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Attenuation and scattering tomography of the deep plumbing system of Mount St. Helens

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We present a combined 3-D P wave attenuation, 2-D S coda attenuation, and 3-D S coda scattering tomography model of fluid pathways, feeding systems, and sediments below Mount St. Helens (MSH) volcano between depths of 0 and 18 km. High-scattering and high-attenuation shallow anomalies are indicative of magma and fluid-rich zones within and below the volcanic edifice down to 6 km depth, where a high-scattering body outlines the top of deeper aseismic velocity anomalies. Both the volcanic edifice and these structures induce a combination of strong scattering and attenuation on any seismic wavefield, particularly those recorded on the northern and eastern flanks of the volcanic cone. North of the cone between depths of 0 and 10 km, a low-velocity, high-scattering, and high-attenuation north-south trending trough is attributed to thick piles of Tertiary marine sediments within the St. Helens Seismic Zone. A laterally extended 3-D scattering contrast at depths of 10 to 14 km is related to the boundary between upper and lower crust and caused in our interpretation by the large-scale interaction of the Siletz terrane with the Cascade arc crust. This contrast presents a low-scattering, 4–6 km2 "hole" under the northeastern flank of the volcano. We infer that this section represents the main path of magma ascent from depths greater than 6 km at MSH, with a small north-east shift in the lower plumbing system of the volcano. We conclude that combinations of different nonstandard tomographic methods, leading toward full-waveform tomography, represent the future of seismic volcano imaging.