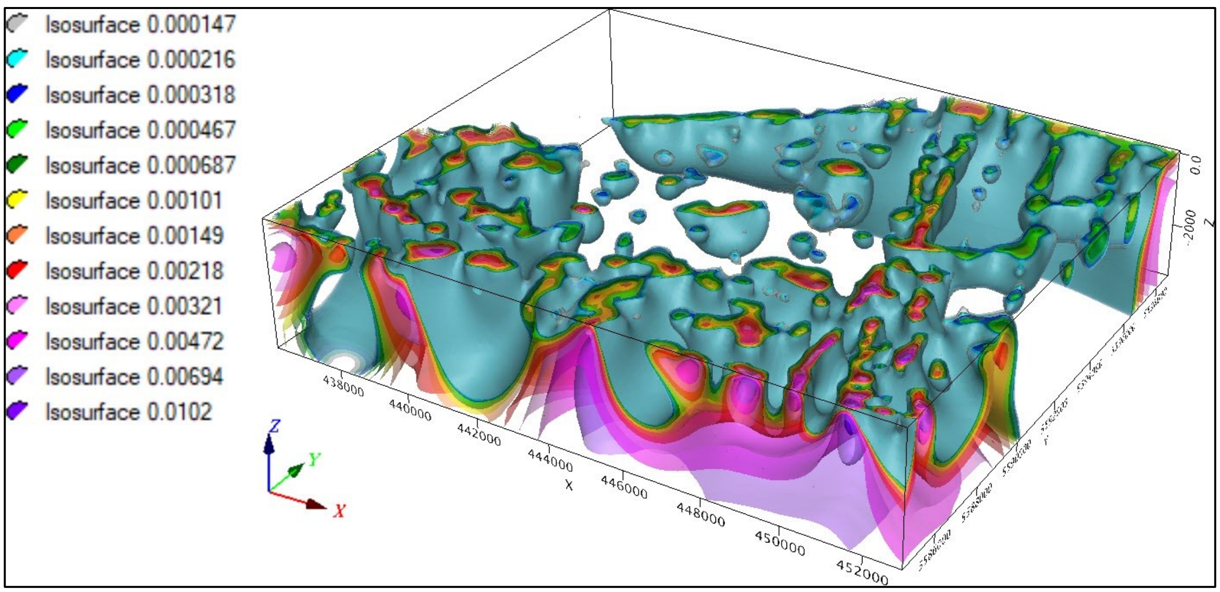


Figure 21: Isosurfaces (log scale) generated from VOXI Regional Coarse Susc. Model

Products list: UAV detail AOI (no regional reference model)

Input grids: “SRTM1.grd”, “northway_uav_tmi_finalt_detrend1e.grd”
Clipping polygons: “Northway_block.ply”

VOXI Susceptibility

VOXI Susc. Voxel: VRR_NW_UAV_Mag_Susc_12p5m.geosoft_voxel

Isosurfaces: VRR_NW_UAV_Mag_Susc_12p5m-linear.dxf,
VRR_NW_UAV_Mag_Susc_12p5m-log.dxf

VOXI Susc depth sections:
VRR_NW_UAV_Mag_Susc_12p5m-Drape[DEPTH]below.grd,
VRR_NW_UAV_Mag_Susc_12p5m-Z[ELEVATION].grd

VOXI MVI

VOXI Magnetization Vector Voxel: VRR_NW_UAV_Mag_MVI_12p5m.geosoft_vectorvoxel

VOXI Magnetization Amplitude Voxel: VRR_NW_UAV_Mag_MVI_Ampl_12p5m.geosoft_voxel

VOXI Magnetization Vector components:
VRR_NW_UAV_Mag_MVI_Eperp_12p5m.geosoft_voxel,
VRR_NW_UAV_Mag_MVI_Eproj_12p5m.geosoft_voxel,
VRR_NW_UAV_Mag_MVI_Susc_x_12p5m.geosoft_voxel,
VRR_NW_UAV_Mag_MVI_Susc_y_12p5m.geosoft_voxel,
VRR_NW_UAV_Mag_MVI_Susc_z_12p5m.geosoft_voxel

Isosurfaces: VRR_NW_UAV_Mag_MVI_Ampl_12p5m-linear.dxf,
VRR_NW_UAV_Mag_MVI_Ampl_12p5m-log.dxf

VOXI Susc depth sections:
VRR_NW_UAV_Mag_MVI_Ampl_12p5m-Drape[DEPTH]below.grd,
VRR_NW_UAV_Mag_MVI_Ampl_12p5m-Z[ELEVATION].grd

