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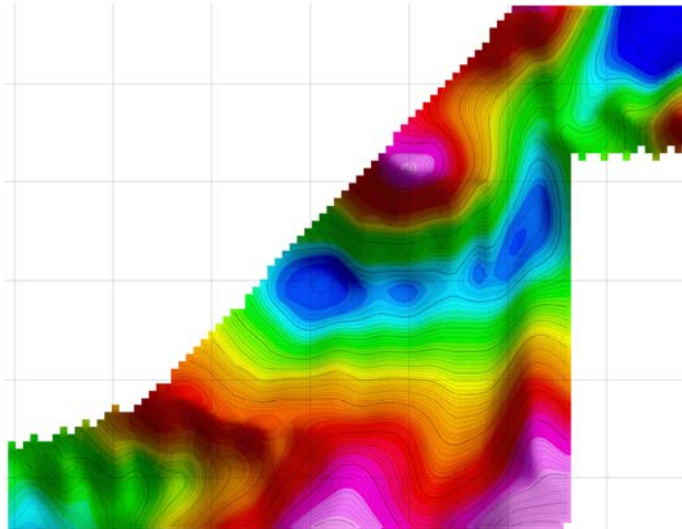
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Report

Drone Magnetic Survey  
Dundonald Property

Dundonald Township  
Porcupine Mining Division



Prepared for:  
C. Villeneuve Construction Co. Ltd.

## **Table of Contents**

- 1.0 Introduction
- 2.0 Location and Access
- 3.0 Regional and Local Geology
- 4.0 Type of Mineral Deposit
- 5.0 Property History
- 6.0 Summary of 2019 drone magnetic survey
- 7.0 Processing
- 8.0 Discussion of Results
- 9.0 Conclusions and Recommendations

Statement of Qualifications

## **Appendices**

- Appendix I Geometrics MFAM specifications
- Appendix II Geometrics G856AX specifications (base station)
- Appendix III DJI M600 Pro Specifications
- Appendix IV Project Costs (Invoice 2019-56)
- Appendix V Quality Control / Tests and Calibrations / Processing Steps

## **List of Maps**

### **Map**

- Total Field Magnetic Survey – Contours
- Grid and Tie Line location map

## 1.0 Introduction

Mining claims 563014, 203872 and 239175 are located in Dundonald Township, Porcupine Mining Division.

A general location and access map is presented as **Figure 1**.

A detailed claim location map is presented as **Figure 2**.

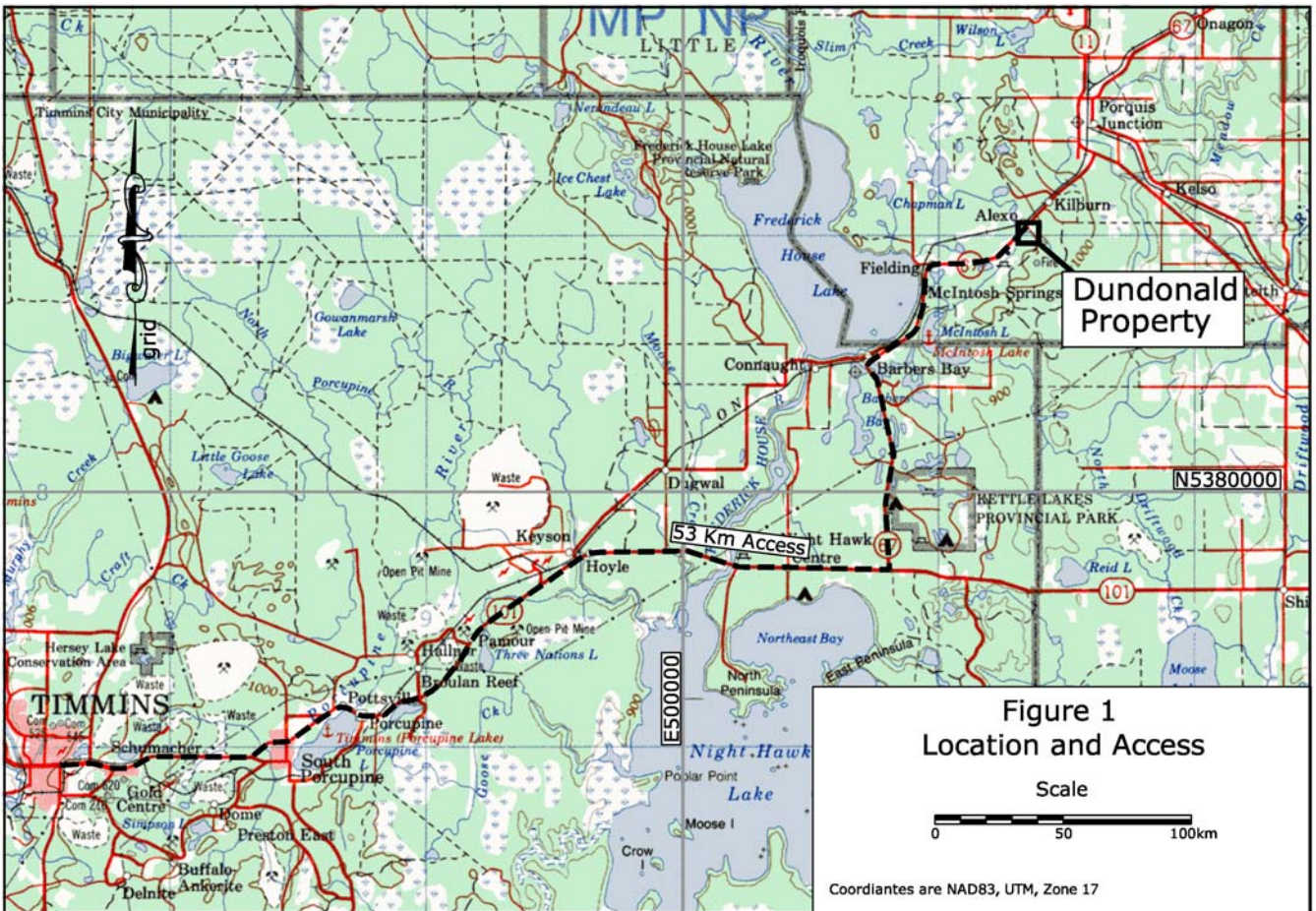
On November 11<sup>th</sup>, 2019 above claims were surveyed using a Geometrics MFAM magnetometer mounted on a DJI M600 drone.

Zen Geomap of Timmins, Ontario carried out the survey on a contract basis for C. Villeneuve Construction Co. Ltd. The survey was performed in order to map the magnetic signature of the underlying lithology.

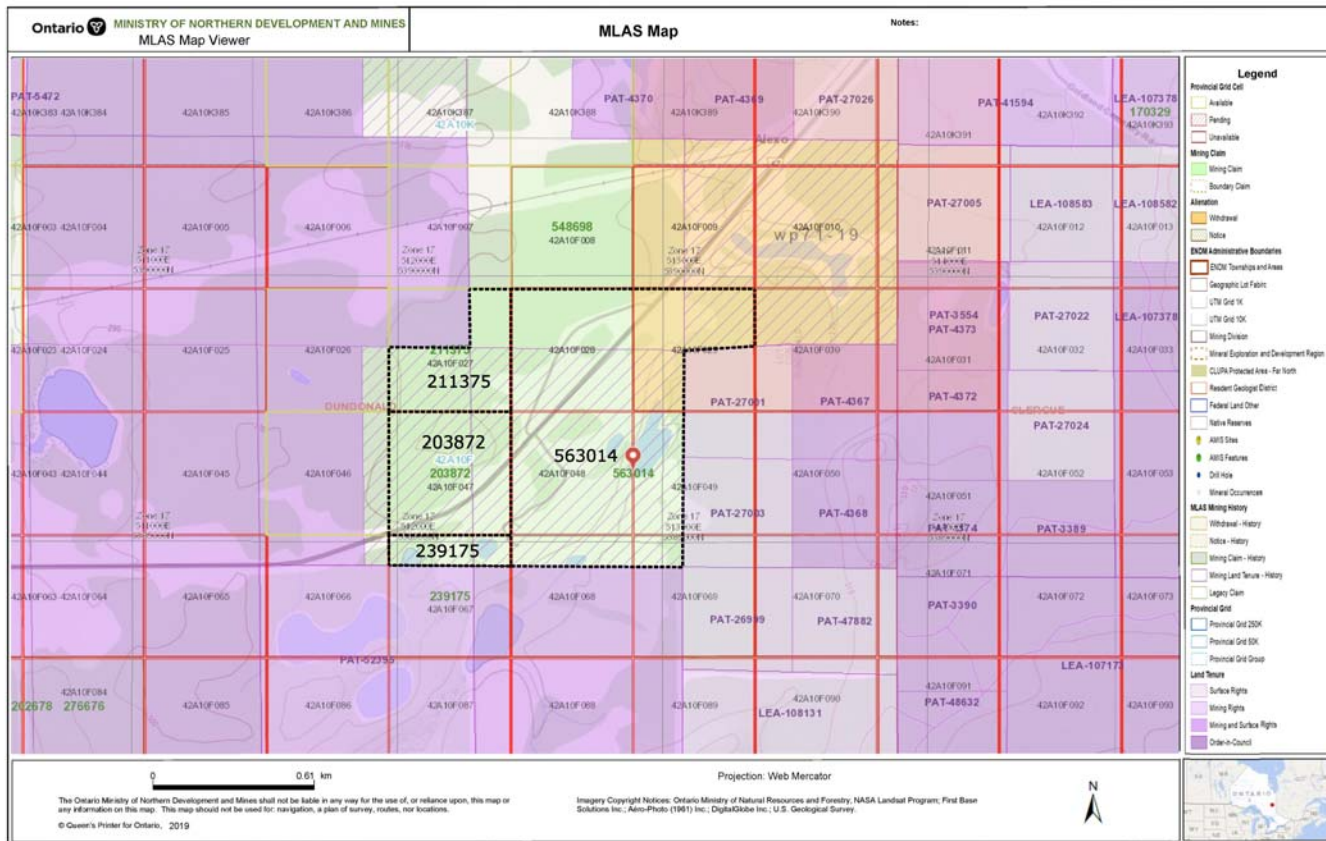
Data processing and maps were completed between Nov 12<sup>th</sup> and 18<sup>th</sup>, 2019. Assessment report was prepared between Nov 14<sup>th</sup> and 23<sup>rd</sup>, 2019.

