

GEOPHYSICAL REPORT  
GROUND VLF AND MAGNETIC SURVEY

**Sixtymile Project (SIX)**

YT, Canada

Work Performed On: August 16, 2020

FOR:

**Flow Metals Corp.**  
1111 Melville Street, 11th Floor  
Vancouver, BC

Report# FM-SIX-GVLF20 / Rev. 01

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## 1.0 Introduction

This report describes data acquisition, data processing, and interpretation results of the 2020 ground VLF-EM and magnetic survey. The GroundTruth Exploration was commissioned by Flow Metals Corp., Vancouver, BC to plan the survey and inversion modeling of data.

On August 16, 2020, a ground VLF (GVLF) survey were completed over the Sixtymile claims (SIX) target located in the Yukon Territory. This survey is a part of a comprehensive study completed in order to target future exploration on the property.

The magnetic lineaments/structures and the electrical conductors were mapped using the derivative, filtered and transformed magnetic RTP grids of 2010 airborne magnetic conducted by Precision Geosurveys for regional, and 2020 ground VLF-EM and magnetic data conducted by GroundTruth Exploration for the survey area.

The inverted models of VLF-EM data will more easily facilitate geologic interpretation and definition of favorable geology than the data alone, and they can be integrated with other geoscience data for 3D analysis.

This report describes the data acquisition and inversion modelling of VLF-EM data and interpretation, conclusion and recommendations.

## 2.0 Purpose and Scope

The primary purpose of completing ground VLF-EM and magnetic geophysical surveys is to determine the spatial distribution of subsurface electrical and magnetic properties of rocks. This, in turn, will allow the characterization of geophysical signatures for zones of mineralization and support geological models and structural mapping.

## 3.0 Survey Description

Data were acquired using GEM-19 portable VLF systems supplemented by a high-sensitivity proton magnetometer. The magnetometer has an absolute accuracy of +/- 0.2nT. Along with basic GPS tracking, GEM provides a navigation feature with the real-time coordinate transformation to UTM and the local grid. Operators can define a complete survey on PC and download points to the magnetometer via RS-232 serial port.

During the survey, a GEM-19 magnetometer was set up as the base station to collect data for correction and removing of unwanted noise arising from solar and atmospheric activity.

Total coverage of the survey block amounted to 15.2 line-km along 25 survey lines tacking 2150 readings at about 5m station spacing. The survey lines are in an azimuthal direction of SW-NE (NE 25°) with a line spacing of 50m. The in-phase and out-of-phase (quadrature) signals were measured as a percentage of the total field for three frequencies. The VLF transmitter frequencies used for this survey are presented in Table 1. The outline of survey areas and layout of flight lines are shown in Figure-1.

