Integrated characterization of natural attenuation of a PCE plume after thermal remediation of the source zone - incl. dual isotope and microbial techniques

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Abstract: PCE DNAPL contamination at the former central dry cleaning facility in Rødekro, Denmark, was subject to thermal (steam) source zone remediation in late 2006. A > 2 km long plume of chlorinated ethenes (PCE and chlorinated degradation products) which has migrated downgradient from the source zone has not undergone active remediation. A study of the natural degradation within the plume prior to source treatment including stable isotope monitoring was conducted in 2006(-2007) by Hunkeler et al. (2011). This investigation documented complete degradation of PCE via TCE to DCE by reductive dechlorination 1-1.5 km downstream the source area, where the plume descends into more reduced groundwater. The objective of the new (2014) study is to evaluate how the source remediation has impacted the plume and in particular the natural attenuation within the plume. A large monitoring campaign including redox, chlorinated ethenes, non-chlorinated degradation products, carbon and chlorine stable isotope composition, as well as specific degraders and their activity was conducted in 2014. The source remediation has, in addition to direct reduction of the concentration level in and flux from the source area, resulted in the release of dissolved organic matter and some geochemical changes. This has had an effect on redox conditions and biodegradation by reductive dechlorination particularly in the near source area. However, also in the further downstream area of the plume redox and contaminant levels have changed, suggesting an evolution in natural attenuation at significant distance (>1 km down-gradient) from the treated source area. Stable carbon isotopic fractionation revealed significant changes (increase) in the degree of degradation of cDCE in particular both near the source area and > 1 km down-gradient which co-inside with the reduction in redox conditions. The findings document a significant increase in cDCE degradation without accumulation of VC. This reduces the risk posed by the contaminant plume to the drinking water resource. This project is unique in the integrated characterization approach for line of evidence evaluation of the natural attenuation of cDCE and VC in the cDCE dominated plume and the monitoring of the effects of source remediation on plume natural attenuation.

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