

## Origin of boron in Okinawa Trough hydrothermal fluids using B isotope as a tracer

TOKI, Tomohiro<sup>1\*</sup>; EBINA, Naoya<sup>1</sup>; SHINJO, Ryuichi<sup>1</sup>; ISHIBASHI, Jun-ichiro<sup>2</sup>

<sup>1</sup>University of the Ryukyus, <sup>2</sup>Kyushu University

The Okinawa Trough is a back-arc basin located around the Ryukyu Arc, where several hydrothermal systems have been discovered. The Okinawa Trough has a very thick sedimentary cover, and the chemistry of the hydrothermal fluids appeared to be influenced by interaction with the sediment. However, the temperature environments below the seafloor have not been clarified yet in detail. In this study, we investigated B isotope ratios ( $\delta^{11}\text{B}$ ) in hydrothermal fluids from Okinawa Trough, and discussed the origin of the boron and the reaction temperature.

The hydrothermal fluid samples were collected by WHATS with Hyper Dolphin and *Shinkai 6500* from Iheya North Knoll, Izena Caldron, Hatoma Knoll, and Yonaguni Knoll IV. The sample was filtered and acidified by  $\text{HNO}_3$ . B was isolated by micro-sublimation, and  $\delta^{11}\text{B}$  measurement was carried out using a MC-ICP-MS (Neptune plus). The precision was within 0.3%. All values reported in this study are presented in delta notation relative to NBS SRM 951.

The concentrations of B in the hydrothermal fluids from Okinawa Trough were higher than those from sediment-starved MOR, and the  $\delta^{11}\text{B}$  showed  $^{10}\text{B}$  enrichments. A difference of  $\delta^{11}\text{B}$  among Okinawa Trough hydrothermal fields was found; Yonaguni IV < Izena Caldron < Iheya North < Hatoma Knoll. The  $\delta^{11}\text{B}$  in the hydrothermal fluids showed the strong correlation with the carbon isotopic ratios of methane ( $\delta^{13}\text{C}\text{-CH}_4$ ) in the hydrothermal fluids, suggesting the factor controlling the variation of  $\delta^{11}\text{B}$  in the hydrothermal fluids is identical with the one controlling the variation of  $\delta^{13}\text{C}\text{-CH}_4$  in the hydrothermal fluids. The controlling factor for the variation of  $\delta^{13}\text{C}\text{-CH}_4$  in the hydrothermal fluids is a mixing ratio between thermogenic methane and microbial methane, implying the controlling factor for the variation of  $\delta^{11}\text{B}$  would be a mixing ratio between B derived from sediment at higher temperature and lower temperature.

We calculated the reaction temperature based on the correlated equation of reaction temperature with  $\delta^{11}\text{B}$  fractionation between solid phase and aqueous phase. For  $\delta^{11}\text{B}$  of the solid phase, reported  $\delta^{11}\text{B}$  of surface sediment from Okinawa Trough ( $-5.4$  and  $-2.2$  ‰) was used. However, all observed  $\delta^{11}\text{B}$  in the hydrothermal fluids could not be explained. Instead,  $\delta^{11}\text{B}$  of solid phase was estimated between 50 and 400 °C; the lowest temperature of leaching B from sediment is 50 °C and the highest temperature of sub-critical water is 400 °C.  $\delta^{11}\text{B}$  of sediment involved in B leaching was estimated to be from  $-20$  to  $-10$  ‰, which are lower than the  $\delta^{11}\text{B}$  in surface sediment from Okinawa Trough. Hydrothermal alteration lowered  $\delta^{11}\text{B}$  in sediment, suggesting the origin of the B in Okinawa Trough hydrothermal fluids would be altered sediment. For the reaction temperature, the lowest value among Okinawa Trough hydrothermal fluids was obtained in Hatoma hydrothermal fluids, following Iheya North, Izena, and Yonaguni IV, suggesting a large amount of sediment is distributed in recharge zone in Hatoma Knoll, and the B would be derived from the sediment at relatively low temperature. On the other hand, sediment is distributed in reaction zone beneath Yonaguni IV, and the B would be derived from the sediment at relatively high temperature.

Keywords: hydrothermal fluid, Okinawa Trough, boron isotope