

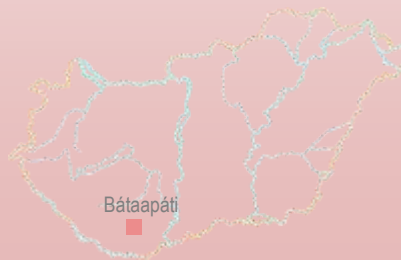


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Designing Low-K Plug in a Compartmented Flow Regime

Background, Desing, Concepts, Outlook

Kálmán Benedek (PURAM)





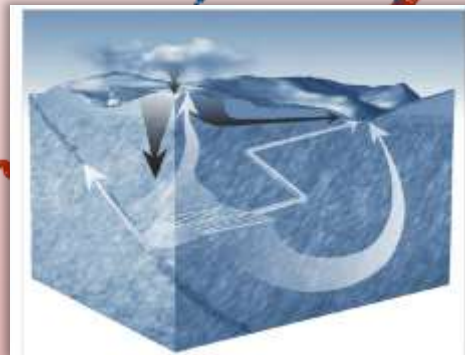
Overview

- Background
- Why do we need a demonstration test? – Hydrogeological background
- Safety aspects of the sealing features
- Schedule
- Options for plug design
- Monitoring





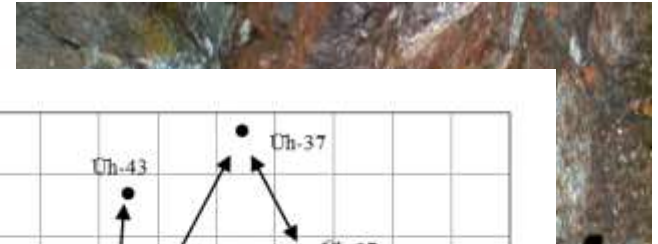
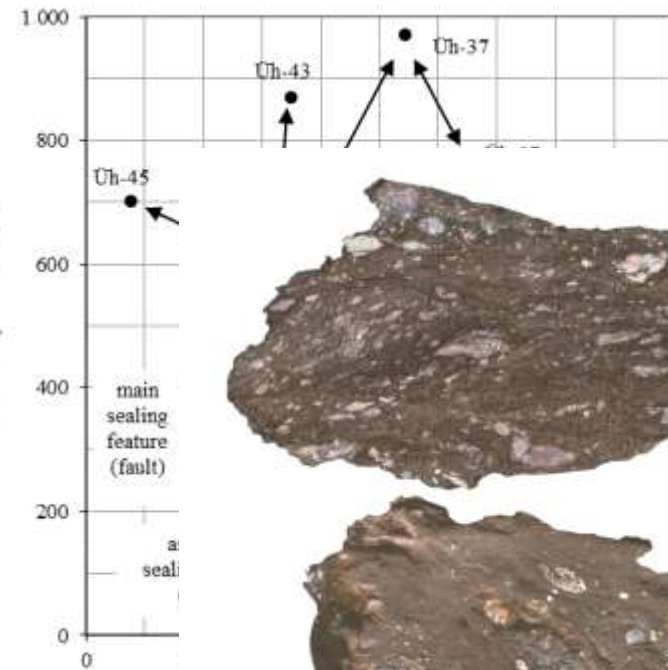
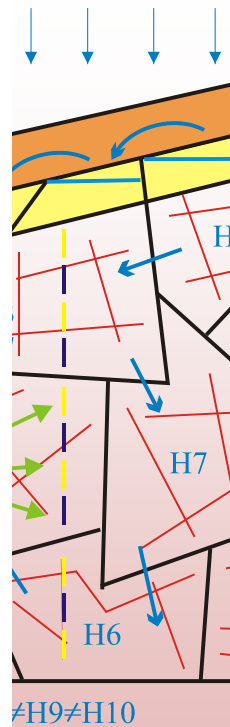
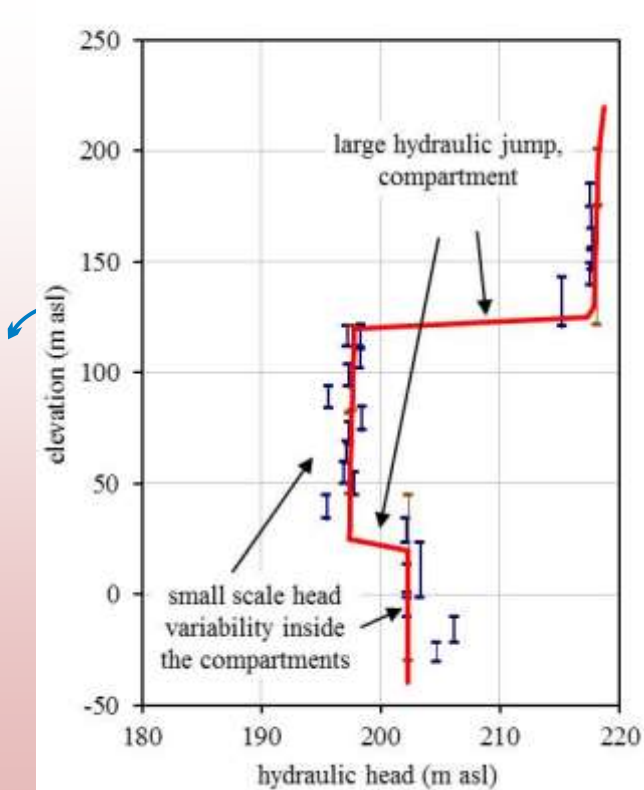
Background





