

Laboratory Noble Gas Migration Experiments Through Rock

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Background

- Lab-scale experiment developed to test advective gas transport through rock samples at in-situ conditions.
- Tests performed at ambient conditions on rocks collected from the site of a field-scale gas experiment.
- Gas transport results are compared to pore and fracture networks of the same samples characterized by micro-CT and petrographic microscopy.
- Field experiment being conducted by NSTec, PNNL and LLNL.

How it Works

- Pressurized gas mix (Ar, Xe, SF₆, and N₂) is released upstream into a 2.5" dia. X 2" long rock sample kept under vacuum. Using a quadrupole mass spectrometer (QMA), downstream gases are measured until steady state concentration is achieved.
- System modified to steadily measure real time arrival of gas mix through sample.

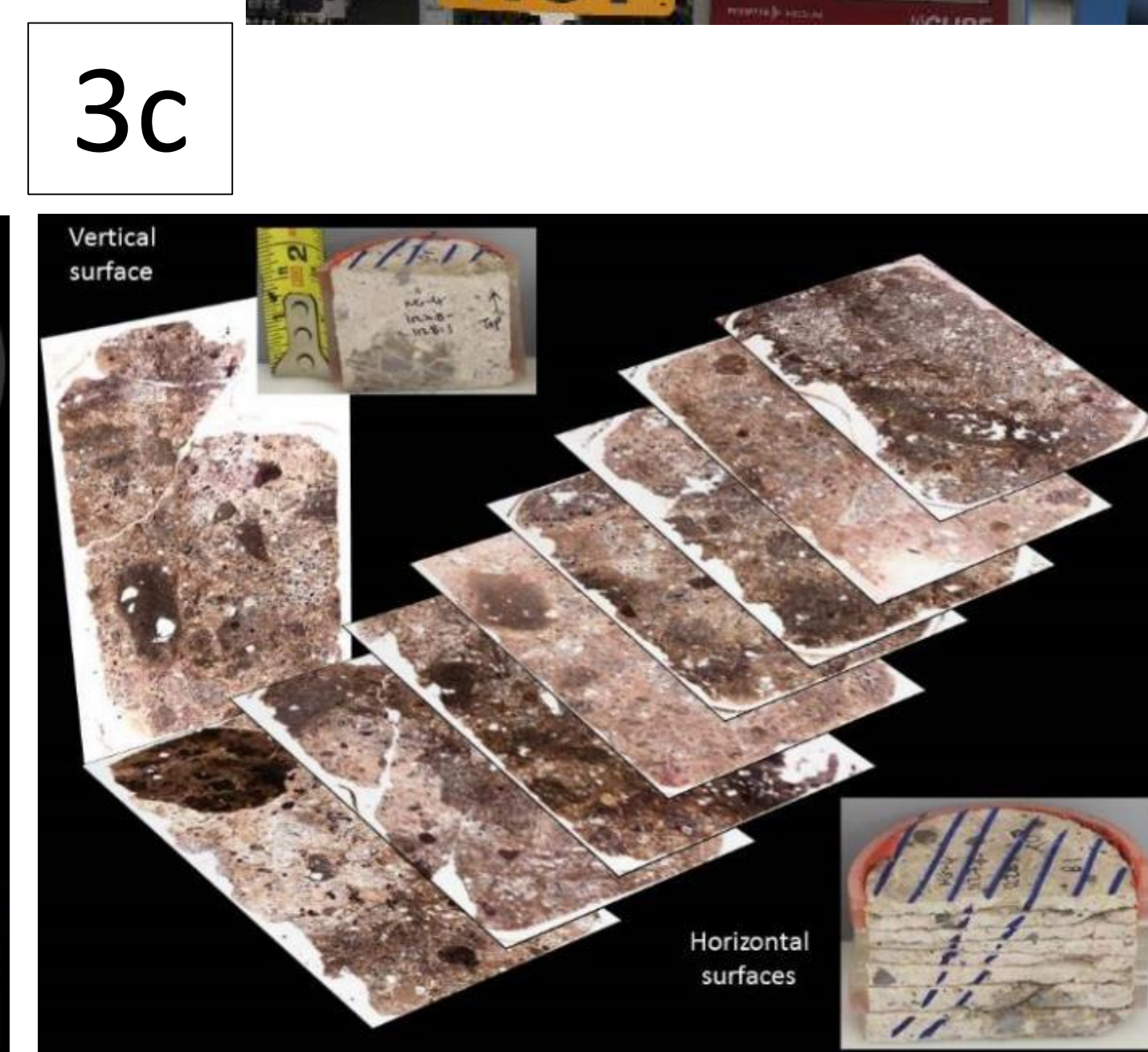
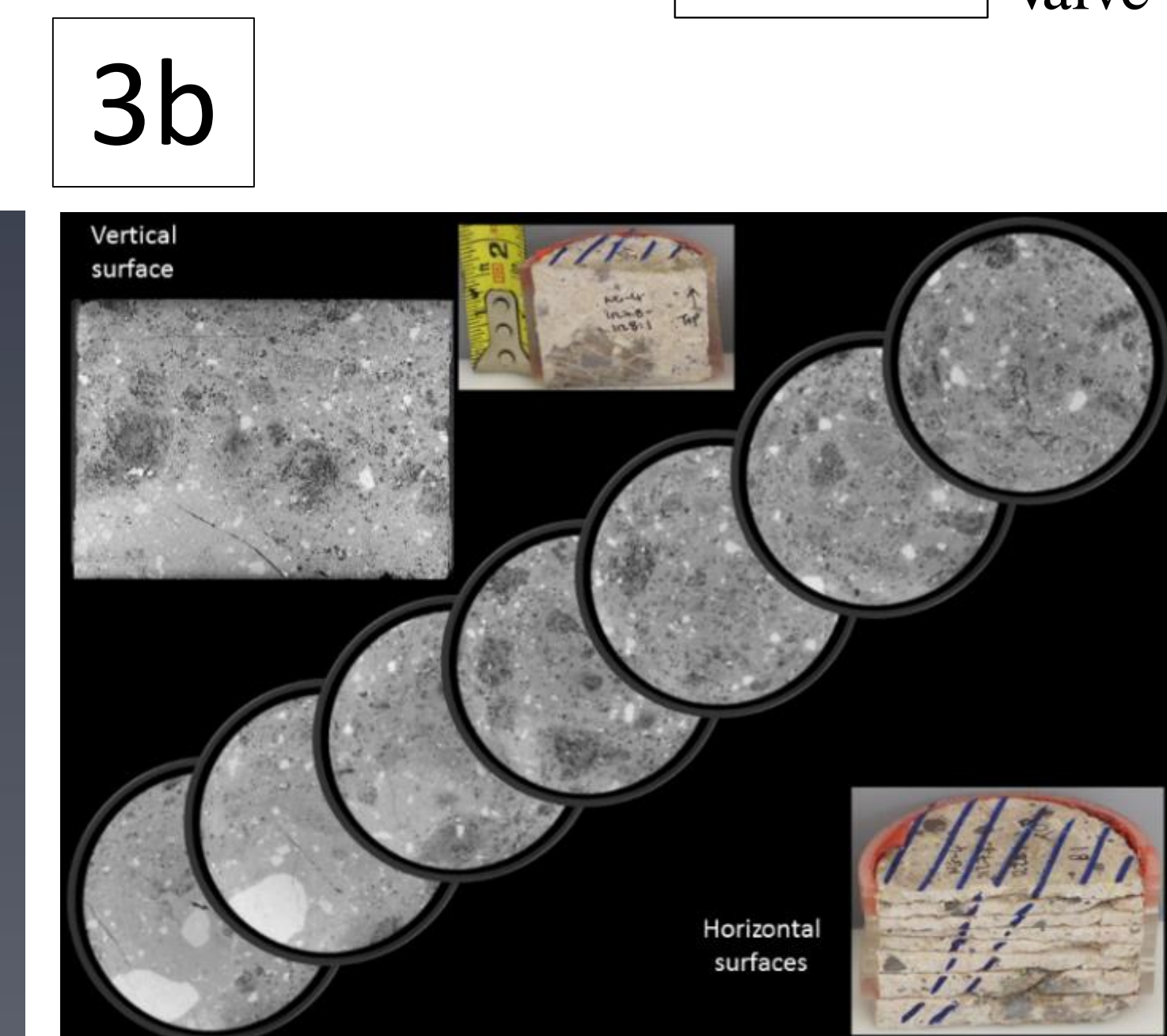
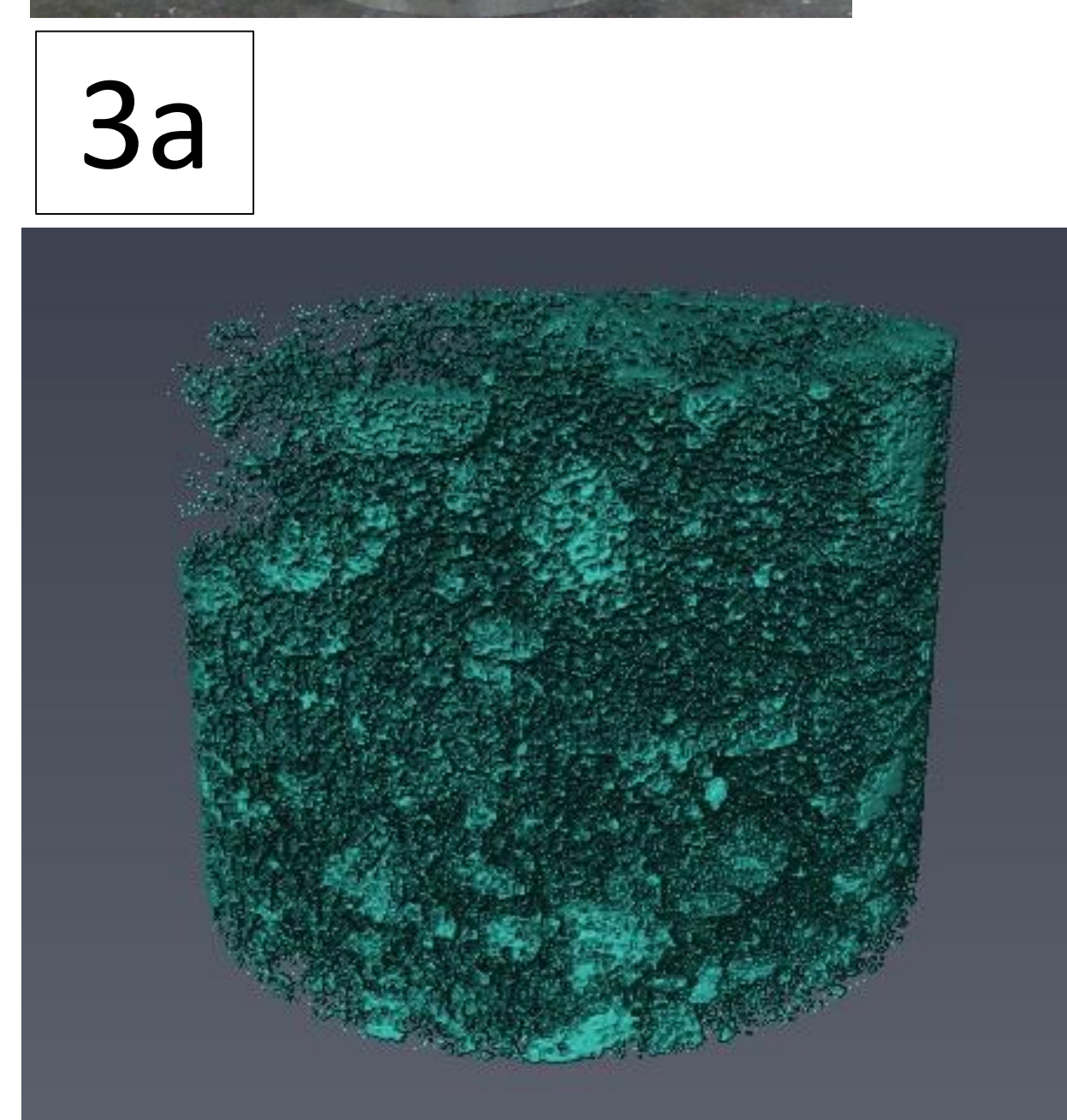
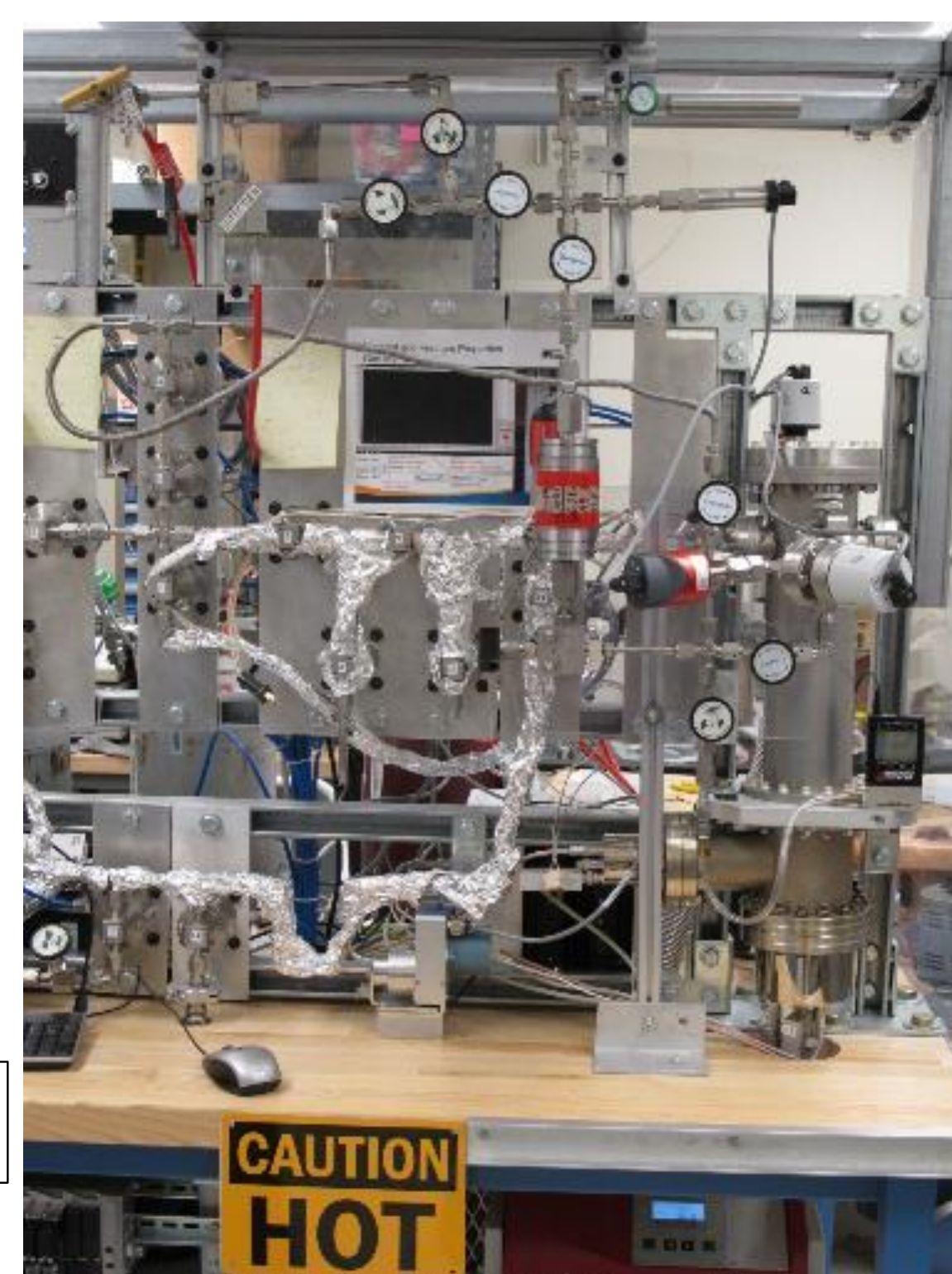
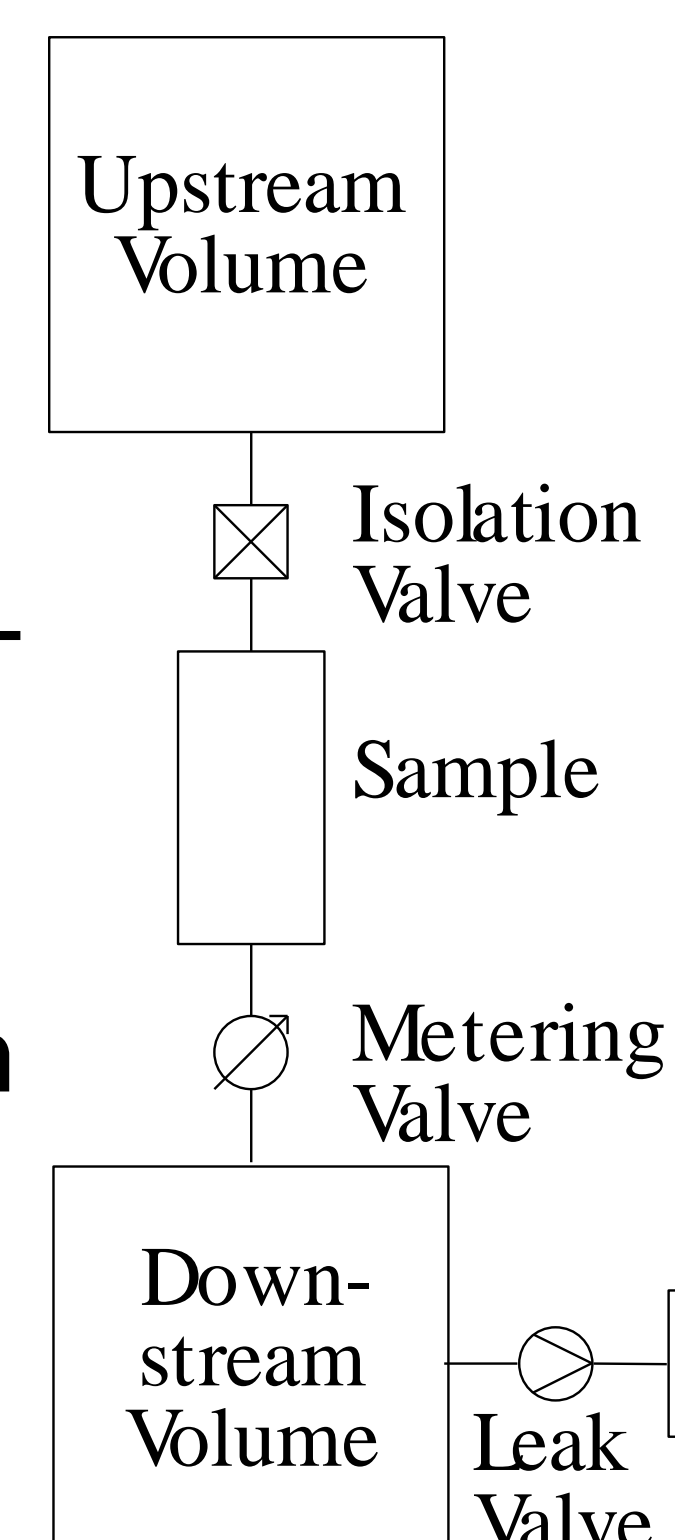
Limitations

