Contribution ID: **368**　　　　Type: **Oral Presentation**

Multiphase relaxation processes at the µm-to-cm scale during storage of gases in rocks

Wednesday, 24 May 2023 12:15 (15 minutes)

The interaction of gases and liquids in the subsurface has become highly relevant as subsurface carbon dioxide sequestration and hydrogen storage have been identified as key technologies to abate climate change. Gas mobility is affected by capillary trapping[1], dissolution[2] and Ostwald ripening[3], as well as the capillary relaxation of the fluid/gas system, with important consequences for gas storage applications.

These processes can occur simultaneously within natural porous media and each have their own characteristic time and length scales. The time and length scales over which fluids relax to capillary equilibrium within geological porous media are poorly understood[4], particularly in the presence of small-scale capillary heterogeneity[5]. It is hence unproven whether a sufficient separation of scales exists between capillary relaxation and trapping, gas dissolution and Ostwald ripening to model these processes independently.

In this work, we investigated the coupled relaxation processes at the pore scale in a 25 x 45 mm Bentheimer sandstone sample, using the HECTOR micro-CT scanner at UGCT[6] to image the pore space at 10 µm resolution. Using a sample that was one order of magnitude larger than typically used in pore-scale investigations made it possible to study the effect of length scales where viscous forces and capillary heterogeneity come into play. We conducted core floods with post-drainage and post-imbibition relaxation, using nitrogen (as model carbon dioxide/hydrogen) and KI brine at a pore pressure of 50 bar. After each fluid invasion, the sample was isolated and maintained at a constant pressure. Preliminary results reveal significant differences between the relaxation processes after drainage and imbibition. Following drainage, the system appears to reach equilibrium almost instantly, with no visible changes in the fluid distribution being observed over the course of several hours. This is in stark contrast with the observations made during imbibition, where the system continues to change even 18 hours after imbibition is stopped.

Understanding relaxation, and all the processes associated with it, has implications for storage security and efficiency during carbon dioxide sequestration and subsurface energy storage.

Participation

In-Person

References

1. Krevor, S. et al. Capillary trapping for geologic carbon dioxide storage - From pore scale physics to field scale implications. Int. J. Greenh. Gas Control 40, 221–237 (2015).
2. Huang, R., Herring, A. L. & Sheppard, A. Investigation of supercritical CO2 mass transfer in porous media using X-ray micro-computed tomography. Adv. Water Resour. 116950 (2022) doi:10.1016/j.advwatres.2022.104338.
3. Blunt, M. J. Ostwald ripening and gravitational equilibrium: Implications for long-term subsurface gas storage. Phys. Rev. E 106, 1–6 (2022).
4. Schlüter, S., Berg, S., Li, T., Vogel, H.-J. & Wildenschild, D. Time scales of relaxation dynamics during transient conditions in two-phase flow. Water Resour. Res. 53, 4709–4724 (2017).
5. Jackson, S. J. & Krevor, S. Small-Scale Capillary Heterogeneity Linked to Rapid Plume Migration During CO2 Storage. Geophys. Res. Lett. 47, (2020).

6. Masschaele, B. et al. HECTOR: A 240kV micro-CT setup optimized for research. J. Phys. Conf. Ser. 463, (2013).

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

Belgium

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

This abstract is related to Energy Transition

Primary author: ELLMAN, Sharon (Ghent University)

Co-authors: SPURIN, Catherine (Imperial College London); JACKSON, Samuel (CSIRO); HARRIS, Catrin (Student); CALLOW, Ben; WANG, Shan; KALYONCU, Gulce; BULTREYS, Tom (Ghent University)

Presenter: ELLMAN, Sharon (Ghent University)

Session Classification: MS06-B

Track Classification: (MS06-B) Interfacial phenomena across scales