Tracing Early Earth Differentiation with ^{142}Nd

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Tracing the Earth's differentiation history is hampered by the scarcity of Archean rocks. Fortunately, short-lived radionuclides such as the ^{146}Sm-^{142}Nd system can provide evidence of early differentiation events. Silicate differentiation of the early Earth between the crust and a residual mantle will result in distinct reservoirs with contrasting Sm/Nd. If formed during the life-time of ^{146}Sm (~500 million years, Ma), the reservoirs will evolve to different ^{142}Nd compositions. Some of the oldest rocks on Earth at ~3.9 billion years (Ga) have an anomalous μ^{142}Nd signature compared to the modern Earth [e.g. 1, 3], while only a very limited number of Neoarchean rocks are anomalous [3]. Interestingly, a large variation in μ^{142}Nd is seen in Paleaoarchean rocks, from –18.0 to + 16.5 [2, 4]. The large variation in positive μ^{142}Nd values has been interpreted as either reflecting a heterogeneously differentiated Earth, or a heterogeneously remixed Earth [1].

To cast a light on global terrestrial differentiation we have expanded the database of Archean samples by analyzing rocks from poorly-investigated Archean terranes from around the world, such as the São Francisco in Brazil, West African cratons in Mauritania, the Lewisian terrane in Scotland and the Yilgarn Craton in Australia.

No resolvable μ^{142}Nd anomaly from modern day terrestrial was obtained on ~2.9 Ga TTGs and 3.3 Ga meta-basalts from the West African Craton. Preliminary results from ~3.3 Ga felsic rocks from the São Francisco craton also display no resolvable anomalies. This emphasizes the lack of significant μ^{142}Nd anomalies outside of North America and Greenland. As such, it can be envisaged that the early Earth was composed of at least two distinct domains, with only one preserving evidence of early silicate differentiation.

[1] Bennett V.C. et al. (2007) Science, 318, 1907 [2] O'Neil J. et al. (2008) Science, 321, 1828 [3] Debaille V. et al. (2013) Earth & Planet. Sci. Lett., 373, 83. [4] Rizo H. et al. (2012) Nature, 491, 96