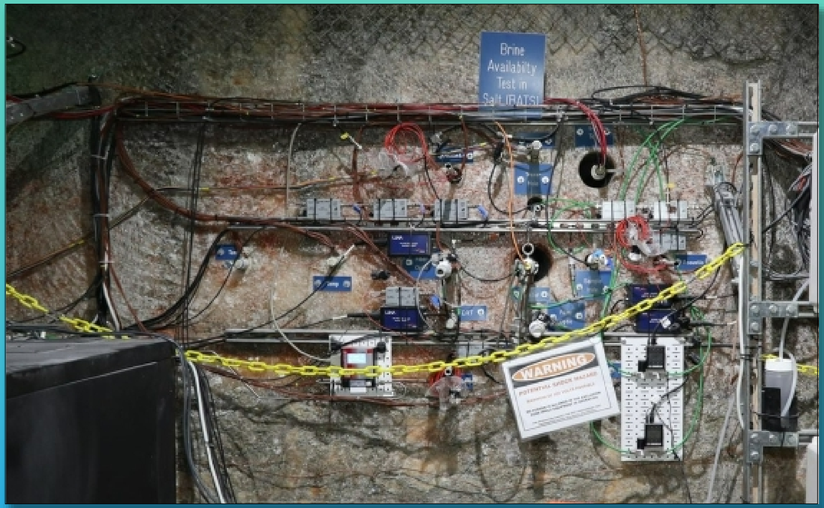
U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Spent Fuel and Waste Science and Technology (SFWST)

SAND2020-13010PE



DECOVALEX-2023 Task E (BATS) Synthesis

DECOVALEX-2023 Task E
Friday November 20, 2020

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Sandia National Laboratories

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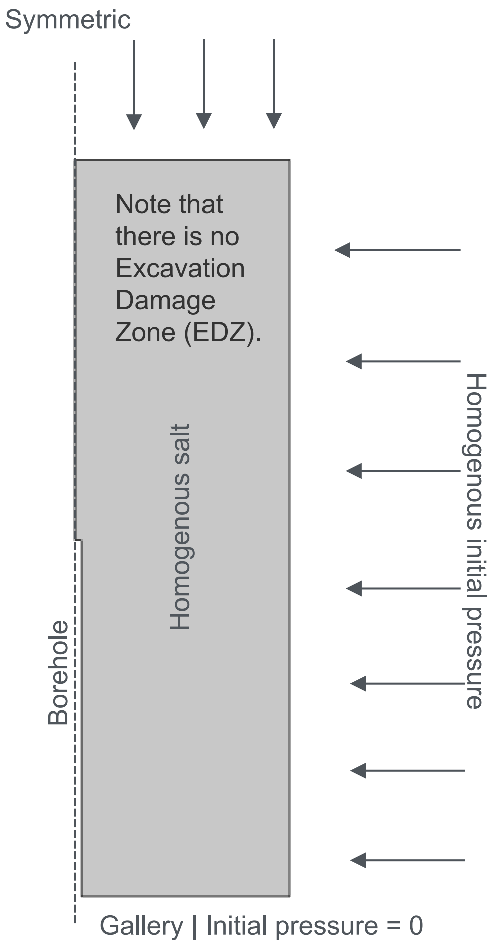
Task E Participating Teams

Team	Modeling Tool	Type
Shao (BGR)	OpenGeoSys V5	FE multiphysics
Bartol (COVRA)	COMSOL	FE multiphysics
Jantschik (GRS)	CODE_BRIGHT	FE THMC
Guiltinan (LANL/LBNL/SNL)	FEHM / TOUGH-FLAC / PFLOTRAN	FV TH(M)C
Watson / Benbow (Quintessa)	QPAC	FV multiphysics

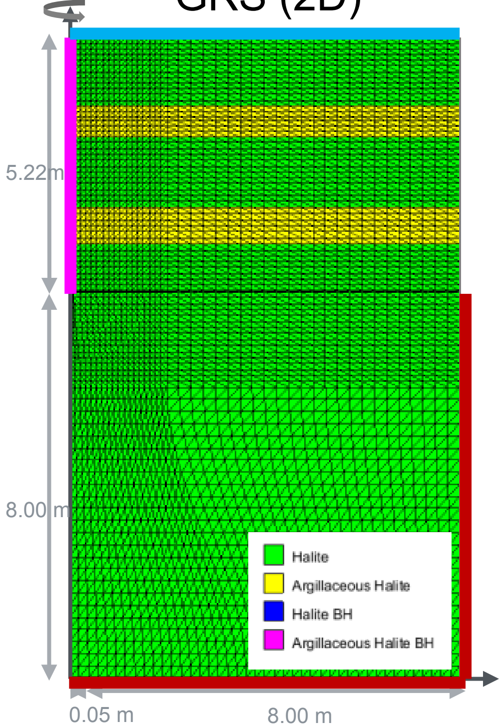
FE: finite element, FV: finite volume (integrated finite differences)

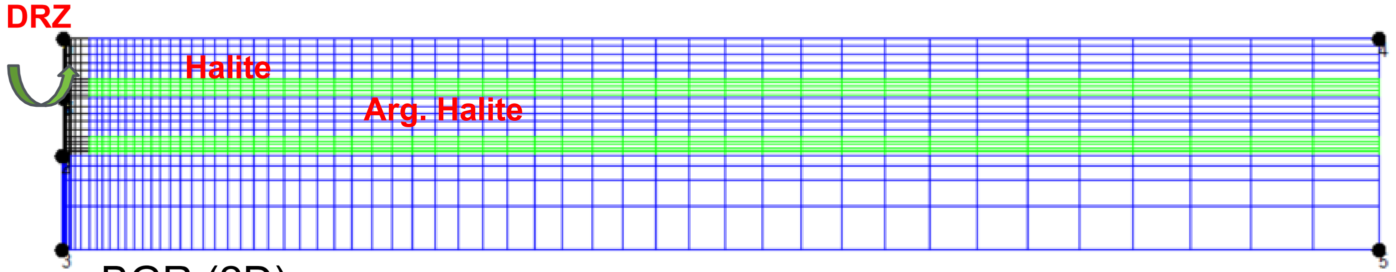
WIPP Small-Scale Brine Inflow: Domains

COVRA (2D)

