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Numerical Simulation of Microbiological Growth in the Capillary Fringe

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The capillary fringe (CF) is a highly dynamic zone in a porous media at the interface between water-saturated aquifer and vadose zone, where steep biogeochemical gradients and thus high bioactivities are expected. In recent years, considerable effort has been undertaken to deepen the understanding of the physical (flow, diffusion, dispersion), geochemical (dissolution, precipitation) and biological (metabolism, excretion, biofilm formation) processes in the CF.

We developed a numerical simulator for multiphase multicomponent flow in porous media which is able to consider simultaneously multiphase flow, component transport, phase exchange, geochemical reactions and microbiological processes. A splitting approach for phase transport, component transport and reaction/phase exchanges allows the usage of higher-order discretizations for the component transport. This reduces numerical dispersion significantly, which is especially important in the simulation of reactive flow.

In a flow-through laboratory experiment performed at the Karlsruhe Institute of Technology, Germany, within the project "Dynamic Capillary Fringes - A Multidisciplinary Approach", the oxygen phase transfer, the growth and the transport of a bacteria (green fluorescent *Escherichia coli*) were investigated. The results of numerical simulations of the *E. coli* growth in the CF with a high nutrient supply under steady-state and transient flow conditions are compared to the experimental data.