In-situ LA-ICP-MS/MS Lu–Hf geochronology of garnet with applications to eclogite-facies rocks

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Lu–Hf geochronology of garnet is a critical tool for investigating the timing of eclogite- facies metamorphism, however requires the chemical separation of Lu and Hf via wet chemistry prior to measurement due to their isobaric interference. The development of in-situ Lu–Hf geochronology using laser ablation tandem inductively coupled mass spectrometry (LA-ICP-MS/MS) allows the separation of ^{176}Lu, ^{176}Hf and ^{176}Yb by introducing NH_3 to the collision cell, creating high order reaction products that can be measured with appreciable sensitivity (Simpson *et al.*, 2021). This technique allows the direct dating of Lu-rich phases such as garnet, apatite, xenotime and calcite (Simpson *et al.*, 2021; 2022; Tamblyn *et al.*, 2022), with age uncertainties that can approach that of conventional techniques when targeted minerals have high and diverse Lu/Hf ratios. This method also offers significant advantages, such as excellent spatial resolution and therefore the ability to target grain zoning and textures, the capability to collect trace element data simultaneously, and the rapid and efficient collection of data with little sample preparation. For garnets, it is an important tool to directly date metamorphism and couple the timing of garnet growth with P-T conditions, distinguish polymetamorphism in single grains, and to undertake rapid campaign-style geochronology across large metamorphic terranes.

We present in-situ Lu–Hf garnet geochronology from several eclogite-facies locations, demonstrating the applicability and limitations of this technique, with particular focus on high-pressure rocks from the Western Gneiss Region, Norway. Campaign-style geochronology of twenty quartzofeldspathic and pelitic lithologies from the Western Gneiss Region shows most samples record ages associated with high to ultrahigh pressure conditions during subduction in the Caledonian Orogeny, as well established in the literature. However some samples, from the Fjørtoft and Verpeneset localities, show a more complex history preserving previously unrecognised polymetamorphic garnets. The age of these metamorphic overgrowths were able to be distinguished despite low Lu/Hf ratios (~4), due to low Lu contents of only 1 ppm in the garnet. In-situ Lu–Hf geochronology of garnet is an efficient way to map the timing of metamorphism across orogens, subduction-related or otherwise, and to identify the presence of older metamorphic events in these terranes.

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