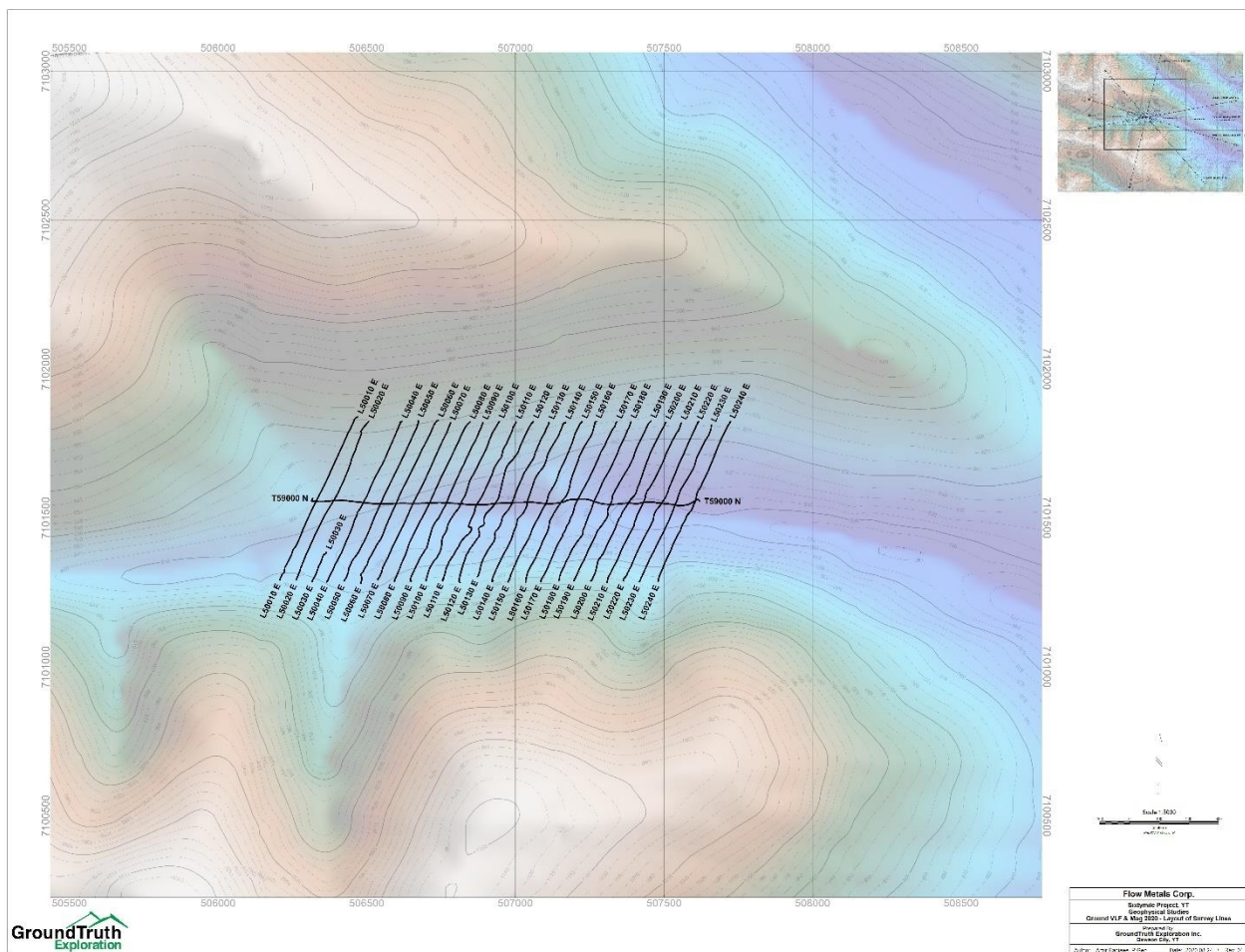


Figure 1: Location map of ground VLF-EM and magnetic survey 2020 on Sixtymile project, YT.

**Table 1:** The parameters of VLF Tx stations.

VLF Tx Station	Frequency (kHz)	Distance (km)	Latitude	Longitude	Azimuth of signal
NML, ND	25.2	~ 3,100	46.365987°N	98.335667°W	~ N 286°
NLK, WA	24.8	~ 2,000	48.203633°N	121.916828°W	~ N 317°
NSS, MD	21.4	~ 9,700	38.977778°N	76.453333°W	~ N 272°

## 4.0 Survey Theory

### 4.1 Very Low Frequency (VLF) survey

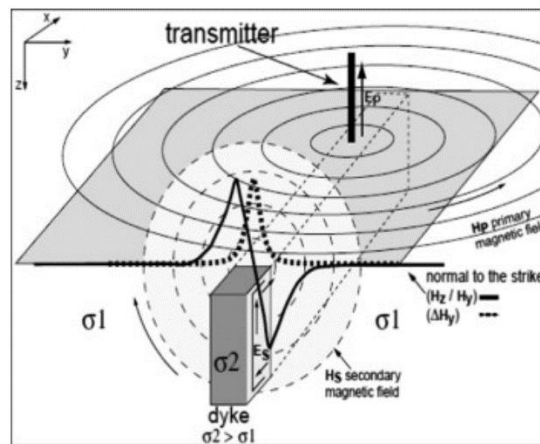
Very Low Frequency Electromagnetics (VLF) is a geophysical ground probing technology that uses powerful remote radio transmitters set up in different parts of the world for the military submarine communication. In radio communications terminology, VLF means very low frequency, about 15 to 25 kHz, while relative to frequencies generally used in geophysical exploration, these are very high frequencies. The radiated field from a remote VLF transmitter, propagating over a uniform or horizontally layered earth and measured on the earth's surface, consists of a vertical electric field component and a horizontal magnetic field component each perpendicular to the direction of propagation.

These radio transmitters are very powerful and induce electric currents in conductive bodies thousands of kilometres away. Under normal conditions, the fields produced are relatively uniform in the far-field at a significant distance (hundreds of kilometres) from the transmitters. The induced currents produce secondary magnetic fields that can be detected at the surface through the deviation of the normal radiated field (Figure 2).

VLF is used in many applications, including mineral exploration, water exploration and more. In mineral exploration, VLF data are used to map geologic structure, including the apparent dip of the fault and shear zones. The data can be interpreted to identify the dip of these structures for reliable drilling. Data are also used to identify conductive ground which might correspond to sulphide or clay rich concentrations. A third application is to map overburden in preparation for drilling and further sampling. All of these features have electrical contrasts with surrounding rocks, tending to be more electrically conductive or resistive and are reasonable targets.

The depth of investigation is controlled by the electrical “Skin-Depth” of the local geology. It varies from shallow to in some cases >100m depending upon the overall background resistivity of the subsurface. Typically, 20-75 meters can be expected. Conductive overburden suppresses signals, and depth penetration may be severely limited at times. VLF works best where rocks are resistive and overburden is minimal or is highly resistive.

The data include in-phase and out-of-phase signals as a percentage of the total field, horizontal component (x), horizontal component (y), and field strength in pT. The electrical conductivity of rocks can be modelled by the inversion of VLF data.



