DATA ACQUISITION
UAV MAGNETOMETRY

TECHNICAL REPORT

Written for:

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Written by:

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SUMMARY

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1 INTRODUCTION

This report presents the results of the magnetometric survey of the Poverty Gulch Project near the municipality of Tonopah, NV, within the scope of the contract for the provision of services signed between Advanced Geologic Exploration, Inc. and Avant GeoSurveys, aiming at the application of magnetometry methodology with UAV (unmanned aerial vehicle) in mineral exploration projects. The acquisition of aeromagnetometric data were carried out between 07/07/2023 to 07/11/2023, totalling 97.5 linear km throughout the project. Most magnetic high anomalies were within the 50-meter (164 feet) depth or less range based on the spectrum power analysis.

The processed data was integrated in a three-dimensional digital model with previous seismic survey sections to provide a more robust geological interpretation. Major contacts and structures are indicated as lines that can be integrated with mapping information (not available for Avant GeoSurveys) for final interpretation and map construction. All products were exported in digital and three-dimensional format to be handled and integrated in other software.

Throughout this report, information will be presented on:

- Characteristics of the local magnetic field in the region of the Project;
- Summary of the magnetometric surveys carried out;
- Maps of the results;
- Conclusions and recommendations.

Complementary information on the fundamentals of magnetometry, methodology, equipment, workflows, and bibliographical references can be found in the appendices of this report.

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2 PROJECT INFORMATION

2.1 Location

The Poverty Gulch Project area is located nearly 150 air miles northwest from Las Vegas, NV, and about a 63 mile drive south of Tonopah, NV (Figure 3-1).

Figure 2-1: Project Survey area, with a total area of approximately 2.0 km².

2.2 Acquisition and total flight distance

The aeromagnetometric data surveys were carried out between 07/07/2023 to 07/11/2023 totalling 97.5 linear kilometers of data acquisition. To reduce the risk of collisions and maintain the best possible adherence to the natural terrain, the SRTM (Shuttle Radar Topography Mission) surface was used in combination with the UGCS flight planning software (https://www.ugcs.com/), to ensure safe flight mission planning.

2.3 Processing

The primary data processing and interpretation were completed within the Oasis Montaj Geosoft Software at the head office of Avant Geofisica in Belo Horizonte, Minas Gerais, Brazil, a technical partner of Avant GeoSurveys. Some interpretation was completed at the Avant GeoSurveys office in Park City, Utah.

2.4 Final deliverables

The following products were obtained by processing the acquired aeromagnetic data:

1) .GDB extension file with raw and processed data;
2) Three-dimensional solids and interpreted lines;
3) Final report of activities and processing.
4) Maps georeferenced and in .GEOTIFF and .KML formats.

3 LOCAL MAGNETIC FIELD

Magnetic Field

Model Used:	IGRF2020
Latitude:	37.312559° N
Longitude:	117.308134° W
Elevation:	1980.0 m Mean Sea Level

Date	Declination (+ E | - W)	Inclination (+ D | - U)	Horizontal Intensity	North Comp (+ N | - S)	East Comp (+ E | - W)	Vertical Comp (+ D | - U)	Total Field
2023-07-09	11.9728°	61.8494°	22,782.0 nT	22,286.4 nT	4,726.0 nT	42,576.2 nT	48,288.2 nT
Change/year	-0.0885°/yr	-0.0067°/yr	-40.1 nT/yr	-31.9 nT/yr	-42.7 nT/yr	-87.0 nT/yr	-95.6 nT/yr

Figure 3-1: Components of the local magnetic field.
(Source: https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#igrfwmm).

The website https://www.ngdc.noaa.gov/geomag/calculators was consulted to verify the optimal position of the sensor and the blind zones at angles smaller than 15° in relation to the local magnetic field (proximal blind zone) and greater than 75° in relation to the local magnetic field (distal blind zone). The site asks for the coordinates in degrees of a point in the search area. In this case, the chosen point is in the geometric center of the area, with coordinates Latitude: 37° 18' 45" N, Longitude: 117° 18' 29" W, 1,980.00 meters altitude according to the Google

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Earth mag project boundary. The reference values obtained are presented in Figure 3-1, in summary:

Total Field 48,288.2 nT, Declination 11.9728° E and Inclination 61.8494°.

4 MAGNETOMETRY SPECIFICATIONS

4.1 Geometric parameters

The spacing between production lines in the area is 25 meters (East-West oriented flight lines) and the spacing between control lines is 250 meters (North-South oriented flight lines) (Figure 4-1).

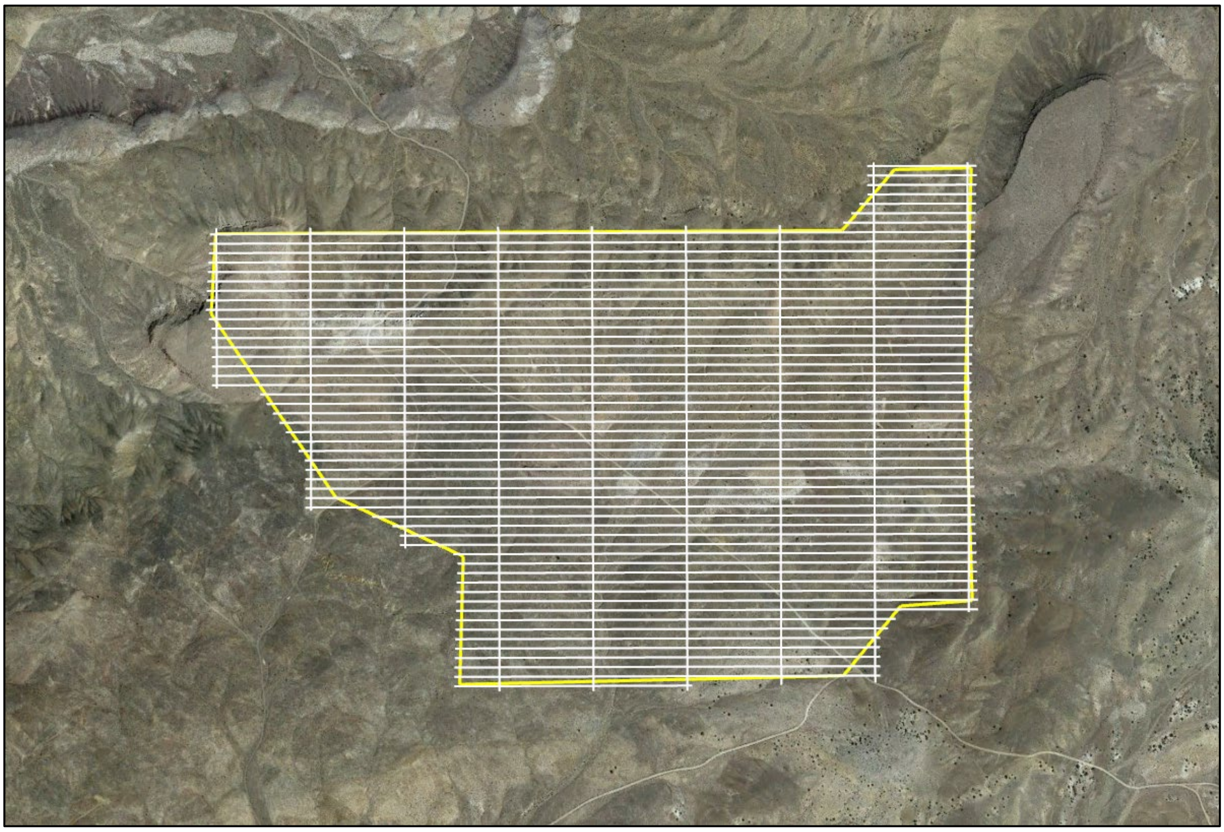

Figure 4-1: Map of Poverty Gulch Project Area (Yellow perimeter) showing Planned Flight Lines (White lines).

4.2 Sensor height – ground reference

The height of the UAV mag sensor averaged around 25m, but varied 5m to 10m at various points for flight safety reasons.

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5 PROCESSING RESULTS

The main maps generated are presented in the following figures. Explanations for the various products will be defined in each section.

5.1 TMI - Total Magnetic Intensity

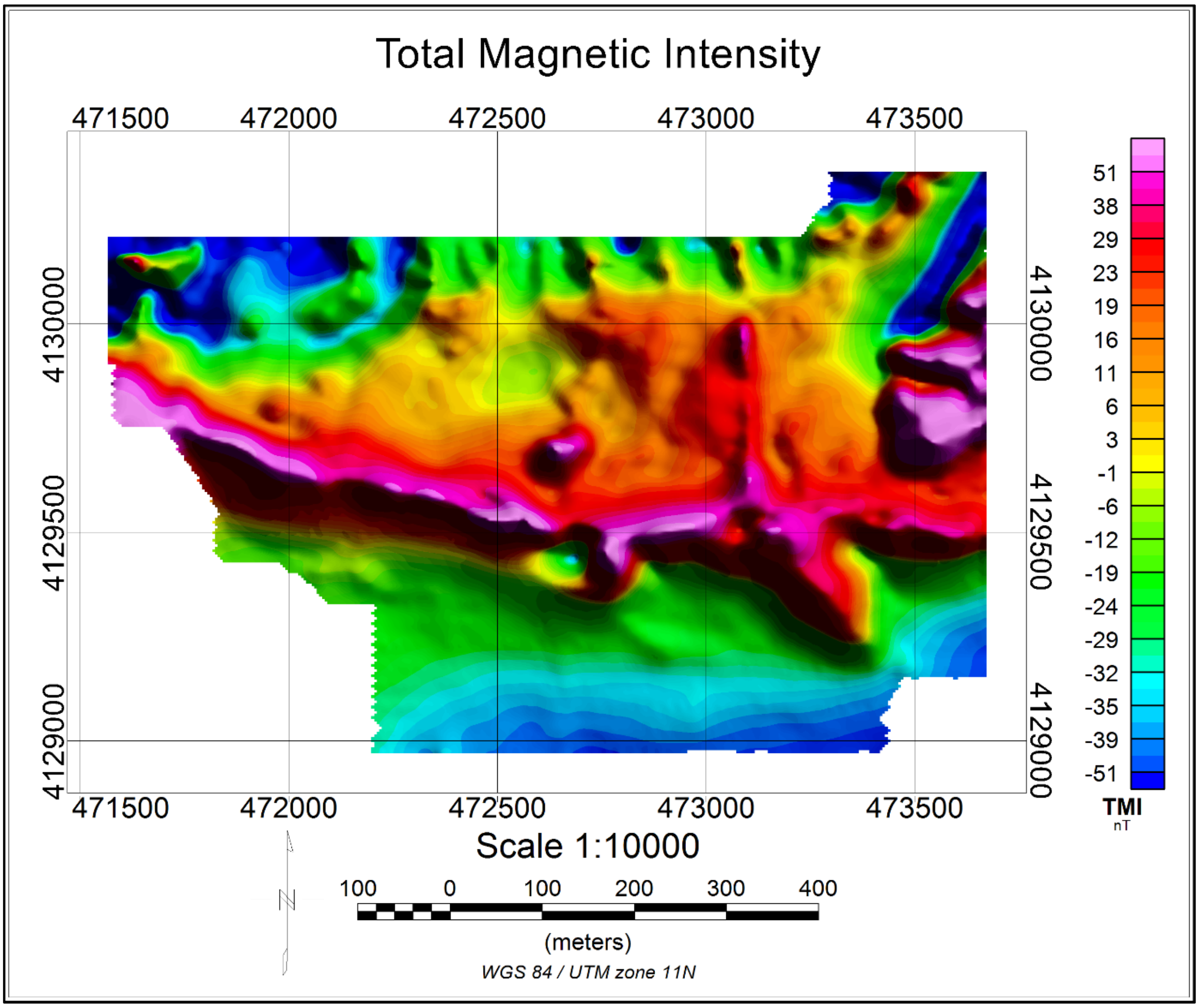

Figure 5-1: Total Magnetic Intensity (IGRF Reduced).

Raw data as measured in field, at a specific time and location (including height), in the presence of the Earth's local magnetic field. These results provide an overview of the magnetic signature of a particular area before any enhanced filtering. Total Magnetic Intensity (TMI) data has dipolar magnetic responses over

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magnetic bodies dependent on the magnetic inclination. Units: nT (Figure 5-1 above).

5.2 TMI - Total Magnetic Intensity – STACKED PROFILES

The stacked profiles can be better visualized in Google Earth as individual lines to help interpret bed inclination and anomalies profiles/asymmetries (Figure 5-2).

