Column Testing of the Migration and Distribution of Humate Injected into Subsurface Systems at Savannah River Site's F/H Area

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Background

- F-Area seepage basins at Savannah River Site (SRS) have received large amounts of low level waste solutions.
- Uranium and various radionuclides are above maximum contaminant levels.
- Remediation by humic acid (HA) has shown to be a potential approach for controlling mobility of contaminants.
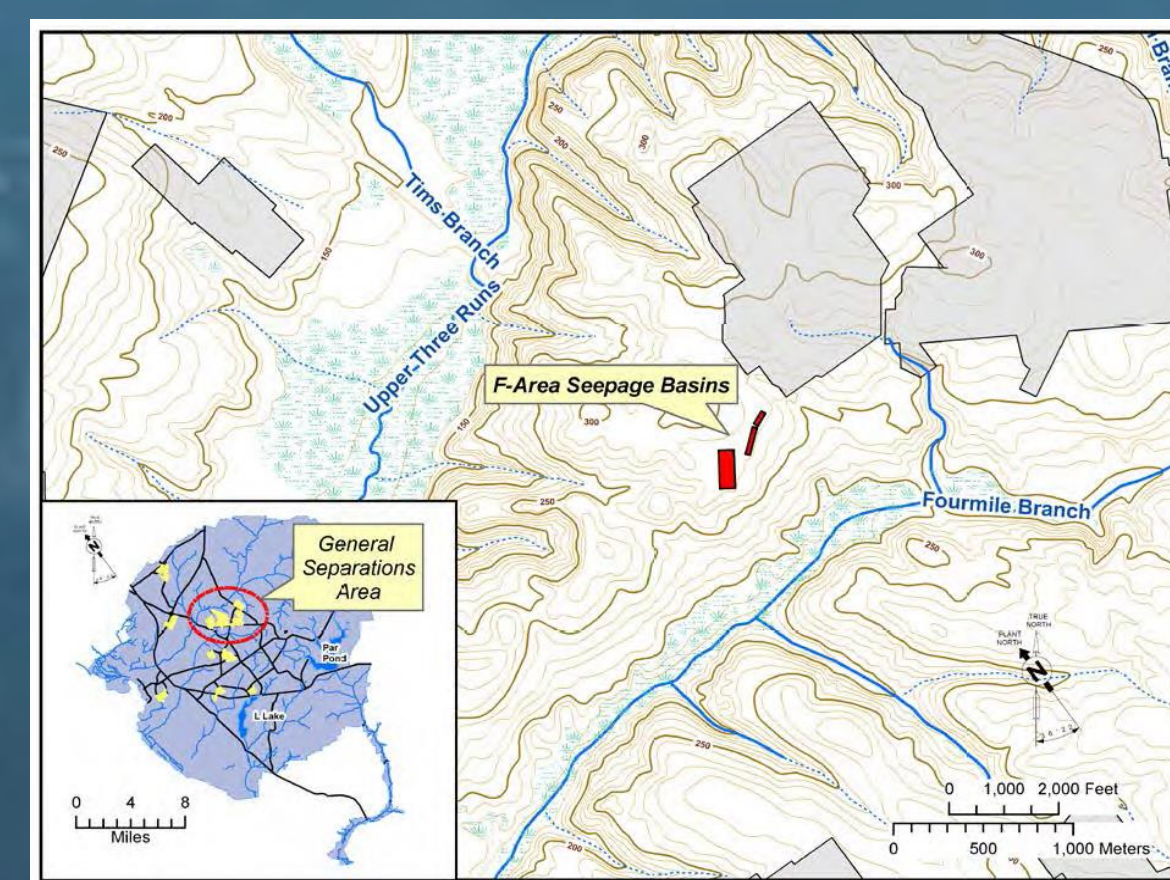