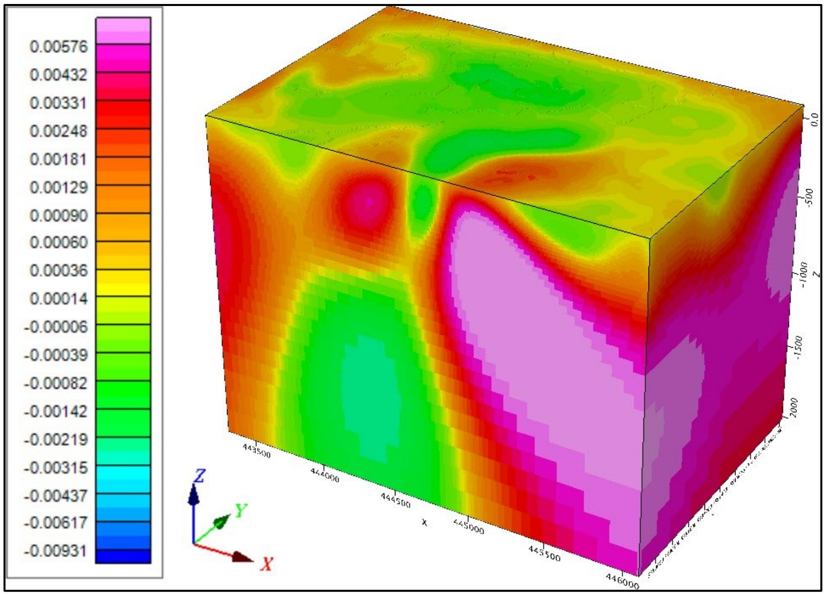


Figure 22: VOXI Fine Susc. Model (no regional reference model)

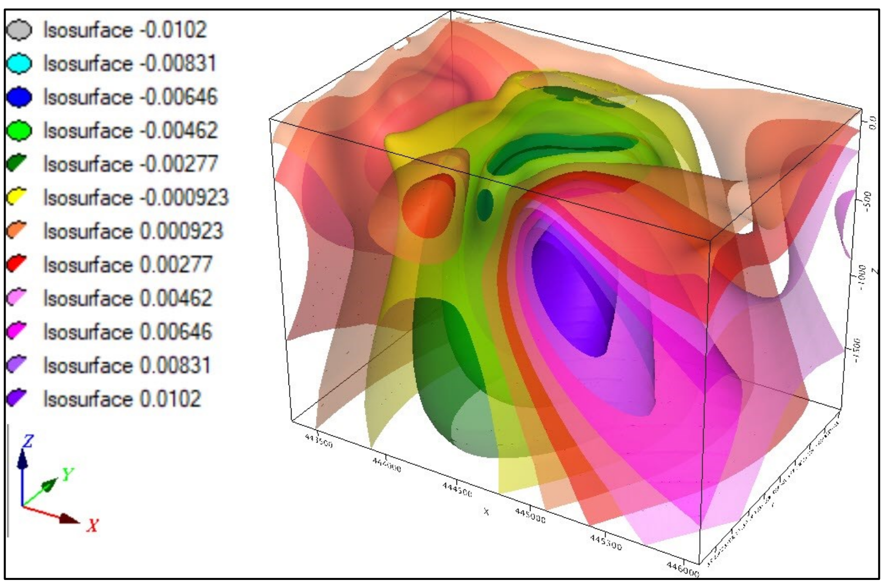


Figure 23: Isosurfaces (linear scale) generated from VOXI Fine Susc. Model (no regional reference model)