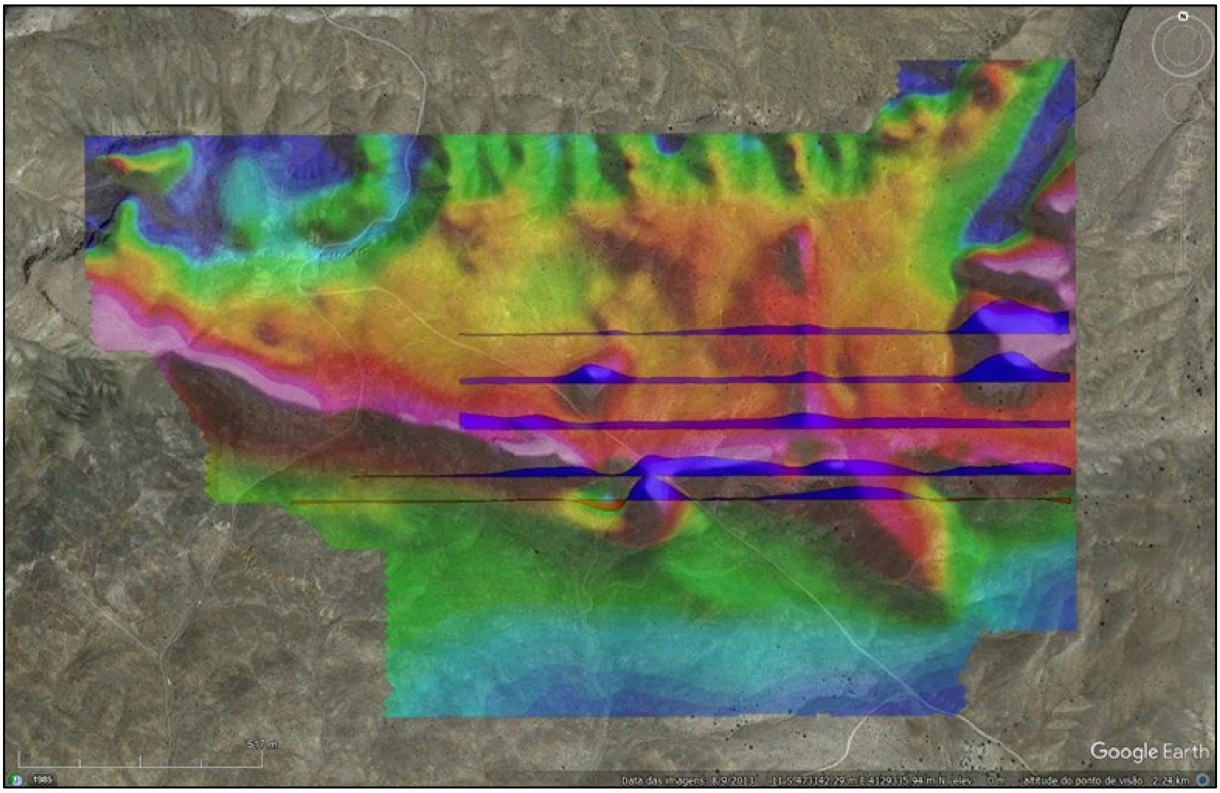

Figure 5-2: TMI stacked profiles and a suggestion of how to visualize it (acquisition data on profiles over gridded data).

The symmetrical stacked peaks are indicative of nearly vertical structures or dikes which can be seen in the eastern portion of the flight area and oriented north-south. These stacked profiles can be used to interpret contacts based on skewness and from line to line. The yellow line is interpreted to be the Wyman Formation – Rhyolite contact. The green oval is a structurally complex portion of the project area (Figure 5-3).

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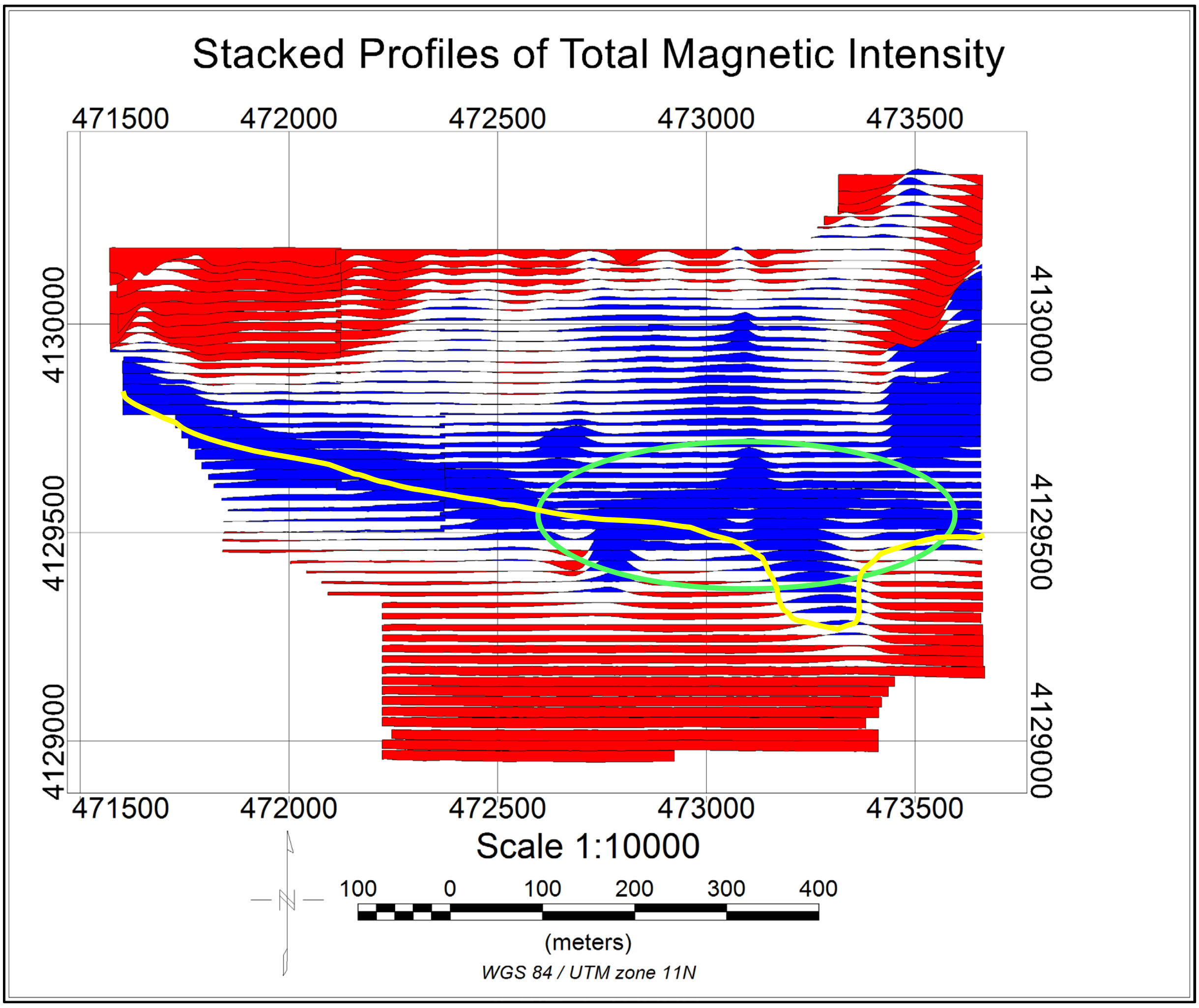

Figure 5-3: Stacked Profiles of Total Magnetic Intensity (IGRF Reduced).

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5.3 RTP – Reduce to Pole TMI

Reduced to the Pole (RTP) process transforms the dipolar response of the TMI to a simple high centered over the magnetic body (induced magnetisation only) as would be obtained over the magnetic north pole. Units: nT (Figure 5-4)

The reduction-to-the-pole process recalculates the observed magnetic field to what it would look like at the north or south magnetic pole, where the Earth's magnetic inclination is vertical. It theoretically removes the asymmetry of the TMI anomaly and places the peak response directly over the magnetic bodies. In practice it can result in artefacts, particularly if remanence is present. It can also be misleading / unstable for N-S striking bodies in low-latitude environments.

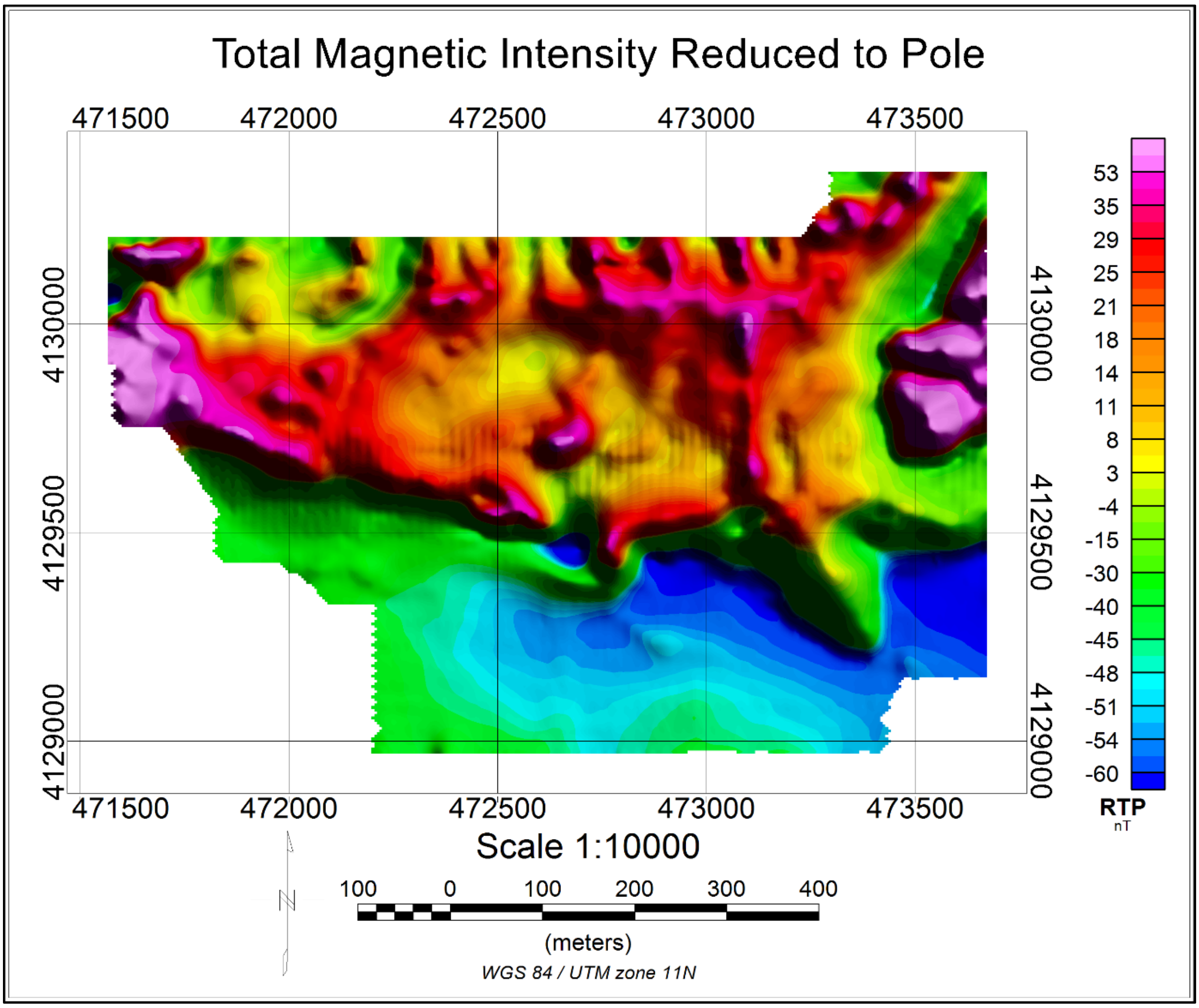

Figure 5-4: Total Magnetic Intensity reduced to pole (IGRF Reduced).

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5.4 ANALYTIC SIGNAL - AS

A combination of the vertical and horizontal derivatives. Always positive values and applied on TMI data. Generates a maximum directly over a discrete body, or alternatively maxima over the edges of wider bodies, regardless of the presence of any remanent magnetisation or the Earth's local magnetic inclination. It can therefore be a useful tool in reducing the difficulties associated with interpreting the location of bodies with remanent magnetisation and/or in low-latitude environments where the RTP is unstable. However, contrary to popular belief, the ANSIG is NOT totally independent of the inclination field or remanent magnetisation, with the size, shape and location of the calculated anomalies still affected by both factors. Black square is potentially remnant intermediate or mafic volcanics but must be confirmed by mapping (Figure 5-5).

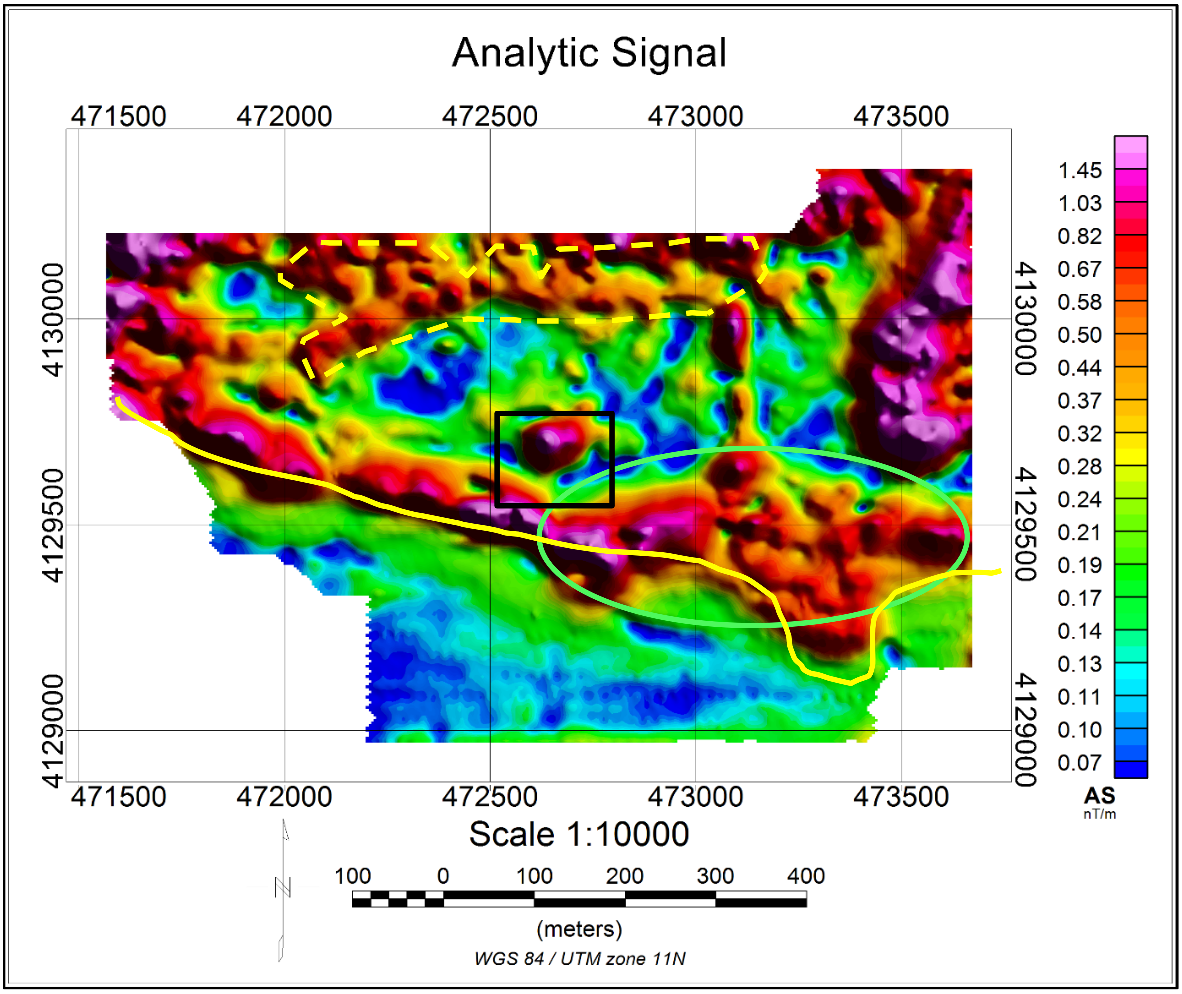

Figure 5-5: Analytic Signal (AS).

