SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

P2.3-298

Transport variability of Xenon and Tritium following an Underground Explosively Driven Release

Foxe, M.(1); Whitehill, A.(1); Liezers, M.(1); Alexander, T.(1); Boukhalfa, H.(2); Rahn, T.(2); Couture, A.(1); Rocco, N.(1); Lyons, S.(1); Rush, L.(1); Abbott, G.(3); Jenkins, A.(3); Goodwin, M.(3); Galvin, G.(3); Archambault, B.(1); Auld, G.(3); Beck, K.(1); Bertschinger, K.(1); Britt, C.(1); Fritz, B.(1); Glasgow, B.(1); Johnson, C.(1); Keillor, M.(1); Knox, J.(1); Moore, M.(1); Perea, R.(1); Roberts, B.(4); Sharma, M.(1); Slack, J.(1); Tafoya, J.(4); Taguba, C.(1); Terry, B.(4); Van Morris, A.(1); Wright, A.(4); The PE1 Experiment Team(5).

(1) Pacific Northwest National Laboratory. (2) Los Alamos National Laboratory. (3) Atomic Weapons Establishment. (4) Sandia National Laboratories. (5) https://doi.org/10.2172/2345984 .

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INTRODUCTION AND MAIN RESULTS

The fractionation between species is important for understanding the source term for isotope detectors.

During a recent field experiment, radioactive tracers were released along with a high explosive source.

Two tracers of interest for this study were ^{127}Xe and tritium gas. The transport of these gases is expected to vary as a function of geologic media, gas sizes, and gas chemistry.

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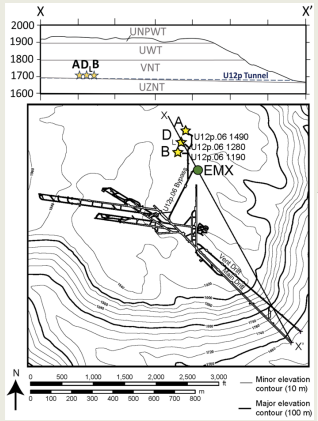
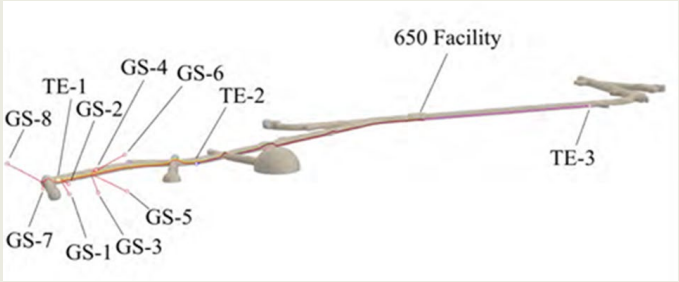
Geologic Properties and Experiment Setup

- The PE1 testbed is located in Aqueduct Mesa P-Tunnel (U12p) of the Nevada National Security Site
- PE1-A was 13.58 metric tons of Composition B chemical explosives detonated with tracer gases placed at the center.
- Test-bed located in a high permeability zone of saturated zeolitized tuff, with the water locked into pores (dry environment)
- Over buried, so the most prevalent gas pathway was to the boreholes and the tunnel

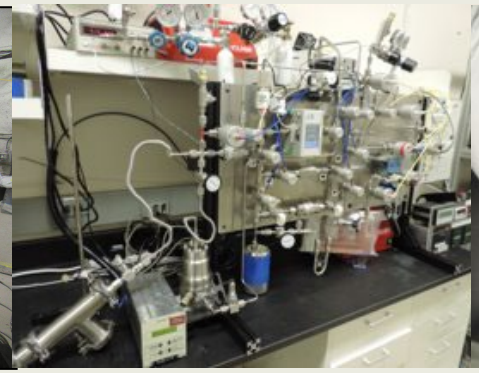


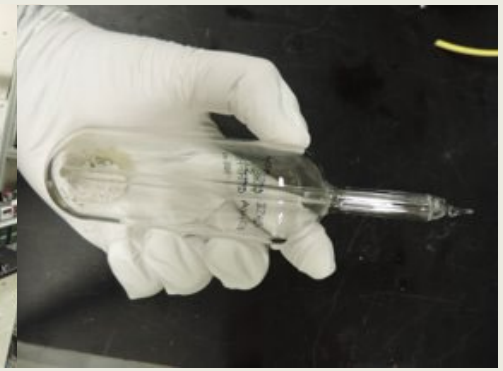


Sampling Location	Grab Sample	Geology Unit in Tuff	Measured Permeability (Darcy)	Borehole Orientation
GS-1	n	VNT-5	0.146	Downwards
GS-2	y	VNT-1	0.145	Upwards
GS-3	y	VNT-6	0.0461	Downwards
GS-4	y	VNT-B	0.348	Upwards
GS-5	n	VNT-8	Low	Downwards
GS-6	y	VNT-B	0.794	Upwards
GS-7	n	VNT-3	N/A	Downwards
GS-8	n	VNT-B	2.36	Upwards
TE-1	y	CS-1490 (06 Drift)	N/A	N/A
TE-2	n	CS-1200 (06 Drift)	N/A	N/A
TE-3	y	CS-00 (06 Drift)	N/A	N/A
VS	n	CS-200 (P-Main exhaust)	N/A	N/A

Gas Measurement Methods

- Following the high explosive experiment, the gases were pushed through the rock to boreholes and the tunnel. The gases were then monitored with a variety of sensors, including real-time radioxenon sensors. 2.5 L grab samples were collected at discrete intervals for subsequent laboratory analysis (left).
- Gas grab samples were then processed in the laboratory to extract tracer gases (including T_2/HT, HTO, and CH_3T) (middle).
- To make HTO measurements, water from 1 L of grab sample air was collected onto alumina and transferred to a small glass bulb (right). The sealed bulbs were heated to generate methane from the water with an aluminum carbide reactant. The methane was then purified and loaded into ultra low background proportional counters for measurement of the tritium signal.





