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Seismic scattering and absorption mapping of debris flows, feeding paths, and tectonic units at Mount St. Helens volcano

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Frequency-dependent peak-delay times and coda quality factors have been used jointly to separate seismic absorption from scattering quantitatively in Earth media at regional and lithospheric scale; to this end, we measure and map these two quantities at Mount St. Helens volcano. The results show that we can locate and characterise volcanic and geological structures using their unique contribution to seismic attenuation. At 3 Hz a single high-scattering and high-absorption anomaly outlines the debris flows that followed the 1980 explosive eruption, as deduced by comparison with remote sensing imagery. The flows overlay a NNW-SSE interface, separating rocks of significant varying properties down to 2-4 km, and coinciding with the Saint Helens Seismic Zone. High-scattering and high-absorption anomalies corresponding to known locations of magma emplacement follow this signature under the volcano, showing the important interconnections between its feeding systems and the regional tectonic boundaries. With frequency increasing from 6 to 18 Hz the NNW-SSE tectonic/feeding trends rotate around an axis centered on the volcano in the direction of the regional-scale magmatic arc (SW-NE). While the aseismic high-scattering region WSW of the volcano shows no evidence of high absorption, the regions of highest-scattering and absorption are consistently located at all frequencies under either the eastern or the south-eastern flank of the volcanic edifice. From the comparison with the available geological and geophysical information we infer that these anomalies mark both the location and the trend of the main feeding systems at depths greater than 4 km.