Shallow volcano-tectonic structures on the Island of Hawai‘i imaged by multimode Rayleigh wave ambient noise tomography

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Seismic tomography of shield volcano can be used to better understand its structure, formation, and evolution. Previous tomographic studies on the Island of Hawai‘i used body waves from earthquakes and active sources and had limited resolution in the shallow crust. In this study, we obtained the empirical Green Functions (EGFs) and empirical Green Tensors (EGTs) from cross-correlating and stacking of multi-year seismic ambient noise recorded on the island. The EGFs/EGTs contained fundamental mode and first higher mode Rayleigh waves. The different modes were separated with a new algorithm and their group velocities were measured. Using all the group arrival times, we inverted for two-dimensional group velocity maps, which provides, for the first time, a full coverage of the Island of Hawai‘i. From the group velocity maps, we inverted for a three-dimensional shear wave velocity model, which shows strong lateral variations and yields new insights into the structure and growth of the volcanoes on the island: Kīlauea's East Rift Zone has prominent high velocities at all depths, whereas the current rift zones of Mauna Loa are characterized by intermediate to high velocities only at depths greater than 1 km below ground surface, which may be attributed to their relatively short history and less developed state. The flanks of the volcanoes, some cut by fault zones, displayed low velocities at over a range of depths, generally interpreted as consisting of extrusive rocks, which could be further shattered by faulting.