BENTONITE EROSION AND STABILITY OF FORMED COLLOIDS

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INTRODUCTION

Colloids produced from the degraded bentonite buffer may effect on the migration of radionuclides and may be significant to the long-term performance of a spent nuclear fuel repository (Fig. 1).

The objective was to study the bentonite erosion and stability of bentonite colloids in different groundwater conditions.

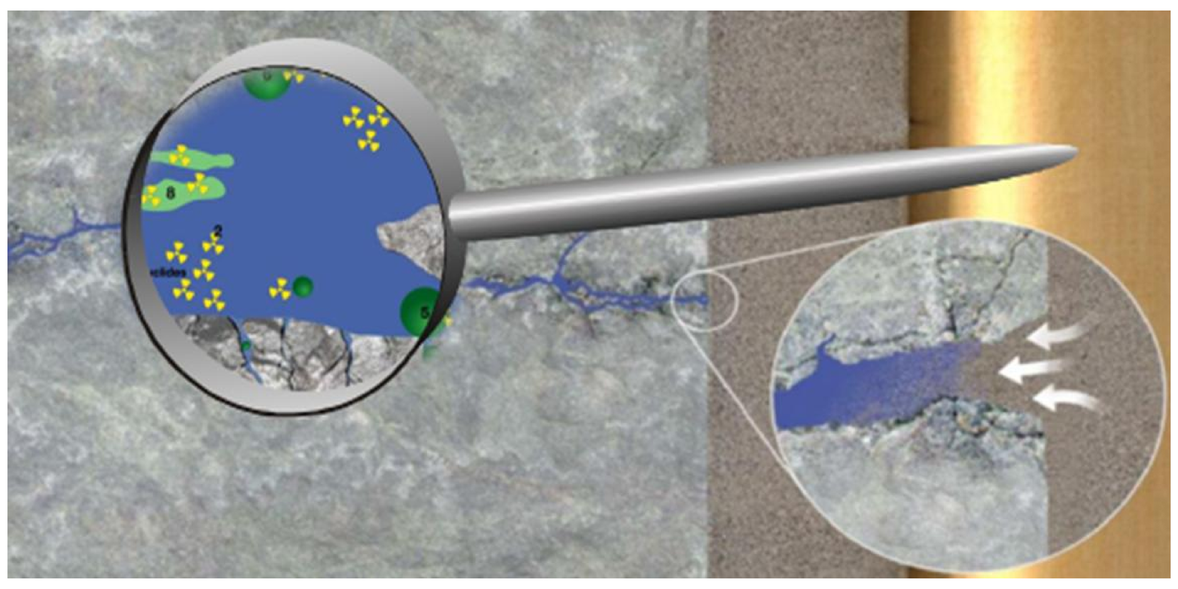

Fig. 1. Colloid/radionuclide and host rock interaction. (EU/BELBaR/T. Schäfer)

EXPERIMENTS

- MX-80 Volclay bentonite
- OLSO (0.517 M) and Allard (4.2 mM) reference groundwater (Table I)
- NaCl, $CaCl_2$ and diluted OLSO (1 mM - 0.1 M)
- 1 g bentonite powder or 2 pellets + 45 mL solution → Samples stored without and with gentle agitation → Centrifugation → Particle size, concentration and zeta potential
- Photon correlation spectroscopy (Malvern Zetasizer Nano ZS)
- The suspension, gel and colloid phase were characterized by the small-angle x-ray scattering (SAXS) to get information on exfoliation or stacking of the clay platelets in colloids [1].

Table I. The main components of Allard (4.2 mM) and undiluted OLSO reference water (0.5 M).

	Allard (mg L^{-1})	OLSO (mg L^{-1})
Na^+	52.43	4800
Ca^{2+}	17.94	4000
Mg^{2+}	4.32	56
Sr^{2+}	-	35
K^+	3.91	21
HCO_3^-	122.9	10
SiO_2^-	6.44	2.5
Br^-	-	105
F^-	-	1.2
SO_4^-	9.6	4.2
Cl^-	40.8	14600

RESULTS

In dilute solutions (1–10 mM), the mean particle diameter was under 500 nm and ZP lower than -30 mV, indicating stable colloid dispersion.

In saline solutions, the mean particle size distribution was wide and ZP near zero indicating particle aggregation.

The colloid formation and size was significantly increased with the slow agitation.

