H_2O budget and high-pressure re-equilibration in polycyclic rocks: a case study from the Dora-Maira Massif (Western Alps)

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During metamorphism, aqueous fluids favour mineral-chemical re-equilibration, acting both as a reaction catalyst and a chemical component in hydrous minerals. During subduction of the oceanic and continental crust, fluid-present conditions are maintained thanks to the break-down of hydrous minerals along an up-pressure (P) up-temperature (T) P–T path. However, a more complex fluid evolution may occur in the case of recycling of a continental crust already metamorphosed during a previous orogenic cycle. This polycyclic crust may be already dehydrated before being subducted. Therefore, its re-equilibration during subduction requires interaction with external fluids: a process that may occur prior or during subduction.

In this study, we estimate the H_2O budget in polycyclic metapelites from the Dora-Maira Massif (Western Alps) and we investigate its role in high-pressure (HP) re-equilibration. A pre-Alpine amphibolite-facies foliation is preserved within a kilometre-scale domain where the Alpine deformation was weak. The amphibolite-facies pre-Alpine minerals are statically replaced by Alpine HP minerals. Polycyclic garnet displays evidence of growth and dissolution. The first garnet generation is pre-Alpine (dated at ~ 324 Ma; Nosenzo et al. 2022) and grew during the amphibolite-facies metamorphism. A second garnet generation grew during the Alpine cycle at ~ 21 kbar ~ 550 °C. Microtextures suggest that pre-Alpine garnet was partially dissolved before the growth of Alpine garnet. Thermodynamic modelling indicates that the rock H_2O content (H_2O bounded in the mineral assemblage) at the peak pre-Alpine amphibolite-facies conditions was not sufficient to develop the observed Alpine mineral assemblage (g-ctd-ph-gl-ru). This suggests that a stage of re-hydration of a minimum of 0.7–1.0 wt% H_2O occurred after the peak pre-Alpine conditions and either before or during the Alpine HP overprint. In the low-strain domain, fluid infiltration may have occurred along anastomosed decimetre-scale shear zones during the late pre-Alpine evolution at LP-LT conditions, as suggested by field, microstructural and geochronological data (Nosenzo et al. 2023).

References

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