Geophysical Research Abstracts
Vol. 16, EGU2014-3832, 2014
EGU General Assembly 2014

Seismic anisotropy of the lithosphere/asthenosphere system beneath the Rwenzori region of the East-African Rift

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We present results from a temporary seismic network of 32 broad-band stations located around the Rwenzori region of the Albertine rift at the border between Uganda and DR Congo. The study aims to constrain seismic anisotropy and mantle deformation processes in relation to the formation of the rift zone. Shear-wave splitting measurements from local and teleseismic earthquakes are used to investigate the seismic anisotropy in the crust and upper mantle beneath the Rwenzori region. At most stations, shear-wave splitting parameters obtained from individual earthquakes exhibit only minor variations with backazimuth. We therefore employ a joint inversion of SKS waveforms to derive hypothetical one-layer parameters. The corresponding fast polarizations are generally rift-parallel and the average delay time is about 1 s. On the other hand, shear phases from local events within the crust are characterized by a bimodal pattern of fast polarizations and an average delay time of 0.04 s. This observation suggests that the dominant source region for seismic anisotropy beneath the rift is located within the mantle. We use finite-frequency waveform modeling to test different models of anisotropy within the lithosphere/asthenosphere system of the rift. The results show that the rift-parallel fast polarizations are consistent with HTI anisotropy caused by rift-parallel magmatic intrusions or lenses located within the lithospheric mantle - as it would be expected during the early stages of continental rifting. Furthermore, the short-scale spatial variations in the fast polarizations observed in the southern part of the study area can be explained by effects due to sedimentary basins of low isotropic velocity in combination with a shift in the orientation of anisotropic fabrics in the upper mantle. A uniform anisotropic layer in relation to large-scale asthenospheric mantle flow is less consistent with the observed splitting parameters.