THE INFLUENCE OF BENTONITE COLLOIDS ON NEPTUNIUM(V) MIGRATION IN GRANITIC ROCK

Outi Elo[(1)], Pirkko Hölttä[(1)] and Nina Huittinen[(2)]

[(1)] Department of Chemistry, University of Helsinki, Finland

[(2)] Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

INTRODUCTION

The bentonite buffer in EBS consists mainly of montmorillonite which, like other aluminosilicates is known to retain radionuclides, thus, contributing to the retention or immobilization of them.

Long-lived Np-237 (2.144 × 10^6 a) in the pentavalent oxidation state forms a neptunyl cation NpO^{2+}, which is rather soluble, poorly sorbed and readily mobile making it highly relevant for research concerning SNF repository safety.

The potential relevance of colloids for radionuclide transport is highly dependent on the formation of stable and mobile colloids in different environmental conditions and the interaction of radionuclides with the formed colloids.

In this study we investigated the sorption of Np(V) on bentonite colloids, montmorillonite and crushed granite in batch sorption experiments and the influence of mobile colloids on Np(V) transport in granite column experiments.

BATCH SORPTION

Sorption experiments were conducted for MX-80 Volclay bentonite colloids, montmorillonite, and crushed Kuru grey granite as a function of pH, solid concentration, time, and Np(V) concentration.

Sorption was investigated in 10 mM $NaClO_4$ either in carbonate-free N_2-atmosphere or under ambient air conditions.

Solid concentrations were 0.08 and 0.8 g/l for colloids, 0.5 and 5 g/l for montmorillonite, and 40 g/l for granite.

Np(V) sorption as a function of pH is presented in Figure 1.

Np(V) sorption as a function of Np(V) concentration at pH 8 and 9 for montmorillonite, and at pH 8, 9, and 10 for bentonite colloids is presented in Figure 2.

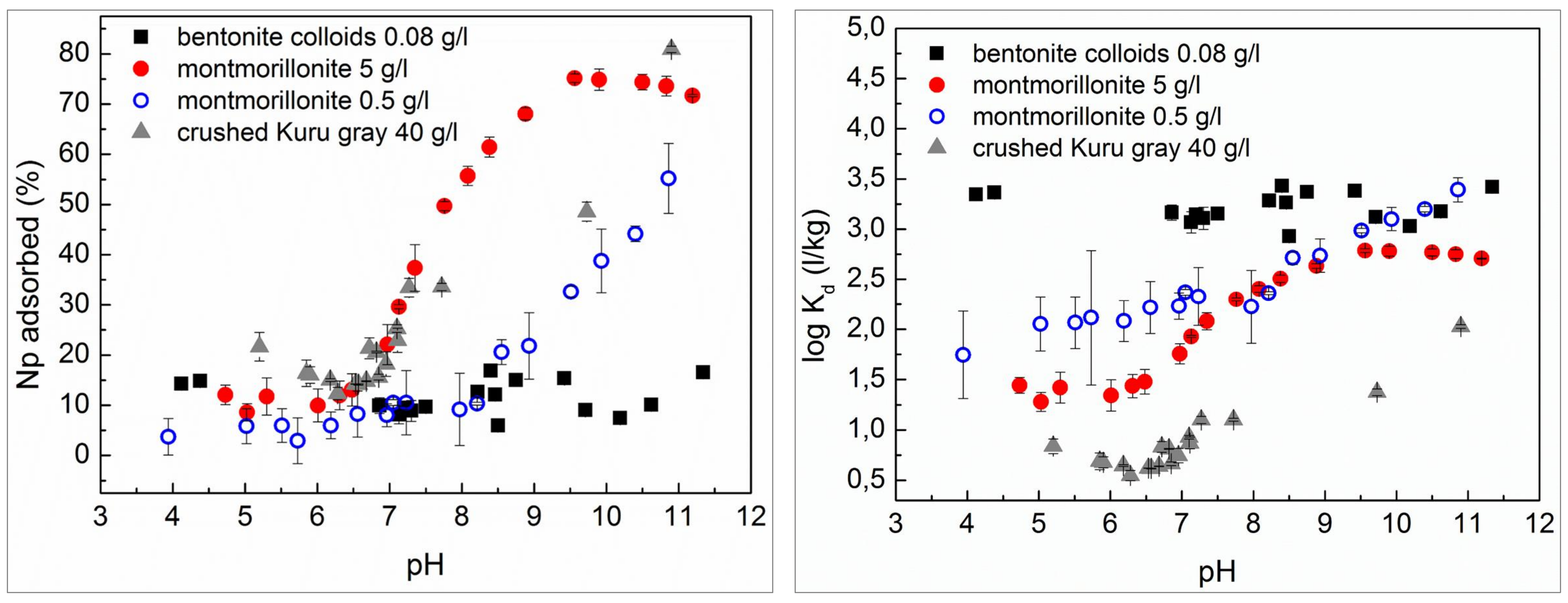

Figure 1. Np(V) (c = 10^{-6}) sorption onto bentonite colloids, montmorillonite and crushed Kuru grey granite in 10 mM $NaClO_4$. Equilibration time in all experiments was 7 days.