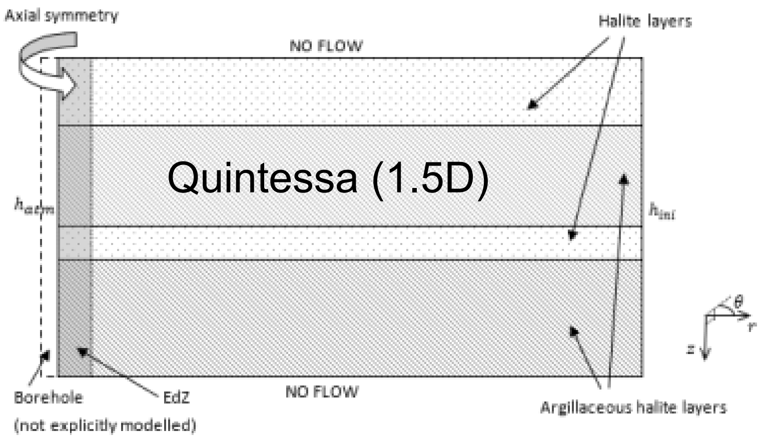


GRS (2D)

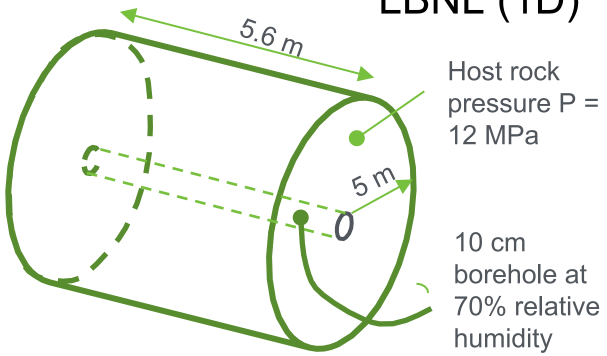


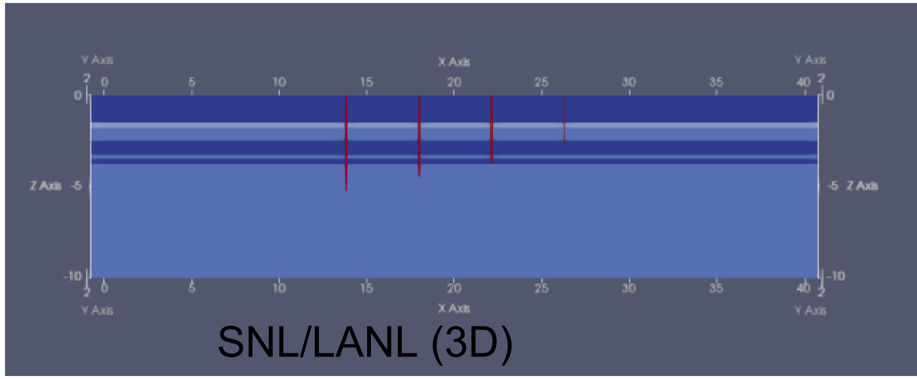


BGR (2D)



LBNL (1D)

