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Comparing the composition of the earliest basalts erupted by the Iceland and Afar mantle plumes.

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The first basalts erupted by mantle plumes are typically generated by mantle melting at temperatures 200–300°C higher than average ambient mantle. This is consistent with the derivation of from a thermal boundary layer at the core-mantle boundary. Mantle plume temperatures decrease with time, likely as large plume heads give way to thin plume conduits. Consequently the early, hot plume basalts are a window into the deep mantle. At it's simplest they provide a test of whether the discrete plume source regions are primordial mantle that have been isolated since soon after Earth accretion, or have substantial contributions from subducted slabs.
Here I present new isotopic and trace element determinations of the earliest picritic basalts from the ∼30 Ma Afar plume in Ethiopia. They will be compared with similar material from the ∼60 Ma proto-Iceland plume (PIP) in an effort to test prevailing models regarding the source of mantle plumes. The extremely primordial nature of the helium in the PIP picrites (3He/4He ∼ 50 Ra) contrasts with much lower values of the Ethiopian flood basalt province (∼21 Ra). The Iceland plume 3He/4He has decreased (linearly) with time, mirroring the secular cooling of the Iceland mantle plume identified by decreasing MgO and FeO in primary melts. In 60 million years the Iceland plume 3He/4He is still higher than the maximum Afar plume value. The Sr-Nd-Pb isotopic composition of the high 3He/4He Ethiopian flood basalt province picrites are remarkably homogenous (e.g. 87Sr/86Sr = 0.70396–0.70412; 206Pb/204Pb = 18.82-19.01). In comparison the PIP picrites have ranges that span nearly the global range of E-MORB and N-MORB. The Afar and proto-Iceland mantle plumes are clearly not initiated in a single deep mantle domain with the same depletion/enrichment and degassing histories, and the same scale of heterogeneity. This implies that there is more than one plume source region/mechanism that is capable of generating comparable volumes of basalt melt at Earth surface.