Saturation and mechanical properties of clays/bentonites with defined interlayer composition

Červinka R., Trpkošová D., Havlová V.

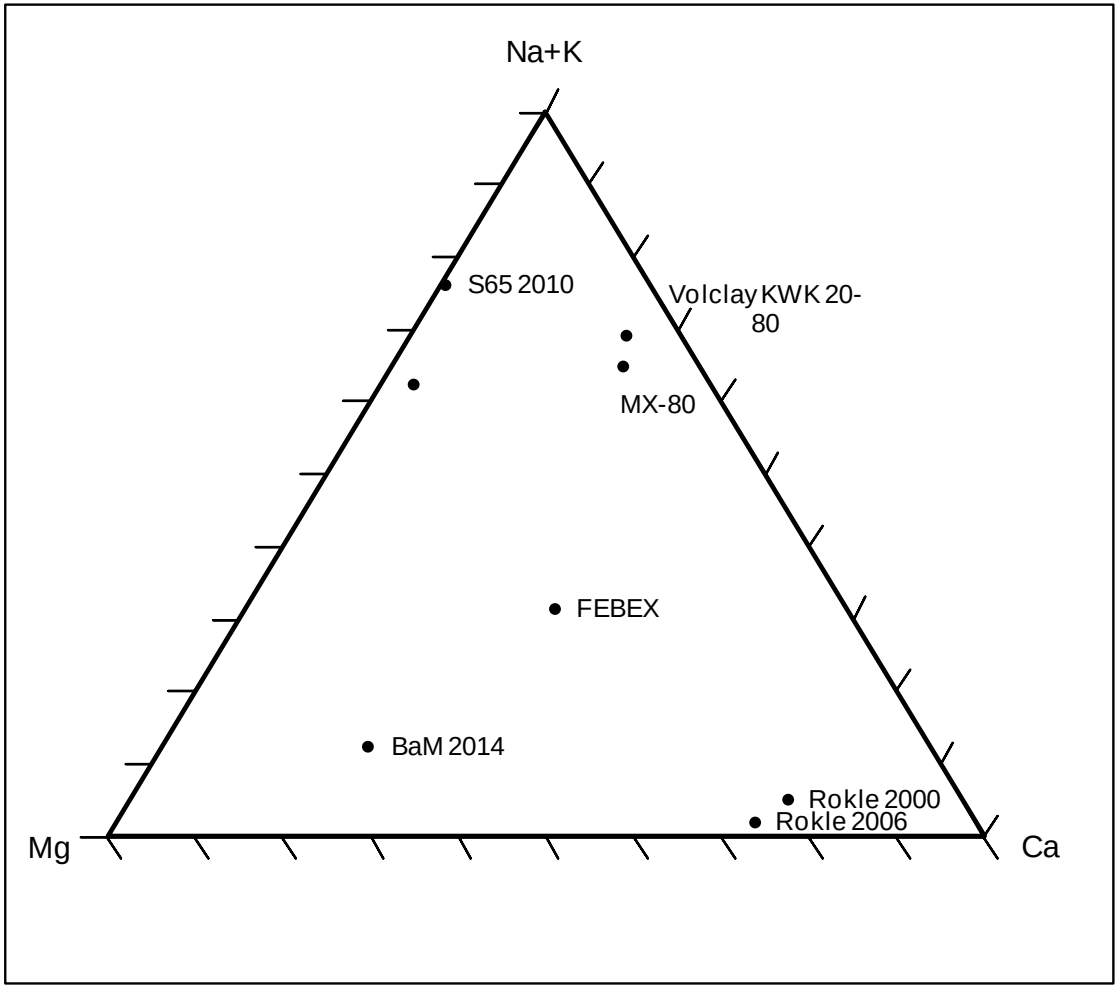
ÚJV Řež, a. s.

