Channelization and reactive fluid flow in subducting slabs

THOMAS ZACK[1] AND TIMM JOHN[2]

[1] Mineralogisches Institut, Universität Heidelberg, INF 236, 69120 Heidelberg, Germany, tzack@min.uni-heidelberg.de
[2] Institut für Geowissenschaften and SFB 574, Universität Kiel, Olshausenstr. 40, 24098 Kiel, Germany, tj@min.uni-kiel.de

Permeabilities in the subducting slab are to low to allow porous flow, thus fluid channelization is a fundamental parameter for the understanding of subduction zone fluid fluxes. Fluid channelization impacts reaction rates and element redistributions during metamorphism of the subducting plate as well as trace element compositions of subduction-related fluids during flow.

Channelized fluid flow predicts that from a rock point of view, most formerly subducted material will show only very limited evidence for fluid flow, consistent with the rarity of observed high fluid fluxes in subduction-related rocks. Fluid produced by dehydration reactions will not percolate through large rock volumes, but rather will be carried away from the dehydration sites by a veining network. Evidence for significant fluid fluxes have indeed been found in high-pressure veins with adjacent selvages, in which case trace element mobilities induced by aqueous fluids can be demonstrated. In such occurrences, LILE’s generally show the clearest signs of mobilization, followed by LREE and then HREE. Compared to HFSE, even Th has higher mobilities.

From a fluid point of view, equilibrium between fluid and surrounding rock will only be approached at sites of fluid production. However, fluids can be significantly modified while moving rapidly upwards through a veining network where the wallrocks are out of equilibrium with the fluid. In a subducting slab, such reactive fluid flow can preferentially dissolve minerals and take up their trace elements (e.g. Ba from phengite, Th and La from monazite). The degree of change in fluid composition will depend on the amount of fluid-mineral surface interaction. The chemical exchange reactions will not be possible to model by trace element partition coefficients alone, instead future models need to incorporate kinetic parameters such as surface reaction rates.