Characterization of Clay Minerals in Soil Near Nuclear Facilities in Korea

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1. Introduction

Unintended leakages of radioactive substances from nuclear facilities induce contamination of the environment. Among various radionuclides, cesium can be strongly bound to clay minerals in soil, and thus cesium is generally fixed in the top soil layer.

Clay minerals are classified into kaolinite, smectite, vermiculite, illite, mica and many others, and each clay mineral provides different Cs adsorption sites with different Cs selectivity. Highly expandable smectite and slightly expandable vermiculite generally adsorb much greater amount of Cs than do non-expandable clay minerals. Adsorption of Cs on expandable clay mineral mainly takes place through outer-sphere complexation of hydrated Cs^+ ions with negatively charged clay interlayers. Though non-expandable clay minerals such as illites and micas can adsorb smaller amount of Cs than expandable clay minerals, the clay minerals provide highly Cs selective adsorption sites, which is kwon as Frayed Edge Site (FES) that adsorb cesium through the formation of stable inner-sphere complexes. Because compositions of soil and clay minerals widely vary by region, characterization of clay minerals in domestic nuclear facility sites and their Cs adsorption behaviors are regarded as important subject to investigate.

2. Experimental

Soils were sampled from near nuclear facilities in Seoul, Wolseong, and Gori, and clay and silt components were separated from sand and gravel by wet-classification. Clay minerals in clay/silt samples were characterized by the classical clay identification method based on ethylene glycol and heat treatment. Cationic exchange capacity (CEC) of clay/silt sample was measured by quantifying desorbed Na^+ after NH_4^+ treatment to the Na^+ saturated clay/silt samples.

3. Result & discussion

Analysis of clay minerals in the soil samples from Seoul, Wolseong, and Gori revealed that a large amount of kaolinite and trace amounts of illite were found in all soil samples. In particular, Wolseong and Seoul soil contained vermiculite, and some hydrobiotite was also found. In the case of the Gori soil, chlorite component was identified (Fig. 1).

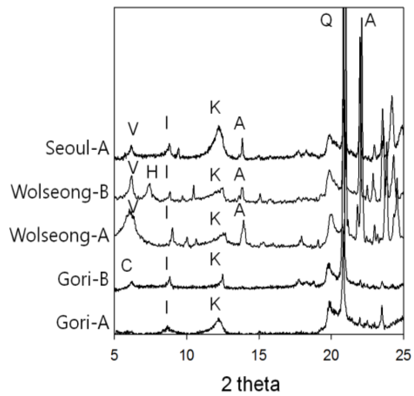

Fig. 1. XRD patterns of clays in Seoul, Wolseong, and Gori soils (C: chlorite, V: vermivulite, H: hydrobiotite, I: illite, K: kaolinite, A: albite, Q: quartz).

Analysis of CEC of clay/silt samples revealed that the Gori sample has a low CEC value because Gori sample is mainly composed of kaolinite and illite. However, Wolseong sample showed the highest CEC values due to vermiculite and hydrobiotite components.

4. CONCLUSIONS

We identified clay minerals in soils from domestic nuclear facility sites. A large amount of kaolinite and trace amounts of Cs selective illite were found in all soil samples. In particular, Wolsong and Seoul soil contained vermiculite, which generally provides Cs selective FES as well as highly Cs adsorbable expandable interlayers.

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