Geophysical Research Abstracts, Vol. 7, 05978, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05978

Surface Wave Investigation of the Effect of the Icelandic Hotspot on the Upper Mantle Beneath the Reykjanes Ridge

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A seismic tomographic analysis of Love and Rayleigh wave data was carried out using surface waves that propagated along the Reykjanes Ridge. The data were generated by regional earthquakes located mainly along the Reykjanes Ridge and along the Gibbs Fracture Zone; the waves were recorded on broadband seismometers located on Iceland as part of the HOTSPOT and ICEMELT experiments and the GSN station BORG. We extracted the phase, group, and amplitude information of narrow-pass filtered waveforms over the period range of ˜14-100s. Over 12000 such measurements are included in an inversion for mantle and crustal shear velocity structure. Given the geometry of earthquake sources and stations, the waveforms are highly sensitive to lithospheric and asthenospheric structure beneath the ridge. We show that surface waves traveling along the ridge are affected by a wide low-velocity "channel" centered beneath the ridge that is formed simply by the thinning of the sub-ridge lithosphere. In addition to the lithospheric effect, the surface waves are affected by low asthenospheric velocities in a very broad and deep region centered beneath the ridge. This low-velocity region is consistent with elevated temperatures ($<$100 degrees) at depths down to ˜400 km and a very small amount of melt ($<$1-2%) at depths down to ˜150 km. Our tomographic images of the shear velocity structure of the upper mantle and crust indicate that the Icelandic hotspot broadly affects the upper mantle beneath the ridge, indicating that hotspot material spreads southward over a broad and deep region. We have not found evidence that hotspot material is preferentially fed southward along the Reykjanes Ridge in a shallow, narrow channel as has been previously suggested.