In situ Biodegradation Rates in Contaminated Sediments via a Novel High Resolution Isotopic Approach

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Compared to measuring contaminant concentrations alone, Compound Specific Isotope Analysis (CSIA), provides the advantage of being able to verify whether decreases in concentrations of a specific contaminant are due to *in situ* (bio)degradation or non-degradative processes, without the need for identifying transformation products. The concept of representative elementary volume (REV) is a foundation in hydrogeology, typically applied in the context of many primary hydrogeological parameters, e.g., porosity and hydraulic conductivity. To date, this approach has yet to be applied for field-scale CSIA. We have used this concept combined with CSIA and high-resolution sampling (every 3 cm) across the sediment – water interface (SWI) at a contaminated field site to identify zones with maximum biodegradation potential. Samples were collected via passive diffusion samplers from sediment contaminated with monochlorobenzene (MCB) and benzene in a field site located in New Jersey, USA.

Isotopic enrichment trends in ^{13}C for MCB (≤5.7 ‰) and for benzene (≤2.2 ‰), indicated biodegradation of both compounds was occurring across the SWI. Further, by applying the REV approach we were able to identify a critical zone of 10-15 cm with highest biodegradation potential in the sediments. Using both stable isotope-derived rate calculations and conventional concentration approaches, we demonstrated a novel approach to determine *in situ* biodegradation rates for both MCB and benzene in this critical biologically-active zone. Compared to conventional approaches, CSIA-derived rate calculations provided more conservative estimates of *in situ* biodegradation rate constants. This project demonstrates how the unique combination of concentration and stable isotope data at high spatial resolution can be used to develop *in situ* rates of degradative processes. This information in turn can be used by site managers to determine if sediment natural recovery processes are sufficiently protective of benthic environments and surface water and improve predictions of recovery time.