Capillary trapping mechanisms for CO2 geological storage : experimental and computational microfluidic

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Résumé

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1.Introduction

Carbon Capture and Storage, or CCS, is one of the solution proposed by the Paris agreement to keep the global warming under the 2∘C threshold. This technique relies on 4 main mechanisms to trap the CO 2 underground : the structural trapping, the solubility trapping, the mineralization and last but not least the capillary or residual trapping, where the CO 2 is trapped by the capillary forces in the rock matrix of a reservoir. But before implementing this technology at the industrial scale, we need to correctly asses the amount of CO 2 that can be trapped in the targeted geological formations. In this work, we study the residual trapping, which relies on complex interractions between the two fluids (brine and supercritical CO 2) and the porous media. To tackle this task, we need to study the phenomenon at the pore-scale (order of micrometers). This is done by reproducing the two-phase flows at the pore scale, using both microfluidics devices and numerical models. This allows us to study the wetting layers forming in porous media during drainage and the impact they may have on the flow.

2.Method

Microfluidics devices, also called micromodels or aquifer-on-chips, are designed to mimic the porous media and to allow for the direct observation of the fluid flow and interfacial dynamics thanks to their transparent nature. In this work, particular interest is given to pore-doublets, whose geometry is composed of two parallel channels linked together at the inlet and the outlet. These pore-doublet are widely used to study two-phase flow in porous media (1) . Their particular structure allow us to experimentally reproduce the complex phenomenons occuring during flow (snap-off, Haine's jump) (2) , while keeping a geometry simple enough to describe the flow using analytical equations. We couple the experimental approach with numerical models derived from the Stoke's equations.

*Intervenant

3.Results

The methodology developed allows us to experimentally demonstrate theoretical results describing an instability occuring during the drainge of a symmetrical pore doublet (3) . We also present a new way to take into account the wetting layers forming in porous media during a drainage, and their impact on the interfacial dynamics during two phase flows. Our study shows that negelecting these effects, as most studies do, can lead to significant errors in the models.

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