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Multiphase Flow in Porous Rock imaged under dynamic flow conditions with fast X-ray computed micro-tomography

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Pore scale events in multiphase flow in porous rock have been directly imaged in real-time by using fast synchrotron-based X-ray computed micro tomography. In the past, pore scale fluid displacements in porous media could only be imaged under quasi-static conditions where at scanning times of several minutes to hours, fluid distributions were subject to capillary re-distribution. Here, for the first time, pore-scale displacement events in porous rock were imaged in-situ at real-time in natural sandstone rock under dynamic conditions, i.e. under flow, where the pressure gradient and the visco-capillary balance were maintained during scanning.
The two elementary processes, Haines jumps in drainage and snap-off in imbibition were studied in detail. We found that most Haines jump events do not displace the wetting phase pore by pore, but typically involve 10-20 individual pores. We also found that 64% of the externally applied work is actually dissipated during these jumps where approximately 36% is converted into interfacial energy.