Imaging of an intraplate volcanic system from source to surface

Matthew Joseph Comeau[1], Michael Becken[2] and Alexey V. Kuvshinov[3]
[1]Institut für Geophysik, Universität Münster (WWU), Münster, Germany, matthew.comeau@uni-muenster.de
[2]Institut für Geophysik, Universität Münster (WWU), Münster, Germany, michael.becken@uni-muenster.de
[3]Institute of Geophysics, ETH, Zürich, Switzerland, kuvshinov@erdw.ethz.ch

SUMMARY

The structure of continental intraplate volcanic systems — which occur far from active tectonic margins, unlike the majority of Earth's volcanism — is enigmatic and not fully understood, as are the underlying mechanisms responsible. Quaternary–Neogene aged, alkaline basalt flows and clusters of volcanic cones are found in Central Mongolia, which is in the continental interior. Using a high-resolution, multi-scale, magnetotelluric dataset, we generate both 3-D and 2-D electrical resistivity models of the lithosphere and uppermost mantle beneath this region. We focus on two volcanic fields that are separated by approximately 100 km. By examining the models and considering all available evidence we propose the following: 1) narrow, vertical, low-resistivity anomalies located in the upper–middle crust beneath the surface expressions of volcanism represent the remnant signatures of ancient, ephemeral magma pathways (or collection of pathways) and record the location of magma ascent; 2) widely distributed low-resistivity zones in the lower crust can be explained by very small amounts of saline fluids in a thermally perturbed region, and are hard to reconcile with magma storage; and 3i) a local low-resistivity zone in the lithospheric mantle and a broad, doming low-resistivity feature in the uppermost mantle are interpreted to represent a metasomatized lithospheric mantle and a mantle upwelling and thermal anomaly explained by low-percent partial melt, which is inferred to be the source for intraplate volcanism. Thus the geophysical images reveal magma generation and transport from a mantle source to the surface beneath a continental intraplate basaltic volcanic system. Furthermore, they are consistent with geochemical and petrological evidence from erupted lavas that point to a single common mantle source region for both volcanic zones and a volatile-enriched, metasomatized sub-continental lithospheric mantle, as well as limited crustal contamination and rapid magma ascent.

Keywords: magma plumbing; intraplate volcanism; mantle upwelling; partial melt; electrical resistivity