

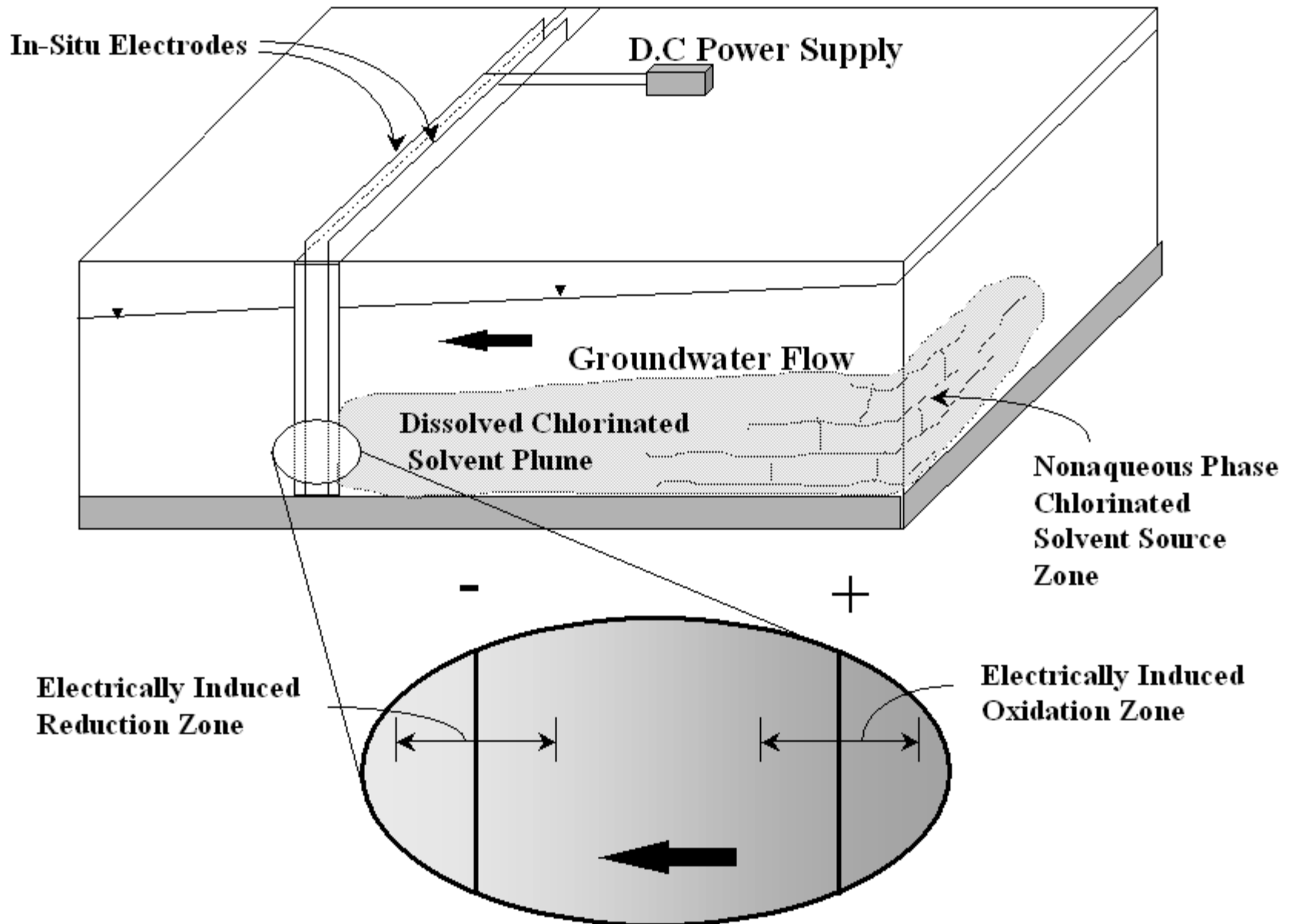
Electrically Induced Redox Barriers (e-barriers)

TOM SALE • DAVE GILBERT

COLORADO STATE UNIVERSITY

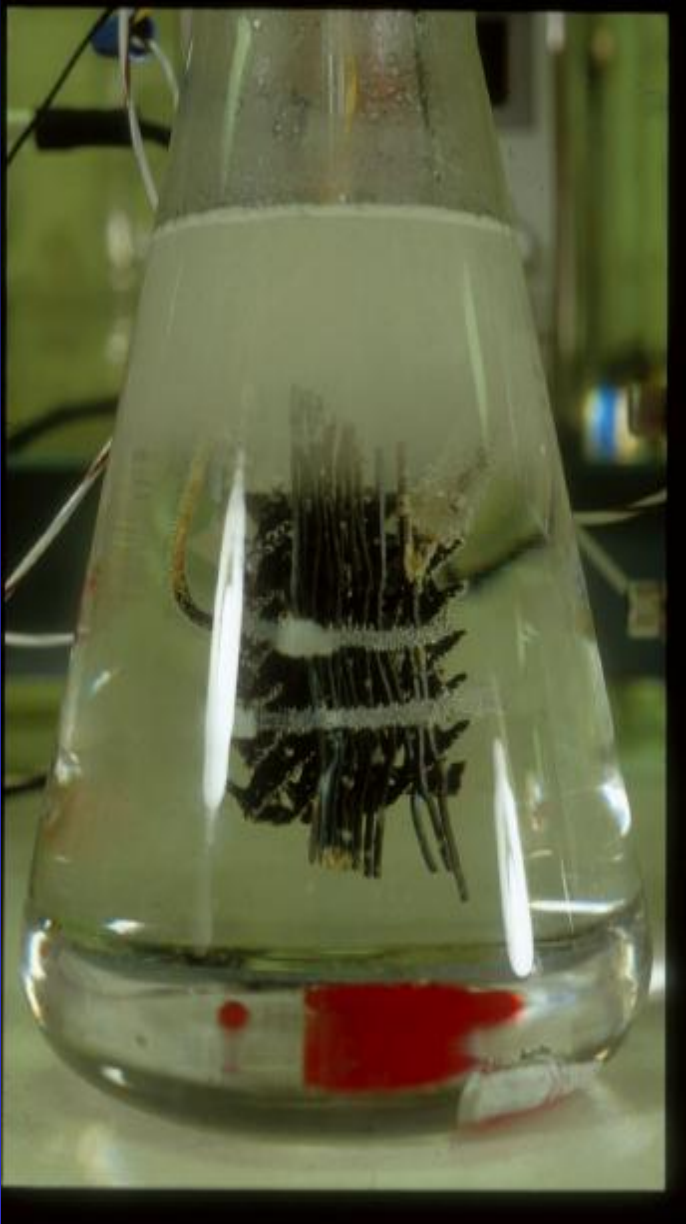
FORT COLLINS • COLORADO

e⁻barrier concept

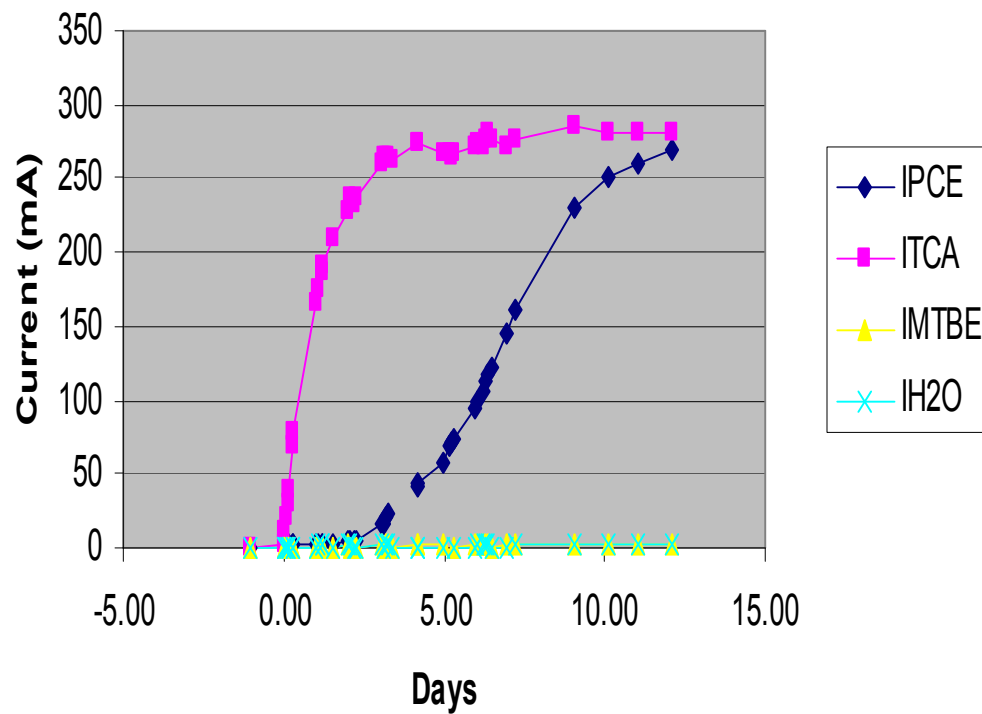


Presentation

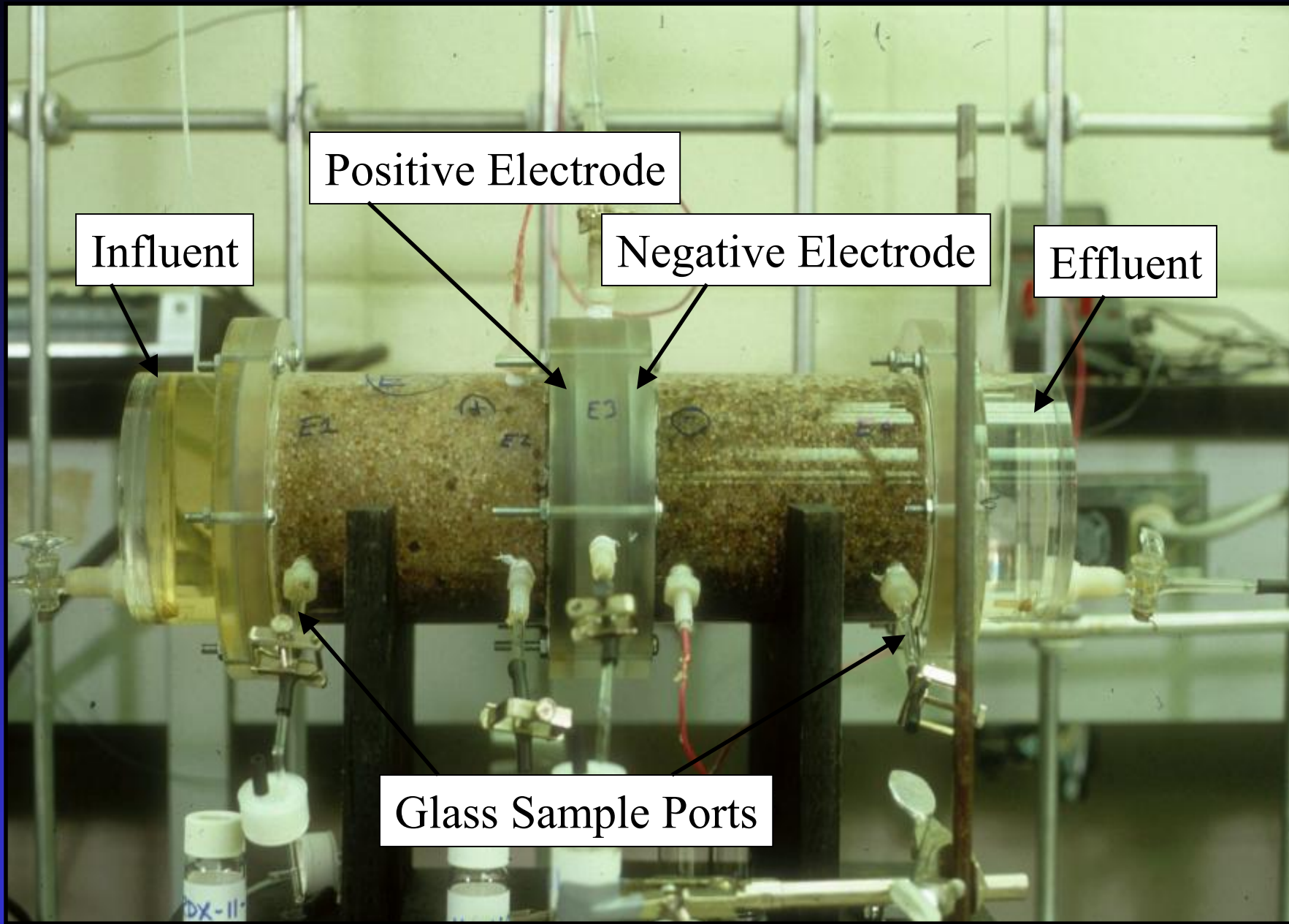
- Laboratory Studies
 - Chlorinated Solvents
 - Energetics
- Field Studies
 - CFB Borden, Ontario
 - F. E. Warren AFB, Cheyenne, Wyoming

