Electrical resistivity structure beneath the Hangai Dome, Mongolia: intraplate volcanism and deformation imaged with magnetotelluric data

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The Hangai Dome in central Mongolia is characterized by intraplate volcanism on a high-elevation intra-continental plateau. Volcanism dates from the Oligocene to the Holocene and is thought to be coincident with the onset of the uplift of the Hangai Dome, indicating that the processes may be linked. However, the processes and driving mechanisms responsible for creating this region remain largely unexplained, due in part to a lack of high-resolution geophysical data over the area.

An extensive magnetotelluric (MT) data set was collected over the Hangai Dome in 2016 and 2017, with broadband data (0.002 – 5,000 s) collected at a total of 294 sites. This data set consists of a large array (~50 km site spacing) and several long (~600 km) and dense (~5 km site spacing) profiles that cross the uplifted Hangai Dome. Additionally, they cross the bounding faults of the Hangai block, the Bulnay fault in the north and the Bogd fault of the Gobi-Altai in the south, which have had several M>8 earthquakes in the past century. These MT data have been used to generate electrical resistivity models of the crust and upper mantle in this region.

Anomalous, low resistivity (~30 ohm-m) zones in the lower crust (~25 – 50 km depth) are spatially associated with the surface expressions of volcanism and modern-day hydrothermal activity. These zones indicate the presence of local accumulations of fluids below the brittle-ductile transition zone. Interestingly, this feature terminates sharply at the South Hangai Fault Zone. Furthermore, lower resistivity pathways in the upper crust (0 – 25 km depth) connect the deeper features to the surface. This is prominently observed below the Hangai’s youngest volcanic zones of Tariat/Khorgo and Chuluut, as well as the hot spring area of Tsenkher, near Tsetserleg. Additionally, an electrical signature can be associated with known fault zones and mineralized zones (such as the Bayankhongor mineral belt).

An anomalous low-resistivity zone in the upper mantle (~70 - 100 km) directly below the Hangai Dome can be explained by the presence of a small amount of partial melt. This zone likely represents the region of melt generation for intraplate volcanism and gives evidence for a small-scale (<100 km) asthenospheric upwelling, which contributes to intraplate deformation.