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Hydrothermal experiments on the metasomatic reactions at crust-mantle boundary.

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Hydration and dehydration reactions play crucial roles on global circulation of H2O in the earth's interior and serpentinization (hydration of ultramafic rocks) is representative hydration process at slow-spreading ridge, bending faults and subduction zone. It is known that silica activity has a large impact on controlling the reaction path during serpentinization [e.g., 1 and 2]. At the crust?mantle boundary, a steeper silica activity gradient is expected, and a large mass transfer including silica would cause metasomatic zoning. However, detailed mechanism to produce metasomatic reactions and its relation to the mass transfer are still poorly understood.

In present study, hydrothermal experiments (250C, Psat) were carried out in two systems: the olivine (Ol)?quartz (Qtz)?H2O and Ol?plagioclase (Pl)?H2O system, as analogues of crust-mantle boundary. Especially, by using unique tube-in-tube type hydrothermal experiments vessel, spatio-temporal evolution for metasomatic reactions as a function of distance from Ol?Qtz or Ol?Pl boudaries were evaluated.

In the Ol?Qtz?H2O experiments, the mineralogy of the reaction products in the Ol-hosted region changed with increasing distance from the Ol?Qtz boundary, from smectite + serpentine (Smc zone) to serpentine + brucite + magnetite (Brc zone). Mass balance calculations revealed that olivine hydration occurred without any supply of silica in the Brc zone. In contrast, the Smc zone was formed by silica metasomatism via competitive hydration and dehydration reactions. In the Smc zone, smectite formed via the simultaneous progress of olivine hydration and serpentine dehydration, and around the boundary of the Smc and Brc zones, serpentine formation occurred by olivine hydration and brucite dehydration.

In the Ol?Pl?H2O experiments, the mineralogy of the reaction products in the Ol-hosted region changed with increasing distance from the Ol?Pl boundary, from chlorite + serpentine (Chl zone) to serpentine + brucite + magnetite (Brc zone). Olivine hydration proceeded in both zones, but the total H2O content in the products was greatest at the boundary than other part of the inner tube in the Ol?Pl?H2O experiments.

Our result indicates that in Ol?Qtz?H2O experiments, the competitive progress of serpentinization and silica metasomatic reactions would cause fluctuations in pore fluid pressure. However, in Ol?Pl?H2O experiments, fluid pressure was not raised. This metasomatic reaction possibly affects the mechanical strengths of the crust?mantle boundary.

References

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