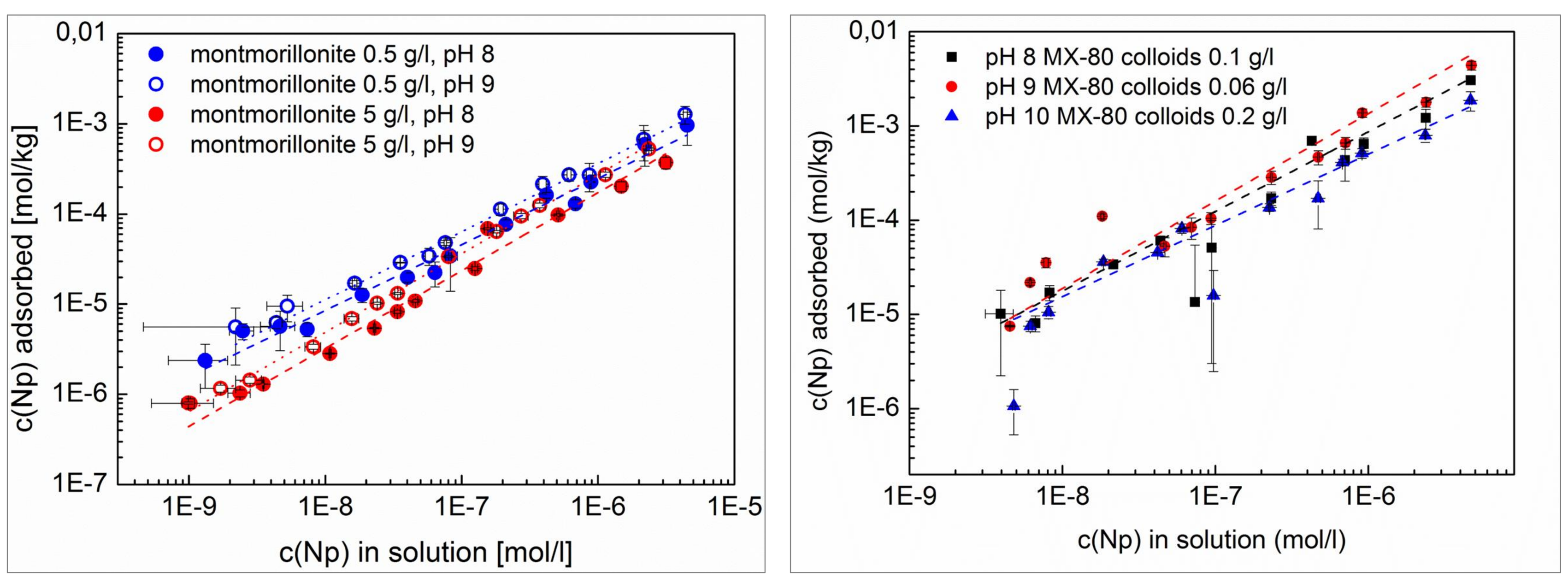

Figure 2. Np(V) sorption onto montmorillonite (left) and bentonite colloids (right) in 10 mM $NaClO_4$ as a function of Np(V) concentration from 10^{-9} to 5 × 10^{-6} M. Equilibration time in all experiments was 7 days.

COLUMN EXPERIMENTS

The effect of bentonite colloids on Np(V) migration was studied in Kuru grey granite drill core and crushed granite columns 10 mM $NaClO_4$.

Drill core columns were constructed from core placed inside a tube to form a flow channel (L = 28 cm, w = 4.4 cm) representing an artificial fracture formed by the 0.5 mm gap between the core and the tube. The crushed granite column diameter was 1.5 cm and the length 15 cm.

The flow properties in a column were determined by using a non-sorbing Cl-36. A constant flow rate through the column was achieved with a peristaltic pump. A tracer was injected into the system through an injection loop of known volume and the out flowing solution was collected with a fraction collector (Figure 3).

