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"In-situ" Lu-Hf garnet geochronology and the correlation to heavy rare earth element distribution profiles.

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Garnets are well suited for Lu-Hf and Sm-Nd geochronology, and a growing number of studies now focus on the Lu-Hf system for evaluating the evolution of different types of metamorphic rocks, because of the difference in the ages obtained by the two isotope systems (Lu-Hf dating early, Sm-Nd dating late growth). Interpretation of ages obtained for garnets by the Lu-Hf system, however, is not always straightforward. There is still ambiguity in the explanation of observed sharp Lu-peaks in garnet cores, and the occurrences of secondary Lu enrichments in garnet rims. Garnet strongly controls the Lu (and other HREE) budget of many metamorphic rocks, and might therefore inherit information obtained during pro- and retrograde growth through enrichment of Lu & HREE in early formed cores. The assumed processes leading to these pronounced Lu enrichments are many, e.g. changes in the garnet forming reaction, uptake through slow matrix diffusion, control by accessory phases, and intra- or inter-crystalline diffusion. The mere occurrence of sharp Lu peaks in garnet cores in rocks of (ultra)high-pressure and high-temperature conditions yet indicates a resistance to metamorphic resetting, therefore attesting to the suitability of Lu-Hf garnet geochronology for complex metamorphic rocks.
This study aims at an "in-situ" garnet chronology approach, where pieces of a large euhedral garnet crystal have been analysed for Lu-Hf dating. Together with the major and trace element distribution we now might be able to evaluate whether a distinct concentration pattern yields hints to the interpretation of Lu-Hf ages. The results show that this garnet comprises at least two times for garnet formation of 22 Ma difference, which also correspond to observed HREE patterns within the central part of the garnet crystal. These patterns clearly show a first inherited core comprising a strong Lu peak, which subsequently has been overgrown with a second garnet generation, and which now also get into a temporal relationship with our "in-situ" dating approach. An interesting fact coming from the analysis of the different garnet zones is that the outermost rim of the garnet crystal has a very low 176Lu/177Hf and represents the most unradiogenic Hf, which we interpret as a consequence of fast depletion of a matrix composition that has become the source for growth of the outer garnet shells. Additionally these results also yield a rate for garnet growth of 0.31mm/Ma. This means that for many metamorphic rocks consisting of garnet crystals of less than 1mm size, the time span for growth of single grains is less than a typical isochron precision of the Lu-Hf system.