

Foam flow in analog porous media

B. Géraud^{1,2}, S. A. Jones¹, I. Cantat¹, Y. Méheust², B. Dollet¹

1 Institut de Physique de Rennes, Univ. Rennes 1, CNRS UMR 6251, Rennes, France

2 Géosciences Rennes, Univ. Rennes 1, CNRS UMR 6118, Rennes, France

Foams have been used for decades as displacing fluids for enhanced oil recovery and aquifer remediation, and more recently as carriers of chemical amendments for the remediation of the vadose zone. Apart from various interesting physico-chemical and biochemical properties, foams are better injection fluids due to their low sensitivity to gravity and their peculiar rheology: for foams with bubbles on the order of at least the typical pore size, viscous dissipation arises mostly from the contact zones between the soap films and the walls.

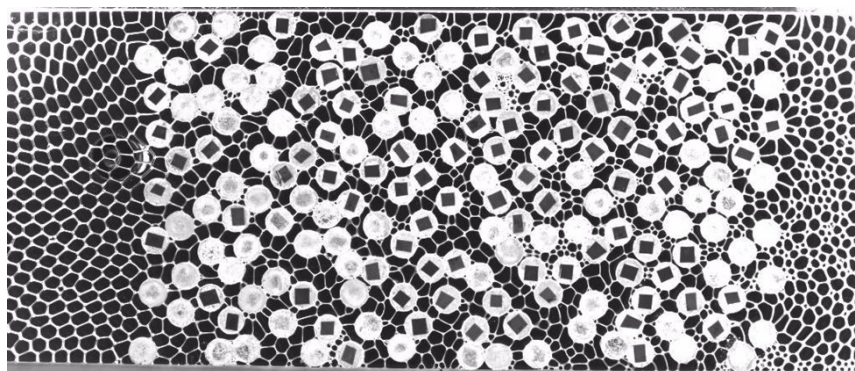


Figure - Snapshot of our experiments: foam flowing from left to right in a two-dimensional porous medium.

In most experimental studies no local information of the foam structure is possible, and only global quantities such as the effective viscosity can be measured. We investigate foam flow through a two-dimensional porous medium consisting of circular obstacles positioned randomly in a horizontal transparent Hele-Shaw cell. The local foam structure is recorded in situ, which provides a measure of the spatial distribution of bubble velocities and sizes. The flow exhibits a rich phenomenology including preferential flow paths and local flow intermittency despite the imposed permanent global flow rate. Moreover, the medium selects the bubble size distribution through lamella division-triggered bubble fragmentation. Varying the mean bubble size of the injected foam, its water content, and mean velocity, we characterize those processes systematically and show that the distributions of bubble sizes and velocities are to some extent correlated¹. We furthermore measure the evolution, along the flow direction, of the distribution of bubble sizes, and measure the efficiency of bubble fragmentation as a function of the control parameters. The bubble fragmentation can be modeled numerically and to some extent analytically, based on statistical measures inferred from the experimental data. This study sheds new light on the local rheology of foams in porous media and opens the way towards quantitative characterization of the relationship between medium geometry and foam flow properties.

1. Géraud B. et al., *The flow of a foam in a two-dimensional medium*, *Water Resour. Res.* 52, 773-790, 2016