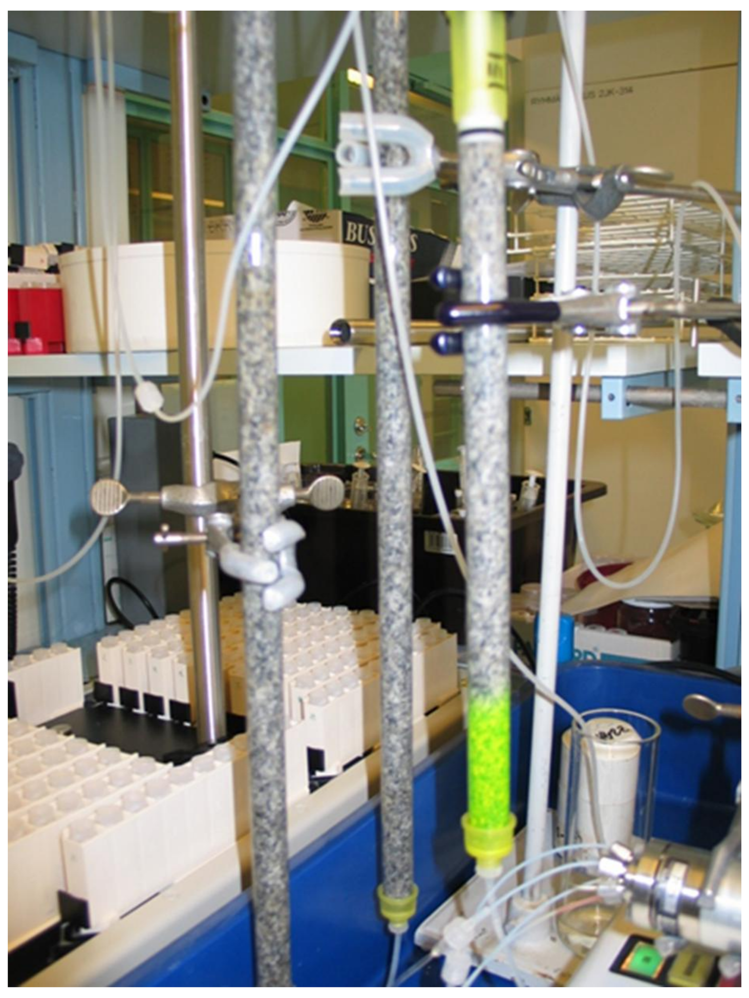

Figure 3. Experimental set-up for the column experiments.

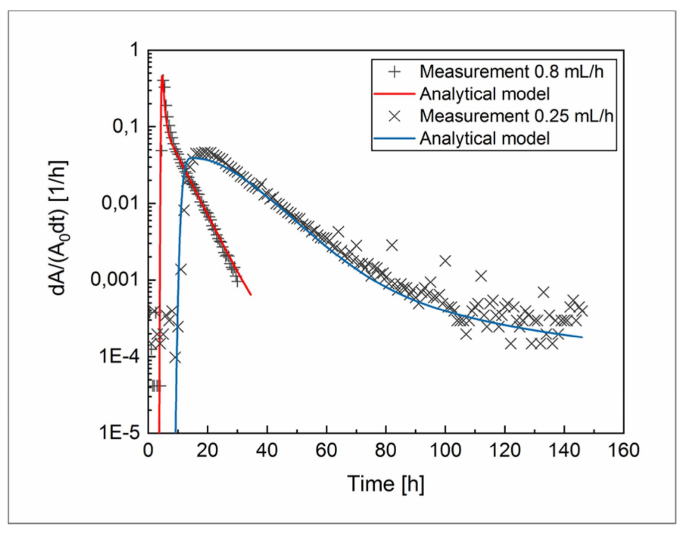

Figure 4. Measured and modeled break-through curves of chloride in the absence of colloids through the drill core column.

