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Effects of pH and silica on the progress of serpentinization deduced from hydrothermal experiments.

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Hydration of ultramafic rocks (serpentinization) commonly proceeds in seafloor hydrothermal systems at mid-ocean ridges along the bending faults, and at the boundary of wedge mantle and subducting plate. The extent and distribution of hydrated mantle plays an important role on the global circulation of H2O. Silica activity and pH conditions are key factors in controlling reaction paths and the rate of serpentinization. (Frost and Beard, 2007; Lafay et al., 2012) In this study, we conduced hydrothermal experiments to investigate the reaction mechanism of serpentinization at oceanic seafloor at which circulating across crust and mantle, especially focusing on the effects of solution pH and silica.

We conducted two types of batch-type hydrothermal experiments at 250, 300 and 350 degreeC at vapor-saturated pressure: (1) olivine (Fo91)-H2O system with varying initial solution pH from under conditions of 250degreeC, 300degreeC and 350degreeC, and (2) olivine-quartz-H2O system as the analogue of boundary between mantle and crustal rocks. In the latter experiments, we used the tube-in-tube vessel with inner alumina tube containing the powder of olivine/quartz/olivine and quartz were set in tube-in-tube vessels under conditions of 250degreeC, 350degreeC and vapor-saturated pressure to examine the temporal evolution of solution chemistry and products in runs of up to 1180h in duration. The extent of the serpentinization was measured by thermogravimetry, and occurrences of the products was observed by using SEM with EDS.

The products of the Ol-H2O experiments after 1812 h are serpentine + brucite. The morphology and extent of serpentinization are nearly constant at pH $<$ 11; serpentine crystals show cone-in-cone and the extent of the serpentinization were ˜40 % at 300 ?C. In contrast, at pH $>$ 11, serpentine crystals become fibrous crystals (chrysotile), and the reaction rate increased significantly (˜ 90 % of olivine was serpentinized at pH =13.5 under conditions of 250degreeC and 300degreeC). Fibrous crysotile veins are commonly observed in serpentinized peridotites which contained mainly mesh-textures of lizardite; therefore, our results may indicate such fibrous crysotile veins is a trace of the high-alkaline solutions. In the experiment at 250 and 300 ?C, the solution pH increased with time, implying acceleration of serpentinization reactions.

In the olivine-quartz-H2O experiments, talc was formed as well as serpentine. At the Qtz/Ol boundary, only talc (Mg/Si = ˜0.8) was formed, whereas talc-serpentine mixture (Mg/Si=1.0-1.2). The total amount of H2O in the products increased with time toward TG loss of ˜ 5 wt%, and then slightly decreased. Especially, the amount of serpentine increased then decreased, whereas the amount of talc increased monotonicly, indicating two step of reactions; initial formation of serpentine minerals followed by talc formation at the boundary between mantle and crustal rocks.

Reference

Klein, F., Bach, W., Jons, et al (2009). Geochimica et Cosmochimica Acta, 73(22), 6868?6893.
Frost, B. R., & Beard, J. S. (2007). JOURNALOF PETROLOGY 48(7), 1351?1368.
Lafay, R. et al.,(2012). Journal of Crystal Growth, 347(1), 62?72.

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