## 2.0 Location and Access

The property was accessed from Timmins by travelling East on HWY 101 to the intersection with HWY 67, then North on HWY 67 to the property, as shown on **Figure 1** (Location and Access map).



**Figure 1** – Location and Access



**Figure 2 – Claim Location Map**

### 3.0 Regional and Local Geology

Areas surrounding Dundonald Property have undergone considerable exploration in the past, mainly with regards to nickel and copper. The Alexo Mine sits 800m to the east. Within a few kilometer radius of the property, there are 9 mineral showings.

The **Mineral Deposits Map** (Figure 3) presents a summary of nearby mineral deposits according to the Mineral Deposits Inventory database (MDI).

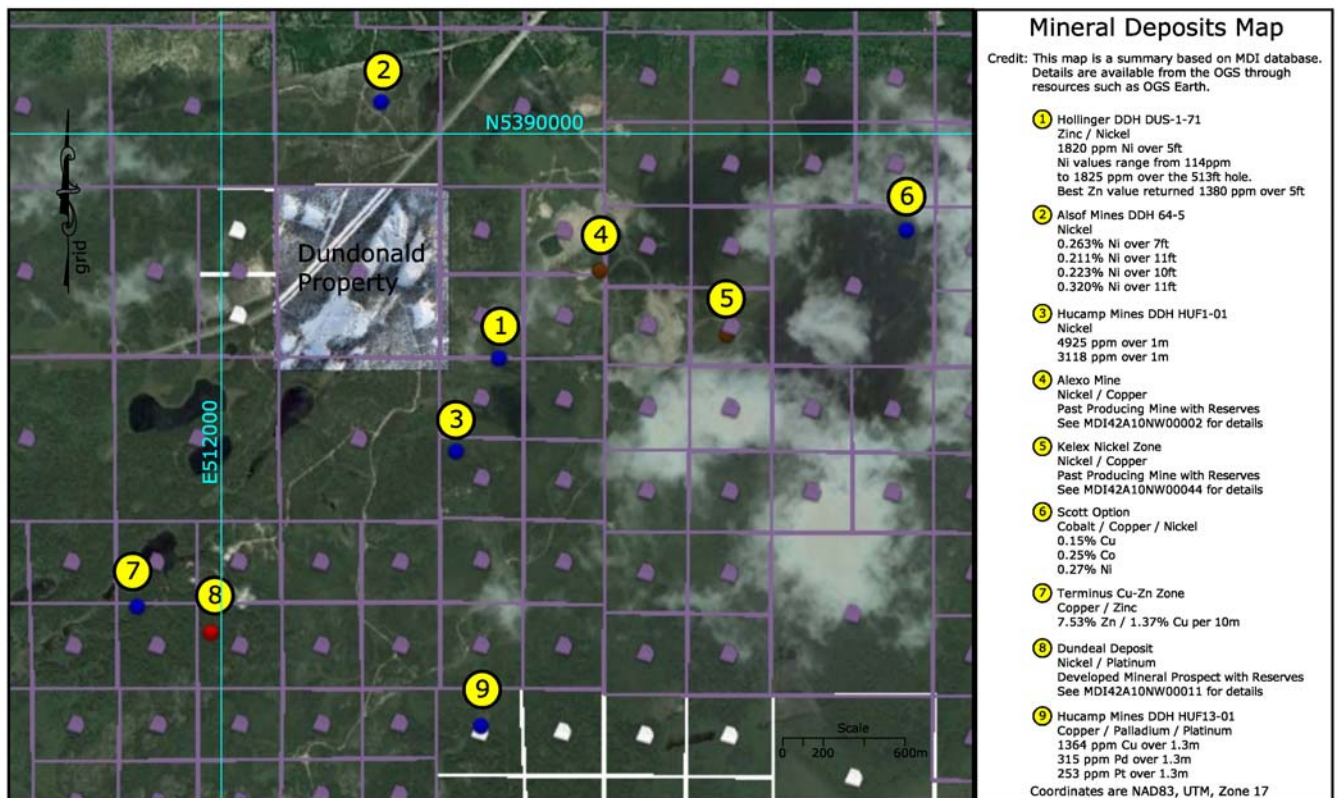
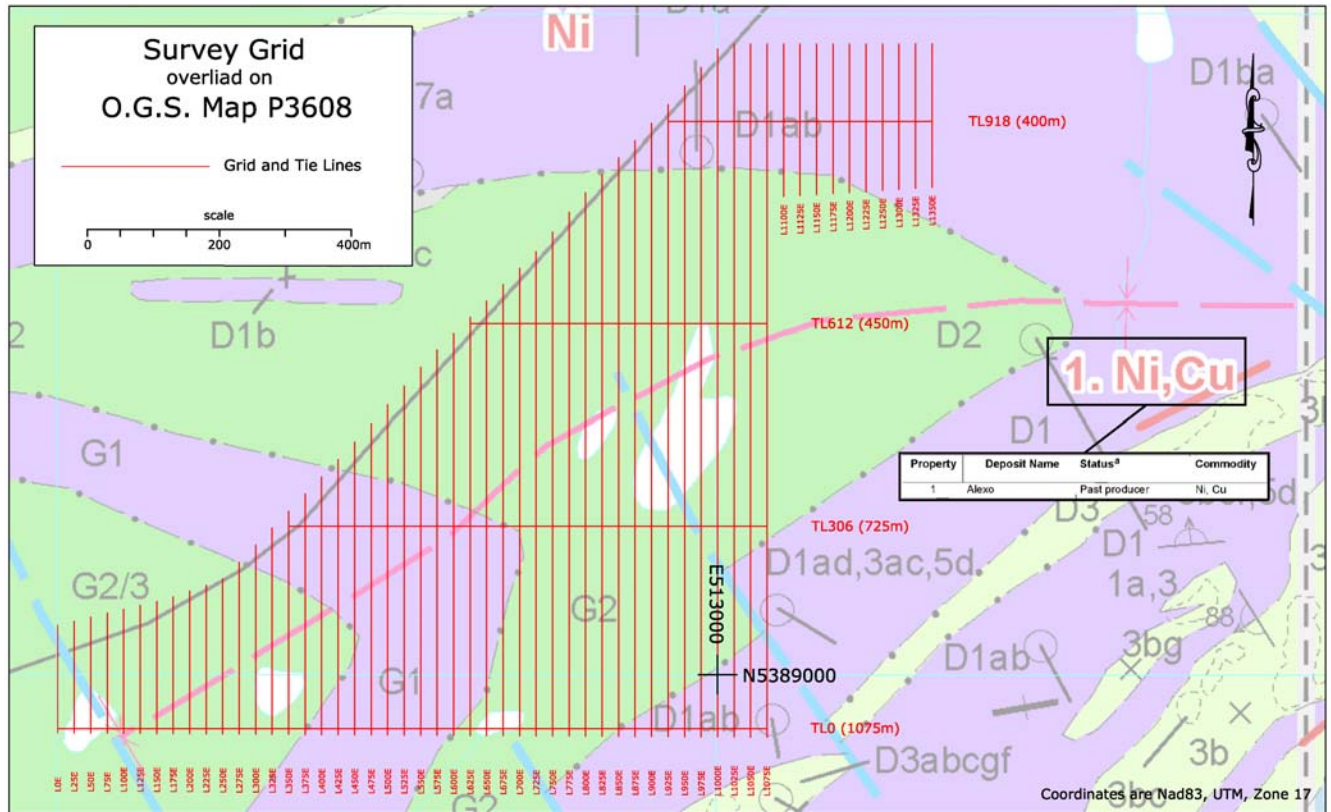


Figure 3

O.G.S. Map P3608 provides a suitable base map showing Precambrian geology surrounding Alexo Mine. The 2019 drone survey grid has been overlaid on P3608 below as **Figure 4**.



**Figure 4**  
Location of 2019 grid overlaid on Map P3608

- 1 (purple) is described as ultramafic metavolcanic / subvolcanic rocks (P3608 legend)
- 2 (green) is described as mafic metavolcanic rocks (P3608 legend)

**Reference:**

O.G.S. Map P3608 – Precambrian Geology – Dundonald Township and Area  
Published in 2009 at scale 1:20,000.



#### **4.0 Type of Mineral Deposit / Commodity**

Nickel and Copper deposits are the main focus for exploration on Dundonald Property.

#### **5.0 Property History**

The property in its current configuration was the subject of geochem sampling in 2015 and limited ground magnetometer survey in 2016. The current drone magnetic survey was carried out at **25m** line spacing, covering a broader area with tighter line spacing compared to 2016 ground mag. (2016 ground mag was carried out at **50m** line spacing).

