Catriona Reynolds

Connection and disconnection events - observations of dynamic connectivity during two-phase flow

We observe a new type of non-wetting phase flow using time-resolved pore scale imaging. The traditional conceptual model of drainage involves a non-wetting phase invading a porous medium saturated with a wetting phase as either a fixed, connected flow path through the centres of pores or as discrete ganglia which move individually through the pore space, depending on the capillary number. We observe a new type of flow behaviour at low capillary number in which the flow of the non-wetting phase occurs through networks of persistent ganglia that occupy the large pores but continuously rearrange their connectivity. Disconnections and reconnections occur randomly to provide short-lived pseudo-steady state flow paths between pores. This process is distinctly different to the notion of flowing ganglia which coalesce and break-up. The size distribution of ganglia is dependent on capillary number. Experiments were performed by co-injecting N2 and 25 wt% KI brine into a Bentheimer sandstone core (4mm diameter, 35mm length) at 50°C and 10 MPa. Drainage was performed at three flow rates (0.04, 0.3 and 1 ml/min) at a constant fractional flow of 0.5 and the variation in ganglia populations and connectivity observed. We obtained images of the pore space during steady state flow with a time resolution of 43 s over 1-2 hours. Experiments were performed at the Diamond Light Source synchrotron.

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