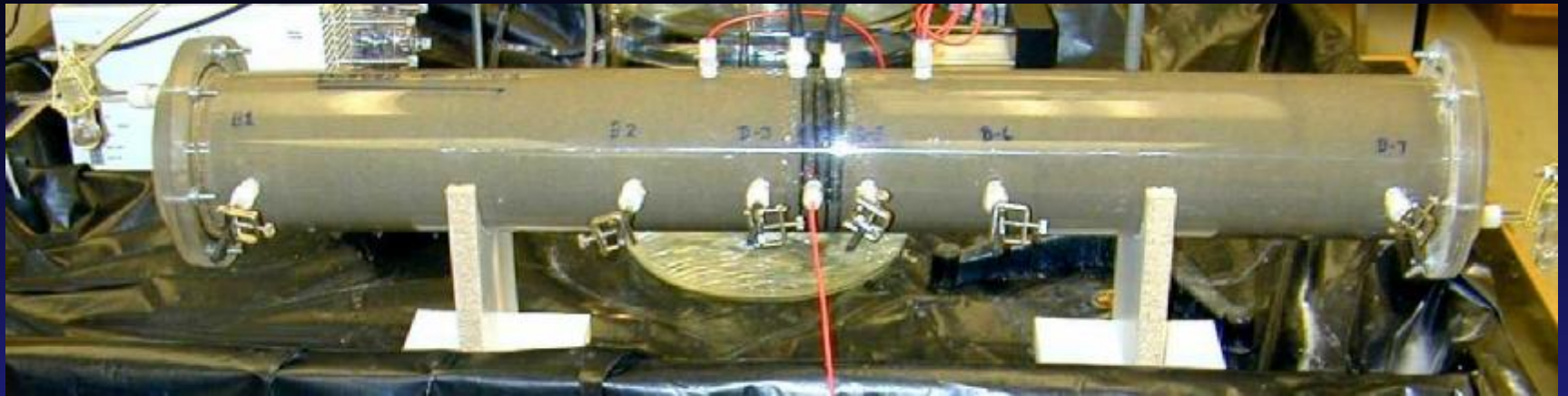


Beaker Test





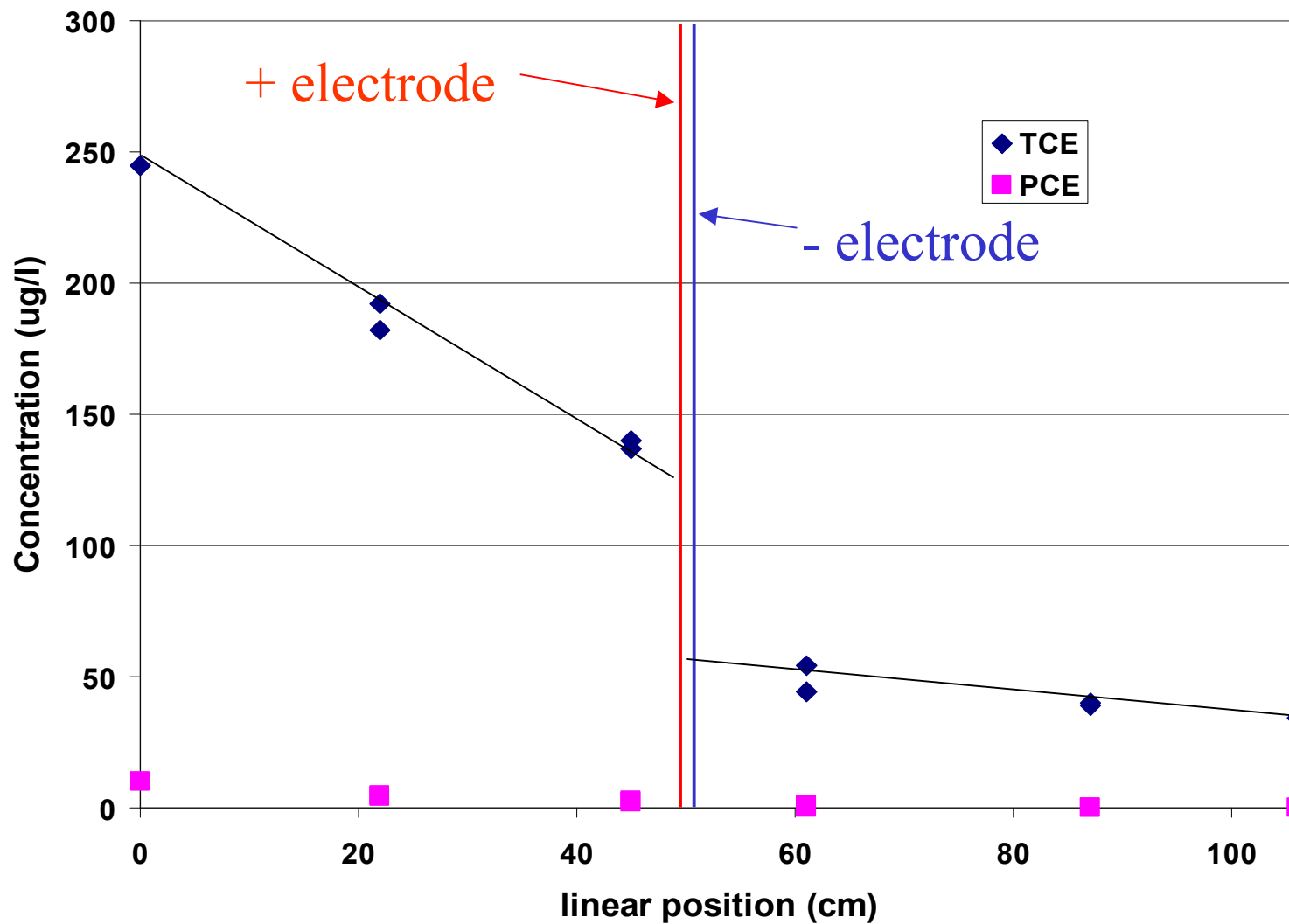


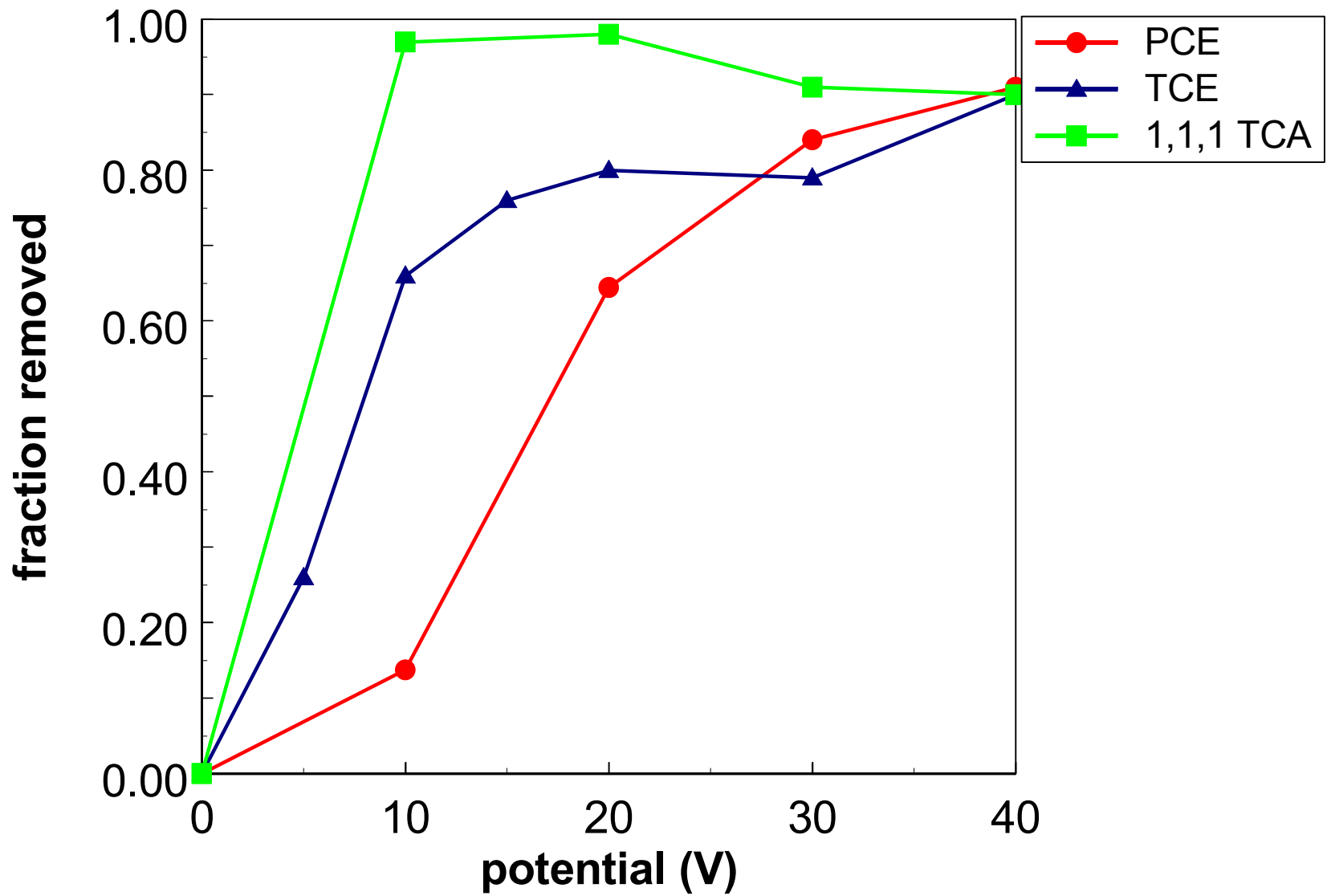


Borden Column and Tank Experiments



Removal in Borden 2-D March 19





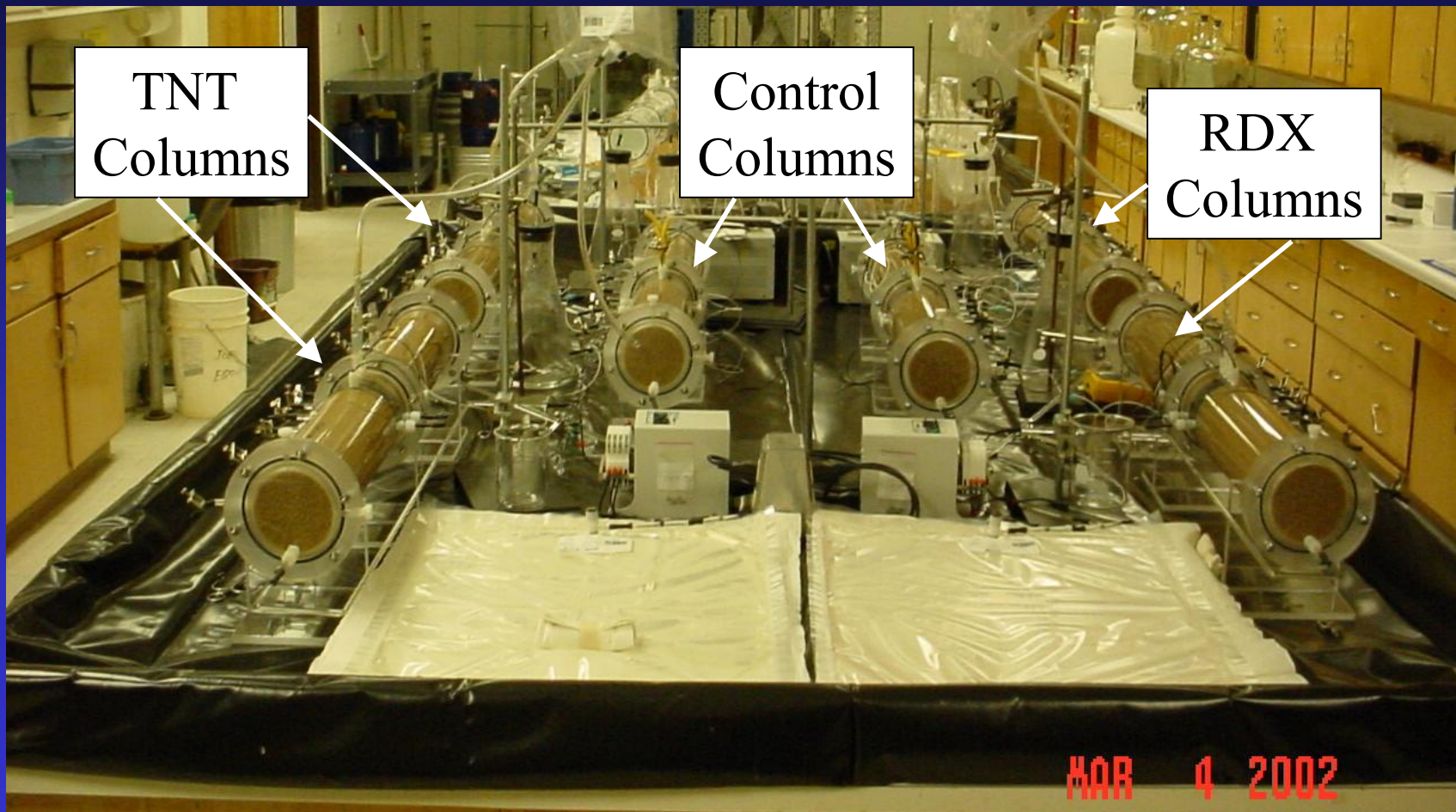
Sequential Electrolytic Degradation of Energetic Compounds in Groundwater



