

Potential role for bacteria in arsenic release to groundwater

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There are both anthropogenic and geological sources of arsenic to the environment of New Jersey [1, 4, 6]. The shale bedrock of the Lockatong and Passaic Formations contains arsenic at concentrations up to 240 mg/kg, and groundwater from these formations contains arsenic levels of up to 215 $\mu\text{g/L}$ [6]. Deep sediments within the Coastal Plain have average arsenic concentrations of 15-23 mg/kg [2, 3]

We hypothesize that microbes play an active role in the mobilization of arsenic from bedrock and subsurface sediments. We have examined the potential impact of microbial activity on the mobilization of arsenic from subsurface sediments into the groundwater at a site on Crosswicks Creek in southern New Jersey. Site bed sediment contains arsenic at 25 mg/kg. Groundwater beneath the streambed contains arsenic at concentrations of 60 $\mu\text{g/L}$, while the site surface water has an arsenic concentration of 0.55 $\mu\text{g/L}$. DNA extracted from site sediment and groundwater was used to characterize the microbial community of the site. The 16s small subunit rRNA gene was amplified, cloned and sequenced to determine the phylogenetic relationships and diversity of the site microbial community. The arsenic respiratory reductase gene, *arrA*, was used as a biomarker for arsenic reducing bacteria [5]. The *arrA* gene was successfully amplified from groundwater, indicating the presence of arsenic reducing microorganisms. Microcosms developed from site sediment and groundwater show active microbial reduction of arsenate. Additionally, the *arrA* gene was amplified from these microcosms, further supporting the presence of arsenic reducing microorganisms that facilitate arsenic release.

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Transport of volatile contaminants in groundwater by gas expansion and mobilization above a dense nonaqueous phase liquid pool

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The dissolution of dense nonaqueous phase liquids (DNAPLs) is typically studied in groundwater systems containing only water and DNAPL in the pore space below the water table. Little is known concerning the effect of mass transfer processes in systems containing trapped gas, created by either natural or remediation-based processes. Where trapped gases are present in the vicinity of a DNAPL source, it has been recently shown that the mass transfer of volatile DNAPL components to the trapped (i. e. discontinuous) gas phase can lead to the expansion and subsequent mobilization of that gas phase.

Transient gas distribution and dissolved DNAPL concentrations were measured over 70 days in a two-dimensional flow cell (70 cm x 60 cm x 1 cm) initially containing trapped atmospheric gases and a single pool of 1, 1, 1-trichloroethane (1, 1, 1-TCA) in 1.1 mm-diameter sand. The partitioning of 1, 1, 1-TCA and other dissolved gases to trapped gas near the pool produced expansion and vertical flow of discontinuous gas clusters, which were mobilized by repeated trapping and coalescence events. Significant concentrations of 1, 1, 1-TCA were detected well above the DNAPL pool later in the experiment, at heights that cannot be explained without considering gas mobilization.

Simulation of gas mobilization and mass transfer using macroscopic invasion percolation techniques showed that the partitioning of 1, 1, 1-TCA to trapped gas, transport by discontinuous gas flow, and partitioning back to the aqueous phase could produce elevated 1, 1, 1-TCA concentrations well above the pool. Simulations also showed that the elevated concentrations could be very short-lived, as 1, 1, 1-TCA is rapidly removed from the trapped gas above the pool and is replaced by other dissolved gases.

This behaviour is not included in common conceptual models of DNAPL-contaminated sites, and has implications for the diagnosis of DNAPL sources based on aqueous data.