Mechanisms of CCl_4 Retention and Slow Release in Model Porous Solids and Sediments

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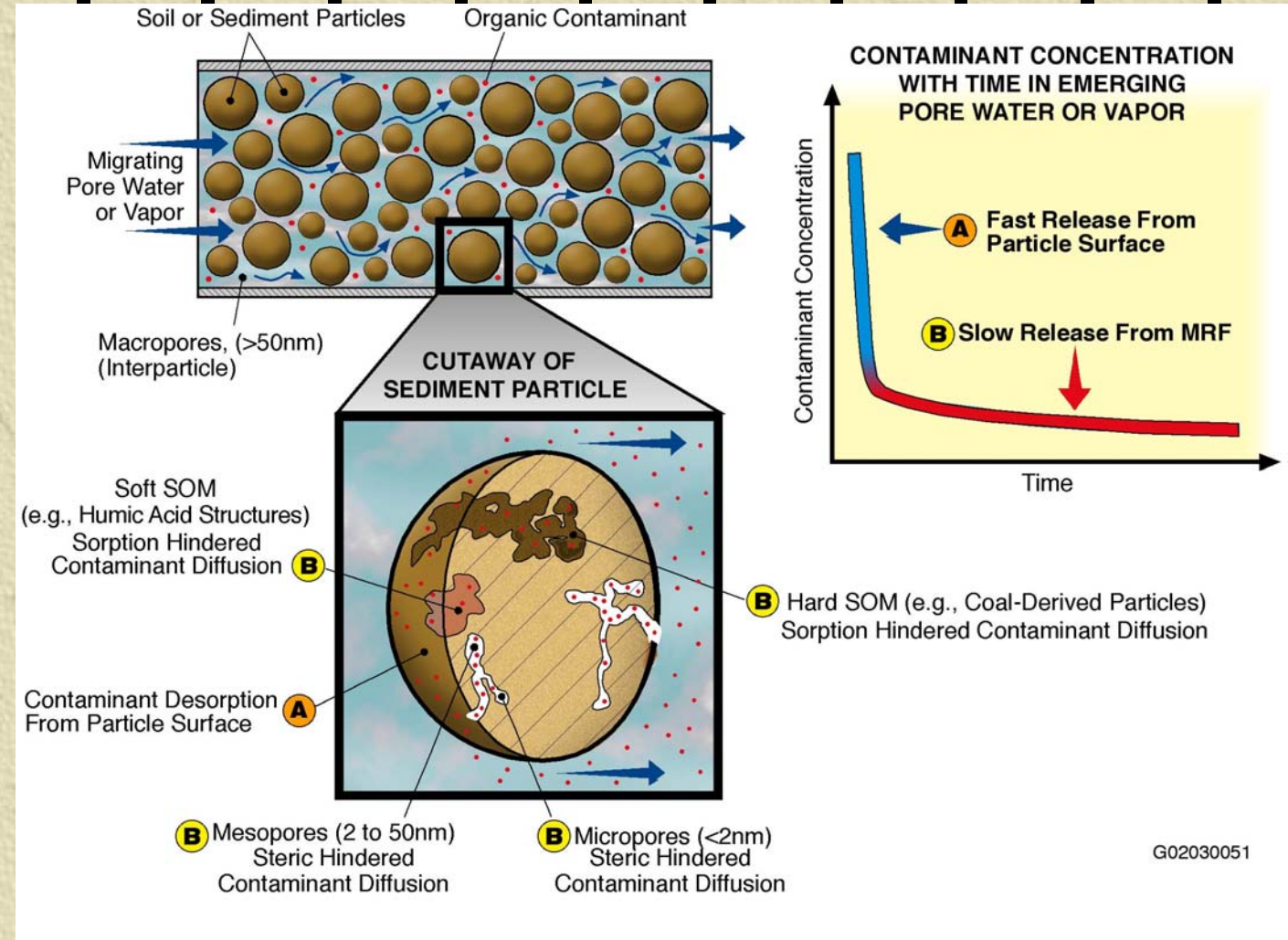
Objective and Products