#### **6.0 Summary of 2019 drone magnetic survey**

The program consisted of a drone magnetic survey carried out on a grid with 54 North-South lines spaced at 25 metres and 4 East-West tie lines spaced at 306 metres.

Total line kilometers:	<b>29.7</b>
Altitude:	<b>30m above ground level</b>
Ground Speed:	<b>50km/h (14m/second)</b>

A Geometrics MFAM magnetometer mounted on a DJI M600 Pro hexacopter drone was used to survey all grid lines.

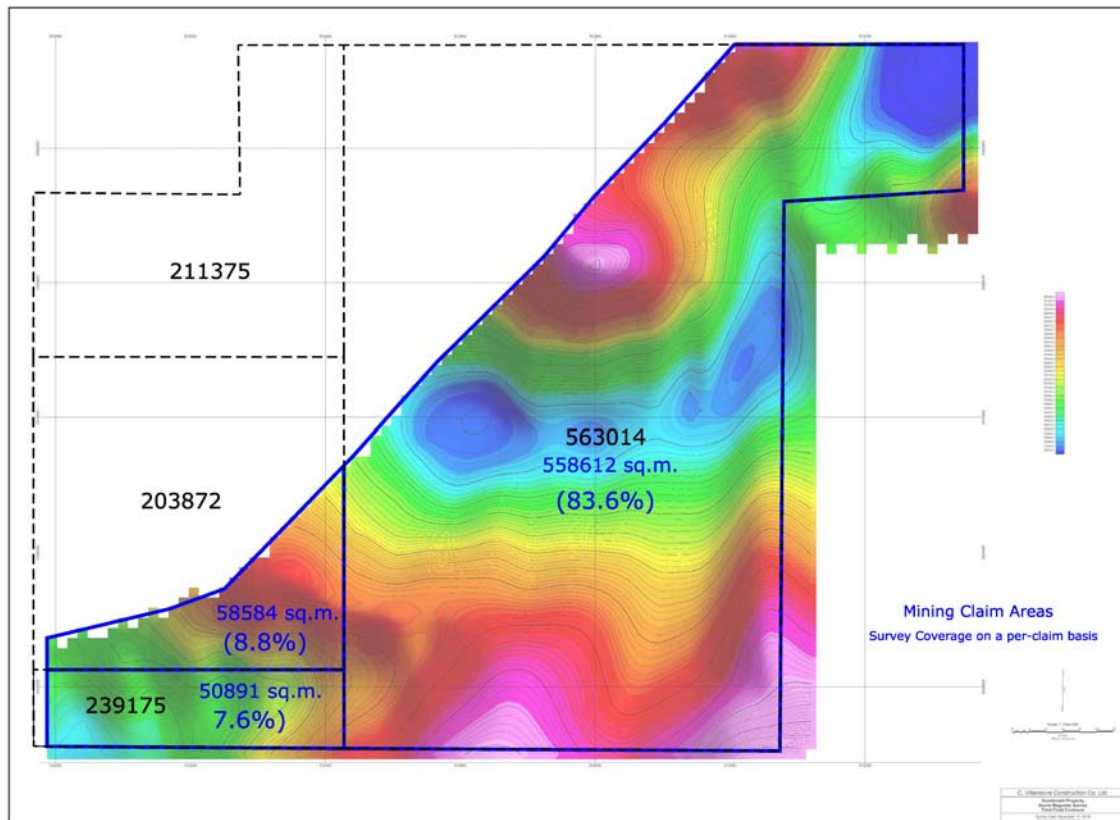
A Geometrics G856AX proton procession magnetometer was operated as a base station throughout the survey to provide diurnal monitoring of the local magnetic field variations. The base station was located at UTM coordinate E 512648 / N5389256.

Equipment specifications are provided in ***Appendix 1, 2 and 3.***

The survey covered a portion of 3 mining claims (563014, 203872 and 239175). The total survey cost (\$8000 pre-hst) will be directed to each claim as follows;

Claim #	% Area	Dollar Value
563014	83.6	\$6,688
203872	8.8	\$ 704
239175	7.6	\$ 608
		-----
		\$8,000 – Total survey cost

**Figure 5** shows survey coverage on a per-claim basis. Supporting Invoice 2019-56 is included as **Appendix IV**.



**Figure 5** – Survey coverage on a per-claim basis

## 7.0 Processing

Magnetometer data was collected on 2 Geometrics MFAM sensors operating at 1000hz. The data was processed through a custom program operating in Python. This converts raw data from Geometrics MFAM into a format compatible with Geosoft Oasis Montaj.

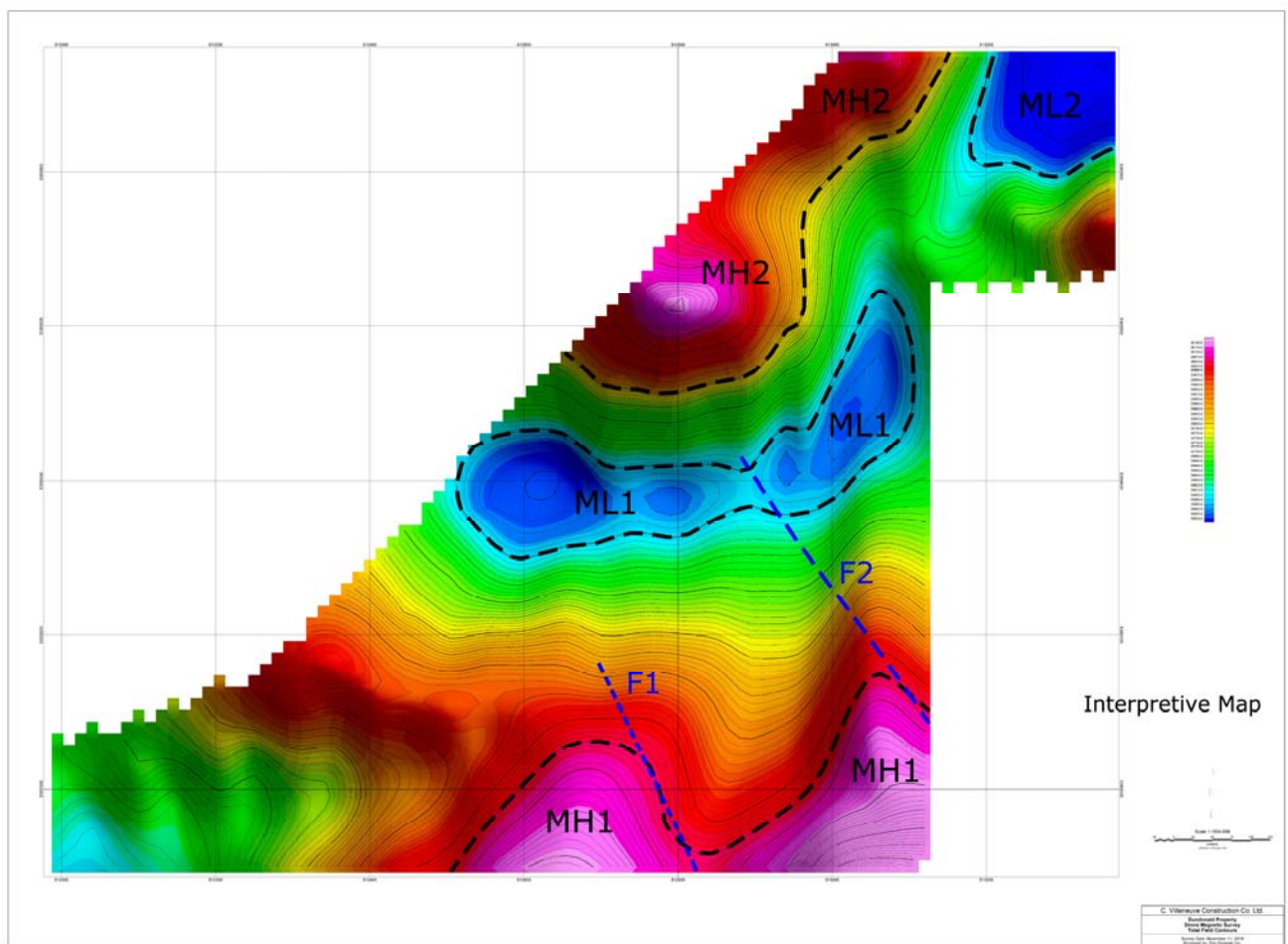
Customized import templates were used within Geosoft, to identify and separate mag readings into organized grid and tie lines. This step eliminates extraneous mag data collected as the drone travels to and from the grid.

Grid and tie line data were corrected to remove *heading error* and *lag*. Corrected grid data was then *leveled* based on tie lines.