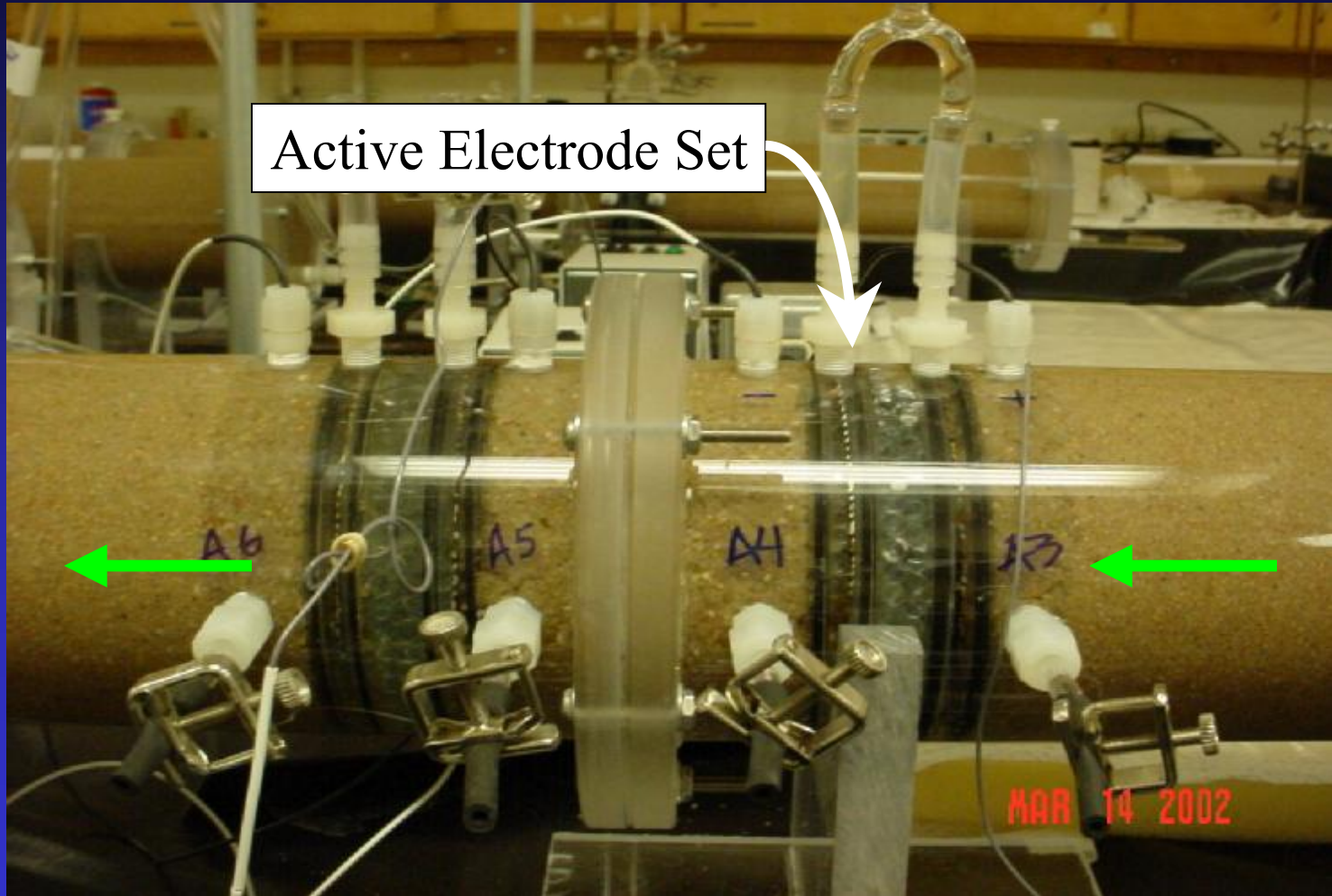
Knowledge to Go Places



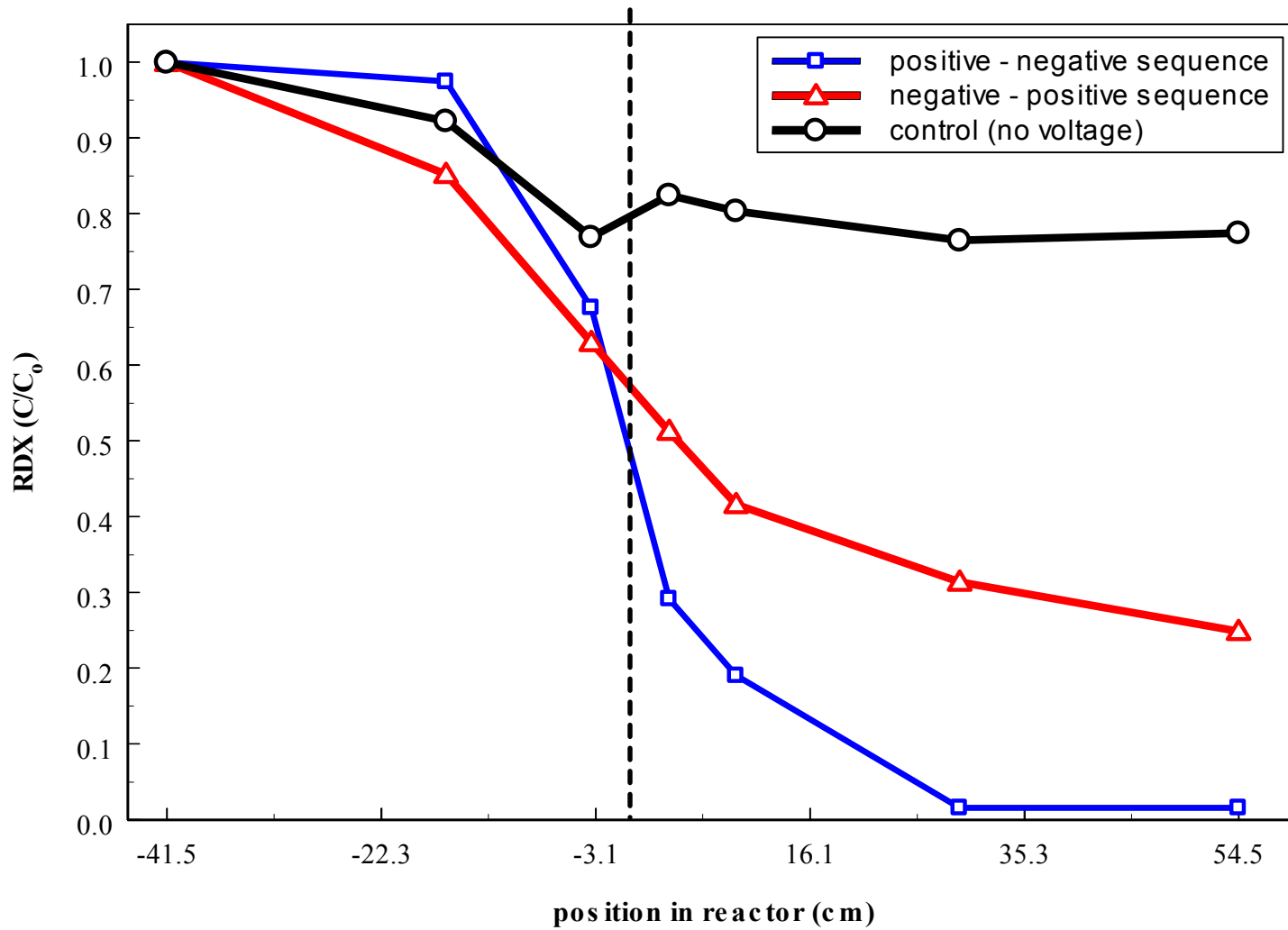
Flow through reactors



Electrode detail

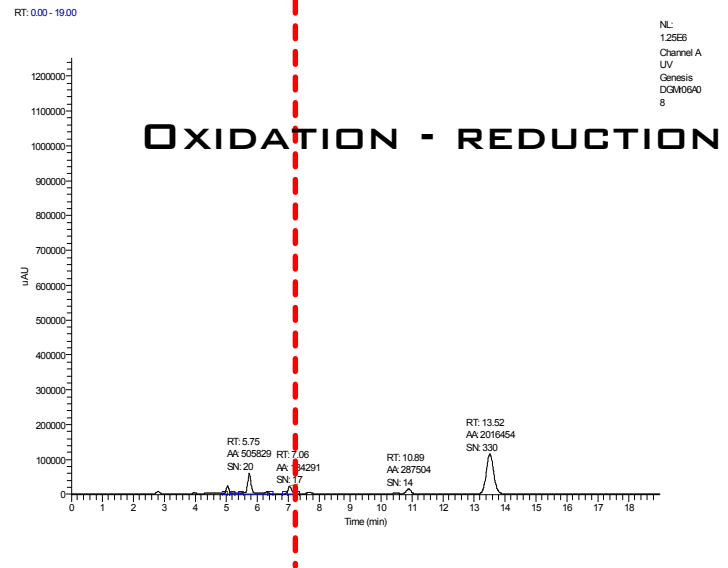
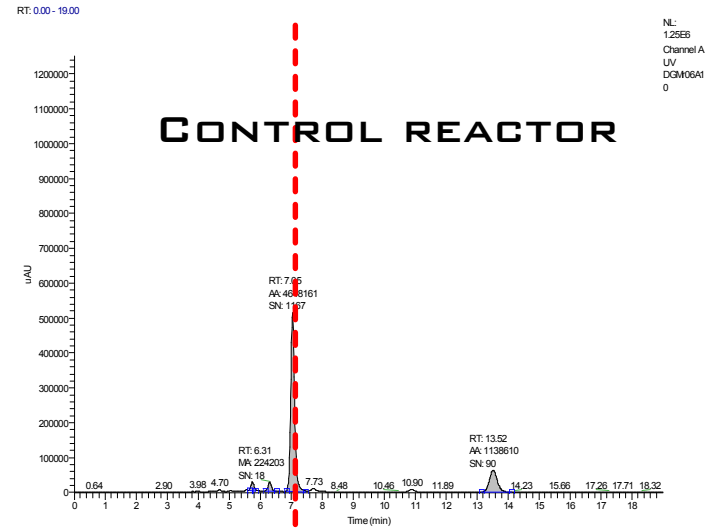


