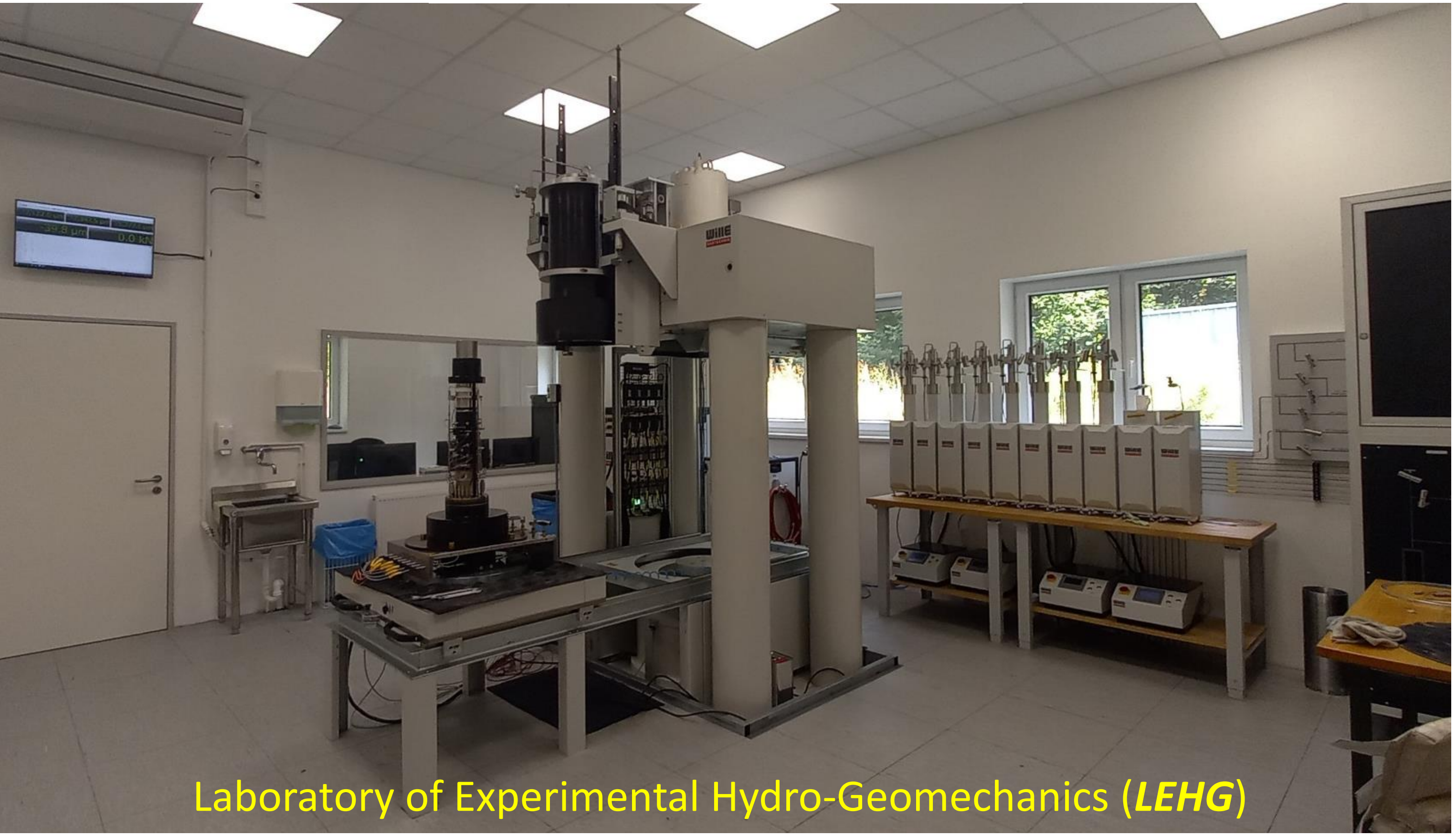
GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

Simulation of different georeservoir conditions on a highly-permeable sandstone

(supplementary material)