IGD TP EF5

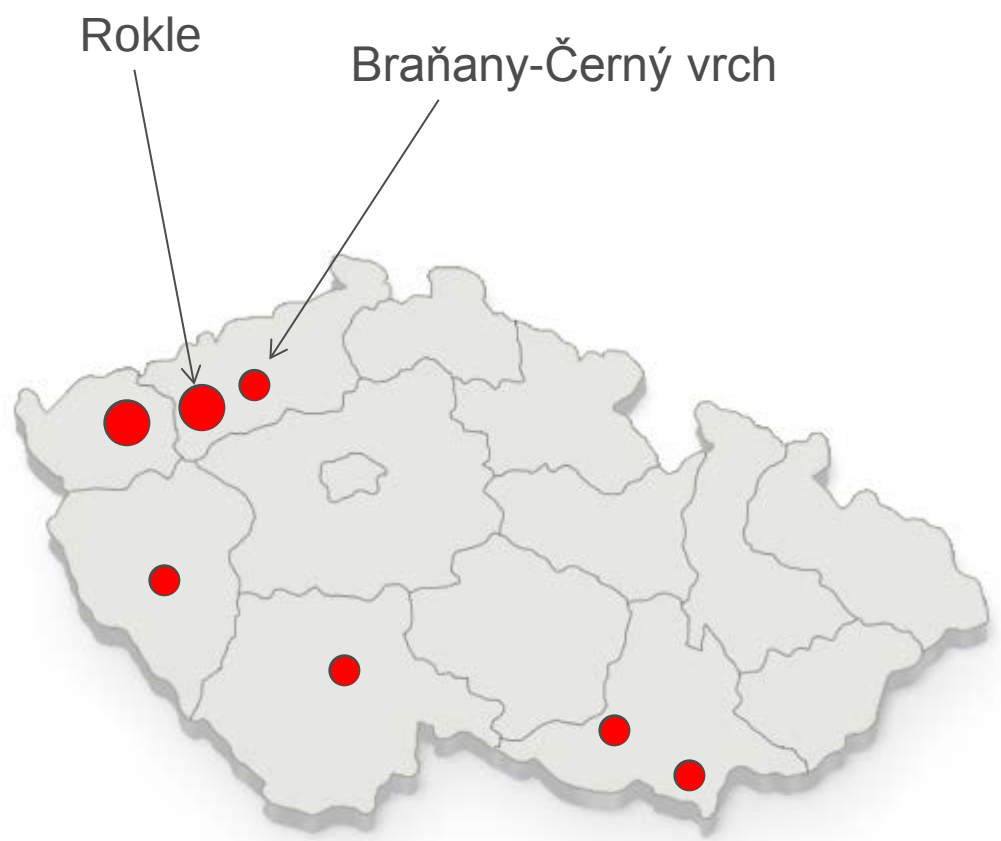
3.11.2015

Issues to be solved: Behaviour of bentonites with defined interlayer composition

- It is important to understand and predict the final condition of the buffer after the swelling and homogenisation
- Generally, bentonites used as a buffer material have usually different interlayer composition
- Definition of „dead-end member“ (homoionic clays/bentonites) properties can help in description of behaviour of areas with potential different composition due bentonite homogenisation / GW saturation
- Simplification: representatives of mono- and di- valent cations (Na and Ca).
- **Used Na:Ca mixtures (0/100; 20/80; 50/50; 100/0)**



