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Data Acquisition and Processing Report

Helicopter-borne **MobileMT**

Electromagnetic & Magnetic survey

Sammy 1 and 2 MobileMT Project

in Ontario for Jadeite Capital,
by Expert Geophysics Limited.

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'Expert Geophysics' Job #21002

June, 2021

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1 Executive Summary

Expert Geophysics Limited (EGL) conducted a helicopter-borne **MobileMT** electromagnetic and magnetic survey in Thunder Bay area, Ontario over two blocks for **Jadeite Capital**. Electromagnetic and magnetic geophysical data were acquired using EGL's airborne **MobileMT** system. Please refer to Appendix I for the Company Profile and Appendix II for the **MobileMT** technology description.

The purpose of the survey was mapping bedrock structure and lithology, including possible alteration and mineralization zones, using apparent conductivity corresponded to different frequencies, inverted EM data into resistivities with depth, available VLF EM data and the magnetic field reflected magnetic properties of the bedrock units. A total of 13 production flights were flown to complete 1455 line-kilometers of the survey over two blocks; Sammy1 with 586 line-kilometers of the survey over a 107 sq.km area; Sammy2 with 869 line-kilometers of the survey over a 152 sq.km area.

The survey was flown using helicopter Eurocopter AS 350BA, registration C-FDYS, of the aviation company Panorama Helicopters. The survey production flights started on April 13, 2021 and data acquisition was completed on April 24, 2021. The survey operations were conducted from Spruce Forest Lodge, Shuniah, Ontario, Canada.

The survey lines for Sammy1 and Sammy2 are oriented N-S (0°N) at 200 m spacing, while tie lines are oriented in perpendicular direction to the survey lines and spaced at 2000 m.

The geophysical survey results are presented in the form of digital databases, maps, grids, sections, elevation slices and 3D voxels. The report describes the data acquisition, processing and inversion procedures, equipment and digital data specifications, basic data analysis.

2 Introduction

The report describes the **MobileMT** airborne electromagnetic and magnetic survey that **Expert Geophysics Limited** (**EGL**, Appendix I) performed for **Jadeite Capital.** in the period of April 13, 2021 – April 24, 2021 over two blocks located approximately 50 km NNE Thunder Bay, Ontario, Canada. Electromagnetic passive fields and magnetic field data were gathered using **MobileMT** helicopter-borne system (Appendix II).

The Survey Area section of the report contains description of the survey area and flight paths. The Field Operation section includes information about the operation flow, the airport and base stations locations and flights dates. The Survey Equipment section describes the main and ancillary equipment used for the data acquisition. The Data Processing and Deliverables Specifications section consists of main data processing and inversion procedures and final products description. The Survey results discussion section includes basic data analysis and recommendations for further data analysis.

The following table includes a brief reference of the survey specifications (Table 1).

Table 1 - Summary Project Information

Client:	**Jadeite Capital**
Client/consultant's contact:	**Aaron Stone** • Office: (514) 235-6012 • e-mail: aaron.stone@jadeitecapital.com
EGL Job Number	#21002
Survey area location:	Shuniah, Ontario, Canada
Crew and aircraft location:	Spruce Forest Lodge, Shuniah, Ontario, Canada
Mag Base station location:	Lat 48.81694 N Long 89.08750 W
EM Ref station location Sammy1:	Lat 48.78893 N Long 89.19475 W
EM Ref station location Sammy2:	Lat 48.82753 N Long 88.91719 W
Block:	Sammy1
Total line kms:	586 line-km
Total Survey Area:	107 sq.km
Traverse line direction/spacing:	0°; 200 m
Tie lines direction/spacing:	90°; 2000 m
Dates flown:	04/22/2021 – 04/24/2021
Block:	Sammy2
Total line kms:	869 line-km
Total Survey Area:	152 sq.km
Traverse line direction/spacing:	0°; 200 m
Tie lines direction/spacing:	90°; 2000 m
Dates flown:	04/13/2021 – 04/21/2021
Helicopter:	Eurocopter AS350BA, C-FDYS, Panorama Helicopters
Average survey speed:	15.8 m/sec
Average Helicopter terrain clearance:	154 m
Average magnetometer clearance:	76 m
Average EM sensor clearance:	57 m
Coordinates Datum:	WGS84
Coordinates Projection:	UTM, Zone 16N, Central Meridian 87° W
MobileMT extracted frequencies, Hz Sammy1:	26, 33, 42, 73, 84, 101, 142, 161, 210, 4274, 5381, 6785, 8550, 10763, 13571, 17099
MobileMT extracted frequencies, Hz Sammy2:	33, 73, 84, 101, 142, 161, 210, 269, 342, 4274, 6785, 8550, 10763, 13571, 17099, 21539

3 Survey Areas and Flight Specifications

The **MobileMT** Sammy1 and Sammy2 survey areas are located near the municipality of Shuniah, and approximately 50 km Northeast of Thunder Bay, Ontario, Canada.

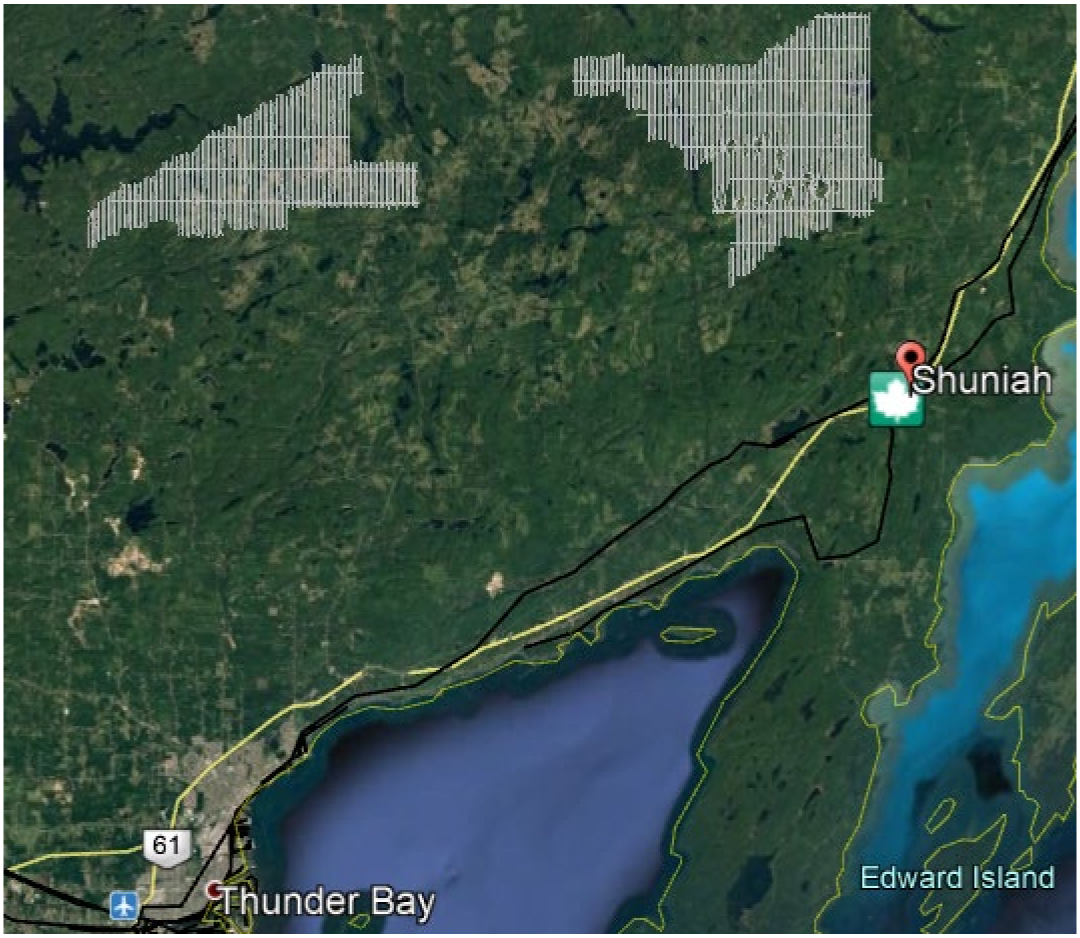


Figure 1 - Survey Area Location. Block names from right to left: Sammy1, Sammy2

The survey flown with an Eurocopter AS350BA, registration C-FDYS, helicopter operated by the aviation company Panorama Helicopters.

- Average terrain clearance of the helicopter during the survey was 154 m, at average speed 15.8 m/sec.
- Average terrain clearance of the magnetometer bird during the survey was 76 m,
- Average electromagnetic sensor terrain clearance 57 m.

3.1 Sammy1 Block

The **MobileMT** Sammy1 Block is located about 45 km N from Thunder Bay City, Ontario (Figure 2). Flight paths over the survey block are presented in Figure 3.

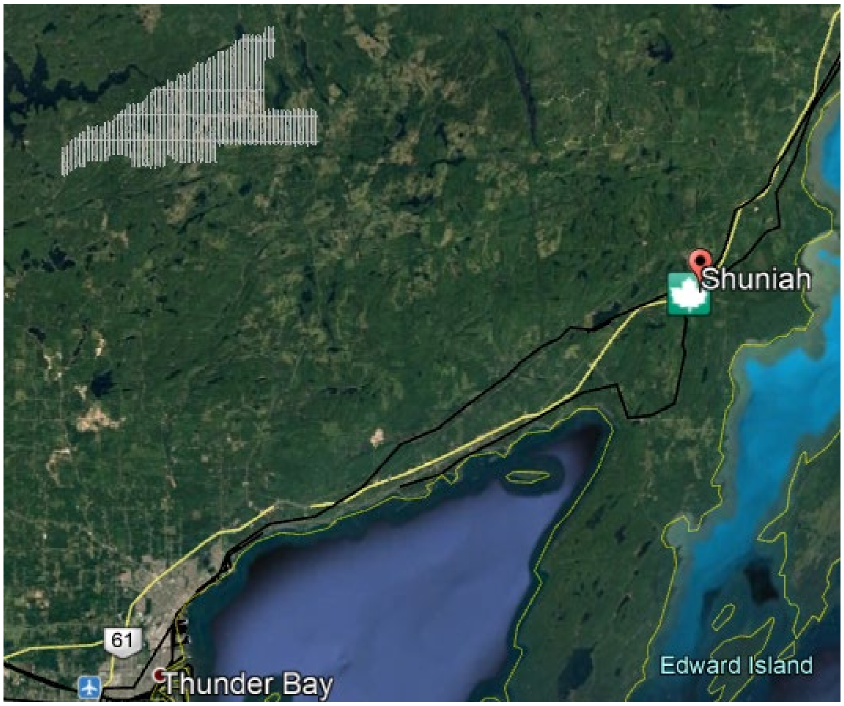


Figure 2 – Sammy1 block location with respect to Thunder Bay City

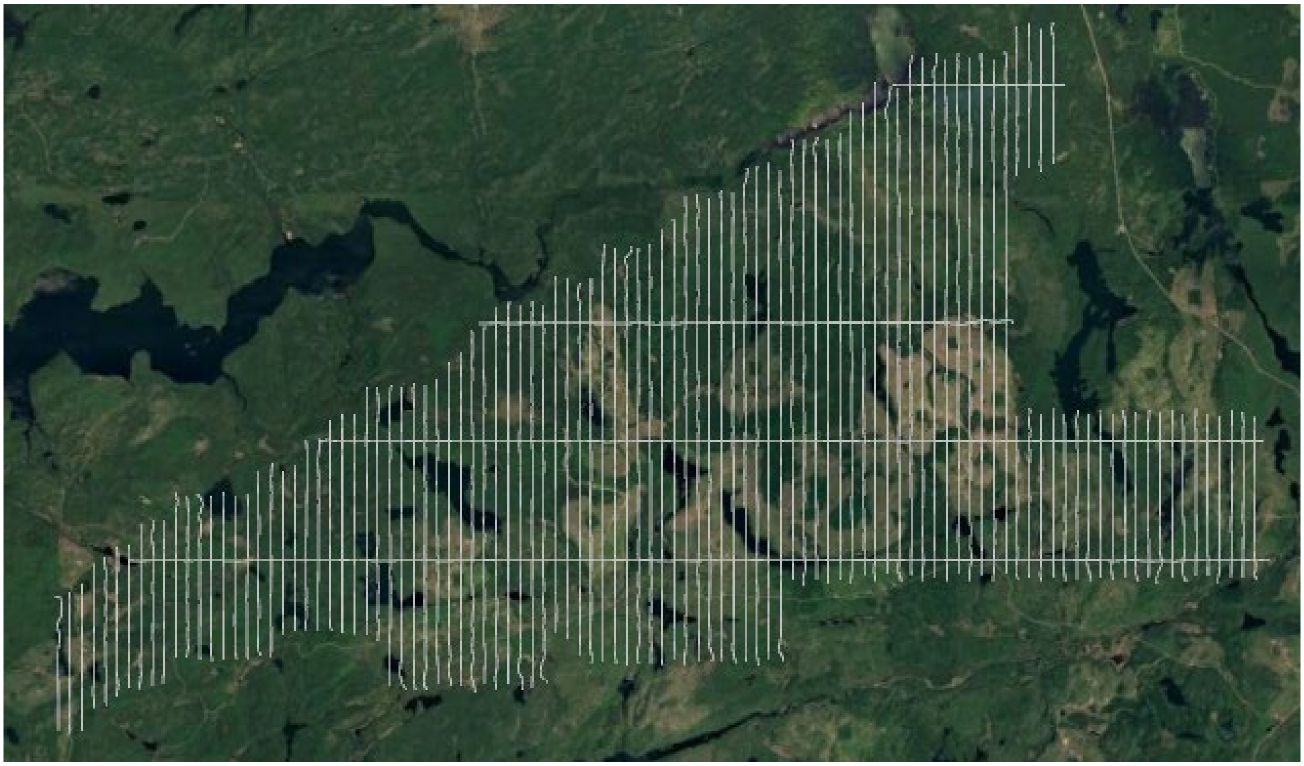


Figure 3 – Sammy1 Survey block flight path

The "WGS84 / UTM zone 16N" coordinate system information is displayed in Table 2. The survey flight lines specifications are in Table 3.

Table 2 - Coordinates of the survey Sammy1 block (WGS84, UTM zone 16N)

Sammy1 Project block			
X	Y	X	Y
326658	5400950	340375	5410687
327251	5400950	339444	5410645
327293	5401204	339402	5410179
328563	5401670	338639	5410179
328648	5402051	338555	5409714
330511	5402008	337581	5409714
330553	5402432	336904	5408824
332416	5402432	336269	5408867
332374	5401500	336226	5408359
335041	5401458	335337	5408359
335041	5402347	335379	5407893
335803	5401797	334321	5407893
339105	5401670	333347	5406665
339105	5403067	332120	5406581
347149	5402940	332162	5406157
347192	5405861	331442	5406073
343127	5405903	331103	5405776
343169	5409841	331103	5405268
343932	5409968	330214	5405268
344059	5412423	330214	5404887
343297	5412338	328860	5404929
343212	5411915	328860	5404464
341434	5411873	328182	5404379
341434	5411407	326785	5403194
340502	5411365	326658	5400950
326658	5400950	340375	5410687

Table 3 - Flight lines specifications (Sammy1)

Line spacing, m	Lines direction	Line numbers	# of lines	Line kms
200 m (traverse)	0°	4000-6400	106	539
2000 (tie)	90°	7000-7080	4	47
Total			**110**	**586**

3.1 Sammy2

The **MobileMT** Sammy2 Block is located about 18 km NNW from the city of Shuniah and about 57 km NNE from Thunder Bay City (Figure 2). Flight paths over the survey blocks are presented in Figure 5.

Figure 4 – Sammy2 Survey block location

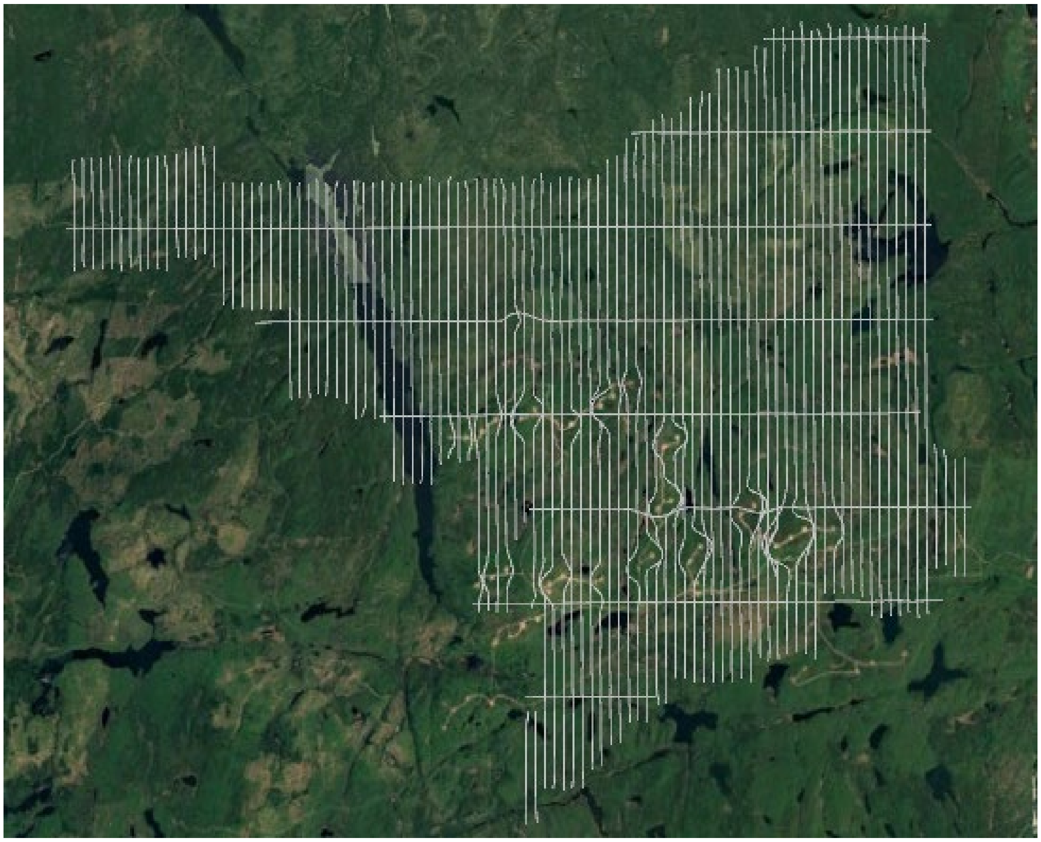


Figure 5 - Survey block Sammy2 flight path

The "WGS84 / UTM zone 16N" coordinate system information is displayed in Table 4. The survey flight lines specifications are in Table 5.

Table 4 - Coordinates of the Sammy2 survey block (WGS84, UTM zone 16N)

Sammy2 Project block			
X	Y	X	Y
357031	5411999	369498	5400039
357031	5411999	367554	5398264
360116	5411999	366793	5398222
360116	5411407	366793	5397588
368145	5411238	366286	5397546
371949	5414281	366328	5400124
375372	5414281	366708	5400208
375161	5405279	366751	5401983
376048	5404984	365398	5402068
375964	5402532	365441	5404730
375161	5402532	363666	5404730
375161	5402532	363708	5405998
375118	5401645	362947	5406167
373893	5401730	362905	5406632
373639	5402237	361510	5406632
372752	5402279	361595	5408576
372710	5400758	360116	5408618
371315	5400884	360158	5409506
371273	5400377	356904	5409548
369498	5400419	357031	5411999
357031	5411999	369498	5400039

Table 5 - Flight lines specifications (Sammy2)

Line spacing, m	Lines direction	Line numbers	# of lines	Line kms
200 m (traverse)	0°	4920-7860	99	792
2000 (tie)	90°	8860-9000	8	77
Total			**107**	**869**

4 Field Operations

4.1 Operation schedule

The survey operations were conducted from the Spruce Forest Lodge, Shuniah, Ontario. The survey executed in 13 production flights started on April, 13, 2021 and data acquisition was completed on April, 24, 2021.

