# 4.4 Surface-Altered Zeolites as Permeable Barriers for in Situ Treatment of Contaminated Groundwater

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## Abstract

The current research focuses on enhanced removal of chromate and perchloroethylene from contaminated water by a combination of a reduction material (represented by zero valent iron, ZVI) and a sorption material (represented by surfactant-modified zeolite, SMZ). Natural zeolite and ZVI were homogenized and pelletized to maintain favorable hydraulic properties while minimizing material segregation due to bulk density differences. The zeolite/ZVI pellets were modified with the cationic surfactant hexadecyltrimethylammonium bromide to increase contaminant sorption and, thus, the contaminant concentration on the solid surface. Results of chromate sorption/reduction indicate that the chromate sorption capacity of pelletized SMZ/ZVI is at least one order of magnitude higher than that of zeolite/ZVI pellets. Compared to SMZ pellets, the chromate removal capacity of SMZ/ZVI pellets in a 24-hour period is about 80% higher, due to the combined effects of sorption by SMZ and reduction by ZVI. The chromate and PCE degradation rates with and without surfactant modification were determined separately. The pseudo first-order reduction constant increased by a factor of three for PCE and by a factor of nine for chromate following surfactant modification. The enhanced contaminant reduction capacity of SMZ/ZVI pellets may lead to a decrease in the amount of material required to achieve a given level of contaminant removal.

We are currently investigating means to scale up production of SMZ/ZVI pellets from lab to pilot-test quantities. We will prepare a multi-ton batch of SMZ/ZVI pellets and install them in a 6-m long by 2-m wide by 2-m deep subsurface permeable barrier in a 10-m by 10-m by 3-m deep simulated aquifer. We will monitor the attenuation of a mixed chromate/PCE plume as it passes through the barrier under simulated groundwater flow conditions. We will compare the resultant contaminant attenuation to predictions based on laboratory characterization of the SMZ/ZVI pellets.

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**R. S. Bowman, K.G. Boggs, and Z. Li**

**New Mexico Tech**

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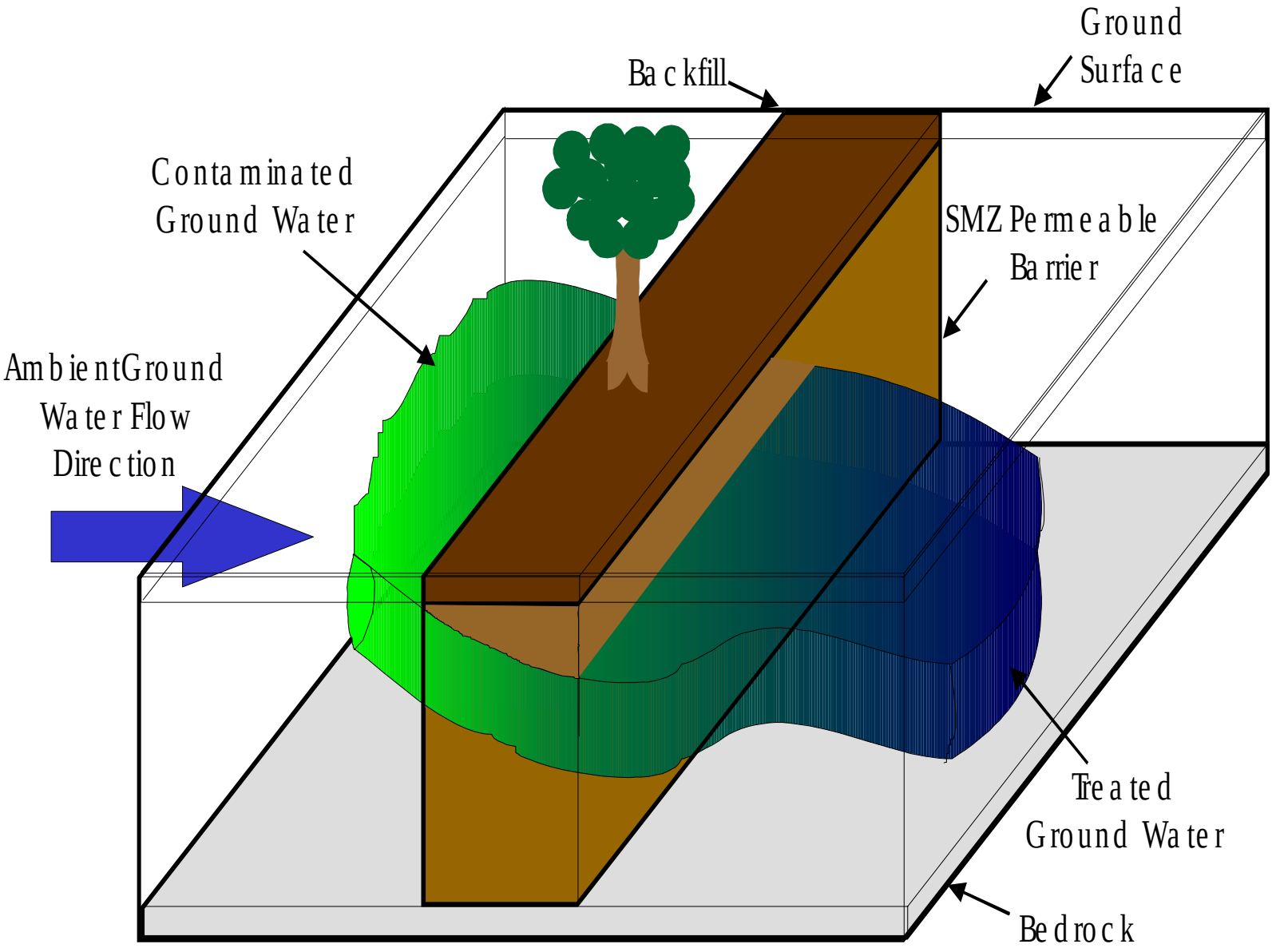
**National Energy Technology Laboratory**

