Geophysical Research Abstracts
Vol. 15, EGU2013-7171, 2013
EGU General Assembly 2013

Modeling of microbiological growth in the capillary fringe

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The capillary fringe (CF) is a highly dynamic soil zone, which is located above the groundwater level. It results from the capillary water rise into the unsaturated soil zone and therewith offers a broad range of growth conditions for microorganisms. These conditions change from aerobic (good oxygen supply) at the top of the CF to anaerobic (no available oxygen) at the bottom of the CF and under the water table.

In recent years, a lot of earth scientists and microbiologists worked together to deepen the understanding of the physical, geochemical and biological processes in the CF. But there is still a lack in knowledge on both sides, since the water content changes in the CF from saturated to almost unsaturated which hampers determination of biological parameters as well as modeling.

In the DFG-project “Dynamic Capillary Fringes - A Multidisciplinary Approach (DyCap)” researchers started to simulate growth of microorganisms in the CF. The biological parameters like growth rates, saturation constants for substrate and oxygen, yield coefficients and maintenance rate were determined in batch assays using parameter estimation. A flow through cell filled with fine sand was used to establish a CF and to investigate the growth of microorganisms in this zone. In order to allow non-invasive visualization and quantification, facultative anaerobic *Escherichia coli*) cells which can grow under aerobic and anaerobic conditions and which produce a green fluorescent protein were used.

We developed a numerical simulator for multiphase multicomponent reactive flow in porous media, which is able to consider simultaneously multiphase flow, component transport, phase exchange and microbiological processes. This tool was used to simulate the *E. coli* growth in the CF with nutrient supply under steady-state condition and the results are finally compared to the experimental data.