

# New insight on lithium and boron isotope fractionation during serpentinization derived from batch reaction investigations

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## Motivation and Approach

Serpentinization plays a crucial role in the geochemical cycling of water and solutes between the ocean, crust and mantle. The fluid mobile elements Li and B are powerful tracers for mass transfers associated with serpentinization. However an explicit experimental investigation of partitioning and isotope fractionation of Li and B during serpentinization does not exist.

We conducted multiple batch experiments (100 °C, 200 °C; 400 bar) reacting fresh olivine (5g; Fo<sub>90</sub>, [B] = <0.01 µg/g; [Li] = 1.66 µg/g) with seawater-like fluids (75 ml, 3.2 wt.% NaCl), which were adjusted in composition with respect to Li (0.2, 0.5 µg/ml) and B (10 µg/ml). We used Dickson-type reactors, consisting of collapsible 100-mL Ti-capped gold reaction vessels housed in steel autoclaves. Concomitant fluid samples were analyzed for pH, major and minor element concentrations (ICP MS) and Li and B isotope ratios (MC ICP-MS). The data provides information on the reaction progress and the ongoing isotope fractionation. Analyses of solid reactants and reaction products via TG/DSC, SEM, XRD, AGFM and MC ICP-MS facilitates a comprehensive quantification of the serpentinization reaction.

## Results

At 200 °C we could confirm a reaction turnover of about 70% after 224 days. The product mineral assemblage matched equilibrium thermodynamic computation results (EQ3/6). A distinct B incorporation into the solid reaction products was accompanied by pronounced isotope fractionation ( $[B]_{\text{Solids}} = 23.6 \mu\text{g/g}$ ;  $\Delta^{11}\text{B}_{\text{S-F}} = -4.7 \text{‰}$ ). In the same run, isotopically light Li was leached from primary olivine ( $[Li]_{\text{Solids}} = 0.48 \mu\text{g/g}$ ;  $\Delta^7\text{Li}_{\text{F(initial-final)}} = -16.48 \text{‰}$ ). At 100°C, the reaction turnover was lower (~11 %), but a significant B uptake could also be observed ( $[B]_{\text{Solids}} = 9.1 \mu\text{g/g}$ ). The observed isotope fractionation was greater at 200°C ( $\Delta^{11}\text{B}_{\text{S-F}} = -13.7 \text{‰}$ ). In contrast to Li-leaching at 200 °C, product mineral phases at 100°C took up significant amounts of Li from the fluid, but the associated isotope fractionation was small ( $[Li]_{\text{Solids}} = 2.05 \mu\text{g/g}$ ;  $\Delta^7\text{Li}_{\text{F(initial-final)}} = -0.27 \text{‰}$ ).