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Fluid dynamics of CO_2 sequestration

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A means of reducing environmental damage due to anthropogenic emissions of carbon dioxide (CO_2) is through geological storage in porous reservoir rocks until well past the end of the fossil fuel era. Here we discuss the propagation and form of the buoyancy-driven propagation of multiphase CO_2-brine plumes bounded by an impermeable barrier or cap rock. Long-term containment of CO_2 is important, and we will quantify some of the risks due to leakage in this system. Finally, stable sequestration through capillary forces or through dissolution of CO_2 into the brine is greatly enhanced by mixing, which is often dominated by layered stratigraphy. Here we describe injection into a two-layered porous medium, and show the sensitive dependence of propagation and mixing on the input flux, Q. For two-layered systems we find that above a critical flux, Q_C, fluid injected at the base of a relatively low permeability layer preferentially flows in the more permeable upper layer leading to an overriding current, thus enhancing mixing. Finally, we apply these ideas to examine the storage of CO_2 within the Sleipner field, where CO_2 has been injected since 1996. The talk will be illustrated by some desktop experiments.