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Assessment Report on a UAV Aeromagnetic Survey at the Halliday Lake Project

Mining claims 645336-645401

Halliday Lake Project

Porcupine Mining Division

Sothman and Halliday Townships

Prepared for: Kelly Malcolm

By: Kelly Malcolm P.Geo (Ontario)

Effective Date: March 24th, 2023

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Summary

This report discusses a UAV Aeromagnetic Survey on the Halliday Lake project located in the Porcupine Mining District, within Sothman and Halliday Townships. The project is located approximately 67km south of Timmins, with the geographical center at 483966m E, 5301363m N (NAD83 / UTM zone 17N).

This survey, conducted by Pioneer Exploration Services Ltd., covered a total area of 1430 hectares of magnetics, utilizing a DJI Matrice 300 RTK UAV with a GEM GSMP-35UA ultra light-weight Potassium magnetometer and a GEM GSM-19 (Overhauser proton) ground magnetometer base station.

Data collection for this survey area was conducted at 25 m spaced lines with 250 m spaced tie lines at an azimuth of 0 degrees for a total of 640.7 line kilometers. The nominal magnetic sensor altitude above ground level (AGL) was set to 35 m. Elevation from the terrain varied depending on the treeline and obstacles on the flight route.

The survey was conducted between March 4th and March 12th, 2023. Kelly Malcolm, P.Geo., of Toronto, Ontario, reviewed the survey data and wrote this report for assessment reporting purposes. The objective of the survey was to identify and determine the extent strength of magnetic anomalies, with a focus on nickel potential (ultramafic-hosted disseminated Ni-sulfide, similar to mineralization identified in neighbouring properties by Aston Minerals and Canada Nickel). In addition, the magnetic data may provide structural and lithological information, which can have a control on emplacement of mineralization.

The survey was successful at delineating numerous structural trends and magnetic anomalies that are proximal to existing mineral occurrences. Discrete high-mag anomalies near the south of the Halliday Lake adjacent to the past-producing Sothman mine display similar magnetic signatures to the Sothman mine and should be investigated with further exploration work. In addition, a large broad magnetic anomaly was identified in the northwestern portion of the survey area that requires investigation.

Future recommendations include compilation of this survey along with historical geophysical and geological work on the property. Following this compilation, the Author recommends inversion of the magnetic data to identify the depths of the identified anomalies. The next step would be either ground-truthing, provided the anomalies come to surface, or diamond drilling, in the event that the inversion data identifies that the anomalies occur at depth.

Table 1: Mining lands on which survey was performed

Tenure Number	Title Type	Tenure Status	Issue Date	Claim Due Date	Holder
810862	Multi-Cell Mining Claim	Active	3/26/2021	3/26/2023	(100) Kelly James Malcolm
810863	Multi-Cell Mining Claim	Active	3/26/2021	3/26/2023	(100) Kelly James Malcolm
810864	Multi-Cell Mining Claim	Active	3/26/2021	3/26/2023	(100) Kelly James Malcolm

Location And Access

The Halliday lake project consists of 3 multi-cell mining claims, as shown in **Table 1**, located approximately 67 km directly south of Timmins. The property is accessible along the southern extension of Pine street south/Grassy road north extension, with year-round access.

The eastern extent of the project benefits from the Ministry of Natural Resources and Forestry (MNRF) logging roadways, which crosscut the project in an east-west direction. Access to the northern extent of the project is from the Halliday Lake, which is a navigable water way, especially during the winter due to ideal freezing conditions. During the March 2023 UAV Aeromagnetic survey, snowmobiles were utilized to reach portions of the property further from the primary access roadway.

Most of the project area is covered by overburden, with generally flat topography and relief. The topography of the area ranges from 1150-1250ft, with rounded hills typically 60ft above marshy areas. The main rock outcrops occur as low bluffs along the shores of Halliday Lakes and the banks of the rivers/streams which drain into the larger waterways.

Vegetation of the rounded hills elevated above the swampy/marsh land contains mixed growth of spruce and poplar with local areas of balsam, birch and jackpine. The lower-lying zones contain scrub spruce, muskeg, alders and limited cedar trees. Areas which are lowest lying consist of swampy zones with associated pools of stagnant rainwater.

The location and access to the property is shown in **Figures 1** and **2**.

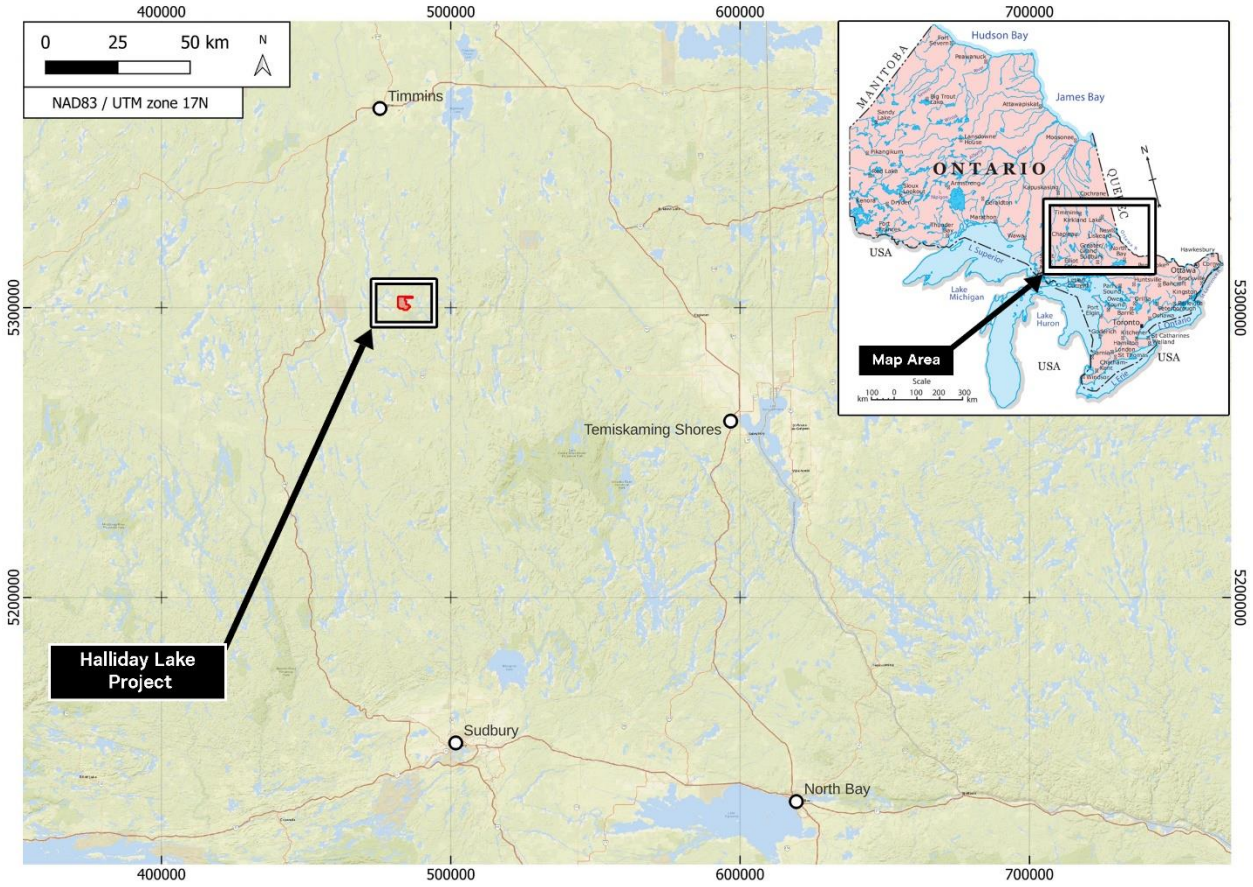

Figure 1: Location of the Halliday Lake Property in Central Ontario, south of Timmins and north of Sudbury.