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The yellow dashed polygon in Figure 5-5 shows areas with exposed Tertiary gravels at the surface. The red, orange, and magenta colored areas within this polygon should be investigated by drilling (preferably by sonic methods) to determine the magnetite and auriferous potential of the sediments. South of the dashed line the gravels are covered by ash. As with the stacked profiles in Figures 5-3 the yellow line is interpreted to be the Wyman Formation – Rhyolite contact. The green oval is a structurally complex portion of the project area.

5.5 AS – STACKED PROFILES

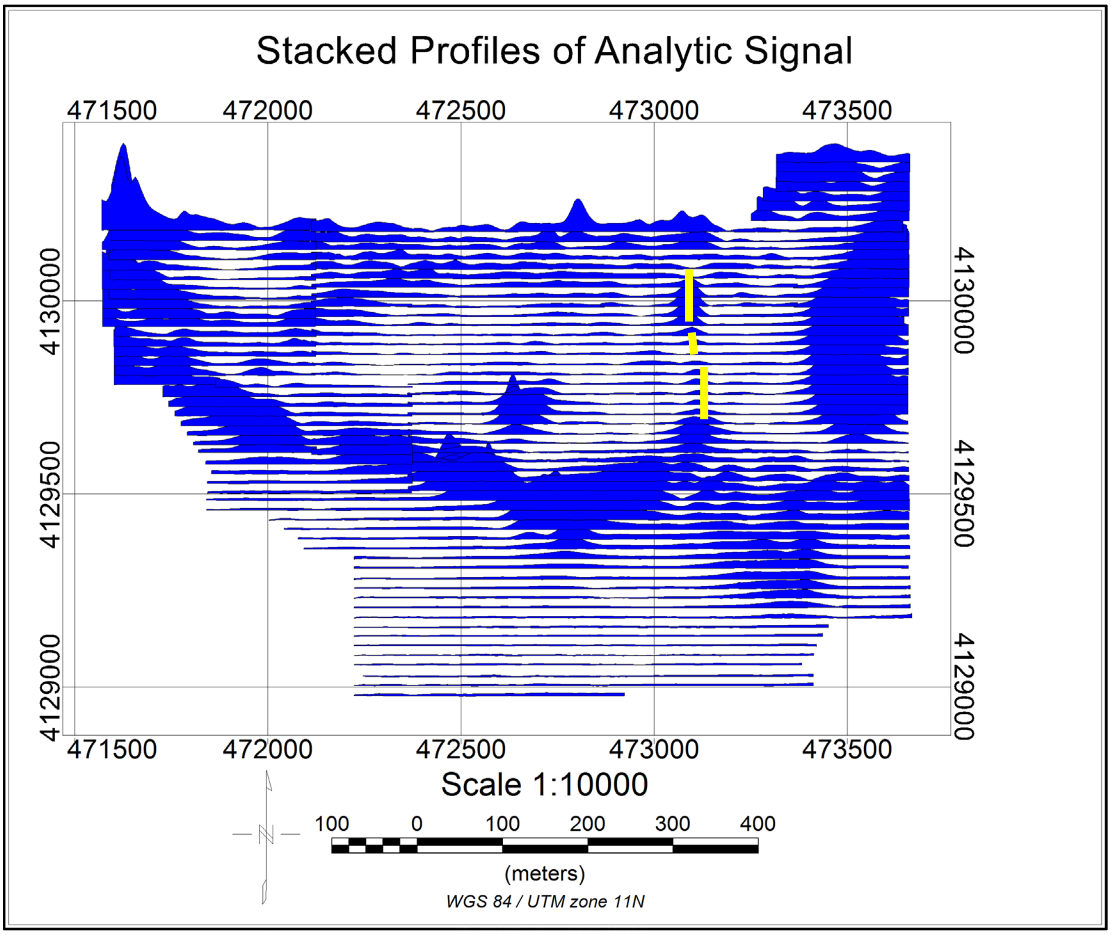

Figure 5-6: Stacked Profiles of the Analytic Signal (AS).

The stacked profiles can be better visualized in Google Earth as individual lines to help interpretation of bed inclination an anomalies profiles/asymmetry. As mentioned previously the symmetrical profiles indicate near vertical structures or

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features (see yellow lines in Figure 5-6) and asymmetrical ones can be used to interpret contacts.

5.6 1VD – 1ST VERTICAL DERIVATIVE

Enhances shallower anomalies and improves the resolution of closely spaced sources by sharpening and separating magnetic anomalies. Equivalent to measuring the magnetic field simultaneously at two points vertically above each other and dividing the result by the distance between the points. Applied to either TMI or RTP. Units nT/m. The wavy colors at the southern portion of the project area are indicative of the contact between the Wyman Formation and the rhyolite (Figure 5-7).

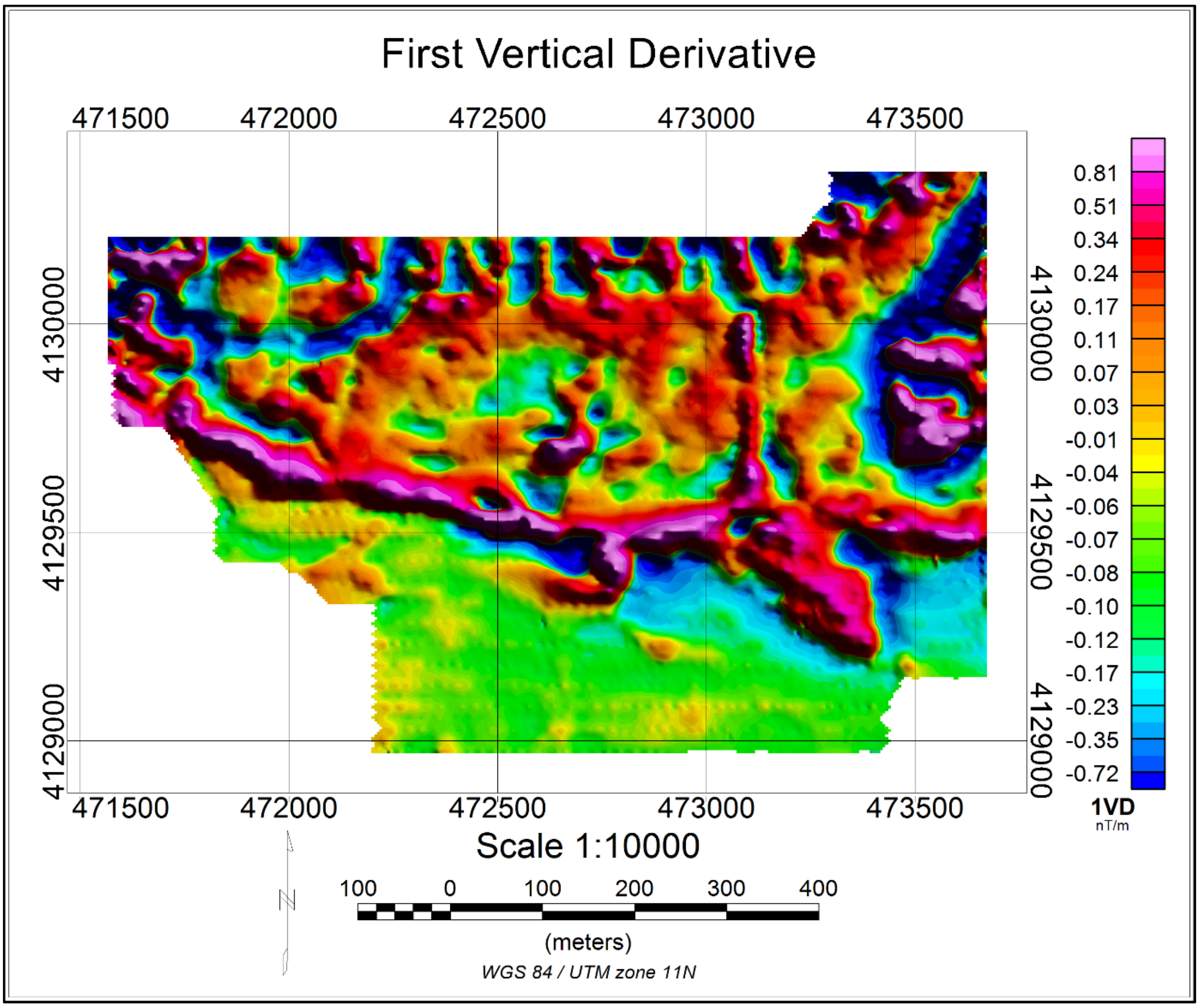

Figure 5-7: Map of First Vertical Derivative (1VD).

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5.7 2VD – SECOND VERTICAL DERIVATIVE

Enhances shallow anomalies even further but needs high quality data as noise levels are also amplified. Equivalent to the rate of change of the 1st vertical derivative relative to height. It is Usually presented as a greyscale image (Figure 5-8). Applied to either TMI or RTP. Units nT/m^2.

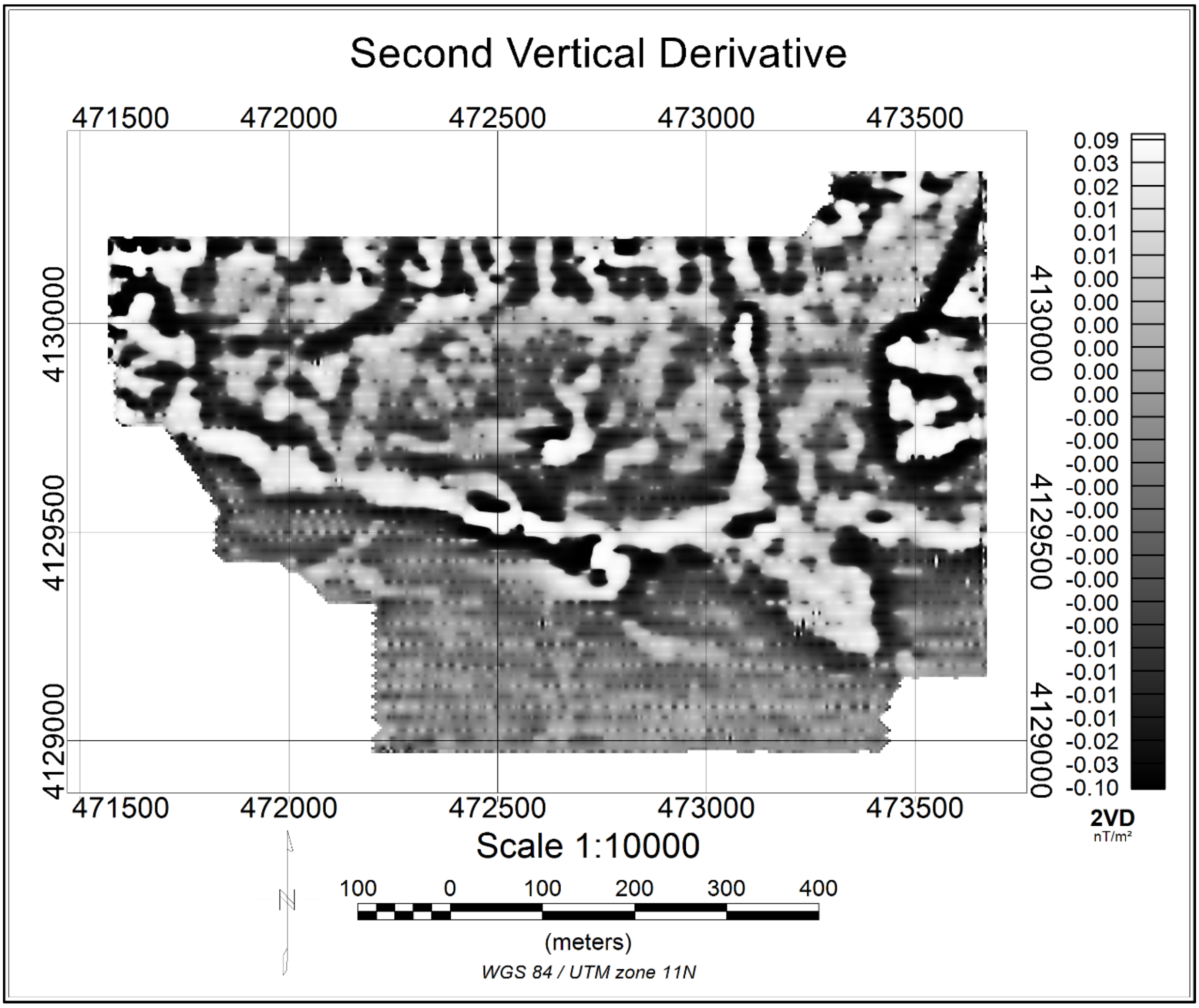

Figure 5-8: Map of Second Vertical Derivative (2VD).

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5.8 TOTAL HORIZONTAL DERIVATIVE - THD

The gradient (slope or rate of change) of the magnetic data with horizontal distance, in a particular direction. Enhances linear features in a direction perpendicular to the direction of the derivative. Places a high over the edges of a wide body. Is always positive (Figure 5-9). The THD is a combination of east-west and north-south gradients of the magnetic data. Better applied to RTP data. Units nT/m. Figure 5-9 below shows a structurally complex area (black rectangle) and an interpreted intermediate to mafic dike (cyan heavy line).

