Engineered barrier 200C

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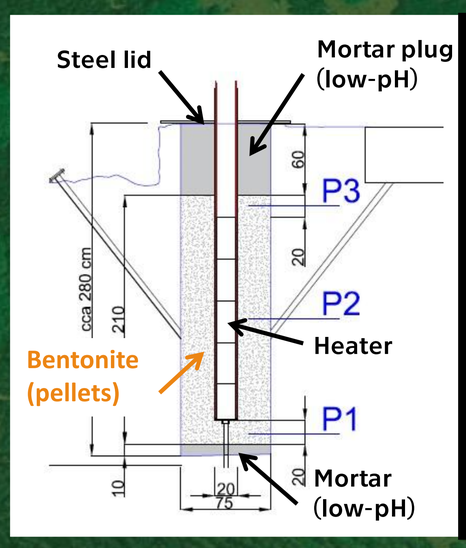
1 FAKULTA STAVEBNÍ ČVUT V PRAZE
2 ČESKÁ GEOLOGICKÁ SLUŽBA
3
4 TERAMED s.r.o.

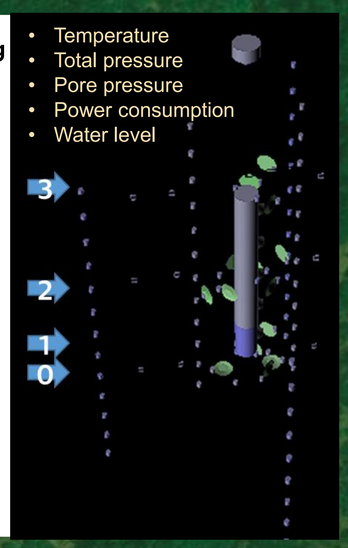
Introduction

The current Czech DGR concept is based on temperatures within the engineered barrier system (EBS) of below 100°C. However, an increase in the permitted temperature could lead to significant cost savings. Thus, the Engineered Barrier 200C (TK01030031) project is focusing on the investigation of the behavior of EBS materials and the EBS system at temperature levels of up to 200°C. The project is being led by the Czech Technical University in Prague; the other participants are the Czech Geological Survey, Charles University and Teramed.

In-situ Experiment

- Electric heater (5 segments, temperature controlled)
- Pellets (average ρd ~1450 kg/m3 after emplacement)
- Natural saturation
- Microbial seedings planted
- Hydrogeological monitoring
- Regular sampling using core drilling

