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Performance Assessment / Uncertainty and Sensitivity Analysis Task



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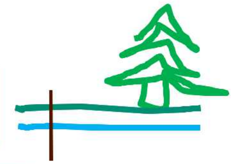
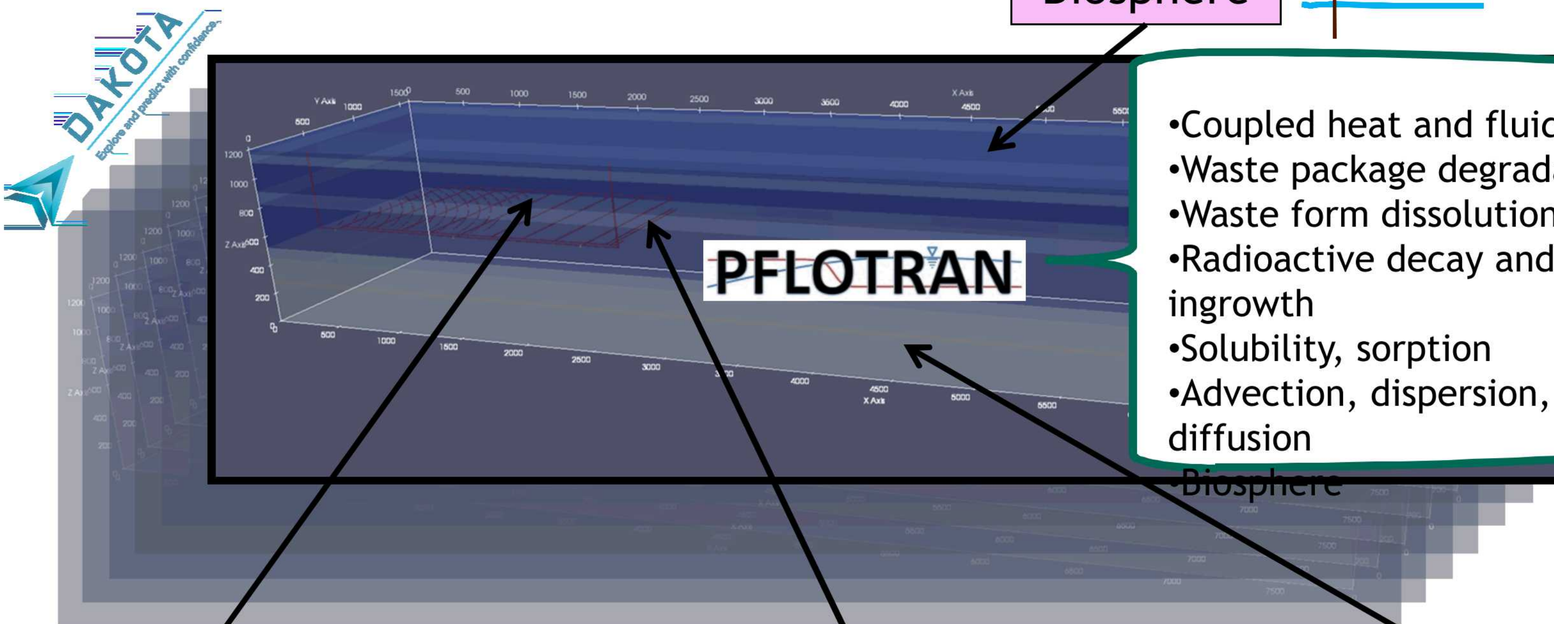
Performance (or Safety) Assessment

Biosphere



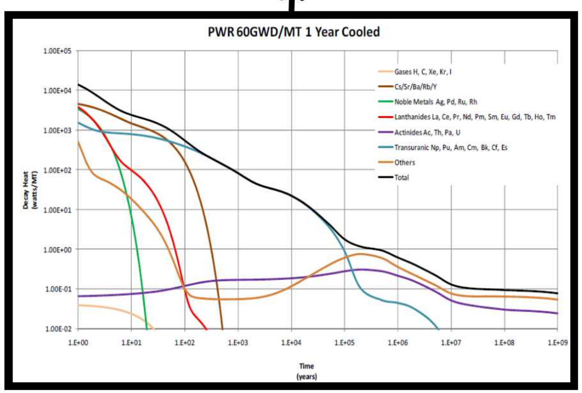


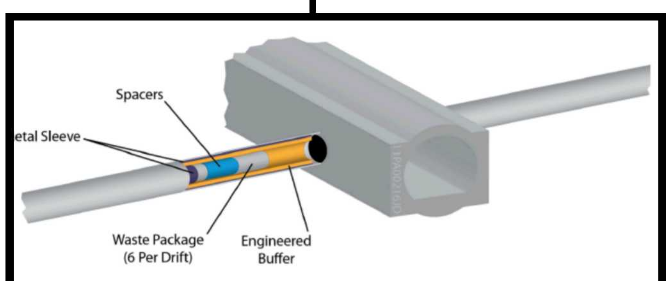
- Coupled heat and fluid flow
- Waste package degradation
- Waste form dissolution
- Radioactive decay and ingrowth
- Solubility, sorption
- Advection, dispersion, diffusion
- Biosphere

