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**“Fluid fluxes and crustal dynamics: New Insights from rift zones”**

ABSTRACT: Rift initiation in thick, strong continental lithosphere challenges current models of continental lithospheric deformation, in part owing to gaps in our knowledge of strain patterns in the lower crust, and the role of volatiles and magmatism in rift initiation. New geophysical, geochemical, and structural data sets from youthful magmatic (Magadi-Natron, Kivu), weakly magmatic (Malawi, Manyara), and amagmatic (Tanganyika) sectors of the cratonic East African rift system provide new insights into the distribution of brittle strain, magma intrusion and storage, and time-averaged deformation. Not only do volcanoes throughout the region have very high $CO_2$ fluxes, but mantle xenoliths show widespread alteration in the presence of mantle-derived fluids. How do the upward percolating fluids influence the distribution of strain and magmatism? We compare and contrast time-space relations, seismogenic layer thickness variations, and fault kinematics using earthquakes recorded on local arrays and teleseisms in sectors of the Western and Eastern rifts, including the Natron-Manyara basins that developed in Archaean lithosphere. Lower crustal seismicity occurs in both the magmatic and amagmatic rift sectors, including sectors on and off craton, and those with and without central rift volcanoes. Lower crustal seismicity along projections of border faults with active $CO_2$ venting may be caused by high gas pressures and volatile migration from active metasomatism and magma degassing. Tomographically imaged mid-crustal sill(s) and magma chambers in a < 5 My old basin attest to the rapid rise of magma and transition within cratonic lithosphere. Volatile release and migration may be critical to strength reduction of initially cold, strong cratonic lithosphere. In weakly magmatic rift zones, the spatial and depth distribution and rate of earthquakes are highly variable along-strike, with activity levels in higher in zones of lower crustal seismicity, which may signal active magmatic underplating. Our comparisons suggest that large offset faults that develop very early in rift history create fluid pathways that maintain the initial along-axis segmentation until magma (if available), reaches mid-crustal levels and initiates a new magmatic segmentation.