# ermeable Barrier



# Outline

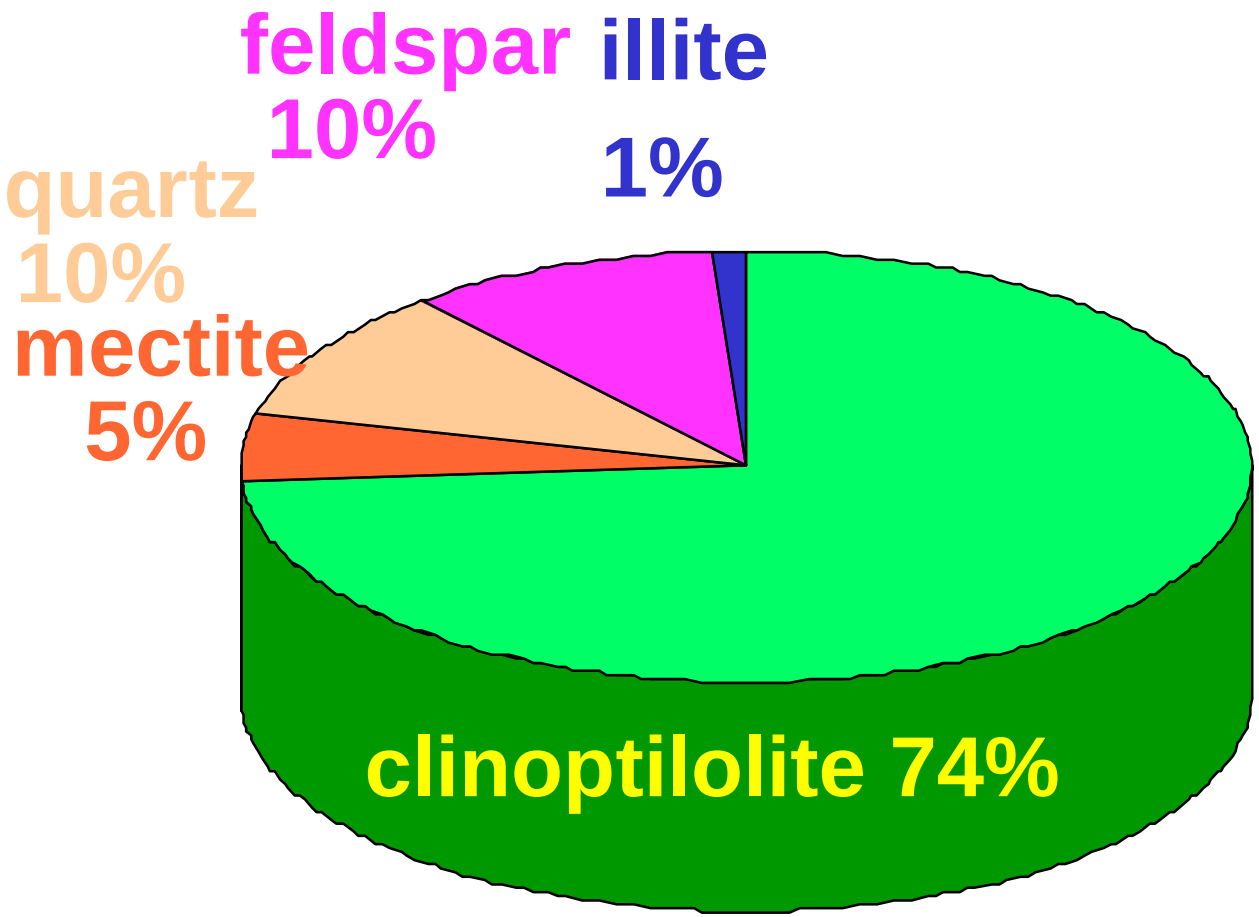
## PREVIOUS PROJECT PHASES

- Development of SMZ
- Lab testing of SMZ
- Pilot testing of SMZ

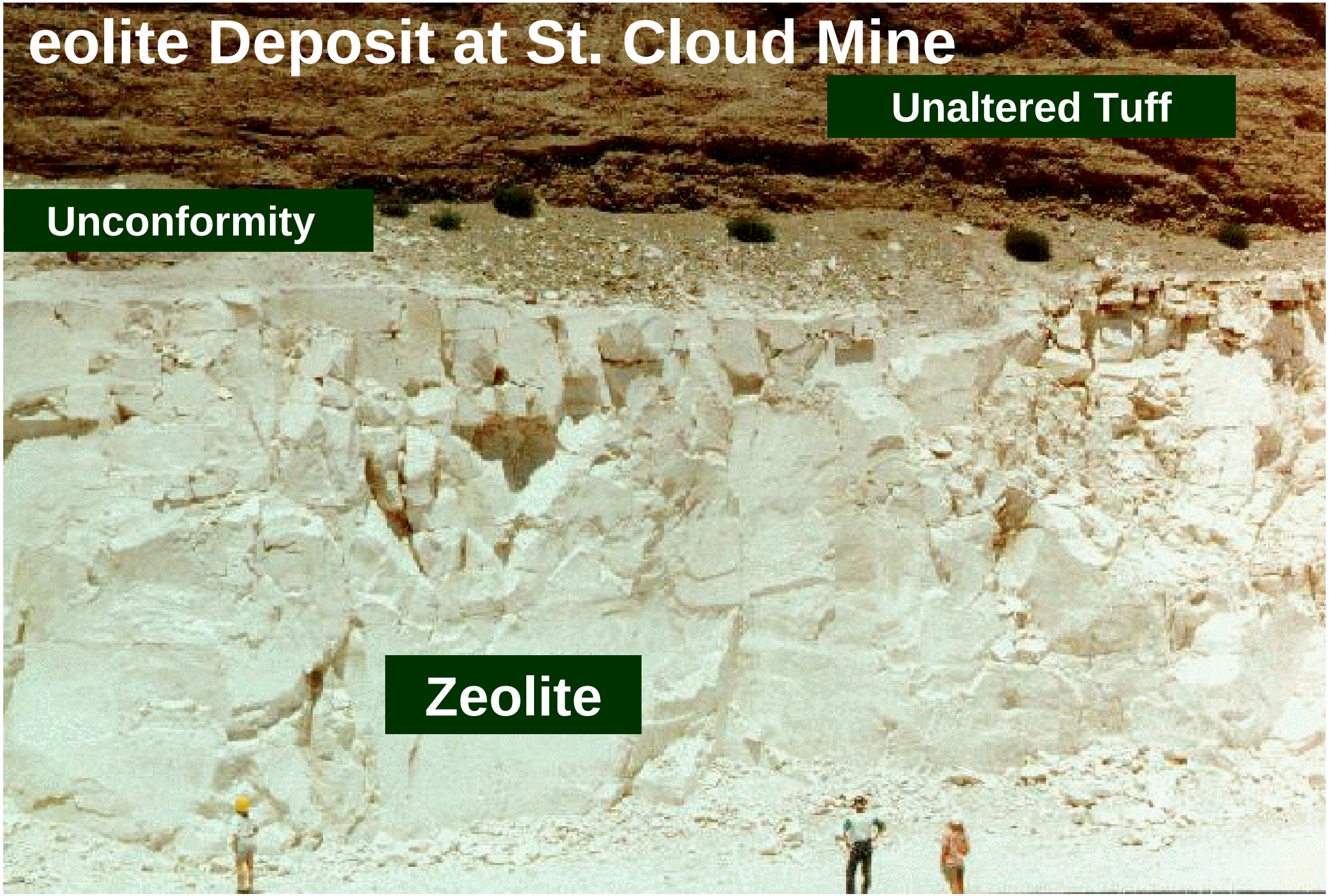
## CURRENT PROJECT PHASE

- Development of SMZ/ZVI pellets
- Lab testing of SMZ/ZVI pellets
- Project schedule

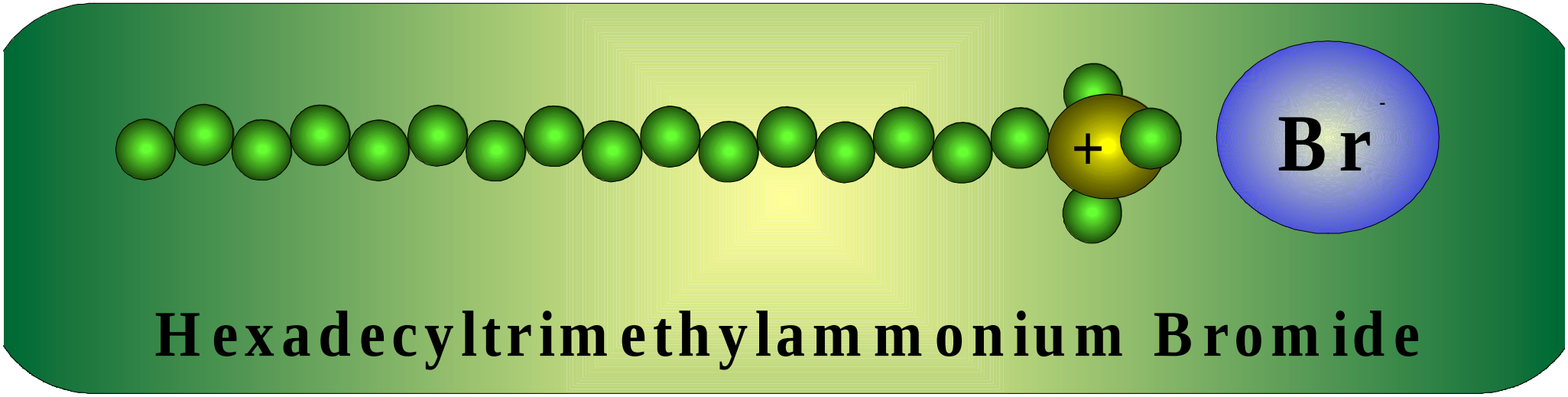
# Zeolite Properties



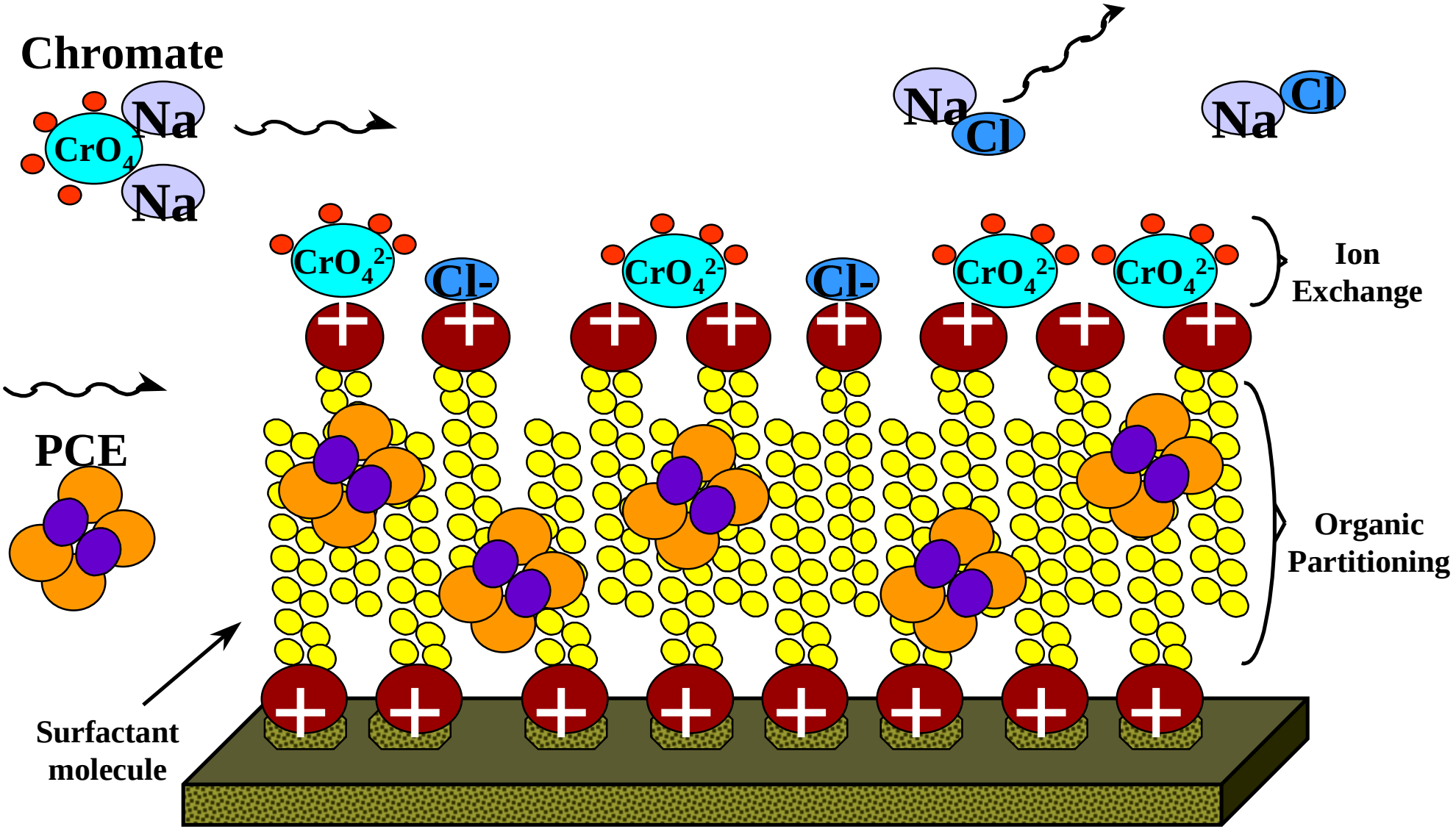

- High surface area
- High internal and external cation exchange capacity
- Can be tailored to any particle size/permeability