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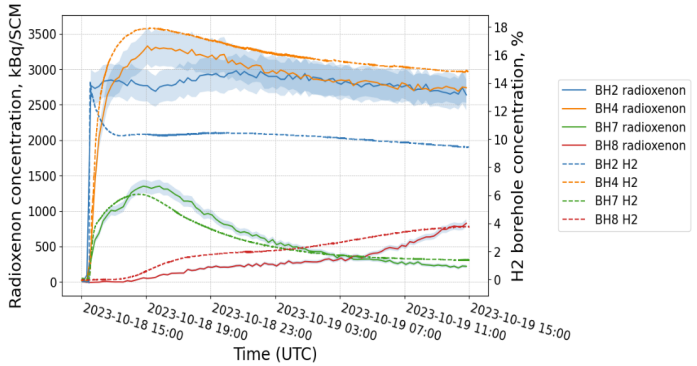
P2.3-298

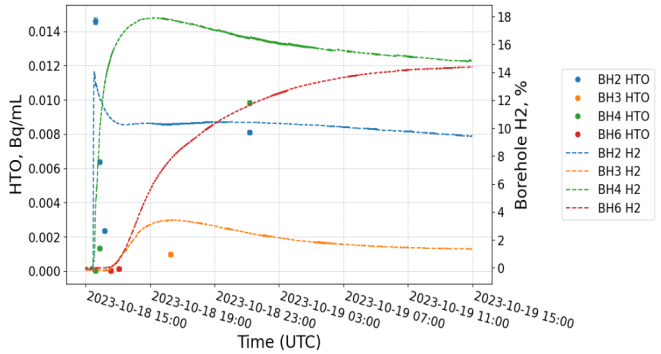
Gas Chemistry, Mobility, Dilution, and Timing

- Pressure driven transport into the tunnel results in similar transport times while the long-range diffusion through the tunnel is controlled by species specific diffusion
- Grab samples and real-time measurements are in good agreement for the xenon measurements. While the tritium has mixed levels of species dependent agreement, more measurements are needed.
- Rate of activity increase of the tunnel environment xenon systems near the high explosive detonation occurs more rapidly than the tunnel environment tritium measurements, but it isn't yet clear if that is transport related or systematic.
- Xenon and hydrogen show similar transport in the boreholes, but tritium shows variation compared to the borehole hydrogen values, indicating chemical fractionation between the hydrogen generated from HE gases and the tritium that forms into HTO. Additional measurements of the HT will allow for a better understanding of the chemistry processes underway.
- HE by-products (such as H_2O) result in more dilute samples near the explosion source.
- While the tritium starts at tritium gas, a large fraction of it is converted into HTO during the explosion. However, the fraction that is converted initially as opposed to during transport is still under investigation.

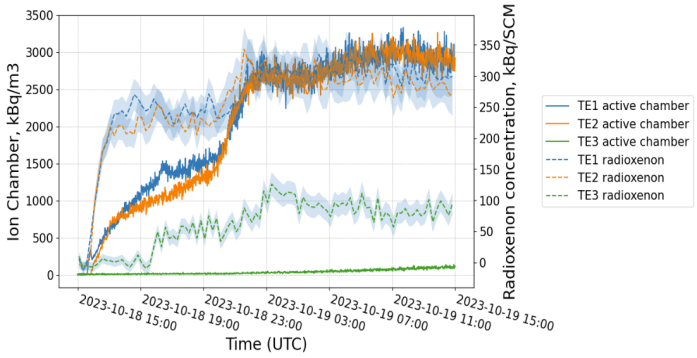
Borehole Radioxenon and Hydrogen measurement



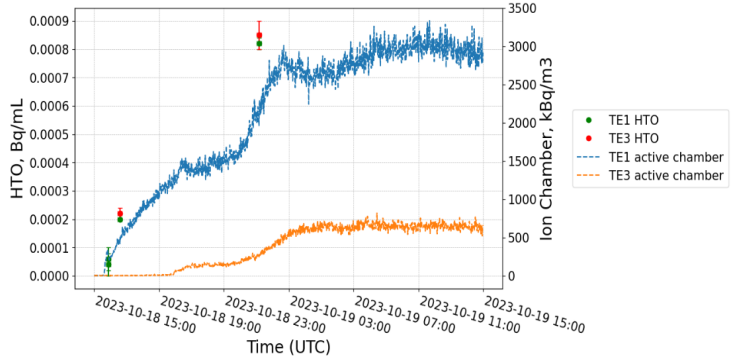
Borehole real-time hydrogen and HTO grab sample measurements



Tunnel environment radioxenon and tritium ionization chamber measurement



Tunnel Environment tritium ionization chamber and laboratory HTO measurements



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The views expressed here do not necessarily reflect the opinion of the United States Government, the United States Department of Energy, or the Pacific Northwest National Laboratory

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