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Effects of varying microbial distributions when modelling pore-scale biodegradation

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We have developed a numerical model to study the impact of single cell processes and micro-scale heterogeneities on biodegradation in contaminated aquifers on the pore level (pore of 1 mm length). The model is able to consider the spatial distribution of solutes along the length and width of the pore and of individual microbial cells and cell clusters along the pore wall. The model was applied to study biodegradation of easily degradable substances as well as of more refractory contaminants. The interplay between total biomass (varying from 100,000 to 10,000,000 cells/cm^3), cell distribution (biomass distributed homogeneously, as a film along the wall, or clustered in two colonies with various distance), and flow rate (between 0.1 and 7 m/d) was tested. First results indicated that scenarios where the inflow concentration was smaller than approximately 5 times the Monod half-saturation constant, degradation varied considerably (up to 50 percent points) between the different microbial distribution types tested. At higher inflow concentration, extent of degradation depended only on the biomass density, not cell distribution. We conclude that depending on how the biomass is distributed, especially for the easier-to-degrade substances, micro-scale distribution of degrader cells matters.