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HT/UHT garnet geo-thermochronology: Limitations and applications from two Neoarchean terranes

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We compare results from garnet growth models to Sm-Nd garnet geochronological data from the Neoarchean terranes of the eastern Beartooth Mountains of the Wyoming Province and the Pikwitonei Granulite Domain of the Superior Province. These examples highlight the challenges associated with constraining the timing of garnet growth in old, hot orogens, with one exhibiting the effects of polymetamorphism and a short duration heating event, and the other exhibiting evidence of longer durations at high temperatures.

The use of garnet as a high-temperature/ultrahigh-temperature (HT/UHT) geochronometer has proven challenging, particularly with the interpretation of ages from bulk garnet separates [1]. Significant scatter in isotopic data can exist between garnet fractions used for multi-point isochron ages, with several factors contributing to scatter in resultant ages, including: a) sampling of garnet from multiple growth events (polymetamorphism), b) a long garnet growth duration [2], and c) protracted high temperatures resulting in diffusionally-controlled differential age resetting. Within any of these scenarios, the unbiased sampling of garnet fractions from a bulk collection of crushed porphyroblasts could result in large age uncertainties and high MSWDs. However, combining garnet geochronology with models of major element and rare earth element diffusion can elucidate what influence the aforementioned factors can have on resultant bulk garnet ages.

Figure 1: Garnet porphyroblast in leucosome of metapelite from Cauchon Lake, Pikwitonei Granulite Domain, Canada

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Garnet geochronology on distinct, microsampled growth zones can provide a more accurate assessment of the rate, duration and periodicity of metamorphism [3], with the potential to distinguish multiple separate high-temperature metamorphic events. While slow cooling from high temperatures can result in intra-mineral age resetting, a detailed isotopic study of large porphyroblasts (those which would be variably reset depending on peak temperature, grain size, and initial cooling rate) may retain information about both prograde growth *and* initial cooling ages. Here, we contrast geochronologic datasets from bulk garnet separates to those from microdrilled garnets to highlight the use of garnet as a possible HT/UHT geo-*thermo*chronometer.

A potentially important limitation of the use of isochron ages to assess the timing of partial melting is the poorly known effects of melt removal on the residual bulk rock isotopic composition that is used to construct the isochron. We present results from models that demonstrate the consequences of this for ages of garnet growth that spans the transition from subsolidus to suprasolidus conditions.

References:

[1] Smit M et al. (2013) EPSL 381: 222-233
[2] Kohn M (2009) Geochim Cosmochim Acta 73: 170-182
[3] Dragovic B et al. (2015) EPSL 413: 111-122