eolite Deposit at St. Cloud Mine
Unaltered Tuff
Unconformity
Zeolite

# HDTMA - A Cationic Surfactant



# Retardation Mechanisms



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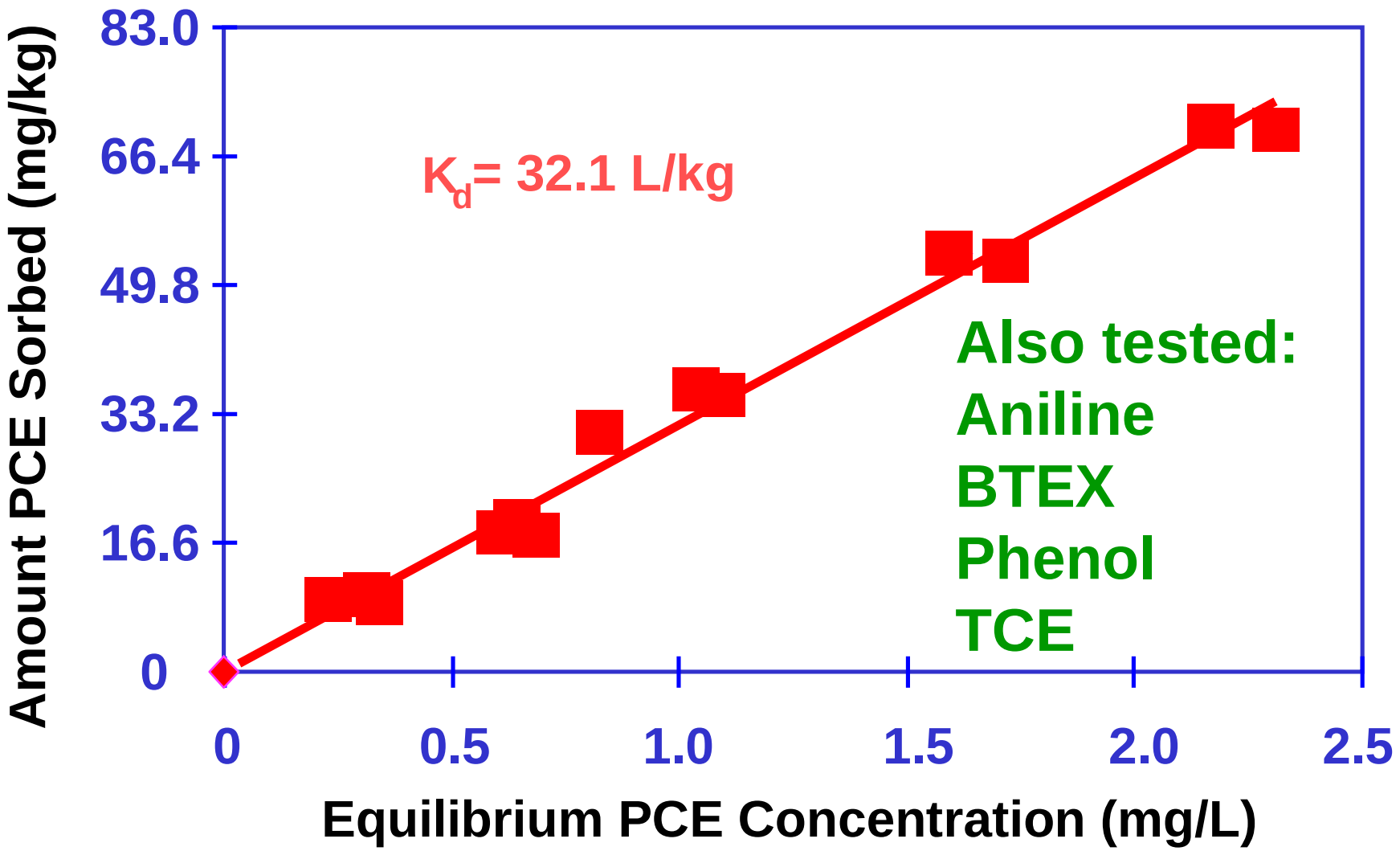
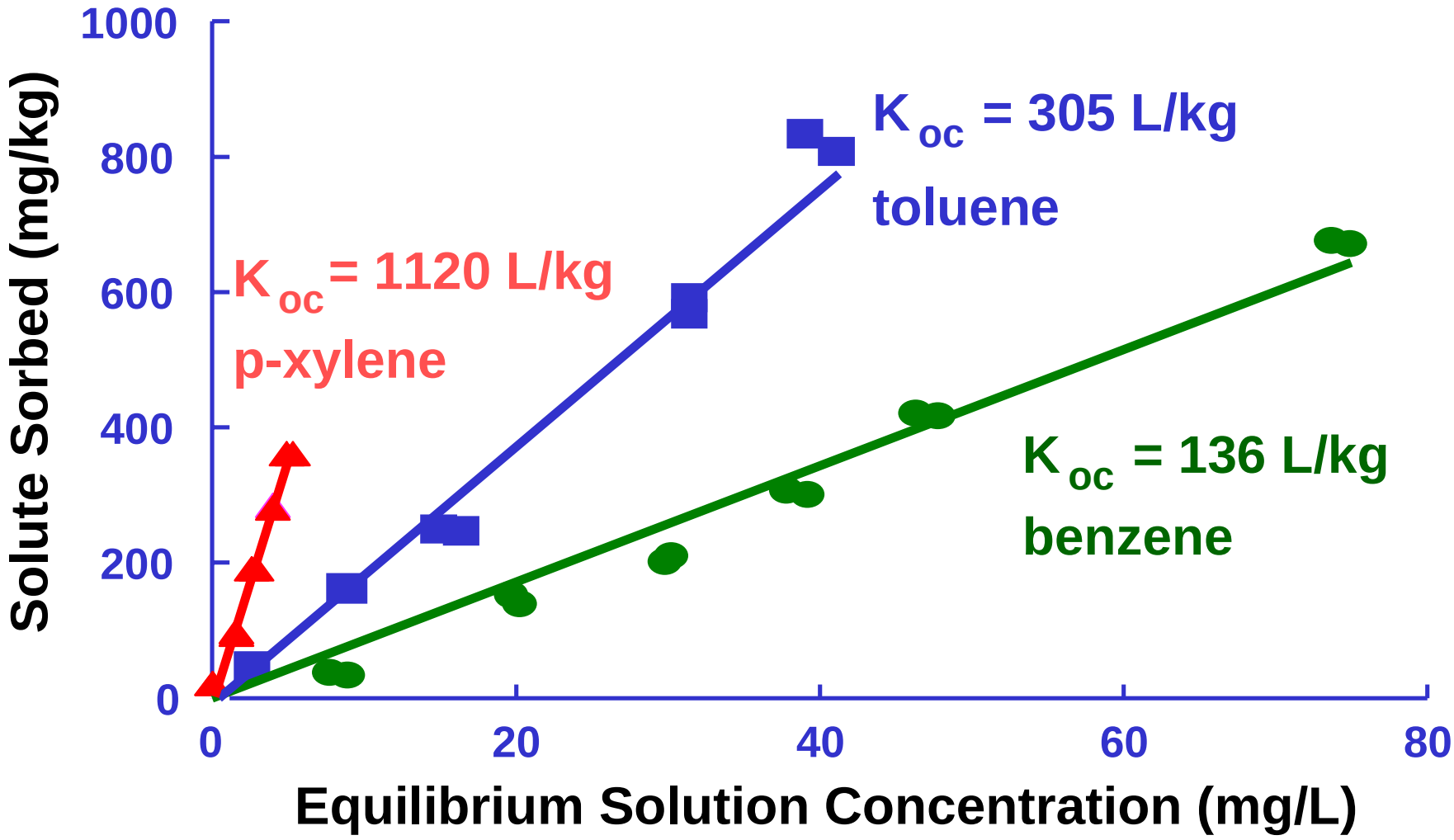
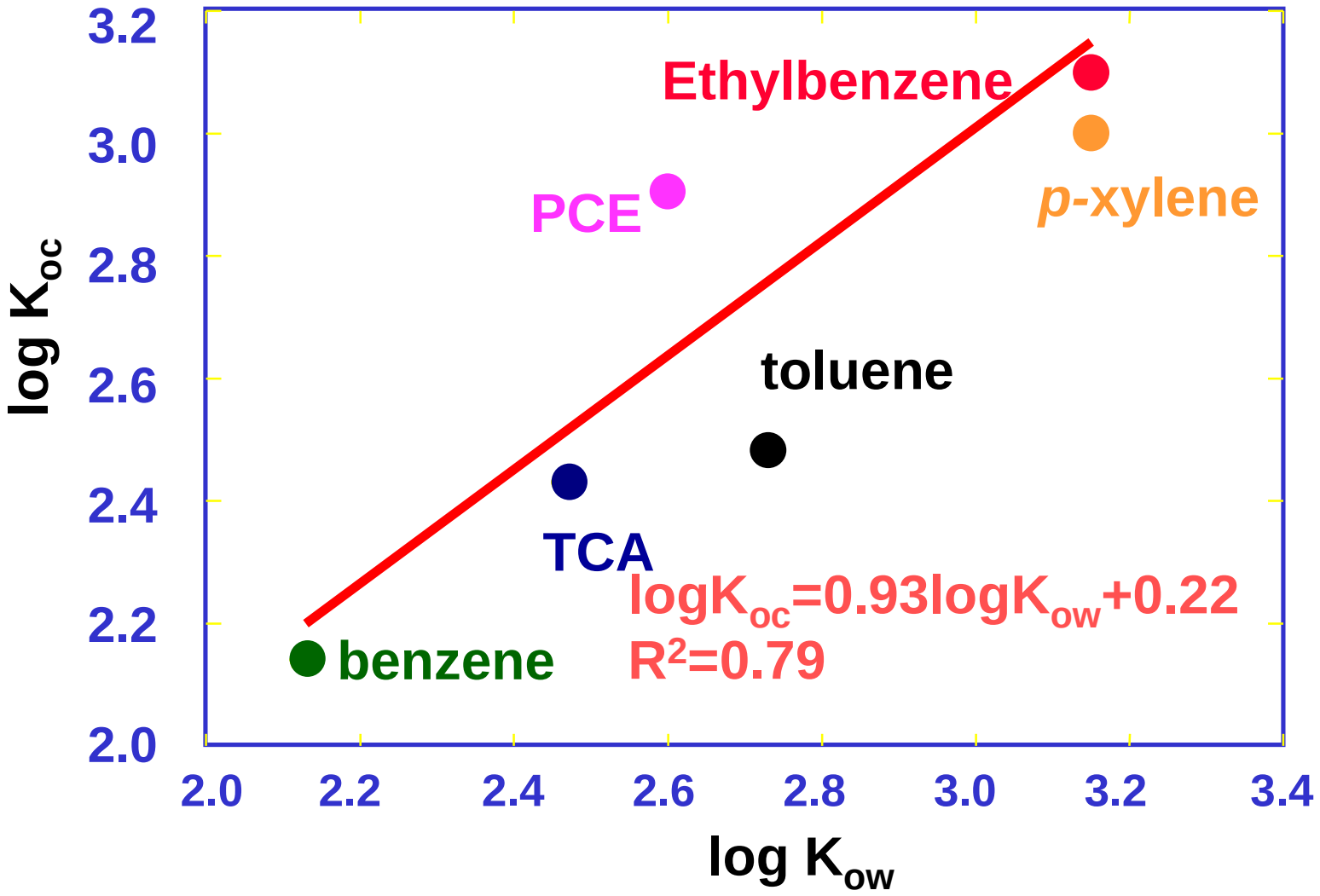
# Sorption of PCE by SMZ



