2007

Chemical analyses in support of Yucca Mountain studies

Harry Reid Center for Environmental Studies

University of Nevada, Las Vegas

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.

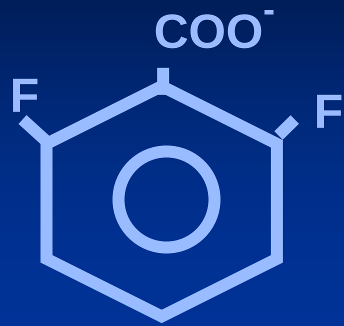
Properties of a Conservative Tracer

- 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

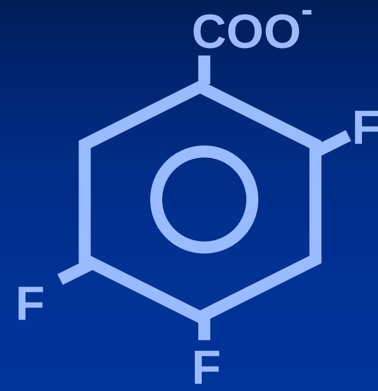
Chloride and Bromide

- 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

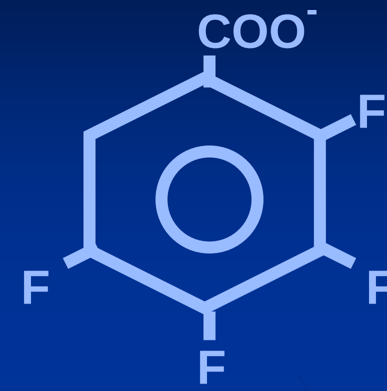
Fluorinated Benzoic Acids



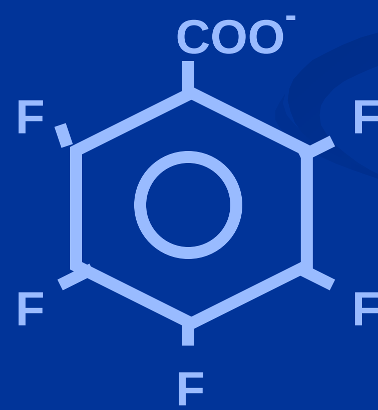
2,6-DFBA



2,4,5-TFBA



2,3,4,5-TFBA



PFBA

•Benson and Bowman, 1994, Soil Science, 58(4) 1123-1129

Benzoate Tracers

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

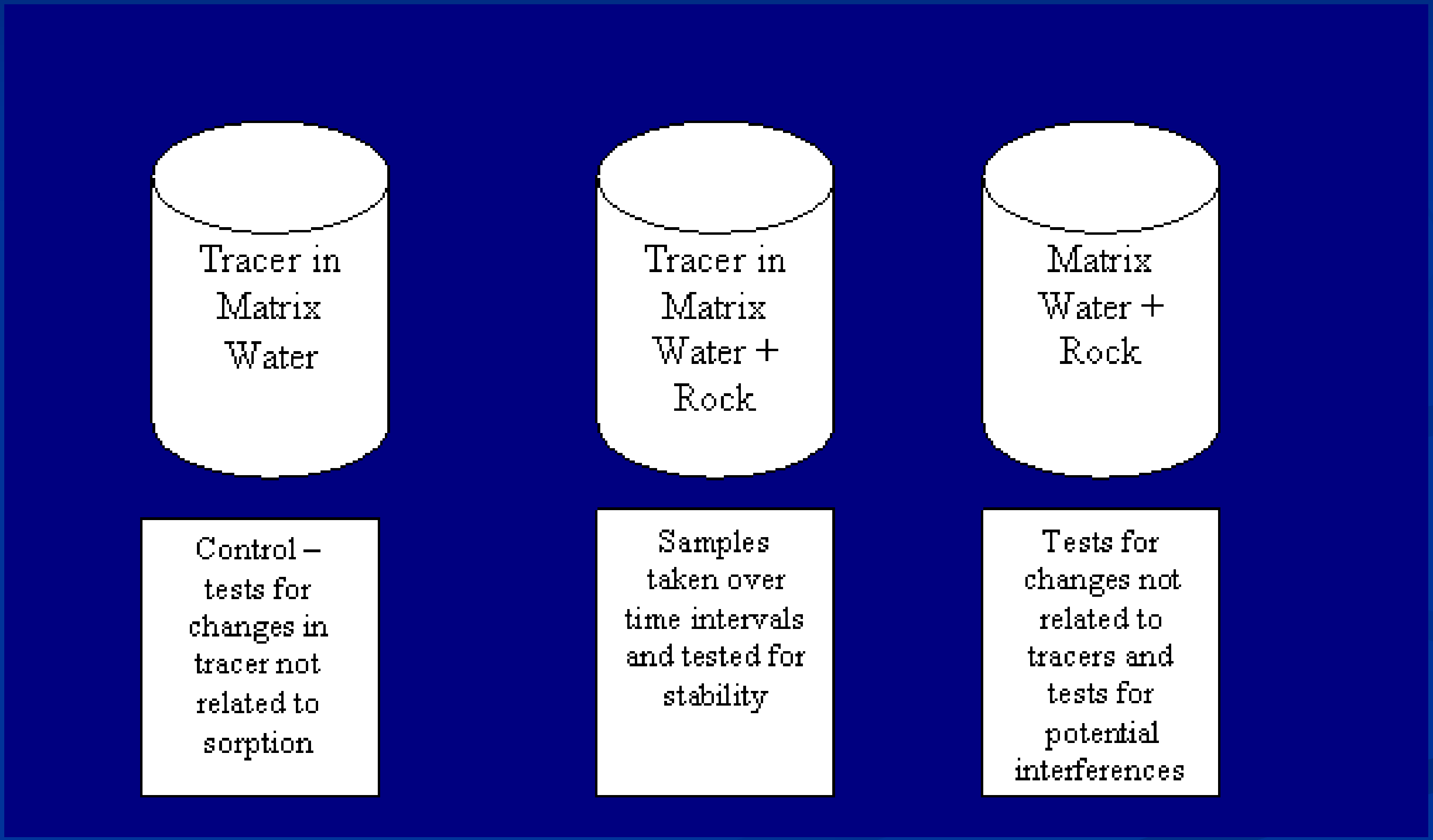
pKa = pH + log [HA] / [A-]