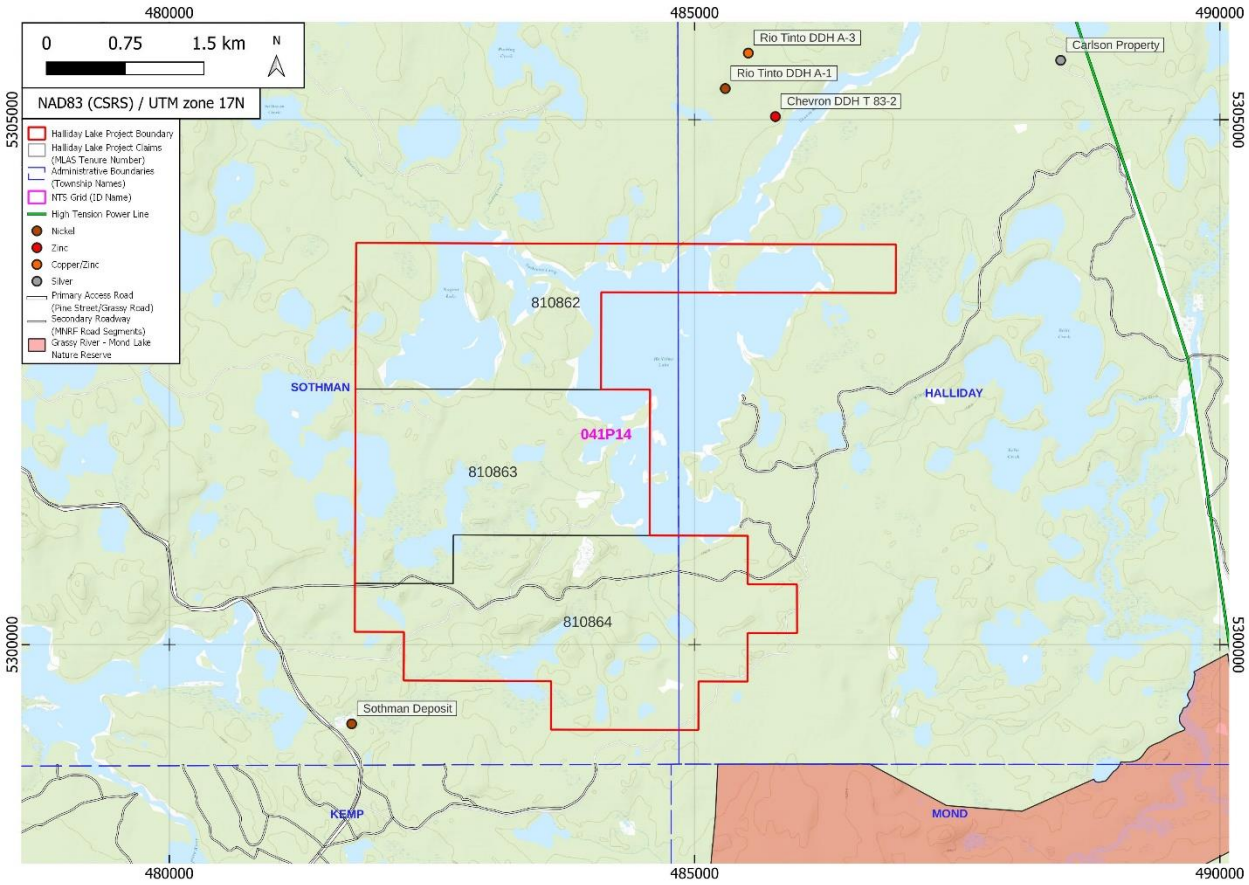

Figure 2: Map showing the Halliday Lake claims, topographic data, OMI mineral occurrences, roads, townships, operational alienations, power lines and the NTS grid.

Property Ownership and Exploration History

The Halliday Lake project was acquired by map staking by the Author. Prior to this UAV Magnetic survey, the Author has not completed any prior work on the property.

Historically, numerous operators conducted small exploration programs on the Property. The historical work included multiple geophysical surveys, geological mapping and prospecting programs. Within the project boundary, there are no historical mineral occurrences recognized by the Ontario Mineral Inventory database.

Within the project boundary, the Ontario Assessment File Database (OAFD) contains multiple assessment reports. The summary of the assessment reports filed within the project area is summarized as follows:

1952 – Geological Survey / Mapping, Magnetic / Magnetometer Survey, with assessment work completed on “Sothman Deposit” covering South-West Portion of Halliday Lake claims. Completed for Dominion Gulf Co.

1956 – Resistivity survey, Completed for Base Metals Mining Corp

1972 - Electromagnetic, Electromagnetic Very Low Frequency, Magnetic / Magnetometer survey, Completed for Newmont Mining Corporation of Canada

1974 - Airborne Electromagnetic, Airborne Magnetometer survey, Completed for Granges Expl Aktiebolag

1975 - Geological Survey / Mapping survey, Completed for A J Salo

1978 - Electromagnetic, Magnetic / Magnetometer Survey survey, Completed for Essex Minerals Co Ltd

1979 - Diamond Drilling, Geochemical survey, Completed for Essex Minerals Co Ltd

1981 - Airborne Electromagnetic survey, Completed for Norcen Energy Resources

1989 - Airborne Electromagnetic, Airborne Electromagnetic Very Low Frequency, Airborne Magnetometer, Compilation and Interpretation, Completed for Falconbridge Ltd

1996 - Induced Polarization, Manual Labour, Resistivity survey, Assaying and Analyses, Electromagnetic Very Low Frequency, Geological Survey / Mapping, Magnetic / Magnetometer Survey and Prospecting, Completed for Panterra Minerals Inc

2014 - Induced Polarization survey, Completed for Sgx Resources Inc

Regional and Project Geology

The project is located within the Superior province in the western portion of the Wawa-Abitibi sub-province. The claim package overlies rocks of dacitic and andesitic flows, tuffs and breccias from the Neo-to-Mesoarchean (2.5 Ga to 3.2 Ga).

The stratigraphy trends approximately east-west with shear zones typically tending Northeast, with north-south trending faults interrupting the stratigraphy.

Primary rock type includes deformed Archean basement complex consisting of metavolcanics, metasediments, mafic-ultramafic intrusives overlain by younger Proterozoic series of generally flat-lying sediments (Cobalt Group). The Archean-age metasediments of the Cobalt Group are not mapped in the immediate area of the Halliday lake project. Ultramafic intrusives occur immediately to the south-west of the Halliday Lake Property in Sothman Township.

The metavolcanic complex consists of flows, tuffs, pyroclastics, breccias,and their schistose equivalents; their composition ranges from felsic types (rhyolite, dacite, sericite schist) to mafics (andesite, chlorite schist).

A geological map of the project is shown in **Figure 3**.

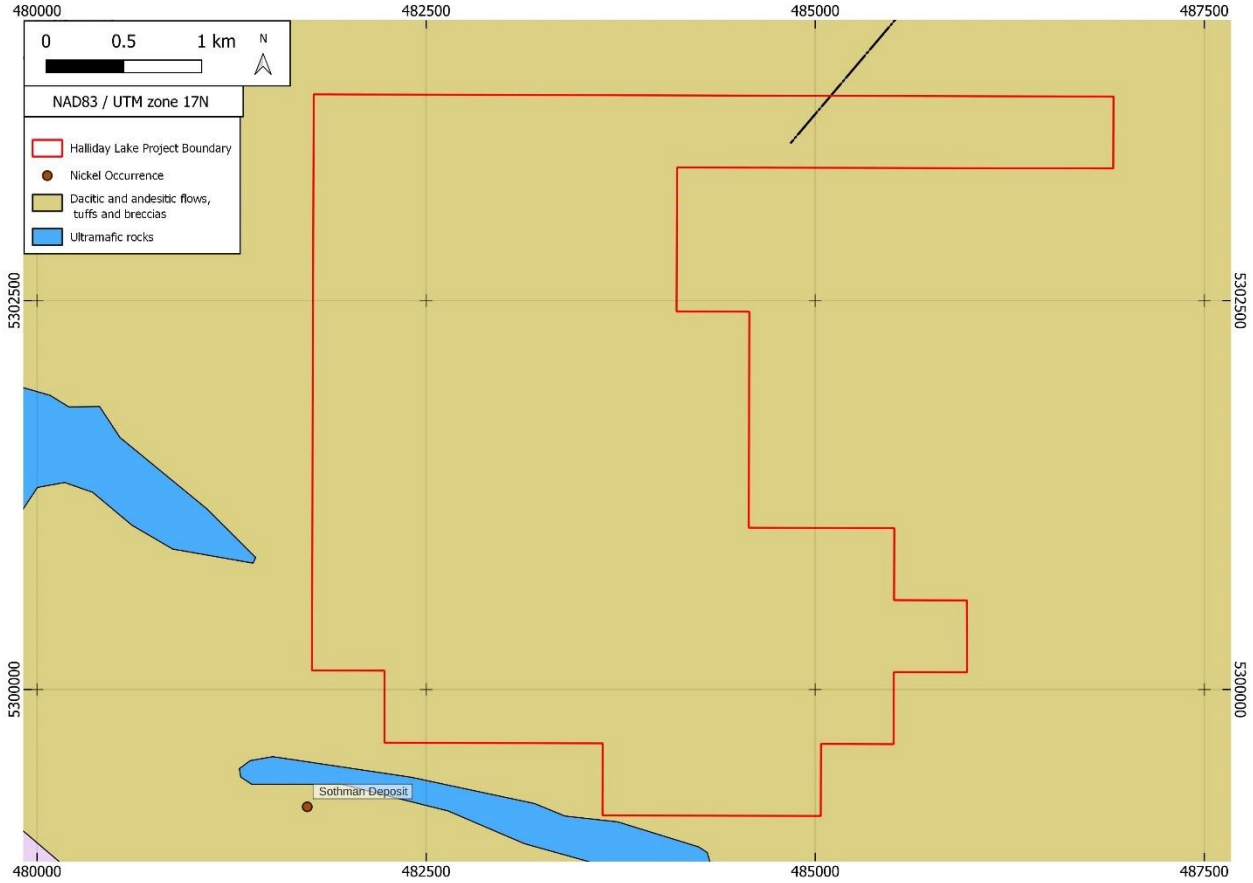

Figure 3: Geology map displaying Halliday Lake claim boundary, OMI mineral occurrences, and geological formations located within the project's surrounding area. Adapted from Ontario Geological Survey.

