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Laurion Mineral Exploration Inc.

UAV-MAG™ Survey Logistics Report

GLOBAL UAV
TECHNOLOGIES

Pioneer Aerial Surveys Ltd. is a Subsidiary of Global UAV Technologies Ltd., a vertically integrated drone technology company that is publicly traded on the Canadian Securities Exchange under the symbol UAV. For more information refer to www.globaluavtech.com

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Introduction

From August 20h, 2019 to August 29th, 2019, Pioneer Aerial Surveys Ltd. (Pioneer) completed an airborne magnetic survey (UAV-MAG™) using an Unmanned Aerial Vehicle (UAV) near the town of Beardmore, Ontario. The survey was flown at the request of Independence Gold Corp.

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	Thomas Stanley-Jones
Ground Supervisor	Mack Evenden
Data Processing and QA/QC	Kiyavash Parvar

Location

The survey area is located approximately 28 km northeast of the town of Beardmore, ON. The takeoff locations were accessed by truck. The location map of the survey area can be observed in Figure 1, and a detailed map of the survey lines is shown in Figure 2.

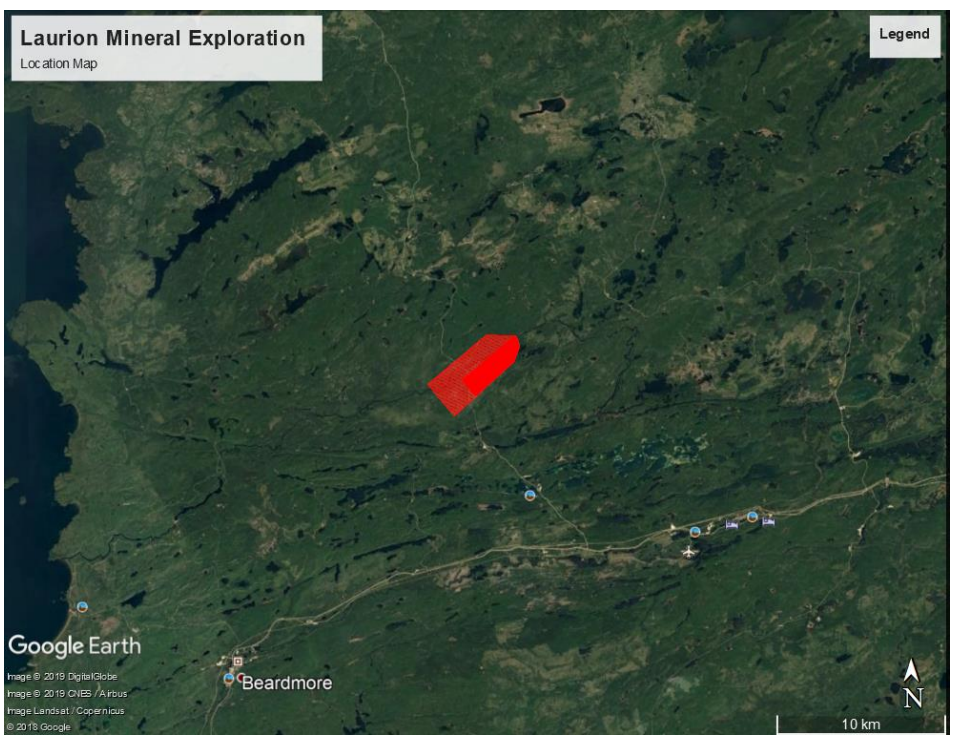

Figure 1: Location of the survey area, approximately 28 km northeast of Beardmore, ON.