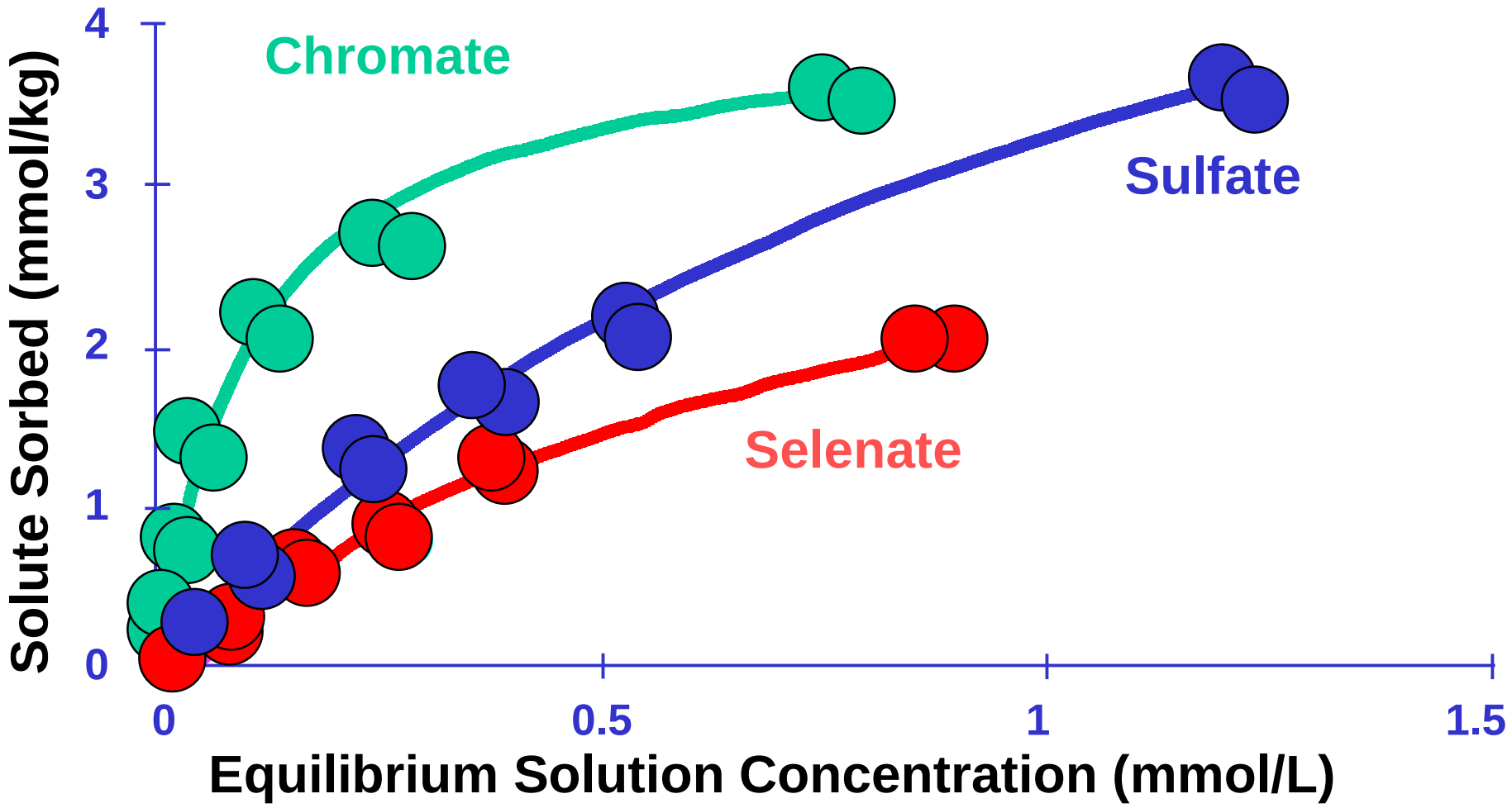
# Sorption of BTX on SMZ



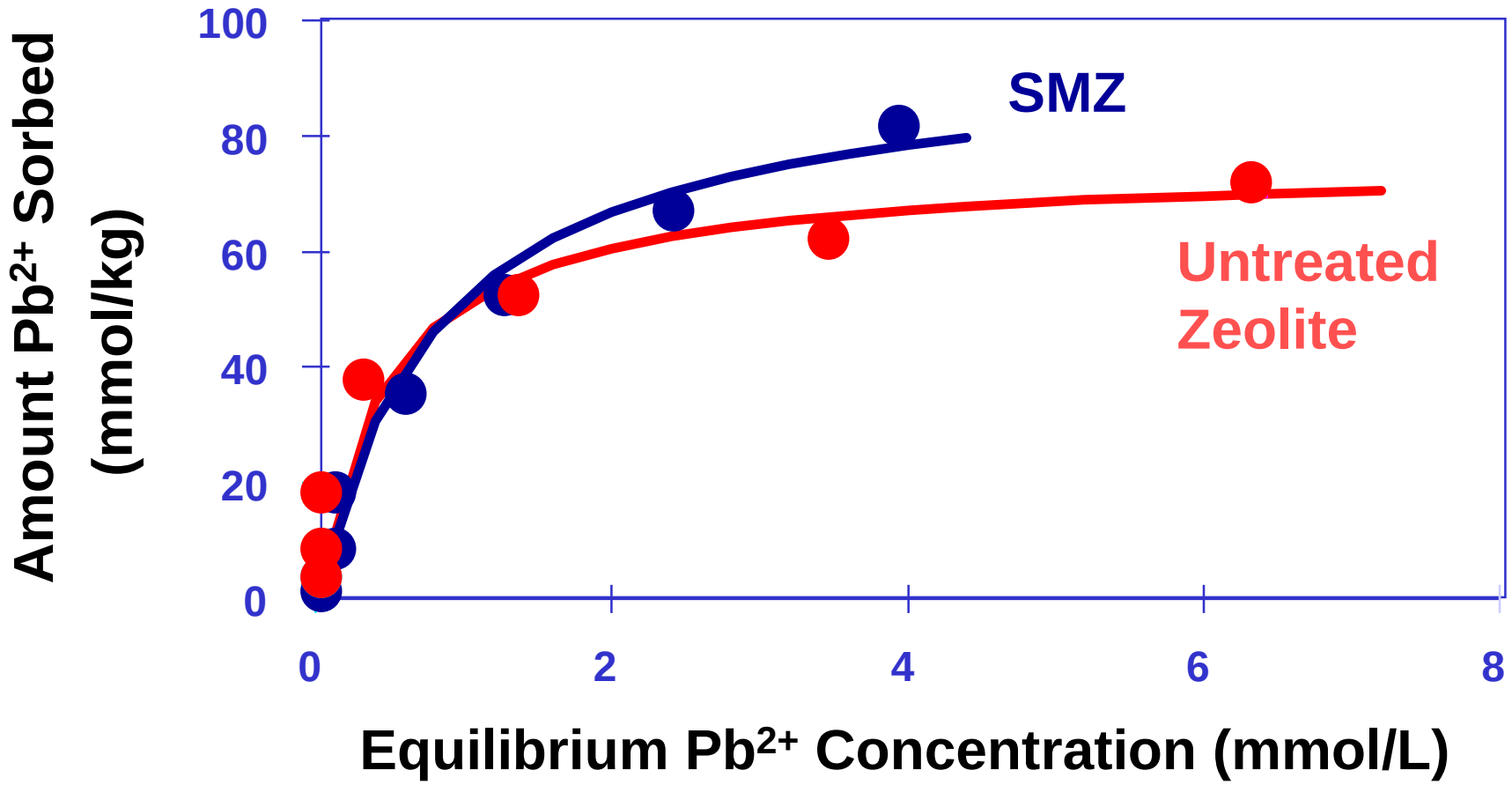
# $K_{oc}/K_{ow}$ Relationship for Organics Sorbed on SMZ



