Europium anomaly in the MORB source mantle

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The bulk continental crust has a negative Eu anomaly based on observations of crustal samples[1,2]. Such Eu depletion in the crust likely results from lower crustal recycling. Based on the observed positive Eu anomalies in primitive mid-ocean ridge basalts (MORB) from the East Pacific Rise, Niu and O'Hara[3] suggested that the MORB mantle may host the Eu that is missing from the continental crust.

We determined high precision Eu/Eu* for 72 primitive MORB glasses (MgO > 8.5%) from the Pacific, Indian and Atlantic mid-ocean ridges. The mean Eu/Eu* of 46 MORB glasses with MgO ≥ 9 wt.% is 1.025 ± 0.025 (2 σ_m), thus the upper mantle, as sampled by MORB, is unlikely to possess a positive Eu anomaly that compensates the Eu deficit in the continental crust. Primitive MORB samples show both positive and negative Eu anomalies, with no correlation between Eu/Eu* and MgO contents. Modeling Sm-Eu-Gd fractionation during spinel peridotite partial melting suggests that the weak positive and negative Eu anomalies seen in primitive MORBs may result from greater incompatibility and faster diffusivity of Eu (II) relative to Sm and Gd during generation of early vs. late melt fractions, respectively.

The MORB source mantle and continental crust do not appear to be complementary reservoirs with respect to Eu, and a third reservoir is required for mass balance in the bulk silicate Earth. The mantle source of ocean island basalts (OIB) may contain recycled lower continental crust as suggested by (1) significant positive Eu anomalies in the bulk primitive OIB samples, and (2) an anti-correlation between Eu/Eu* and $^{206}Pb/^{204}Pb$ for OIB locality averages. These observations suggest a dynamically unstable, dense lower continental crust that founders to the bottom of the mantle.

[1] Rudnick and Gao (2014) in: Holland, H.D., Turekian, K.K. (Eds.), *Treatise on Geochemistry (Second Edition)*. Elsevier, Oxford, pp. 1-51 [2] Tang et al (under review in *Geology*) [3] Niu and O'Hara (2009) *Lithos* **112**, 1-17