Yukon Government Geothermal Initiatives

Yukon Geological Survey (YGS) is evaluating the geothermal energy potential of Yukon to help determine the viability of developing these resources. Renewable power is not a top-of-mind issue for Yukoners, as the bulk of our power is generated from renewable sources (mainly hydro, with increasing components of solar and wind). However, projected power demands for potential new mine developments over the next ten to twenty years will exceed Yukon's current power capacity, and consultations around new hydro developments have met strong public opposition. Additionally, although our power grid is currently over 90% renewable, four communities are off-grid, and the majority of Yukon homes and businesses are heated with hydrocarbons. All hydrocarbons used in the territory are trucked from the south.

Previous geothermal investigations in Yukon include numerous regional and site-specific studies by the Geological Survey of Canada (Grasby et al., 2012), Yukon Energy Corporation (unpublished studies) and the Canadian Geothermal Energy Association (CanGEA, 2016). Our current research builds on these studies and has four components:

- Modeling regional heat flow in the mid to shallow crust;
- Calculating potential heat production from young granites;
- Direct measurement of thermal gradient in two ground temperature monitoring wells; and
- Geophysical surveys over an active deep crustal fault structure.
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Heat flow was modeled by Witter and Miller (2017) by calculating Curie Point depths (CPD) using public domain regional aeromagnetic data from NRCAN. CPD estimates were subsequently improved upon by Li et al. (2017; Fig. 1) using a global EMAG2 magnetic dataset as discussed in Witter et al. (2018). The Curie Point, defined as the temperature above which a magnetic substance loses its magnetic properties, corresponds to a temperature of roughly 580°C for the commonly occurring mineral magnetite. CPDs calculated for Yukon correspond well with the heat flow map of Grasby et al. (2012), with the shallower CPDs occurring across southern Yukon.

Additional, shallow sources of potential heat were identified by calculating the heat generated from the natural radiogenic decay of U, Th and K in granites. Using the technique of Rybach (1981), heat-production values were calculated from existing whole rock geochemical data. Granites in southern Yukon locally have significantly higher heat production values than "average" granites (over 10μW/m^3 vs. 2.45μW/m^3 for an average granite). Notable are Cretaceous granites which have higher heat generation values compared to younger Paleogene ones.

Direct ground temperature data were collected from two 500 metre-deep wells drilled between November 2017 and March 2018. One well is located midway between Takhini hot spring (46°C surface water temperature) and a granite pluton that yielded a heat-production value of 5.96μW/m^3. The granite is thought to provide a heat source to infiltrating meteoric waters, possibly in permeable carbonate rocks. The second well targeted the Tintina trench, a major dextral fault that transects Yukon. This location was selected to assess whether enhanced permeability in the fault creates a locally elevated geothermal gradient.

Current research involves the acquisition of ground-based gravity and ELF-EM (Extremely Low Frequency Electro-Magnetics) data over a portion of the Denali Fault, near the community of Burwash Landing, southwest Yukon (a community which is diesel dependent for electricity). The purpose of the surveys is to: 1) help estimate the variations in thickness of glacial overburden and other Quaternary sediments and 2) differentiate subsurface lithologies (based on density and electrical resistivity) to aid in the interpretation of the complex structural relationships associated with the Denali Fault and subsidiary faults. Data from this study will be used to determine locations of future temperature gradient wells.

As results of this work are written up over the next few months, YGS is taking some time to engage communities regarding results obtained to date and assess interest in carrying out further research.

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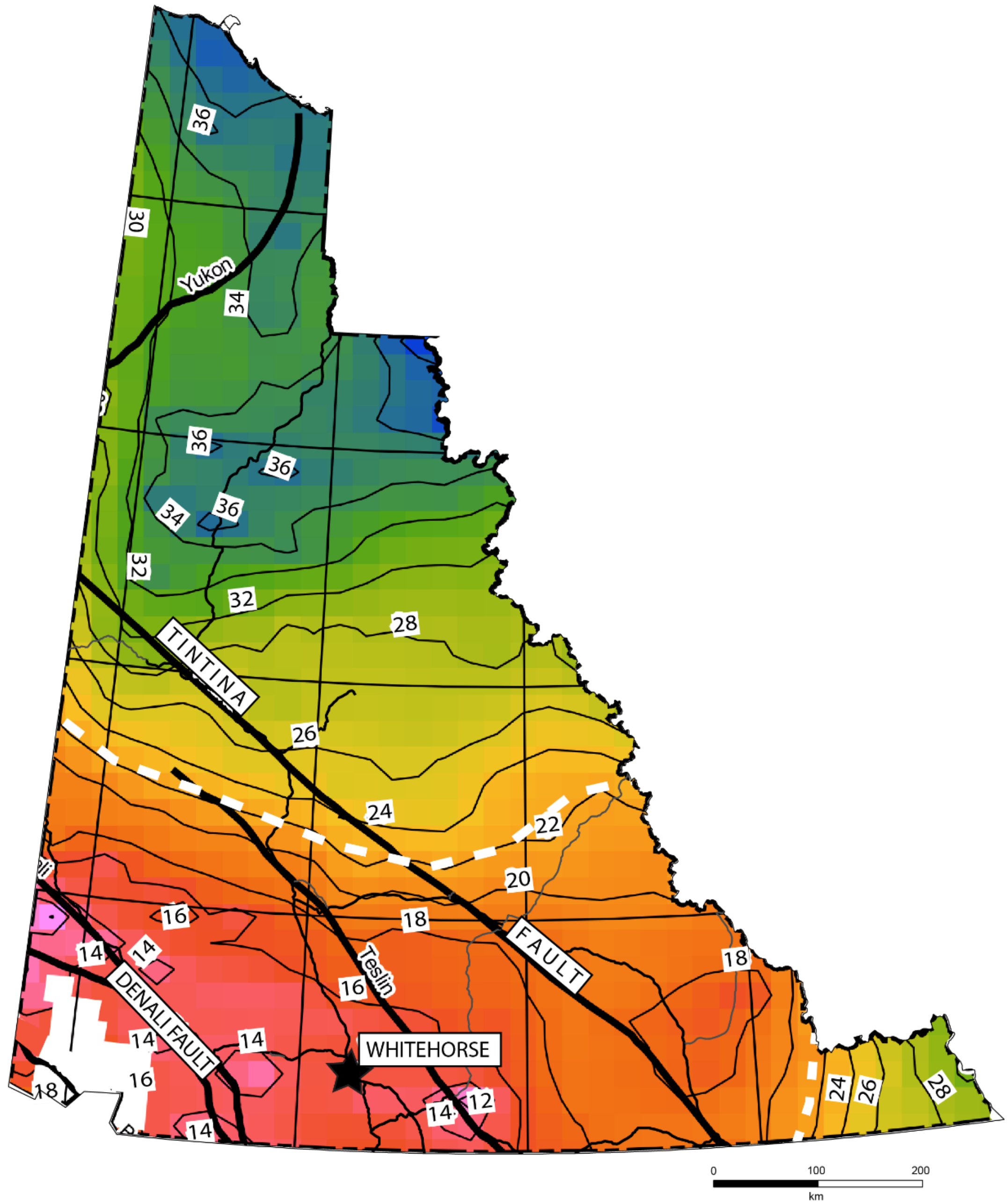

Figure 1. Curie Point depth (CPD) map for Yukon (generated from data of Li et al., 2017 by Witter et al., 2018). Depth contours in kilometres. White polygons denote areas with no data. Areas to south and west of the white dotted lines indicate the shallowest CPD in the territory, which can be used as a proxy for areas of high heat flow to surface.