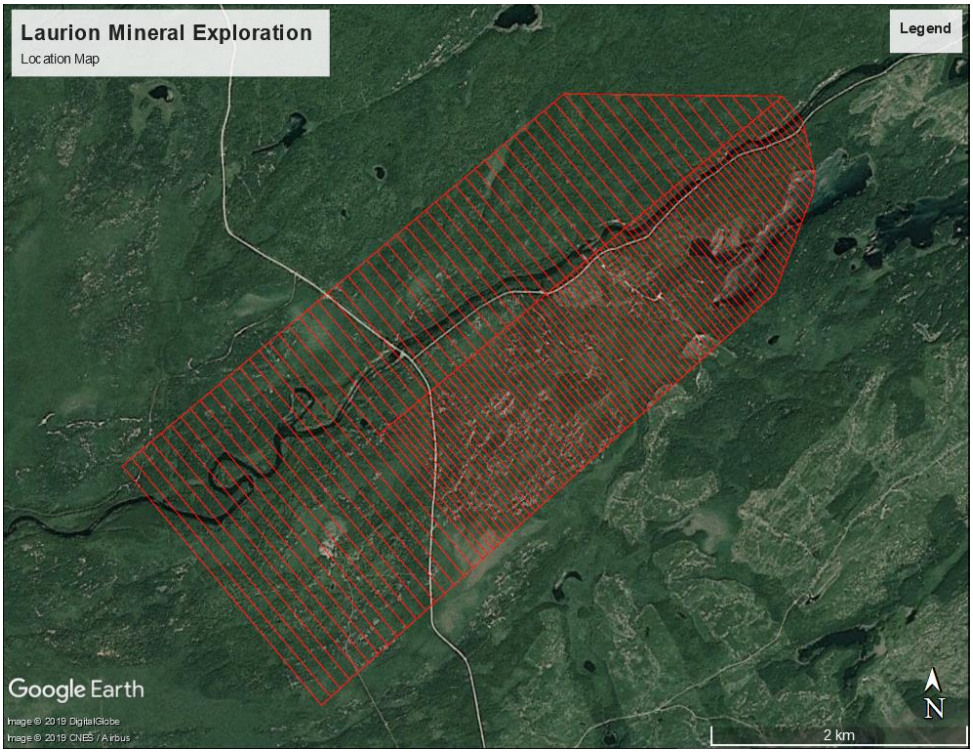

Figure 2: The survey flight lines are spaced at 100 m, with a higher resolution section at 50 m spacing.

Survey Specifications and Procedures

The nominal altitude above ground level (AGL) was set to 45 m for this survey. Elevation data for this survey was sourced Shuttle Radar Topography Mission 1-Arcsecond Global Dataset. The nominal production airspeed is 10 m/s for flat topography with no wind. This may be modified by the field crew in areas of rugged terrain or in windy conditions.

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)	Flight Lines (km)	Tie Lines (km)	Total Line Kilometres (km)
Laurion Mineral Exporation Inc	50	141°	500	90.57	17.13	107.70
	100	141	1000	83.99	4.41	88.40
						196.10

Instrumentation and Software

The principal airborne sensor used was a Gem Systems Canada GSMP-35UA potassium vapor sensor mounted on a UAV platform. Ancillary equipment included a laser altimeter with a 130m range, 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 was 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 600 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 helicopter 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-MAG™ Configuration

GEM System's UAV GSMP-35UA is a potassium magnetometer providing unmatched sensitivity in addition to a low heading error effect. The GSMP-35UA operates on principles similar to other alkali vapor magnetometers however benefits from the unique nuclear properties of potassium. Each GSMP-35UA system has 0.0002 nT sensitivity combined with +/- 0.1 nT absolute accuracy over its full operating range. More details on the instrument can be found in Appendix 1: Instrument Specification.

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
FlightDate	Date	YYYY/MM/DD
hhmmss_s	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: 54200 nT)	Nanotesla
Final	Final leveled and micro-leveled data	Nanotesla
VD1	1st Vertical derivative	nT/m
AS	Analytic Signal	nT/m
Dist	Distance to the first point of the line	metres
Laser	Laser altimeter data	metres

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 Field

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 remnant magnetic signals and/or low magnetic latitude complicates interpretation.

