Magmatic priming of a phreatic eruption sequence: The 2012 Te Maari eruptions at Mount Tongariro (New Zealand) imaged by Magnetotellurics and Seismicity

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SUMMARY

Tongariro Volcanic Centre is a large andesite-dacite stratovolcano complex located at the southern termination of the Taupo Volcanic Zone in the central North Island of New Zealand. Data from 128 magnetotelluric (MT) measurements have been re-inverted using a 3-D inversion code that uses an unstructured tetrahedral mesh to model the pronounced topography of the Tongariro Volcanic Centre.

Incorporating topography adds information which helps stabilise the inversion and facilitates comparison with the seismicity. The inversion enables details of the shallow hydrothermal system and its relationship with the underlying magmatic system to be resolved. An electrically conductive zone between 4 and 12.5 km depth marks the underlying magmatic system, which is linked via a conductive pathway to the area where the most recent phreatic eruptions at Tongariro occurred in August and November 2012.

By combining the magnetotelluric resistivity image with relocated seismicity, we can see that seismicity (a proxy for magma ascent) migrated from the top of the magmatic system into the hydrothermal system in the months preceding these eruptions. Magmatic interaction with the extant hydrothermal system likely caused over pressurisation resulting in a phreatic eruption since no new magmatic components were found in the eruption deposits. This work highlights the utility of combining geophysical methods and petrological data to constrain phreatic eruption processes.

Keywords: magnetotellurics, volcanology, seismicity, New Zealand