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Chemical analyses in support of Yucca Mountain studies

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Chemical Analyses in Support of Yucca Mountain Studies

*Harry Reid Center for Environmental
Studies, University of Nevada, Las Vegas*

Research Objectives

SIP-UNLV-034

- Provide preparation of injectates, sorption studies and analyses for tracer tests
- Provide REE, trace metals, majors and field measurement data from wells of the Nye County Early Warning Drilling Program (NCEWDP) and Inyo County
- Other laboratory needs as they arise

Tracer Tests

- Provide insight into groundwater flow characteristics and contaminant transport processes.
- Important for contaminant migration issues including remediation and safe disposal of hazardous and radioactive materials.

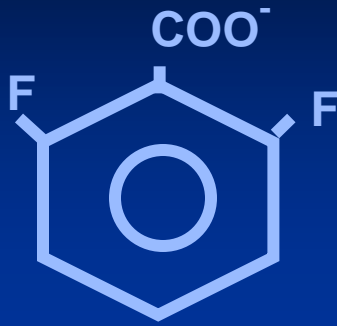
Properties of a Conservative Tracer

- Must be water soluble
- Should not sorb to aquifer material
- Should be chemically and biologically stable for the duration of the test
- Should be foreign to the environment
- Should be nontoxic
- Should have good analytical sensitivity
- Ability for simultaneous analysis

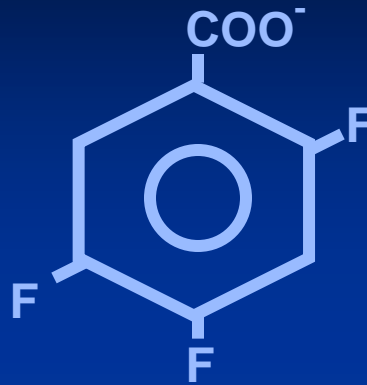
Chloride and Bromide

- Considered almost ideal tracers
 - Rarely sorb to soil particles
 - Anion exclusion – repulsion of anions from negatively charged solid particles
 - Concentration of Br^- generally much less than Cl^- in matrix waters

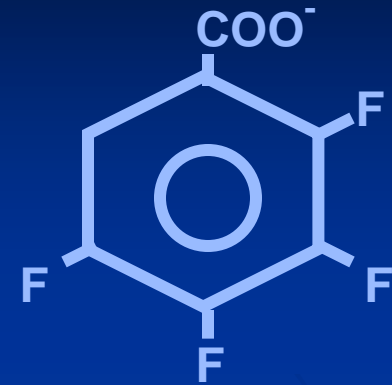
Fluorinated Benzoic Acids



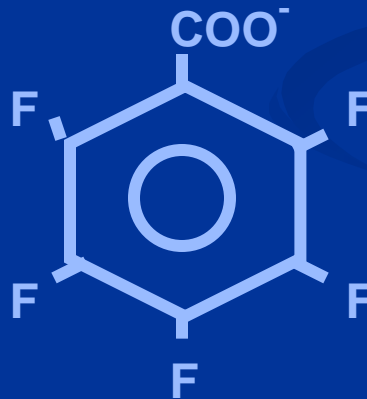
2,6-DFBA



2,4,5-TFBA



2,3,4,5-TFBA



PFBA

Benzoate Tracers

- Mobility mimics bromide
- Can degrade
- Sorption and transport are pH dependent
- pKa values low

