Inferring the roots of volcano-geothermal systems in the Rotorua and Okataina calderas with Magnetotelluric models

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Summary

A combination of 365 land and 34 lake-bottom magnetotelluric (MT) measurements at ~2 km spacing are used to investigate the structure of magmatic systems that drive high-temperature geothermal fields and volcanism in the northern part of the Taupo Volcanic Zone (TVZ), New Zealand. These data encompass the Rotorua Caldera and Okataina Volcanic Centre, covering an area of 2,800 km^2, and were inverted to create an image of the 3-D electrical resistivity structure of the crust to a depth of 20 km. Below shallow layers of quaternary volcanic deposits, the model is everywhere resistive, with the exception of a singular conductive zone (~500 km^2) below ~8 km depth that we interpret to be relatively mafic magma, consistent with petrologic and other geophysical data. Discrete fingers of low-resistivity (conductive) material rise from the margins of this inferred magmatic zone and connect directly with the locations of high-temperature geothermal fields at the surface.

Notably, one of the conductive fingers rises beneath the Haroharo Dome complex within the Okataina Volcanic Centre where 39 km^3 of silicic magma has been extruded in the last 9,000 years. These recent domes, which are electrically resistive, appear to cap and arrest the conductive finger (high-temperature fluids) at ~2 km depth, with surface geothermal activity displaced to the northeast, and along lake shorelines at the margin of the dome complex.

Keywords: Lake-Bottom Magnetotellurics, Taupo Volcanic Zone, Magma, Caldera, Geothermal