U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: TRANSPORT AND REACTIVE TRACER TESTING AT THE C-WELLS COMPLEX

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C-Wells Reactive Tracer Testing

Principal Investigator:

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Objectives

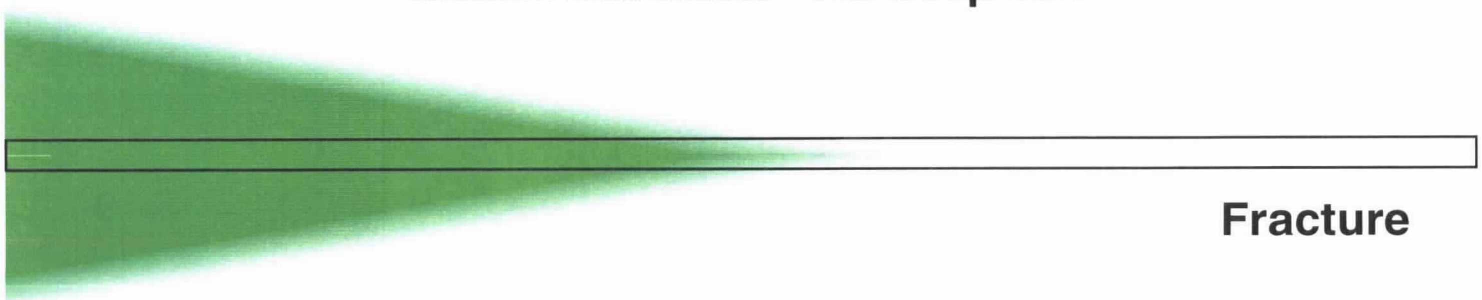
- Validate SZ Transport Conceptual Model
  - Dual-Porosity System
  - Matrix Diffusion
  - Sorption in Matrix and Fractures
- Demonstrate Field-Scale Applicability of Lab Sorption Data
- Obtain Field-Scale Transport Parameter Estimates

