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Boron and Chlorine contents of Shatsky Rise, North Pacific, and their implications for the alteration of oceanic plateau

Masaya Miyoshi[1*], Takashi SANO[2], Kenji SHIMIZU[3]

[1]BGRL Kyoto University, [2]National Museum of Nature and Science, [3]IFREE, JAMSTEC

Oceanic crust is a large reservoir of Boron (B), Chlorine (Cl) and the other fluid-mobile elements. Investigation of these element contents of oceanic crust is necessary for clarifying the material circulation in the Earth and the alteration mechanism. Sea mount chain and oceanic plateau probably supply large amount of fluid to the mantle in plate convergent zones. However, little is known about the concentrations of B and Cl within the Sea mount and oceanic plateau. We therefore measured the B and Cl contents of the thick altered basalt sequences and fresh glasses in Shatsky Rise.

The B-Cl-K data show that low-temperature submarine alteration was dominant on altered rocks from Shatsky Rise, especially Site U1349 samples, as described below. The altered rocks have extensively higher B (up to 130 ppm) and B/K (up to 0.07) than fresh glasses (up to 5 ppm and 0.002, respectively). The high B contents in the altered rocks are most likely caused by the uptake of boron into secondary minerals in equilibrium with seawater at low temperature (<150 degree C). On the other hand, Cl contents of the altered rocks (33-1760 ppm) are nearly identical to those of fresh glasses (90-1100 ppm). The Cl data show that hydrothermal alteration was negligibly small on upper Shatsky Rise, because high Cl concentration of altered oceanic crust would be achieved during hydrothermal alteration at high temperature conditions (˜400 degree C).

The extensive low-temperature alteration is also proposed by descriptions of secondary minerals in the altered rocks from the Shatsky Rise (Sager et al., 2010, Proceedings of IODP Expedition 324). The main secondary minerals are calcite and clay minerals, which can be candidates of high B contaminant of Shatsky altered rocks. Calcite (126 ppm in B) would not be main contaminant, because B/K of calcite (>0.7) is distinctly higher than that of contaminant (<0.07) that estimated by B/K of the Shatsky altered rocks. Thus clay minerals would be the main contaminant of the high B concentration of the altered rocks.

We also compared the B content of Shatsky Rise rocks to those of normal sea floor, Site 1179 located near the Shatsky Rise. The B contents of Shatsky rocks (up to 130 ppm) are significantly higher than the Site 1179 basement rocks (less than 40 ppm). This observation indicates that Shatsky Rise is important budget of B on the Pacific sea floor.

Keywords: Shatsky Rise, Boron, Chlorine