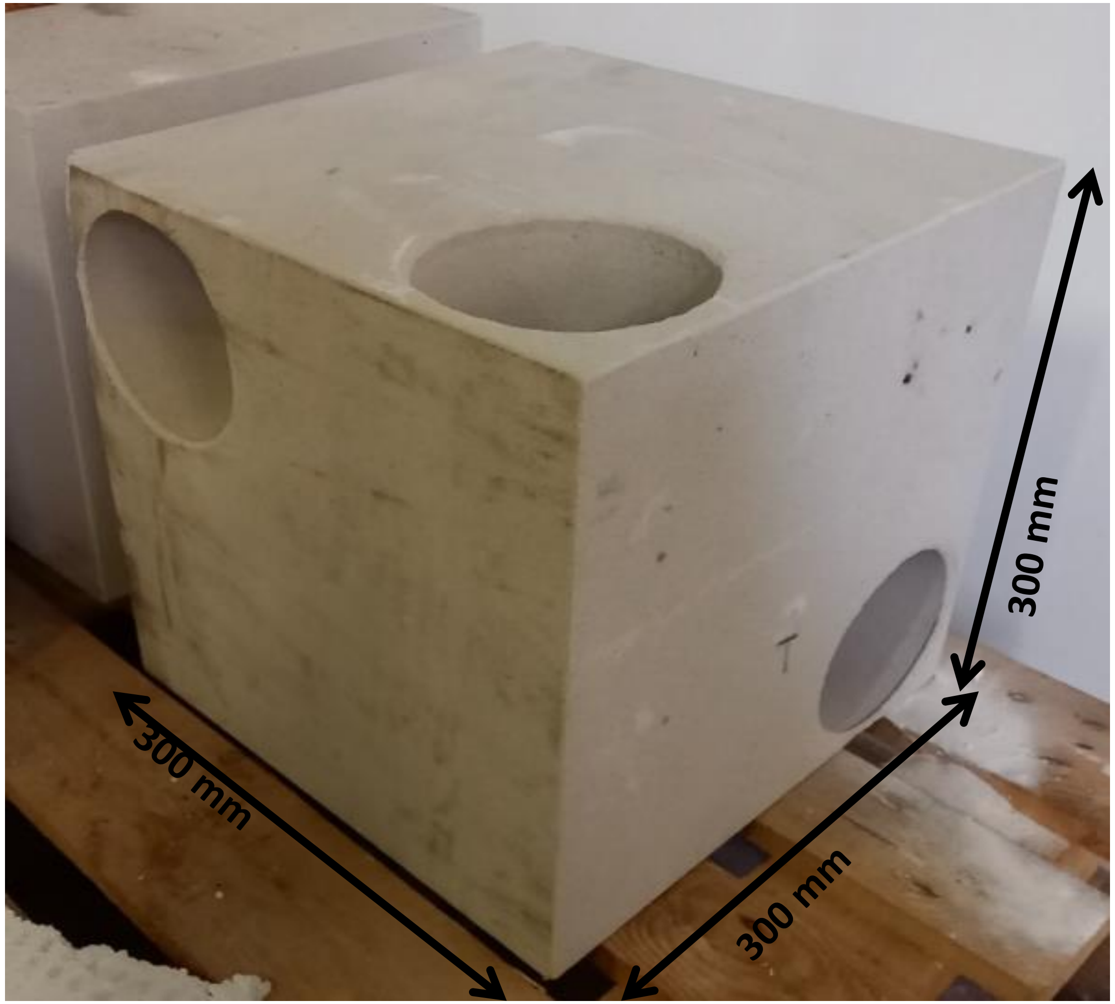


Laboratory of Experimental Hydro-Geomechanics (***LEHG***)