Hydrogeological Background

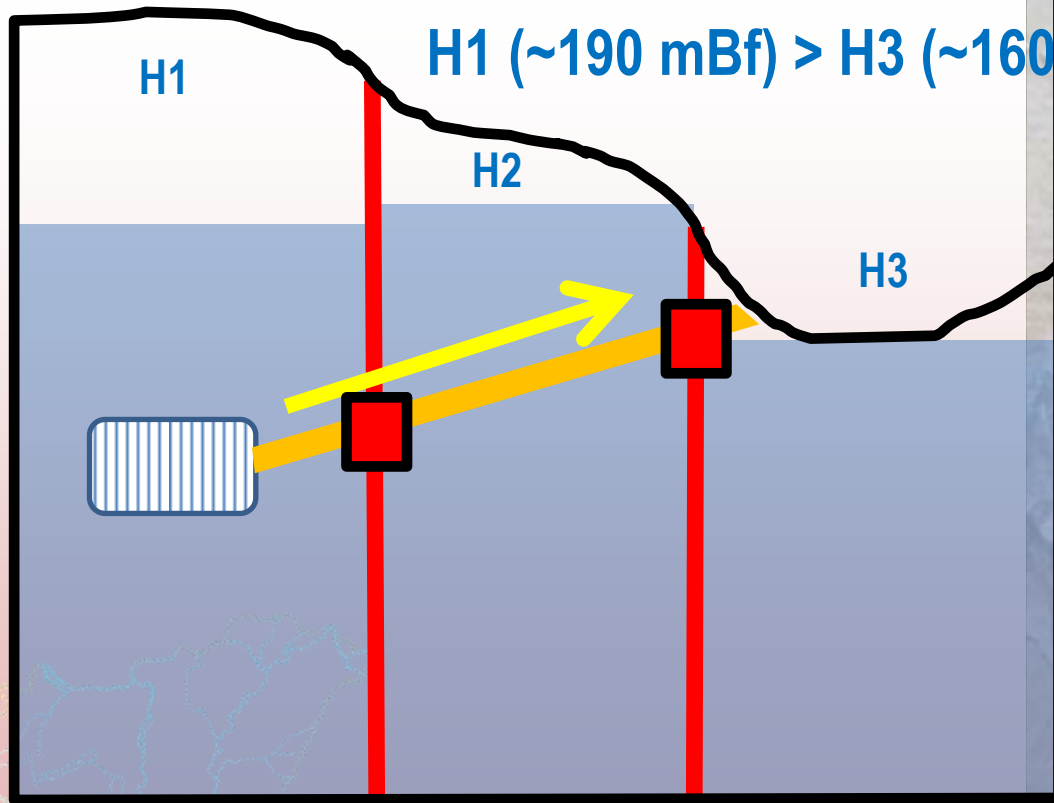
Uh-28



Characteristic hydraulic head profile



Safety Aspects

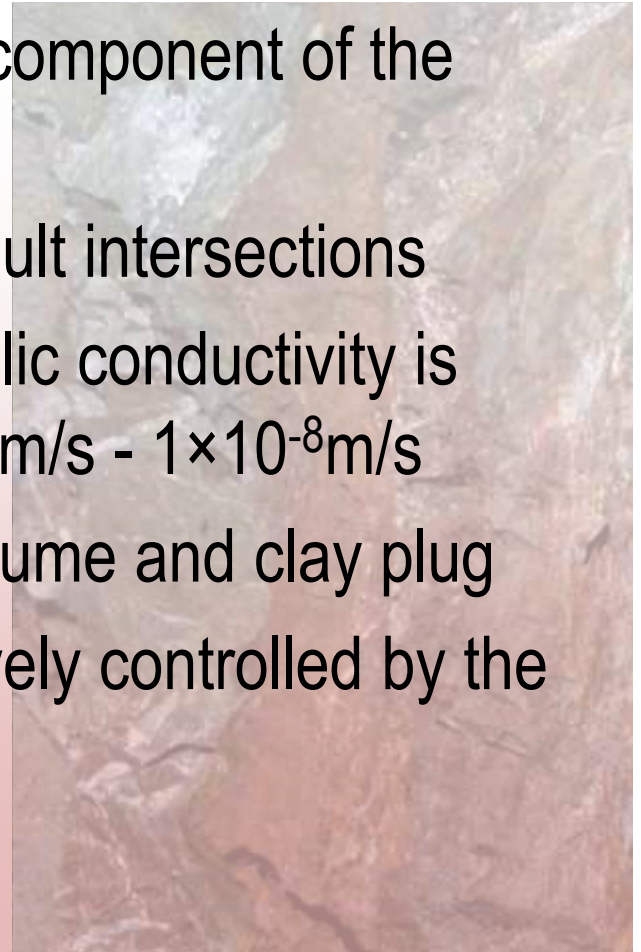


- Minimize hydraulic gradient within compartment
- Minimize hydraulic communication between compartments
- Force diffusive transport
- Increase travel time



