ASSESSMENT OF NATURAL ATTENUATION OF HALOGENATED SOLVENTS USING STABLE ISOTOPE TECHNIQUES

Ivonne Nijenhuis[1] & Hans-Hermann Richnow[2]

[1]phone: +49 341 235 1356 / fax +49 341 235 1443 e-mail: ivonne.nijenhuis@ufz.de
[2]phone: +49 0341 235 1212, fax +49 341 235 1443 e-mail: hans.richnow@ufz.de

Department of Isotope Biogeochemistry, UFZ-Centre for Environmental Research Leipzig-Halle, Permoserstrasse 15, Leipzig, D-04318 Germany

Keywords: compound specific isotope analysis (CSIA); in situ microcosm; natural attenuation; case studies, molecular marker

Natural attenuation (NA) as a strategy to manage contaminated site requires the evaluation of in situ degradation as mineralization is a sustainable reduction of the contaminants load within an environmental compartment. We studied polluted anoxic aquifers in Germany for assessing the natural attenuation processes of the chlorinated ethenes and benzenes applying stable isotope tools. An integrated approach, combining geochemistry, compound specific stable isotope analysis (CSIA), microcosm studies with ^{13}C labelled contaminants and molecular markers was used to assess in situ biodegradation of halogenated compounds in groundwater for analysing NA (Imfeld et al. 2008a; Stelzer et al.,2009).

The presence of the dechlorination products, dichloroethenes (DCE), vinyl chloride (VC) and ethenes indicated reductive dechlorination of tetrachloroethene (PCE) and trichloroethene (TCE) in situ. Compound specific isotope analysis (CSIA) was employed for quantification in natural attenuation processes (Imfeld et al., 2008b). Monochlorobenzene (MCB) accumulated apparently as the end product of the dechlorination of higher chlorinated benzenes and Lindane at the field site. CSIA of MCB provide opportunities for characterizing anaerobic transformation of this compound in situ.

In situ microcosms with ^{13}C-labeled components is employed a test system for proving *in situ* degradation and could be used to study biotransformation of MCB derived carbon into biomass as a parameter for mineralization (Nijenhuis et al., 2007).

Laboratory microcosms confirmed the potential of the in situ microbial community for complete dehalogenation of the chlorinated ethenes to ethene and the mineralization of MCB under strict anoxic conditions. Parallel taxon specific 16S rDNA based PCR amplification was used for the detection of several groups of known dehalorespiring microorganisms and confirmed the presence of microorganisms potentially capable of the dehalogenation of chlorinated ethenes or benzenes (Imfeld et al., 2008b). This integrated approach can be used for providing lines of evidence for anaerobic degradation of chlorinated pollutants in contaminated field site as well as for quantifying in situ degradation processes.

References

Imfeld G., Nikolausz M., Nijenhuis I., Zeiger S., Paschke H., Drangmeister J., Grossmann J., Richnow H.H., Weber S. (2008a) Assessment of in situ degradation of chlorinated ethenes and bacterial community structure in a complex contaminated groundwater system. Water Research 42, 871-882.

Imfeld G., Estop Aragonèsa C., Zeiger S., Paschke H., Richnow H.H. (2008b) Characterization of in situ biodegradation in a model subsurface flow constructed wetland treating 1,2-dichloroethenes. Environ. Sci. Technol., 42, 7924–7930..

Nijenhuis I., Stelzer N., Kästner M., Richnow H.H. (2007) Sensitive detection of anaerobic monochlorobenzene degradation using stable isotope tracers. Environ. Sci. Technol., 41, 3836-3842.

Stelzer N., Imfeld G., Thullner M., Lehmann J., Poser A., Richnow H.H., Nijenhuis I. (2009) Integrative approach to delineate natural attenuation of chlorinated benzenes in anoxic aquifers. Environ. Pollut., 157, 1800–1806..