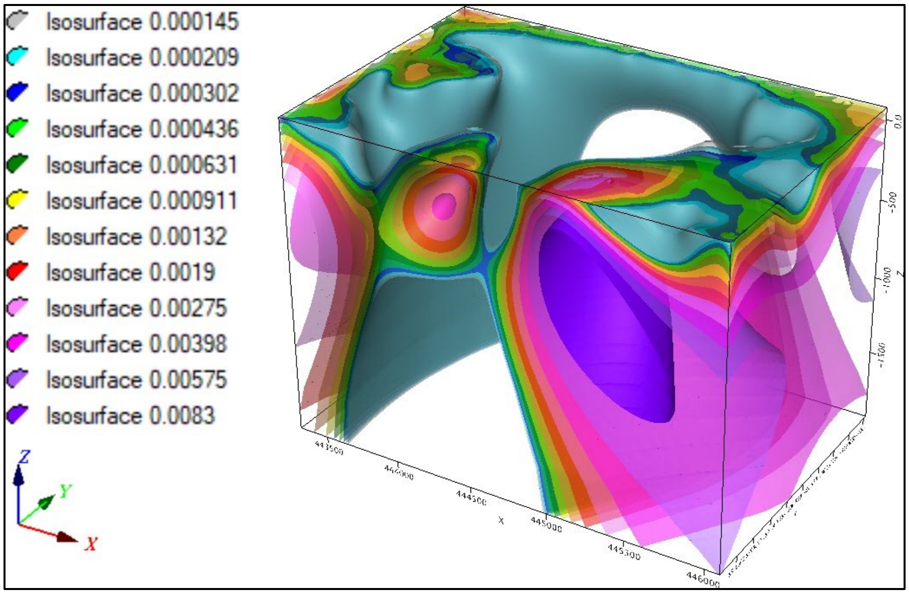


Figure 24: Isosurfaces (log scale) generated from VOXI Fine Susc. Model (no regional reference model)

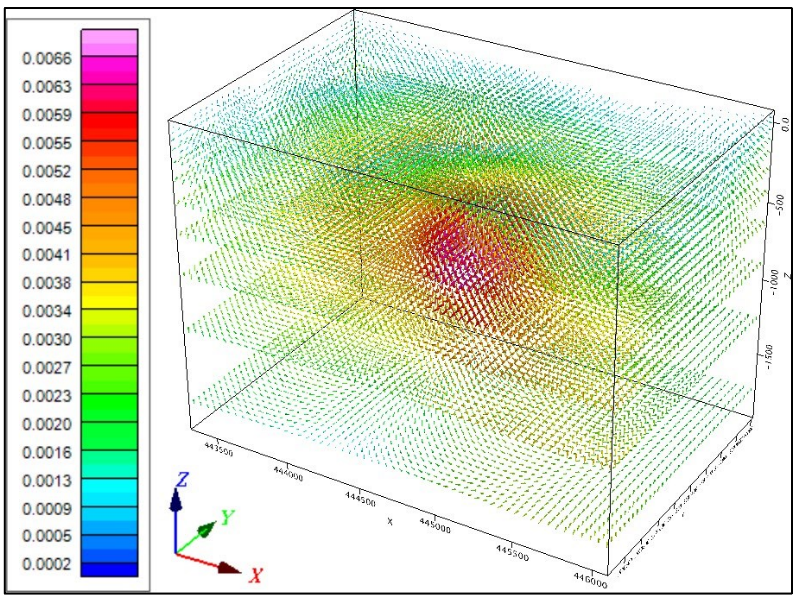


Figure 25: VOXI Fine MVI vector voxel magnetization model.

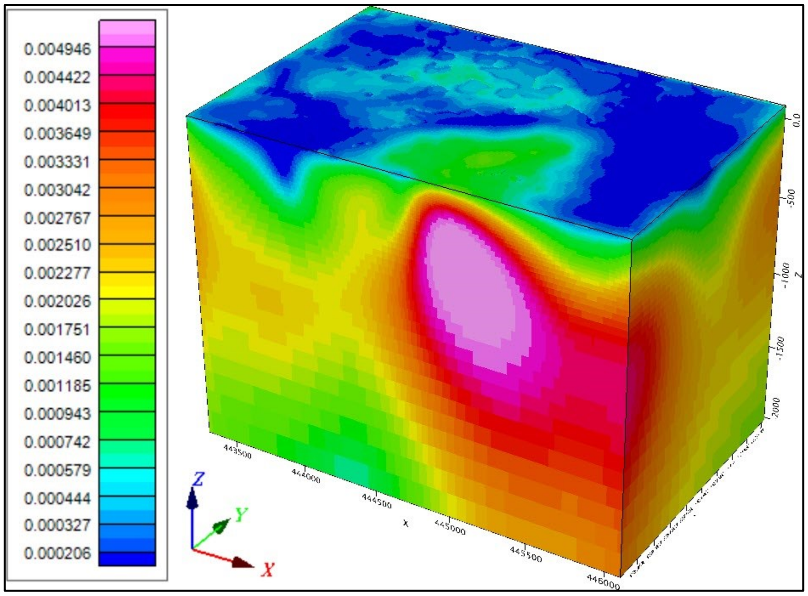


Figure 26: VOXI Fine MVI magnetization amplitude model.