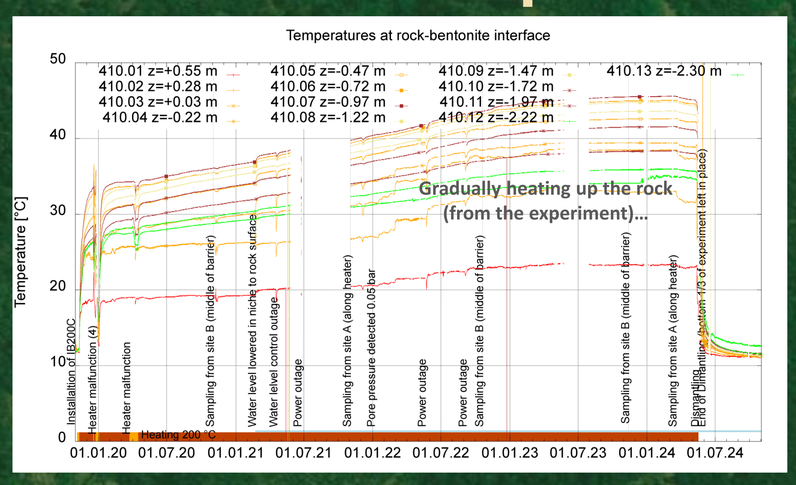




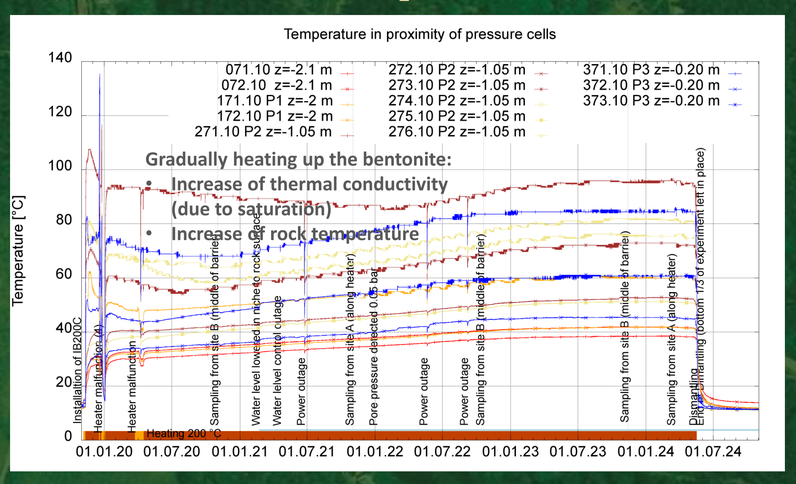
Schedule

Characterisation and experiment preparation:	2018-2019
Installation (bentonite, heater, plug):	29.-31.10.2019
Start of heating:	11:11 11.11.2019
Dismantling:	05-06.2024
Results of post-mortem analyses :	12.2025

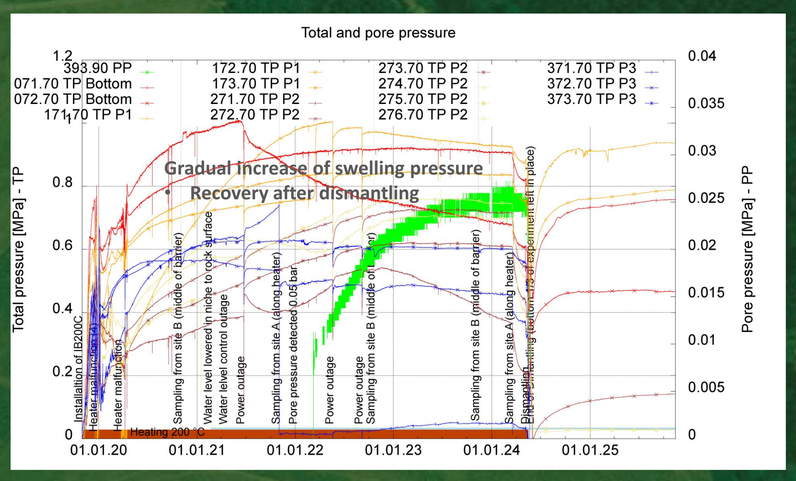
Bentonite-rock – temperature



Bentonite – temperature



Bentonite – total pressure

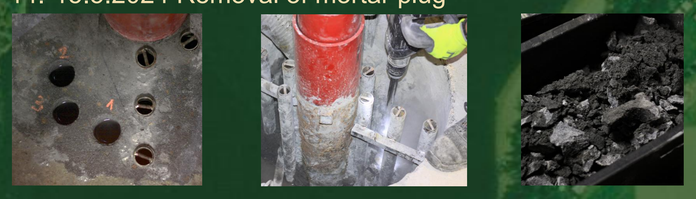


Dismantling

- 6.-9.5.2024 Core sampling trough the lid

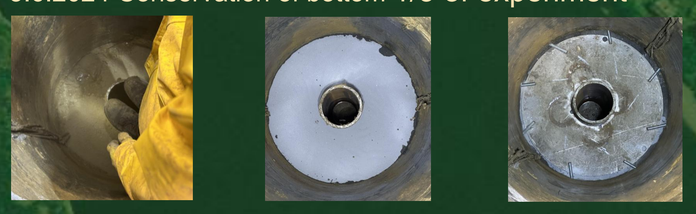
- 9.5.2024 Core sampling using diagonal borehole

