Multiple Resolution seismic Attenuation imaging (MuRAt): how scattering and attenuation signatures bias seismic imaging in volcanoes

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Over the last 15 years, seismic attenuation imaging has grown as a novel take on the description of the 3D geometry of magmatic systems. The more seismic heterogeneity and attenuation grow, the lesser the efficiency of standard seismic imaging in volcanoes. MuRAT is a computational tool for imaging magmatic systems using coda waves. It uses the increased heterogeneity of volcanoes with respect to the crust as a source of illumination for melt accumulation and fluid propagation. Here, I will discuss its application to calderas and deep volcano-tectonic interactions. Attenuation imaging provides greater insight into the Campi Flegrei caldera structure than seismic tomography, allowing to link sources of ground deformation with their seismic imprint. Still, it cannot be applied with the same hypothesis at all available frequencies and scales of the caldera, as heterogeneity is non-homogeneous, adding resonant characteristics to coda envelopes that go well beyond topographic effects. The consequences are biases that affect both travel-time and ambient noise interferometry imaging at the caldera. These characteristics are particularly relevant in the presence of shallow heterogeneity induced by volcano dynamics. A key case-example is the influence of the massive debris flow of the 1980 Mount St. Helens eruption, with the flow signature corrupting seismic images relying on full seismic waveform information. The only way forward to produce high-resolution reliable images of a volcano is through modelling of its scattering and attenuation properties: we demonstrate the improvement this produces in terms of data fit and interpretation using data recorded just before the Mount St. Helens 2004 eruption.