# Effects of wetting and drying cycles on autochtonous soil colloid mobilization

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suggest that suitable theoretical frameworks for particle transport in surface and subsurface environments are tractable.

## 11. The Effect of Air and Water Phase Configuration on Colloid Retention in Partially Saturated Porous Media

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In a partially saturated system the accumulation of colloid at interfaces such as air-water (AW), solid-water (SW) and air-water-solid (AWS) interfaces depend on the area of those interfaces and its accessibility to the water phase. Accumulations of colloids near the three-phase contact line (AWS) depend on the water volume associated with that line. The area of interfaces and contact line can be varied independently by adjusting the capillary pressure (or moisture content) and/or contact angle. In the present study, we keep the contact angle constant and vary only capillary pressure to vary interface configurations and areas of AW and AWS interfaces. Experiments are being conducted using 3D pore-scale micromodels, made from rectangular capillary tube with inner dimension of 100 μm by 1000 μm, packed with glass beads which have average diameter of 75 μm, and with fluorescent latex microspheres with diameter of 1 μm. Both capillary tube and glass beads were treated with acid to achieve uniform hydrophilic surface. Using a fast laser scanning microscope, volumetric (3D) images are collected in near real time during dynamic flow conditions as well as static conditions. The images will allow for investigation of the air and water phase configurations and its effect on colloid retention at the interfaces. An advanced confocal software Volocity is used for particle tracking and image analysis to quantify the number of particles retained for specified areas. Modeling involves Progressive Quasi-static Algorithm implementation of level set method to predict the configuration of fluids in porous media by varying the pore space geometry (square and equilateral triangles sphere-sphere configurations) and interfacial (capillary) pressure. Results from the micromodel experiments will be used to validate the model.

## 12. Effect of Wetting and Drying Cycles on Autochthonous Soil Colloid Mobilization

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Understanding colloid mobilization and transport in soils is a major concern for environmental protection and water resources management: They can act as vectors for sorbing pollutants, transporting them farther and faster through the vadose zone towards the water table than pollutants simply dissolved in water. Additionally, the existence of preferential flow paths in the soil such as cracks or invertebrate burrows is known to lead to an even faster breakthrough of the colloids. Some column or field scale undisturbed soil studies have identified the factors favouring/disfavouring particle mobilization, such as ionic strength, pH, initial soil moisture, trapping at air water interfaces or rainfall intensity. It appears however that one potentially important factor has been overlooked: the influence of the irrigation pattern undergone during the soil history. As a first step toward the study of this parameter, we carried out a series of infiltration-drainage experiments to investigate systematically the effects of periods without rain (pauses) on autochtonous particle mobilization in undisturbed soil columns. We showed that pause duration effect on mobilization is significant: the cumulative mass of particles eluted with the first 120ml of effluent is fifteen times higher when pause duration lasts 200 hours than when it lasts 1 hour. This variation occurs mainly during the transient stage of the flow (see figure). We found that this behavior is correlated with soil mean water content and proposed a mobilization mechanisms based on our observations. In a second experimental step we compare pause duration and ionic strength effects in term of mobilization efficiency. For this purpose we performed a new series of infiltration drainage-experiments keeping the pause duration constant, but changing the ionic strength of infiltration water from 10-5 to 10-1 M. We will discuss the outcome of this comparison, and highlight the practical impacts of our findings on an engineering and policy making point of view.

## 13. Effect of Hydrodynamics on Colloid Retention in Unsaturated Pore-Scale Experiments

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Understanding colloid transport in soil is important for the ability to predict colloid and colloid-associated transport of contaminants and to protect soil and groundwater resources. Unsaturated porous media often serves as a representation of unsaturated soil thus providing a more general understanding of colloid retention mechanisms. While sample-scale (column) experiments provide the key data in colloid transport, pore-scale experiments involving various imaging techniques have become an additional valuable source of information. In unsaturated porous media, colloids can be potentially retained at solid-water interface (SWI), air-water interface (AWI), and contact line. In particular, the retention at AWI and contact line is in general poorly understood. While the solution chemistry parameters such as pH and ionic strength and surface properties of colloids and porous media have been extensively investigated, more recent studies suggest the importance of hydrodynamics in colloid retention. The first part of the present study is a pore-scale experimental investigation of colloid retention employing a microfluidic channel and a confocal microscope. The micromodel visualization focuses on colloid behavior in the interfacial region (AWI and contact line) under dynamic conditions, with different interface velocities of both advancing and receding interfaces. Hydrodynamic conditions have been shown to affect colloid retention at AWI and contact line by affecting colloid availability for the retention as well as affecting the efficiency of colloid interfacial interactions. Relative preference of AWI and contact line for colloid retention has been analyzed. The second part is the development of a computational approach to simulate the viscous flow and colloid transport near the AWI and moving contact line. A mesoscopic multiphase lattice Boltzmann method and a Navier-Stokes based volume-of-fluid method are applied simultaneously to simulate the interfacial flow. The trajectories of colloids are then integrated numerically by solving the colloid's equation of motion, under the influence of physicochemical, hydrodynamic, capillary, Brownian and body forces and torques. Results from the computational approach will be compared to the micromodel observations, including the shape of the air-water interface and distribution of colloids near AWI and contact line.