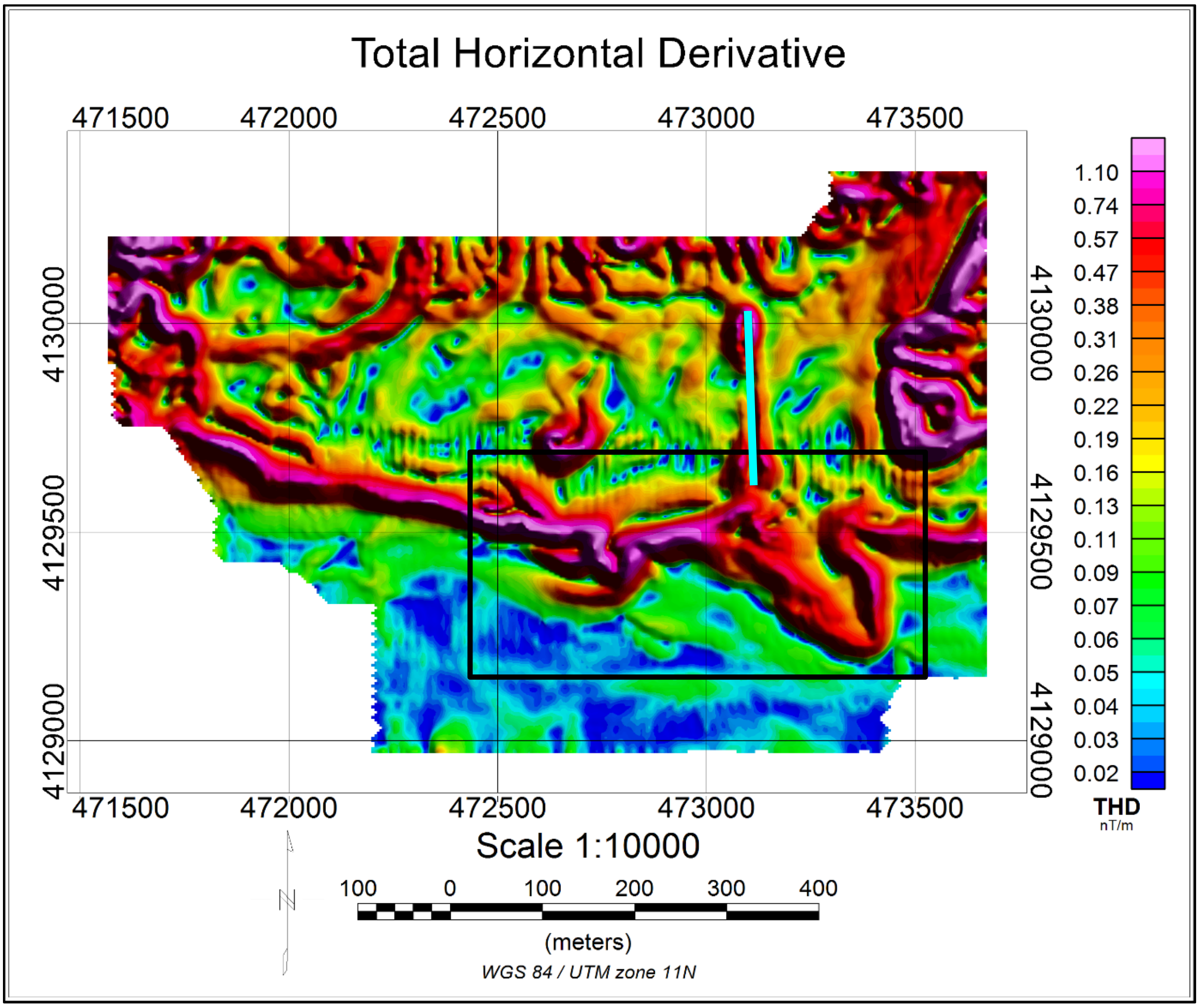

Figure 5-9: Map of Total Horizontal Derivative (THD).

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5.9 TILT ANGLE OR TILT DERIVATIVE

Uses a ratio of the vertical and total horizontal derivatives to enhance magnetic bodies and their edges (Figure 5-10). Maximum values are detected directly over the center of the magnetic body, while the zero value corresponds to the edge of the source. This method provides a sharper indication of magnetic contacts than the AS/ANSIG. This method is also independent of the magnitude of the magnetic response and is therefore useful for mapping stratigraphy in low amplitude areas. Like the AGC filter, the TILT cannot be used to directly compare anomaly amplitudes. Applied to the RTP data as not invariant with inclination. Units: Radians ($-\pi/2$ to $+\pi/2$).

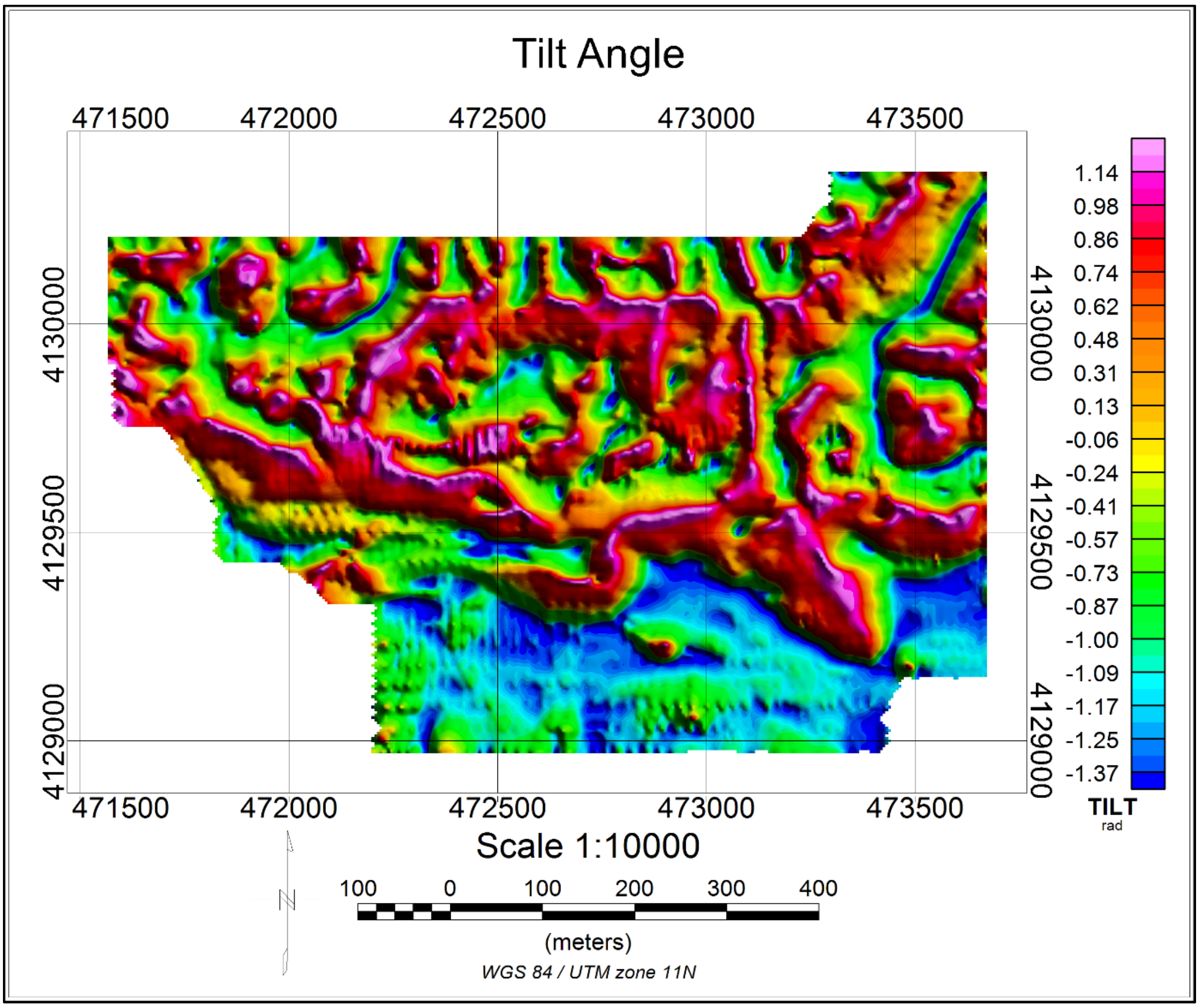

Figure 5-10: Map of Tilt Angle.

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5.10 ASVI - ANALYTIC SIGNAL OF THE VERTICAL INTEGRAL

Like an analytic signal but retains deeper features as the data is integrated before calculation of the analytic signal. Data integration serves to smooth the data initially before application of the derivative filters. Always positive (Figure 5-11). Applied to TMI data. Units: nT (same as RTP and TMI). Body should be located under or close to the high, but the anomaly is more diffuse than AS.

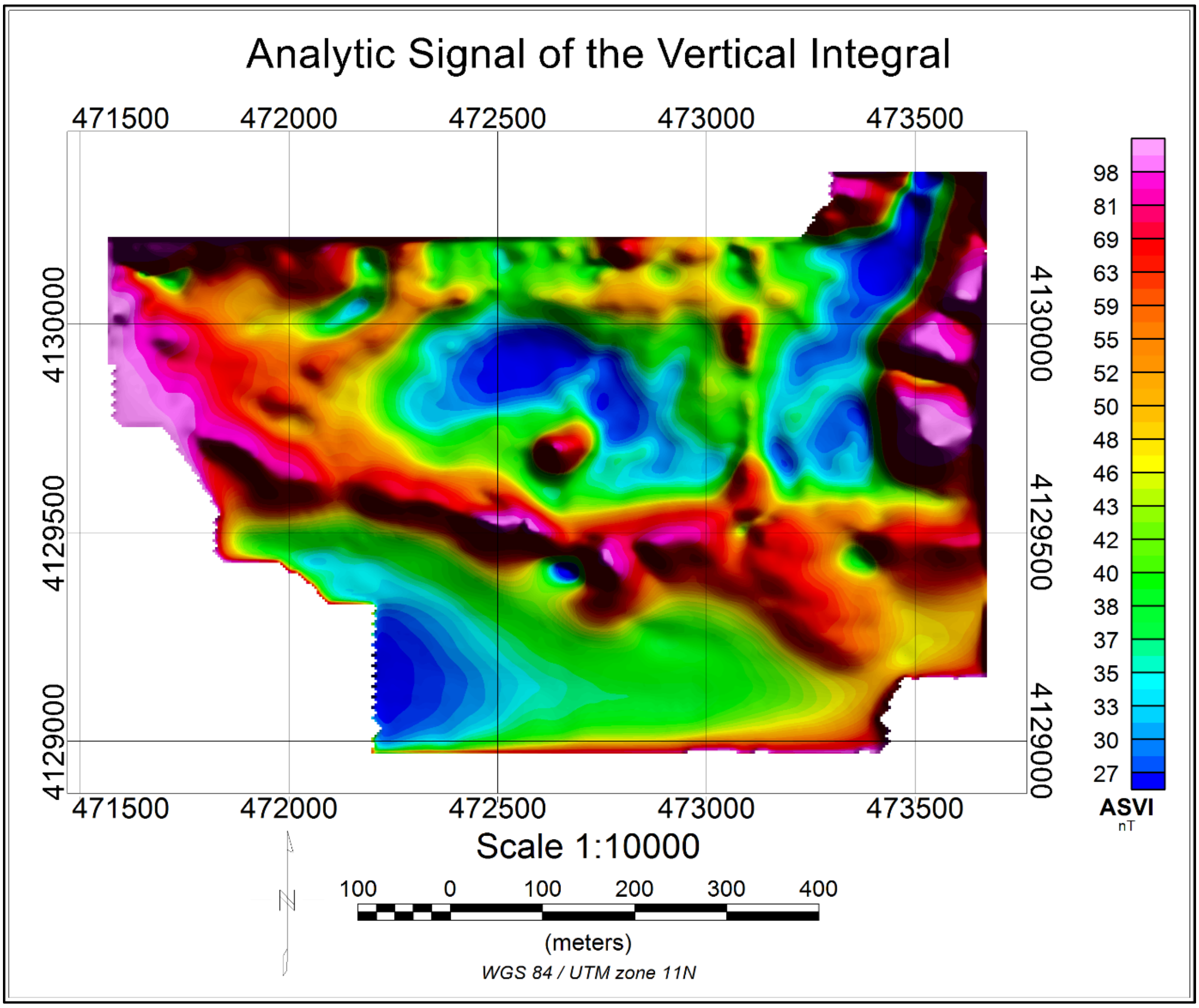

Figure 5-11: Map of ASVI - Analytic Signal of the Vertical Integral.

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5.11 TRD_THD - TOTAL HORIZONTAL DERIVATIVE OF THE TILT ANGLE

THD Filter applied over the Tilt Angle to enhance contacts. The amplitudes are sensitive to source depth and contacts became less sharp with increase on depth (Figure 5-12). Peaks over borders and zero over center of tabular and vertical magnetic sources. Units: Rad/m.

