

# *Abiotic Natural Attenuation of Dichloroethylene Isomers*

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# *Natural attenuation*

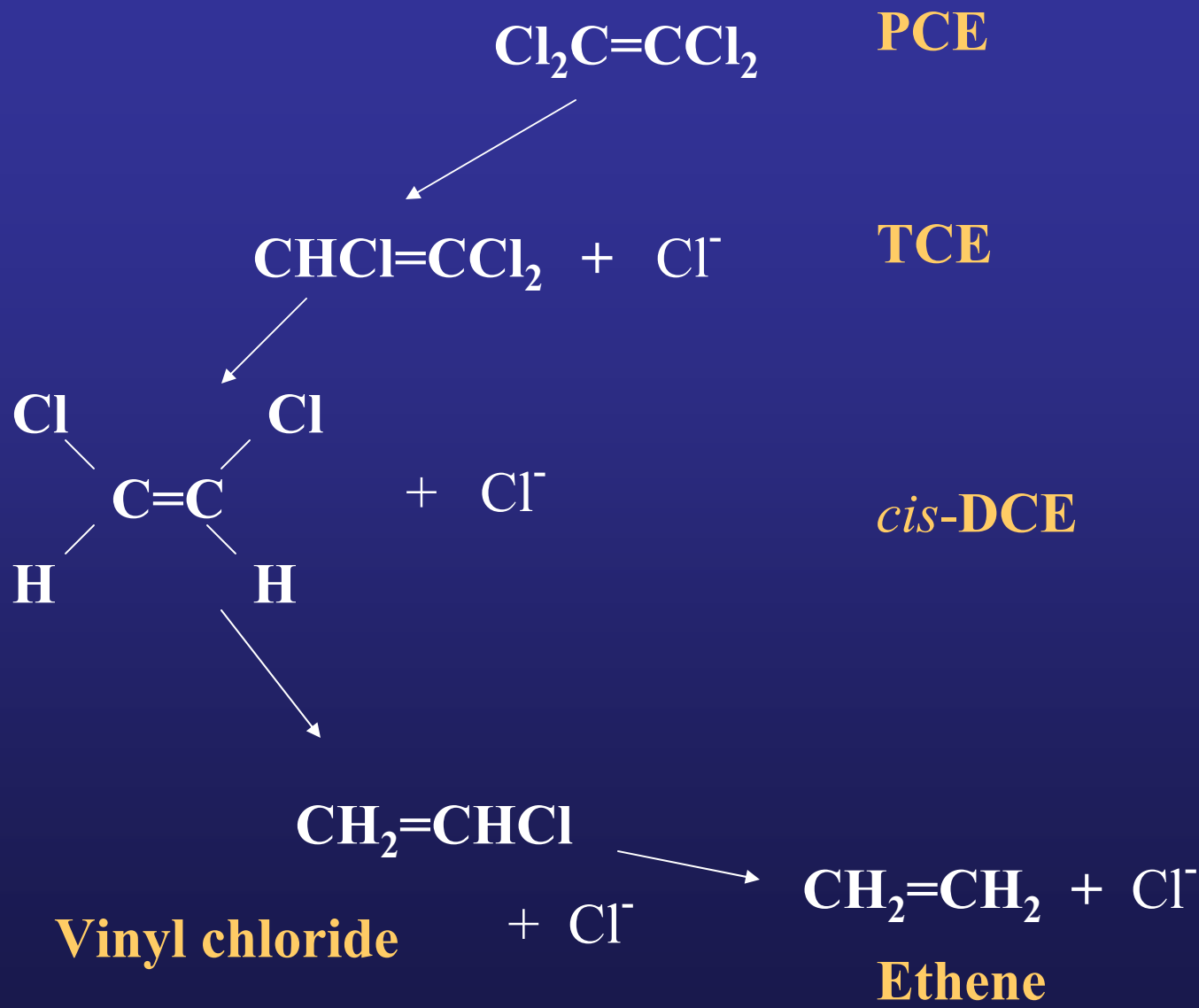
- “. . . a variety of physical, chemical, or biological processes that, under favorable conditions . . . reduce the mass, toxicity, mobility, volume, or concentration of contaminants.”

