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Crustal structure of the southern Ethiopian rift: evidence from forward and inverse modeling of gravity and topographic data

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Crustal structure along the transition between the southern Main Ethiopian Rift (MER) and the Turkana rift in northern Kenya is virtually unknown. In this study using forward modeling of new and existing Bouguer gravity, the distribution of crustal thinning in the southern sector of the Ethiopian rift is examined. This is supplemented by the maximum entropy method of spectral analysis of Bouguer gravity and topographic data. The aim of the spectral analysis of combined gravity and topographic data is to assess the small-scale variation of lithospheric strength along north-south axis of the rift system.

The result of the 3D forward modeling of gravity profile across three rift zones revealed that the crust beneath the Omo rift is significantly thin (22 km) as compared to the ChewBahir and Ganjuli grabens which are characterized by crustal thickness of 28 km and 30 km, respectively. The strong correlation between active seismcity and crustal thinning beneath the Omo rift suggests that the transition between the southern MER and the Turkana depression has experienced different episodes of rifting history which resulted in thinning of the crust.

The result of the maximum entropy method of spectral analysis of Bouguer gravity and topographic data shows that effective elastic plate thickness (Te) varies from 27 ± 5 km in the northern part of the Omo rift to 17 ± 6 km beneath the Turkana graben. This result allows to examine the relationship among the thickness of the strong upper crust, Te, total crustal thickness and the thickness of the mechanical mantle. The relationship between these parameters is discussed in light of the response of the lithosphere to surface and subsurface loads.