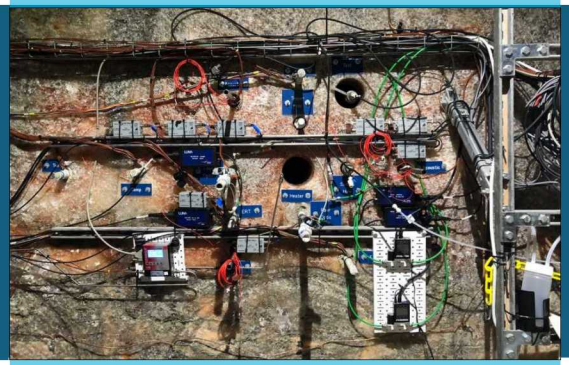
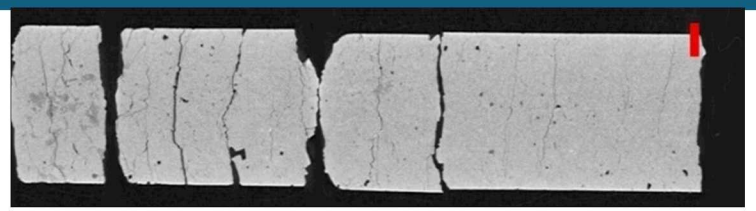
SAND2020-8350PE

Generic Salt Reference Case – United States





Richard Jayne

Sandia National Laboratories

Salt Scenario Meeting August 11 - 13

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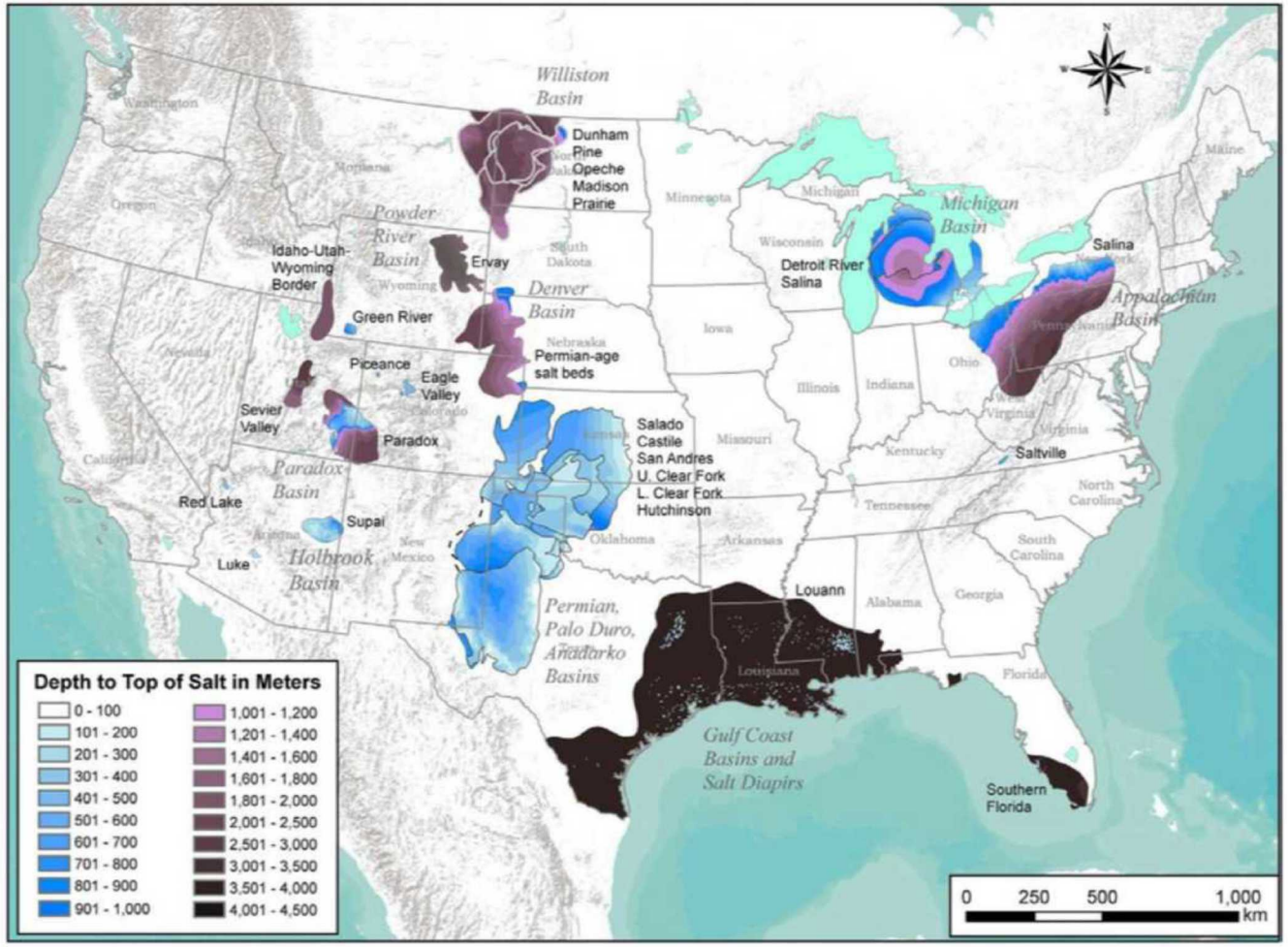
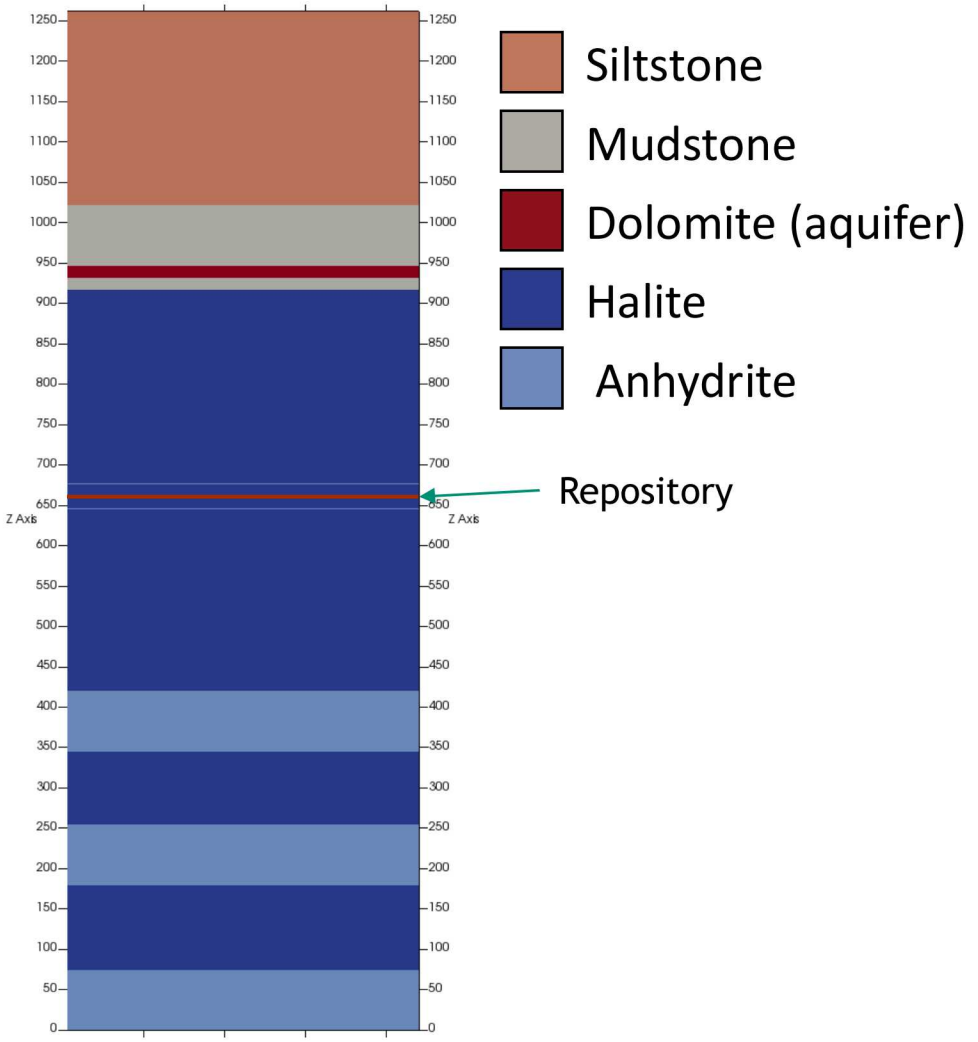
Geologic Setting

