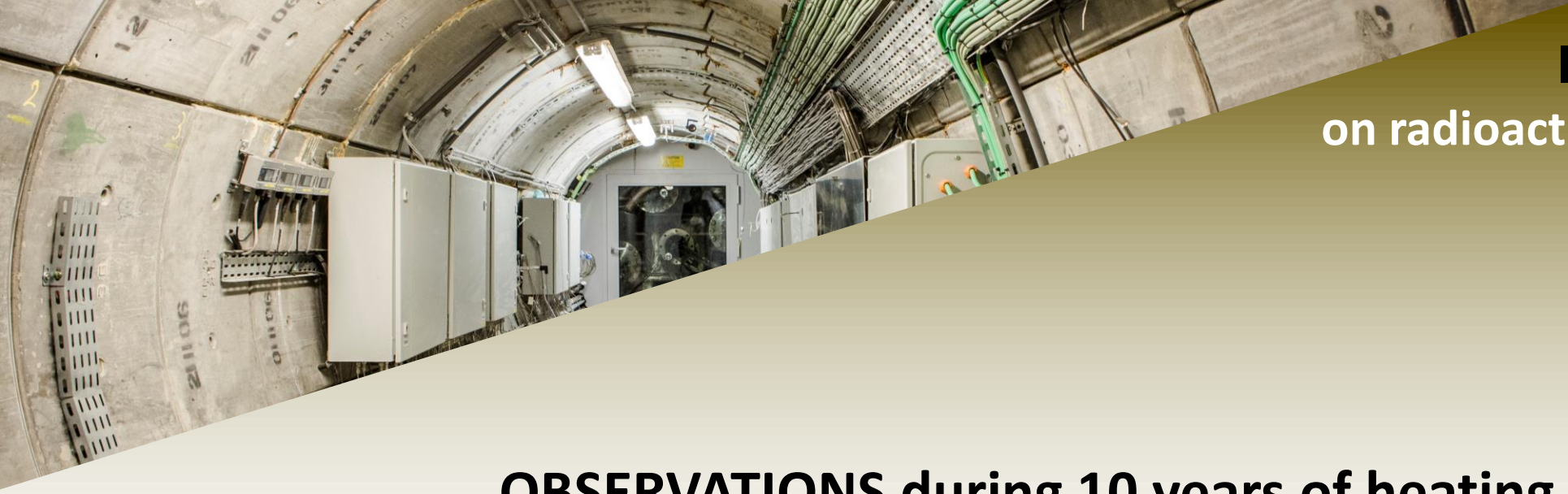


Belgian programme
on radioactive waste management

OBSERVATIONS during 10 years of heating

Can the clay withstand the thermal load from heat-emitting waste?

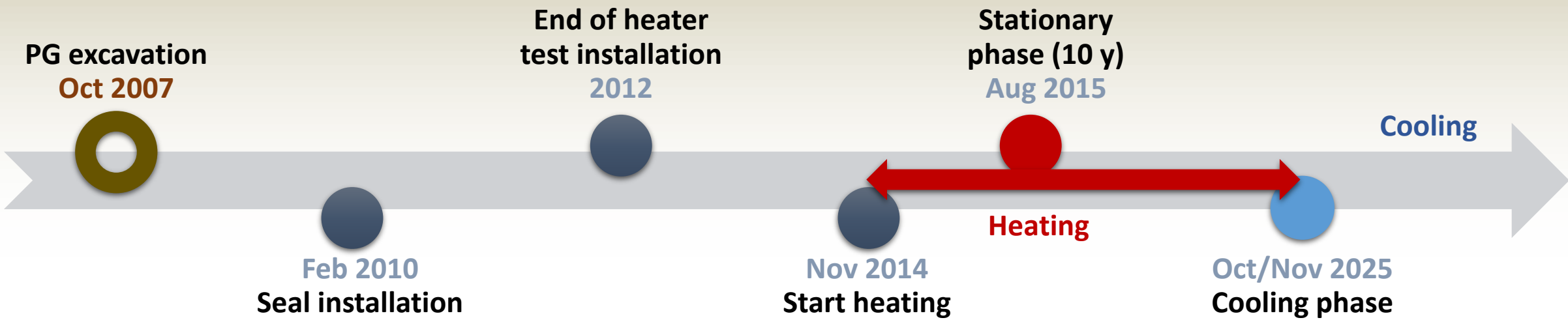
T. Georgieva, A. Dizier, J. Verstricht, D. Nackaerts, S. Levasseur