RDX Results

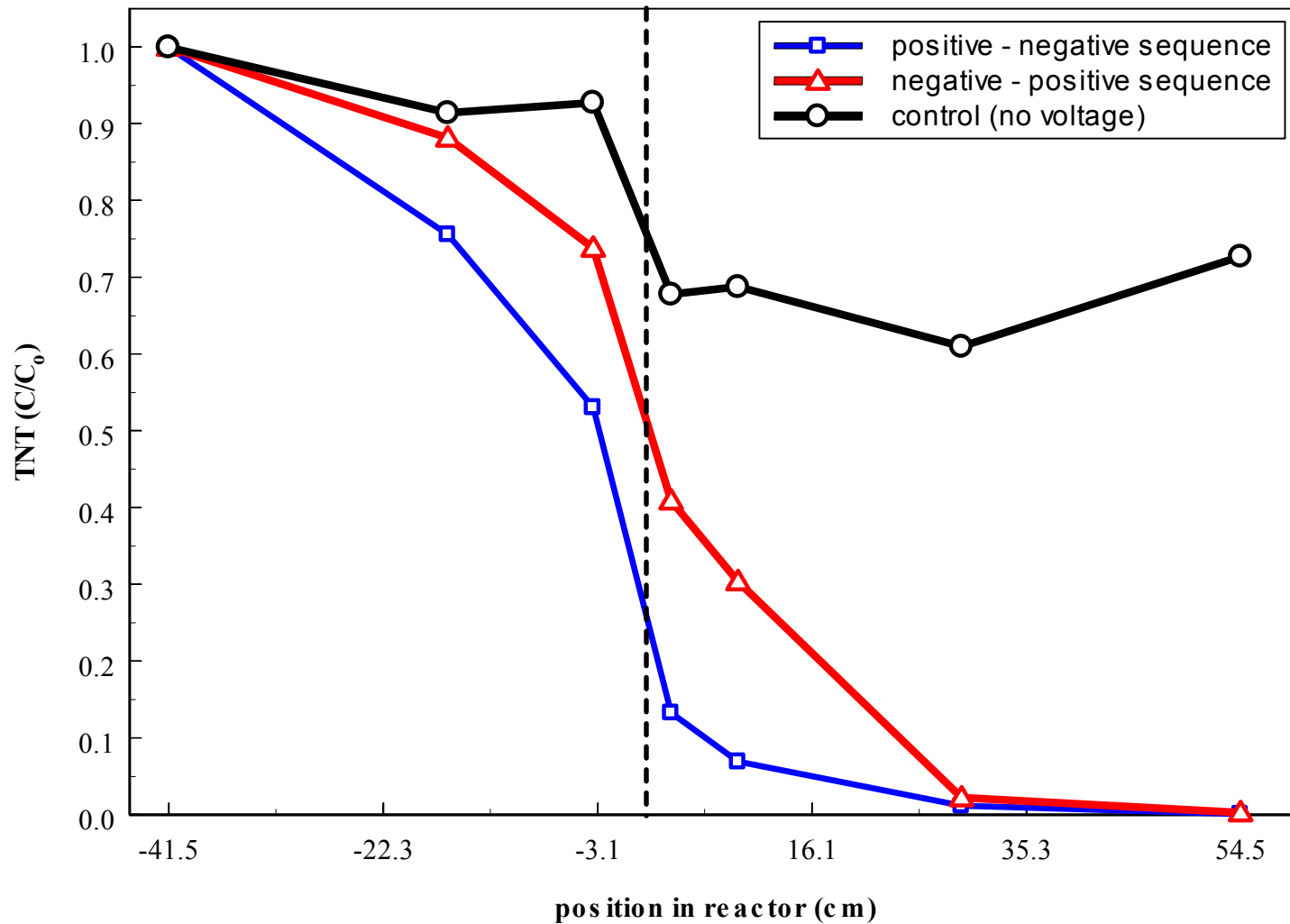


RDX Results

- minor peaks present also in control
- oxidation products transient

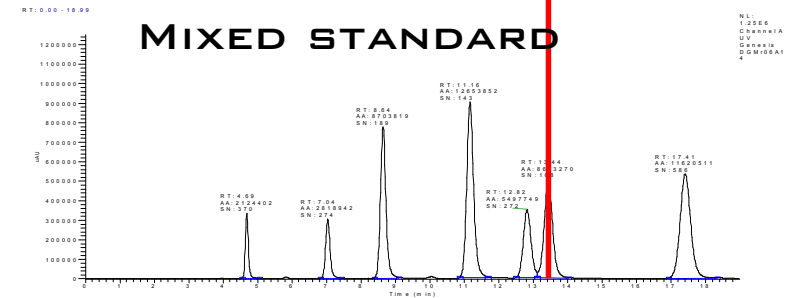
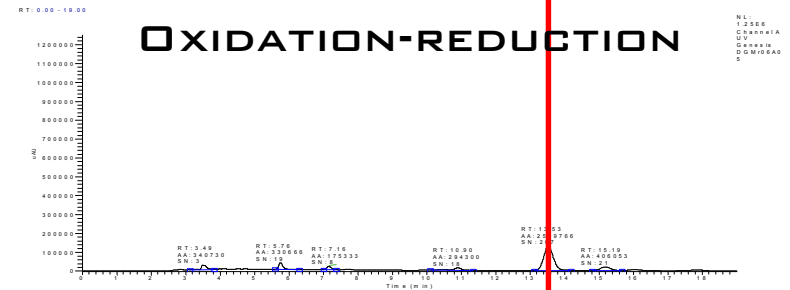
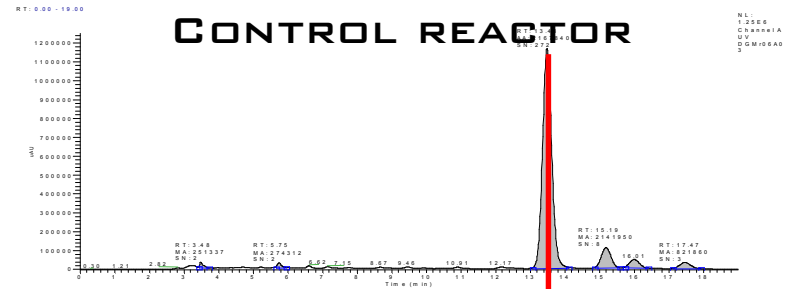


TNT Results



TNT Results

- common intermediate compounds absent
- minor peaks present also in control



CFB Borden Field Experiment



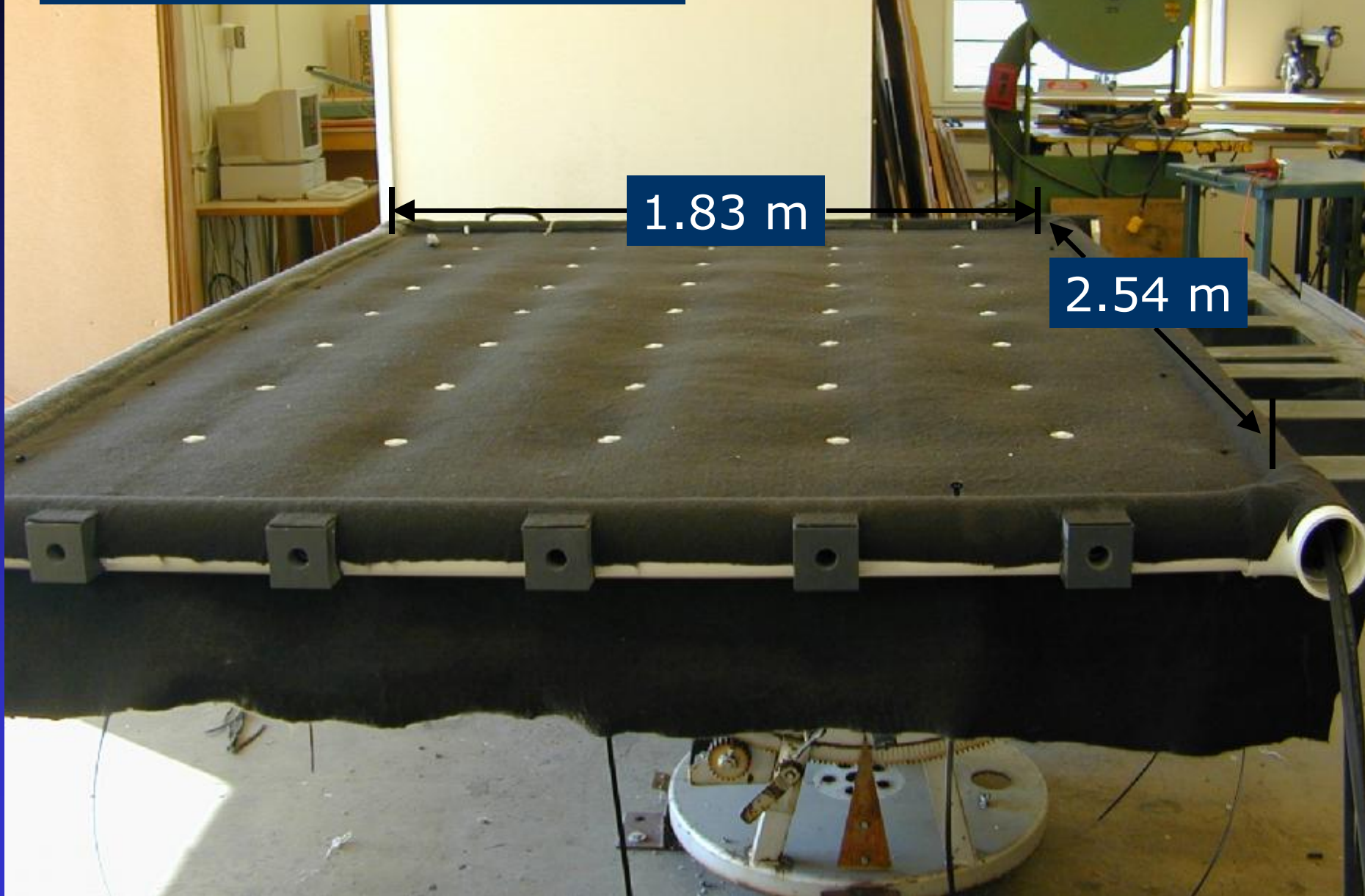
Knowledge to Go Places



Field Prototype Objectives

- Evaluate Scaling Lab to Field
 - Panel Fabrication/Construction
 - Installation
 - Performance
 - Electrical
 - pH and pe shifts
 - PCE-TCE depletion

