Contribution ID: **601** Type: **Poster**

Capillary hysteresis and pore-scale heterogeneity limiting the migration of buoyant immiscible fluid in a porous medium

Wednesday, 16 May 2018 18:15 (15 minutes)

In geological carbon storage, understanding main mechanisms affecting migration and redistribution of injected CO2 in aquifers is needed for developing predictive models to assess post injection environmental risks and designing long term monitoring schemes. This work presents experimental and modeling studies to investigate processes contributing to post-injection CO2 plume distribution and stabilization. We conducted flow cell experiments (0.5mx0.05mx0.01m) with two fluid phases in macroscopically homogeneous glass-bead porous medium to study post-injection plume behavior. A recently developed hysteretic macroscopic two-phase flow model considering microscale fluctuations in pore size and geometry was used to interpret the experimental results and to understand main processes leading to plume stabilization. Findings demonstrate that both hysteresis and pore-scale heterogeneity control the plume behavior and limit the plume extent. Redistribution of injected plume is extremely slow and occurs through more or less discontinuous jumps over long times. The occurrence of such a phenomenon in real storage formations can make monitoring and assessment of plume stability considerably more challenging. Experimental results at larger more realistic porous media systems are needed to further understand post-injection plume behavior and test post-injection predictive models.

References

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Session Classification: Poster 3

Track Classification: GS 1: Fundamental theories of porous media