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Crustal reworking and hydration: Insights from an oxygen isotope study of high pressure rocks (Sesia Zone, Western Alps)

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Exhumed portions of subducted crust provide the only direct observational evidence for investigating the fluid flow within and out of the descending slab. The Sesia Zone consists of accreted continental fragments of polymetamorphic and mono-metamorphic lithologies such as metagranitoids, metasediments and metabasites that experienced pre-Alpine amphibolite to granulite facies metamorphism and blueschist to eclogite facies metamorphism during the Alpine orogenic cycle. Because the granulitic protoliths were inherently anhydrous, the formation of eclogitic assemblages necessarily required addition of water either during the pre- or early-Alpine evolution. Reconstructing the conditions of the hydration stages can shed light on the dynamics and potential drivers of crustal reworking.

An approach that combines petrology and geochronology with the study of oxygen isotope and trace element geochemistry has been applied to different lithologies from the Eclogitic Micaschist Complex (EMC). Garnet, which mainly forms by dehydration reaction, shows a variety of textures with major and trace element compositional zoning not always reconcilable with simple growth zoning, but also indicating resorption and replacement processes driven by fluid influx (Giuntoli et al., 2018). However, the origin of the fluid and the degree of fluid-rock interaction remain largely unknown.

Garnets in metasediments show a notable decrease in δ18O values of up to 5.5 ‰ from the pre-Alpine cores to the Alpine rims. Chronology and trace element patterns of zircon and allanite as well as trace elements in garnet corroborate Permian high-grade metamorphism overprinted by Alpine high-pressure metamorphism, and hint to Triassic reworking at low-grade metamorphic conditions. Texturally, subsequent pulses of externally derived fluids are related to fracturing and resorption of pre-Alpine garnet, new growth of high-pressure garnet and late atoll garnet formation with pervasive growth of phengite, with a distinct δ18O signature. On the other hand, garnets in metabasites have a typical growth zoning, locally affected by late replacement textures that show no significant isotopic shift in δ18O composition and are therefore ascribed to internally buffered fluids.

Petrological and isotopic modelling is used to investigate two possible scenarios: (1) the interaction with sea-water during Triassic rifting or (2) the pervasive input of fluids derived from dehydration of mafic and ultramafic rocks during Alpine subduction.

Giuntoli, F., Lanari, P., & Engi, M. (2018). Fracturing, dissolution-precipitation, and diffusion processes recorded by garnet textures of the central Sesia Zone (western Italian Alps). Solid Earth, 9(1), 167-167.