USDA-CSREES 2006 National Water Quality Conference

Colloid Transport and Retention in Unsaturated Porous Media: Mechanisms and Quantification

Colloids may affect drinking water quality from wells once they are transported through the vadose zone in the ground water. Precise prediction of the fate and transport of colloid in the vadose zone relies on quantification and determination of the governing mechanisms of colloid retention in unsaturated porous media. Although column breakthrough experiments may provide insight in colloid retention properties, it is not possible to deconvolute the output signal in the individual processes. Visualization together with quantification of colloid behavior at the pore scale offers an opportunity to characterize individual retention mechanism. In this study, synthetic microspheres and bacteria were injected into a horizontal flow chamber packed with partly saturated clean sand to quanitify the retention of colloids in unsaturated porous media. The flow chamber was mounted under a Laser Scanning Confocal Microscope (Leica TCS SP2) which allows the acquisition of time series and 3D reconstruction of pore-scale images. Qualitatively, pore-scale visualizations indicated that colloids in unsaturated porous media were mainly retained through attaching at the Air/Water meniscus/Solid interfaces. Two methods were used to quantify the number of attached colloids. The Region Method performed with the Image J software measured the area of attached colloids and then finds the number of colloids by dividing the area by the size of a single colloid. The Boolean method performed with the KS400 sotware counts the number colloids or colloid clusters, that are either static or moving. Both methods yield reliable results which are suitable to quantify colloid attachment to interfaces over time. A theoretical model was developed describing the rate of attachment and detachment under steady state conditions. However, relative minor changes in flow rates and associated changes in the position of the meniscuses, had large effect on retention processes and could not be modeled as a deterministic process

Author: Tammo Steenhuis
Coauthor(s): Yuni Zevi, Annette Dathe, Bin Gao, Jennifer Smith, Samary Amaro-Garcia, Brian K. Richards, Anthony Hay and John F. McCarthy