- 10.5.2024 Removal od supports and lid
- 13.-14.5.2024 Core sampling of mortar plug
- 14.-15.5.2024 Removal of mortar plug



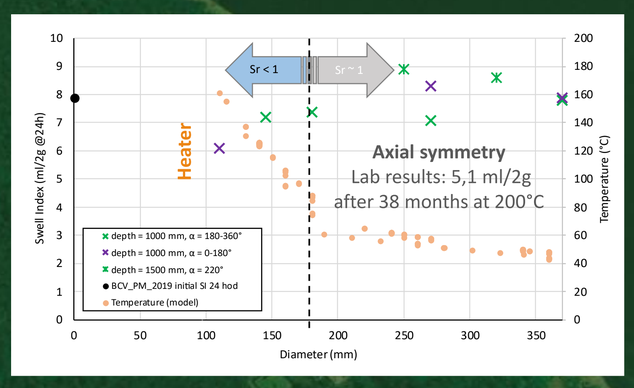
- 17.5.2024 Heater switch off and removal
- 20.5.-3.6.2024 Dismantling/sampling of bentonite

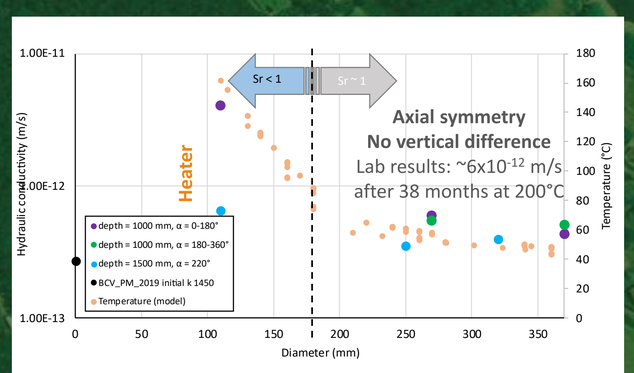
- 3.6.2024 Conservation of bottom 1/3 of experiment

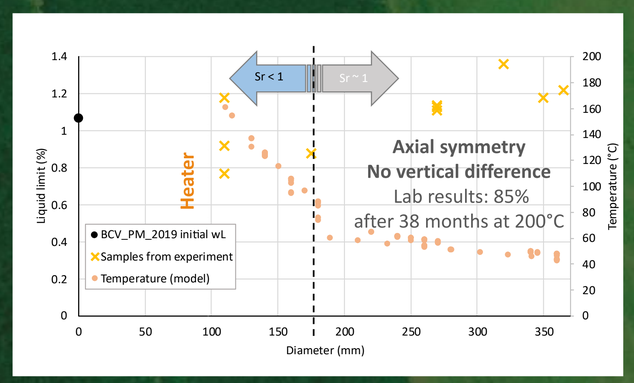


Results (dismantling)

- Axial symmetry confirmed, No vertical differences
- Dry part close to the heater
- Transition to fully saturated part approx. 5-7 cm from heater
- Results in accordance with lab results







