Constraining strain and magmatism patterns between the Ethiopian and East African plateaux from new seismic and geodetic data

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Lateral heterogeneities in crust and mantle structure influence the distribution of strain and magmatism in continental rift zones. Sutures between Archaean cratons and younger orogenic belts represent some of Earth's largest lateral heterogeneities: > 170 km-thick, buoyant and relatively dry lithosphere juxtaposed to ~120 km-thick, more volatile-rich mantle lithosphere. The seismically and volcanically active Turkana Depression between the Ethiopian and East African plateau magma-rich Eastern rift formed near the eastern edge of the Archaean Tanzania craton. This area was affected by rifting in Mesozoic and Paleogene time, and may have been a thin zone when magmatism started at ~40 Ma. Several hypotheses had been proposed to explain the unusual ~300 km-breadth of the Turkana Depression. We use new data from the Turkana Rift Arrays to Investigate Lithospheric Structure (TRAILS) to evaluate spatial variations in the location of strain, and in the direction and magnitude of seismic anisotropy, which is strongly influenced by mantle flow patterns along lithosphere-asthenosphere topography, fluid-filled cracks (e.g., dikes), and pre-existing mantle lithosphere strain fabrics. Complementary data sets provide a strong contextual framework. Our results and those of regional studies show that strain is currently localized to ~100 km-wide section of the Depression, and the western sectors are inactive. We suggest that the original location of strain and magmatism was near the eastern edge of the Tanzania craton above a steep lithosphere-asthenosphere gradient, and that rifting has migrated eastward to form a more contiguous zone between the Main Ethiopian and Eastern rift zones.