PVC Panel Frame



Construction Materials

HDPE Geonet Spacer

Titanium Electrode

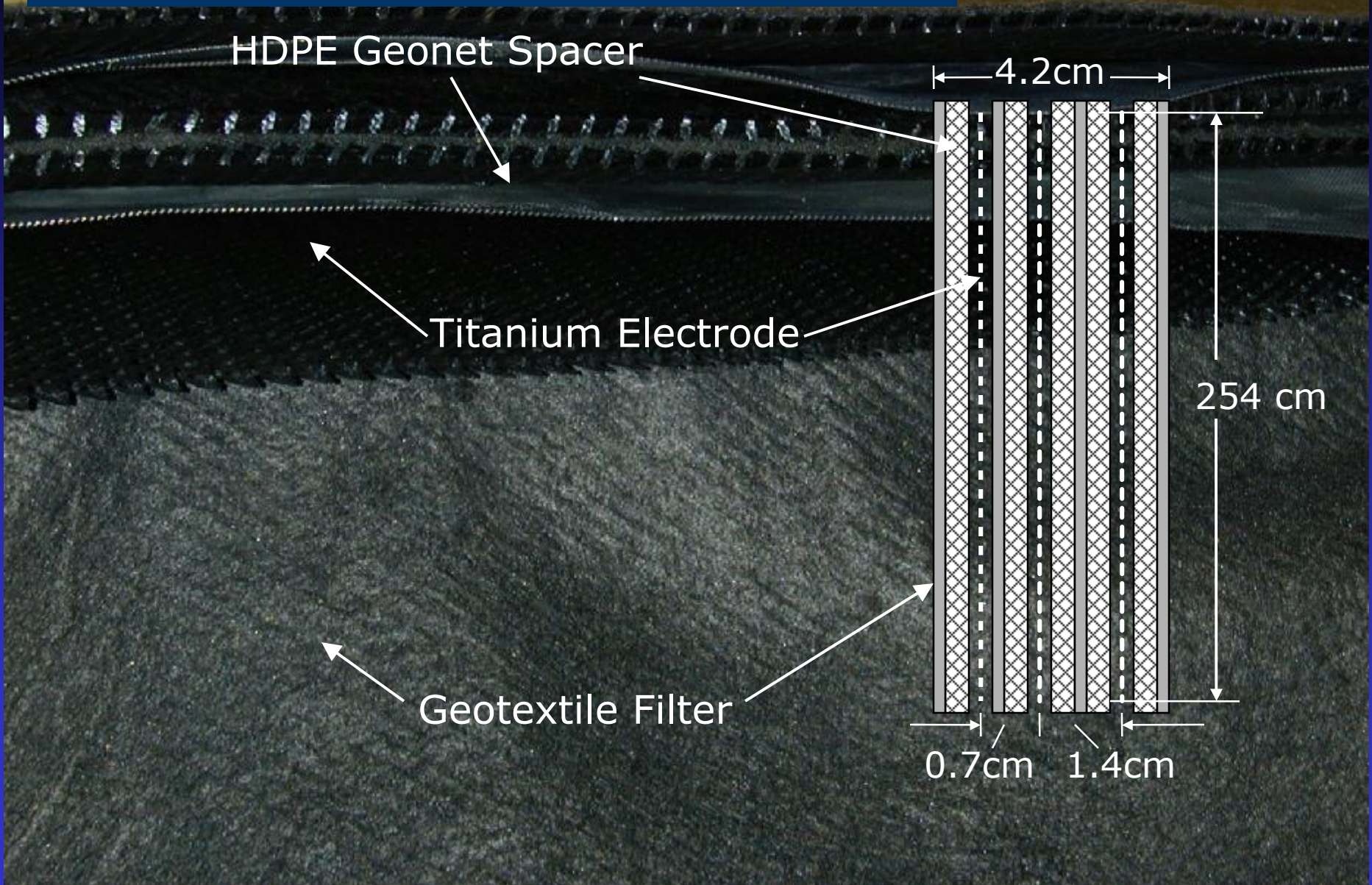
Geotextile Filter

4.2cm

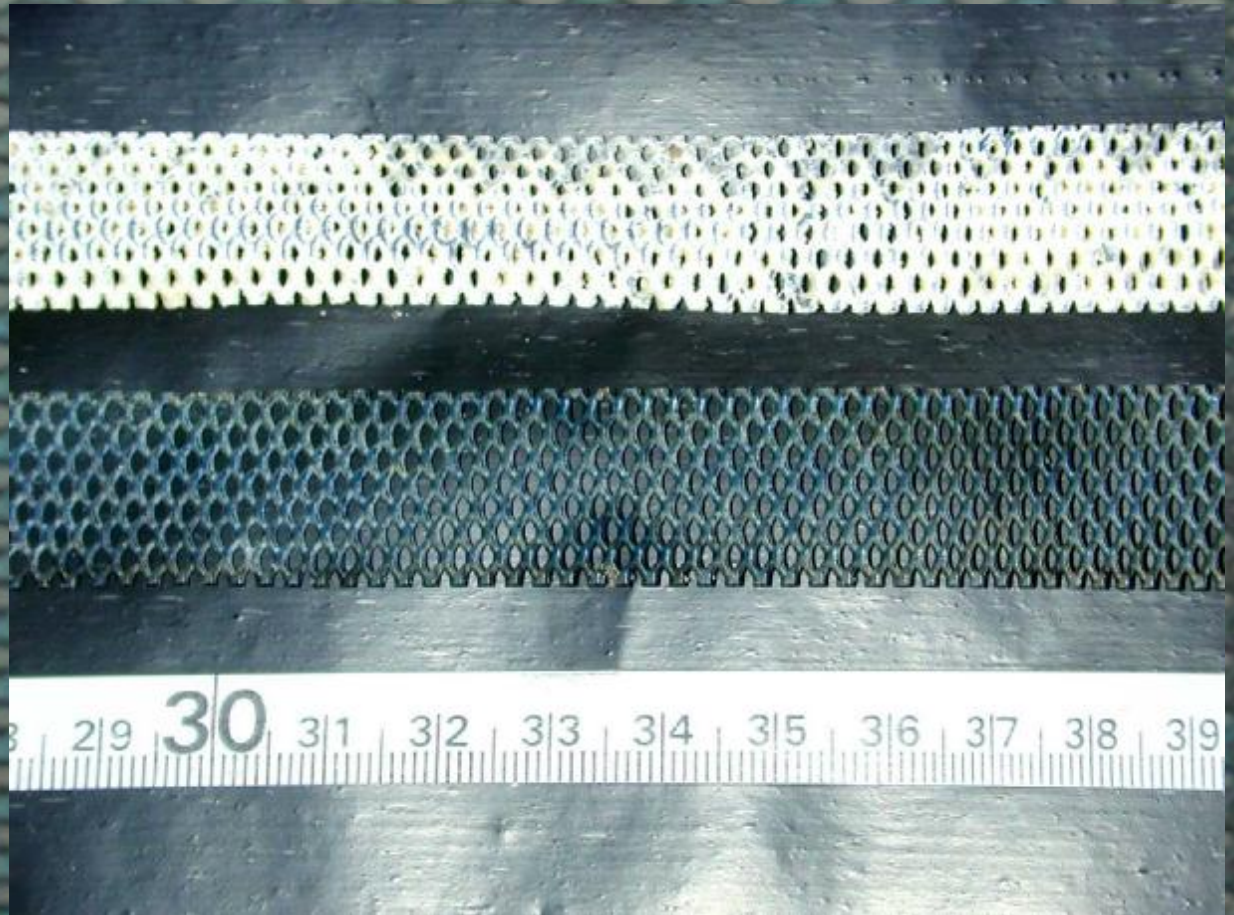
254 cm

0.7cm

1.4cm

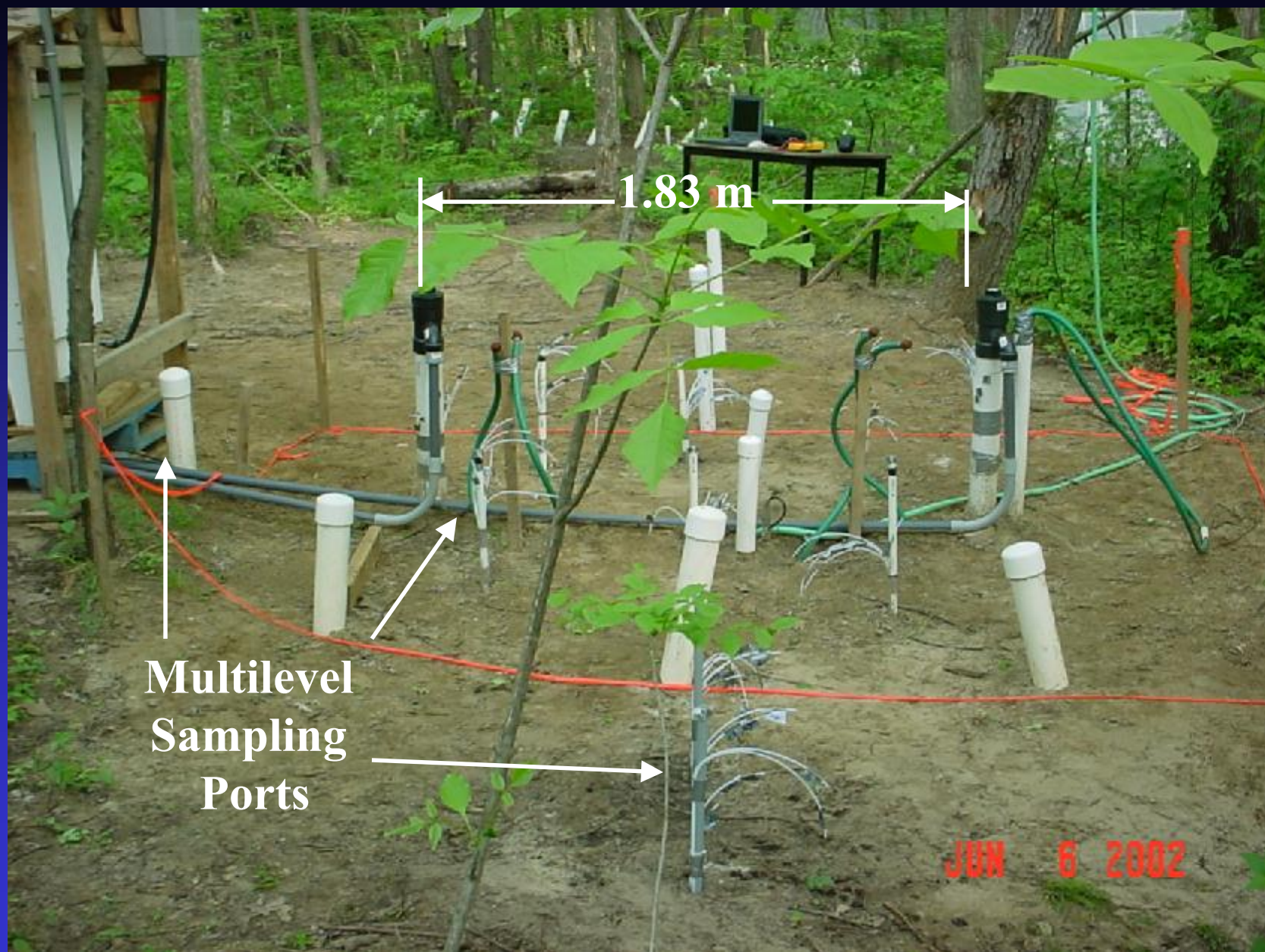


Expanded titanium

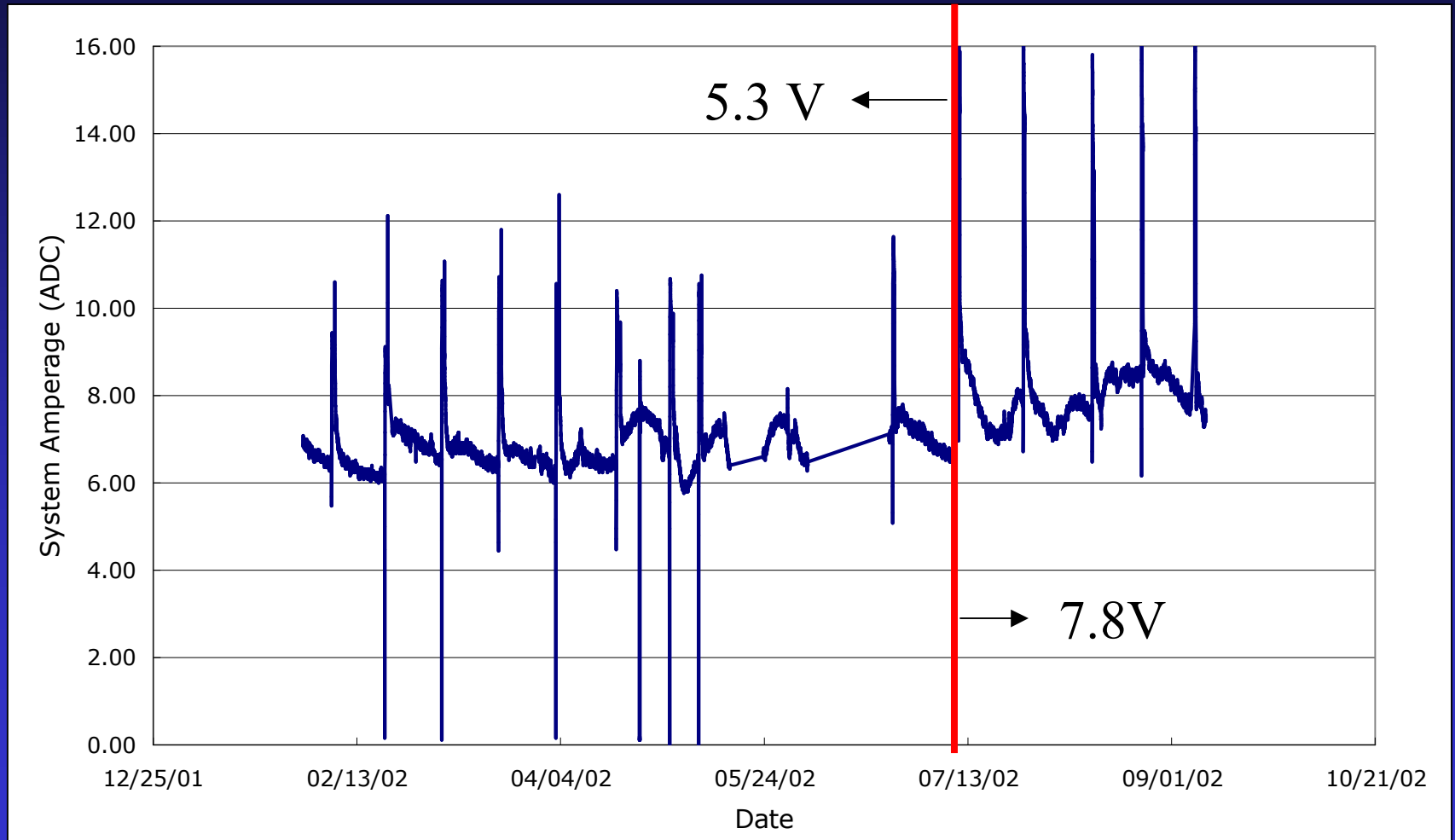


Borden Field Prototype

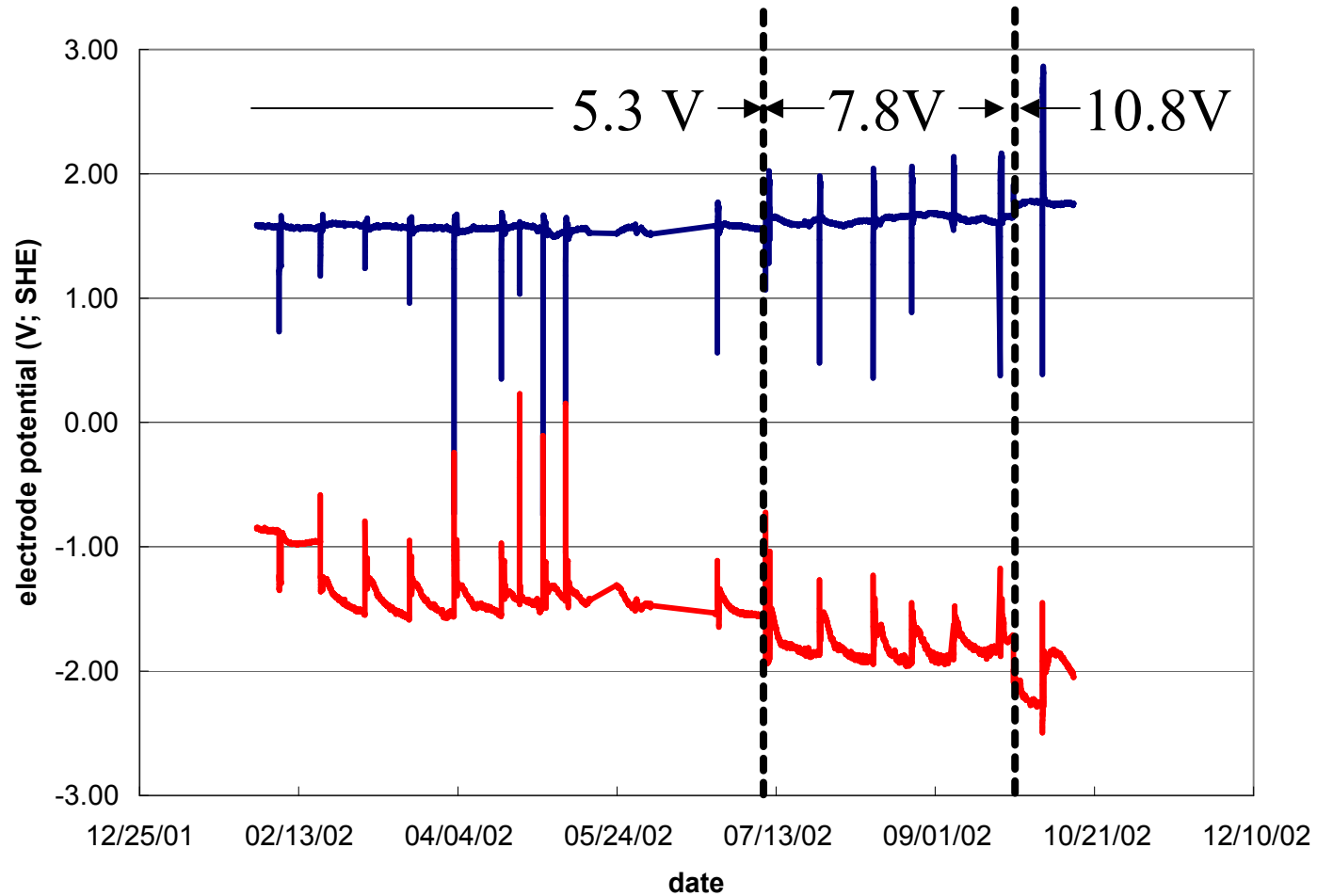




Amperage vs. Time