# Sorption of Oxyanions by SMZ



# $Pb^{2+}$ Sorption on Untreated Zeolite and SMZ



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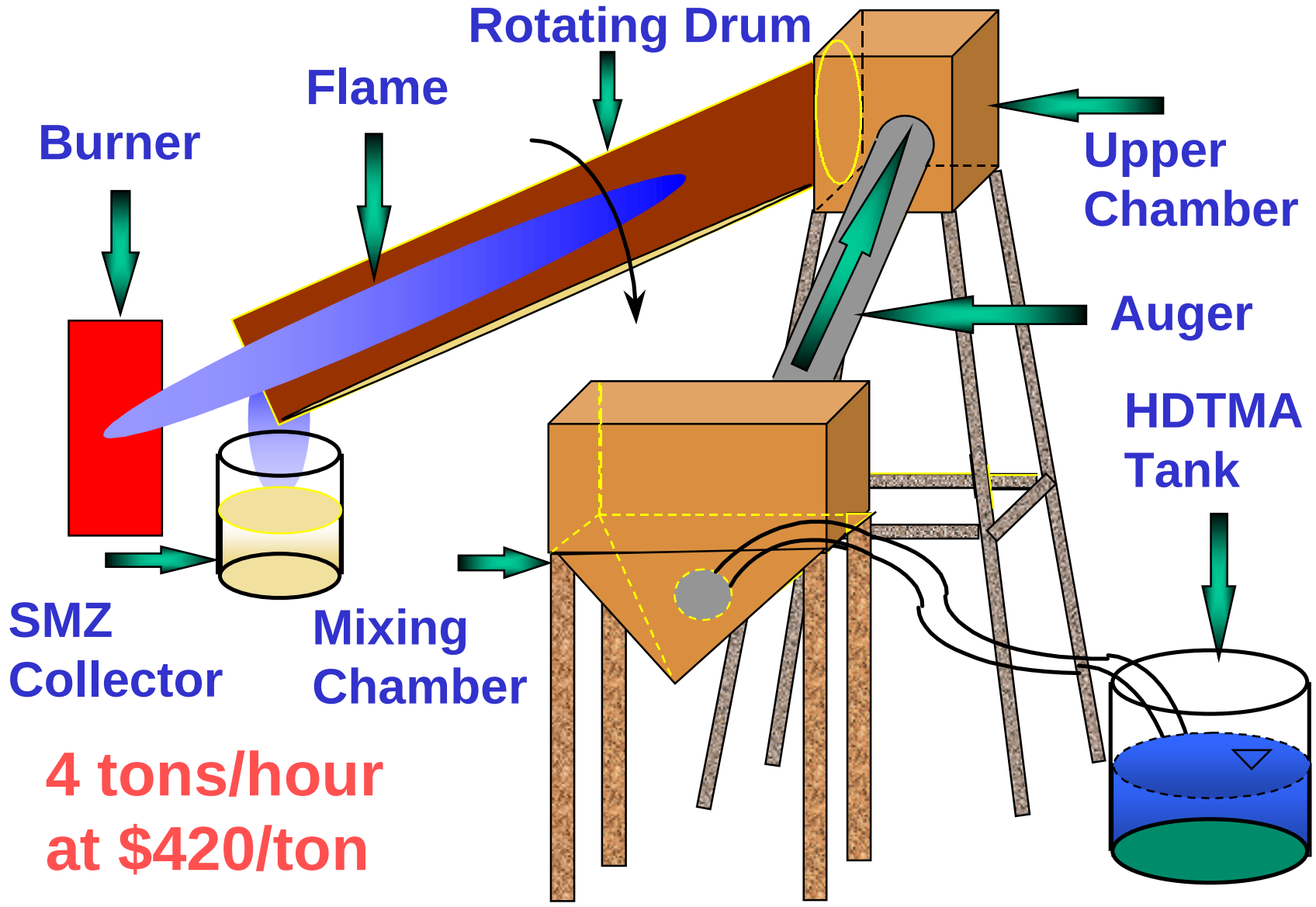
# SMZ Preparation Facility




**4 tons/hour**
**at $420/ton**

# Economics of SMZ

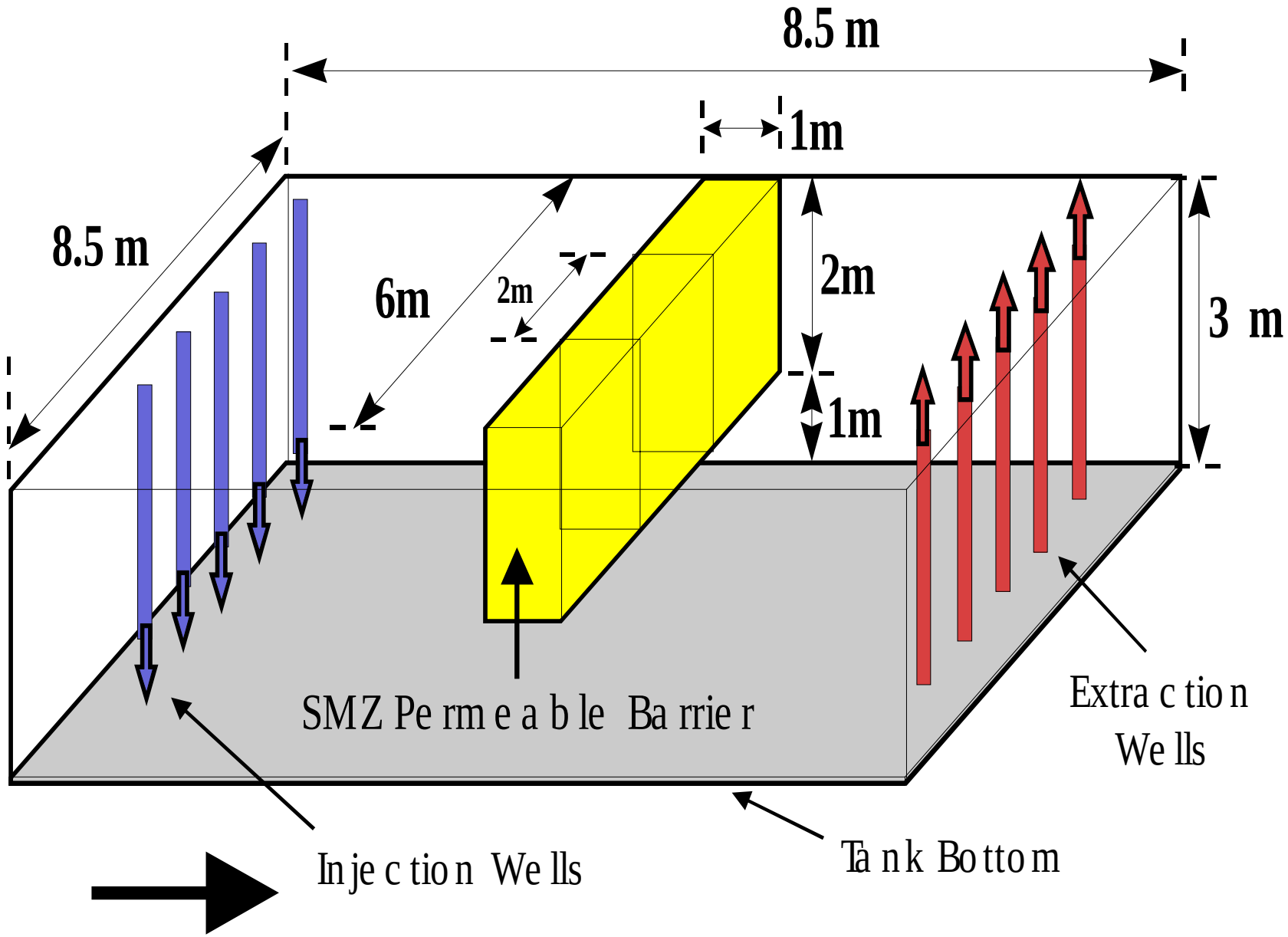
- Zeolite + Surfactant + Processing = Cost

