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EXAFS analysis of temperature dependence of cesium adsorption in the sediment at Lake Onuma on Mt. Akagi

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1 Introduction

In the Lake Onuma on Mt. Akagi, exceeding radioactivity of cesium over the standard value had been still detected from the lake water and aquatic lives due to the Fukushima Daiichi Nuclear Power Plant accident. Currently radioactivity of water decreased under the standard value, but a decreasing trend of the radioactivity of cesium of the lake was being slowly after 2015 [1].

Since the continuous survey of the lake shows that dissolved Cs is dominant of radioactivity at a bottom of lake, we conjecture that radioactive cesium might be eluted from bottom of lake sediment. The adsorption experiment of radioactive cesium with sediments was conducted and it was found that about 70% of it was adsorbed. However, drying the sediment at 100 °C prior to the adsorption experiment suggested that the particle size may change due to drying, possibly underestimating cesium adsorption. Therefore, temperature dependence of adsorption was investigated by conducting stable cesium adsorption experiments using sediments dried at room temperature, 50 °C, 70 °C, 100 °C, and 150 °C. In order to evaluate the adsorption of cesium-adsorbed sediment, we have investigated the local structure of cesium in sediment by EXAFS.

2 Experiment

The sediment was dried at room temperature, 50 °C, 70 °C, 100 °C, 150 °C. for 24 hours. Five samples (room temperature, 50 °C, 70 °C, 100 °C, 150 °C) were added to 1 M CsCl solution, stirred for 1 hour, allowed to settle for 24 hours to adsorb cesium, filtered from liquid and each temperature (room temperature, 50 °C, 70 °C, 100 °C, 150 °C). EXAFS measurement was carried out at High Energy Accelerator Research Organization Photon Factory BL-27B, in transmission mode, using CsL_{III}-absorption edge.

3 Results and Discussion

Cesium dissolved in water is bonded via oxygen of 8 water molecules. In addition, cesium ion specifically adsorbed by clay minerals such as layered silicates forms much stabilized as an inner-sphere complex than hydrated state in solution [2].

Figure 1 shows that structural functions of Cs adsorbed on five samples (room temperature, 50 °C, 70 °C, 100 °C, 150 °C). The peak of the first neighbor is a bond with oxygen of hydrated water, i.e.,2.3 Å. The peak of the second neighbor is considered to be oxygen of the clay minerals, i.e., 3.5Å. This peak shows that the coordination number increased as the drying temperature increased. It was suggested that there is a correlation between drying temperature of sediment and Cs adsorption.

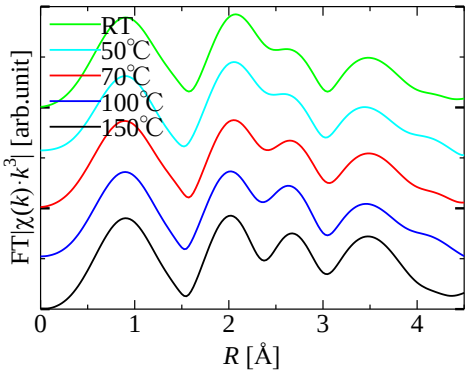

Fig. 1: Structural functions of Cs-adsorbed sediments with different drying temperatures.

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References

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