Geophysical Research Abstracts
Vol. 17, EGU2015-13633-1, 2015
EGU General Assembly 2015

Receiver function imaging of the lithosphere-asthenosphere boundary and melt beneath the Afar Rift in comparison to other systems

Catherine A. Rychert and Nicholas Harmon
Southampton, National Oceanography Centre, Ocean and Earth Science, Southampton, United Kingdom
(c.rychert@soton.ac.uk)

Heating, melting, and stretching destroy continents at volcanic rifts. Mantle plumes are often invoked to thermally weaken the continental lithosphere and accommodate rifting through the influx of magma. However the relative effects of mechanical stretching vs. melt infiltration and weakening are not well quantified during the evolution of rifting. S-to-p (Sp) imaging beneath the Afar Rift provides additional constraints. We use two methodologies to investigate structure and locate robust features: 1) binning by conversion point and then simultaneous deconvolution in the frequency domain, and 2) extended multitaper followed by migration and stacking. We image a lithosphere-asthenosphere boundary at ~75 km beneath the flank of the Afar Rift vs. its complete absence beneath the rift. Instead, a strong velocity increase with depth at ~75 km depth is imaged. Beneath the rift axis waveform modeling suggests the lack of a mantle lithosphere with a velocity increase at ~75 km depth. Geodynamic models that include high melt retention and suppress thermal convection easily match the required velocity-depth profile, the velocity increase arising from a drop in melt percentage at the onset of decompression melting. Whereas, models with conservative melt retention that include thermal buoyancy effects cannot reproduce the strong velocity increase. The shallow depth of the onset of melting is consistent with a mantle potential temperature = 1350 - 1400°C, i.e. typical for adiabatic decompression melting. Trace element signatures and geochemical modeling have been used to argue for a thick lithosphere beneath the rift and slightly higher mantle potential temperatures ~1450°C, although overall, given modeling assumptions, the results are not in disagreement. Therefore, although a plume initially destroyed the mantle lithosphere, its influence directly beneath Afar today is not strong. Volcanism continues via adiabatic decompression melting assisted by strong melt buoyancy effects. This contrasts with a similar feature at much deeper depth, ~150 km, beneath Hawaii, Iceland, and Galapagos. Improved high resolution imaging of rifting, ridges, and hotspots in a variety of stages and tectonic settings will increase constraints on the forces sustaining volcanism and the factors that dictate the style of breakup beneath rifts.