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In situ Lu–Hf dating tracks isotopic modification of garnet during resorption

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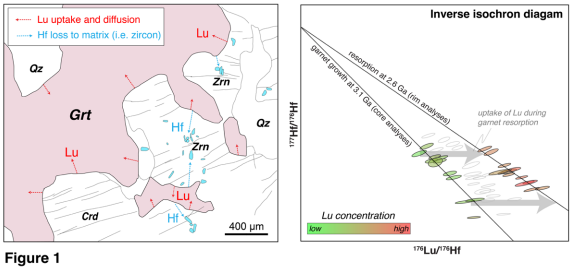

Figure 1

Garnet is a key mineral in constraining the pressure–temperature–time (*P–T–t*) history of crustal metamorphism. While garnet geochronology by isotope dilution offers valuable insights into the timing, rates, and duration of tectonic processes, the inherent loss of textural context and time-consuming sample preparation are limiting factors in its application. The recent advent of in situ Lu–Hf dating via laser ablation reaction cell ICP–MS has enabled the efficient acquisition of texturally-constrained age data from garnet, allowing for detailed assessments of isotopic disturbance of the Lu–Hf system in garnet. Here, we present in situ garnet Lu–Hf and trace element data from two Archean polymetamorphic terranes that record a complex history of Paleoarchean garnet growth and subsequent breakdown (resorption) during a later metamorphic overprint. In both cases, garnet Lu–Hf analysis produces strongly scattered data that do not conform to a single age population. Specifically, Lu–Hf analyses located at or close to resorbed grain margins of garnet show elevated heavy rare earth element (HREE) abundances and typically define the youngest age component in the datasets, while analyses from undisturbed garnet domains yield lower HREE and imply an older age component, interpreted as the timing of garnet growth. The systematic modification of the Lu–Hf data appears to be the result of the uptake of ‘garnet-compatible’ elements (including Lu) during garnet resorption, while Hf is lost to the surrounding matrix (i.e., zircon), thereby shifting the primary garnet Lu–Hf systematics to higher Lu/Hf ratios and producing younger apparent ages. Although garnet is typically regarded as a robust geochronometer that is resilient to isotopic disturbance after growth, our work demonstrates that the application of in situ garnet Lu–Hf geochronology is not necessarily limited to dating the timing of garnet growth, but can also inform on processes that subsequently modify the primary isotope systematics of garnet.