Matrix Diffusion and Sorption

No Matrix Diffusion or Sorption

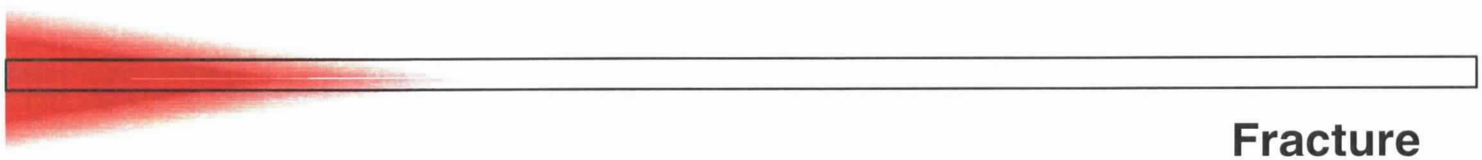
Flow Direction

Matrix Diffusion - No Sorption

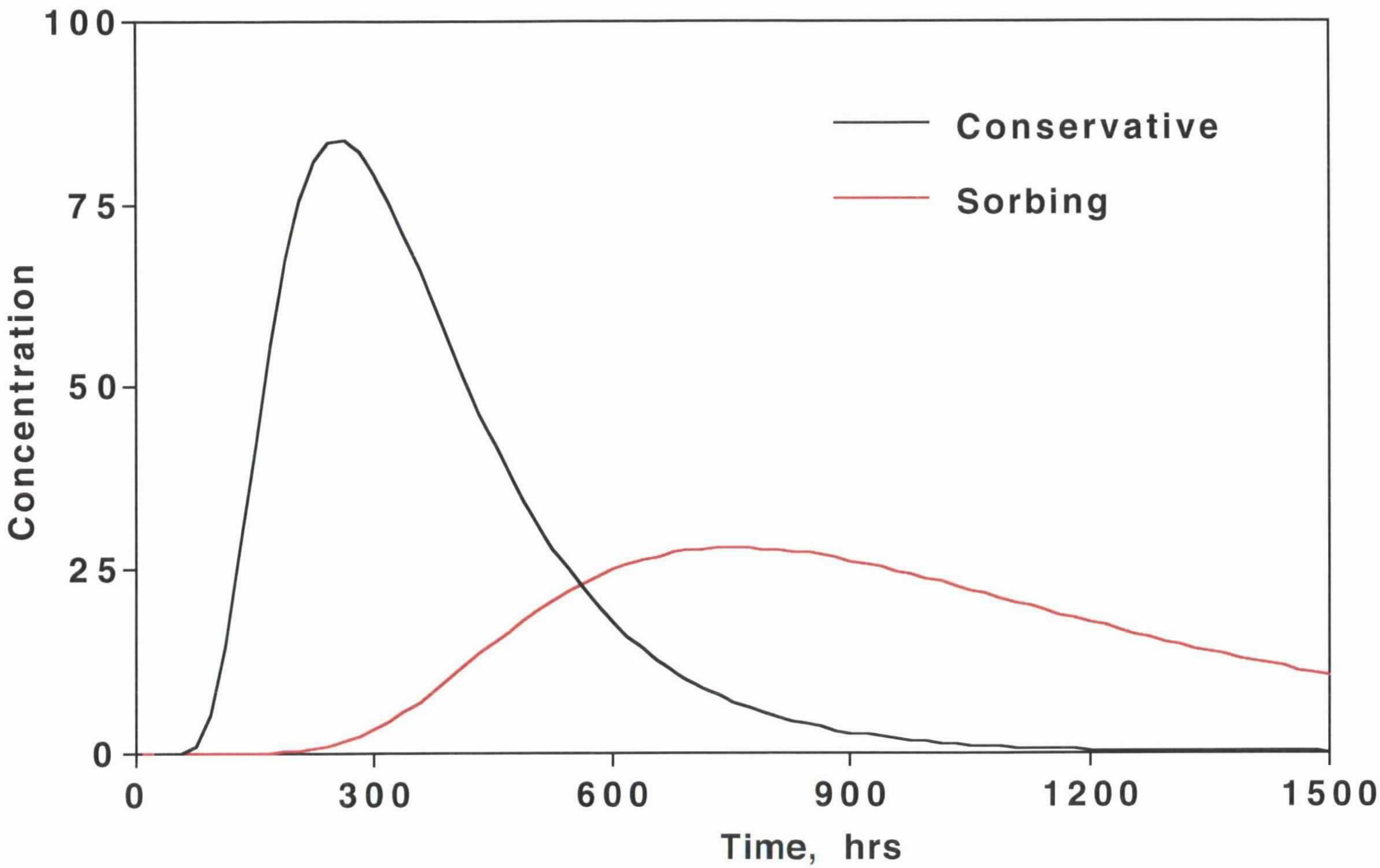


Flow Direction

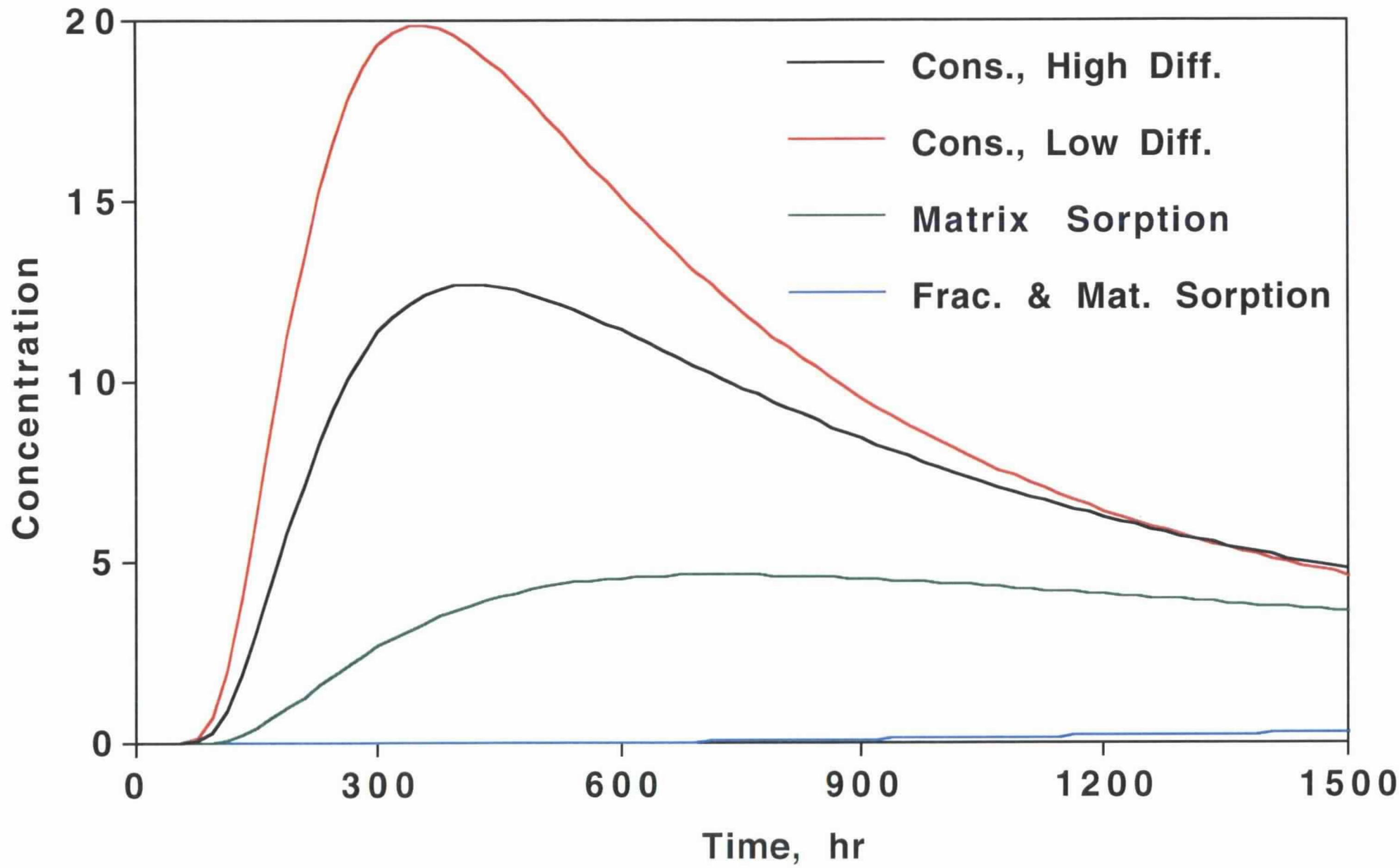
Sorption and Matrix Diffusion



Single-Porosity Aquifer



Effects of Sorption and Matrix Diffusion



