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# Competitive sorption effects of Al on Eu retardation on quartz and K-feldspar: A surface complexation and regional scale modeling approach

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The adsorption of radionuclides (RNs) onto mineral surfaces is a key retardation process playing a critical role in the long-term safety assessments of radioactive waste repositories. While many studies[1,2,3] have focused on the sorption of trivalent actinides (e.g. Am, Cu) and lanthanides (e. g. Eu, Y) onto various minerals, these experiments often investigate geochemically simple systems, typically in binary configurations with single surfaces and single sorbates. However, natural systems are more complex, with competitive sorption, bulk and surface precipitation, incorporation and co-precipitation processes affecting RN retardation behavior.

This study examines the competitive sorption of Eu (analogue for trivalent actinides) and Al onto quartz and K-feldspar, using a combination of batch and column experiments along with mechanistic surface complexation modeling (SCM). Aluminum, an ubiquitous component in natural groundwater systems, can compete with RNs for sorption sites. Due to its low solubility at near-neutral pH, Al may also undergo surface precipitation which alters the surface charge of the mineral and thus influence sorption behavior.

Batch experiments were carried out under varying geochemical conditions, including pH, ionic strength, and initial concentrations of Al and Eu. Results show that Al sorption onto quartz arises at lower pH compared to Eu with sorption edges at pH 4.5 w.r.t. Al and 5.5 for Eu (50% sorbed). Batch sorption data is used for SCM calibration via inverse modeling which are then qualified with 1D reactive transport simulations using data from column experiments. Furthermore, an outlook will be provided how to integrate these findings in regional scale (reactive) transport simulations using a state-of-the-art coupling of a geochemical solver with the 3D transport code $d^3f{+}{+}$[4].

These findings and innovative approaches support the importance of the understanding of geochemical surface reactions in general that help to improve the reliability of long-term safety assessments for radioactive waste repositories.

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