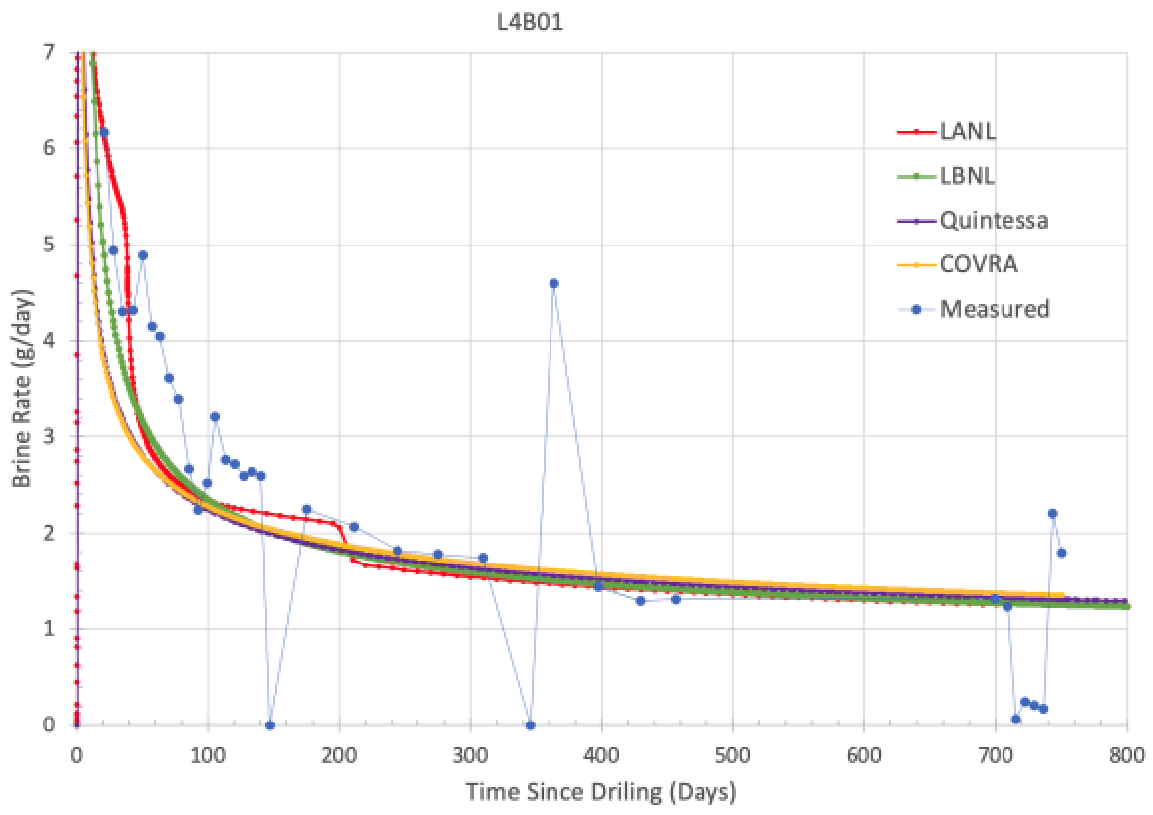


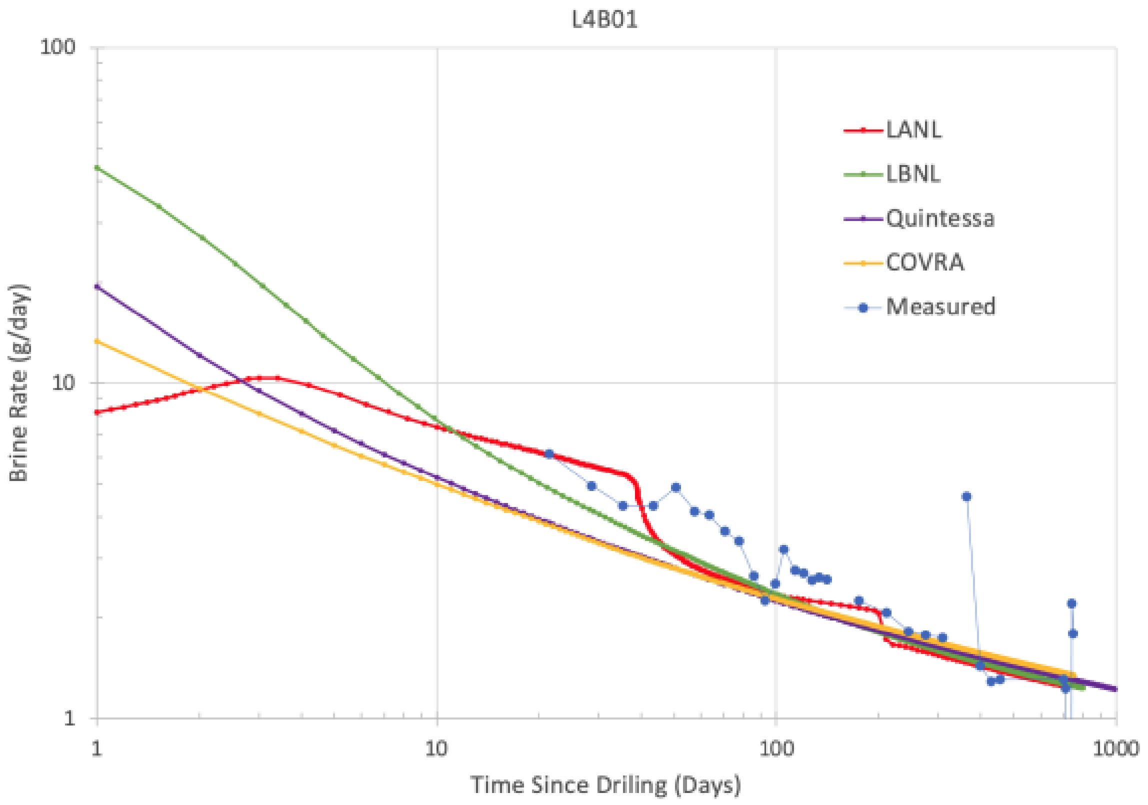


WIPP Small-Scale Brine Inflow

Team	D	Bore/Drift DRZ?		MU?	L (m)	P(L) (MPa)	k
BGR	2D	Y	N	Y	80	10	layers
COVRA	2D (+ 3D)	N	N	N	0.5–6	2–16	uniform
GRS	2D	N	N	Y	8	12	layers
DOE:LBNL	1D	N	N	N	5	12	uniform
DOE: SNL/LANL	3D	Y	Y	Y	5×10×40 10×30×40	12	layers
Quintessa	1.5 D	N	N	Y	12	9–15	k(r) in layers

