

Long-term prediction on the presence of colloidal ferrihydrite and the radionuclide sorption

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Actinides such as Pu are transported in groundwater associated with colloidal ferrihydrite. We propose a geochemical reaction model to estimate how the concentration of ferrihydrite will change in a disposal site of trans-uranic (TRU) waste, which contains large amounts of radionuclides and nitrate ion. The model considers four processes, input of Fe(II) from rocks to groundwater, oxidation of Fe(II) to Fe(III) by nitrate ion and nitrite ion, formation of colloidal ferrihydrite, and transformation of ferrihydrite to goethite and hematite crystals. The model was applied to the groundwater of the Lake Karachai area, where TRU waste was disposed of. Here, we show that colloidal ferrihydrite persists for more than 60,000 years in the groundwater as long as Fe(II) is supplied from the surrounding rocks and the oxidizing agent, nitrate ion, exists in the groundwater. Thermodynamic consideration has revealed that Pu is kept sorbed to the colloidal ferrihydrite for long time. Our results suggest that actinides even with low solubility are transported downstream associated with colloidal ferrihydrite for long time in a TRU disposal site.

Keywords: ferrihydrite, colloid, Pu, transport of radionuclides, radioactive wastes, Lake Karachai, Russia