Wettability Impact on Two-Phase Flow Dynamics

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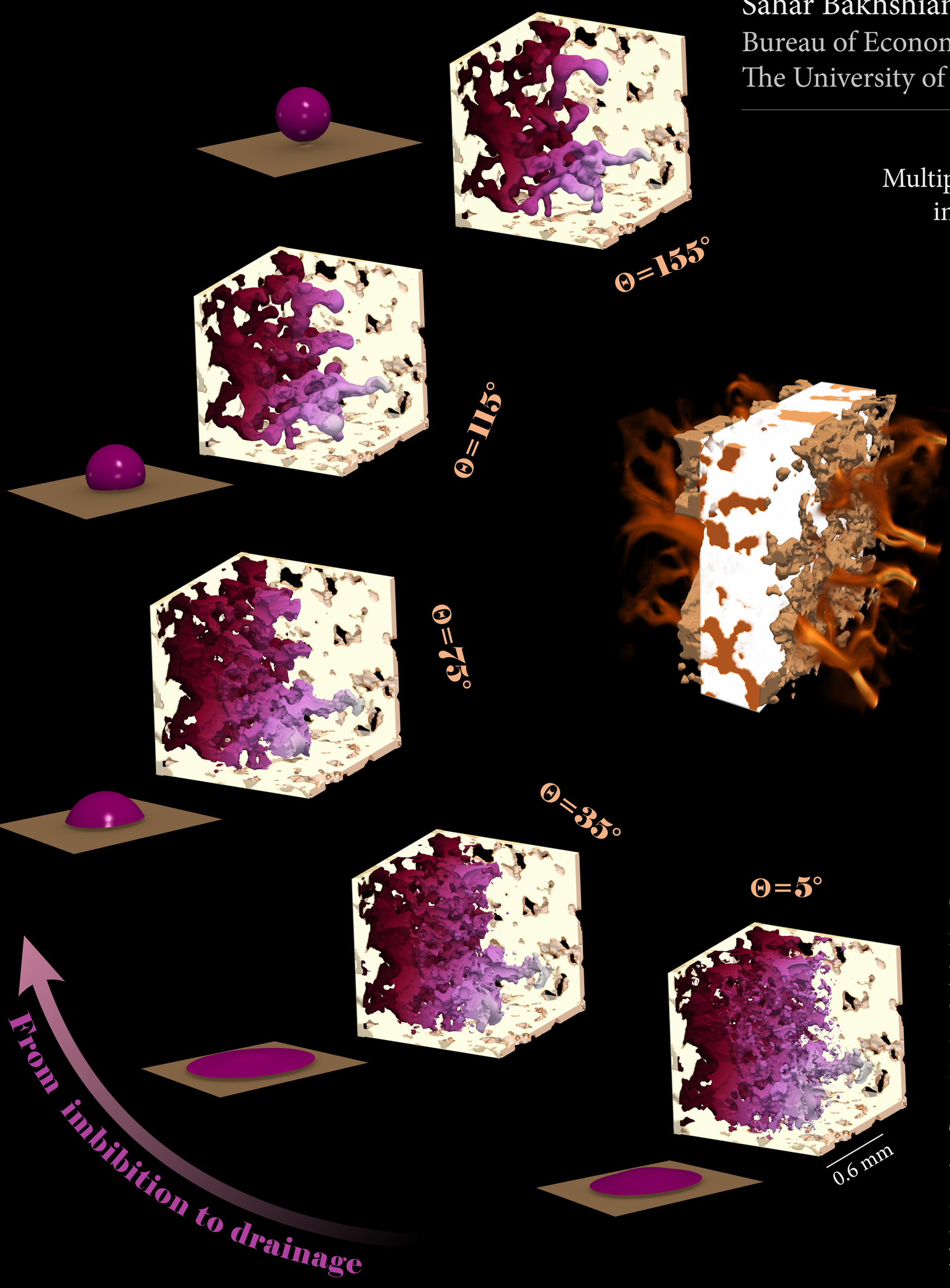

Multiphase flow in porous media is of essential importance in industrial applications including geological storage of CO_2, enhanced oil recovery, groundwater remediation and nuclear waste storage. Wettability which is characterized by the equilibrium contact angle (θ) between the fluid-fluid interface and solid surface, has a significant impact on the efficiency and dynamics of immiscible displacement in multiphase flow.

This study presents a pore-scale simulation of two-phase flow in a realistic rock model of Tuscaloosa sandstone under strong-, intermediate- and weak-wet conditions. These visualizations display the displacement pattern of the invaded fluid, which has a ramified pattern under the strong drainage conditions (large θ). However, the coroner flow mechanism prevails under imbibition condition (small θ) in which filling of smaller pore throats is favored over large pores. As the wettability of a porous medium changes to an intermediate-wet condition, complication in fluid physics arises, as a mixed population of concave and convex interfaces appear in the displacement front.

The present study remarkably contributes to assessment of sweep efficiency and storage capacity of CO_2 storage projects and provides information on the behavior of these multiphase systems in contact with rock formations having various wetting properties.

References: [1] Bakhshian, S., Hosseini, S.A., Shokri, N., 2019, Pore-scale characteristics of multiphase flow in heterogeneous porous media using the lattice Boltzmann method. Sci. Rep. v. 9, Article number: 3377. [2] Bakhshian, S., Hosseini, S.A., 2019, Pore–scale analysis of supercritical CO_2-brine immiscible displacement under fractional-wettability conditions. Adv. Water Resour. V. 126, p. 96-107.