Application of the pressure dependence of ideal gas Xenon to hydrogen and CO_2 storage challenges using the microCT scan.

Antje van der Net, IGP, NTNU

Unique micro-CT scan experiments in our lab by Mark Willemsz[1] have shown that the ideal gas Xenon gives a pressure dependent signal (attenuation) at pore scale in a sandstone. As part of the project, this research shall be continued to exploit to what extend this physical effect can be applied to understanding multiphase gas flow in porous media. It might open up the unique opportunity to visualize local pressure variations in various kind of fluid-gas flow experiments in porous media or to use Xenon as a gas tracer. Applications to explore are for example foam flooding for control of the gas mobility for hydrogen or CO_2 storage, capillary pressure curve determination of caprock and use of Xenon as tracer in gas trapping studies.

The Xenon pressure dependent microCT scan signal has been studied as single phase in sandstone[1]. The next step is to introduce brine as 3rd phase, beside gas and rock and observe whether similar Xenon pressure - attenuation correlations can be found, as finally we want to prove the concept for a multiphase flow application.

By introducing brine also the interaction of Xenon with brine is to be studied. Theoretically Xenon has a solubility in brine, which likely is not neglectable and therefore can affect the contrasts.

Additionally, to enable an analysis of all phases, a suitable contrast between rock and brine and the gas phase needs to be obtained, where the gas phase adsorption will vary, depend on the gas pressure. Normally contrast enhancers are added to the brine to enhance its X-ray adsorption or named attenuation, see Figure. The brine attenuation dependence on the Xenon solubility is to be derived and additionally brine attenuation is planned to be measured at 100% brine saturation in a core with different contrast enhancer concentrations. With a correlation of contrast enhancement and predicted effect of the Xenon solubility, a suitable brine enhancement can be chosen. Calibration curves of Xenon pressure versus Xenon attenuation at residual brine saturation are the initial aimed goal. Challenges that were identified in the initial work, like pore size dependence of the signal needs also here attention in the data analysis.

Depending on the results, the next phase will be to proof the concept studying the effect under dynamic conditions or for a specific application.

1 **Willemsz** M., June 24, 2022, 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, Norwegian University of Technology.

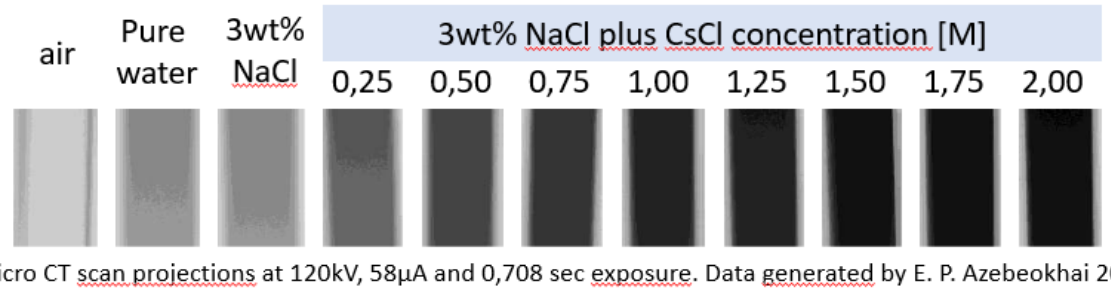

Figure. The change in attenuation of brine with inclusion of cesium chloride (CsCl). Single projections at 120kV of a square container filled with salt solutions at room temperature. The darker the color the higher the X-ray adsorption or attenuation. Air and pure water are added as comparison.