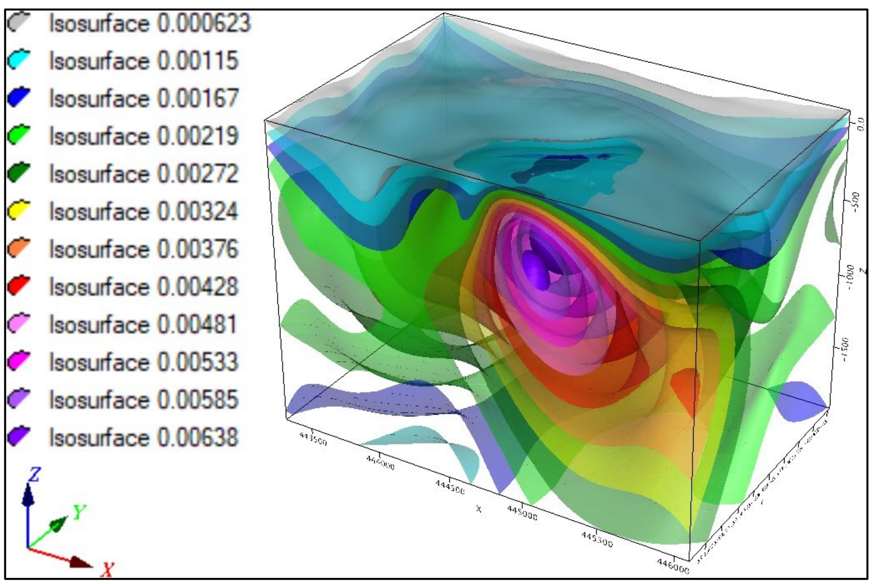


Figure 27: Isosurfaces (linear scale) generated from VOXI Fine MVI magnetization amplitude model.

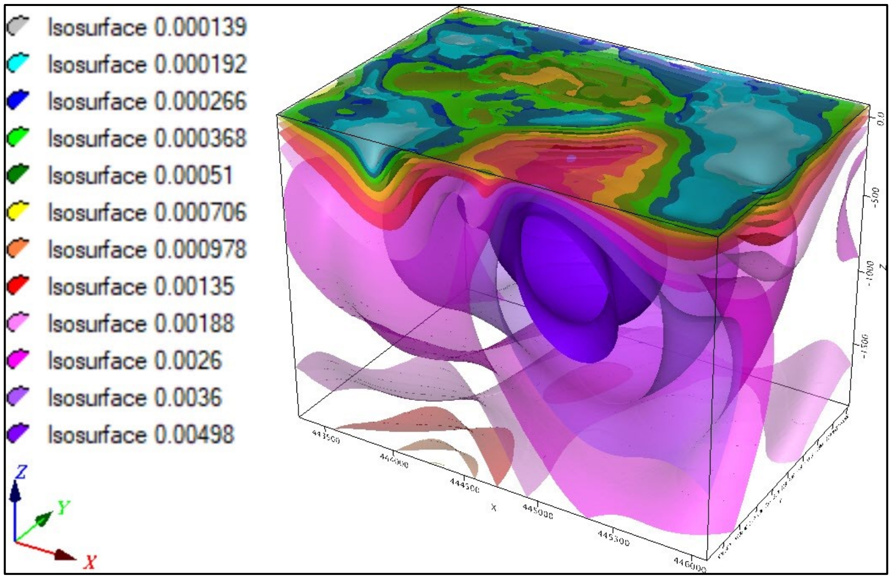


Figure 28: Isosurfaces (log scale) generated from VOXI Fine MVI magnetization amplitude model.

Products list: UAV detail AOI (with regional reference model)

Input grids: “SRTM1.grd”, “northway_uav_tmi_finalt_detrend1e_detrend1e2regional.grd”
Clipping polygons: “Northway_block.ply”

VOXI Susceptibility

VOXI Susc. Voxel: VRR_NW_UAV_Mag_Susc_RegRef_12p5m.geosoft_voxel

Isosurfaces: VRR_NW_UAV_Mag_Susc_RegRef_12p5m-linear.dxf,
VRR_NW_UAV_Mag_Susc_RegRef_12p5m-log.dxf

VOXI Susc depth sections:
VRR_NW_UAV_Mag_Susc_RegRef_12p5m-Drape[DEPTH]below.grd,
VRR_NW_UAV_Mag_Susc_RegRef_12p5m-Z[ELEVATION].grd