- Bedded Salt Formation
  - Hundreds of meters thick
  - Form in near-shore and shallow-marine environments
  - Very low permeability and porosity halite
  - Can contain other evaporite minerals and clay seams
- Present concept
  - Relatively pure halite (>50%) at min. 76 m thick
  - Depth to top 305 – 1067 m
  - Topographic slope < 1°
  - Heat flow 35 – 65 mW/m^2
- Formations that fit criteria
  - Michigan Basin
  - Appalachian Basin
  - Permian Basin
  - Paradox Basin



Generic Geologic Setting

- Halite Host Rock
  - 901 m thick
  - 30 m thick repository
  - 1 m anhydrite layers sandwich repository
- DRZ
  - Portion of host rock adjacent to engineered barrier system that experiences durable changes
  - Elevated permeability and porosity
  - Potential radionuclide transport pathways
- DRZ shaft continuous from repository to top of model
- Overlying mudstone, siltstone, and fractured dolomite = potential pathways for radionuclide release

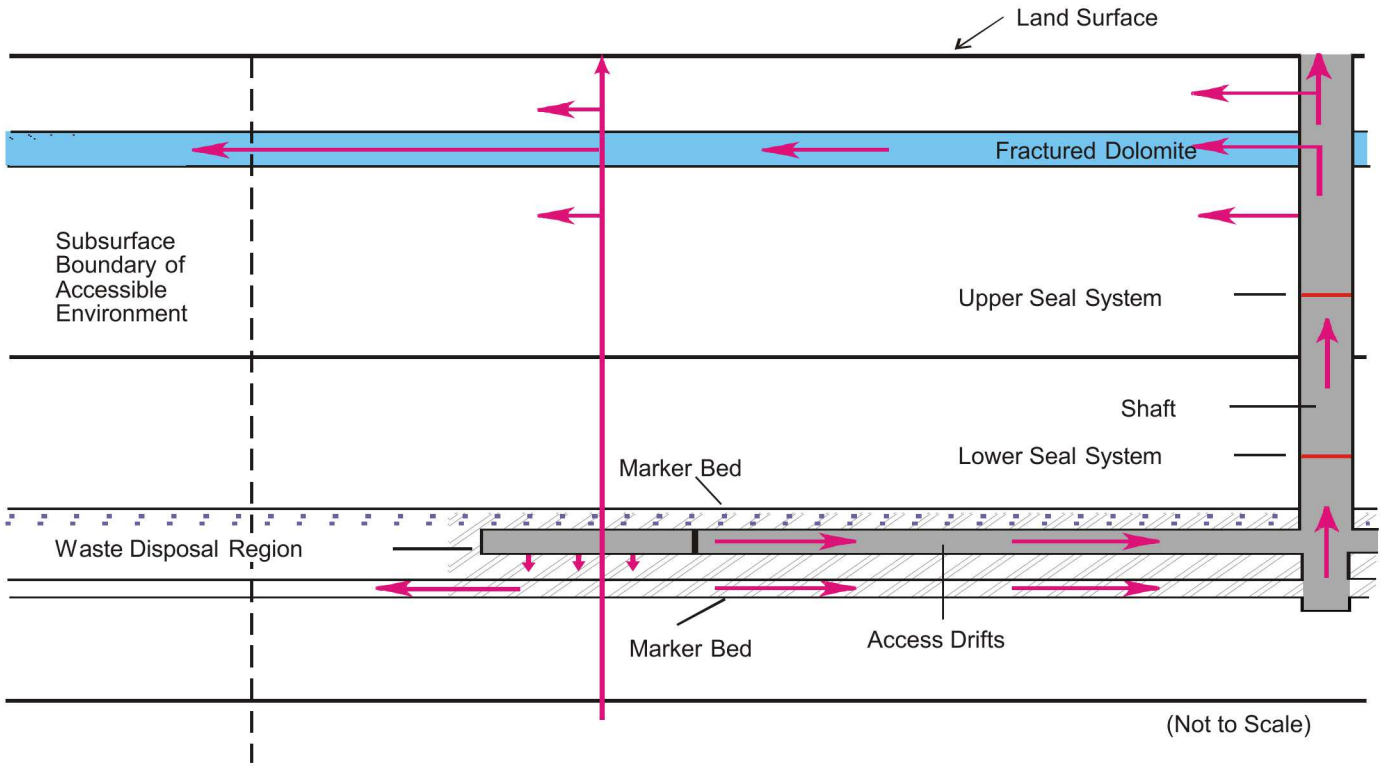


CONCEPTUAL FRAMEWORK

Region	Component	Key characteristics	Key processes included in PA
Engineered Barrier	HLW (source term)	Glass waste form	Radionuclide decay, waste form dissolution
	DSNF (source term)	Metallic fuel waste form	Radionuclide decay, instantaneous dissolution
	Waste Package (control on source terms)	Carbon steel	Degradation and breach
	Waste Package (region of domain)	Package plus contents	Radionuclide advection, diffusion, and decay
	Crushed Salt Backfill	Enhance permeability and porosity compared to intact halite	Radionuclide advection, diffusion, decay
Natural Barrier	Halite	Low permeability and porosity	Radionuclide advection, diffusion, decay
	DRZ	Enhanced permeability and porosity compared to intact halite	Radionuclide advection, diffusion, decay
	Anhydrite	Higher permeability than halite, potential pathway for release	Radionuclide advection, diffusion, sorption, decay
	Mudstone	Moderately low permeability	Radionuclide advection, diffusion, sorption, decay
	Aquifer	Fractured dolomite	Radionuclide advection, diffusion, sorption, decay
	Siltstone	Moderately high permeability	Radionuclide advection, diffusion, sorption, decay

