2. BELBaR Meeting, Meiringen, CH, 16.-18.06.2014

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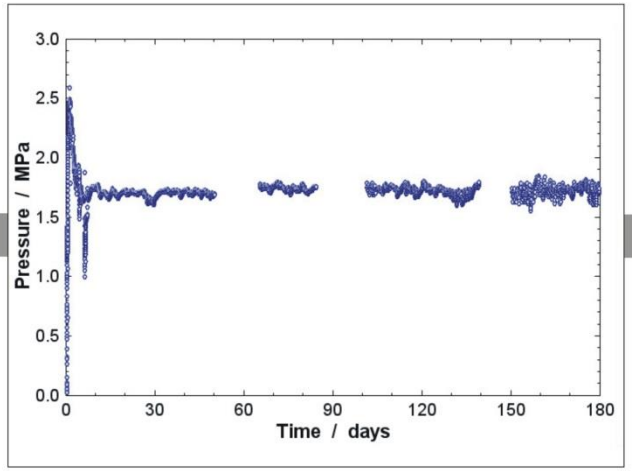
Update on Erosion Experiments and Characterization of released Material

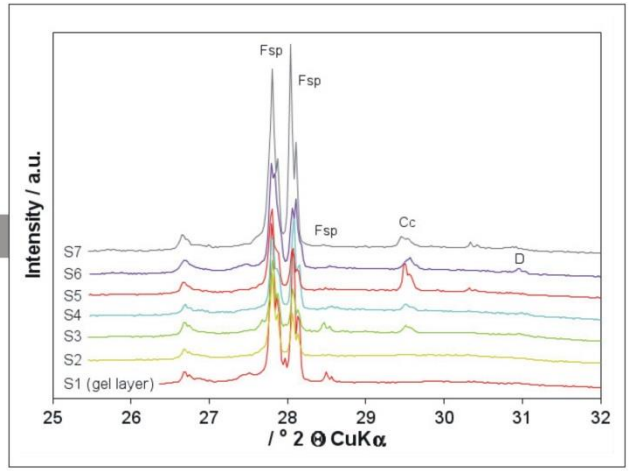
INSTITUTE FOR NUCLEAR WASTE DISPOSAL (INE)

Erosion

Swelling Pressure



Mineralogy



Outline

- *The flow through cell set-up*

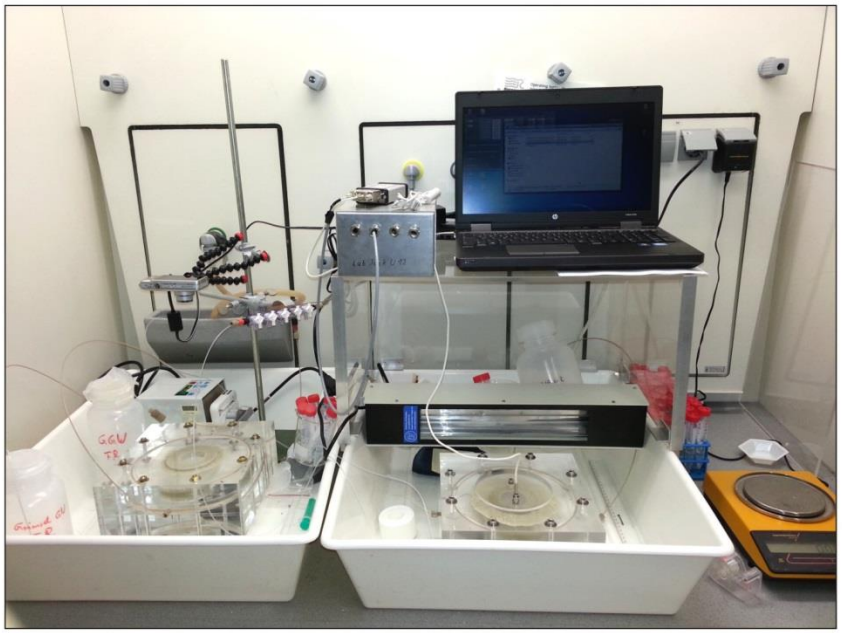
  - Swelling pressure measurements

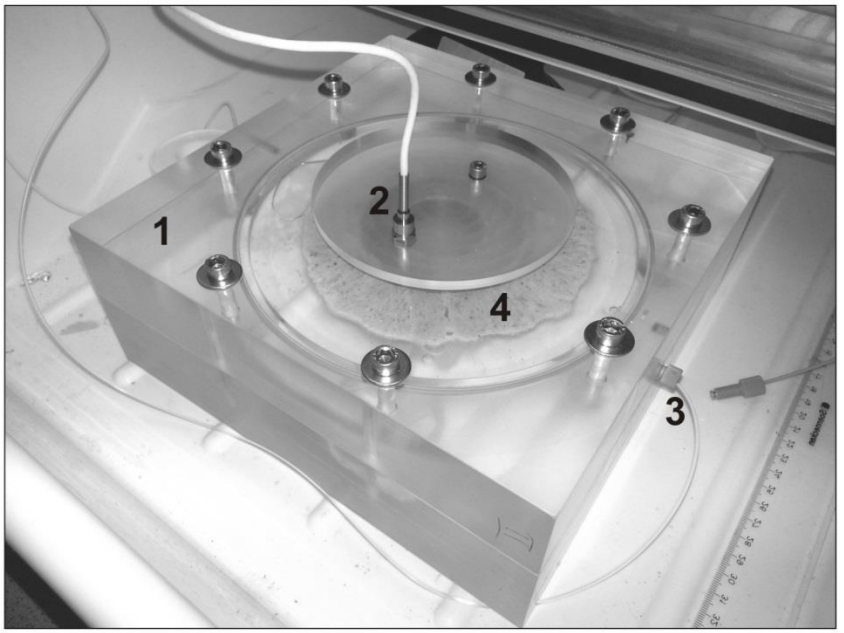
  - Sampling for mineralogical analysis

- *Characterization of the erosion „halo“ and of colloidal material*

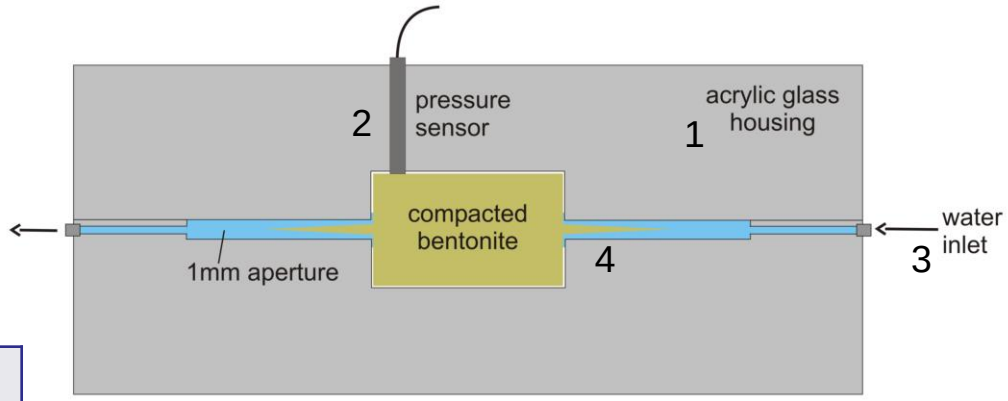
- *Hydration of cation exchanged FEBEX-bentonite - outlook*

Flow through Cell set-up





Left	Experiment for the mineralogical characterization of the erosion-“halo”. (running for 30-40 days)
Right	Set-up equipped with pressure sensor - for long-term erosion experiment. (running since October 2013)

