Oxygen isotope zoning in garnet from granulite facies rocks

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Oxygen isotope ratios can be an indicator of fluid-mineral or melt-mineral interactions [1]. Among metamorphic minerals, $\delta^{18}O$ zoning in garnet is a key to understand fluid or melt evolution during metamorphism. This is because garnet can preserve multiple growth stages as major and trace element zonings.

The studied sample is a garnet-biotite-sillimanite gneiss from the Sør Rondane Mountains (SRM), East Antarctica. The SRM are considered part of the collision zone between East and West Gondwana during ca. 750-620 Ma East African-Antarctic Orogeny [2] and were also affected by ca. 570-500 Ma Kuunga Orogeny [3]. In this sample, the core/rim boundary of garnet porphyroblasts is marked by a strong decrease in phosphorous (P), and Cl-rich biotite and apatite are exclusively included in the P-poor garnet rim. The core is homogeneous in Fe, Mn, Mg, and Ca, while Fe and Mn increase and Mg and Ca decrease at the rim. The *P-T-t* conditions of the Cl-rich biotite entrapment is estimated to be ~ 800 °C, ~ 0.8 GPa, and ca. 600 Ma, implying Cl-rich fluid or melt infiltration at the garnet core/rim boundary [4].

In situ microscale oxygen isotopes analysis of the garnet porphyroblast was performed by SIMS. The $\delta^{18}O$ values gradually decrease from the P-rich core towards the P-poor rim and become constant ~ 400 μm outside of the core/rim boundary defined by phosphorous. Intragrain variation in $\delta^{18}O$ is ~ 4 ‰. These observations suggest that the $\delta^{18}O$ values preserve a diffusion profile and imply metasomatic modification from external fluids or melts. The $\delta^{18}O$ zoning can be used to infer a minimum time of duration for high-temperature metamorphism.

[1] Hoefs (2004) Stable Isotope Geochemistry. [2] Jacobs & Thomas (2004) Geology 32, 721-724. [3] Meert (2003) Tectonophysics 362, 1-40. [4] Higashino et al. (2013) Precambrian Research 234, 229-246.