MICROBIALLY INFLUENCED CORROSION IN DIFFERENT BENTONITES

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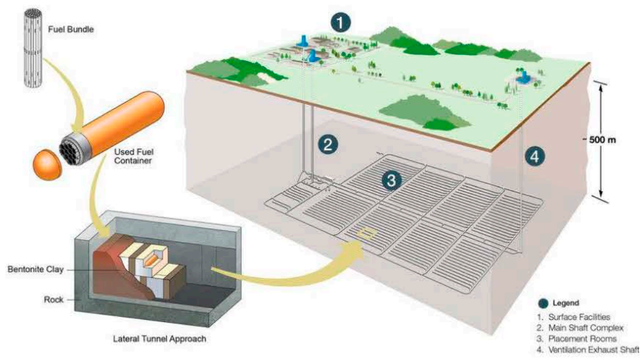
WHY BENTONITE?

- Low hydraulic permeability (in saturated state);
- Swelling pressure (self-sealing ability and closes gaps in the installed barrier);
- Stable for a long time (for millions of years).

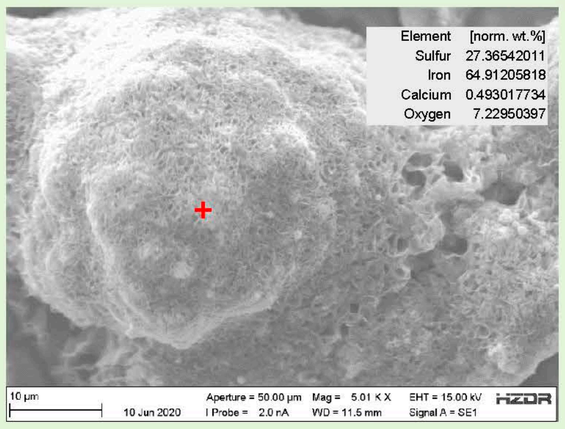


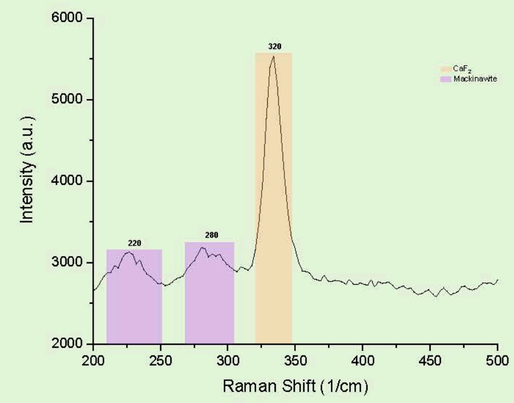
Canadian DGR Concept

Sources of bacteria in bentonite:

- Surrounding environment (underground water, host rock);
- Bentonite itself.

SEM-EDX and RAMAN RESULTS





	B25			MX-80			Calcigel		
	-	Lactate	H_2	-	Lactate	H_2	-	Lactate	H_2
Sulfides	R		SE	SE		R/SE	R/SE		
Carbonates	R/SE	R/SE	R/SE	SE	R/SE	SE	SE	R/SE	SE
Iron Oxides				R					