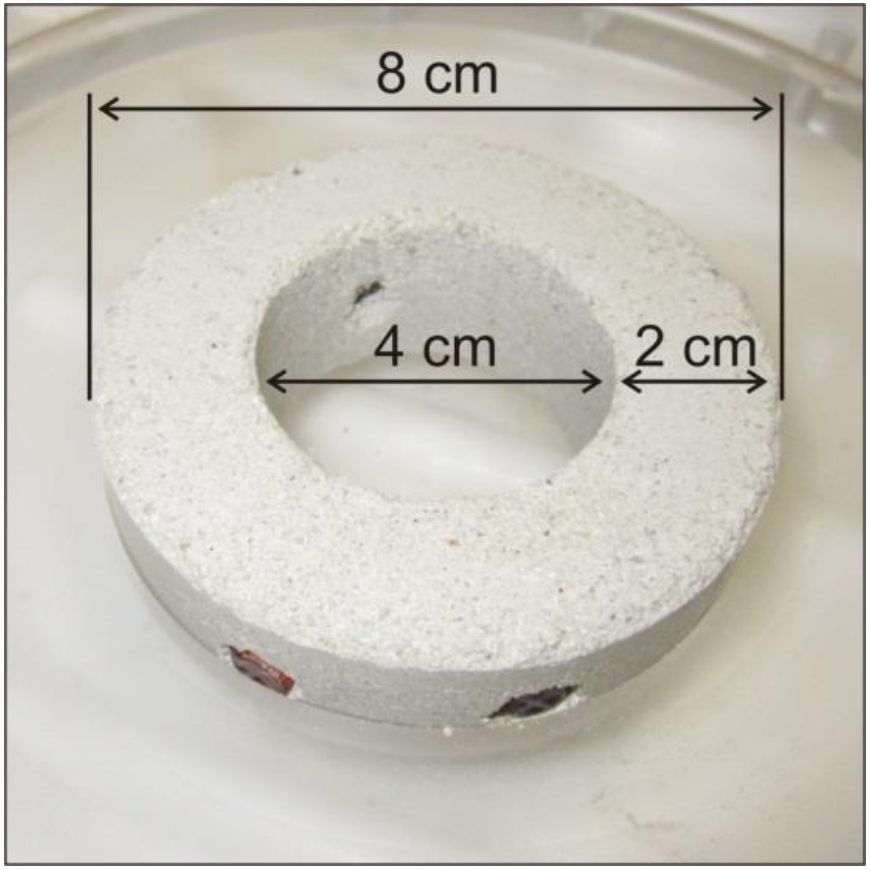


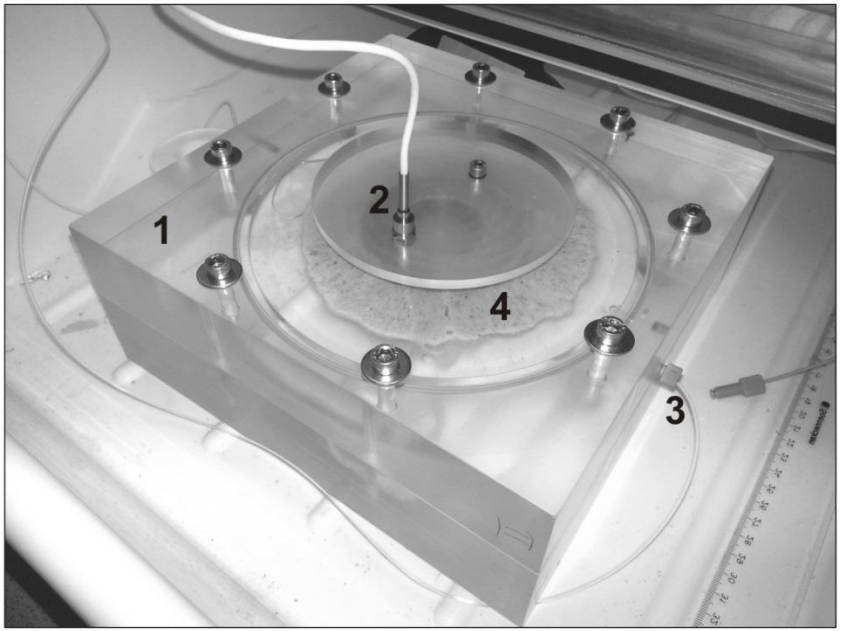
side view

1	acrylic glass housing (with 1mm aperture)
2	the pressure sensor
3	water inlet
4	erosion halo

The Bentonite Ring

Some bentonite rings contain glass vials with tracers





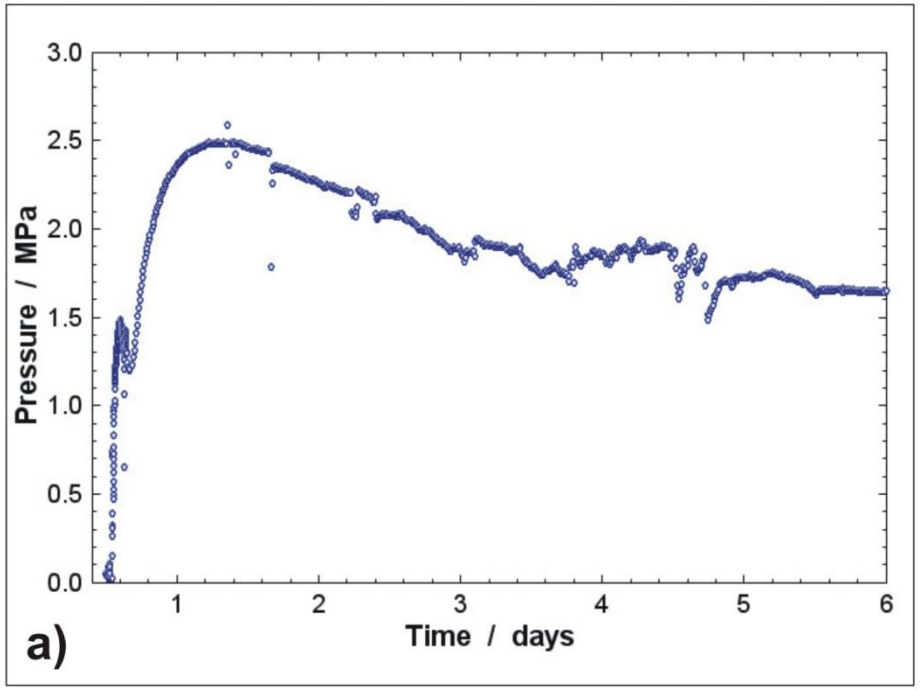
Compacted bentonite 1650 kg/m^3
provided by CIEMAT

