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WP2

BENTONITE EROSION EXPERIMENTS UNDER DYNAMIC CONDITIONS

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Compacted bentonite is envisaged as a suitable hostrock / backfill material in most designs of high level radioactive waste repositories

What will happen if glacial melt water flows down to the repository and enters in contact with the compacted bentonite? Buffer mass loss and less diffusion control?

Erosion processes under realistic conditions have to be identified and understood, i.e. from:

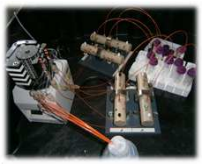
- **Compacted and confined bentonite,**
- **Under dynamic conditions to simulate the effect of a water conducting fracture**

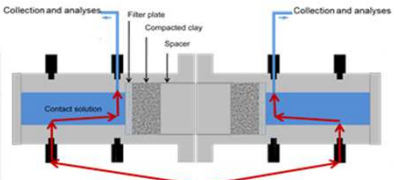
MATERIAL

- MX80 (Volclay)
- Sieved fraction < 63 µm used
- Raw or homo-ionic : Na or Ca form
- Compacted into pellets (1.6 g.cm^{-3})
- Simulated glacial melt water type (SGW)

EXPERIMENTAL SETUP

- 4 Double-side reactors
- 2 identical clay pellets
- V_{dead} = 11.6 mL
- Erosion flow rate: (3.0 ± 0.1) µL.min^{-1}
- pH = (8.3 ± 0.3)

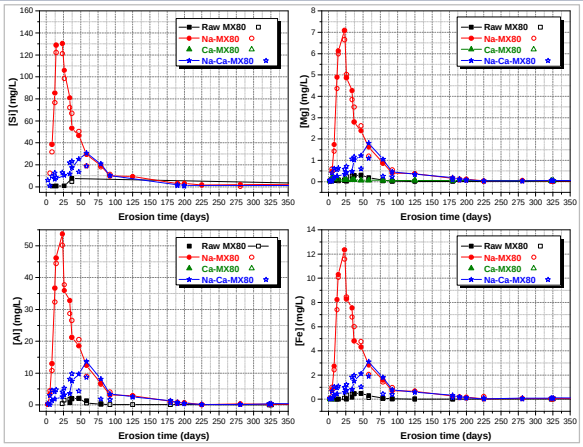




Started ~ 3 years ago (March 2013)

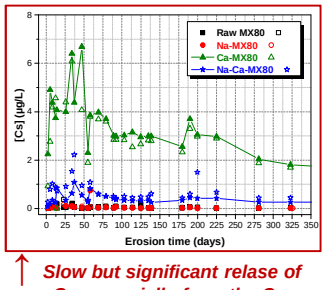
R E S U L T S

In agreement with literature

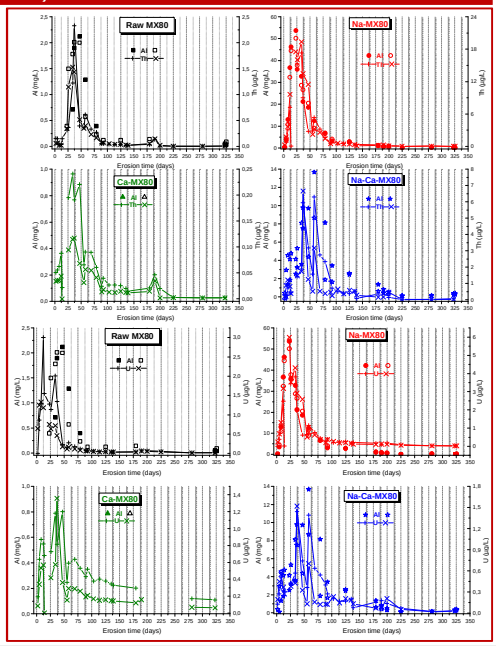


- ✓ *Typical main elemental clay components Breakthrough Curves (BCs) measured over 9 months (325 days)*
- ✓ *Clay colloid detachment clearly evidenced except from the compacted Ca-MX80 pellets*
- ✓ *Mineral dissolution: instantaneous release of Na^+, SO_4^{2-}, Cl^- from the Raw-MX80 pellets*
- ✓ *Ca^{2+} release from the Ca-MX80 clay pellets*

NEW: Cs, Th and U BCs !