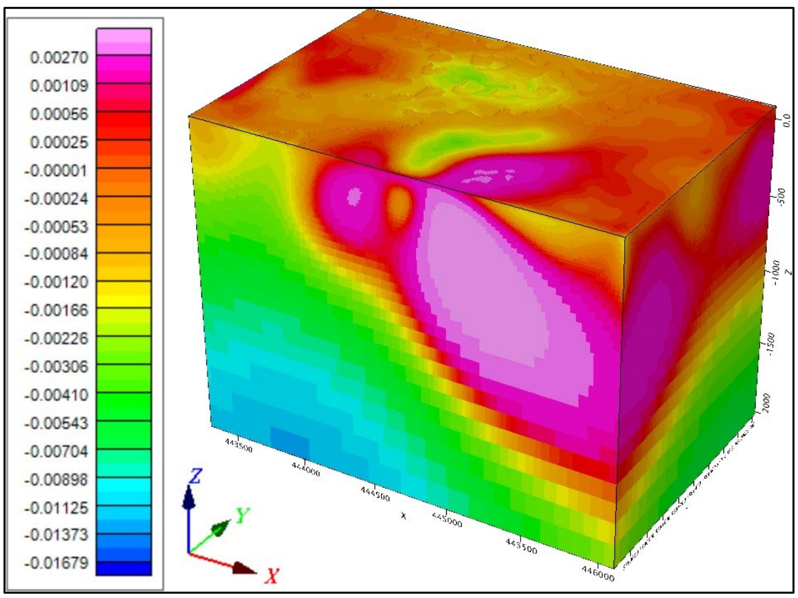


Figure 29: VOXI Fine Susc. Model (with regional reference model)

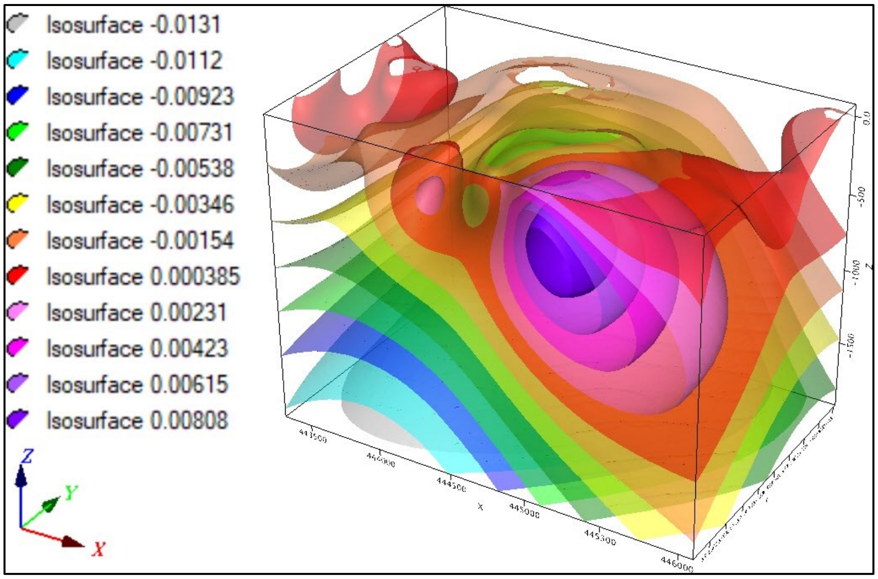


Figure 30: Isosurfaces (linear scale) generated from VOXI Fine Susc. Model (with regional reference model)

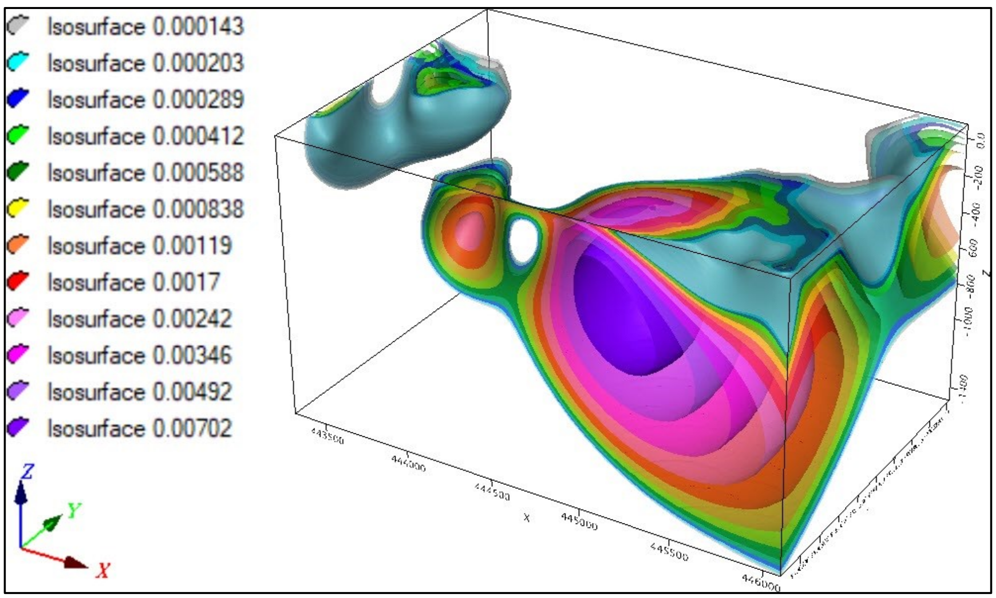


Figure 31: Isosurfaces (log scale) generated from VOXI Fine Susc. Model (with regional reference model)

References

No logistics report at the time of writing.

