Experimental modeling of slab-mantle interaction under UHP conditions

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Although it is widely accepted that metamorphic fluids and melts released from the slabs play a crucial role in subduction zones, processes at slab/mantle interface remain poorly studied, so far. Laboratory experiments carried out at 750-900oC and 2.9 GPa illustrate metasomatic alteration of the mantle wedge rocks such as dunite, lherzolite, and websterite caused by infiltration of COH fluids and acid melts released from the carbonate-bearing amphibolite during its eclogitization.

Melt pathways are usually cryptic in the newly formed eclogite but often visible in ultramafic layers as submicron spots at grain boundaries or/and melt segregations near walls of the capsules. The melt segregations are of rheolitic composition. In the olivine-bearing layers, they are surrounded by magmatic and metasomatic mineral assemblage (Omp±Phl±Opx±Grt).

Fluxes of melt/fluid into ultramafic lithologies produce different reaction zones at the interface with the metabasite: Opx+Grt+Mgs±Phl is developed after dunite, Omp+SiO_2 - after websterite, and Omp+Grt+Mgs – after lherzolite. The reaction zones act as filters for migrating liquids. For example, the reaction zone in the dunite retains potassium and no sodium in contrast to the one in websterite, that stores sodium but no potassium.

Metasomatic effects above the reaction zones strongly depend on the primary ultramafic medium. Alteration of websterite is minimal, and is expressed in partial replacement of augite by omphacite. Olivine-bearing layers are effectively modified. Orthopyroxene and garnet with minor magnesite are developed after olivine in dunite. As a result, the dunite turns into mineralogy of garnet harzburgite in which the olivine is of the different origin than the other minerals. Pervasive migration of the same melt/fluid through the lherzolite also facilitates growth of garnet and orthopyroxene, but is accompanied by the dissolution of clinopyroxene. Thus garnet harzburgite mineralogy is produced in this case from more fertile rock due to the filtration of silica-rich melt.

The documented processes might be widespread not only in Phanerozoic but also in Precambrian subudction zones.

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