Multiple early Earth differentiation events revealed by ^{142}Nd, ^{182}W, and HSE abundances in Isua samples

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The short-lived ^{146}Sm-^{142}Nd and ^{182}Hf-^{182}W systems have the potential to provide information about the earliest phases of Earth's evolution. Eoarchean metabasalts from the Isua Supracrustal Belt are characterized by ^{142}Nd excesses relative to the terrestrial standard of as much as 13 ppm. Coupled with ^{147}Sm-^{143}Nd, these results suggest that the mantle source of these rocks differentiated at 4.47± 0.05 Ga [1]. The same metabasalts are also characterized by excesses of up to 15 ppm of ^{182}W. These positive anomalies were previously interpreted to reflect incomplete mixing of late accreted materials into the mantle source of the rocks [2]. Absolute and relative abundances of highly siderophile elements (HSE) in seven metabasalts, however, are similar to those of modern basalts. We also analyzed rocks from seven spatially-related ultramafic units. Two samples show low abundances of all HSE measured, except for Ru. This kind of HSE depletion in ultramafic rocks has previously been interpreted to reflect sulphide break down during emplacement, or late stage mobility of sulphide [3]. The other ultramafic samples analyzed show similar HSE abundances to modern lherzolites. If the "normal" HSE abundances of the metabasalts and ultramafic rocks are reflective of their mantle source, they are inconsistent with derivation from mantle that is missing a late accretionary component. One alternate explanation for the ^{182}W excesses is that they were created by a mantle differentiation event that occurred during Earth's first 50 Ma, subsequent to primarly late accretion. The different time scales for ^{142}Nd and ^{182}W growth, however, might require two or more events to account for enrichments in both systems. Alternately, the enriched ^{182}W but "normal" HSE may reflect geochemical decoupling of W from HSE, perhaps by fluid mobilization. The ultimate source of the excess ^{182}W remains problematic.

[1] Rizo *et al* (2011) *EPSL* **312.** [2] Willbold *et al* (2011). *Nature* **477.** [3] Fischer-Godde *et al* (2011) *Chem. Geol.* **280**, 365-383.