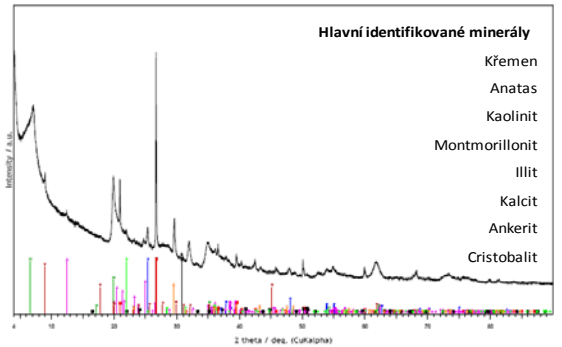
Czech bentonite deposits

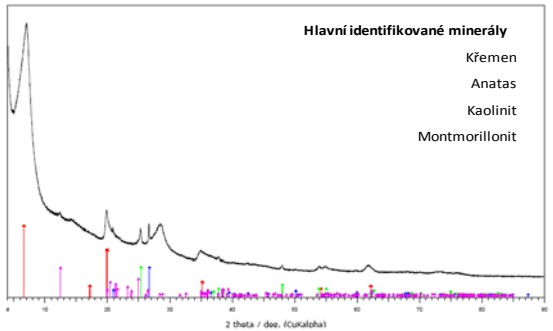


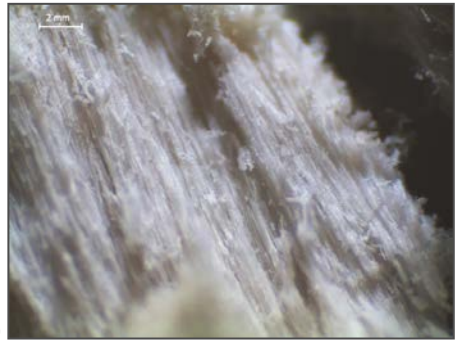
- Operating bentonite deposits (4/31)
  - Božíčany-Osmosa-jih
  - Braňany-Černý vrch
  - Maršov u Tábora
  - Rokle (44 mil. t.)
    - Stock in total 304 mil. t. (y 2010)
- Rokle
  - Rokle bentonite (Tertiary neovolcanic area, NW Bohemia) is Ca-Mg bentonite representing by a complex mixture of (Ca,Mg)-Fe-rich montmorillonite, micas, kaolinite and other mineral admixtures (mainly Ca, Mg, Fe carbonates, feldspars and iron oxides).
  - Commercial product (partly Na-activated) denoted as Bentonite 75 (B75).

Current work: Homoionic (HI) clay/bentonite characterisation

- Preparation of homoionic clays/bentonites (Na, K, Mg, Ca) is a basic tool for performance of some of the experiments (e.g. Clay colloid stability) and enables to study simplified system in order to gain more detailed description of ongoing processes
- Material characterisaion (bulk chem. analysis, XRD, CEC, SA) and migration properties (migration of RN) are ongoing (FP7 EU BELBaR & CZ national project)







Purification procedure

Carbonates removal	sodium acetate-acetic acid buffer	✓
Iron removal	sodium dithionite in acetic acid buffer / washed by NaCl	✗ used only for clay particles separation
Fractionation by sedimentation	washed by pure water, fract. < 2 µm-fraction	✗ used only for clay particles separation
Transfer to homoionic form - Ca/Na	$NaCl/CaCl_2$ washed by pure water	✓
Dialysis	conductivity < 10µS/cm	✓
Drying / lyofilization	final product bentonite in Na^+ or Ca^{2+} form	✓

(FP7 EU project BELBaR)

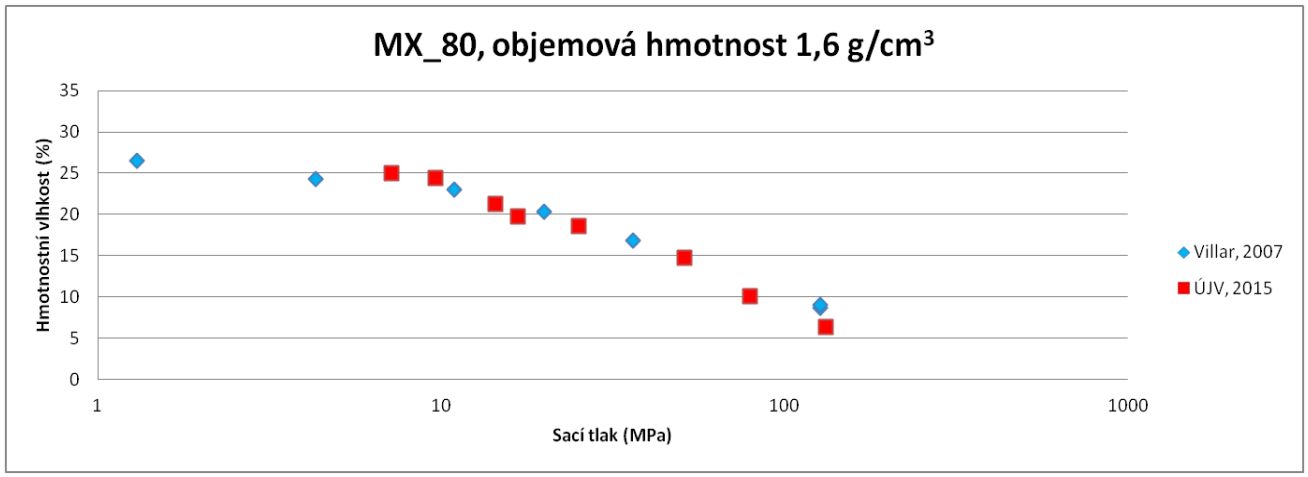
To be done: Saturation and mechanical properties for homoionic clays