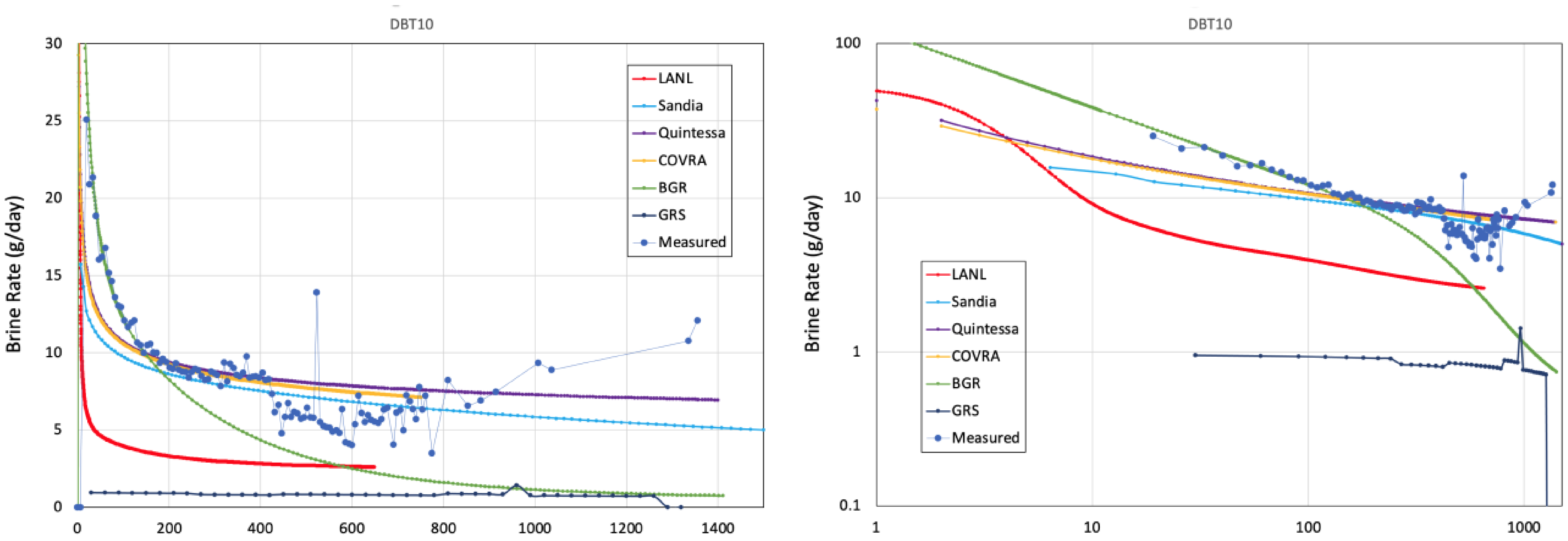
WIPP Small-Scale Brine Inflow: L4B01





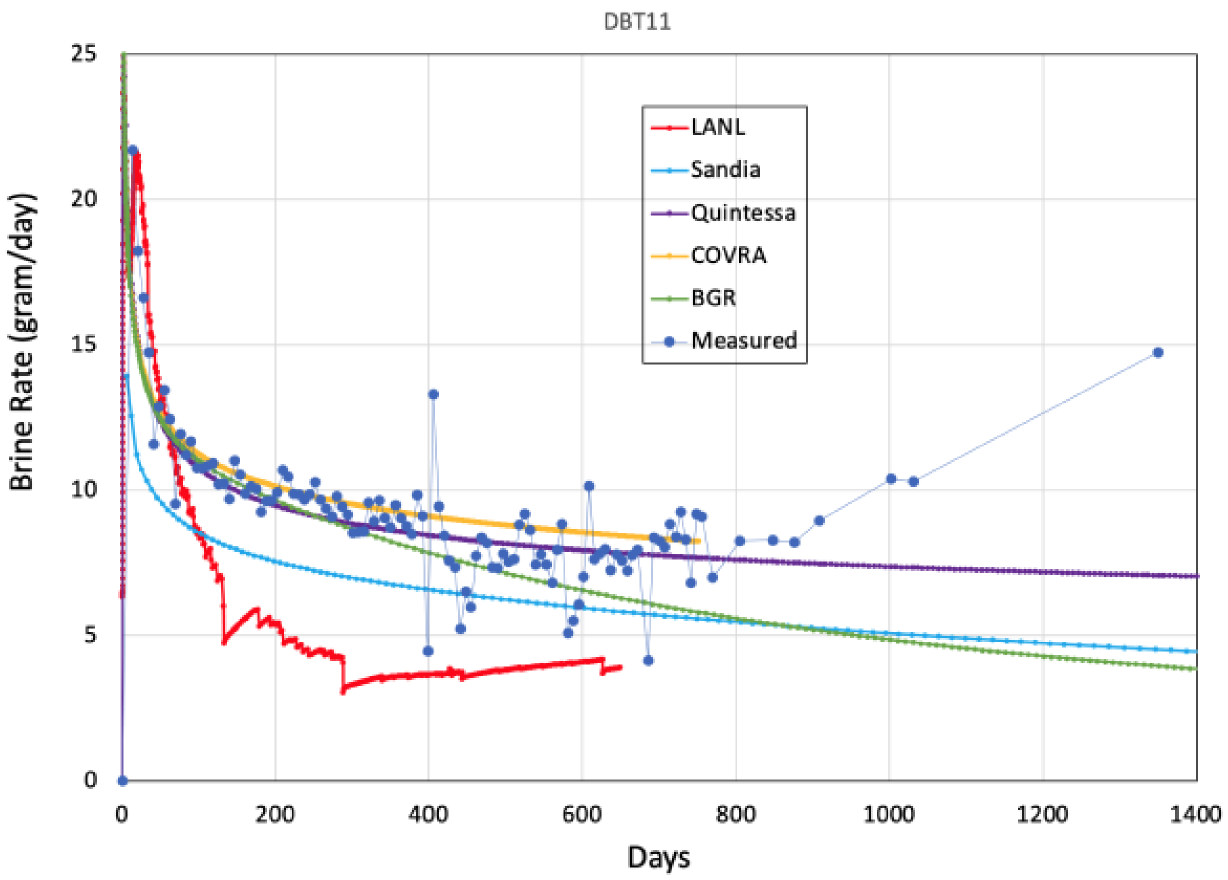
L4B01: Horizontal borehole in Map Unit 0 (MU-0), “argillaceous halite”

