Boron isotope ratios in pore fluids from mud volcanoes off Tanegashima

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Mud volcanoes are geological phenomena, where sediments are venting together with gas accumulated in sediments. They play an important role in geochemical cycle as a path from great depths. It is important to investigate chemical and isotopic compositions of pore fluids in surface sediments for understanding geochemical cycle from great depths. Recently, highly accurate topographical survey was carried out over the mud volcanoes off Tanegashima, and a new mud flow was observed on the seafloor of the mud volcanoes off Tanegashima. In this study, we investigated the chemical and isotope compositions of pore fluids from the mud volcanoes off Tanegashima to discuss the origin and migration processes of fluids in the mud volcanoes off Tanegashima.
From August 19 to September 1, 2015, sediments about 350 cm were sampled from the top of two mud volcanoes (MV#1 and MV#14) off Tanegashima during KH-15-2 cruise of R/V Hakuho using a piston corer. From the recovered sediments, pore fluid was immediately extracted on the ship, distributed to a plastic bottle. The sample was added with 3N nitric acid, and was kept in cool and dark place until analysis.
In the pore fluid sample, boron was separated using the micro-sublimation method, and the boron isotope ratio was measured using a multi-collector inductively coupled plasma mass spectrometer. Boron isotopic ratios were expressed as δ^{11}B (‰) as a deviation from the international standard material (NBS SRM 951). Precision was less than 0.9‰. Chloride ion concentration was measured by ion chromatography and oxygen and hydrogen isotope ratios of water were measured at the Kochi Core Center by cavity ring-down spectroscopy.
Concentration of chloride ion decreased below that of seawater with increasing depth in both sites. The δ^{18}O value of water increased with increasing depth and the δD value decreased with increasing depth. In addition, the degree of the change was larger in MV#1 than MV#14. On the other hand, the δ^{11}B value became lower than that of seawater with increasing depth in MV#1, and higher in MV#14.
It suggests that fluids with low-Cl, high-δ^{18}O and low-δD were supplied from the deeper part in both mud volcanoes. In addition, the difference of these change would represent the difference of the flux of deep-sourced fluids, and it suggests that the flux of fluid from the deeper part is larger in MV#1 with larger change than MV#14 with smaller change. Based on the combination of δ^{18}O and δD values of water, the origin of the fluid would be dehydration of clay mineral in both mud volcanoes, and come from a temperature environment of 60 to 160˚C at which the dehydration reaction of clay minerals occurs. Assuming normal geothermal gradient, the temperature environment is estimated to be several kilometers below the ocean floor. Different δ^{11}B values would be due to the degree of secondary processes during ascending through the sediment column, and it could be related to the flux of the deep-sourced fluids.
In this study, the chemical and isotope compositions of pore fluids from two mud volcanoes off Tanegashima were investigated. These mud volcanoes suggested that there was a difference in the flux of fluid from deep layers. In the mud volcanoes with smaller fluid flux, the secondary reactions would occur in the ascending process of the fluid.

Keywords: Boron isotope, pore fluid, mud volcano, off Tanegashima