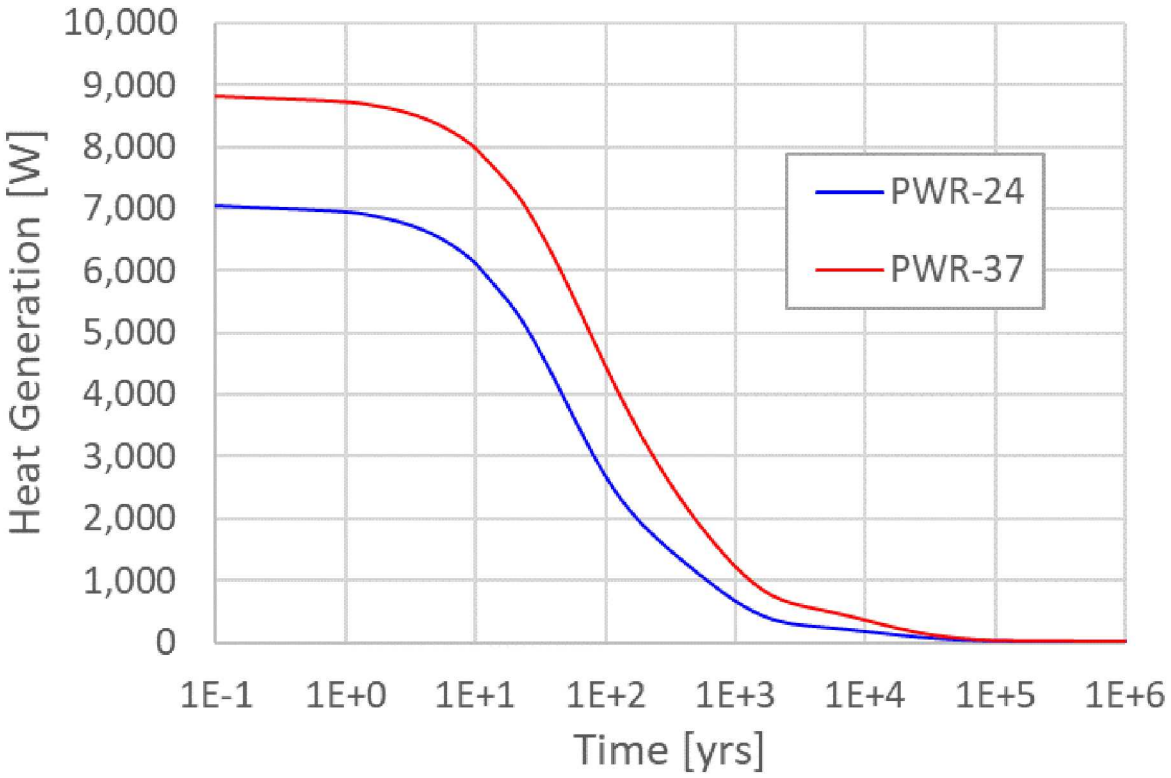
Conceptual Framework

- How is the system expected to behave?
- How could radionuclides escape?
- What disruptive events might we consider?
  - Human intrusion
  - Seismic
- Not included, but would like to incorporate:
  - Creep
  - Backfill consolidation
    - 2 phases
      - 0 - 200 years
      - 200 + years



