Mantle volatile signatures from the East African Rift and the origin of economically-viable helium-rich seeps

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The East African Rift System represents a classic example of modern day rifting and early stage continental breakup. Rifting and volcanism traverse two prominent uplifted plateaus: the Ethiopia and Kenya domes. The Ethiopia Dome hosts the Afar and Main Ethiopian rifts, which splits into the Western and Kenyan rifts, and encircles the Archean-aged Tanzanian Craton. Geophysical and seismic constraints suggest that dynamic support for the elevated topography of the domes is derived from upwelling convective mantle.

Geochemical evidence (e.g., $^{3}He/^{4}He$) strongly suggests a primordial mantle plume origin for convective uplift in the Ethiopia Dome. In contrast, volatiles from the Kenya Dome display an admixture of upper-mantle and plume-like signatures, likely due to extensive crustal contributions associated with the thick Tanzanian Craton and the transient nature of deep mantle volatile contributions. Within this framework, I will discuss the distribution of mantle and crustal volatiles in Tanzanian lavas, gases, and fluids, as well as the apparent discrepancy in He isotopes between these various phases.

In addition, I will discuss the origin of high concentrations of radiogenic helium in gas seeps found on the periphery of the Tanzanian Craton. These unique features are likely related to the heating and fracturing of the Archean Tanzanian Craton and Proterozoic Mozambique Belt by the younger, Western and Kenyan rifts (< 5 Ma). The distribution of high helium seeps along active faults shows increased communication between the shallow and deep crust. This, combined with the presence of gas traps in the region, suggests that there may be a significant recoverable helium resource in Southern Tanzania.