Data Processing

In general, all typical 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/ programing languages. Presentation of final maps used ESRI ArcMap and/or Geosoft's 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 116U

- Scale Factor: 1:20000
- 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. A final combination of all data formed the final results including lines that were re-flown due to weak or insufficient magnetic signal.

The base station readings were initially processed and filtered to remove sudden spikes. 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 extra high frequency features which mostly occur because the sensor is in the dead zone. This usually occurs 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, to mitigate the corrugation effect associated with gaps between the data lines, the data was micro-leveled. This task was done by applying a high-pass butterworth filter with the threshold of 100 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.

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 negligible therefore only a minor lag correction was applied
- Heading biases were negligible therefore no heading correction was applied
- Micro-leveling
- Analytic Signal calculation
- First Vertical Derivative calculation

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

Data Comments

Pioneer's UAV-MAG™ surveys result in a high quality, high resolution data products. The increased flight line density and low flight elevation with the use of a UAV platform result 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 error during data collection compared to traditional airborne surveys.

Logistics remains a major challenge for 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 having several staging locations to cover a survey area, and sometimes requires the employment of additional equipment such as an aerial platforms to achieve unobstructed line of sight. These smaller blocks typically flown in UAV surveys requires greater attention in the post acquisition processing.

Pioneer Aerial Surveys makes every effort to identify potential sources of noise and mitigate their impact on collected survey data. Additionally, weather is carefully monitored during the surveys and when excessive data inconsistency is noted due to weather conditions, flights area suspended until conditions improve.

Respectfully submitted,

Kiyavash Parvar, Masc. Geophysics
Manager of Geophysics

Pioneer Aerial Surveys Ltd.

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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)

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.

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

Appendix 2: Final Maps

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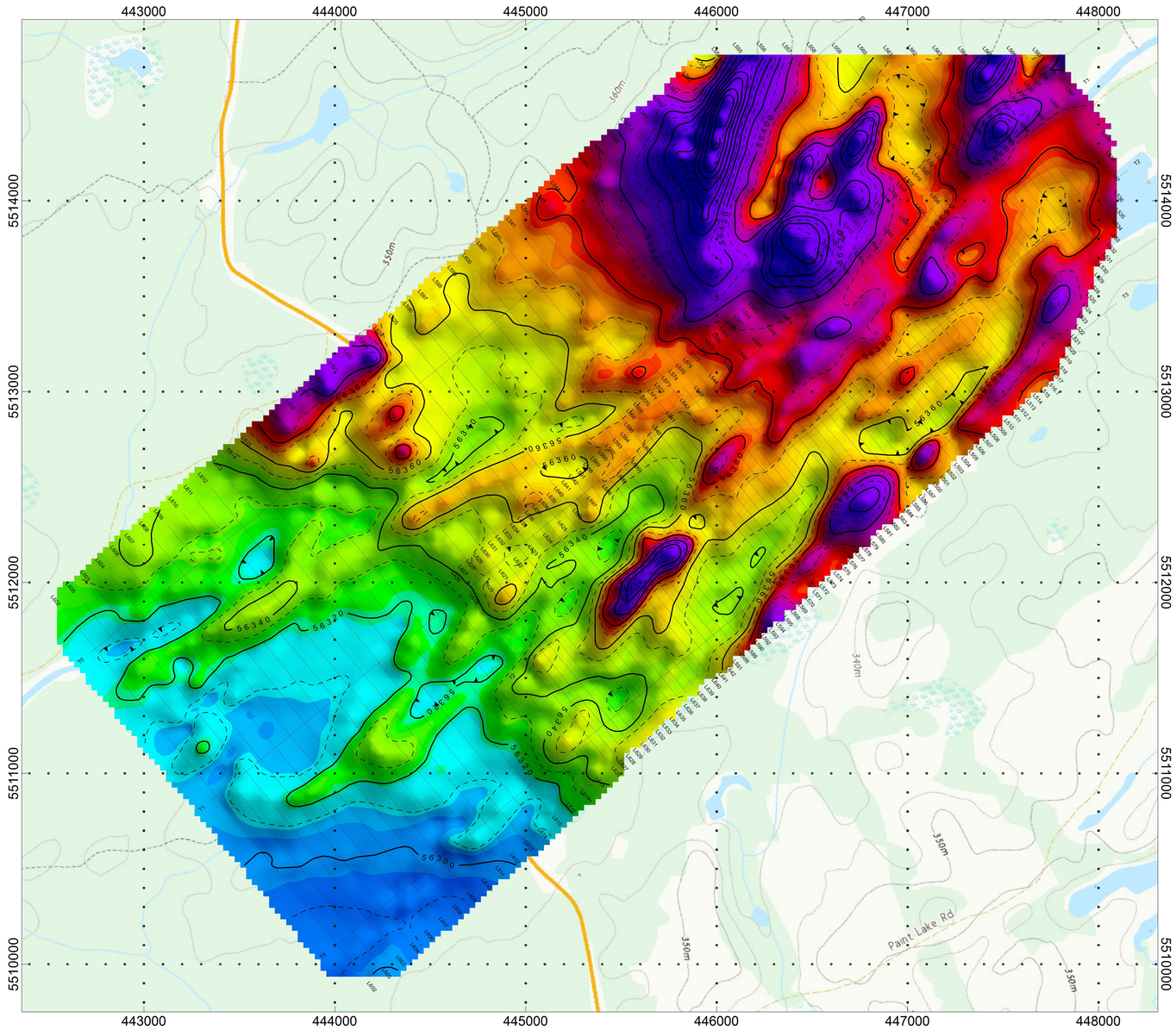
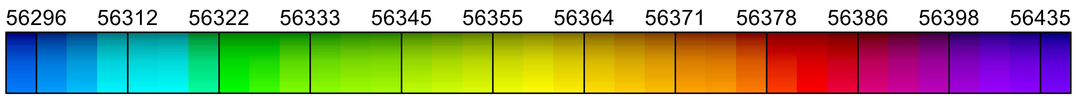