Marco Fazio & Martin Sauter

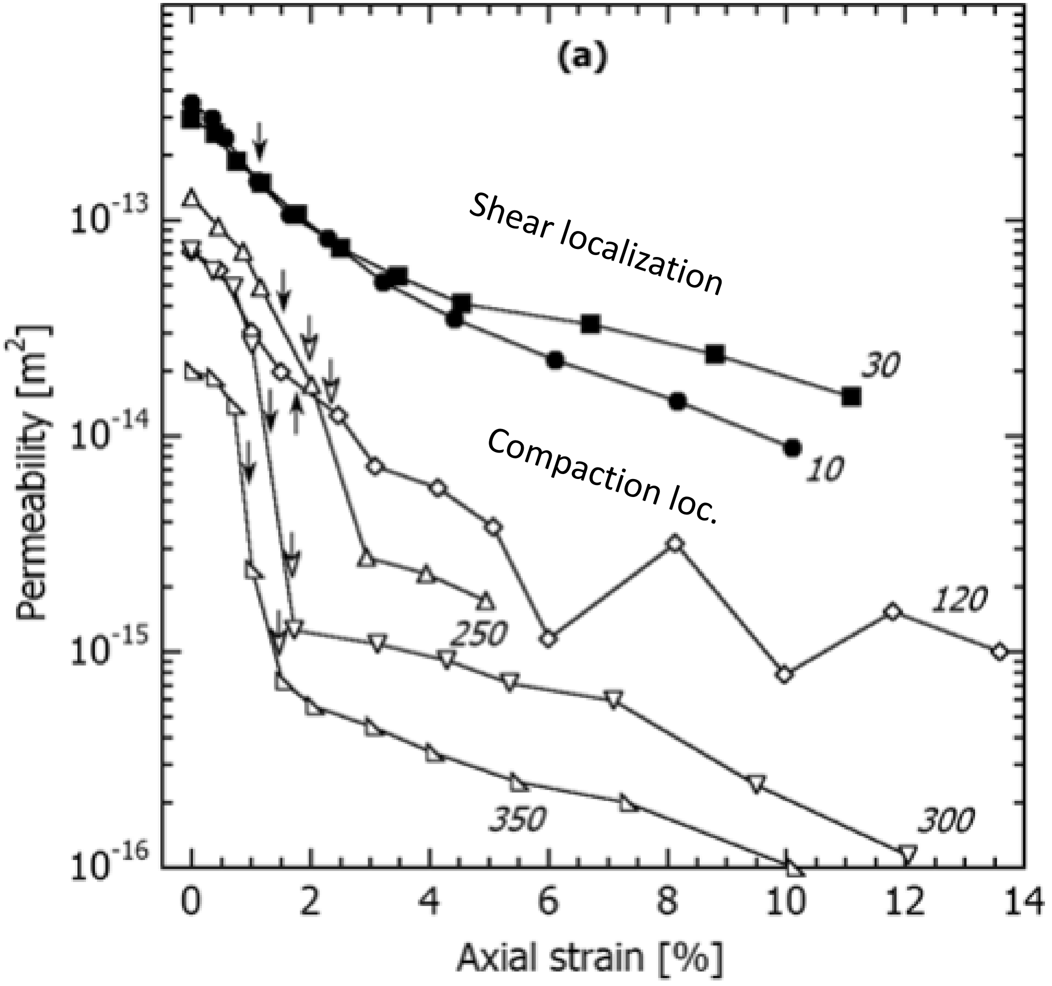
EGU, Coupled thermo-hydro-mechanical-chemical (THMC) processes in geological media, 24.04.2023, Vienna

Homogeneity at the block scale



Sample #	1T	2N	3E
m_d (g)	3830.05	3842.94	3845.14
l (mm)	250.28	250.6	250.36
$Ø$ (mm)	99.12	99.17	99.31
ρ_d (g/cm^3)	**1.98**	**1.99**	**1.98**
n (%)	**24.34**	**24.36**	**24.38**