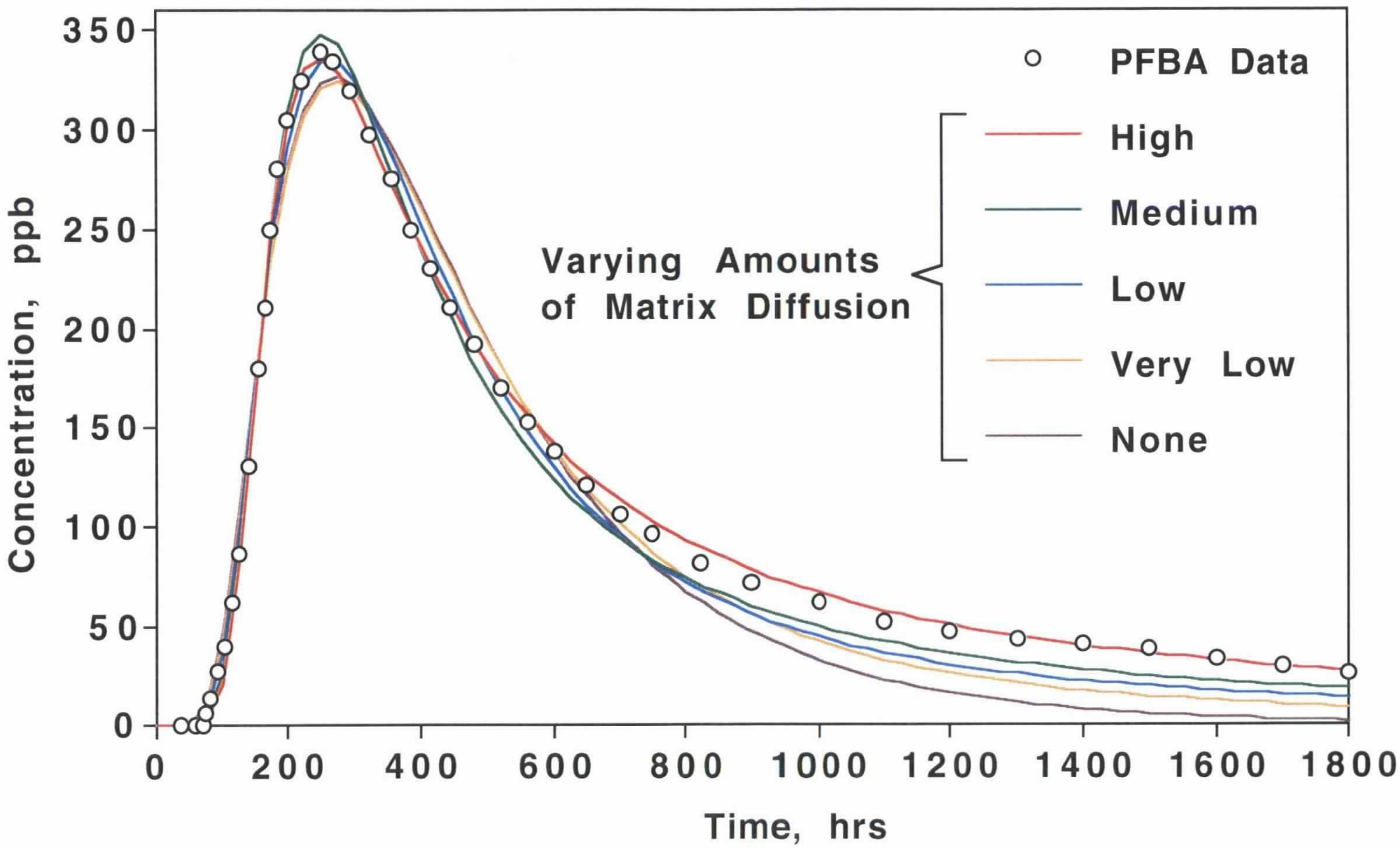
Test Strategy

- Laboratory Sorption Studies
- Initial Conservative Pilot Test
- Multiple Tracers to Distinguish Processes:

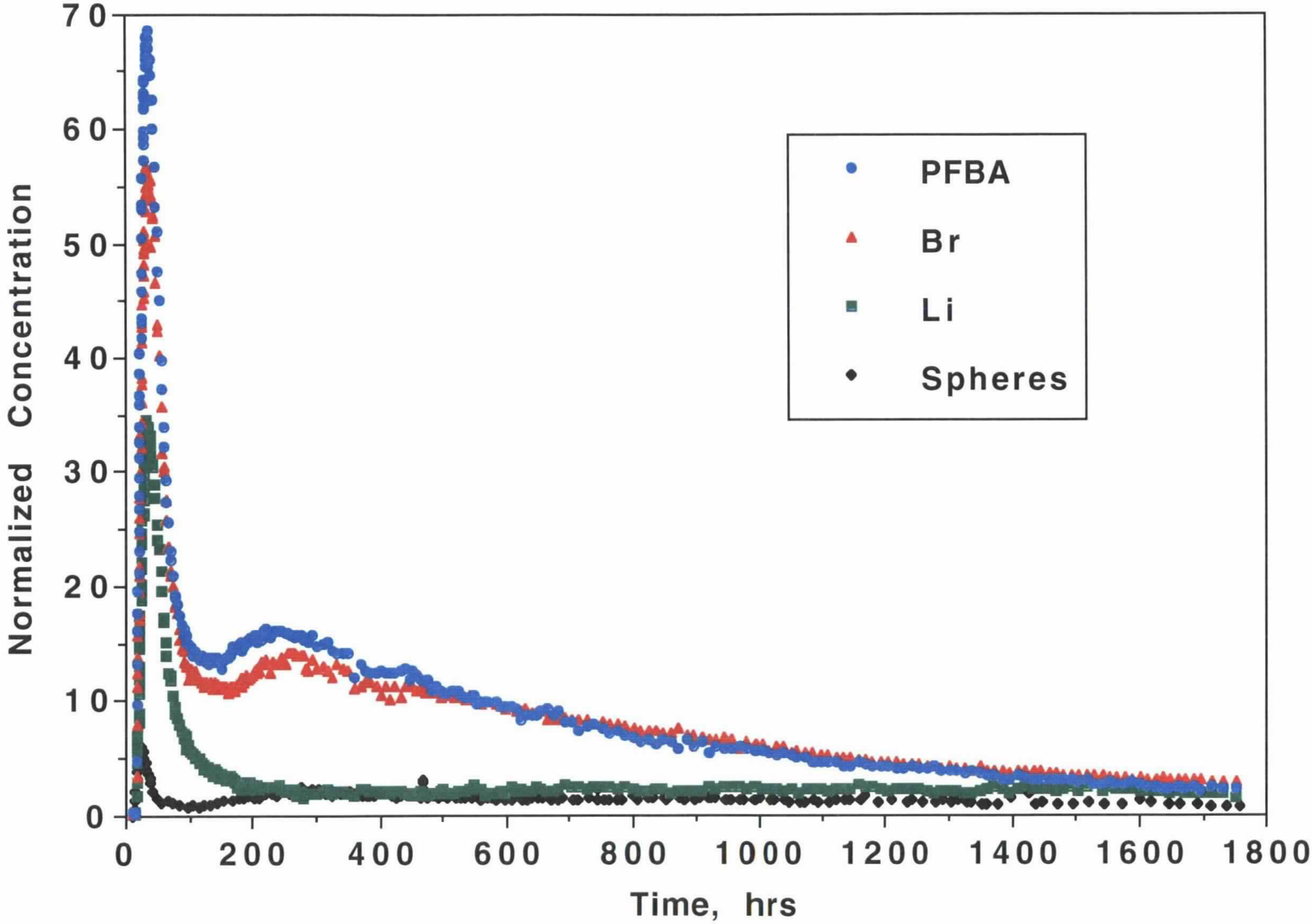
Tracer	*Category*	*Diffusivity*	*Sorption*
PFBA	Solute	Low	None
Br^-	Solute	High	None
Li^+	Solute	Intermediate	Low
Microspheres	Colloid	Very Low	None