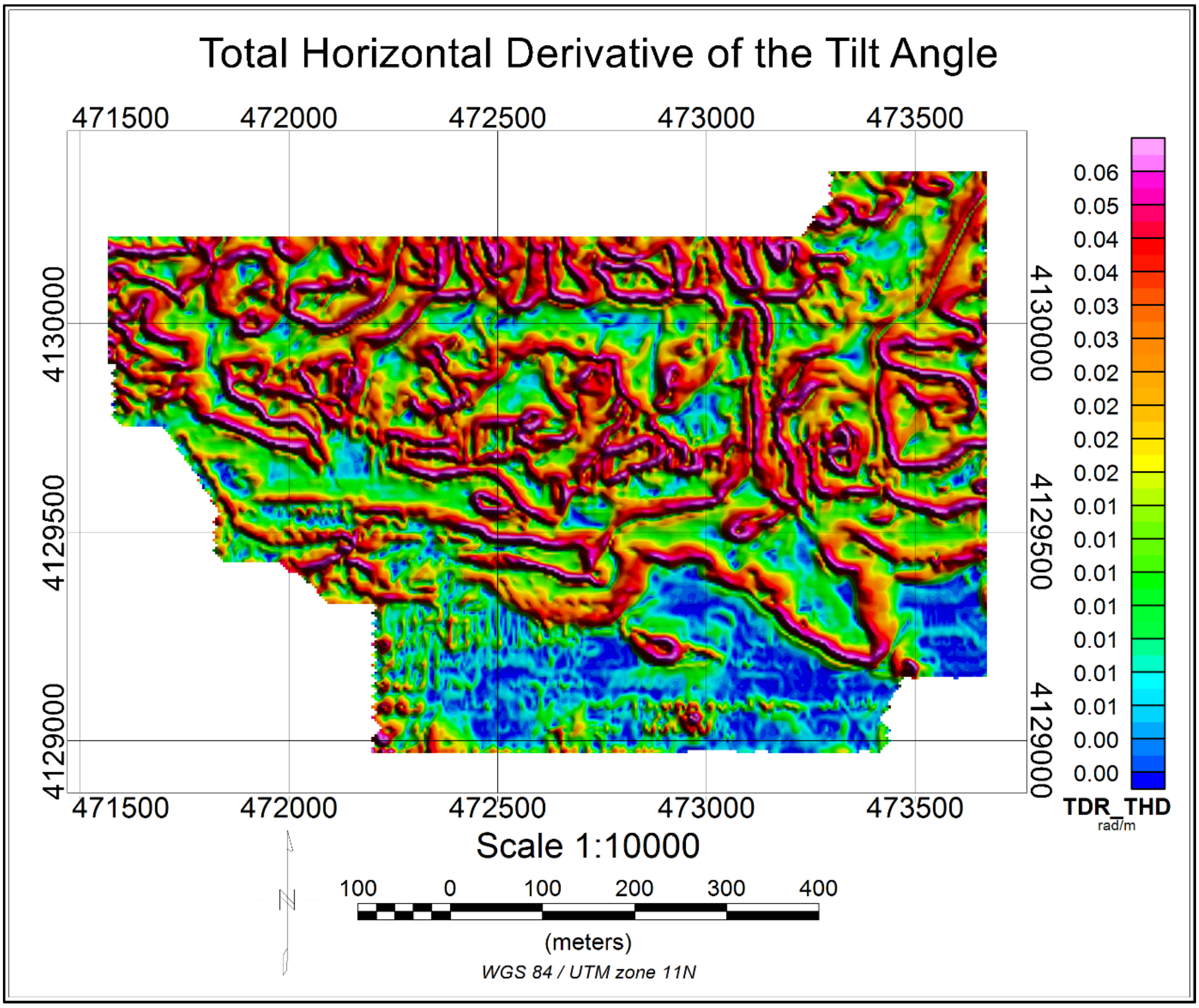

Figure 5-12: Map of Total Horizontal Derivative of the Tilt Angle (TDR_THD).

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5.12 TAHG - TILT ANGLE OF THE TOTAL HORIZONTAL DERIVATIVE

Tilt Angle Filter applied over the THD to enhance contacts. The amplitudes **are not sensitive to source depth**, providing sharper contacts than TDR_THD map. Peaks over borders and Zero over the center of tabular and vertical magnetic sources (Figure 5-13). Units: Rad. This map also indicates magnetic zones that can be discrete according to the texture.

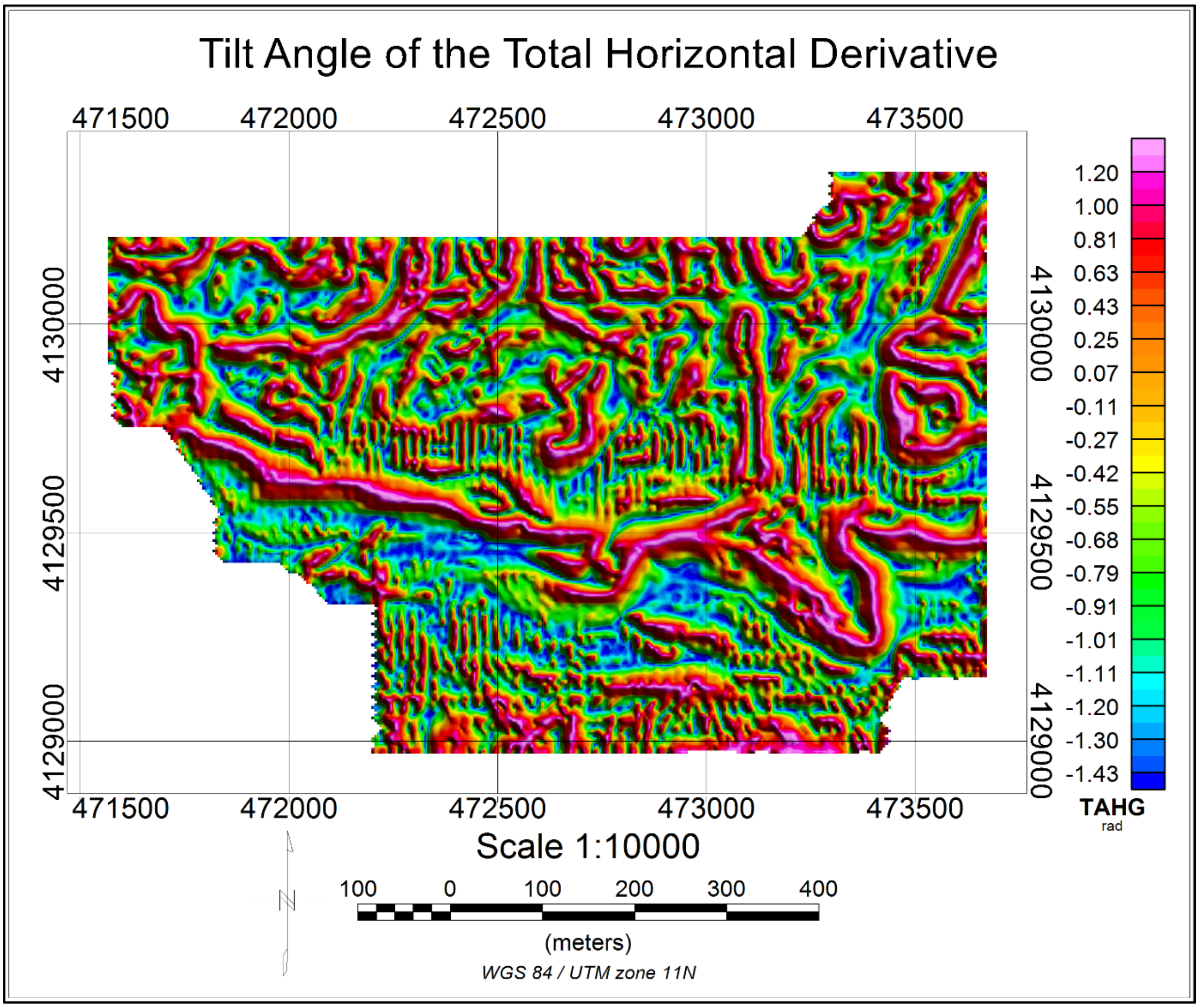

Figure 5-13: Map of the Tilt Angle of the Total Horizontal Derivative (TAHG).

6 INTERPRETATION

As previously mentioned, the processed data was preliminarily integrated in a three-dimensional digital model (Leapfrog Geo software) with previous seismic survey sections to provide a reference geological interpretation in a 1:10,000 scale (Figure 6-1 to Figure 6-6). The 3D model objective was to visualize the spatial distribution of the gravel and mudstone units, and its probable outcrop domains. No detailed 3-D modelling was conducted to model the faults indicated by seismic surveys which is desirable for more accurate interpretation but would require another service order/contract.

Major contacts and structures that are indicated as lines in the following figures, were also exported in shapefile format to be handled or visualized in other software. These lines were interpreted in a 1:10,000 scale, with no intention of 100% accuracy as closed polygons. Is strongly recommended that this information must be integrated with mapping information (not available for Avant GeoSurveys) for final interpretation and map construction.

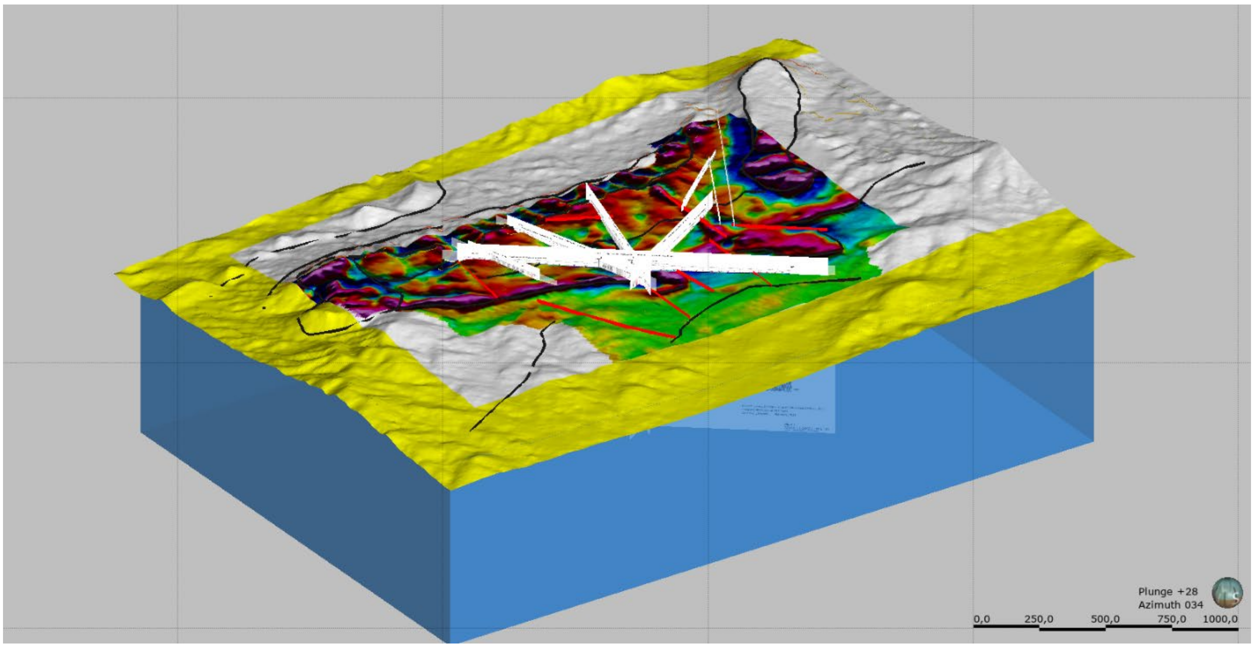

Figure 6-1: 3D Geologic Model Visualization (with seismic) – seismic survey sections in white.

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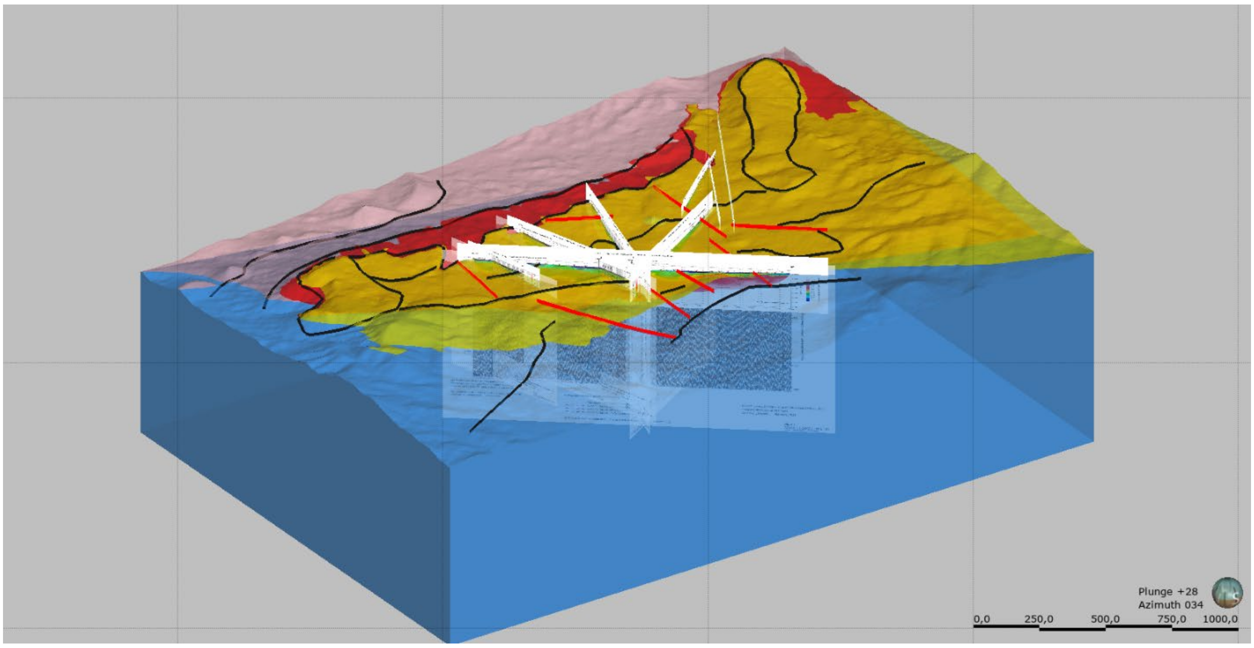

Figure 6-2: 3D Geologic Model Visualization – without topography and seismic survey sections are shown in white. Wyman Formation in blue, Ash layer in yellow and rhyolite in pink. The "gravel+mudstone" unit indicated in red.