Effect of shear deformation

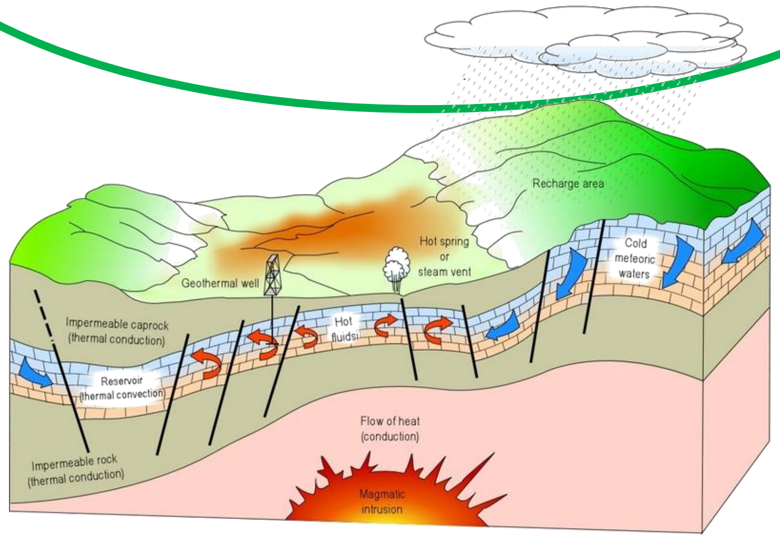


Vajdova et al., 2004, JGR

High shear deformation levels decrease the permeability

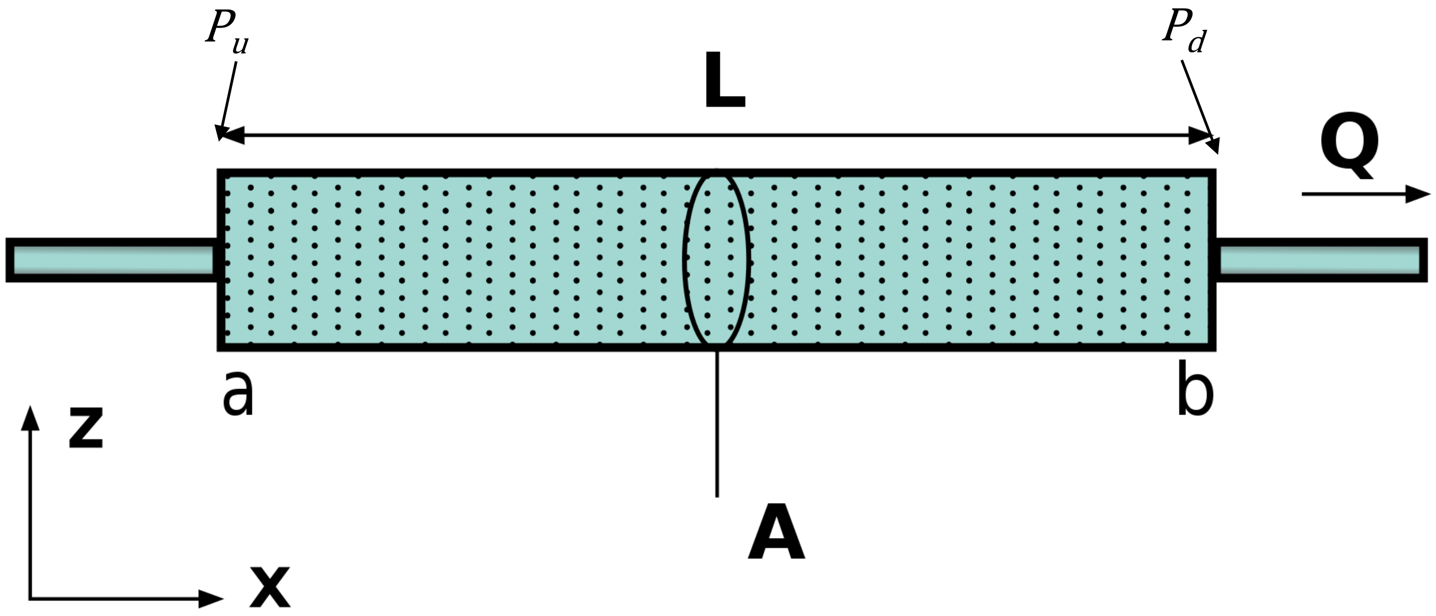
BS chosen for

- Deep warm aquifer for potential low-cost geothermal energy in Netherlands
- Case study rock for anhydrite cementification in georeservoirs



