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MECHANISMS OF NATURAL REDUCTIVE BIODECHLORINATION (RDC) OF CHLORINATED SOLVENTS IN AN OLD POLLUTED SITE

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ABSTRACT

A thirty years old polluted site (Néry-Saintines, Oise, France) is selected for the development and *in situ* implementation of a chemical process for the reductive dechlorination (RDC) of chlorinated solvents (CS) in groundwater. Before this implementation, the pollution was investigated through the underground water analyses: i) during 15 years (2000-2014) from several tens of piezometers distributed in a large area of more than 1 km², and ii) during 6 months (July-December, 2014) locally, from 12 piezometers sampled at minus to depths (-10 and -20 m) and located in the pilot implementation zone of 50 m x 50 m, or 2500 m² (0.0025 km²). The objective of the study is to improve understanding on the mechanisms and kinetics of natural bioremediation occurred in the groundwater of this so old polluted site.

The pollution in the sandy aquifer (Cuisian period) stands today as a majority of CSs and their metabolites. The nature and the relative abundances of these compounds are investigated and their spatiotemporal evolutions are charted. Some other parameters or species were measured and considered (temperature, pH, redox potential, conductivity, contents in chloride, bicarbonate, dissolved iron, sulfate, phosphate, sulfide, ..). Chloride ion is the principal produced component (evolution from 20 mg/L in a near not impacted zone to up to 350 mg/L, fig. 1), as well as bicarbonate (150 to up to 650 mg/L). Chloride ion, is the result of reductive biodechlorination of (presence in w/w percentage): Tetrachloroethylene or PCE (0.3-1.0%), Trichloroethylene, TCE (25-45%), trans-1,2-DiChloroEthylène (DCE) (0.3-0.4 %), cis-1,2-DCE (0.5-15.0 %) and 1,1-DCE (40-50%), Vinyl Chloride (VC) (0.7-1.0%), 1,1-DiChloroEthane (0.8-1.3%), DC-Methane (0.2-0.4%), TCMethane (3.5-6.0), TetraCMethane (0.3-0.4%). The nature and the relative abundances of the components show the mechanism and the limiting steps of the RDC. The bicarbonate is resulted from CO₂ dissolution after its production by the total biodegradation of organics. The higher the chloride content, the higher the conductivity, the higher the bicarbonate content and the lower the redox potential. This means that the reductive biodechlorination and the anaerobic biodegradation occur concurrently in the same zones. These investigations once again confirm the mechanism of RDC (fig. 1) as proposed in the literature by Morrison and Murphy (2006), for natural RDC and also give and clear indication on its kinetics.

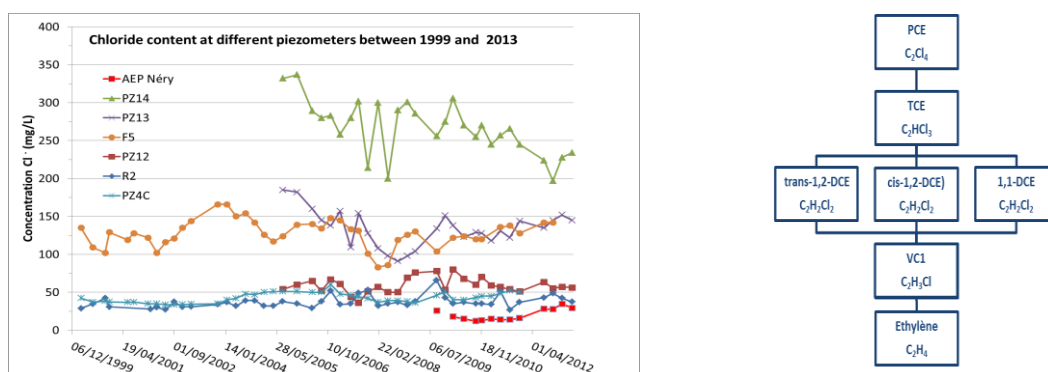


Fig. 1. Chloride spatiotemporal content evolution at some piezometers and mechanism of the RDC of PCE.

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References: Morrison R.D., Murphy B.L. (2006). Environmental Forensics: Contaminant Specific Guide, Chapter 12: Chlorinated Solvents. Elsevier Academic Press, 259-277.