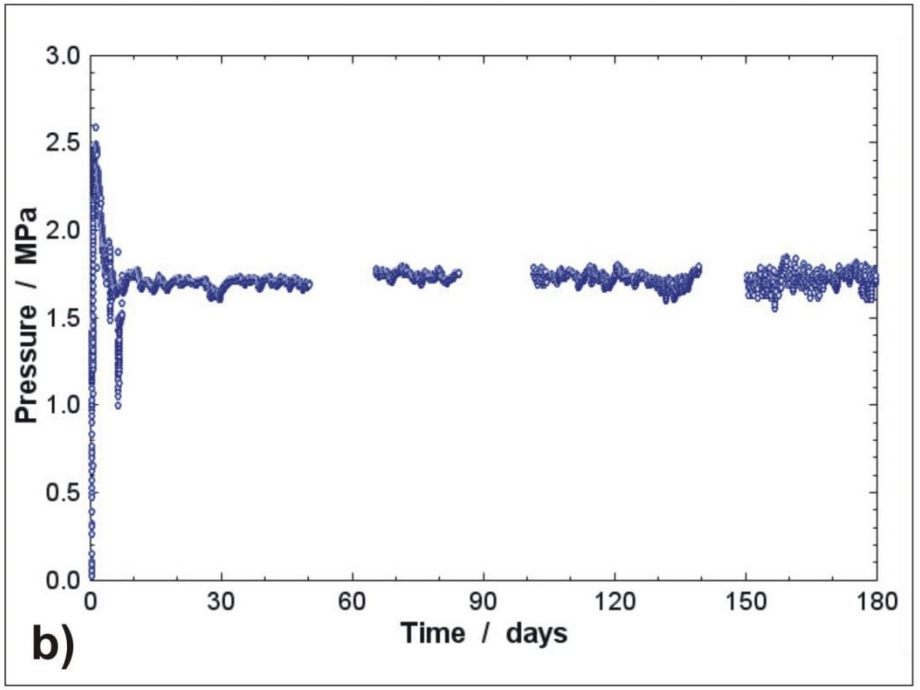
Grimsel Groundwater
Initial flow velocity: v_{init} = 10^{-5} m/s

glass vials containing

- 220 mg synthetic (Ni-labeled) montmorillonite
- 10 mg uranine (conservative tracer)
- the homologues Eu, Th, Hf and Tb (25 µg per vial)

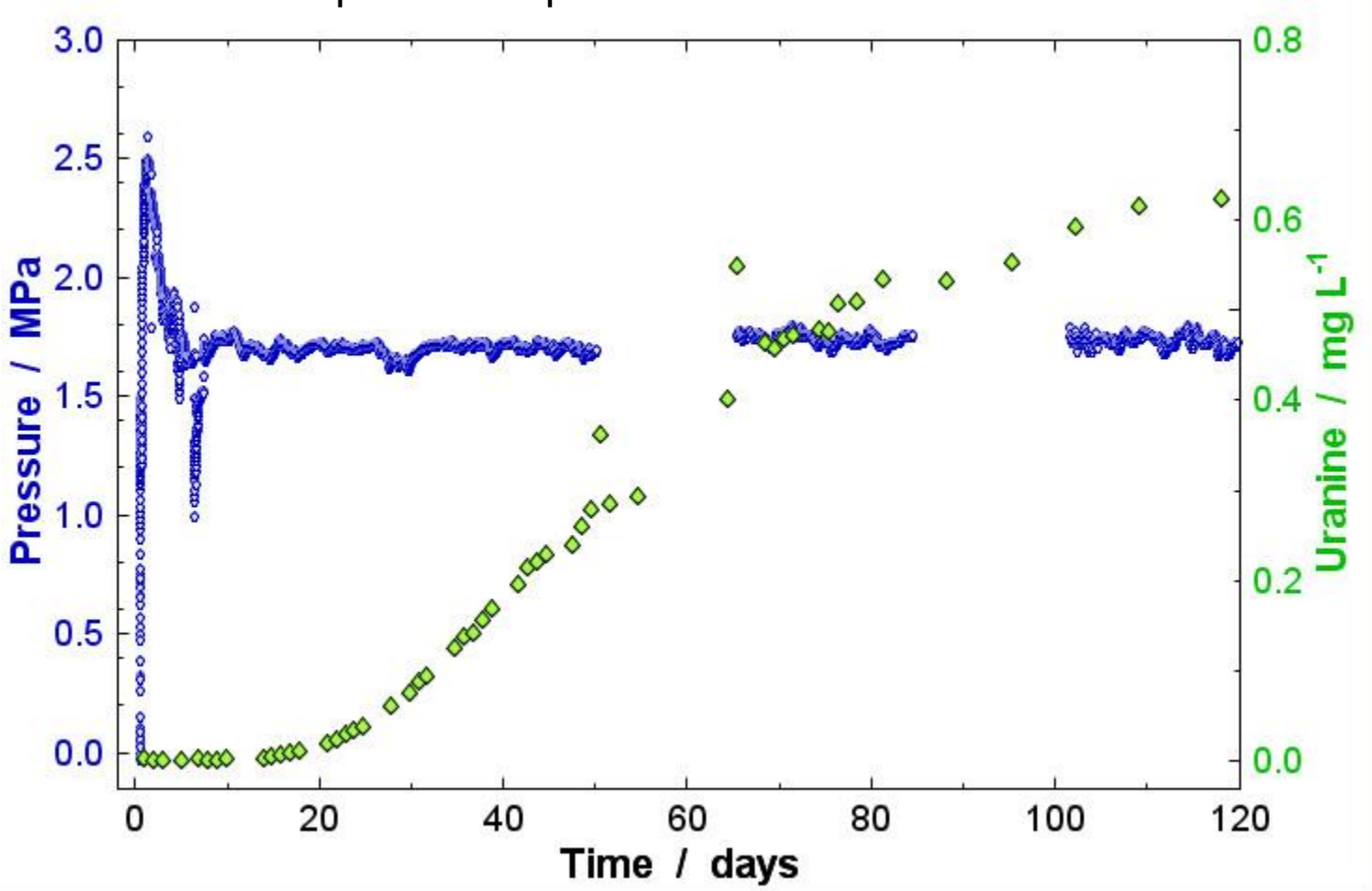
Swelling Pressure Measurements





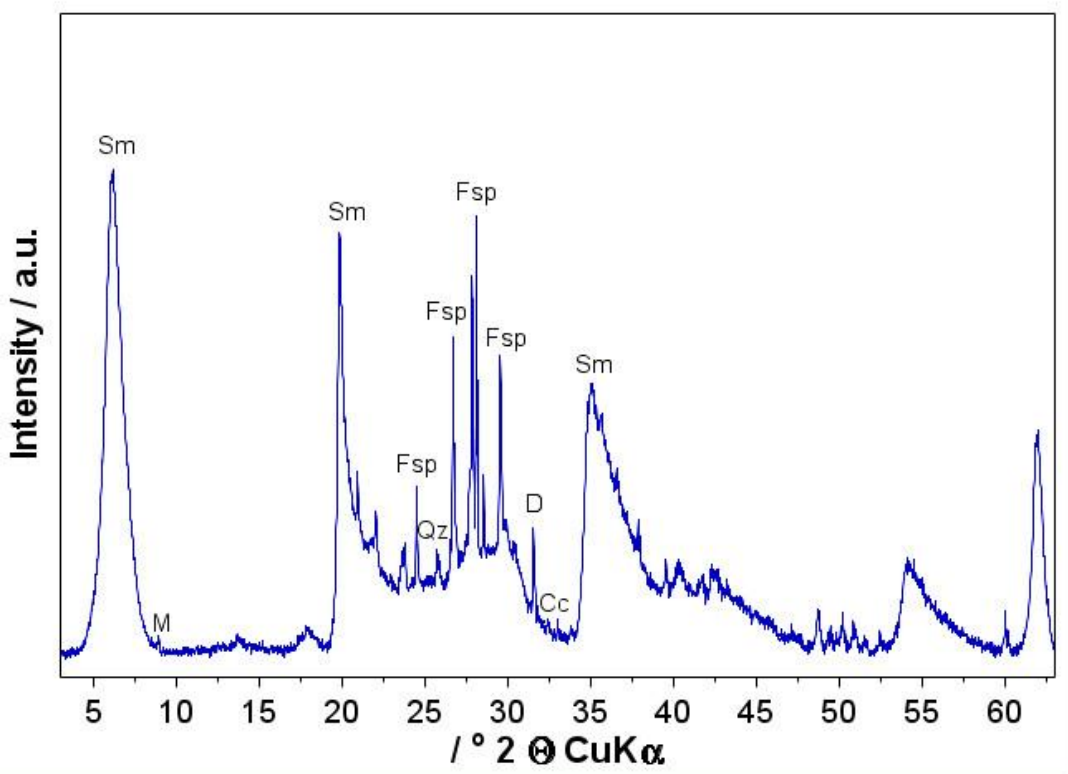
- strong pressure increase after start
- max. pressure 2.6 MPa after about 30 hours
- decrease to constant values around 1.7 MPa
- steady state conditions for 200 days

