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Heterogeneous Hadean chemical evolution revealed by ^{142}Nd, ^{143}Nd and ^{176}Hf isotopic variations in Meso-Eoarchean terranes, Southwest Greenland

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Variations in ^{142}Nd signatures (from ^{146}Sm decay; half-life = 103myr) derive from silicate differentiation processes occurring in the first ca. 300 myr of Earth history. Previous studies have demonstrated the existence of positive (up to +20 ppm) anomalies compared with modern rocks in the Eoarchean Itsaq gneiss complex (IGC) of Southwest Greenland. Here we extend this work in both space and time and present new, high precision ^{142}Nd data for mafic dykes cutting the IGC, and from samples dated by U-Pb zircon SHRIMP from presently adjacent Mesoarchean terranes including Kapisilik, Tuno, Akia, and Tasiusarsuaq [1], as well as from heavy mineral separates from stream sampling. A notable result is that Mesoarchean samples have positive ^{142}Nd anomalies of +4 to +9 ppm for both felsic and mafic samples, including all samples from the 3.07 Ga Ivisaartoq mafic/ultramafic pillow basalt complex. This suggests a long-lived mantle signature rather than reworking of Eoarchean crust. As the Mesoarchean terranes did not amalgamate with the IGC and first share a common history until later in the Archean [1], the high ^{142}Nd domain was likely originally a much larger (>10^5km^2), regional chemical feature. Initial ^{176}Hf is not simply correlated with Nd. For example, some Mesoarchean rocks from Ivisaartoq have positive epsilon ^{176}Hf and ^{143}Nd, with an epsilon ^{176}Hf - ^{143}Nd array similar to the IGC and distinct from the traditional Hf-Nd isotopic correlation. Also, at 3.72Ga the Isua supracrustal belt ‘garbenschiefer’ unit of boninitic-like chemistry and units of the same age with island arc tholeiite–like chemistry, show positive and chondritic initial epsilon^{176}Hf, respectively, but identical +13±2 ppm ^{142}Nd anomalies. This requires Lu/Hf fractionation event(s) that post-dated and were thus unrelated to Hadean Sm/Nd fractionation. This more accords with a petrologic model of lithospheric residual garnet storage rather than magma ocean generation of high Lu/Hf domains.

Contrasting isotopic histories for SW Greenland terranes as compared with some other Archean regions emphasise that Hadean-formed and persistent (>1.5 byr) chemical heterogeneities, reflecting the existence of variable but synchronous geodynamic regimes, may be a key characteristic of early Earth.

[1] Friend and Nutman (2019), *Gondwana Research* 72, 213-237.