Ancient ^{182}W Signatures in Modern Ocean Island Basalts

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The short-lived ^{182}Hf-^{182}W isotope system ($t_{1/2}$ = 8.9 Ma) is an important tool to study processes that took place within the first 60 Ma of Solar System (SS) formation. Hafnium is fractionated from tungsten by metal-silicate segregation, as well as silicate crystal-liquid fractionation processes. If such processes occur during the lifetime of ^{182}Hf, materials with diverse tungsten isotopic compositions result.

Some ocean island basalts (OIB) have been interpreted to derive from deep-seated, primitive mantle domains. Evidence for this includes the existence of basalts with high ^{3}He/^{4}He, consistent with contributions to their mantle sources from un-degassed, primitive mantle domains. Evidence for the existence of primitive mantle domains might also be provided by short-lived radiogenic isotope systems, such as Hf-W.

Here, we report ^{182}W data for OIB from several hotspots, some representing major endmember components (EMI, EMII, HIMU) defined by long-lived radiogenic isotope systems. Samples from Hawaii, Samoa, Iceland, Pitcairn and the Caroline hotspots are characterized by ^{182}W/^{184}W ratios that range from normal to as much as 18 ppm lower than the ambient, modern upper mantle. While ^{182}W shows no correlation with long-lived radiogenic isotope systems (Pb, Os, Nd, Sr), a negative-correlation of ^{182}W with ^{3}He/^{4}He is observed.

The deficits in ^{182}W compared to modern upper mantle, coupled with high ^{3}He/^{4}He may reflect contributions from one or more deep Earth domains which formed with low Hf/W and primitive noble gas compositions, within the first 60 Ma of SS history. Potential candidates include the core, and metals that formed by disproportionation reactions in early magma oceans, and that may now be stranded in the lower mantle. The presence of the primitive isotopic signatures in modern rocks reveals that the primitive domains have somehow remained isolated from the convective mantle for all of Earth history.