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Study of cesium and strontium sorption on Rokle bentonite in different electrolytes

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Sorption of radionuclides on bentonite represents in most of deep geological repository (DGR) concepts important process retarding radionuclide migration into geosphere. In the Czech Republic, DGR concept takes local bentonite into account as material for both buffer and backfill. The candidate bentonite comes from the Rokle deposit (NW Bohemia) and represents complex mixture of (Ca,Mg)-Fe-rich montmorillonite, micas, kaolinite and other mineral admixtures (mainly Ca, Mg, Fe carbonates, feldspars and iron oxides). This bentonite is different in composition and properties from worldwide studied Na-bentonite (e.g. MX-80, Volclay) or Na-Ca bentonite (e.g. Febex). This fact leads to the need of investigation of Rokle bentonite in greater detail to verify its suitability as a buffer and backfill in DGR.

Despite a number of studies concerning cesium sorption on bentonites, there are still some issues requiring clarification, especially the effect of cesium-selective minerals (micas and mica-type clay minerals). Their amount in bentonite and their effect on cesium sorption at different conditions represents great uncertainty in cesium sorption evaluation. In this study, the general trends of cesium and strontium sorption on Rokle bentonite (different samples) in comparison to well-defined reference material (Ca-montmorillonite SAz-1) were compared. Then, the effect of changing solution ionic composition on both Cs and Sr sorption was investigated in detail for average sample of Rokle bentonite and associated uncertainties in distribution coefficient (K_d) determination were evaluated.

The comparison with reference sample demonstrates that cesium-selective minerals are very important for cesium sorption even at its trace concentrations. For strontium there are no selective minerals to sorb it and the sorption is influenced mainly by the cation exchange capacity (CEC) of the bentonite. Comparing different electrolytes for cesium, the potassium has the highest competitive effect (competition on selective sites), in contrast to sodium and calcium. For strontium, the calcium has the highest competitive effect (competition on regular ion exchange sites), then the potassium and the last one the sodium. No significant differences were found for three selected samples of Rokle bentonite in sorption behavior for cesium and strontium, except the effect of total CEC of bentonite.

The main uncertainty sources for cesium arise from the presence of cesium-selective minerals in Rokle bentonite samples in varying amount. For strontium, the amount of smectite (which has the highest CEC in natural bentonite) represents the main source of uncertainties. It also follows from the performed experiments that the cesium sorption on studied bentonite cannot be described using simple K_d value.

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