




# Synthesis

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# Long time span of the project: about 10 years

- Enough flexibility is required
  - to face the unforeseen results
  - the scientific progress
    - computer science, modelling, unsaturated behaviour, ...
  - the evolution in the Belgian programme

# The initial goals of the project have been adapted

- preparation to the in-situ test + demonstration (installation, hydration and thermal load)  demonstration + scientific output
- observation of the THM behaviour (instrumentation)  better understanding of the THM processes
- limited characterisation of the fresh material ( $P_s$ ,  $w$ ,  $d$ ,  $K$ ,  $\lambda$ )  characterisation extended to THM behaviour

# The purpose of the dismantling programme has been extended

- Chemical and mineralogical analyses
- Microbiological analyses
- THM characterisation of the exposed material
- Corrosion tests
- Modelling
- Knowledge management

# Main results (1)

- Very long hydration time
  - ⊗ the emplacement of the radioactive waste after the hydration of the system is not realistic
- All technological voids are filled by swelling during the early hydration phase
  - ⊗ limit corrosion
  - ⊗ limit microbiological activity
- But joints remain visible
  - ⊗ unhomogeneous swelling
  - ⊗ unhomogeneous material (d, W)

# Main results (2)

- Increasing in Si, Cl<sup>-</sup> and TOC toward the steel heater
- Decreasing in HCO<sub>3</sub><sup>-</sup> concentration
- Presence of sulphide and of Sulphate Reducing Bacteria
  - ⊕ problems of corrosion
- Increase of the permeability
- Decrease of the swelling pressure
  - limited (but for long period of time?)
- AISI 321 more corrosion resistant than AISI 304

# Lessons learned (1)

- Experience has been gained in the installation of engineered barriers
- Difficulty to characterise the components of the engineered barriers and to understand the governing processes for  $T^{\circ} > 100^{\circ}\text{C}$ 
  - ⊕ change of the temperature criterion:  
 $T^{\circ} < 100^{\circ}\text{C}$  in the engineered barriers  
and in Boom Clay

# Lessons learned (2)

- Bacteria could be present in the engineered barrier system
  - ⊗ Necessity to limit transport processes
  - ⊗ Technological voids have to be avoided
- The space between bentonite blocks could be optimised to get a more uniform swelling
- Instrumentation can disturb strongly the chemistry of the engineered barrier system and can lead to severe corrosion problems

# Experience gained for future programmes

- strategic view from the beginning of the project up to the end keeping sufficient flexibility
- levelling and integration of the different research aspects: modelling, scientific results and demonstration target
- integration of the research from different disciplines and overcoming the typical slang and the different background
- importance of knowledge management

The OPHELIE mock-up  
brings major inputs for the  
development of the  
reference design