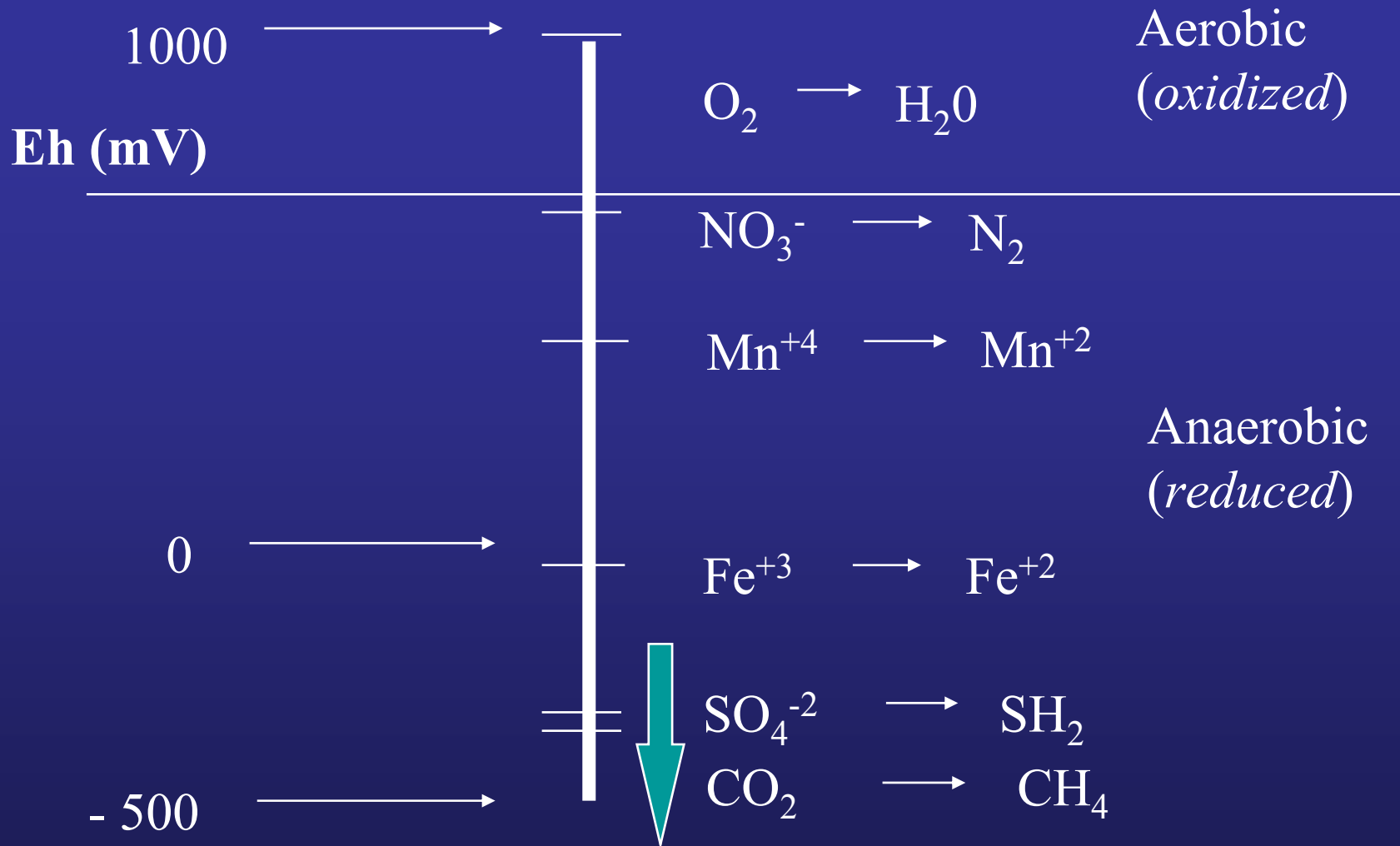
*(EPA, 1999)*

# *Dominant processes in natural attenuation*

- Biological reductive dehalogenation
- Sorption
- Dilution

Abiotic mechanisms are ignored.





(from Bouwer, 1994)

	3U020	3M020	3L020	4U020
O <sub>2</sub>	9.5 ppm	0.8	1.8	0.02
NO <sub>3</sub> <sup>-2</sup>	2.6	<0.1	<0.1	<0.1
Mn <sup>+2</sup>	0.13	1.12	1.3	0.67
Fe <sup>+2</sup>	<0.1	<0.1	<0.1	1.8
SO <sub>4</sub> <sup>-2</sup>	28.	3.3	4.6	6.8
ORP	118	-60	-119	-243
CH <sub>4</sub>	ND	0.035	0.015	0.007
DOC	2.4	1.3	1.3	2.3

	03U020	03M002	03U314
<i>TCE</i>	904	150	210
<i>c-DCE</i>	4.0	2.1	1.2
<i>t-DCE</i>	<i>ND</i>	<i>ND</i>	<i>ND</i>
<i>VC</i>	<i>ND</i>	<i>ND</i>	<i>ND</i>
<i>Ethene</i>	<i>ND</i>	<i>ND</i>	<i>ND</i>

