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In Situ Imaging of Dynamic Processes in Chalk

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Carbon storage (CS) in geological formations is a promising technology for mitigating climate change (IPCC, 2021). Historically, sandstone have been targeted for CS, but in the specific case of Denmark, chalk represents a more promising storage medium as it has a much higher storage potential (Bonto et al., 2021). Chalk, however, has a much higher reactivity with CO_2-saturated brines than sandstone. The interaction between the CO_2-saturated brine and the chalk can result in the dissolution and subsequent weakening of the chalk. This weakening can cause subsidence, which is detrimental to CO_2 storage (Liteanu et al., 2013). It is, therefore, imperative that the properties of chalk is studied in detail to verify its suitability for CS.

We designed a novel triaxial flow cell (shown in fig. 1) to enable in situ imaging of chalk. The cell is capable of maintaining up to 300 bar of pressure at 90 $^\circ$C, which allows for the simulation of specific reservoir conditions. The central part of the cell is made of aluminium to maintain X-ray transparency. This is strictly necessary as it reduces the exposure time needed, which improves temporal resolution.
The temporal resolution of the CT scans is further improved by using the reconstruction algorithm presented by Rasmussen et al. (2021). This algorithm makes it possible to reduce exposure time and the number of projections without sacrificing image quality by utilising a high-quality reconstruction of the chalk sample. The high-quality reconstruction constrains the reconstruction of the in situ data, which improves image quality. Using this algorithm provides us with a temporal resolution of approximately 15 to 20 minutes.

The cell has been used for a series of non-reactive and reactive core flooding studies on reservoir chalk cores. Figure 2 shows the transport of a radiotracer (Cs_2CO_3) in a chalk sample. In the figure, we see two reconstructions of the chalk sample at different points in time. Note the bright band to the right in both figures is due to density variation in the chalk and is not caused by the radiotracer, unlike the bright region to the left in the images, which clearly advances during the experiment.

In fig. 3, we see the results from a triaxial compaction study. In this study, we slowly increased the triaxial pressure on a chalk core until it fractured, which occurred at approximately 82 bar based on the pressure drop recorded in fig. 3a. The fracture can easily be seen in fig. 3b, which shows a reconstruction of the sample after compaction. This study is valuable as it provides us with a baseline on which chalk weakened by CO_2 injection can be compared.

We demonstrate that our setup, in conjunction with the previously mentioned reconstruction algorithm, provide valuable insights into the suitability of chalk as a medium to store CO_2.

Participation

In-Person

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