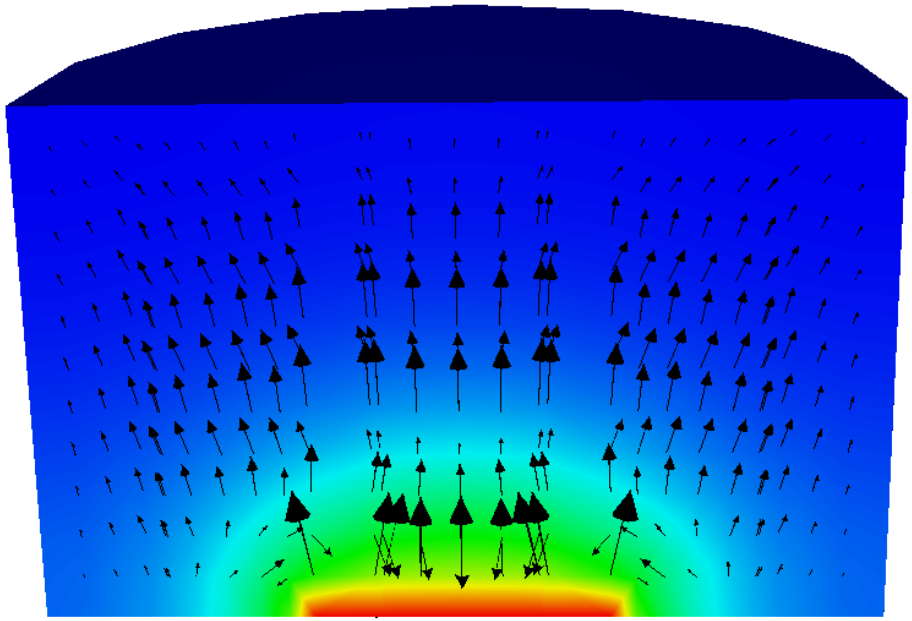
Hydromechanical Simulation of Bentonite

Mika Laitinen
Numerola Oy

19.8.2014

The Goal is to Simulate the Evolution of Relevant Variables in the Bentonite Buffer