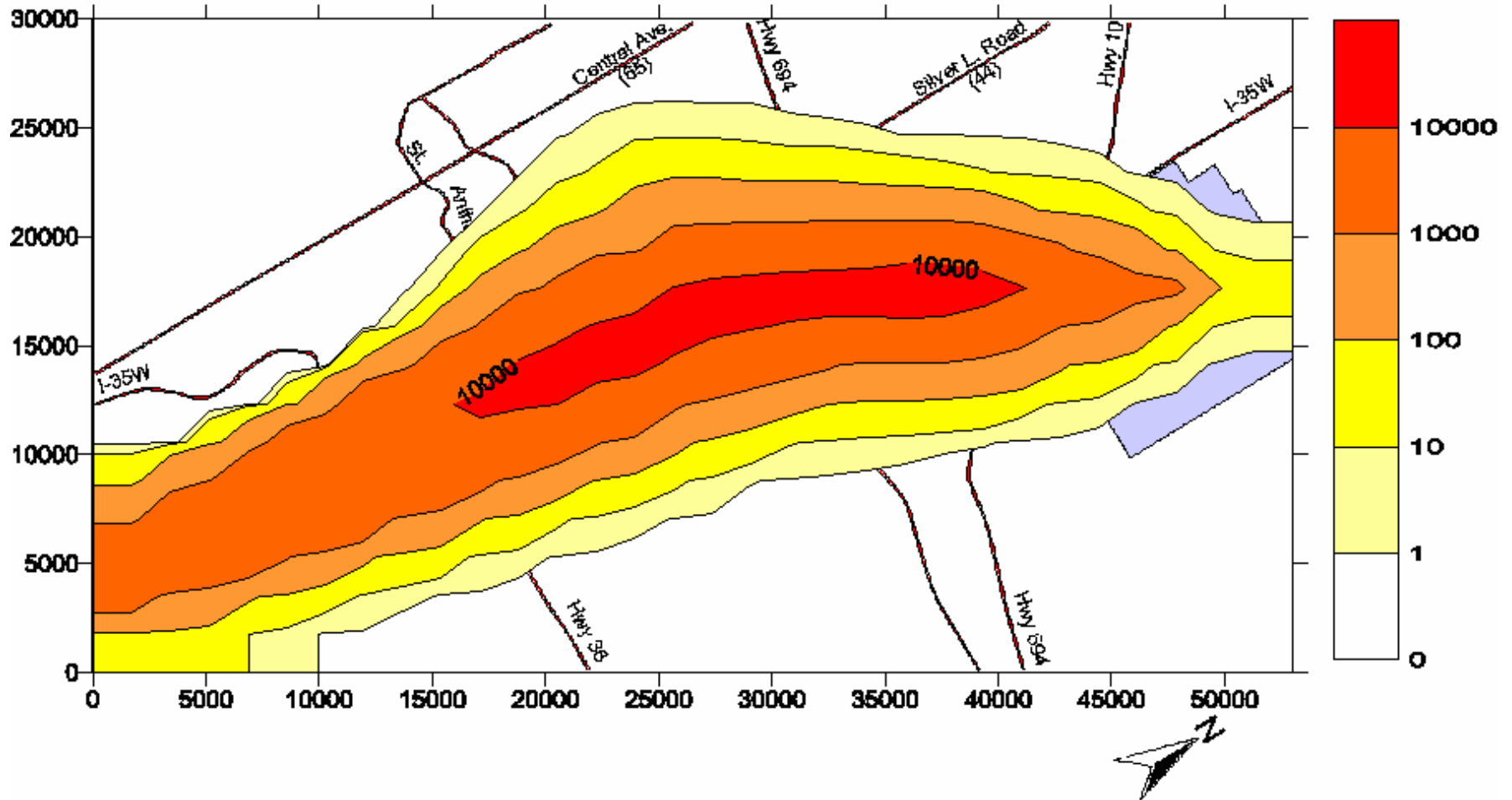
# *1998 TCAAP Natural Attenuation Study*

- EPA *beta*-testing of the newly developed natural attenuation remedy protocol.
- Insight to the long-term fate of the TCAAP deep ground water contaminant plume.
- Rationale for remedial decisions for ground water.



