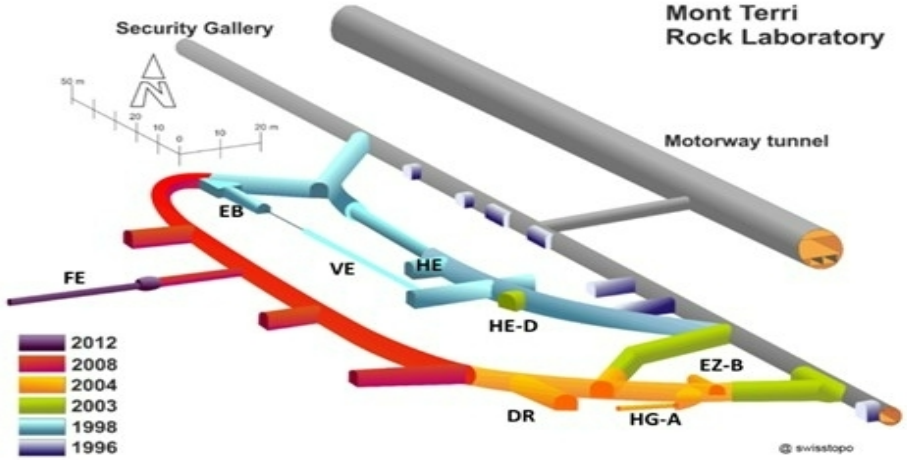
SAND2022-1888C

Sandia National Laboratories

DECOVALEX23: Task C, Step 1 SNL Preliminary Thermal Hydrologic Modeling of Full-Scale Heater Experiment

DECOVALEX23 Interim Meeting

Feb 21, 2022



PRESENTED BY

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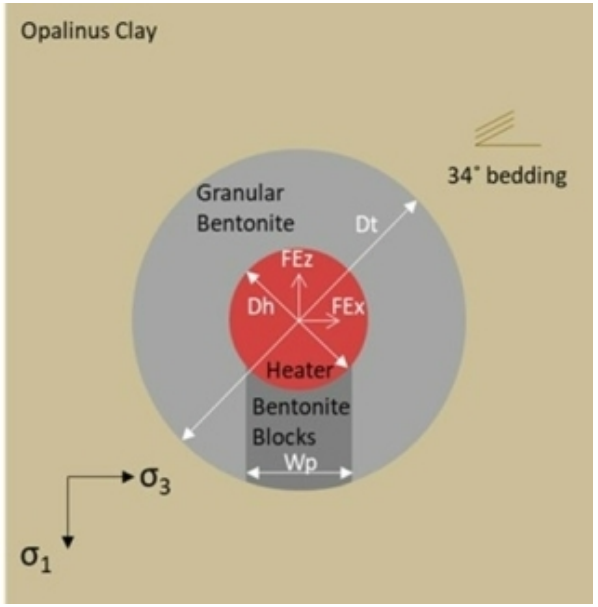
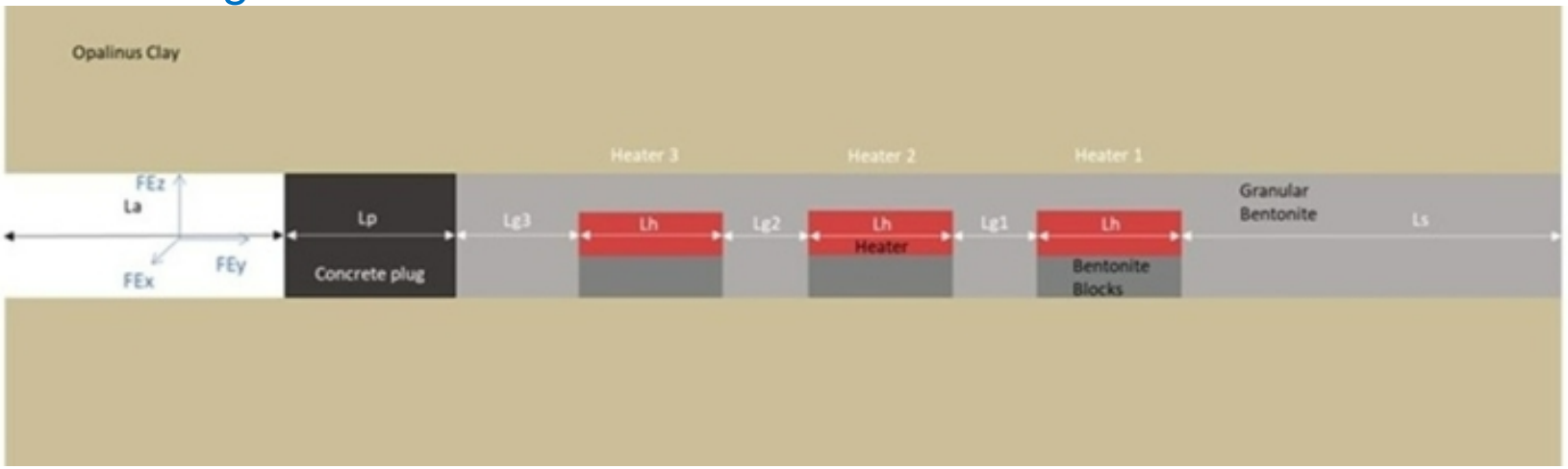
Outline

