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Infiltration of Viruses in a Shallow Bedrock Aquifer: A Field Experiment Using Bacteriophage

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Bedrock aquifers in eastern North America which have minimal overburden cover are exposed to virus contamination from a variety of sources such as on site waste disposal and agricultural activity. To explore the processes of virus migration from a surface source to the fractures at depth in an aquifer which provide the water supply, a field-scale viral infiltration experiment was conducted. The bacteriophage -X174 and the fluorescent dye Lissamine FF were utilized as viral and solute tracers, respectively. The experiment was conducted in a gneissic aquifer with sparse fractures of near vertical and approximately horizontal orientation. Typical apertures (as determined hydraulically) range from 0.2-0.6 mm for individual fractures. Tracers were mixed with water and applied to an exposed rock outcrop exhibiting fractures with known connection to two nearby wells as a result of shallow fractures located above the water table at depths of up to 4m. The experiment was designed to mimic transport conditions during heavy rainfall as water was allowed to pond on the surface. Breakthrough of the bacteriophage was extremely rapid and observed in both shallow (approximately 4 m depth) and deeper fractures (11-16 m depth). Colloidal transport processes were dominant and significantly decreased dispersion and slow-release kinetic sorption were identified.