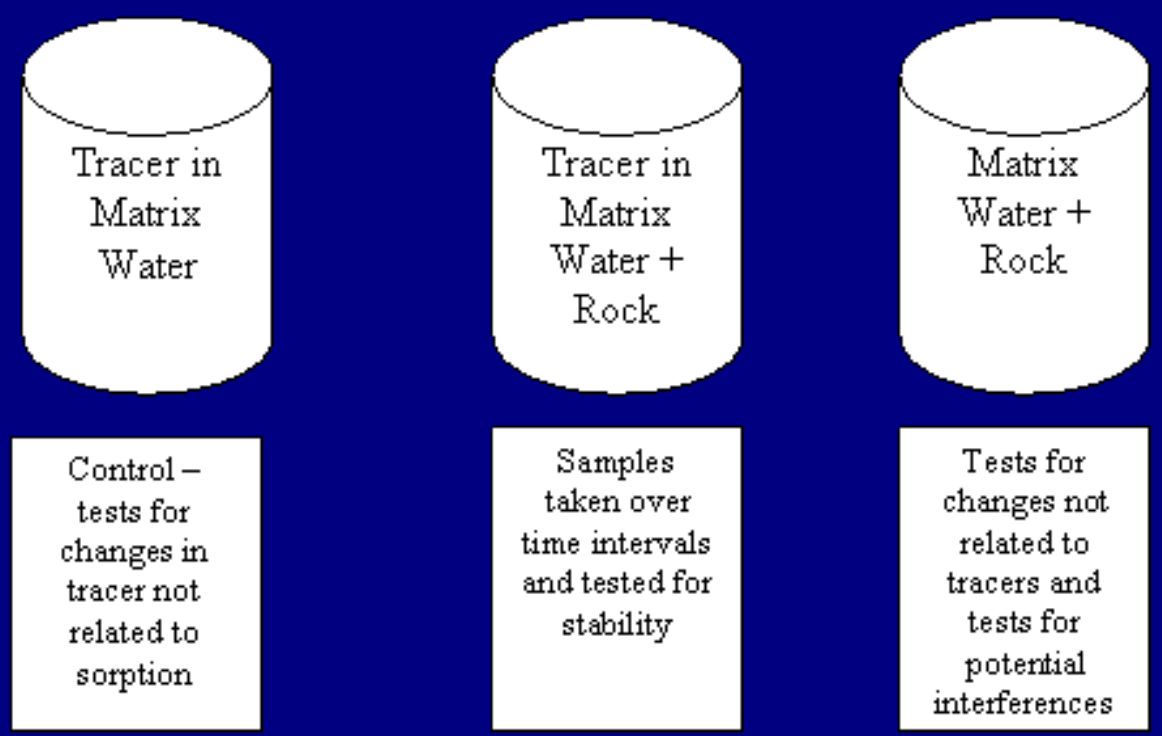
$$\text{pK}_a = \text{pH} + \log [\text{HA}] / [\text{A}^-]$$

- pka's of FBA's range from ~2.5 - ~4.0
- pH system will influence retention of FBAs in geologic material
- At pH's above the pKa, anionic form dominates.
- Geologic material generally negatively charged
- At neutral pH, FBA tracers will be greater than 99% in anionic form, as pH becomes more acidic, tracer potentially more reactive

Batch Tests

- Used to evaluate the stabilities of potential tracers in an environment that closely simulates that of the tracer test
- Looking for changes in tracer concentration due to sorption of tracer onto rock or biodegradation by microbes