TMI
nT

Scale 1:20000
250 0 250 500
metres
WGS 84 / UTM zone 16N

Flight Parameters:

Flight line spacing: 50-100 m
Flight line azimuth: 130°N
Tie-line spacing: 500 m
Tie-line direction: 040°N
Nominal sensor elevation above ground: 40 m

Instrumentation:

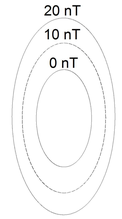
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

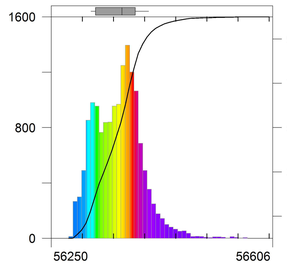
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 16U)

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

Contour Legend:





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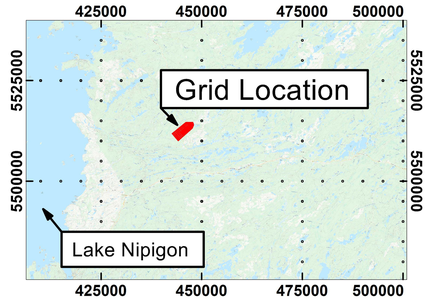
Maximum:	56560
Mean:	56360
Geo.Mean:	56360
Median:	56360
Mode:	56350
Std.Dev.:	37.85
Std.Err.:	0.3017
Skew:	0.6428
Kurtosis:	1.385



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Leveled And Micro-Leveled UAV-MAG™ Survey
Total Magnetic Intensity (TMI)
Units: nT

