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Stretching and Folding in Intermittent Two-Phase Porous Media Flows GAUTE LINGA, PoreLab, The Njord Centre, University of Oslo, JOACHIM MATHIESEN, Niels Bohr Institute, University of Copenhagen, FRANCOIS RENARD, The Njord Centre, University of Oslo, TANGUY LE BORGNE, Gosciences Rennes, University of Rennes 1 — Mixing in multiphase porous media flows is crucial to a wide range of processes taking place in the subsurface as well as in industrial and biological settings, including CO_2 sequestration, catalysts, and drug delivery. Here we investigate the effect of intermittent multiphase flow on fluid stretching and folding, a key mechanism driving solute mixing and reaction in porous media. We show that the addition of a second fluid phase and an intermittently propagating immiscible fluid-fluid interface induces chaotic flows, characterized by exponential stretching in the pore space. Using lattice Boltzmann simulations across a wide range of flow rates, we quantify the Lyapunov exponent (mean chaotic stretching rate) as a function of the capillary number. Exponential stretching is underpinned by folding events associated with the intermittent motion of the interface. The Lyapunov exponent is found to decay with increasing capillary number, implying that the increasing flow intermittency observed at lower capillary numbers increases the mixing efficiency. We propose a mechanistic model that allows linking the basic multiphase flow properties to the chaotic mixing rate, opening new perspectives to understand mixing and reaction in multiphase porous media flows.

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