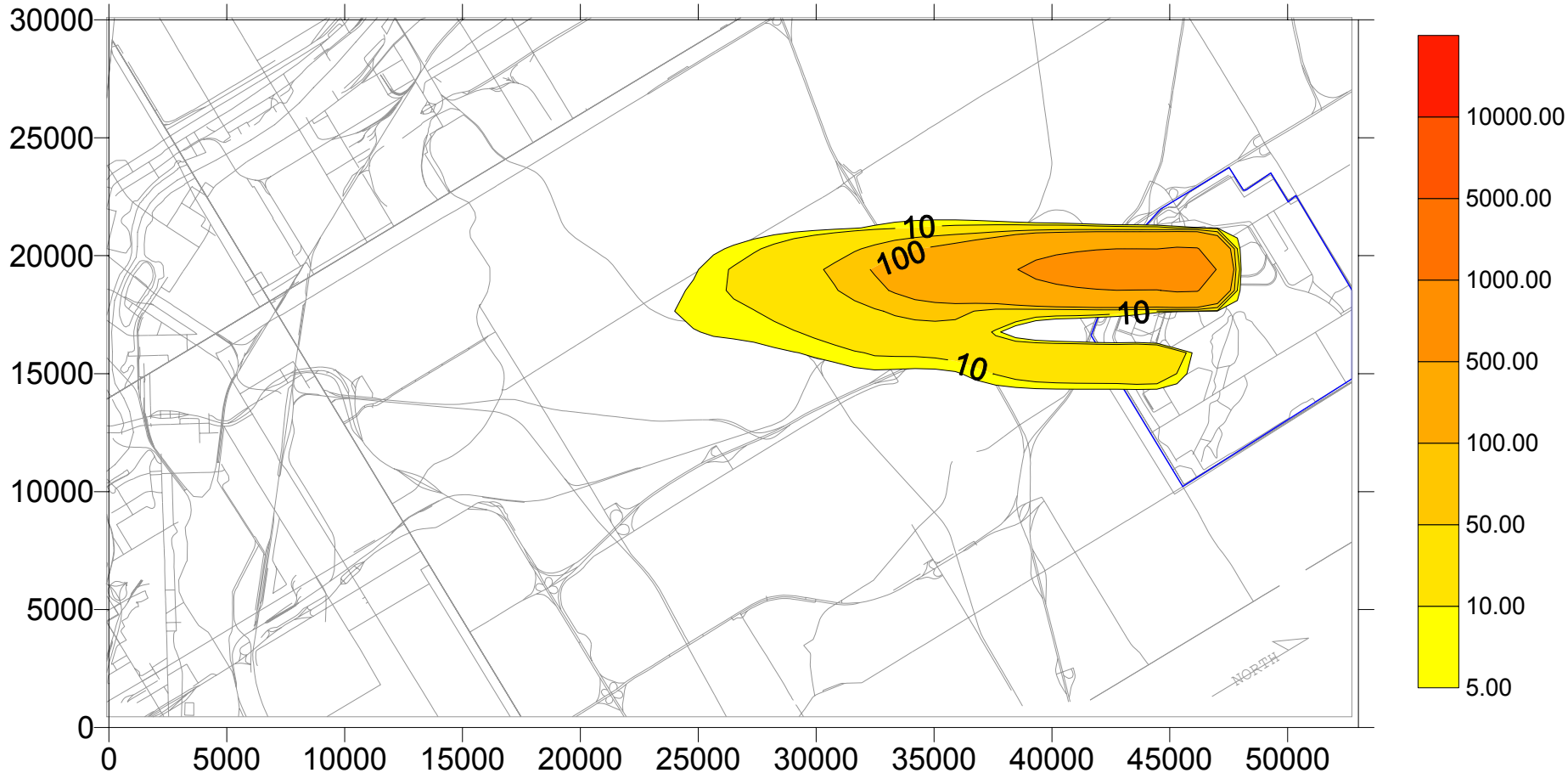
# Anticipated TCAAP plume

**1998 - NO NATURAL ATTENUATION**



# Actual TCAAP Plume

Time = 1998

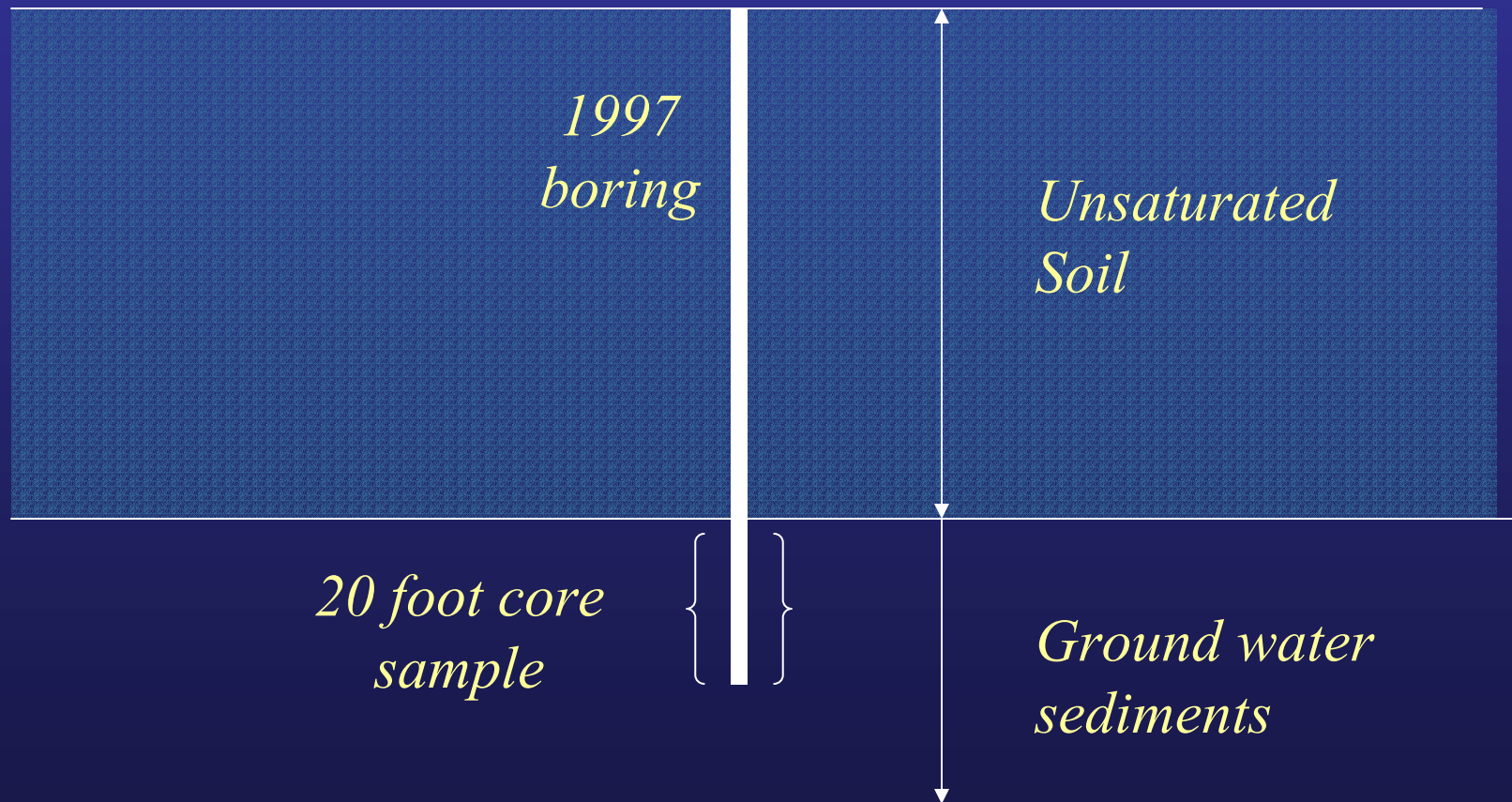


**TCAAP Simulated TCE  
With Source and Dissolved  
Phase Decay**

- A contaminant first-order decay rate of at least  $-0.2 \text{ yr}^{-1}$  is required to account for the current size of the plume.
- The aquifer environment was not favorable to biological degradation of chlorinated solvents.