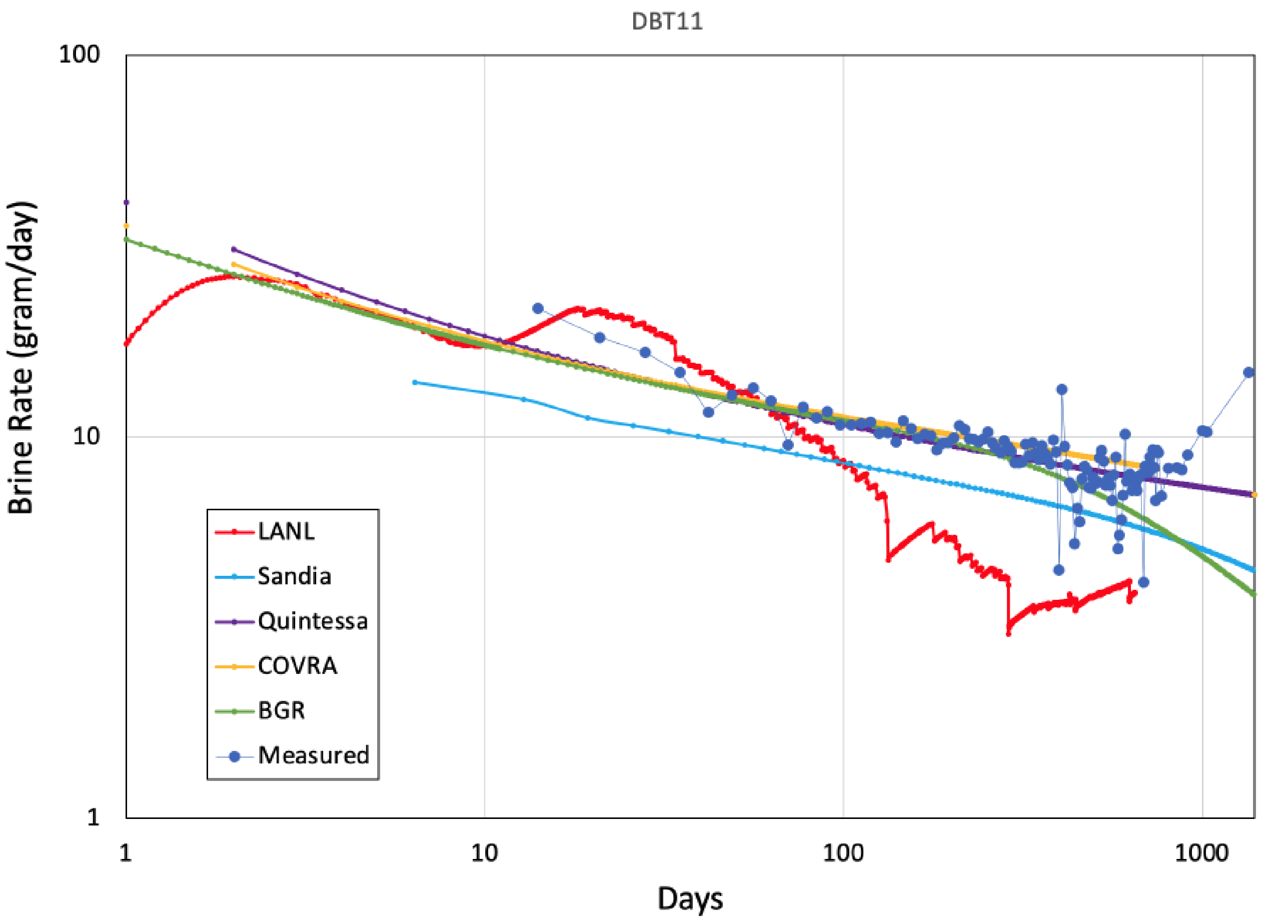
WIPP Small-Scale Brine Inflow: DBT10



DBT10 Vertical borehole across MU-0 through MU-6, including “Clay F”

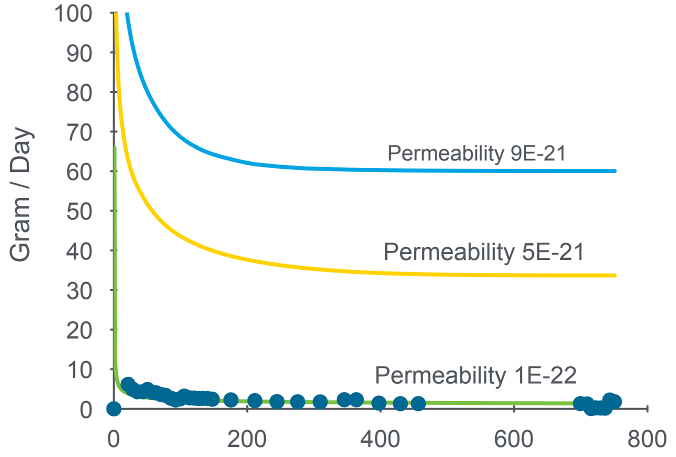
WIPP Small-Scale Brine Inflow: DBT11

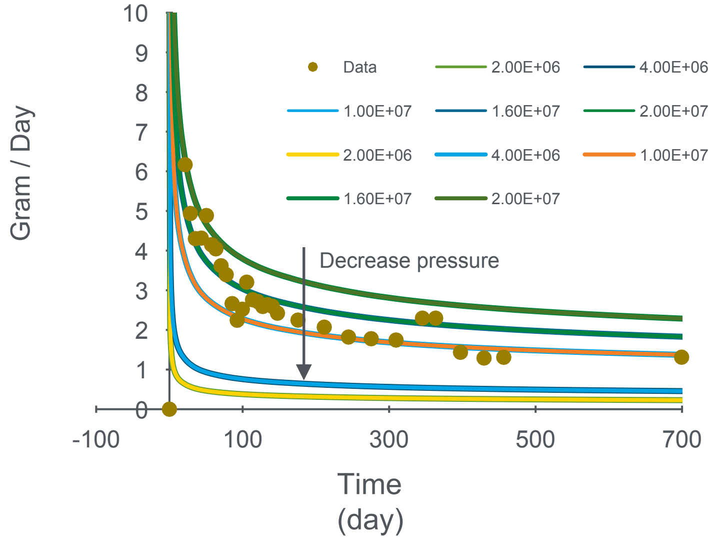


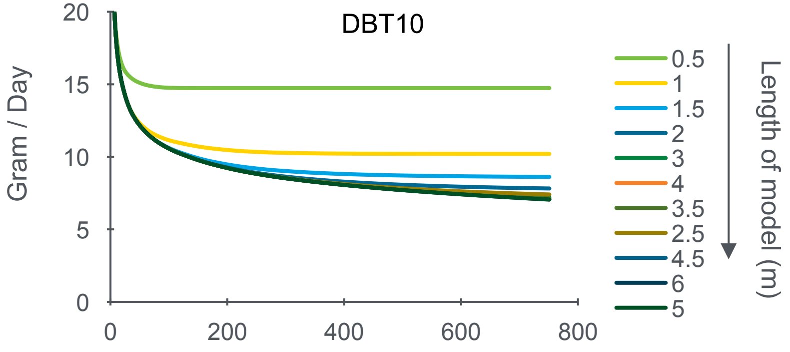


DBT11: Vertical borehole across MU-0 through MU-6, including “Clay F”

WIPP Small-Scale Brine Inflow: Sensitivity





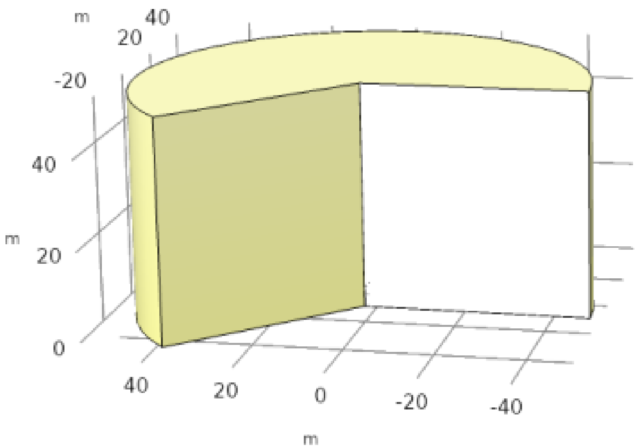


WIPP Small-Scale Brine Inflow: Lessons Learned

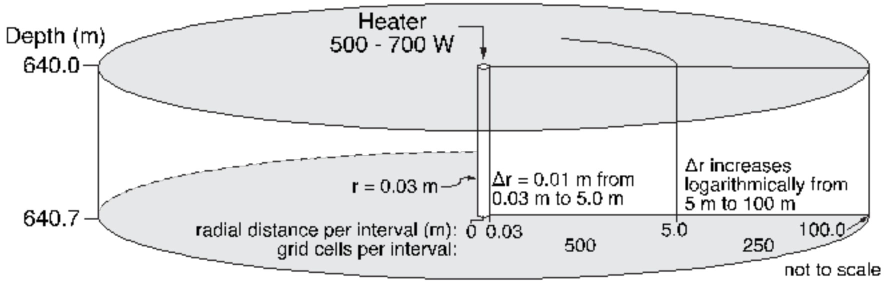
- Permeability:
  - Most sensitive parameter
  - Most teams had k layer-specific (~1 order-of-mag difference)
  - Many teams had DRZ of borehole/drift
  - Quintessa had k(r) in each layer
  - BGR had DRZ size change in time
- Domain Size:
  - >5 m needed to minimize boundary effects
  - Boreholes didn't interfere with each other too much
- Does DRZ impact results more at early vs. late time?
- COVRA / Quintessa sensitivity analyses were insightful

