Oxygen isotope zoning in garnet from Sør Rondane Mountains, East Antarctica

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Oxygen isotope ratios can be an indicator of fluid-mineral or melt-mineral interactions. Among metamorphic minerals garnet is a particularly robust one that forms over a wide pressure-temperature stability field and can preserve multiple growth stages as major and trace element zoning. Therefore, zoning in oxygen isotopes in garnet is a key to understand fluid or melt evolution during metamorphism.

The studied sample is a garnet-biotite-sillimanite gneiss from Balchenfjella, 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 (Jacobs and Thomas, 2004) and were also affected by the Kuunga Orogeny at ca. 570-500 Ma (Meert, 2003). Protracted magmatism lasting for more than 100 Myr has been proposed for the collision process in the SRM (e.g., Jacobs et al., 2015; Elburg et al., 2016).

In the studied sample, the core/rim boundary of garnet porphyroblasts is marked by a strong decrease in phosphorus (P). Cl-rich biotite and apatite are exclusively included in the P-poor garnet rim. The core is homogeneous in Fe, Mn, Mg, and Ca ($Alm_{69}Prp_{26}Sps_2Grs_3$), while Fe and Mn increase and Mg and Ca decrease at the rim ($Alm_{78}Prp_{17}Sps_2Grs_3$). The pressure-temperature-time 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 (Higashino et al., 2013). *In situ* microscale oxygen isotopes analysis of the garnet porphyroblast was performed by secondary ion mass spectroscopy (SIMS). The garnet shows large $\delta^{18}O$ variations from the core to the rim. The $^{18}O/^{16}O$ 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 P. This implies metasomatic modification from external fluids or melts at the core/rim boundary. The garnet zoning profile in $^{18}O/^{16}O$ is well fitted by diffusion equation, considering the core/rim boundary as the interface. Using experimentally and theoretically derived oxygen diffusion coefficients in garnet (Zheng and Fu, 1998; Scicchitano et al., 2016), residence at 800 °C after the garnet rim formation is estimated to be less than 5 Myr. This is significantly shorter than the continental collision process in the SRM.

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