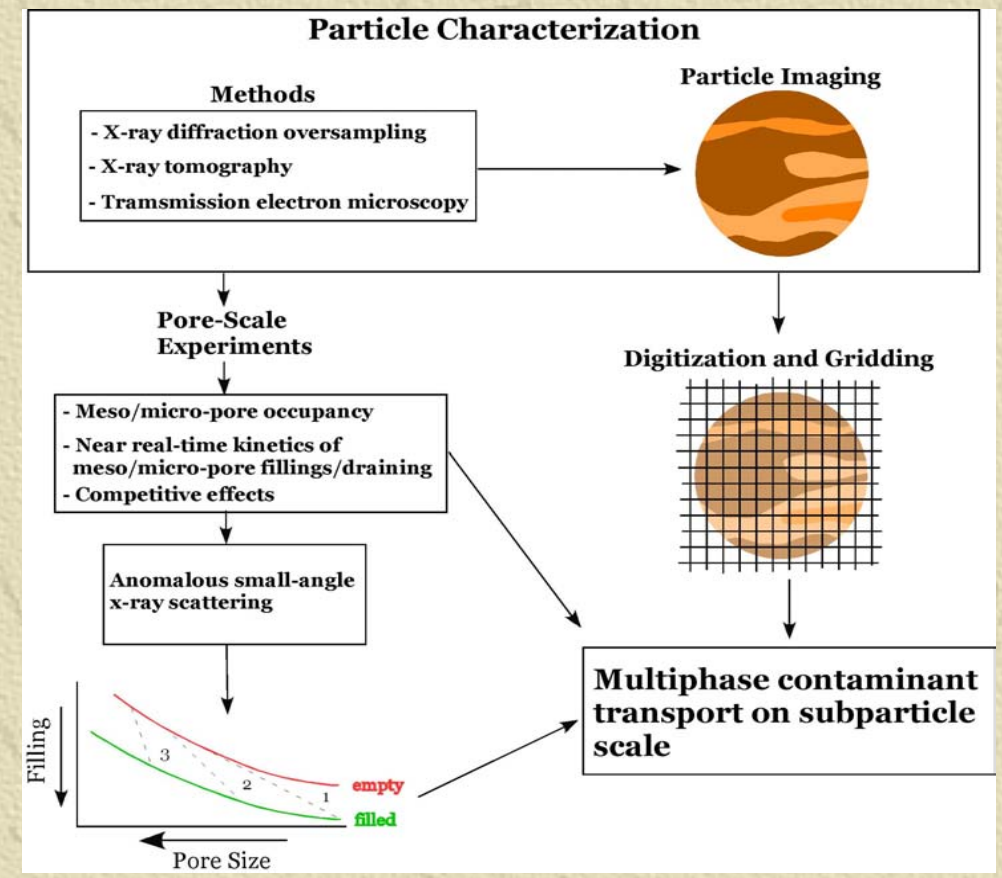
- Assess the magnitude and behavior of CCl_4 migration resistant fractions (MRF) in model porous materials and sediments
  - Macroscopic scale
  - Meso/microscopic scale
- Refined conceptual model
- Kinetic term and data for transport model

