

THE RELEVANCE OF ALTERNATIVE NATURAL ATTENUATION PROCESSES FOR CHLORINATED HYDROCARBONS

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Natural attenuation surveys at sites contaminated with volatile chlorinated hydrocarbons (VOCl) such as PCE and TCE are usually aimed at obtaining evidence for the occurrence of reductive dechlorination. Extensive experience at sites contaminated with PCE and TCE in Western Europe has shown that in up to 50% of the cases, the natural reductive dechlorination is incomplete and stalls at *cis*-dichloroethene (cDCE) or vinyl chloride (VC). Since these degradation products are more mobile and more toxic than the original contaminants, MNA is generally considered not to be a viable option for these cases.

Scientific research has shown that destructive processes other than biological reductive dechlorination may play a role in the natural attenuation of VOCl. Laboratory evidence has been presented for the anaerobic biological oxidation of cDCE and VC under several redox conditions. More recently, studies have shown that VOCl can also be degraded via abiotic reduction, a process involving iron(II)minerals. The relevance of these alternative natural attenuation processes is largely unknown since they are not considered in the traditional MNA surveys and since there are no validated tools for demonstrating these processes.

In a research project partly financed by SKB, a consortium consisting of Tauw bv, the VU University Amsterdam, TNO, VITO, and the University of Neuchâtel is developing a toolbox for demonstrating the occurrence of these alternative NA processes. This toolbox consists of GCMS screening for alternative degradation products from abiotic reduction and of compound-specific stable carbon isotope analysis for both processes.

In laboratory experiments, abiotic reductive dechlorination by a number of minerals is being investigated. Unexpectedly rapid reduction of PCE and TCE by iron sulfide (FeS) has been observed, while several other minerals also resulted in significant dechlorination. Ethene appears to be the main end product. The carbon isotope fractionation factors for these processes are presently being determined. The carbon isotope fractionation factor for anaerobic oxidation of VC is presently being studied in scientific research; for cDCE a theoretically derived fractionation factor will be used.

To determine the practical significance of the alternative NA mechanisms, six VOCl contaminated sites are presently being studied. At a number of these sites complete dechlorination is occurring, whereas at other sites the dechlorination stalls at cDCE or VC. The interpretation of the isotope results will be done with an adapted version of the isotope fractionation reactive transport model developed at the VU University Amsterdam.