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Phase redistribution in heterogeneous porous media during periods of no-flow

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Subsurface gas storage will involve next to periods of injection and production, periods of no-flow. During these no-flow periods, redistribution of the liquid and gas phases can occur, driven by dissolution and exsolution processes. To better understand this redistribution, we have carried out microfluidic drainage and imbibition experiments, using pre-equilibrated CO2 and water, after which the system was isolated. Experiments were conducted under two configurations: 1. Fully isolated (undrained) system, where the chip was sealed at the inlet and outlet. 2. Connected outlet system, where the chip was sealed at the inlet, but the outlet was connected to a small reservoir filled with CO2, mimicking a connection to a highly porous rock or fracture. The pH indicator Bromothymol Blue was used to monitor the amount of dissolved gas in the water. In the fully isolated (undrained) system, redistribution was observed due to the dissolution-driven process of Ostwald ripening. In the connected outlet system, gradual gas exsolution occurred over time. The results of these experiments suggest that local pressure variations arising from rock heterogeneity make redistribution during periods of no flow significantly more complex than can be explained by Ostwald ripening alone.

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References

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