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Interaction between viruses and clays in static and dynamic batch systems

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The transport and fate of viruses in subsurface formations are mainly governed by virus attachment onto the solid matrix and inactivation. Furthermore, virus attachment onto clay colloids is primarily controlled by electrostatic interactions between surfaces. Consequently, bacteriophage MS2 and ΦX174 were used as surrogates for human viruses in order to investigate the interaction between viruses and clay particles. The selected phyllosilicate clays were kaolinite and bentonite. Numerous reactor vessels were filled with 0.5 g of clay and 50 mL of sterile phosphate buffered saline solution (1.2 mM sodium chloride, 0.027 mM potassium chloride, and 0.1 mM phosphate buffer salts) and adjusted to a pH of 7. A series of static and dynamic experiments for various bacteriophage concentrations were conducted at two different temperatures. Half of the reactor vessels were placed in a refrigerator at 4 °C and the rest in a constant temperature room at 25 °C. The dynamic batch experiments were performed with the reactor vessels attached to a small bench-top tube rotator. Appropriate adsorption isotherms were determined. Subsequently, the Derjaguin-Landau-Verwey-Overbeek (DLVO) theory was applied in order to determine the interaction energies between the bacteriophage and clay surfaces. In addition, the electric properties related to the viral surfaces were also obtained from measurements of the electrokinetic features of bacteriophages at different pH values and ionic strength levels using a zeta potential meter (Zetasizer Nano ZS with He-Ne red laser at 633 nm, Malvern Instruments).