Geophysical Research Abstracts
Vol. 16, EGU2014-16053, 2014
EGU General Assembly 2014

From needles to parabolas: the shapes of nonlinear fingers in reactive-infiltration instability

Piotr Szymczak (1) and Anthony Ladd (2)

(1) University of Warsaw, Institute of Theoretical Physics, Faculty of Physics, Warsaw, Poland (piotr.szymczak@fuw.edu.pl, (+48 22) 621 94 75), (2) University of Florida, Chemical Engineering Department, Gainesville, FL, USA

The reactive-infiltration instability, which develops when a porous matrix is dissolved by a flowing fluid is an important mechanism for pattern development in geology, with a range of morphologies and scales from cave systems running for hundreds of miles to laboratory acidization on the scale of centimeters. Theoretical investigations of this phenomenon have typically focused on initial instability of a planar, steadily propagating dissolution front that separates regions of high and low porosity. Much less is known, however, about the nonlinear regime, when the initial perturbations of the interface are transformed into finger-like structures that advance into the system. By conducting a series of numerical simulations of porous media dissolution for different flow rates and reaction rates we have analyzed the shapes and propagation velocities of these fingers. Interestingly, we find a transition in the finger shapes as the Peclet number is changed. At high Pe, the forms similar to Saffman-Taylor fingers are formed, occupying a fraction of the porous channel. Conversely, for small Pe, the fingers of parabolic shapes are formed, spanning the entire cell and advancing with a constant velocity into the system. We study numerically the details of this transitions and relate the results to the natural systems.