- Preliminary thermal and TH simulations of Step 1
- Meshing and representation of tunnel
- PFLOTRAN simulations
- Summary of modeling results and future work

I. Step 1: TH Modeling using PFLOTRAN

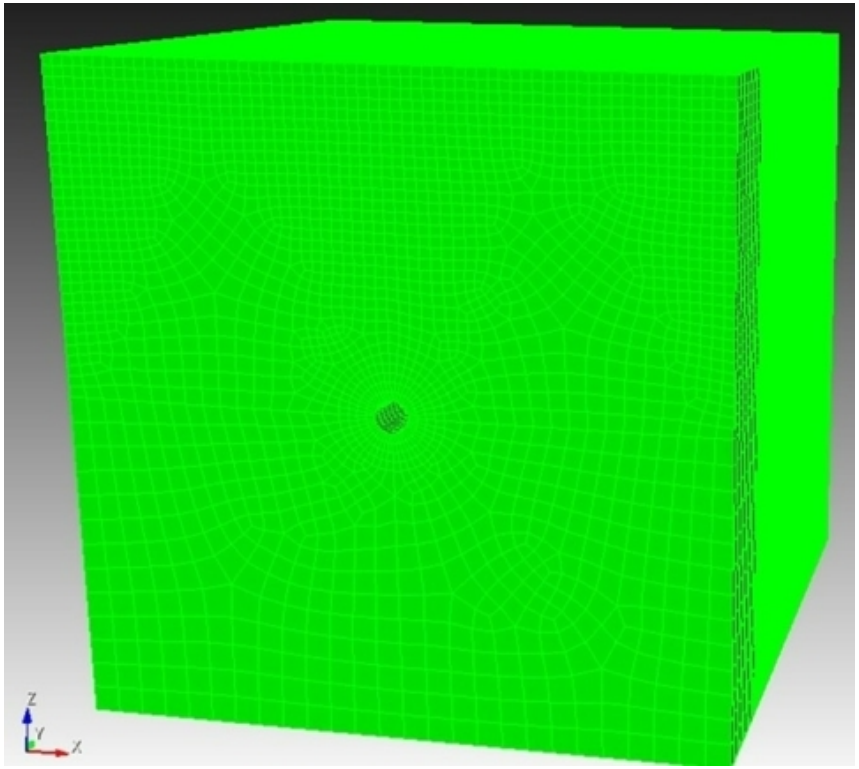
- Preliminary thermal and thermal-hydrology modeling of Step 1 for the full-scale in-situ heater test
- Used properties developed in Step 0
- Used Task C specified material properties:
  - Thermal conductivity vs saturation equation
  - Density of water equation with constant thermal expansion
  - Porosity and pore compressibility equation
- Heating schedule of the three heaters





PFLOTRAN TH Model Setup

- Initial condition:
  - T = 15 °C everywhere
  - Hydrostatic pressure at opalinus clay
  - Bentonite blocks initial condition:
  - Calculated liquid saturation = 0.919
  - Granular bentonite initial condition:
    - calculated liquid saturation = 0.227



