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Eclogitization of the Allalin gabbro under heterogeneous stress conditions

Cindy Luisier[1], Philippe Yamato[2], Horst R. Marschall[1], Evangelos Moulas[3], and Thibault Duretz[1,2]
[1]Institut für Geowissenschaften, Goethe-Universität Frankfurt, Frankfurt am Main, Germany
[2]Université de Rennes, CNRS, Géosciences Rennes UMR 6118, Rennes, France
[3]Institut für Geowissenschaften, Johannes Gutenberg-Universität Mainz, Mainz, Germany

Eclogitization reactions in mafic rocks involve large volume changes, porosity evolution and fluid transfer. They impact many important geological processes such as the localization of deformation and fluid channeling at intermediate depth in subduction zone. The study of exhumed eclogitic bodies in orogens shows that eclogitization of the oceanic crust is heterogeneous from both a structural and metamorphic point of view. For example, in the European Alps, the Allalin metagabbro shows high strain areas, consisting of hydrous metagabbros, fully equilibrated under eclogite-facies conditions during the Alpine orogeny. Conversely, large volumes of low strain, fluid-undersaturated gabbros remained largely unaffected by the high-pressure (HP) metamorphism, locally preserving igneous textures and even, occasionally, relics of their magmatic mineralogy. The intensity of deformation as well as the degree of eclogitization in the metagabbro have been shown to be directly related to the extent of pre-Alpine hydration during high-temperature hydrothermal alteration [1]. However, the influence of this degree of hydration on (1) reaction kinetics and/or (2) enhancing rheological contrasts leading to heterogeneous deformation patterns and metamorphic conditions is still debated.

In order to address this issue, we propose a multidisciplinary study involving petrographic and microtextural observations combined with 2D thermo-mechanical numerical models allowing to discuss the role of pre-Alpine hydrothermal alteration on the development of HP metamorphic assemblages.

We present petrographic and textural data from three different types of rocks from the Allalin metagabbros: i) undeformed and mostly untransformed metagabbros, with relics of igneous augite and plagioclase, ii) coronites, with olivine pseudomorphs showing different levels of hydration, rimmed by a garnet corona, and iii) eclogitized metagabbros, with olivine and plagioclase sites fully replaced by high-pressure assemblages.

The role of protolith hydration on the observed range in metamorphic facies is then tested by using 2D thermo-mechanical models that allow to simulate the deformation of a strong and dry rock with several randomly oriented weak and hydrous zones. Our results show that the shearing of heterogeneous rock can lead to the formation of localized ductile shear zone within a matrix that remains relatively undeformed but where plastic deformation can occur. The associated *P*

field is also highly heterogeneous, with *P* ranging from 1 to 3 GPa. The deformation patterns and *P* modelled may suggest that locally hydrated portions of the gabbro acted as rheological perturbations sufficiently efficient in producing the structural and metamorphic record now observed in the field.

[1] Barnicoat, A. C. & Cartwright, I. (1997) Journal of Metamorphic Geology 15, 93–104