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Seismic structures of the Rwenzori region in Western Uganda derived from local and teleseismic earthquakes

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The Rwenzori Mountains are located within the Albertine rift in Western Uganda with altitudes exceeding 5000 m. We have carried out a passive-source seismological experiment in order to study the crust and mantle beneath the mountains within the framework of the multidisciplinary RiftLink research group. Local and teleseismic events have been recorded from May 2006 to September 2007. The project was performed with the objective of mapping active fault systems, investigating focal mechanisms and the velocity structure and anisotropy of the crust and lithosphere.
The recordings show very high seismic activity in the investigated area. We were able to locate an average of 800 local events per month. Focal depths reach down to 30 km on the eastern side of the mountains. In the northwestern part hypocenters are concentrated between 10 and 20 km. Also, a cluster of anomalous deep earthquakes has been detected which we attribute to delamination of the lithosphere or deep magmatic intrusions. P-wave polarities have been used to determine fault plane solutions. Our study reveals predominant normal faulting with strike directions approximately parallel to the rift axis.

In order to resolve the 3D velocity structure of the crust and upper mantle down to roughly 100 km local and teleseismic tomography has been applied using P and S arrival times. Pronounced negative velocity anomalies have been found in the upper five kilometers near the western flank of the Rwenzori mountain range which can be related to the Buranga hot springs. A deep anomaly in the central eastern part may indicate hot material ascending from the mantle.

Teleseismic events have been used to compute receiver functions revealing Moho depths of about 30 km in this region. The Rwenzori range is characterized by a complex inner crustal structure. We have found evidence for crustal thinning beneath the Rwenzori mountains with Moho depths ranging between 28 and 21 km. In the southeastern part, receiver functions indicate a low velocity layer within the crust.

Shear-wave splitting parameters derived from SKS phases reveal fast-polarization directions that are parallel to the rift with delay times of about 1.2 seconds. Measurements of shear-wave splitting from deep earthquakes (50-60 km) in combination with measurements from crustal and teleseismic events allow the discrimination between anisotropic contributions from the crust, mantle lithosphere, and asthenosphere. The results show that crustal anisotropy in the Rwenzori region is highly variable and relatively insignificant in comparison to anisotropy at greater depths that affects teleseismic phases.