- Simultaneous Tracer Injection
- Interpret by Comparing Responses

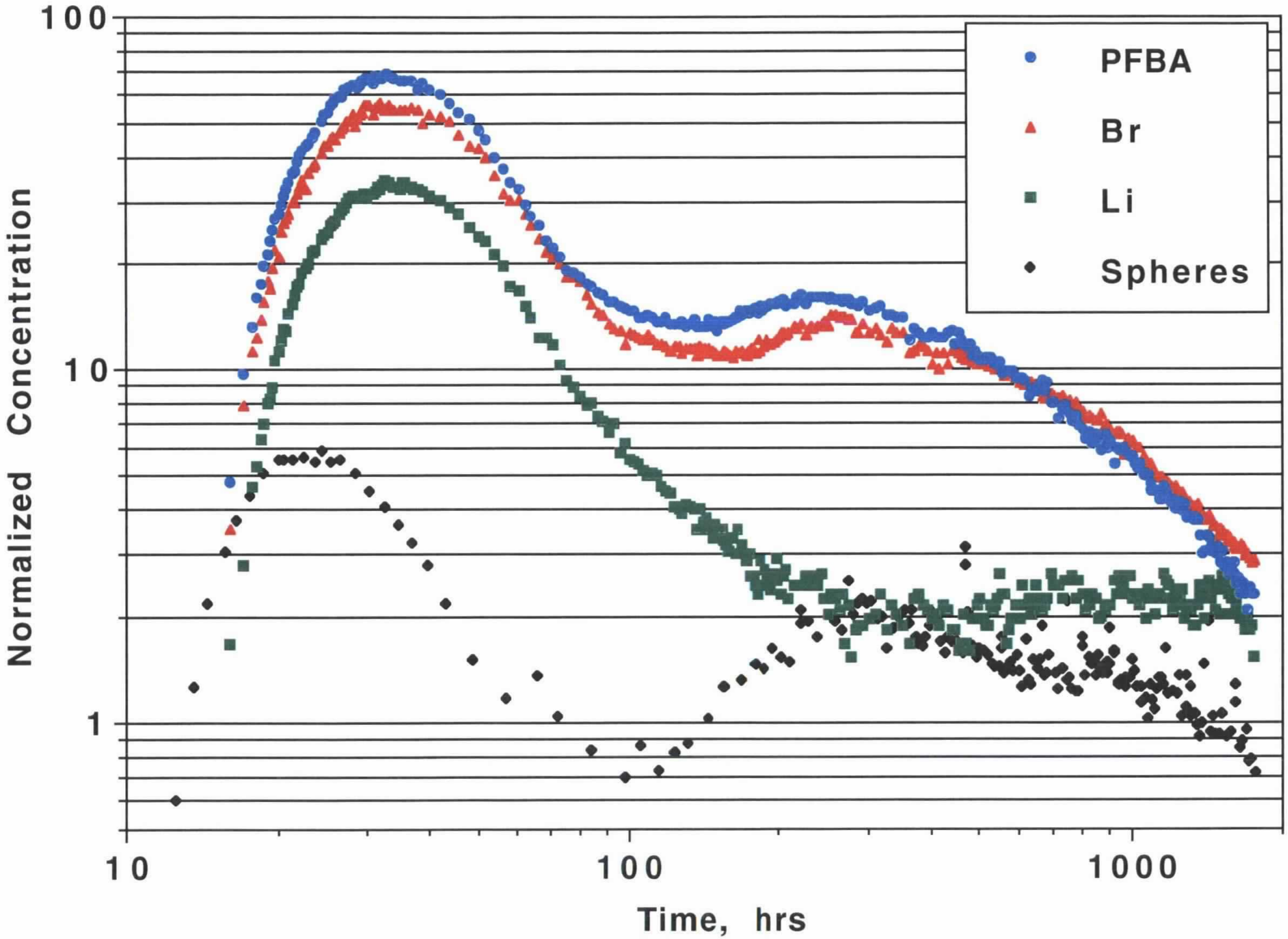
May '96 Pilot Test
Single Conservative Tracer