4 years@200°C

- In-situ experiment in Josef URL
- Laboratory programme
- Numerical modelling

- Geotechnics
- Mineralogy
- Geochemistry
- Microbiology

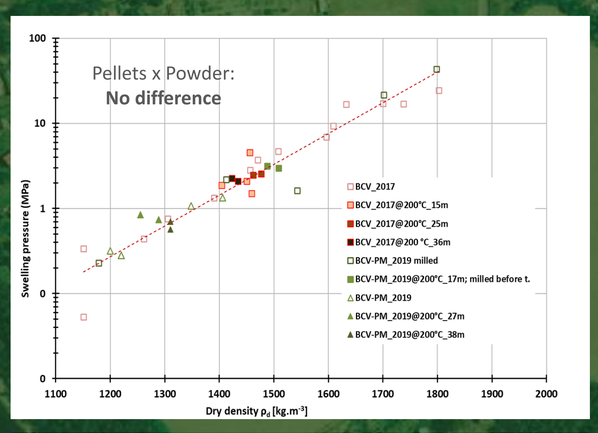
Laboratory Programme

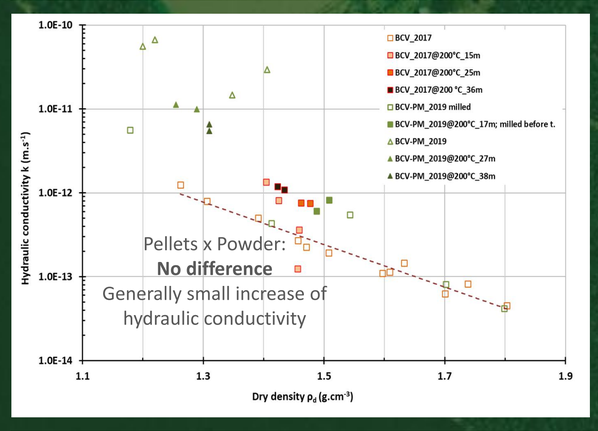
- **BCV** bentonite (dry) thermally treated @200 °C
- **Powder** and **pellets** (BCV_2017 and BCV-PM_2019)
- Sampled at regular intervals
- **Geotechnics**: Liquid limit, hydraulic conductivity, swelling pressure, swell index, thermal properties
- **Mineralogy and geochemistry**: FTIR, BET, CEC, TG-DTA, PXDR
- **Microbiology**: Cultivation and microbial screening

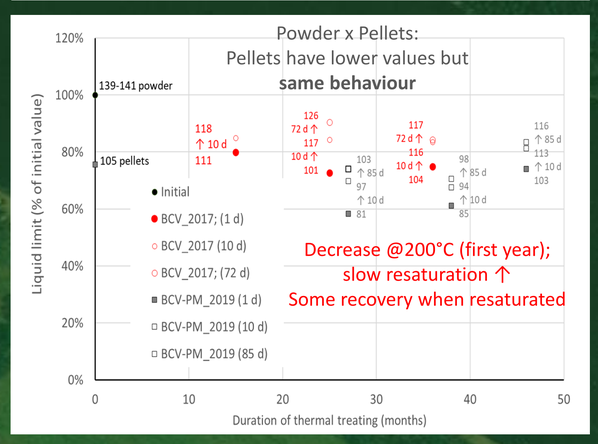
Laboratory Results

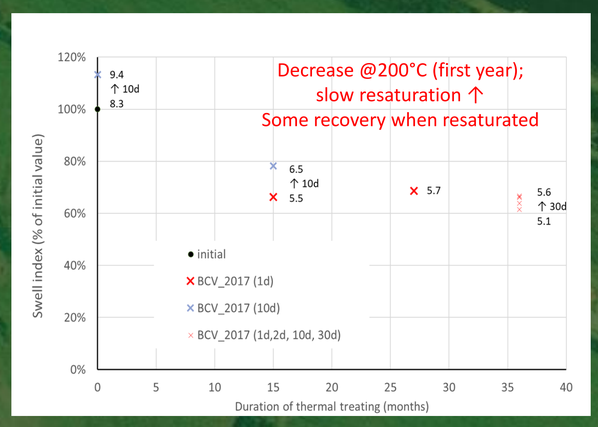
- A crust with different color on top material in oven observed

- Only very minor differences in mineralogical composition between treated and untreated material. White dots in original material and samples identified as kaolinite.
- Geotechnical properties partially affected (no effect on swelling pressure, increase of hydraulic conductivity, decrease of retention properties). All changes within first year.
- Given sufficient (resaturation) time the properties improve towards original (not fully).









Conclusion

- Laboratory and in-situ experiment successfully simulated high temperature concept.
- Although some material changes have been identified during the laboratory program and dismantling, they are not progressing, and they are not prohibitive for usage in deep geological repository.
- Results of analyses from the in-situ experiment are in line with those from the laboratory.
- While the current Czech concept (up to 95 °C) is demonstrated by the Mock-Up-Josef experiment, this work supports the potential to increase the current limit.

T A C R
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