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Transport of bacteriophage PRD1 through saturated clean sand columns as a function of Calcium concentration

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Groundwater is a major source for drinking water, because of its good microbial quality in its natural state as compared with fresh surface water. Nevertheless, it may be contaminated with pathogenic microorganisms, especially viruses, and that may hamper drinking water production. The two most significant processes controlling virus mobility in the subsurface environment are virus attachment and inactivation. Based on previous studies, many factors have been identified that impact these processes. One of these factors is the concentration of divalent cations, in particular calcium, which is one of the major cations in groundwater. Although the effects of divalent cations have been studied in several studies, quantitative relations between cations concentration and adsorption coefficient rate are still not available. The objective of this work was to investigate and obtain quantitative relations for the effects of Ca concentration on virus removal in saturated soil. In order to do so, a systematic study was performed with a range of calcium concentrations corresponding to natural field conditions. These experiments were conducted in a 50-cm column with clean quartz sand under saturated conditions. Value of pH and ionic strength were fixed at 7 and 20 mM, respectively. Bacteriophage PRD1 was used as a conservative model virus for virus removal. Attachment, detachment and inactivation rate coefficients were determined from fitting the breakthrough curves. Attachment rate coefficients were found to increase with increasing calcium concentration. Results were used to calculate sticking efficiency values and an empirical formula for it as a function of Ca was developed. The applicability of this empirical formula at field scale requires further investigation. Also preliminary result on the effects of Ca, pH and ionic strength on the inactivation rate coefficients will be presented.

Keywords Colloids, solute transport, bacteriophage PRD1, Ca, pH, ionic strength