CHARACTERIZING SMALL-SCALE MIGRATION BEHAVIOR OF SEQUESTERED CO2 IN A REALISTIC 2D GEOLOGICAL FABRIC

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Various methods and scenarios of carbon storage are being researched to study the long term effect of CO2 sequestration. The density difference between sequestered CO2 and the connate water results in the buoyant CO2 rising slowly that would be countered by capillary forces. In this work, we model the behavior of such stored CO2 on high-resolution (2 million element model) small-scale real geological sample (0.521 m x 0.264 m). Equivalent small-scale reservoir models were generated in an invasion percolation based basin scale simulator and a commercial reservoir simulator and we obtained similar major CO2 migration pathways in both cases. The model showed transition of CO2 movement from predominantly fingering structures to more back-filling front as the fluid parameters were varied. We characterize this transition of flow behavior between gravity-dominated to capillary-dominated regimes as a function of fluid properties, model scale, reservoir's structural heterogeneity and correlation length. The major fluid properties are the density difference between CO2 and connate water. The structural heterogeneity of the reservoir is characterized by grain size distribution that relates to threshold pressure range and mean threshold pressure of the field. The percentage saturation at percolation as well as fluid migration regime (fingering vs. back-filling) can thus be predicted as we vary the 'extent' of reservoir heterogeneity and fluid properties.

For a given set of threshold pressure distribution and fluid properties at a given length scale, it would thus be possible to indicate the migration regime that CO2 would most likely follow. If the CO2 migration regime tends towards 'fingering' then the estimated storage capacity would be lesser and vice-versa for the 'back-filling' regime. Hence for site selection to achieve efficient sequestration, a reservoir with 'back-filling' regime drivers would be desired due to higher local capillary trapping above residual saturation.