Table 6 - Operation schedule

Date	estim. flown, km	Operation
12-Apr-21	0.0	Crew and helicopter mobilization from Marathon to Thunder bay area.
13-Apr-21	64.3	Base station scouting and setting. F09 completed over tie lines by the end of the day.
14-Apr-21	0.0	No production flights due to light and freezing rain throughout the day.
15-Apr-21	211.3	F10 no issues to report. F11: base station stopped recording data after 1 hour of production.
16-Apr-21	25.5	F12 two lines flown
17-Apr-21	183.5	F13 accepted, F14 rejected due to base station malfunctioning
18-Apr-21	0.0	System was opened and weather strip and shock absorber were replaced.
19-Apr-21	0.0	Shock absorbers finished and reassembly beginning by end of day
20-Apr-21	165.2	Placed base station and finished bird reassembly
21-Apr-21	184 km	3 production flights, with flight 16 rejected due to base station error, flight 17 split in half due to checking on the base station partway through
22-Apr-21	56.1	Moved base locations, flew one production flight
23-Apr-21	374.8	2 production flights with third aborted due to deteriorating weather. Ministry of Environment inspected fuel cache
24-Apr-21	107.2	1 production flight, mag bird repairs, Heli installation BNC/TNC threads on skin cable stripped
25-Apr-21	0.0	Crew moved to Northern Light Resort, picked up base station along way.

Activity type stats during the survey is shown in Figure 6.

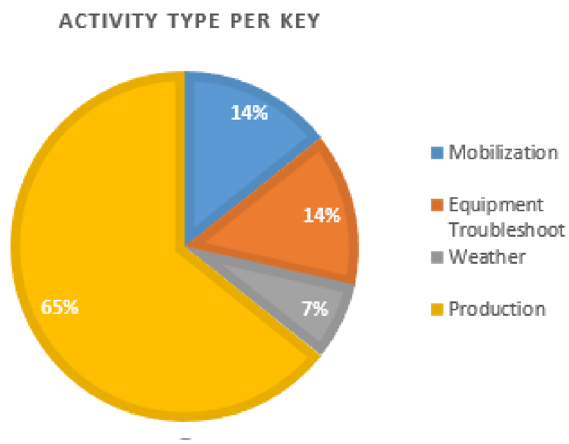


Figure 6 - Activity During the Survey

4.2 Aircraft parking and base stations locations

Locations of the aircraft parking, magnetic base station and MobileMT reference base station are specified in Table .

Table 7 - Aircraft parking and base stations locations

	Position
Aircraft parking	Spruce Forest Lodge, Shuniah, ON
Mag base station	Lat 48.81694 N / Long 89.08750 W
EM Ref base station Sammy1	Lat 48.78893 N / Long 89.19475 W
EM Ref base station Sammy2	Lat 48.82753 N / Long 88.91719 W

4.3 Re-flights

Identified, during the survey quality control (QC), and re-flown flight-lines for Sammy2 are specified in Table . Only accepted by QC lines data are included into the final databases. There were no re-flights for Sammy1 Block.

Table 8 - List of re-flown lines for Sammy2

Line Number	Length, km	Reason
4940	2.5	Low natural signal
5200	12.3	
5620	12.8	
5880	7.7	
5900	9.4	
5920	9.3	
6040	6.0	
6060	6,5	
6280	4.5	
6300	4.6	
6440	2.7	

4.4 Office and Field Personnel

The following personnel participated in the project support and field operations:

Project Managers: Andrei Bagrianski (EGL);

EGL Operators: Werner Hilla, Julian Arbelaez and Matthew Johnston;

EGL Technician: Igor Filonenko

DataQC, Processor: Andrei Bagrianski (EGL);

Tech.support: Igor Filonenko;

Final data processing, finals producing, report: Alexander Prikhodko (EGL); Julian Boada (EGL).

5 Survey Equipment and Specifications

5.1 Equipment composition

The main instrumentation installed on the **MobileMT** tow-bird:

- Three orthogonal induction coils (1.4 m diameter each) to measure naturally occurring magnetic fields in the frequency range 25 Hz – 20,000 Hz
- Geometrics G822A Cesium Magnetometer, installed in a separate towed-bird, 20 m above the **MobileMT** bird, sensitivity of 0.001 nT/10 Hz sampling
- GPS antenna, installed on the towed-bird with the magnetometer.

The main instrumentation installed on the helicopter:

- EGL PC-104 based Data Acquisition System
- EGL Navigation system with Pilot Steering Indicator
- Smartmicro model UMRR-0A Radio Altimeter, 0 – 500 m range
- GPS antenna, installed on the helicopter tail

Base Stations and Ground Support instrumentation comprises:

- **MobileMT** Ground Base Station, 4-channel (2 channels for signal and 2 channels for reference signal), to measure variations of the electric field in two directions with 4 pairs of electrodes. Electrical line length – 100 m each line, direction X – 45 degrees, Y – 135 degrees (N1 base station).
- GEM Systems GSM-19 Base Station Magnetometer, 0.1 nT sensitivity, with data logger;
- A Field Data Processing Workstation and a full suite of software for the quality control and preliminary processing of the airborne geophysical data.

MobileMT VLF specifications:

- VLF-EM System: EGL proprietary digital system
- Model: Matrix Plus
- Manufacturer: EGL
- Antenna: used in the MobileMT three orthogonal coils (x,y,z)
- Primary Sources: up to 4 discrete frequencies (stations)
- Output Parameters: Amplitude (secondary field), vertical and planar ellipicities, azimuth, tilt angle
- Sample Rate: 0.1 second
- Gain: Constant gain setting
- Filtering: No filtering

MobileMT EM specifications:

- Airborne receiver: Three orthogonal induction coils (1.4 m diameter each)
- Airborne shell: Aerodynamic shaped capsule

- Digitizing rate: 73,728 Hz
- Tow cable length: 97 m
- Ground sensors 4 pairs of electrodes
- Electrode separation 100 m
- Lines EM base station directions 45^0, 135^0
- Frequency range: 25 Hz – 20,000 Hz
- Output computed parameters: Apparent conductivity for selected frequencies
- Output frequencies: Selectable from 25 Hz – 20,000 Hz depending on signal strength.

Selected frequencies and corresponded frequency gates are in Table 6

Table 6 - Frequency gates extracted from the data (Hz)

Start	End	Center
22.8	30.4	26.6[1]
28.7	38.4	33.6[1,2]
36.1	48.3	42.2[1]
57.3	76.7	67.0[1,2]
72.3	96.6	84.5[1,2]
91.0	121.8	106.4[1,2]
114.7	153.4	134.1[1,2]
144.5	193.3	168.9[1,2]
182.1	243.5	212.8[1,2]
229.4	306.8	268.1[2]
289.0	386.6	337.8[2]
3670.3	4909.3	4289.8[1,2]
4624.3	6185.3	5404.8[1]
5826.2	7793.0	6809.6[1,2]
7340.6	9818.5	8579.6[1,2]
9248.6	12370.6	10809.6[1,2]
11652.5	15585.9	13619.2[1,2]
14681.2	19637.1	17159.2[1,2]
18497.1	24741.1	21619.1[2]

Sammy[1], Sammy2[2]

5.2 The Airborne Magnetometer System

The airborne magnetometer is a state-of-the-art system developed by EGL. It utilizes a Geometrics G822A cesium magnetometer sensor, installed in the towed-bird and the high accuracy Larmor frequency counter developed.

5.3 The Airborne GPS Navigation System

EGL uses a proprietary GPS navigation system utilizing the GPS Receiver with Linx RXM-GNSS-TM GPS Engines. The key features of the GPS Receiver are:

• L1 1575.42MHz, C/A code

• 33-channel satellite tracking

• Position accuracy: 2.5m

• 10 Hz update rate

• Constellation System Support:

- GPS
- GLONASS
- GALILEO
- QZSS

• DGPS support:

- (SBAS) Satellite-Based Augmentation System
- (RTCM) Radio Technical Commission for Maritime Services
- (WAAS) Wide-Area Augmentation System
- (EGNOS) European Geo-Stationary Navigation System
- (MSAS) MTSAT Satellite-Based Augmentation System
- (GAGAN) GPS-Aided Geo-Augmented Navigation

An EGL Computer/Pilot Steering Indicator is used to compute the flight path grids in real-time onboard the helicopter (Figure 7, Figure 8).

Figure 7 - Pilot Steering Indicator and Radio Altimeter Indicator

Figure 8 - EGL Navigation Computer, Moving-map Display

5.4 Data Acquisition System

The data acquisition system features an EGL PC-104-based data acquisition system. The EGL data acquisition system is an instrument developed by EGL for airborne geophysical data acquisition tasks. It features EGL proprietary technology and software. The EGL data acquisition system simultaneously records data on internal flash disk and displays it on a color LCD display, at a repetition rate of 0.33 sec, for post-flight computer processing. The five main functions fulfilled by the data acquisition system are: 1) system control and monitoring, 2) data acquisition, 3) real-time data processing, 4) navigation, and 5) data playback and analysis.

5.5 Radar-Altimeter

A Smartmicro model UMRR-0A radar altimeter system records the ground clearance to an accuracy of 3% over a range of 0 ft to 1,640 ft (0 to 500 m). The altimeter is interfaced to the navigation system and the data acquisition system with an output repetition rate of 10 Hz and digitally recorded.

5.6 MobileMT ground base station

The MMT Ground Base Station comprises:

- 4 pairs of electrodes, 100 m separation each;
- Lines directions 45^0, 135^0
- EGL PC-104 based Data Acquisition System with a GPS system to record the GPS time together with the electric data;
- A power supply unit.

5.7 MobileMT Magnetometer base station

The Magnetometer Base Station was a GSM-19 Overhauser magnetometer.

The base-station magnetometer, with digital recording, operated continuously throughout the airborne data acquisition, with a sampling interval of 0.2 seconds, and sensitivity of 0.1 nT. The ground and airborne system clocks synchronized using GPS time, to an accuracy of far better than 1 second. At the end of the day's work, the digital data transferred from the base station's data-logger to the FWS. This base station located in a place with low magnetic gradient (less than 2nT/m). The base station sited away from moving steel objects, vehicles or hydro transmission lines to ensure minimum interference and noise levels.

5.8 Field Computer Workstation

The Field Data Processing Workstation (FWS) is a dedicated computer system for use at the technical base in the field. The workstation to be used on this project is designed for use with Geosoft OASIS Data Processing Software. It is also capable of processing and imaging all the geophysical and navigation data acquired during the survey, producing semi-final, preliminary-levelled maps.

The main features of the FWS are:

- Portability;
- Digital Data Verification - flight data quality and completeness were assured by both statistical and graphical means;
- Flight Path Plots - flight path plots quickly generated from the GPS satellite data to verify the completeness and accuracy of a day's flying;
- Versatility - the FWS used in both the field and the office. Data pre-processed in the field up-loaded to the computers at the Data Processing Centre to speed up data turnaround;
- Preliminary Maps - the FWS software permitted creation preliminary maps of the electromagnetic and magnetic data during the survey;
- Quality Control – acquired data quickly and efficiently checked for quality in the field on daily basis.

6 Data Processing and Deliverables Specifications

6.1 EM Data Processing

The data recorded by the towed bird sensors (three mutually orthogonal dB/dt components of the EM field) is first merged with the recorded two mutually orthogonal electrical components of electric field on the stationary base station into one file. The program which is proprietary of EGL applied the FFT to the records of the merged file and calculates the matrices of the relation between the magnetic and electrical field signals on the different time bases and in the different frequency bands. The module of the determinant of each matrix is a rotation invariant parameter and it is used as an output parameter.

The frequencies for the data processing selected based on the signal strength for each surveyed block and the local noise interference. The selected frequencies for the survey presented in the Table 6.

6.2 EM data inversions:

MobileMT data was inverted with nonlinear least-squares iterative inversion developed by N. Golubev for MobileMT. The inversion algorithm is based on the conjugate gradient method with the adaptive regularization (*Zhdanov M.S, Geophysical Inverse Theory and Regularization Problems. Methods in Geochemistry and Geophysics, 36. Elsevier, 2002. 609 p.*). The inversion procedure is executed for each station independently without stations sampling along a line. The algorithm uses weighting of the inverted parameters. Consequently, sensitivity of the data to resistivity of each layer is approximately equal and independent of the layer's depth. This way provides high resolution of deep parts of a model, as upper part. Each measured data station along lines is inverted.

The data inversion procedures include:

- Data preparation and its conversion for the software input;
- Creation an inversion parameter file and a starting model. The model consisted of 100 "layers", 30 m thickness with uniform resistivity. The starting resistivity is calculated as an average value for each station apparent resistivity curve;
- Inversions;
- Results control and analysis (RMS, data and model comparison);
- The inverted data import into Geosoft for database, sections, depth slices and a 3D voxel compilation.

Misfit of inversions (RMS) is calculated as:

$$RMS(\rho)=\sqrt{\frac{\sum_{n=1}^{N}(\rho_n^{pr}-\rho_n^{obs})^2}{N}}$$

Where obs – observed, pr – predicted resistivity. The misfit values are in the inversion database followed the report.

All electromagnetic data (apparent conductivity for different frequencies) where inverted into resistivity-depth distribution. The resulted products of the inversions include 3D voxels, resistivity-elevation slices, resistivity sections for each surveyed line.

6.3 Magnetic Data Processing

Raw total magnetic field data are recorded at 0.1-second sampling intervals.

The Earth's magnetic field is known to vary as a function of time. Time varying magnetic events such as magnetic storm transients and more regular diurnal variations which occur during the acquisition of magnetic data may affect the accuracy of the survey data and distort magnetic anomalies. Separation of the time-dependent variations in the magnetic field from a real geomagnetic anomaly requires an independent estimate of the transient magnetic field events. Base station magnetometer data provides this independent estimate. The diurnal base station data was analyzed for spikes and spurious sections which were manually removed from the dataset. A 10-point low pass filter was then applied to the diurnal data.

The magnetic data was corrected for the diurnal variations, leveled and filtered. Raw magnetic data has initial preprocessing only (spike removal, short gaps interpolated). On the next stage, all of the magnetic data processed by an adjustment procedure that statistically treats the line data. It is designed to recognize and remove systematic bias and small random errors in the data which can cause survey line mis-ties. Bias errors in the magnetic data arise from changes in the level of the total magnetic field.

To remove bias errors, each profile of a given data set in the survey was shifted up or down systematically by an amount such that the sum of the square of the mis-tie errors for that data set over the entire survey network is minimized. The systematic corrections are further constrained such that the sum of the systematic corrections is zero, effectively eliminating DC shifts to the network as a whole. After this systematic adjustment, the remaining intersection mis-ties studied and removed. The final statistical choice of the data values at each intersection is a function of the reliability weights of each line for each data set. The random error correction for each data set prorated between intersections. After editing the adjusted line data for line pulls and data quality, they were input to a minimum curvature gridding algorithm and a grid produced.

As additional products IGRF (total regional field) removal (ResMag) and calculated vertical derivative (cvg) were produced.

6.4 VLF Data Processing

VLF-EM data were captured using the MobileMT three components receiver. The instrument is capable of simultaneously monitoring up to four VLF frequencies, recording amplitude (secondary field), transmitter station azimuth (relative to aircraft orientation), vertical and planar ellipticities and tilt angle.

For this project, the following VLF transmitters were monitored:

- Station NAA: Cutler, Maine – 24.0 kHz
- Station NML: La Moure, North Dakota – 25.2 kHz
- Station NLK: Jim Creek, Washington – 24.8 kHz

But the 24 kHz signal was accepted and presented in the final database.

Processing of the raw amplitude data consisted of the following:

- Mask out any embedded “off-line” data
- Noise reduction filtering using non-linear Naudy filtering (5 pt filter width)
- Initial levelling (mean subtraction)
- Fine levelling (micro-levelling)

The finalized data for accepted frequency(s) were presented as a series of amplitude colour images. High amplitude values correspond to conductive zones.

6.5 Ancillary data processing

Positions and altitudes of the magnetic sensor and EM receiver are derived from data of two GPS antennas (A – on the helicopter, B- on the magnetic sensor bird) and radar-altimeter positioned on the helicopter. A digital elevation model (DEM) channel has been calculated by subtracting the filtered radar-altimeter data from the GPS-A elevation.

6.6 Data Deliverables

6.6.1 Sammy1 Block

EM Database: Sammy1_EM.gdb presented in a Geosoft GDB format

- The database channels description is in Table 7.

Table 7 - Geosoft Sammy1_EM.gdb Data Format

Channel Name	Units	Description
xe:	metres	EM bird UTM Easting WGS84 Zone 16 North
ye:	metres	EM bird UTM Northing WGS84 Zone 16 North
ze:	meters	EM bird elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_e:	Metres	EM bird terrain clearance
DTM:	metres	Digital Elevation Model
PLM:	Units	Powerline monitor
ac_26:	mS/m	Apparent Conductivity for freq 26 Hz
ac_33:	mS/m	Apparent Conductivity for freq 33 Hz
ac_42:	mS/m	Apparent Conductivity for freq 42 Hz
ac_73:	mS/m	Apparent Conductivity for freq 73 Hz
ac_84:	mS/m	Apparent Conductivity for freq 84 Hz
ac_101:	mS/m	Apparent Conductivity for freq 101 Hz
ac_142:	mS/m	Apparent Conductivity for freq 142 Hz
ac_161:	mS/m	Apparent Conductivity for freq 161 Hz
ac_210:	mS/m	Apparent Conductivity for freq 210 Hz
ac_4274:	mS/m	Apparent Conductivity for freq 4274 Hz
ac_5381:	mS/m	Apparent Conductivity for freq 5381 Hz
ac_6785:	mS/m	Apparent Conductivity for freq 6785 Hz
ac_8550:	mS/m	Apparent Conductivity for freq 8550 Hz
ac_10763:	mS/m	Apparent Conductivity for freq 10763 Hz
ac_13571:	mS/m	Apparent Conductivity for freq 13571 Hz
ac_17099:	mS/m	Apparent Conductivity for freq 17099 Hz

The EM and MAG databases can be synchronized based on *gtime* channel.

Mag Database: Sammy1 presented in a Geosoft GDB format

- The database channels description is in Table 8.

Table 8 – Geosoft Sammy1_MAG.gdb Database Format

Channel Name	Units	Description
xm:	metres	mag bird UTM Easting WGS84 Zone 16 North
ym:	metres	mag bird UTM Northing WGS84 Zone 16 North
zm:	meters	mag bird elevation above geoid
xh:	metres	heli UTM Easting WGS84 Zone 16 North
yh:	metres	heli UTM Northing WGS84 Zone 16 North
zh:	meters	heli elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_m:	Metres	mag bird terrain clearance
DTM:	metres	Digital Elevation Model
GPS_B_LAT:	Decimal degrees	Mag bird latitude, WGS84
GPS_B-LON:	Decimal degrees	Mag bird longitude, WGS84
basemag:	nT	Magnetic base station data
Magair:	nT	Measured magnetic field
Magcor:	nT	Corrected for diurnal magnetic field
TMI:	nT	Total magnetic intensity, levelled and microlevelled
CVG_TMI:	nT/m	Calculated vertical derivative of the magnetic field

The EM and MAG databases can be synchronized based on *gtime* channel.

VLF Database: Sammy1 presented in a Geosoft GDB format

- The database channels description is in Table 9.