Ellis, R. G., de Wet, B., Macleod, I. N., 2012, Inversion of magnetic data for remanent and induced sources. ASEG Extended Abstracts 2012: 22nd Geophysical Conference: pp. 1-4.

MacLeod, I. N., Ellis, R. G. 2013, Magnetic Vector Inversion, a simple approach to the challenge of varying direction of rock magnetization. ASEG Forum on the Application of Remanent Magnetization, 2013 ASEG general meeting.

Ontario Geological Survey 2005. Ontario airborne geophysical surveys, magnetic and electromagnetic data, Squirrel River – Otter Rapids – Moose River areas; Ontario Geological Survey, Geophysical Data Set 1228.

VOXI Susceptibility Inversion and Magnetic Vector Inversion Parameters

VOXI

Spatial Reference

Polygon File
Name: .\AOI-rev.ply
Coordinate System
Name: NAD83 / UTM zone 17N
Units: m
Surface Definition
DEM Grid File: c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\SRTM1.grd(GRD)

Data

Database
Database File:
c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\VRR_NW_Regional_Mag_Susc_100m.geosoft_voxi.data\DatabaseFromGrid.gdb
X Channel: X
Y Channel: Y
Sensor Elevation Channel: Z
Data Type:
Type: Magnetic
Data Sampling Optimization: Yes
Samples Per Cell: 1
Sensor Channel:
Type: Magnetic
Channel: sensor
Fit Error - Absolute
Value: 6.464
Background Trend - Constant
Constant Value: -94.36418
Physical Model:
Type: Susceptibility
IGRF
Date: 1981-06-01
Field Strength (nT): 60027
Inclination (degrees): 77.4
Declination (degrees): -11.1

Measurement Data from Grid

Sensor Grid File
Name: .\or1_tmi_gsclev-taoi-rev_detrend1e.grd(GRD;TYPE=FLOAT)
Elevation definition:
Elevation Type: Constant Above Terrain
Constant To Add: 80

Mesh Parameters

Active Volume

	X	Y	Z
Cell sizes (m)	100	100	50
Dimensions (cells)	172	143	26
Minima (m)	435999.1	5584507.9	-3581.4
Maxima (m)	453001.0	5598793.0	90.5

Base and Padding

	Base	Horizontal Padding	Vertical Padding
Dimensions (cells)	24	9	9
Cell expansion ratios	1.08	1.2	1.2

Top of Model
Value: 90.467
Lin-Log Transition
Value: 40

Constraints: Susceptibility

Starting Model
Default Value: Default for system
Parameter Reference Model
Default Value: 0
Gradient Reference Model
Default Value: 0
Upper Bounds Model
Default Value: 1e+20
Lower Bounds Model
Default Value: -1e+20
Parameter Weighting Model
Default Value: 0.0001
EW Gradient Weighting Model
Default Value: 1
NS Gradient Weighting Model
Default Value: 1
Vertical Gradient Weighting Model
Default Value: 1
Reweighting model
None
Active Model
Default Value: 1
IRI Focus
None
Reweighting Model
Default Value: 1

Global Settings

Acceleration
Radius of Influence (m): 1000000
Computational Error Tolerance: 0.0002
Regularization - Auto-Fit
Data fit: 1
Attempts: 20

VOXI

Spatial Reference

Polygon File
Name: .\Northway_Block.ply
Coordinate System
Name: NAD83(CSRS) / UTM zone 17N
Units: m
Surface Definition
DEM Grid File: c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\SRTM1.grd(GRD)

Data

Database
Database File:
c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\VRR_NW_UAV_Mag_Susc_12p5m.geosoft_voxi.data\DatabaseFromGrid.gdb
X Channel: X
Y Channel: Y
Sensor Elevation Channel: Z
Data Type:
Type: Magnetic
Data Sampling Optimization: Yes
Samples Per Cell: 1
Sensor Channel:
Type: Magnetic
Channel: sensor
Fit Error - Absolute
Value: 2.5
Background Trend - Constant
Constant Value: -77.17533
Physical Model:
Type: Susceptibility
IGRF
Date: 2022-03-24
Field Strength (nT): 56258
Inclination (degrees): 74.4
Declination (degrees): -10.4

Measurement Data from Grid

Sensor Grid File
Name: .\northway_uav_tmi_finalt_detrend1e.grd(GRD;TYPE=FLOAT)
Elevation definition:
Elevation Type: Constant Above Terrain
Constant To Add: 54

