



## Pattern palette for complex fluid flows

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From landslides to oil and gas recovery to the squeeze of a toothpaste tube, flowing complex fluids are everywhere around us in nature and engineering. That is not to say, though, that they are always well understood. The dissipative interactions, through friction and inelastic collisions, often give rise to nonlinear dynamics and complexity manifested in pattern formation on large scales.

The images displayed on this poster illustrate the diverse morphologies found in multiphase flows involving wet granular material: Air is injected into a generic mixture of granular material and fluid contained in a 500  $\mu\text{m}$  gap between two parallel glass plates. At low injection rates, friction between the grains - glass beads averaging 100  $\mu\text{m}$  in diameter - dominates the rheology, producing “stick-slip bubbles” and labyrinthine frictional fingering. A transition to various other morphologies, including “corals” and viscous fingers, emerges for increasing injection rate. At sufficiently high granular packing fractions, the material behaves like a deformable, porous solid, and the air rips through in sudden fractures.