Geophysical Survey Objectives and Results

A total of 640.7 line kilometres of the recorded data were collected and compiled by Pioneer Exploration Services. Deliverables include maps of total magnetic intensity (TMI), first vertical derivative (1VD) and 3D analytical signal (AS). Specifics on the UAV magnetic survey can be seen in Table 1 and Table 2.

The objective of the survey was to identify targets for follow-up work for base metal mineralization, utilizing magnetic data to identify structural and lithological trends that may have controls on mineralization. Additionally, the magnetic data may identify mineral targets in and of themselves, with both magnetic high or low anomalies.

The survey was successful at delineating numerous structural trends, and identified magnetic anomalies that are directly related to proximal mineral occurrences.

Specifics on equipment that was used in the survey can be viewed in Appendix 1. Flight lines of the aeromagnetic survey are shown in **Figure 4**. Final maps for TMI, 1VD and AS included in **Figures 5**, **6** and **7**.

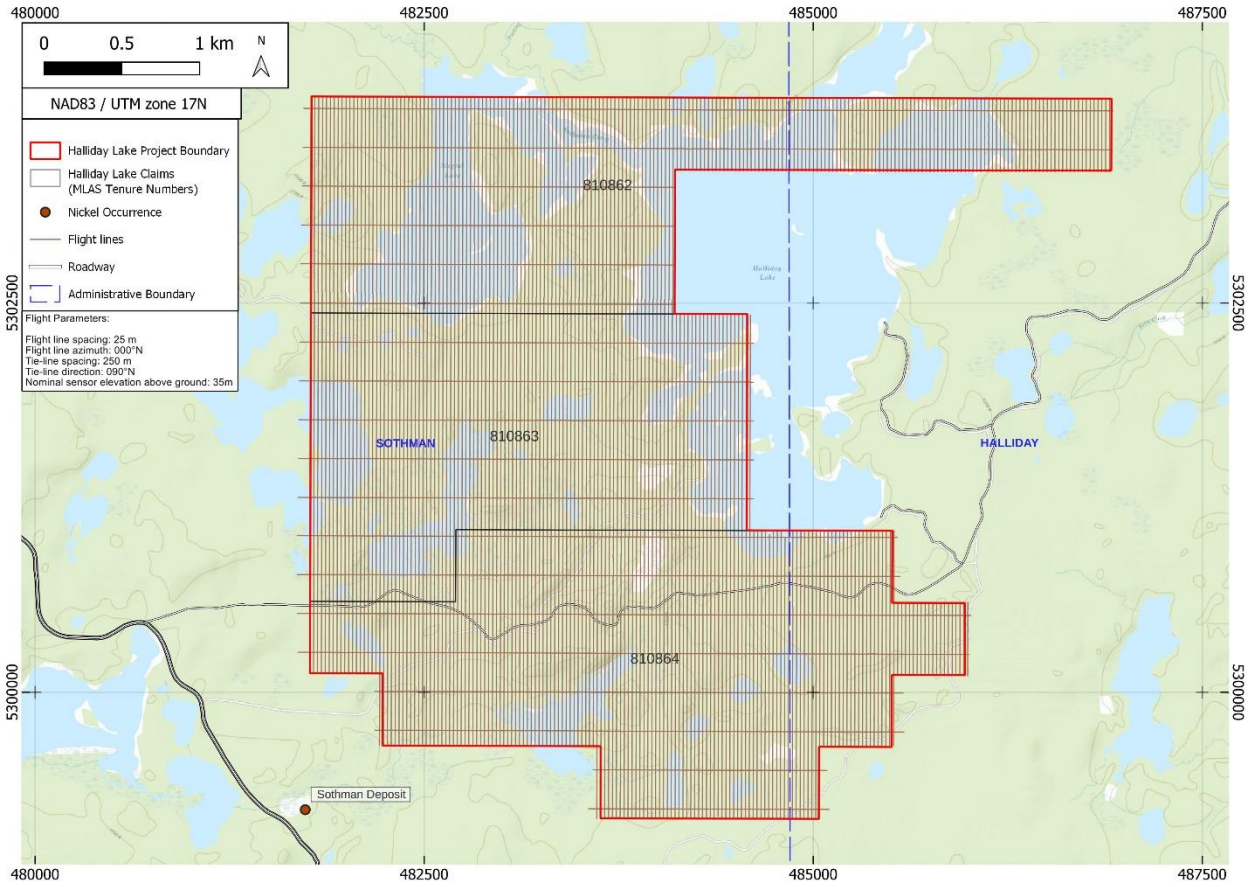

Figure 4: Flight path for the survey displayed along with mineral claims, topo, OMI mineral occurrences, roads, and townships.

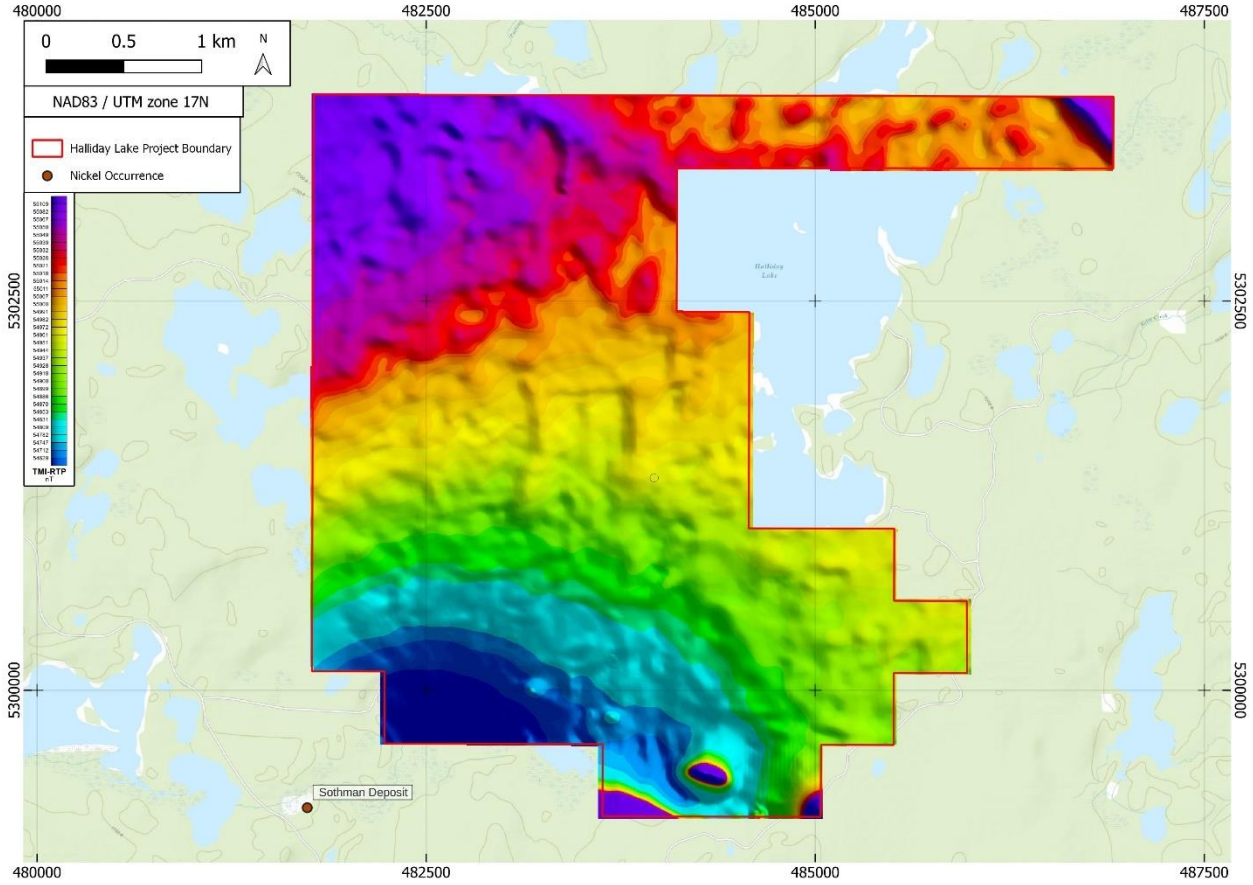

Figure 5: Total magnetic intensity (TMI) displayed along with topo and OMI mineral occurrences.