Table 9 – Geosoft Sammy1_VLF.gdb Database Format

Channel Name	Units	Description
xe:	metres	EM bird UTM Easting WGS84 Zone 16 North
ye:	metres	EM bird UTM Northing WGS84 Zone 16 North
ze:	meters	EM bird elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_e:	Metres	EM bird terrain clearance
DTM:	metres	Digital Elevation Model
Amplitude:		VLF secondary field amplitude for freq 24.0 kHz
Azimuth:	degrees	transmitter station azimuth (relative to aircraft orientation)
TiltAngle:		In-Phase [VLF Tilt]
El_Vert:		Quadrature [VLF Vertical Ellipticity]
El_Plan:		VLF Planar Ellipticity

Grids and Maps for Sammy1 block:

- Refer to Table 10 for summary of grids and maps (Appendix III) which accompany this report.

Table 10 – Lists of Sammy1 Block grids (in Geosoft format) and maps (in Geosoft and PDF formats).

Grids	Maps	Description
CVG	CVG	Calculated vertical derivative of the magnetic field
TMI	TMI	Total magnetic intensity
ac_26		Apparent Conductivity for freq 26 Hz
ac_33		Apparent Conductivity for freq 33 Hz
ac_42		Apparent Conductivity for freq 42 Hz
ac_73		Apparent Conductivity for freq 73 Hz
ac_84		Apparent Conductivity for freq 84 Hz
ac_101		Apparent Conductivity for freq 101 Hz
ac_142		Apparent Conductivity for freq 142 Hz
ac_161		Apparent Conductivity for freq 161 Hz
ac_210		Apparent Conductivity for freq 210 Hz
ac_4274		Apparent Conductivity for freq 4274 Hz
ac_5381	AC-5381	Apparent Conductivity for freq 5381 Hz
ac_6785	AC-6785	Apparent Conductivity for freq 6785 Hz
ac_8550	AC-8550	Apparent Conductivity for freq 8550 Hz
ac_10763	AC-10763	Apparent Conductivity for freq 10763 Hz
ac_13571	AC-13571	Apparent Conductivity for freq 13571 Hz
ac_17099	AC-17099	Apparent Conductivity for freq 17099 Hz
DepthSliceASL	DepthSliceASL_XXXXm	Resistivity Depth slice from surface from -400m to 400m with 100m interval
ResSec	ResSec_LXXXX	Resistivity Line Sections
Amplitude	Amplitude	VLF Secondary Field Amplitude for Frequency 24.0 kHz

6.6.2 Sammy2 Block

EM Database: Sammy2_EM.gdb presented in a Geosoft GDB format

- The database channels description is in Table 11.

Table 11 - Geosoft Sammy2_EM.gdb Data Format

Channel Name	Units	Description
xe:	metres	EM bird UTM Easting WGS84 Zone 16 North
ye:	metres	EM bird UTM Northing WGS84 Zone 16 North
ze:	meters	EM bird elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_e:	Metres	EM bird terrain clearance
DTM:	metres	Digital Elevation Model
PLM:	Units	Powerline monitor
ac_33:	mS/m	Apparent Conductivity for freq 33 Hz
ac_73:	mS/m	Apparent Conductivity for freq 73 Hz
ac_84:	mS/m	Apparent Conductivity for freq 84 Hz
ac_101:	mS/m	Apparent Conductivity for freq 101 Hz
ac_142:	mS/m	Apparent Conductivity for freq 142 Hz
ac_161:	mS/m	Apparent Conductivity for freq 161 Hz
ac_210:	mS/m	Apparent Conductivity for freq 210 Hz
ac_269:	mS/m	Apparent Conductivity for freq 269 Hz
ac_342:	mS/m	Apparent Conductivity for freq 342 Hz
ac_4274:	mS/m	Apparent Conductivity for freq 4274 Hz
ac_6785:	mS/m	Apparent Conductivity for freq 6785 Hz
ac_8550:	mS/m	Apparent Conductivity for freq 8550 Hz
ac_10763:	mS/m	Apparent Conductivity for freq 10763 Hz
ac_13571:	mS/m	Apparent Conductivity for freq 13571 Hz
ac_17099:	mS/m	Apparent Conductivity for freq 17099 Hz
ac_21539:	mS/m	Apparent Conductivity for freq 21539 Hz

The EM and MAG databases can be synchronized based on *gtime* channel.

Mag Database: Sammy2_Mag.gdb presented in a Geosoft GDB format

- The database channels description is in Table 12.

Table 12 - Geosoft Sammy2_Mag.gdb Database Format

Channel Name	Units	Description
xm:	metres	mag bird UTM Easting WGS84 Zone 16 North
ym:	metres	mag bird UTM Northing WGS84 Zone 16 North
zm:	meters	mag bird elevation above geoid
xh:	metres	heli UTM Easting WGS84 Zone 16 North
yh:	metres	heli UTM Northing WGS84 Zone 16 North
zh:	meters	heli elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_m:	Metres	mag bird terrain clearance
DTM:	metres	Digital Elevation Model
GPS_B_LAT:	Decimal degrees	Mag bird latitude, WGS84
GPS_B-LON:	Decimal degrees	Mag bird longitude, WGS84
basemag:	nT	Magnetic base station data
Magair:	nT	Measured magnetic field
Magcor:	nT	Corrected for diurnal magnetic field
TMI:	nT	Total magnetic intensity, levelled and microlevelled
cvg:	nT/m	Calculated vertical derivative of the magnetic field

The EM and MAG databases can be synchronized based on *gtime* channel.

VLF Database: Sammy2 presented in a Geosoft GDB format

- The database channels description is in Table 13.

Table 13 – Geosoft Sammy1_VLF.gdb Database Format

Channel Name	Units	Description
xe:	metres	EM bird UTM Easting WGS84 Zone 16 North
ye:	metres	EM bird UTM Northing WGS84 Zone 16 North
ze:	meters	EM bird elevation above geoid
gtime:	Sec of the day	GPS time
RdAlt:	metres	helicopter terrain clearance from radar altimeter
alt_e:	Metres	EM bird terrain clearance
DTM:	metres	Digital Elevation Model
Amplitude:		VLF secondary field amplitude for freq 24.0 kHz
Azimuth:	degrees	transmitter station azimuth (relative to aircraft orientation)
TiltAngle:		In-Phase [VLF Tilt]
El_Vert:		Quadrature [VLF Vertical Ellipticity]
El_Plan:		VLF Planar Ellipticity

Grids and Maps for Sammy2 block:

Refer to Table for summary of the grids and maps (Appendix III) which accompany this report.

Table 15 – Lists of Sammy 2 Block grids (in Geosoft format) and maps (in Geosoft and PDF formats).

Grids	Maps	Description
CVG	CVG	Calculated vertical derivative of the magnetic field
TMI	TMI	Total magnetic intensity
AC-33hz		Apparent Conductivity for freq 33 Hz
AC-73hz		Apparent Conductivity for freq 73 Hz
AC-84hz		Apparent Conductivity for freq 84 Hz
AC-101hz		Apparent Conductivity for freq 101 Hz
AC-142hz		Apparent Conductivity for freq 142 Hz
AC-161hz		Apparent Conductivity for freq 161 Hz
AC-210hz		Apparent Conductivity for freq 210 Hz
AC-269hz		Apparent Conductivity for freq 269 Hz
AC-342hz		Apparent Conductivity for freq 342 Hz
AC-4274hz		Apparent Conductivity for freq 4274 Hz
AC-6785hz		Apparent Conductivity for freq 6785 Hz
AC-8550hz		Apparent Conductivity for freq 8550 Hz
AC-10763hz		Apparent Conductivity for freq 10763 Hz
AC-13571hz		Apparent Conductivity for freq 13571 Hz
AC-17099hz		Apparent Conductivity for freq 17099 Hz
AC-21539hz		Apparent Conductivity for freq 21539 Hz
DepthSliceASL	DepthSliceASL_XXXXm	Resistivity Depth slice from surface from -300m to 300m with 150m interval
ResSec	ResSec_LXXXX	Resistivity Line Sections
Amplitude	Amplitude	VLF Secondary Field Amplitude for Frequency 24.0 kHz

7 Summary and recommendations

The purpose of the survey was mapping bedrock structure and lithology, including possible alteration and mineralization zones, using apparent conductivity corresponded to different frequencies, resistivity-depth distribution and the magnetic field which reflects magnetic properties of the bedrock units.

The total natural field data for up to 19 frequencies, depending on natural signal, in the range 26.6-21,619 Hz, were used to produce apparent conductivity grids and maps (Table 10, Appendix III, and followed the report files and databases). Since the areas are in highly resistive environment, only high frequencies were used (beginning from 4274 Hz) for data inversions to get resistivity distribution in the 1000 meters depth range.

In the results of the EM data inversion, the resistivity distribution is presented in 3D voxels, resistivity sections (Figure 9, Figure 10, Figure 11) and resistivity elevation slices (Appendix III).

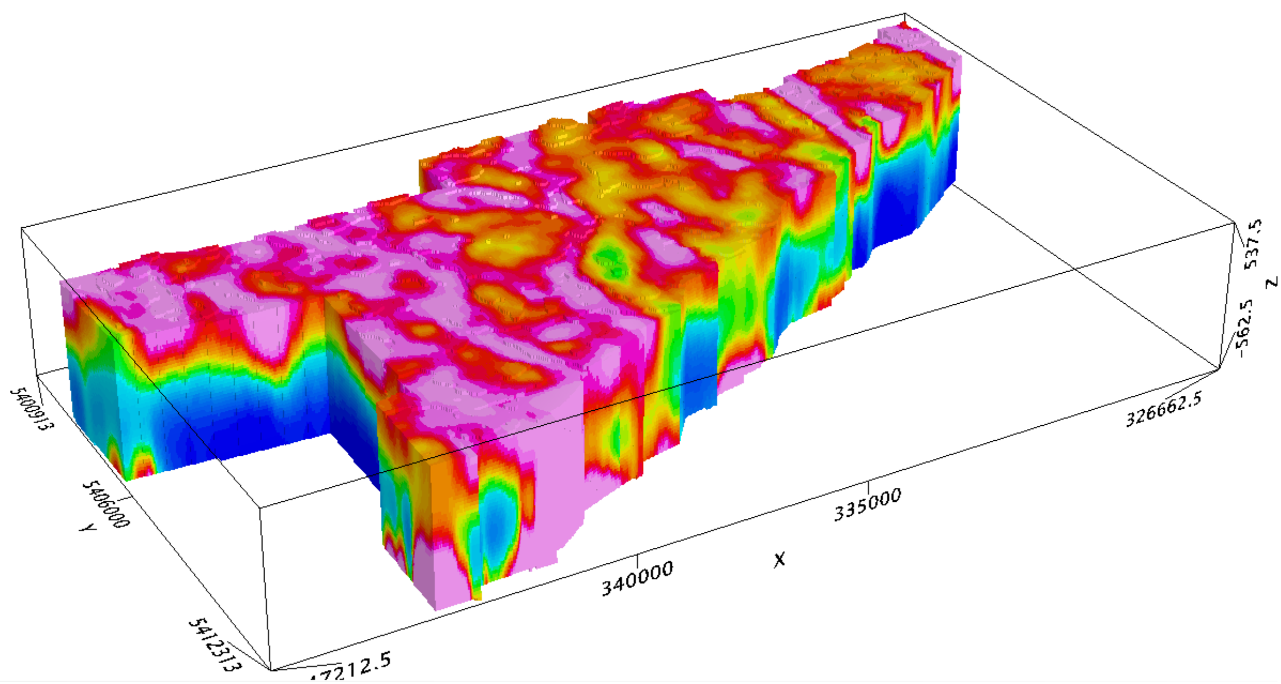


Figure 9 – 3D resistivity voxel for Sammy1 block

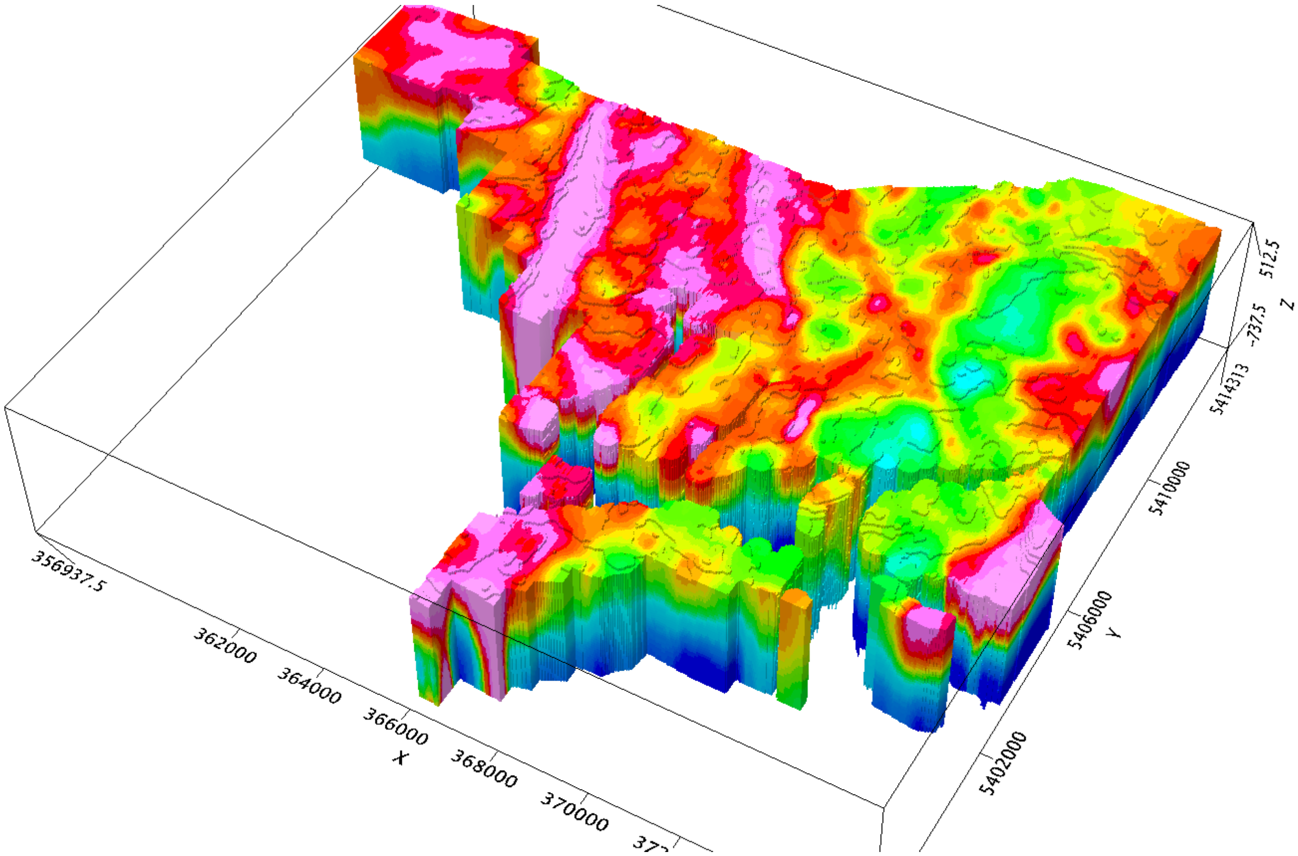


Figure 10 – 3D resistivity voxel for Sammy2 block

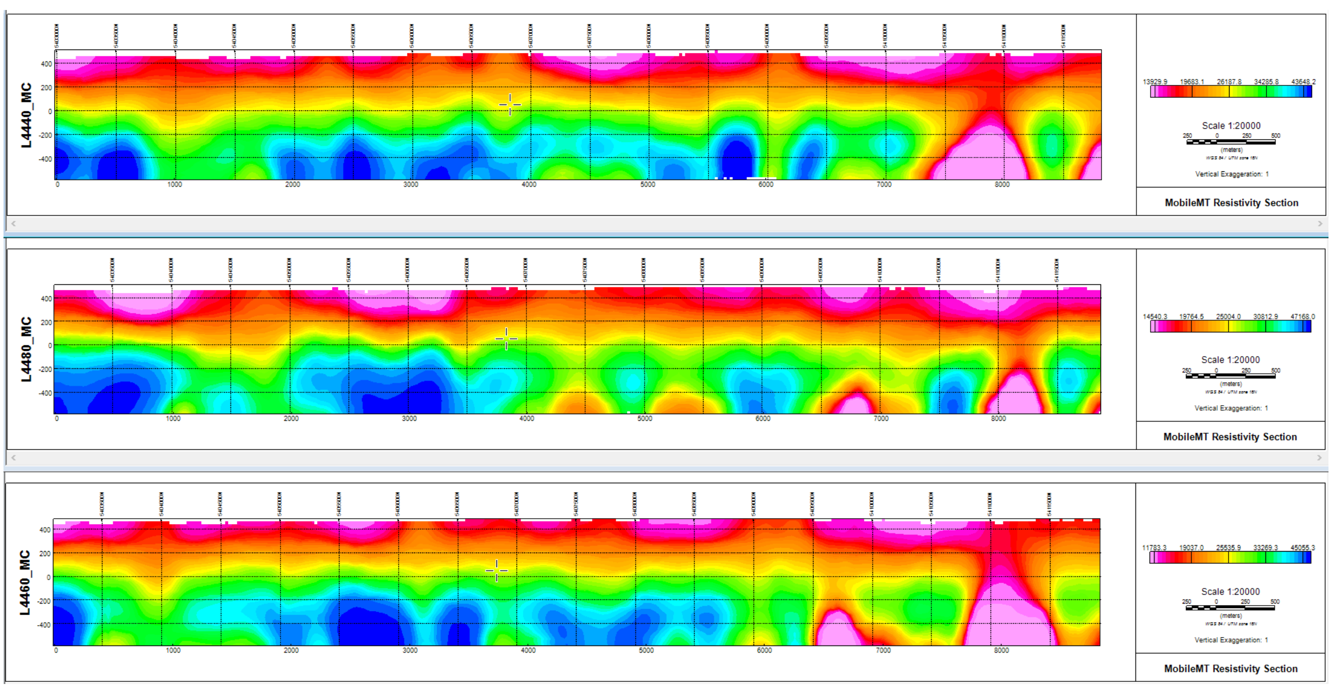


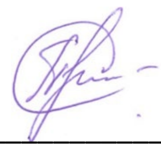
Figure 11 -Examples of MobileMT resistivity sections (from Sammy1 block)

The geological environment of the surveyed block is in the range of inverted resistivities 3000-70,000 Ohm-m (Sammy1&2) but possible local anomalies could relate to targets with less resistivities.

There is a circular structure in the magnetic field on the eastern part of the Sammy2 block when only linear EW dyke-similar magnetic anomalies are presented in the Sammy1 block. The circular magnetic structure (Sammy2), on its edge, followed by some discrete conductors. Both blocks contain linear and isometrical, near surface and comparatively deep conductors. VLF amplitude maps reflect only near surface parts of conductors (~ tens of meters depth).

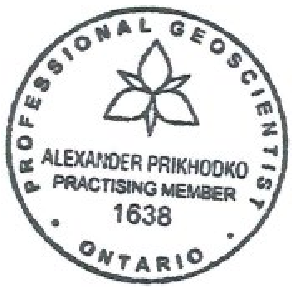
It is recommended to analyze all data, MobileMT EM, VLF and magnetic, in relation with an exploration model considered on the properties and integrating with all available geological and geochemical information, for outlining prospective places for following up.

Alexander Prikhodko, Ph.D., P.Geo



June, 2, 2021

MobileMT Job#21002 for Jadeite Capital



Appendix I Company Profile

About us

Expert Geophysics Limited is based in Toronto, Canada.

President and founder, **Andrei Bagrianski**, Ph.D., P.Geo., has over 35 years of professional experience in the acquisition, processing, and interpretation of airborne and ground geophysical data for a wide range of applications. From 2002 to 2016, he was Chief Operating Officer and General Manager at Geotech Ltd. Andrei has been directly involved in contracting, organizing, and supervising hundreds of airborne geophysical surveys on all continents except Antarctica. Andrei has extensive international field work experience that includes projects in Australia, Brazil, Bolivia, Colombia, Ecuador, Peru, Botswana, Malawi, South Africa, Libya, USA, Canada, Russia, Kazakhstan, and India.