Comparison of pressure vs. released uranine



- pressure increase starts with experiment start
- release of uranine starts after 16 d (after cavities are filled)

Sampling and X-ray Diffractometry



Sampling

XRD: Sampling line with 7 spots from gel-layer (GL) close to the ring

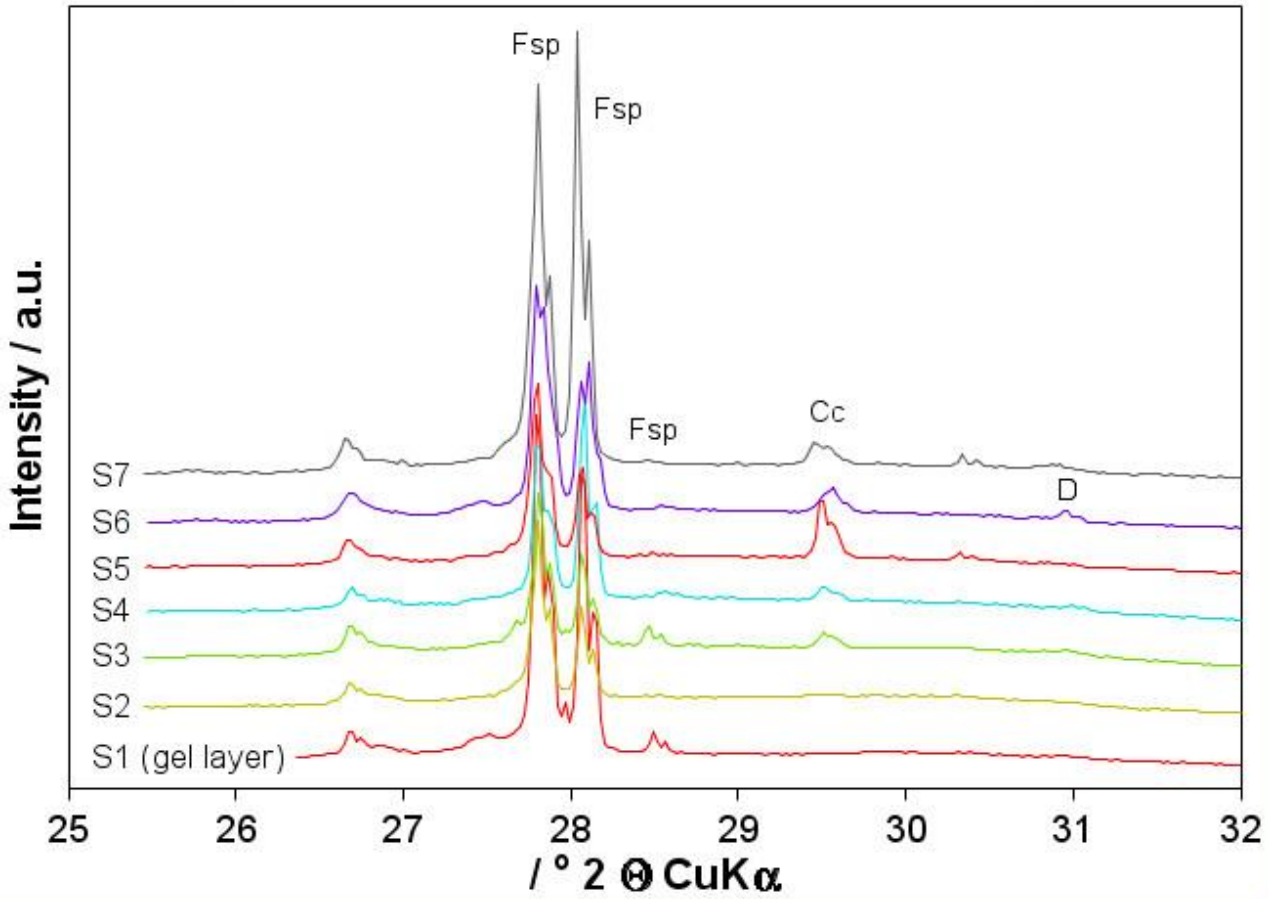
SEM: Samples of gel-layer, halo and ring

Mineralogy

Smectite (Sm)	80
Mica (Biotite) (M)	2
Quartz (Q)	3
2 Feldspars (Plagioclase, Anorthite) (Fsp)	9
Calcite (Cc)	2
Dolomite (D)	3

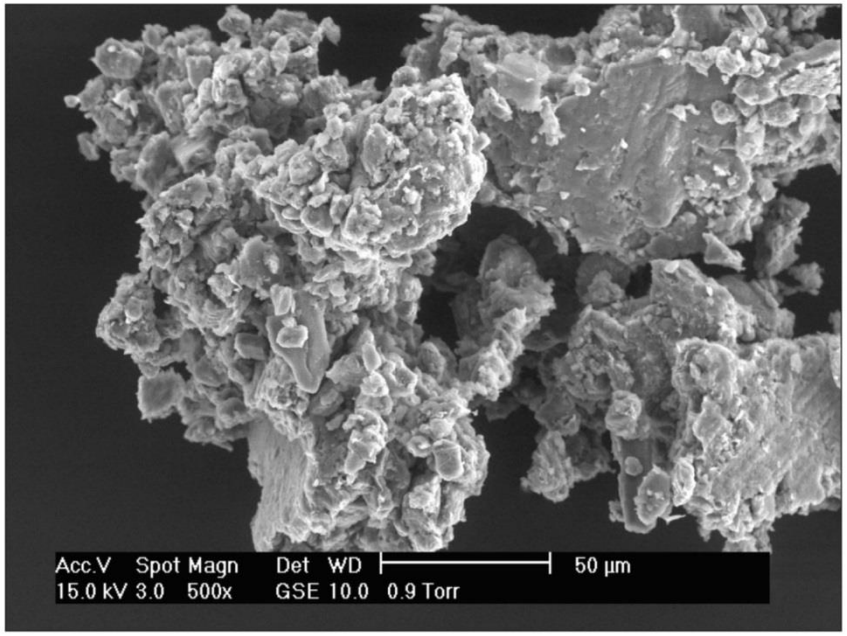
e.g. Caballero et al. (2005) Clay Min., 463.