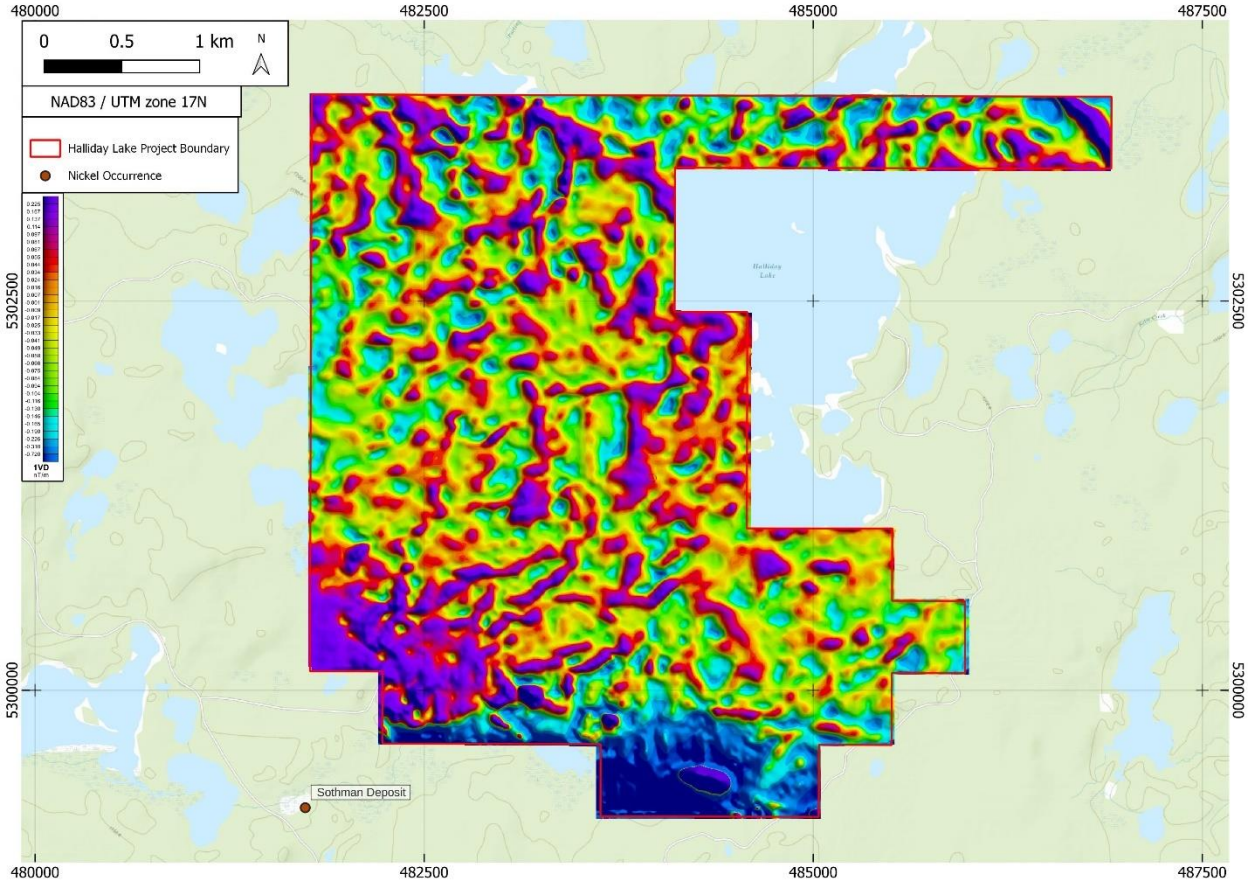

Figure 6: First vertical derivative (1VD) magnetics, reduced to the pole, displayed along with topo and OMI mineral occurrences.

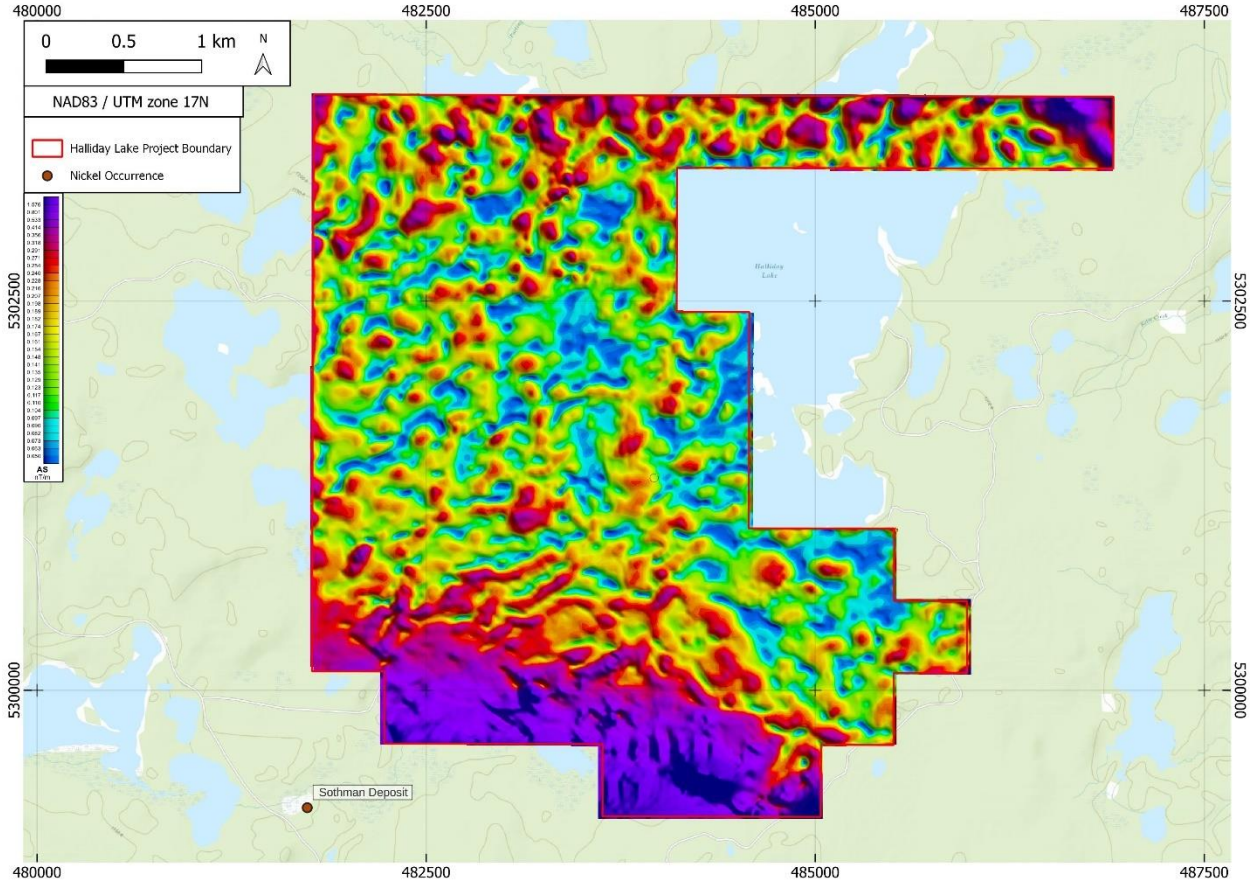

Figure 7: Analytic Signal (AS) map, displayed along with topo and OMI mineral occurrences.

Survey Specifications and Procedures

Data collection for this survey area was conducted at 25 m spaced lines with 250 m spaced tie lines. The nominal magnetic sensor altitude above ground level (AGL) was set to 35 m. Elevation from the terrain may vary depending on the treeline and obstacles on the flight route. A satellite-based 5 m resolution DSM was acquired from third parties. This was used 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.

See **Appendix** for additional information.

Information regarding the personal involved with the completion and collection of geophysical data is summarized within **Table 2**.

Table 2: Personnel involved in the survey

Pilot in Command	Fredrique Bowen
Ground Crew	Andrew Murrical

Data Processing and QA/QC	Kiyavash Parvar (M.A.Sc. Geophysics), Andrew Gagnon-Nandram (M.A.Sc. Geophysics), Oladele Olaniyan (PhD Geophysics)

Addition details on the completed survey can be found in **Table 3**.

