Dating crustal anatexis in UHT granulites with Lu-Hf

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Ultra-high temperature (UHT) metamorphism is a thermal regime that can be attained by the lower continental crust in exceptional contexts and that is usually accompanied by fluid-absent dehydration melting. Such conditions are observed in the Gruf Complex, a 12 x 10 km migmatitic body located in the Central Alps, which is characterized by the presence of UHT granulitic schlieren and enclaves within migmatitic orthogneisses and charnockites. Two types of granulites, both with a massive and melanocratic texture, were investigated. The first granulite contains sapphirine, garnet, orthopyroxene, K-feldspar and biotite in the peak mineral assemblage, whereas the second type displays garnet, orthopyroxene, sillimanite and biotite. In both granulites, garnets are porphyroblastic and can reach up to 2 cm in size. These garnets are almost pure almandine-pyrope solid solutions and are zoned, showing pyrope-richer rims (Alm\(_{43.54}\)Prp\(_{43.55}\)Sp\(_{0.2}\)Gr\(_{1.6}\)) compared to cores (Alm\(_{47.62}\)Prp\(_{32.48}\)Sp\(_{5}\)Gr\(_{2.9}\)). A clear zoning is also observed in the rare earth elements (REE), with garnet cores showing the highest REE concentrations. Moreover, the porphyroblastic garnets are characterized by the presence of numerous melt inclusions (MI), which can be noticed both in garnet cores and rims. The MI occur as polycrystalline (nanogranitoids) and glassy inclusions, and dominantly display a peraluminous, rhyolitic composition, suggesting that they were originated, along with the host garnet, by incongruent, fluid-absent melting reactions during crustal anatexis. Lu-Hf ages obtained for the MI-bearing garnet cores of both granulites indicate that they formed at about 41 ± 4 Ma, which therefore can be interpreted as the time that crustal anatexis generated the UHT granulites. Considering the granulites in the context of the alpine framework, it is also inferred that UHT conditions in the lower crust were achieved as a consequence of asthenospheric upwelling, probably related to slab steepening or slab breakoff.