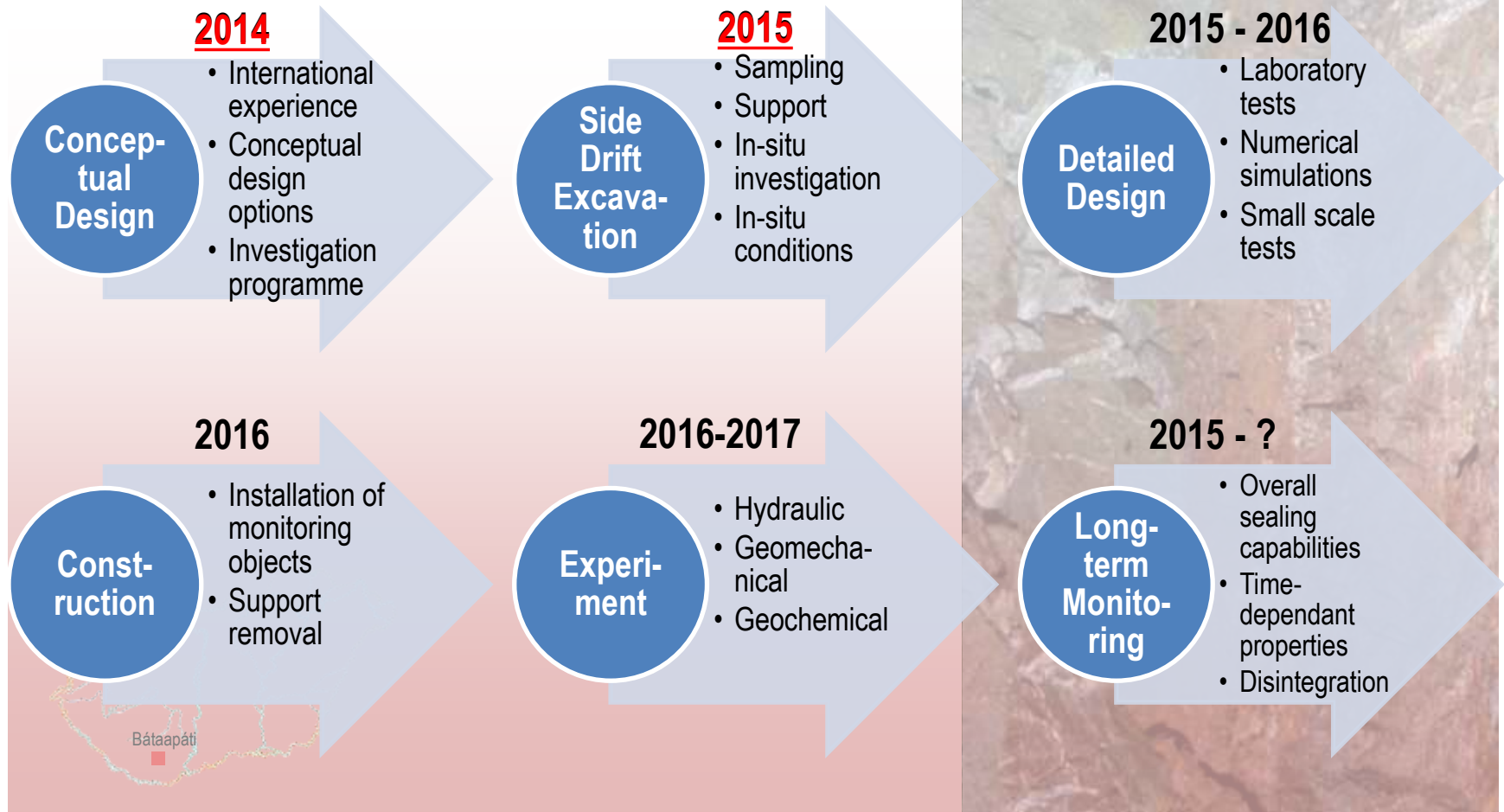
Safety Aspects

- Sealing features appear to be a key component of the safety case
- Sealing plugs have to be placed at fault intersections
- Assuming perfect sealing, plug hydraulic conductivity is required to be in the range of $1 \times 10^{-12} \text{m/s}$ - $1 \times 10^{-8} \text{m/s}$
- Minimize the interaction of alkaline plume and clay plug
