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Geothermal exploration in western Canada using magnetotelluric data

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ABSTRACT

The magnetotelluric (MT) method is used to image subsurface electrical conductivity, or its reciprocal electrical resistivity. This is a useful physical property to measure during geothermal exploration because it is sensitive to the presence of fluids such as geothermal brines and partially molten rocks, as well as clay minerals formed by hydrothermal alteration. These substances have low electrical resistivity, compared with dry, unaltered host rocks.

The MT method is a passive source electromagnetic (EM) geophysical method. It uses naturally occurring radio waves as the source and frequency as a proxy for depth. The highest frequencies are measured in the audiomagnetotelluric (AMT) band, and they are used to image the shallowest structures. A wide range of lower frequencies are used in broadband magnetotelluric (BBMT) data collection, and they can image structures throughout the crust.

BBMT data were collected near Mount Meager, southwestern BC, in 2019 and 2020. They were used to image the magmatic and geothermal systems beneath this Holocene volcanic centre. A 3-D electrical resistivity model, from inversion of BBMT data, revealed a magma body at 5-15 km below sea level, as well as fluid pathways from this magma body to the surface near active fumaroles. Geochemical and petrological information was used to infer the physical properties of the magma body.

AMT and BBMT data were collected in southwestern Yukon in 2021-2023. AMT data measured near Haines Junction were used to image the uppermost 3-4 km of the subsurface. BBMT data measured near Whitehorse and Carmacks were used to image the upper 30-60 km. Three new 3-D electrical resistivity models will facilitate investigations of crustal structure in southwestern Yukon and interpretations in regard to geothermal potential. Initial interpretations of the new data and models will be presented, and implications for geothermal energy development will be discussed.