Mother-of-Pearl: Architecture and possible formation mechanism

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Biominerals in general [1-4] and nacre, or mother-of-pearl, in particular [5-8] attract the attention of scientists in biology, material science, and geochemistry because of their remarkable mechanical properties and the fascinating mysteries that still surround the formation mechanisms of these materials.

The structure and formation of aragonitic mollusk shell nacre are widely studied but still poorly understood. In this work we analyze *Haliotis rufescens* (red abalone) nacre with synchrotron spectromicroscopy, using linearly polarized soft-x-rays as illumination, and x-ray absorption near-edge structure (XANES) spectroscopy. We demonstrate high imaging contrast between adjacent individual nacre tablets, dependent on their crystal orientation with respect to the polarization vector. We compare data from previous reports and our new data with models for columnar nacre growth and find that the data are most consistent with a model with randomly distributed nucleation sites for nacre tablets, pre-formed into organic matrix layers.

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Experimental study on the B-isotope fractionation between tourmaline and fluid: A re-investigation

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The boron isotopic composition of magmatic and metamorphic tourmaline shows a wide spread in $\delta^{11}B$-values which may range up to 40‰. Fractionations of boron isotopes between tourmaline, fluids, and melts have been used to infer quantitative information on fluid-rock and melt-rock processes in which tourmaline is involved. However, experimental data on $\Delta^{11}B_{(tourmaline-fluid)}$ are scarce and restricted to hydrothermal experiments by Palmer *et al*. (1992) performed at 350 to 750°C and 50 to 200 MPa.

We reinvestigated the boron isotopic fractionation between tourmaline and fluid by hydrothermally synthesizing dravite with excess fluid between 400 and 700°C at 200 MPa, and at 500°C, 500 MPa using different synthesis techniques. One series used oxides, water and boric acid (90% excess) in a single capsule; the other boric acid (10% excess) and a two-chamber capsule (von Goerne *et al*. 1999). Run products were characterized by XRD with Rietveld refinement, SEM, EMP and P-TIMS.

Dravitic tourmaline was always the main solid phase sometimes accompanied by traces of other phases, which essentially are boron-free. Dravites from the first series are uniform in size (about 20 μm long), the second series produced a bimodal distribution consisting of small dravite aggregates plus large needles up to 350 μm long. Fractionation of boron isotopes between tourmaline and fluid from the first series give consistent results of -0.4‰ at 700°C and -2.6‰ at 400°C. The temperature dependence is approximated by $\Delta^{11}B_{(tourmaline-fluid)}$ = -3.82 (1000/T[K]) + 2.88, R^2 = 0.61. No pressure dependence was observed. The values are interpreted as equilibrium fractionations, and are significantly lower than those reported by Palmer *et al*. (1992) for similar conditions. Small and large dravites from the second series of experiments were analyzed separately. Boron isotope ratios between handpicked large crystals and aggregates of small crystals may differ by a few ‰ resulting in apparently larger $\Delta^{11}B_{(tourmaline-fluid)}$. This is interpreted as resulting from Rayleigh fractionation of boron isotopes at various stages during tourmaline growth. The effect was enhanced by the fact that the overall excess of boron acid was much smaller in the latter series of experiments.

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