- Effective dose in biosphere is effectively controlled by the quality of the sealing plugs





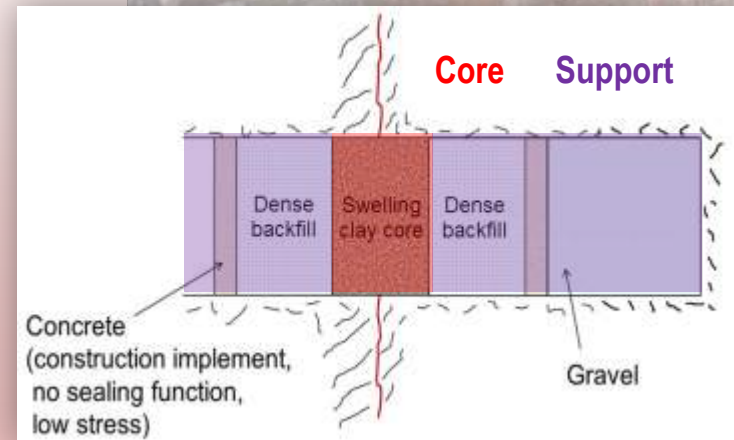
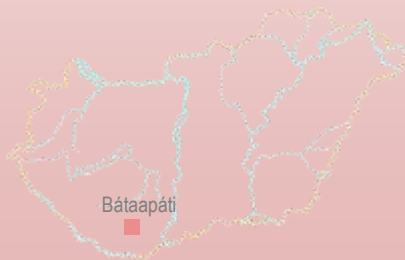
Schedule





System Components, the Plug

- „Natural” features: fresh rock, fault damage zone, fault gouge
- Engineering components: gravel backfill, concrete plugs, dense backfill, clay core, EdZ, EDZ, rock bolts, shotcrete, shotclay, different support structures



Mott MacDonald (2014)



