Metal Earth Project

Geophysics Survey Report

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Prepared by:

Amir Maleki

William Mcneice

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1. Introduction

Metal Earth is a seven-year study to determine how mineralized areas differ from those that are not mineralized and to better understand mineral endowment in Precambrian Era rocks. As the rocks in mineralized vs poorly mineralized greenstones are similar, any differences must lie in the mid to lower crust. To better understand this problem, transects perpendicular to strike were developed, along which Metal Earth is doing reflection seismic, magnetotellurics and supporting geology and geophysics. Included in the supporting geophysics is measurement of gravity data and magnetic susceptibility data. This report summarizes gravity data and physical rock properties data acquisition across the Rouyn-Noranda, Amos-Malartic and Chibougamau Transects as part of the Metal Earth project. Gravity data acquisition in the project includes data collection, QA/QC, initial field processing and liaising with the coordinator. In conjunction, magnetic susceptibility data and rock samples for density measurements were taken on outcrops along the transects. These rock properties will be used to shed light on the surficial magnetics of the regions and compare them to total magnetic signatures (magnetic susceptibility) and to associate outcrops with lithologies and augment and assist the gravity modelling (density). The acquired gravity and rock property data will be integrated with seismic and magnetotelluric models to provide concise and reliable models of the subsurface.

2. Data Acquisition

Gravity

The Metal Earth project contains total of 14 transects, three of which have been acquired during this data acquisition phase, namely Rouyn-Noranda (~93 line km), Amos-Malartic (~88 line km), and Chibougamau (~128 line km). A total of 1066 observations were acquired along the above three measured gravity transects from 23rd of June to 25th of August 2017.

The average spacing between observations is ~300m. The stations were mostly chosen alongside roads or within walking distance of roads. However, where the acquired data values appeared angular on plotted profiles, with sharp changes, infill data with 150 m spacing from adjacent stations were selected and additional data was acquired. Also, in order to have data on small traverses perpendicular to the main transect, three side road measurements with 300 m station spacing, for a total side traverse length of 900 m total were acquired when side road access allowed.

All gravity readings were taken using two geophysics crews equipped with two Scintrex CG6 gravity meter instruments. Seven new base stations (control points) were established at strategic locations (three of them for the Rouyn-Noranda transect, two for the Chibougamau transect, and two for the Malartic transect). The control point values were refined by tying them to existing base stations at the first day of data collection for each area.

In order to compare two CG-6 measurements with each other, ten percent of the total number of daily measurements by both devices were designed to be measured by both devices. Also, in order to evaluate the accuracy of measured data by each device during the day, one station designed for each crew to be measured at the beginning, middle, and at the end of the cycle every day.

During the field period, readings were taken at control points at the start and end of each day. Each of these readings was taken over a 60 second measurement period, and the readings were repeated at least five times for every occupation. At all other stations, gravity was measured for 30 seconds and these readings were also repeated at least five times for each station and the average measured values was recorded for the station. Figures 1 to 3 shows the location of the measured stations throughout each of the three acquired areas.

Global Navigation Satellite System (GNSS) data (GPS, GLONASS, etc.) were acquired using a Juniper Systems Geode handheld device. Data from each unit was downloaded to a laptop every evening, along with data from a nearby GPS base station, which was processed using EZSurv post-processing differential correction software. The output from this software was an ASCII file containing station numbers, eastings, northings, heights and the respective errors. The final data is stored in the Geographic Coordinate System (Datum) of NAD83 – Canadian Spatial Reference System (Zone 17N, 18N).

Physical Rock Properties

Magnetic Susceptibility and samples for density measurements were collected when an outcrop was within 60 m of a gravity measurement. The coordinates of this data was only needed to this accuracy because the aeromagnetic data is being compared to only responds to an area that spans approximately 60m. In this case, the team collecting the data would split up. One member would tend to the CG6 data collection while the other would go collect a rock sample and magnetic susceptibility on the outcrop.

To collect magnetic susceptibility, a preferably fresh and flat surface with at least the same area as the device sensor (circular area approximately 6 cm in diameter) is required. Once this is found, a reading can be taken, starting with a free air calibration by pressing the record button. Once the first beep confirms the first reading, the sensor can be placed flush with the fresh, flat surface and the button can be pressed again. After the second beep, the device should be lifted back into the free air to collect one more measurement. These two free air readings before and after the actual outcrop reading provide a baseline for the actual measurement to be related to. After the final beep, the measurement can be saved.

This process was repeated 10 times at different location on each outcrop or lithology. These 10 readings were taken to represent the rock materials and any geologic features running through them. For example, if the rock in question had quartz veins running through it and a dyke, readings would be taken on each of these features and on the host rock. Once 10 readings were taken, a voice note would be saved denoting the gravity station it relates to.


Gravity Measured Stations _ Rouyn-Noranda
N
W
E
S
Legend
Gravity Measured Stations
0 1.75 3.5 7 10.5 14
Kilometers

Figure 1 - The location of the measured stations across the Rouyn-Noranda transect.

