Natural Attenuation of Chlorinated Aliphatics in Wetlands:

Linking Hydrology, Geochemistry, & Microbiology

Michelle M. Lorah
Wetlands: Unique Challenges

- Sensitive ecosystems
- Inaccessibility and permitting
- Large number of fate processes
- Steep biogeochemical gradients
- High spatial variability
- High seasonal variability
- High microbial diversity
WEST BRANCH CANAL CREEK
ABERDEEN PROVING GROUND, MD

Tidal Freshwater Wetland
*Phragmites* dominated

Nested ¾”
Drive-Point
Piezometers

Floating Walkways
- Hydrogenolysis
- Dehydrochlorination
- Dichloroelimination
Vertical Transformation Using Piezometers

(WB26 May 1999)
Spatial Variability: A vs. C Transect

[Diagram showing spatial variability with labels for Wetland, Canal Creek, Aquifer, and West Branch Canal Creek, with contour lines for total PCA (ppb) and summer 1995.]
Spatial Heterogeneity in Geochemistry

CH4, Peeper Comparison, WB36, 5/01

Total VOCs, Peeper Comparison, WB36, 5/01

Concentration (umol/L)

Depth (cm)
AIS Model DLK-100A Electrochemical Analyzer Rev 3.2

File Name: 081502.660

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<th>Technique</th>
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<th>Final Pot</th>
<th>Step Size</th>
<th>Pulse Ht</th>
<th>Range</th>
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The graph shows the electrochemical analysis with peaks labeled as Fe3+, HS, and FeS. The current and voltage (V) are plotted against each other.
Microelectrodes

Elect., In Situ

Peeper, Field

Elect., N₂ Bag

Peeper, Field

Elect., N₂ Bag
Seasonal Variability in Geochemistry

Winter vs. Summer

- VOCs highest in summer
- Cyclic change related to changing water levels
- Natural attenuation still efficient throughout year
Iron, March 1999

**FERROUS IRON (µM)**

- **WB30**
- **Live Control**
- **WB23**

**NUMBER OF DAYS**

0 5 10 15 20 25 30 35 40 45 50

*USGS*
Methane, March 1999

- WB23
- Live Control
- WB30

METHANE (µM) vs. NUMBER OF DAYS
**Spatial Heterogeneity in Microbes**

**Microcosm: WB23**

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*Desulfuromonas strain BB1<sup>a</sup>*

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*Dehalococcoides ethenogenes<sup>a</sup>*

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Seasonal Heterogeneity in Microbes

Dehalococcoides

Desulfuromonas

Seasonal Changes
PCA Removal- WB23 Microcosms

March '99 5°C WB23
July '99 19°C WB23
March '99 19°C WB23
Slower summer microbial degradation related to plant growth?
Spatial Heterogeneity in Microbial Diversity
VOCs in Surface Water at West Branch Canal Creek--FY99

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<th>Date</th>
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1122 PCA 112 TCA 12 DCA
PCE TCE 12 DCE
CT CF
Delineate Seeps

• Use aerial and ground TIR imaging surveys to identify seeps

• Evaluate the effectiveness of high-resolution TIR imaging in seep delineation
Thermal Infrared Imaging Study

- Low altitude aerial TIR surveys during low tide by helicopter to identify suspected seeps
- FLIR SCR1000, fixed lens, TIR camera (digital video and still images) in collaboration with ATC
- Ground and boat TIR survey during low tide to confirm locations and scan areas not observable by helicopter
Characterize Seeps

• Use Passive Diffusion Samplers to collect representative samples of shallow ground water
• Co-located surface-water samples

• Analyze for VOCs, methane
Conclusions

• **Think multi-disciplinary**

• **Be creative**

• **Define spatial and seasonal variability**

Hydrology

Chemistry

Microbiology

Vegetation