

US EPA ARCHIVE DOCUMENT



# Bacteria-mediated Bioremediation of Benzene in a Shallow, Stratified Lake

## Environmental Issue

Lake Mishawum is contaminated with toxic Volatile Organic Compounds (VOCs)

- Artificial, shallow lake is stratified year round
- Methane-rich anoxic bottom layer, oxic upper layer
- Groundwater inputs contaminated with toxic VOCs
  - benzene, toluene and phenol

Studies of Lake Mishawum suggest the major pathway for benzene is bioremediation by bacteria<sup>1</sup>

- 80% of the benzene entering the lake is degraded
- Rates of degradation highest at oxic/anoxic interface
  - High methane, limited oxygen
- Degradation stopped with bacterial enzyme inhibitors
  - Picolinic Acid

Methane-oxidizing bacteria (methanotrophs) may be the key bacterial population in bioremediation

- Methanotrophs are known to oxidize benzene
  - benzene→phenol→catechol (readily degraded)
  - Unique enzyme methane monooxygenase.<sup>2</sup>
- Methane and oxygen present at interface

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**Citations:** Wick, L. Y. & P. M. Gschwend. 1998. Environ. Sci. Technol. 32:1319-28. 2. Hanson, & T.E. Hanson. 1996. Microbiol. Rev. 60:439-71. 3. McNeill, K., Wick, L.Y., Rojo, M., Kane, & P.M. Gschwend. Manuscript in prep. 4. Wick, L.Y., McNeill, K., Rojo, M., Medilanski, E., & Gschwend. 2000. Environ. Sci. Technol. 34:4354-62.

## Scientific Approach

### Hypothesis:

Methane-oxidizing bacteria are facilitating the high rates of benzene disappearance observed at the oxic/anoxic interface of Lake Mishawum.

### Research Questions:

**What is the diversity and abundance of methanotrophs at the oxic/anoxic interface in Lake Mishawum?**

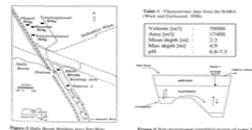
- Molecular techniques including PCR and QPCR
- Amplify, identify, and quantify methanotroph genes
- Culturing of methanotrophic isolates

**Do methanotrophs play a key role in the observed disappearance of benzene at the oxic/anoxic interface?**

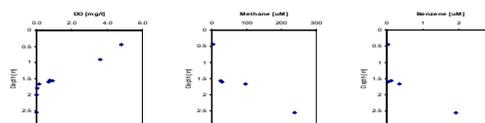
- Biodegradation rates of benzene at oxic/anoxic interface
- Inhibitors of methanotroph activity vs. other bacteria

## Field Site

Lake Mishawum

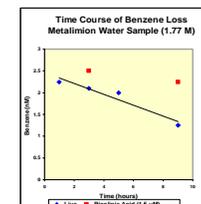
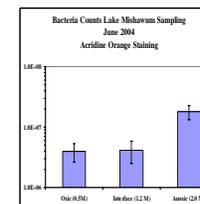
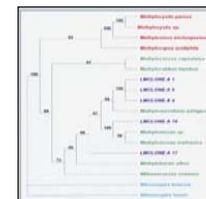


Depth Profiles of Dissolved Oxygen, Methane and Benzene in Lake Mishawum



## Results

Phylogenetic tree: particulate methane monooxygenase gene



## Issue Impact

### Bioremediation of VOCs in unique environments

- Comparisons of bioremediation in oxic and anoxic environments
- Bioremediation at an interface
- Bacterial communities and processes involved

### Engineered solution to groundwater contamination

- Stratified lake shows high rates of VOC degradation
- Engineered solution to groundwater VOC contamination.