Components of the Engineering Barrier - Core

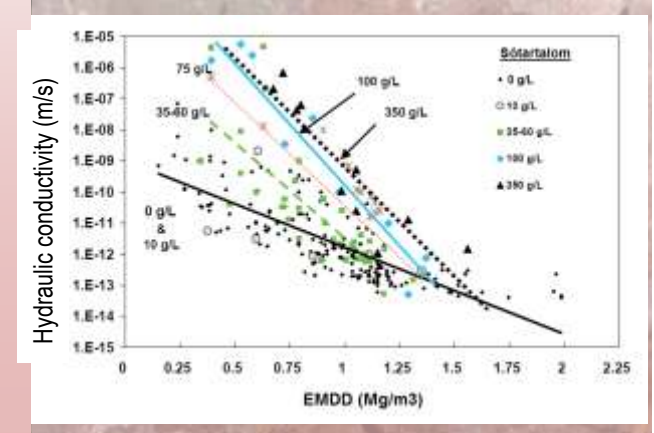
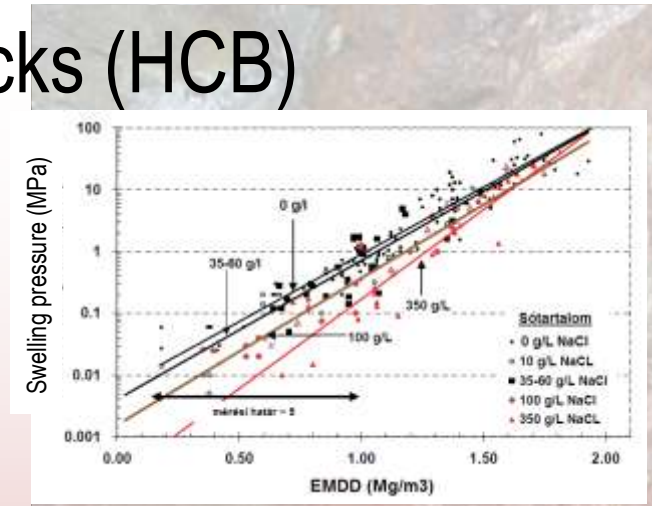
- Highly compacted bentonite bricks (HCB)
 - Swelling
 - Geochemical stability



Installation of bentonite bricks
(Chandler et al., 2002)



Bátaapáti

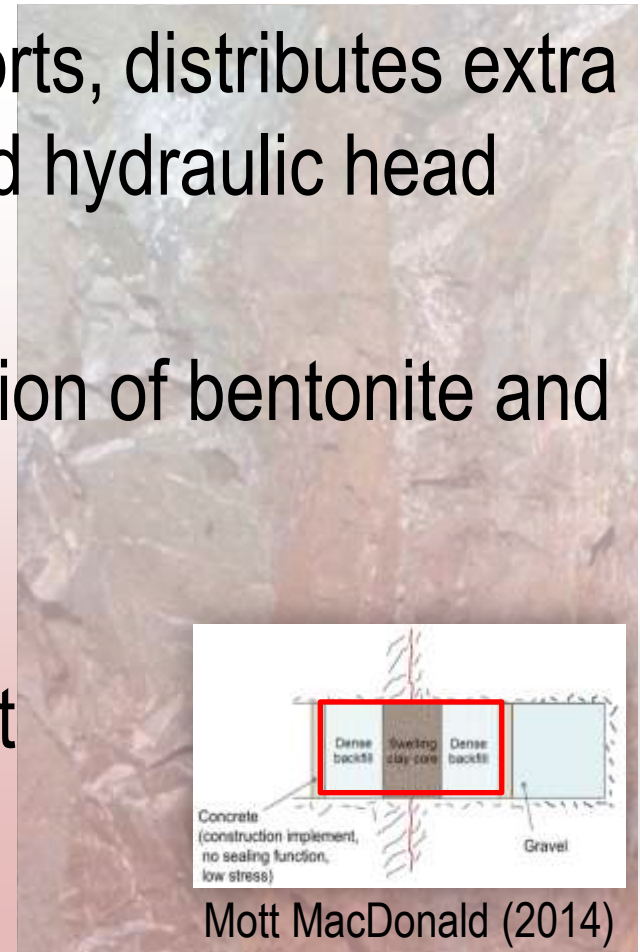




Bentonite and dense backfill bricks

- Backfill does not seal, but supports, distributes extra stress generated by swelling and hydraulic head difference
- The dense backfill is a composition of bentonite and local granite gravel
- Gradual development of these sections, gradual removal of drift support

Bataapal

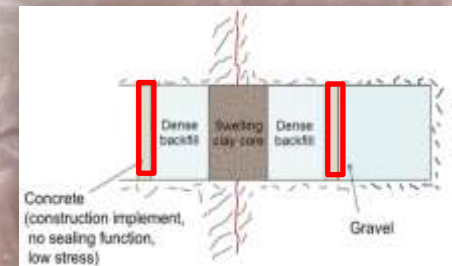


Mott MacDonald (2014)



