Reactive fluid flow and trace-element mobilization in slabs: insights from dehydrating blueschist

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The mafic high-pressure rocks of the Tianshan (NW China) display an interconnected network of eclogite-facies veins caused by the dehydration of blueschists. They provide unique insight into fluid-rock interaction and long-distance fluid flow occurring during the major fluid release of subducting oceanic crust. This case study focuses on an eclogite-facies transport vein, its blueschist host and a reaction zone, which is located in the central part of the vein. The blueschist mainly consists of glaucophane, white micas, epidote, dolomite, and garnet whereas the vein consists of omphacite, quartz and apatite. Within the reaction zone glaucophane, paragonite, dolomite, titanite and some epidote have been replaced by omphacite, garnet, and minor rutile. Rock textures indicate that the infiltration of external fluids produced the transport vein due to hydraulic fracturing. These fluids also triggered the eclogitization of the reaction zone. The low in trace element vein-forming fluid -with a high potential for complexation and clustering- caused a strong mobilization of all trace elements in those parts of the host the passing fluid reacted with. 40-80 % of the trace elements were scavenged, which coincided with a loss of the LILE and LREE, almost double the loss of the HREE and HFSE. Around 75% of the total carbon was released as CO_2 into the reactive fluid.

The main difference between the blueschist host and the reaction zone is the replacement of glaucophane, dolomite, and titanite by omphacite, garnet, and minor rutile respectively, whereas garnet, epidote, rutile, and phengite occur in both zones of the rock. Therefore, the conditions during the dissolution of the reacting minerals and the precipitation of the reaction products –the fluid composition and the fluid velocity– rather than the mineral assemblages and equilibrium partition coefficients mainly control the trace element mobilities in open sytems such as dehydrating slabs. Thus, trace-element mobilities are mainly controlled by the solubility of their carriers under the given conditions and the potential of the fluid to hold these elements in solution during transport. The mobilized trace elements coincide with those needed to create the slab signature of arc magmas. Hence, such an interconnected vein network may represents pathways for the slab-to-wedge fluid and element transfer.