Environmental Investigations Using Versatile, Vapor-Permeable, Adsorbent-based Passive Samplers

Jay W. Hodny, Ph.D. & George Shaw
W. L. Gore & Associates, Inc.

7th Passive Sampling Workshop and Symposium
Reston, VA
April 24–26, 2007
Outline

• Introduction
• Environmental investigations
  – Passive sampling – soil gas, subslab soil gas, air
  – Common applications
  – Benefits
• GORE™ Module
  – What it is and how it works
• Example
• New advances
  – Concentration reporting – air, water
• Examples
Do you prefer an informative picture before an operation?

Where’s the problem?
Do you prefer an informative picture before remediating?

Reconnaissance Tool
• Type
• Source
• Extent

"Environmental X-ray"
Common Applications – Passive Sampling

- Site assessment (Conceptual Site Models)
- Vapor intrusion
- Remedial optimization
- Property transfer - Brownfields
- Monitoring
  - Long-term GW
  - Remediation
- Pipeline integrity

* - partial list
Benefits – Passive Sampling

- Rapid, inexpensive, unobtrusive installation & retrieval
  - Minimal operator & field sampling error
- Time-integrated sampling
  - ppt sensitivity
  - Sensitivity to broad range of compounds VOCs, SVOCs, PAHs
  - Minimizes sampling variability
- Virtually any soil and moisture condition
- No forced extraction of vapor
- No mechanical parts
- No energy required

Limitations

Mercury and vapor concentration, no longer a limitation.
Comparison

- **Active** soil gas and subslab soil gas
  - Forced withdrawal of vapor
  - Complex setup
    - Potential for error

- **Passive** soil gas and subslab soil gas
  - No forced withdrawal of vapor
  - Simple setup
    - Minimal error

Limitations

Mercury and vapor concentration, no longer a limitation.
Why Passive Sampling?

**Time-integrated:** Sensitive to a broader range of compounds, present in lower concentrations, in virtually any soil condition.
1) GORE-TEX® Membrane
   - Chemically-inert, waterproof, vapor permeable

2) Engineered sorbents
   - Hydrophobic
   - VOCs, SVOCs, PAHs

3) Sample analysis
   - EPA 8260/8270 or TO-15
   - Duplicate samples
   - Direct detection of organic compounds
   - Sample integrity protected
GORE™ Module

Subsurface Installation

String and cork

Field Kit

Insertion rod
Installation - Soil Gas, Subslab Soil Gas and Air

Soil Gas

Subslab Soil Gas

Air

Crawlspace air

Indoor air

Slam bar

Hammer drill

Module insertion

Angle beneath slab

GORE, GORE-TEX and designs are trademarks of W. L. Gore & Associates © 2007 W. L. Gore & Associates, Inc.
Installation – Sediment and Groundwater

Sediment

Groundwater

Vertical Profiling in Wells
Remedial Optimization Example

Manufacturing Facility

Objective: optimize recovery well placement

- Chlorinated compounds in groundwater
- 30ft weathered, “tight” clay ($10^{-8}$), fractured bedrock
- Groundwater ~30ft depth
- Geophysical survey lacked resolution
- Active soil gas survey failed
- PETREX survey performed poorly
- 77 GORE™ Modules, 30 x 4ft sample spacing
Remedial Optimization Example

"Groundwater Data"
Remedial Optimization Example

“Soil Gas Data & New Recovery Well”
Remedial Optimization Example

Conclusions

- Sample spacing delineated suspect fracture
- TCE in groundwater detected in soil gas
  - Challenging site geology
- Recovery well location optimized
- 25x increase in fluid removal
- 75% increase in TCE removal
Calculating Concentrations

- Quantify (measure) uptake rate
  - Experimental conditions
  - Varying concentrations, conditions
  - Air, water

- Exposure period

- Quantify (measure) mass desorbed

- Soil gas
  - Eff. Diff. = f[total porosity, water-filled porosity]*
    - Johnson-Ettinger VI model terms
    - Millington-Quirk

- Conc = f[volume=f(uptake rate, time), mass, soil*]

- Approach – IH methods-solid, sorbent-based diffusion samplers
  - ASTM 6306 (1998); 6246 (1998); 4597 (1987)
  - MDHS 70 (1990); 80 (1995); 27 (1983)
Vapor Intrusion Investigation

Basement

Subslab

Crawlspace

NAPL

GW Impact

Monitoring Well
Indianapolis site

- US EPA - IDEM
- Objective:
  - “First look”
    - July
    - VOCs, SVOCs, PAHs
  - Guide next sampling
    - July, August
    - “sampling boot camp”
Vapor Intrusion Concentration Example

July

TCE Calculated vs Measured Concentrations

- 3 ft sample depth
- Excellent correlation

August

TCE \( (r^2 = 92\%) \)

Courtesy of Todd McAlary, GeoSyntec Consultants
Vapor Intrusion Concentration Example

- 3 ft sample depth
- One hour exposure
- Correlates spatially
- Matches P5

TCE

503053 – 2.7 ppmv  503055 – 8.8 ppmv  503051 – 17.1 ppmv

P-5 - 9.4 ppmv
Groundwater Sampling Example

Dry cleaner site – southeast US
• Chlorinated solvents in groundwater
• Shallow water table ~ 8ft.
• Up to four GORE™ Modules per four wells
  – Vertical profile
  – One hour exposure
• Slow purge (peristaltic pump); disposable bailer
Groundwater Sampling Example

**PCE, TCE, cis-1,2-DCE (µg/L)**

- n = 12
- y = 1.1611x + 0.982

**PCE - Slow Purge & Baller vs GORE Module**

- Monitoring Well
- GORE Modules placed at multiple depths (deeper to the right)

© 2007 W. L. Gore & Associates
Conclusions

GORE™ Module - versatile, membrane-based passive sampler
• Effective in broad scope of environmental investigations

• Sample virtually any media
  – Air, soil gas, water

• Inexpensive installation, retrieval & operation
  – Minimizes sampling error

• Concentration reporting
  – Relatively new capability
  – Sound science
  – Favorable data comparisons
THANK YOU!
The authors acknowledge:
Louise Parker, USACE
US EPA
IDEM
Todd McAlary, GeoSyntec Consultants
S & ME

For more information, contact:
gshaw@wlgore.com
j hodny@wlgore.com
410-392-7600
www.gore.com/surveys