Batch Test



Tracer in
Matrix
Water

Control –
tests for
changes in
tracer not
related to
sorption

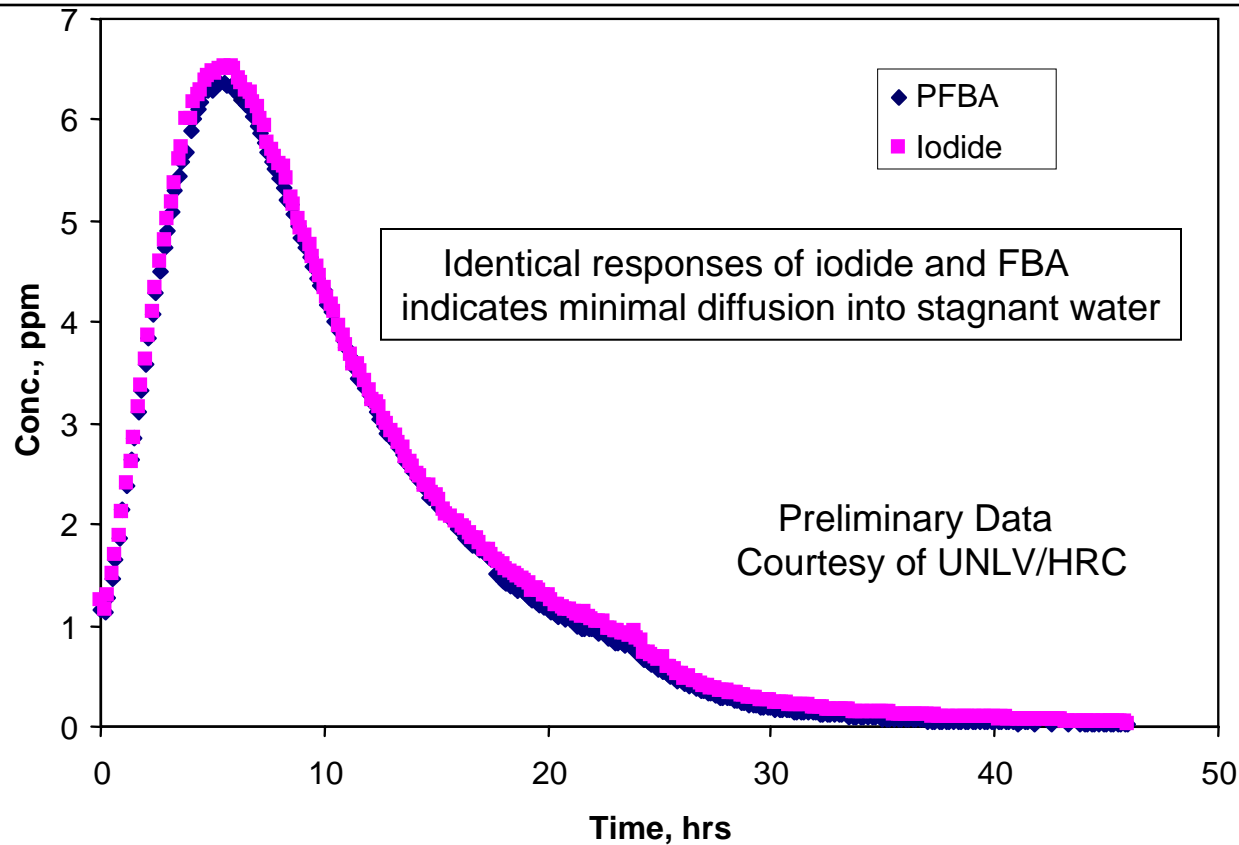
Tracer in
Matrix
Water +
Rock

Samples
taken over
time intervals
and tested for
stability

Matrix
Water +
Rock

Tests for
changes not
related to
tracers and
tests for
potential
interferences

Normalized Tracer Concentrations in 1st Single-Well Test Indicate Minimal Diffusion into Stagnant Water



Tracer concentrations normalized to injection mass
Graph courtesy of P.Reimus/LANL

Methods of Analysis

- Organics – High Performance Liquid Chromatograph (HPLC) with UV/Vis detector
- Inorganics – Ion Chromatograph (IC) with conductivity detector
- Rhenium – Ion Coupled Plasma Mass Spectrometer (ICP-MS)

- Two conservative (nonsorbing) tracers with different diffusion coefficients in each test
- Tracers diffuse into the rock, and the larger molecules cannot enter the pore spaces that the smaller molecules can and will travel faster through the water.
- Identical responses of halide and fluorinated benzoate indicate no appreciable diffusion into storage porosity

Progress

- Since 2003, we have completed four tracer tests.
 - Site 22 Cross-Hole Tracer Test Using Perrhenate – Rhenium, Iodide
 - Single Well, Push/Pull Tracer Test at Well NC-EWDP 22S – PFBA and Iodide
 - Single Well, Push/Pull Tracer Test at Well NC-EWDP 22S – 2,3,4,5 TFBA and Iodide
 - Cross-Hole, Multiple-Well Tracer Test at Site 22 – Lithium, Bromide, 2,6 DFBA, 2,5 DFBA and 2,4,5 TFBA
- Currently working on a natural gradient cross-hole tracer test – PFBA and Bromide

Total Samples Analyzed and Submitted to TDA Between FY03 and FY06

NCEWDP and INYO

- REEs: 38
- Trace Metals: 49
- Field Measurements: 71
- Cations: 173
- Anions: 176

Tracers

- Inorganics: 2946
- Organics: 2290

Task Members

■ Tracers

- Nicole McGinnis/Jeanette Daniels – organics
- Amber Howerton/Julie Bertoia - inorganics

■ NCEWDP/Inyo County

- Tatjana Jankovic – field measurements
- Caixia Guo – REEs
- Kaz Lindley – Trace Metals
- Julie Bertoia/Caixia Guo - majors

Acknowledgements

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- Nicole McGinnis
- Oanh Le
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- Joe Lloren
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- John Campanella, Questa Engineering