## 8.0 Discussion of Results

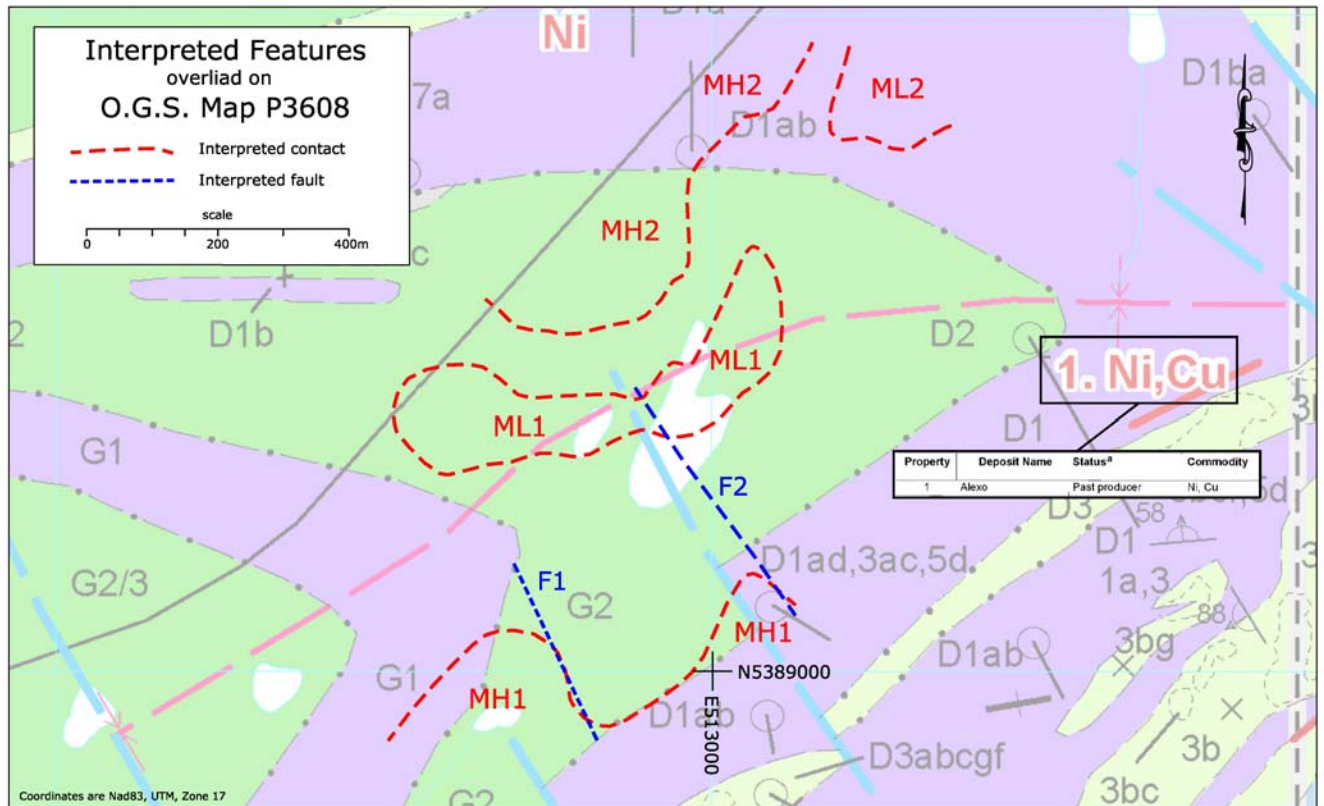
A total field colourized contour map is included at full-scale at bottom of report.

The survey covered a magnetic value range of 645Nt. Magnetic-high anomalies MH1 and MH2, along with magnetic-low anomalies ML1 and ML2 are outlined on **Figure 6** below. Two faults (F1 and F2) have been interpreted as well.



**Figure 6**  
Interpretive Map

Interpreted features were overlaid onto Map P3608, as shown on **Figure 7** below.



**Figure 7** – Interpreted features on P3608

Interpreted line MH1 is likely the contact between rock units G2 and D1.  
Interpreted Faults F1 and F2 make sense with faults indicated on Map P3608;

- F1 is offset approximately 110m NE compared to fault shown on P3608.
- F2 is offset approximately 37m NE compared to fault shown on P3608.

Interpreted line MH2 is likely the contact between rock units G2 and D1.

Detailed drone magnetics provide better location on above contacts and faults.

## **9.0 Conclusions and Recommendations**

Alexo Mine sits 800m east of current survey.

Interpreted faults and contacts within the current survey indicate similar geological and structural setting to Alexo.

It is recommended that future exploration focus on the interpreted MH1 contact and F1 / F2 fault area.

# Statement of Qualifications

Author - Kevin Cool		
<i>Education</i>		
from	to	Description
	1983	Photography - 1 year, Humber College, Toronto Ontario
1988	1990	Survey Engineering Technician - 2 year honours diploma, Northern College Porcupine Campus
	2014	Received Permanent Prospectors Licence, by reason of having held a Prospector's Licence for 25 years or more
	2014	Aviation Ground School, Transport Canada Compliant Unmanned Aerial System training seminar
	2014	Radio Operators Certificate - Aeronautical
<i>Companies owned and operated</i>		
1990	2001	<b>General Surveys &amp; Exploration</b> - mining, exploration, aggregate, construction survey and computer drafting.
2000	2005	<b>Big Red Diamond Corp.</b> - traded publicly on TSX Venture exchange under symbol DIA. Junior mining company exploring for diamonds. Participated in and managed regional-scale airborne geophysical programs, stream sampling, geochem sampling and camp construction. Property-scale work includes ground magnetometer, grid cutting and survey.
2005	2011	<b>True North Mineral Laboratories Inc.</b> - heavy mineral separation by heavy liquid. Crushing / pulverizing for other assay. 30+ employees. Provided services to the mining and exploration industry such as claim staking, till and geochem sampling, magnetometer survey.
2014	current	<b>UAV Timmins</b> - drone aerial mapping and survey. 1st company to apply drone air photo survey as valid mining claim assessment in Ontario.
2017	current	<b>Zen Geomap Inc.</b> - drone magnetometer survey. 1st company to apply drone mag survey as valid mining claim assessment in Ontario.

I, Kevin Scott Cool, of 15 Prospector St., Gold Centre in the City of Timmins, Province of Ontario, hereby certify that:

- 1) I am a graduate of Northern College of Applied Arts and Technology, May 26<sup>th</sup> 1990, Porcupine Campus, with a 2 year Honors Diploma in Survey Engineering Technology
- 2) I have subsequently operated above businesses, directly engaged with the mining and exploration industry.
- 3) I have been actively engaged in my profession since May, 1990, in all aspects of ground and airborne exploration programs including the planning and execution of regional and property-scale programs, supervision, data processing, maps, interpretation and reports.

Kevin Scott Cool



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**Zen Geomap**  
204-70C Mountjoy ST. N.  
Timmins, ON P4N 4V7

# Appendix I

## Geometrics MFAM Magnetometer Specifications

### System Basics

- System utilizes 2 MFAM sensors
- Sensors are controlled by 1 sensor module
- Sensor module communicates with a Texas Instruments main board
- Sensitivity: 0.00003nT
- Sensors operate at 1000Hz (collect 1000 readings per second on both sensors)

### Technical Specifications

#### **SPECIFICATIONS:**

Mechanical:

Enclosure Dimensions: 9" x 6 5/8" x 1 3/16"

Sensor Cable length (Development box to Sensor): 20.5 inches

Power:

AC adapter: 13.5 to 16 Volts DC at 1.0A

Battery Pack: 12 volt 1800 mA-Hour Lithium Polymer

#### **FEATURES:**

- 1) **TIVA TM4C1294NCPDT Micro controller:** This is a 32 bit ARM Cortex-MF4 based microcontroller running at up to 120 MHz. It has 1024K of flash, with 256K bytes of RAM, and 6 KBytes of EEPROM.
- 2) **USB 2.0 Micro Connector:** USB functionality is provided by the TIVA microcontroller and TIVAWare support libraries.
- 3) **Four User LEDs:** Four user controlled LEDs are wired to TIVA microcontroller GPIO pins PK0, PK1, PN0, and PN1.
- 4) **Two User Switches:** Two user read switches are wired to the microcontroller pins PK6 and PJ1.
- 5) **One Microcontroller Reset Switch:** This switch is used to reset the microcontroller.
- 6) **Wi-Fi port for TI CC3100 Wi-Fi Booster Pack:** The Development board layout allows a TI CC3100 Wi-Fi Booster pack to be directly plugged in. Using TIVAWare libraries, software can be developed to allow Wi-Fi communication between the Development board and a computer.
- 7) **USB XDS110 Port for Firmware Downloading and Debugging:** This second USB port is used as a debug/firmware download interface between the TI Code Composer Studio development suite and the Development Kit.



- 8) **Two RS-232 Serial Ports with RJ-45 Connectors:** Two general purpose serial ports are available to the user. The first serial port is wired to TIVA microcontroller UART4, and supports RTS and CTS handshaking. The second serial port is wired to TIVA microcontroller UART5. This port supports only TxD and RxD. Both of these ports use +/- 8 volt voltage swings, and support baud rates up to 920 KBaud. Note that these two ports are wired as Data Terminal Equipment (DTE) Thus to connect either of these two ports to a computer it would need to connect through a null modem. .