Concrete Plug

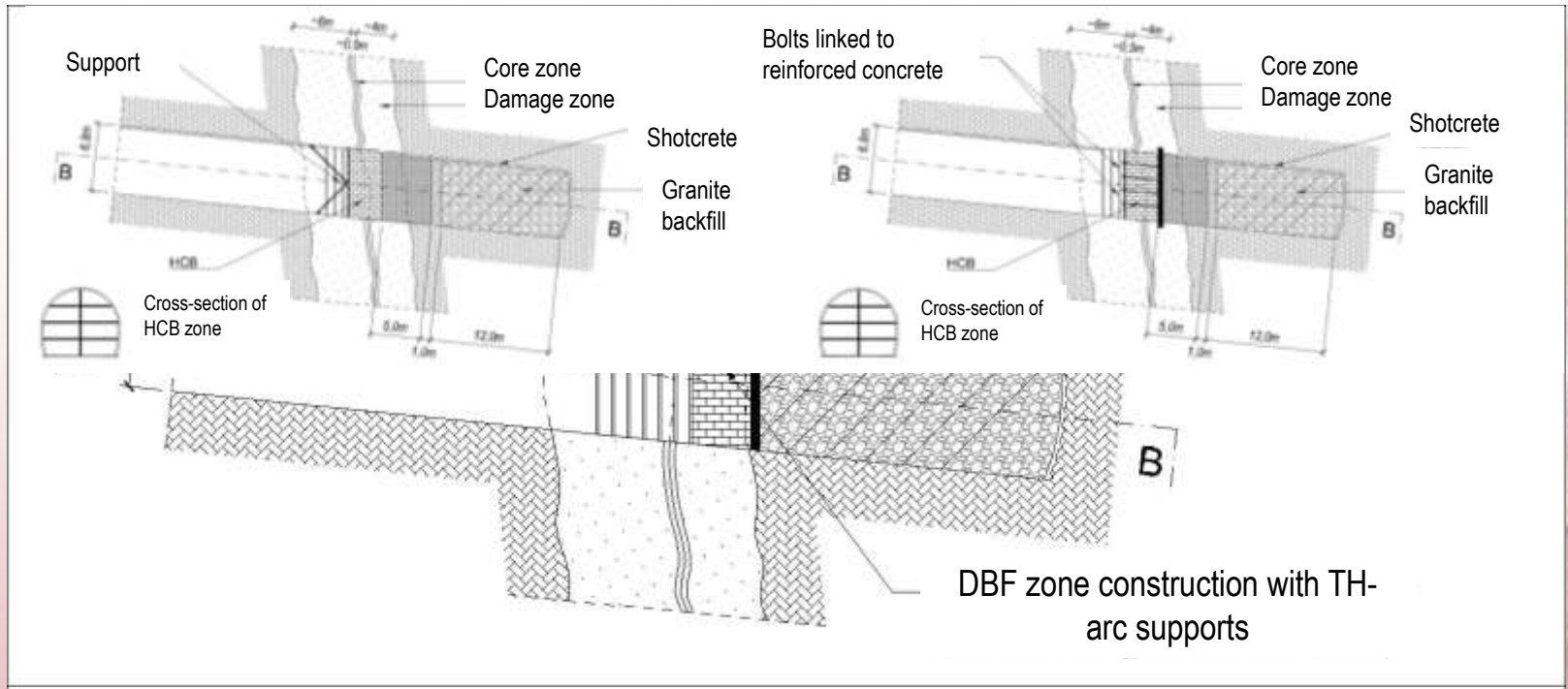
- No need for hydraulic sealing
- To support the clay core and to force radial swelling
- Minimize pH plume – clay interaction (Ca bentonite? Low pH concrete)
- Concrete degradation may alter the long-term stability of the core
- Heat generation, shrinkage cracks



Mott MacDonald (2014)



Steps of Plug Construction



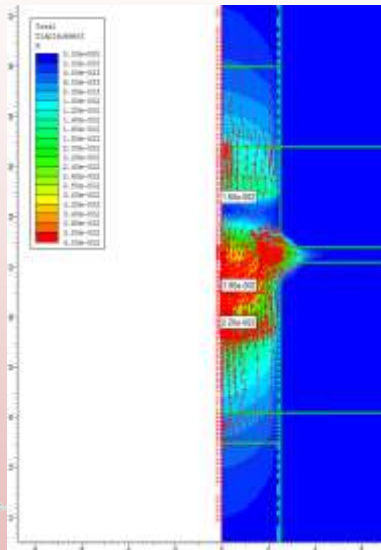
Backfilling of the open face
Alternative methods to support the
backfill
free face