**Figure 2:** EM field distribution for the VLF method in E-polarization with theoretical signals over a vertical conductive dike (after Bosch and Müller, 2001).

## 4.2 Magnetic surveys

Magnetic is the most commonly used geophysical method for gold, diamond, platinum group metals and base metal exploration. Measurements of the magnetic field contain information about subsurface variations in magnetic susceptibility. Data can be acquired in the air (planes, satellites), on the ground (stationary, moving platforms, marine) and underground (boreholes, tunnels). The measurements record the sum of Earth's field and fields induced in magnetic materials. More magnetic (i.e. susceptible) materials have stronger induced fields. Removing Earth's field from the observations yields anomalous fields that can be interpreted in terms of where magnetic material lies and also its susceptibility and shape. Processed data are presented as maps or profiles, and advanced processing, involving inversion, yields parametric structures or 3D models of the subsurface susceptibility distribution.

Magnetic surveying is extremely versatile and can be applied in many areas in the geosciences including geologic mapping and mineral exploration. In gold exploration, magnetics helps in direct detection of associated mineralization and for mapping large- and local-scale structure (faults, dikes, and shear zones).

To a first approximation, Earth's magnetic field resembles a large dipolar source with a negative pole in the northern hemisphere and a positive pole in the southern hemisphere. The dipole is offset from the center of the earth and also tilted. The north magnetic pole at the surface of the earth is approximately at Melville Island. The field at any location on the Earth is generally described in terms described of magnitude  $|B|$ , declination  $D$  and inclination  $I$  as illustrated in Figure 3.

When the magnetic source field is applied to earth materials it causes the material to become magnetized. Magnetization is dipole moment per unit volume. This is a vector quantity because a dipole has a strength and a direction. Because Earth's field is different at different locations on the earth, then the same object gets magnetized differently depending on where it is situated. As a consequence, magnetic data from a steel drum buried at the north pole will be very different from that from a drum buried at the equator.

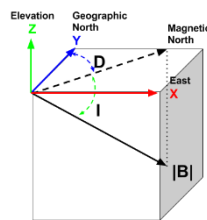


Figure 3: Earth's magnetic field, declination ( $D$ ) and inclination angles (2018, GeoSci Developers).

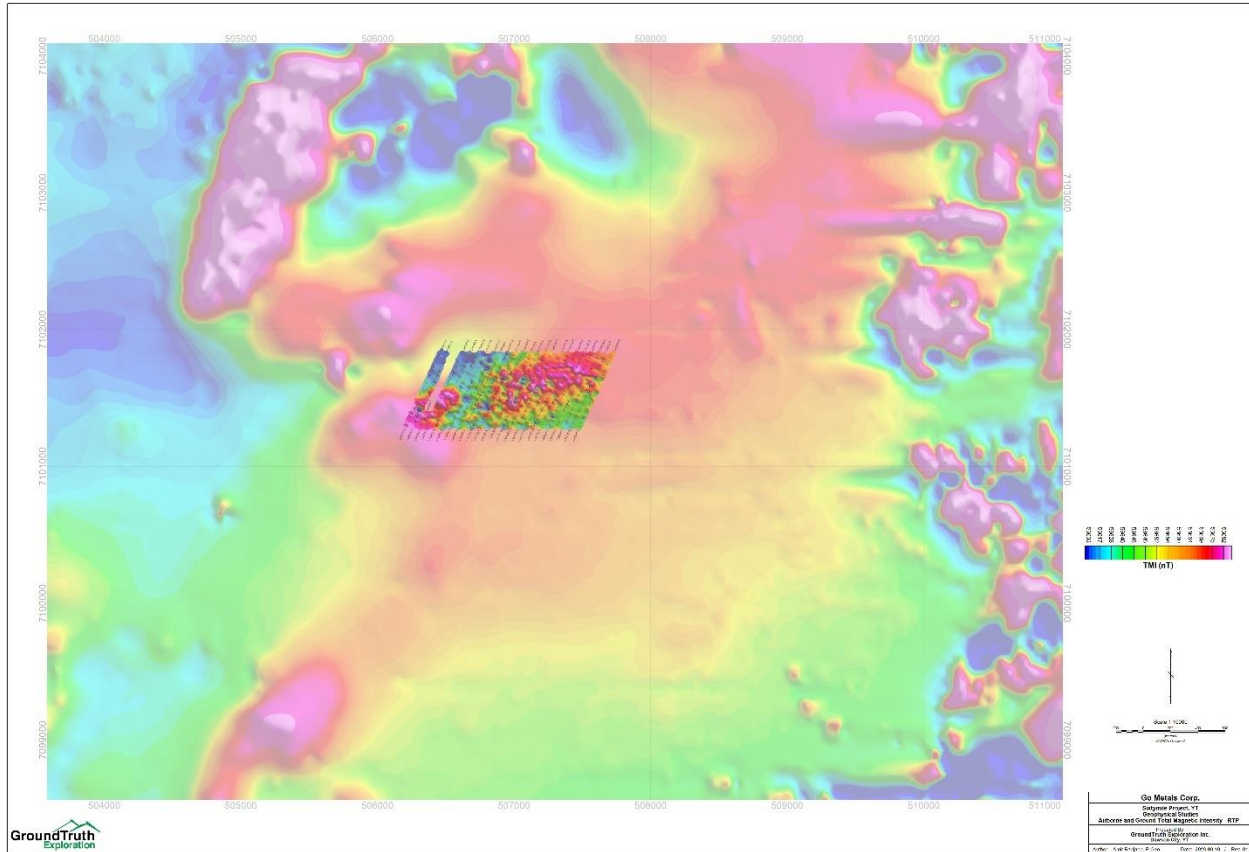
## 5.0 Data processing and Inversion modelling