Definition of MRF

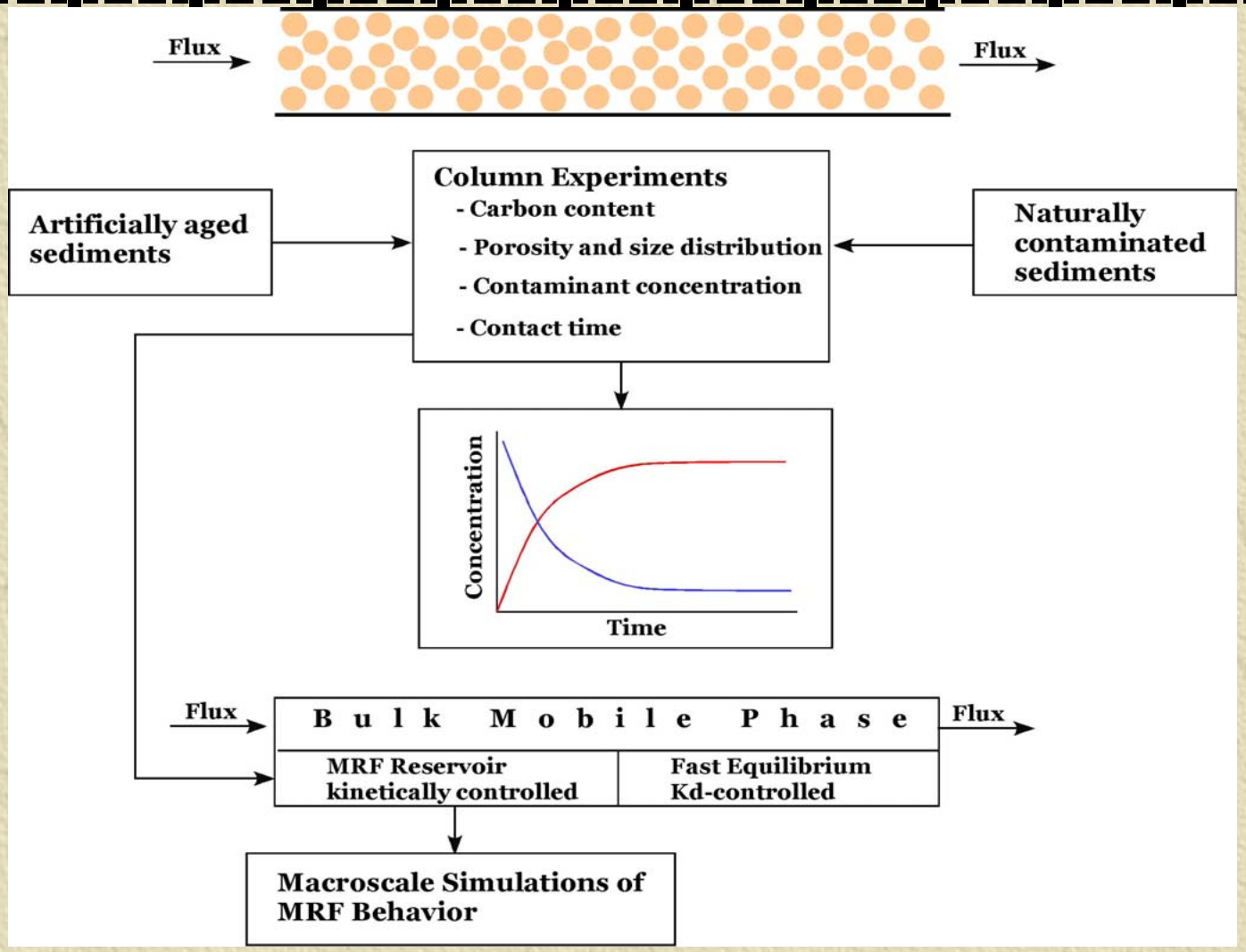
A migration-resistant fraction is a portion of a polluted sediments inventory that exhibits slow release.