Survey Date: August 2019

Map Author: Kiyavash Parvar

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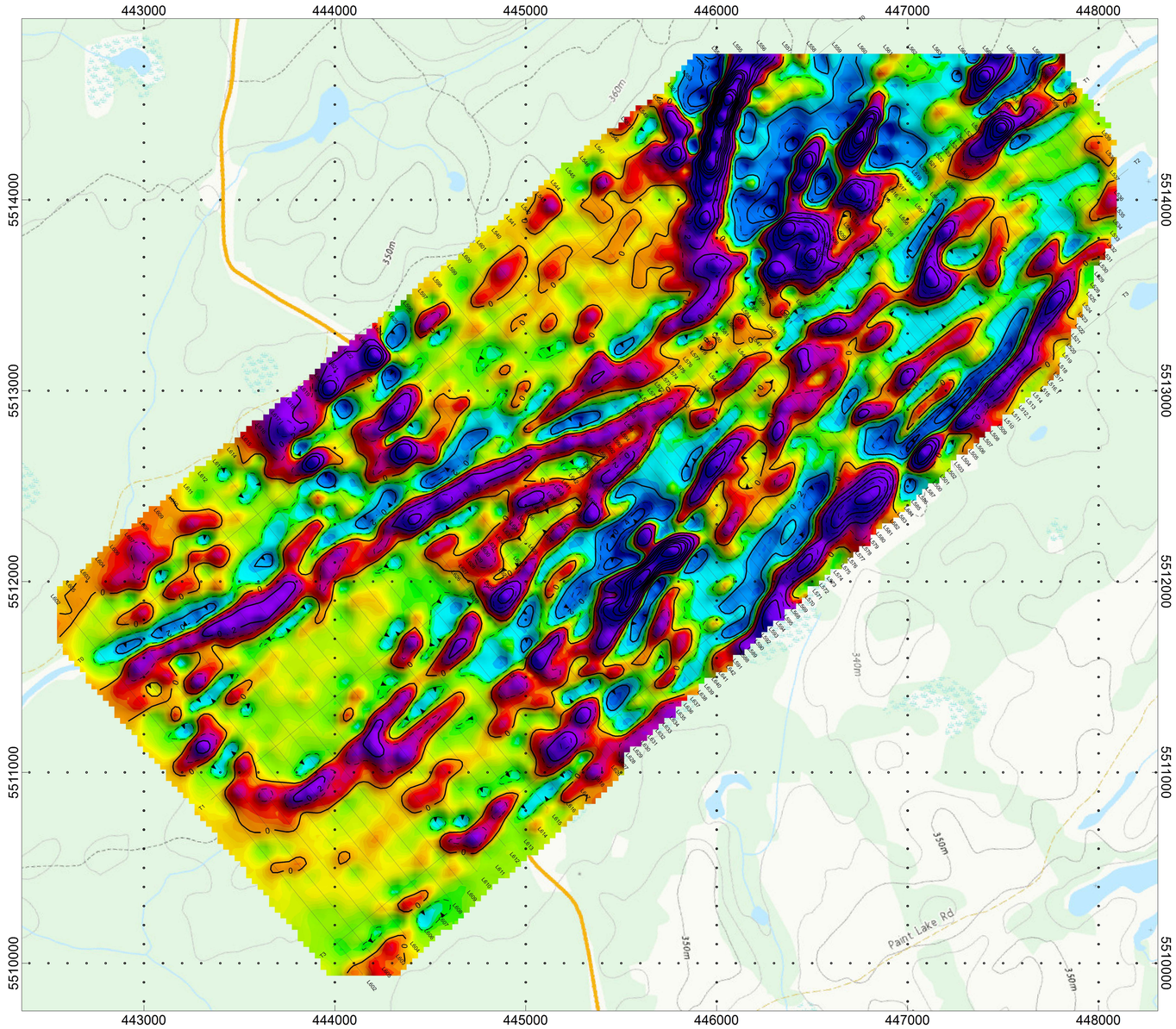
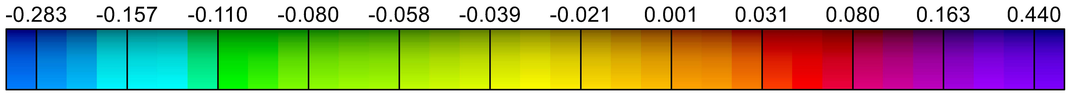




