Sustained role of a mantle plume in Ethiopia and Afar

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The East African Rift System (EARS) represents one of the best locations to study the evolution of continental rifting as it transitions toward an oceanic spreading regime dominated by decompressional melting. While a mantle plume appears to have played a key role in initianing rifting at the northen extent of the EARS, the present thermal anomaly and estimated depths of melt formation are less extreme than in other plume-influenced regions. Therefore, the forces involved in sustaining rifting are not entirely clear: can relic plume material stored in the shallow mantle account for the geochemical and geophysical observations? Or does ongoing deep mantle upwelling continue to assist in melt production and rifting?

Our study explores the unique geodynamic implications of combining geochemical datasets with geophysical observations. We assembled a large dataset of new and published fluid inclusion $^{3}He/^{4}He$ measurements from mafic minerals to produce a He isotope "map" covering the Ethiopian and Afar Rifts. The striking correlation between the He isotope map and tomographic S-wave velocities, which are thought to primarly reflect shallow melt content, suggests deep mantle input continues to encourage melting. The correlation is less clear in Afar where mobilization of relic plume material stored in the shallow mantle – augmented by localized upwelling of high $^{3}He/^{4}He$ material – seems a more likely explanation.