A petrogeochemical model perspective on the interplay between rock transformation and aqueous fluid production in subduction zones

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The release of aqueous fluids within the crust and interactions with surrounding rocks are fundamental processes on Earth especially in subduction zones. Examining the mineral record of high-pressure rocks, such as eclogites, exhumed to the surface can elucidate the pathways of aqueous fluids during metamorphism. Fluctuations in the $\delta^{18}O$ composition of fluids are recorded in the oxygen isotopes of minerals in high-pressure rocks. In these settings, the breakdown of minerals can trigger pervasive fluid flow because metamorphic reactions modify the rock volume. Documenting such triggers is critical for understanding the shift between closed and open system behaviours and how aqueous fluids flow at high-pressure conditions. Important aspects are: (1) mineral reactions and their impact on system properties; (2) reaction overstepping which can delay metamorphic reactions.

The petrogeochemical model presented herein simulates rock dehydration and fluid extraction at equilibrium via metamorphic reactions along typical subduction pressure-temperature-time gradients. The model uses Gibbs Energy minimization coupled to a physical model for fluid extraction and a fractionation model of oxygen isotopes for fluid and minerals. The application to a set of eclogitic rocks and their developed *P-T-t* path shows that changes in mineral assemblages and mineral modes can trigger the creation of fluid-filled porosity at elevated pressures and temperatures. The effects of *P–T–t* trajectories and reaction overstepping on the generation of fluid-filled porosity and tempo of the main extraction steps (continuous or episodically) are also investigated.

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