All data were provided in the NAD83 UTM Zone 7N coordinate system. The modelling was carried out in the same coordinate system. Topographic data were obtained from the 2010 airborne magnetic dataset. This topography surface was used as a reference for inversion modeling of VLF-EM data.

All data were imported into Geosoft, examined and edited for the spikes. Then the International Geomagnetic Reference Field (IGRF) was removed from the data. The Magnetic Field Intensity of 2010 airborne and 2020 ground based data is shown in Figure-4. The magnetic RTP continuation residual resulting after 200m and 500m upward



continuation of airborne magnetic gridded data were processed for interpretation of magnetic regional lineaments and features.



**Figure 4:** The Magnetic Field Intensity of 2010 airborne and 2020 ground based surveys.

The VLF-EM data are processed in advanced levels using inversion modelling techniques recently developed for the 2D inversion of VLF data. The EMTOMO-VLF2Dmf which is a software program for the 2D inversion of VLF-EM data based on the finite element (FE) method. This will ensure that geological models respect a consistent structural, stratigraphic, and topological framework as well as consistency between different geophysical models. The resistivity sections from the inversion of VLF-EM data are presented in Appendix A.



## 6.0 Interpretation

The geologic setting of epithermal deposits includes faulted, fractured, and brecciated rocks. Predominantly, magnetic signatures of epithermal deposits can be characterized as short-wavelength magnetic anomalies common over volcanic terranes because of variable magnetizations and polarizations. This pattern may contrast with an area of moderate to intense alteration that will display a longer-wavelength low, often linear in the case of vein systems, caused by magnetite destruction. Local magnetic highs may be associated with intrusions. Magnetic lows will be related to alteration. However, discriminating such lows from the background may be difficult on a deposit scale. The magnetic data are discussed first, followed by descriptions of the various VLF-EM anomalies.

The airborne RTP magnetic residuals and other derivative products have served to highlight the more subtle features without distorting the more readily identifiable responses. Conversely, the ground magnetic data has effectively integrated the responses from small individual and shallow sources and thus was useful in determining average strike directions and dominant lithologies. Therefore, the interpreted lineaments are to identify the main lithological units and structural features underlying the survey area and outline target zones for further exploration.

Figure 5 shows the lineaments mapped from the 2010 airborne magnetic grids. The major interpreted lineaments/structures directions are SE-NW, E-W, and SW-NE. The results from the 2020 ground magnetic survey identify sets of sub-parallel magnetic linear features striking SSE-NNW and E-W. Detailed interpretation of lineaments from ground magnetic data is displayed in Figure 6 for E-W and in Figure 7 for NW trending magnetic features.

