Geophysical Research Abstracts
Vol. 13, EGU2011-7895, 2011
EGU General Assembly 2011

Spatio-temporal variations of microbial metabolic activity caused by pore scale heterogeneity of porous media

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Natural porous media such as soils or aquifers are characterized by various pore scale heterogeneities. This includes the temporal variability of substrate supply, and the spatial heterogeneity of pore sizes. As a consequence, microbial growth conditions in natural porous media environments may differ from typical laboratory setups used to study microbial behavior. Pore scale heterogeneities and the resulting transport regime can lead to highly complex distribution patterns of substrates and the corresponding microbial growth conditions including the frequent occurrence of stress periods for the microbial population. Microorganisms can respond to such stress periods by switching from an active into an inactive or dormant state, and the corresponding microbial abundance and dynamics may exhibit rather complex temporal and spatial patterns.
This study considers an extended modeling concept for the growth and degradation activity of microbial species able to switch between two different physiological states. This concept is implemented into a pore network model which allows simulating the changes of microbial growth conditions in heterogeneous porous media. The model is used to study the impact of pore scale heterogeneities on the distribution and activity of microorganisms in such media and to determine the biodegradation capacity of the microbial population.