Table 3: Survey details

Line Spacing (m)	Line Direction (deg)	Tie Line Spacing (m)	Total Line Kilometres (km)
25	000	250	640.701

Instrumentation and Software

See **Appendix**

Data Deliverables and Channel Descriptions

See **Appendix**

Data Processing

See **Appendix**

Discussion of Results

When completing preliminary analysis of the results of the survey, there appears to good contrast and correlation between the magnetically high zones and the background signal from felsic volcanics.

Magnetic data appears to differentiate quite sharply between the two major rock types within the project boundary. Magnetically flat zones typically align with the felsic geological rock types, while the magnetic anomalies themselves may be correlated with intrusive packages, possibility ultramafic bodies.

The aeromagnetic survey detected multiple anomalous zones on the property that could indicate the presence of ultramafic bodies, with discrete anomalies identified in the south/southwest corner of the project and broad high-mag anomalies in the northwest.

The discrete magnetic anomalies identified are within the vicinity of the past-producing Sothman Mine, which is a nickel-bearing ultramafic intrusive. This zone is located approximately 1km south-west of lower southwest corner of the project and indicates that the discrete high-magnetic anomalies within the Halliday Lake project may display similar characteristics.

Conclusions and Recommendations

The survey completed over the Halliday Lake project was successful in generating high-quality and high-resolution magnetic data over the project area. The survey was successful in identifying magnetic anomalies within project boundary. Structural features are readily apparent too, particularly in the 1VD maps, which may provide help in targeting mineralization.

It is recommended that prior to follow-up geological prospecting, that a full dataset compilation of historical work on the property is assembled and investigated. Following this compilation, the Author recommends inversion of the magnetic data to identify the depths of the identified anomalies. The next step would be either ground-truthing, provided the anomalies come to surface, or diamond drilling, in the event that the inversion data identifies that the anomalies occur at depth.

References

Ontario Mineral Inventory database, Ministry of Northern Development, Mines, Natural Resources, and Forestry.

Ontario Department of Mines Geological Report 79 by E.G. Bright (1970)

Geology of Sothman Township, Ministry of Northern Development, Mines, Natural Resources and Forestry, Report ARV62-06 by E.M. Abraham (1954)

Halliday Township District of Sudbury Report, Ministry of Northern Development, Mines, Natural Resources and Forestry, Report P0385 by E.G. Bright (1968)

SIGNATURE PAGE

This report entitled: "Assessment report on a UAV Aeromagnetic Survey on the Halliday Lake Project" and dated March 24, 2023 was prepared by and signed by the following author:

Signed at Toronto, ON
March 24, 2023

" *Kelly Malcolm, P.Geo.*" (signed)
Kelly Malcolm, P.Geo.

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CERTIFICATE OF AUTHOR

I, Kelly Malcolm, P. Geo. do hereby certify that:

1. I am President of a geological consulting firm headquartered in Toronto called Generic Geo Inc.
2. I hold the following academic qualifications: h.B.Sc. (Geology) and B.A. Economics from Laurentian University, 2014.
3. I am a registered Professional Geoscientist with the Association of Professional Geoscientists of Ontario (No. 2864) and a member in good standing.
3. I have worked in the mining and exploration industry for over 10 years.
4. I am not aware of any material fact, or change in reported information, in connection with the subject property, not reported or considered by me, the omission of which makes this report misleading.
5. I am the author responsible for the preparation of the Assessment Report entitled "Assessment Report on a UAV Aeromagnetic Survey on the Halliday Lake Project" dated March 24th, 2023

Appendix: Geophysical Report

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UAV Aeromagnetic Survey
Logistics Report

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Introduction

From March 4th to March 12th, 2023 Pioneer Exploration Consultants Ltd. (Pioneer) completed an airborne magnetic survey using an Unmanned Aerial Vehicle (UAV) around Timmins area in northern Ontario. The survey was flown at the request of Generic Geo Inc.

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	Fredrique Bowen
Ground Crew	Andrew Murrical
Data Processing and QA/QC	Kiyavash Parvar (M.A.Sc. Geophysics), Andrew Gagnon-Nandram (M.A.Sc. Geophysics), Oladele Olaniyan (PhD Geophysics)

Location

The Halliday Lake survey area is located in northern Ontario, south of Timmins. The project is approximately 40 km west of Matachewan, Ontario, Canada. The survey was staged by 4 x 4 truck as well as snowmobiles. The location and completed survey lines for the Tashiro survey are illustrated in Figure 1.

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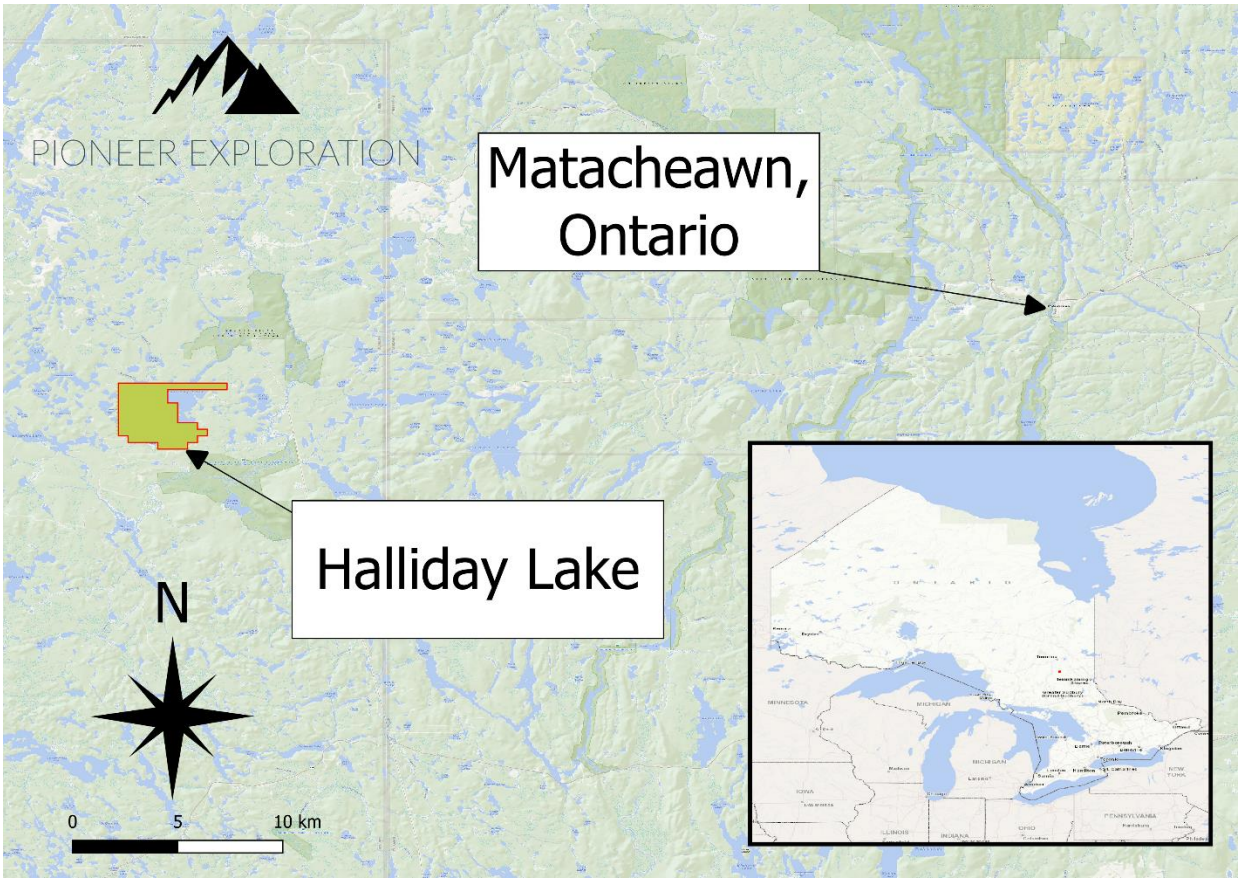

Figure 1: The HallidayLake survey area is outlined in red, with the completed survey lines overlain in Yellow. Inset, the project location can be observed 40 km west of Matachewan, Ontario.

Survey Specifications and Procedures

Data collection for this survey area was conducted at 25 m spaced lines with 250 m spaced tie lines. The nominal magnetic sensor altitude above ground level (AGL) was set to 35 m. Elevation from the terrain may vary depending on the treeline and obstacles on the flight route. A satellite-based 5 m resolution DSM was acquired from third parties. This was used 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

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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.

