Isotopic transport variation as a function of environmental conditions

Michael Foxe[1], Elizabeth Denis[1], Mindy Zimmer[1], Heather Cunningham[1], Kellen Springer[1], Derek Haas[2], Joseph Lapka[2], Lance Hubbard[1], Martin Liezers[1], and April J. Carman[1]

1. Pacific Northwest National Laboratory
2. University of Texas: Austin

Poster P2.4-217

POSTER

PNNL-SA-162616

The views expressed here do not necessarily reflect the views of the United States Government, the United States Department of Energy, the National Nuclear Security Administration or the Pacific Northwest National Laboratory
This research was funded by the National Nuclear Security Administration, Defense Nuclear Nonproliferation Research and Development (NNSA DNN R&D). The authors acknowledge important interdisciplinary collaboration with scientists and engineers from LANL, LLNL, MSTS, PNNL, and SNL.

Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

ABSTRACT

As gaseous and particulate signatures are produced during an underground nuclear explosion, it is important to understand their transport to the surface for subsequent atmospheric transport and detection. By understanding the transport throughout the subsurface, the atmospheric measurements have the potential to allow for a better understanding of the fractionation and total release fraction of radionuclides from a nuclear explosion. We have performed microscale studies of formation of particulate and transport of gaseous species within a variety of geologic media. In this presentation, we discuss the use of exploding wires to simulate the formulation of particulate and the use of inverse gas chromatography to characterize gas transport parameters for a variety of geologic media.

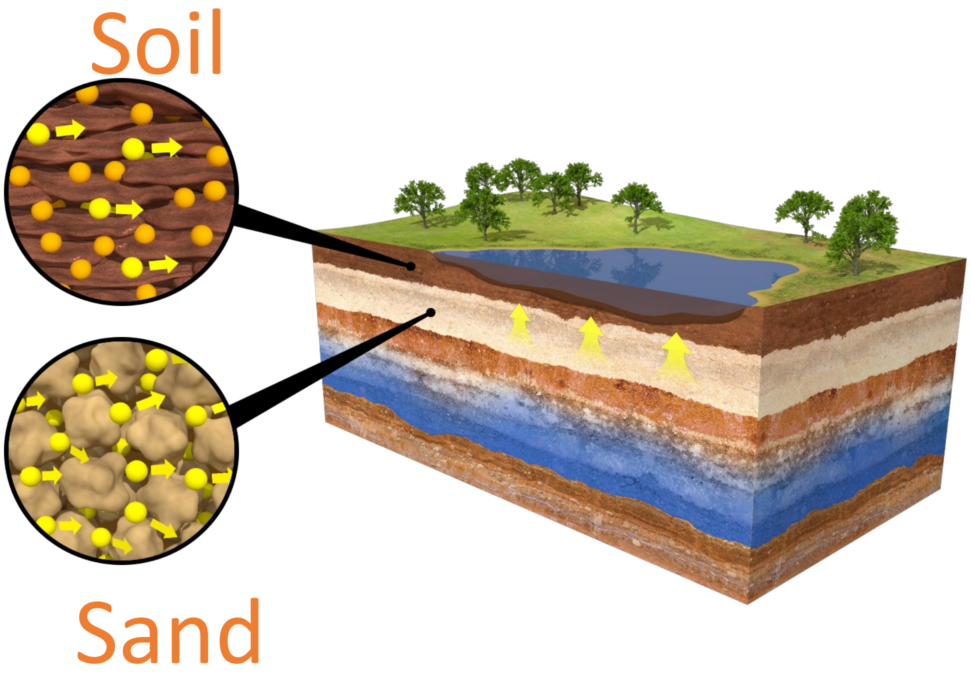
Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

INTRODUCTION

Goals: To understand radioactive material creation and transport.

- What is the material as it is generated in an explosion?
- How does the material evolve during the transportation process to the surface?