1VD
nT/m

Scale 1:20000
250 0 250 500
metres
WGS 84 / UTM zone 16N

Flight Parameters:

Flight line spacing: 50-100 m
Flight line azimuth: 130°N
Tie-line spacing: 500 m
Tie-line direction: 040°N
Nominal sensor elevation above ground: 40 m

Instrumentation:

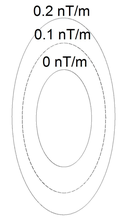
Unmanned aerial vehicle: Matrice 600 UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

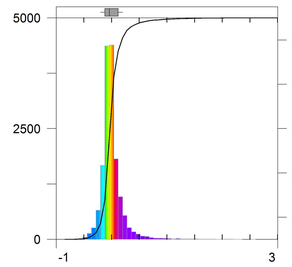
Coordinate system:

Datum: WGS84
Projection: Universal Transverse Mercator Central meridian: (Zone 16U)

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

Contour Legend:





Distribution of Data

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Mode:	-0.05417
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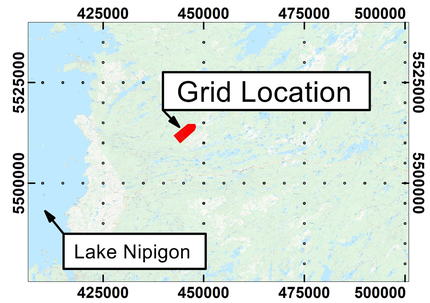
Std.Err.:	0.00161
Skew:	3.206
Kurtosis:	21.91



Pioneer Aerial Surveys Ltd.

Leveled And Micro-Leveled UAV-MAG™ Survey
First Vertical Derivative (1VD)
Units: nT/m

Survey Date: August 2019

Map Author: Kiyavash Parvar

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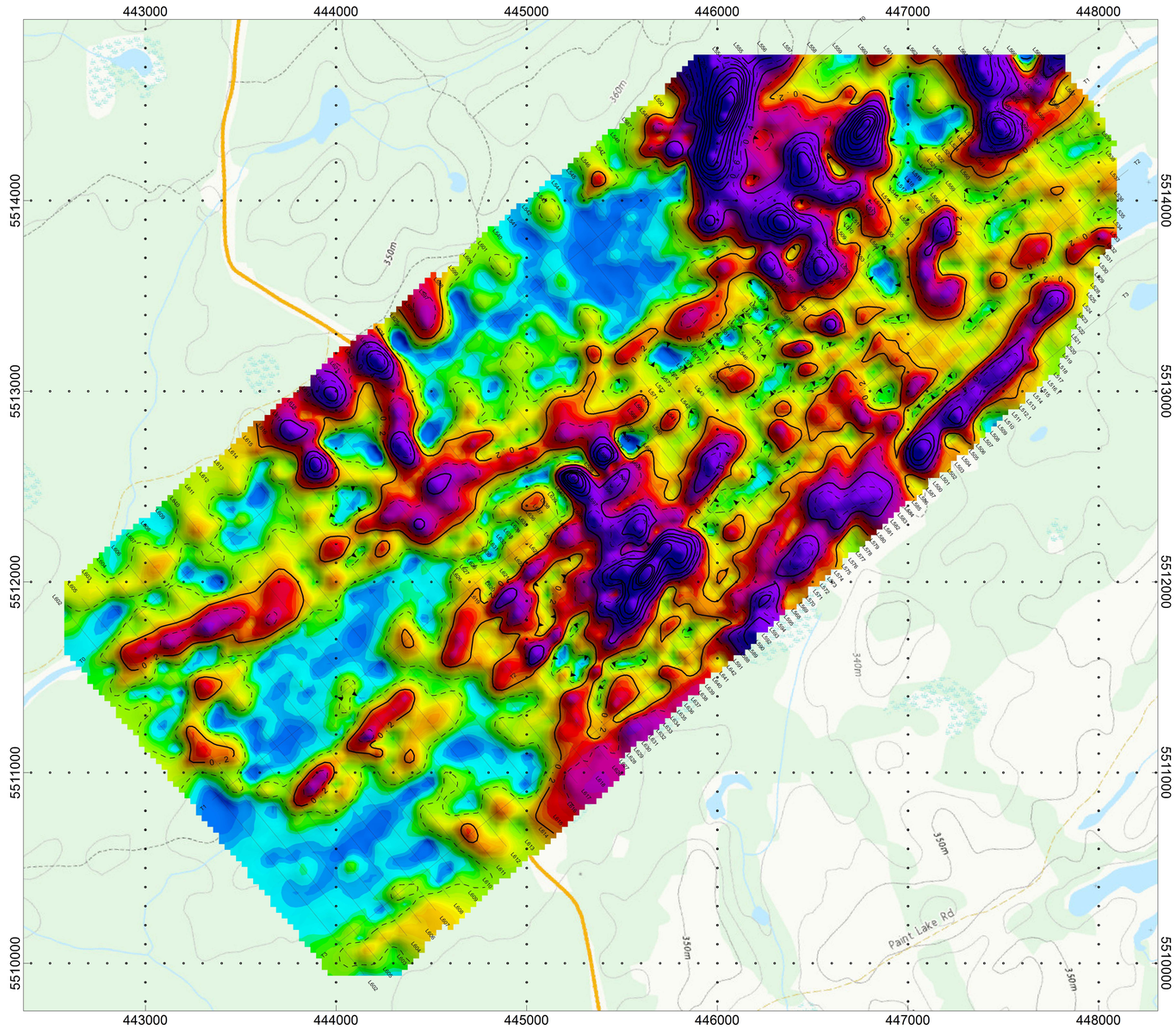