WIPP Small-Scale Brine Inflow: Domains

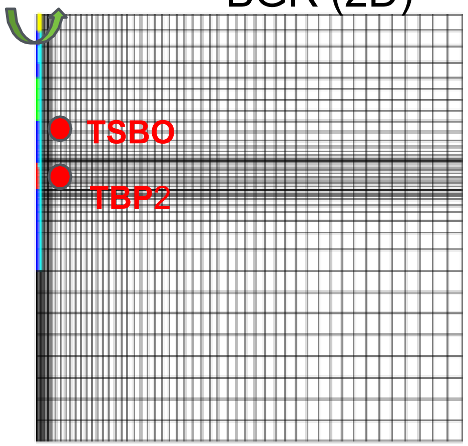
COVRA (2D)



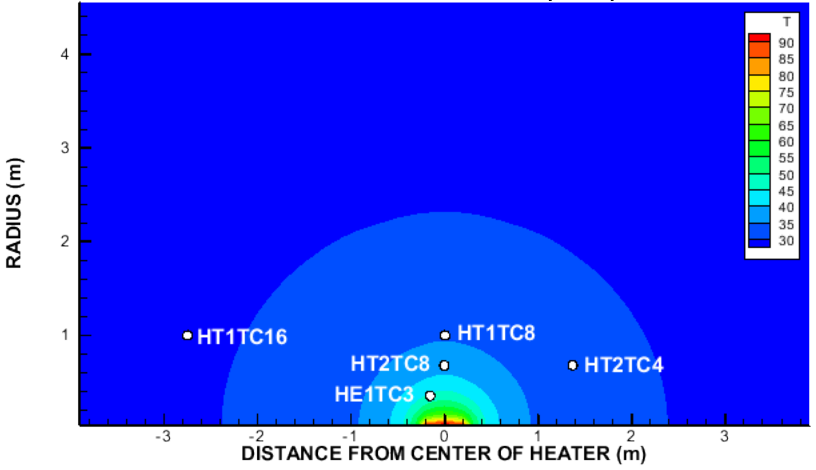
SNL (1D)



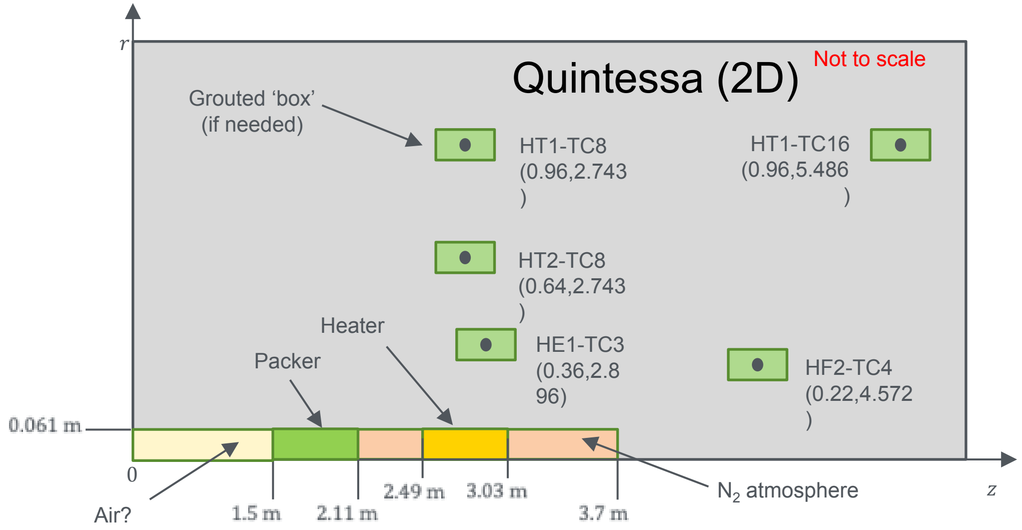
BGR (2D)



LBNL/LANL (2D)



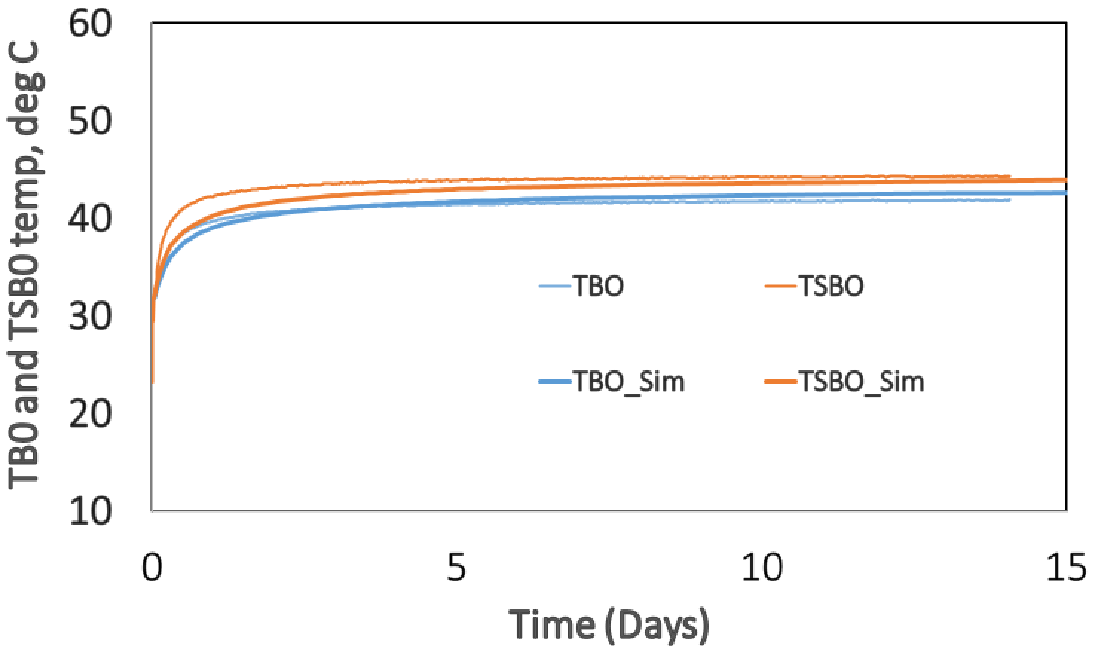
Quintessa (2D)

