Predicting the heterogeneity of actinide retention at the pore scale of host rocks

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The retention efficiency of migrating actinides in the host rock of a nuclear repository is a critical factor for predictive concepts. Current reactive transport modeling (RTM) approaches utilize simple retention coefficients [1] to describe interactions at the pore scale of host rocks. A key constraint that needs to be implemented into RTM approaches is the crystal surface energy that is controlled by multiple factors, e.g., crystallographic orientation, crystal defects, and nanotopography [2,3].

Here, we present and discuss experimental results that focus on the Eu(III) and U(VI) sorption efficiency on multiple mineral components in the Opalinuston rock type, including the sandy facies. Sheet silicates, calcite, and feldspar crystal surfaces are investigated using atomic force microscopic and interferometric microscopy techniques to provide insight into the crystal surface energy variability and distribution. Radiographic and spectroscopy methods reveal the Eu(III) and U(VI) sorption efficiency. We utilize the experimental results to parameterize an improved surface complexation model that implements crystal surface energy and sorption heterogeneity.

As a general result, we expect quantitative insight into the actinide retention variability in the host rock at the pore scale, thus contributing to an upscaling strategy at the core scale and above.

[1] Karimzadeh et al., Chemosphere, 178, (2017)
[2] Fischer et al., Appl Geochem 91, 140 (2018)
[3] Fischer et al., Appl Geochem 43, 132 (2014)