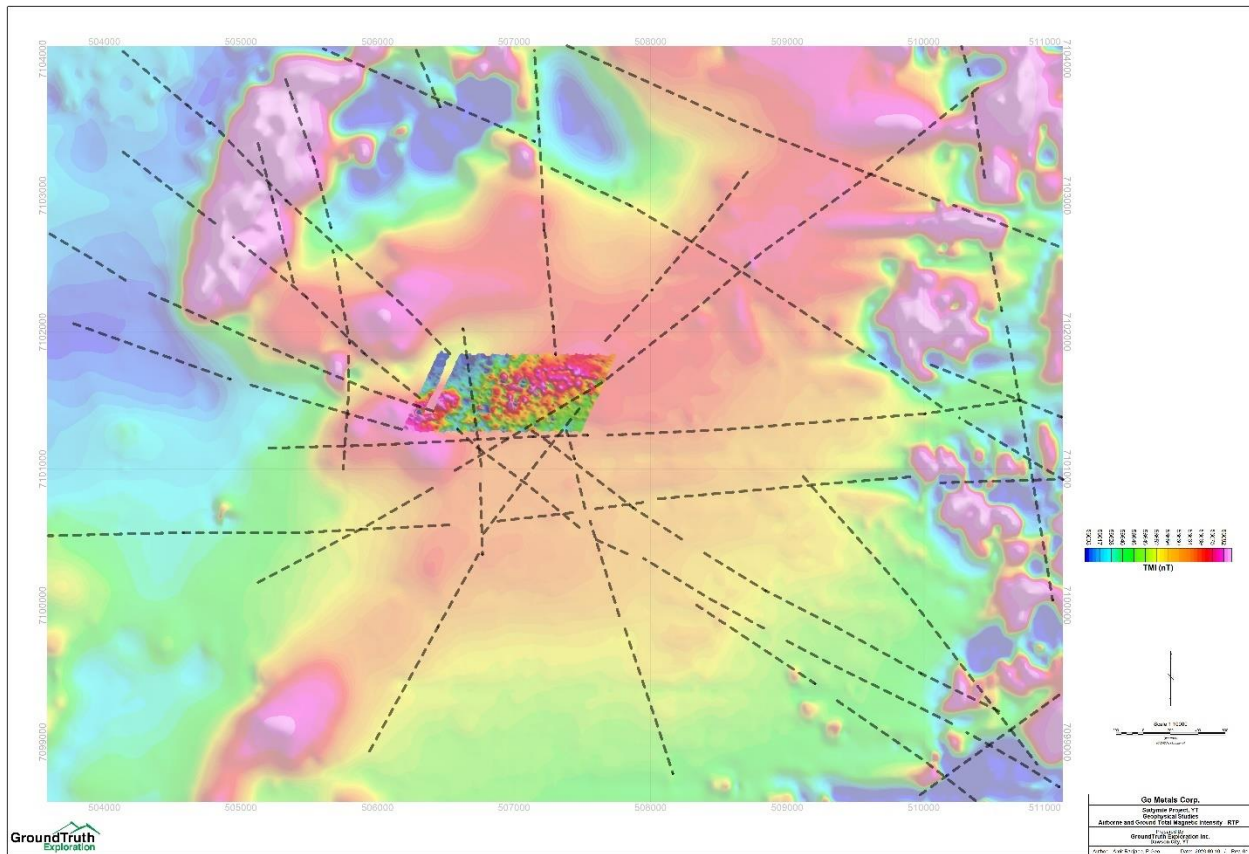
VLF-EM conductors' interpretations are based on the resistivity depth slices extracted from 2D inversion modelling of VLF-EM data at 10m, 30m and 50m. The dominant shallow conductor trend over the survey area is E-W and could be resulted from the creek sediments and the fracture/shear zones (Figure 8). This conductive zone is broken at several locations with sets of NW trending conductors better identified at deeper depth slices (Figure 9 and 10). The resistivity sections presented in Appendix-A provide dip and extension of the VLF-EM conductors.

## 7.0 Conclusion and recommendations

Ground VLF-EM and magnetic survey was performed along 25 survey lines on the Sixtymile project, YT. The VLF data are processed in advanced levels using inversion modelling techniques to render a 2D resistivity model. The airborne and ground based magnetic data were processed and interpreted for lineaments indicating lithological and structural features.

In follow up work, 3D inversion of airborne and ground magnetic data is recommended. Also, the distribution of physical properties can help to identify potential exploration areas, and inclusion of additional information in the form of geologic knowledge (conceptual model, overburden thickness, drilling, outcrop lithology, etc.), petrophysical information, and further geophysics, will help guide the selection of inversion parameters and constraints so that models with enhanced resolution can be obtained. This should make exploration more successful and cost-effective.

Geochemical surveys, including soils and rocks sampling programs would be very important in characterizing and understanding the geophysical signature and are recommended.



