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Multi Scale Imaging of Seismic Structure beneath the Western Branch of the East-African Rift

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In this study, we investigate the crustal and upper mantle velocity structure beneath the East African Rift System (EARS) as a whole and beneath the Rwenzori Mountains in western Uganda in particular. The most interesting features here is the mountain range of approximately 50 km-wide, with a length of about 150 km, which is situated within the western branch of the East African rift zone and reaches the altitudes of more than 5000 m. The joint tomographic inversion of teleseismic and local earthquake data was used to investigate the velocity structure beneath the Rwenzoris on a local scale down to the depth of about 75 – 80 km. The dataset contained arrival times from 2053 local and 284 teleseismic earthquakes recorded by a temporary network equipped 35 short period and broad-band stations covering the area of 140×90 km2. To estimate resolution ability and stability of the obtained results we performed many different tests. The tests show that the best horizontal resolution is achieved in the northern part of the study area, where the density of the ray coverage is highest. In shallow depths where rays from local earthquake dominate, the vertical and horizontal resolution is relatively high, while in deeper sections covered with teleseismic rays, the anomalies seem to be strongly smeared and can be interpreted only on a qualitative level. Velocity structure in the upper crust agrees with the distribution of the main geological units, such as sedimentary basins, igneous outcrops, thermal fields etc. For the uppermost mantle, our results reveal an inclined boundary between the high-velocity Tanzania craton and low-velocity patterns beneath the rift. The same feature was obtained in the regional tomographic study of the entire EARS based on the ISC data for the years from 1964 to 2007. The regional tomographic scheme uses the arrival times from earthquakes located in the study area which were recorded by worldwide stations. Velocity models were computed independently in several overlapping circular regions, and then combined in one model. The results of the regional tomography reveal presence of a high velocity root of the African and Tanzania cratons and two merged plumes beneath the Afar and Kenya. Based on the multiscale tomography results we conclude that beneath the Tanzania craton the mantle is overheated. The hot mantle material moves up along the bottom of the lithosphere and appears at the surface along the perimeter of the craton in western and eastern branches. This causes rifting and volcanic activity along Eastern and Wester branches of the craton.