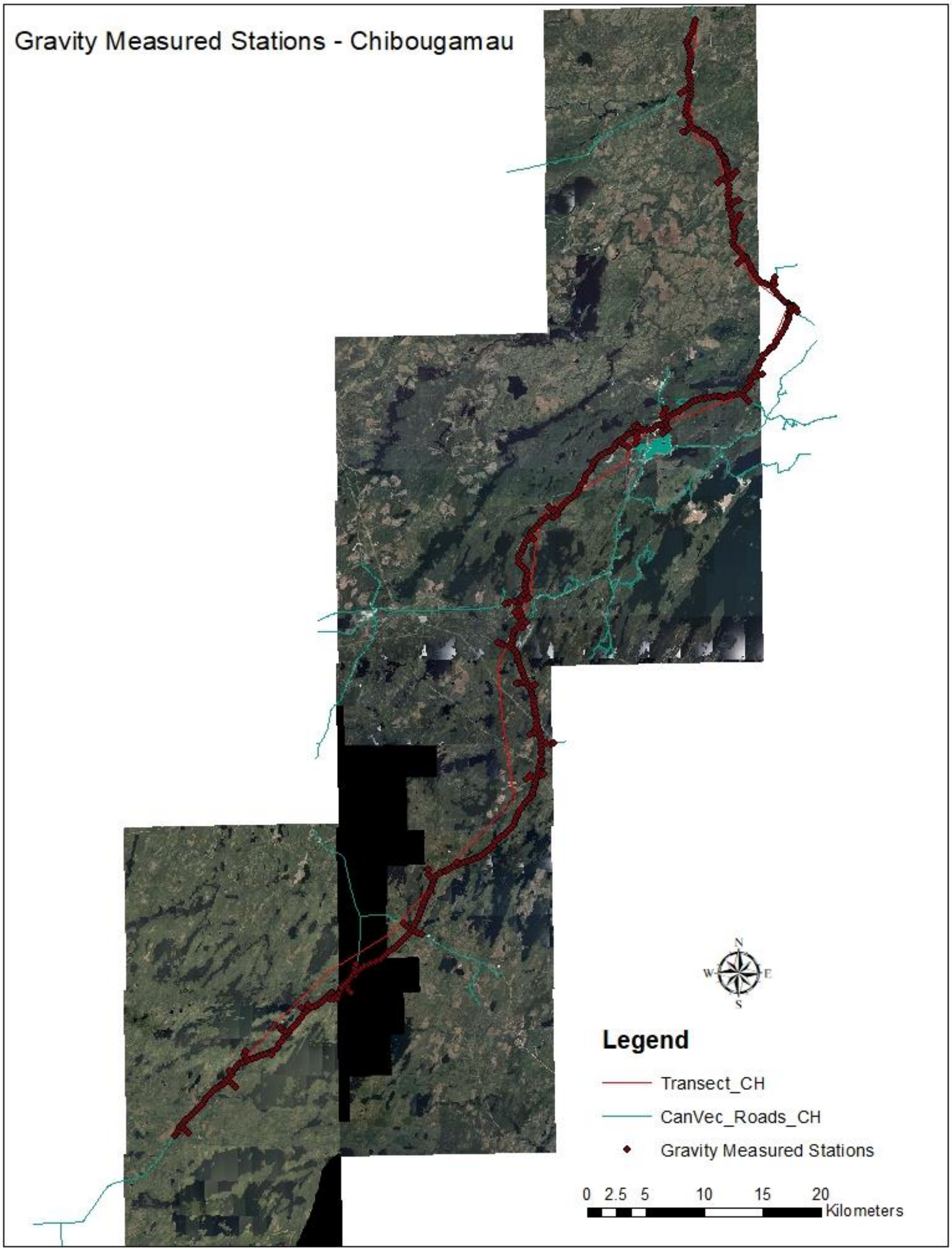

Figure 2 - The location of the measured stations across the Chibougamau transect.

Figure 3 - The location of the measured stations across the Malartic transect.

3. Gravity Data Processing

The first step in field processing of the gravity data was to check for drift errors. Drift has been defined as the difference between the readings at the control points at the start and end of the day. These drifts were interpolated to the time that data was acquired at each station and used to correct for the drift of the instrument at that station.

The positional data from the differential GPS processing was then associated with each gravity reading. Therefore, each record consisted of station number, easting, northing, height and difference from the gravity at the base station.

The CG6 gravity meter uses the position and time from an internal GPS system to calculate an earth-tide correction. Subsequent field processing of the gravity data at each station involved the following:

- Calculate the observed gravity (G_{obs}) (mGal).

  $$G_{obs} = G_{base} + \textit{difference from base}$$

- Calculate the theoretical gravity (G_{the}) (mGal) using the 1967 International Gravity Formula. λ is the latitude of the station in radians.

  $$G_{the} = 978031.846(1 + 0.005278895\sin^2\lambda + 0.000023462\sin^4\lambda)$$

- Calculate the free-air correction (FA) (mGal). This corrects for the height of the station above the ellipsoid/geoid, and is equal to a reduction of 0.3086 mGal per metre. In this equation, *h* is the station's height above the geoid in metres.

  $$FA = -0.3086h$$

- Calculate the Bouguer correction (BC). This corrects for the mass between the station and the ellipsoid/geoid. In this equation ρ is the density of rocks between the station and the ellipsoid. The usual value of 2.67 $t.m^{-3}$ was adopted.

  $$BC = 0.04191\rho h$$

- Lastly, the spreadsheet calculates the Bouguer Anomaly (BA). In this equation the terrian correction *TC* is zero, as this has not yet been calculated.

  $$BA = G_{obs} - FA - BC + TC - G_{theo}$$

4. Summary:

In the gravity data acquisition, a total of 1066 gravity observations have been acquired, controlled and the Bouguer Anomaly has been calculated to compile an initial database. Further steps include terrain corrections to generate the complete Bouguer Anomaly and then 2D and possibly 3D modelling integrated with magnetic data, as well as seismic and magnetotelluric models. The geophysics crew also collected 166 sets of 10 magnetic susceptibility readings and 140 samples from outcrops along the 3 transects. This data will be augmented by magnetic susceptibility and rock sample data collected by the geology crews working in each transect, excluding the Chibougamau transect. The data from the geology crews will be important in Malartic because there were only 10 outcrops along the main transect road.