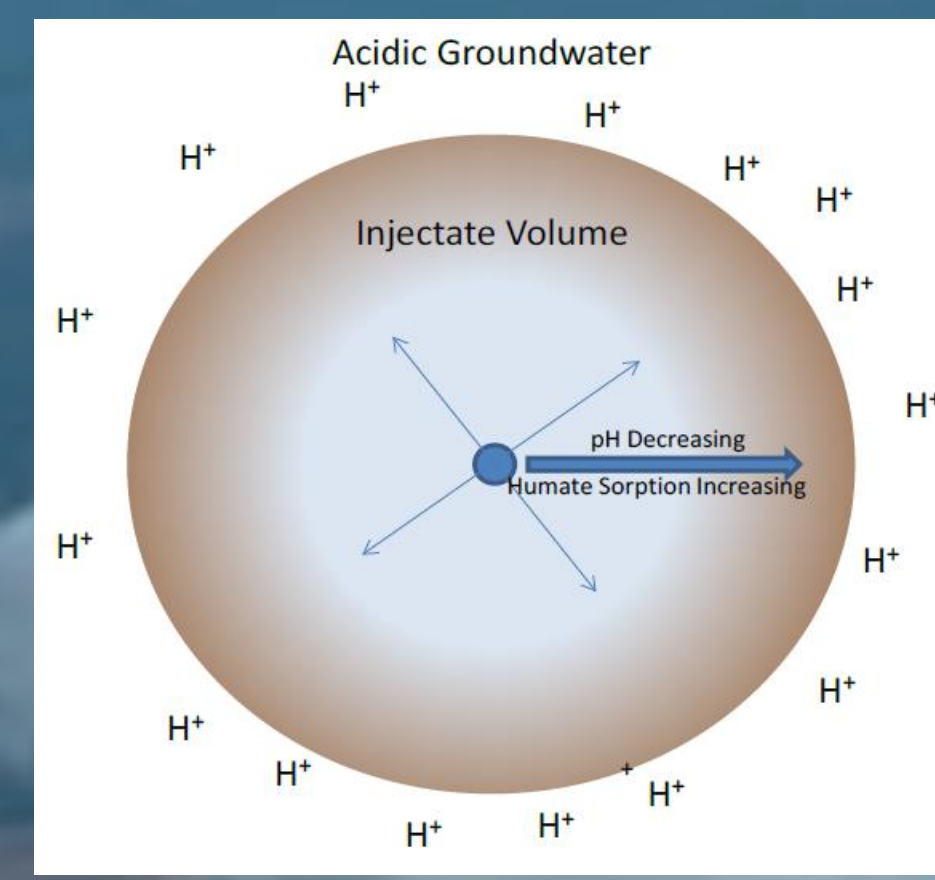Fig 1. Area seepage basins (from Millings et al., 2013).

Fig 2. Conceptual Behavior of Humate Injected

Objectives

- Study the migration and distribution of HA injected in to subsurface systems by column experiments in support of uranium remediation.
  - Obtain sorption and desorption parameters and understand sorption under different levels of pH