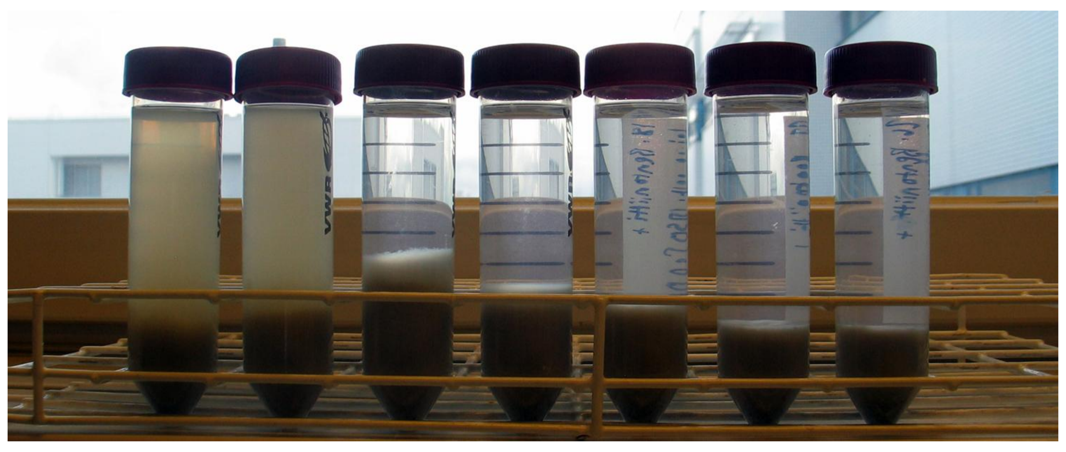

Fig. 2. Formation of bentonite colloids in diluted OLSO, I = 1–30 mM. A thin layer between suspension and colloid fraction is a result of bentonite erosion via gel formation.

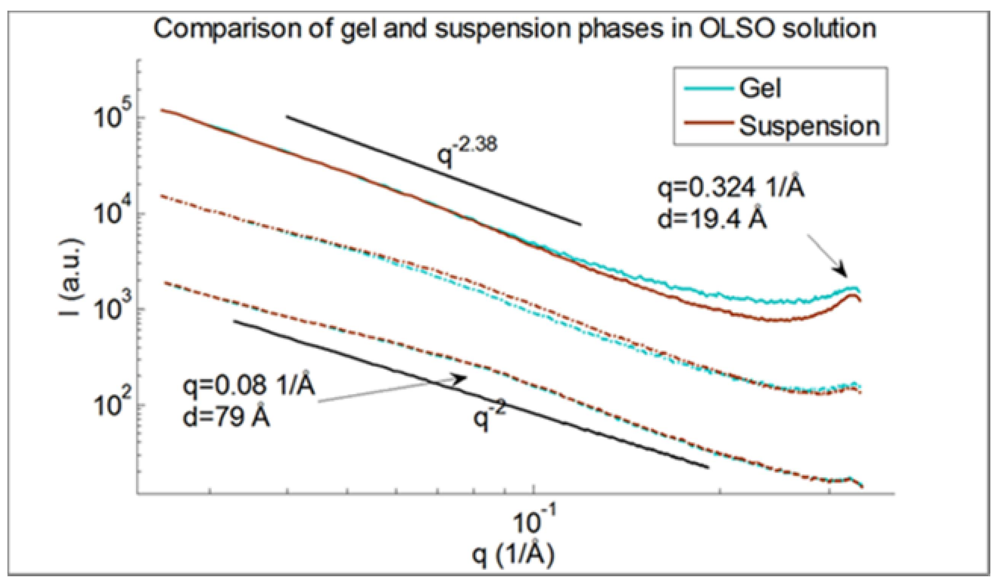

Fig. 3. Comparison of the scattering graphs between the bentonite suspension and gel phase 0.01 M OLSO solution characterized by SAXS [1].