Project	Line Spacing (m)	Line Direction (deg)	Tie Line Spacing (m)	Total Line Kilometres (km)
Generic Geo Halliday Lake	25	000	250	640.701

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 20 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 aircraft. 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 300 RTK

Pioneer used the Matrice M300 RTK UAV to complete this survey. The Matrice 300 (M300) is DJI's platform designed for professional industrial applications. It incorporates a number of DJI technologies in order to increase flight efficiency and safety. These include the 6 directional sensing optical sensors, RTK positioning system, built in FPV camera and advanced flight controller system with built in digital display. As stated by the manufacturer, some of the advantages to using this type of multirotor systems are:

Total Integration: The modular design makes the M300 easy to set up and ready to use in just minutes. The mechanical design, along with quick-release landing gears and mounted folding arms, makes it easy

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to transport, store, and prepare for flight. The built in FPV camera and compatibility with a suite of DJI gimbals and sensors makes this a versatile system that can suit a number of projects.

Extended Flight Time: The M300 features an advanced power module with dual smart batteries that enhance flight safety and ensure a safe power supply to the aircraft. This allows for a maximum flight time of up to 55 minutes (with no payload).

DJI Smart Controller: The M300 Smart Controller comes complete with an integrated HD display, featuring an Android system with multiple connectivity functions such as Bluetooth, Wi-Fi and HDMI. The transmission system supports 2.4 GHz and 5.8 GHz channels under AES-256 ecryption, with HD video transmission range of up to 15 km.

Smart Flight Safety: The M300 has multiple built in safety features, including 6 directional optical sensors for obstacle avoidance and vision positioning. The integrated Air-Sense system alerts the user to nearby aircraft in the surrounding airspace to ensure safety. The system is also has an ingress protection factor of IP45, providing significant protection from moisture to the internal electronics.

RTK Positioning: The aircraft has a built-in RTK module, which provides more accurate heading data for positioning. Positioning data down to cm level precision can be achieved when using a GNSS base station.

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 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.

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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: 53300 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. 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.

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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 17N
- Scale Factor : 1 : 10000
- 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 bi-directional line gridding algorithm 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 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.

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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
- First Vertical Derivative calculation

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

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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

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Appendix 1: Instrument Specification

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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

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Matrice 300 RTK

Structure

Diagonal Wheelbase	895 mm
Aircraft Dimensions	810 mm x 670 mm x 430 mm (Unfolded, propellers excluded) 430 mm x 420 mm x 430 mm (Folded, propellers included)
Intelligent Flight Battery Quantity	2
Weight	3.6 kg (no batteries) 6.3 kg (two TB60 batteries)
Max Takeoff Weight	9 kg

Performance

Hovering Accuracy (P-mode with GPS)	Vertical: ± 0.1 m (Vision System enabled) ± 0.5 m (GPS enabled) ± 0.1 m (RTK enabled) Horizontal: ± 0.3 m (Vision System Enabled) ± 1.5 m (GPS enabled) ± 0.1 m (RTK enabled)
Max Angular Velocity	Pitch: 300°/s Yaw: 100°/s
Max Pitch Angle	30° (P-mode, Forward Vision System enabled: 25°)
Max Speed of Ascent	S Mode: 6 m/s P Mode: 5 m/s
Max Speed of Descent	S Mode: 5 m/s P Mode: 4 m/s
Max Speed	S Mode: 23 m/s P Mode: 17 m/s
Max Wind Resistance	15 m/s (12 m/s when taking off or landing)
Service Ceiling Above Sea Level	5000 m (with 2110 propellers, takeoff weight ≤ 7 kg) / 7000 m (with 2195 propellers, takeoff weight ≤ 7 kg)
Max Flight Time	55 min
Ingress Protection Rating	IP45
GNSS	GPS + GLONASS + BeiDou + Galileo
Operating Temperature	-20°C to 50°C (-4°F to 122° F)

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Remote Controller

Operating Frequency	2.4000-2.4835 GHz 5.725-5.850 GHz
Max Transmitting Distance (unobstructed, free of interference)	NCC/FCC: 15 km CE/MIC: 8 km SRRC: 8 km
EIRP	2.4000-2.4835 GHz: 29.5 dBm (FCC) 18.5dBm (CE) 18.5 dBm (SRRC); 18.5dBm (MIC) 5.725-5.850 GHz: 28.5 dBm (FCC); 12.5dBm (CE) 20.5 dBm (SRRC)
Battery Life	Built-in battery: Approx. 2.5h Built-in battery+External battery: Approx. 4.5h
USB Power Supply	5 V / 1.5 A
Operating Temperature	-20°C to 40°C (-4 °F to 104 °F)

Vision System

Obstacle Sensing Range	Forward/Backward/Left/Right: 0.7-40m Upward/Downward: 0.6-30m
FOV	Forward/Backward/Downward: 65° (H), 50° (V) Left/Right/Upward: 75°(H), 60°(V)
Operating Environment	Surfaces with clear patterns and adequate lighting (> 15 lux)

Intelligent Flight Battery

Name	TB60
Capacity	5935 mAh
Voltage	52.8 V
Battery Type	LiPo 12S
Energy	274 Wh
Net Weight	Approx. 1.35 kg
Operating Temperature	-4°F to 122°F (-20°C to 50°C)
Ideal storage temperature	71.6°F to 86°F (22°C to 30°C)
Charging Temperature	-4°F to 104°F (-20°C to 40°C)
Charging time	Using BS60 Intelligent Battery Station: 220V input: 60 minutes (fully charging two TB60 batteries), 30 minutes (charging two TB60 batteries from 20% to 90%) 110V input: 70 minutes (fully charging two TB60 batteries), 40 minutes (charging two TB60 batteries from 20% to 90%)

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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	161 mm x 64 mm (external diameter) with 2m cabling; 0.43 kg
Electronics Box	236 mm x 56 mm x 39 mm; 0.46 kg
Option 1 cabling	0.125 kg
Option 3 light weight battery	0.250 kg

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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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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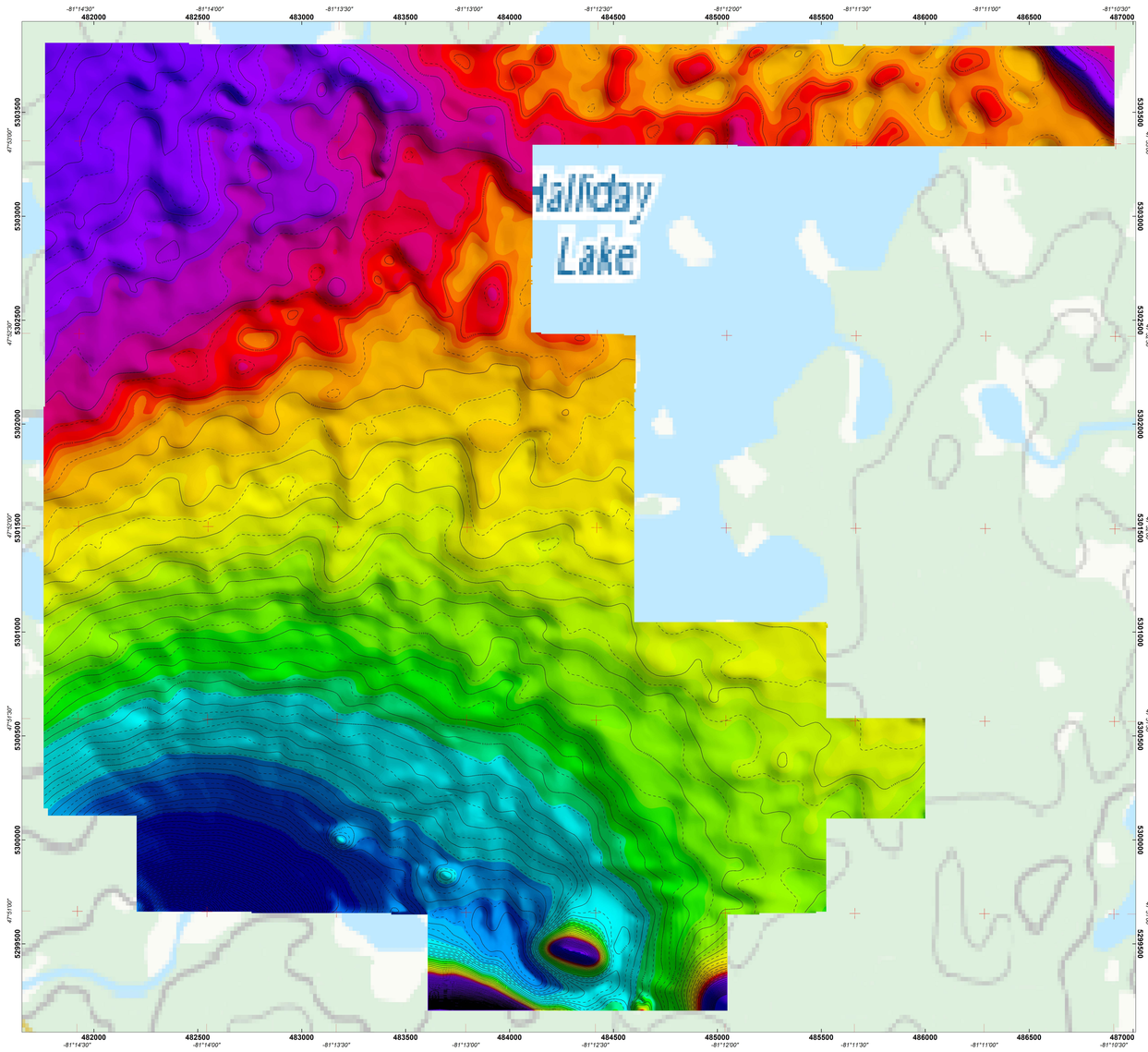
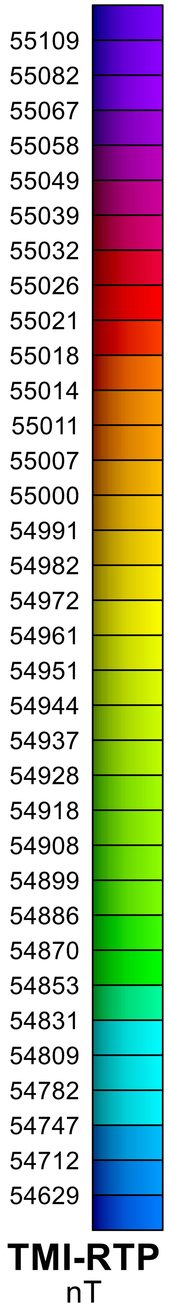
Appendix 2: Final Maps

