Formation of brucite reaction zone with antigorite veins from the Oman ophiolite and its comparison with hydrothermal experiments.

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The reaction zones around veins provide valuable information on the flux and timescale of fluid flow in the Earth’ s interior. However, as experimental studies on the formation of reaction zones are limited, the formation mechanism of the reaction zone is still poorly understood. In this study, we analyzed the brucite-rich reaction zones developed around antigorite veins found in fully serpentinized dunite from the crust-mantle transition zone of the Oman ophiolite. We also conducted hydrothermal experiments to form brucite from serpentinite and discussed the formation mechanism of the reaction zone.
The sample observed is a dunite at the crust-mantle boundary obtained from the Oman Ophiolite drilling (Oman Drilling Project CM1A). The dunite is completely serpentinized, showing mesh texture consisting of lizardite, brucite, magnetite, and Cr-rich spinel. This matrix (low-T serpentinite) was cut by later antigorite veins (width of 400 −500 um). It is noted that distinct reaction zones (width of 0.5 −4 mm) were developed at both sides of the antigorite veins. The mass balance and thermodynamic calculation indicate that 6.3 mol_{SiO2} kg_{matrix}^{-1} of silica should be leached from the matrix during the antigorite precipitation in the vein.
We conducted hydrothermal experiments to reproduce the brucite-rich reaction zone. The experimental samples were pieces of fully serpentinized dunite from the Oman ophiolite (2 mm x 2 mm x 1 mm), which placed in a stainless-steel reaction vessel with different pH solutions (NaOH solution with pH 12.1 - 13.8, MilliQ, and H_2SO_4 with pH 2.2), and heated in a furnace at 300 ˚C for 5 days. After each run, the surface was observed by SEM, and the solution chemistry was measured by ICP-OES. As a result, brucite precipitated on the surface in the cases of NaOH solution and MilliQ. In contrast, brucite was not observed in the case of H_2SO_4. As a result of the plot of the solution composition after the experiment in the activity diagram, it was found that the NaOH solution was saturated with brucite, while the H_2SO_4 solution was undersaturated, which is consistent with the observations. The solution chemistry after the experiments shows increasing in Si concentration (0.77 ppm −113 ppm), while the Mg/Si ratio showed a decreasing trend with increasing pH (Mg/Si = 4×10^{-3} at pH = 13.8 - 7×10^{1} at pH = 2.22). These results indicate that (1) the mineralogy and rates of the reaction zone are a strong function of pH of fluids, and (2) the brucite reaction zone from the Oman ophiolite was formed by leaching of silica-related to neutral to alkaline conditions.

Keywords: Serpentinite, Reaction zone, Hydrothermal experiment