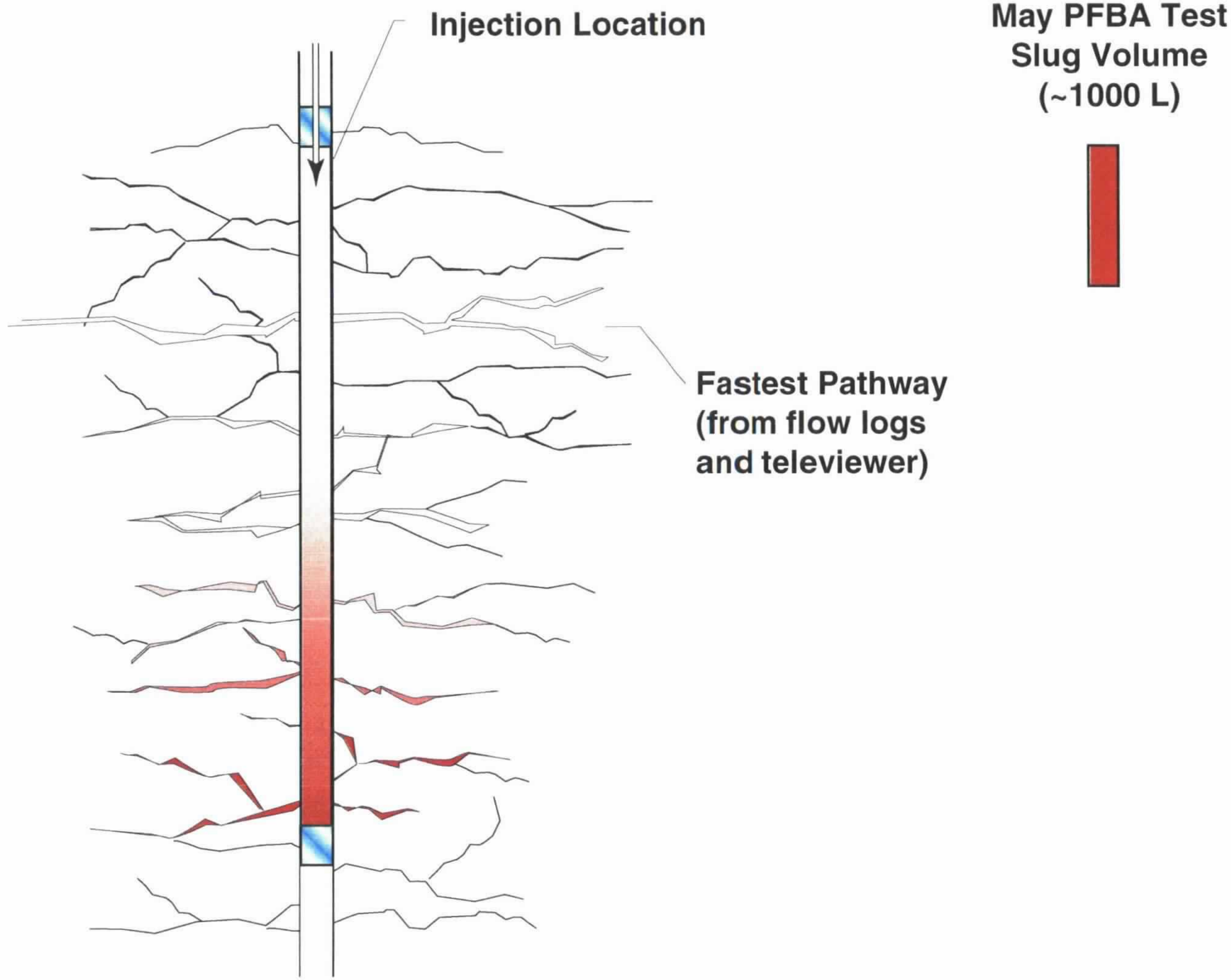
Reactive Tracer Test Results



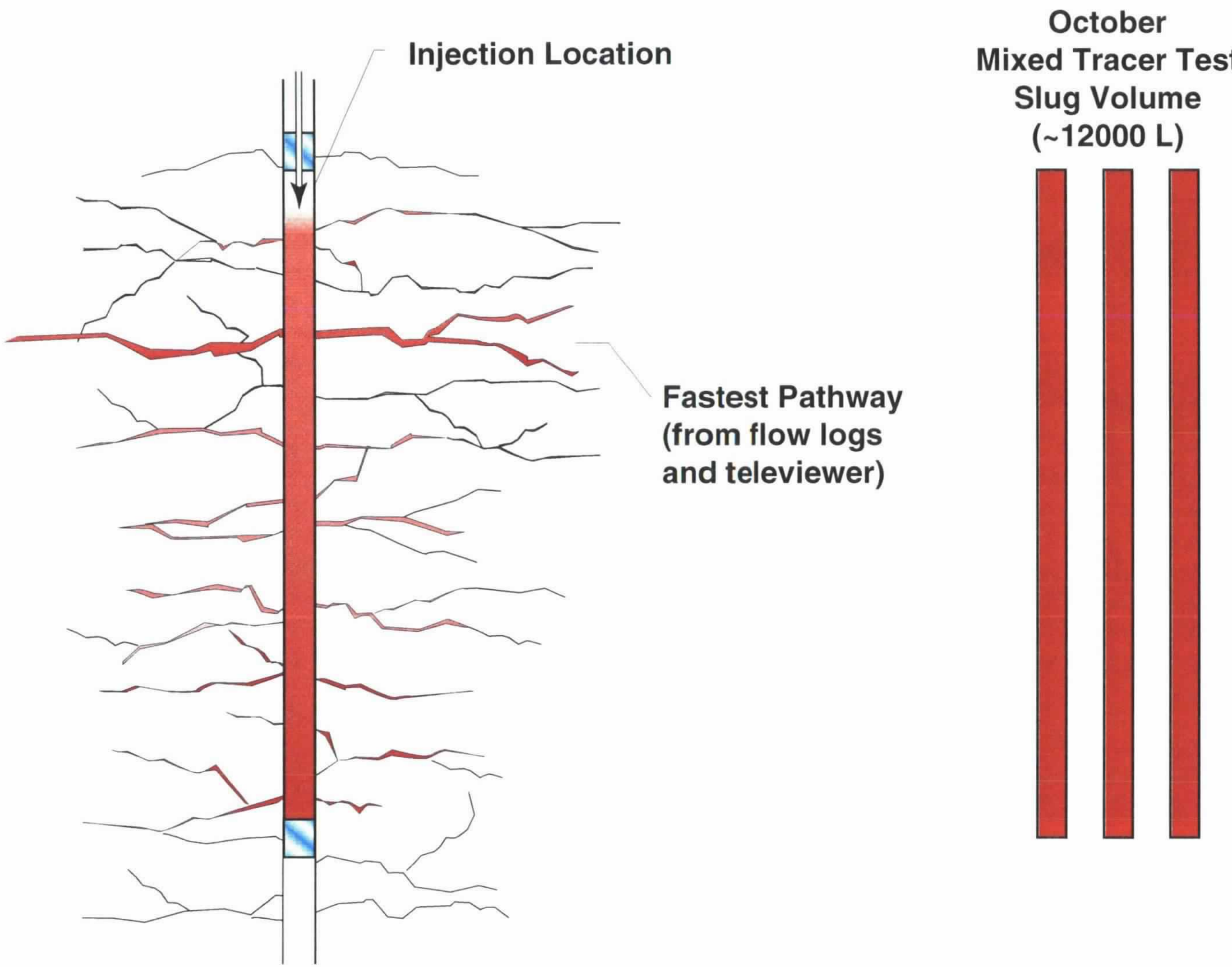
Reactive Tracer Test Results



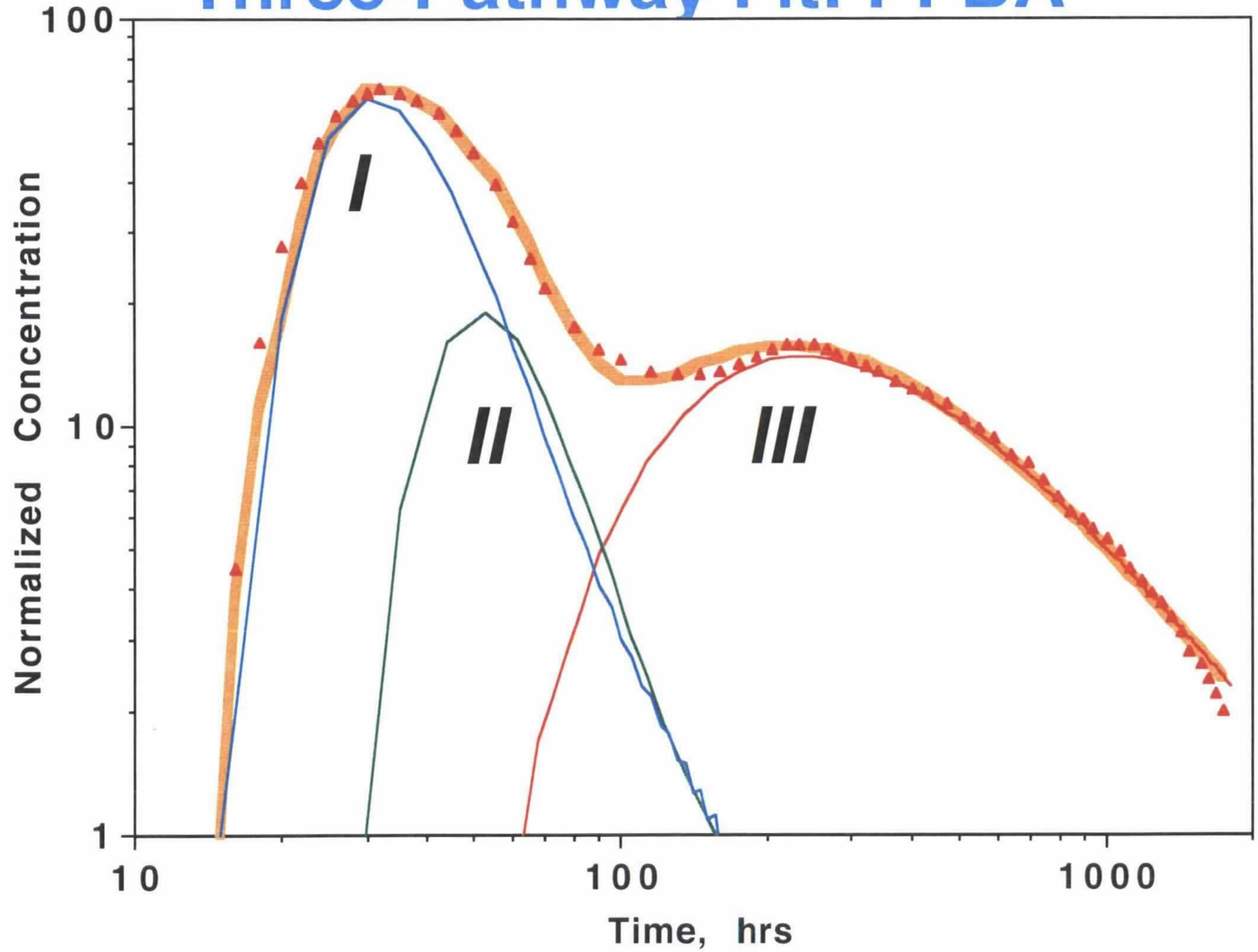
May Injection -- Small Volume



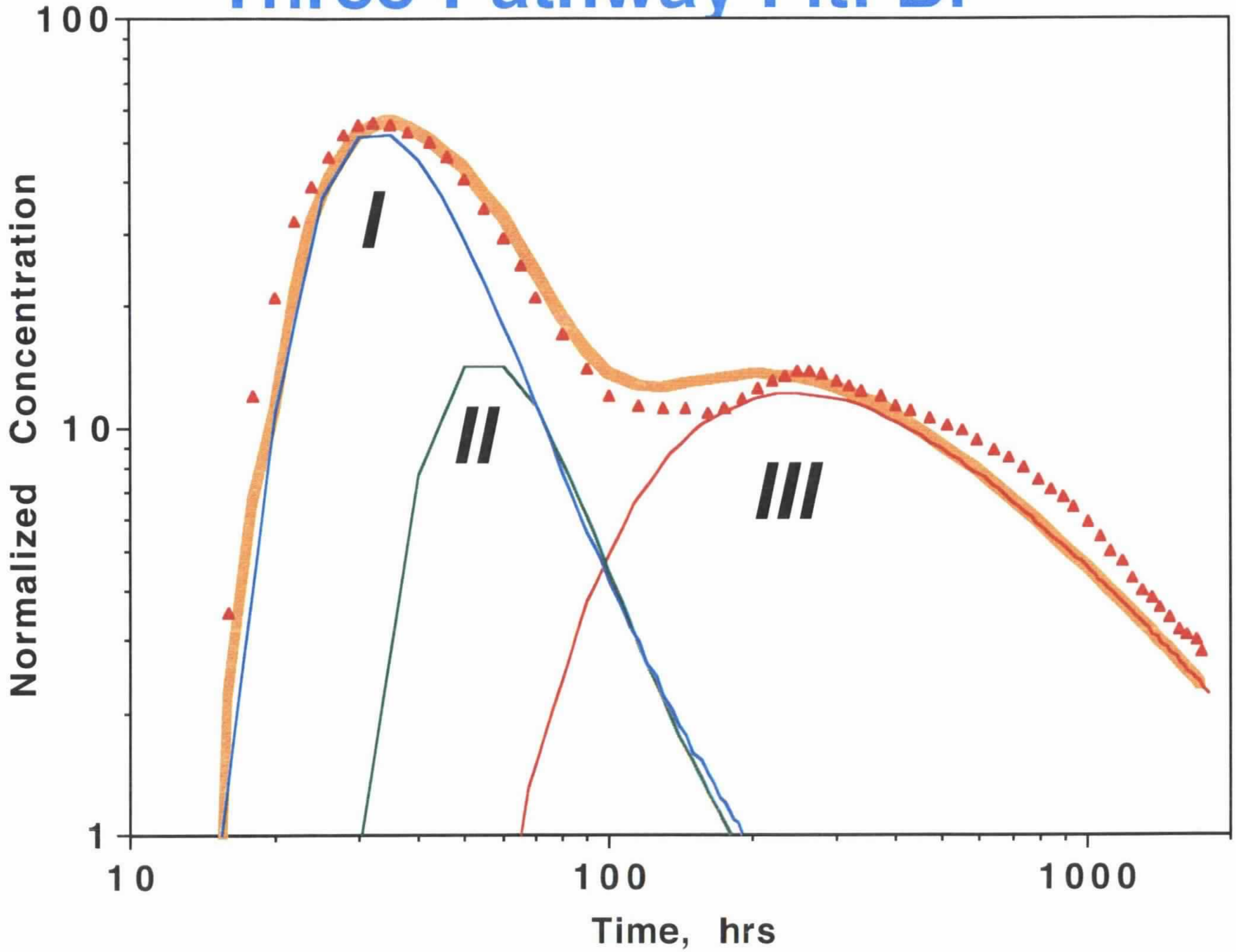
October Injection -- Large Volume



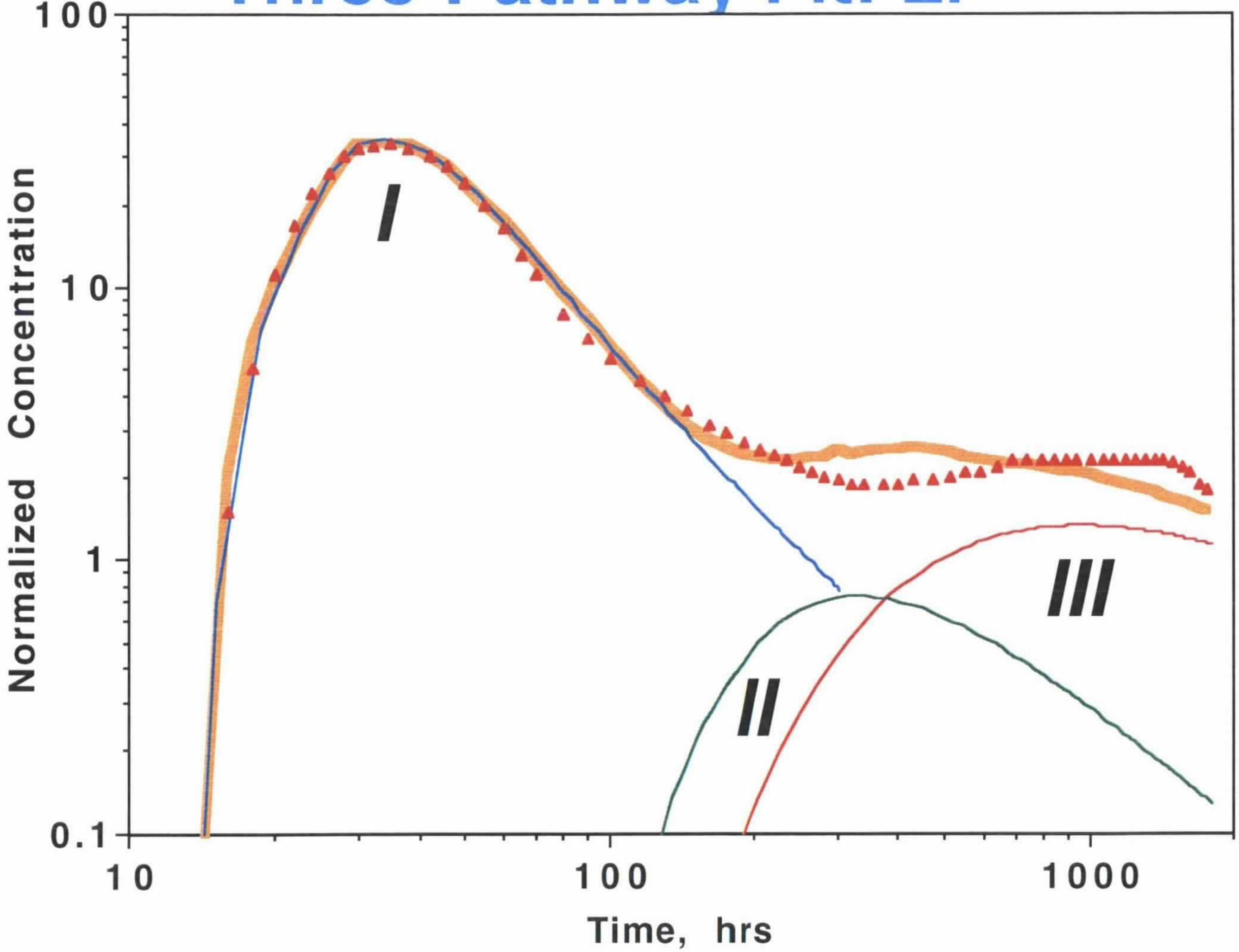
Three-Pathway Fit: PFBA



Three-Pathway Fit: Br^-



Three-Pathway Fit: Li^+



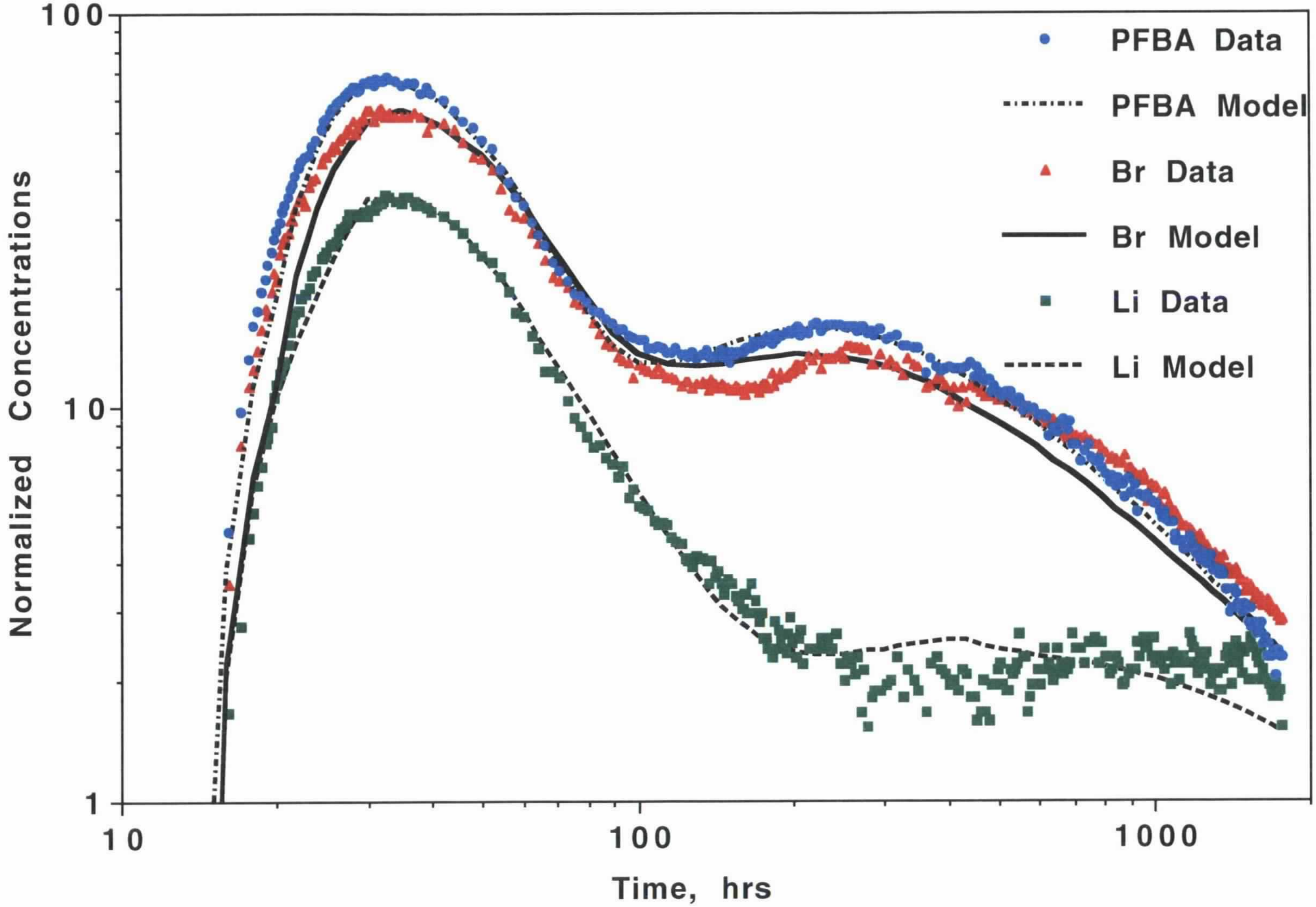