- $45 + $300 + $75 = $420/ton

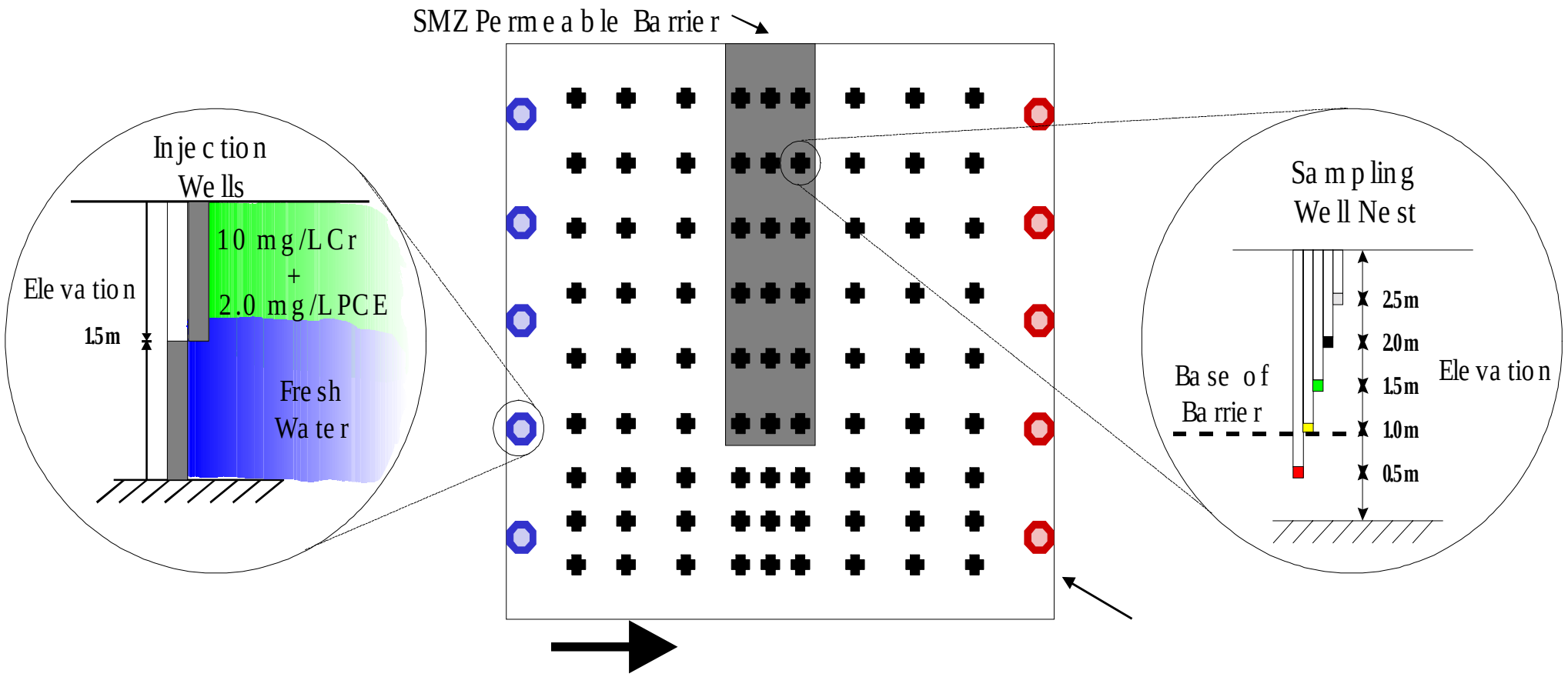
  = $13/$ft^3$

  = $460/$m^3$

# ilot Scale Study Tank

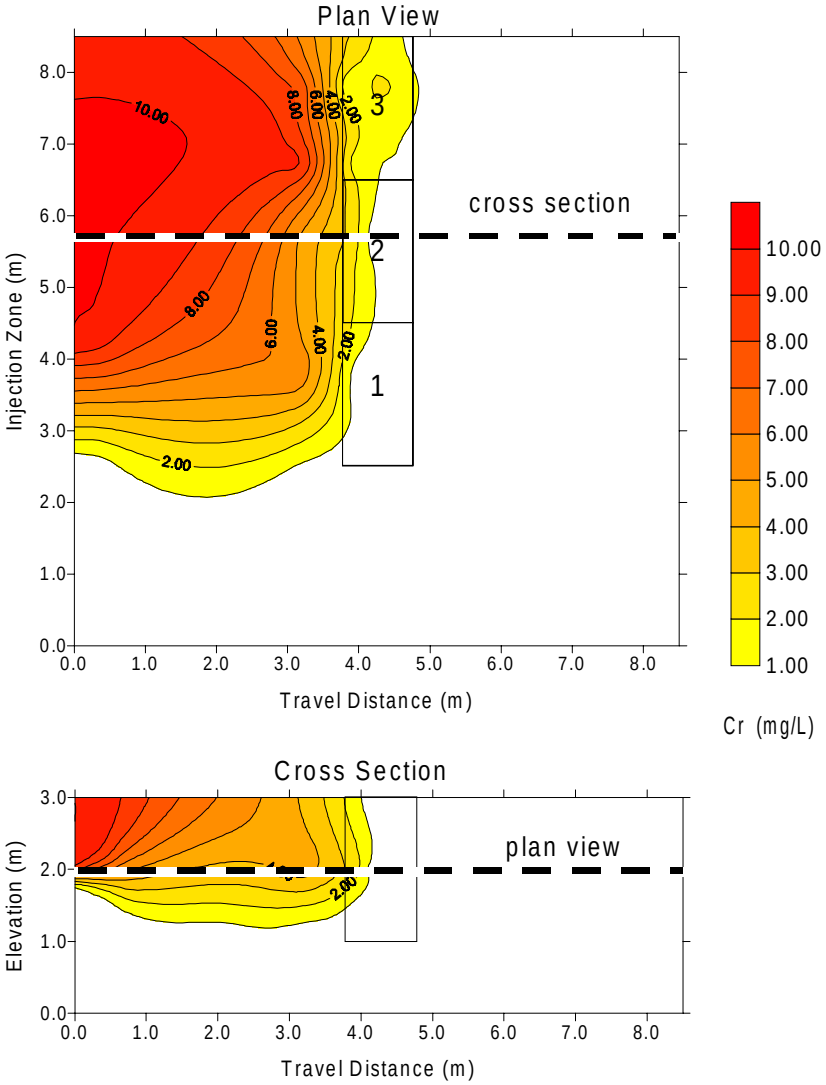


# ample Well Locations

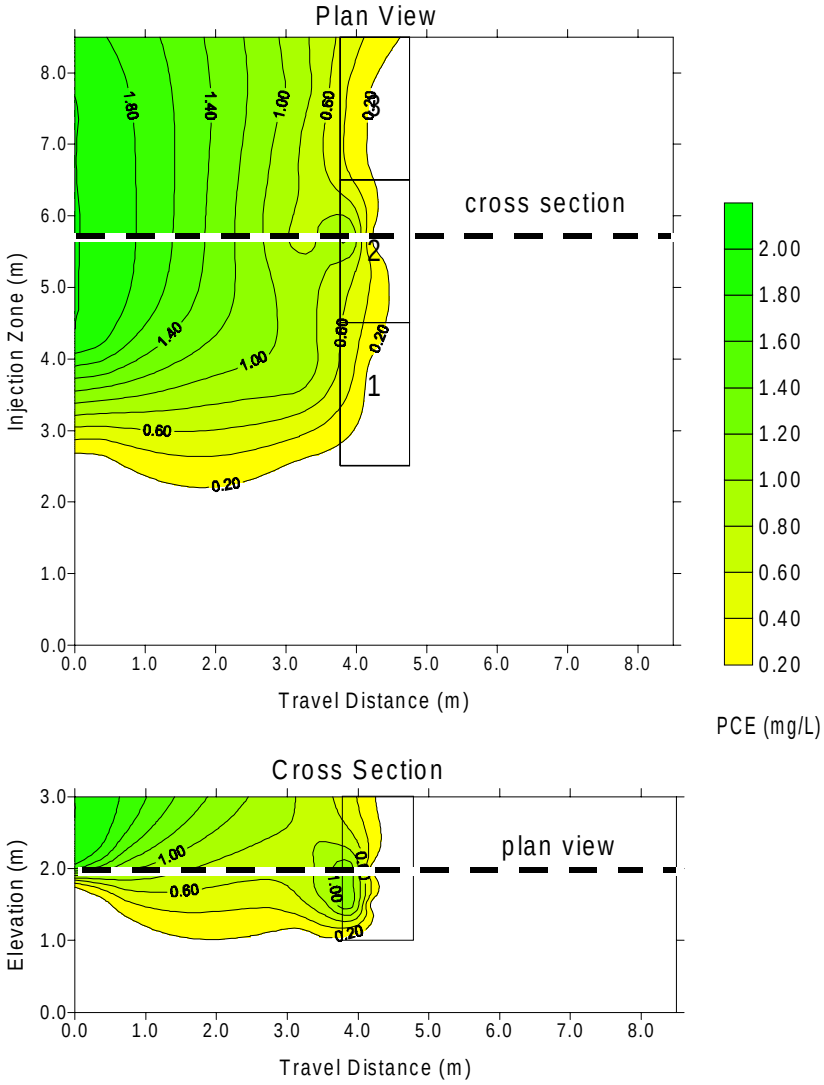


# r and PCE Distributions, Day 41

**Cr Distribution after 41 days of injection (8/20/98)**




**PCE Distribution after 41 days of injection (8/20/98)**



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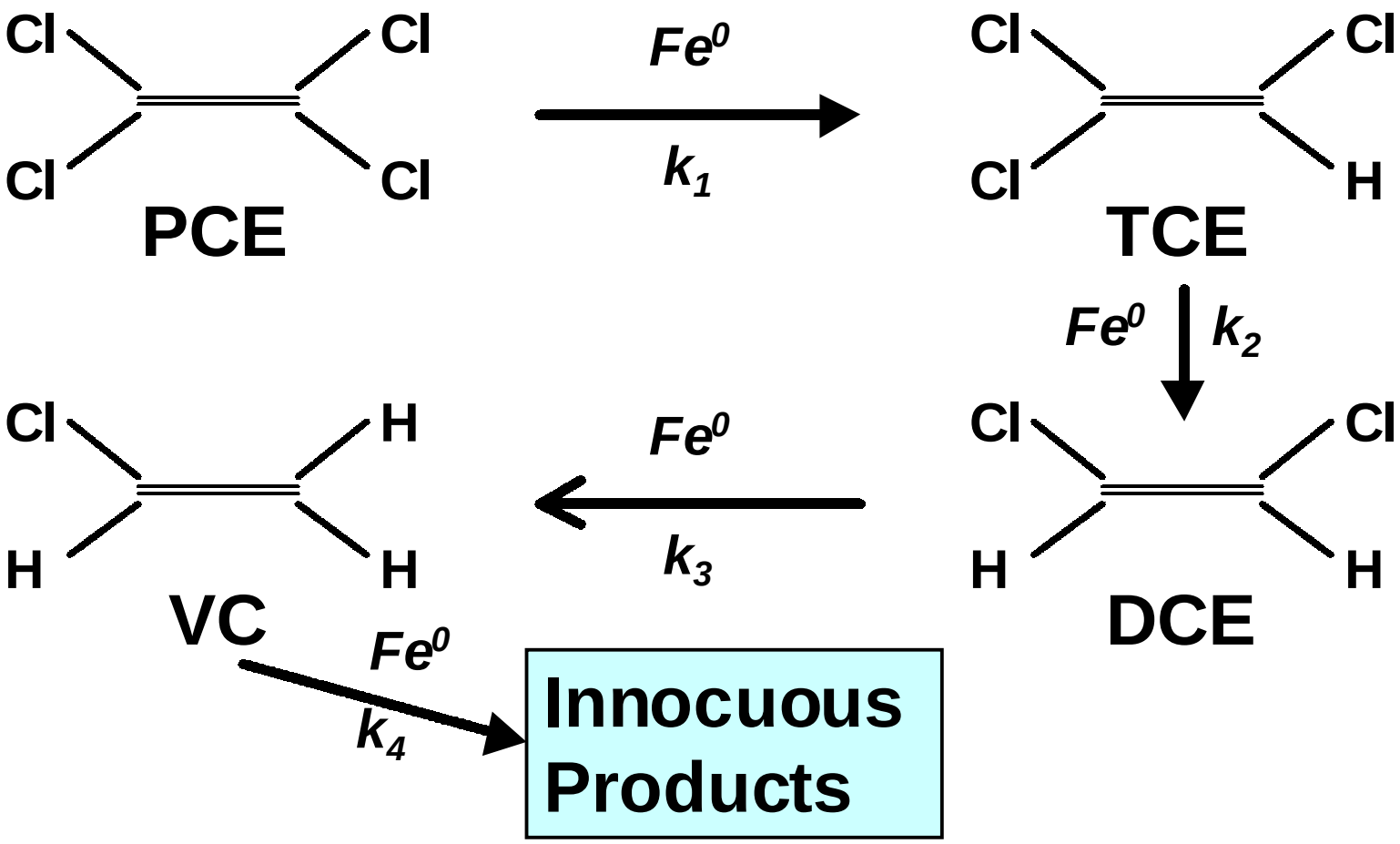
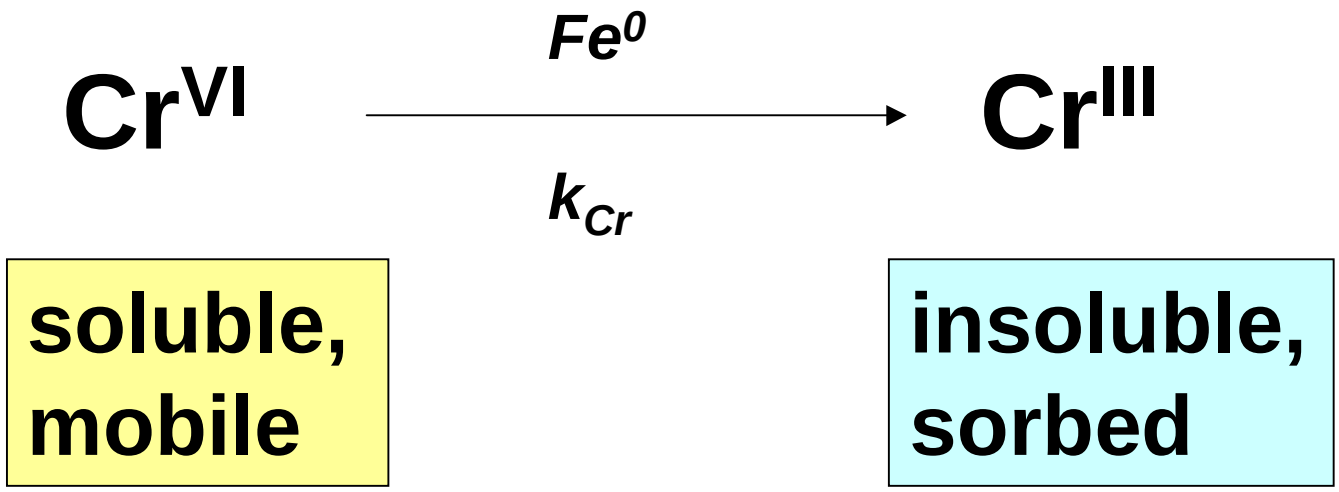
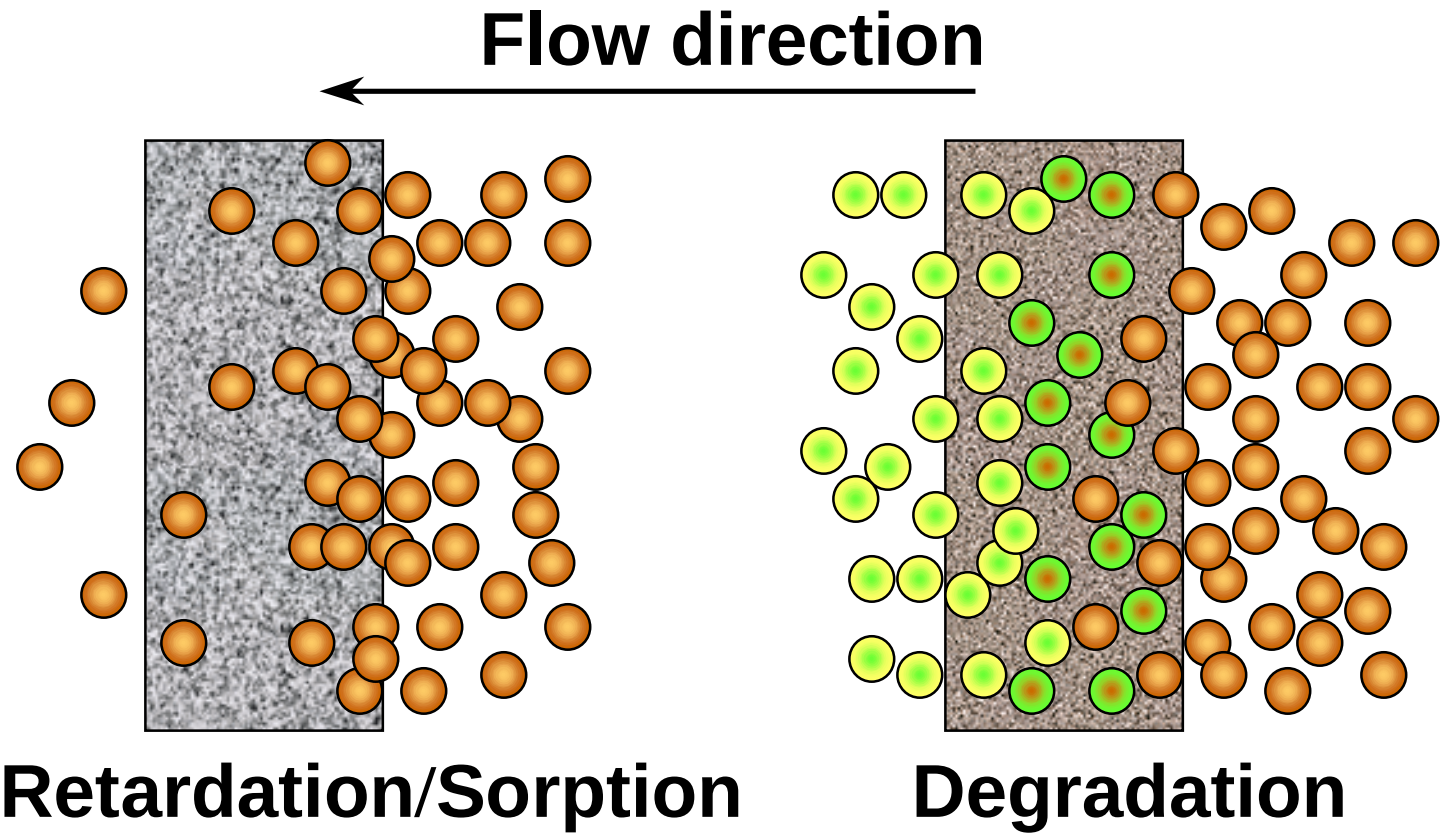
# Chlorinated HC Reduction



