Scaling of imbibition front dynamics in heterogeneous porous media

GCCC Publication Series #2020-02

S. Bakhshian
M. Murakami
S.A. Hosseini
Q. Kang

Keywords: fluid characterization, fluid flow model, monitoring, reservoir

Cited as:
Bakhshian, Sahar, Margaret Murakami, Seyyed A. Hosseini, and Qinjun Kang, 2020, Scaling of imbibition front dynamics in heterogeneous porous media, GCCC Publication Series #2020-02, originally published in *Geophysical Research Letters,* 47, e2020GL087914.

Abstract

We report a quantitative study on the dynamics of countercurrent imbibition in fractured rock samples with the application of CO_2 geosequestration, as the rock matrix is saturated with CO_2 and brine exists in the adjacent microfracture. Direct pore-scale simulations of spontaneous and forced imbibition in a three-dimensional heterogeneous porous matrix enable us to capture the effect of microscopic properties on the imbibition dynamics as these pore-level descriptions are ignored in the existing coarse-grained models. We have established new scaling classes for the propagation of the center of mass of the imbibition front and fluid-fluid interface broadening. It has become evident that the wettability is a major factor which leads to anomalies in these scaling laws. While the governing capillarity under the water-wet condition induces fast roughening dynamics of the interface, the adverse effect of capillary pressure under the intermediate-wet condition leads to a damping effect on the imbibition front fluctuations.