Isotope composition of high Ti picrites from the Ethiopian Flood Basalt province: implications for the source and evolution of mantle plumes.

FINLAY M. STUART[1] NICK ROGERS[2] MARC DAVIES[2] SAM HAMMOND[2] IAN PARKINSON[3] GEZAHEGN YIRGU[4]

[1] Scottish Universities Environmental Research Centre, East Kilbride G75 0QF, UK (fin.stuart@glasgow.ac.uk)
[2] School of Environment Earth and Ecosystems, The Open University, Milton Keynes, UK (nick.rogers@open.ac.uk)
[3] School of Earth Sciences, University of Bristol, Bristol, UK (ian.parkinson@bristol.ac.uk)
[4] School of Earth Sciences, Addis Ababa University, Addis Ababa, Ethiopia

Olivine phenocrysts from 20 early high Ti picritic basalts erupted in the Ethiopian Flood Basalt province have $^{3}He/^{4}He$ of up to 22 R_a. This upper limit is slightly higher than previously measured and is the highest value yet recorded from any part of the east African Rift system. Basalts with MgO = 15-16 wt % (the primitive composition of the HT2 basalts) have the highest $^{3}He/^{4}He$. Samples with higher (and lower) MgO have likely accumulated (or lost) olivine during storage prior to eruption, which allowed magmatic He to exchange with more radiogenic lithosphere He. Consequently the $^{3}He/^{4}He$ range provides no constraints on source heterogeneity. Sr (0.703955– 0.704081) and Nd isotopes (0.512912-0.512987) show minimal variation. Pb isotope variation is significant but small ($^{206}Pb/^{204}Pb_i$ = 18.698-19.043) likely reflects large scale mixing of the Afar plume and continental mantle lithosphere. A secular change in $^{3}He/^{4}He$ of the Ethiopian is associated with a reduction in the depth of melt generation, and mantle potential temperature and a reduction in the proportion of pyroxenitic material in the mantle source. These observations are at odds with a model in which the high $^{3}He/^{4}He$ is associated with a homogeneous peridotitic component in the Afar mantle plume. The covariation of Tp with $^{3}He/^{4}He$ may point to a common origin for the high temperature and ^{3}He in mantle plume heads. The results differ significantly from the proto-Iceland plume picrites which has significantly higher $^{3}He/^{4}He$ and highly variable trace element and isotopic composition.