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Morphology and dynamics of an immersed porous medium crossed by an ascending gas flow

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We study the dynamics and invasion pattern when gas is injected punctually, at constant flow-rate, at the bottom of an immersed porous medium confined into a vertical Hele-Shaw cell. At short times, the gas invades the medium either by percolation or fracture, depending on the gas flow-rate and on the local heterogeneities. At long times, a fluidized zone develops, independent of the initial invasion pattern. In stationary regime, the morphology of the fluidized zone is parabolic. It does not depend on the injected flow-rate, and does not exhibit any significant variation when tilting the experimental cell, i.e. when changing the effective gravity in the system. We describe the growth dynamics of the fluidized zone, and report the existence of three different regions: (1) a central fluidized zone in which two convection rolls transport the grains around the path followed by the air; (2) a compact zone far from the center; (3) a 'stick-slip zone' (SSZ) separating the fluidized and the compact zones. The SSZ width decreases with time, until disappearing when the system reaches a stationary state. We compare these experimental observations to similar phenomena observed in geological processes.