Geophysical Research Abstracts
Vol. 21, EGU2019-10774-1, 2019
EGU General Assembly 2019

Seismological investigation of melt retention in the upper mantle underneath La Réunion

John Armitage, Thijs Franken, Nobuaki Fuji, and Alexandre Fournier
Institut de Physique du Globe de Paris, Equipe Dynamique des Fluides Geologiques, Paris, France (armitage@ipgp.fr)

Regions of low seismic velocity below mid-ocean ridges, volcanic islands, and active rift zones are routinely interpreted to be due to the presence of some quantity of partial melt. This is somewhat logical, given the evidence of magmatism at the surface. However, the exact quantity of melt, or the porosity, within the upper mantle remains elusive. Regions of low seismic velocity below, for example Iceland, Afar, and La Réunion have historically been interpreted to be due to a porosity of up to 0.05. Such high retention of melt would require slow rates of melt transport, on the order of $\mathrm{cm\,yr^{-1}}$. Yet U-series isotope studies and the apparent climatic sensitivity of volcanism at both Iceland and mid-ocean ridges would suggest that melt rises rapidly, at rates of $10\,\mathrm{m\,yr^{-1}}$ or more. We cannot have both situations. To try and unravel this dichotomy we aim to predict the seismic observations by using a geodynamic model to calculate porosity, and the seismic structure for various physically reasonable scenarios of partial melting. The key uncertainty is permeability, which links melt transport rates to porosity. Focusing on La Réunion, we use the predicted seismic structure for the full waveform propagation of source earthquakes to make comparisons between synthetic and observed seismic arrivals. Using the SKS arrivals from 21 source events at epicentral distances of between 60 and 120°, we find that the travel time delay correlates best with models that predict mean porosity of ~ 0.03, with a low rate of melt transport. However, the waveform misfit for the SKS arrival correlates best with models that predict a very low mean porosity of < 0.01 and fast transport. Given waveform misfit and isotope studies would both suggest fast transport, perhaps classic travel time tomographic studies have overestimated the retention of melt in the asthenosphere.