Extracting Regional Structural Features from Airborne Geophysical Data in the TREK Project Area, Central British Columbia

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INTRODUCTION

Regions covered by glacial till and vegetation are always challenging regions in which to confidently identify structural features, such as in the northern Interior Plateau/Nechako region of central British Columbia. One method to identify structures is by interpreting regional geophysical data by applying methods for detecting the edges of magnetic anomalies. This method has been widely regarded as an effective tool in structural studies (Li, 2013). Many derivative layers of the magnetic data such as analytical signal, vertical derivative, total horizontal derivative and tilt derivative (Ferreira et al., 2011; Verduzco et al., 2004) can be considered. In this research a multiscale enhanced edge detection method (worm's model) is used to identify lineaments and extract favourable information on the dip of structural features. The approach is based on upward continued levels (UCL), to which total horizontal derivative (THD) is applied. The tilt derivative (TDR) is then used to extract deep structures. This project aims to identify and to add value to deep structural information and, ultimately, to understanding structural constraints on mineralization.

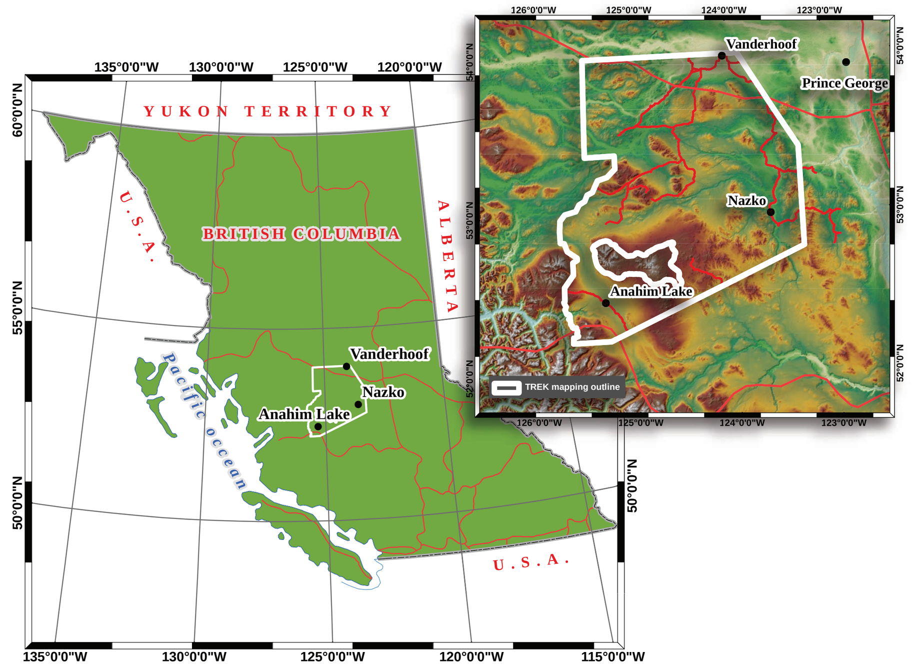


Figure 1: Location of the area of interest (AOI) on the map of British Columbia

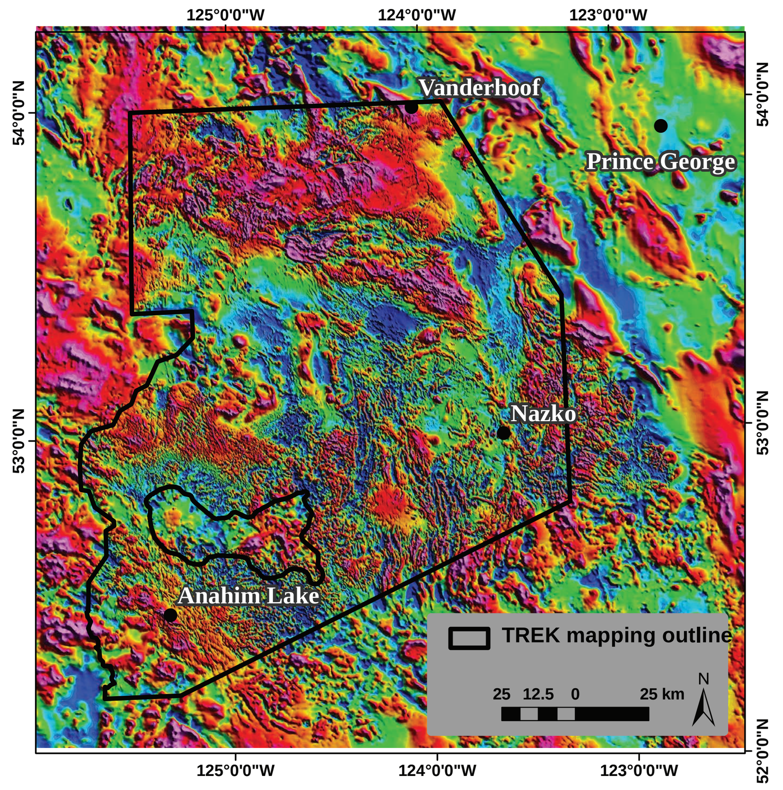


Figure 2 : Total Magnetic Field Intensity (TMI) map and TREK mapping project outline

