Transport and role of aqueous fluid in subduction: insights from multi-phase flow and oxygen isotopes modeling

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Dehydration reactions occurring during prograde metamorphism generate large amounts of aqueous fluids that ascend through the Earth's interior. Interactions between these fluids and the surrounding rocks play a major role in element transfer. In subduction zones aqueous fluids participate in the hydration of the mantle wedge, effectively lowering its solidus temperature. Although the process of aqueous fluids generation during prograde metamorphism is relatively well understood, it remains challenging to track fluid-pathways, leading to a lack of constraints and quantitative data on the evolution of fluid composition. In particular, the rates and mechanisms for fluid transport are still poorly understood.

The composition in oxygen isotopes of metamorphic minerals is sensitive to fluid-rock interaction processes and can provide insights on these questions. An oxygen isotope fractionation model was recently developed to better quantify the conditions of fluid-rock interaction (Vho *et al.*, 2019, 2020). The fractionation model, based on internally-consistent thermodynamic data, can be used to determine fluid sources and was applied to simulate mantle wedge hydration.

In this study, we present a 2D dynamic numerical model simulating multi-phase flow channeling due to decompaction weakening in a visco-elastic matrix. Element transport is taken into account via chemical advection in the aqueous fluid and in the solid phase. The model is coupled with thermodynamic and oxygen isotope simulations to investigate serpentinization of the mantle wedge. Starting from realistic values of oxygen isotope ratios for the subducting slab and the mantle wedge, chemical interaction and transport of oxygen isotopes is induced by the ascent of an aqueous fluid in the mantle. The evolving composition of the fluid can be tracked. The goal is to bring new constraints on the timescale and the geometry of fluid-pathways required to reach isotope ratios currently observed on serpentinites produced in this type of settings.

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