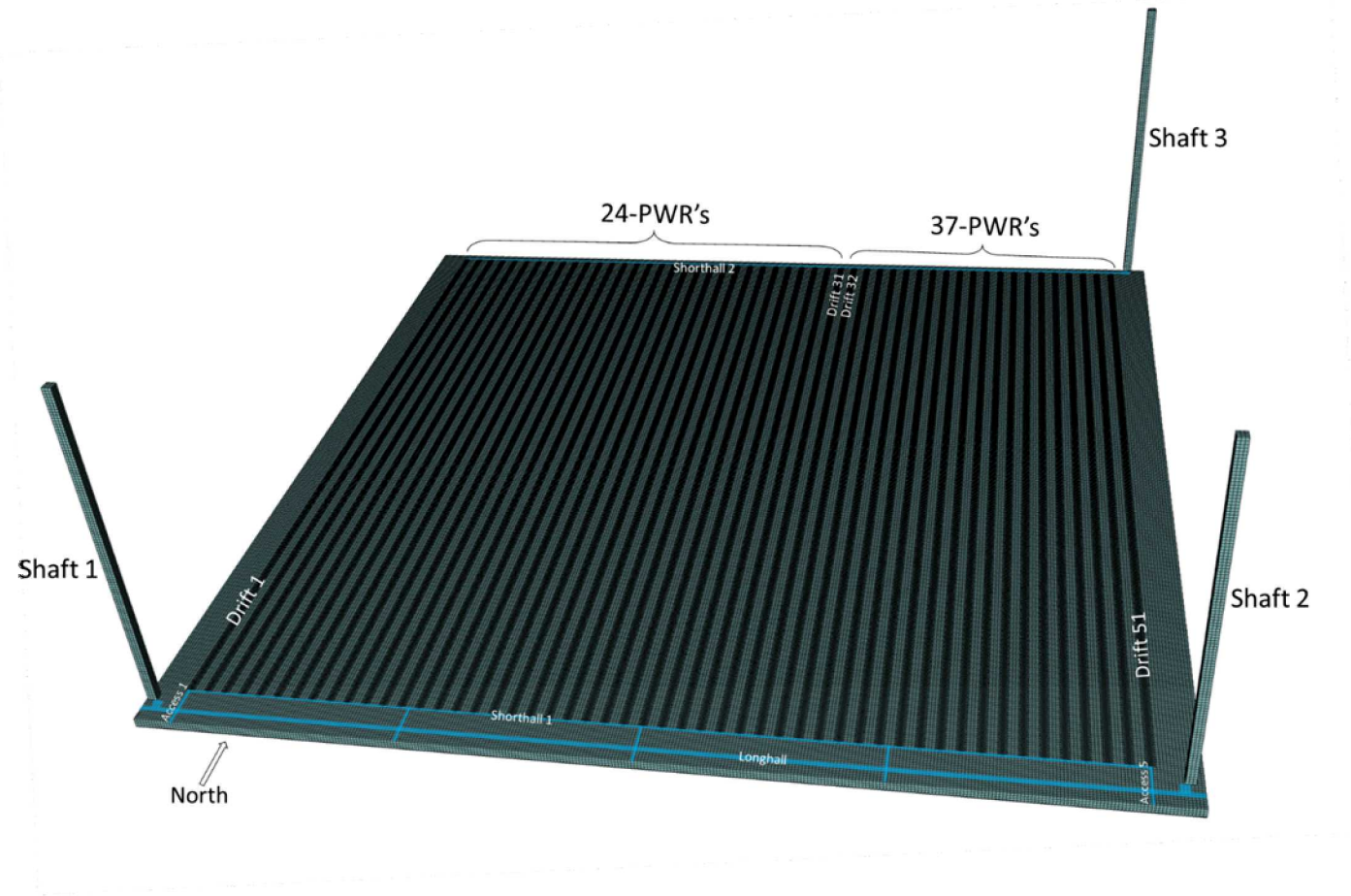
Waste Package Heat Sources

- Heat sources = transient
- Each package assumed 50 years OoR
- 40 - 60GWd/MTHM
- Initial heat generation
  - 7058 W – 24-PWR
  - 8810 W – 37-PWR

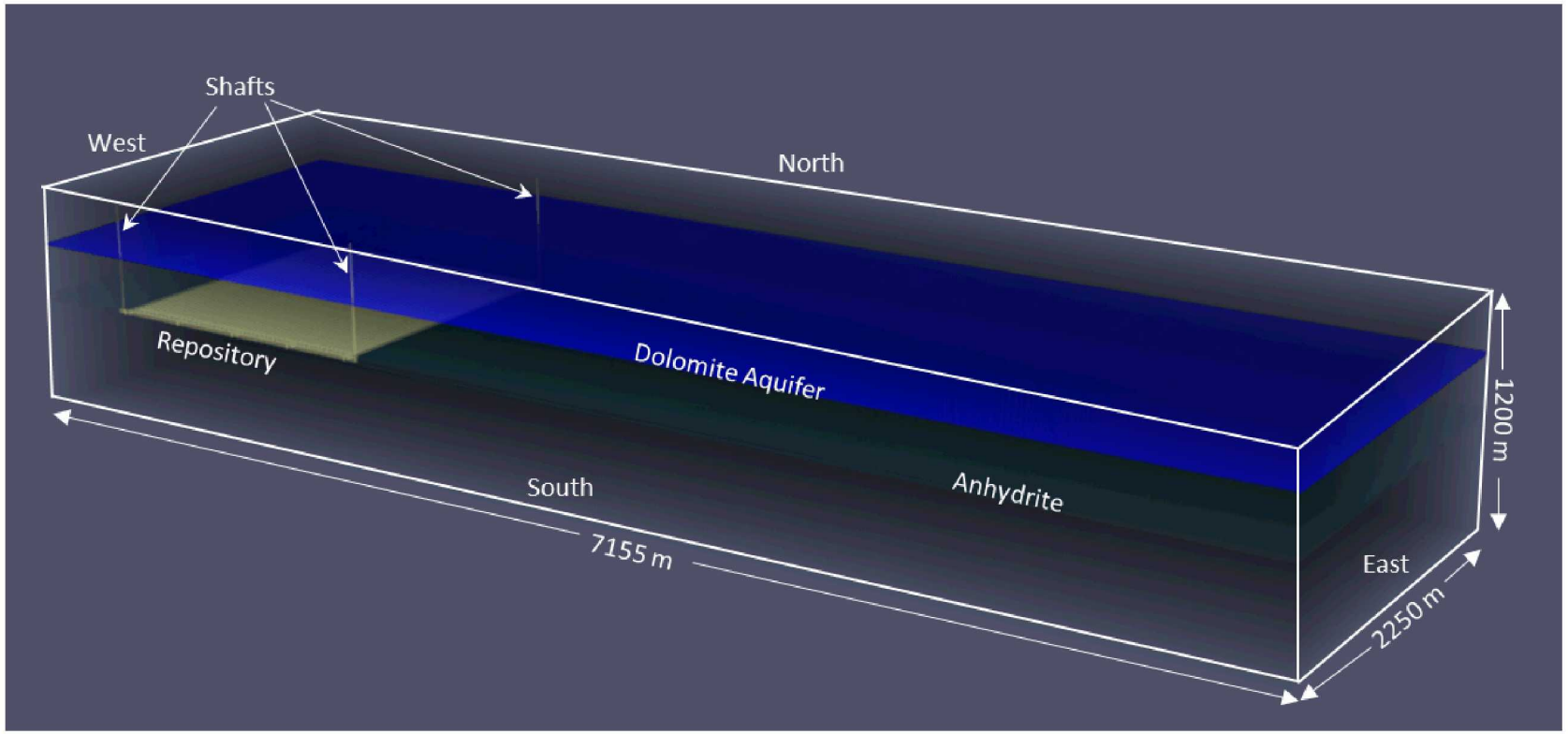


Model Domain

- Mined repository at 661 m depth
- 6 vertical shafts
- 69,748 MTHM
  - 24-PWRS – 34,968 MTHM
  - 37-PWRS – 34,780 MTHM
- 102 emplacement drifts
  - 1,525 m in length
  - 5 m wide
  - 30 m from center-to-center
  - 50 waste packages in each
- ~11 W/m^2 peak heat production
- Model domain
  - Half symmetry
  - 7,155 m x 2,250 m x 1,200 m
  - 9,156,747 elements

