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# Evaluation of electrostatic force in the vicinity of the three-phase contact region

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## Abstract

Trapping of fluid in porous media by capillary forces is a key process in many subsurface processes, such as carbon capture and storage in deep saline aquifers, groundwater remediation, and enhanced oil recovery in petroleum reservoirs. Wettability properties at the vicinity of the three-phase contact region are a key parameter to describe trapping mechanisms as well as the long-term stability of trapped droplets. The wettability of the system can be expressed via the inter-molecular interactions at this region. The inter-molecular interaction for the three-phase contact region is studied through the different components of the disjoining pressure. Therefore, an accurate expression of the disjoining pressure close to the contact region is indispensable in determining the wettability and dynamics of the contact point. Conventionally the disjoining pressure is expressed as a function of the thickness of the wetting phase alone. Doing so will neglect the effect of the actual profile of the wetting phase *i.e.* its slope and curvature. There were some attempts to drive an analytical expression for the dispersion component of the disjoining pressure that takes into account the slope and curvature. However, the analytical expression for the electrostatic component is quite complex and utilizes some simplifications. To overcome this, we numerically solved the Poisson-Boltzmann equation to obtain a more accurate result for the electrostatic force. We further implemented a surface complexation model for the case of carbonate-water-oil system to obtain the appropriate boundary conditions on the rock-water and water-oil interfaces. Finally, we studied the effect of salinity alteration on the electrostatic component and the dynamic of the three-phase contact region.

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