Petr Kuzmin, Ph.D., the designer of the **MobileMT** system, has over 40 years of experience in the development of ground and airborne TDEM, MT, and IP methods, equipment, and software. Working for Geotech Ltd., Canada, from 2000 until 2009, Dr. Kuzmin was the principal designer of the award winning systems VTEM, ZTEM, and AirMt. Since 2009, Dr. Kuzmin has completed a number of successful developments: ground AFMAG, ultra-fast airborne TD (HiRes), airborne VLF system, an airborne navigation system, a high accuracy magnetometer counter, and the MobileMT. Dr. Kuzmin holds a doctorate in Geophysics, has authored nearly 20 patents, and published over 40 technical papers.

Vice President and Chief Geophysicist, **Alexander Prikhodko**, Ph.D. in geoscience, P.Geo., Executive MBA, has previously held Chief Geophysicist position, for 10 years, in a gold-platinum mining company extensively used in its mineral exploration programs borehole, ground and airborne geophysics. He has been associated with the airborne geophysics industry since 2005 (Aeroquest Limited and Geotech Ltd.) holding management positions as Regional General Manager, Data Interpretation Manager, Director of Geophysics and working on exploration projects for diverse commodities in regions over the world. He is an author and co-author of many publications dedicated to airborne EM. In 2019 he was awarded Barlow Medal for Best Geological Paper published in CIM publications (Canadian Institute of Mining, Metallurgy and Petroleum).

Services

Expert Geophysics Limited specializes in airborne geophysical surveys with advanced electromagnetic systems. **EGL** offers surveying with **Mobile MagnetoTellurics** (**MobileMT**), the most advanced generation of airborne AFMAG technologies. The patent pending **MobileMT** technology utilizes naturally occurring electromagnetic fields in the frequency range of 25 Hz – 30 000 Hz. The **MobileMT** technology is the product of extensive experience in developing equipment and signal/data processing algorithms for natural electromagnetic fields measurement.
MobileMT combines the latest advances in electronics, airborne system design, and sophisticated signal processing techniques.

Appendix II MobileMT electromagnetic technology

MobileMT (Mobile MagnetoTellurics) is a newly developed approach to electromagnetic data acquisition from synchronized a towed three component inductive magnetic sensor and grounded two orthogonal electric lines. The system is designed and implemented in order to overcome existing limitations of airborne techniques based on passive electromagnetic fields principles and, ultimately, for improving exploration efficiency.

MobileMTis a passive airborne electromagnetic technique that records magnetic (in the air) and electric (on the ground) fields generated by natural sources in the audio frequency range. The natural electromagnetic primary field sources for MobileMT are considered with frequencies ranging from 25 Hz to 30 kHz (ELF+VLF). The exploration system includes two pairs of grounded electric wire lines, one of them is for reference signal, and moving three-component inductive coil system softly suspended and with low-noise signal amplifiers for magnetic field measurements (dB/dt) in three orthogonal directions. A crucial element of the technology is the capability of aerial acquisition magnetotelluric data in four decades frequency band. Field data are acquired using stationary orthogonal pairs of electrical field sensors (grounded wire dipoles) and towed magnetic field detectors (three orthogonal induction coils).

In order to continue evolution of the airborne electromagnetic passive fields technology and in comparison with the last AFMAG development (Bob Lo, 2009) the current development is focused on:

- Expanding measured frequencies range into high end to complement deep exploration with near surface, shallow and medium depth of investigation;
- Increasing sensitivity and reducing system noise level to provide with data at low natural electromagnetic fields signal conditions especially in the range of the last hundred – first thousands Hz frequencies band where the field spectral density is lowest (dead-band);
- Providing ability to recover electrical properties differences between geological boundaries of any direction, including and between horizontal and vertical boundaries;
- Increasing spatial and frequency data resolution;
- Measuring of elements of admittance-type transfer functions of the magnetotelluric field.

Theory and Method

Some part of the thunderstorm energy is converted into electromagnetic fields that are propagated in the ionosphere-Earth interspace. These electromagnetic fields and the currents induced by these fields in the subsurface are used in audiomagnetetotelluric prospecting to measure the electrical resistivity of geological environment.

Measuring telluric currents induced by the natural electromagnetic fields in the subsurface on the ground synchronised with measuring the magnetic components of the natural audio frequency electromagnetic fields in the air and mutual processing both airborne and ground data (Figure 1) is a way to improve the quality and increase informative of the measured airborne data. In practice the reference fields may be measured by inductive coils or grounded electric lines (Labson et al., 1985). To obtain accurate signal of the natural field spectrum and eliminate noise spectra of sensors we use electrical field measurements at the base station. One of the reasons of choosing electrical components for reference is capacity to control the natural signal strength in the wire lines. Each electrical field component on the base station is registered independently from two sensors, signal and reference, which is utilized to eliminate the data bias distortions (Labson et al., 1985). This technical solution is critically helpful in periods of weak natural field signals in some frequency bands.

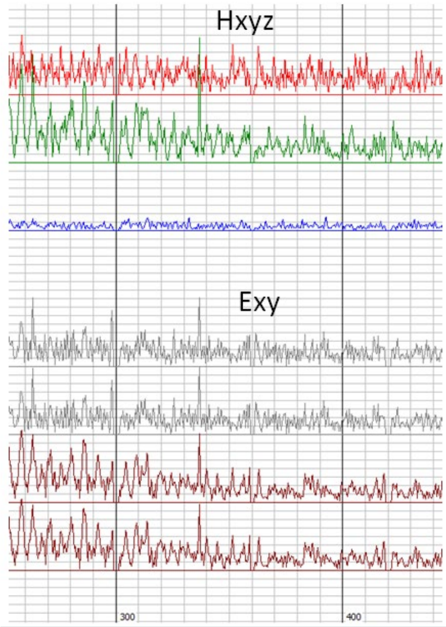


Figure 1. A section of time series of *E*xy and *H*xyz data

Exploiting signals of two horizontal electric components along with three magnetic components we can process them with the magnetotellurics response functions based on linear relations between components of the electric and magnetic fields. In general, processing of the field data is based on the Larsen and Chave robust remote-reference method (Chave et al., 1987; Larsen, 1989). The data processing program merges the stationary measured electrical two horizontal components and the moving orientation irrelevant receiver of three magnetic field components into one file. The program applies FFT technique to the recordings and calculates the matrixes of the relations between the electric and magnetic signals (six admittances) on the different time bases and in different frequency bands. In the result of modular computation of the matrixes determinants, as rotation invariant parameters, we calculate apparent conductivity in mS/m as a parameter of EM mapping. The rotation invariant parameters are free from the receiver motion distortions. The admittances (***Y***) are represented as the electric field horizontal vectors projection into the space of the magnetic field three components. In other words, the combined system measures combination of tensor and scalar (rotational invariant) components as the transfer function of a total magnetic field, through the three orthogonal directions measurements of an airborne receiver, to the two orthogonal horizontal directions of electric field measured at a ground base location. Generalizing the Weiss-Parkinson relationship (Berdichevsky and Zhdanov, 1984), such as that measured three orthogonal magnetic field components (***H***xyz) are linearly related to the horizontal electric fields measured on the ground (***E***xy, reference), with adoption it to the admittances domain (***Y***):

$$\begin{bmatrix} Hx \\ Hy \\ Hz \end{bmatrix} = \begin{bmatrix} Yxx & Yxy \\ Yyx & Yyy \\ Yzx & Yzy \end{bmatrix} \begin{bmatrix} Ex \\ Ey \end{bmatrix} \qquad (1)$$

Solutions of the equations are obtained by averaging over a number of closely spaced frequencies **Error! Reference source not found.**(Table below).

An example of frequency windows used for harmonics averaging. Base 15 Hz, Gates ratio 2.

N	Window, Hz		
	start	end	mid
1	15	30	23
2	30	68	49
3	68	135	101
4	135	270	203
5	270	540	405
6	540	1080	810
7	1080	2160	1620
8	2160	4320	3240
9	4320	8640	6480
10	8640	17280	12960
11	17280	28800	23040

The windowing way is flexible and can be optimized depending on signals, cultural noise and an exploration task.

H (magnetic) and ***E*** (electric) components time series data, fully synchronized, digitized and recorded at 73,728 Hz frequency, is converted from time to frequency domain using FFT technique. The complex data spectrums (field examples in 2 and 3) is expressed in apparent conductivity (σ) equivalent to its real part:

$$\sigma = \mu\omega|Y^2| \qquad (2)$$

where ***Y*** is the determinant of the corresponded matrix in (1); $\boldsymbol{Y^2}$ = im($\boldsymbol{Y^2}$)/re($\boldsymbol{Y^2}$); μ is the magnetic permeability of free air and ω is the angular frequency.

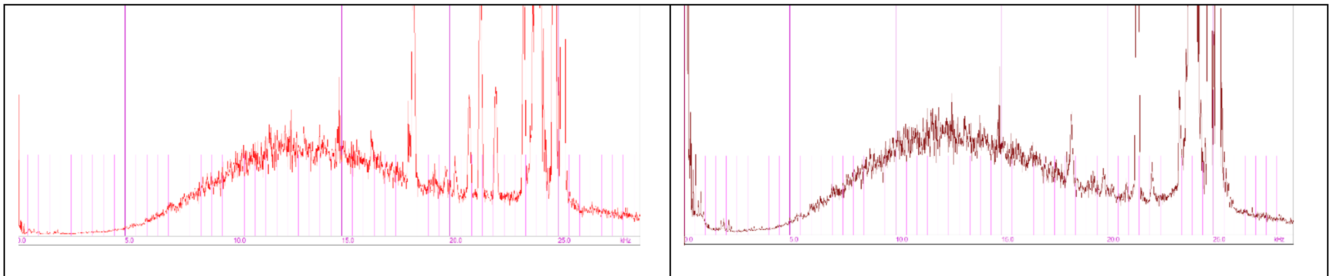


Figure 2 Airborne magnetic X-coil spectrum up to 30,000 Hz range (left) with the corresponding electric X-line 1 spectrum (right)

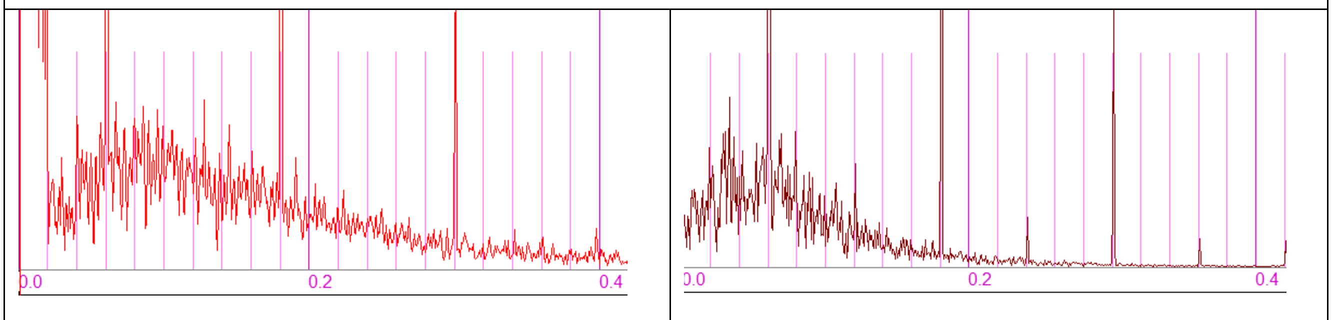


Figure 3 Airborne magnetic X-coil spectrum up to 400 Hz range (left) with the corresponding electric X-line 1 spectrum (right)

References

Berdichevsky, M.N., and M.S. Zhdanov (1984), Advansed theory of deep geomagnetic sounding: Elseiver.

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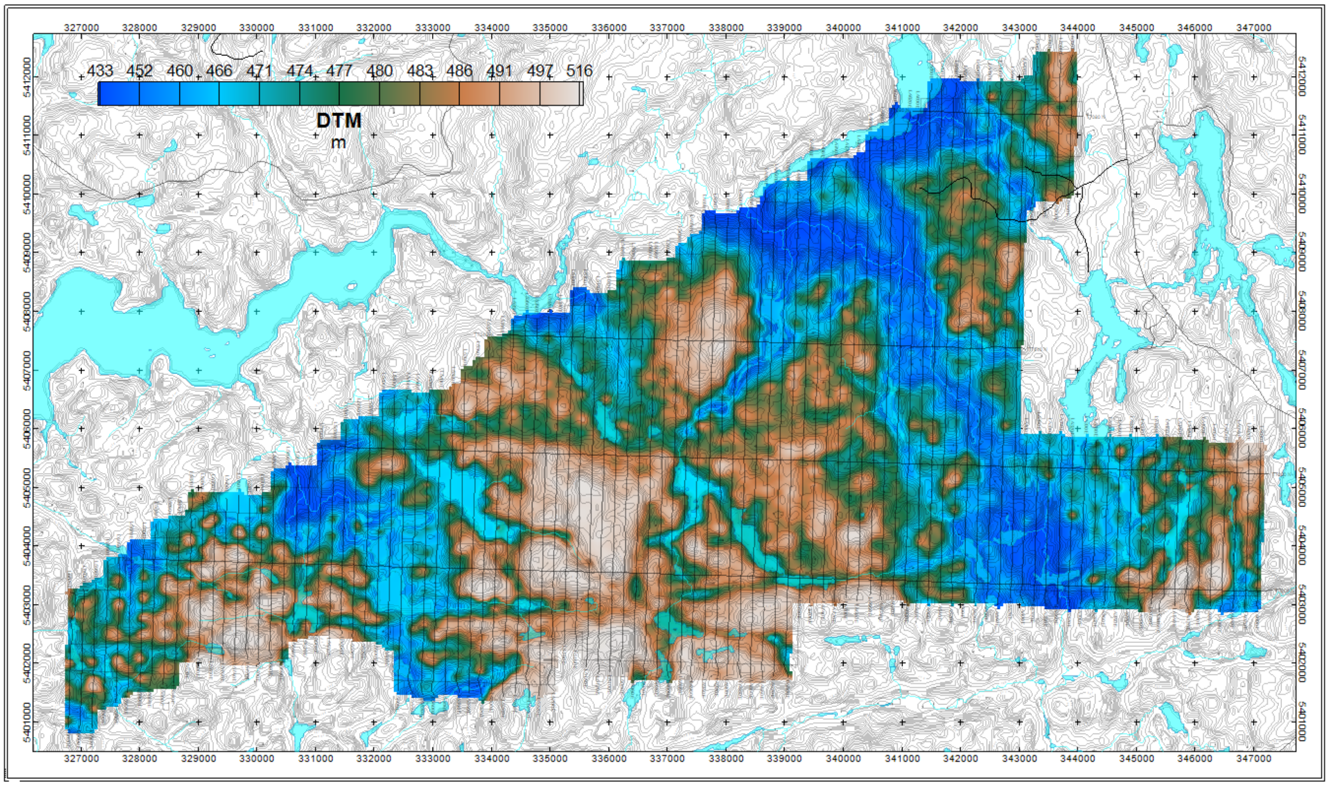
Larsen, J. C. (1989), Transfer functions: smooth robust estimates by least-squares and remote reference methods: Geophysical Journal International, **99**, 645-663.

Lo, B., J. Legault, P.Kuzmin (2009), Z-TEM (airborne AFMAG) tests over unconformity uranium deposits. Extended Abstract 20th International Geophysical Conference and Exhibition, Adelaide, South Australia.

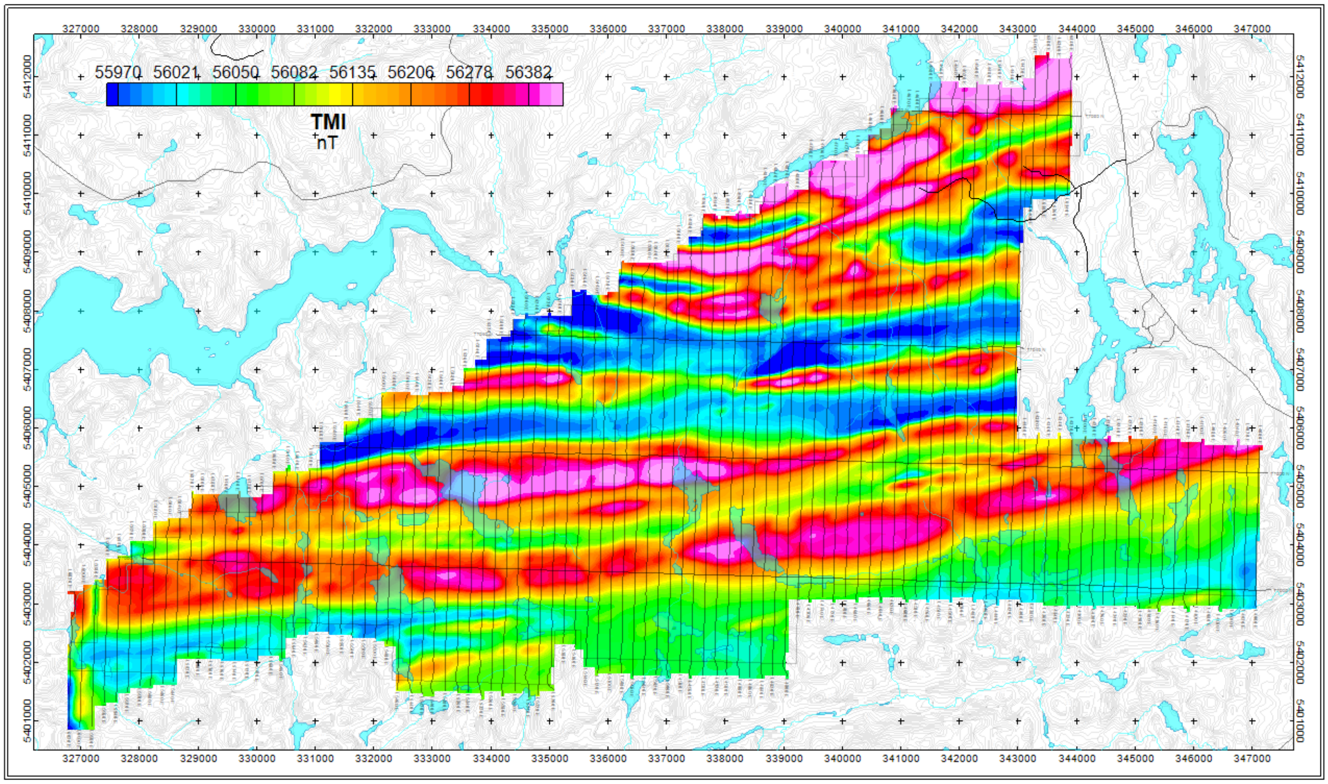
Appendix III MobileMT maps images[1]

