

Kinetics of olivine weathering in seawater: an experimental study

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Enhanced weathering of basic to ultra-basic silicate rocks such as dunite (>90% olivine) has been proposed as a possible climate engineering approach with the goal of long-term CO₂ sequestration. Olivine weathering is expected to increase seawater alkalinity, leading to CO₂ uptake from the atmosphere. Still, the kinetics of olivine weathering in seawater and its interaction with the seawater – carbonate system remain poorly constraint. This study presents results from batch experiments, in which olivine (forsterite) + pyroxene³ (90%) was reacted with seawater, using different solid/liquid ratios (5g/200ml, 10g/200ml, 20g/200ml). First results show that after an initial increase in seawater alkalinity due to olivine dissolution, also accompanied by a DIC increase, alkalinity decreased again below the initial value. The initial increase and subsequent decrease are also mirrored in pH-values during the early stage of the experiment. Visible formation of precipitates in the bottles indicate the formation of secondary minerals. XRD-scans together with complete decomposition and subsequent chemical analysis of the precipitate show the formation of carbonates (calcite, aragonite), sepiolite, and talc along with other amorphous Mg-Si phases. Calculations based on DIC, TA and pH were carried out to assess the saturation states of calcite and aragonite. These showed that the saturation states in- and decreased rapidly at the beginning of the experiment before they stabilized despite a constant drop of pCO₂ and a depletion in DIC. Thereby the first increase as well as the final values are lower, for lower solid/liquid ratios. This indicates a catalyzation of the secondary mineral formation process by the presence of altered olivine.

The secondary mineral formation appears to be the main reason for the reduction of total alkalinity. The overall loss of alkalinity and, more important, the possible catalyzing effect of olivine gives reason to assume that despite a plausible theoretic approach, the artificial weathering of olivine in seawater is to be contemplated critically. Further investigations towards the chemical reactions under natural in situ conditions could certainly shed light on this problematic aspect.