Conceptual Model

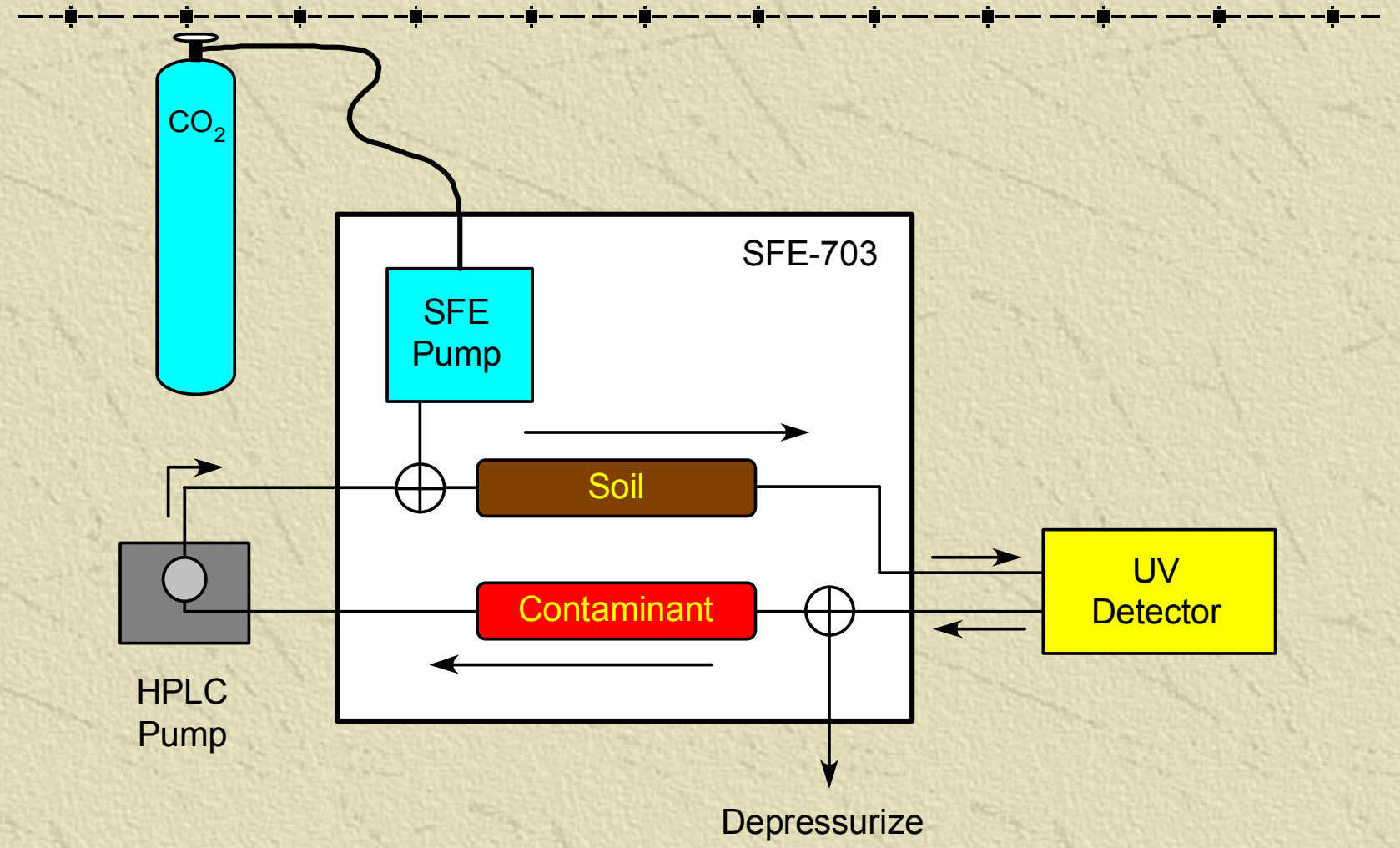



Particle Characterization
Methods
- X-ray diffraction oversampling
- X-ray tomography
- Tramsmission electron microscopy
Particle Imaging
Pore-Scale Experiments
- Meso/micro-pore occupancy
- Near real-time kinetics of meso/micro-pore fillings/draining
- Competitive effects
Anomalous small-angle x-ray scattering
Digitization and Gridding
Multiphase contaminant transport on subparticle scale
Filling
Pore Size
empty
filled
1
2
3

