Spreading and dissolution of CO\textsubscript{2} in horizontal aquifers: theory and experiments

CHRISTOPHER MACMINN, Massachusetts Institute of Technology, JEROME NEUFELD, Cambridge University, MARC HESSE, University of Texas at Austin, HERBERT HUPPERT, Cambridge University — Injection of carbon dioxide into saline aquifers is widely regarded as a promising tool for reducing atmospheric CO\textsubscript{2} emissions. While an accurate assessment of the post-injection spreading and migration of the CO\textsubscript{2} is essential for estimates of storage security, many of the physical processes controlling CO\textsubscript{2} migration are poorly understood. CO\textsubscript{2} is buoyant relative to groundwater at reservoir conditions. This is undesirable because the presence of a pre-existing well or fracture, or the activation of a fault, could lead to leakage. It is well known, however, that the dissolution of CO\textsubscript{2} increases the density of the groundwater, resulting in convective currents that dramatically enhance CO\textsubscript{2} dissolution. Once dissolved, the CO\textsubscript{2} is considered to be securely stored within the subsurface. Recent numerical and experimental work has led to a greatly improved understanding of the resulting rate of CO\textsubscript{2} dissolution into groundwater. Here, we use analog experiments and simple theoretical models to study dissolution from a plume of CO\textsubscript{2} as it spreads upward against the caprock in an aquifer of finite thickness. We show that the interaction between spreading, dissolution, and the finite thickness of the aquifer has a strong influence on the ultimate distribution of the CO\textsubscript{2}.

Christopher MacMinn
Massachusetts Institute of Technology

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