Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19251

Character and timing of mantle metasomatism in orogenic settings: trace-element zonation and U-Pb dating of garnet

JANA KOTKOVA[1], RENATA COPJAKOVA[2], LEO J. MILLONIG[3], HORST MARSCHALL[3] AND AXEL GERDES[4]

[1]Czech Geological Survey
[2]Department of Geological Sciences, Masaryk University
[3]FIERCE (Frankfurt Isotope & Element Research Center), Goethe University Frankfurt
[4]Goethe-Universität Frankfurt, Institut für Geowissenschaften

Presenting Author: jana.kotkova@geology.cz

Orogenic garnet peridotites occurring as fragments in collisional settings represent unique archives of crust and mantle interaction. However, the evidence for metasomatism is generally obscured due to its mostly cryptic character and subsequent overprint due to deformation and extensive serpentinization. Multiphase solid inclusions (MSI) in garnet in ultrahigh-pressure and ultrahigh-temperature garnet peridotites from the Variscan Bohemian Massif document metasomatism by melts derived from garnet pyroxenite whose composition is similar to kimberlites, i.e. enriched in alkali metals (Na, K), LILE (Ba, Sr), U, Th, LREE and volatiles (CO_2, Cl, F, P). Garnet trace element and U-Pb isotope analyses by LA-ICP-MS allowed us to distinguish several garnet generations in peridotites. Large garnet crystals (>1 mm diameter) preserve a prograde HREE zonation reflecting its metamorphic growth dated at ~370–360 Ma. The similarity of the trace-element distribution in peridotite garnet adjacent to garnet pyroxenite, dated at ≥355 Ma, suggests material transfer at this stage. The majority of MSI-free garnet cores shows a metasomatic enrichment in U (<2.1 µg/g), Th, Pb and LREE, with a gradual decrease towards the rim (<0.1 µg/g U). The MSI-bearing garnet rim domains show variable degrees of U (<3.2 µg/g), Th, Pb and LREE enrichment. Both the metasomatic garnet cores and the MSI-bearing rims yielded similar U-Pb ages of ~345–335 Ma, reflecting a complex metasomatic history. The more pronounced “humps” in the LREE distribution profiles of garnet rims compared to the cores, and MSI entrapment only in garnet rims, suggest an evolution from silicate to carbonate metasomatism during garnet growth. The distinction of two garnet age clusters, even within a single thin section, demonstrates that garnet U-Pb dating by LA-ICP-MS is capable of resolving events on relatively short timescales in (ultra)high-temperature terranes (estimated peak T ~ 1000 °C/4 GPa) where other geochronometers are often disturbed or reset. Our study further shows that this method can be successfully applied to low-U garnet (<0.1 µg/g U) and provides evidence for a very high closure temperature of the U-Pb system in garnet.