7.1 Sammy 1 Block

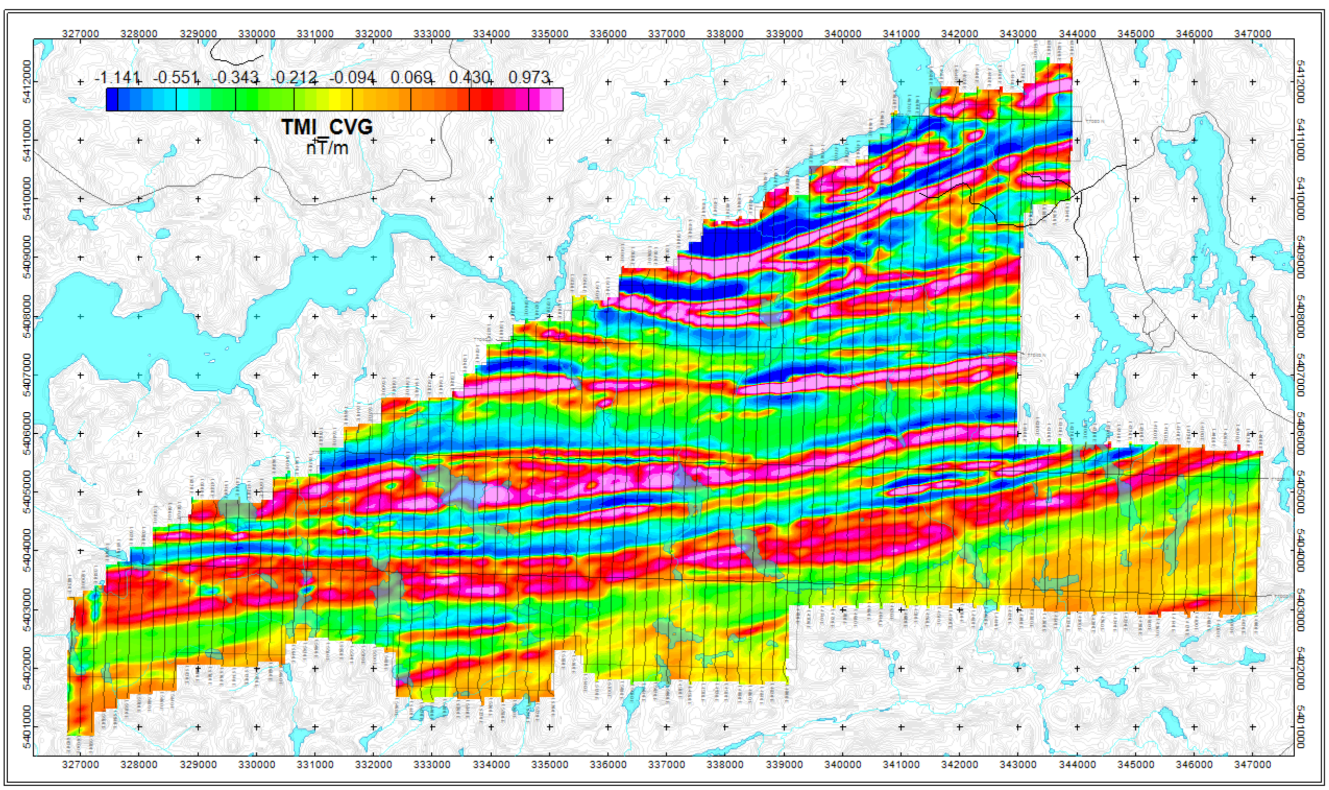


Digital Terrain Model (DTM)

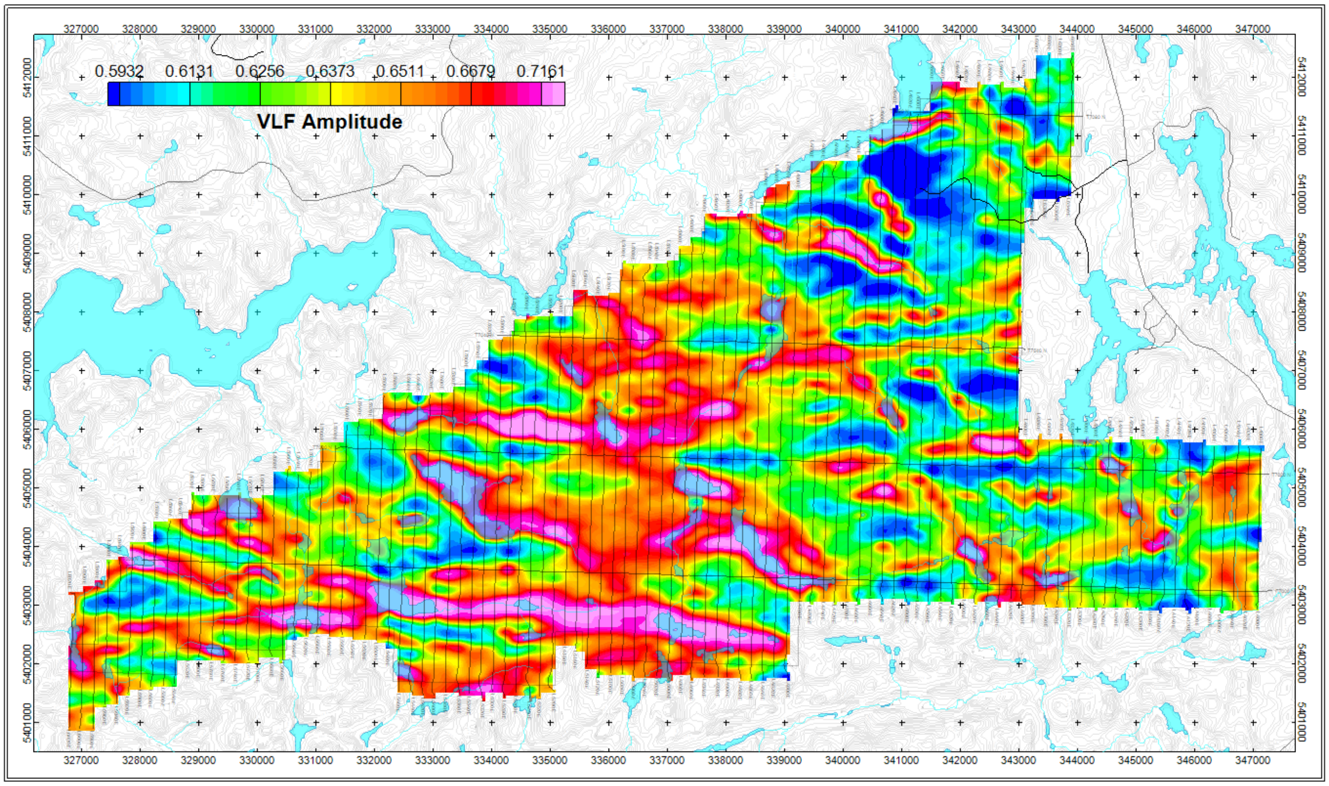
[1] The full set of maps following the report in Geosoft and PDF formats



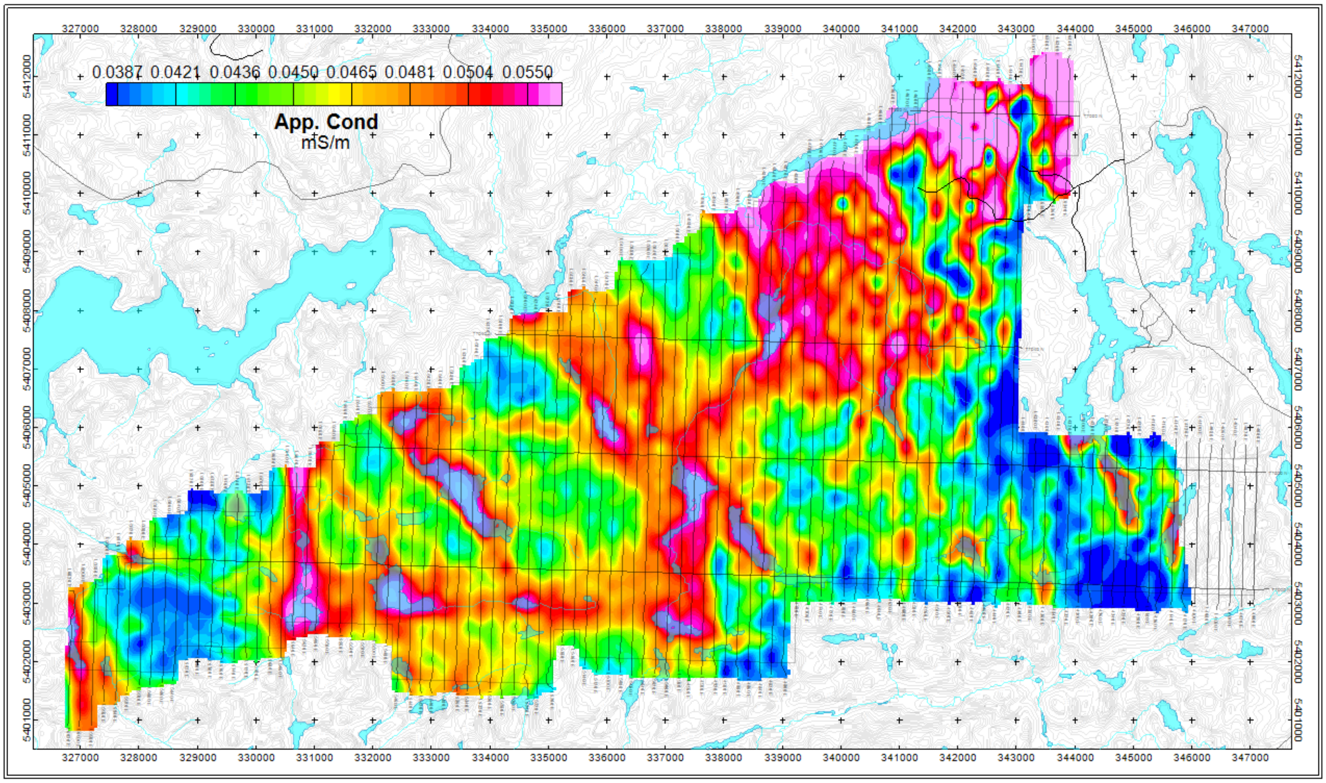
Total Magnetic Intensity Map (TMI)



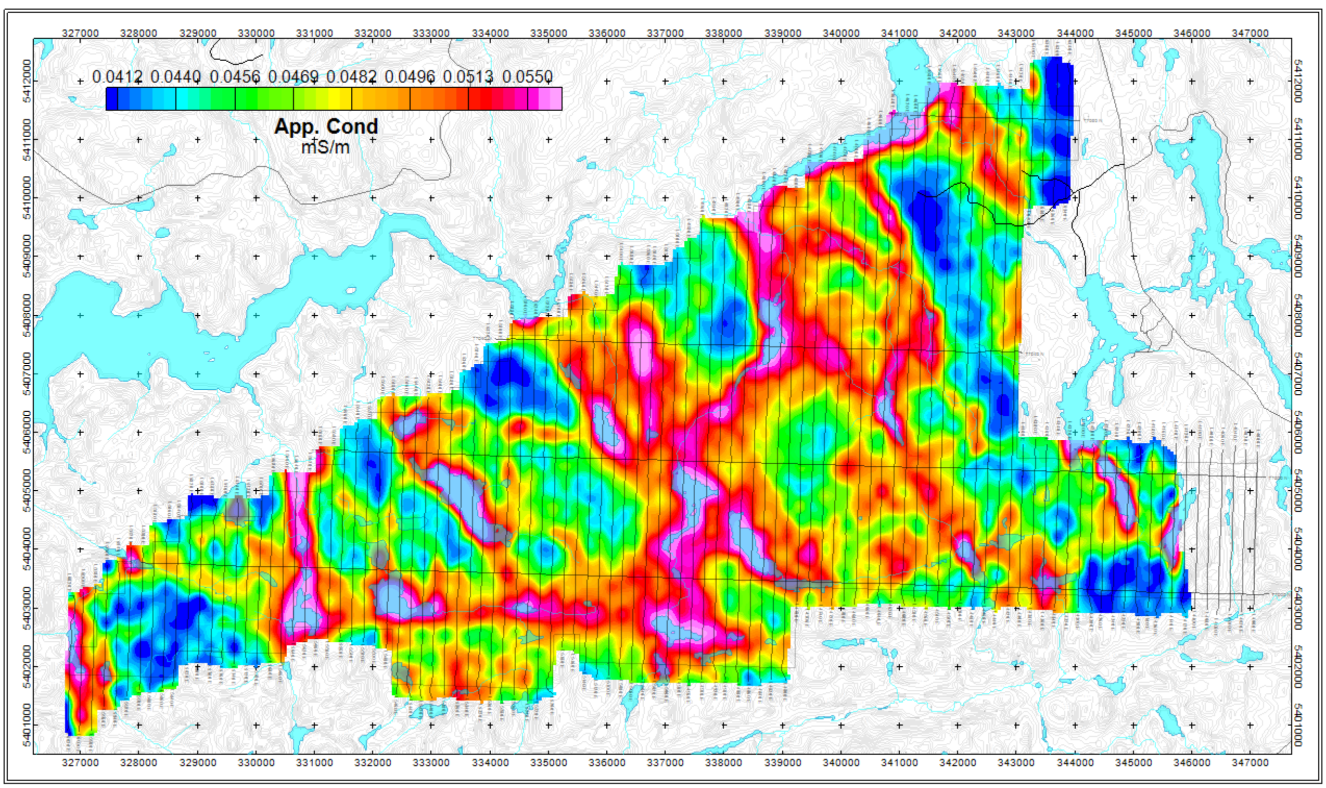
Calculated Vertical Derivative Map of magnetic field (CVG-TMI)



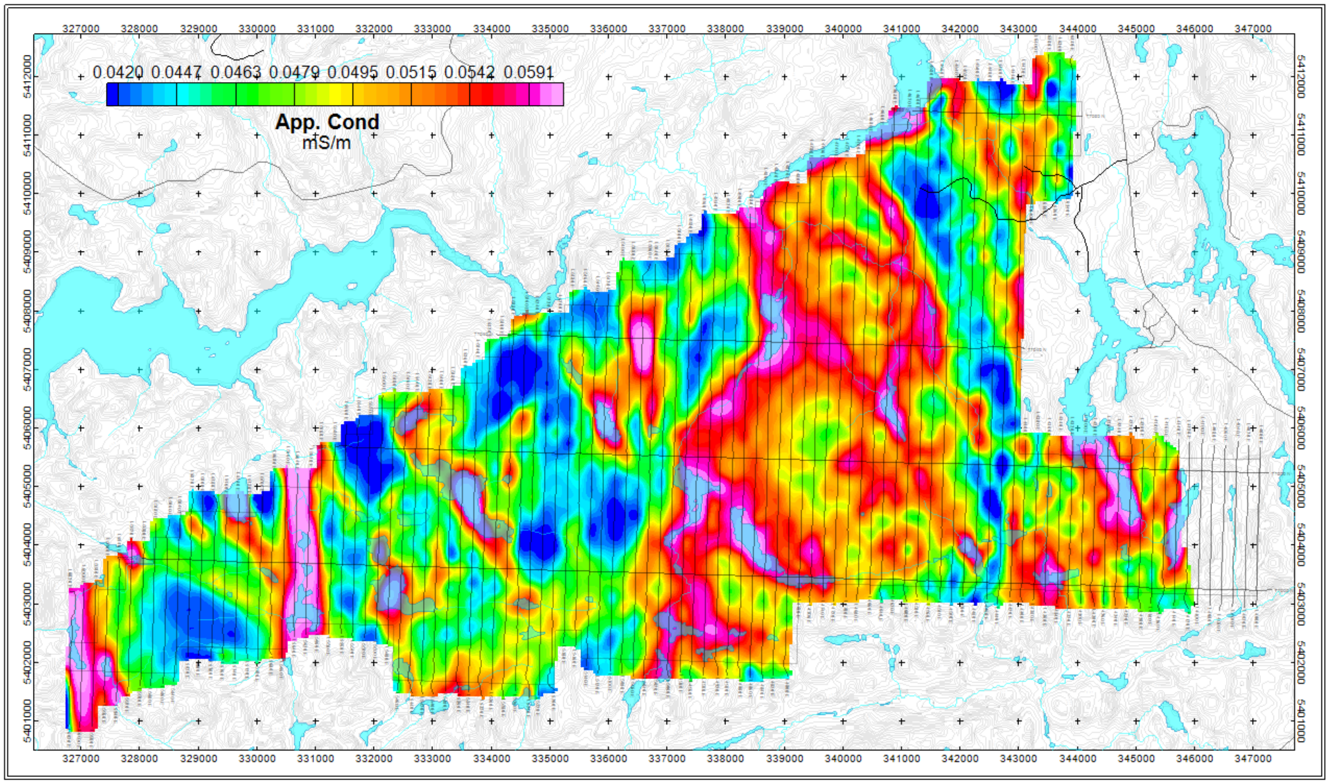
VLF amplitude map, 24 kHz



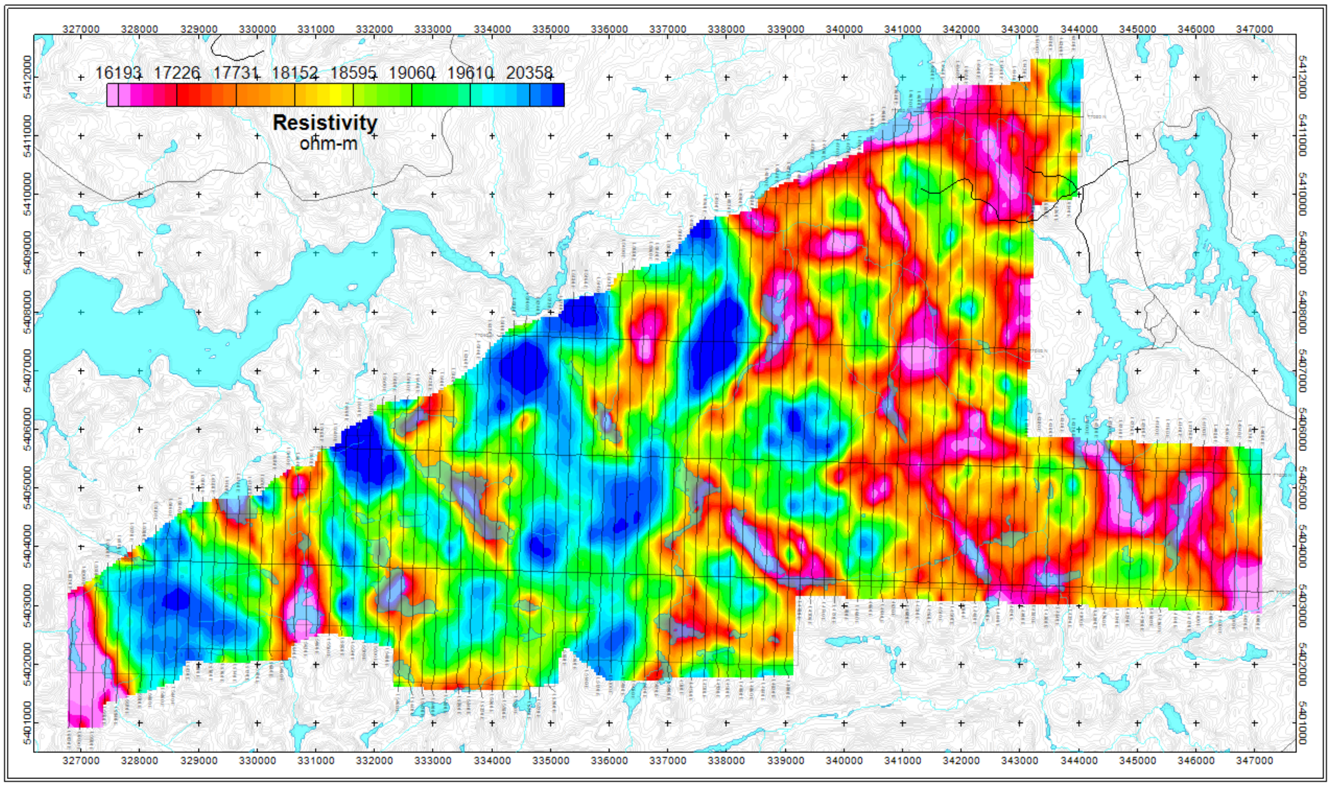
apparent conductivity (4274 Hz)