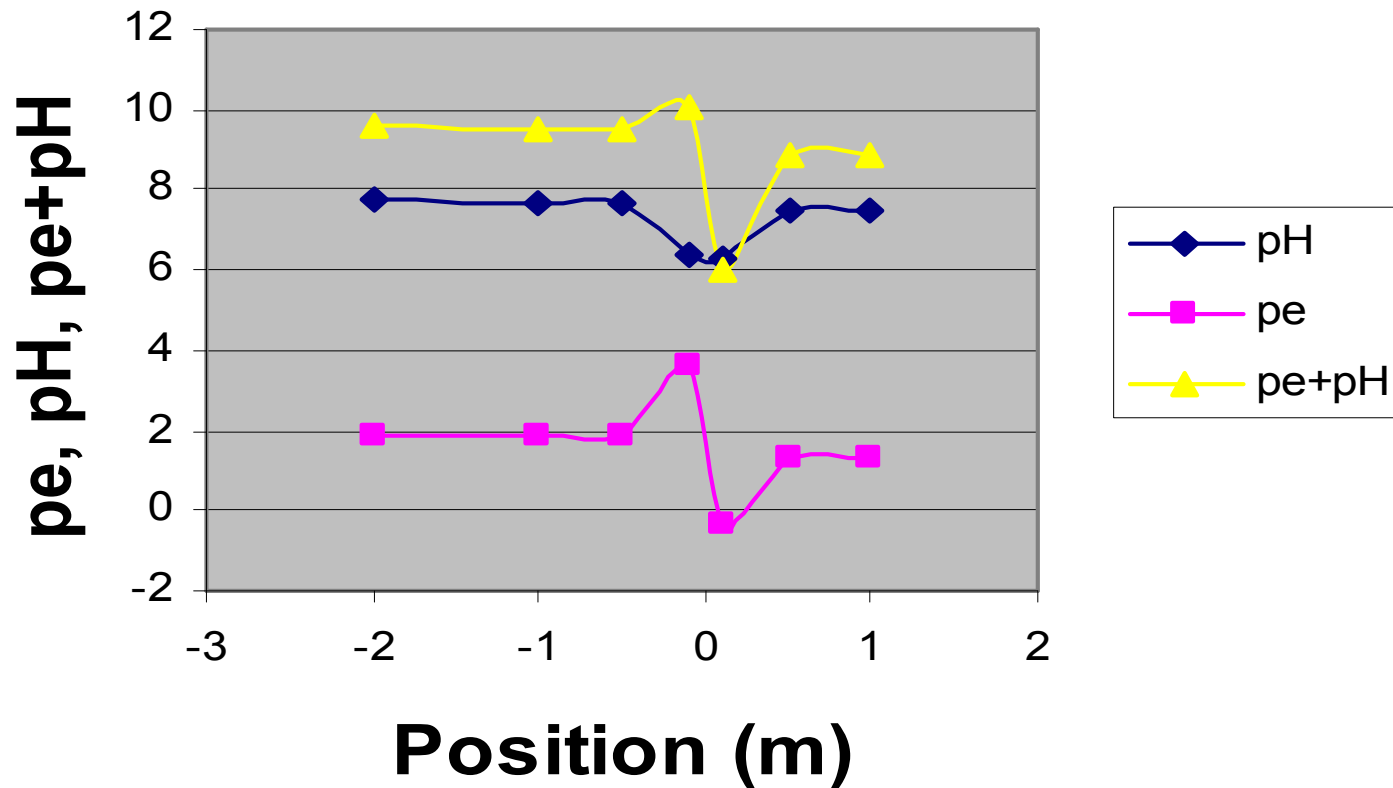


Reference Electrodes



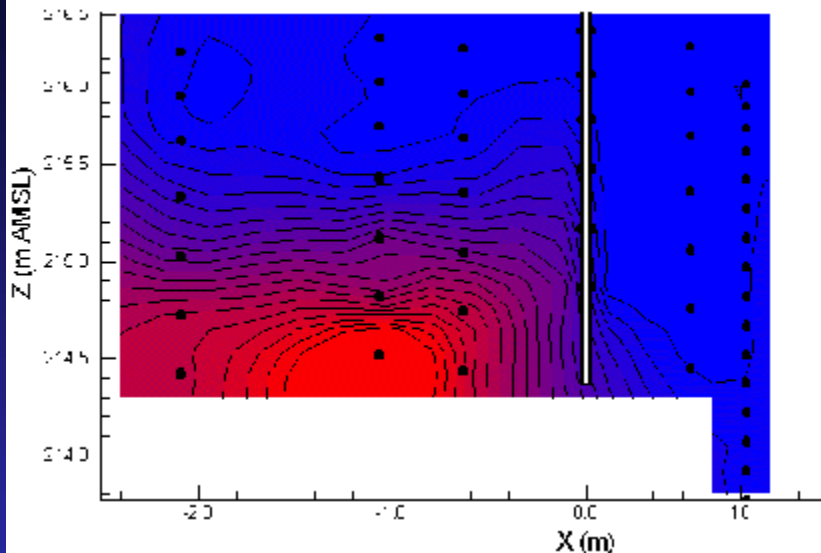
pH and pe

10 ft Transect 3/18

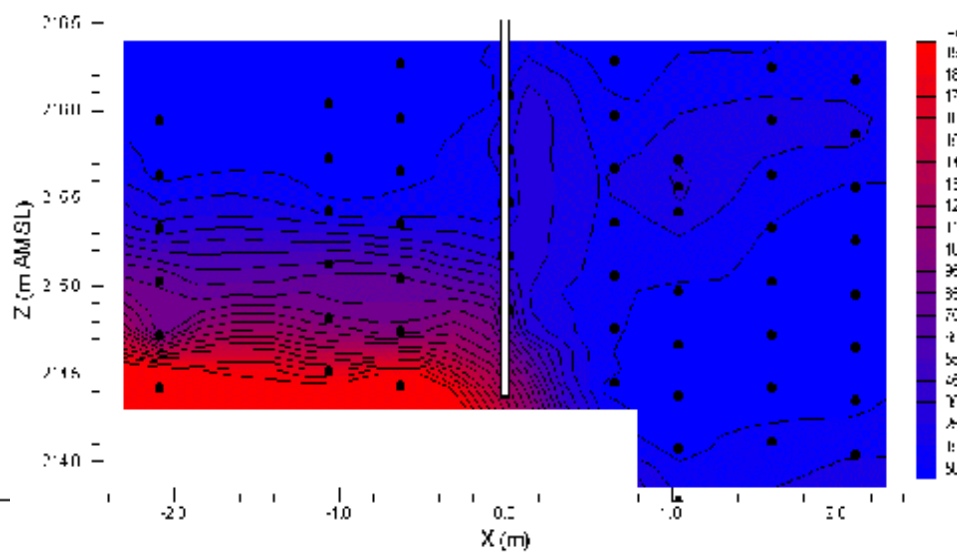


Results - PCE

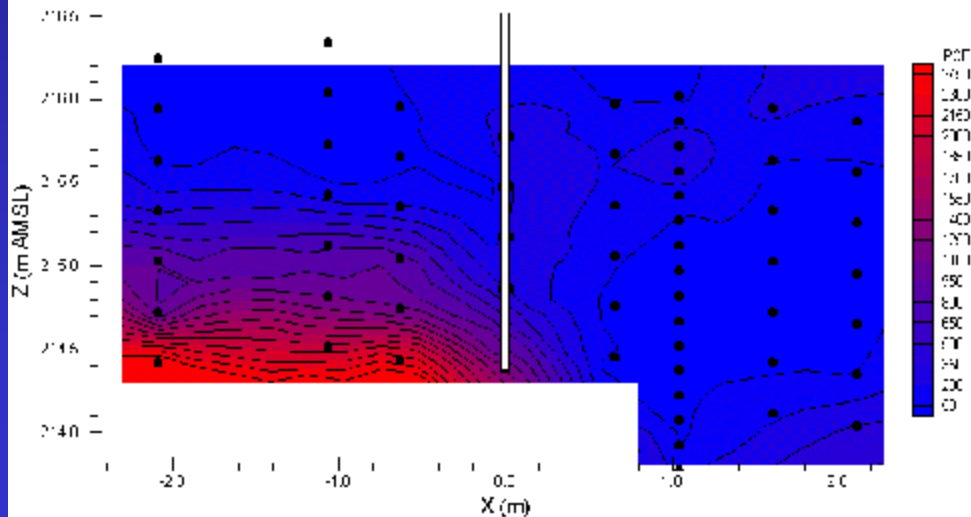
Background PCE (ug/L) January 14, 2002 -0.0V



B- Transect PCE (ug/L) July 9, 2002 -5.4V (Week 24)

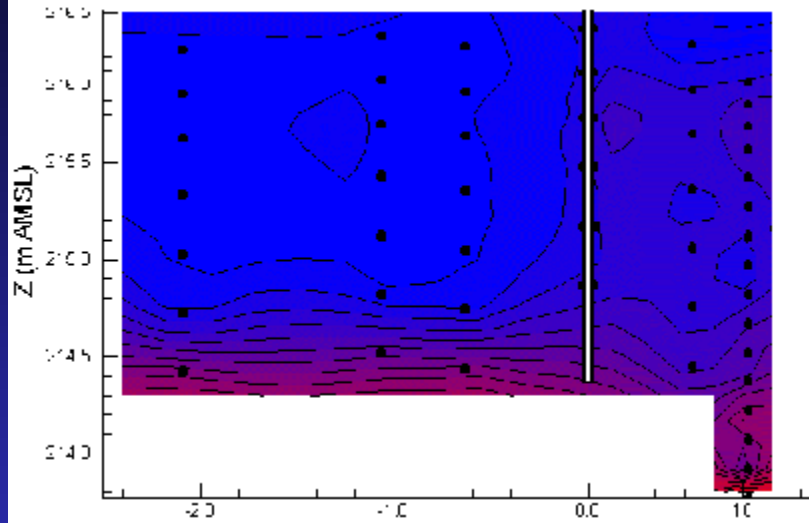


B- Transect PCE (ug/L) August 22, 2002 -7.8V (Week 30)

