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Lactate Biostimulation for Remediation of Aquifers Affected by Recalcitrant Sources of Chloromethanes

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Abstract : In the transition zone between aquifers and basal aquitards, DNAPL-pools of chlorinated solvents are more recalcitrant than at other depths in the aquifer. Although degradation of carbon tetrachloride (CT) and chloroform (CF) occurs in this zone, this is a slow process, which is why an adequate remediation strategy is necessary. The working hypothesis of this study is that the biostimulation of the transition zone of an aquifer contaminated by CT and CF can be an effective remediation strategy. This hypothesis has been tested in a site on an unconfined aquifer in which the major contaminants were CT and CF of industrial origin and where the hydrochemical background was rich in other compounds that can hinder natural attenuation of chloromethanes. Field studies and five laboratory microcosm experiments were carried out at the level of groundwater and sediments to identify: i) the degradation processes of CT and CF; ii) the structure of microbial communities; and iii) the microorganisms implicated on this degradation. For this, concentration of contaminants and co-contaminants (nitrate and sulfate), Compound Specific Isotope Analysis, molecular techniques (Denaturing Gradient Gel Electrophoresis) and clone library analysis were used. The main results were: i) degradation processes of CT and CF occurred in groundwater and in the lesser conductive sediments; ii) sulfate-reducing conditions in the transition zone were high and similar to those in the source of contamination; iii) two microorganisms (Azospira suillum and a bacterium of the Clostridiales order) were identified in the transition zone at the field and lab experiments that were compatible with the role of carrying out the reductive dechlorination of CT, CF and their degradation products (dichloromethane and chloromethane); iv) these two microorganisms were present at the high starting concentrations of the microcosm experiments (similar to those in the source of DNAPL) and continued being present until the last day of the lactate biostimulation; and v) the lactate biostimulation gave rise to the fastest and highest degradation rates and promoted the elimination of other electron acceptors (e.g. nitrate and sulfate). All these results are evidence that lactate biostimulation can be effective in remediating the source and plume, especially in the transition zone, and highlight the environmental relevance of the treatment of contaminated transition zones in industrial contexts similar to that studied.

Keywords : Azospira suillum, lactate biostimulation of carbon tetrachloride and chloroform, reductive dechlorination, transition zone between aquifer and aquitard
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