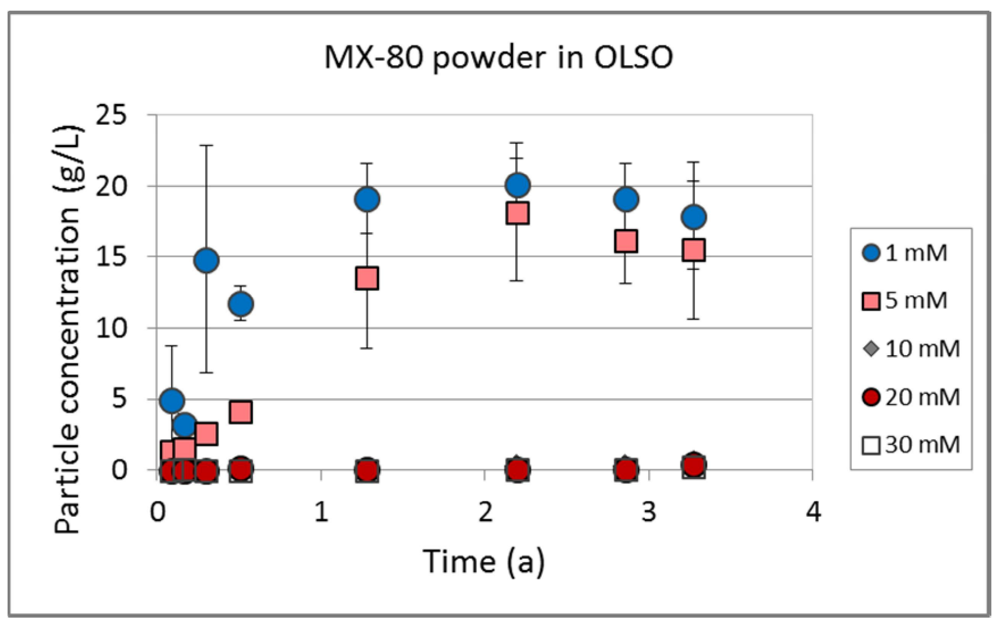

Fig. 4. Mean particle concentration of colloids formed from MX-80 bentonite powder in diluted OLSO reference groundwater.

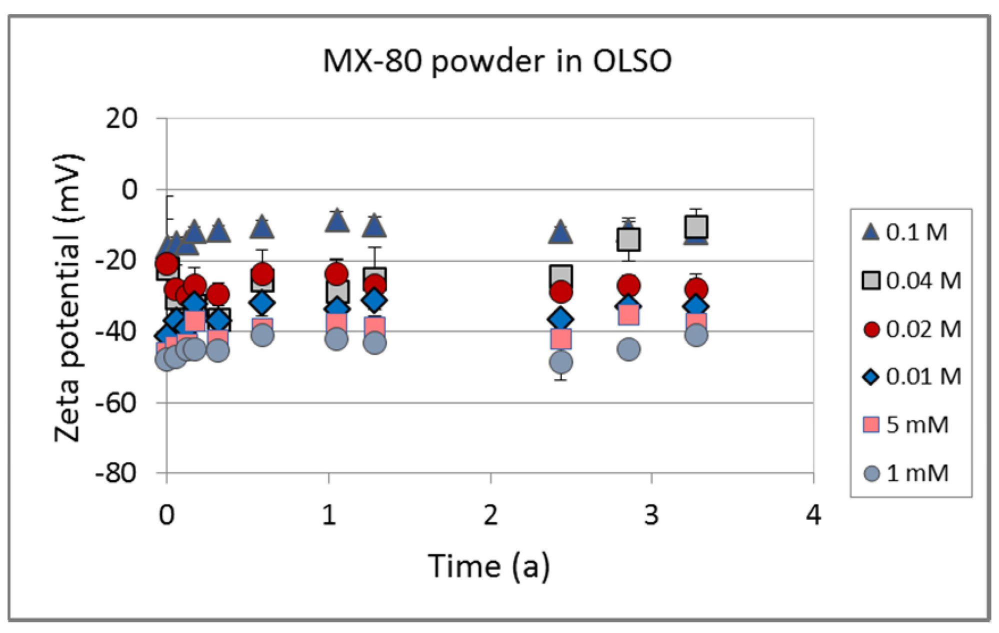

Fig. 5. Mean zeta potential of colloids formed from MX-80 bentonite powder in diluted OLSO reference groundwater.

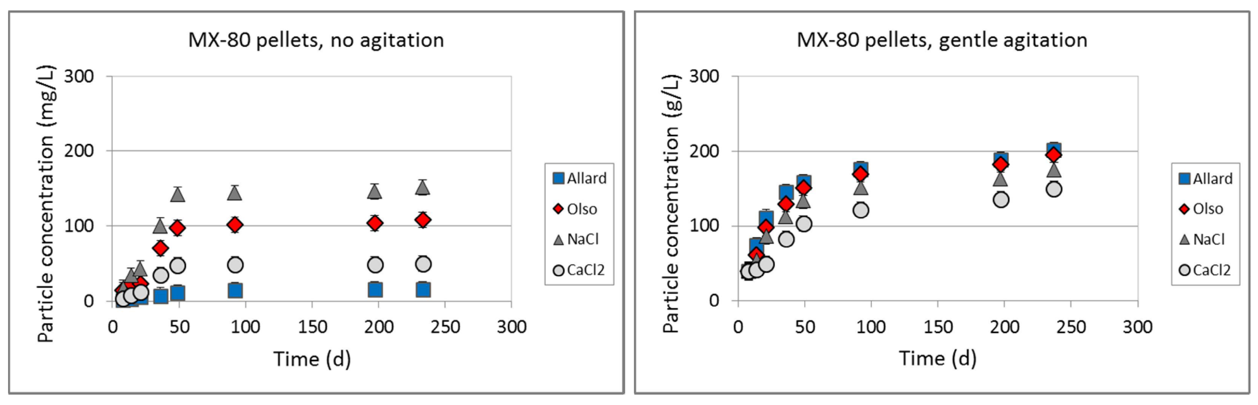

Fig. 6. Mean particle concentration of colloids formed from bentonite pellets in 4.2 mM Allard and 1 mM OLSO, NaCl and $CaCl_2$ solution without (left) and with gentle agitation (right).

