

A unified mantle plume hypothesis for the East African Rift System

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Magmatism along the East African Rift System (EARS) is generally believed to be related to mantle plume activities, but the number and nature of mantle plumes are controversial. Recent geophysical data indicate the African Superplume as the main source of plume magmatism [1]. On the other hand, the highly variable composition of EARS volcanic rocks appears to suggest a plume centered at or near the Afar region in the northern EARS [2] and a number of plumes in the southern EARS such as those in e.g., Kenya Rift, Virunga volcanic province, Rungwe volcanic province, and the whole southern EARS. However, closer inspection of available data provides support for an alternative hypothesis that the compositions of EARS plumes converge to a single plume with a restricted range in composition [3]. The hypothesis posits that the observed variation of EARS lavas is mainly due to mixing of material from the Superplume with the compositionally variable lithospheric mantle beneath the isotopically depleted, Late Proterozoic Pan-African mobile belt and isotopically enriched, Early Proterozoic Nubian plate (+/- Archaean Tanzanian craton). Additionally, the Superplume has been modifying the lithospheric mantle beneath the entire region to a ~common composition through carbonatite metasomatism for, at least, 500 my [4]. This has created a fourth, pseudo lithospheric mantle source, which is mainly characterized by extremely high incompatible trace element contents, but restricted, ~near bulk silicate Earth Sr and Nd isotopic ratios. Although there are exceptions, mixing of Superplume/metasomatized lithosphere with Pan-African lithospheric mantle produces the bulk of lavas from the northern EARS as far south as the northern Kenya Rift. In contrast, mixing with lithospheric mantle beneath the Nubian plate/Tanzanian craton (+ variable upper crust) produces the bulk of lavas from the southernmost Kenya Rift and Western Rift. A depleted upper mantle contribution appears minimal and restricted to the northernmost EARS. EARS lavas have highly variable Pb isotopic ratios because of the variable Pb isotopes of the lithosphere and the Superplume is a young HIMU type, generated mainly from recycled marine carbonate with inherently high U/Pb ratio [5].

[1] Hansen *et al* (2012) *EPSL* **319-320** 23-34. [2] Rooney *et al* (2012) *JPet* **53**, 365-389. [3] Castillo *et al* (2012) *AGU Fall Meeting Abst.* T43C-2687. [4] Vollmer & Norry (1983) *EPSL* **64**, 374-386. [5] Castillo (2013) *Min. Mag.* **77.5**, 838.