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Hydrate film formation in subsea carbon storage

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Growth mechanisms of CO2 hydrates in pores dictate the capacity, injection rates, and long-term security of sequestered carbon. We reveal a previously unrecognized reactive transport mechanism dictating hydrate growth in pores: capillarity. Hydrate crystals, having superhydrophilic surfaces (θ~0°), form a secondary microporous medium (~ 100 nm pores) within individual lithologic pores (~ 10 to 100 μm pores) that promotes hydrate growth in a positive feedback cycle wherein water is imbibed spontaneously through the hydrate that forms at the water-CO2 interface. This self-reinforcing process drives hydrate film growth along the pore wall, and acts as a supply mechanism of water for hydrate formation in the gas-filled pores. The importance of capillarity on hydrate growth is validated experimentally and numerically through fluorescent imaging and by tracking the water phase movement during hydrate formation. Hydrate stability against temperature perturbations is provided by the endothermic nature of hydrate dissociation that would otherwise cause catastrophic release of CO2 from hydrate.

Participation

In-Person

References

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