

## Curie Point Depth (CPD) and Moho analysis in Alberta in support of geothermal exploration

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### Summary

Building on the work presented at the 2024 Geoconvention (Hassan & Harms, 2024), the Curie Point Depth (CPD) analysis has been expanded to cover the entire province of Alberta (study area shown in figure 1).

The expansion of this work is in collaboration with the Alberta Geological Survey (AGS) and is paid for by the Alberta Minerals Grant as part of the Government of Alberta's Minerals Strategy and Action Plan (Alberta Energy, 2021). This plan seeks to increase the availability of public geoscience information on Alberta's emerging resources. As part of this program, between 2021 and 2024 the AGS acquired modern high-quality airborne magnetic data over the entire province outside the mountains and foothills, and localized gravity data, filling data gaps and replacing outdated data (Alberta Geological Survey, 2024). All data and publications from this program are freely available on the AGS Mineral Mapping program webpage (Alberta Geological Survey, 2025).

The study presented here is designed to estimate the CPD isotherm using the radial average power spectrum of the new aeromagnetic data. The CPD is one of the most-used regional scale geothermal prospecting tools used to assess the regional temperature of crustal rocks. The use of the power spectrum of magnetic data to estimate

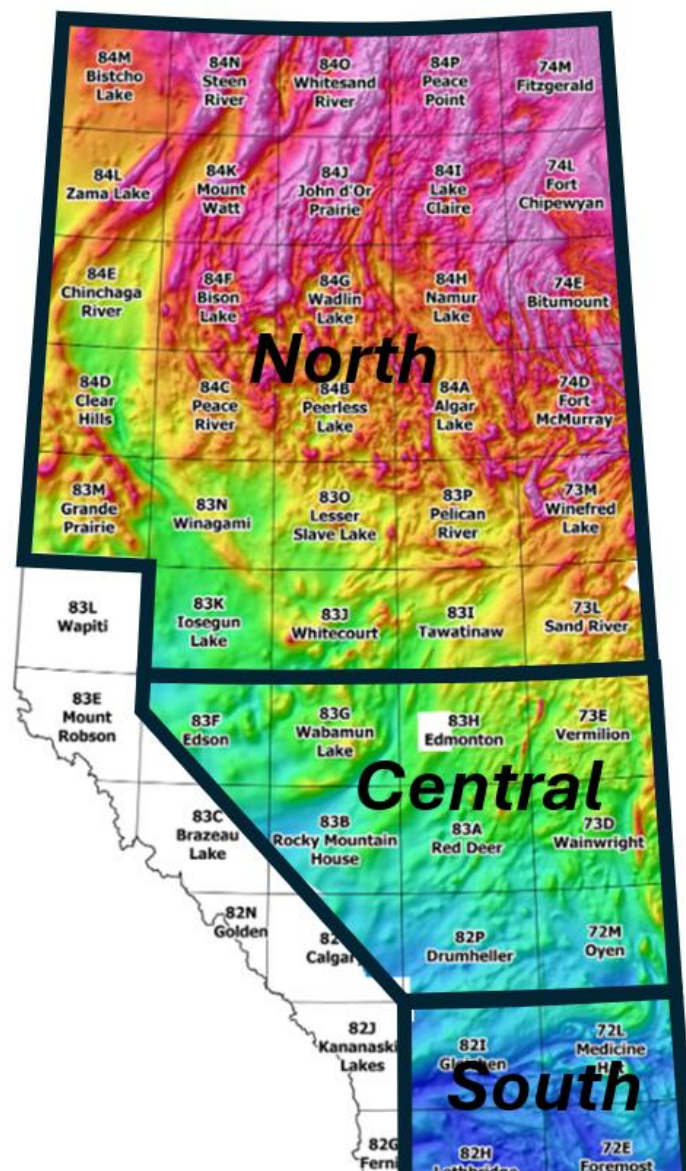


Figure 1. Magnetic data coverage in the province of Alberta, overlain by study area boundaries.

the CPD isotherm is not a new concept; it was introduced in the 1970's as a reconnaissance tool for geothermal exploration in Japan. However, as the demand for clean, renewable, sustainable, and environmentally friendly sources of energy is increasing, the technique has been getting more attention among scientists in recent years.

The CPD is an isotherm surface formed deep in the Earth's crust, and at which the temperatures of crustal rocks reach the Curie point of 580°C. At this temperature, ferromagnetic minerals such as magnetite ( $\text{Fe}_2\text{O}_3$ ), lose their magnetic properties and become non-magnetic. Accordingly, the CPD coincides with maximum depths to the bottom of magnetic sources (DBMS) where magnetization reaches zero. Therefore, we basically map the maximum depths that can be detected from magnetic data. The radial power spectrum of magnetic data is one of the most popular methods used to estimate depth to magnetic layers in the Earth's crust to a maximum depth at which the Curie temperature (i.e. 580 °C) is intercepted. Accordingly, we used two popular approaches to map the bottom of magnetic sources from magnetic data; the centroid and the fractal (Bouligand et al., 2009, Li et al., 2010, (Ravat et al., 2007). The centroid assumes that magnetization of sources is uncorrelated and behaves randomly. The fractal approach assumes that the power spectrum exhibits self-similarity or fractal behavior and, therefore, it needs to be corrected accordingly. Both approaches result in a DBMS surface which covers the province of Alberta.

In addition, the depth to Moho was estimated by completing a 3D gravity inversion of regional publicly available data. The depth to Moho represents an estimate of crustal thickness. It is assumed that areas of thinner crust correlate with areas of higher heat flow and higher geothermal gradients. Since the Moho depth and CPD are derived from different physical properties (gravity and magnetics respectively), inferences to the reliability of using these attributes to infer geothermal characteristics can be made.

This study shows that gravity and magnetic data can be used to provide useful indirect information about the regional distribution of deep sourced geothermal energy in the province of Alberta by computing the DBMS from radial power spectrum of magnetic data and estimating depth to Moho by using a 3D gravity inversion. We assume that the DBMS surface is equivalent to mapping the CPD isotherm surface, since both surfaces coincide at the same level (i.e., at Curie point temperature, 580°C). From this relationship, inferences can be made of average geothermal gradients and areas of higher relative geothermal resource potential.

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