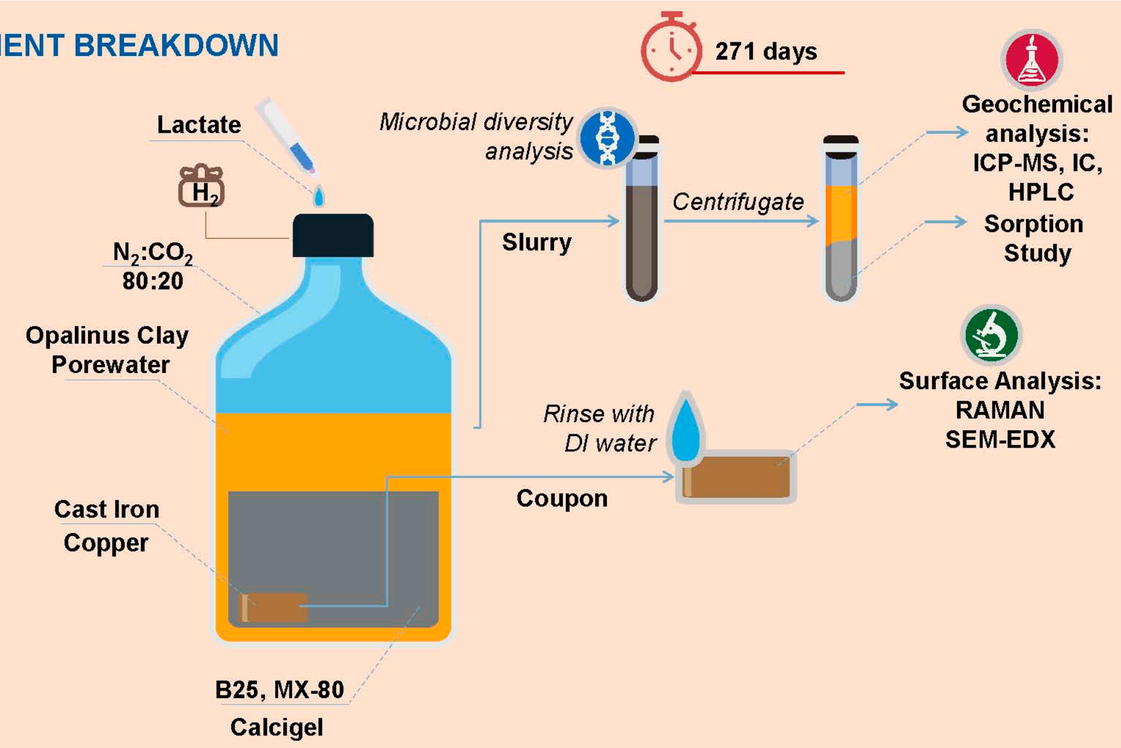
EXPERIMENT BREAKDOWN

Synthetic Opalinus Clay Porewater recipe [1]

Salt	mM
NaCl	212
$CaCl_2$	26
KCl	1.6
Na_2SO_4	14
$MgCl_2$	17
$NaHCO_3$	0.47
$SrCl_2$	0.51

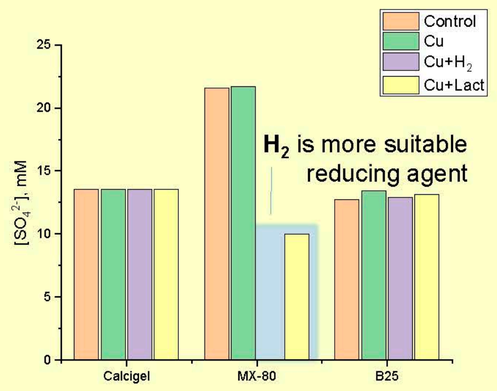
The element composition of the bentonite materials expressed as weight percent of major element oxides of dry mass after sintering [2]

Oxide	MX-80	Calcigel %DM	B25*
SiO_2	61.2	56.6	61.5
Al_2O_3	18.4	17.8	21.1
CaO	1.15	1.69	3.8
Fe_2O_3	4.15	6.11	6.4
K_2O	0.599	1.55	2
MgO	2.02	2.92	4
MnO	0.0146	0.085	0.1
Na_2O	1.56	0.251	0.4
P_2O_5	0.0541	0.0531	0.1
TiO_2	0.148	0.402	0.5
LOI	5.9	7	15

