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福島風化黒雲母へのCs吸着実験
Cesium (Cs) Sorption Experiments into Weathered Biotite in Fukushima

菊池 亮佑[1*] ; 小暮 敏博[1]
KIKUCHI, Ryosuke[1*] ; KOGURE, Toshihiro[1]

[1] 東大院地惑
[1]Earth and Planetary Sci., Univ. Tokyo

After the accident of Fukushima Daiichi nuclear power plant in March 2011, radioactive contamination of the soil around the plant has become an urgent problem in Japan. Previous studies proposed that weathered micaceous minerals present favorable sorption environments for Cs^+. Because the contaminated areas in Fukushima are mainly covered with weathered granite soil, weathered biotite with hydrated (vermiculite) interlayers is abundant. Hence basic understanding of Cs^+ sorption process into the biotite is important to find the recipe for decontamination of radiation. Some of previous studies reported that Cs^+ is adsorbed mainly at the frayed-edge sites of such micaceous crystals. However, other studies indicated that Cs^+ penetrates deeply inside the crystals, along the interlayer regions by ion-exchange. In this study, we performed Cs^+ sorption experiments using single-crystals of Fukushima weathered biotite with well-regulated edge surfaces, and considered the relationship between the weathering state of biotite and Cs^+ sorption property.

Fresh and two kinds of weathered biotite were collected from granodiolite of Abukuma granite body in Fukushima prefecture. For each sample, cross sections of <1 mm thick perpendicular to the basal planes were prepared. Surface damage formed by the mechanical grinding/polishing was removed by Ar^+ ion sputtering. These sections were immersed in 30 mL of CsCl aqueous solution of 2000 / 200 / 20 / 0 ppm for 24 hours at room temperature to incorporate Cs^+.

After the reaction, the surfaces of the sections were investigated using scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS). SEM-EDS with various acceleration voltage indicated that the concentration of the sorbed Cs^+ does not change in the depth direction of ~several microns range. Cs^+ was apparently sorbed at 2000 ppm but not at 200 ppm for fresh biotite, whereas Cs^+ was sorbed at both concentrations in the weathered biotite. Back-scattered electron (BSE) images and EDS analysis showed preferred sorption of Cs^+ at the regions probably with dense vermiculite interlayers in the weathered biotite. Moreover, some specimens were processed into this foils using focused ion beam (FIB) and examined using scanning transmission electron microscopy (STEM). High-angle annular dark field (HAADF) imaging in STEM has visualized Cs^+-incorporated interlayer regions individually in the weathered biotite.

Keywords: Biotite, Vermiculite, Cesium, SEM-EDS, FIB, HAADF-STEM