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Chemical and oxygen isotope zonings in garnet from subducted continental crust record mineral replacement and metasomatism

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Garnet is a key mineral in metamorphic petrology for constraining pressure, temperature and time paths. Garnet can preserve multiple growth stages due to its wide P-T stability field and the relatively slow diffusivity for major and trace elements at sub-solidus temperatures. Pressure-temperature-time-fluid paths of the host rock may be reconstructed by combining metamorphic petrology with microscale trace element and oxygen isotope measurements in garnet.

Subduction zones represent relevant geological settings for geochemical investigation of element exchanges during aqueous fluid-rock interactions. The Sesia Zone consists of a complex continental sequence containing a variety of mono-metamorphic and poly-metamorphic lithologies such as metagranitoids, sediments and mafic boudins. The precursor Varisican-Permian amphibolite-facies basement (6-9 kbar 650-850°C; Lardeaux and Spalla, 1991; Robyr et al., 2013) experienced high pressure metamorphism (15–22 kbar 500–550°C; Regis, et al. 2014; Robyr et al., 2013) during Alpine subduction. In different lithologies of the Internal Complex (Eclogitic Micaschist Complex), including metabasites from the Ivozio Complex, Ti-rich metasediments from Val Malone and pre-Alpine Mn-quartzites associated to metagabbros from Cima Bonze, garnet is abundant and shows a variety of complex textures that cannot be reconciled with typical growth zoning, but indicate resorption and replacement processes and possible metasomatism.

In-situ, microscale oxygen isotopes analysis of garnet zones was performed by ion microprobe with the Swiss-SIMS Cameca IMS 1280-HR at University of Lausanne and SHRIMP-SI at the Australian National University. Each sample has a distinct δ18O composition, and the δ18O values show different degrees of variation between domains. Homogeneously low values of < 5‰ are measured in the garnets from the Ivozio Complex metagabbro. Intragrain variations of up to $\sim$ 3.5‰ in the porphyroblasts from Val Malone metasediments, and variations up to $\sim$ 6.5‰ in Cima Bonze garnets suggest significant metasomatic replacement from external fluids.

The combination of oxygen isotopes, trace element geochemistry and P-T modelling allows reconstructing the major stages of metasomatism, as well as identifying the nature of the fluid interacting with the rock at each metamorphic stage.

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