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# Microfluidic Study of CO2 Dissolution Dynamics under Geological Sequestration Conditions

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CO2 geologic sequestration in deep saline aquifers and depleted oil reservoirs is an effective option for large-scale and long-term carbon mitigation to address global climate challenges.[1] After being injected into the target geological formations with a low permeability caprock above them (structural trapping), CO2 is stored by trapping in the pores (residual trapping), dissolving in the formation water (solubility trapping), and reacting with the minerals (mineral trapping).[2] Solubility trapping is significant both in the amount of trapping capacity they provide and long-term storage security in the long term (>100 years).[3] In addition, the transformation of CO2 from a separate phase to CO2 (aq) and HCO3- by dissolution will influence the mineral dissolution and precipitation processes, which is critical to permanent carbon storage.[4]
In this work, we studied the CO2 dissolution dynamics in porous media under realistic reservoir conditions of deep saline aquifers. We developed a high-pressure and high-temperature microfluidic system and captured the spatio-temporal evolution of the dissolution process of residual trapped CO2 under various pressures and temperatures (gas, liquid, and supercritical CO2). The CO2 dissolution kinetics was calculated by analyzing the optical images obtained by a high-resolution camera. The results showed a two-stage process of CO2 dissolution into the aqueous phase in porous media. In the first stage, CO2 dissolves rapidly into the ambient aqueous phase to reach a local saturation. The second stage showed a lower but constant CO2 dissolution rate with the CO2-water interface propagating linearly with time toward the CO2 phase. The CO2 dissolution rate is sensitive to the sequestration pressure and temperature, whereas supercritical CO2 shows a more than ten-time slower dissolution rate than gaseous CO2. Moreover, dissolution-induced fingering of water invading CO2 was observed due to local pressure instability, which would affect the two-phase flow of CO2 and the formation water. Our research reveals the CO2 dissolution mechanisms in porous media under geological sequestration conditions, which provides a new insight for estimating the time scale for CO2 geological sequestration.

## Participation

In-Person

## References

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