Geophysical Research Abstracts
Vol. 17, EGU2015-8591-2, 2015
EGU General Assembly 2015

Rheological variations across an active rift system – results from lithosphere-scale 3D gravity and thermal models of the Kenya Rift

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Due to its tectono-volcanic activity and economic (geothermal and petroleum) potential, the eastern branch of the East African Rift System (EARS) is one of the best studied extensional systems worldwide and an important natural laboratory for the development of geodynamic concepts on rifting and nascent continental break-up. The Kenya Rift, an integral part of the eastern branch of the EARS, has formed in the area of weak Proterozoic crust of the Mozambique mobile belt adjacent to the rheologically stronger Archean Tanzania craton. To assess the variations in lithospheric strength between different tectonic domains and their influence on the tectonic evolution of the region, we developed a set of structural, density, thermal and rheological 3D models.

For these models we integrated multi-disciplinary information, such as published geological field data, sediment thicknesses, well information, existing structural models, seismic refraction and reflection data, seismic tomography, gravity and heat-flow data. Our main approach focused on combined 3D isostatic and gravity modelling. The resulting lithosphere-scale 3D density model provides new insights into the depth distribution of the crust-mantle boundary and thickness variations of different crustal density domains. The latter further facilitate interpretations of variations of lithologies and related physical rock properties. By considering lithology-dependent heat production and thermal conductivity, we calculate the conductive thermal field across the region of the greater Kenya Rift. Finally, the assessed variations in lithology and temperature allow deriving differences in the integrated strength of the lithosphere across the different tectonic domains.