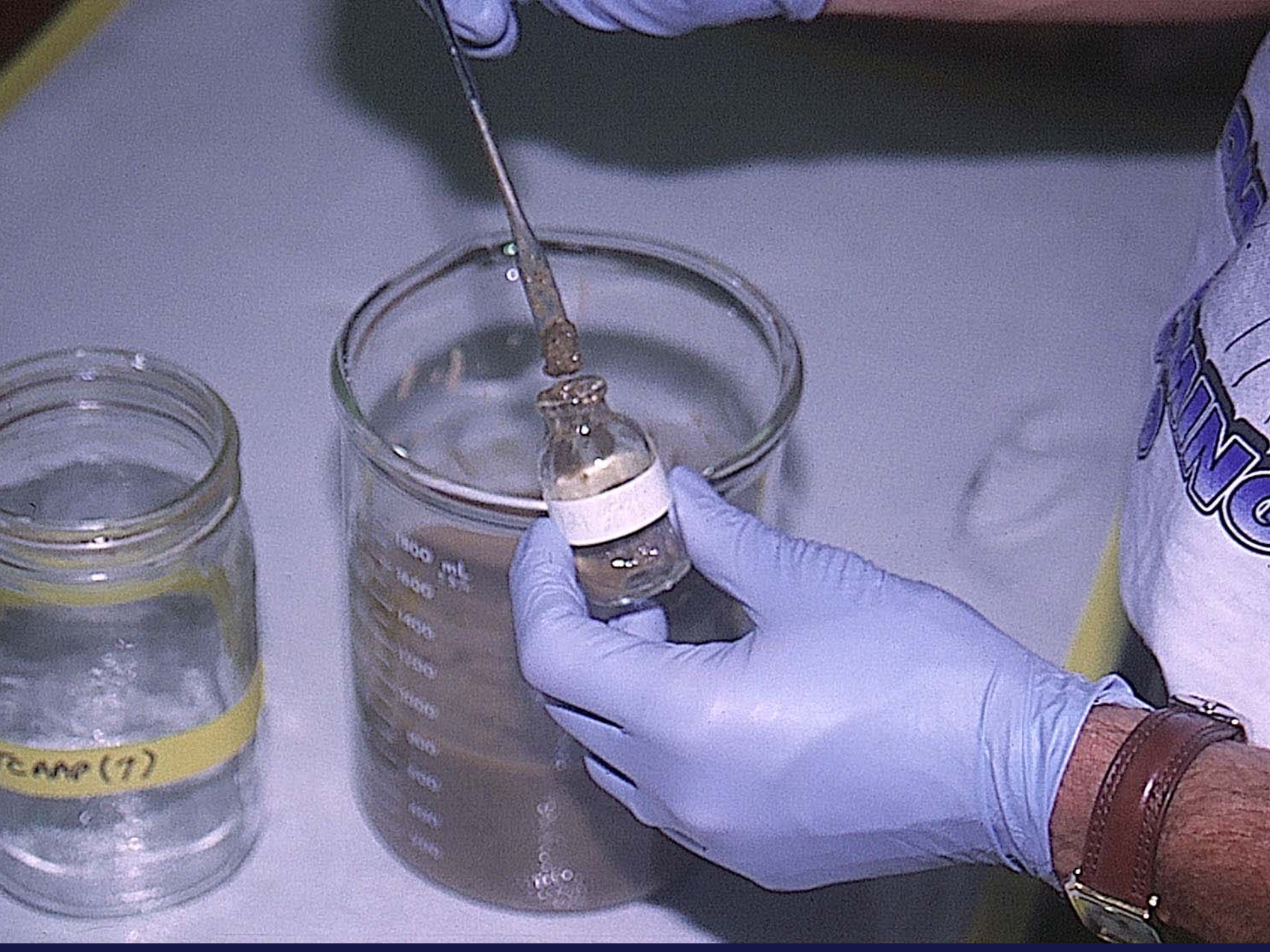
# Microcosm sediment sample collection

Contaminant source area









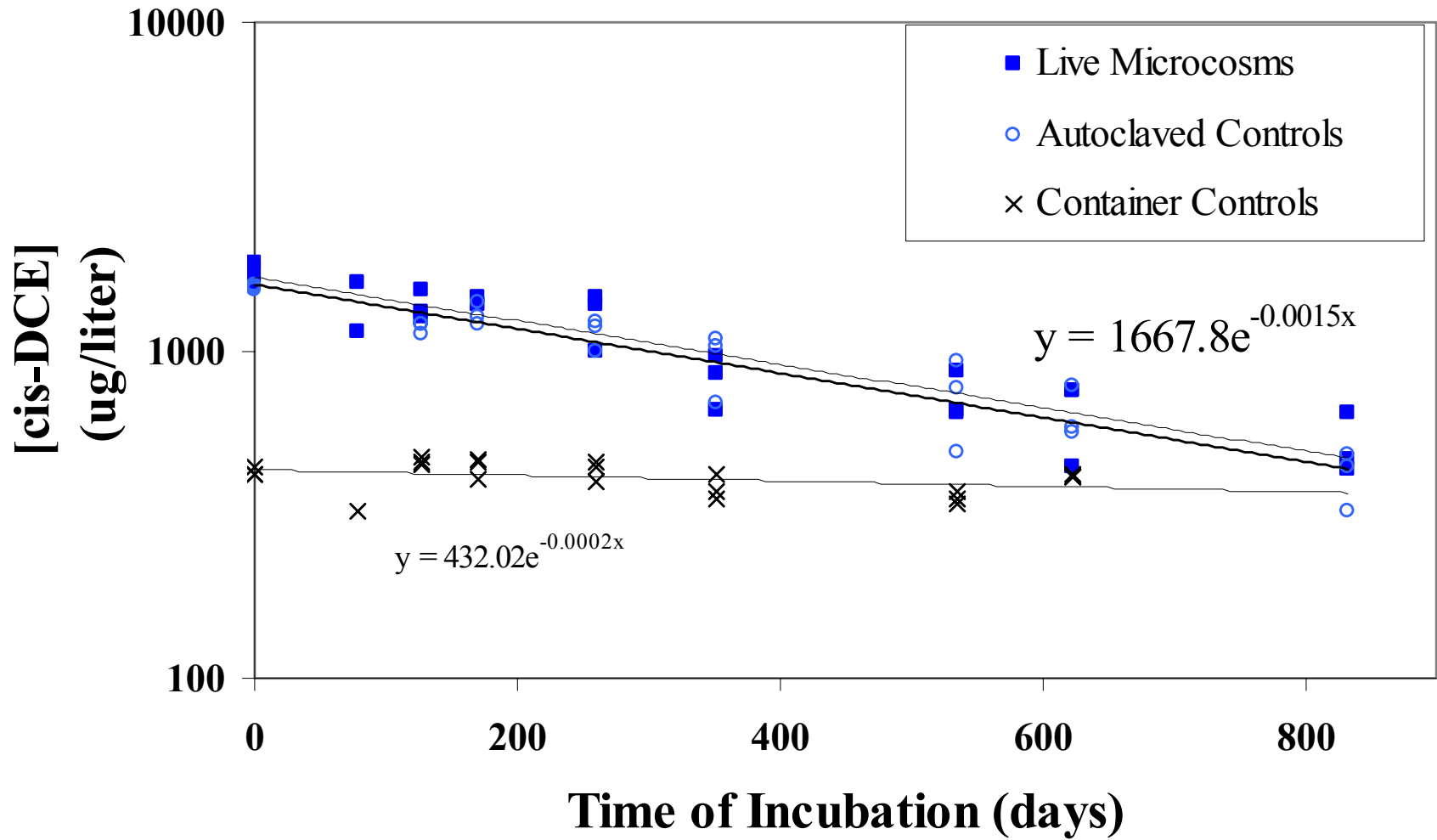




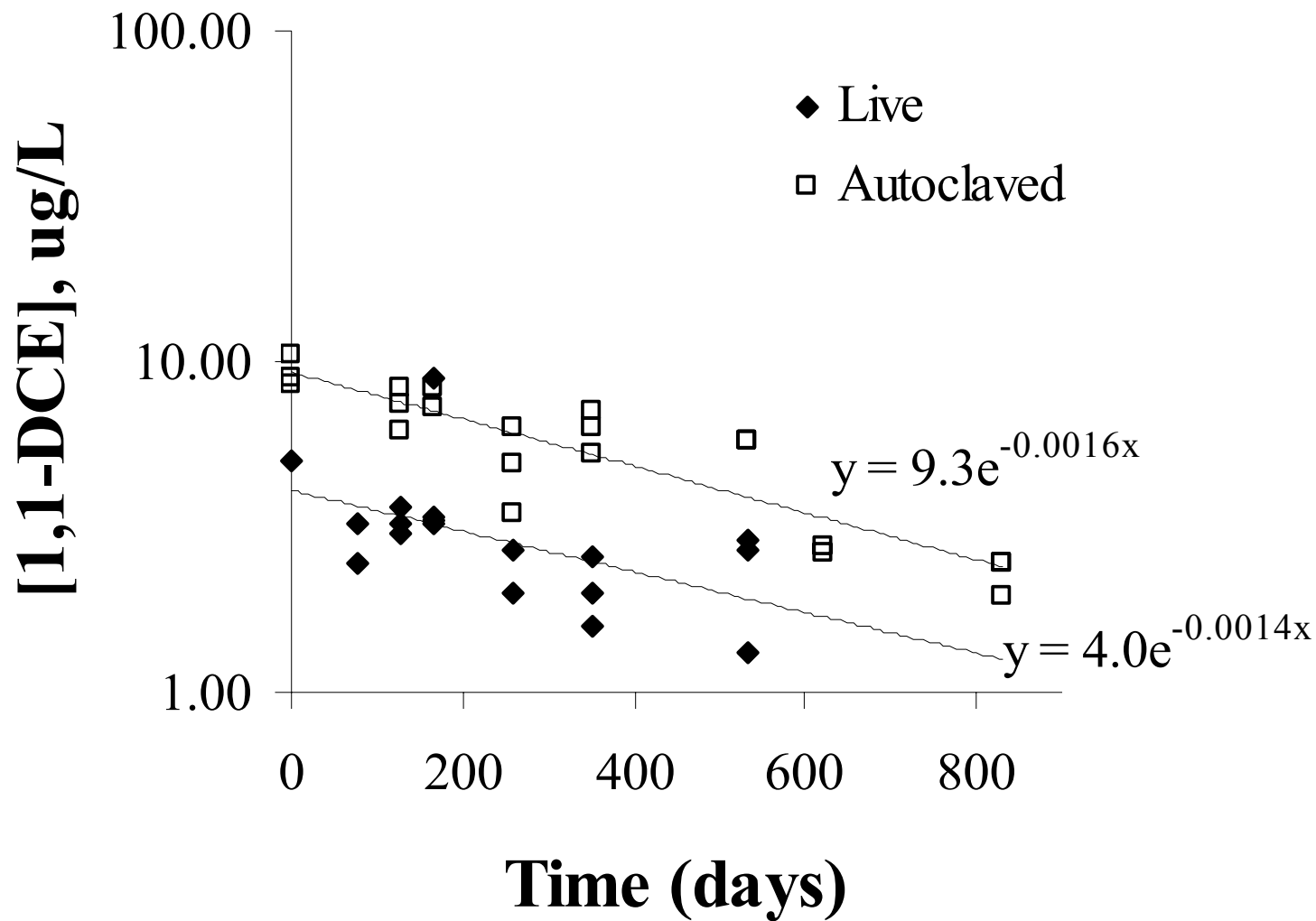
# *Microcosms*

- 45 g sediment slurry in each microcosm
- Spiked with either *cis*-DCE or 1,1-DCE
- One half of the microcosms were heat-killed
- Stored in an anaerobe chamber for 830 days
- Sampled quarterly

