Geophysical Research Abstracts
Vol. 18, EGU2016-3173, 2016
EGU General Assembly 2016
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Evaluation of Colloid Retention Site Dominance in Variably Saturated Porous Media: An All Pores Pore-Scale Analysis

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It is well accepted that colloid and nanoparticle transport processes in porous media differ substantially between water saturated and unsaturated conditions. Differences are frequently ascribed to particle immobilization by association with interfaces with the gas, as well as to restrictions of the liquid medium through which colloids are transported. Yet, the current understanding of the importance of particle retention at gas interfaces is based on observations of single pores or two-dimensional pore network representations, leaving open the question of their statistical significance when all pores in the medium are considered. In order to address this question, column experiments were performed using a model porous medium of glass beads through which Silver particles were transported for conditions of varying water content and water chemistry. X-ray microtomography was subsequently employed as a non-destructive imaging technique to obtain pore-scale information of the entire column regarding: i) the presence and distribution of the main locations where colloids can become retained (interfaces with the water-solid, air-water, air-solid, and air-water-solid, grain-grain contacts, and the bulk liquid), ii) deposition profiles of colloids along the column classified by the available retention location, and iii) channel widths of 3-dimensional pore-water network representations. The results presented provide a direct statistical evaluation on the significance of colloid retention by attachment to interfaces or by strainig at contact points where multiple interfaces meet.