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A Novel Method for Analyzing Chlorine Isotope Fractionation for Source and Fate Assessment of Organochlorine Soil and Groundwater Pollutants

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We developed a simple and accurate analytical method for compound-specific determination of chlorine isotopic composition (δ^{37}Cl) or organochlorines based on GC/MS analysis and standard isotope bracketing. Good accuracy (comparison with off-line thermal ionization mass spectrometry) and a precision comparable to other on-line δ^{37}Cl-methods (0.6 permil vs SMOC) were achieved. We applied this method to assess biodegradation of polychlorinated phenols used for wood preservation at a former sawmill site in northern Sweden. To come up with a δ^{37}Cl-based estimation of the importance of on-going aerobic microbial degradation, we analyzed ^{37}Cl-enrichment during enzymatic dechlorination of polychlorinated phenols in laboratory experiments. We also investigated δ^{37}Cl fingerprints of chloroperoxidase-mediated chlorinated phenols, which can be used for apportionment of natural and anthropogenic sources of chlorophenols in boreal soils. Furthermore, we investigated natural attenuation of chlorinated ethenes in a contaminated aquifer in the Czech Republic. At this site, the extent of naturally occurring reductive tetrachloroethene (PCE) dechlorination was estimated based on PCE-δ^{37}Cl. Overall, our laboratory and field studies demonstrate the potential of using compound-specific chlorine isotope analysis for assessing the source and fate of organochlorine groundwater and soil contaminants.