# Chromate Reduction



# Permeable Barriers Types



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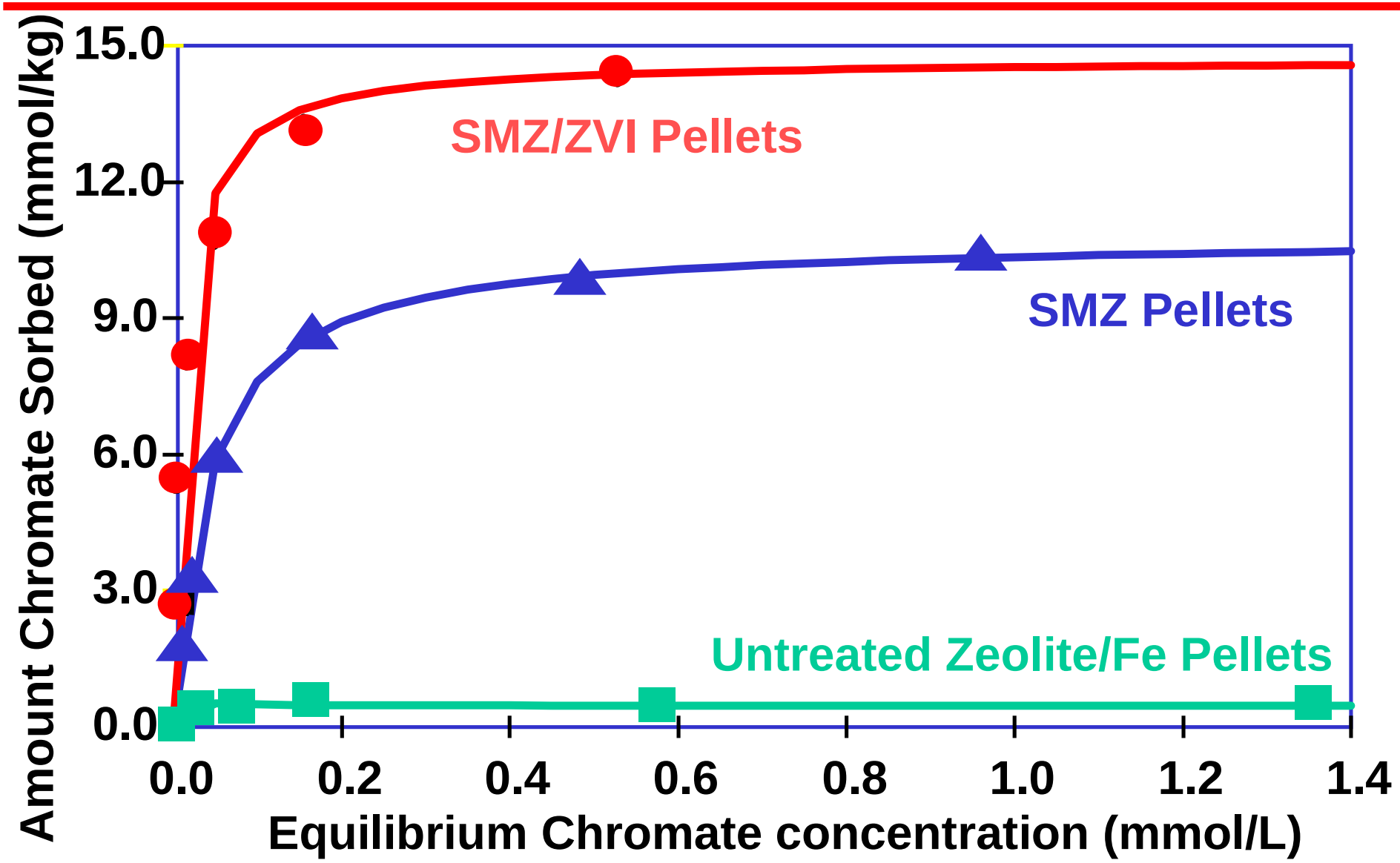
# Chromate Sorption/Reduction