Methodology

- Characterization of F-area soil.
- Perform column flow through bromide tracer tests.
- Preparation of artificial groundwater to mimic SRS groundwater.
- Preconditioning of columns to bring pH of soil to field conditions.
  - pH of 3.5, 5.0, 6.0, 7.0 will be attained.
- Injection of Huma-K into column and study the sorption by analyzing the effluent via UV-Vis spectrophotometer.
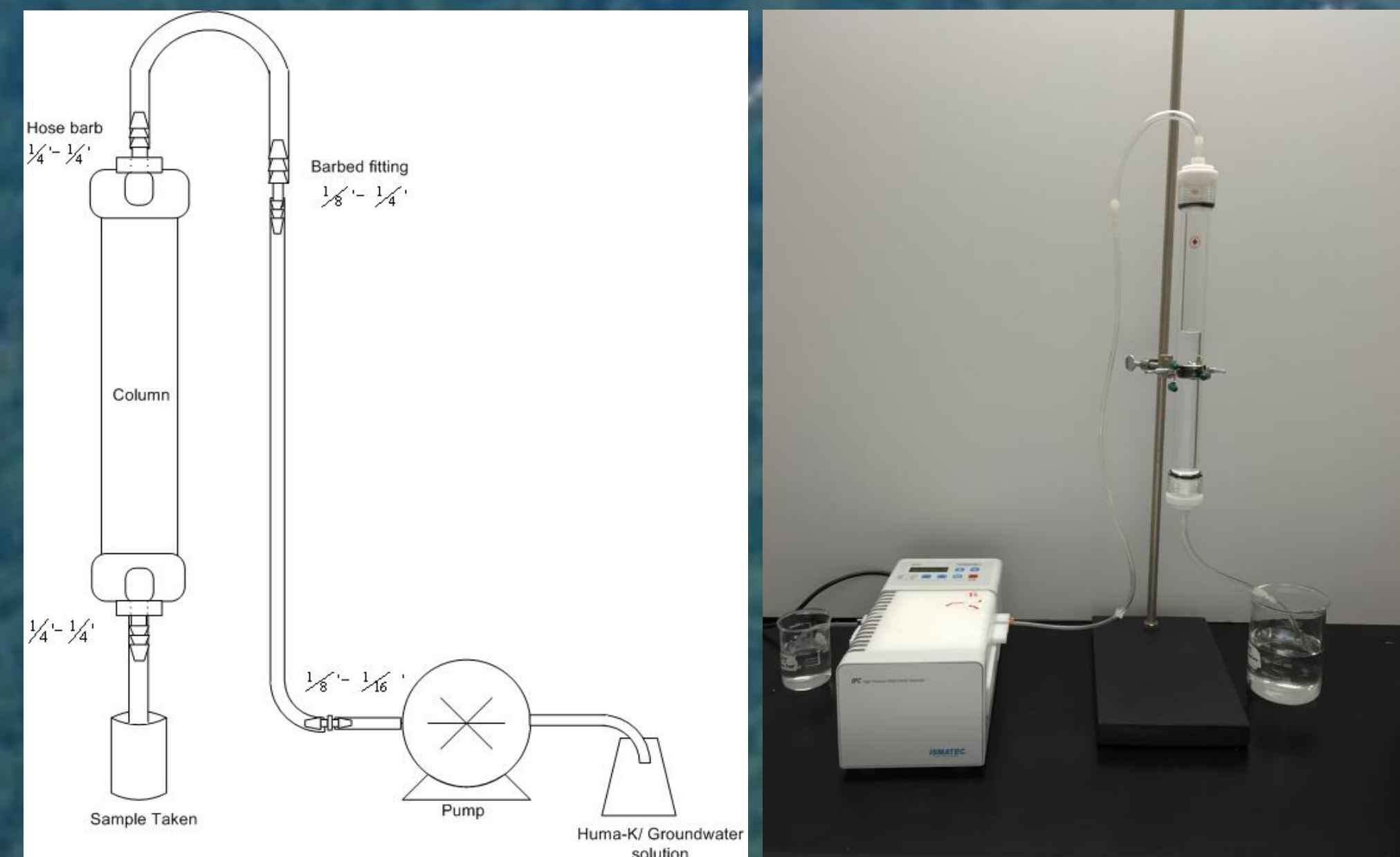- Perform desorption for 3.5, 5, 6, and 7 pH solutions.

Fig 3-4. Experimental Column Setup

Results

- The preliminary data for column experiments have been found, including the properties of SRS soil and concentration of Huma-K needed.

- Soil Characterization: FAW-1 60'-70'
  - Bulk density: 1.334 g/cm^3
  - Particle density: 2.645 g/cm^3
  - Porosity: 0.496
  - pHw: 4.06

- Humate Injection scenarios are used to predict the sorption of HA on sediment and determine optimum concentration of Huma-K and flow rate, as well as to compare to experimental breakthrough curves.

