



# **Introduction to the Beacon Project: WP4 – Laboratory Testing**

Klaus Wieczorek

GRS

Workshop “Mechanical Properties of Bentonite Barriers”

Kaunas, 19-20 June 2017

## Background and objectives

### Main objective of Beacon

- Provide an increased understanding of the **mechanical evolution** of a bentonite barrier/seal

### Limitations in the current state of art

- The models have rarely been tested on mechanical problems in bentonite - the main focus has generally been on hydration
- Many of the performed experiments have been done with other issues in mind and the mechanical part is often not evaluated
- The models are complex and the issue of homogenisation and swelling of the barrier is challenging both from a conceptual and a numerical point of view
- A robust predictive capability of the models has not been demonstrated

### Objectives of WP4 – Laboratory Testing

- Provide **input data and parameters** for development and validation of models
- **Reduce uncertainties** about conditions and phenomena influencing bentonite homogenisation, through experimental studies

# Conditions and phenomena relevant for buffer evolution

## Initial state of the buffer

- Single density (block) or multi-density (pellets, blocks/gaps, blocks/pellets) system
- Observation scale!

## Hydration conditions and history

- Solution composition
- Thermal and mechanical load
- Hydration history

## Interplay heterogeneity – swelling pressure – mechanical properties

- Effect of heterogeneity on overall swelling pressure and mechanical properties
- Shearing behaviour at interfaces

→ Task of WP4:

Complete respective data and provide support and parameters for advanced material models

## Organisation of Work Package 4

### Task 4.1

- Homogenisation of an initially inhomogeneous bentonite system

### Task 4.2

- Persistence or development of inhomogeneities in the bentonite system under various mechanical and hydraulic conditions

### Task 4.3

- Natural analogues

## Task 4.1: Homogenisation of an initially inhomogeneous bentonite system

### Hydration experiments on heterogeneous samples, involving

- Various scales (pellet scale to decimetre scale)
- Tests in constant-volume and perforated cells
- Mechanical (swelling pressure) and hydraulic (permeability) measurements
- Microstructural characterisation (X-ray, ESEM, NMR) and water binding state
- Tests in transparent cells to obtain qualitative information about texture evolution

### Determine parameters for newly developed material models, with regard to

- Water retention
- Hydraulic conductivity
- Swelling properties

### Partners

- CEA, CIEMAT, CTU, CU, KIT, GRS, ICL

## Task 4.2: Persistence or development of inhomogeneities

### Experiments addressing

- Temporal and spatial development of stress, porewater pressure and swelling response
- Development of heterogeneities and their impact on swelling pressure
- Water transport and swelling behaviour (X-ray tomography)
- Impact of hydration on gas flow and assessment of erosion
- Shear strength in relation to temperature and suction

### Partners

- BGS, EPFL, JyU

## Task 4.3: Natural analogues

### Creep behaviour of bentonite

- Study a horizontal drill core from a European bentonite deposit to try to find evidence for or against long-term creep in bentonite

### Partners

- SKB

## WP4 challenges

- Demanding and inhomogeneous work programme – due to different requirements of modelling groups
- Maintain flexibility to react to the needs of model developers and validators (WP3/5)
- Avoid double work to get maximum output
  - within WP4
  - by not replaying existing experiments (→ WP2)

## Acknowledgment

- This project receives funding from the Euratom research and training programme 2014-2018 under grant agreement No 745942



**Thank you!**