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Constraints on the seismic structures of the Rwenzori region in western Uganda from local and teleseismic events

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Extended Abstract

Within the framework of the multidisciplinary RiftLink research group we have carried out a passive-source seismological experiment in order to study the Rwenzori Mountains in western Uganda close to the Congo border. Local and teleseismic events have been recorded during a period from May 2006 to September 2007. Our temporary network consisted of 8 broad-band Guralp CMG-3 T and 12 short period Mark L4C 3D seismometers located partly at varying locations in order to increase the spatial coverage but also to prevent vandalism. For local seismicity additional data is available from a project carried out by the BGR in the northern part of the Rwenzori region. Our aim is to map active faults and to derive the velocity structure of the crust and the uppermost mantle to constrain the development and uplift of the 5000 m high mountain range.

The microseismic activity in the region turned out to be unexpectedly high. On average 800 events have been located per month (Fig. 1). Their hypocenters are concentrated along the flanks of the mountains and the rift shoulder, but only a few of them are located within the Rwenzori massive itself. Localization and mapping of the hypocenters illustrate the position and orientation of active fault planes in the investigated area. On both sides of the northern Rwenzoris different seismicity patterns have been found: East of the mountains, beneath the rift shoulder, hypocenters span the entire crust and reach as deep as 30 km, while on the western side focal depths terminate at 20 km. This agrees with Moho depths derived from receiver functions. Also, the upper crust on the western side, i.e. within the rift valley, is aseismic down to 10 km depth. In addition, a cluster of unsual deep events has been detected. Most of the hypocenters in the study area are concentrated at a depth range from about 14 to 16 km. P-wave polarities are utilized to determine fault plane solutions for selected events. About 90 % of them reveal normal faulting with strike directions roughly parallel to the

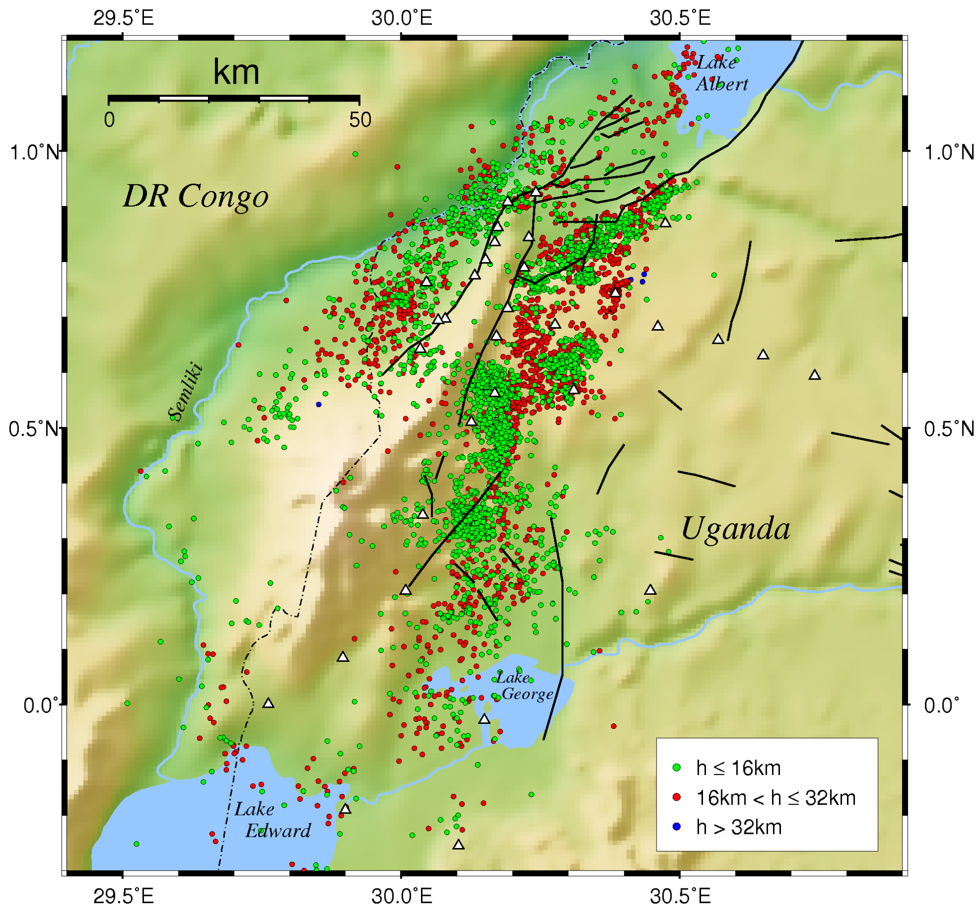

Fig. 1: Distribution of local seismicity and major faults

rift axis and extension forces perpendicular to it. Also, strike-slip and thrust mechanisms occur in some parts of the investigated area.

In order to resolve the 3D velocity distribution of the crust and upper mantle local and teleseismic data have been used for a joint tomographic inversion based on P wave arrival times. We have found a shallow pronounced negative velocity anomaly in the upper five kilometers near the western flank of the Rwenzori mountains. This can be related to the Buranga hot springs situated at the northern edge of this anomaly. Low velocities are also found in the southern part of the region at depths ranging from the upper crust down to about 50 km. This could partly be explained by the sedimentary cover but could also be due to a low velocity layer at 15 km depth, that was detected with receiver functions. The extension in depth of the anomaly derived from tomography may be caused by smearing effects as the resolution is quite low in this area. A further low velocity anomaly is detected at greater depth below 35 km in the central east. The anomaly reaches down at least 80 km and is probably connected to the asthenosphere.

