Afar and the East African Rift - a lithosphere in transition

TYRONE O. ROONEY*

Michigan St. Univ., E. Lansing, MI 48824, U.S.A.,
*(correspondence: rooneyt@msu.edu)

A central tenet of the plate tectonic paradigm requires that, as a continent breaks apart to form an oceanic basin, it must be accompanied by a transition from continental to oceanic lithosphere. While deceptively simple as a concept, it is, in practice, a significant challenge to establish the precise mechanisms that facilitate this transition. Spanning the gamut of extensional morphologies from initiation to mature rifting, it is currently active continental rifts such as the East African Rift that hold the keys to this transition.

Magma generation and emplacement is a primary pathway facilitating element flux and lithospheric weakening - processes central to the continent to ocean transition. In East Africa, the dominant magma reservoirs have been identified as: continental lithosphere, ambient depleted mantle, and one or more mantle plumes. The formation of exotic melts by thermo-baric perturbation of easily fusible metasomatic mantle domains facilitates internal redistribution of elements, and provides weak zones within the continental lithosphere. The interaction of a thermo-chemical mantle plume with the lithosphere results in the eruption of flood basalts, formation of magmatic underplates, and metasomatic re-enrichment of the continental lithosphere. Associated thermo-mechanical erosion and melt-related weakening may facilitate rifting. As a precursor to oceanic lithosphere formation, mature rifts exhibit decompression melting of the ambient upper mantle and other reservoirs, which result in the wide-scale replacement of continental crust with basalt, and the eventual destruction of the continental lithospheric mantle.