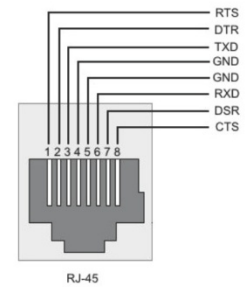
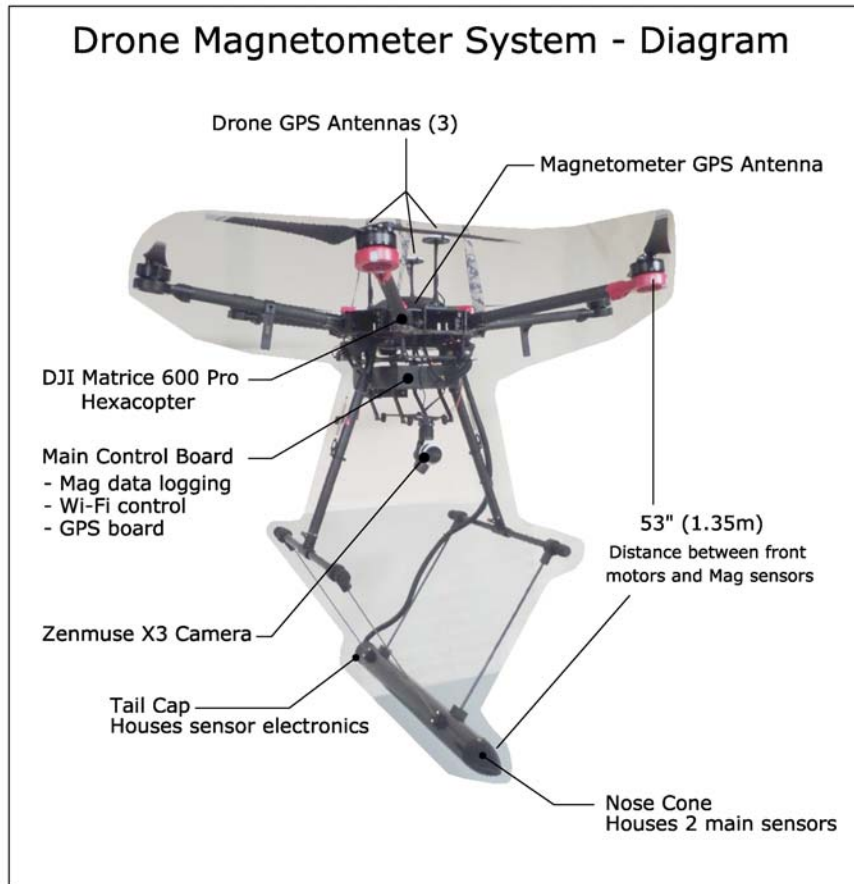


Figure 3: Serial Port Pinout

- 9) **On Board GPS Module:** An Adafruit GPS module is included with the Development Kit. It features 66 channels, -165 dBm sensitivity, and 3 Meter accuracy. An external GPS antenna is included so that signals can be received inside the box even with the cover in place. By default the GPS powers up to 9600 baud with several GPS sentences being output. The firmware that comes with the Development kit reconfigures the GPS to output only an RMC sentence at 115200 baud. This RMC string is sent with the output TCP data packet as described in the “Ethernet Data Format” section. The GPS is wired to UART7 on the TIVA microcontroller using 0-3.3 volt logic swings.

The 1PPS pulse from this GPS goes to the MFAM development module and disciplines the cycle rate to exactly 1 kiloSamples per second.

- 10) **Micro SD Card Slot for Storing Data Locally:** A micro SD card slot is available for the user to read and write data using a SPI interface. It is connected to SPI port 1 of the TIVA microcontroller.
- 11) **10 MHZ Timing Reference Input Port:** This input port takes a 10 MHz reference signal from a GPS disciplined reference oscillator, buffers and squares it up, and sends it to the MFAM module. The purpose of this signal is to lock the MFAM clocking system to this reference signal so that the Larmor frequency can be measured to an absolute standard. At this time, the MFAM does not support this feature. This function will be implemented in the future.
- 12) **Ethernet port with Power over Ethernet Compatibility:** The Tiva microcontroller contains a fully integrated Ethernet MAC and PHY. In addition, the Ethernet port can power the Development Kit via Power over Ethernet (PoE) using an Ethernet power injector.
- 13) **1.8 Amp-Hour Battery pack:** Three on board lithium/polymer batteries can power the system for 2 hours. A switch on the Development board allows the battery to be turned on/off. In addition, if the battery voltage falls below 8 volts the MFAM module will automatically shut down while keeping the microcontroller alive.
- 14) **Integrated Battery Charging system:** A lithium/polymer battery charging system is on board. If the battery switch is turned on, and the AC power adapter is plugged in, the batteries will be charged.
- 15) **Four Differential Analog Input Channels:** There are four differential analog inputs available for use. Channels 0 and 1 are +/- 2.5 volts full scale, while channels 2 and 3 are 0 to +5 volts full scale. In the firmware supplied with the Development kit (which sends MFAM/GPS data to the MFAMConsole program on the computer), all four channels are sampled synchronously with the MFAM data input to the Tiva are included in the data stream.
- 16) **On board Power/Status LEDs:** Several Status and Power LEDs are arranged along the front edge of the board. They include the four user LEDs, Power status LEDs (which power source is powering the board, and whether the battery is charging or the voltage low). They are listed in the Front and Back Panel Connection and Indicator section below.



#### Description and Location of components

The Geometrics MFAM magnetometer “main board” is attached directly below the central body of the DJI Matrice 600 Pro hexacopter drone. This box contains a small, Texas Instruments computer that collects and stores magnetometer readings on a micro-SD card. It also houses a 66 channel Adafruit GPS module, which operates independent of the (3) internal drone GPS modules. The Adafruit GPS collects and stores “GPS readings” (Lat / Long / Altitude / Time ). The GPS readings are assigned to each mag reading, as the drone navigates along grid lines. A Wi-Fi module is attached to the Texas Instruments computer, which allows the operator to start and stop the magnetometer at a distance.

The Geometrics MFAM magnetometer operates using 2 separate mag sensors, attached to a “sensor module” with a flexible circuit board. The sensor module and 2 sensors are housed in a carbon graphite tube, which is mounted (suspended) 53 inches (1.35m) below the 2 front motors of the drone.

Magnetic shielding (mu-metal) is installed at 6 locations around the drone body, to provide additional shielding between drone components and the 2 mag sensors.

The magnetometer GPS antenna (for the internal Adafruit GPS) is mounted on top the drone body, to allow for clear signal. The vertical distance between this antenna and the 2 mag sensors, is 1.20m. This value is considered when reporting “mean terrain clearance”, by subtracting 1.2m from the elevation assigned to each mag reading.

# Appendix II

Geometrics G856AX  
Proton procession magnetometer specifications

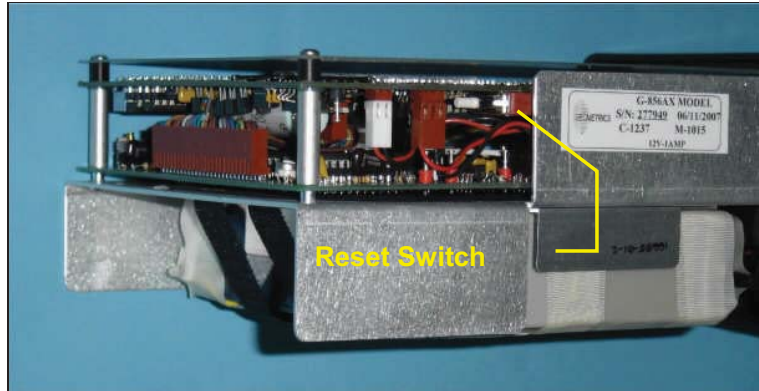


Figure 23. Internal reset switch.

## Specifications

- Displays - Six digit display of magnetic field to resolution of 0.1 gamma or time to nearest second. Additional three-digit display of station, day of year, and line number.
- Resolution - Typically 0.1 gamma in average conditions. May degrade to lower resolution in weak fields, noisy conditions or high gradients.
- Absolute accuracy - One gamma, limited by remnant magnetism in sensor and crystal oscillator accuracy.
- Clock - Julian clock with stability of 5 seconds per month at room temperature and 5 seconds per day over the temperature range of -20 to +50 degrees Celsius.
- Tuning - Push button tuning from keyboard with current value displayed on request. Tuning range 20 to 90  $\mu$ T.
- Gradient - Tolerates gradients to 1800 gammas/meter. When high Tolerance gradients truncate count interval, maintains partial reading to an accuracy consistent with data.
- Cycle Time - Complete field measurement in three seconds in normal operation. Internal switch selection for faster cycle (1.5 seconds) at reduced resolution or longer cycles for increased resolution.
- Manual Read - Takes reading on command. Will store data in memory on command.
- Memory - Stores more than 5700 readings in survey mode, keeping track of

time, station number, line number day and magnetic field reading. In base station operation, computes for retrieval but does not store time of recording designated by sample interval, allowing storage of up to 12,000 readings.