- Advective transport does not give diffusive properties of material.
- Planning but have not yet modeled gas concentration curves.



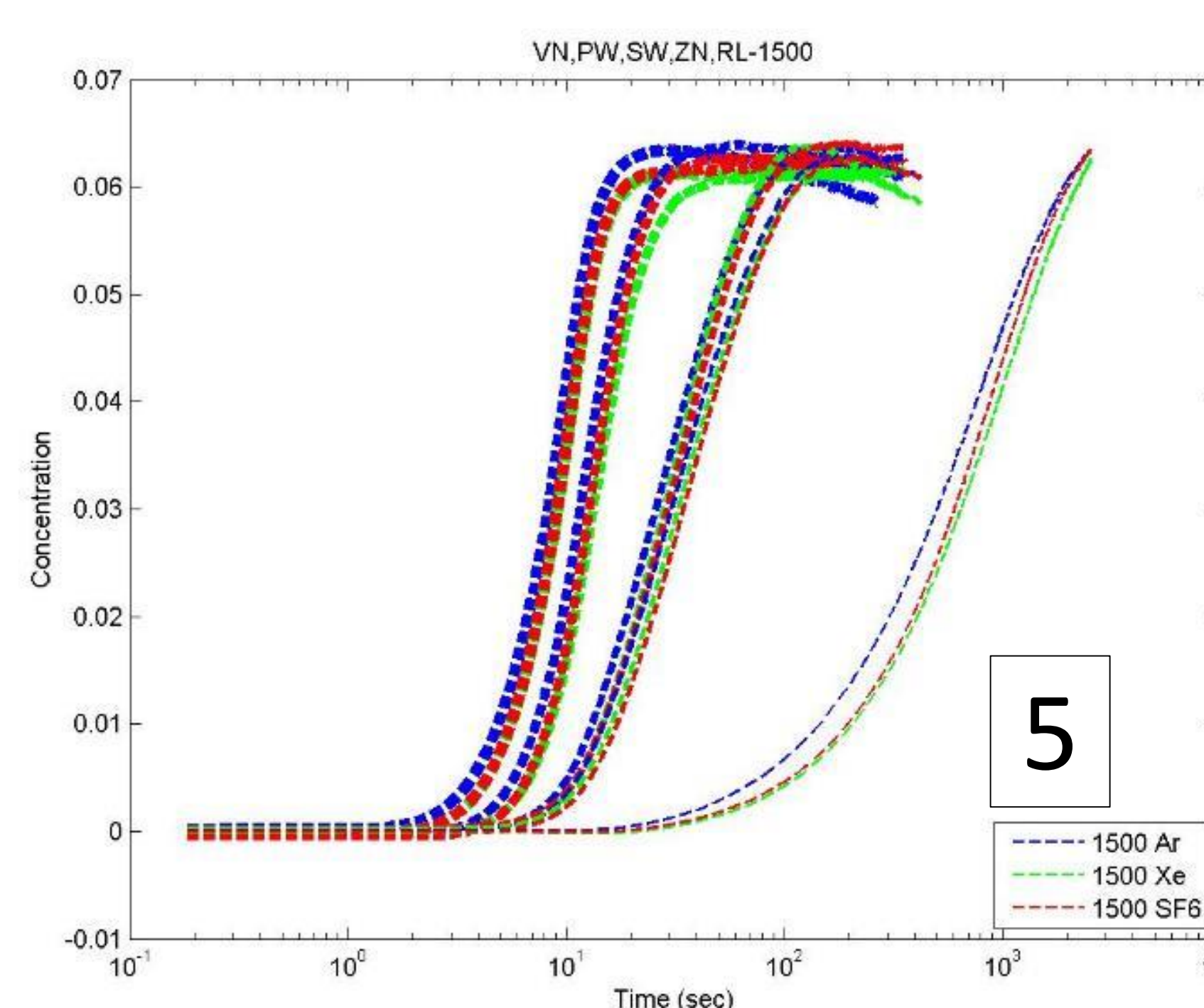
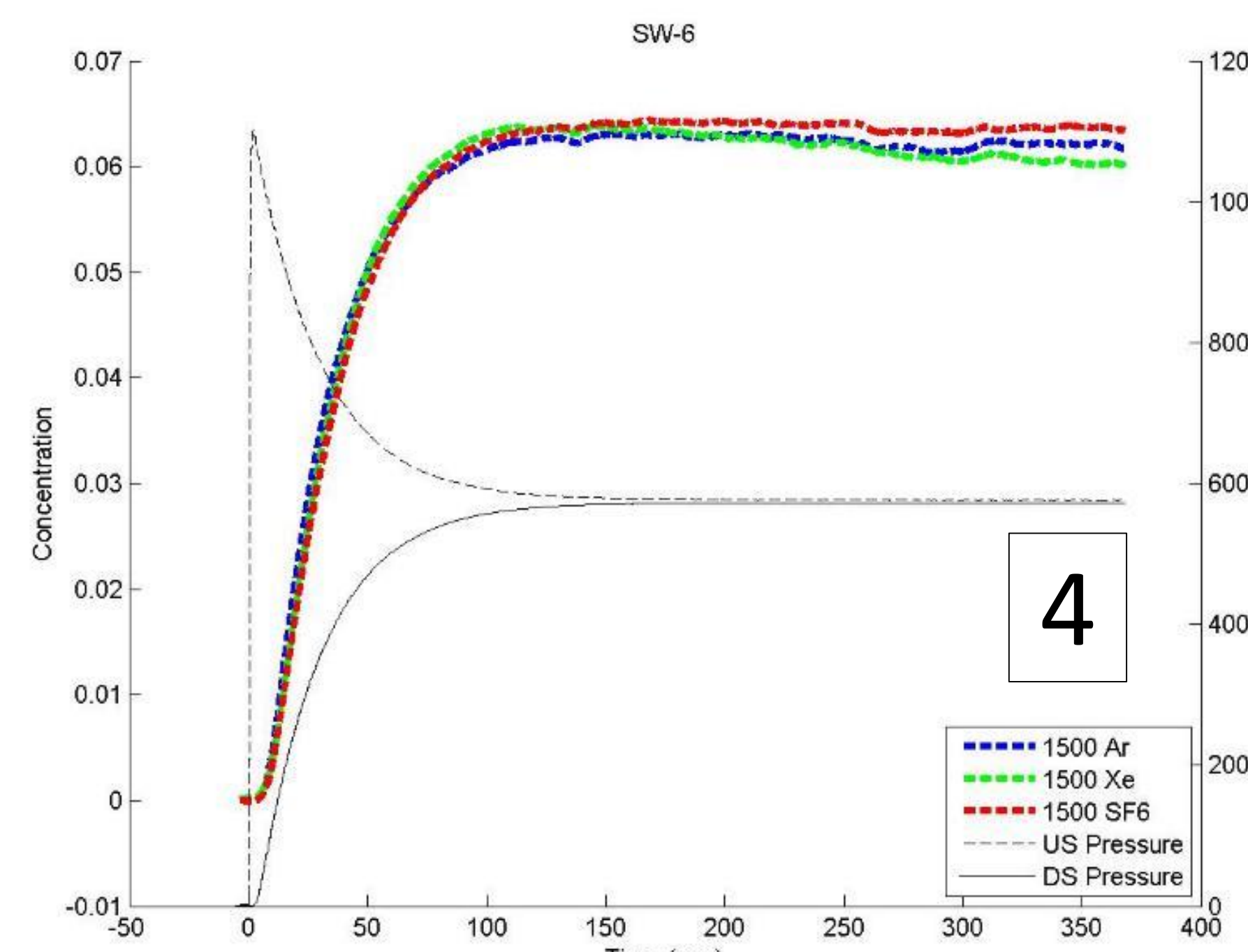
Figures

