Micro-scale heterogeneous bacterial distribution impacts on biodegradation

Susanne I. Schmidt*a, Jan-Ulrich Kreftb, Rae Mackayc, Cristian Picoreanud, Martin Thullnere

a Institute for Environmental Sciences, University of Koblenz-Landau, Germany; schmidt-s@uni-landau.de
b Centre for Computational Biology & Institute of Microbiology and Infection & School of Biosciences, University of Birmingham, UK; J.Kreft@bham.ac.uk
c Faculty of Science and Technology, Federation University, Gippsland, Gippsland Mail Centre VIC 3841, Australia; rae.mackay@federation.edu.au
d Department of Biotechnology, Faculty of Applied Sciences, Delft University of Technology, The Netherlands; C.Picioreanu@tudelft.nl
e Department of Environmental Microbiology, UFZ – Helmholtz Centre for Environmental Research, Leipzig, Germany; martin.thullner@ufz.de
* Presenting author: Susanne I. Schmidt schmidt-s@uni-landau.de

Abstract
The microorganisms in groundwater rarely cover the matrix uniformly, but form colonies. This limits substrate bioavailability and biodegradation. With a high-resolution numerical model of a pore channel with bacterial colonies we simulated the transport and biodegradation of organic substrates and compared them to 1D simulations based on effective rate laws for bioavailability-limited biodegradation. We quantified bioavailability limitations and evaluated the applicability of established effective rate concepts if microorganisms are heterogeneously distributed. Effective bioavailability was reduced (> one order of magnitude).

Key words
pore-scale microbial degradation
bioavailability
effective rate laws

Session Microorganisms in heterogeneous flows: integrating from the cellular to the system-scale and from fundamental physics to applications