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Traditional applications and novel approaches in Lu-Hf geochronology

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Lutetium-Hf geochronology is currently becoming a routine method for dating metamorphism of garnet bearing rocks, such as eclogites. Prograde garnet growth ages are mostly preserved because blocking temperatures exceed 630 °C [1] and prograde Lu zoning patterns have even been observed in samples that were exposed to temperatures above 800 °C [2]. Here we discuss Lu-Hf ages from various eclogite localities, such as the Northern Tianshan, Kyrgyzstan (∼ 470 Ma), the Kola Peninsula, Russia (∼ 1900 Ma) [3], Cuba (∼70 Ma and ∼124 Ma), Alpine Corsica (∼ 34 Ma) and the Tauern Window (∼32.7 Ma). Age precisions are in the order of 0.1 to 1 % and all ages can be safely attributed to the timing of garnet growth.

Some samples, however, contain two garnet populations which complicates Lu-Hf geochronology. In the Adula Nappe (Central Alps) relict garnet has survived a second orogenic cycle, including subduction to mantle depth. By carefully separating the two garnet populations present within the same eclogite sample we obtained a minimum Variscan age of 333 Ma and a maximum Alpine age of 38 Ma [4]. A similar relationship is now evident in samples from the Tauern Window (Eastern Alps), where only one population of garnet generation is visible macroscopically. However, few relics of Variscan garnet inside Alpine garnet are observed in electron microprobe element maps and are also evident from isotopic heterogeneity in 176Lu/177Hf vs. 176Hf/177Hf space. Garnet relics stemming from previous metamorphic events are frequently observed in HP units around the world and the Lu-Hf system is a promising tool to resolve the respective growth ages.

Apart from garnet, lawsonite Lu-Hf geochronology was recently identified as a new tool to investigate subduction processes [5]. Here we present a lawsonite Lu-Hf isochron 37,6 $\pm$ 1.4 Ma (MSWD = 0.30; n =5) from a lawsonite blueschist from Alpine Corsica. The lawsonite slightly predates the timing of garnet growth (∼34 Ma) in three eclogite samples, collected from other paleogeographic units of Alpine Corsica. The age discrepancy between lawsonite and garnet could be used to calculate subduction rates. Most importantly however, the Lu-Hf system provides virtually the first reliable tool for dating low grade blueshist assemblages.

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