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In situ Microbial Activity Assessment in contaminated Aquifers

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Some of the “grand challenges” in microbial ecology are identifying the key microorganisms responsible for compound turnover in the environment. More important, for successful application of Natural Attenuation processes, environmental engineers need a reliable assessment of the in-situ contaminant turnover in a contaminated aquifer. Here, we report details of two recently developed approaches for the assessment of in-situ biodegradation: I) determination of the cumulated microbial degradation in a contamination plume by measuring the fractionation of stable isotopes at natural abundance and II) determination of the actual degradation under the respective environmental conditions in the aquifer by using in-situ microcosms (BACTRAPs) amended with ^{13}C labeled substrates.

Based on stable isotope fractionation analysis, the degradation occurring under anaerobic biogeochemical conditions at a respective site can be calculated for the entire plume. This has been shown for benzene and toluene at the “Zeitz” site and partly for chlorobenzene at the “Bitterfeld” site. By use of the in-situ microcosm approach with ^{13}C-labeled compounds, the microbial in-situ degradation under strictly anaerobic conditions could be proven for toluene, benzene, and chlorobenzene at several sites. The transformation of ^{13}C from labeled substrate into microbial fatty acids pro-

vided evidence for the degradation of the pollutant with formation of biomass. In addition, metabolites such as benzylsuccinic acid specific for anaerobic degradation of toluene could be identified. The results corresponds to the geochemical conditions found at the field site and the BACTRAPs approach can be also be used to assign in situ degradation pathways governing the biodegradation in the aquifer.

In addition, the composition of the microbial communities were analyzed by genetic profiling and sequencing of partial 16S rRNA genes PCR-amplified from total DNA, extracted directly from the microcosms. Sequences retrieved from the microcosms indicated a dominance of not-yet cultivated bacteria. Several sequences were phylogenetically closely related to sequences of bacteria known to be iron and sulphate reducers, typically found at sites polluted with BTEX and/or mineral oil. The results show that the current methods for monitoring microbial in-situ activity at present stage are valuable tools for improving environmental control of compound turnover and will speed up engineering approaches.