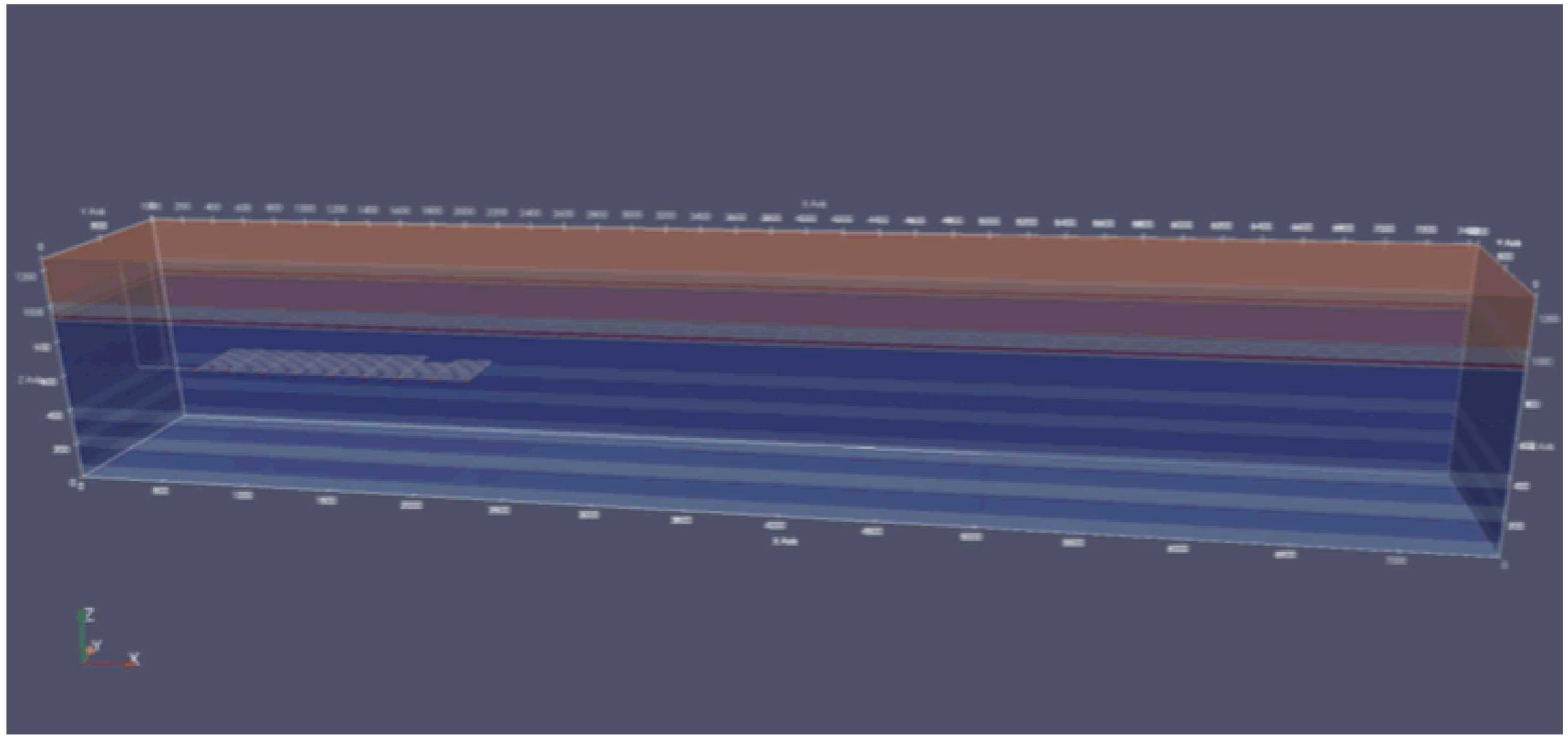


Initial Conditions



- Initial temperature of repository= 30°C
- Fluid pressure
  - Regional flow from E – W
  - ~0.15 MPa difference
  - -0.0021 gradient between E and W boundaries

