Geophysical Research Abstracts
Vol. 16, EGU2014-16861, 2014
EGU General Assembly 2014

Fluid displacement fronts in porous media: pore scale interfacial jumps, pressure bursts and acoustic emissions

Franziska Moebius and Dani Or
ETH Zurich, Soil and Terrestrial Environmental Physics, Zurich, Switzerland

The macroscopically smooth and regular motion of fluid fronts in porous media is composed of numerous rapid pore-scale interfacial jumps and pressure bursts that involve intense interfacial energy release in the form of acoustic emissions. The characteristics of these pore scale events affect residual phase entrapment and transport properties behind the front. We present experimental studies using acoustic emission technique (AE), rapid imaging, and liquid pressure measurements to characterize these processes during drainage and imbibition in simple porous media. Imbibition and drainage produce different AE signatures (AE amplitudes obey a power law). For rapid drainage, AE signals persist long after cessation of front motion reflecting fluid redistribution and interfacial relaxation. Imaging revealed that the velocity of interfacial jumps often exceeds front velocity by more than 50 fold and is highly inertial component (Re>1000). Pore invasion volumes reduced deduced from pressure fluctuations waiting times (for constant withdrawal rates) show remarkable agreement with geometrically-deduced pore volumes. Discrepancies between invaded volumes and geometrical pores increase with increasing capillary numbers due to constraints on evacuation opportunity times and simultaneous invasion events. A mechanistic model for interfacial motions in a pore-throat network was developed to investigate interfacial dynamics focusing on the role of inertia. Results suggest that while pore scale dynamics were sensitive to variations in pore geometry and boundary conditions, inertia exerted only a minor effect on phase entrapment. The study on pore scale invasion events paints a complex picture of rapid and inertial motions and provides new insights on mechanisms at displacement fronts that are essential for improved macroscopic description of multiphase flows in porous media.