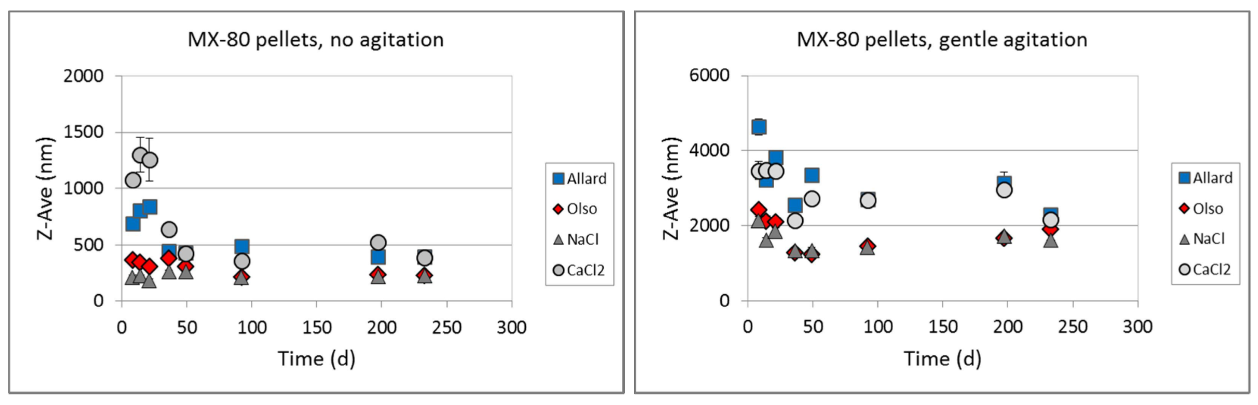

Fig. 7. Mean particle diameter of colloids formed from MX-80 bentonite pellets in 4.2 mM Allard and 1 mM OLSO, NaCl and $CaCl_2$ solution without (left) and with gentle agitation (right).

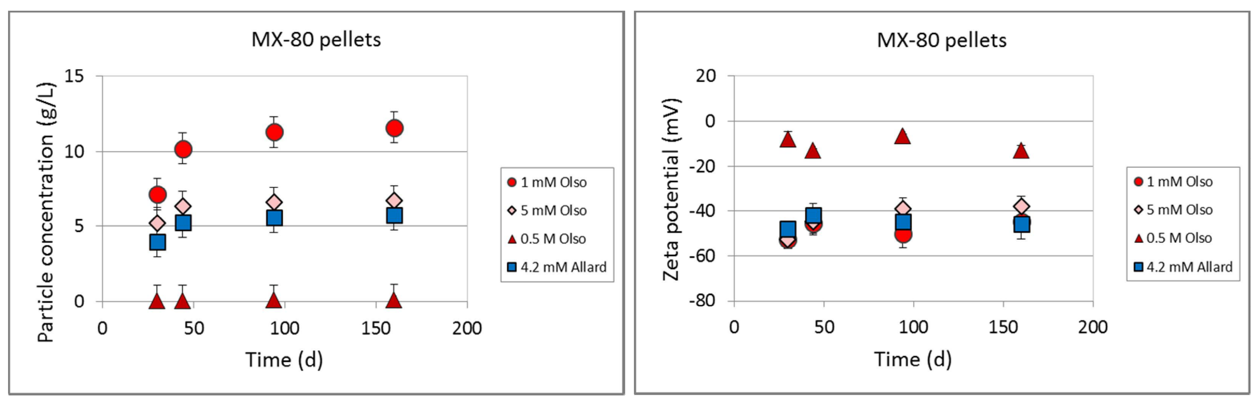

Fig. 8. Mean particle concentration (left) and zeta potential (right) of colloids formed from bentonite pellets in Allard and OLSO solutions with gentle agitation.

CONCLUSIONS

The stability of bentonite colloids depended strongly on the ionic strength and the valence of the cations in the solution.

The colloid dispersion has remained stable in low salinity solutions so far over three years.

At saline conditions in Olkiluoto, colloids are unstable → No effect on the radionuclide transport. The possible post-glacial dilute groundwater implies that the colloids may have to take into account.

REFERENCES

[1] M. Westenius, 2014. En röntgenstudie av kolloidal bentonit. Master's thesis, University of Helsinki.

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