Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23825

Early Earth evolution characterized by extensive and persistent Hadean-formed mantle domains as recorded in isotopic (^{142}Nd, ^{176}Hf, ^{143}Nd) patterns of Meso-Eoarchean (2.8-3.9 Ga) terranes, SW Greenland.

VICKIE C. BENNETT[1] AND ALLEN NUTMAN[2]

[1]Research School of Earth Sciences, The Australian National University

[2]GeoQuEST, School of Earth, Atmospheric and Life Sciences, University of Wollongong

Presenting Author: vickie.bennett@anu.edu.au

The Eoarchean terranes of SW Greenland, known collectively as the Itsaq gneiss complex (IGC; ca. 3000 km^2) and including the Isua supracrustal belt are characterised by positive ^{142}Nd anomalies of up to +20 ppm [e.g., 1] compared with modern rocks. As variations in ^{142}Nd isotopic compositions reflect Sm/Nd fractionation during the first ~300 myr of solar system history, when the parent ^{146}Sm ($t_{1/2}$=103 myr) was actively decaying, or nucleosynthetic component variability, they are undisputed recorders of Hadean processes and importantly, are considered largely immune to secondary alteration. To understand the origins and significance of terrestrial ^{142}Nd variations, we have extended this work in space and time. The Eoarchean IGC is bordered across major Archean faults (terrane boundaries) to the northwest and southeast by extensive Mesoarchean terranes recognised over >90,000 km^2, each with distinct geologic histories [2]. From these terranes, high precision ^{142}Nd compositions from U-Pb dated mafic and felsic Mesoarchean samples demonstrate widespread positive ^{142}Nd anomalies, dramatically extending the known extent of these Hadean signatures.

Literature Hf isotopic data along with new data from zircon populations extracted from rocks using the approach developed in [3] to obtain accurate initial ^{176}Hf, shows most Mesoarchean samples have chondritic to slightly superchondritic Hf compositions, with negative values only found in rare instances of confirmed local re-working of older Eoarchean crust. The ^{143}Nd-^{176}Hf patterns are similar to those documented for the older IGC and interpreted as the evolution of a distinctive long-lived, Hadean mantle source influenced by crustal extraction.

The demonstration of large scale, contrasting isotopic histories including ^{142}Nd variations between Archean regions requires Hadean-formed chemical domains that were not erased for at least 1.7 billion years. These observations further question the validity of simple whole Earth isotopic models for planetary evolution, or using any single locality as a "type" early Earth example. Rather, early chemical heterogeneity likely reflects the operation of variable but co-existing geodynamic regimes on the early Earth.

[1] Nutman, Bennett, Friend, Polat, Hoffmann & Van Kranendonk (2021) *Precambrian Research 367.*

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

[3] Hiess, Bennett, Nutman & Williams (2009) *Geochim. Cosmochim. Acta* 73.