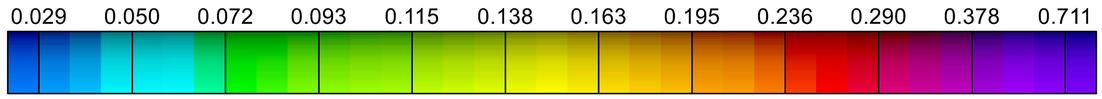

AS
nT/m

Scale 1:20000
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WGS 84 / UTM zone 16N

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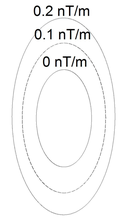
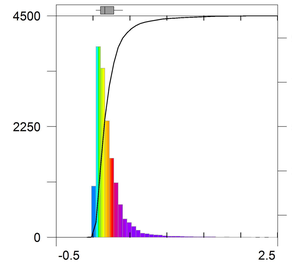
Hill shade inclination:045°N
Hill shade declination:045°N (NE-SW)

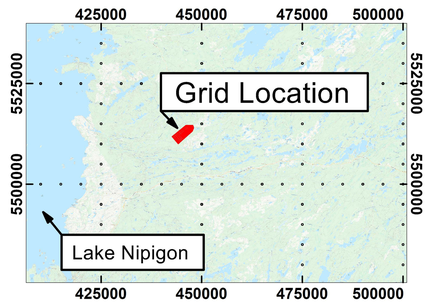
Contour Legend:





Distribution of Data

Samples:	15677
Minimum:	-0.0401
Maximum:	2.475
Mean:	0.2063
Geo.Mean:	0.1458
Median:	0.1502
Mode:	0.1567
Std.Dev.:	0.2069
Std.Err.:	0.001653
Skew:	3.546
Kurtosis:	19.47



Pioneer Aerial Surveys Ltd.

Leveled And Micro-Leveled UAV-MAG™ Survey
Analytic Signal (AS)
Units: nT/m

Survey Date: August 2019

Map Author: Kiyavash Parvar