Identification of degradation pathways of chlorinated hydrocarbons in saturated low permeability sediments using compound-specific isotope analysis

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Compound-specific isotopic analysis (CSIA) has been developed to track reactive processes affecting chlorinated hydrocarbons in aquifer systems. The method is based on isotope effects associated with degradation processes. In contrast to aquifers, it is unclear whether CSIA can also be used in saturated low permeability sediments to gain insight into biochemical transformation processes.

To address this reasearch gap we evaluated the potential of CSIA to differentiate degradation pathways of chlorinated hydrocarbons in saturated low permeability sediments. The study was conducted at a site, where a complex mixture of chlorinated hydrocarbons contaminated an aquitard. Nearly 50 years after contaminant releases, high resolution, concentration, CSIA and microbial profiles were determined. The CSIA profiles showed that in the aquitard cis-dichloroethene (cDCE), first considered as a degradation product of trichloroethene (TCE), is produced by dichloroelemination of 1,1,2,2-tetrachloroethane (TeCA). Several microorganisms capable of degrading chlorinated hydrocarbons were detected in the aquitard suggesting that aquitard degradation is microbially mediated. Furthermore, numerical simulations reproduced the aquitard concentration and CSIA profiles well. This allowed determining degradation rates for each transformation pathway, which is beneficial for predicting plume persisence due to back diffusion following contaminant source zone remediation.