Darcy‘s law

$$k = \frac{Q * \mu * L}{A * (p_u - p_d)}$$



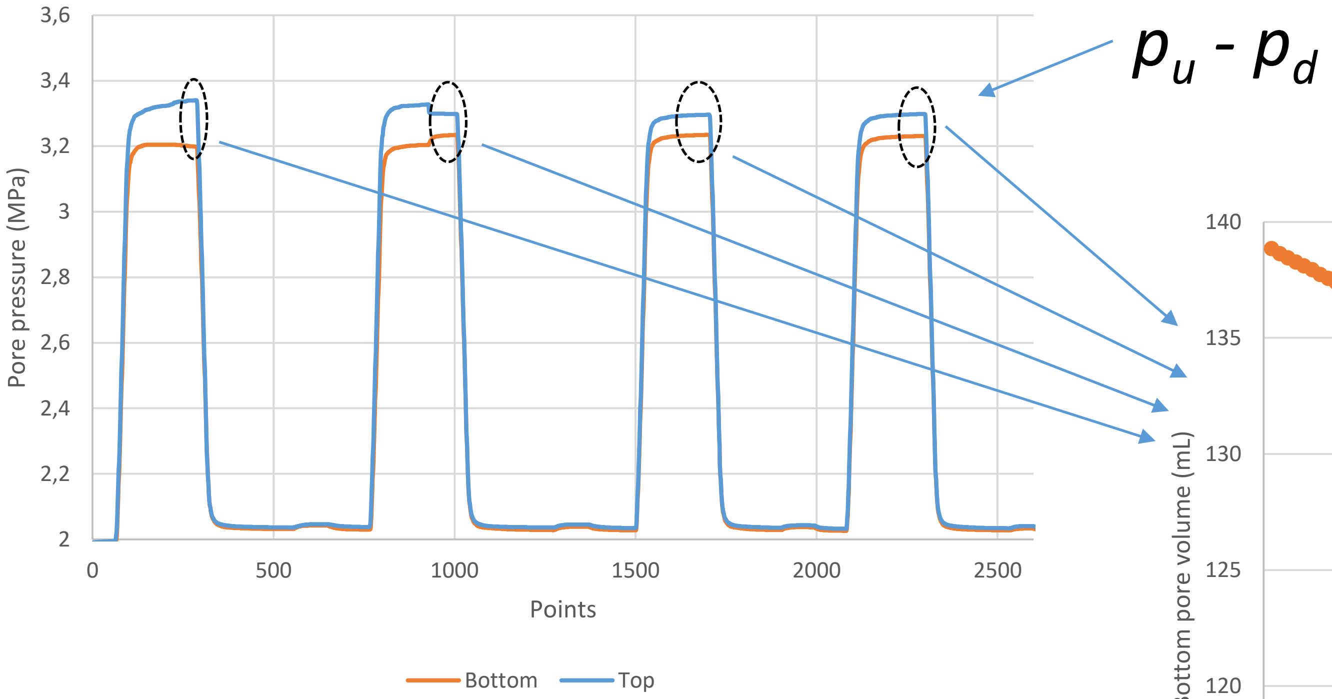
k = permeability (m²)
Q = Volumetric flow rate (m³/s) ($\Delta V / \Delta t$)
μ = fluid viscosity (Pa*s)
L = length of the sample (m)
A = surface area of the sample (m²)
p_u = upstream pressure (Pa)
p_d = downstream pressure (Pa)

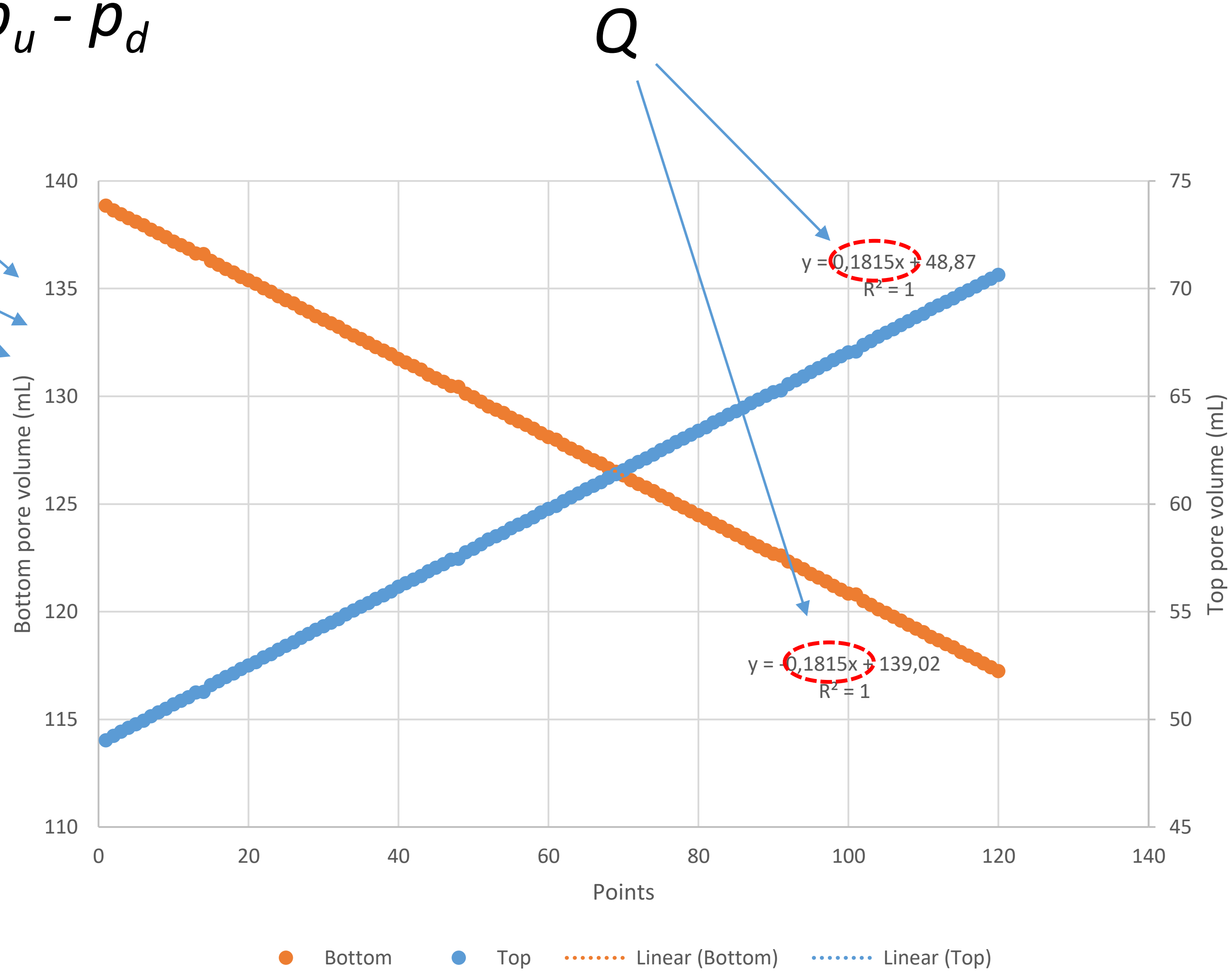
- A and L changes are negligible
- µ calculated through Korson et al. (1969) equation and Schmelzer et al. (2005) tabulated values