Best-Fit Parameters

	Process	Pathway I	Pathway II	Pathway III
m_p	mass fraction	0.08	0.037	0.68
τ, hr	travel time	26	43	1000
Pe	1 / dispersivity	10	21	1.4
α, cm^{-1}	matrix diffusion	1.5	1.5	0.57
R_m (Li)	matrix sorption	5	5	5
R_f (Li)	fracture sorption	1	4	3

Laboratory Results

R_m (Li)	matrix sorption	3 - 6
R_f (Li)	fracture sorption	Planned Work

Reactive Tracer Test - Data and Model



Preliminary Results

- Multiple pathways with different transport characteristics
- Matrix diffusion observed in all paths
- All pathways show matrix sorption of Li^+, some also show fracture sorption
- Li^+ field sorption agrees well with lab sorption data
- Dispersivity ranges from ~ 4 m to ~ 50 m, larger in longer residence time paths

Conclusions

- SZ transport conceptual model is valid (at least for Bullfrog Tuff at C-Wells)
- Field measurements of Li^{+} sorption agree with lab measurements
- Matrix diffusion and sorption are effective retardation and dilution mechanisms

Planned Testing

- Field -- Additional reactive tracer tests in:
  - Different formations at C-Wells
  - Different locations around Yucca Mountain
- Laboratory:
  - Identify other reactive tracers (other sorption mechanisms, e.g. surface complexation)
  - Study reactive transport in fractures
- Modeling:
  - Integrate C-Wells results into ongoing efforts
  - Examine effects of dimensionality and heterogeneity