Imaging the magmatic system of the Katmai volcanic group, Alaska

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SUMMARY

The Katmai volcanic group (KVG) within the Alaskan Aleutian arc is an unusually dense group of active volcanic centres (Mounts Martin, Mageik, Trident, Katmai, Griggs, Snowy, and Novarupta). The KVG was the locus of the largest eruption of the 20th century. During the 1912 eruption, rhyolite erupted from a new vent (Novarupta) contemporaneous with the collapse of nearby Mount Katmai (10 km away). A magmatic connection has been hypothesized between the two vents based on the above observation and on a small volume of juvenile andesitic magma with the geochemical signature of Mount Katmai that erupted from Novarupta at the onset of the three-day eruption. Unanswered questions about the structure and dynamics of the KVG include the origin and storage zone for the 1912 erupted rhyolite, its connection (if any) to the dense group of andesitic stratovolcanoes surrounding the Novarupta vent, the factors leading to the formation of off-arc centres, such as Mount Griggs, and the reason for enhanced magmatic flux beneath the KVG relative to other segments of the arc. Our recent wideband magnetotelluric survey of the region encompasses the entire Katmai group of volcanoes (110 sites) and is bisected by an arc-perpendicular profile crossing the Alaska Peninsula (18 sites) where the subducting slab descends from 60-200 km depth. Both impedance and tipper data were collected across a bandwidth from 1 kHz to 1 mHz. The magnetotelluric data are dominated by coast effects, however qualitative analysis of the data shows evidence of the moderately conductive Jurassic sedimentary section upon which the arc is built, the highly resistive arc itself, and a swath of elevated conductivity beneath the arc axis. Three-dimensional inversion models image three pipe-like conductors beneath the main axis of the volcanic front, spaced at ca. 20 km intervals from a common depth of ca. 7 km and dipping toward the backarc. Interpreted as zones of magma storage and ascent, the flat tops of these conductors implies buoyancy control on upper-crustal magma storage while separate conductors beneath the different volcanic centres (Mageik/Martin, Katmai/Trident/Novarupta, and Snowy) imply discrete magma supplies and crustal pathways.

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