

Geochemical tracers of fluid-rock interactions in exhumed mantle domains: a comprehensive study of serpentinization processes

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In rifted margins, exhumed mantle has extensively interacted with fluids leading to the complete replacement of primary ferromagnesian minerals (mainly olivine, pyroxenes) to secondary hydrous mineral phases (i.e., serpentine minerals) and oxides (e.g., [1]). Such interactions are responsible for important chemical fluxes that are still poorly constrained, as well as the conditions (pH, temperature) in which they occur. Considering that these reactions are involved in major present-day social issues such as natural H₂ production, CO₂ storage or the formation of seafloor massive sulfide (SMS) deposits [2], we focus our study on material fluxes resulting from fluid-rock interactions and typically observed at rifted margins.

We present results of “open-system” hydrothermal experiments where fresh peridotite reacted with seawater at the temperature range of 100-300°C. Secondary mineral phases are identified by XRD, SEM and Raman spectroscopy. The mobility of elements is addressed by systematic measurements of major (μ -XRF and ICP-AES) and trace elements (ICP-MS) in the fluid and solid phases. Experimental results are compared to natural serpentinites from present-day (Iberia-Newfoundland) and Alpine fossil margins. Our experimental results show that, major elements such as Mg, Ca, Na, K and Si are rapidly mobilized in the fluid phase as the reaction proceeds. Among the trace elements, some incompatible elements, including B, Li, and LREE, also concentrate increasingly in the fluid phase. Finally, transition metals such as Cr, Fe and Ni are also significantly mobilized, which may efficiently contribute to the formation of SMS deposits at seafloor.

[1] Marcaillou et al. EPSL, 2011; [2] Marques et al. MG, 2007