**Figure 5:** Lineaments and features mapped from 2010 airborne magnetic grids

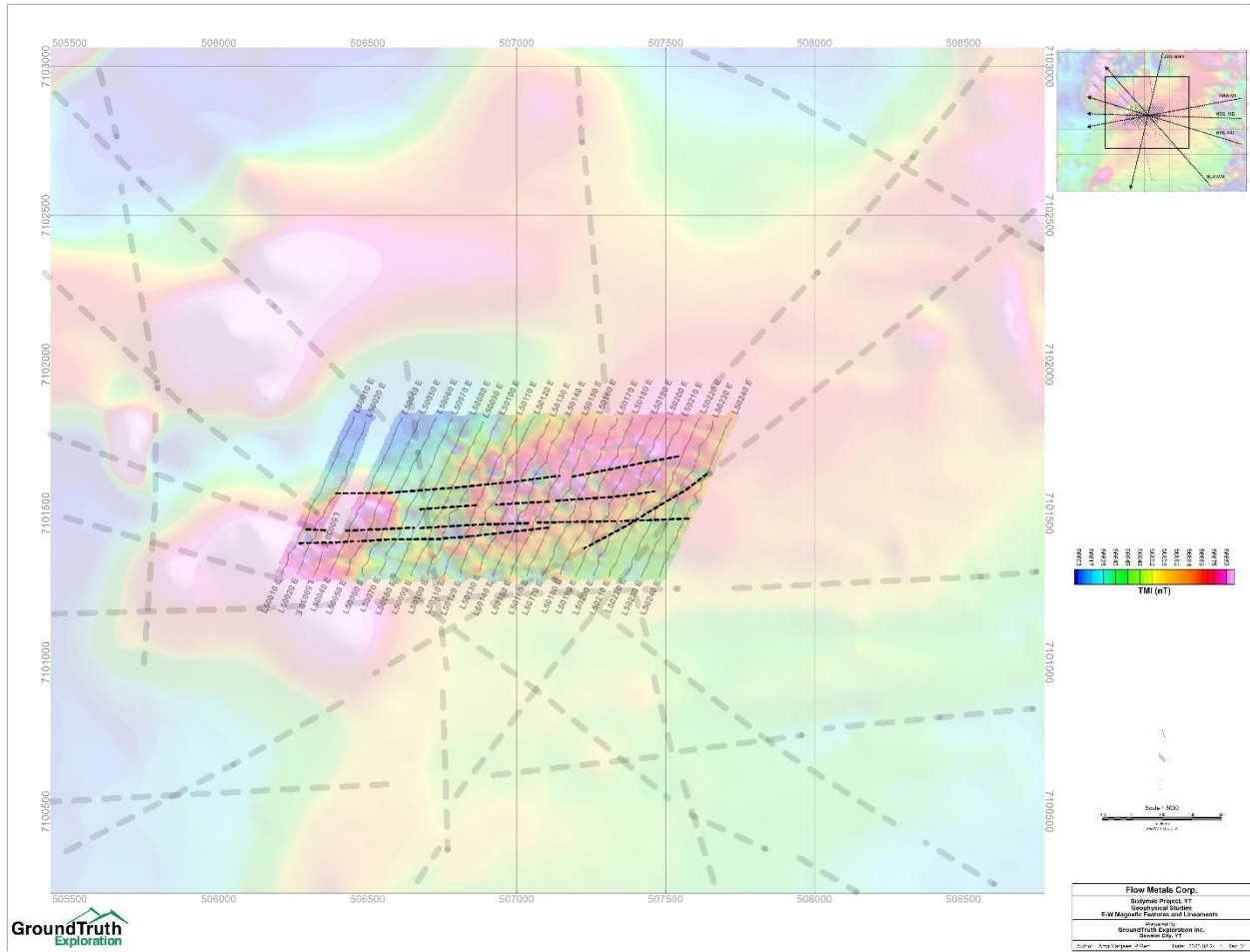


Figure 6: Detailed interpretation of 2020 ground magnetic data E-W trending features.