Receiver functions have been computed from teleseismic events in order to image the crustal structure, i.e. seismic discontinuities. Our study reveals a rather simple crust beneath the eastern rift shoulder where a gradual velocity increase has been found. The

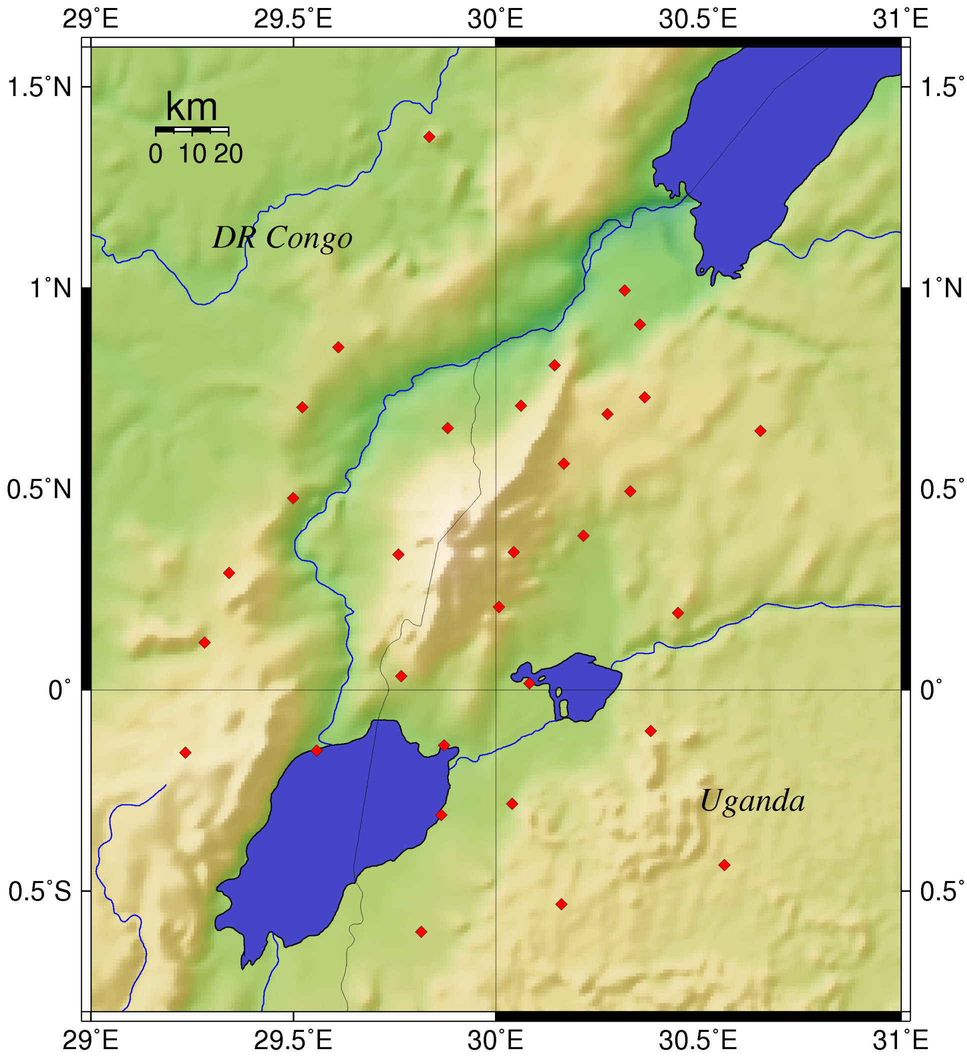

Fig. 2: Station distribution of the temporary network during the second field campaign.

Rwenzori range, however, is characterized by a complex inner crustal structure. We have applied different techniques using travel time and waveform information to derive the Moho depths beneath the stations. Our results provide evidence for the absence of a deep crustal root underneath the mountain range: Beneath the eastern rift shoulder the crustal thickness is rather uniform and only varies slightly around 32 km. Beneath the Rwenzori Mountains we find stronger variations and a significant thinning to 21 km at some station. The average Moho depths beneath the mountain range is approximately 24 km. In the southeastern part of our network, a pronounced negative phase is detected as mentioned above in the context of the low velocities in the south found by the tomography. We interpret this signal as the top of a low velocity layer at about 15 km depth. The strong velocity decrease in this layer may be indicative for partial melt that we relate to the volcanic fields situated in the south within the Lake Edward and Lake George Basins. The bottom of the layer is not detected at most of the relavant stations. A layer thickness of about 5 km is obtained from RF inversion.

The dataset will also be used for a detailed SKS splitting analysis which will provide constraints on anisotropy of the crust and upper mantle in the study area. A new network has been set up in September and October 2009 (Fig. 2). The area under investigation is thereby extended further to the south and to the west including ten stations in the D.R. Congo. This will significantly enhance the database in regions where the coverage has been poor so far. The new network will enable us to investigate also the structure and thickness of the crust as well as the local seismicity beneath the western rift shoulder.