deformations
water content
temperature
Ion concentrations



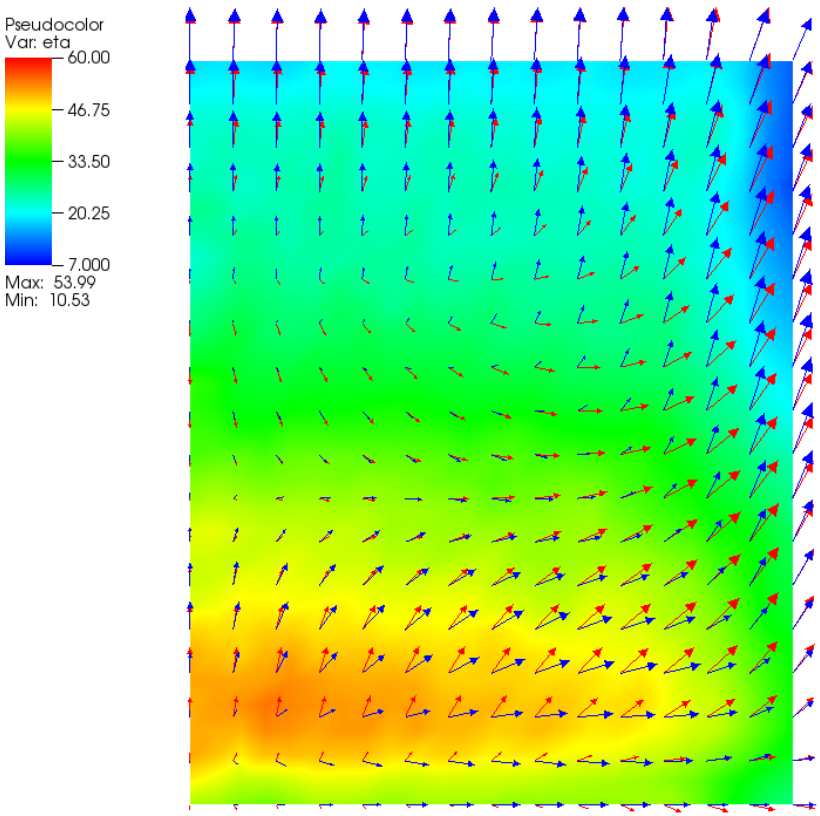
Facts about the Simulation Software

- Implemented with Numerrin modelling language, an in-house software of Numerola Oy
- Software $\approx$ solver code, a plain GUI exists
- Works with 3D and 2D-cylinder symmetric geometries
- Mechanical model: Elastoplastic model of Markku Kataja (JyU) with moisture dependent parameters
- Hydrological model: Diffusion of liquid water and water vapour
- Thermal model: Heat conduction
- Chemical model: Implemented for 5 ions, but not validated
- The software and numerical methods are working. Challenges are in the modelling.

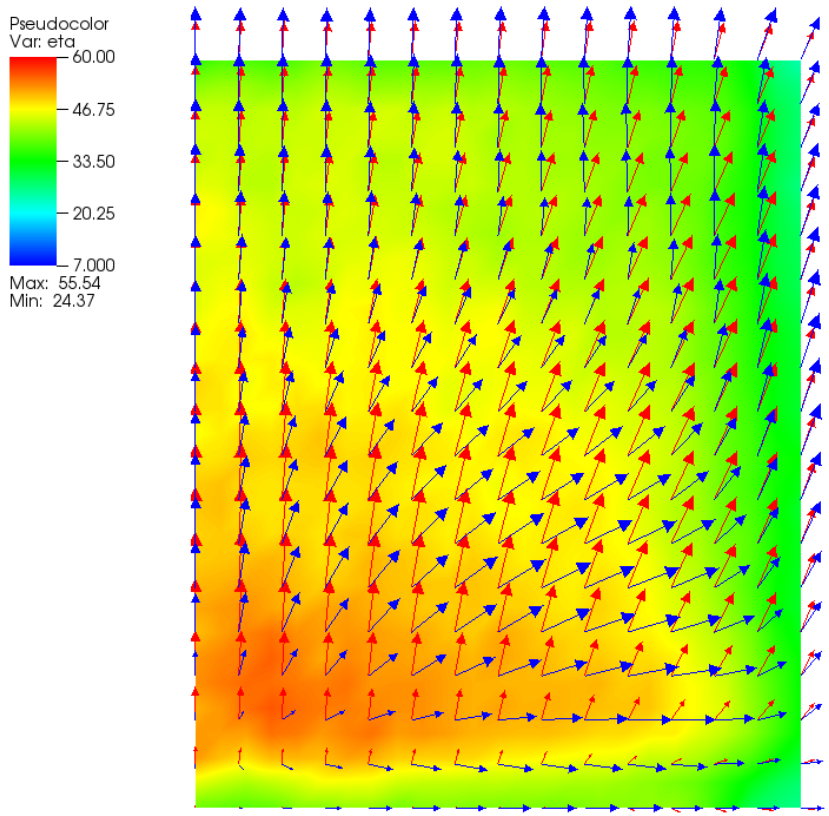
Parametrisation of the Mechanical Model

- Goal is to predict deformations of bentonite in presence of wetting and swelling
- Based on X-ray tomography wetting studies at JyU
- Mechanical parameters are moisture dependent for a wide range of water contents
- Model is tested by simulating wetting experiments and simulation results are compared to tomography data