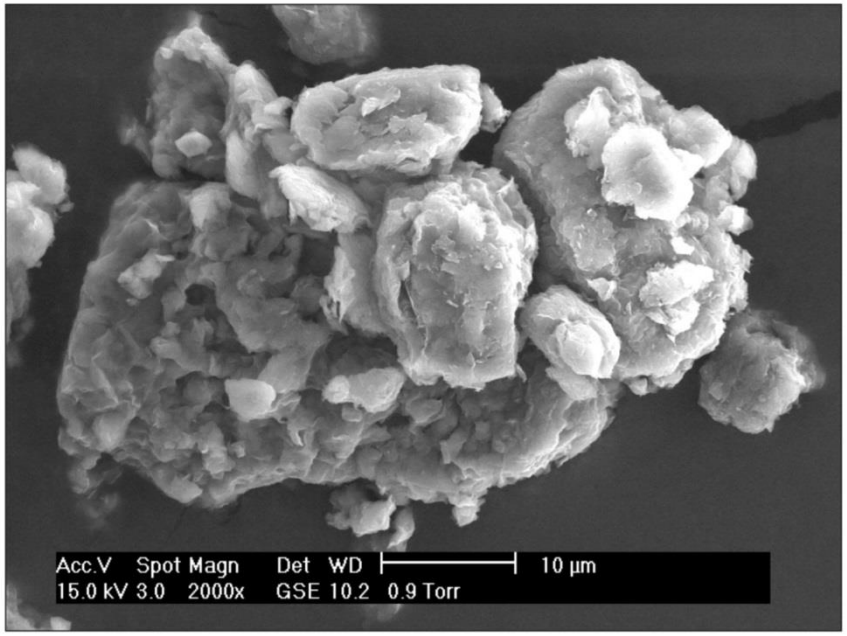
Swelling Pressure Measurements

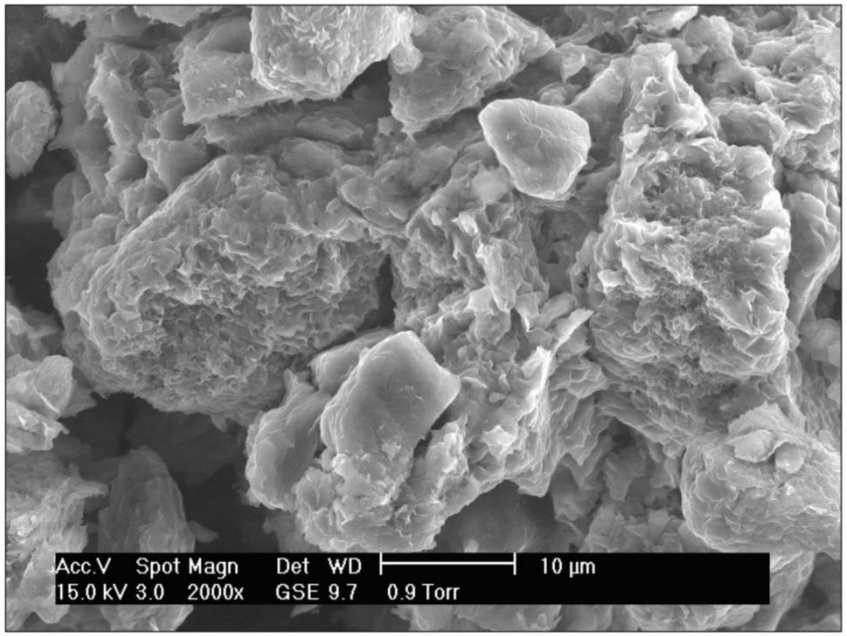


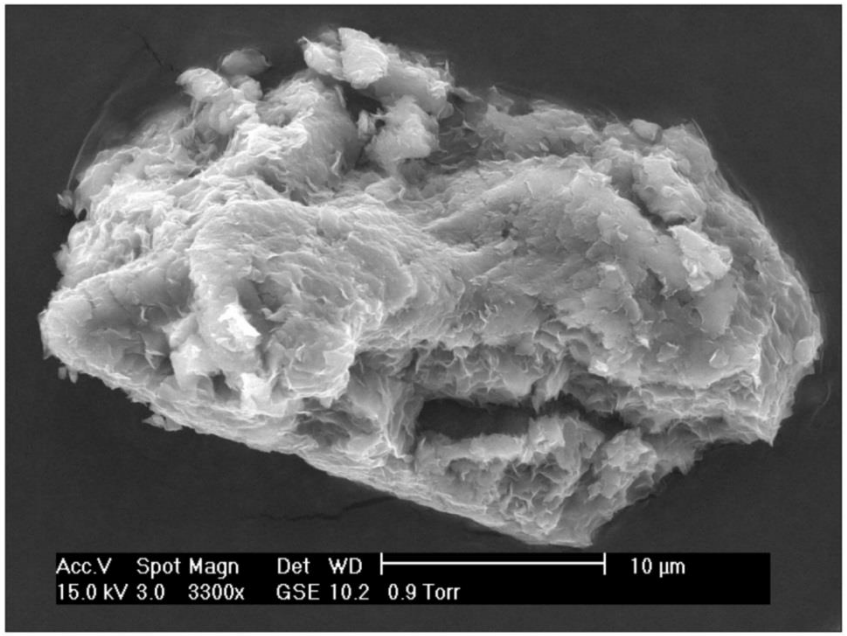
	Smectite	Mica	Dolomite	Ca-Feldspars	Calcite
S1 (gel-layer)	++	+	-	+	-
S2	++	+	-	+	-
S3	++	-	-	+	-
S4	++	-	-	+	+
S5	++	-	-	+	+
S6	++	-	-	+	+
S7 (near ring)	++	-	+	+	+