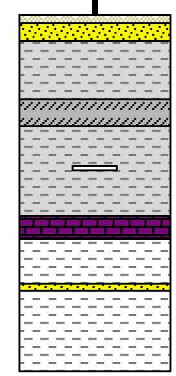
Waste Source Term

Engineered Barrier System

Natural Barrier System







Objectives

This task is intended to build confidence in the models, methods, and software used for performance assessment (PA) and/or to bring to the fore additional research and development needed to improve PA methodologies.

- Investigate crystalline and salt generic repository concepts.
- Query the effect of alternative conceptual, constitutive, and/or numerical models, including use of high-fidelity process models vs. reduced order models or emulators.
- Compare methods of propagating uncertainty and methods of sensitivity analysis.
- Develop understanding of best system modeling practices.

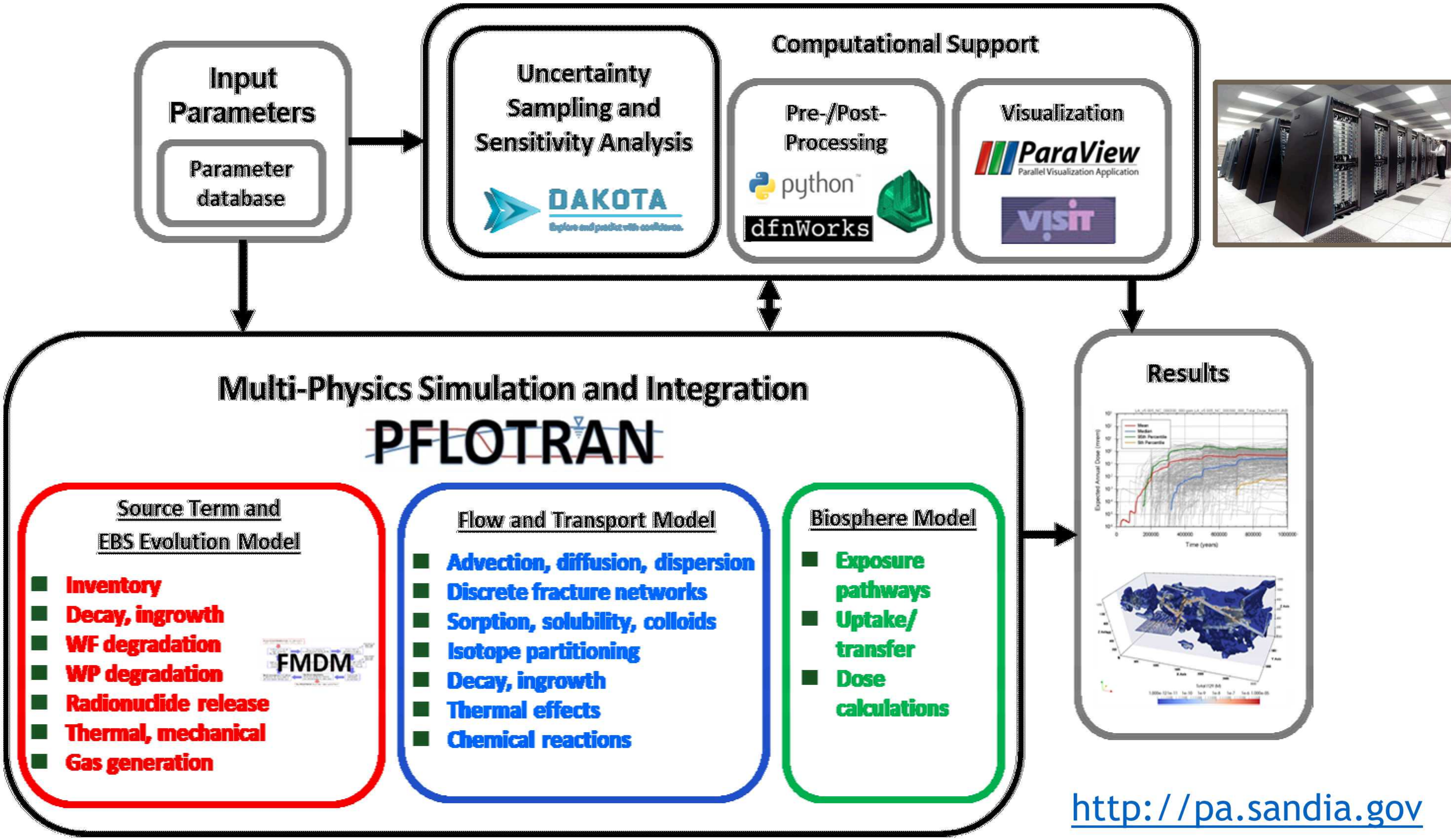
Staged Approach to Comparison

1. Coupled-process submodels (e.g. waste package corrosion, spent fuel dissolution, radionuclide transport, etc.) comprising the full PA model.