Mesh Parameters

Active Volume

	X	Y	Z
Cell sizes (m)	12.5	12.5	6.25
Dimensions (cells)	225	148	59
Minima (m)	443303.3	5590399.5	-3581.4
Maxima (m)	446103.1	5592232.0	90.5

Base and Padding

	Base	Horizontal Padding	Vertical Padding
Dimensions (cells)	50	9	9
Cell expansion ratios	1.08	1.2	1.2

Top of Model
Value: 90.467
Lin-Log Transition
Value: 40

Constraints: Susceptibility

9/15/22, 4:24 PM VRR_NW_UAV_Mag_Susc_12p5m_2022-09-12_16-19-37_Parameters.html

Starting Model
Default Value: Default for system
Parameter Reference Model
Default Value: 0
Gradient Reference Model
Default Value: 0
Upper Bounds Model
Default Value: 1e+20
Lower Bounds Model
Default Value: -1e+20
Parameter Weighting Model
Default Value: 0.0001
EW Gradient Weighting Model
Default Value: 1
NS Gradient Weighting Model
Default Value: 1
Vertical Gradient Weighting Model
Default Value: 1
Reweighting model
None
Active Model
Default Value: 1
IRI Focus
None
Reweighting Model
Default Value: 1

Global Settings

Acceleration
Radius of Influence (m): 1000000
Computational Error Tolerance: 0.0002
Regularization - Auto-Fit
Data fit: 1
Attempts: 20

VOXI

Spatial Reference

Polygon File
Name: .\Northway_Block.ply
Coordinate System
Name: NAD83(CSRS) / UTM zone 17N
Units: m
Surface Definition
DEM Grid File: c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\SRTM1.grd(GRD)

Data

Database
Database File:
c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\VRR_NW_UAV_Mag_MVI_12p5m.geosoft_voxi.data\DatabaseFromGrid.gdb
X Channel: X
Y Channel: Y
Sensor Elevation Channel: Z
Data Type:
Type: Magnetic
Data Sampling Optimization: Yes
Samples Per Cell: 1
Sensor Channel:
Type: Magnetic
Channel: sensor
Fit Error - Absolute
Value: 2.5
Background Trend - Constant
Constant Value: -77.17533
Physical Model:
Type: Vector Magnetization
IGRF
Date: 2022-03-24
Field Strength (nT): 56258
Inclination (degrees): 74.4
Declination (degrees): -10.4

Measurement Data from Grid

Sensor Grid File
Name: .\northway_uav_tmi_finalt_detrend1e.grd(GRD)
Elevation definition:
Elevation Type: Constant Above Terrain
Constant To Add: 54

Mesh Parameters

Active Volume

	X	Y	Z
Cell sizes (m)	12.5	12.5	6.25
Dimensions (cells)	225	148	59
Minima (m)	443303.3	5590399.5	-3581.4
Maxima (m)	446103.1	5592232.0	90.5

Base and Padding

	Base	Horizontal Padding	Vertical Padding
Dimensions (cells)	50	9	9
Cell expansion ratios	1.08	1.2	1.2

Top of Model
Value: 90.467
Lin-Log Transition
Value: 40

Constraints: VectorMagnetization

Starting Model
Default Values: Default for system, Default for system, Default for system
Parameter Reference Model
Default Values: 0 , 0 , 0
Gradient Reference Model
Default Values: 0 , 0 , 0
Upper Bounds Model
Default Value: 1e+20
Lower Bounds Model
Default Value: -1e+20
Parameter Weighting Model
Default Values: 0.0001 , 0.0001 , 0.0001
EW Gradient Weighting Model
Default Value: 1
NS Gradient Weighting Model
Default Value: 1
Vertical Gradient Weighting Model
Default Value: 1
Reweighting model
None
Active Model
Default Value: 1
IRI Focus
None
Reweighting Model
Default Value: 1

Global Settings

Acceleration
Radius of Influence (m): 1000000
Computational Error Tolerance: 0.0002
Regularization - Auto-Fit
Data fit: 1
Attempts: 20

9/15/22, 4:24 PM VRR_NW_UAV_Mag_Susc_12p5m_2022-09-12_15-17-42_Parameters.html

VOXI

Spatial Reference

Polygon File
Name: .\Northway_Block.ply
Coordinate System
Name: NAD83(CSRS) / UTM zone 17N
Units: m
Surface Definition
DEM Grid File: c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\SRTM1.grd(GRD)