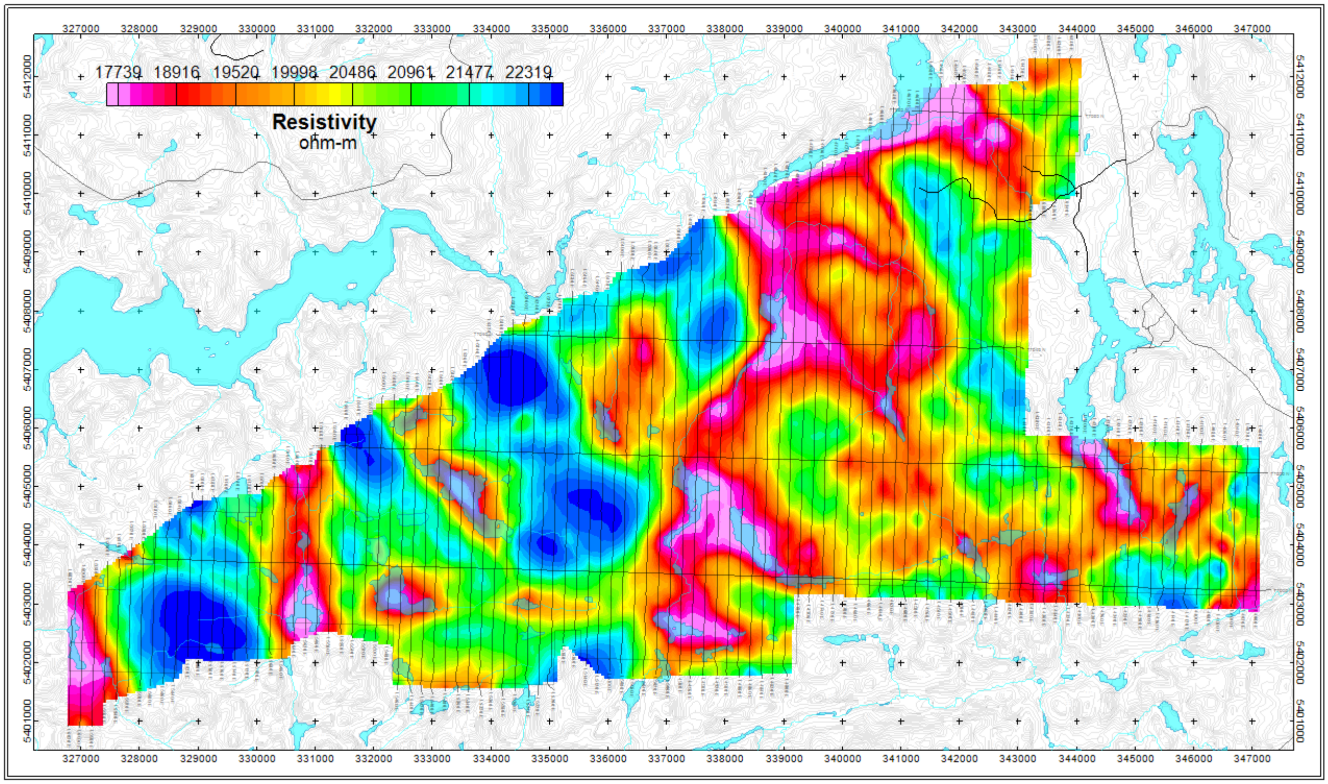
apparent conductivity (6785 Hz)



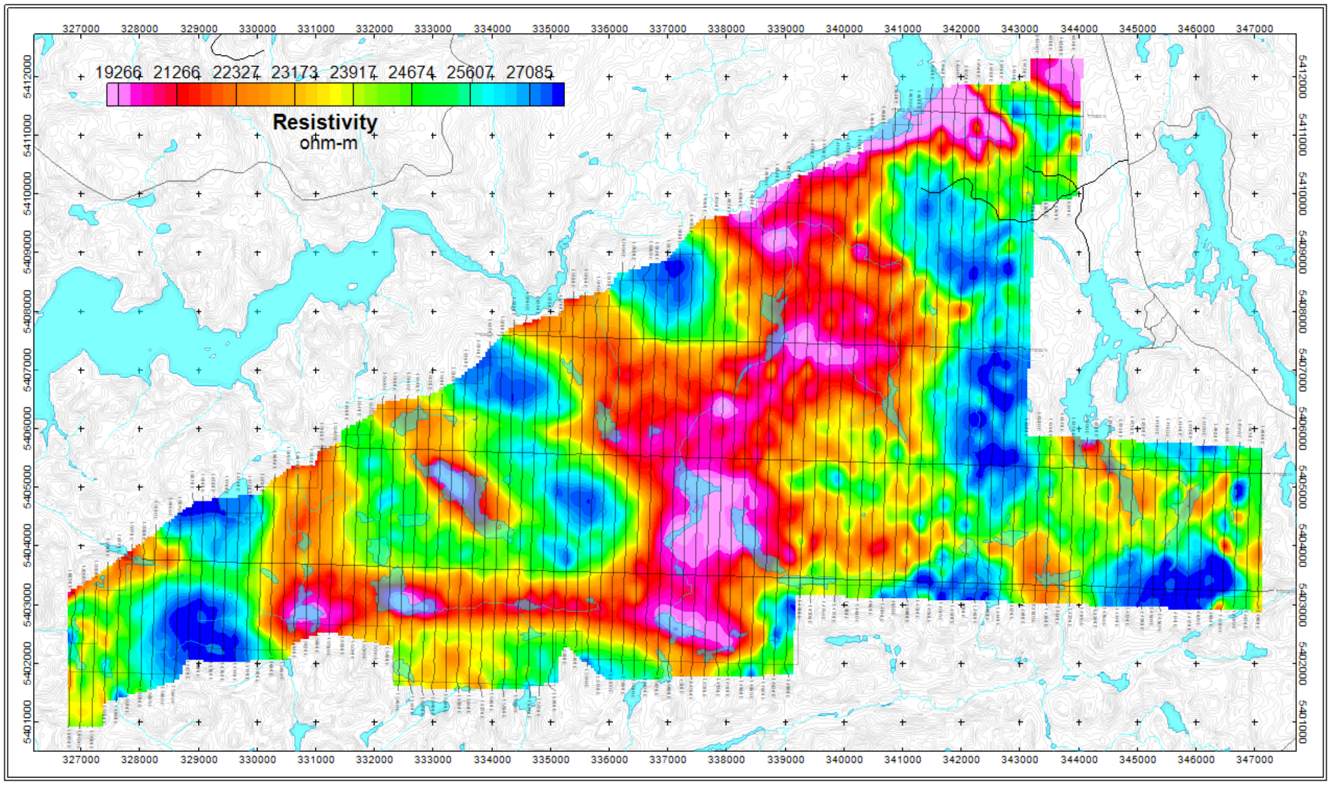
apparent conductivity (10763 Hz)



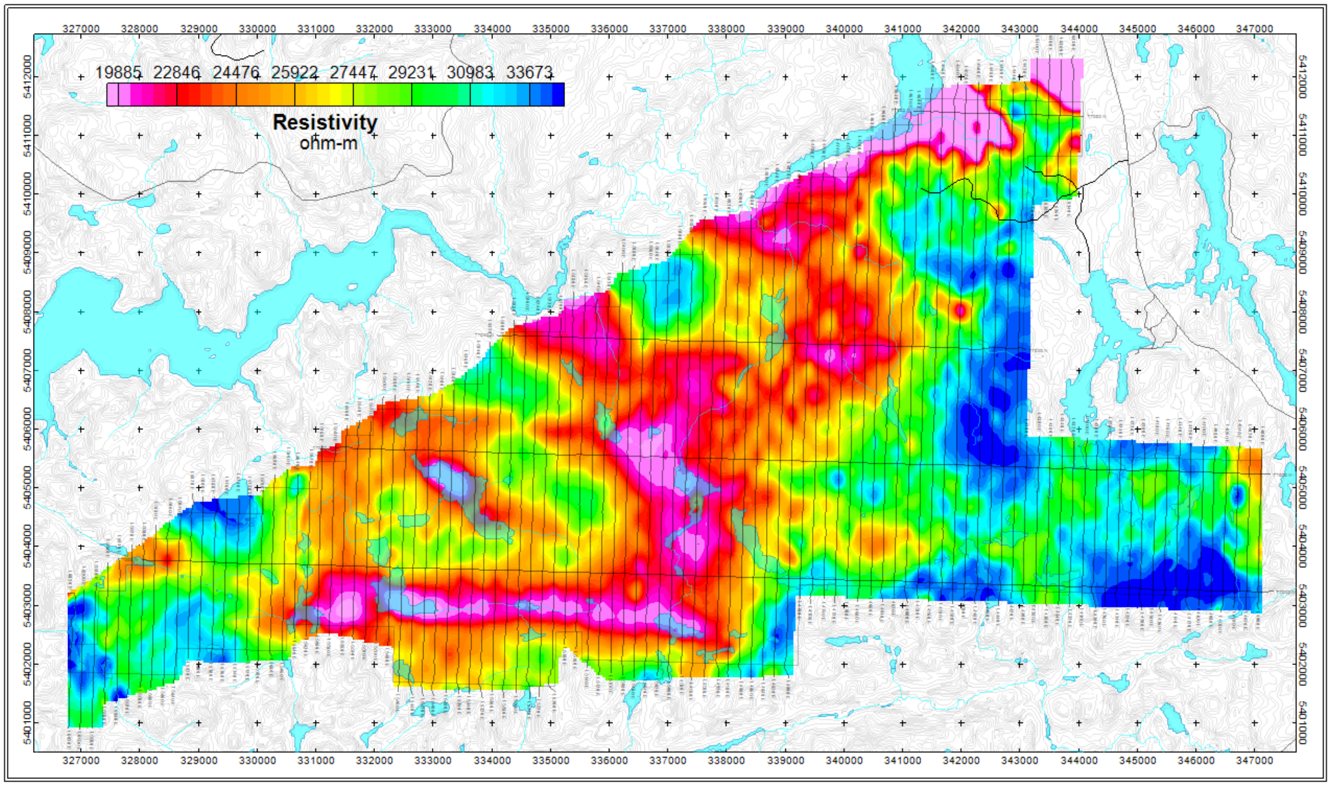
Resistivity at elevation of 400m ASL (from EM data inversions)