OVERVIEW OF DATASETS

The avaiable datasets in the area include total magnetic grid file of Geoscience BC TREK area (2014) which combines high resolution, helicopter-borne magnetic data in the TREK project area from RJK Explorations Ltd. (RJK) and Deveron (Greencastle) Resources Ltd.

The magnetic surveys total 1584 line-km and 1450 line-km, respectively, and each were flown using 100 m line spacing.

The RJK data was flown by Fugro as Job 10071 from 19 December 2010 to 11 January 2011. The RJK survey comprises approximately 1584 km in total over two survey blocks. The Deveron data was flown by Fugro as job 10059 from 21 October to 27 October 2010. The Deveron data comprises approximately 1450 km of data collected as one survey block. Both surveys had an average sensor height of 48 m on east-west lines with an average flight line separation of 100 m and with north-south tie lines approximately every 1000 m. All data is presented in the NAD83 UTM Zone 10 datum and projection.

The remaining area was flown by Geoscience BC during the TREK data acquisition and the TREK data was flown on a designed drape surface (Geoscience BC, 2014).

APPROACH AND METHODOLOGY

Regional geophysical data is an important source of information in areas covered by glacial till and vegetation. This data support to delineate the geological framework as well as structural zones which may localize mineralization. The data have value in aiding detection of lineaments and subsurface structure (Henson et al., 2010; Bierlein et al., 2006) which are useful in exploration targeting. Deep-seated fault systems and their intersections, repeated reactivation of faults and magnetic destruction due to alteration processes are the features which can be investigated by the data.

Many edge detection filters are applied to accomplish this task including analytical signal, vertical derivative, total horizontal derivative (THD) and tilt derivative (TDR) (Ferreira et al., 2011; Ma and Li, 2012). In recent years, significant developments have been made in proven geophysical methods to interpret and visualize geophysical data. In this research multi-scale edges with an enhanced edge detection method were used to identify lineaments at different levels in magnetic data to identify major structures and finally to build the 3D architecture.

To apply the model on the data following steps were done:

- Filtering Techniques
  - To put the magnetic anomalies over the source
  - To enhance magnetic anomaly characteristics
  - To determine major crustal-local structures
  - To determine different depth information of fault systems
  - To extract all linear structures
- Processing methods and outputs
  - Multi level edge detection
  - 3D modeling of structural features
  - Ring structures and their relations with mineralization
  - Tracing the mapped structures into mineralized zones
  - Selective evaluation of alteration zones

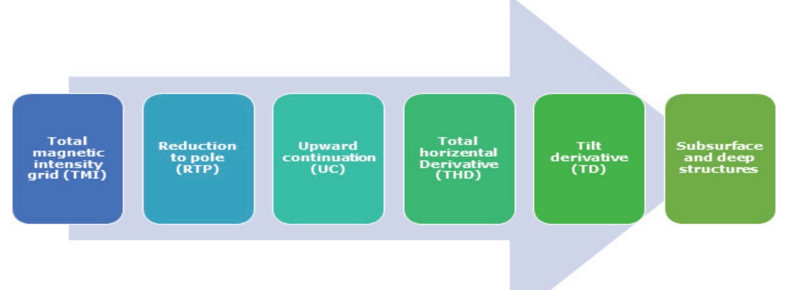


Figure 3: The steps of the edge detection method to extract linear features.

SUMMARY OF RESULTS AND DISCUSSION

A multiscale edge detection method (worm's model) has been applied to extract structural information from aeromagnetic data. The approach is based on maximum horizontal gradient in potential field anomalies which indicates a boundary between underlying units of differing geophysical properties. Progressively upward continued levels of data tend to be influenced by geological structure at increasing depth (Henson et al, 2010).

Using this method, subsurface and deep structures are mapped to provide better understanding of structural control on geology and mineralization in the Area Of Interest (AOI).