Domain size: 50 m x 50 m x 50 m

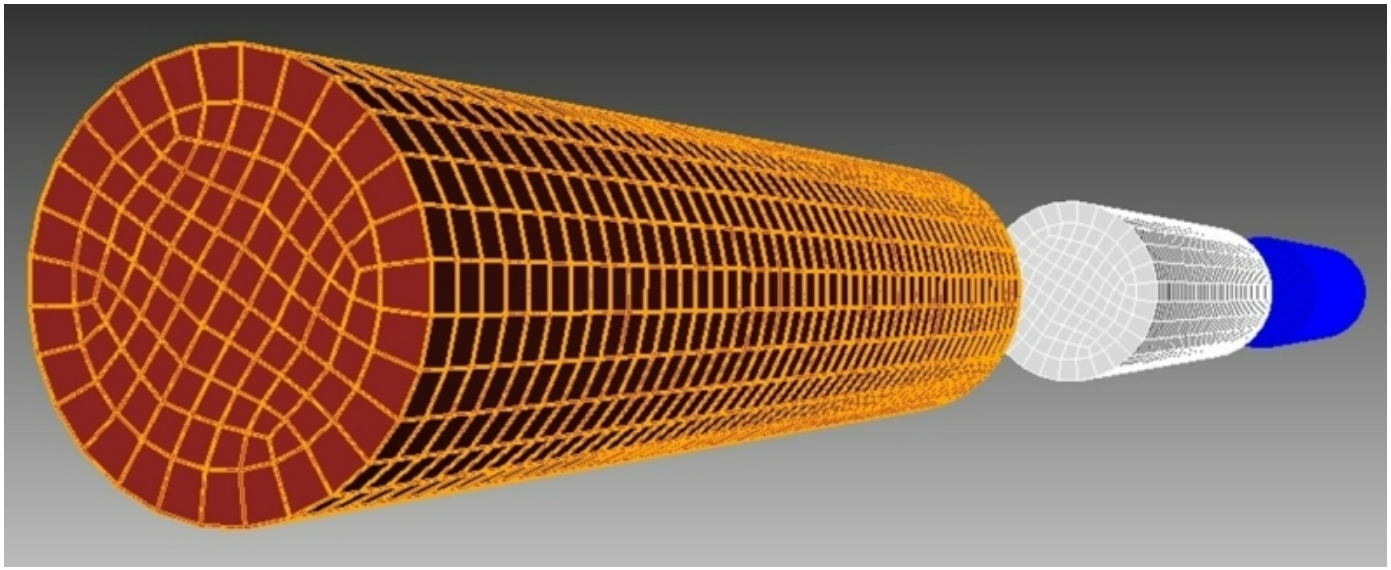
Diffusion Coefficient:

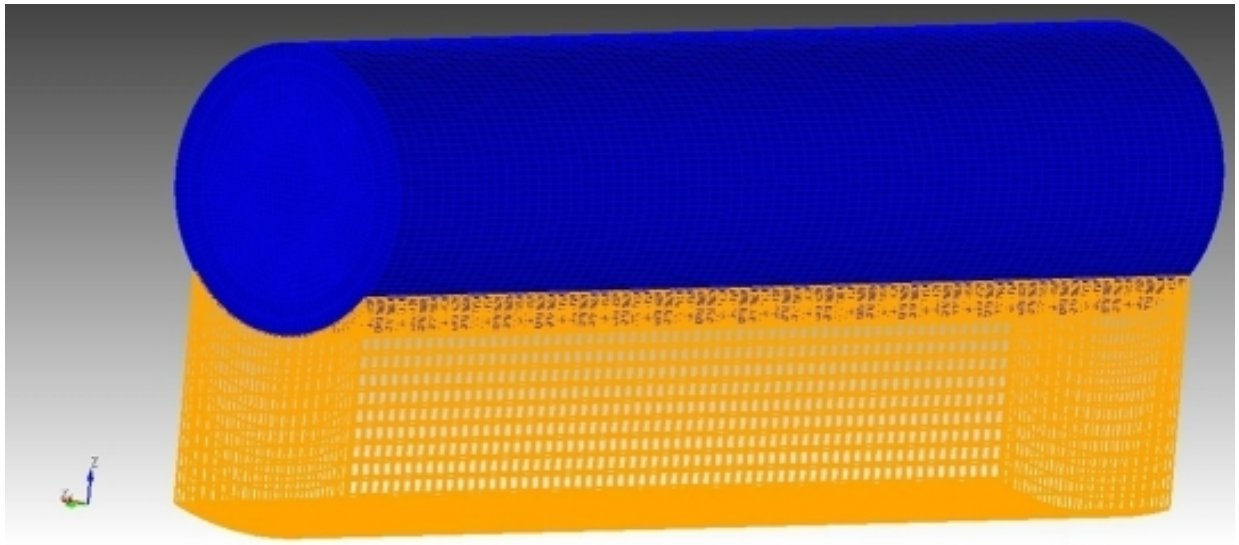
- Liquid phase: 2.0 x 10^{-9} m^2/s
- Gas phase: 2.42 x 10^{-5} m^2/s

