A geochemical and seismic search for deep, active MASH zones

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The search for melting, assimilation, storage, and homogenization (MASH) zones near the crust-mantle transition via seismic techniques has proven difficult due to the non-unique nature of seismic properties. The southern Puna Plateau of the central Andes is one locality where an active MASH zone has been interpreted based on seismic results, but this interpretation requires validation through geochemical proxies. We compare rare earth element ratios and aluminum saturation index vs. SiO_2 with those expected from geochemical modeling of igneous differentiation processes over a wide range of silica content in young (ca. <8 Ma) Puna volcanics. We find geochemical signatures for deep fractionation and crustal assimilation in recent magmatism at depths where garnet is stable. When our geochemical results are combined with geobarometric results, shear-wave velocities, and body wave attenuation measurements, we pin down the depths at which these processes are occurring to be located near the crust-mantle transition, indicative of an active MASH zone.

As a comparison, we apply a similar integrated geochemical and seismic approach to the modern Cascade volcanic arc, which differs in many regards from the southern Puna Plateau. We find that the geochemical and seismic evidence for deep MASH processes is more variable than observed beneath the southern Puna Plateau. These differences may indicate variable depths of magma stalling in the lithosphere, possibly controlled by lateral heterogeneity in arc lithospheric stress-state, magma input, crustal thickness, and/or other factors. Investigating what controls these factors and how they relate to the geochemical and seismic signatures of a region will allow for a better understanding of the prevalence and spatial extent of active deep MASH zones globally.