$$\log \frac{\mu_T}{\mu_{20}} = \frac{a(20 - T) - b(T - 20)^2}{T + c}$$

T = temperature (°C)
μ_{20} = water viscosity at 20°C = 1.002×10^{-3} Pa*s
a = 1.1709; b = 0.001827; c = 89.93

Flow rate & pressure drop



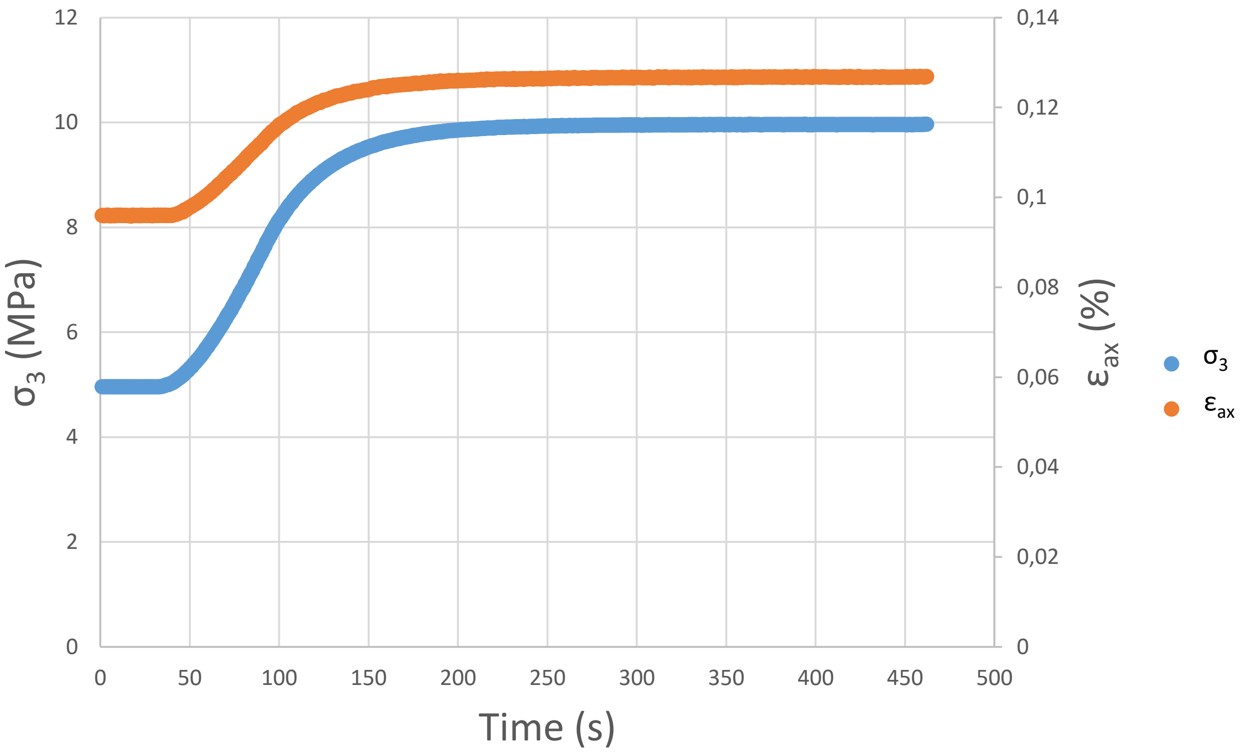


Highly permeable rock

⬇

Steady-state-flow method: apply constant **pore pressure gradient** and wait for constant and equal (but opposite sign) **flow rate** at each end of the samples