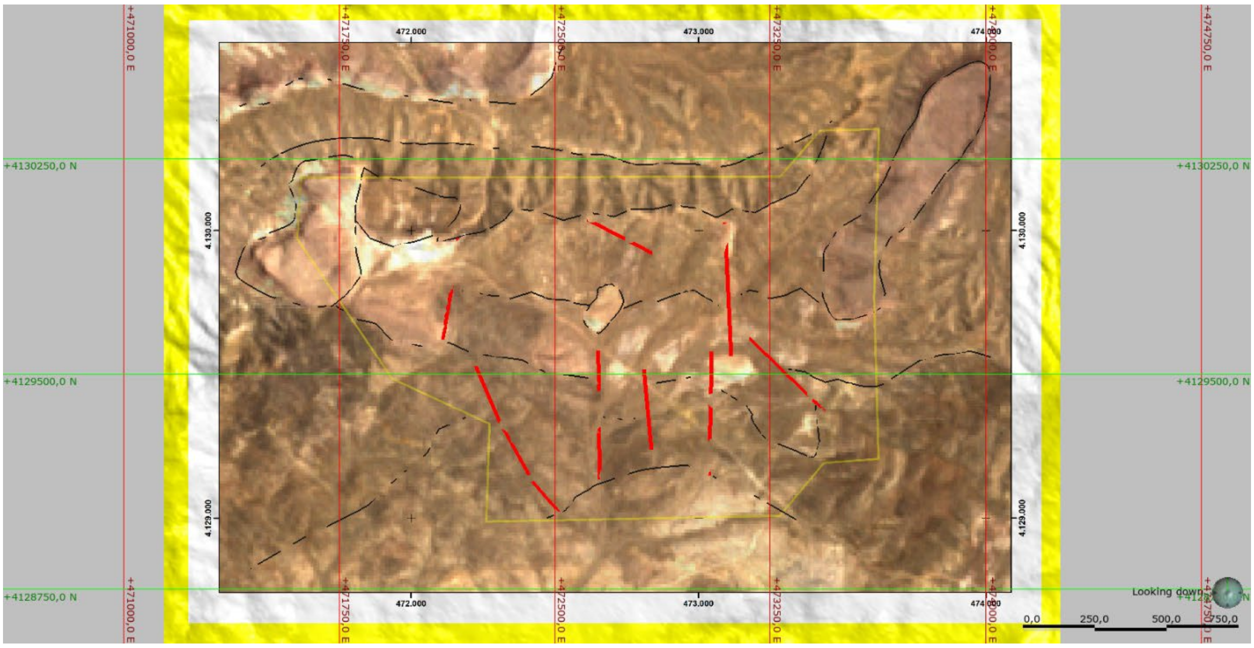

Figure 6-3: Interpreted Geologic Contacts – contacts are in black lines and structures are in red lines over "TRUECOLOR MAP".

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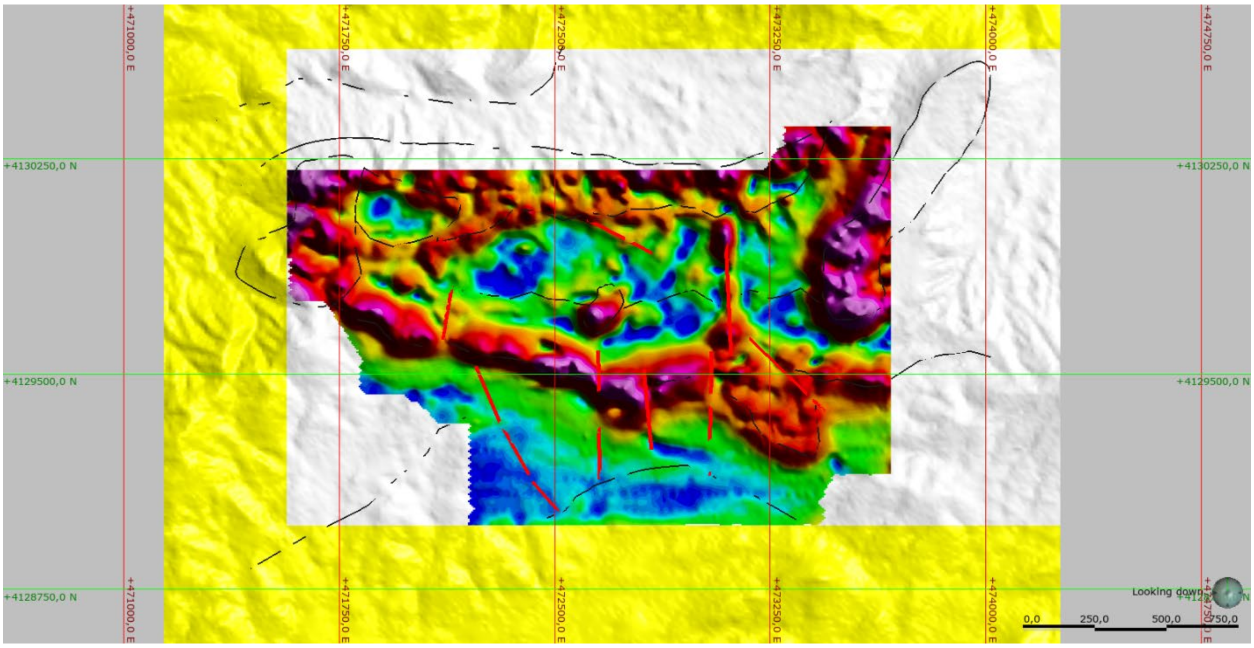

Figure 6-4: Interpreted Geologic Contacts (AS mag map) – contacts (black lines) and structures (red lines) over the AS map.

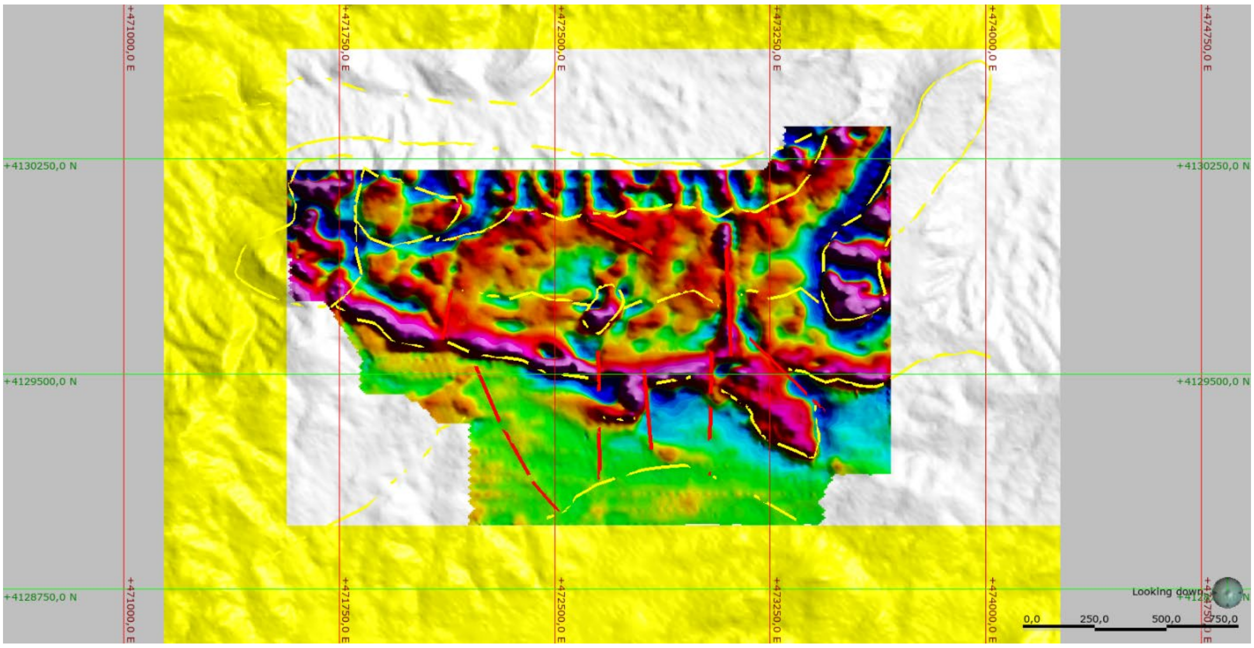

Figure 6-5: Interpreted Geologic Contacts (1VD mag map) – contacts (yellow lines) and structures (red lines) over the 1VD map.

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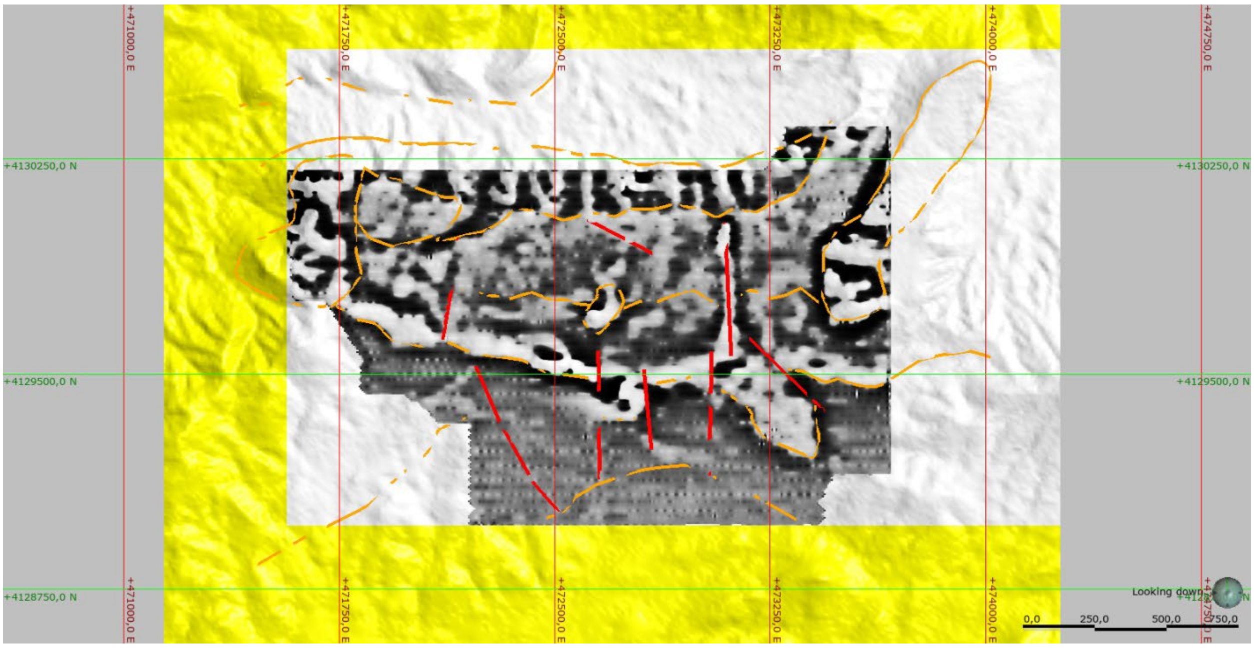

Figure 6-6: Interpreted Geologic Contacts (2VD mag map) – contacts (orange lines) and structures (red lines) over the 2VD map.

7 CONCLUSIONS AND RECOMMENDATIONS

In general terms, the method of magnetometry with drones proved to be effective in the study area. The results allow the delimitation of the main domains and magnetic structures. It is recommended to use the Google Earth free software for the interpretation of structures and magnetic domains. Many processed products and map combinations are available. Choose a set of maps that best fits your geologic interpretation. From the list of maps, one or two will form the main interpretation image and the others will be used to check your line work and positioning of the magnetic bodies. One suggestion is to display two images and making the top layer semi-transparent, as example: the RTP2VD_NL (30% transparent) above the RTP_image as below (Figure 7-1).

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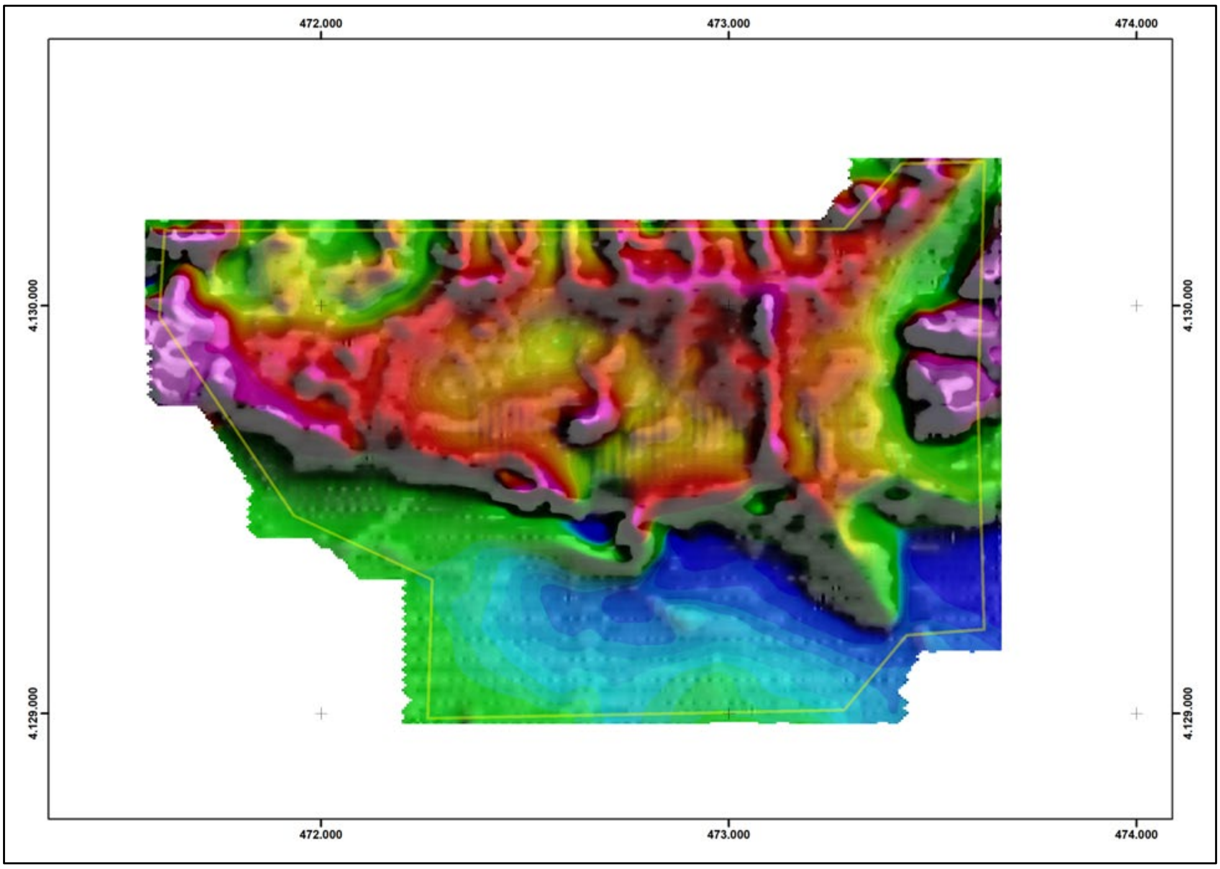

Figure 7-1: Combined images for geological interpretation (2VD with transparency over RTP)

The exposed gravels at the north end of the project area have several magnetic highs that should be drill tested to determine the mineral potential. The methods and filters applied individually to highlight the anomalous source can be used together, considering that each procedure has its mathematical proposition, best solution and resolution. However, when used together in the spatial analysis of the anomaly, they highlight the aspects most inherent to the magnetic anomaly. Such a perspective thus generates greater reliability in the interpretation. Field checking of the identified magnetic domains and the integration of mapping points with the results are indicated for an adequate magnetic interpretation and to associate the pattern of anomalies observed with geological units, lithotypes, contacts and structures.

