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Seismic structure of the upper crust in the Albertine Rift from travel-time and ambient-noise tomography – a comparison

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Here we present results of the investigation of the upper crust in the Albertine rift around the Rwenzori Mountains. We use a data set collected from a temporary network of 33 broadband stations operated by the RiftLink research group between September 2009 and August 2011. During this period, 82639 P-wave and 73408 S-wave travel times from 12419 local and regional earthquakes were registered. This presents a very rare opportunity to apply both local travel-time and ambient-noise tomography to analyze data from the same network.

For the local travel-time tomographic inversion the LOTOS algorithm (Koulakov, 2009) was used. The algorithm performs iterative simultaneous inversions for 3D models of P- and S-velocity anomalies in combination with earthquake locations and origin times. 28955 P- and S-wave picks from 2769 local earthquakes were used. To estimate the resolution and stability of the results a number of the synthetic and real data tests were performed.

To perform the ambient noise tomography we use the following procedure. First, we follow the standard procedure described by Bensen et al. (2007) as modified by Boué et al. (2014) to compute the vertical component cross-correlation functions between all pairs of stations. We also adapted the algorithm introduced by Boué et al. (2014) and use the WHISPER software package (Briand et al., 2013) to preprocess individual daily vertical-component waveforms. On the next step, for each period, we use the method of Barmin et al. (2001) to invert the dispersion measurements along each path for group velocity tomographic maps. Finally, we adapt a modified version of the algorithm suggested by Macquet et al. (2014) to invert the group velocity maps for shear velocity structure. We apply several tests, which show that the best resolution is obtained at a period of 8 seconds, which correspond to a depth of approximately 6 km.

Models of the seismic structure obtained by the two methods agree well at shallow depth of about 5 km Low velocities surround the mountain range from western and southern sides and coincide with the location of the rift valley. The Rwenzori Mountains itself and the eastern rift shoulder are represented by increased velocities. At greater depths of 10 – 15 km some differences in the models care observed. Thus, beneath the Rwenzories the travel time tomography shows low S-velocities, whereas the ambient noise tomography exhibits high S-velocities. This can be possibly explained by the fact that the ambient noise tomography is characterized by higher vertical resolution. Also, the number of the rays used for tomographic inversion in the ambient noise tomography is significantly smaller.

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