Electron Microscopy / Gel-Layer

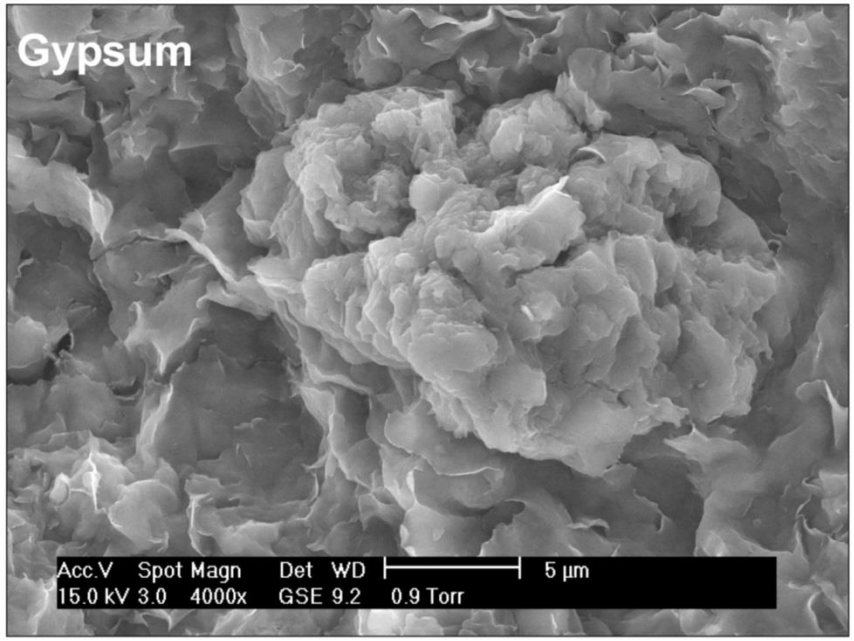


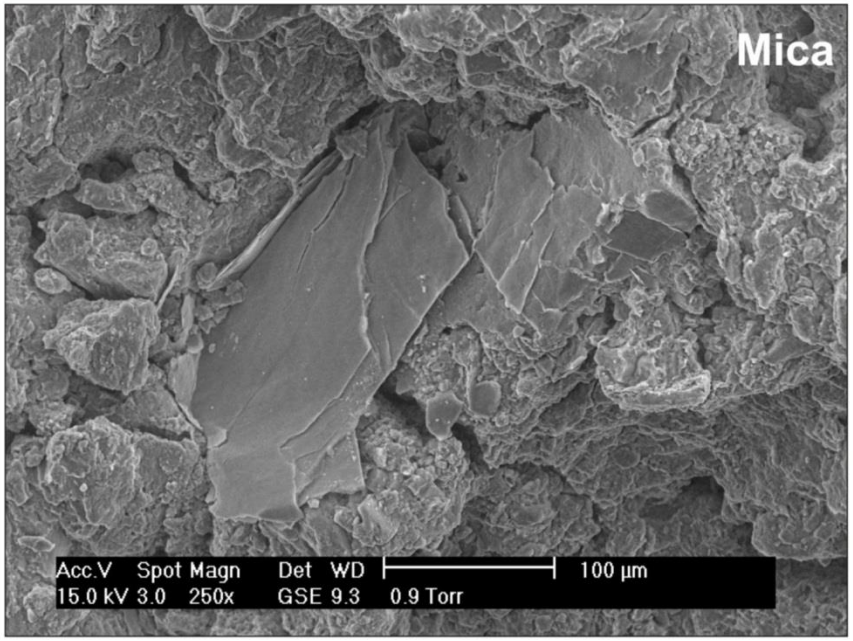


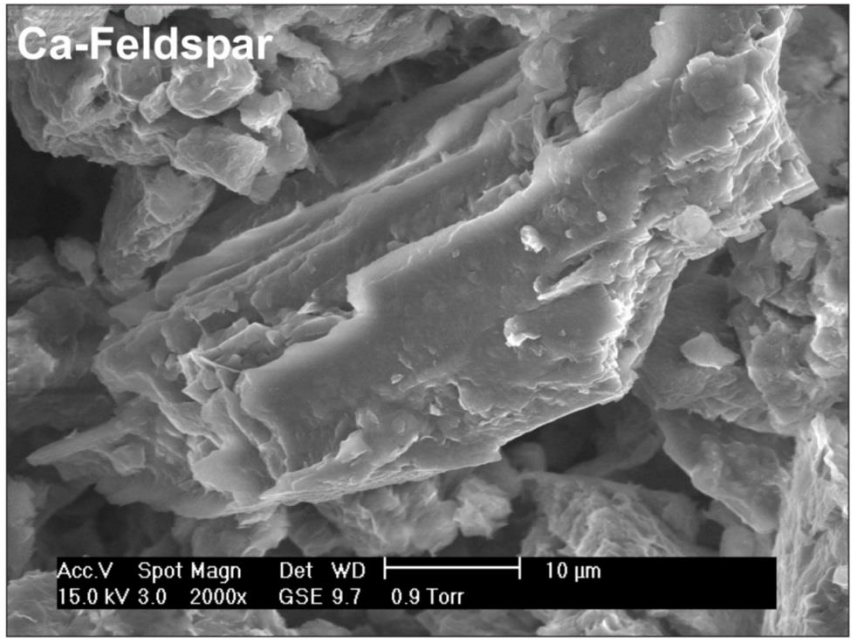


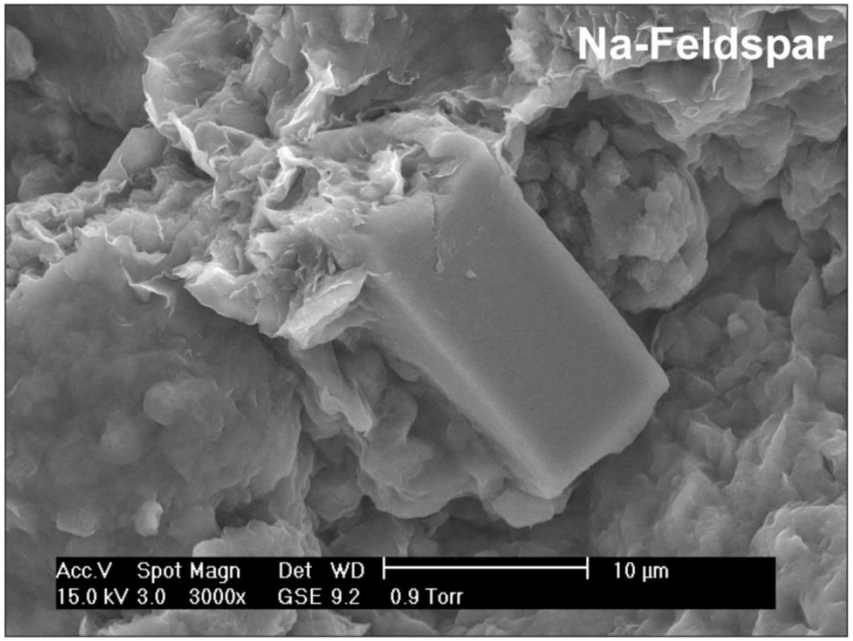


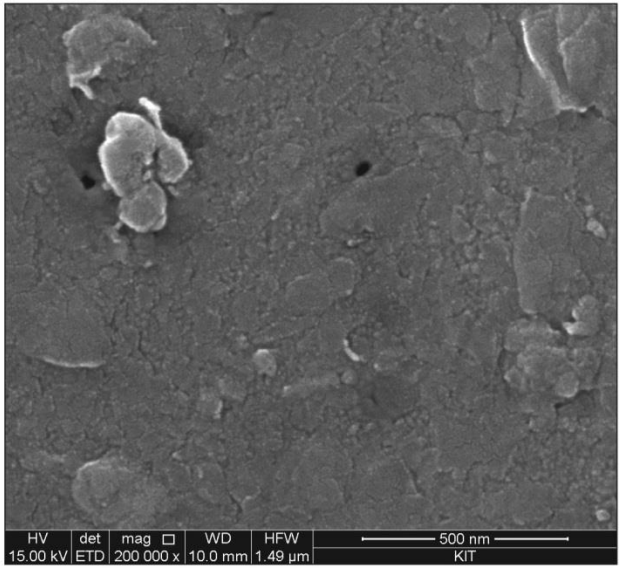
Electron Microscopy / "Halo"

