Master project proposals Porelab February 2023

1. Pore scale imaging of CO_2 storage mechanisms using Xenon in a micro-CT scanner.

Supervision; Antje van der Net

Multiple storage mechanisms occur during CO_2 storage in the subsurface where capillary trapping and solubility trapping are two of them. When injected CO_2 forms a gas cap, the dissolution of gas from the gas cap is significantly enhanced by a natural convective motion, driven by the density difference between the formation brine and CO_2 enriched brine. These convective flows are crucial to distribute the CO_2 saturated brine, reduce the CO_2 gas phase and thereby enhancing the storage potential of the reservoir, but no well understood and described in porous media.

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The objective of this project is to visualize convective flow in 2D and 3D porous media and characterize capillary trapping by in-situ gas pressure measurements using Xenon, currently not feasible using CO_2 directly. This shall ultimately lead to an improved description of CO_2 storage capacity based on CO_2 solubility and transport. Depending on the availability different research objectives can be targetted:

> ***O1. Pore scale visualization of convective flow in 1, 2 and 3 D models***
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> ***O2. Pore scale monitoring of capillary trapping and Ostwald ripening***
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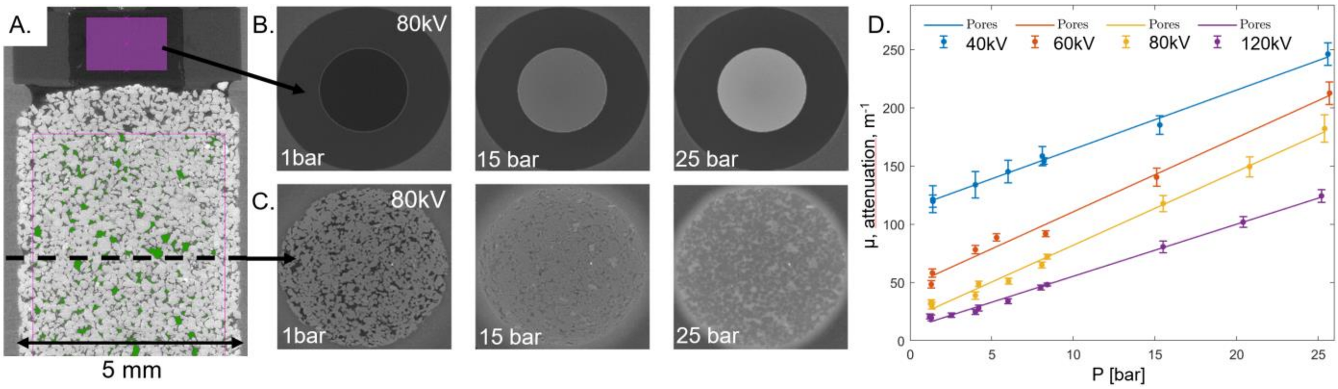
> ***O3. Local gas pressure measurements during capillary trapping and Ostwald ripening (see Figure below)***



Figure; The pressure dependence of Xenon visualized by mCT scanning of a void space in a plastic ring and a cylindrical Bentheimer sandstone core, both seen in A. The resulting cross sections of the void space and the Bentheimer core at set pressure levels of 1, 15 and 25 bar are presented in B. and C. respectively. Though hardly visible, the measured Xenon signal in the pores of the core differs from the void signal at the same pressure as a consequence of pseudo-enhancement. At 15 and 25 bar the Xenon in the pores has a higher (brighter) signal than the sand grains around, opposite to the image at 1 bar. In D. the linear correlations between static Xenon pore pressure and attenuation inside the pores are presented dependent on X-ray energy levels. The yellow curved for 80 kV is derived from images C. The ultimate objecive is to use these curves to derive pressure from microCT scan images of Xenon gas flow in porous media. [Willemsz2022, A micro computed tomography-study on the use of Xenon as a pressure indicator in porous media. Internship report NTNU-TU Eindhoven, supervisor A. van der Net, NTNU]