2. Deterministic simulation(s) of the entire PA model for reference scenario(s).
3. Probabilistic simulations of the entire PA model.
4. Uncertainty and sensitivity analysis methods for probabilistic simulations of reference scenario(s).

Background: U.S. Program

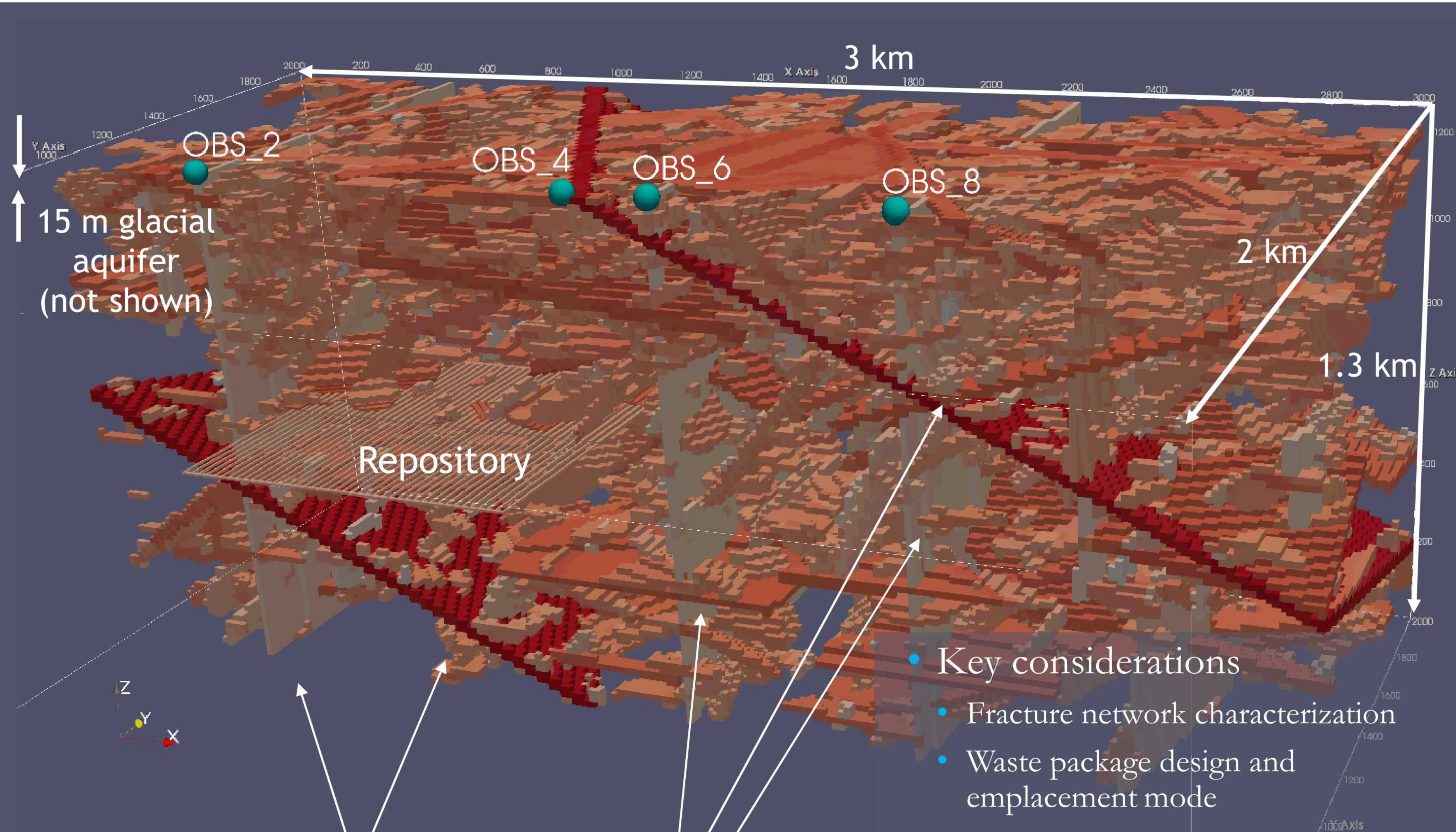
- Developing high-performance computing software framework for multi-physics simulations and uncertainty/sensitivity analysis.
- Simulate coupled thermal, hydrological, mechanical, and chemical processes affecting performance while minimizing abstractions and maximizing computational efficiency.
- Because site-specific research is currently not possible in the U.S., new capabilities are tested for well-designed generic reference cases.
- PA group works closely with other groups to achieve adequate representation of early system perturbation and coupled processes.

