Geophysical Research Abstracts
Vol. 18, EGU2016-2155, 2016
EGU General Assembly 2016

Synergistic degradation of chlorinated hydrocarbons with microorganisms and zero valent iron

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Sites contaminated with chlorinated hydrocarbons (CHC) are located mainly within build-up regions. Therefore in most cases only in-situ technologies without excavation of soil material can be used for remediation. This project examines a novel in-situ remediation method, in which the biotic degradation via bacteria is combined with abiotic degradation via zero-valent iron particles (ZVI). ZVI particles are injected into the aquifer where CHC-molecules are reductively dechlorinated. However Fe0 is also oxidized by reaction with water leading to generation of H2 without any CHC degradation. To achieve biotic degradation often strictly anaerobic strains of the bacteria Dehalococcoides are used. These bacteria can dechlorinate CHC by utilizing H2. By combining these processes the H2, produced during the anaerobic corrosion of Fe0, could be used by bacteria for further CHC degradation. Therefore the amount of used Fe0 and as a consequence also remediation costs could be reduced. Additionally the continuous supply of H2 could make the bacterial degradation more controllable.
Different Fe0 particles (nano- and micro-scale) were tested for their perchloroethene (PCE) degradation rate and H2 production rate in microcosms. PCE-degradation rate by different bacterial cultures was investigated in the same microcosm system. In course of these experiments the 13C enrichment factors of the PCE degradation of the different particles and cultures were determined to enable the differentiation of biotic and abiotic degradation.
Preliminary results showed, that the nano-scale particles reacted faster with PCE and water than their micro-scaled counterparts. The PCE degradation via micro-scaled particles lead to 13C enrichment factors in the range of -3,6 ‰ ± 0,6 to -9,5 ‰ ± 0,2. With one of the examined bacterial cultures a fast reduction of PCE to ethene was observed. Although PCE and TCE were completely degraded by this culture the metabolites DCE and VC could still be detected.
Further microcosm experiments will be implemented by the time of the EGU General Assembly 2016. In the framework of these experiments other bacterial cultures and ZVI particles as well as the combination of biotic and abiotic dehalogenation will be investigated.