The structures identified by edge detection can be broadly grouped into three categories: NE-SW, N-S and NW-SE. The NE-SW structures are associated with late Eocene normal faulting (Anderson et al., 1998). The N-S structures are concentrated in the southern half of the AOI and have been attributed to early Eocene normal faulting (Bordet, 2014). Recent mapping has tied the NW-SE set to mid-Cretaceous compressional deformation (Angen et al., 2016).

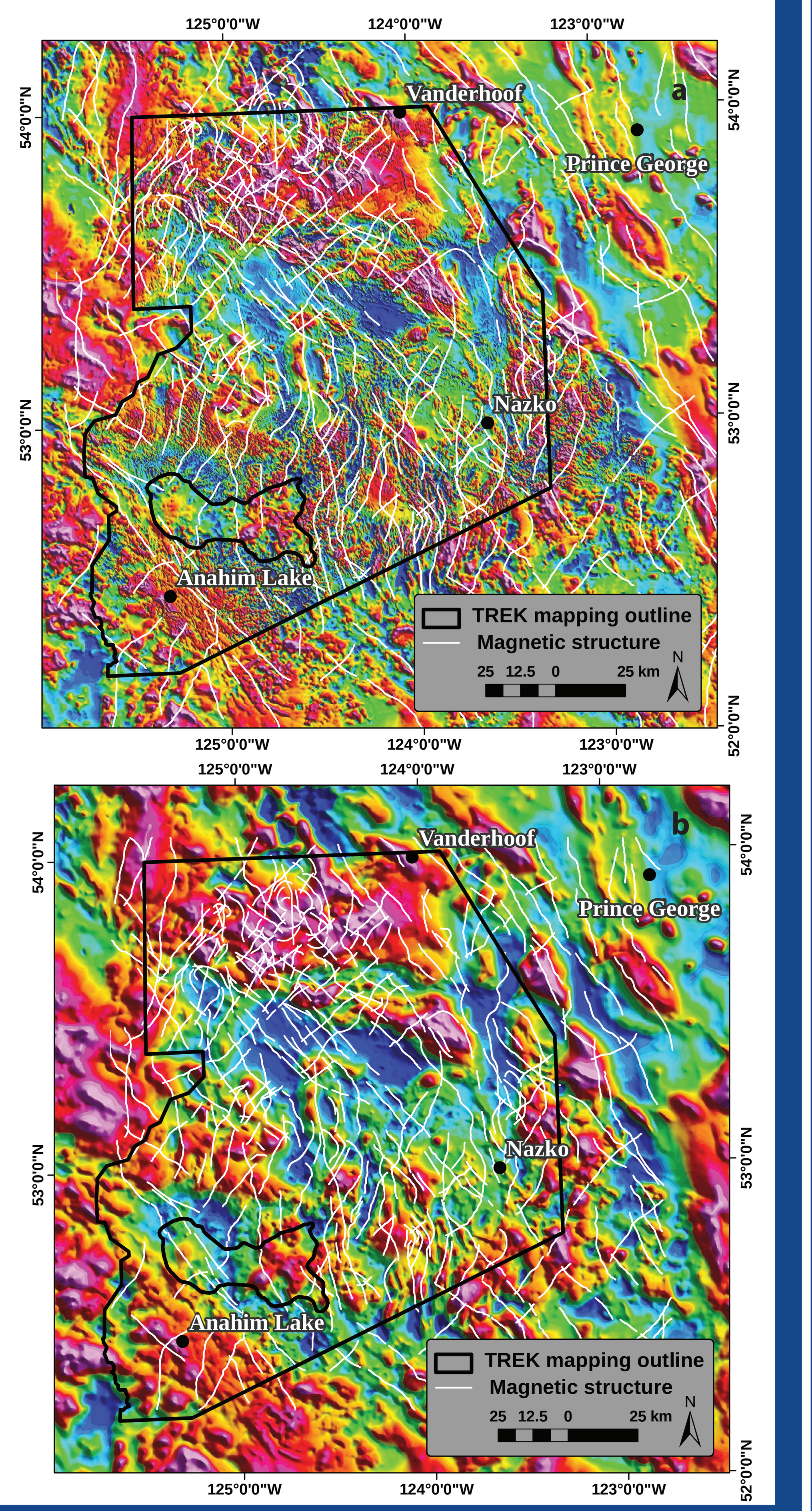
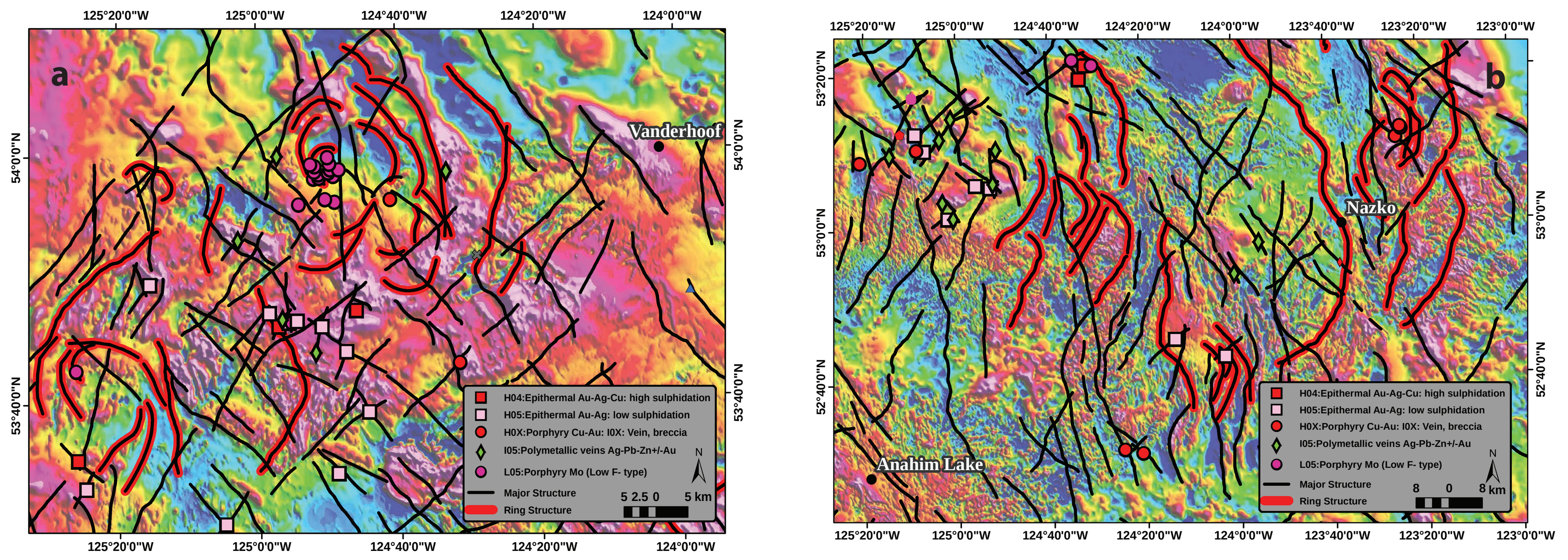
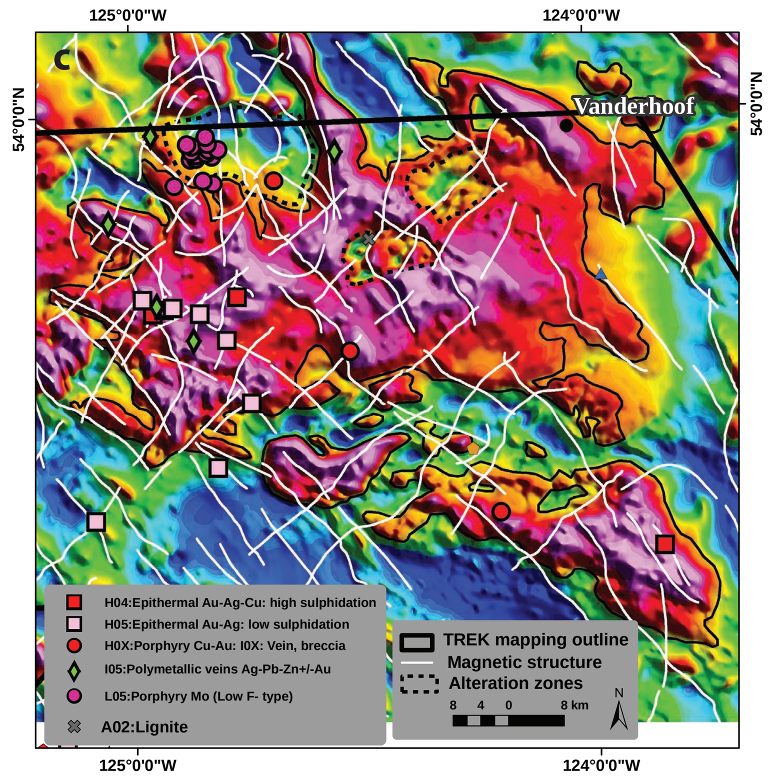


Figure 4: AOI structural lineaments extracted from geophysical magnetic data using RTP-UC-HD-TD approach over a) Reduction to pole b) Upward continuation filters.