- Boundary Condition:
  - Column outer boundary at 2.0 MPa and 15 °C
  - Specified heat applied at heater boundary

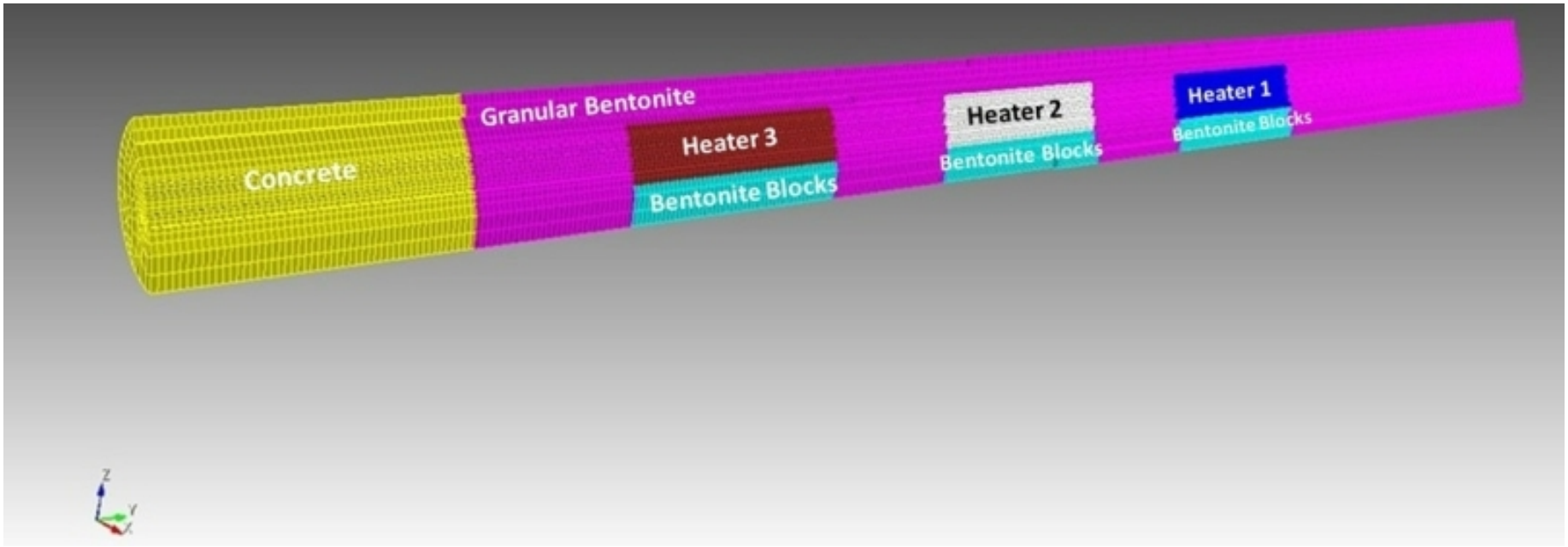
- Opalinus Clay:
  - Anisotropy in permeability and thermal conductivity

