Searching for the deep roots of arc volcanoes: seismic imaging in the Washington Cascades (Invited)

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Many arc volcanoes erupt mantle-sourced basalts and high-temperature lower-crustal magmas, yet seismic images of this deep plumbing are almost non-existent. Are deep partial-melt bodies too small for seismology to see, or are typical seismic arrays too limited to detect them? We address these questions with a 2014-16, 70-station broadband array around Mount St. Helens (MSH), termed iMUSH (imaging Magma Under St. Helens). Receiver functions image 35-40 km of upper-plate crust and a subducting plate 65-68 km directly beneath MSH. This leaves very little mantle to melt, yet basalts are present. As elsewhere in the Cascades, the upper-plate Moho vanishes in the forearc (west of MSH), an observation usually interpreted as serpentinized mantle. Ambient-noise tomography shows slightly low wavespeeds consistent with partially hydrated mantle, requiring temperatures low enough for serpentines to be stable. However, the vanishing Moho is largely a consequence of upper-plate geology: very high wavespeeds are observed in the lower crust west of MSH, greatly reducing the Moho velocity contrast. This is likely due to the presence of an accreted oceanic plateau terrane (Siletzia), which is present everywhere in Cascadia the Moho has vanished. Overall, we see little evidence for melt except far east of MSH, and these observations show little sign of the deep magma plumbing system. Instead, they imply that the lower crust and uppermost mantle are too cold directly beneath the edifice to generate the observed melts. To reconcile these observations with the volcanism at MSH requires significant lateral melt transport within the crust. Melt may originate beneath mafic vent fields 25-40 km east of MSH, or somewhere south of iMUSH.

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