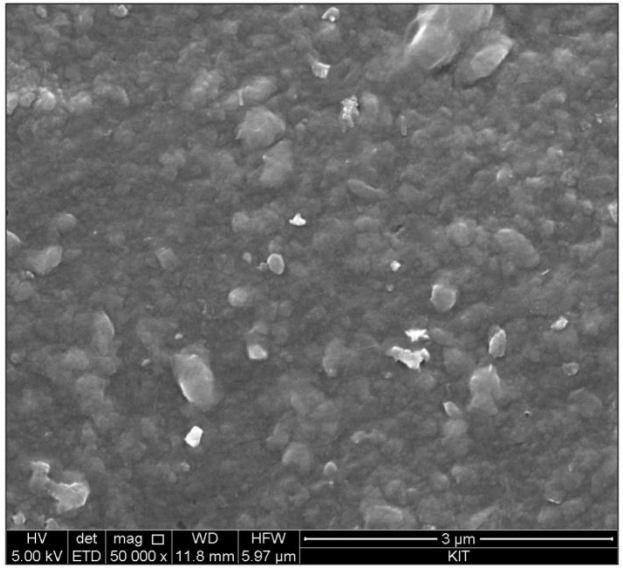


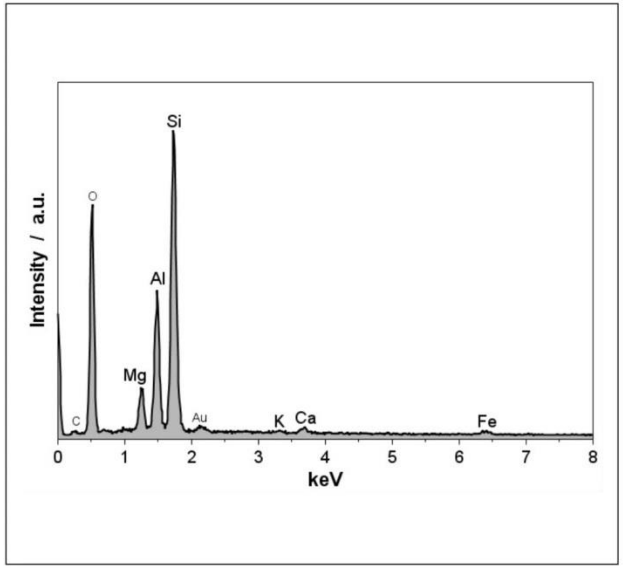


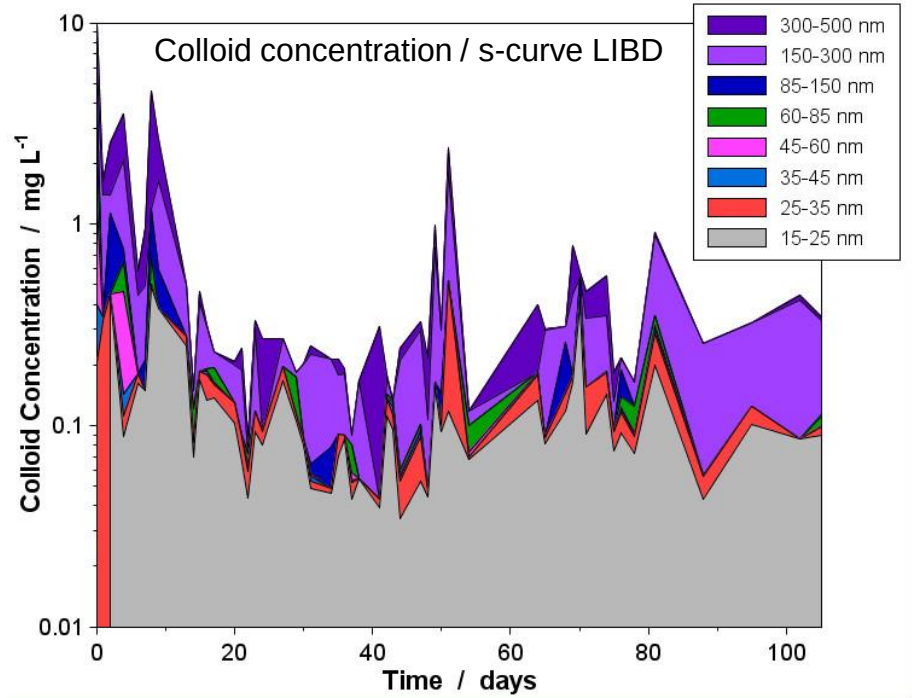












Colloidal concentration in water samples (filter)

Outlook

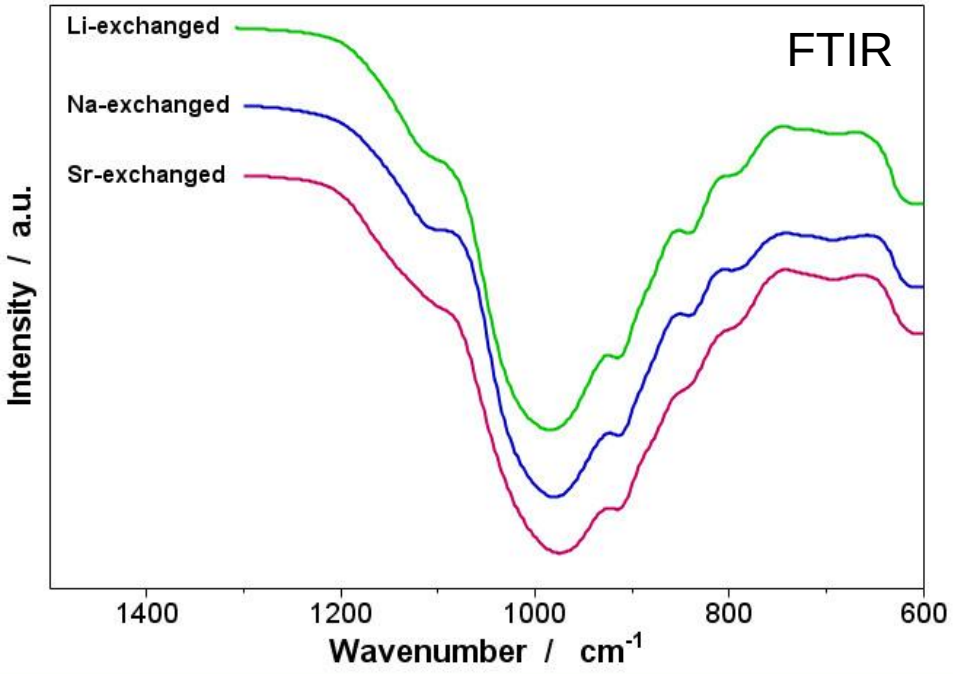
Ongoing frequent water sampling →

Analysis of elemental composition, (fluorescence), pH, colloid size and concentration. (ca. 70 samples)

Effect of Mineral Chemistry

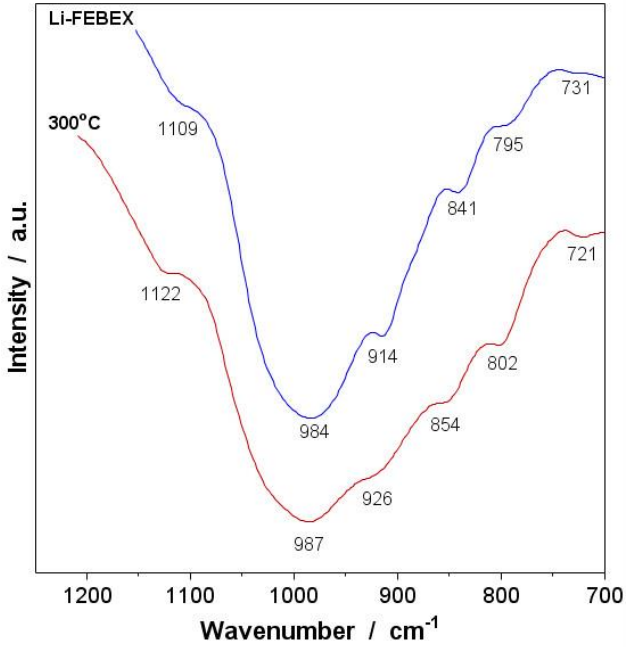
Materials

1. Na-exchanged sample (effect of monovalent cation)
2. Sr-exchanged sample (effect of divalent cation)
3. Li-exchanged/heated sample (reduction of layer charge)

