Geophysical Research Abstracts, Vol. 9, 06097, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06097

Lattice Boltzmann modeling of residual non-aqueous phase liquids flow in underground porous domains.

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The immiscible displacement of a non-wetting fluid by a wetting one in porous media is encountered in many processes of scientific and practical interest, such oil production and the decontamination of underground aquifers from organic pollutants. The mobilization of trapped non-aqueous phase liquids (NAPL's) is of key importance to such processes.

In this contribution we study the immiscible two-phase flow in porous domains for high saturations of the wetting phase using a Lattice Boltzmann model. Under these conditions the non-wetting phase flows in the form of disconnected ganglia and the wetting phase is spanning the entire domain. The ganglia can be trapped in low permeability regions of the domain due to strong capillary forces and become immobile. We study the conditions under which these ganglia are remobilized in order to enhance the recovery of the non-wetting phase.

We focus on the population dynamics of the non-wetting ganglia, namely the temporal evolution of the average ganglion size and the fraction of the immobile ganglia with respect to the Capillary number, the viscosity ratio and the wetting phase saturation. Our results show that the system reaches a steady state where the average values of the studied parameters remain constant in time although the temporal fluctuations maybe significant. The average volume of the ganglia decreases (and the population of the ganglia increases) as the Capillary number increases, namely as the viscous forces become more significant over capillary forces. Under such conditions the fraction of

the trapped liquid clusters decreases and the ganglia become mobile.