Extreme fractionation of boron isotopes in Altay No.3 pegmatite

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Relative narrow variations of B isotopes in granites and simple pegmatites have been reported previously (Jiang and Palmer, 1998). However, no detailed systematic study has been conducted on the B isotope of tourmalines in an intensively differentiated zoned pegmatite.

The Altay No.3 pegmatite is one of the most completely differentiated LCT-type pegmatites throughout the world and it is composed of nine textural zones from the rim to its core except for a border zone and wall zone. The δ^{11} B values of 25 tourmalines from the internal zone and the altered wall rock are within the range of -41.1~-9.2 per mil (Fig.1).



Fig. 1. The boron isotope compositions of tourmalines. Abbrev.: A. Exocontact; B. Altered rock

32 per mil of boron isotope difference in tourmalines cannot be explained merely on fractionation between fluid and melt for the fractionation coefficients is estimated to be 1.005~1.010. As evolution of the studied pegmatite was under a relatively closed system, the boron isotopic variations resulted from influence of an externally-derived fluid can be excluded. In peraluminous melt and tourmaline, boron is thought to be in the form of trigonal coordination, while boron is incorporated mainly into the tetrahedral structures of muscovite and tetraborate (Hervig et al., 2002). So, with continued fractional crystallization, ¹⁰B preferentially partitions into the tetrahedral structure of muscovite or tetraborate, and results in the increase of δ^{11} B for the tourmalines crystallized in the late residual melt.

References

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Dynamic rare earth element distributions in seawater as influential tracers of oceanic circulation

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Because of the simplicity and predictability of their chemical systematics, rare earth elements (REEs) are receiving increased attention in marine geochemistry. After 1990s, REE concentration in seawater has been recognized worldwide with high precision (between one and a few percent), by use of ID-TIMS or ICP-MS, without contamination. Although more detailed arguments are possible regarding the geochemical processes controlling the concentration, distribution, fractionation and anomalous behaviors in the ocean, discussion of its use as a tracer of water mass and an oceanic circulation mechanism is still limited, because the geochemical behavior of REEs in the marine environment is extremely complicated. Our current results relating to REE studies of the oceanic circulation in the Japan Sea confirm that the Tsushima warm current, which mixes with the shallow shelf water effected by the water from the Changjiang River, flows north to the Eastern Japan ocean basin in early autumn. Moreover, our results suggest that the shallow water (New Bottom Water) of the Japan Sea, which sank off Vladivostok in the winter of 2001, flows into the bottom water mass of the Eastern Japan Basin, which contributes significantly to the elucidation of the deep convection system in the Japan Sea. These imply that REEs, in particular the adjacent heavy REEs, could be extremely useful for characterizing water mass and as tracers of detailed shortterm ocean circulation, because of their susceptibility to the geochemical variations than salinity and/or dissolved oxygen. Simultaneously, it will be necessary to pay attention to the scavenging between dissolved and particulate phases, which play a key role in controlling the relative REE abundance and distribution in the ocean. At present, while it is developed as a determination by on-line column pre-concentration ICP-MS or flow-injection ICP-time-of-flight MS, the in-situ REE measurement technique in seawater will be more convenient, practical and rapid on the world scale.



Fig. 1. Er distributions in the north Pacific and Indian Ocean, which notably correspond with the ocean currents.