Light elements in oceanic and ophiolitic serpentinites and implications for element recycling in subduction zones

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For a complete understanding of light element systematics in back-arc volcanoes, source parameters are crucial. In general, unserpentinized mantle is thought to contain very low concentrations of Li, Be and B and thus plays a minor role in the light element recycling. The oceanic plate, on the other hand, should bring these elements into the subduction zone factory.

Our study of minerals in serpentinites from the mid-Atlantic ridge (MAR, ODP Leg 209) using SIMS revealed that serpentine is an important carrier of B, whereas Li is depleted within these rocks compared to the unmodified mantle. Calculations based on our measurements and on literature data of the Li and B budget of the oceanic plate and possible input into subduction zones showed that the B budget is controlled by the serpentinized mantle, whereas the Li budget is dominated by the oceanic crust.

We also studied light element concentrations in minerals in peridotite samples from the Totalp, Platta and Malenco ophiolites (Alps), representing a transect with increasing grade of regional alpine metamorphism. Along this transect, a crystallographic change in serpentine (chrysotile to antigorite) with increasing metamorphic grade is observed. Associated with the polymorphic change, B concentration in serpentine is decreasing (lower B concentration in antigorite compared to chrysotile), and similar loss is observed for Li. Thus the chrysotile-antigorite transformation at shallow levels (<50km) in the subduction zone releases B and Li from the slab, and enriches the shallow mantle wedge. As a result, less B can be released from the slab at deeper levels (~120km), when antigorite breaks down, into the source of back-arc volcanoes. Nevertheless, the B concentration is still one order of magnitude higher than depleted mantle at antigorite break-down depth. We conclude that B enrichment of the mantle wedge related to serpentine occurs both at shallow and at deep levels during subduction of the oceanic plate.

Solid solution in the system calcite - $NaEu(CO_3)_2$

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The structural incorporation of trivalent actinides and lantanides in calcite could be an important retention mechanism for nuclear waste repositories. Recent spectroscopic investigations suggested that the incorporation of Eu(III) in calcite occurs via the coupled substitution Eu(III) + Na(I) = 2Ca(II) [1]. Our atomistic model calculations show that the hypothetical $NaEu(CO_3)_2$ end member has a dolomite-type structure. The enthalpy of the reaction $NaEu(CO_3)_2 + Na_2CO_3 = Na_3Eu(CO_3)_3$ is computed to be -48 kJ/mol. Therefore, the standard enthalpy of the dolomite phase can be calculated from the standard enthalpies of Na_2CO_3 and $Na_3Eu(CO_3)_3$, if the standard enthalpies of the reaction products are known. As no thermodynamic data are available for $Na_3Eu(CO_3)_3$, we synthesized it hydrothermally in order to perform calorimetric measurements. The unit cell parameters of the synthetic sample (a = 9.944, b = 11.027, c = 7.153 Å) are in good agreement with the parameters reported in literature [2]. The calorimetric measurements are now being planned.

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