Early silicate differentiation of the Isua mantle? Insights from Tungsten isotopes and HSE abundances

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Interpreting the origin of $^{182}$W anomalies in mafic Archean rocks and the role of a putative missing late veneer hinges on tightly constraining the Archean mantle abundances of highly siderophile elements (HSE). However, most HSE estimates for Archean mantle-derived rocks are based on their mafic derivatives, an approach with large uncertainties. Previous $^{182}$W isotope studies did either not include measurements of HSE or examined inadequate mafic-ultramafic lithologies, where the ultramafic rocks could not unambiguously be identified as mantle peridotites.

Here, we present the first high-precision W-isotope measurements for $>3.8$ Ga old peridotites from Isua that unambiguously show the geochemical characteristics of depleted mantle harzburgites or associated dunites. These mantle peridotites exhibit resolvable excesses in $^{182}$W of $+15$ ppm ($\pm 2$ ppm, 95% conf. limit). The observed absolute abundances and ratios of the PGE (Os, Ir, Ru, Pd, Pt), have previously shown to equal those of modern mantle peridotites, arguing against a missing late veneer component in these rocks. Our data are further corroborated by $^{182}$W- and $^{176}$Lu-$^{176}$Hf isotope data for 3.72 Ga boninite-like metabasalts from the Isua supracrustal belt and 3.4 Ga Ameralik dikes. Both rock suites exhibit excesses in $^{182}$W up to $+20$ ppm. Positive initial $\varepsilon_{Hf}$ values point to a derivation from a depleted mantle source. At a first glance, this would tentatively support models, where an early depletion of the Isua mantle might have caused the $^{182}$W anomalies. However, up to 100 fold enrichments of W in many samples relative to similarly incompatible elements like Th argue for selective W mobilization. Hence, inheritance of the anomalous W isotope signatures from metasomatic fluids or from subduction zone components in an arc setting can therefore not be ruled out.