- Injection Scenarios
  - a: 2082 mg/kg
  - b: 0.0025 L/mg
  - Cell pore vol/time step: 0.4
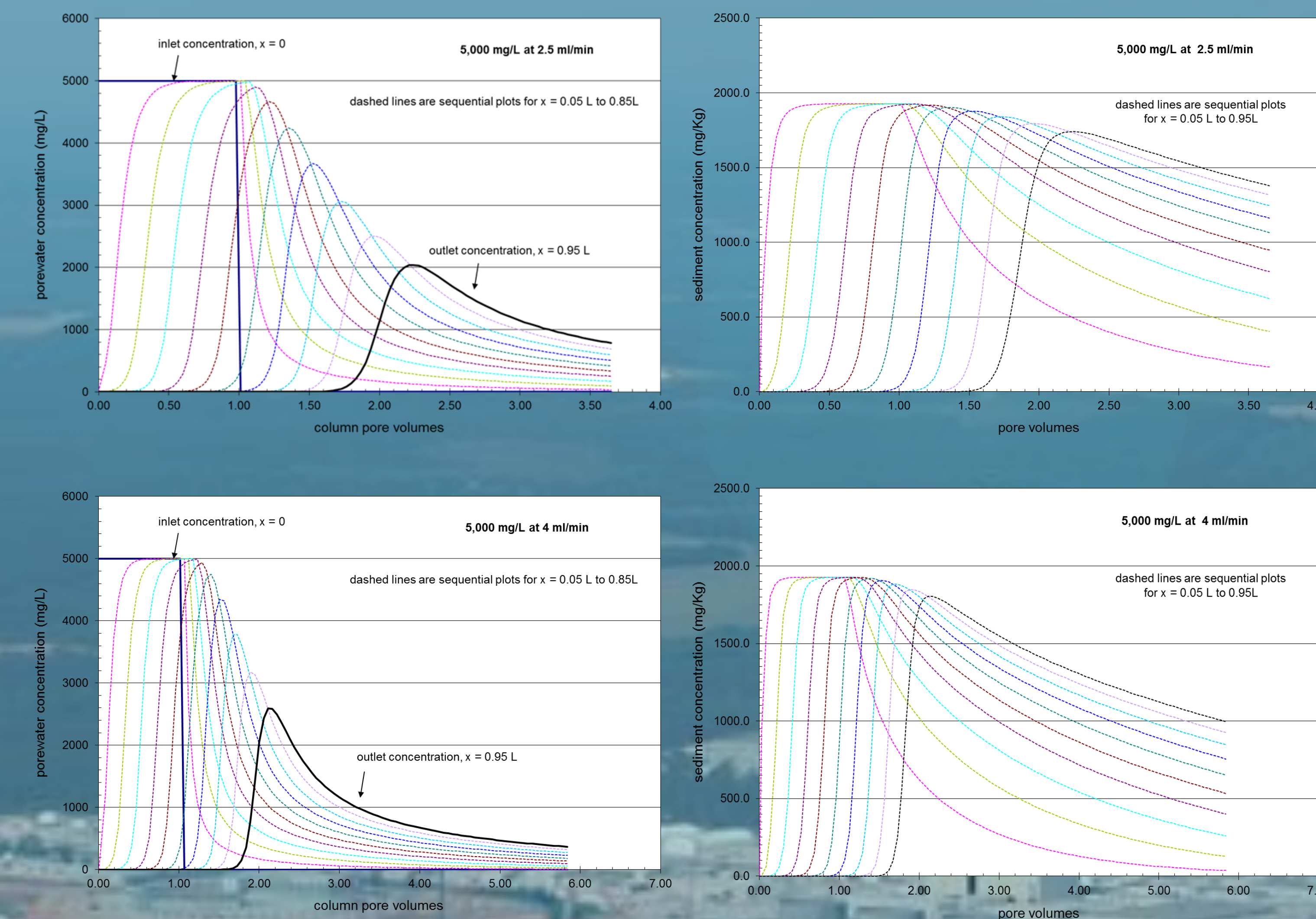 - Huma-K Concn: 5000 mg/L

Fig 5-8 Simple conceptual models of humate injection using Langmuir isotherm.

Discussion

- The injected Huma-K at high pH is expected to decrease the mobility of organic molecules as pH decreases, as it interacts with the soil and flushing of artificial groundwater.
- The expected results should demonstrate that humate sorbed to soil should bind with uranium at acidic pH.
- The modeled injection scenarios suggests the optimal Huma-K concentration and flow for columns should be 5000 mg/L at 2.5 ml/min, avoiding over saturation and best amount of sorption to sediment.
- The results from previously conducted humate injection tests will be used to compare the properties of humic acid.

Future Work

- Continue column experiments to determine sorption and desorption properties to use for actual field deployment
- In addition to uranium, ICP tests will be performed for iron and silica.
- Data from this experiment will be used to develop a subsurface flow, rate, and transport model of distribution of humic acid for in situ treatment

Abstract

The F-Area seepage basins at Savannah River Site (SRS) have received approximately 1.8 billion gallons of low-level waste solutions, containing nitric acid, radionuclides and dissolved metals due to plutonium separation operations from 1955 to 1988. The waste solutions became a source of contamination for groundwater and soil at the site, with U(VI) and other radionuclides above their maximum contaminant levels (MCLs). For remediation, humic acid (HA) technology has shown to be a potential approach for controlling mobility of radionuclides. Because sorbed HA and uranium develop a strong bond at slightly acidic pH, the mobility of the contaminant molecules should decrease with flushing of SRS groundwater. Column experiments are planned using SRS soil from the F/H Area to examine the sorption and desorption properties of HA in SRS soil. The data from these experiments will then be used to perform modeling of the migration and distribution of HA injected into the subsurface.

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