

# **Field-Scale In Situ Measurements of Vadose Zone Flow and Transport Using Multiple Tracers at INEEL Vadose Zone Research Park (VZRP)**

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## **Research Objective**

This study is aimed at obtaining a better understanding of vadose zone flow and transport processes at the field scale and establishing defensible links between laboratory- and field-derived transport parameters for conservative and reactive elements in the vadose zone. The study site (Vadose Zone Research Park [VZRP] at INEEL) provides a three dimensional instrumentation array strategically surrounding a new infiltration pond slated for initial use in the upcoming year, and the Big Lost River, and intermittent stream proximal to the infiltration ponds. The proposed research will utilize the infiltration ponds and the Big Lost River to study the effects of fluid flux, water chemistry and degree of saturation on contaminant transport in the vadose zone. Our research plan has four major objectives: 1) determine the transport of conservative and reactive solute and colloid tracers through the vadose zone and local perched water zones; 2) examine isotopic variations of U and Sr and compare these to introduced sorbing and non-sorbing tracers; 3) develop and calibrate a conceptual flow and transport model, and 4) examine the effects of flow and geochemical transients on tracer transport.

## **Research Progress and Implications**

As of June 25, 2003, this report summarizes the work after about 9 months of a 3-year project. Infiltration ponds at the VZRP were activated in August 2002, several months earlier than expected and two months before EMSP funds were in place. LANL and INEEL managed to procure emergency funds to begin a sampling routine. Hundreds of samples were collected and most are now analyzed for major cations and anions. Assessment of these data is underway. Due to the early filling of the ponds, tracer permits were not obtained in time to inject tracers. In September of 2003, Catherine (Kate) Jones was hired to participate in the project. Kate has an M.S. degree in Earth Sciences from the University of New Mexico and is currently enrolled in the Ph.D. program at New Mexico Tech where she will work under the supervision of Robert Bowman (NMT) and Robert Roback (LANL) on aspects of this project. In June of 2003, Elizabeth (Beth) Nichols was hired as a summer student to assist in summer field and analytical activities. Beth will begin work in the fall toward her M.S. degree under the supervision of Yemane Asmerom (UNM) and Robert Roback (LANL) of various laboratory and analytical aspects of this project. Tracer permits were obtained in the spring of 2003 through the diligence of Larry Hull (INEEL). During the first two weeks of June 2003, LANL and INEEL personnel initiated the first tracer test the VZRP. The test consisted of pouring pre-dissolved 2,4,5 trifluorobenzoic acid into the south infiltration pond during normal discharge operations. Sampling of 9 sampling ports (monitoring wells and lysimeters) commenced shortly after tracer application and continues, at nearly around the clock sampling frequency, today. Over 1000 samples have now been collected. Analysis for the tracer and cations, anions and isotopes will begin at LANL shortly. In addition to these activities, project personnel have collaborated with a number of INEEL personnel who have separate projects at the VZRP. These include Gail Heath, who is conducting geophysical surveys at the site to image water flow, and Kristine Baker, who is managing and evaluating the extensive data set generated from instrumented boreholes at the site. These collaborations have been tremendously useful in planning of the recent test and will undoubtedly enhance our overall understanding of the system.

## **Planned Activities**

Sampling from the most recent test will wind down this week. The last of the LANL field team will return and INEEL personnel will continue a low frequency sampling program for the next few weeks. Analysis of the many samples collected from this test will begin shortly, with data management, processing and evaluation continuing along with its generation. We plan to conduct a second tracer test this summer, probably late in July. This second test will utilize the north pond, which has been dry for nearly a year. Thus, the second test will be performed in relatively dry conditions relative to the conditions of the first test. The second test will also generate a large number of samples. Analysis and evaluation of data from both tests will be the primary activities throughout the fall.

### **Information Access**

R. Roback presented an overview talk at the EMSP PI workshop at PNNL in May.