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Tungsten isotopic compositions of high-$^3He/^4He$ Baffin Island lavas

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High $^3He/^4He$ ratios associated with some mantle plumes may be evidence of primordial reservoirs in the deep mantle that have been preserved since planetary accretion. Alternatively, the outer core may supply ^3He-rich helium to mantle plumes [1]. To test this hypothesis, we analyzed the tungsten isotopic compositions of glass rims from eight pillow lavas on Baffin Island (Canada), where lavas have the highest known $^3He/^4He$ ratios of any terrestrial igneous rocks (50 times the atmospheric ratio) [2]. Tungsten isotopes are uniquely well suited for detecting core material in lavas because (a) tungsten is siderophile in metal-silicate systems and therefore abundant in the core and (b) the $^{182}W/^{184}W$ of the core is ~200 ppm lower than the mantle [1]. This isotopic difference arose because the decay of ^{182}Hf, an extinct radionuclide ($t_{1/2}$ = 8.9 Myr) of the highly lithophile hafnium, produced radiogenic ^{182}W in the silicate portion of Earth after core formation while ^{182}Hf was extant. Determining the $^{182}W/^{184}W$ of Baffin Island lavas is important, not only because their $^3He/^4He$ ratios imply that their mantle source might be relatively primitive, but also because previous $^{182}W/^{184}W$ measurements of these lavas yielded anomalously high $\mu^{182}W$ (+8.3 ± 5.6 and +48.4 ± 4.6 [3]) relative to Earth's mantle (0), ocean island basalts (+3 to -18 [4]), and ancient rocks (+10 to +15 [5]). To our knowledge, these data represent the only positive ^{182}W anomalies measured in high-$^3He/^4He$ lavas; elsewhere high $^3He/^4He$ and low $^{182}W/^{184}W$ ratios are negatively correlated, consistent with core-derived helium and tungsten in mantle plumes. The Baffin Island source, therefore, could provide unique insights into the chemical heterogeneities of the lower mantle.

[1] Rizo et al. (2019) *Geochem Prespec Lett. 2*, 6–11. [2] Stuart et al. (2003) *Nature* 424, 57–59. [3] Rizo et al. (2016) *Science* 352, 809–812. [4] Mundl et al. (2017) *Science* 356, 66–69. [5] Reimink et al. (2020) *G-Cubed* 21, 1–16.