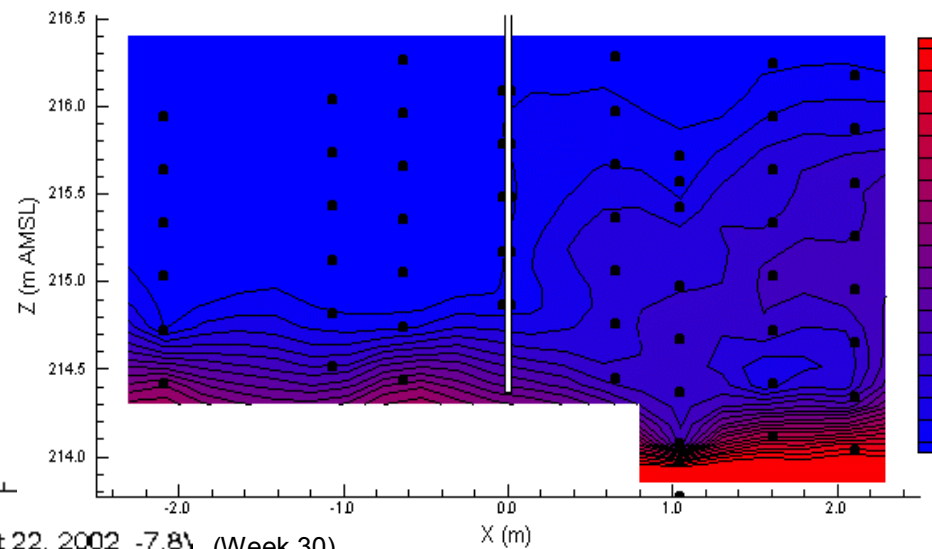


Results - TCE

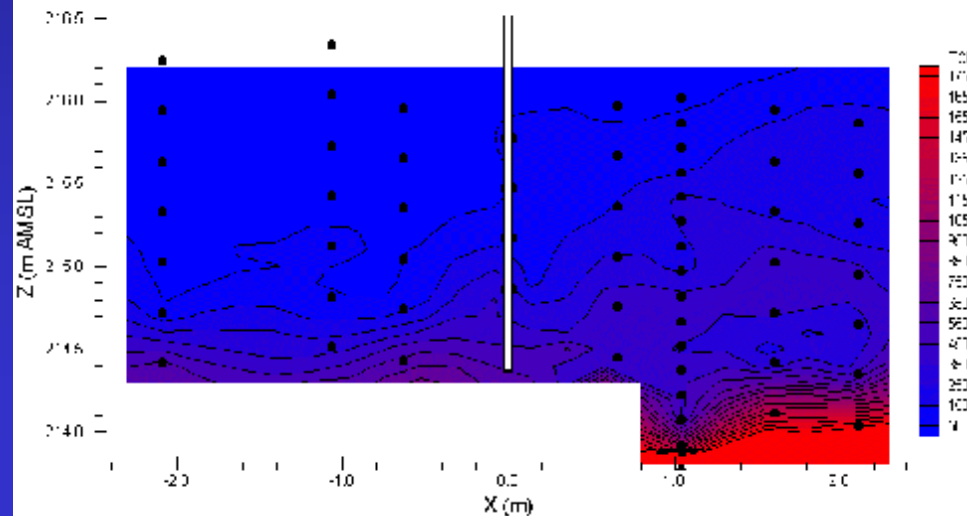
Background TCE (ug/L) January 14, 2002 -0.0V



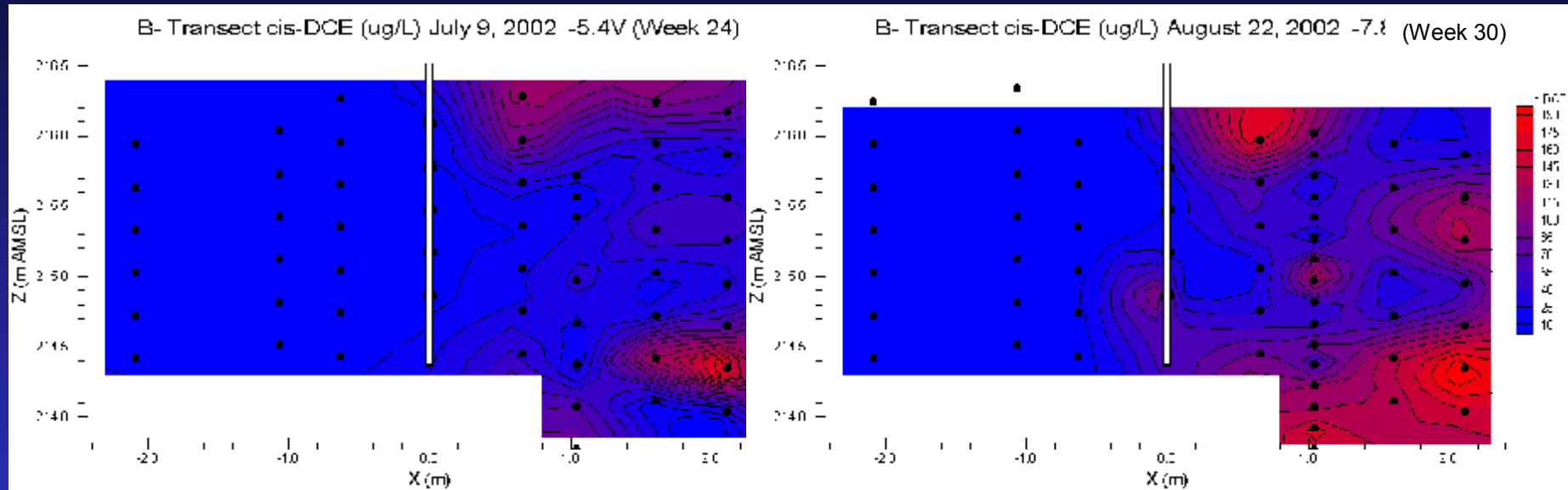
B- Transect TCE (ug/L) July 9, 2002 -5.4V (Week 24)



B- Transect TCE (ug/L) August 22, 2002 -7.8V (Week 30)



Results - c-DCE



CFB Borden

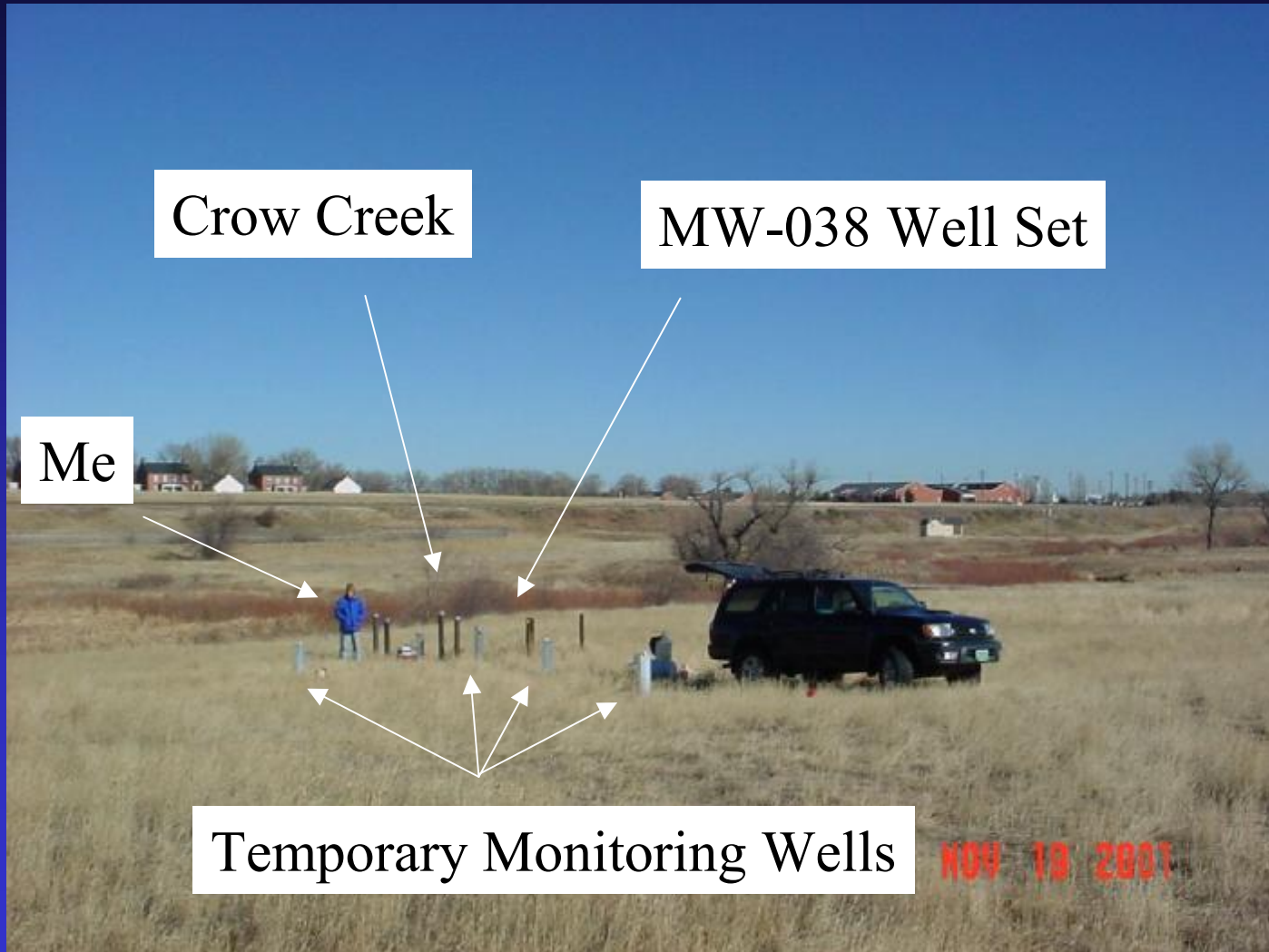
Preliminary Conclusions

- Panel Construction – Worked, room for improvement
- Installations – Feasible, challenging
- Performance
 - Sustained amperage
 - Cost ~ \$0.01/day/m²
 - pH, pe, Ref Potentials shifted
 - High level of PCE depletion sustained, generation of cis-DCE

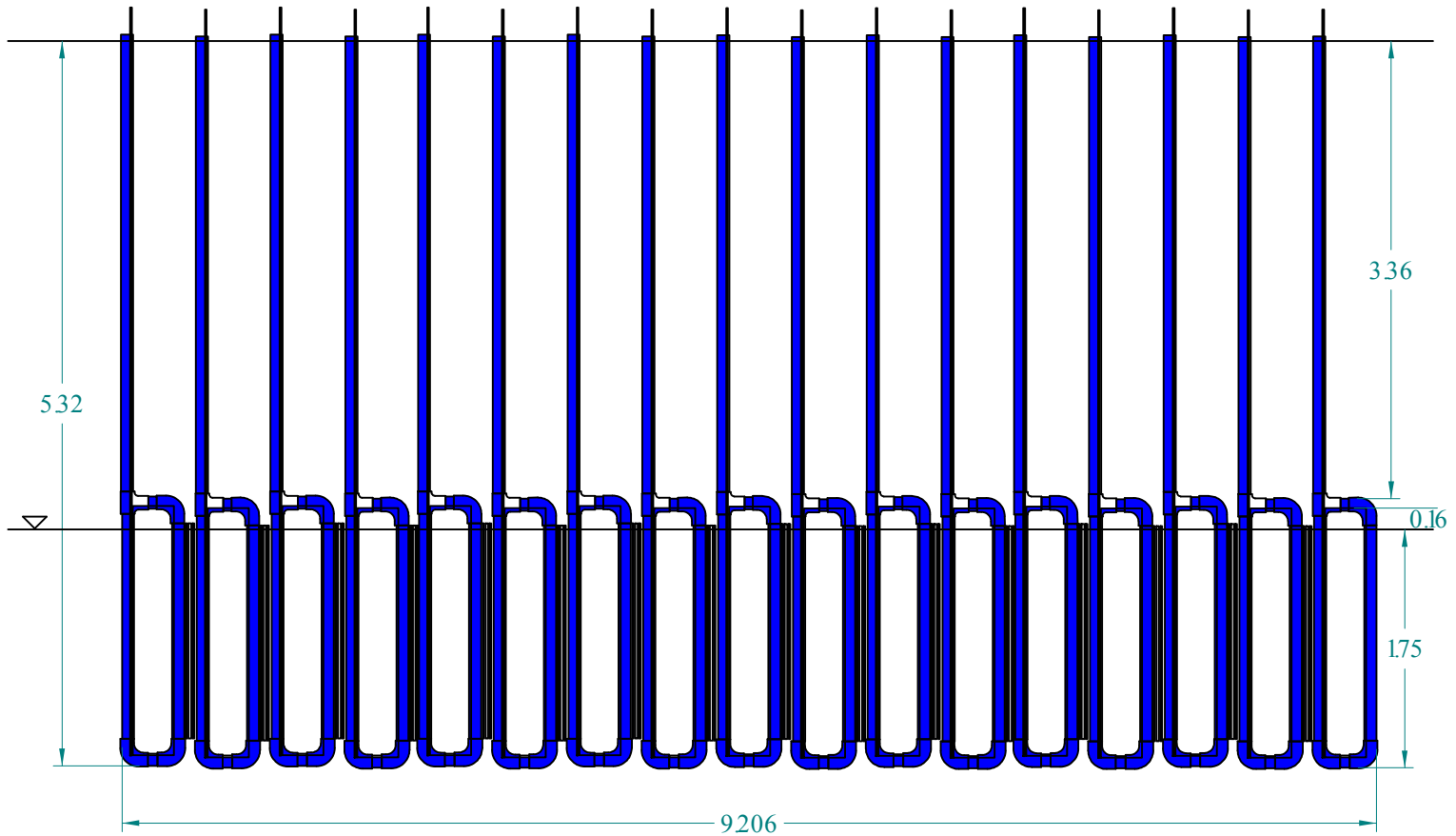
Electrically Induced Redox Barrier for Treatment of a Trichloroethylene Plume



