Boron and lithium isotope constraints on fluid-rock interactions in the shallow megathrust at the Japan Trench

TSUYOSHI ISHIKAWA[1], JUN MATSUOKA[2], KAZUYA NAGAISHI[2], JUN KAMEDA[3] AND JAMES SAMPLE[4]

[1] Kochi Instute for Core Sample Research, JAMSTEC, Japan (t-ishik@jamstec.go.jp)
[2] Marine Works Japan Ltd., Japan
[3] Hokkaido Univ., Japan
[4] Northern Arizona Univ., USA

IODP Expedition 343 (JFAST) drilled through the plate boundary near the Japan Trench to investigate the cause of very large fault slip during the 2011 Tohoku-Oki earthquake. Here, we report B and Li isotope systematics of interstitial fluids and rocks from JFAST, and evaluate fluid-related processes that occurred in the shallow megathrust fault zone at the Japan Trench.

Depth profiles of B content and $\delta^{11}B$ value for the interstitial fluids show a clear minimum and a maximum, respectively, around the plate-boundary fault, with the vicinity of the fault being characterized by lower B content and higher $\delta^{11}B$ value compared with seawater. The Li contents and $\delta^{7}Li$ values of the JFAST fluids are thoroughly higher and lower than seawater, respectively, without no significant minimum nor maximum around the fault. The B and Li contents and $\delta^{11}B$ values of the plate-boundary fault rocks are indistinguishable from those of equivalent source smectite-rich sediments.

In the systems composed of seawater-like fluid and sediment, both B concentrations and $\delta^{11}B$ values in the fluid and solid phases are temperature-sensitive, and higher temperatures result in higher B and lower $\delta^{11}B$ in the fluid phase and lower B and lower $\delta^{11}B$ in the solid phase. Actually, interstitial fluids and rocks from ODP site 808 (Nankai Trough) showed such characteristics at the depths with temperatures higher than 50 ºC for fluids and higher than 100 ºC for rocks (You et al., Geoogy, 1995). The B and $\delta^{11}B$ characteristics observed for the JFAST fluids and rocks thus indicate that fluids and rocks within and around the plate-boundary fault analyzed here have no clear record of fluid-rock interactions at high temperatures. The lack of high-temperature signals around the fault is also consistent with the Li and $\delta^{7}Li$ data for the JFAST fluids and rocks. These observations provide constraints on the nature of fluid-rock interactions in the shallow megathrust fault zone during the Tohoku-Oki earthquake.