Step 1: Meshing of Heaters and Bentonite Blocks

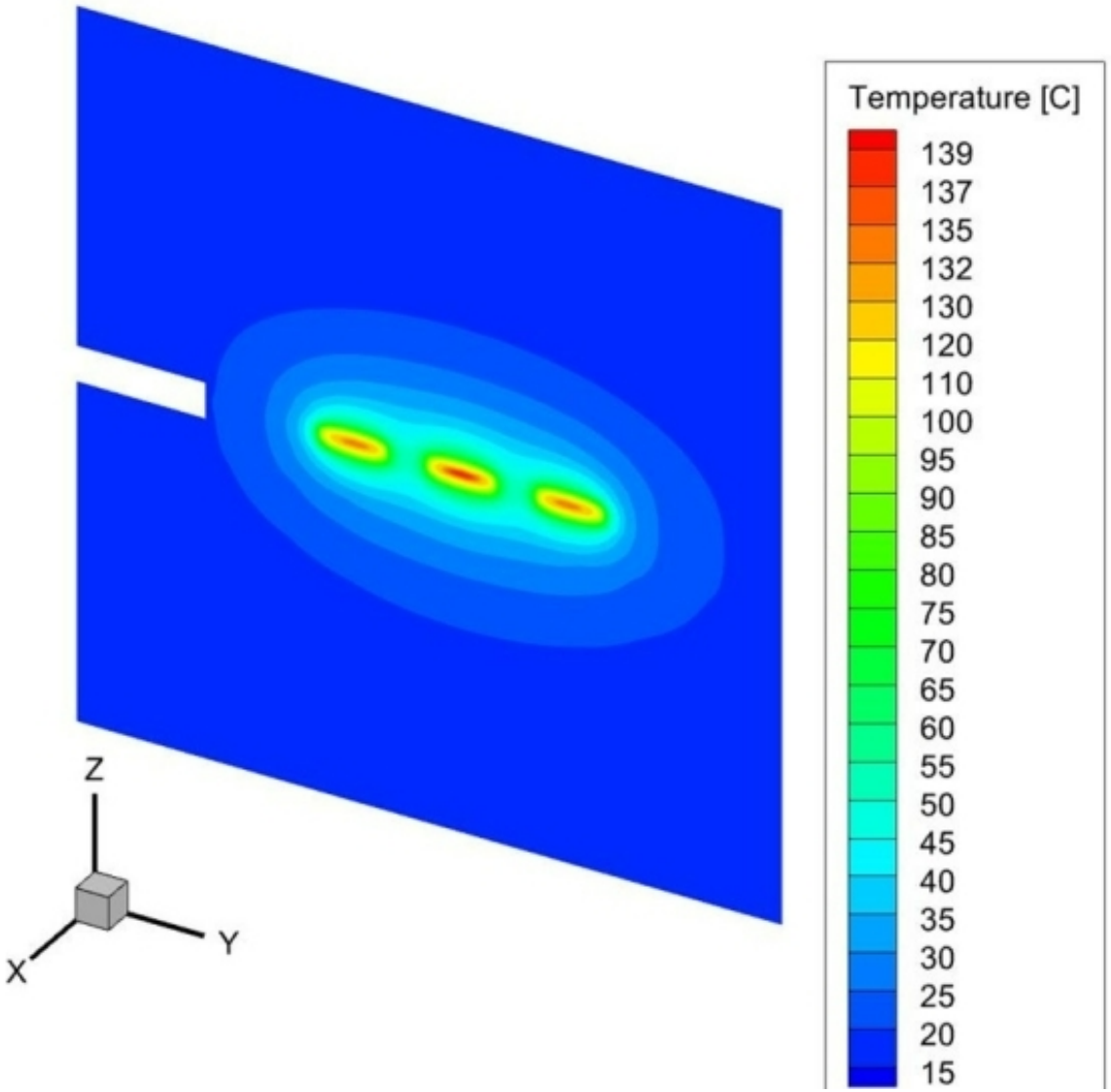