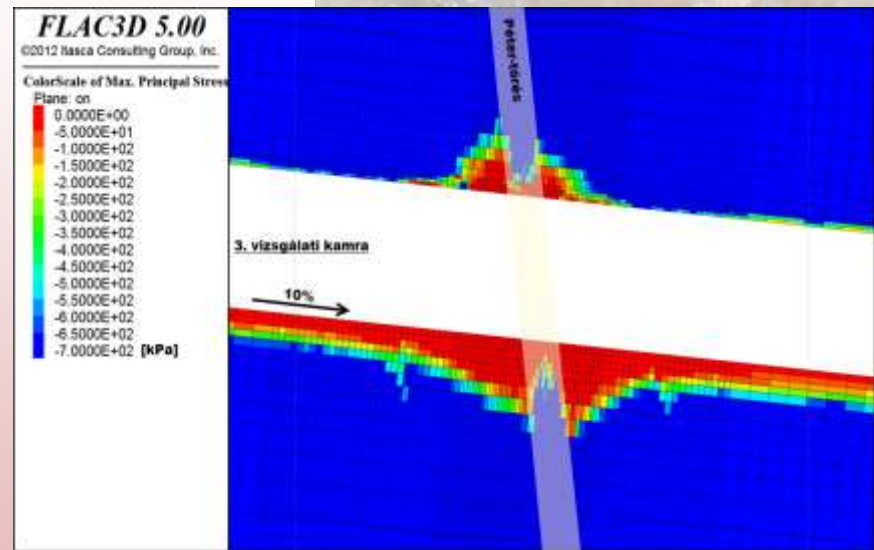


Numerical Modelling

- Goal to quantify hydraulic and geomechanical properties of the sealing system
- To test design concepts



Dislocation due to swelling and hydraulic head difference, Phase2, (Mott MacDonald, 2014)

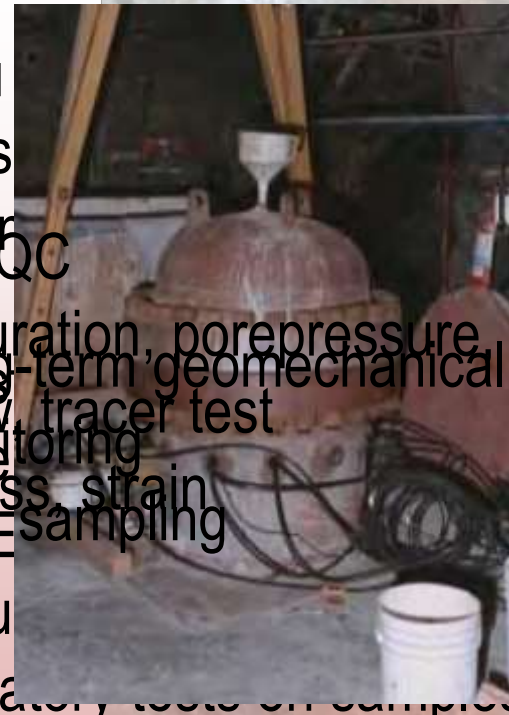


Stress distribution in the support system, Flac3D, (Mott MacDonald, 2014)

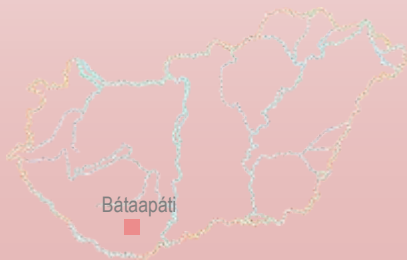


Experiment, Monitoring

- Monitoring before testing, initial conditions
- Small-scale experiments
- Monitoring during the test
- Post-test monitoring



In situ
 Stress
 Transf
 QA/QC
 Strain
 Saturation, porepressure, swelling
 Long-term geomechanical
 Flow, tracer test
 Monitoring
 Stress, strain
 EDZ/E
 Fracture
 Laboratory tests on samples
 entation
 E, etc.)



Chandler et al. (2002)



Summary

- Goal to demonstrate long-term hydraulic sealing of compartments
- Alternative conceptual designs
- Ongoing excavation
- And to be continued....



THANK YOU!!!