Dissolution kinetics of forsterite olivine at >200 ˚C: implication for the kinetics of serpentinization.

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Serpentinization (hydration of mantle peridotite) gives significant changes to both chemical and physical properties of the oceanic lithosphere. Several studies suggested that the rate of serpentinization is maximized at 250-300˚C, and the rate-limiting process of serpentinization is the dissolution of primary mineral (e.g., Malvoisin et al., 2012). Therefore, the dissolution rate of olivine at 250-300˚C is consequently a critical parameter to understand the progress of serpentinization in the oceanic lithosphere. However, the olivine dissolution rates at > 150˚C have never been measured (Rimstidt et al. 2012), and the olivine dissolution rate extrapolatory calculated at 300˚C was inconsistent with the olivine serpentinization kinetics (Malvoisin et al., 2012). Towards the improved understanding of serpentinization kinetics, measuring dissolution rates of olivine as a function of solution composition and the temperature is required.

In this study, the dissolution rate of natural olivine ($(Mg_{0.91}, Fe_{0.09})_2SiO_4$) was measured at 200-400 ˚C and 50 MPa using a flow-through reactor (Suzuki et al., 2015). A 0.5 mol/kg NaCl solution was introduced at a constant rate of 2.0 mL/min during experiments. A preliminary experiment revealed that steady-state dissolution rate of olivine at 200 ˚C and far-from-equilibrium conditions was ca. -4.8 [mol/m^2/s] in log units. The obtained dissolution rate was consistent with the extrapolated dissolution rate (log_{10}(Rate) = ca. -4.72 [mol/m^2/s]), which was extrapolated from their pH-temperature dependence at 25-150 ˚C (Rimstidt et al., 2012). Based on dependences of temperature, salinity, and ΔG on dissolution rate, the timescales on hydrothermal alteration of peridotite will be discussed.

References

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