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Understanding the role of accessory minerals in the Sm-Nd isotopic evolution of ancient rocks: An in-situ LA-(MC)-ICP-MS approach

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The long-lived radiogenic isotope systems Lu-Hf and Sm-Nd have been widely used by geochemists to study magma sources and crustal residential times of (igneous) rocks in order to understand how early crust formed and to model the production rate and volume of continental crust on global and regional-scales during the last ~4.4 Ga. However, while throughout most of Earth's history Nd and Hf isotope signatures in terrestrial rocks are well correlated due to their very similar geochemical behavior, some of Earth's oldest rocks show an apparent inconsistency in their Nd and Hf isotope signatures. While Hf isotopes in early Archean rocks are generally (near) chondritic, Nd isotope signatures can be distinctly super- or sub-chondritic. The super-chondritic Nd isotope values in Eoarchean samples would suggest that these rocks are derived from a mantle reservoir depleted by prior crust extraction. The chondritic Hf isotope values, on the other hand, support a mantle source from which no significant volume of crust had been extracted. While a range of different processes, some of them speculative, might explain this Hf-Nd isotope paradox, recent research [1, 2] has shown that relatively simple, post-magmatic, open-system processes can explain decoupling of the typically correlative Hf-Nd isotope signatures. This talk will focus on the importance of identifying Nd-bearing accessory minerals in (Archean) rocks to understand how the Sm-Nd isotope system is controlled and how in situ isotope and trace element analyses by LA-(MC)-ICP-MS in combination with detailed petrographic observations help to understand when and via which processes the two isotope systems become decoupled. Reconstructing the isotopic evolution of the different isotope systems since formation of the protoliths has important implications for our understanding of early crust formation and questions some of the proposed current models for early crust extraction from the mantle.

[1] Hammerli et al. (2019) Chem. Geol 2; [2] Fisher et al. (2020) EPSL