Slow but significant relase of Cs, especially from the Ca-MX80 compacted pellets, Na/Cs exchange ?



Release of naturally present RNs (Th, U) from the backfill material itself: the activity rate release can be determined; Erosion markers ? →

CCLs: unseful data for PA provided!

	Main Characteristics & Results				
		Raw MX80	Na-MX80	Ca-MX80	Na-Ca-MX80
Dry Density	1.6 g/cm^3				
Dimensions	ø:19 mm; h: 10 mm				
Composition		100 % of raw material	100 % Na-MX80	100 % Ca-MX80	50:50 % Na- : Ca-MX80
	EROSION CONDITIONS				
SGW Composition	pH = 8.4 ± 0.1 and $E_{h(SHE)}$ = +0.35 ± 0.05 V [Na^+] = 1.2 mM, [Ca^{2+}] = 0.05 mM, [F^-] = 0.1 mM, [Cl^-] = 0.074 mM, [SO_4^{2-}] = 0.04 mM, [HCO_3^-] = 1 mM, Si traces				
Ionic Strenght	1.3 mM				
Test duration	2.5 years / 907 days / 21768 hours				
Flow	(3.0 ±0.1) µL / min or 2.3 10^{-4} m/s				
Sloped	yes				
Free Swelling	no				
Confined	yes				
Fracture dimensions	cm²	Stainless Steel Porous filter: 20 µm; Surface area: 2.86 cm²; porosity 29.4%. frit volume 134.7 µL. real surface contact area: 0.842 cm²			
Extrusion Distance	0.16 cm (Filter Thickness)				
	RESULTS				
pH		8.3 ± 0.3	8.3 ± 0.3	8.3 ± 0.3	8.3 ± 0.3
Mass Eluted (colloids)	mg	5.5 ± 0.1	77.8 ± 2.1	none	31.2 ± 6.3
Eluted mass loss/initial mass	%	0.11 ± 0.01	1.8 ± 0.1	none	0.6 ± 0.1
Eluted mass loss	kg/m²	0.065 ± 0.001	0.92 ± 0.2	none	0.37 ± 0.07
Average eluted mass loss rate (AMLR)	kg/(y·m²)	0.026 ± 0.005	0.37 ± 0.01	None	0.15 ± 0.03
Activity rate Th	Bq/(y.m²)	5.4 ± 0.3	44.7 ± 0.1	1.2 ± 0.4	20 ± 5
U	Bq/(y.m²)	19 ± 5	39.8 ± 0.1	*(25 ± 15)*	21 ± 4
Time used for AMLR calculations 21768 hours / 907 days					
Eluted mass loss rate (MLR)	kg/(y·m²)	0.051 ± 0.007	1.01 ± 0.02	none	0.37 ± 0.08
Time used for MLR calculations 7800 hours / 325 days					
Size: hydro. Ø		Raw MX80	Na-MX80	Ca-MX80	Na-Ca-MX80
PCS. f(I)	nm	162 ± 32	131 ± 3	-	132± 7
PCS. f(V)	nm	131 ± 98	93 ± 52	-	83± 40
Mole ratios (325 days)	Theo.				
Si/Al	2.49	-	2.54 ± 0.04	-	2.8 ± 0.6
Al/Mg	6.62	5.6 ± 1.2	6.75 ± 0.02	-	6.66 ± 0.01
Al/Fe	7.57	10.2± 2.5	8.93 ± 0.13	-	9.0 ± 0.1

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