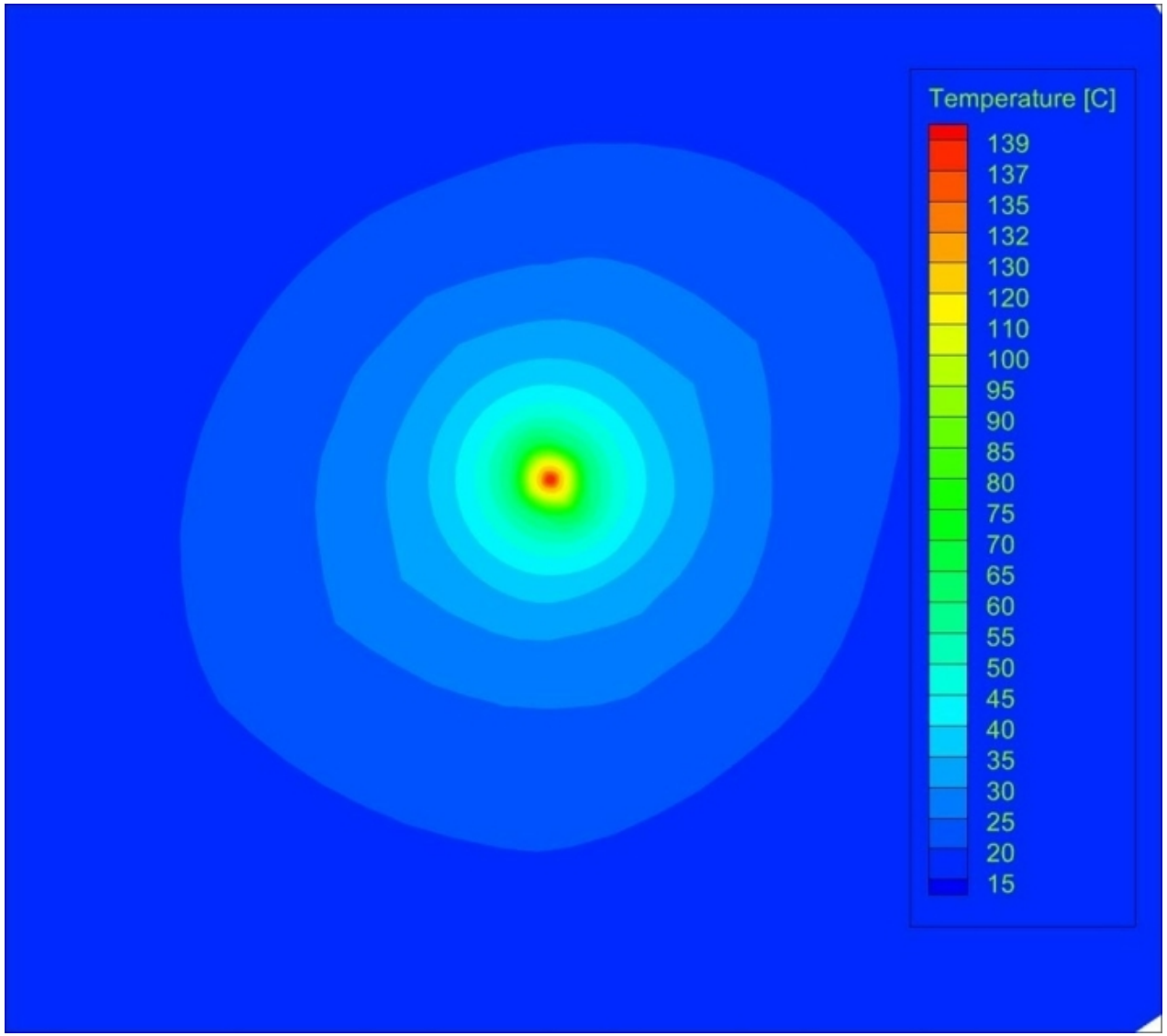
Step1: Representation of the Experimental Tunnel



