Imaging Trans-Crustal Magmatic Systems with Receiver Functions – A Path Towards Linking Tectonic and Eruptive Processes

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Processes and structures related to magma formation, transport, emplacement, and eruption at volcanoes transect the entire crust, but a longstanding barrier to understanding these systems on a large scale is the challenge of constraining deep-crustal magmatic structure beneath volcanoes. Scattered wave seismic imaging techniques, in particular receiver function analysis, provide a promising pathway towards imaging the mid- to deep-crustal magmatic structure beneath volcanoes with only a modest number of broadband seismic instruments (N < 10). Using seismic data from two recently-active volcanoes in Alaska's Aleutian arc, Akutan and Cleveland, we demonstrate the feasibility of seismically imaging crustal magmatic structure with only three and seven local broadband seismometers at each volcano, respectively. The two volcanoes have significantly differing eruptive histories: Akutan last erupted in 1992 and has since only experienced a shallow dike intrusion in 1996, whereas Cleveland is one of the most frequently-erupting volcanoes in the Aleutian arc. Both also have significantly different depths-to-slab, with Cleveland representing one of the global shallow end members at ~ 70 km depth, and a more globally-average depth of 85 km at Akutan. Receiver functions reveal different underlying crustal magmatic structures, with a mid-crustal sill-like structure that has a well-defined top and base beneath Akutan, and a thicker and deeper magmatic region with less abrupt boundaries beneath Cleveland, providing motivation for similar analyses at additional Aleutian volcanoes. Looking forward, the relatively low number of seismic stations required for this approach makes it a convenient method to apply at other volcanoes, potentially at a global scale.