PIONEER EXPLORATION





TMI-RTP
nT

Scale 1:10000

800 0 800 1600

metres
WGS 84 / UTM zone 17N

Generic Geo Inc.

Flight Parameters:

Flight line spacing: 25 m
Flight line azimuth: 000°N
Tie-line spacing: 250 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 35m

Instrumentation:

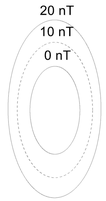
Unmanned aerial vehicle: DJI Matrice 300 RTK UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

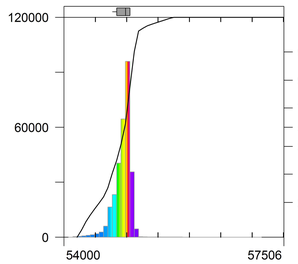
Coordinate system:

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

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

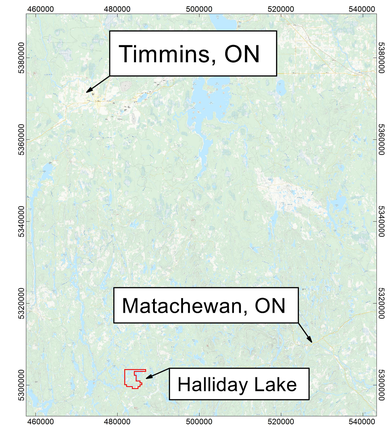
Contour Legend:





Grid Data Distribution

Samples:	296521
Minimum:	54130
Maximum:	57130
Mean:	54940
Geo.Mean:	54940
Median:	54970
Mode:	55020
Std.Dev.:	142
Std.Err.:	0.2608
Skew:	-0.002866
Kurtosis:	17.03



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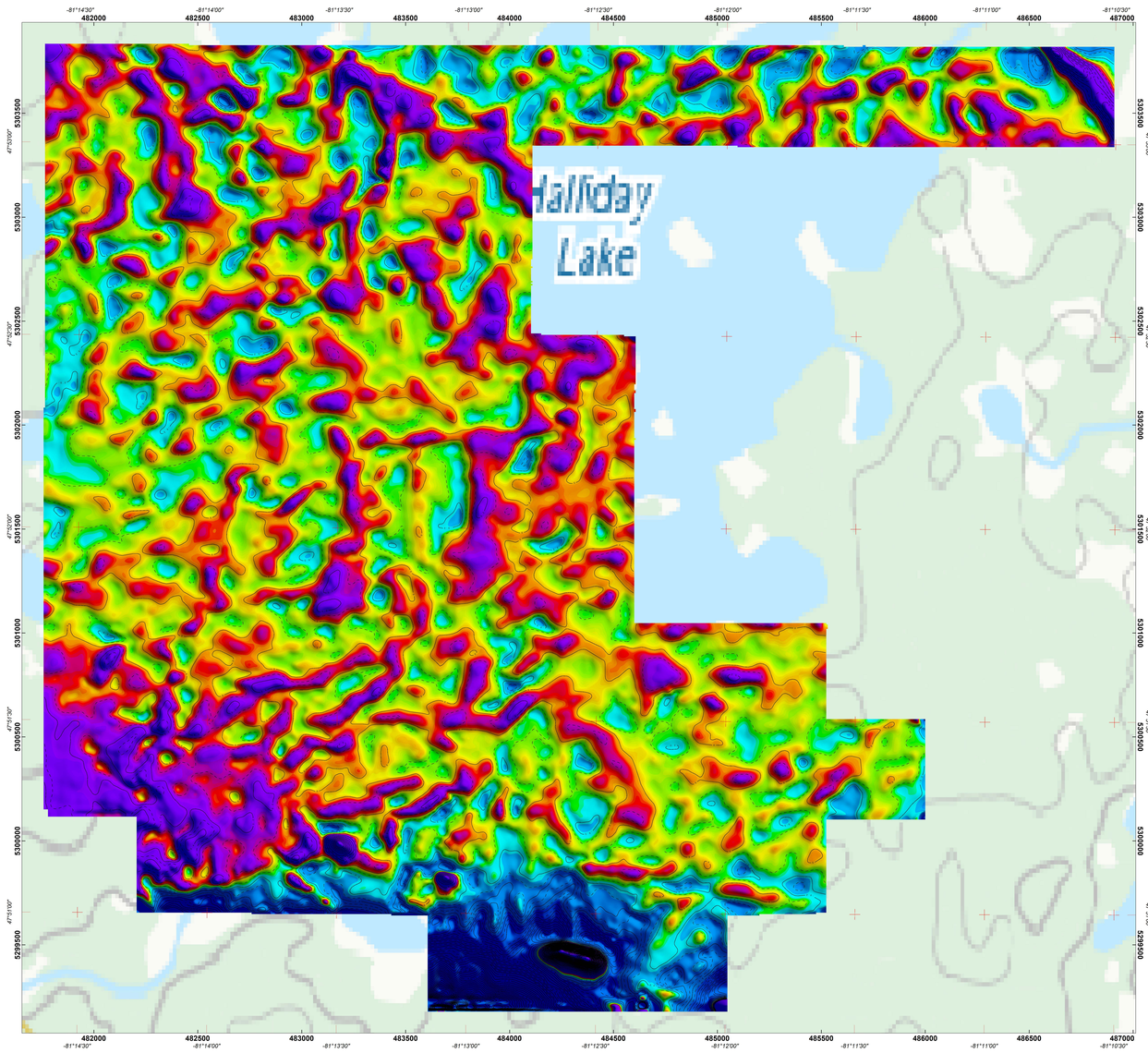
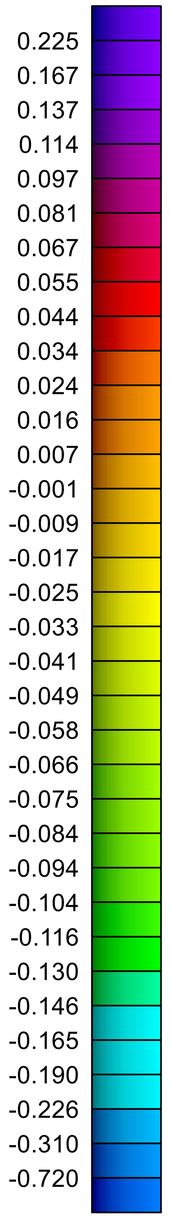
Levelled and Micro-Levelled Drone Magnetic Survey
Total Magnetic Intensity, Reduced to Pole (TMI-RTP)
Units: nT

Survey Date: February 2023
Claim: Halliday Lake

Map Author: Kiyavash Parvar, M.A.Sc. Geophysics

PIONEER EXPLORATION





1VD
nT/m

Scale 1:10000

800 0 800 1600

metres

WGS 84 / UTM zone 17N

Generic Geo Inc.