- 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

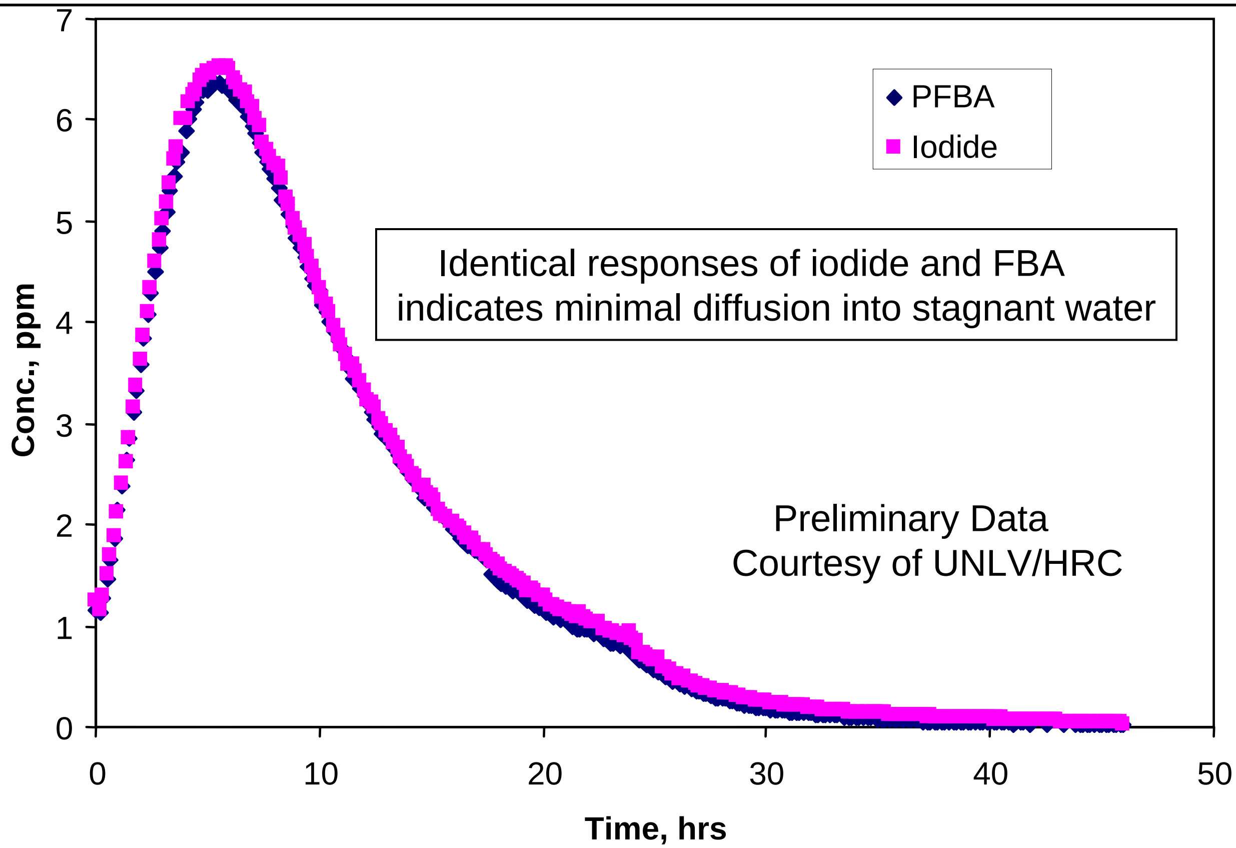
- Used to evaluate the stabilities of potential tracers in an environment that closely simulates that of the tracer test
- Looking for changes in tracer concentration due to sorption of tracer onto rock or biodegradation by microbes

Batch Test



Tracer in Matrix Water
Tracer in Matrix Water + Rock
Matrix Water + Rock
Control – tests for changes in tracer not related to sorption
Samples taken over time intervals and tested for stability
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

<u>NCEWDP and INYO</u>

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

<u>Tracers</u>

- 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

- DOE Cooperative Agreement DE-FC28-04RW12232
- Julie Bertoia
- Nicole McGinnis
- Oanh Le
- Helen Luu
- Joe Lloren
- John Earle, USGS
- Paul Reimus, LANL
- John Campanella, Questa Engineering