Contact angle effects on the transport and retention of colloids in the vadose zone

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Abstract. Colloid retention mechanisms in saturated and partially saturated porous media have typically been derived from column breakthrough experiments. Pore-scale experiments of colloid attachment can determine colloid retention mechanisms directly. A confocal microscope system was used to collect images of colloid retention at various surfactant concentrations in partially saturated pores and small microchannels. Stacks of images were analyzed to quantify colloids retained at various attachment sites. Since confocal microscope can only collect data in one plane we concentrated our observations at the thin water film along the edge of meniscus where the air-water and water-solid (AW, WS) interface closely approach each other, (also called the air-water meniscus-solid (AWmS) interface). We observed that increasing of surfactant concentration reduced the contact angle and the colloid retention at the AWmS interfaces. Increasing contact angles also decreases the colloid retention. Experimental results as well a theory explaining the results are presented. The basis for the theory is the capillary force imposed by the meniscus on colloids in thin films. This force can be decomposed in a force parallel to to grain that pushes the colloid back into the bulk solution and a force perpendicular to the grain that results in a friction force resisting colloid movement. The relative magnitude of the friction force and the force parallel to the surface dertermines if a colloid near the AWmS interface is retained or not.