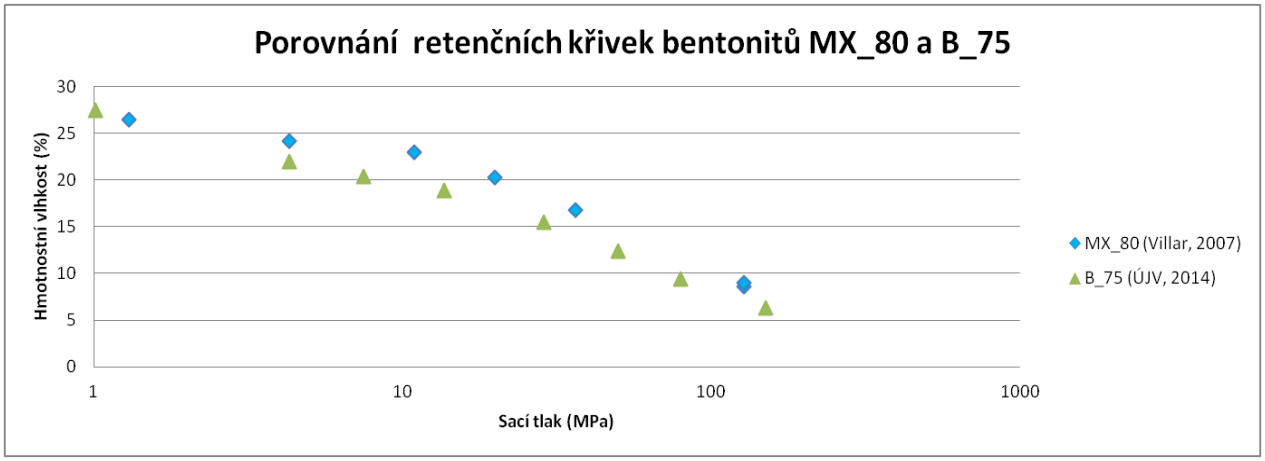
- **Hydraulic conductivity**
  - Triaxial high pressure chamber – up to 10 MPa
  - Cell without chamber presssure
- **Swelling pressure**
  - Cell without pressure chamber
- **Saturation of homoionic clays:**
  THM PHYSICAL MODELS
  - Cells developed within EU FP7 project DOPAS
  - Meaurement:
    - pressure and infiltrated water amount in the beginning of the sample
    - Swelling pressure on the end of the sample
    - Relative saturation in 9 observation points

(FP7 EU project DOPAS)

To be done: Saturation and mechanical properties for homoionic clays – to be done

- **Retention curves**
  - Block method
  - Relative humidit measured on the samples with known humidity
  - Comparison with published results (Villar, 2007)