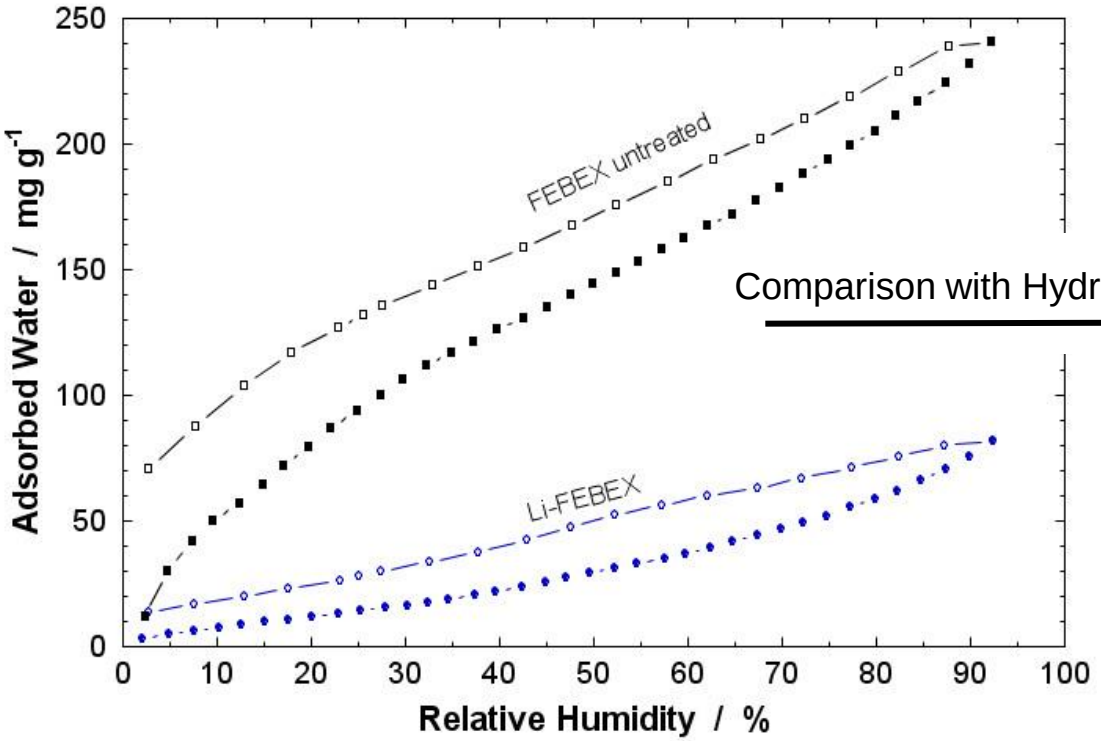


Li-exchange

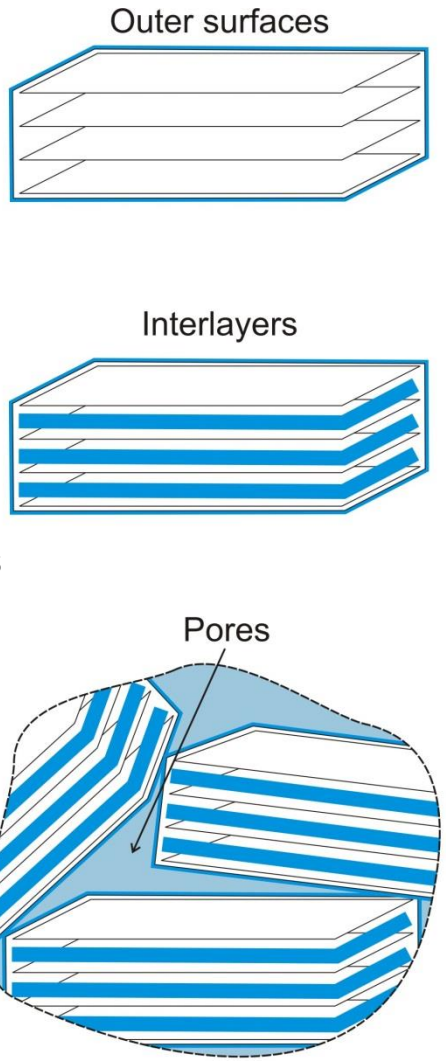
Migration of Li ↔ effect on layer charge



Water adsorption-desorption isotherms
(Quantachrome Hydrosorb-1000)



Comparison with Hydration-Models



e.g. Cases et al. (1992) Langmuir, 2730.

Water adsorption-desorption isotherms
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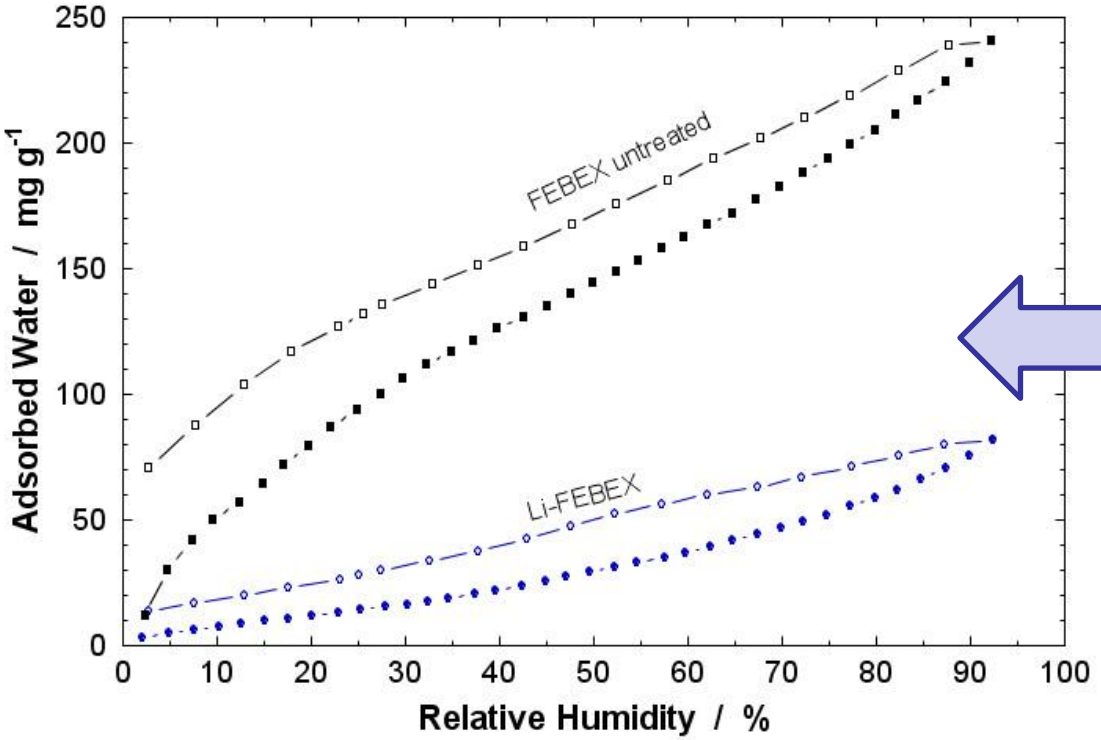
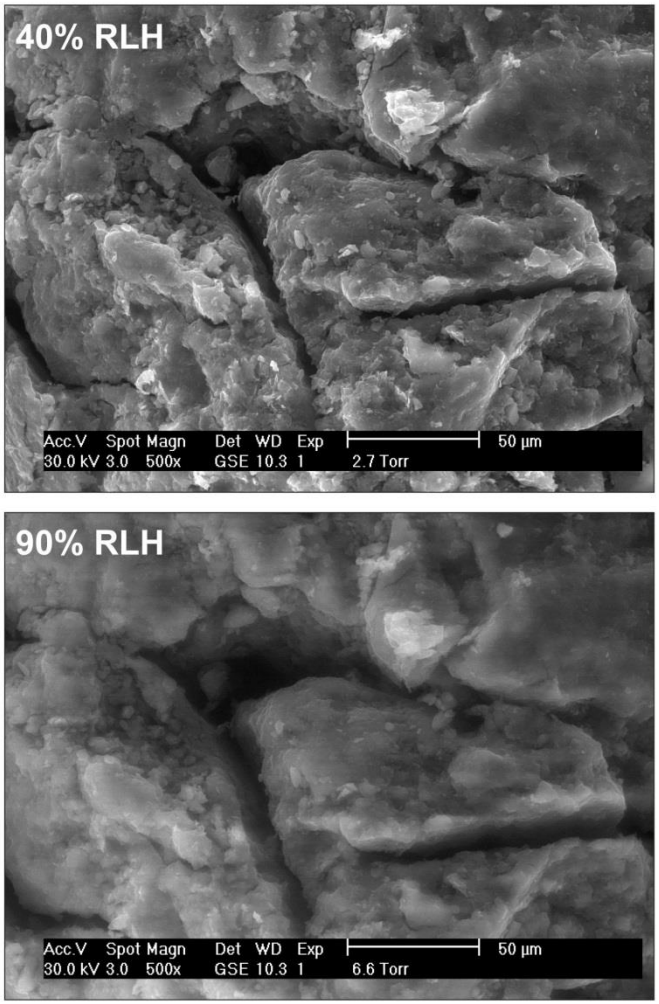


ESEM / Hydration-experiments



e.g. Montes-H et al. (2005) Colloid Surface A, 14.