Session: Biofilm ecology and ecotoxicology

Mechanisms driving intermittency in preferential flow paths in porous media biofilms

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Fluid flow through environmental and industrial porous media, such as soils or filters, affects biofilm development through shear stress and nutrient supply while in turn the biofilm affects the fluid flow. This interplay can lead to the formation of preferential flow paths (PFPs) through the bio-clogged porous medium as well as strong intermittency. The intermittency manifests itself by the rapid opening and slow closing of the preferential flow paths which leads to drastic changes in the local fluid flow and mass transport.

We unravelled that the mechanism driving PFP intermittency is the competition between microbial growth and shear stress. Microfluidic experiments in analog porous media allowed us to quantify *Bacillus subtilis* biofilm formation and behavior for different pore sizes and flow rates, in total 12 different conditions. This combined with a mathematical model accounting for flow through the biofilm and its rheological properties enabled us to reveal the underlying mechanisms for preferential flow path intermittency. We further find that the closing of PFPs is driven by microbial growth and the opening of PFPs is driven by flow-induced shear stress. We thereby demonstrate that in bio-clogged porous media, the competition between microbial growth and shear stresses can lead to strong temporal variability in fluid flow and chemical transport conditions.