Bacterial transport: Integrating aqueous and solid phase qPCR measurement of bacterial numbers with physicochemical parameters by multivariate analysis

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Developing a complete understanding of factors that control the fate and transport of bacteria in saturated subsurface environments at the field-scale requires knowledge of the spatial distribution of bacteria in both the aqueous and solid phases, and an integration of that data with the physical and chemical parameters of the saturated matrix. We describe an approach, based on real-time quantitative PCR (qPCR), that accurately determines the numbers of organisms of interest in both groundwater and sediment samples from a sandy aquifer in Oyster, Virginia used for bacterial transport studies. Using this approach, in situ transport experiments were conducted in which two different strains of injected bacteria were simultaneously tracked in the aqueous phase during a seven-day transport period, and the resulting spatial distribution of adhered bacteria was determined through analysis of sediments from post-injection cores.

Bacterial observations were analyzed in conjunction with extensive geological, hydrologic, geophysical, and geochemical sediment characterization data using multivariate statistical methods to identify relationships between sediment properties and bacterial attachment to sediment surfaces. Preliminary results indicate a high degree of predictability of attached bacterial concentrations based on geochemical properties of the sediment, in particular: metal oxyhydroxides, sorbed organic and inorganic species, and streaming potential measurements. These results, in combination with novel methods for non-intrusive geophysical characterization of sediment properties being developed by collaborators, offer promise for development and application of predictive models of bacterial transport at the field scale in heterogeneous aquifers.