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A multi-siderophile element connection to Earth's core?

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The discovery of nearly ubiquitous correlations between He and anomalous W isotopic compositions among global ocean island basalts (OIB) has reignited discussion surrounding core-mantle interaction and its impact on the planetary mass balance of siderophile elements [1]. We report a moderately strong positive correlation between published W isotopic compositions and Ru/Ir ratios among Hawaiian and Icelandic OIB. The abundances of highly siderophile elements (HSE) like Ru and Ir can be modified by fractional crystallization, however the correlations persist despite (Hawai'i: MSWD = 2.9) or are improved by (Iceland: MSWD = 0.7) a correction for fractional crystallization, suggesting that there is a different control on the Ru/Ir ratios of OIB sources. Similar to the observed $^{3}He/^{4}He$-$^{182}W/^{184}W$ correlations, the Ru/Ir-W correlations for Hawai'i and Iceland possess distinct slopes (6.3 ±4.3 and 2.1 ±2.5, 95% c.i., respectively).

Metal-silicate equilibration may variably fractionate HSE in theoretical core-mantle equilibrated domains [2]. We explore several models in which the observed correlations can be reproduced. In general, models that assume metal-silicate equilibration under modern core-mantle boundary conditions (c.f., [1]) produce Ru/Ir-W trends that are much steeper than either Hawai'i or Iceland OIB. The data for Hawai'i OIB are better matched by models assuming that metal-silicate equilibration occurs at relatively low pressures, such as those expected for terrestrial core formation (e.g., [3]). The best match to data for both hotspots occurs when the equilibrated domain is additionally assumed have not inherited its W isotopic composition directly from the core, but rather has a W isotopic composition between the core and modern depleted mantle compositions. These conditions are compatible with a model in which a low-$^{182}W/^{184}W$ domain formed very early in Earth's history, possibly contemporaneously with core formation, which could permit a range of Hf/W ratios compatible with variable modern W isotopic compositions. Protracted interaction between such domains and the silicate Earth, potentially through time-integrated mantle plume flux, may have profoundly affected its siderophile budget over its history.

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