Macro-Scale Studies/Modeling

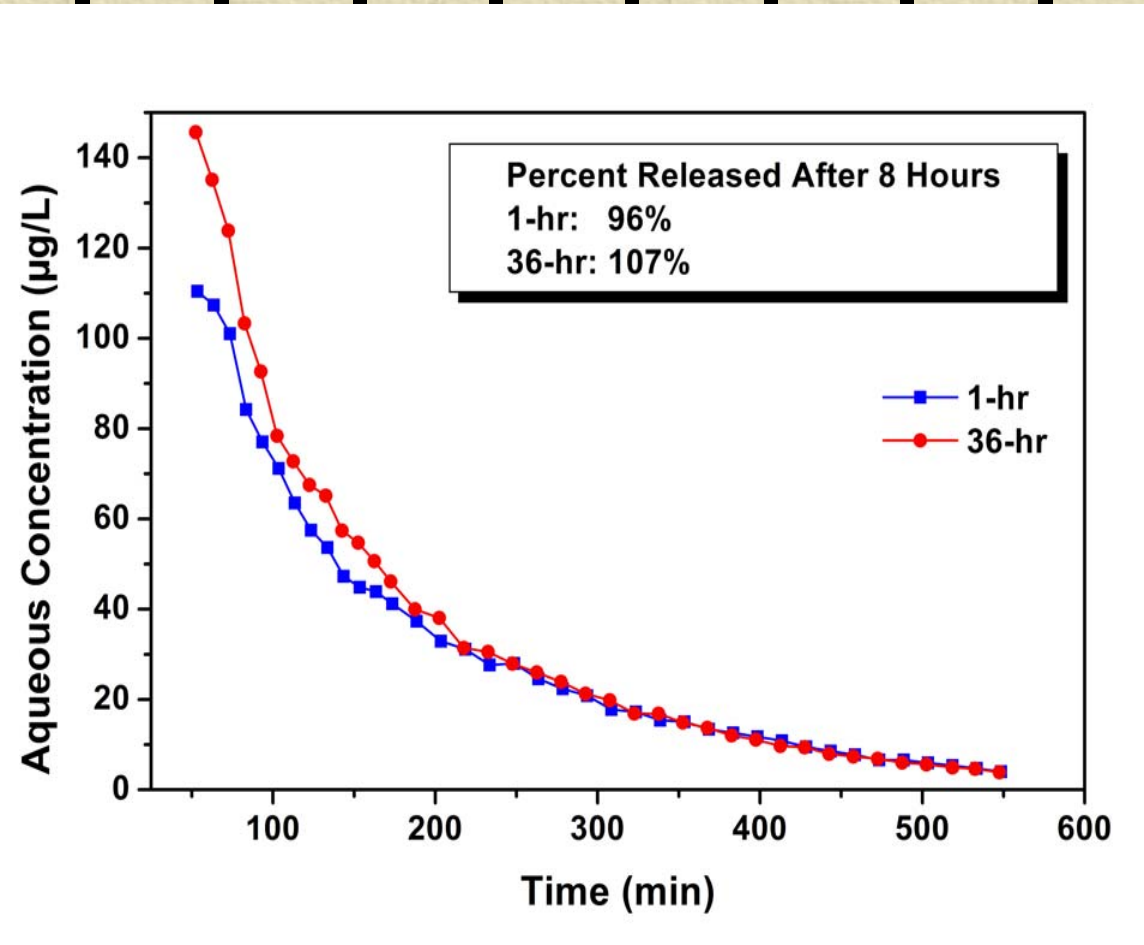


Supercritical Fluid Loading System

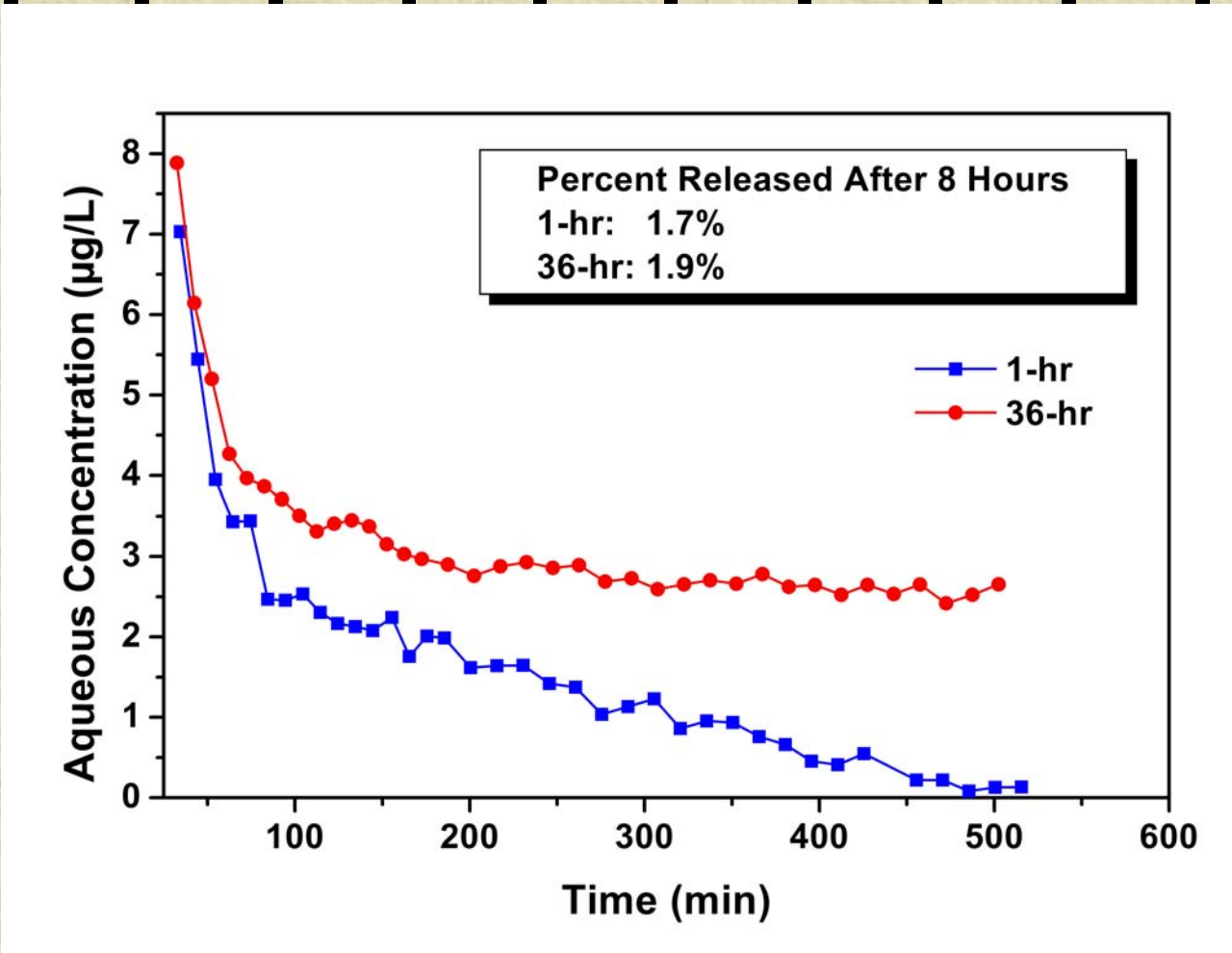


Supercritical Fluid Loading System

Aqueous Desorption of Artificially Aged Hanford Soil

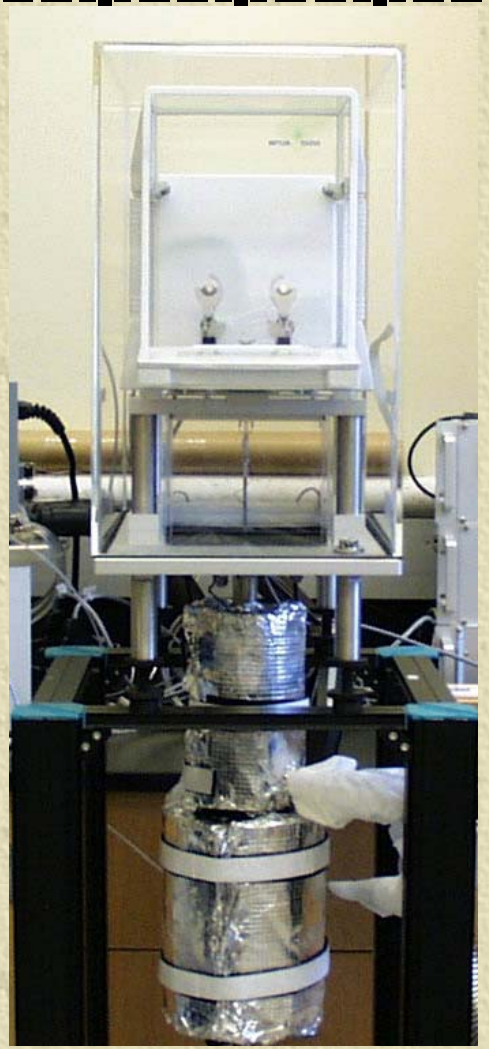


Aqueous Desorption of Artificially Aged Iron River Soil

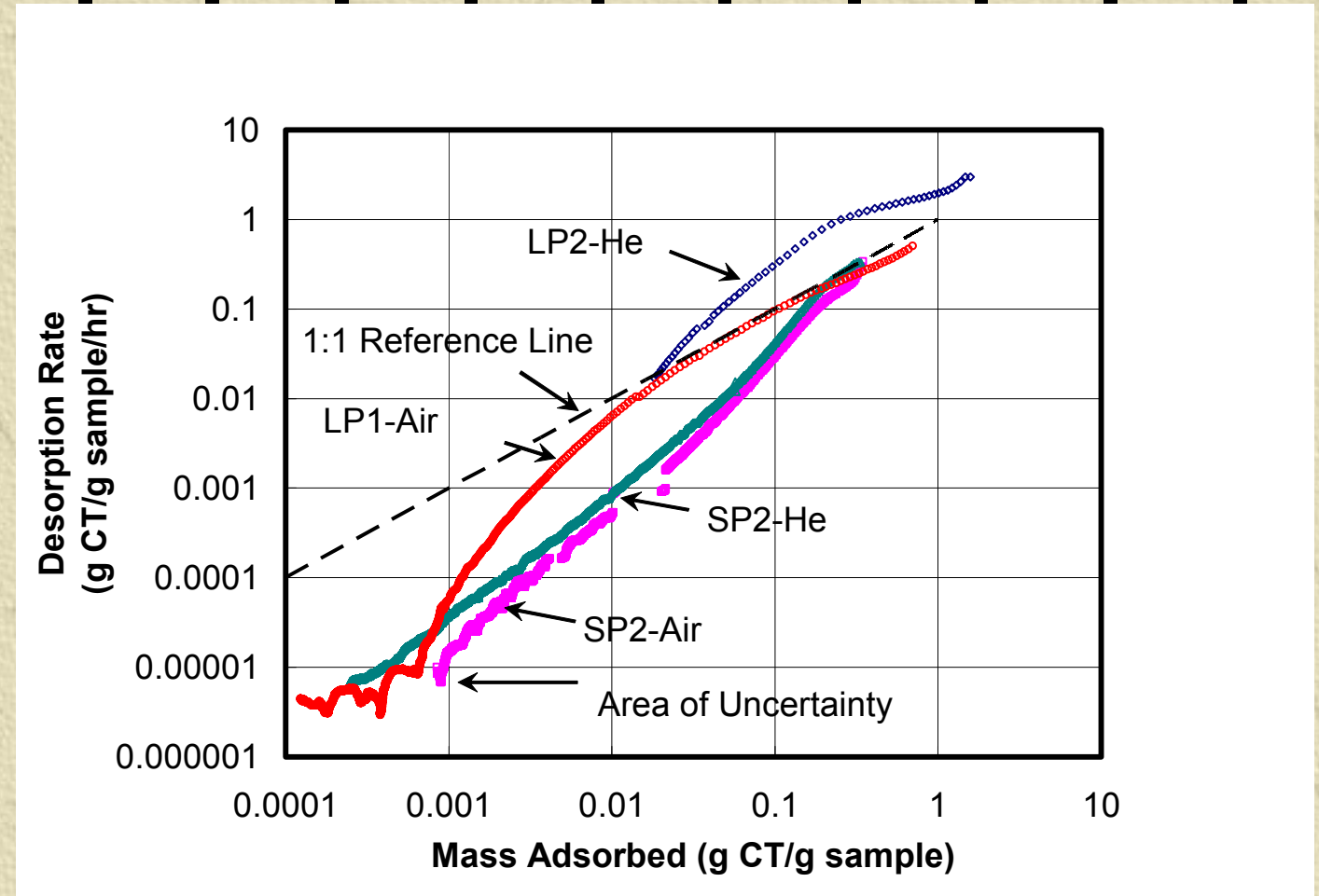


Rubotherm Balance

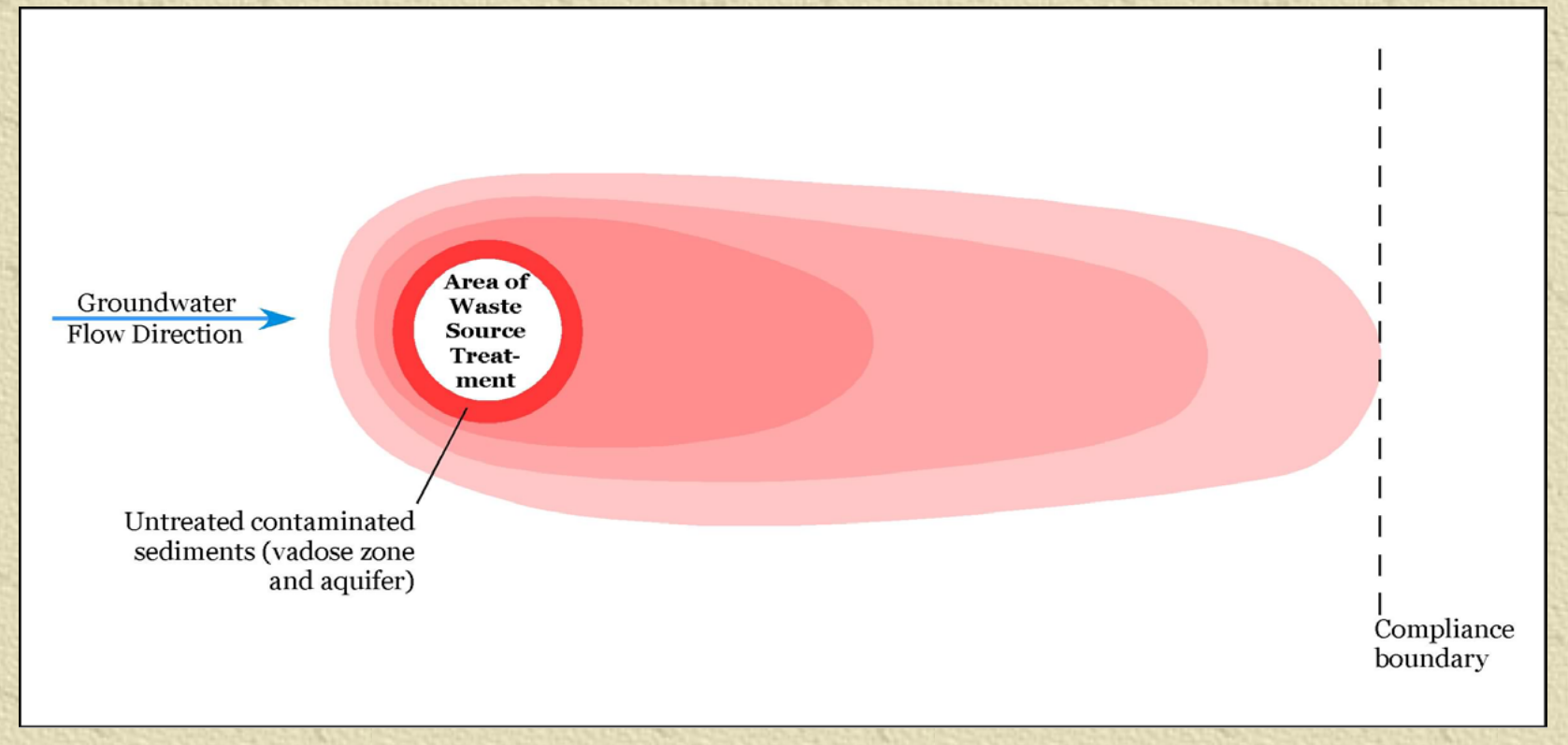
Direct measurement of long-term sorption and desorption rates of volatile contaminant in unsaturated porous media.



Desorption Rate Curves