- Output - Plays data out in standard RS-232 format at selectable baud rates. Also outputs data in real time byte parallel, character serial BCD for use with digital recorders.
- Inputs - Will accept an external sample command.
- Special - An internal switch allows:
  - adjustment of Functions polarization time and count time to improve performance in marginal areas or to improve resolution or speed operation
  - three count averaging
  - choice of lighted displays in auto mode.
- Physical -
  - Instrument console: 7 x 10 ½ x 3 ½ inches (18 x 27 x 9 cm), 6 LB (2.7 kg)
  - Sensor: 3 1/2 x 5 inches (9 x 13 cm), 4 LB (1.8 kg)
  - Staff: 1 inch x 8 feet (3cm x 2.5m), 2 LB (1kg)
- Environmental: Meets specifications from 1 to 40°C. Operates satisfactorily from -20 to 50°C.
- Power - Depending on version, operates from internal rechargeable Gel-cells or 9 D-cell flashlight batteries . May be operated from external power ranging from 12 to 18 volts external power. Power failure or replacement of batteries will not cause loss of data stored in memory.
- Standard system (P/N 16600-02) components:
  - Sensor (P/N 16076-01) and sensor cable (P/N 16134-01)
  - Console (P/N 16601-01)
  - Staff, one top section (P/N 16535-01), two middle sections (P/N 16536-01) and 1 bottom section (P/N 16537-01)
  - Carry harness (P/N 16002-02)
  - Two sets of rechargeable batteries (P/N 16697-01) and battery charger (P/N 16699-01)
  - Carrying case (P/N 16003-01)
  - Download cable (P/N 16492-01)
  - Hardcopy operation manual (P/N 18101-02)
  - Magnetometer CD (P/N 26648-01)
- Optional accessories:
  - Tripod kit for base-station operation (P/N 16708-02)
  - Gradiometer kit (P/N 166651-01)
  - Gradiometer carry/storage case (16003-01)

# Appendix III - DJI Matrice 600 Pro Specifications

## Specifications

### • Aircraft

Diagonal Wheelbase	1133 mm
Dimensions	1668 mm × 1518 mm × 727 mm with propellers, frame arms and GPS mount unfolded (including landing gear) 437 mm × 402 mm × 553 mm with propellers, frame arms and GPS mount folded (excluding landing gear)
Weight (with six TB47S batteries)	9.5 kg
Weight (with six TB48S batteries)	10 kg
Max Takeoff Weight Recommended	15.5 kg
Hovering Accuracy (P-GPS)	Vertical: ±0.5 m, Horizontal: ±1.5 m
Max Angular Velocity	Pitch: 300°/s, Yaw: 150°/s
Max Pitch Angle	25°
Max Wind Resistance	8 m/s
Max Ascent Speed	5 m/s
Max Descent Speed	3 m/s
Max Speed	40 mph / 65 kph (no wind)
Max Service Ceiling Above Sea Level	2170 propellers: 2500 m, 2195 propellers: 4500 m
Hovering Time* (with six TB47S batteries)	No payload: 32 min, 6 kg payload: 16 min
Hovering Time* (with six TB48S batteries)	No payload: 38 min, 5.5 kg payload: 18 min
Flight Control System	A3 Pro
Supported DJI Gimbals	Ronin-MX; ZENMUSE™ Z30, Zenmuse X5/X5R, Zenmuse X3, Zenmuse XT, Zenmuse Z15 Series HD Gimbal: Z15-A7, Z15-BMPCC, Z15-5D III, Z15-GH4
Retractable Landing Gear	Standard
Operating Temperature	14° to 104° F (-10° to 40° C)

### • 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	FCC Compliant: 3.1 mi (5 km), CE Compliant: 2.2 mi (3.5 km) (Unobstructed, free of interference)
Transmitter Power (EIRP)	10 dBm @ 900M, 13 dBm @ 5.8G, 20 dBm @ 2.4G
Video Output Port	HDMI, SDI, USB
Operating Temperature	14° to 104° F (-10° to 40° C)
Battery	6000 mAh LiPo 2S

### • Charger (Model: MC6S600)

Voltage Output	26.1 V
Rated Power	600 W
Single Battery Port Output Power	100 W



### • Standard Battery (Model: TB47S)

Capacity	4500 mAh
Voltage	22.2 V
Battery Type	LiPo 6S
Energy	99.9 Wh
Net Weight	595 g
Operating Temperature	14° to 104° F (-10° to 40° C)
Max Charging Power	180 W

### • Optional Battery (Model: TB48S)

Capacity	5700 mAh
Voltage	22.8 V
Battery Type	LiPo 6S
Energy	129.96 Wh
Net Weight	680 g
Operating Temperature	14° to 104° F (-10° to 40° C)
Max Charging Power	180 W

\* Hovering time is based on flying at 10 meters above sea level in a no-wind environment and landing with a 10% battery level.

**CE1313**  **RoHS** 

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:  
(1) This device may not cause harmful interference, and  
(2) this device must accept any interference received, including interference that may cause undesired operation.

**HDMI**  
HIGH DEFINITION MULTIMEDIA INTERFACE

DJI incorporates HDMI™ technology. The terms HDMI and HDMI High-Definition Multimedia Interface, and the HDMI Logo are trademarks or registered trademarks of HDMI Licensing LLC in the United States and other countries.

Download the detailed user manual at:  
[www.dji.com/matrice600-pro](http://www.dji.com/matrice600-pro)

※ This content is subject to change without prior notice.

MATRICE™ is a trademark of DJI.  
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Designed by DJI. Printed in China.

### **Drone Operation and Ground Control Methods**

The DJI Matrice 600 Pro drone is programmed to fly an automated flight path (the survey grid lines and tie lines), using software that is available and ready to use on a wide variety of drones. Zen Geomap uses UgCS software, Drone Deploy and Pix4D software;

- Drone Deploy and Pix4D, on simple grids that do not require advanced control with regards to following complex terrain (example – flying in relatively flat ground, using Google Earth or other simple elevation model).
- UgCS, in rugged terrain, where we obtain a detailed 3D terrain model (DEM or DTM) using photogrammetric drone prior to magnetic survey. In this case we upload our own, custom DEM into UgCS software and the DJI M600 drone will follow the terrain at a fixed offset.

### **Using a Drape**

The automated flight path will always use (follow) a “drape” in one form or another.

- On simple grids in flat terrain, the drape is generated as an offset of a simple DEM, such as Google Earth or other coarse elevation model such as DEMs available on-line through USGS.
- In complex terrain, the drape is generated as an offset of our own, custom DEM.

All of our piloting software is capable of following a drape at a fixed offset. We typically program the drone to fly 50m above coarse DEMs, such as Google Earth, or USGS. When a custom DEM is available, we typically fly 25-30m above DEM.

The actual / final “height above terrain” (or mean terrain clearance), is determined in the field by our crews. They visually inspect and look for obstacles such as hills, trees, buildings and towers.

The height above terrain (or mean terrain clearance) is included in the logistical and assessment reports we prepare for our clients.

### **Ground Control Methods**

The DJI M600 drone uses a combination of 3 separate GPS receivers and 3 separate barometers. This system developed by DJI is called the A3 Controller.

The A3 controller is designed to maintain a stable altitude, relative to the take-off point. Over a 5 year period (2014 to current), we have found the A3 controller to be reliable to sub-metre accuracy, when it comes to maintaining stable altitude over a typical 20 to 30 minute flight.

Based on this long-term record, we rely on the A3 controller to navigate the drone at a pre-programmed, fixed offset above DEM. Over the same 5 year period, we have observed consistent and accurate agreement between the A3 GPS locations and the Adafruit (Magnetometer) GPS locations. When plotted in plan view, the A3 GPS tracks have always agreed with the Adafruit tracks to approximately 1 metre accuracy.

The author of this report has been an active surveyor since 1990 and is familiar with real-time (RTK) GPS and post-processed GPS methods.

# Appendix IV

## Project Costs

Invoice 2019-56



# Appendix V

## Quality Control / Tests and Calibrations / Processing Steps

### Quality Control

Throughout the data acquisition phase, data are monitored closely for quality control and error-checking on all channels. Output from the Geometrics MFAM magnetometer includes a wide range of error codes, which are written to the raw data file to help diagnose problems when they occur in the field.

All data are checked on a daily basis, as field data are transferred to Zen Geomap offices in Timmins or North Bay, Ontario. When errors or problems occur, the field crew is instructed to re-fly problem areas.

### Tests and Calibrations

The following tests and calibrations are carried-out on all magnetometer equipment and sensors employed by Zen Geomap Inc.;

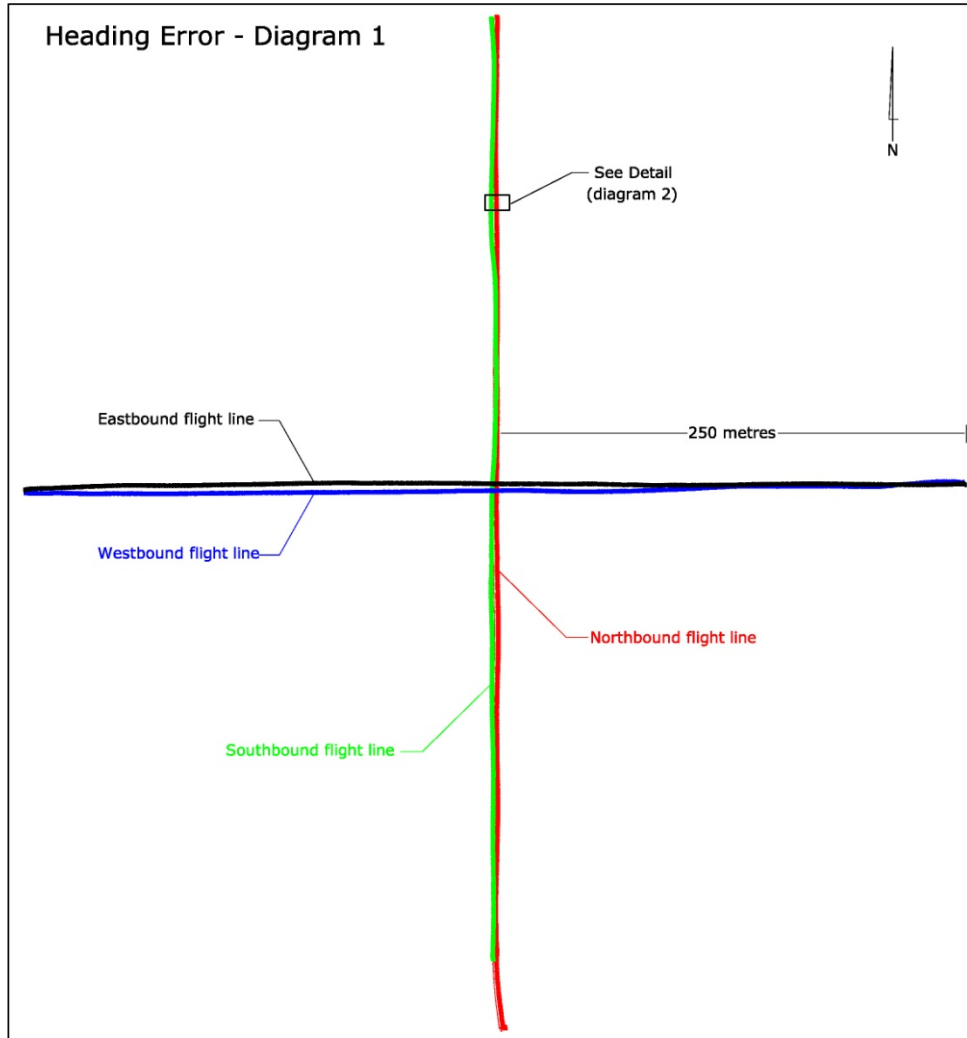
#### Heading Error

Upon receipt of a new magnetometer (or after significant repair or modification to any system component), a test flight is carried-out to determine heading error.

