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Reevaluation of the highly contested Nd isotope record of the 4.0-2.9 Ga Acasta Gneiss Complex, Canada

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The Hf and Nd isotope records of the 4.0-2.9 Ga Acasta Gneiss Complex (AGC), Canada, provide key context for the formation of the earliest continental crust. The substantial range (-4.8 to +3.6) in whole-rock initial ε_{143Nd} at ~4.0 Ga in the AGC was originally ascribed to mantle heterogeneity resulting from extensive continental crust formation in the Hadean [1]. However, the AGC zircon Hf isotope record is almost entirely subchondritic, and therefore is incoherent with the whole-rock Nd isotope record, suggesting that the Nd record may not be primary. Additionally, an errorchron regression of the Sm-Nd isotope data may indicate that these values are artifactual due to regional-scale metasomatism at ~3.4 Ga [2]. Because the REE-rich accessory minerals in these rocks record mineral-scale redistribution of Sm and Nd during <3.0 Ga thermal perturbations, they do not have conclusive bearing on whether there was comprehensive metasomatic resetting of REEs in these rocks at 3.4 Ga [3].

Our interpretation is that the errorchron is erroneous and that the majority of whole-rock Sm-Nd data from the AGC is likely primary on the hand-sample scale, apart from highly strained rocks where mixtures of distinct rocks has resulted in spurious initial ε_{143Nd}. A change in magmatic source at ~3.6-3.5 Ga is evident in the zircon Hf isotope record of the AGC and corresponds with a change in chondrite-normalized La/Yb interpreted to document a transition between shallow- and deep-seated melting regimes <3.6 Ga [4]. When considered alongside this contextual geochemical information, the majority of whole-rock Sm-Nd isotope data is consistent with the expected alignment of shallow-sourced Eoarchean melts and more deeply sourced Paleoarchean melts in ^{147}Sm-^{143}Nd isochron space and therefore is likely to record primary information.

[1] Bowring & Housh (1995) Science. [2] Moorbath et al (1997) ChemGeo. [3] Bauer (2017) MIT PhD thesis. [4] Reimink et al (2018) Earth's Oldest Rocks v.2.