Significance of silica transport on serpentinization: insights from hydrothermal experiments

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Serpentinization plays important roles in various geological processes in the earth and similar planets. Serpentinization does not always proceeds under "isochemical" conditions; however, the importance of mass transport on the path and overall rate of reactions are poorly understood. We conducted hydrothermal serpentinization experiments (at 250°C and under vapor-saturated pressure) within olivine (Ol)–orthopyroxene (Opx)–H_2O and Ol–quartz (Qtz)–H_2O systems using a configuration of composite mineral layers. The Ol–Opx–H_2O experiments produced serpentine as a hydrous mineral and involved serpentinization as a result of coupling of the silica-releasing reaction of orthopyroxene and the silica-consuming reaction of olivine, and the reaction progress was controlled by the relative magnitudes of silica diffusion with respect to the two reactions. The Ol–Qtz–H_2O experiments involved the addition of a quartz-saturated fluid into the Ol-hosted region of the experiment and recorded the development of a silica metasomatic zone associated with a change in assemblage from smectite + serpentine to brucite + serpentine + magnetite with increasing distance from the Ol–Qtz boundary. The formation of silica-metasomatic minerals such as smectite or talc means that the overall hydration rate of olivine is reduced as a result of silica supply. At the crust–mantle boundary, where unreacted olivine remains, the hydration of olivine and silica-metasomatic dehydration reactions occur simultaneously, which could result in fluctuations in pore fluid pressure in such boundary zones.