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Compound-Specific Chlorine Isotope Analyses as an Assessment Tool for Contaminated Sites

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The fate of organic contaminants in soils and groundwater is highly dependent on the subsurface processes, making the investigation and remediation of contaminated sites challenging. IsoSoil is a FP7 European Commission project that aims promote the use of CSIA - Compound Specific Isotope Analysis – for the assessment and monitoring of such sites, with regard to natural attenuation or active processes affecting the distribution of the contaminants. Chlorine coupled to carbon isotope analysis of organochlorinated compounds is a powerful powerful tool to deduce both the mechanism and extent of the degradation processes.

Chlorine isotopic (δ^{37}Cl) analysis was used to investigate reductive dechlorination of chloroethenes (CEs) at a contaminated field site in the Czech Republic. This former carcass disposal plant used tetrachloroethene (PCE) for fat extraction. Frequent operational PCE leakages of total 150 – 250 tons caused a large contamination that led to a PCE plume of more than 100 meters in the in a sandy river terrace aquifer. Maximal concentrations were 5550 μg/L at the source zone dropped to 372 μg/L 90 m downstream the source zone. We measured significant shifts in PCE-δ^{37}Cl– up to 0,8‰ with respect to the putative source area – along the groundwater flow. This clearly suggested an on-going hydrogenolysis. These results combined with carbon isotopes (δ^{13}C) analyses allowed for determining δ^{37}Cl/δ^{13}C correlation that led to identification of site-specific isotopic enrichment factors (ε). This will allow for quantification of the degrees of naturally on-going PCE biotransformation in the investigated aquifer. Furthermore, this dual carbon-chlorine isotope approach will be applied to the analysis of samples from laboratory microcosms made from contaminated aquifer sediment experiments samples, which will be compared to the site-specific enrichment factors, as well as offer a reference ε-value for reductive PCE dechlorination.

Overall, the results demonstrate the potential of δ^{37}Cl compound-specific isotope analysis for assessing the fate of organochlorinated groundwater contaminants.