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Upscaling transport of Bacillus subtilis endospores and phiX174 coliphages in heterogeneous porous media from the column to the field scale

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Groundwater contamination and subsequent transport of viruses and bacteria are a major concern in aquifers worldwide. To ascertain the ability of these aquifers to remove pathogens, tracer tests with microbial indicators are carried out. But because these tests are laborious and require special permission, column tests are often done instead. Unfortunately, results from column tests tend to grossly overestimate removal rates λ when compared to the field scale, which can lead to underestimations of groundwater contamination risks. Scale is an important consideration when examining pathogen transport through porous media, as pathogen removal rarely happens by linear processes. Field tests were carried out with Bacillus subtilis endospores and phiX174 coliphages over a distance of 25 m in an alluvial gravel aquifer in Vienna, Austria. The sandy gravel material from the field site was also used in column tests with the same tracers. Both attachment-detachment and Colloid Filtration Theory were used to model these tests. The results show a big difference in removal between the two scales. A comparison with the literature showed a correlation between the heterogeneity (or preferential flow) of the porous media and the difference in removal rates between the column and field scale.