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Variable decoupling of whole-rock Nd and zircon Hf isotope signatures in the Rae craton

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Radiogenic isotopes are common geochemical tools used to investigate the provenance of crustal blocks and their lithospheric architecture, particularly in Archean terranes, where lithological or elemental signatures may be overprinted or convoluted by poly-metamorphic histories. Although whole-rock Nd isotope signatures are widely available across all Archean terranes, the propensity for their disturbance by metamorphism [1] has led to an explosion in the use of zircon Hf isotope data, which are typically more resilient and can be linked to a specific age.

The Rae Province of northern Canada was an integral crustal block in the formation of the proto-Laurentian craton and Nuna and experienced at least five metamorphic events. Until recently, crustal provenance studies have relied on whole-rock Nd isotope data; however, the effects of metamorphism on isotope systematics have not been assessed. Here, we use a new set of zircon Hf isotope data from over 300 samples to evaluate the resiliency of the whole-rock Nd data to metamorphism across the Rae Province.

Initial epsilon values and depleted mantle model ages (T_{DM}) from the two datasets follow a broad positive correlation. However, the whole-rock εNd and zircon εHf data do not show a consistent offset and do not conform to the crustal array [2]. Instead, the degree to which the results differ from the crustal array is greatest in Mesoarchean samples (up to 6 εHf) and decreases in Neoarchean (up to 4 εHf) and Proterozoic samples (2 εHf). These discrepancies are reflected in the T_{DM}, where the results for Nd and Hf are up to 700 Myrs different and is greatest in areas that experienced high-grade metamorphism. The regional variations in zircon Hf T_{DM} also correlate better with known boundaries of crustal blocks compared to the whole-rock Nd data. These results contribute to growing evidence for the resilience and utility of a zircon-based method in polymetamorphic terranes.

[1] Hammerli et al. (2019) *Chemical Geology* 524, 394-405

[2] Vervoort et al. (2011) *Geochim Cosmochim Acta* 75, 5903-5926