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Tracking Hadean Chemical Domains in Time and Space using Neodymium-142 Isotopic Signatures Measured from southwest Greenland Terranes

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Variations in ^{142}Nd isotopic compositions in terrestrial rocks record chemical fractionation events (changes in trace element patterns, i.e. Sm/Nd ratios) occurring within the first ca. 400 myr of solar system history, that is whilst the parent isotope ^{146}Sm ($t_{1/2}$= 103 myr) was actively decaying. The preservation of these Hadean formed isotopic anomalies in younger rocks thus provides a powerful tracer of geologic processes associated with the formation and destruction of early mantle chemical reservoirs. Moreover, ^{142}Nd isotopic signatures are largely impervious to secondary alternation events.

To investigate further the ^{142}Nd record in time and space we have determined precise isotopic compositions using multidynamic TIMS measurements for geographically, compositionally and chronologically diverse samples from terranes across southwest Greenland. This builds on previous, more restricted work, focussed largely on the 3.7-3.8Ga Isua supracrustal belt. The new data are from samples ranging in age from ca. 3.0 to 3.9 Ga and include regional 3.2 Ga to 3.5 Ga mafic dyke swarms (Nutman et al, 2004). The samples are regionally extensive including from newly-dated Archean nunataks within the inland ice (Nutman, 2021). The analysed samples are compositionally diverse including rare Eoarchean gabbros with MORB-like trace element compositions.

The ^{142}Nd isotopic anomalies are from 0 to +19 ppm relative to modern terrestrial values with the majority of samples having strongly positive (>+10 ppm) signatures. There is no evidence of negative ^{142}Nd signatures as previously described in three Archean mafic dykes (Rizo et al, 2012), suggesting this is a localised feature. Where possible ^{176}Hf isotopic compositions were obtained from zircons extracted from the same rocks, including rare igneous zircons from metagabbros. Initial ε_{Hf} reproduce previous observations of near chondritic values for many samples (e.g. Hiess et al, 2009) but also confirm localised highly positive Eoarchean initial ε_{Hf} ($\leq$+7) in boninite-like rocks, as previously documented by Hoffmann et al. (2010) from whole rock studies. ^{142}Nd values are not correlated with ^{176}Hf compositions. The expanded ^{142}Nd dataset integrated with geologic and other isotopic and geochemical observations provides new perspectives on the extent, origin and mineralogical controls on the evolution of chemical domains in the early Earth (Hadean-Archean).