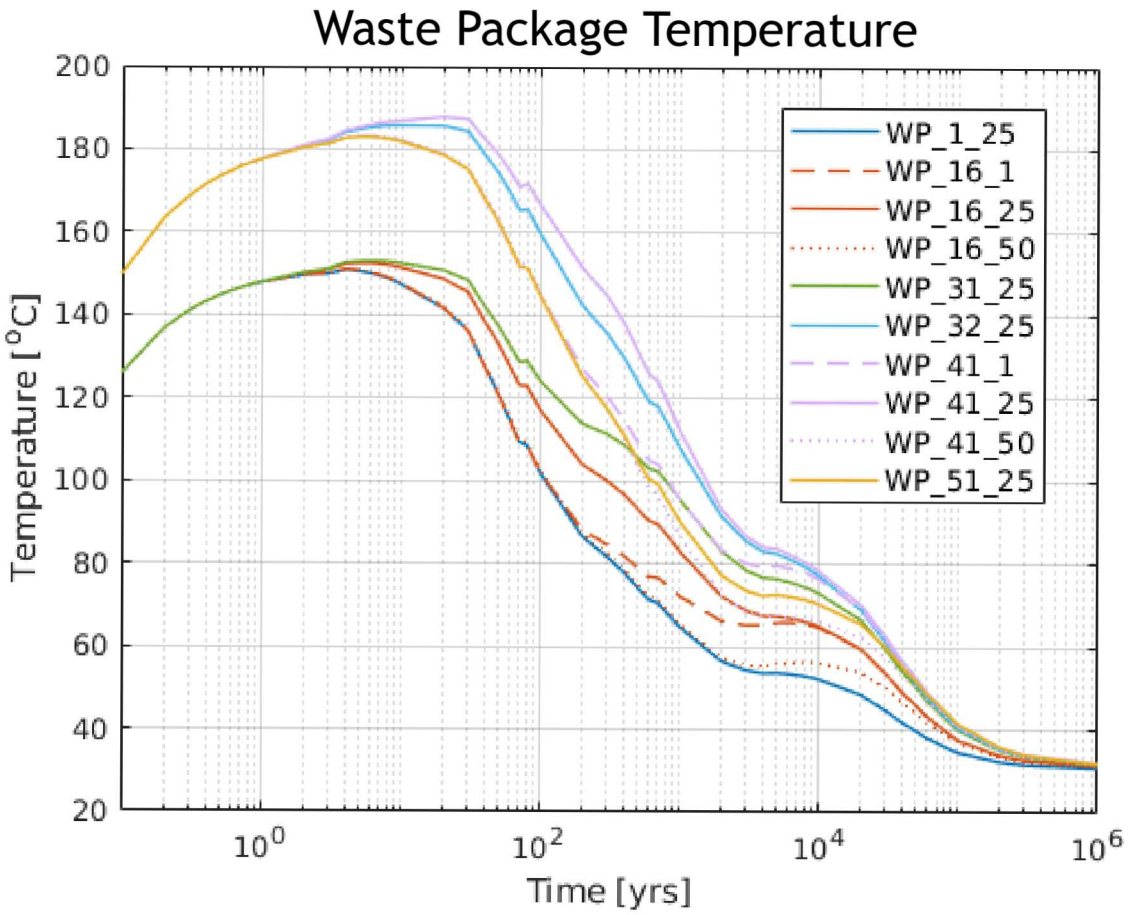
Numerical Implementation

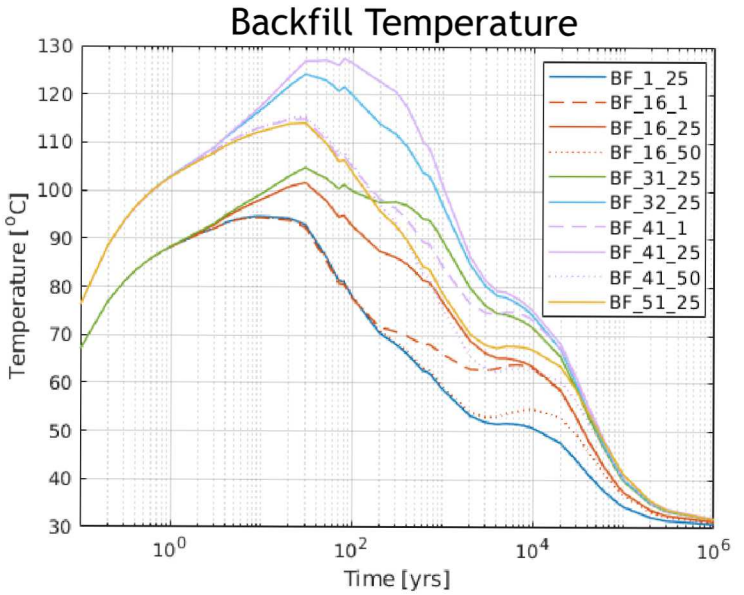


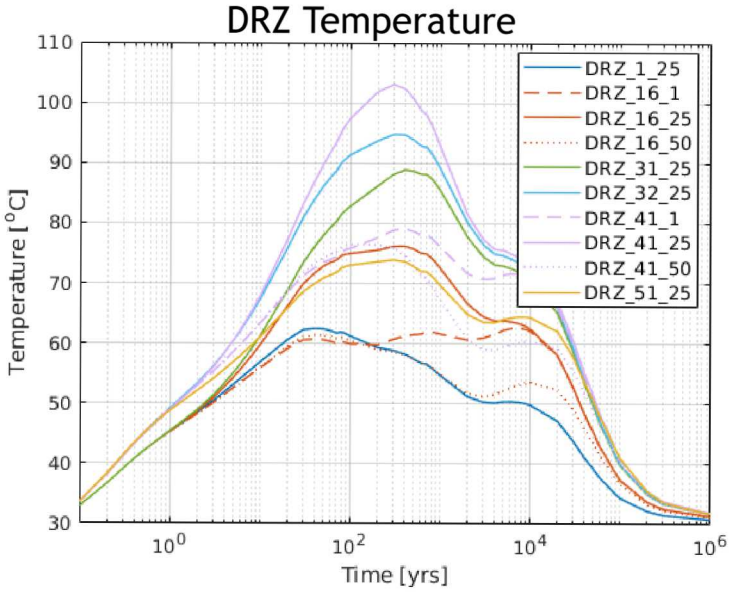
(Sevougian et al. 2016)

- Deterministic simulation
- 50 probabilistic simulations
  - Uncertainty and sensitivity analyses
  - Generic Disposal System Analysis framework (Mariner et al., 2015 & 2016)
- 1,000,000 year simulation

