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Hydrodynamic fingering instability induced by a precipitation reaction

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We experimentally demonstrate that a precipitation reaction at the miscible interface between two reactive solutions can trigger a hydrodynamic instability due to the build-up of a locally adverse mobility gradient related to a decrease in permeability. The precipitate results from an A+B $\rightarrow$ C type of reaction when a solution containing one of the reactant is injected into a solution of the other reactant in a porous medium or a Hele-Shaw cell. Finger-like precipitation patterns are observed upon displacement, the properties of which depend on whether A displaces B or vice-versa. A mathematical modeling of the underlying mobility profile in the cell reconstructed on the basis of one-dimensional reaction-diffusion concentration profiles confirms that the instability originates from a local decrease in mobility driven by the precipitation. Nonlinear simulations of the related reaction-diffusion-convection model reproduce the properties of the instability observed experimentally. In particular, the simulations suggest that differences in diffusivity between A and B may contribute to the asymmetric characteristics of the fingering precipitation patterns.