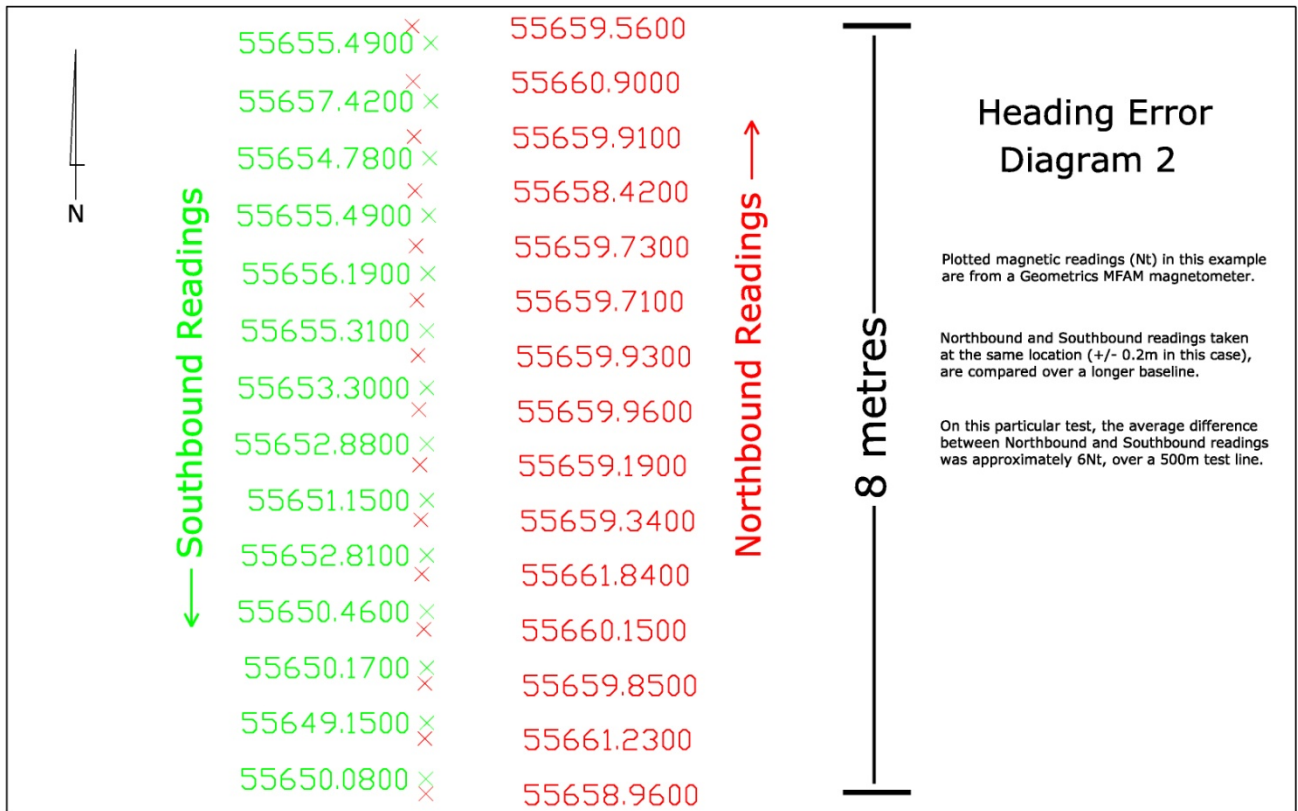
A cross-pattern is flown as shown in **Diagram 1**, with 500 metre N-S and E-W lines. Magnetic readings are collected along the same lines, flown in opposite directions.

Northbound and Southbound readings at the same location (+/- 0.2m in this example) are compared. Eastbound and Westbound readings undergo the same process.

(See: Heading Error – **Diagram 2**).



**Example test flight by Zen Geomap, August, 2019**



**Example – Geometrics MFAM readings, August, 2019**

The difference between Northbound and Southbound readings, averaged over a 500m baseline is calculated. The resulting value (6 Nt in above example), is used to apply a correction for heading error during processing.

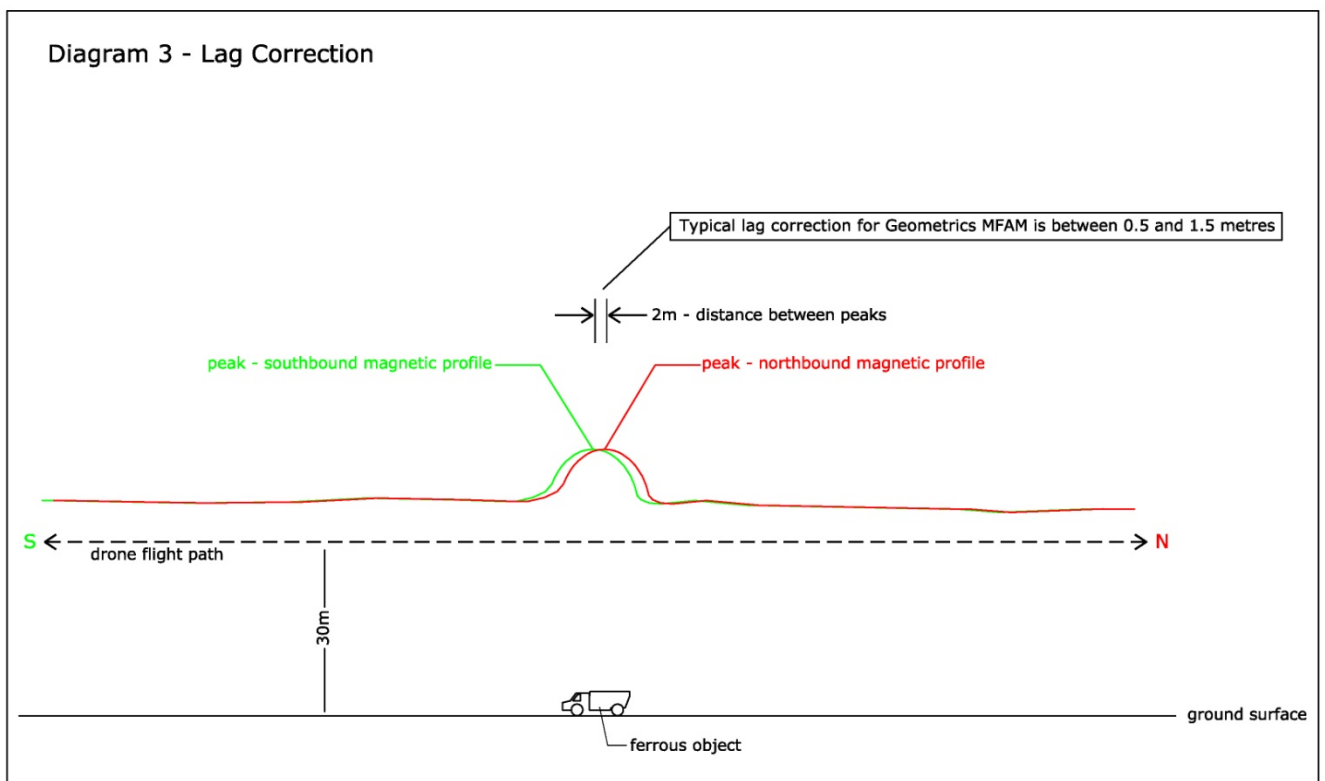
Each mag sensor will produce a unique result, however we typically apply a correction of 3Nt or less, to adjacent flight lines.

## Lag Correction

Tests are performed to determine lag correction, by flying the drone magnetometer in opposite directions over top a ferrous object. Suitable objects include steel bridges, vehicles or heavy equipment.

**Diagram 3** shows a typical flight test to determine lag correction.

A Geometrics MFAM magnetometer will typically have a lag error between 0.5 and 1.5 metres. Each mag sensor will produce a unique value. We typically apply a correction of 1m or less, to the location of magnetic readings on adjacent lines.



## **Diurnal Correction**

A Geometrics G856AX proton procession magnetometer is operated as a base station on all projects, to provide diurnal monitoring of the local magnetic field variations. Adjustment may be applied to the raw MFAM readings, when variations exceed 10 or more Nt over the course of any flight. However, we typically re-fly grid lines, if the magnetic field variation is excessive.

The location (UTM coordinate) of the base station is included in the report body.

## **Processing Steps**

Diurnal is examined for flights covering tie lines.

If magnetic field variation is excessive during tie line flights, all readings across tie lines are corrected using the base station data.