Field Demonstration Site



Panel Design

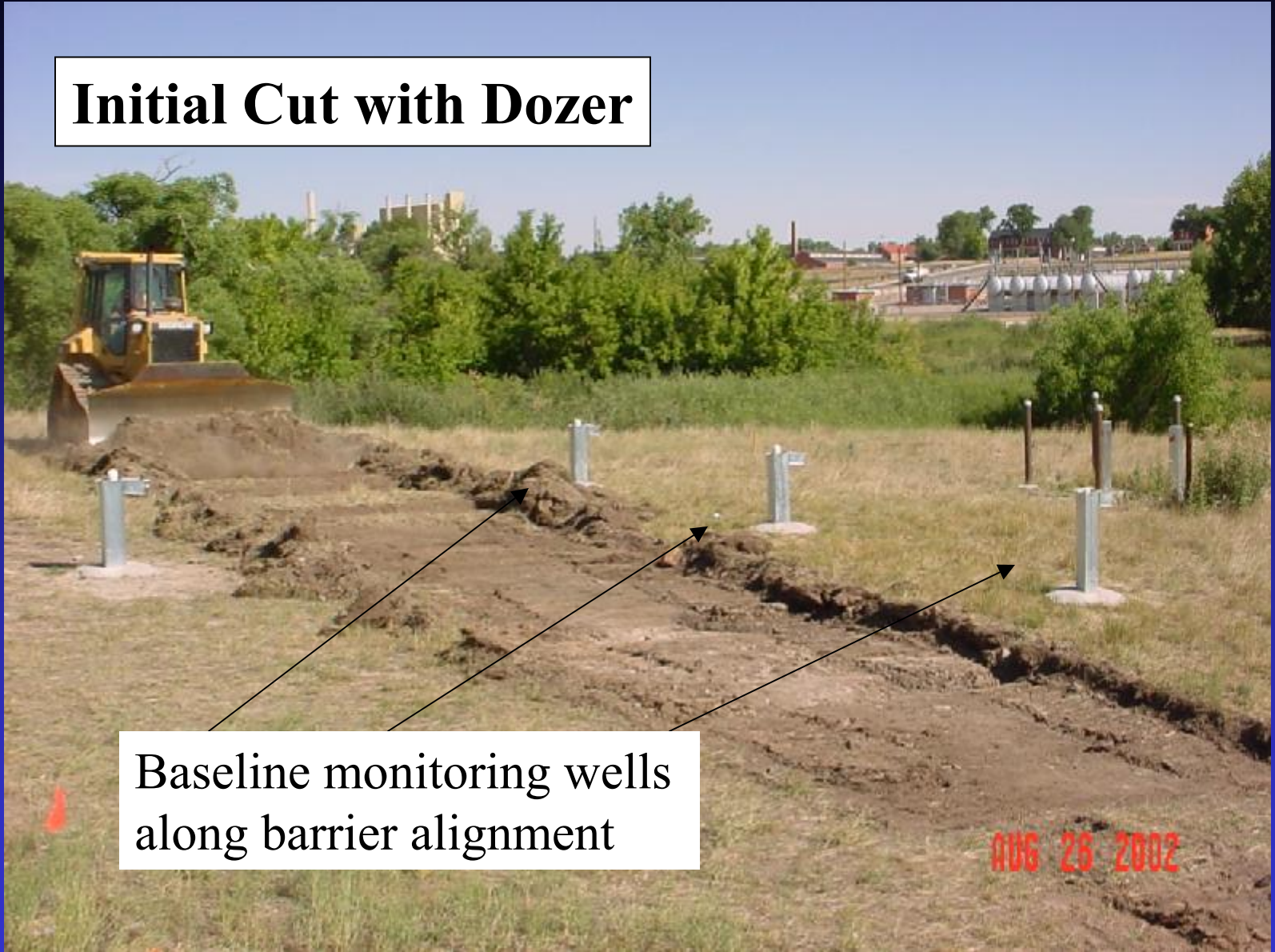


(Dimensions in m)

Initial Cut with Dozer

Baseline monitoring wells
along barrier alignment

AUG 28 2002



Initial Cut With Excavator



Set ½ Barrier in the Trench



AUG 28 2002

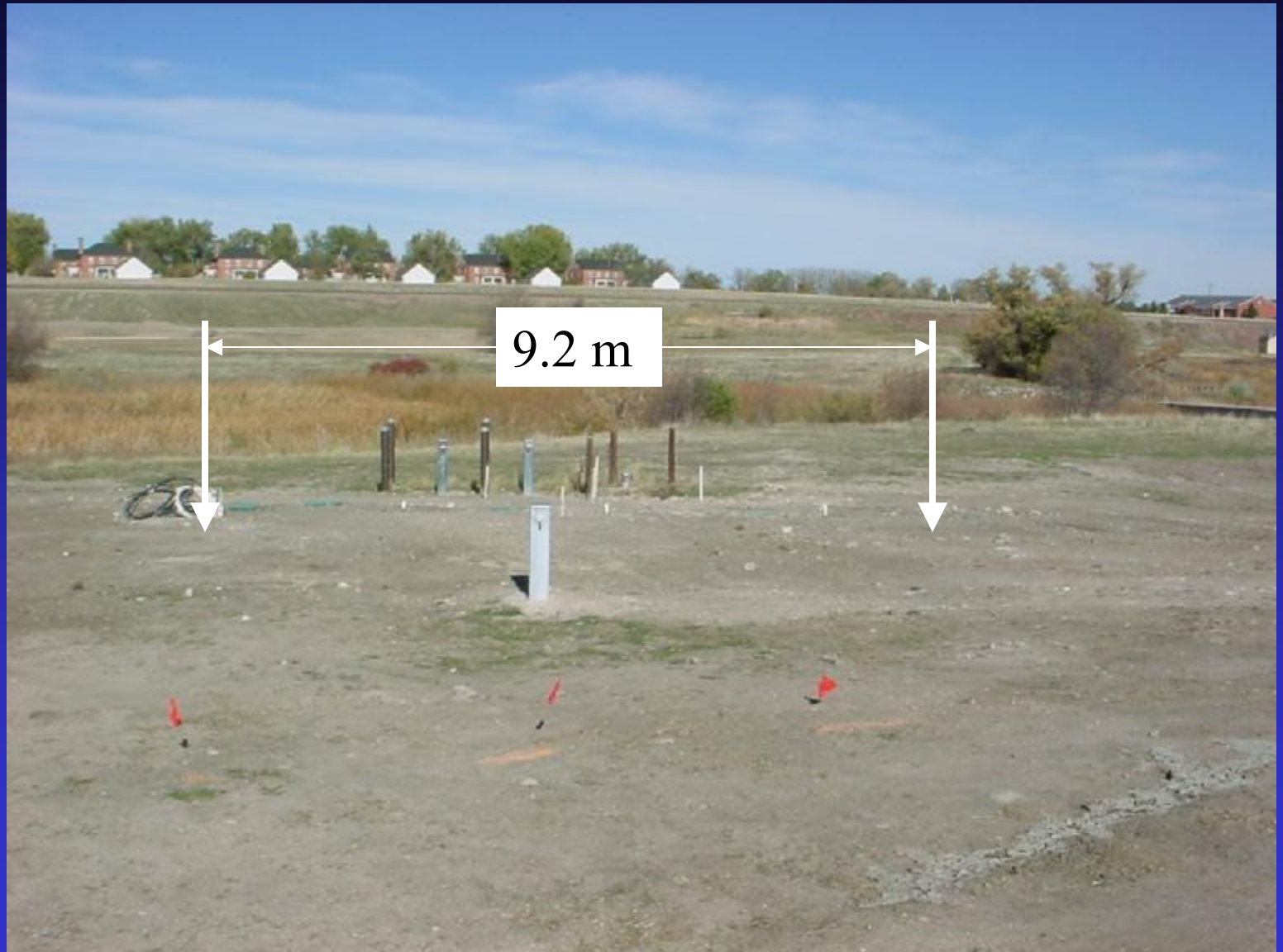
1/2 of the Barrier Set



Well Sorted Medium Sand Backfill

AUG 28 2002

Finish Assembly at Grade



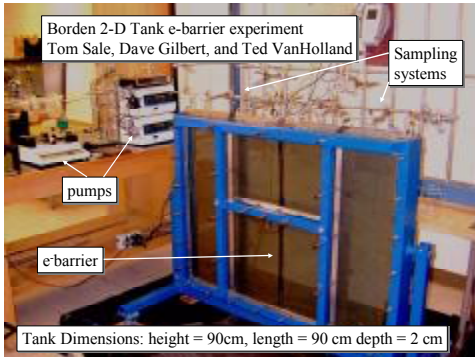
Evolution Concept → Technology



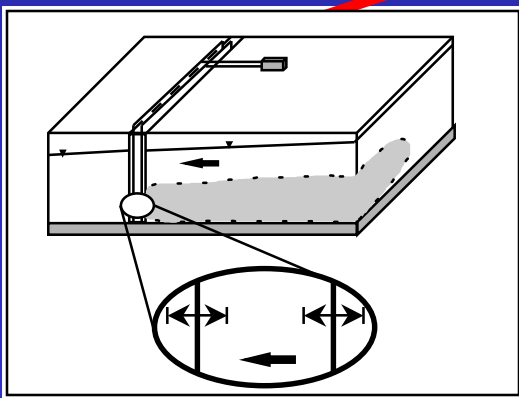
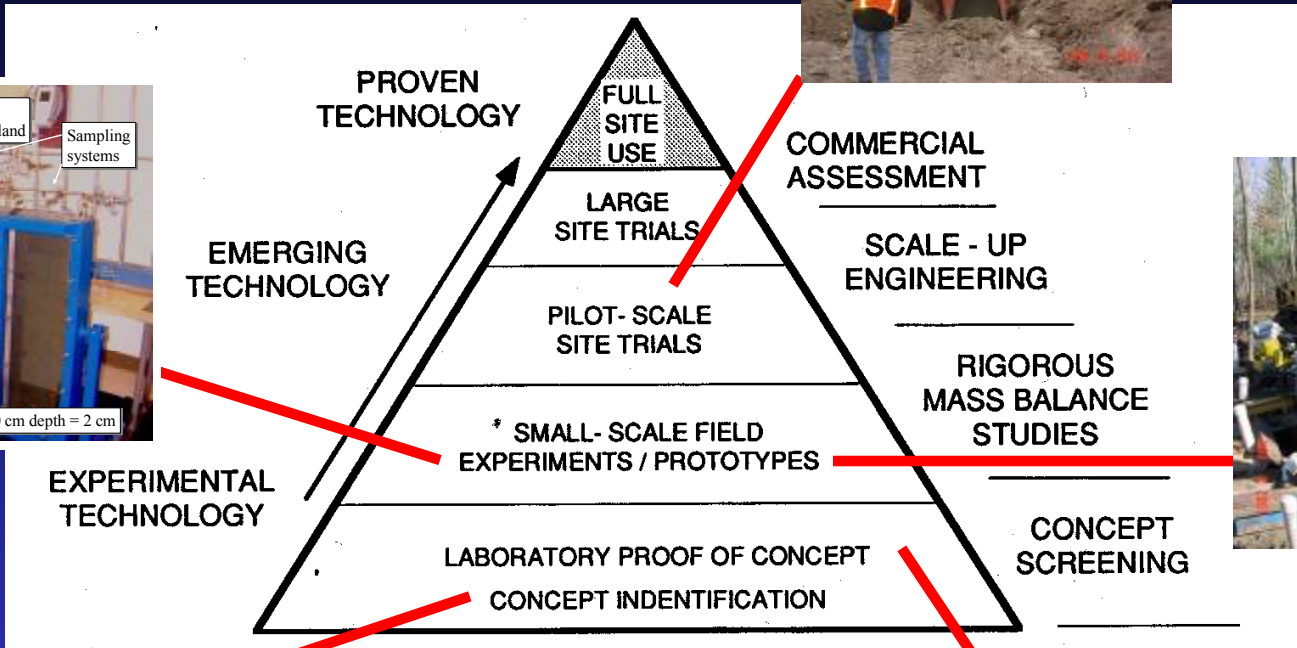
2002



2001



2000



1998

1999



Acknowledgements - Funding

- University Solvents-in- Groundwater Research Consortium
- ESTCP
- SERDP
- United Technologies Corp.
- National Science Foundation

Acknowledgements

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