Understanding the early Earth isotope record: the role of accessory minerals

C.M. FISHER [1,] A.M. BAUER[2,3,] J.D. VERVOORT[1]

[1]School of the Environment, Washington State University, Pullman, WA 99164 (*corr: chris.fisher@wsu.edu)
[2]Department of Geoscience, University of Wisconsin-Madison, Madison, WI 53706
[3]Department of Earth Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139

The Hf and Nd isotope record of Eoarchean rocks has long been used to constrain the crustal growth history of the early Earth. Based on the Hf isotope record from zircon, the Eoarchean localities thus far sampled have mostly chondritic compositions, with no evidence for the existence of a depleted mantle until ~ 3.8 Ga; and by implication, minimal amounts of preserved continental crust. In stark contrast, the Nd isotope record from the same terranes suggests that a crust-mantle system was established in the Hadean.

Using simultaneously determined U-Pb ages and Lu-Hf/Sm-Nd isotope compositions measured using the "Laser Ablation Split Stream" method, we explore this Hf-Nd dichotomy from the perspective of common accessory minerals (e.g., zircon, apatite, titanite) that serve as the major repositories of the Lu-Hf and Sm-Nd budgets of Eoarchean rocks. The Hf isotope compositions of precisely dated magmatic zircon preserve the initial isotopic compositions of their host rocks. Nd isotope compositions of apatite and titanite, however, reveal that the Sm-Nd isotope system has been mobilized during thermomagmatic episodes that post-date rock formation and, therefore, this system may not faithfully record initial isotope compositions. These results highlight the pitfalls of relying on whole rock Nd isotopes for determining crustal growth histories in complex, polyphase rocks and may explain the existing Hf-Nd dichotomy.