

Distribution of boron in slope sediment of Nankai accretionary prism off Kumano using B isotope as a tracer

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1. Introduction

In oceanic mass balance, boron is taken up into clay minerals, thus seafloor sediment plays a role as an important sink of boron (Spivack et al., 1987). But a mechanism of the uptake has not been clarified yet in a detail. Isotopic fractionation has a specific value for each reaction, thus to investigate isotopic fractionation enables to infer in-situ reaction mechanisms. But the isotopic fractionation in the previous study through laboratory experiments cannot exactly explain reaction mechanisms in natural environments, especially at a low-temperature condition. In this study, isotopic fractionation of boron in surface sediment at a lower temperature than 25 °C was investigated to discuss a behavior of boron in natural environments at a low-temperature condition.

2. Materials and analytical methods

Samples of pore water were extracted from surface sediment recovered from Nankai accretionary prism off Kumano during IODP Expedition 338. The boron concentrations in the pore waters were measured on board by the inductively coupled plasma atomic emission spectroscopy (Strasser et al., 2014). The precision was within $\pm 2.5\%$. The boron isotope ratios in the pore waters were measured by the multi-collector inductively coupled plasma mass spectrometry after its isolation (Wang et al., 2010). The analytical results were normalized by the standard material, NBS SRM 951, and denoted as a $\delta^{11}\text{B}$ value. The precision was within $\pm 0.7\text{‰}$.

3. Results and discussion

The boron concentration in the pore water was higher than that of seawater at the surface, and decreased with increasing a depth. The $\delta^{11}\text{B}$ value in the pore water was lower than that of seawater at the surface, and higher with an increasing depth. Isotopic fractionation, α , between solid and aqueous phases for each layer ranged from 0.950 to 0.970, lower than the reported values through a laboratory experiment between 0.975 and 0.980 (Palmer et al., 1987). In a laboratory experiment, there would be factors that could not imitate enough to natural environments; in-situ pressure, porosity, mineral compositions, ion strength of aqueous phases, and so on.

The relationship was verified between isotopic fractionation and several factors; in-situ temperature, pH, plagioclase abundance, and total organic carbon content. The relationship with pH showed a slightly negative, and the similar relationship was observed in surface sediment all around the world (You et al., 1993; Kopf et al., 2000; Teichert et al., 2005). This relationship would present uptake of $\text{B}(\text{OH})_4^-$ enriched in ^{10}B , because $\text{B}(\text{OH})_4^-$ is dominant in a solution when pH is higher.

4. Conclusions

Isotopic fractionation of boron in surface sediment of Nankai accretionary prism would be moderately controlled by pH, suggesting a reaction mechanism at a low-temperature condition has never been precisely imitated in laboratory experiments.

Keywords: Nankai Trough, Accretionary prism, slope sediment, Boron isotope