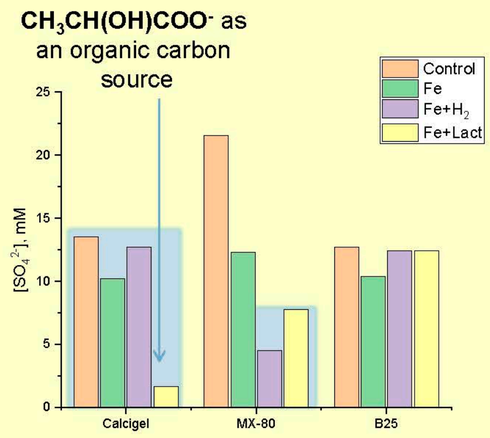


SULFATE CONSUMTION RESULTS

measured by Ion Chromatography



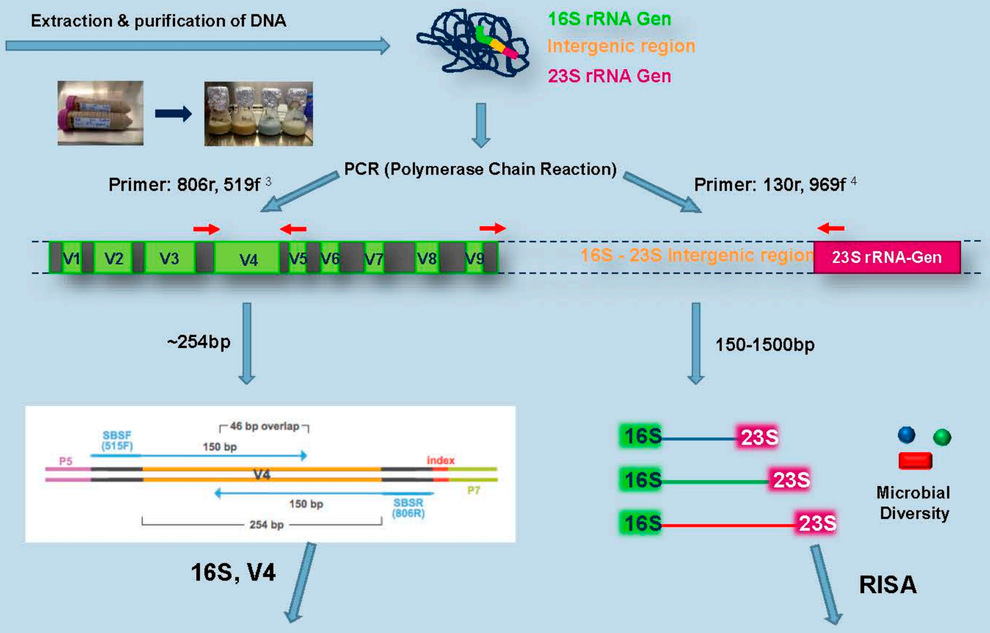
Copper coupons

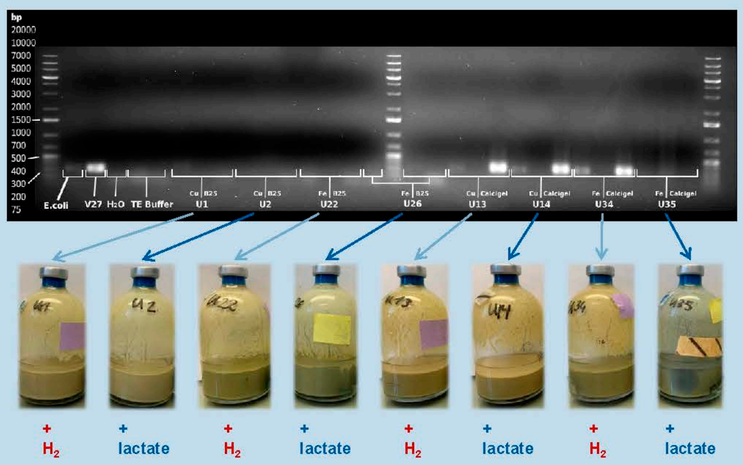


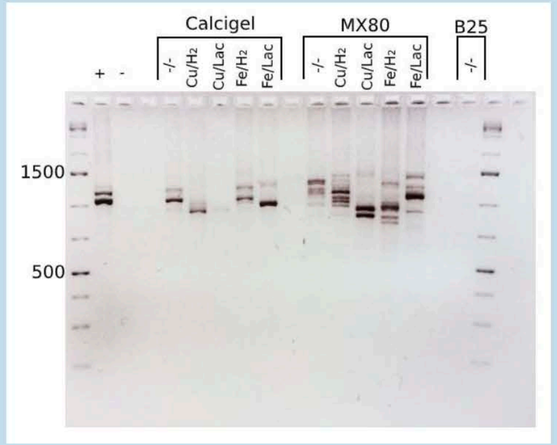
Cast Iron coupons

MX-80: $[SO_4^{2-}]_{Cu} > [SO_4^{2-}]_{Fe}$ => Fe(0) can act as a reducing agent and decrease the competition of SRB's with methanogens for electrons [5]

PCR RESULTS







From the DNA extracted from B25 bentonite no 16S rRNA genes could be amplified. The conditions used in the experiment are not favorable for bacterial growth in B25-bentonite compared to MX-80 and Calcigel.

SUMMARY

- Signs of microbial activity were found in all of the components of the mesocosms (solution, clay and metal plates) for MX-80 and Calcigel bentonites.
- Further investigation is the characterization of the microbial communities and the corrosion that could be done by their activity

NEXT STEPS

- Sequencing of the 16S rRNA gene fragments of selected samples (MX-80, Calcigel)
- Metal coupons' topography characterization (White-Light Interferometry)
- Bentonite analysis (XRD, RAMAN)
- Selection of the bentonite for a new microcosm setup and sorption studies on microbially transormed bentonite (with Eu, Cm, Pu)
- Setup of an upscaling „flow-cell"- experiment with compacted bentonite

[1] Nicole Matschiavelli, Sindy Kluge and etc. The Year-Long Development of Microorganisms in Uncompacted Bavarian Bentonite Slurries at 30 and 60 °C. Environ. Sci. Technol. 2019, 53, 10514−10524
[2] Trevor Taborowski, Andreas Bengtsson. Bacterial presence and activity in compacted bentonites. MIND Report from 25.04.2019 (Version 2)
[3] Caporaso et al. 2010, PNAS 108:4516-4555
[4] Fan et al. 2012, PLos ONE 7(6): e39948. doi:10.1371/journal.pone.0039948.
[5] Jingxin Zhang & etc. Bioaugmentation and functional partitioning in a zero valent iron-anaerobic reactor for sulfate-containing wastewater treatment – 2011, Chemical Engineering Journal, v. 174(1), pp. 159-165