Waste Package Temperature Results

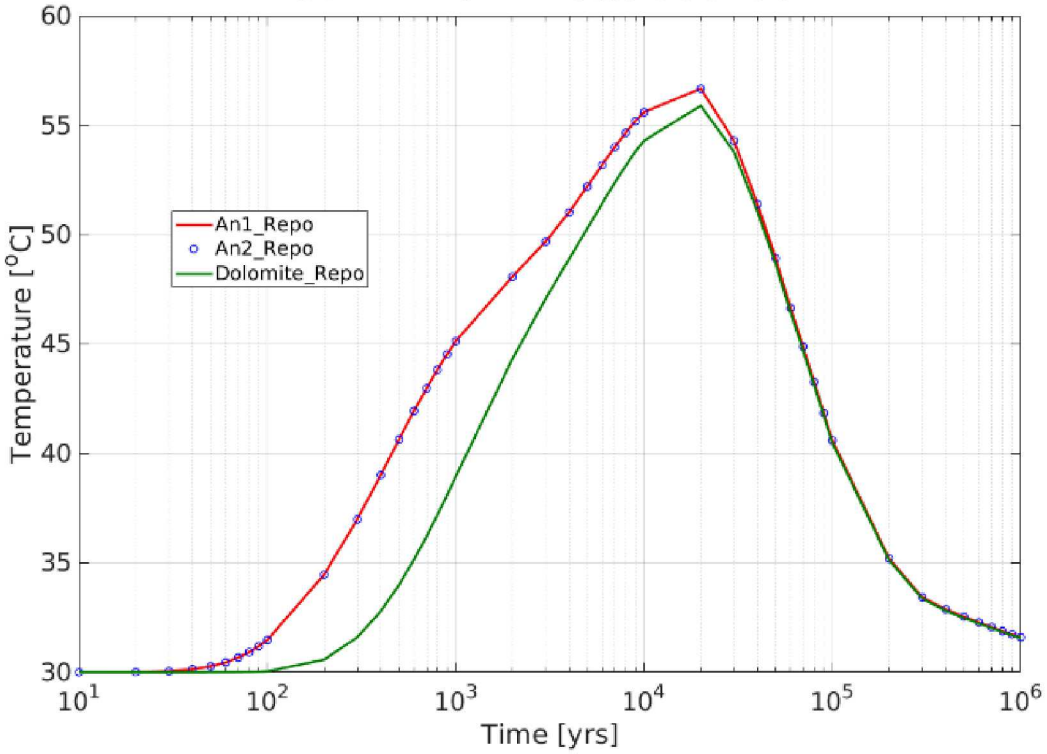




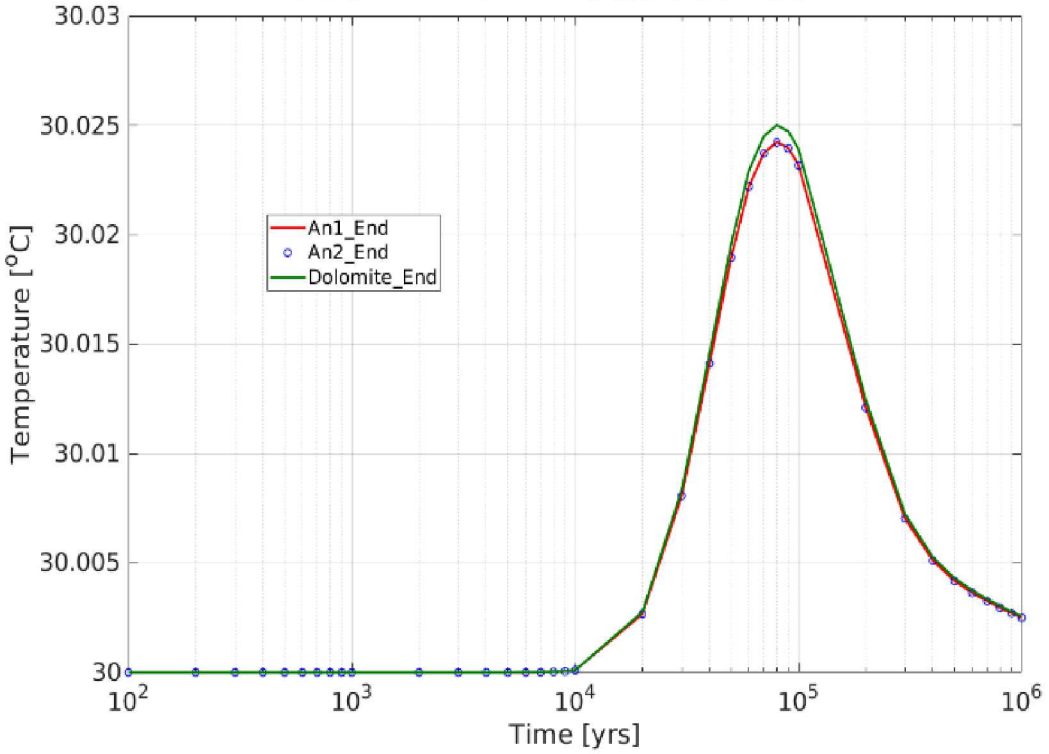


Observation Temperature Results

185 m From Heat Source

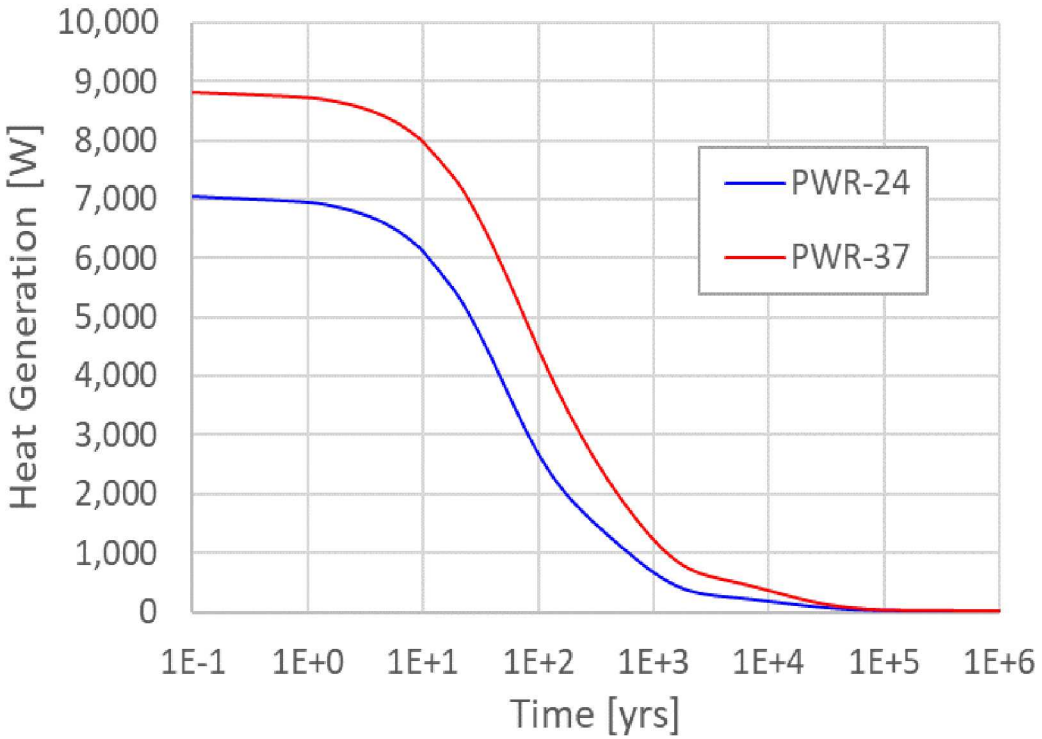


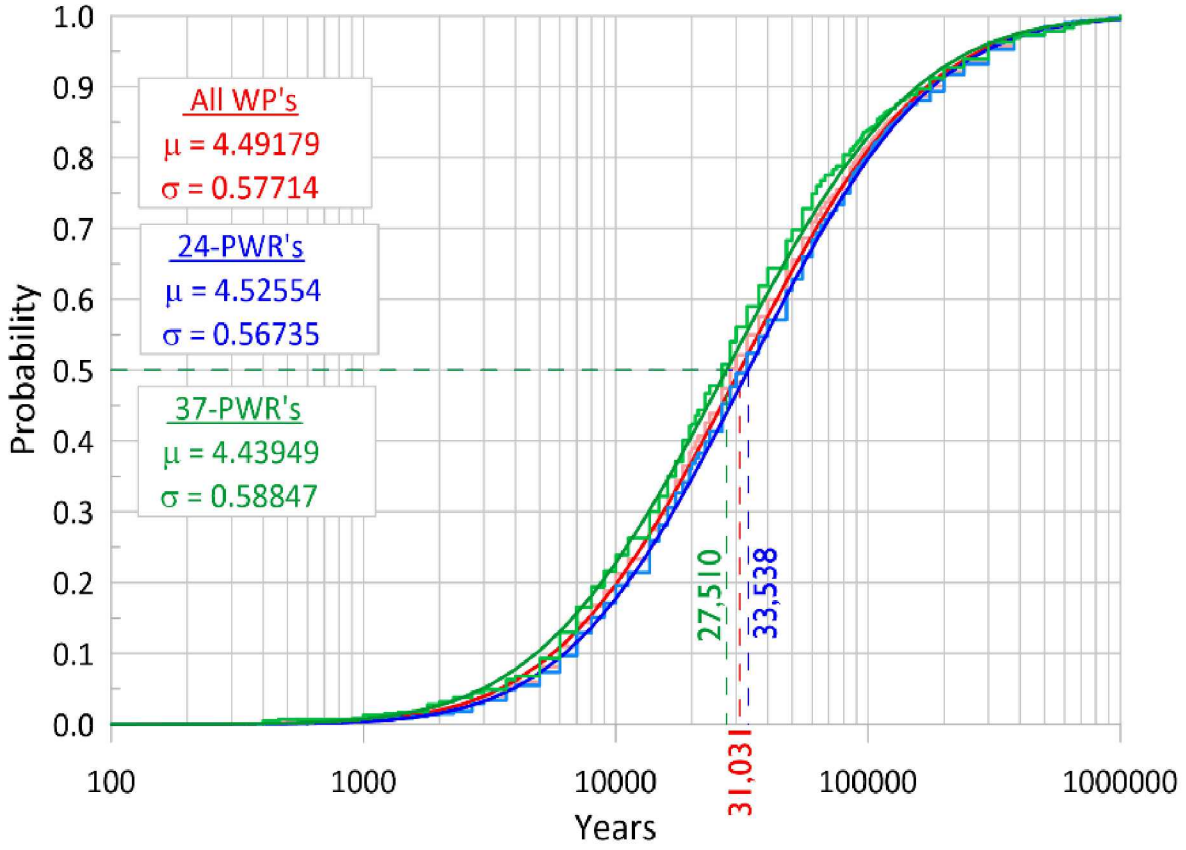
5000 m from Heat Source



Waste Package Breach Time

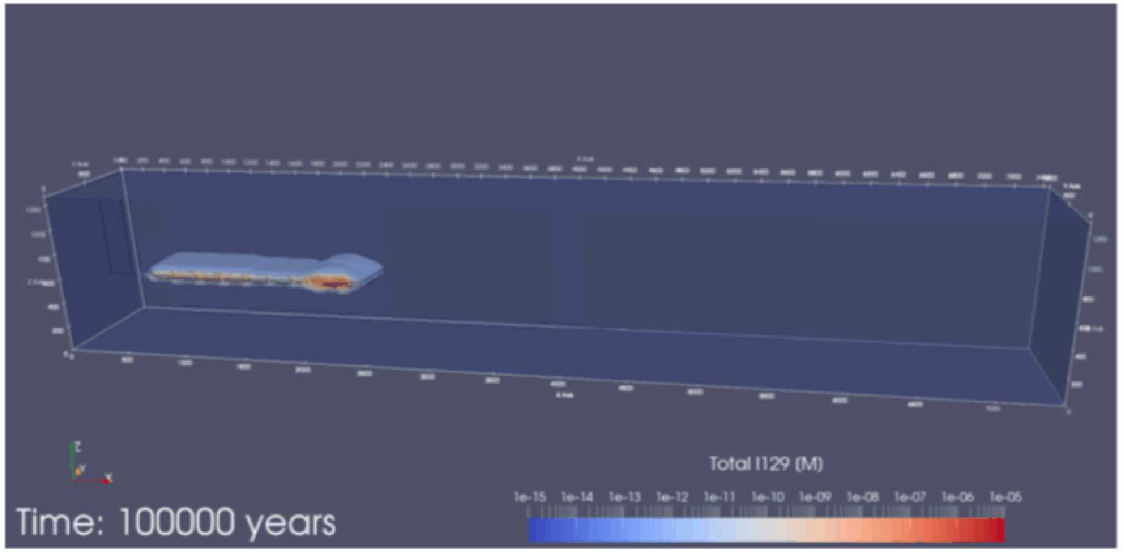
- Average breach time
  - 24-PWR = 33,538 yrs
  - 37-PWR = 27,510 yrs