1. Sample of Rhyolitic Lava. 2. Schematic (left) and picture (right) of test system. 3a. Micro-CT image, 3b. Micro-CT image sections and 3c. thin sections from Zeolitic Nonwelded sample.



Main Achievement

- Gas breakthrough curves measured on 5 lithologies from experimental field site.
- Arrival times are correlated to permeability of the 5 lithologies.
- Successful modeling of upstream and downstream pressure response to determine porosity and permeability.



Impact

- Field gas migration experimentalists and gas migration modelers have shown great interest.
- Correlating gas arrival to other material properties such as porosity, permeability, microfracture density, and microscopic structure is an important tool to reach the goal of better understanding when noble gases may be detected from a possible UNE.

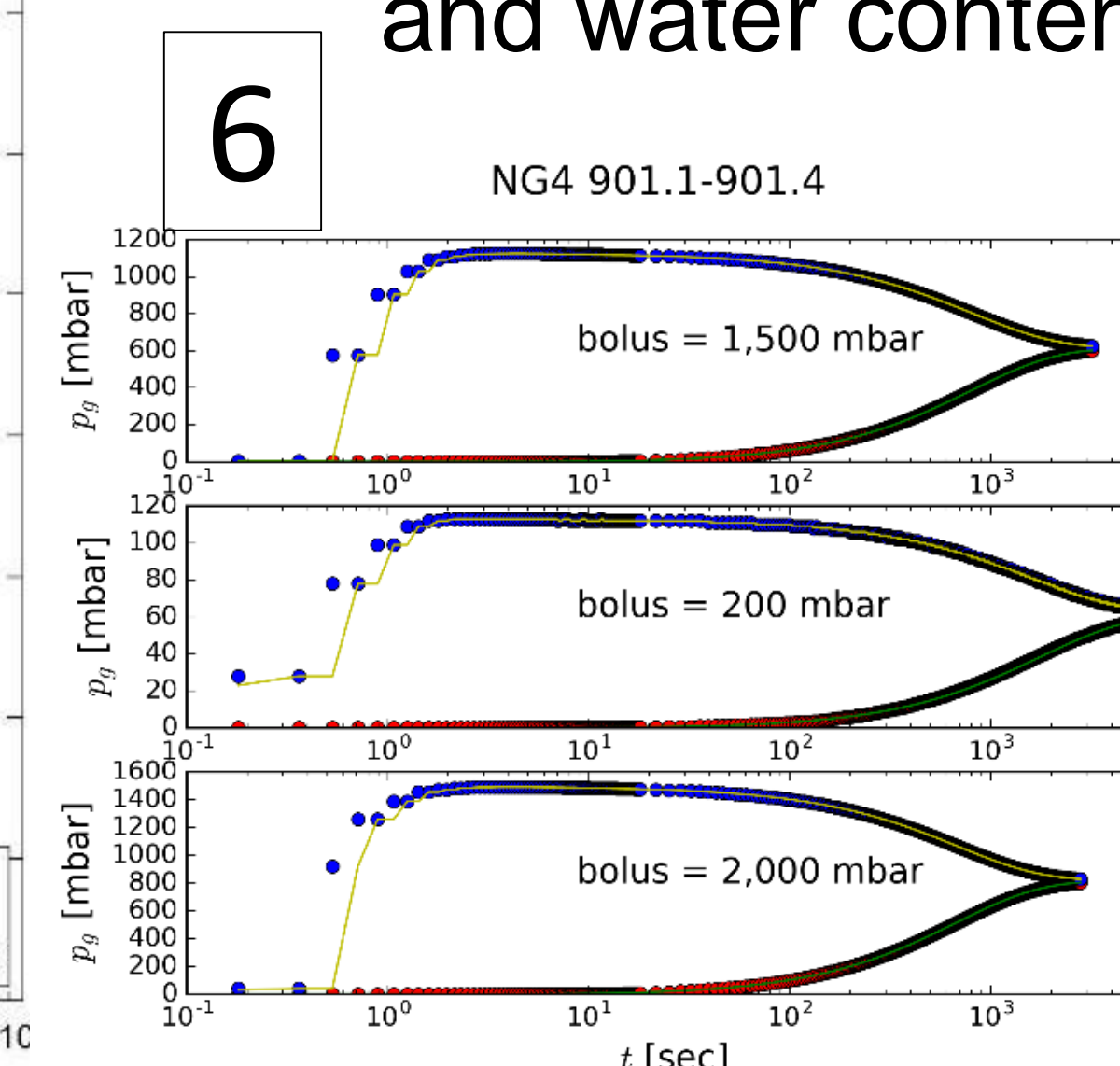
- Poster was presented at fall AGU conference in 2016 and was well received by other DOE labs.

Current FY

- Diffusion line build in progress. Plan to determine diffusive properties on same lithologies of current work.
- Tortuosity will be calculated from known diffusion coefficients.

Future FY

- Test advective and diffusive properties on material under varying pressure, temperature and water content.



Figures

4. Gas breakthrough curves for Strongly Welded sample. 5. Breakthrough curves for all lithologies tested. 6. Modeling of upstream and downstream pressure response.

The Underground Nuclear Explosion Signatures Experiment (UNESE) was created to apply a broad range of research and development (R&D) techniques and technologies to nuclear explosion monitoring and nuclear nonproliferation. It is a multi-year research and development project sponsored by NNSA DNN R&D, and is collaboratively executed by Lawrence Livermore National Laboratory, Los Alamos National Laboratory, National Security Technologies, Pacific Northwest National Laboratory, and Sandia National Laboratories.

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