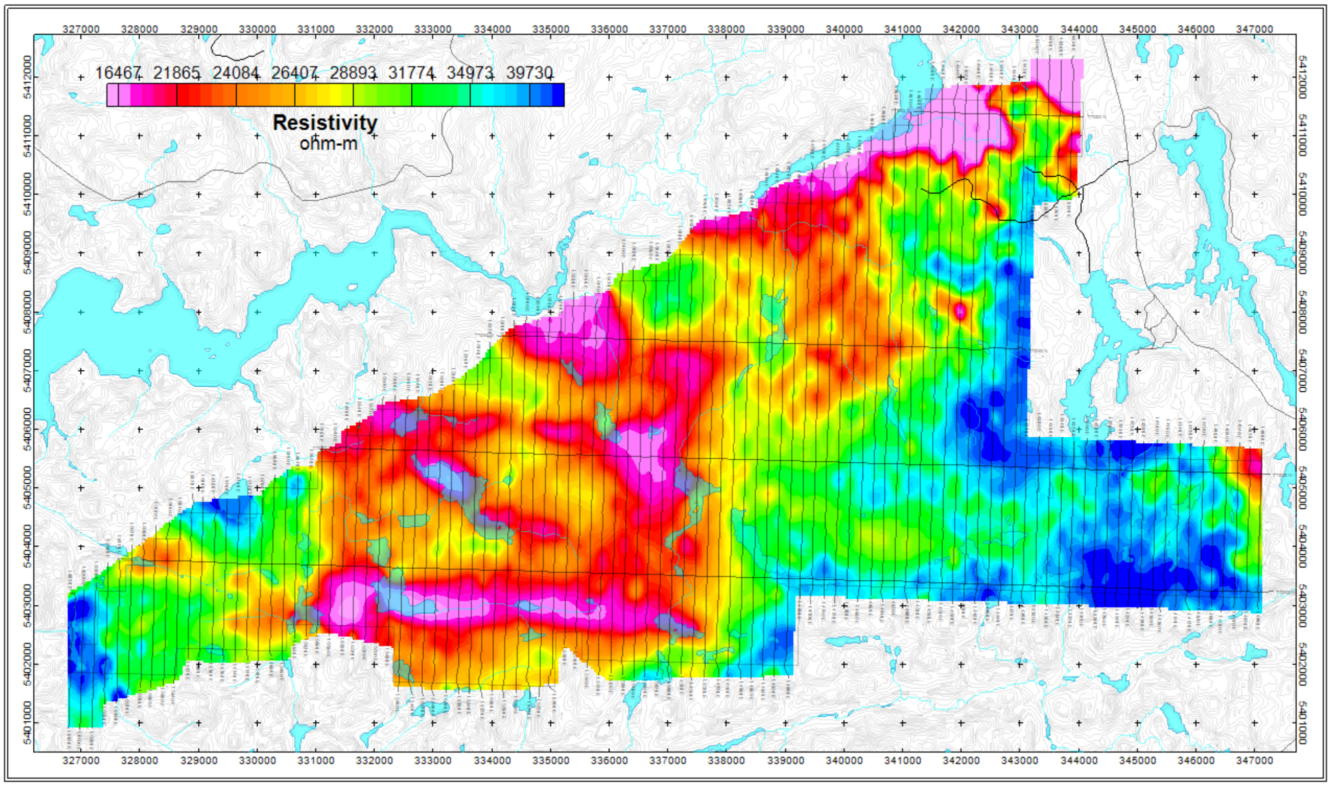
Resistivity at elevation of 200m ASL



Resistivity at elevation of 0m ASL

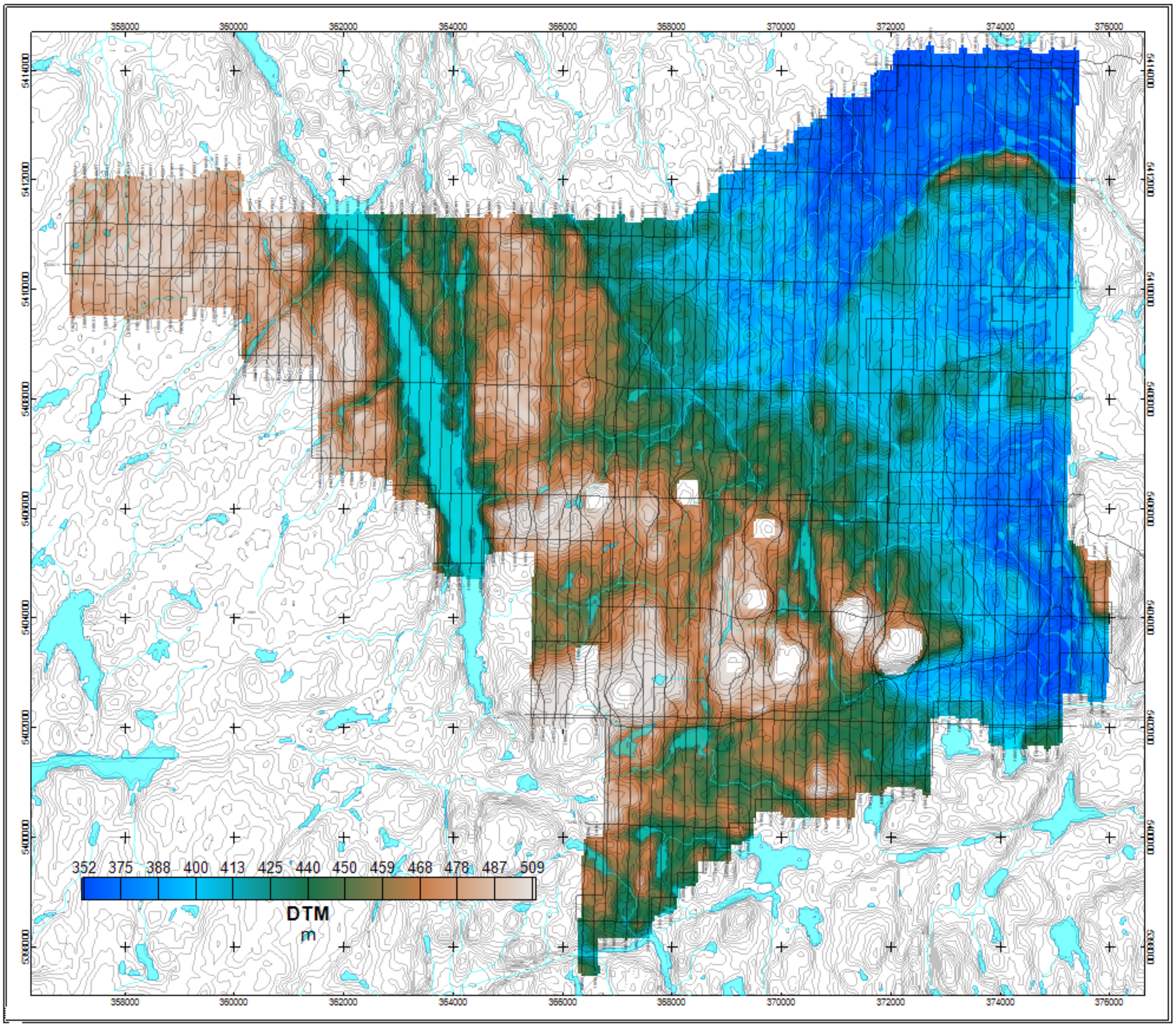


Resistivity at elevation of -200m ASL

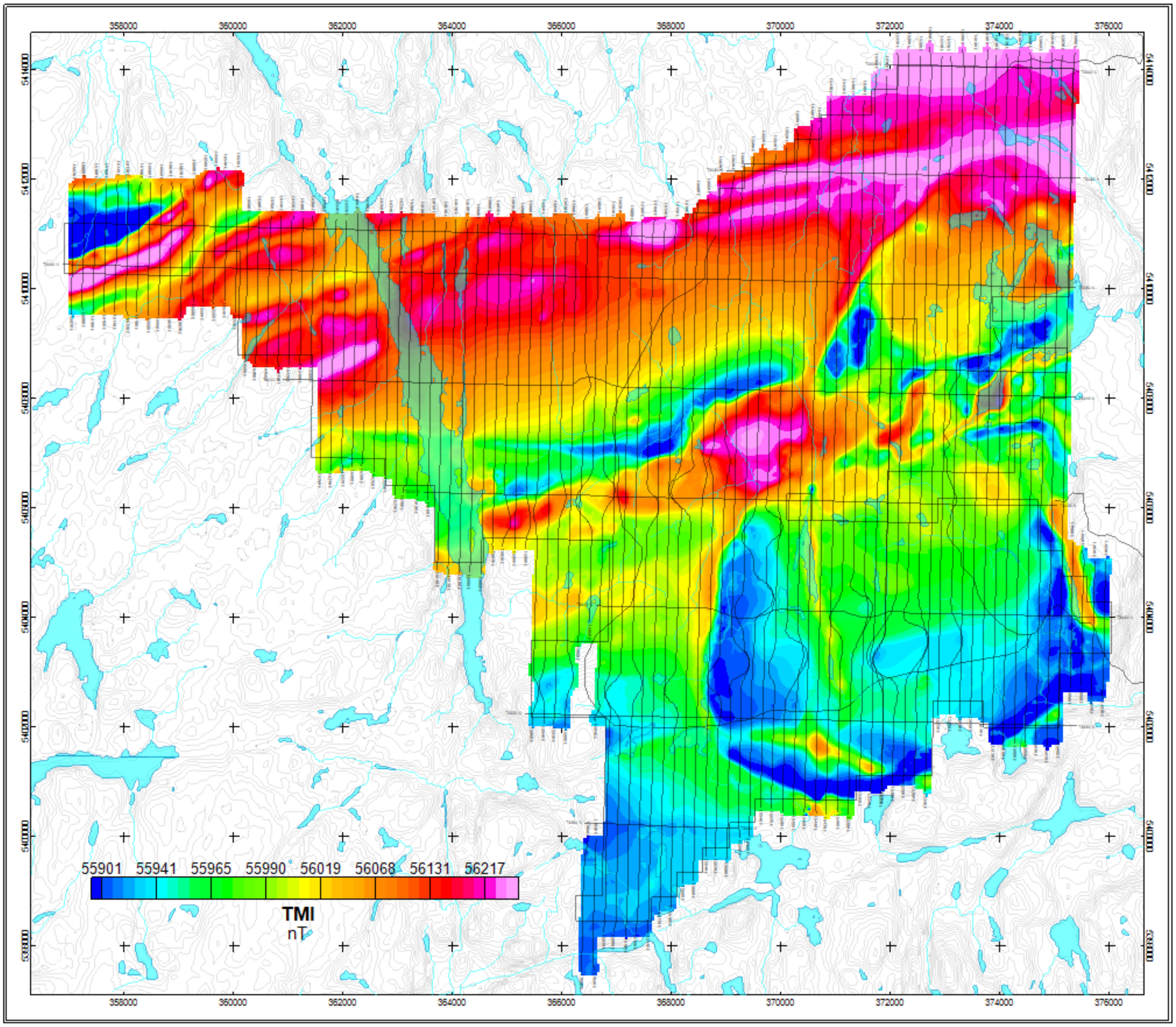


Resistivity at elevation of -400m ASL

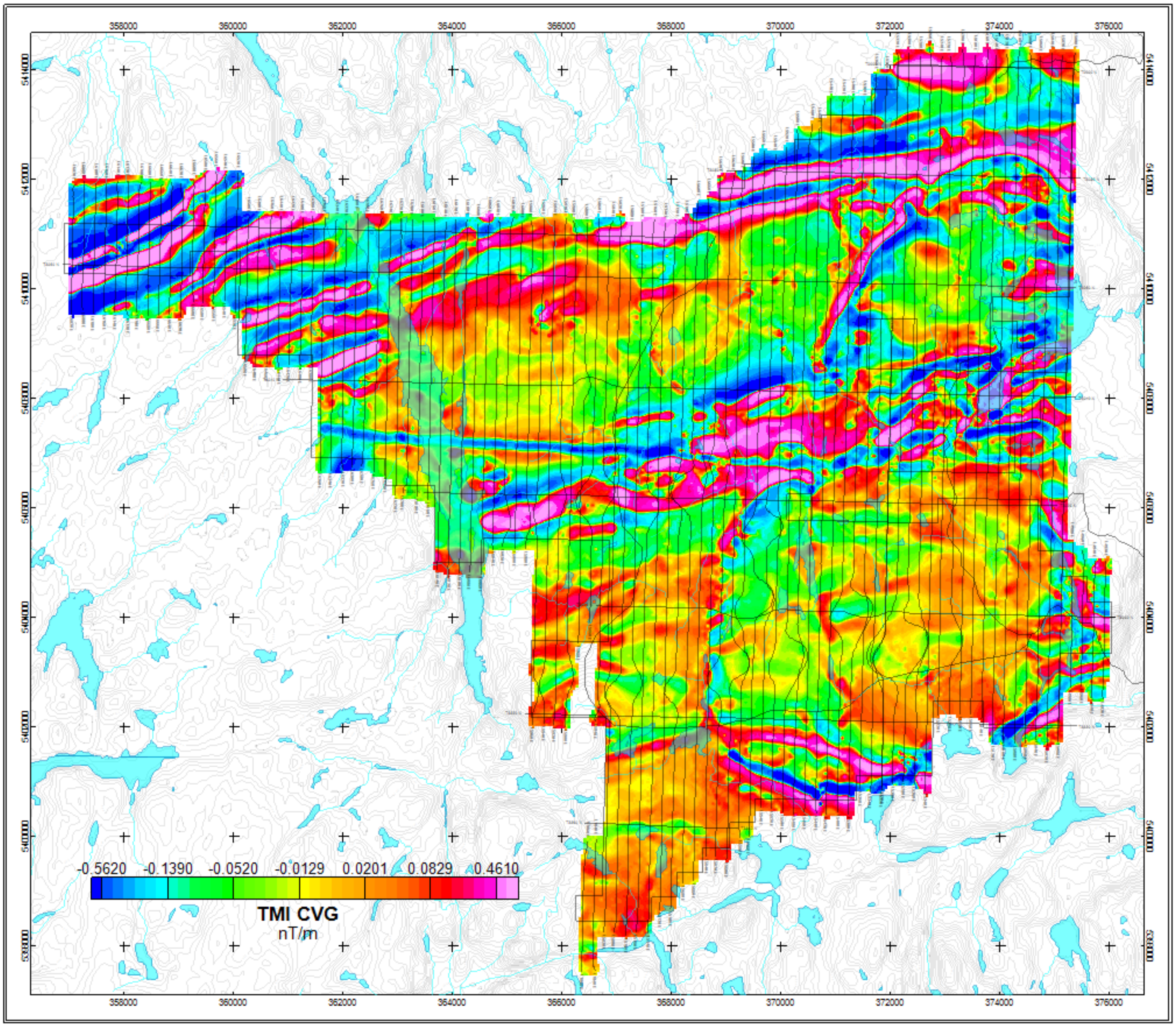
7.2 Sammy 2 Block



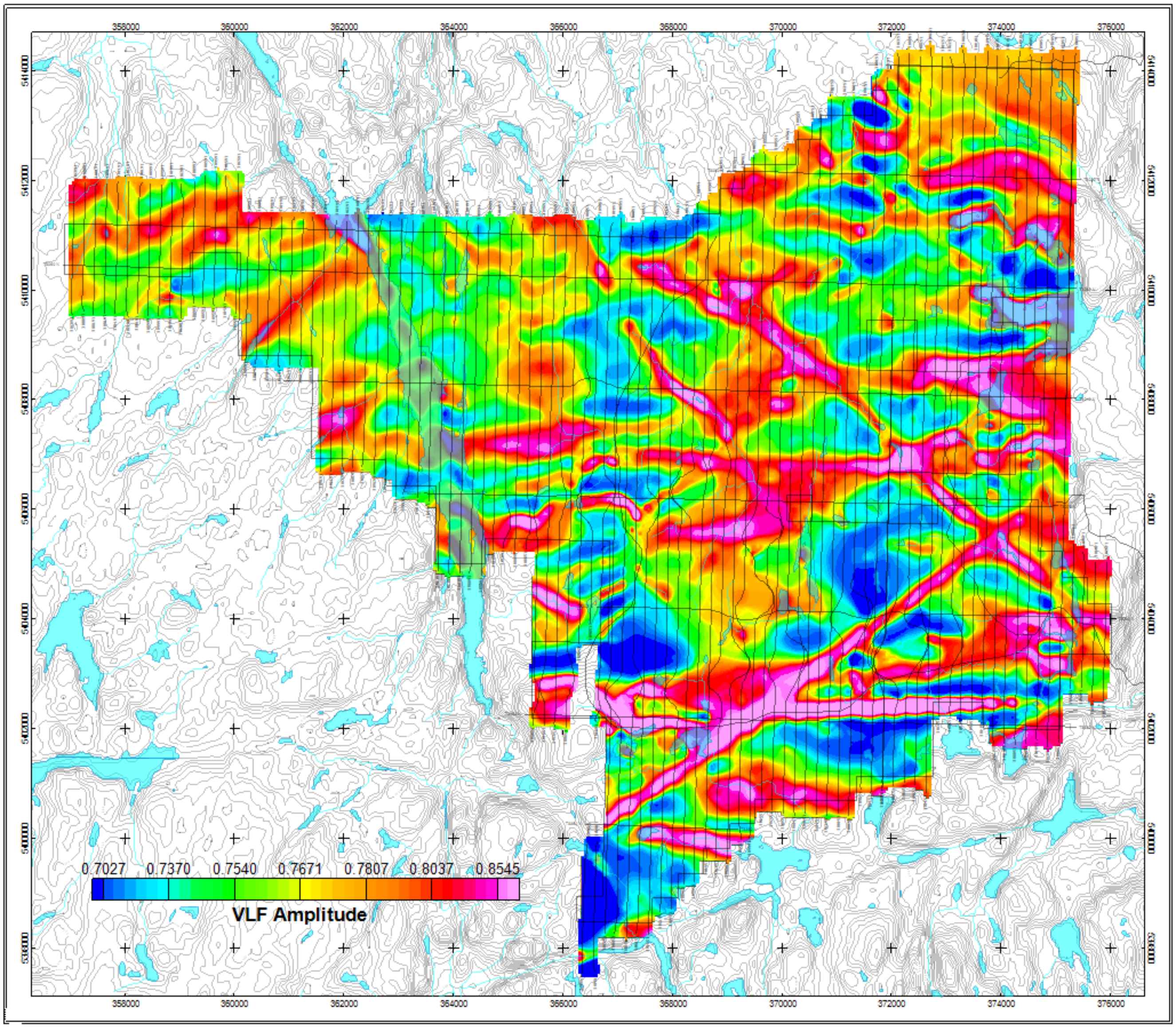
Digital Terrain Model (DTM)



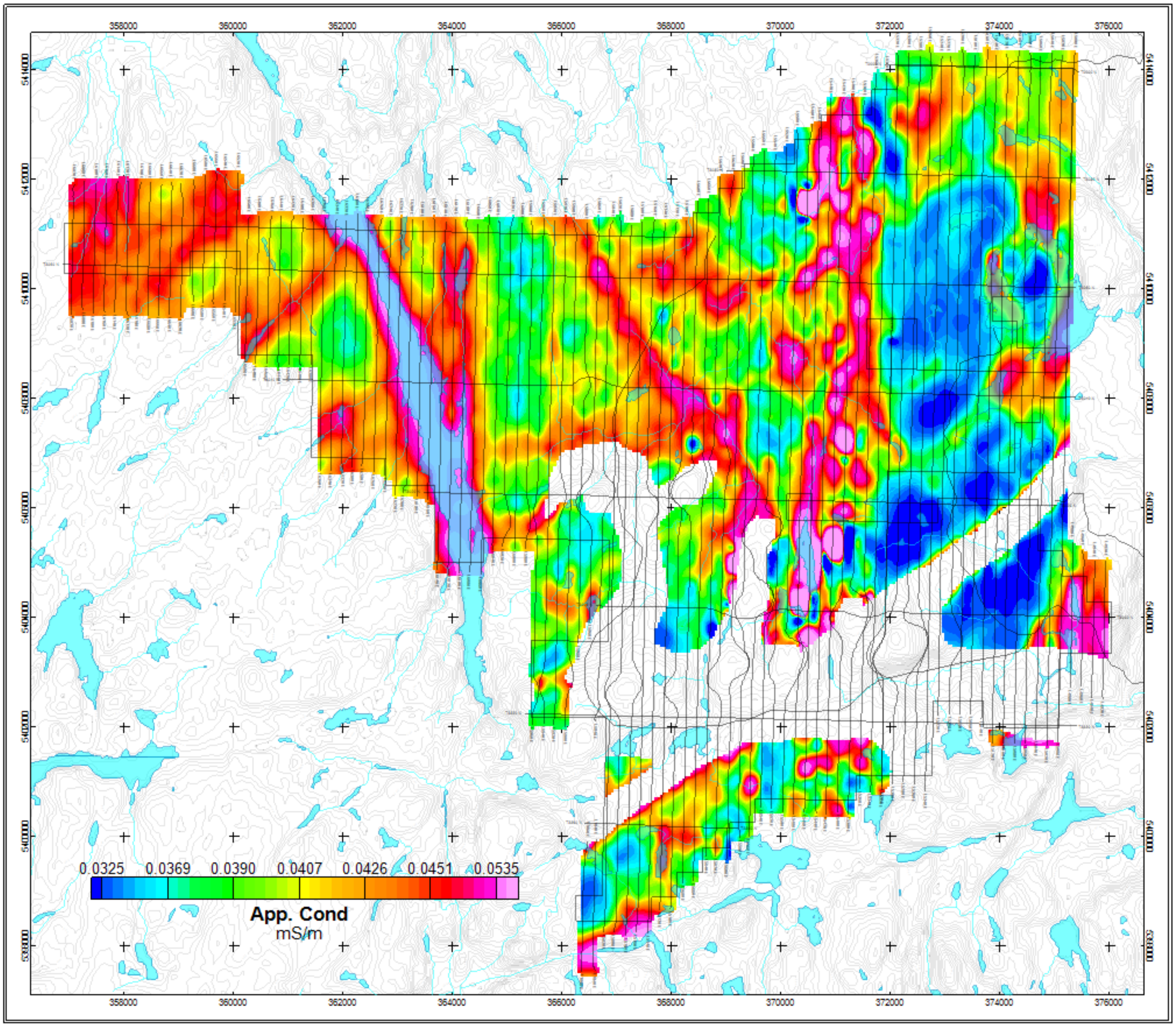
Total Magnetic Intensity Map (TMI)



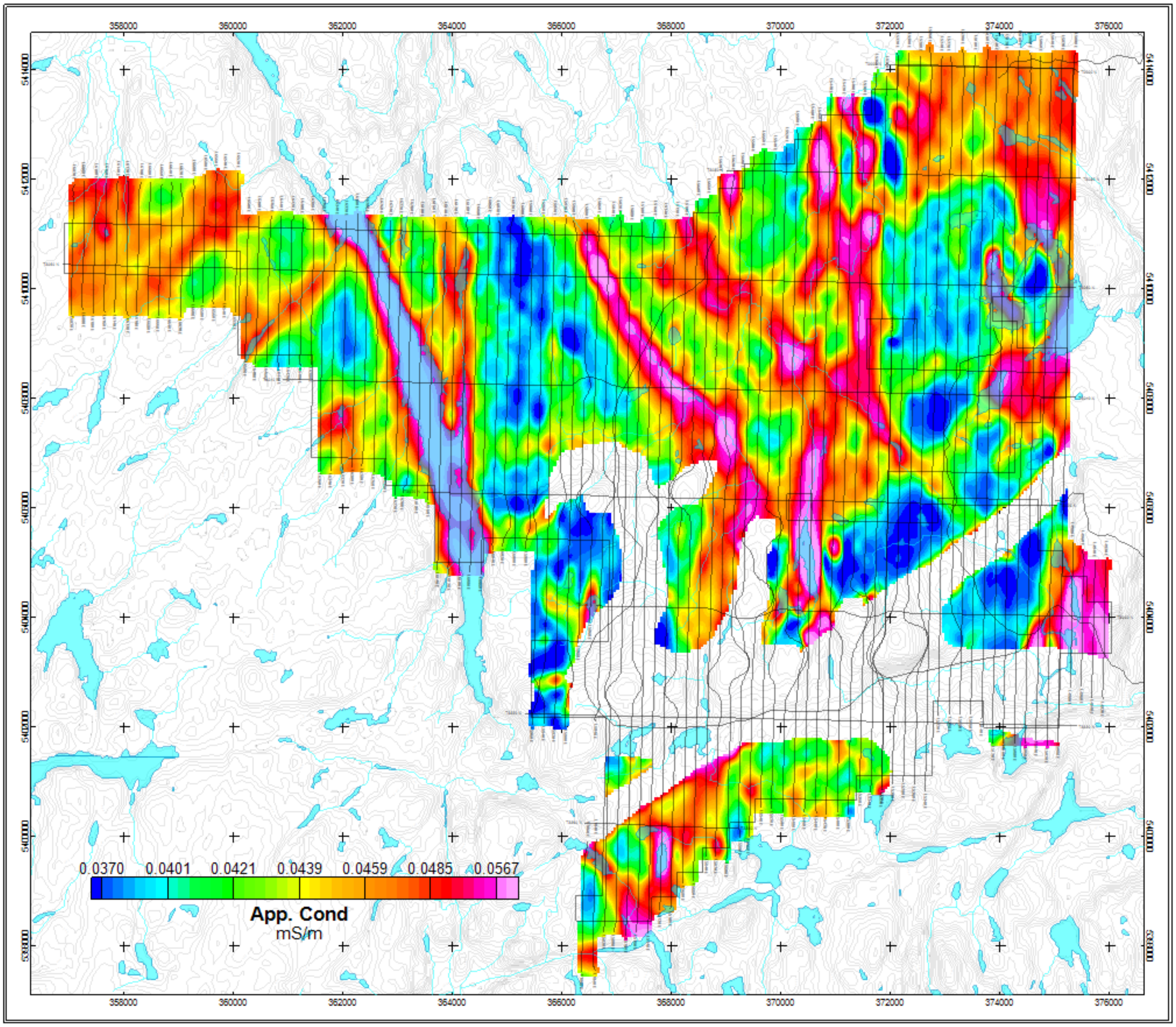
Calculated Vertical Derivative of magnetic field Map (TMI-CVG)



