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Flow field measurements of trapped and mobilised non-wetting phase in a microfluidic porous medium

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Abstract
Immiscible two-phase flow in porous media is a process encountered in various applications such as oil recovery, soil remediation, CO2 sequestration and some other industrial systems. Almost all models of two-phase flow are based on Darcy law, which is valid only for the phases that form a continuous domain. But, there exist many applications where one of the fluid phases is (partially) discontinuous. Movement of a discontinuous phase has been the subject of various studies 1–4 There exist theories formulated on the basis of data, which analyse the phenomenon based on the overall movement of the ganglia. There is still lack of understanding of the mechanisms that lead to ganglion mobilization. One such mechanism is the interaction between the flowing wetting phase and the discontinuous phase.
In this work, we focus on the interaction between the two phases and more specifically on the momentum transfer from the continuous wetting phase to the discontinuous non-wetting phase in a porous medium. As the porous medium, we used a PDMS micro-model. The non-wetting phase was doped with Rhodamine 6G particles. In this study, the setup of a La Vision MicroPIV system with an AxioObserver.Z1 microscope was used. During the whole experimental procedure, the evolution of trapped non-wetting phases was recorded and the local velocity distributions were evaluated with Particle Tracking Velocimetry (PTV) algorithms implemented in MATLAB5. More specifically, we focus on the velocity field evolution within the ganglion and around it prior, during, and after the ganglion mobilization.

In this study, our objective is to fill this gap evaluating the steady and instantaneous flow fields inside individual droplets, blobs and ganglia using micro-Particle Image Velocimetry. Our aim is to provide a clear interpretation of how the interaction between the wetting and the non-wetting phases leads to mobilisation of the trapped phase, as the capillary number increases. Therefore, experiments are carried out prior and during the mobilisation identifying quasi-static and dynamic removal of the entrapped phases.

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