Data

Database
Database File:
c:\data\work_VRR_northway_work\dronemag\data_review2\geosoft\VRR_NW_UAV_Mag_Susc_12p5m.geosoft_voxi.data\DatabaseFromGrid.gdb
X Channel: X
Y Channel: Y
Sensor Elevation Channel: Z
Data Type:
Type: Magnetic
Data Sampling Optimization: Yes
Samples Per Cell: 1
Sensor Channel:
Type: Magnetic
Channel: sensor
Fit Error - Absolute
Value: 2.5
Background Trend - Constant
Constant Value: -250
Physical Model:
Type: Susceptibility
IGRF
Date: 2022-03-24
Field Strength (nT): 56221
Inclination (degrees): 74.4
Declination (degrees): -10.4

Measurement Data from Grid

Sensor Grid File
Name: .\northway_uav_tmi_finalt_detrend1e_detrend1e2regional.grd(GRD;TYPE=FLOAT)
Elevation definition:
Elevation Type: Constant Above Terrain
Constant To Add: 54

Mesh Parameters

Active Volume

	X	Y	Z
Cell sizes (m)	12.5	12.5	6.25
Dimensions (cells)	225	148	59
Minima (m)	443303.3	5590399.5	-3581.4
Maxima (m)	446103.1	5592232.0	90.5

Base and Padding

	Base	Horizontal Padding	Vertical Padding
Dimensions (cells)	50	9	9
Cell expansion ratios	1.08	1.2	1.2

Top of Model
Value: 90.467
Lin-Log Transition
Value: 40

Constraints: Susceptibility

Starting Model
Default Value: Default for system
Parameter Reference Model
Voxel File: .\VRR_NW_Regional_Mag_Susc_100m_2022-09-08_13-55-22_Susc-regrid12p5-topoclip.geosoft_voxel
Gradient Reference Model
Default Value: 0
Upper Bounds Model
Default Value: 1e+20
Lower Bounds Model
Default Value: -1e+20
Parameter Weighting Model
Constant Value: 0.001
EW Gradient Weighting Model
Default Value: 1
NS Gradient Weighting Model
Default Value: 1
Vertical Gradient Weighting Model
Default Value: 1
Reweighting model
None
Active Model
Default Value: 1
IRI Focus
None
Reweighting Model
Default Value: 1

Global Settings

Acceleration
Radius of Influence (m): 1000000
Computational Error Tolerance: 0.0002
Regularization - Auto-Fit
Data fit: 1
Attempts: 20

Northway Project Expense Report
Drone Mag survey and Inversion

Invoice	Company	Date	Item	Total Charge	Charge to Northway	Calculation	tax	total	Comment
202205-05	Pioneer Exploration	5/4/2022	Drone-MAG survey	$ 28,501.86	$ 9,715.93	(114.305/335.316)	$ 1,263.07	$ 10,979.00	114.305 line kilometers flown on North Grid at Northway out of 335.316 l-km total
			Mob/Demobe	$ 2,900.00	$ 988.57	(114.305/335.316)	$ 128.51	$ 1,117.09	
			12m DSM	$ 850.00	$ 289.75	(114.305/335.316)	$ 37.67	$ 327.42	
			Extra Deliverables	$ 500.00	$ 170.44	(114.305/335.316)	$ 22.16	$ 192.60	
IN107394	Expedition Heli.	5/6/2022	FR#46531 - March 22	$ 5,232.50	$ 1,783.69	(114.305/335.316)	$ 231.88	$ 2,015.57	Mobilization to Otter Rapids and project area from Cochrane
			FR#40790 - March 23	$ 6,727.50	$ 2,293.32	(114.305/335.316)	$ 298.13	$ 2,591.45	Deployment of crew to HK and Northway projects
			FR#40791 - March 24	$ 2,840.50	$ 968.29	(114.305/335.316)	$ 125.88	$ 1,094.17	Deployment of crew to HK and Northway projects
			FR#40792 - March 25	$ 1,340.50	$ 456.96	(114.305/335.316)	$ 59.40	$ 516.36	Return to Cochrane
			Fuel Delivery	$ 3,360.00	$ 1,145.38	(114.305/335.316)	$ 148.90	$ 1,294.28	Delivery of fuel to Otter Rapids camp
			Jet A Bulk 180L/hr	$ 3,265.92	$ 1,113.31	(114.305/335.316)	$ 144.73	$ 1,258.04	Jet A fuel for Helicopter at 180L/hr
			Daily crew surcharge	$ 209.40	$ 71.38	(114.305/335.316)	$ 9.28	$ 80.66	Pilot per diem
2022-145	Condor North Consulting	9/19/2022	Magnetic susceptibility smooth model	$ 6,000.00	$ 6,000.00	100%	$ 300.00	$ 6,300.00	MVI and Mag Susceptibility inversions of Nortway magnetic data
				$ 61,728.18	$ 24,997.03		$ 2,769.61	$ 27,766.65	