EGU24-4680, updated on 18 Feb 2025
https://doi.org/10.5194/egusphere-egu24-4680
EGU General Assembly 2024

Pore-fluid pressure evolution across the blueschist-to-eclogite-facies transition: constraints from the Eclogite Zone (Eastern Alps)

Leonie Strobl and Andrew Smye
Pennsylvania State University, Department of Geoscience, State College, USA

Variations in pore fluid pressure modulate effective normal stresses along fault zones and the subducting interface. Fluid availability is controlled by the decomposition of hydrous mineral phases and the subsequent rate of drainage. Geophysical observations suggest that the plate interface is a fluid-enriched region under near-lithostatic pore fluid pressure that may result in slow slip events (SSE) and non-volcanic tremor (NVT). The potential for fluid redistribution depends on dynamic changes of the porosity and permeability of the host rock as a function of solid-bound fluid volume change and the total system volume change during dehydration. Understanding the mechanisms involved with the evolution of porosity and permeability below the seismic zone is critical to gain insight into the formation of fluid networks and their rheological implications.

Here we present a petrological and mechanical analysis of the evolution of a suite of eclogite-facies veins from an archetypal HP-LT terrain: the Eclogite Zone, Eastern Alps. We define two dominant compositional types of mafic eclogite: banded and metagabbroic, respectively. Prograde metamorphic evolutions are similar for the two types of eclogites and comprise garnet core growth at 2.1 ± 0.25 GPa, 585 ± 15°C and rim equilibration at 2.6 ± 0.2 kbar, and 630 ± 10 °C. Contemporaneously to prograde garnet growth, the mafic eclogites underwent dehydration via the breakdown of several volumetrically significant hydrous phases: lawsonite, Na-amphibole (glaucophane), and epidote. The decomposition of lawsonite and glaucophane released up to 8 wt. % H_2O, resulting in the formation of a transient fluid filled porosity of □ 15 vol. %.

Phase equilibria calculations serve as a framework to constrain a mechanical model explaining the formation of both tensile fractures (type I) and vein segregates (type II) within the brittle-ductile transition zone. We propose a petrological-mechanical model for the formation of Type I tensile veins associated with periods of rapid dehydration and Type II dilatant structures in which rock deformation is outpaced by the reduction in pore fluid pressure, leading to a decrease in silica solubility and the precipitation of high-pressure mineral phases. Finally, this suggests that the rate of dehydration during the blueschist-eclogite transition plays a significant role in determining the dominant mode of deformation possibly affecting the fluid storage capacity of the subducting interface.