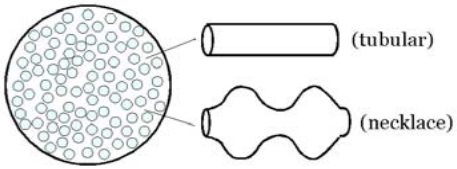
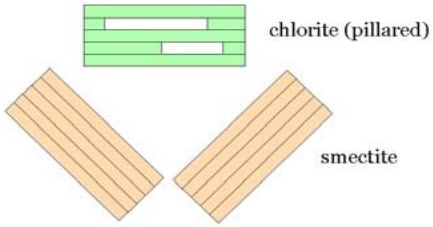
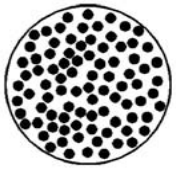
Site Conceptual Model



Potential Effects of MRF on Waste Source Remediation and Compliance Strategies

Remediation Strategy	Compliance Strategy
• Effectiveness of natural attenuation increased due to slow release of source material to the groundwater • Complete removal of waste source may not be required in order to meet compliance requirements for site closure • Expensive pump and treat strategies may be terminated earlier based on less conservative model predictions	• Compliance requirements for site closure can consider release rate of source and may allow leaving some source in place • Transport models that account for the slow release process may eliminate an element of conservativeness in predicting when groundwater compliance may be achieved

Model Materials and Sediments

Model Material	Natural Sediment
Porous silica 	- Hanford formation (80-85 ft) - Ringold Formation (150-155 ft) - Ringold Formation (197-222 ft) - Savannah River
Clay 	- Ringold Formation (245 ft) - INEEL (103-107 ft) - INEEL (226-241 ft)
Organic resin or activated carbon 	- Co-contaminant-coated Hanford formation? - Co-contaminant-coated Ringold Formation?

Established Collaborations/Contacts

- Hanford Groundwater Monitoring Project
  - Well Installation
- Fluor Daniel Hanford, Inc. (FHI)
  - Operable Unit Investigations
  - System Assessment Capability Modeling
- Hanford Science and Technology Program
- INEEL
  - Lithologic Core Storage Library
  - CCl_4 Modeling at SDA
- Savannah River Site
  - MNA/EPR Project

Project Team

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- V.J. Rohay (FHI)