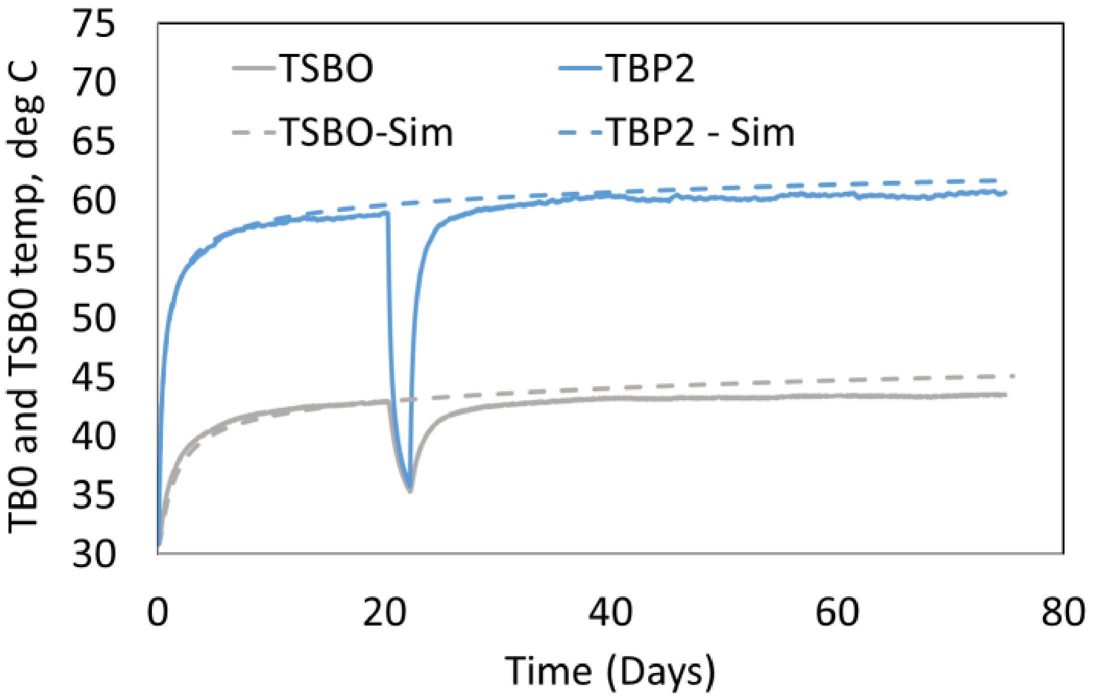


BATS Temperature Response

Team	D	Liquid?	Bore/Drift DRZ?		$k_T(T)$	L (m)
BGR	2D	Y	Y	N	N	80
COVRA	2D (+3D)	N	N	N	Y	50
DOE:LBNL/ LANL	2D	Y	N	N	N	5
DOE: SNL	1D	Y	Y	Y	N	100
Quintessa	2D	N	N	N	Y	10