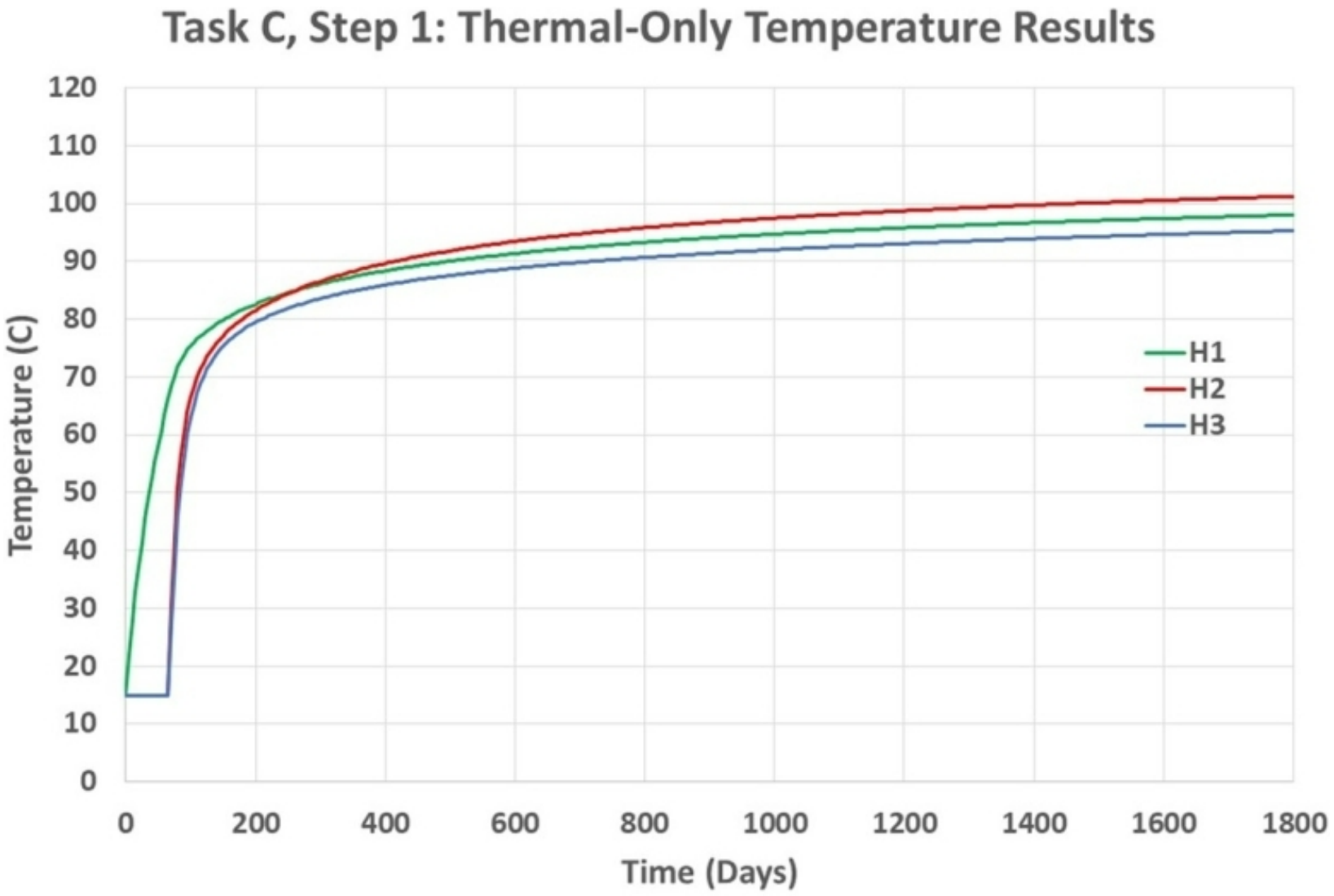
Step 1-Thermal: Prediction of Temperature Distribution along Tunnel Axis at 5 Years



Step 1-Thermal: Prediction of Temperature Distribution at 5 Years: Cross-section at Heater 2



Step 1-Thermal: Prediction of Temperature Evolution at Selected Observation Points



Summary

- Conducted preliminary Task C, Step 1 PFLOTRAN simulations using material properties developed in Step 0
- Next Steps:
  - Updated Step 1 thermal and thermal-hydrology modeling
  - Comparison of modeling results with experimental data