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Decoupling of Long- and Short-lived Sm-Nd Isotopic Systems in Acasta Gneisses

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The Hf and Nd isotopic records of early Archean rocks suggest different evolution histories for the early Earth's crust (i.e., the Hf-Nd paradox). Recent studies of discordant Nd and Hf signatures of the same Eoarchean rocks suggest this is the likely result of metamorphic Sm-Nd isotope disturbances where the break-down and formation of REE-enriched accessory phases such as apatite, titanite and allanite reset the Sm-Nd isotopic systematics at the whole-rock scale (1-3). Our current understanding of Hadean crust-mantle differentiation relies heavily on the short-lived ^{146}Sm-^{142}Nd system where ^{146}Sm became extinct prior to the Archean. The potential post-formation open-system behavior of the Sm-Nd system (i.e., the net loss or gain of Nd) raises concerns about the preservation of ^{142}Nd isotope anomalies in ancient rocks. Here we selected a suite of 4.0 – 3.7 Ga rocks from the Acasta Gneiss Complex (AGC) to test this question. Our *in situ* Sm-Nd isotope measurement of apatite grains extracted from these rocks verifies open-system Sm-Nd isotope disturbances at ~2.5 Ga and ~1.9 Ga in AGC. The ^{142}Nd isotopic compositions of apatite grains from the same separates, however, give μ^{142}Nd values between -7 and -10, suggesting a basaltic source of ~4.4 Ga, consistent with the whole-rock results (4). The Nd-rich minerals, therefore, retain the Hadean Nd faithfully despite the later modification of their ^{147}Sm-^{143}Nd systematics. This also implies that the ^{142}Nd signature of Nd-rich minerals in Archean rocks may be more reliable in tracing their Hadean history.

References

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