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Mid-crustal magma reservoirs at Cleveland and Akutan Volcano imaged through novel receiver function analyses

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Processes related to magma formation, transport, emplacement, and eruption at volcanoes are linked by structures that transect the entire crust, but imaging the mid- to lower-crustal portions of these magmatic systems has been a longstanding challenge. Tomography, local seismic source studies, geodetic, and geochemical constraints are typically most sensitive to shallow storage and/or have insufficient resolution at these depths. Scattered wave seismic imaging techniques, particularly receiver function analyses, 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 experienced 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. Future work using similar approaches will enable an unprecedented comparative examination of magmatic systems beneath sparsely instrumented volcanoes globally.