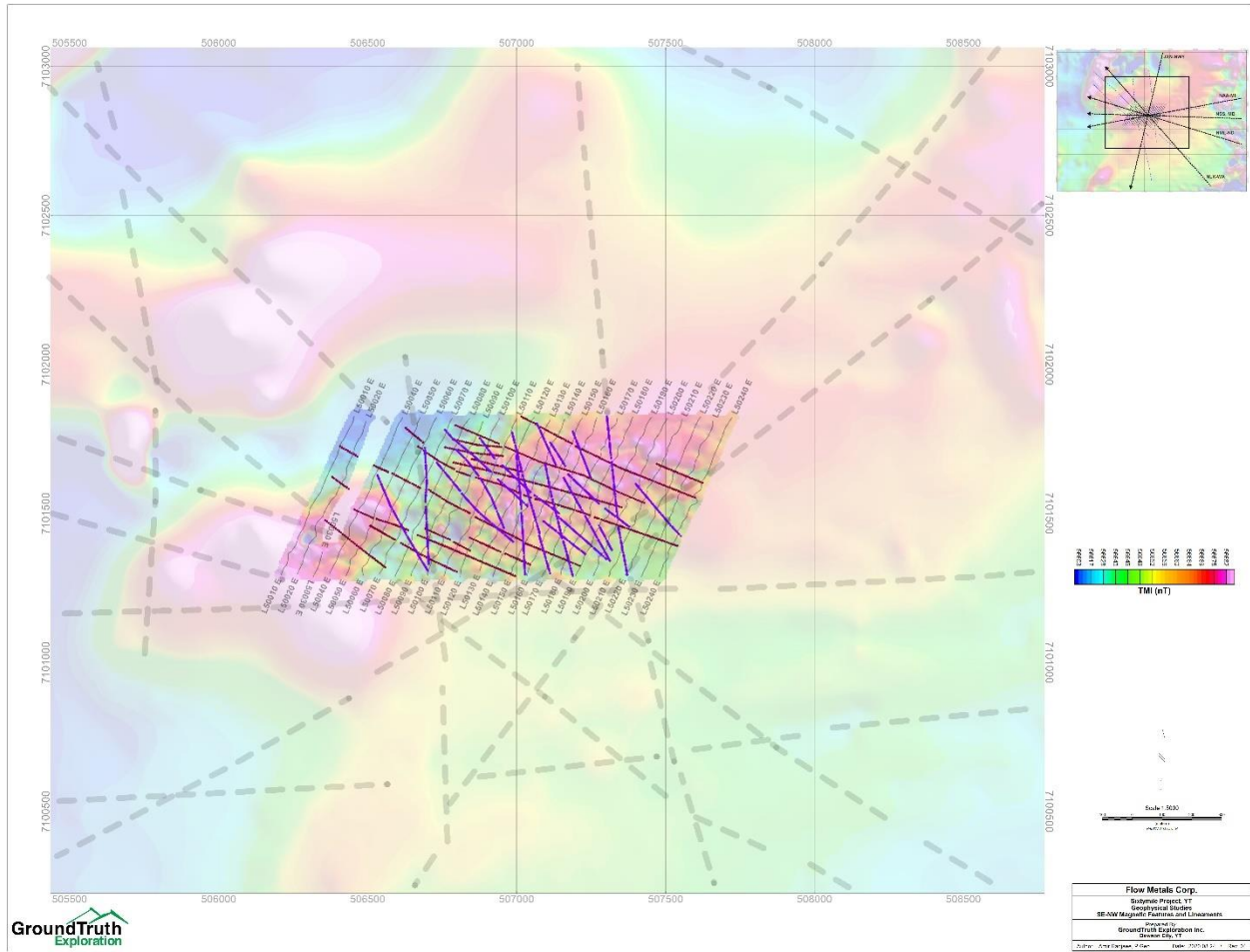


Figure 7: Detailed interpretation of 2020 ground magnetic data NNW trending features.



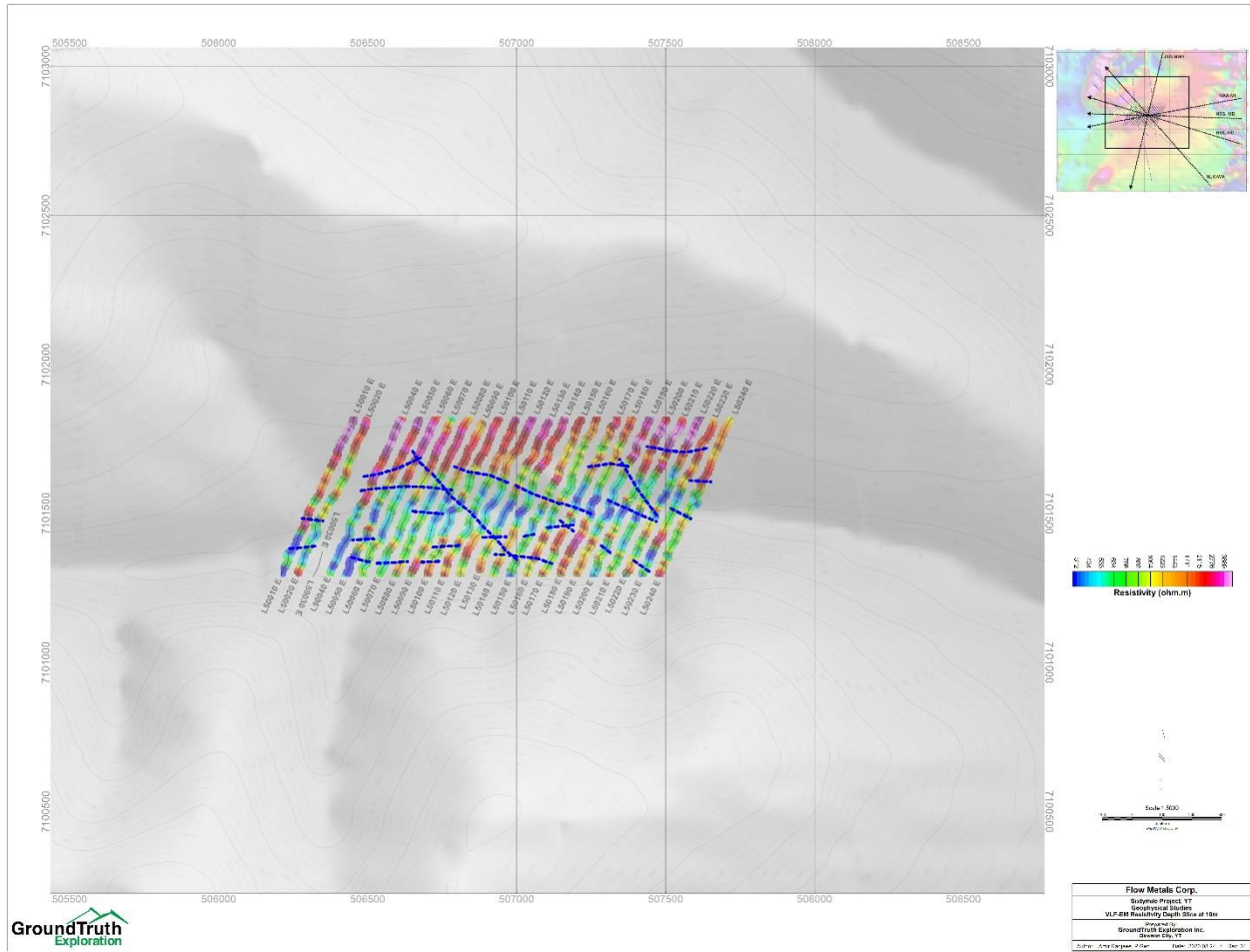


Figure 8: VLF-EM resistivity depth slice at 10m and VLF conductors.





