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Displacement of colloidal dispersions in Porous Media: experimental & numerical approaches

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The displacement of colloidal dispersions is of particular interest in many applications ranging from environmental issues to petroleum recovery. Natural porous media such as soils, aquifers or reservoirs contain colloidal particles of different nature (bacteria, viruses, clay, metal complexes …). Colloids can act as vehicles for micro organisms' transport in aquifers causing danger for human health. In petroleum recovery techniques, water containing colloids is sometimes injected and their release and adsorption may alter the petrophysical properties of reservoirs causing their damage. This talk focuses on the study of colloid transport in porous media under different hydrodynamic and physicochemical conditions (pH, salinity) using both experimental and numerical approaches. Typical laboratory experiments consist in the injection of a colloidal dispersion of a given concentration in a porous column. The analysis of the effluents after brine-flushing allows investigating the kinetics of release and adsorption of colloids inside the porous medium. In-situ investigations are performed either by post-mortem destructive methods or by using more sophisticated non-destructive methods. Moreover, a first approach to model these processes consists in solving the appropriate convection-dispersion-reaction equations involving macroscopic properties. Although this gives valuable qualitative insight on the displacement mechanisms, a more detailed study at the pore-scale is needed. Numerical approaches have been used at the pore-scale to study the displacement of colloidal particles. As a first approximation, the transport of the mass center of the particles has been considered. More complete numerical methods have allowed to study the transport of a colloidal particle taking into account pore-surface roughness, hydrodynamic forces and particle/pore physicochemical interactions (DLVO forces monitored through the change of the ionic strength of the suspending fluid). An overview of our experimental and numerical studies will be presented.