Quantification and Monitoring of Fluid Phase Behaviour and Trapping in Geological Carbon Sequestration Sites

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ABSTRACT

Geological storage of CO2 involves complex multiphase systems, including brines, hydrocarbons and carbon dioxide in both supercritical and gaseous phases. Whilst 4-D seismic is the primary method of monitoring the sub-surface movement of CO2, the resolution of seismic surveys is insufficient to capture much of the heterogeneity that is present within the reservoir rocks. The resolution of well logging tools is often also not capable of capturing fine scale structures which can have a strong effect on the displacement of CO2 and brine. These heterogeneities, in combination with the low viscosity of CO2 and gravity driven fluid migration can result in strongly non-uniform fluid saturation distributions. This can lead to inaccuracies in reservoir storage capacity estimates and a limited ability to predict the extent of the CO2 plume. As a first step towards improving our understanding of sub-resolution heterogeneity on CO2 trapping, a high pressure core-flooding system was designed and built. The system was designed to perform acoustic measurements of P- and S- wave velocities, with simultaneous imaging of flows by 3D X-Ray computed tomography (X-Ray CT). For this study, a range of types of core including reference rocks, such as Boise Sandstone, and more heterogeneous samples from a potential carbon dioxide storage project in South West Western Australia were used. Recently developed techniques have been applied to characterise sub-core scale heterogeneity in the rock samples, in terms of porosity and permeability (Pini and Benson, 2013). Observations from the core flooding experiments include a sequence of dry, brine-flooded and CO2 flooded rocks, which are analysed in terms of both average and sub-core saturation distributions. These are reconciled against macro-scale acoustic measurements as well as commonly applied empirical relationships such as the Gassmann equation. References Pini R, Benson SM, 2013. Characterisation and scaling of mesoscale heterogeneities in sandstones. Geophysical Research Letters, Vol: 49, Pages: 3903-3908.