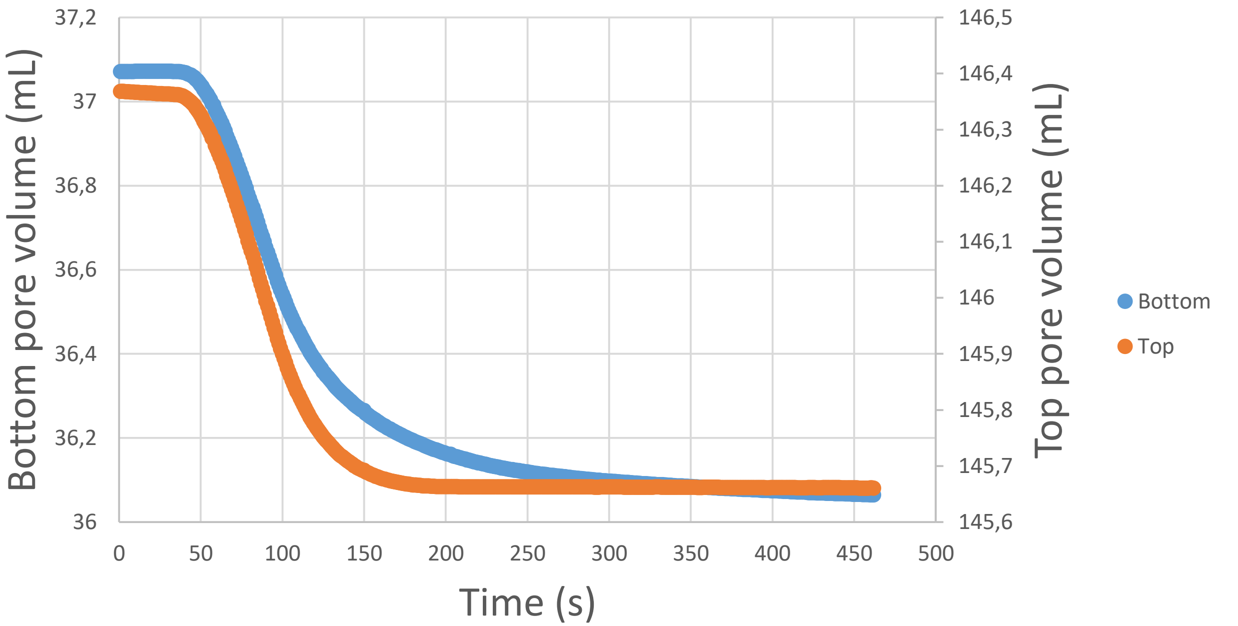
Porosity measurement



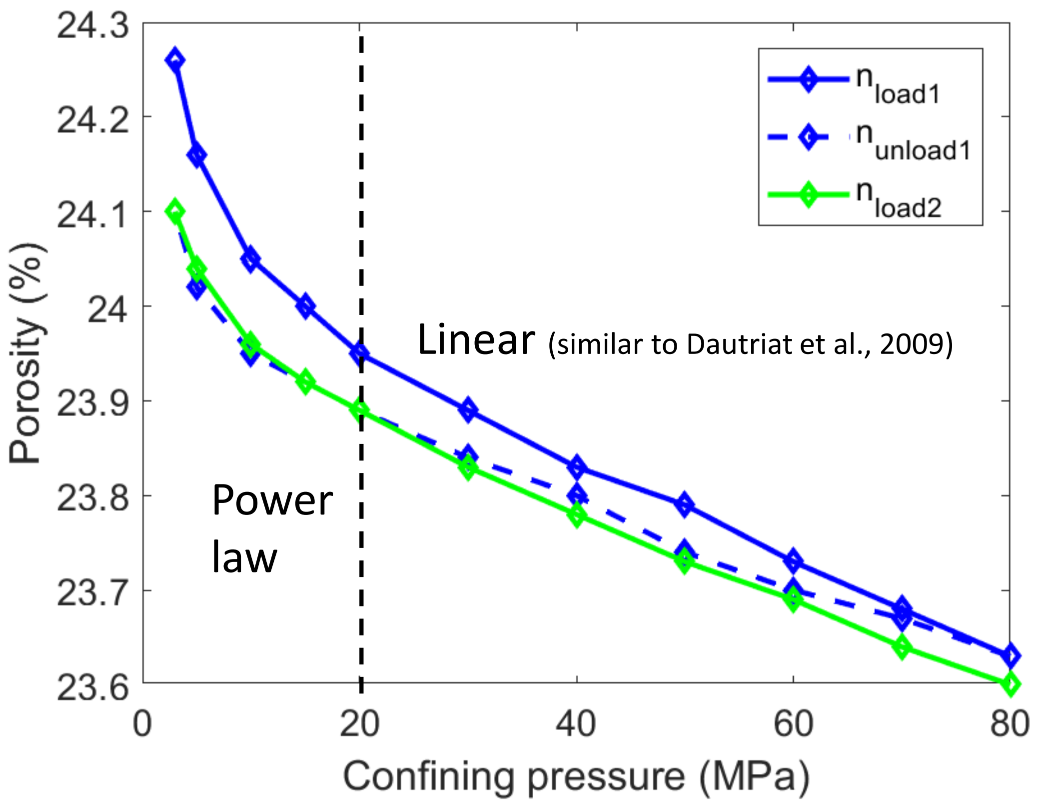
For each σ_3 or σ_{diff} increase, both top and bottom pore volume were monitored before and after the step, at constant pore pressure.

$$V_{p,i} = V_{p,i-1} - \Delta V$$
$$= V_{p,i-1} - [(V_{top,.} - V_{top,i-1}) + (V_{bottom,i} - V_{bottom,i-1})]$$

$$n_i = \frac{V_{p,i}}{V_{dry} + V_{p,i}}$$



Effect of σ_3 on Porosity