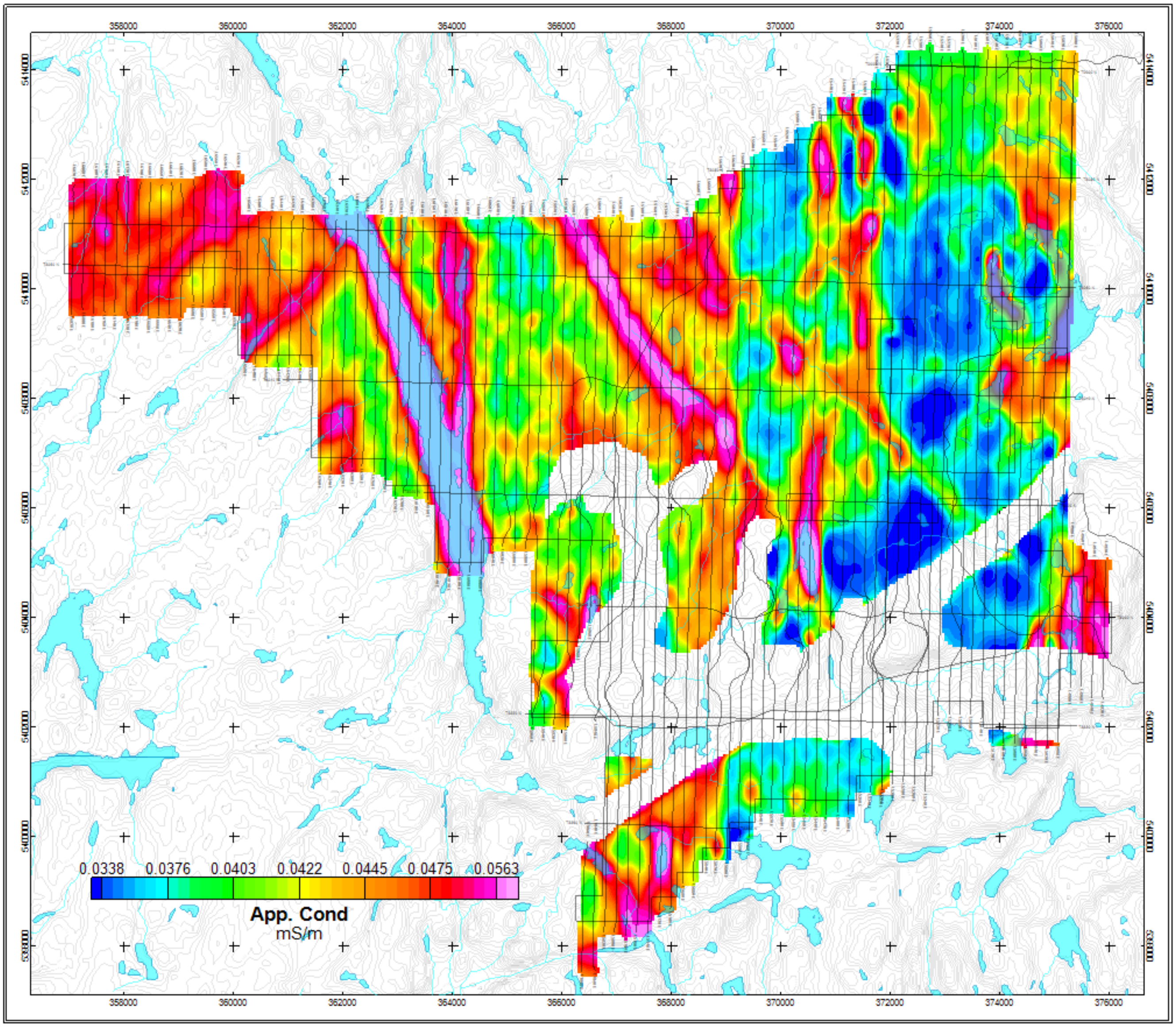
VLF amplitude map for 24 kHz



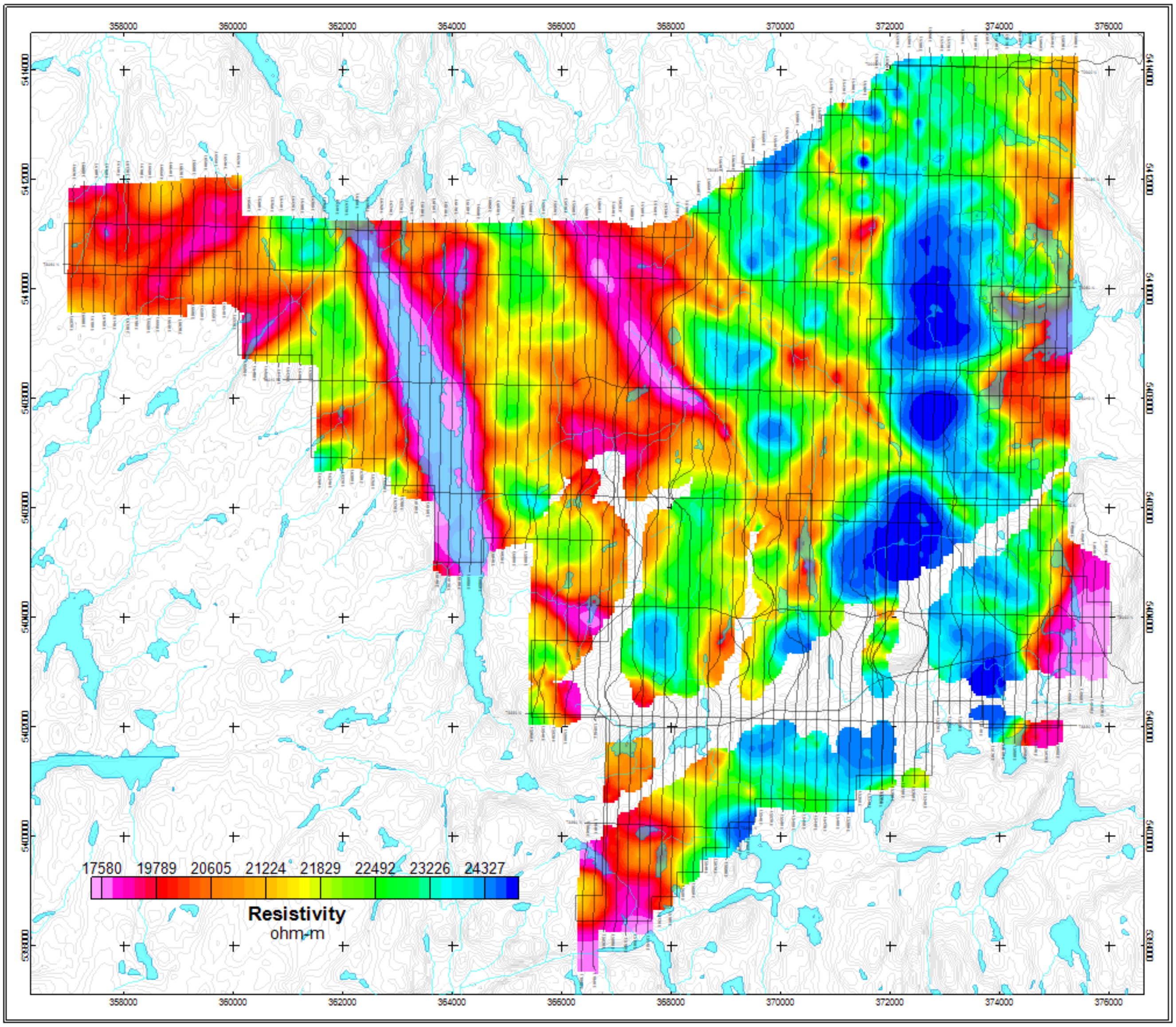
apparent conductivity (6785 Hz)



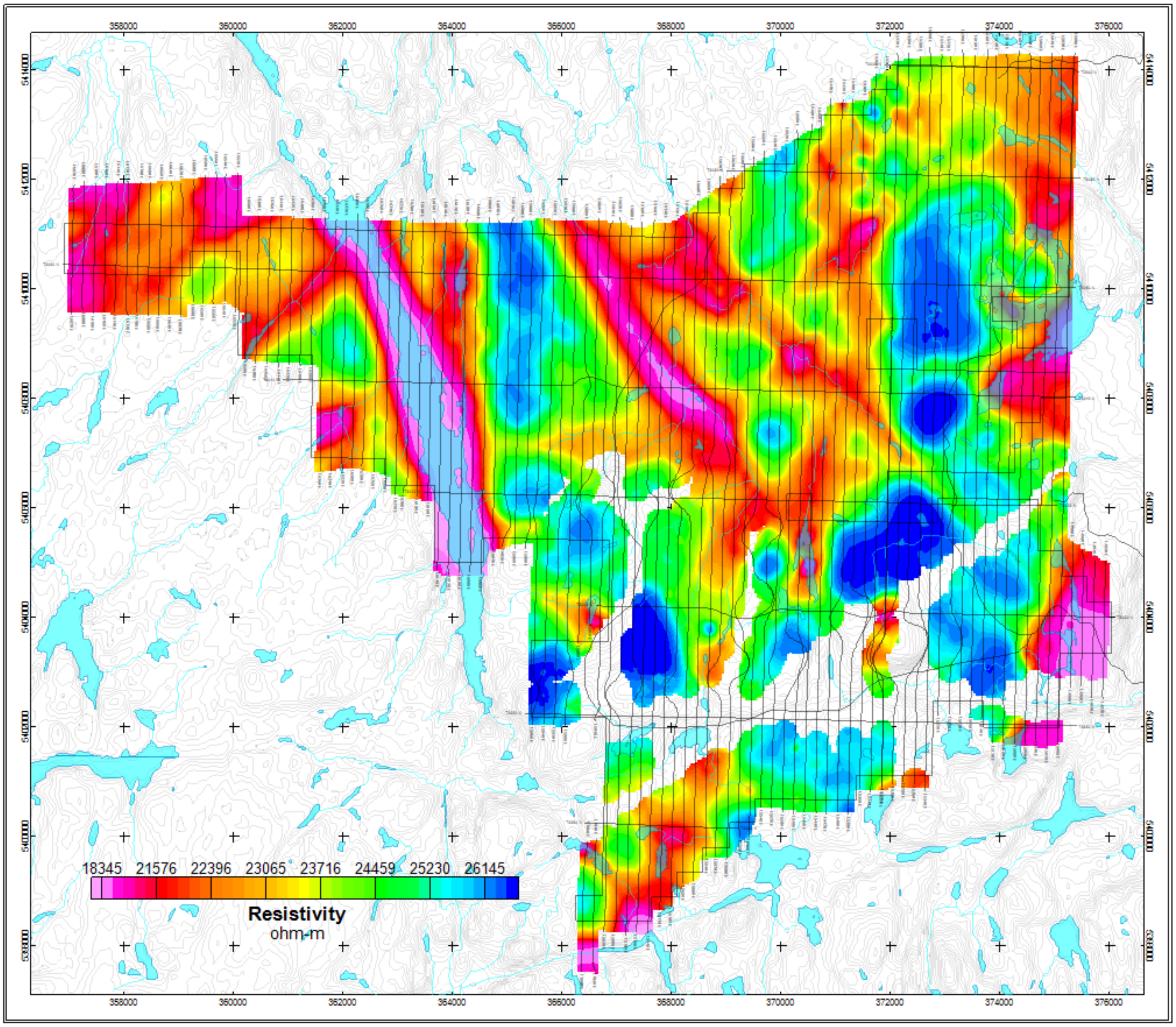
apparent conductivity (8550 Hz)



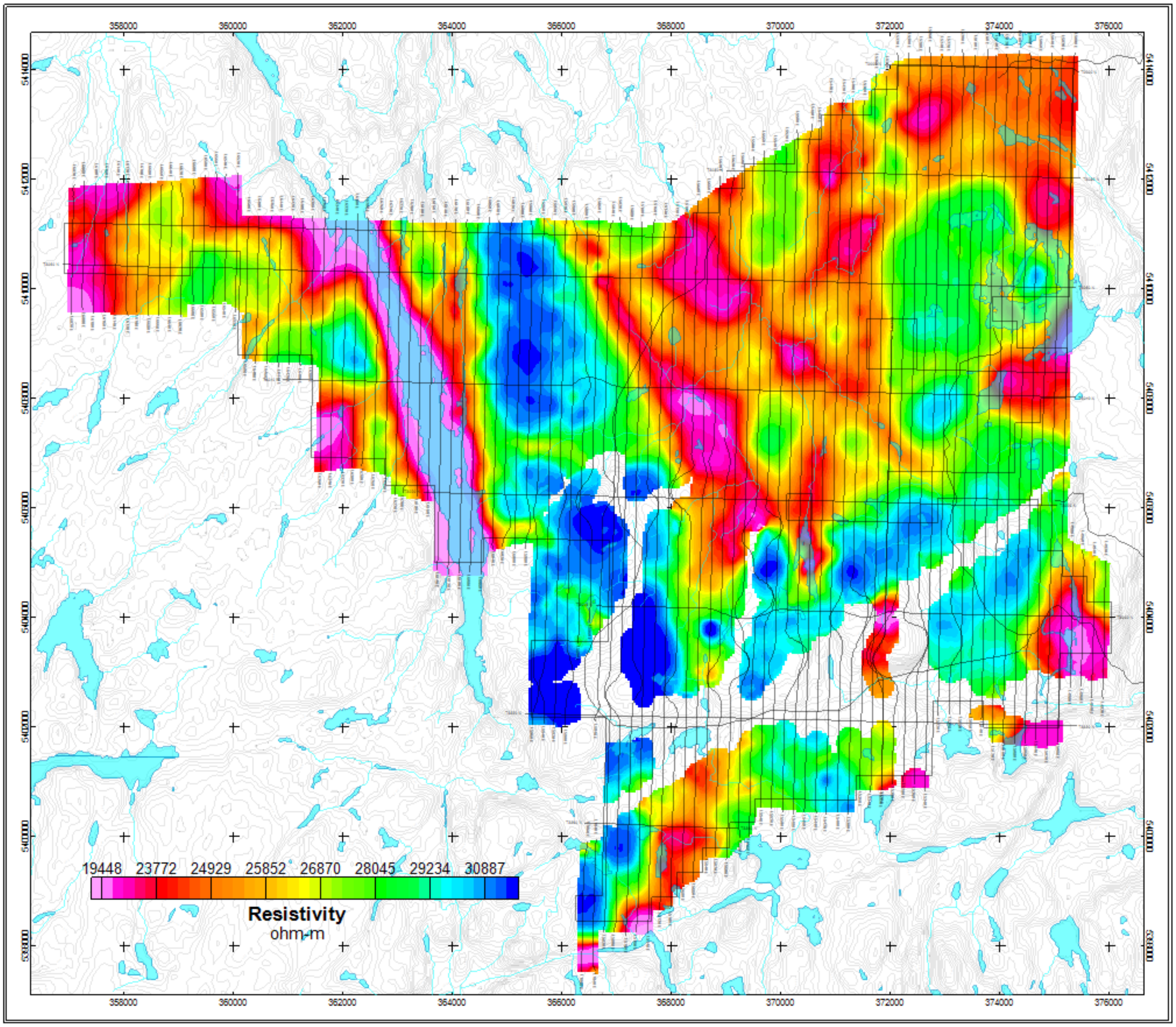
apparent conductivity (10763 Hz)



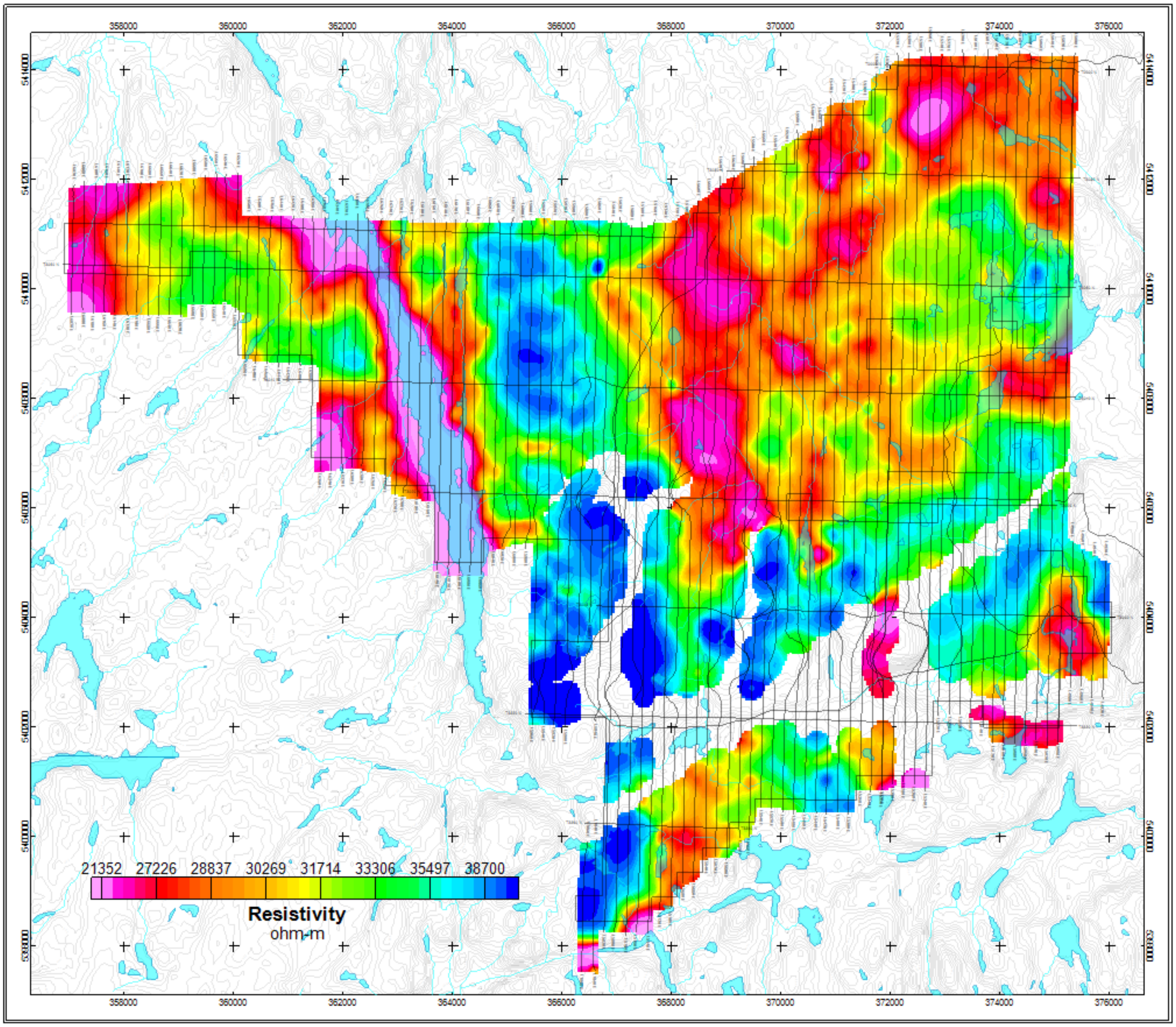
Resistivity at elevation of 300m ASL



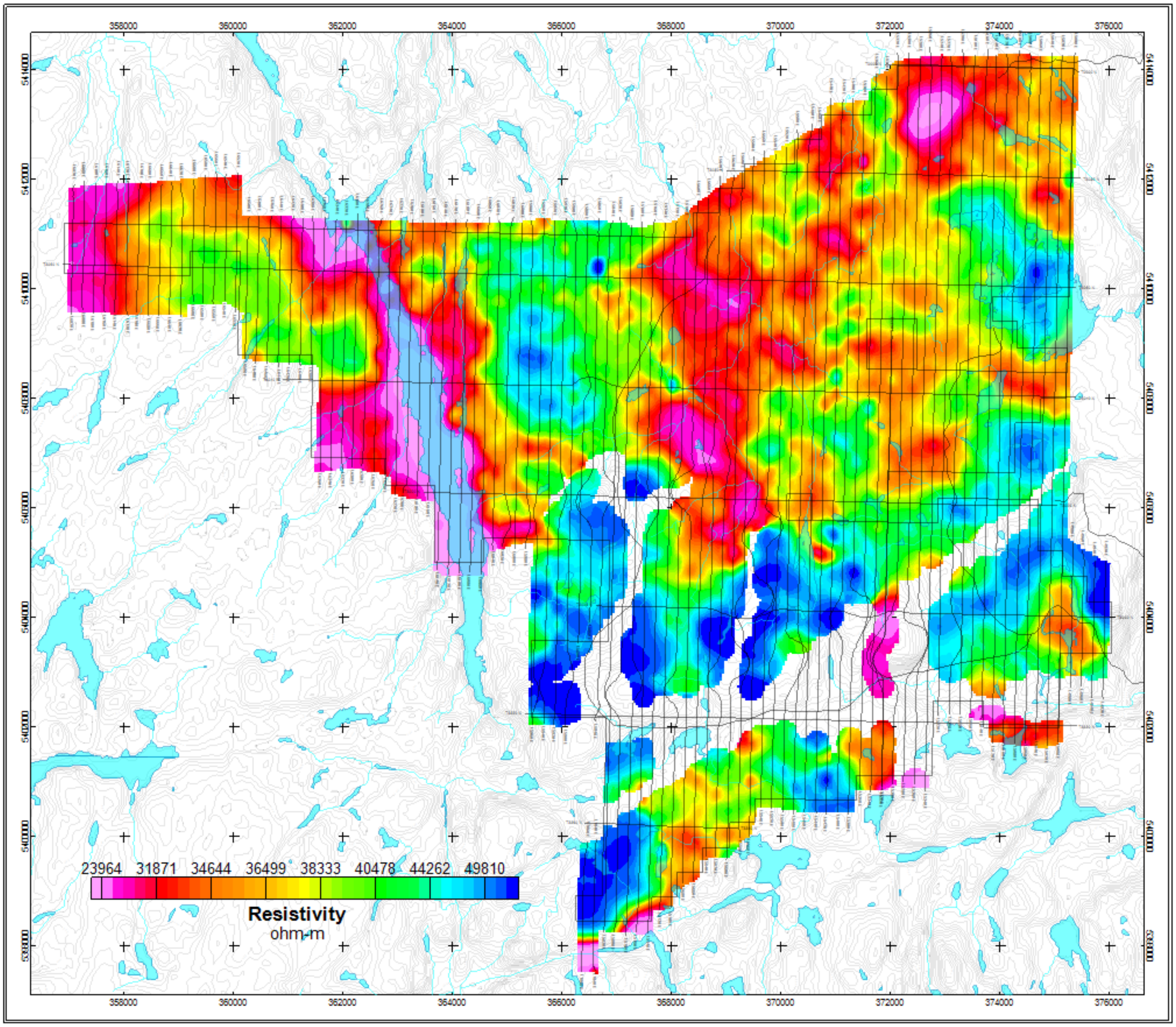
Resistivity at elevation of 150m ASL



Resistivity at elevation of 0m ASL



Resistivity at elevation of -150m ASL



Resistivity at elevation of -300m ASL