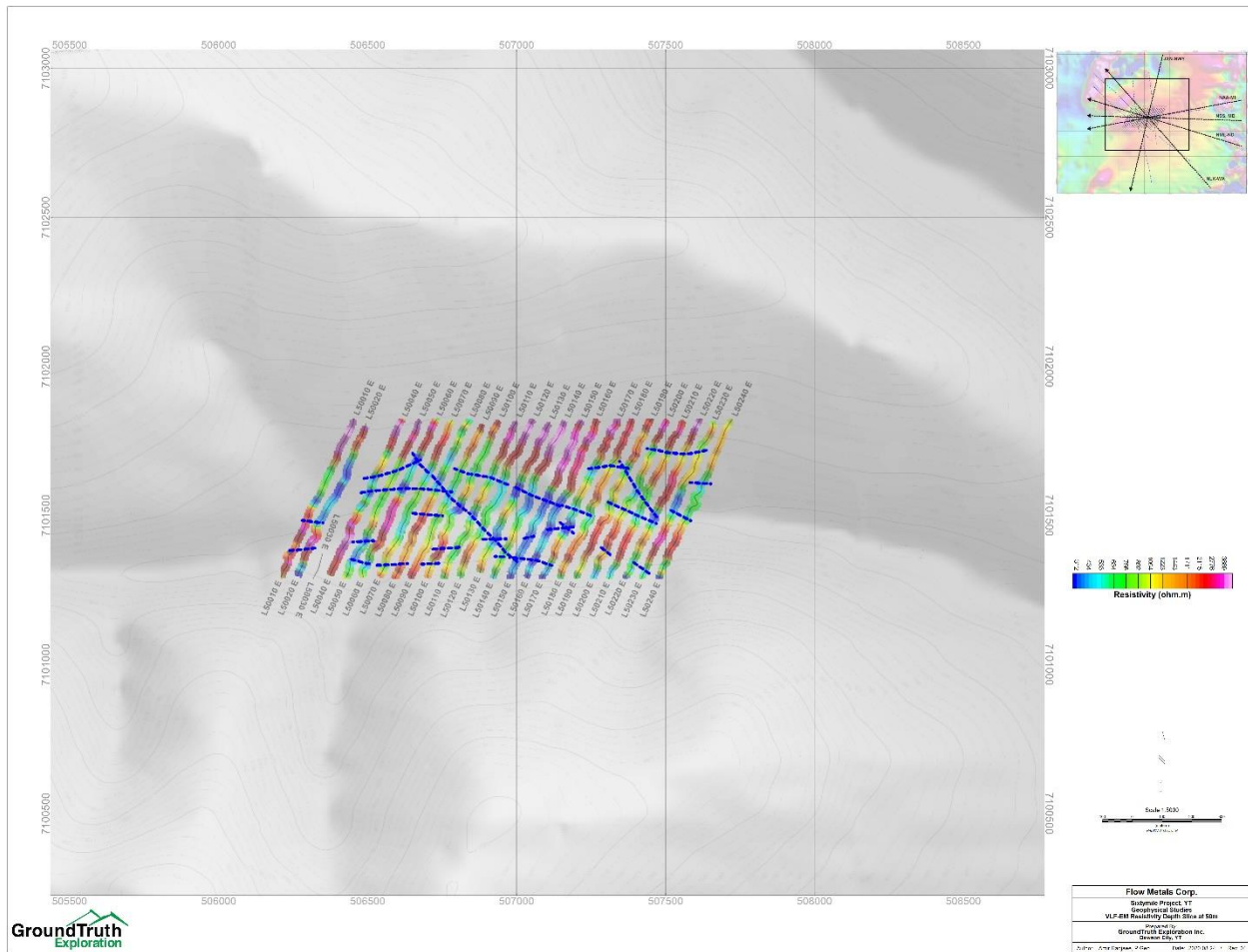


Figure 10: VLF-EM resistivity depth slice at 50m and VLF conductors.

## 8.0 Deliverables

Report in .pdf format

Database in Geosoft .dbf and .xyz formats

Resistivity Sections and maps in .jpg format

Magnetic Grids in Geosoft and Tiff format

Location Maps in .pdf and .jpg formats

## Appendix-A

### VLF-EM Resistivity Sections

