

Biodegradation of chlorinated hydrocarbons in aerobic groundwater

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The project MULTIBARDEM aims at the field demonstration of the MULTIBARRIER concept. „Altlast O24“ in Austria is one of the project sites, where the aerobic aquifer (3 mg/L O₂) is contaminated with low concentrations of chlorinated aliphatic hydrocarbons: tetrachloroethene (TeCE), trichloroethene (TCE), 1,2-cis-dichloroethene (DCE), 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA).

The goal of the presented lab-study was to test the indigenous aquifer organisms for their degradation potential under anaerobic and under initially aerobic conditions (1 mg/L and 8 mg/L initial O₂) with several nutrient amendments.

Batch conditions

- medium: yeast extract (20 mg/L), NH₄NO₃ (16 mg/L), K₂HPO₄ (9 mg/L) and pollutant-mixture (Figs. 1-3) in groundwater from the site; initial pH 7.2
- addition of different nutrients (Tab. 1)
- controls: no additional nutrients and sterile control
- inoculum: aquifer material (225 µL/vial)
- 10 mL medium in 20 mL headspace vials with Teflon-coated butyl rubber septa with N₂-, air- or with 2.4%-O₂-headspace. Six parallels for each tested nutrient and corresponding controls.
- agitation at 20°C till GC/ECD-analysis

Tab. 1: Nutrients in degradation experiments.

Substance group	Nutrient	Conc. [mM]	Stimulation of
organic acids (sodium salts)	acetate	2	heterotrophs
	lactate	1.33	
	propionate	1.33	
	fumarate	1	
complex organic material	humic acids (sodium salts)	2 mg/L	heterotrophs
salts	ammonium chloride	4.5	nitrifying bacteria
sugars	glucose	1.32	heterotrophs and O ₂ -reduction
alkanes	natural gas	1 mL/vial	methanotrophs

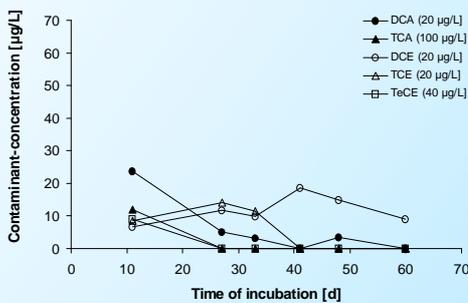


Fig. 1: Anaerobic conditions with lactate (start-concentrations in brackets)

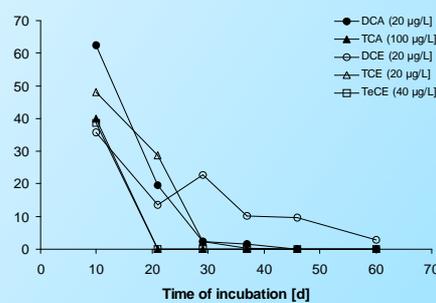


Fig. 2: Initially aerobic conditions (1 mg/L O₂) with glucose (start-conc. in brackets)

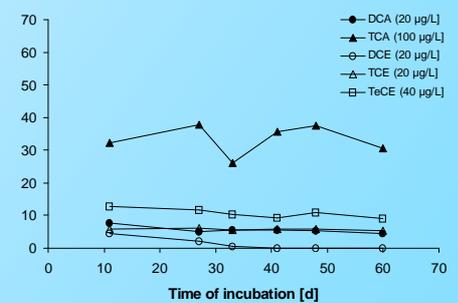


Fig. 3: Aerobic conditions (8 mg/L initial O₂) with ammonium chloride (start-conc. in brackets)

Results and Conclusions

Pollutant-transformation by indigenous aquifer organisms was enhanced or stimulated by different nutrients:

- each of the short chain organic acids enhanced biodegradation under anaerobic conditions (Fig. 1)
- glucose helped to create anaerobic conditions and stimulated the contaminant transformation at initially aerobic conditions (Fig. 2): at least 90% of the pollutants were degraded within 60 days
- ammonium and natural gas stimulated DCE degradation only under strict aerobic conditions (Fig. 3)
- humic acids did not affect the degradation activity of the aquifer organisms

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Partners

