



Contribution ID: 387

Type: Oral Presentation

Understanding the influence of pore-scale structural heterogeneity in CO₂ geo-sequestration

Tuesday, 31 May 2022 12:15 (15 minutes)

1. Introduction

Of the viable strategies outlined by the Intergovernmental Panel on Climate Change (IPCC) for atmospheric emission reduction strategies and technologies, geological storage of CO₂ holds an enormous promise with the potentials to have significant impacts on emission and atmospheric CO₂ reduction. Predicting the behavior of CO₂-brine in the complex heterogeneous porous structure of reservoir rocks as well as the interaction between these fluids with minerals in rocks are important for designing and managing CO₂ storage sites in CCS technology. To increase the effectiveness of the underground CO₂ sequestration, the multiphase-flow and its relevant mechanisms that change the distribution and concentration of the underground CO₂ must be assessed. To date, CO₂ geo-sequestration as a complex multiphase fluid flow in heterogeneous rock systems has not yet been given enough attention due to various reasons including lack of high quality experimental data, coupled fluid-fluid-rock interaction that is made even more complex due to rock heterogeneity, difficulty of in-situ experimentation and acquisition of usable data etc.

2. Materials and Methods

The focus of this research is directed towards understanding the role of rock heterogeneity on the safety and capacity of CO₂ geo-sequestration at the pore and core scales. We will present a pore-scale tomographic and experimental study of CO₂ trapping mechanisms in homogeneous and heterogeneous sandstones. The in-situ experiments consist of multiple sets of drainage and imbibition experiments on three sandstone rocks with different types of heterogeneities. The working fluids in the experiments were super-critical CO₂ (scCO₂) and Potassium Iodide (KI) brine. High resolution X-ray micro Computed Tomography (XCT) scans were acquired to resolve pore scale features and fluid distribution in the system. The experimental setup [1] is composed of a high pressure/temperature triaxial flow cell for in-situ flow experiments.

3. Results and Conclusion

Rock heterogeneity at the pore scale can be mapped in 3D and we have correlated rock morphology with multi-phase fluid distribution. Our results show larger amounts of trapped scCO₂ in heterogeneous rock compare with the homogeneous ones at a high rate. Residual scCO₂ are mostly trapped in pores with larger radii with high aspect ratios. Moving toward pores with smaller radius and aspect ratio decreases the amount of scCO₂ in the pores. We have also conducted in-situ cyclic brine-CO₂ flooding experiments, and our results show that residual CO₂ accumulates in layers parallel to the low-perm lamination layers, and primarily below the layers present in the rock. Further, we observe that scCO₂ saturation profiles below the low-perm layers align after drainage. These results agree with the conceptual model that the cyclic fluid injection creates a preferential high-flow pathway below the low-perm layer [2]. We observe that at low flow rates; the capillary trapped CO₂ increases in volume as the number of injection cycle increases, however, at high flow rates, lower residual trapping of CO₂ is observed.

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References

- [1] P.E. Øren et al. <https://dx.doi.org/10.2139/ssrn.3366008>
- [2] A. L. Herring, et al. <https://doi.org/10.1029/2021WR030891>

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Unsure

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