

Selenium and cesium adsorption onto biogenic iron oxyhydroxides: Comparison with inorganic iron oxyhydroxides

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Iron(Fe) oxyhydroxides are considered to be important sorbents of trace elements in surface environment. This widely view mainly extends from many laboratory studies using inorganic Fe oxyhydroxides. However, most of the natural Fe oxyhydroxides are referred to as biogenic Fe oxyhydroxides (BIOS) which are complex mixtures with various organic matters. The presence of organic matters in BIOS can cause unique adsorption behaviors of trace elements for BIOS, but they have not been characterized well. This study aims to reveal adsorption characteristics of trace elements onto BIOS.

Biogenic Fe oxyhydroxides were collected from Sambe hot-spring in Shimane prefecture. The samples consist of very fine particles of two-line ferrihydrite, coexisting with biogenic organic matters including stalks, extracellular polysaccharides, and bacterial cells. We have conducted adsorption experiments of selenium (Se) and cesium (Cs) on BIOS and synthesized ferrihydrite in a batch system. Our experiments revealed significant differences in Se and Cs adsorption between BIOS and inorganic Fe oxyhydroxides in a wide range of pH, even though they have similar Fe mineralogy. In the case of positively-charged Cs, BIOS showed larger adsorption than inorganic Fe oxyhydroxides. In contrast, negatively-charged Se showed smaller adsorption on BIOS compared with that on inorganic Fe oxyhydroxides. Especially, the decrease of Se adsorption on BIOS compared to inorganic Fe oxyhydroxides was more significant in Se(VI) than in Se(IV), corresponding to their formation of different surface complexes. We consider that the unique adsorption behaviors of Cs and Se on BIOS and their difference with inorganic Fe oxyhydroxides can be explained by the electrostatic effect caused by the coexisting biogenic organic matters in BIOS.

Keywords: iron oxyhydroxides, bacteria, adsorption behavior