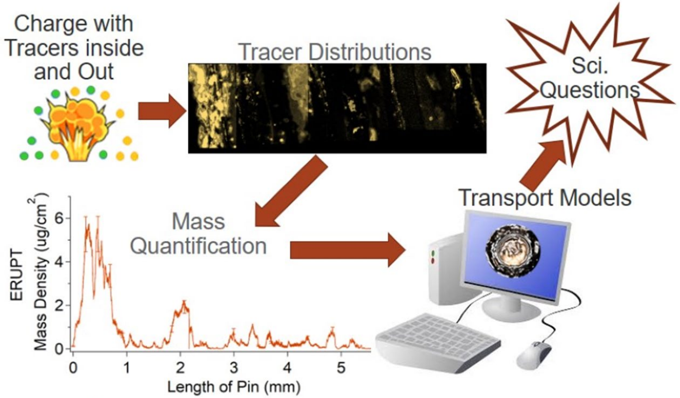
Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

METHODS

How can we better understand particulate movement underground?

- Answer: with a non-rad surrogate particle



- Fabricated robust luminescent particles (ERUPT)
  - Varying color profiles to aid post-shot analysis
  - 100 nm to 4 μm sizes
  - Microscale explosive tests

Isotopic transport variation as a function of environmental conditions

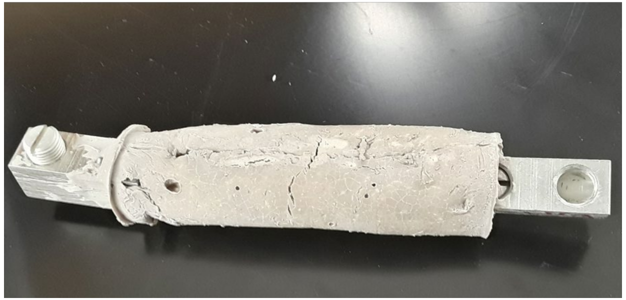
Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

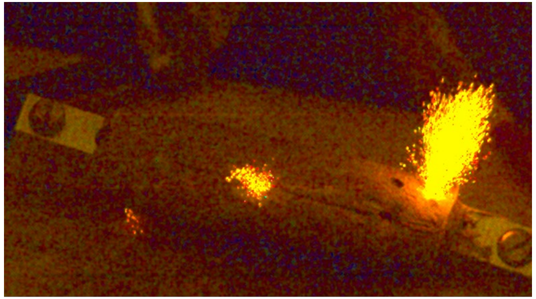
RESULTS

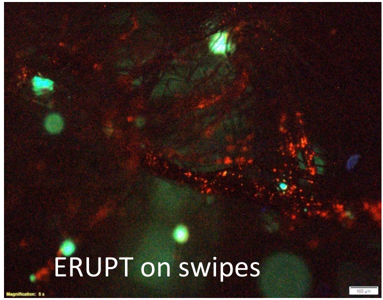
1. **Using an exploding wire setup, we tested the ERUPT particles within a small explosion**

2. **The ERUPT particles ranged in both size and color to allow for the quantification of the particle escape**

3. **Following the exploding wire experiment, tracers of both green and orange were seen in the surrounding area.**







Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

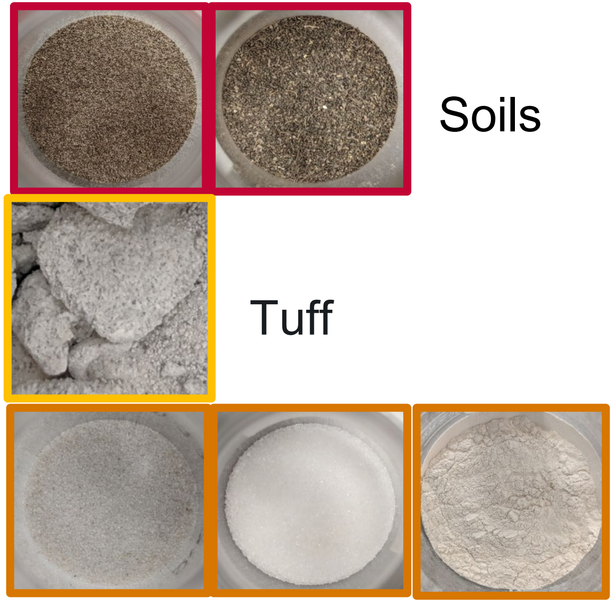
METHODS

1. Understand chemistry of gas-media interactions in soil test bed

- How are volatile compounds transported through geologic media?
- What are sorption effects in different soil types, temperature, and humidity conditions?
- Help define boundary conditions for chemical sorption in modeling inputs

