Geophysical Research Abstracts,
Vol. 11, EGU2009-7154, 2009
EGU General Assembly 2009
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Mobilization of trace-elements due to Ca-metasomatically induced eclogitization of blueschist

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In the subduction complex of the Tianshan Mountains in western China, blueschist facies metamorphosed oceanic crust is cross cut by a major fluid conduit which is surrounded by a reaction zone mainly composed of the eclogite facies mineral assemblage omphacite and garnet. Based on petrological as well as geochemical evidence, formation of the vein and the eclogitic selvage around the vein resulted from fluid infiltration during peak metamorphic conditions of 22 kbar ± 3 kbar and 520 °C ± 30°C. The combination of bulk rock with mineral trace element concentrations as well as mass-balance calculations reveal substantial differences between the unaltered host rock and the eclogitic reaction zone around the fluid flow path which resulted from fluid-rock interaction. These differences include: 1.) strong depletion of mainly large ion lithophile elements (LILE) as well as Li of up to 60 % relative to their concentrations in the unaltered blueschist host rock; 2.) an extreme enrichment of Ca (~ 115 %) and Sr and Pb (> 300 %) in those parts of the vein-wall rock system which were affected by the fluid; 3.) redistribution of heavy rare earth elements (HREE) from partly replaced rutile and recrystallized titanite in the blueschist-eclogite transition zone into newly grown garnet rims in the eclogitic selvage around the vein; 4.) transformation of high Nb/Ta rutile into low Nb/Ta titanite during which Nb becomes preferably mobilized over Ta; and 5.) decoupling of Zr and Hf from Nb and Ta, the latter are depleted by ~ 30 % relative to the unaltered blueschist host rock whereas Zr and Hf concentrations are depleted by only ~ 10 % due to inert behavior of zircon during fluid-rock interaction. Infiltration of a Ca-rich fluid into Ca-poor blueschist (6-7 wt. % CaO) was the prerequisite for its transformation into Ca-rich eclogite (up to 16 wt. % CaO). The release of trace elements can be attributed to partitioning of these elements into the passing fluid phase during dissolution-reprecipitation processes in the course of eclogite formation. Flow of the Ca-rich reactive fluid was controlled by the major fluid conduit during the eclogitization supporting the evacuation of the trace elements from the system. Therefore, reactivity of the precursor mineral assemblage and the chemical gradients between the reacting and the passing fluid of the conduit rather than equilibrium partitioning coefficients or the mineral assemblage are mainly responsible for trace-element mobilization in the studied samples. The suite of trace elements released upon fluid-induced eclogitization of the reactive wall rock resembles that in island arc magmas showing strong enrichment of LIL elements, strong depletions in HFS elements and intermediate concentrations of REE.