Simulated (blue) and Measured (red) Displacements, Measured Water Content

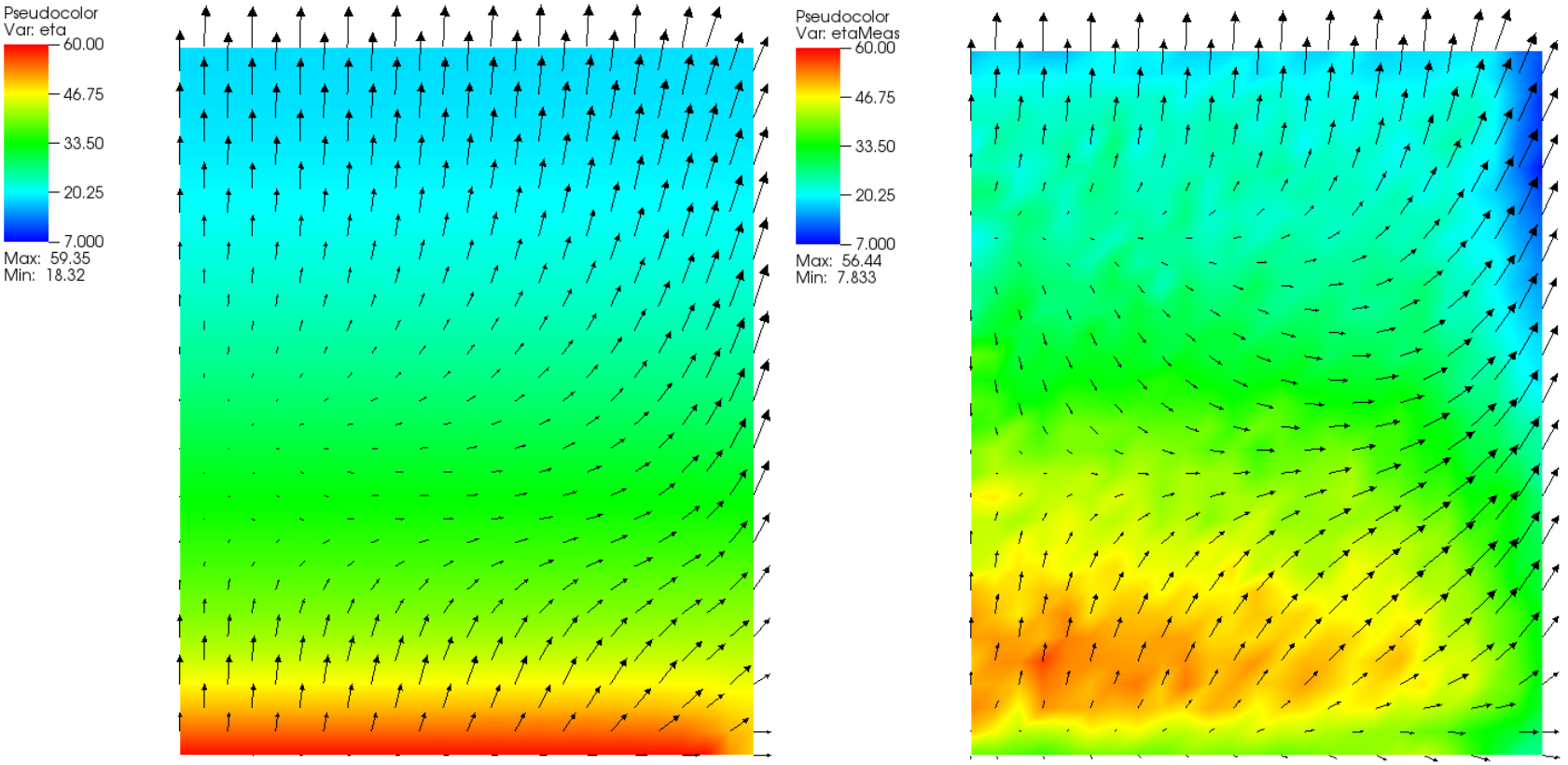


t=15 h



t=39 h

Simulated Displacements and Water Content (left) cf. Measurements (right)



t=15 h

Conclusions

- Mechanical model captures many qualities of water-bentonite interaction
- Simulations of two distict experiments show similar trends
- At initial stages of wetting, there seems to be also capillary driven flow which is ignored in hydrological model
- More measurements are needed for more accurate description