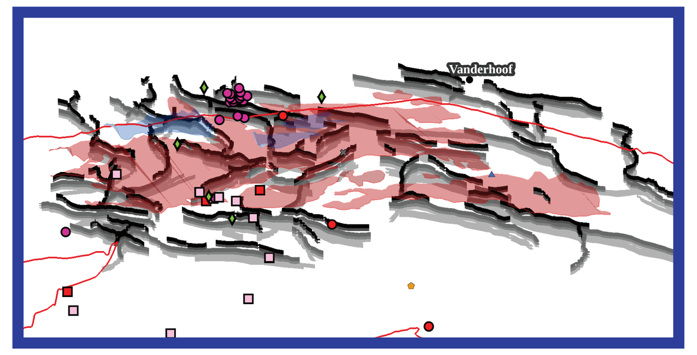


Figure 5: Extracted structure using multi edge detection approach, ring structure and location of different types of deposits mapped on RTP (a & b) and possible alteration zones in relation to major geophysically detected structures and mineral occurrences (c) and 3D structural model of target area.

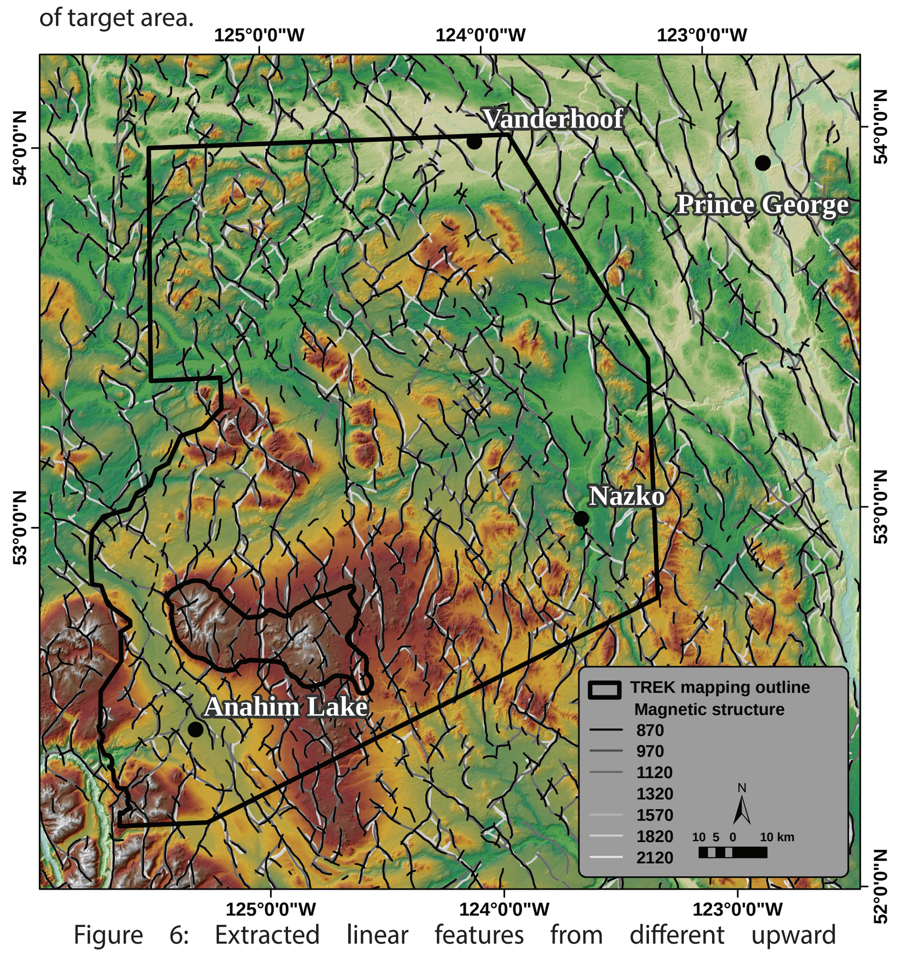


Figure 6: Extracted linear features from different upward continuations on DEM of AOI in the background.

CONCLUSION

In subsurface and deep structure studies, multiscale edges of potential field data provide a better understanding of the structural setting of the area. The mapped structures are consistent with three major trends including N-S, NE-SW and NW-SE. The intersections of these structures may be prospective for porphyry and epithermal mineralization in the area of interest which can be considered as an exploration key in unexplored areas. Ring structures and their association with subvolcanic shallow depth bodies are another exploration key to add value to database for future exploration projects in the AOI. Also, the data are a suitable for recognizing alteration zones which are prospective for porphyry and epithermal mineralization.

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