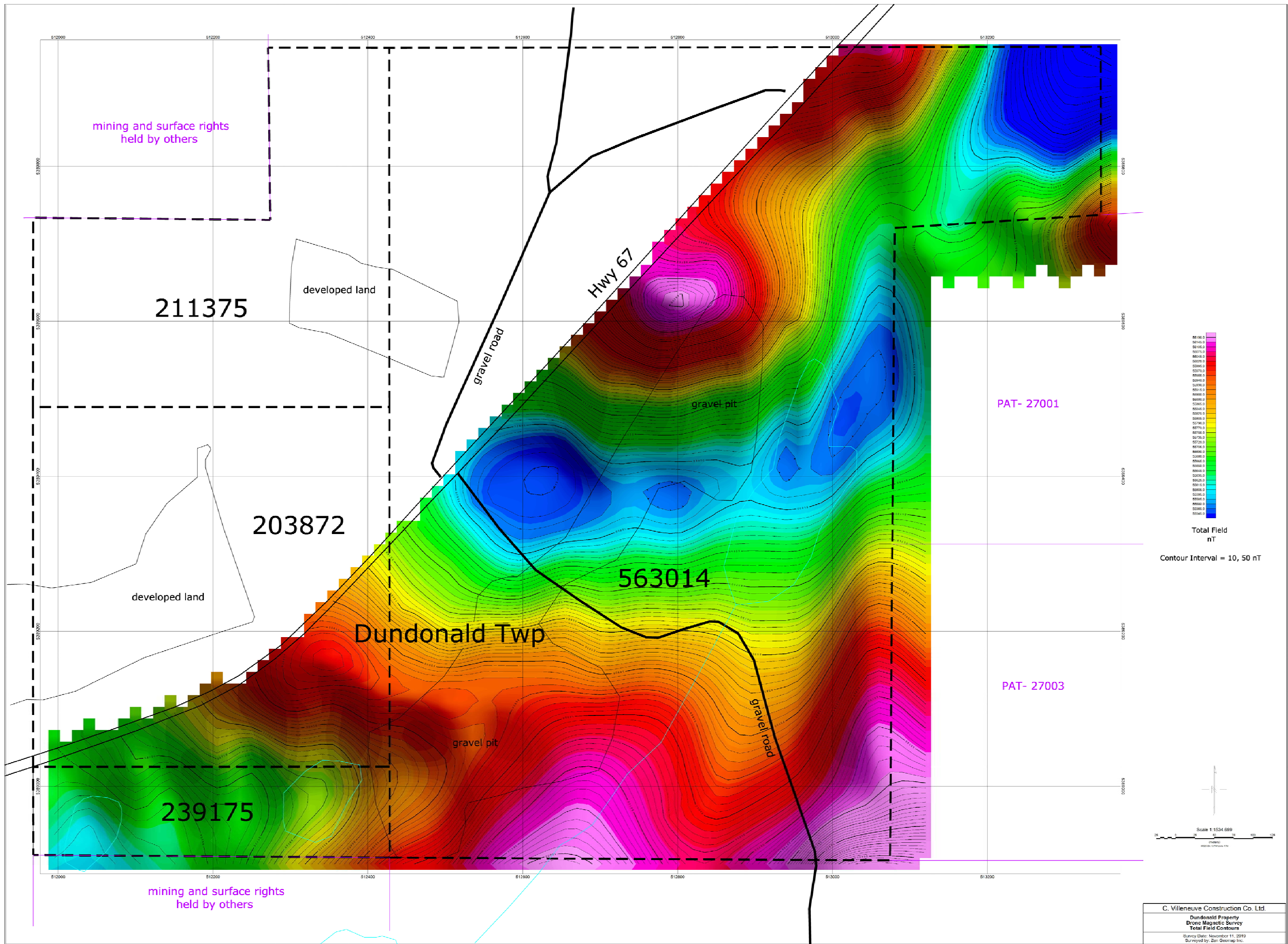
Tie lines provide a framework for leveling grid lines.

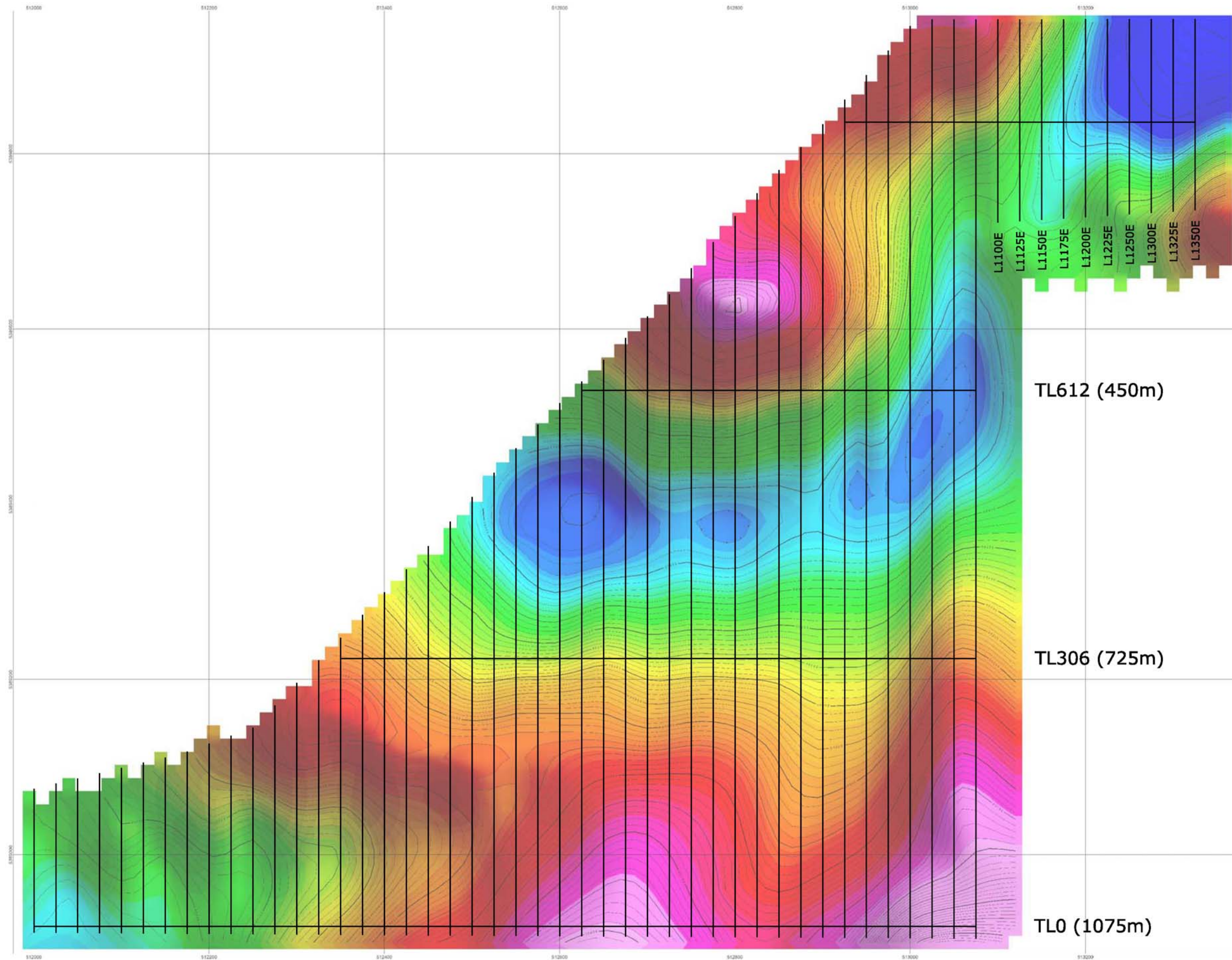
Readings on grid lines (once corrected for heading error and lag), are translated to conform to the tie lines. This process involves adjusting individual grid line segments, based on tie line intersections.

Unlike conventional airborne survey, such as fixed-wing or helicopter, a drone will take-off and land multiple times during the course of a survey. The resulting ferry lines are removed from the overall dataset prior to processing. Zen Geomap has developed import templates that run in Geosoft Oasis Montaj, to accomplish this task.

Geometrics MFAM data is not directly compatible with industry-standard software such as Geosoft. Zen Geomap has developed software (Python code) to convert raw MFAM data into a format compatible with Geosoft and other industry-standard geophysical software. The raw data from MFAM is processed through Python, prior to initial processing.

The Python code developed by Zen Geomap has been adopted by Geometrics, as the standard conversion software for drone-mounted MFAM. Geometrics has been the industry leader for airborne magnetometer equipment since 1969.





TL918 (400m)

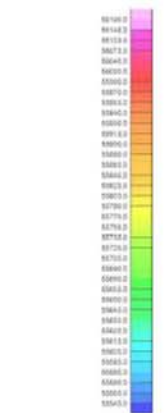
TL612 (450m)

TL306 (725m)

TL0 (1075m)

L1100E  
L1125E  
L1150E  
L1175E  
L1200E  
L1225E  
L1250E  
L1300E  
L1325E  
L1350E

L0E  
L25E  
L50E  
L75E  
L100E  
L125E  
L150E  
L175E  
L200E  
L225E  
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L825E  
L850E  
L875E  
L900E  
L925E  
L950E  
L975E  
L1000E  
L1025E  
L1050E  
L1075E



Total Field  
nT  
Contour Interval = 10, 50nT

Total Line Km: 29.65km  
(27km Grid / 2.65 Tie Lines)