GDSA (Geologic Disposal Safety Assessment) Framework



http://pa.sandia.gov

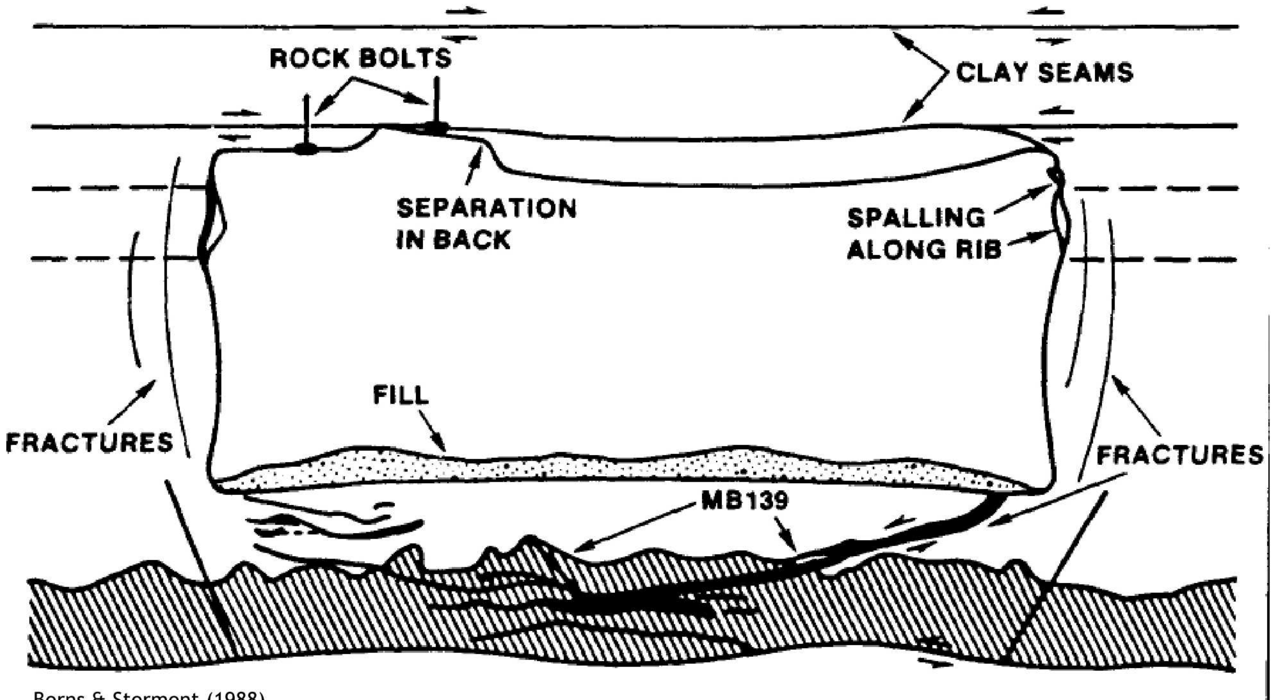
Crystalline Reference Case



5 deterministic fracture zones (3 gray, 2 red)

- Key considerations
  - Fracture network characterization
  - Waste package design and emplacement mode
  - Buffer erosion processes
  - Corrosion mechanisms
  - Fuel dissolution rate/mechanism

(Bedded) Salt Reference Case



Borns & Stormont (1988)

- Key considerations
  - Crushed salt backfill - reconsolidation
  - Disturbed rock zone – properties and evolution
  - Drift creep closure
  - Permeable pathways (and evolution)
  - Disruptive events (human intrusion?)

Principle Experimental Data

Characterize Engineered and Natural Systems

- Thermal, hydrologic, mechanical, and chemical properties
- Constitutive relationships
- Fracture network distributions
- Etc.

Using data relevant to participants, from

- Underground research laboratories
- Field sites
- DECOVALEX-related laboratory experiments

Staged Approach to Task Development

1. Definition of reference case scenarios – incorporating relevant features, events, processes
2. Comparison of subsystem models – e.g., waste package degradation, fuel dissolution, etc.
3. Comparison of deterministic simulation of the reference case
4. Quantification and propagation of parameter uncertainty (optional)
5. Uncertainty analysis and comparison of probabilistic PA
6. Sensitivity analysis and comparison of methods
7. Synthesis