2. Measure sorption properties of variety of geologic material using an Inverse Gas Chromatograph

- Enthalpy (heat) of sorption
- Diffusion coefficient
- Partition coefficient

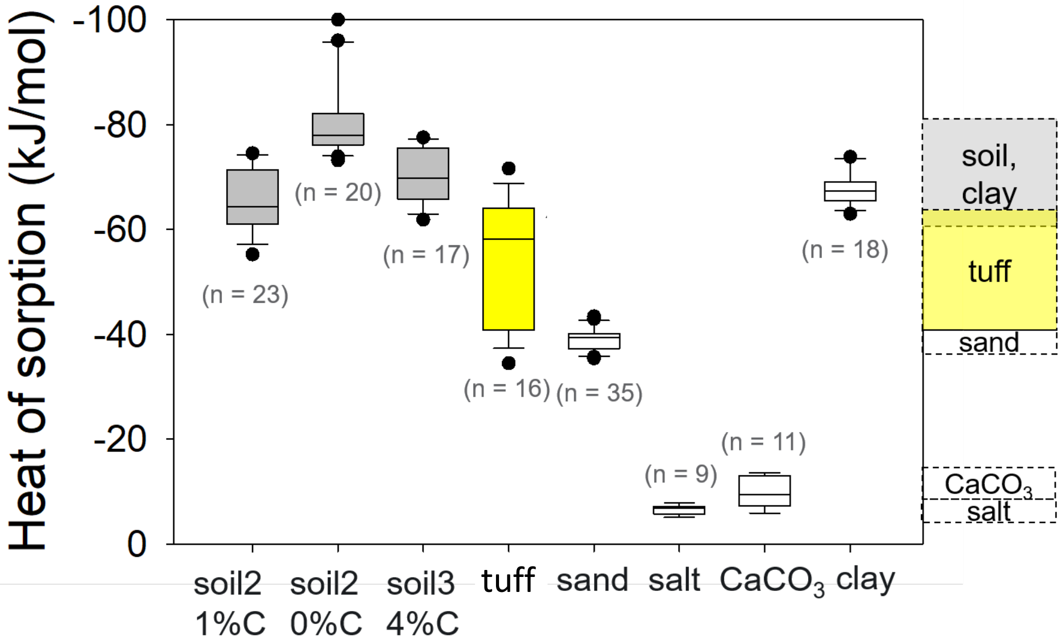


Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

RESULTS

1. **Soil and clay have greater sorption than simpler single mineral media. Tuff falls between these two end members**
2. **Sorption increased with organic C removal**
   a) **Complex nature of bonding sites in soil: Organic Matter**
   b) **Bentonite clay ($Al_2H_2O_6Si$) complex structure and a variety of bonding sites?**



Probe gas = octane

Isotopic transport variation as a function of environmental conditions

Michael Foxe (Michael.Foxe@pnnl.gov), Elizabeth Denis, Mindy Zimmer, Heather Cunningham, Kellen Springer, Derek Haas, Joseph Lapka, Lance Hubbard, Martin Liezers, and April J. Carman

CONCLUSIONS

- We have developed the capability of making unique luminescent tracers to act as radioactive particulate surrogates
- These tracers can be tracked after an experiment through spectral detection
- We can quantify the mass of ERUPT particles deposited on materials from explosions.
- We have quantified the transport properties for a range of geologic media using an Inverse Gas Chromatograph
- The transport properties will act as inputs into future sub-surface gas transport models