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Assessment of chlorinated ethenes biodegradation in an anaerobic aquifer by isotope analysis and microcosm studies

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Abstract This work focused on identification and quantification of natural attenuation of chlorinated ethenes in a contaminated aquifer beneath an industrial area using compound specific isotope analysis (CSIA). Presence of cis-1,2-dichloroethene (cis-DCE) and vinylchloride (VC), as well as *in situ* redox conditions indicated degradation of the primary contaminant trichloroethene (TCE) by reductive dechlorination. The potential for VC degradation was further corroborated by PCR-analysis on water samples which confirmed the presence of *Dehalococcoides* strains and VC reductases. *In situ* biodegradation was estimated by various approaches, including concentration measurements along the groundwater flow path, microcosm studies and by compound specific stable carbon isotope analysis. Using the Rayleigh model carbon isotope enrichment factors, ε, were determined both in the field and in microcosm experiments for each dechlorination step. Estimates of biodegradation based on enrichment factors derived from microcosms (–8.6‰ (cis-DCE) and –27.2‰ (VC)) were consistently lower (up to 40%) than those based on field data. Our results of the isotope study at field scale, microcosm experiments and molecular marker analysis provided conclusive information on natural attenuation processes and can be recommended as a general approach for site characterisation and risk assessment in NA studies.

Key words natural attenuation; chlorinated ethenes; CSIA; microcosm experiments; carbon isotope fractionation