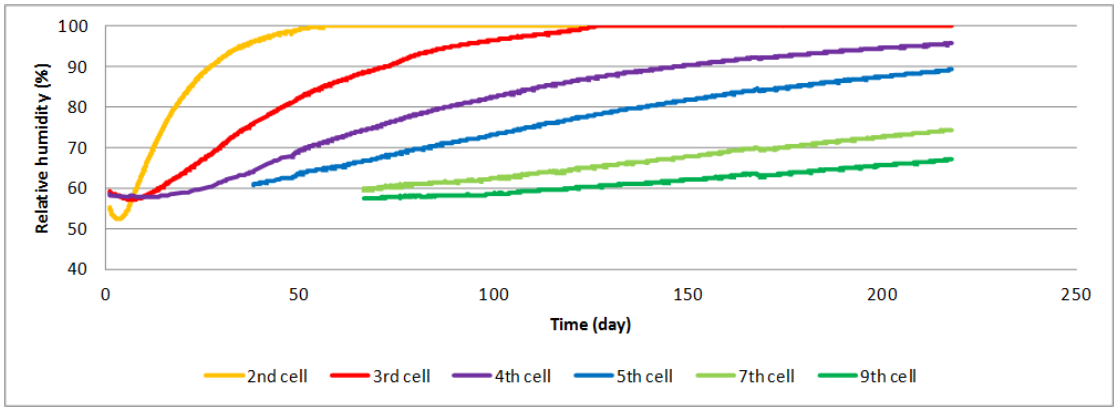


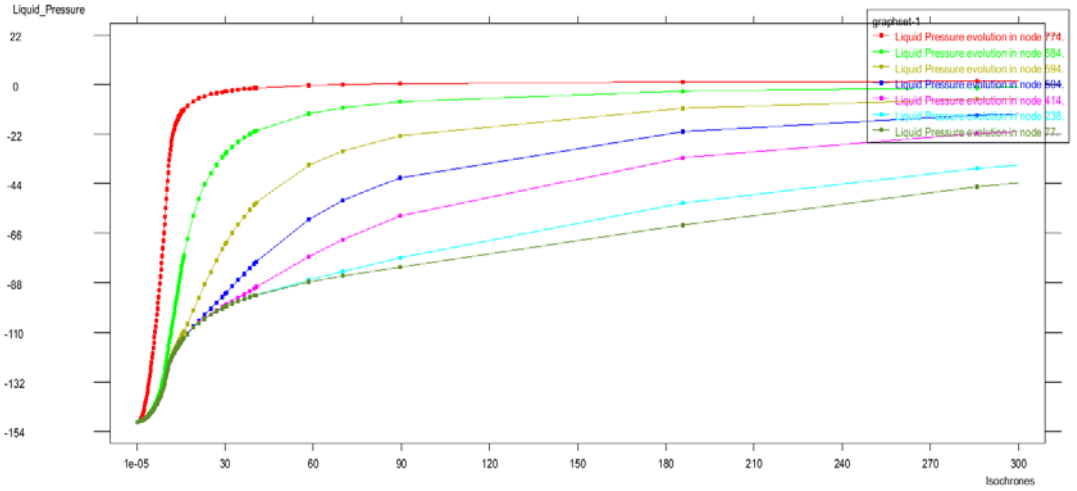


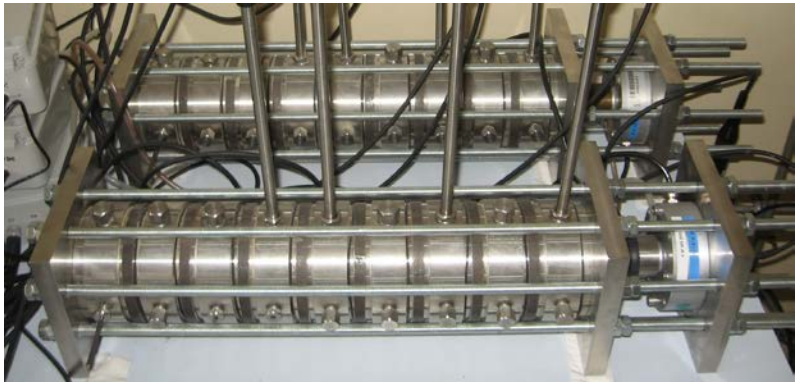
(FP7 EU project DOPAS)

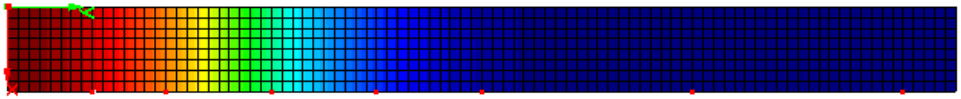
Modelling of THM processes in homoionic clays/bentonites

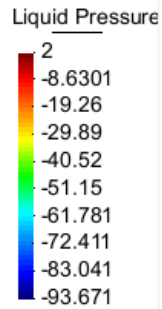
- **Simulation of THM processes**
  - Code_Bright code
  - Simulation of bentonite saturation
  - Calibration of model materil properties on the basis of laboratory experiments











(FP7 EU project DOPAS)

Resources

- **We presume 4 year of the project and 3 years for material preparation, experimental and modelling**
- **Homoionic bentonite preparation, including characterisation (bulk chem. analysis, mineralogy, CEC, specific surface, swell index, etc.)**
  - Ca an Na forms – 2 kg total
  - Preparation of mixtures (Na/Ca: 0/100; 20/80; 50/50; 100/0)
  - **10 000,- Euros for material preparation and characterisation**
  - Potential supplement for other experiments (additional expenses)
- **THM physical models**
  - **84 500 Euros for 4 cells/materials**
- **Mechanical properties**
  - **11 000 Eur**
- **Modelling**
  - **60 000 Eur**
- **Background available**
  - HI bentonite preparation procedure
  - Laboratory equipment
  - Code licence
  - Material properties and transport properties can be added as additional information

TOGETHER: ~ 166 000 €

References

- EU FP7, Bentonite Erosion: effects on the Long term performance of the engineered Barrier and Radionuclide transport (BELBaR)
- FP7 – 323273 – EC projekt, Full-scale demonstration of plug and seal (DOPAS)
- TA04021378 – Vývoj aparatur pro charakterizaci materiálů inženýrských bariér hlubinného úložiště radioaktivních odpadů a vyhořelého jaderného paliva (CZ project)

Thank you for your attention

www.ujv.cz