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Lines of Evidence for anaerobic MCB Degradation in contaminated Groundwater based on Stable Isotope Tools

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Chlorinated benzenes are xenobiotic compounds which play a major role in the production of pesticides, solvents, degreasers, dyes and pharmaceuticals. Due to its common industrial use chlorobenzenes are widely spread in the environment and many contaminated field sites exist worldwide. Natural Attenuation is one approach to remediate polluted sites taking advantage of the ability of the microorganisms to degrade contaminants thus cleaning up the environment.

In this study we focus on the anaerobic degradation of Monochlorobenzene (MCB). To our knowledge, MCB degradation has been studied under aerobic conditions but thus far complete anaerobic mineralization of MCB has not been reported yet.

To examine the MCB degradation we applied different stable isotope tools. In a first approach an in situ tracer experiment (BACTRAPs) was done to investigate the fate of MCB under in situ conditions. Within small bioreactor systems we provided $^{13}C_6$-labelled MCB loaded to a sorption material. During the incubation in the groundwater parts of the microorganisms settling on the sorption material mineralized the labelled compound. The bacteria incorporated the label into their biomass upon metabolisation of MCB as demonstrated by fatty acid isotope analysis. The isotope signature of fatty acids clearly indicated that microorganisms were capable of MCB degradation under in situ conditions.

In a second approach the concept of stable isotope fractionation analysis (SIFA) was tested to provide further evidence for in situ biodegradation of MCB. With increasing distance from the contamination source, the decrease in MCB concentration along

with the enrichment in theg?^{13}C isotope signature by up to 4 g%¸ clearly indicated degradation processes of the compound.

In parallel to these field applications, laboratory microcosms were prepared with groundwater and amended with $^{13}C_6$-labelled MCB. In several anaerobic microcosms the methane isotope signature remained stable over the monitored period while CO_2 became highly enriched in ^{13}C indicating a mineralization of the supplied MCB.

In conclusion, using stable isotope tools we could show that the microbial community was capable of anaerobic MCB degradation in situ as well as in laboratory experiments. This provided evidence for in situ biodegradation necessary for the application of the Natural Attenuation concept as a remediation strategy. Further research is necessary to identify the microorganisms involved in the MCB degradation and to study the degradation pathway.

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