

Enhancement of Microbial Sulfate Reduction for the Remediation of Hydrocarbon Contaminated Aquifers – a Laboratory and Field Scale Demonstration – Fifth & Sixth Quarterly Progress Reports

Period Covered by the Report: January 1, 2002 to March 31, 2002

Date of Report: April 30, 2002

EPA Agreement Number: R827015 – 01 – 0

Title: Enhancement of Microbial Sulfate Reduction for the Remediation of Hydrocarbon Contaminated Aquifers – a Laboratory and Field Scale Demonstration

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Research Category: Groundwater Remediation

Project Period: October 1, 2000 to September 30, 2001 (N/C Ext. to May 31, 2002)

Objectives: The primary goal of this project is to design, implement, and monitor a simple but effective enhanced anaerobic bioremediation technology for treating hydrocarbon contamination in aquifers. The specific goals of this project are:

1. Evaluate existing data for long-term trends in benzene, toluene, ethylbenzene and xylenes (BTEX) concentrations.
2. Use laboratory experiments coupled with geochemical, hydrological and contaminant characterizations to design the sulfate injection process and to evaluate the feasibility of this approach.
3. Establish baseline contaminant, geochemical, and microbiological conditions prior to nutrient injection.
4. Monitor the performance of the enhanced anaerobic biodegradation process.
5. Identify the applicability and limitations of enhancing sulfate reduction for stimulating BTEX biodegradation.

Progress Summary/ Accomplishments: Geochemical, microbiological and contaminant characterizations of the site suggested that BTEX biodegradation could be stimulated by enhancing sulfate reduction in the aquifer by the addition of sulfate. Sulfate reduction in the studied aquifer was limited by sulfate availability. Laboratory experiments demonstrated that the addition of sulfate increased the rates of sulfate reduction and stimulated benzene biodegradation in samples obtained from contaminated site. Also, we showed that sulfate-reducing activity in situ depends on sulfate concentration (Fig.1).

Our laboratory findings were confirmed in the field experiment. After 6 months of sulfate injection the rates of sulfate reduction increased with increase of sulfate content in groundwater. In many wells increase of sulfate-reducing activity was coupled with benzene biodegradation. In some parts of the aquifer benzene level was reduced significantly, however in other parts benzene was not affected. One of the possible explanation was that benzene biodegradation was inhibited by preferential degradation of other available substrates including other hydrocarbons. Thus, in our laboratory experiments set up with the sediments from the site we showed preferential alkane biodegradation relatively to benzene biodegradation.

METHODS: Sulfate-reducing activity was measured by using radiotracer technique. Hydrocarbons were measured by GC. Sulfate and other anions in groundwater were measured by IC.

Fig.1 Sulfate-reducing activity in the groundwater with different sulfate concentrations

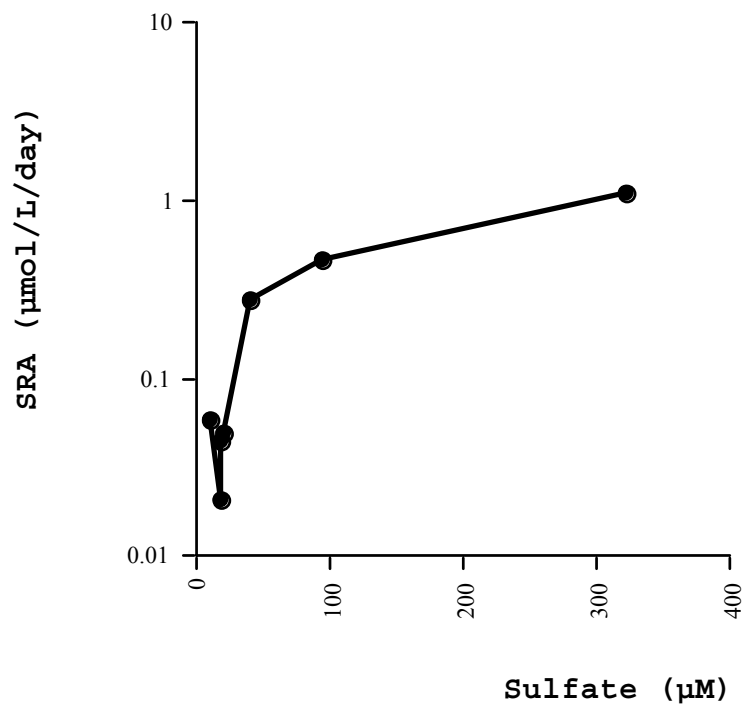


Table 1. Sulfate-Reducing Activity in Selected Wells after 6 Months of Sulfate Injection

Wells	Sept, 2001 μmol S/L/day	Febr, 2002 μmolS/L/day	June,2002 μmolS/L/day
SI-5S	0.049 sulfate 25 μM	0.047 sulfate 850 μM	0.193±0.04 sulfate 21 μM
SI-5D	No data	0.03 sulfate 1039 μM	0.185±0.1 sulfate 636μM
SI-10D	0.021 sulfate 18.3	0.11 sulfate 2360μM	0.24±0.08 sulfate 239μM
SI-17D	3.1 ± 0.3 sulfate 405 μM	No data	1.46 ± 0.33 sulfate 162μM

CONCLUSIONS: Geochemical, chemical and microbiological characterization of the site suggested that enhancement of microbial sulfate reduction by addition of sulfate is a feasible option for the remediation of a hydrocarbon contaminated aquifer. We designed a sulfate injection process and successfully implemented it in the field. Addition of sulfate resulted in substantial decrease in benzene content in some parts of contaminated aquifer.