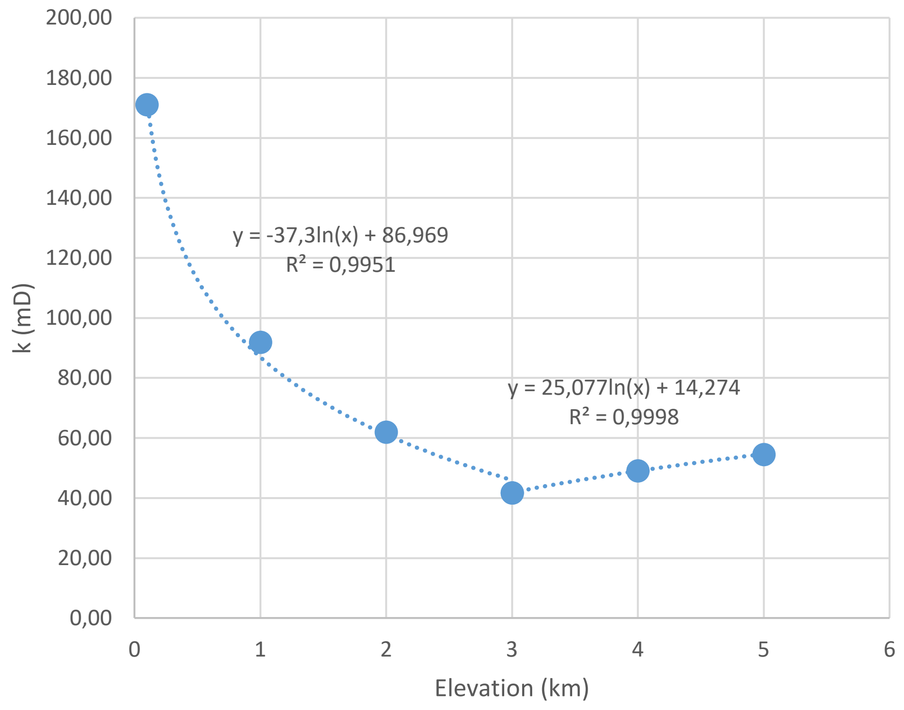


Porosity evolution through pore volume changes (only with ↑↓ $\boldsymbol{\sigma_3}$)

- n decreases non uniformly with ↑ $\boldsymbol{\sigma_3}$ and does not fully recover after unloading cycle → loss of pore space
- ρ = 1.98 kg/m^3 → 80 MPa corresponds to depth > 4km
- 2.9% loss of porosity, but still highly porous

Depth simulations

Ⱶ to bedding planes



// to bedding planes