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The sorption of nickel(II) and europium(III) in the absence and presence of competing metal cations on various oxide minerals with different surface properties

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Studies on the competitive sorption of radionuclides and other metal ions are often conducted using elements with similar chemical properties, such as oxidation states. A study by Bradbury and Baeyens [1] suggests that metal ion sorption on clay minerals is non-competitive when the metal ions have significantly different chemical properties. Thus, metals with same oxidation states and a similar tendency towards hydrolysis would compete with one another, while metals with different properties would not. For example, competition for the surface sorption sites would occur for Eu(III) and La(III) but not for Eu(III) and Ni(II). The effect of sorption competition has to be considered correctly in performance assessment calculations for nuclear waste repositories, in order not to overestimate the retention of radionuclides in the presence of multiple solutes.

In the present study, the possible sorption competition of metal cations on oxide minerals with different pH dependent surface charge properties is investigated by batch sorption experiments. At first the influence of pH on the sorption behaviour of europium(III), lanthanum(III) and nickel(II) on different minerals is investigated in a series of experiments without a competing cation. In a second step, sorption competition studies are conducted using Ni(II) and Eu(III) that have different oxidation states and hydrolysis behaviour and with Eu(III) and La(III) that have similar chemical properties to resolve whether or not the findings of Bradbury and Baeyens can be applied for the investigated mineral systems. The oxide minerals TiO₂, ZrO₂ and α -Al₂O₃ were chosen based on their different surface charge properties. Experiments are done with and without the competing element in buffered solutions in a glove box under N₂ atmosphere. The competing element is added before, at the same time or after the primary metal addition to distinguish the role of different kinetics of sorption and desorption. The metal concentration of at least one element has to be high enough to be outside of the ideal sorption range where site saturation effects are expected to occur. Initial results indicate that Eu(III) and Ni(II) are not competing for the same sorption sites as the hypothesis of Bradbury and Baeyens [1] suggests. The batch experiments are still on-going and a summary of the main results will be given in the presentation.

[1] Bradbury M. H. and Baeyens B., (2005) Experimental measurements and modelling of sorption competition on montmorillonite, *Geochimica et Cosmochimica Acta*, 69, 4187-4197.

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