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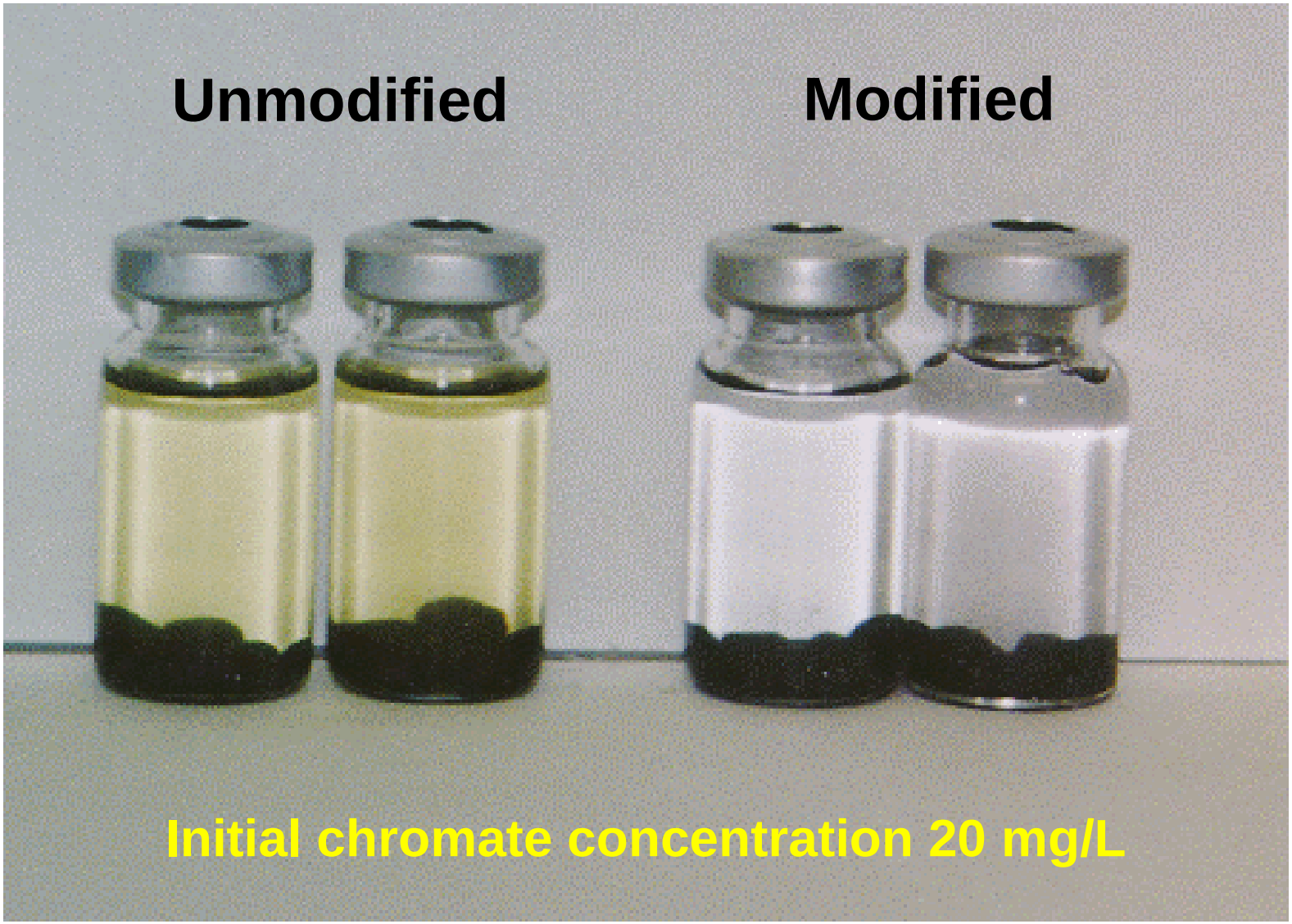
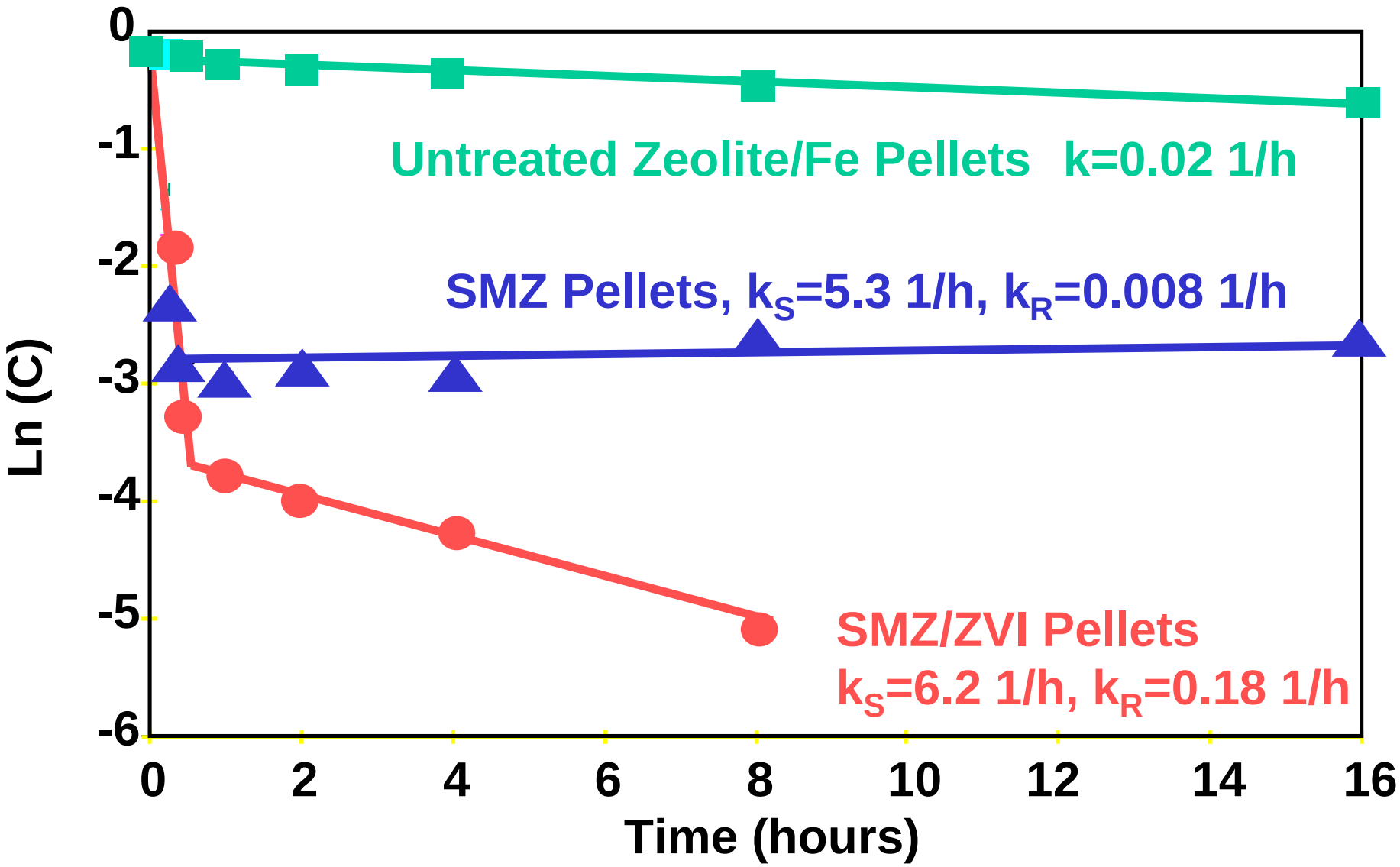
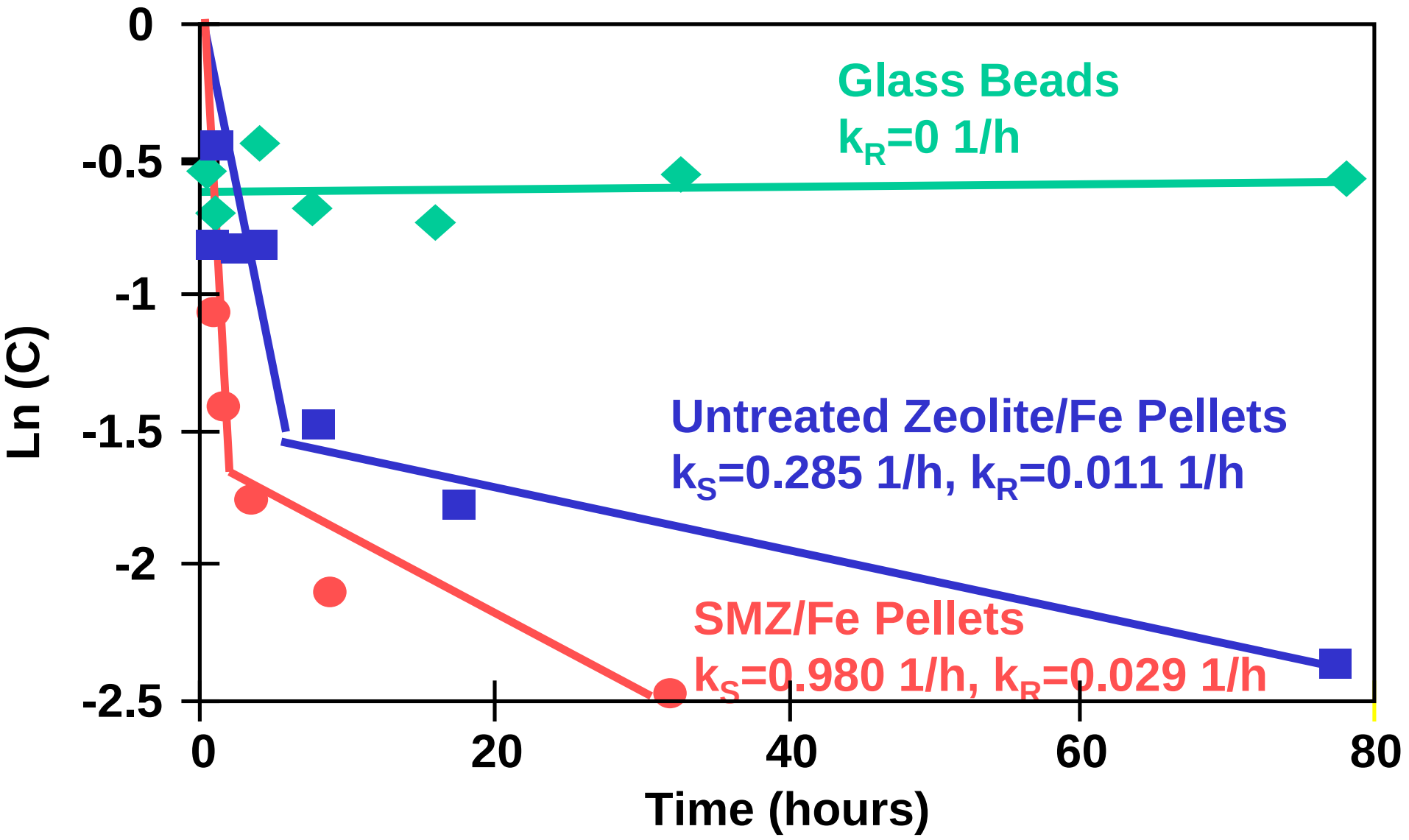


# Chromate Reduction Kinetics



# PCE Reduction Kinetics



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# Schedule of Current Phase

| TASK | COMPLETION DATE |
| --- | --- |
| Optimize formulation | August 2000 |
| Manufacture pellets | December 2000 |
| Conduct pilot test | May 2001 |
| Analyze results | June 2001 |
| Topical Report | August 2001 |