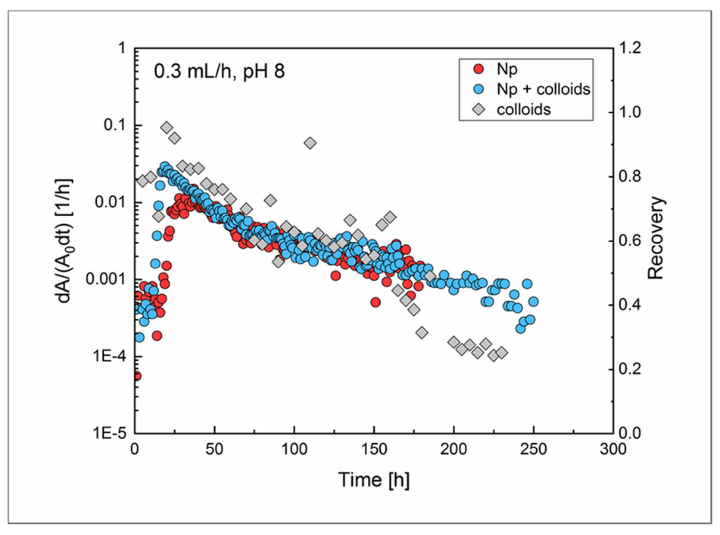

Figure 5. Comparison between the breakthrough behavior of neptunium(V) in the absence and presence of colloids, and the recovery of colloids.

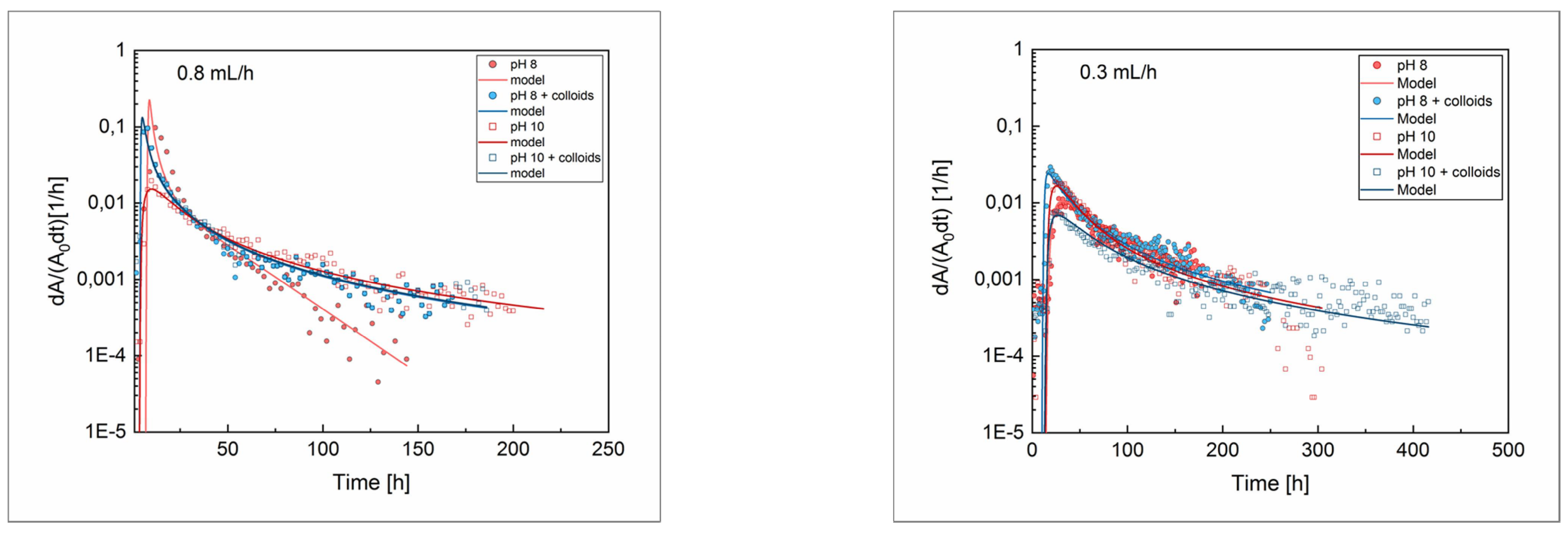

Figure 6. Measured and modelled breakthrough curves for Np(V) through the drill core column, a flow rate of 0.8 mL/h (left) and 0.3 mL/h (right) , pH 8 and 10 in the absence and presence of colloids. Analytical solution of advection–matrix diffusion equation (Voutilainen and Kekäläinen)

CONCLUSIONS

Np(V) sorption on bentonite colloids was found to be independent of the pH, while, Np(V) sorption on montmorillonite and Kuru gray was dependent of the pH.

Bentonite colloids showed a noteworthy sorption capacity for Np(V).

The isotherm data indicated that the sorption of Np(V) remained constant regardless of the pH, as predicted by our sorption studies as a function of pH.

The column experiments indicated that bentonite colloids would enhance the migration of Np(V) as expected based on the sorption data.

ACKNOWLEDGEMENT

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