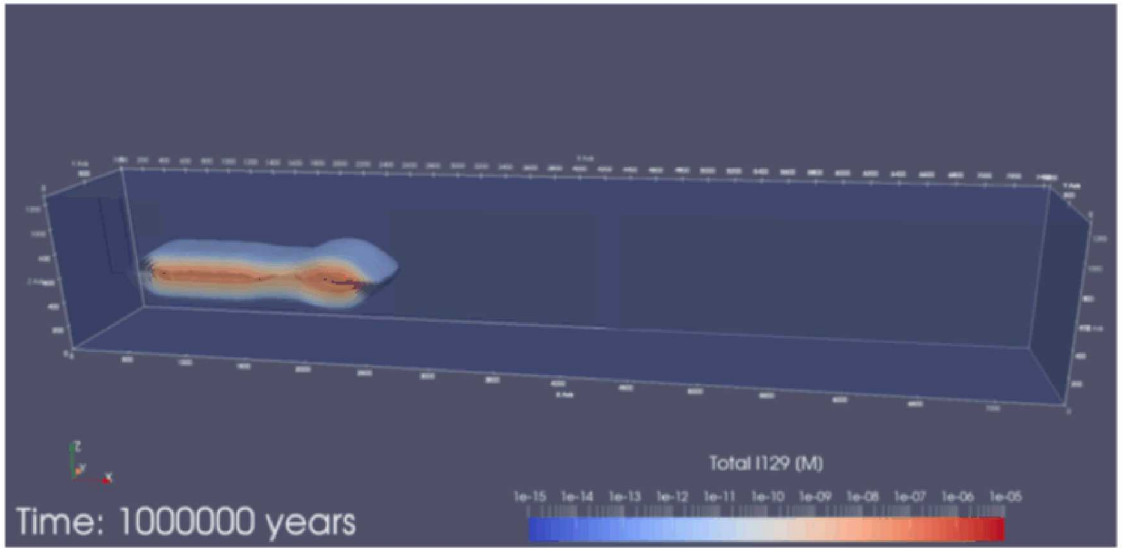




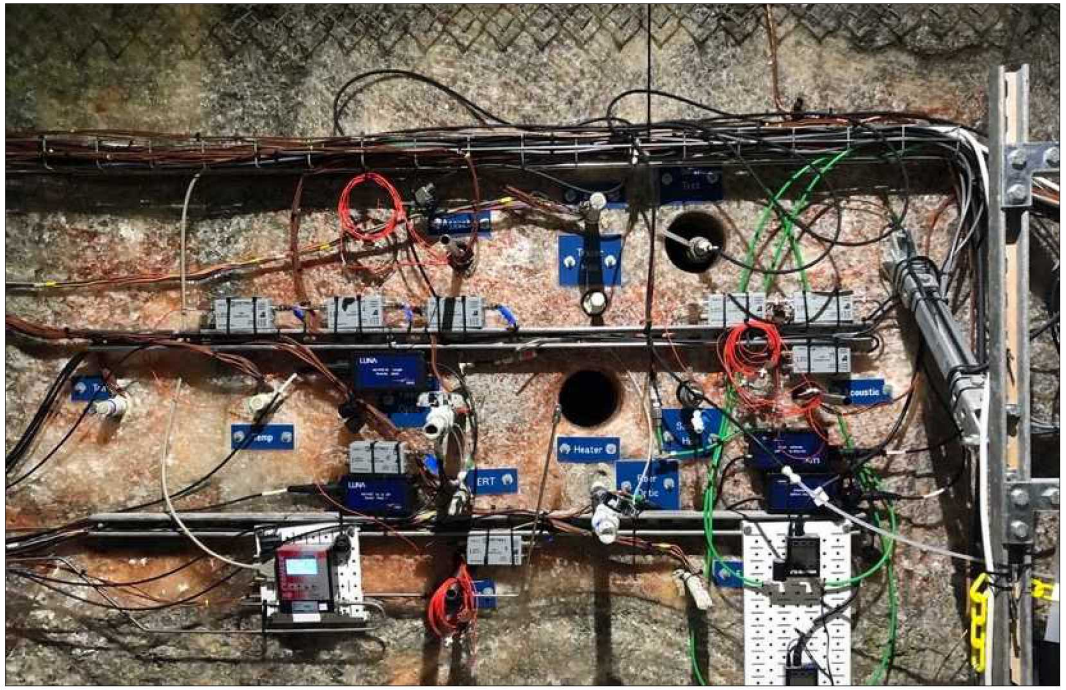
Radionuclide Results

- **Radionuclide**
  - Radionuclide release is a function of fluid fluxes and waste package breach
  - ^{129}I $t_{1/2}$ = 1.57 x 10^7 yr
  - ^{129}I assumed to have unlimited solubility and non-sorbing
  - ^{129}I and ^{237}Np do not reach overlying aquifer





Thank You!



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