Flight Parameters:

Flight line spacing: 25 m
Flight line azimuth: 000°N
Tie-line spacing: 250 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 35m

Instrumentation:

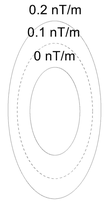
Unmanned aerial vehicle: DJI Matrice 300 RTK UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

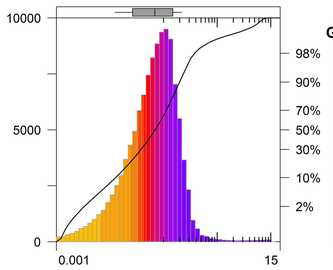
Coordinate system:

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

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

Contour Legend:





Grid Data Distribution

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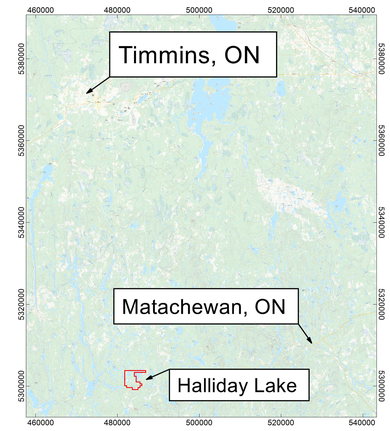
Median:	-0.02877
Mode:	-0.0582
Std.Dev.:	0.5977
Std.Err.:	0.001098
Skew:	-4.29
Kurtosis:	108.2
Log:	
Mean:	-1.23
Median:	-1.158
Skew:	-0.4246



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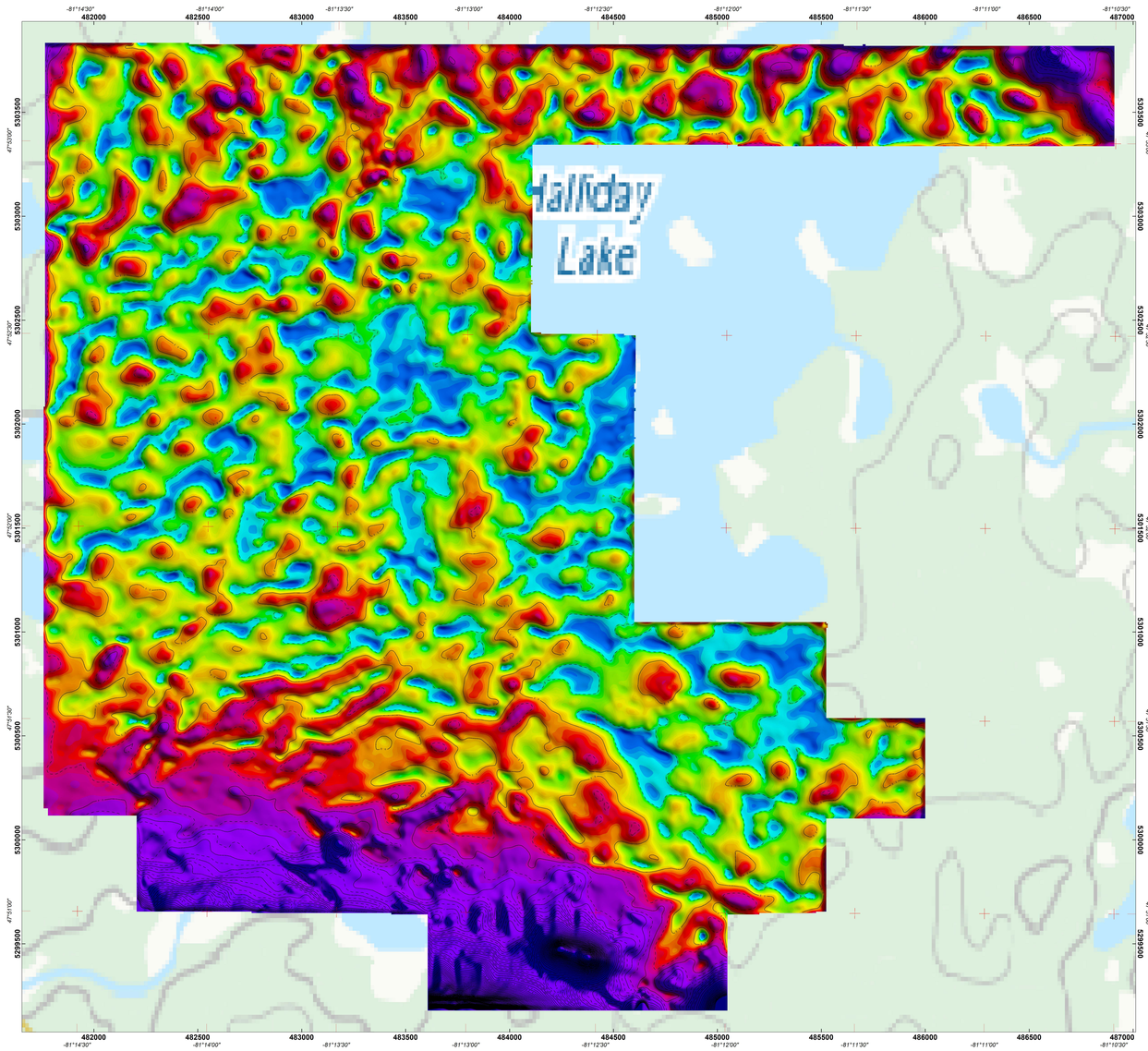
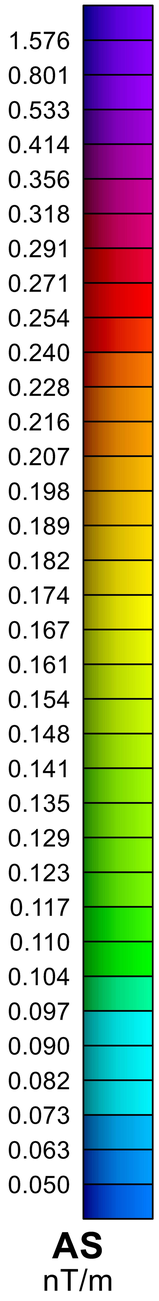
Levelled and Micro-Levelled Drone Magnetic Survey
1st Vertical Derivative (1VD)
Units: nT/m

Survey Date: February 2023
Claim: Halliday Lake

Map Author: Kiyavash Parvar, M.A.Sc. Geophysics

PIONEER EXPLORATION





Scale 1:10000

800 0 800 1600

metres

WGS 84 / UTM zone 17N

Generic Geo Inc.

Flight Parameters:

Flight line spacing: 25 m
Flight line azimuth: 000°N
Tie-line spacing: 250 m
Tie-line direction: 090°N
Nominal sensor elevation above ground: 35m

Instrumentation:

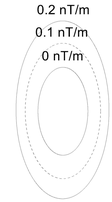
Unmanned aerial vehicle: DJI Matrice 300 RTK UAV
In-flight magnetometer: GEM Systems GSMP-35UA (Potassium vapor)
In-flight sampling lime: 10 Hz (0.1 s)
Ground magnetometers (base station): GEM GSM-19 (Overhauser proton)
Base station sampling rate: 0.16 Hz (6.0 s)

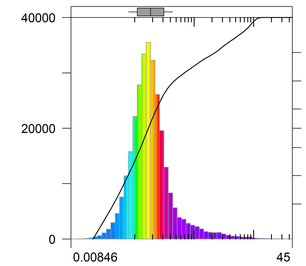
Coordinate system:

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

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

Contour Legend:





Grid Data Distribution

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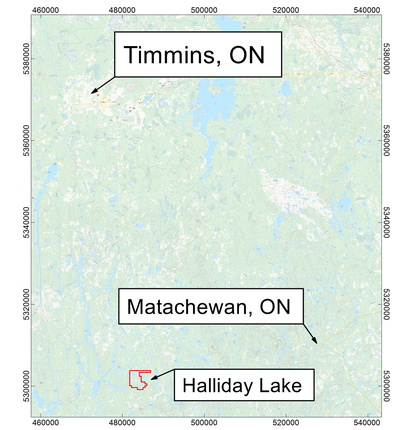
Minimum:	0.008459
Maximum:	43.09
Mean:	0.3407
Geo.Mean:	0.187
Median:	0.1708
Mode:	0.1252
Std.Dev.:	1.008
Std.Err.:	0.001851
Skew:	15.02
Kurtosis:	347.5
Log:	
Mean:	-0.7281
Median:	-0.7676
Skew:	1.342



Pioneer Exploration Consultants Ltd.

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

Survey Date: February 2023
Claim: Halliday Lake

Map Author: Kiyavash Parvar, M.A.Sc. Geophysics