Cesium adsorption on acid/base-activated siliceous mudstone and biotite

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Chemically synthesized adsorbents for removing radioactive cesium (^{137}Cs) have high efficiency, but are expensive to produce and are not environmentally friendly. Recently, interest in adsorbents using natural minerals such as biotite and zeolite has been increasing. The objectives of this study were to evaluate the adsorption efficiency of cesium on siliceous mudstone and biotite as well as to investigate the effect of mineral surface activated by acidic/basic treatment on cesium adsorption.

The siliceous mudstone and biotite were crushed to a size of less than 75 ㎛ and treated with the acid (HCl) or base (NaOH) solutions for surface activation. The Cs-contaminated water (10 mg/L) was prepared using non-radioactive cesium chloride (^{133}Cs, CsCl). The adsorption experiments were conducted by adding 0.2 g of the minerals into 40 ㎖ of Cs-contaminated water for 2 hours. Mineralogical characterization of the minerals was performed by XRD and SEM-EDS. The surface charge and area of the minerals were measured by the zeta-potential and BET. ICP–MS analysis was used to determine the amount of Cs removed after reaction.

The siliceous mudstone (SM) consisted of opal-CT, quartz and feldspar. The biotite (B) was a single mineral without any other minerals. Mineralogy of SM and B were not changed after the acid/base activation. However, the chemical properties and surface charge/area of SM and B increased with base activation. As a result of adsorption test, the Cs removal efficiencies using siliceous mudstone were 44.95% for SM, 88.56% for acid-treated SM, and 98.53% for base-treated SM, respectively. In case of using biotite, the Cs removal efficiencies were 77.78% for B, 97.50% for acid-treated B, and 78.41% for base-treated B, respectively. These results showed that the base-activated siliceous mudstone and acid-activated biotite enhanced Cs removal efficiency because the acid/base-activation modified the surface charges of SM and B negatively. Therefore, the siliceous mudstone has a high potential as an adsorbent because of its high adsorption efficiency of Cs compared with biotite. In addition, acidic and basic treatments of minerals affect the mineral surface activity and are expected to be selectively applied to enhance Cs-adsorption efficiency.