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Experimental investigation of human adenovirus cotransport with clay colloids and TiO_2 nanoparticles in water saturated porous media

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Particles such as clay colloids (e.g. kaolinite and montmorillonite) and metal oxides (e.g. TiO_2) have great potential for controlling the fate and transport of viruses in the subsurface. Although human adenoviruses (hAdVs) are used worldwide to indicate human fecal pollution in groundwater, their transport behavior in the subsurface environment is not fully understood. This study focuses on the effects of both clay colloids (kaolinite, KGa-1b and montmorillonite, STx-1b), and TiO_2 nanoparticles (NPs), on hAdV transport and retention in porous media. Laboratory-scale cotransport experiments were conducted in columns packed with glass beads, at three pore water velocities (0.38, 0.74, and 1.21 cm/min). The experimental results suggested that the presence of KGa-1b, STx-1b, and TiO_2 NPs increased the attachment and inactivation of hAdVs, mainly due to the contribution of additional attachment sites. Retention of hAdVs by the packed column was shown to be highest in the presence of TiO_2 NPs and lowest in the presence of KGa-1b. Moreover, the mass recovery values of both clay colloids and TiO_2 NPs were affected by the presence of hAdVs, under all of the experimental conditions examined in this study. However, no distinct relationship between mass recovery and water velocity could be established from the present experimental cotransport results.