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Pore space characteristics deduced from acoustic emissions and pressure bursts induced by interfacial jumps at moving fluid fronts

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The macroscopically steady and regular motion of fluid displacement fronts through porous media is composed of numerous pore scale rapid interfacial jumps and associated pressure bursts at the front. We study details of fluid displacement in sintered glass-beads cells having well-defined pore spaces using high speed camera (1000 images/s). The imagery enabled documentation of rapid interfacial velocities that were then coupled with data from pressure transducers and acoustic emission (AE) sensors linking pressure and AE bursts with rapid air-water interfacial reconfiguration. Imposed steady drainage or imbibitions fluxes resulted in front motion via a series of invasion jumps and pressure/AE fluctuations with characteristic waiting time distribution between events. It has been shown that waiting times and event magnitude are determined by capacitive interfacial volumes and by pore size distribution both linked to porous medium properties of interest. We evaluated different fluids, pore sizes and arrangement to deduce pore-space geometrical properties from AE and pressure statistics. Additionally, the resulting fluid trapping behavior of such rapid events (with interfacial velocities exceeding 1 m/s – Re>100) was studied to deduce dynamic effects of displacement front passage on resulting phase distribution and hydraulic properties. Phase trapping and pore scale displacement dynamics provide the physical basis for understanding phenomena such as hysteresis and dynamic capillary pressure.