Geophysical Research Abstracts,
Vol. 11, EGU2009-3555, 2009
EGU General Assembly 2009

Crustal velocity structure (P- and S-velocities and Vp/Vs ratio) in the Rwenzori region, Uganda, from isotropic and anisotropic local travel-time tomography

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We investigate the upper crustal velocity structure beneath the Rwenzori Mountains in western Uganda. This approximately 50 km-wide mountain range, with a length of about 150 km, is situated within the western branch of the East African rift zone and reaches altitudes of more than 5000 m. The tomographic inversion is based on 2053 local earthquakes recorded by a temporary network which covers an area of 150×90 km and comprises up to 35 short period and broad-band stations. The station deployment was mainly constricted by the international border between Uganda and Congo, whereby most recorded events lie outside of the perimeter of stations. We perform a number of synthetic tests to assess the effect of location uncertainty on the results of the tomographic imaging. The resolution of the derived velocity models, accuracy of source location and the trade-off effect between them were thoroughly studied using a number of different synthetic tests. We perform iterative simultaneous inversions for velocity and source parameters using both Vp-Vs and Vp-Vp/Vs schemes using the LOTOS code. In all cases the derived Vp, Vs and Vp/Vs structures fit rather well with each other. We have also constructed a synthetic model that reproduces the same pattern of velocity anomalies as that obtained after inversion of the real data. Our models exhibit an unexpected and relatively strong negative P-wave anomaly (up to -10 %) beneath the Rwenzori Mountains - down to at least 15 km. Other regions of low velocities are found in the north-eastern section of the array at shallower depths (above 10 km) and are likely related to sedimentary deposits. Higher velocities throughout the upper crust are found beneath the eastern rift shoulder and are thought to be related to old cratonic crust. The presence of low Vp velocities with high Vp/Vs ratio in the northwestern section of the array my be related to a magmatic intrusion beneath the Buranga hot springs. We also made an attempt to derive the 3D anisotropic velocity structure in the region. For the anisotropic inversion, we assume that the elastic properties of the crust can be characterized by a simplified form of transverse isotropy, which can be defined by four parameters: a fast and slow velocity and two angles to determine the orientation of the fast velocity axis. Average isotropic velocity variations obtained from the 3D anisotropic model are in good agreement with the results from the purely isotropic inversion. We find that the fast axes in the northern region of the Rwenzori Mts. are dominantly oriented NS, approximately parallel to the strike of major faults. Several tests are performed to constrain the uncertainties of the anisotropic model.