The results show lateral coherence, in a different direction from the lines of flight, and for this reason the structuring observed in the maps (i.e. AS, 1DV) are

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interpreted as representing subtle variations in the susceptibility of local lithologies. In cases of uncertainty, it is suggested to schedule a meeting to clarify questions and interpret the geological context of the project, thus allowing a better delimitation of the main magnetic domains, interpretation of structures, based on the products generated from the respective magnetic aerial survey and its maps. The Deliverables folder has the following structure (Figure 7-2).

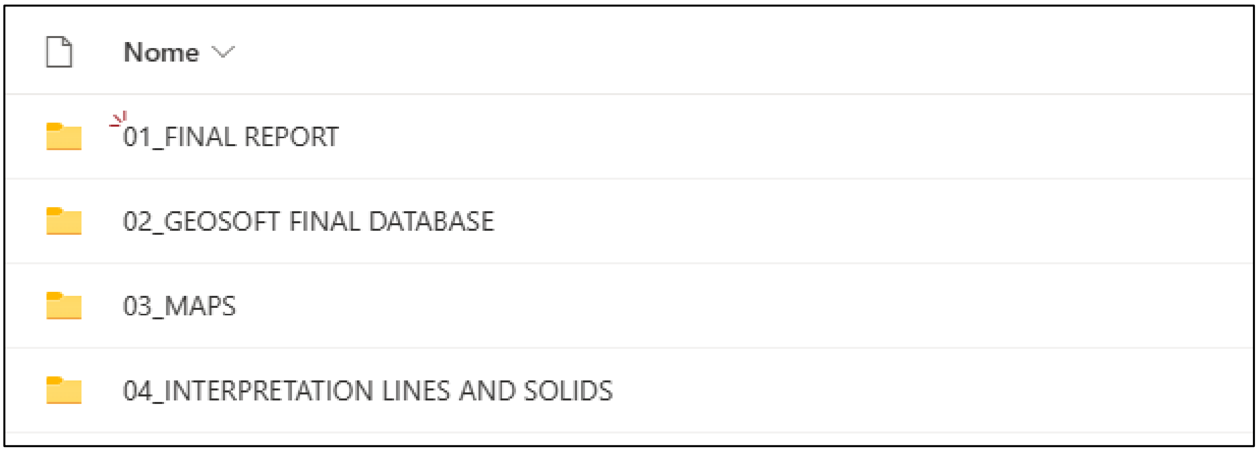

Figure 7-2: Deliverables Folder structure.

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8 TECHNICAL TEAM

The following professionals participated in the team for this project:

Table 8.1: Technical team

Geol. Randall Childers	Acquisition Manager
Eng. Marcio Cisnaldo	Data processing
Geol. Henrique Bylaardt	Technical Manager
Geoph. Leonardo Nascimento	Data processing
Geol. Daniel Ferreira Mariano	Technical Director

We thank you in advance for this opportunity and would like to establish a business relationship with ADVANCED GEOLOGIC EXPLORATION for future work. We are at your disposal for any clarification that may be necessary.

Best regards,

Randall Childers

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9 APPENDIX I – EQUIPMENT SPECS

Table 9.1 shows the main equipment used during data acquisition.

Table 9.1: Equipment specs

RPA: DJI Matrice 600 Pro	
Factory	DJI Matrice 600 Pro
GPS	*A3 Flight Controller*
Mag acquisition system: GEM GSMP 25U	
Magnetometer	GEM GSMP 25U *(Potassium Optical Pumped)*
GPS	GEM GSMP 25U
Laser Altimeter	LF-11
Base Station	GEM GSM -19T

9.1 UAV/DRONE

The DJI Matrice 600 Pro UAV is a hexacopter; it has excellent flight performance and good load capacity. Pre-installed arms and antennas reduce the time required for assembly, and the system's design makes it easy to mount additional modules. The airframe is equipped with the latest technologies, including the A3 Pro flight controller, smart batteries, and battery management system.

9.2 UAV GPS and Navigation

The navigation of the DJI Matrice 600 Pro is done by the Flight Controller A3 system, which is equipped with 3 IMUs (Inertial Measurement Units) and 3 GNSS units (Global Navigation Satellite System), with analytical redundancies, working together with advanced diagnostic algorithms, which ensures reliability and centimetric accuracy in position.

9.3 Laser Altimeter

The SF11 Laser Altimeter is part of the acquisition systems. The altimeter takes accurate distance measurements to solid surfaces up to an altitude of 120 meters and to water up to 40 meters. The SF11 works by measuring the time it takes for a very short pulse of laser light to travel to the ground and back again.

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The accuracy of the measurement is not affected by the color or texture of the ground, nor by the angle of incidence of the pulse. The SF11 is virtually immune to backlight, wind and noise, making it the ideal AGL altimeter for all types of terrain.

- Laser: GEM SF11;
- Resolution: 1 cm;
- Range: 0.2 – 120 m (natural targets), 2 – 40 m (water);
- Sampling Rate: 20 Hz;
- Accuracy: 0.7 meter (70% target reflected @ 20°C).

9.4 Magnetometer acquisition GEM GSMP-25U

The DRONEmag™ system (GSMP-25U) was developed by GEM Systems to be the first lightweight, high-sensitivity magnetometer designed specifically for RPAS. Weighing less than 1 kg, the sensor is based on GEM's well-known optically pumped potassium magnetometer, which offers high gradient sensitivity, accuracy, and resolution. The sampling rate can be adjusted to 1, 2, 5, 10 and 20 Hz. The system comes complete with 128Mb of onboard data storage suitable for long flights, laser altimeter and GPS navigation system. All acquired data are stored in the system's internal memory and subsequently transferred to field computers and processed. The data recording format on board the RPA includes the following information in Table 9.2.

9.5 Rover Magnetometer

The magnetic sensor coupled to the system is based on potassium vapor technology. The signal is received and stored in the main unit of the system.

GEM GSMP-25U

- Resolution: 0.0001 nT
- Sensitivity: 0.022 nT @ 1 Hz
- Sampling Rate: 1, 2, 5, 10 and 20 Hz

Magnetometer readings are taken every 0.1 second, which is equivalent, for the average UAV speed of 8 m/s, to approximately 0.8 meters on the ground.

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Table 9.2: Exported channels from rover magnetometer

ID	Format/Type	Description
TIME	hhmmss.s	UTC tIME
CT	nT	Total Field
L	0 ou 1	Locking Status . 0-unlocked, 1-locked
H	0 ou 1	Heater Status. 0-off, 1-on
FR	0	Field Reversal control. 0-standart, 1-reverse
uA	3.4	Lamp current
Ampl	096	Signal Amplitude
RFVDC	07.9	RF DC Lamp voltage
VHeater	14.3	Heater DC voltage
VSupply	25.6	Battery DC voltage
SensorTemp	48	Sensor Temperature
BoxTemp	42	Eletronic box temperature
Lat	043.8559518	GPS Latitude
Long	-079.3540940	GPS Longitude
utmE	0632278.64	GPS UTM Leste
utmN	4857190.49	GPS UTM Norte
Alt	00189	GPS Altitude - amsl
Sat	06	GPS Sattelite number
Zone	23K	Zone UTM
Laser	45	Laser Altimeter (m)

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9.6 Navigation and positioning system

The acquisition systems are equipped with their own GPS. Positioning information is recorded for further processing. Its accuracy is about 0.7 meters. The GPS coordinates (latitude/longitude) are stored and transferred, together with other data, to the field computer.

9.7 Terrestrial base station

For daily control of variations in the Earth's magnetic field, a portable GEM magnetometer, model Geometrics G-857, with a resolution of 0.1 nT and noise envelope at an equivalent level was used. The total magnetic field readings were taken every 10 seconds and stored in the equipment's memory.

The magnetometers were installed in a place with a smooth magnetic gradient, free from moving objects and cultural interference.

At the end of each production day, the files containing the diurnal variation data were transferred to the computers in the field bases for processing the diurnal variation, using the example of the record Figure 10-1 of the base magnetometer as a parameter.

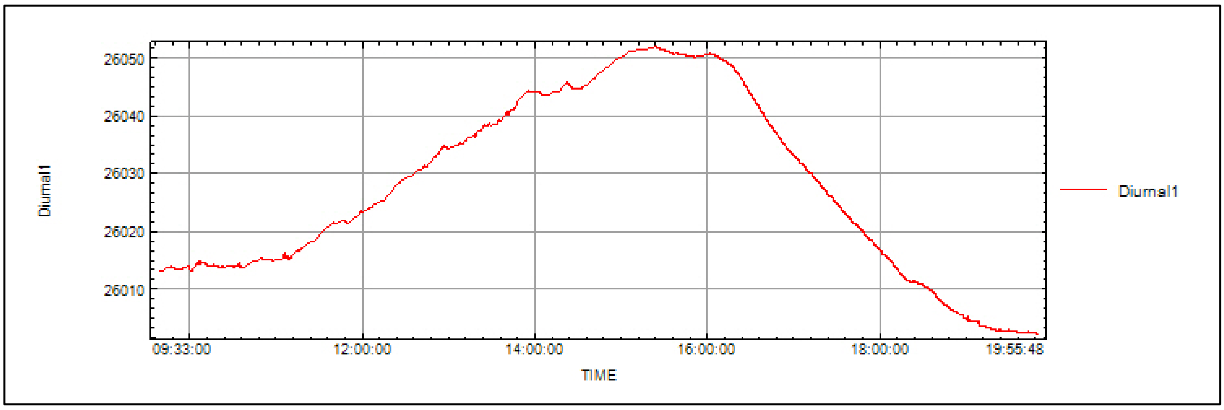

Figure 9-1: Base station record example

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10 APPENDIX II – THEORETICAL FUNDAMENTALS

10.1 Basic concepts

- The analysis of magnetometric data allows an approach beyond surface mapping, both showing outcropping geological features and defining their continuity in depth, as well as non-outcropping features.
- Magnetic susceptibility is the physical property directly related to the response of these features and directly depends on the amount and mode of distribution of magnetic minerals. The concentration of magnetic minerals produces anomalies in the Earth's magnetic field.
- The terrestrial magnetic field is derived from a potential function and shows anomalies caused by contrasts in the physical properties of rocks at depth and is used as a tool for recognizing areas with exploratory potential (Blakely, 1996).
- This magnetic field is dipolar and behaves like a magnetic bar located in the Earth's core, with the north pole located in the Arctic and the south pole in Antarctica.
- The Earth's geomagnetic field is composed of three essential components (Telford et al. 1990):
  - Component due to the main field: responsible for 99% of the magnetic field intensity measured at the Earth's surface. It is related to the convection currents of conductive material circulating in the liquid outer core, between 2,800 and 5,000 km, probably composed of a combination of nickel and iron, which are excellent conductors;
  - Component due to the external field: small portion of the geomagnetic field associated with electric currents in the ionized layers of the upper atmosphere. It is the result of diurnal variations of the magnetic field and magnetic storms and varies rapidly, whose nature is partly cyclic and random;
  - Component due to local variations of the main field: it has much lower intensity than the main magnetic field, being relatively constant in time and space. It results from the variation in the content of magnetic minerals in rocks close to the Earth's surface, with sometimes strong intensity, but with restricted spatial distribution. They represent the main magnetic targets.

In the magnetic-structural interpretation, where the main investigated features are faults, the registered anomalies are related to magnetic susceptibility contrasts. Such a contrast may be linked to the formation of magnetic minerals in the fault planes, or even to the susceptibility contrast of the geological materials separated by the structures.

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10.2 Processing routines

The processing of magnetic data aims to design the structural framework of the study area through the application of different enhancement methods. The maps derived from the application of magnetic anomaly enhancement methods form the basis for qualitative interpretation. The definition of structural-magnetic trends can be outlined based on those methods, which are indicated below: horizontal gradients (Gx, Gy derivatives - Cordell & Grauch 1985) and vertical gradient (Gz derivative – Evjen 1936), amplitude (GHT) and slope (IGHT) of the total horizontal gradient (Cordell & Grauch 1985; Cooper & Cowan, 2006), amplitude of the total horizontal gradient enhanced (Fedi & Florio 2001), amplitude (ASA) and slope (ISA) of the analytical signal (Nabighian 1972 ; Roest et al. 1992; Miller & Singh 1994), total horizontal gradient of analytical signal slope (GHT-ISA - Verduzco et al., 2004), Theta map (Wijns et al. 2005), analytical signal slope of gradient total horizontal (ISA-GHT) – Ferreira et. al., 2013.