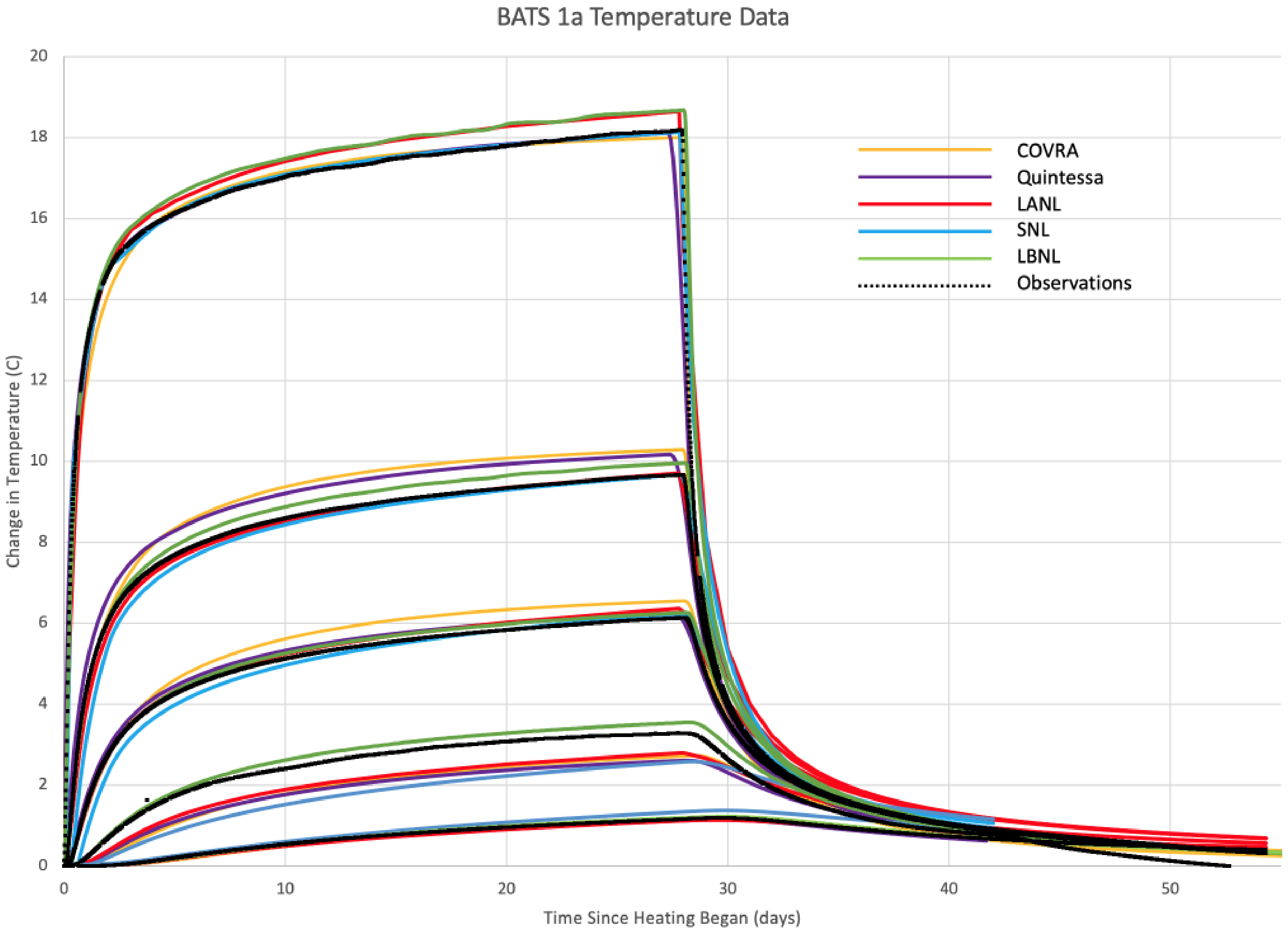
BATS Temperature Response



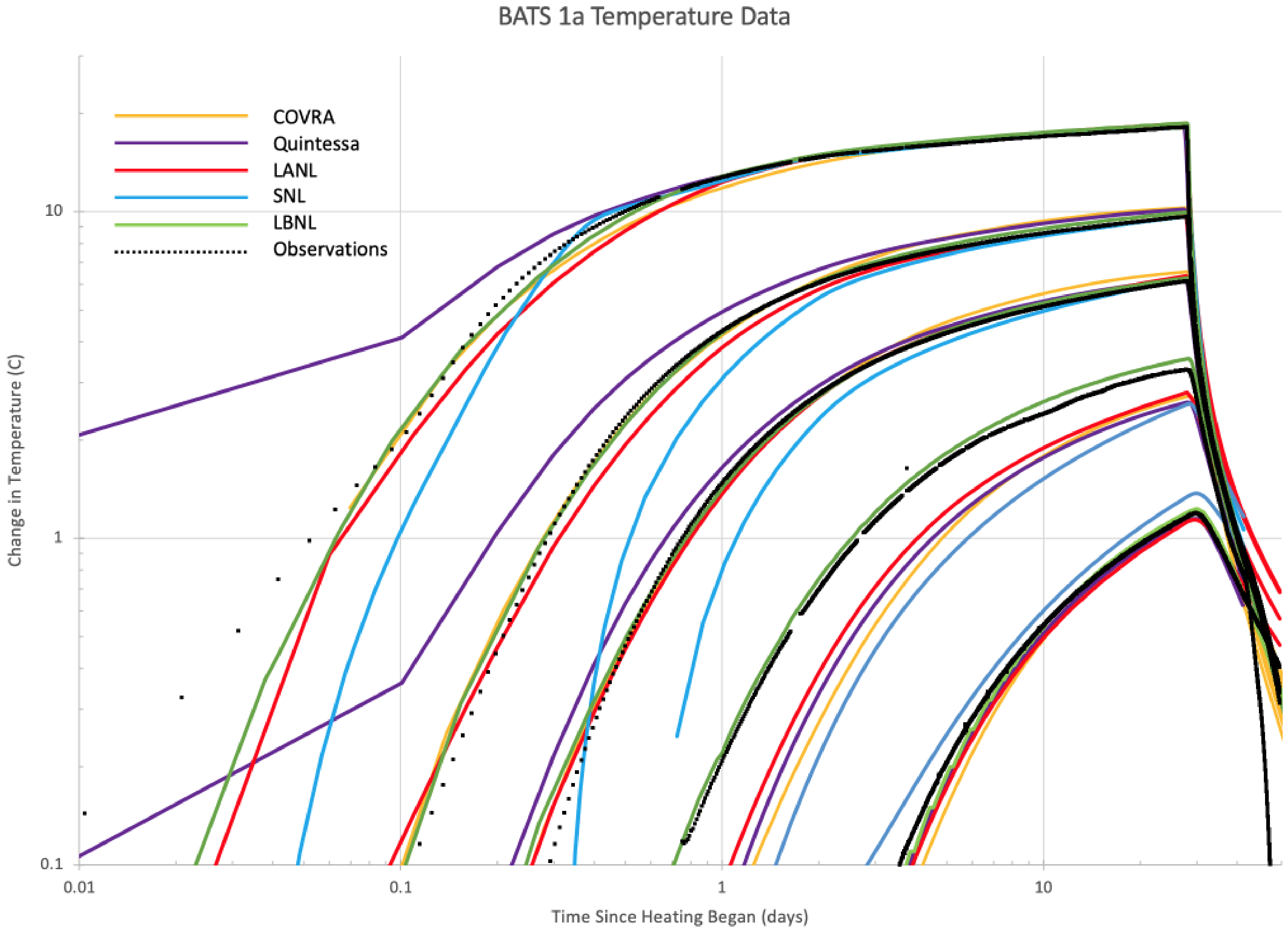


- BGR used very similar approach, but simulated “shakedown” test
  - Needed ~50% efficient heater

BATS Temperature Response



BATS Temperature Response



BATS Temperature Response: Lessons Learned

- Most simulations were 2D
- Heat conduction
  - Some TH simulators (TOUGH,FEHM,OpenGeoSys) still simulated flow
- Power applied at heater
  - <100% efficient energy transfer (50% BATS 1s, 90% BATS 1a)
- Sensor Locations
  - Mis-locating a sensor by 1-2 cm can impact results by ~0.5 C
  - Possible (likely?) error in computing sensor location (will fix)

Task E Next Steps

Step 0: Single-process H^1 and T benchmarks

Step 1: TH^1 benchmark & H^2M/H^2 unheated brine inflow test case

Step 2: TH^2M heated brine inflow test case

Step 3: Alternatives (ERT/AE joint inversion, seals, TH^2MC, creep)

Table 3. Proposed detailed Task E schedule of steps.

	Apr.	Nov.	Apr.	Nov.	Apr.	Nov.	Apr.	Nov.
	2020		2021		2022		2023	
Step 0								
Step 1								
		Midterm Report → (Nov 2021)						
Step 2								
Step 3								
						Papers and Final Report → (Nov 2023)		

Infrared heater in BATS HP borehole

H^1= single-phase; H^2 = two-phase