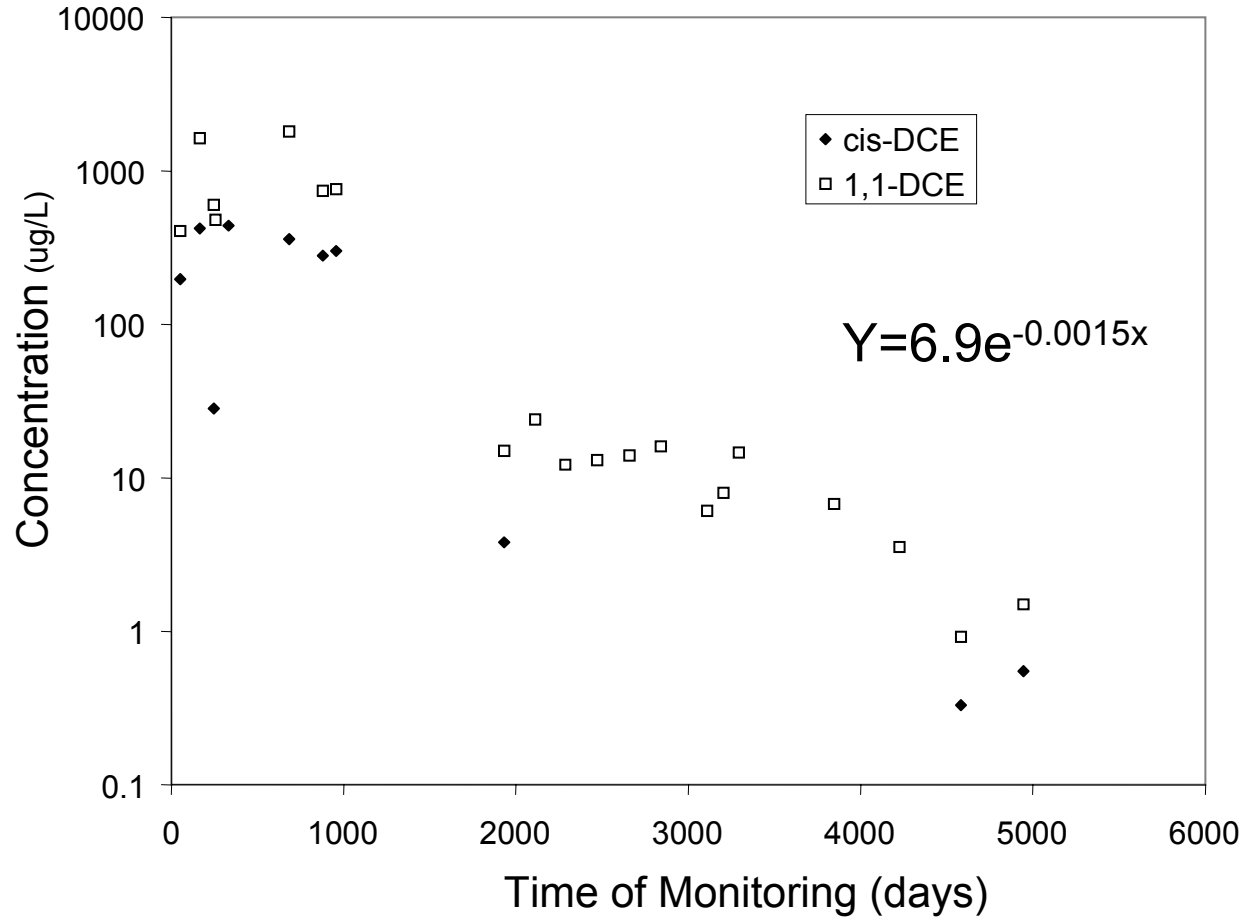




### Deep Sediments



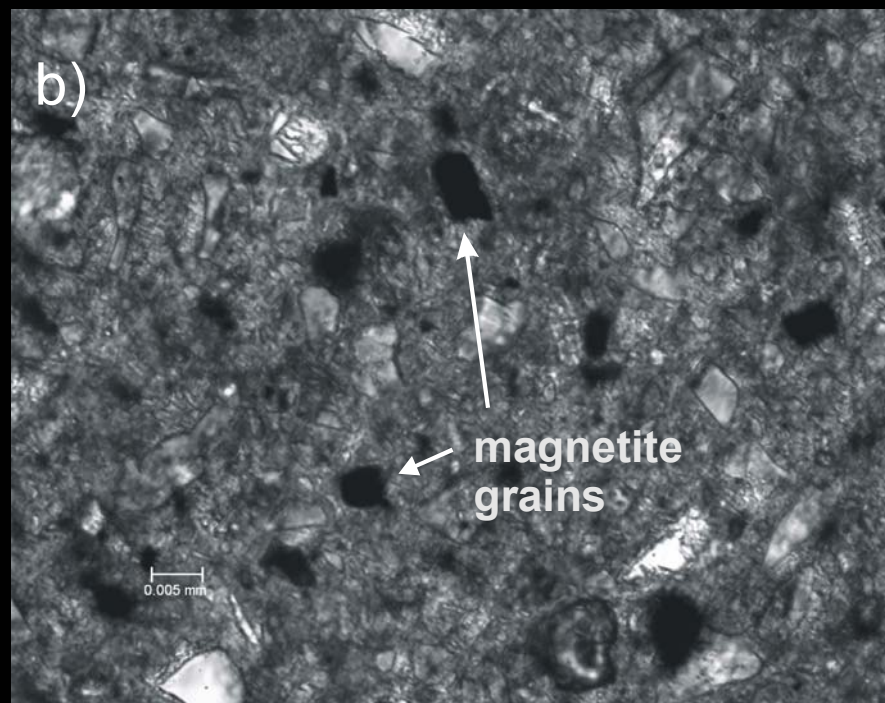
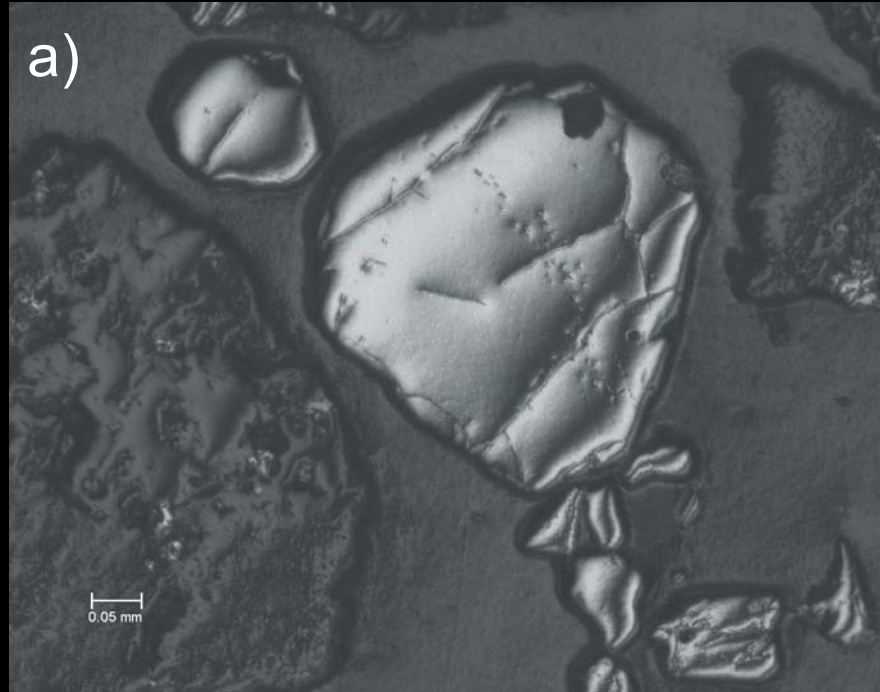
# *Monitoring well near contaminant source*



- Lee and Batchelor, ES&T 2002
  - Abiotic reductive dechlorination of chlorinated ethenes by magnetite and pyrite.
  - Vinyl chloride not generated by the reductive dechlorination of DCE.

*“(iron containing minerals) could be more important than microorganisms under some conditions in affecting the fate of chlorinated ethenes.”*

- TCAAP sediments are 0.3 wt% magnetite.
- Magnetite accounts for 25% of total iron in the sediments.
- There is ample magnetite in the sediments to reduce all of the DCE added to the microcosms.



## *Iron content in TCAAP sediments*

<b>Depth Below Water Table (Approx ft)</b>	<b>Total (XRF)</b>	<b>Total (Nitric Acid)</b>	<b>Bioavailable</b>
0-5	7,820 ± 110	6,515	556 ± 15
10	12,450 ± 1820	10,251	649 ± 109
15-20	11,190 ± 1250	9,164	567 ± 112

- Non-biological attenuation may be more important than biological mechanisms.
- Natural attenuation studies should consider the possibility of abiotic degradation processes for chlorinated solvents.