Such techniques were applied to the aerial data in correspondence with the increment of the derivation order, in the sense of attenuating the noises and verifying the persistence of the structures in depth, whose result should be a map of the magnetic-structural framework of the study area. The main semiquantitative method used was the Signum Transform of degrees one and two (Souza & Ferreira, 2012, 2013; Oliveira et al., 2015). Among the calculated variables, we highlight the declination and inclination of the local geomagnetic field on the date of the survey, whose data are necessary for carrying out the reduction to the pole. Figure 10-1 shows the equations corresponding to each method and their geometric relationships.

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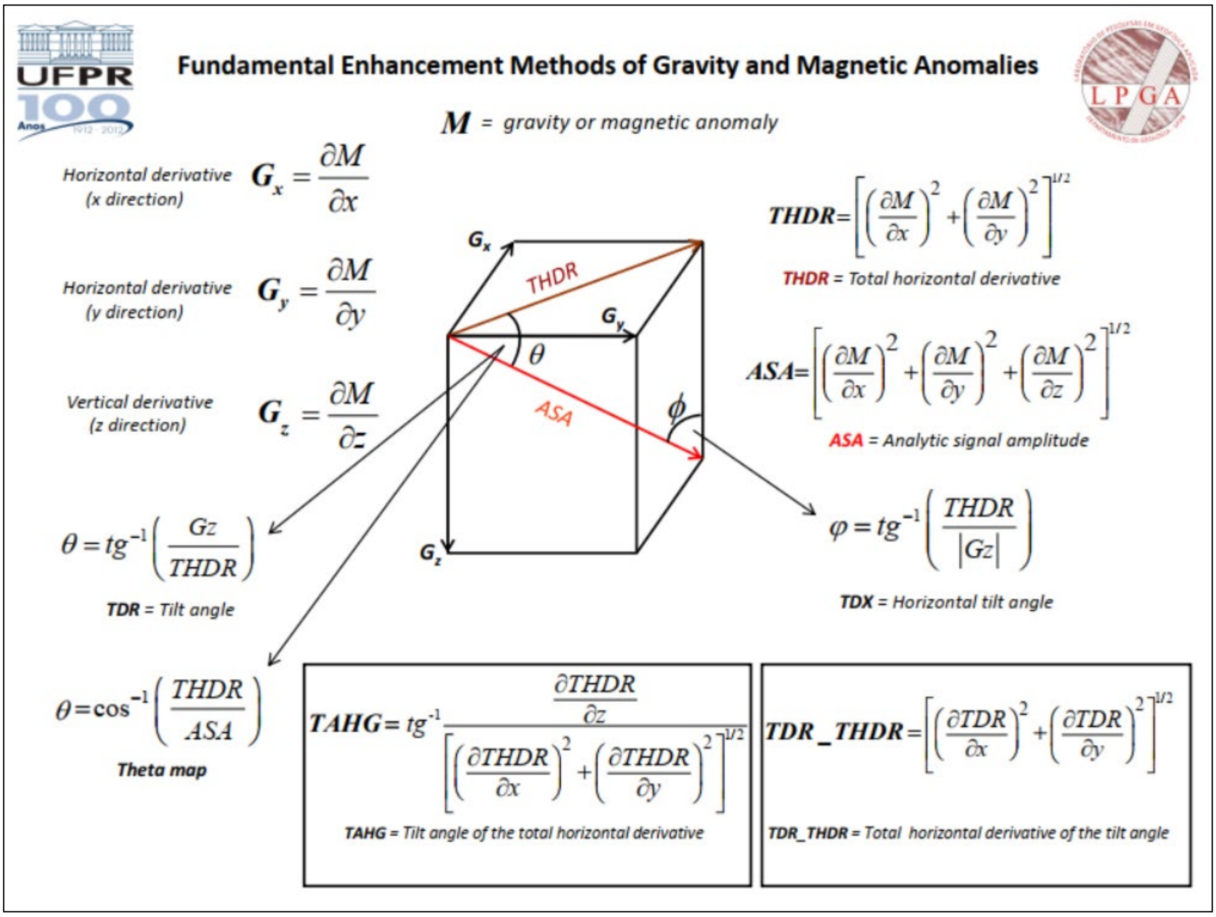

Figure 10-1: Methods for magnetic data processing (Source:LPGA/UFPR).

11 APPENDIX III – DATA PRE-PROCESSING

In the pre-processing of project data, the Oasis Montaj Geosoft software (version 9.10) was used, which allows the import of ASCII data collected directly from the GSMP-25U acquisition system. The preprocessing flowchart used for the survey as follow: acquisition, Geosoft import, line cutting, spike removals and QA/QC procedures, cultural artifacts anomalies removal, diurnal variation removal/correction and levelling. More details are provided in the next paragraphs.

11.1 Database preparation

The raw data recorded in ASCII format (.txt) in the acquisition systems are converted to XYZ format and imported by Geosoft, into the flight database

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(.gdb). Positioning information, total field strength, height, and flight altitude, etc. are grouped, and then line cuts and data quality control begin.

11.2 Noise removal

The magnetic field measured by the magnetometer is usually accompanied by noise. Noise is any unwanted signal that interferes with the local magnetic field. When the noise is very intense, it can impair the reading and/or interpretation of the magnetic signal. Cultural noises are unwanted signals caused by human activity. They can originate from large metallic objects such as railways, metallic fences, houses, sheds, industries, transmission lines, nearby cities, etc. The elimination of this noise is usually done by analysing the profile, identifying, and removing the section with noise and interpolation of the data. Noise identification is done by comparing the satellite imagery obtained by AVANT before the survey or by Google Earth images, and observation by field staff during the survey in relation to the Stacked Profiles of the Anomalous Magnetic Field.

11.3 Diurnal correction

The values obtained by the monitor magnetometer were initially subtracted from the magnetic field readings taken on board the aircraft, having the sampling time as a common variable, fixed with a precision of tenths of a second. The differences found, positive or negative, were then algebraically added to the mean of the diurnal channel in the database. The resulting values correspond to the total intensity of the magnetic field corrected for diurnal variation.

11.4 Levelling

The application of levelling through the Oasis Montaj Geosoft software basically consists of adjusting the control lines based on the average of the differences (or 1st order difference) with the flight lines. This procedure assumes that such differences are randomly distributed, so that a trend of at most 1st order defines the gap between the flight and control lines. The procedure comprises two distinct steps, namely:

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1° - The control lines are levelled by applying values that reduce the differences with the flight lines to minimum values. This procedure assumes that there are enough crossings to adequately model the level differences between the control lines.
2° - After levelling the control lines, all flight lines are adjusted to the control lines, so that the magnetic field values found at their intersections are equivalent. This procedure is conducted by the command XLEVEL.GX. These values are stored in the database and used in the calculation of corrections to be applied to the flight lines. Crosses where the magnetic gradient exceeded 2 nT/fiducial (0.025 nT/m) were discarded by the program. Based on this gradient, the program also analysed the intersections for their applicability, assigning lower weight the higher the gradient. Thus, an intersection located in a zone of strong magnetic gradient had little or no influence on the levelling. Oasis Montaj Geosoft also allows the visual examination of the Intersection Table, allowing its manual editing when necessary. For example, the level line can be compared to its version obtained at different stages of the process.

11.5 Final data base files

The final files of the survey profiles were saved in AVANT's Google Drive in ASCII files, in XYZ format and in a database in ". gdb" (GEOSOFT), as well as this report in PDF format (Adobe Acrobat).

12 APPENDIX IV – DATA PROCESSING

12.1 Total Magnetic Intensity

The TMI channel constant in the Geosoft Data Base (GDB) was interpolated in the form of a regular mesh with 6.25m, which represents 1/4 of the spacing between the flight lines, resulting in the map of the anomalous magnetic field or TMI – Total Magnetic Intensity of the study area, which constitute the database for the application of subsequent enhancement techniques. After the generation of this first product, processing followed two main fronts: qualitative processing and

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semi-quantitative processing. The products resulting from the application of qualitative processing through enhancement methods aim to facilitate the interpretation of geophysical data according to the characteristic of interest, such as the detection of axes or edges of magnetic bodies, in this case related to structures and possible magnetic sources. Signum Transform's semi-quantitative processing attempts to classify the presence or absence of magnetic minerals.

12.2 Analytical Signal

The Analytical Signal (AS) is one of the most important enhancement techniques for positioning anomalies directly over magnetic sources and has been known since the work of Nabighian (1972). This product is elaborated from the anomalous magnetic field and integrates a function of the partial derivatives in the x, y, z directions squared, and its root extracted, which is why the values are expressed in nT/m and will always be positive. Another consequence of this filter is the more pronounced visualization of shallow sources when applied directly over the CMA (Figure 5-2) and its corresponding stacked profile. The absolute values of ASA also confirm what has already been pointed out for the magnetic field, that is, low magnetic susceptibilities of the lithological bodies, especially in the central and southwest portion of the area.

12.3 Reduction to pole

The qualitative processing started with the application of the reduction to pole filter (RTP - BARANOV 1957; GRANT & DODDS 1972, MACLEOD et al. 1993), followed by the application of the anomaly enhancement methods. Reduction to the pole (RTP) is a processing technique that recalculates the total magnetic field data as if the induced magnetic field acted with a 90° inclination and zero declination. RTP transforms dipole magnetic anomalies into monopolar anomalies centered on their generating bodies, which can simplify data interpretation (Figure 12-1). RTP makes the simple association that the rocks in the research area are all magnetized parallel to the Earth's magnetic field, that is, at the pole and considering that they have not undergone remanence.

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The RTP filter has the property of locating the anomalies on the magnetic sources that cause them, regardless of the latitude and longitude of the magnetic inclination and declination at the location. However, some studies show that there are instabilities for this filter at low latitudes (- 20o to +20o) (LI, 2008). The objective of the filter is to eliminate the dipolar character of the anomalies (positive and negative pairs) so that the result is equivalent to the signal registered in the magnetic pole (SPECTOR & GRANT, 1970). Even with the reduction to the pole the anomalies continue to present bipolarity, this means that they present remanence.

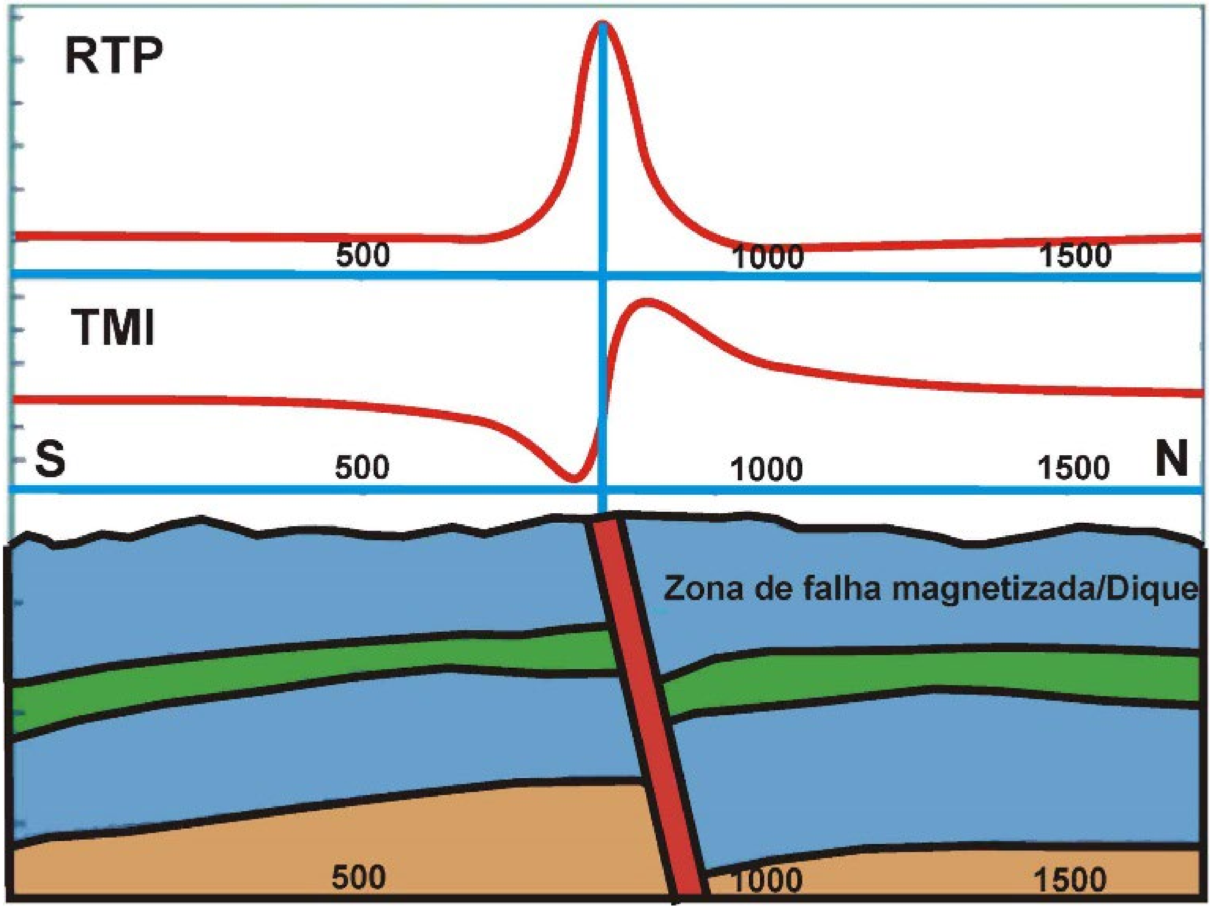

Figure 12-1: Effect of RTP on an anomaly (TMI) from a magnetized fault zone.

Source: The University of Oklahoma.

The derivation of other enhancement techniques from the CMA-RTP allows the visualization of specific features for each filter, trying to optimize as much as possible the costly magnetometric acquisition survey. Therefore, the processing

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of the filters to be presented in the sequence may reflect one or more features that may be correlated with the geology and consequently a better use in its final interpretation.

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