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Differential sorption behavior of Cesium depending on humic acid content in clay minerals

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The sorption behavior of Cs was investigated on three types of clay minerals, namely montmorillonite, illite, and kaolinite, with varying humic acid contents. Humic acid was dissolved in a 0.1 M NaOH solution to prepare different concentrations of 0.5, 1, 2, 3, 6, 9, and 12%. These concentrations were then mixed with 1 g of each type of clay in separate conical tubes and agitated for 24 hours at room temperature. To verify the adsorption of humic acid on clays, total organic carbon (TOC) values were measured before and after the adsorption process. The results showed that montmorillonite, illite, and kaolinite adsorbed about 58%, 92%, and 84% of the humic acid, respectively. Subsequently, a 500 ppm Cs solution was added to all samples and mixed for 24 hours at room temperature, and the Cs concentrations in the mixture and effluent were measured. The distribution coefficient (K_d) value was calculated to interpret the adsorption behavior of Cs. The K_d values for montmorillonite containing the humic acid content of 0.5%, 1%, 2%, 3%, 6%, 9%, and 12% were 1.68, 1.37, 1.13, 1.06, 1.02, 0.81, 1.12, and 1.40, respectively. Interestingly, the K_d values decreased with an increase in humic acid content up to 6%, after which they increased. In contrast, for illite and kaolinite, the K_d values increased with an increase in humic acid content, even below 6%. The K_d values for illite were 0.42 and 1.04 for humic acid contents of 0.5% and 12%, respectively, showing a gradual increase. Similarly, the K_d values for kaolinite were 0.30 and 1.23 for humic acid contents of 0.5% and 12%, respectively, but with a sharper increase than illite. Furthermore, the results showed that montmorillonite adsorbed more Cs than illite and kaolinite under all tested conditions. To better understand and explain the decrease in K_d values for montmorillonite with a humic acid content of 0-6%, additional experiments were prepared to measure the surface area of clay minerals using the EGME (Ethylene glycol monoethyl ether) and N2-BET (Brunauer-Emmett-Teller) methods.