**Experimental investigation of virus and clay particles cotransport in partially saturated columns packed**

**with glass beads**

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**Abstract**

Suspended clay particles in groundwater can play a significant role as carriers of viruses, because, depending on the physicochemical conditions, clay particles may facilitate or hinder the mobility of viruses. This experimental study examines the effects of clay colloids on the transport of viruses in variably saturated porous media. All cotransport experiments were conducted in both saturated and partially saturated columns packed with glass beads, using bacteriophages MS2 and ΦΧ174 as model viruses, and kaolinite (KGa-1b) and montmorillonite (STx-1b) as model clay colloids. The various experimental collision efficiencies were determined using the classical colloid ﬁltration theory. The experimental data indicated that the mass recovery of viruses and clay colloids decreased as the water saturation decreased. Temporal moments of the various breakthrough concentrations collected, suggested that the presence of clays significantly influenced virus transport and irreversible deposition onto glass beads. The mass recovery of both viruses, based on total effluent virus concentrations, was shown to reduce in the presence of suspended clay particles. Furthermore, the transport of suspended virus and clay-virus particles was retarded, compared to the conservative tracer. Under unsaturated conditions both clay particles facilitated the transport of ΦΧ174, while hindered the transport of MS2. Moreover, the surface properties of viruses, clays and glass beads were employed for the construction of classical DLVO and capillary potential energy profiles, and the results suggested that capillary forces play a significant role on colloid retention. It was estimated that the capillary potential energy of MS2 is lower than that of ΦΧ174, and the capillary potential energy of KGa-1b is lower than that of STx-1b, assuming that the protrusion distance through the water film is the same for each pair of particles. Moreover, the capillary potential energy is several orders of magnitude greater than the DLVO potential energy.