EURIDICE

07-11-2025
27th Exchange Meeting

PRACLAY 2025
CLOSING THE HEATING CHAPTER,
OPENING THE COOLING PHASE

PHASES of the PRACLAY EXPERIMENT



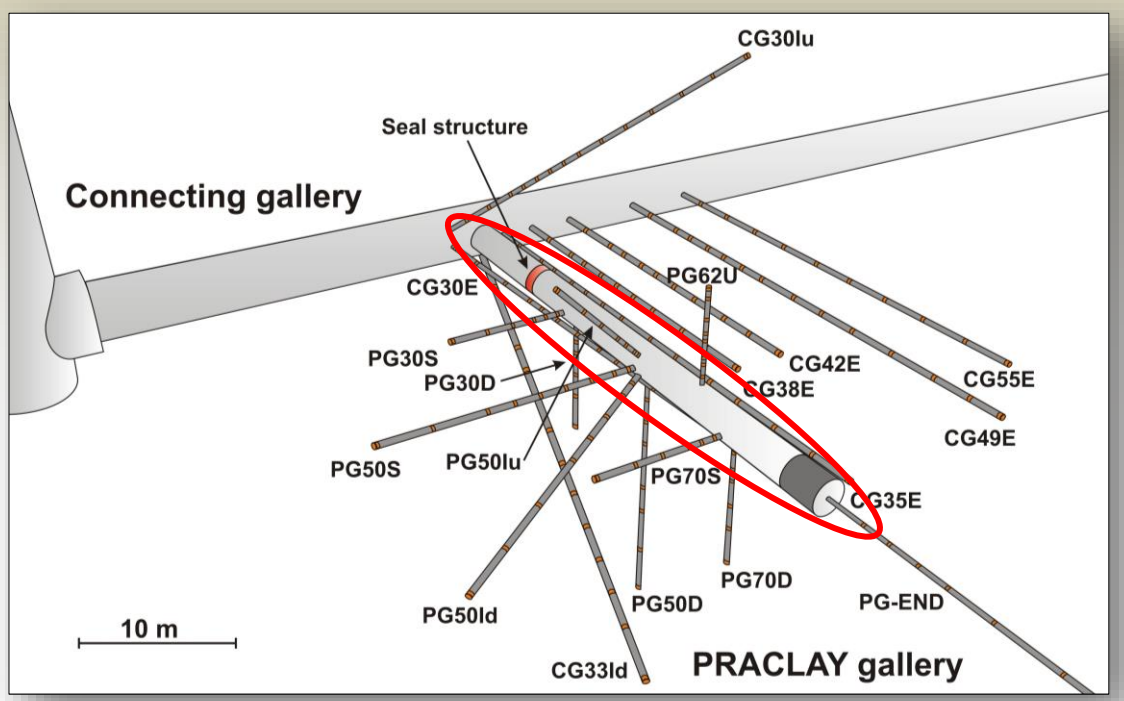
NIRAS ONDRAF EURIDICE sck cen Exploring a better tomorrow

PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

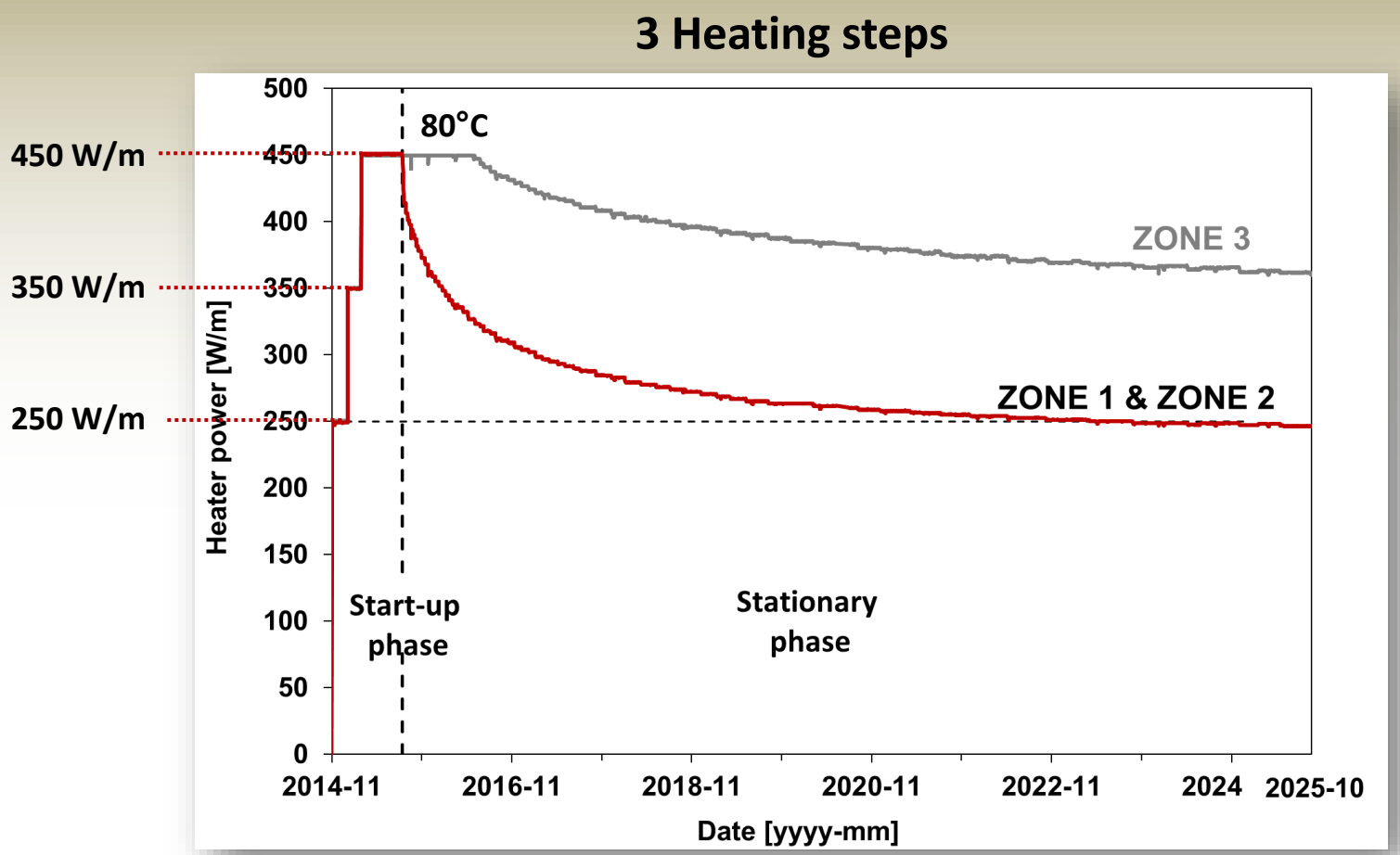
OUTLINE

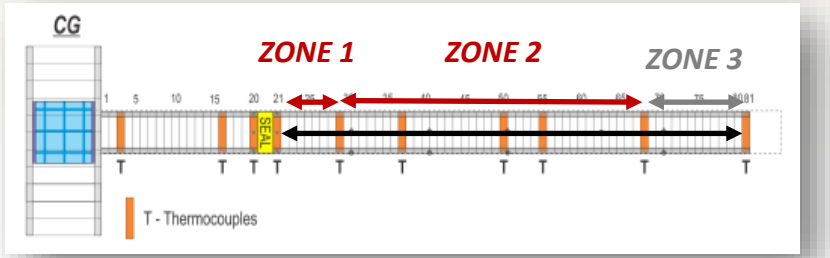
- Heater Test – Steering parameters
- Observations
  - Boom Clay
  - Test set-up (Seal/ Concrete lining)
- Conclusion

Monitoring set-up



Heating the clay to 80°C

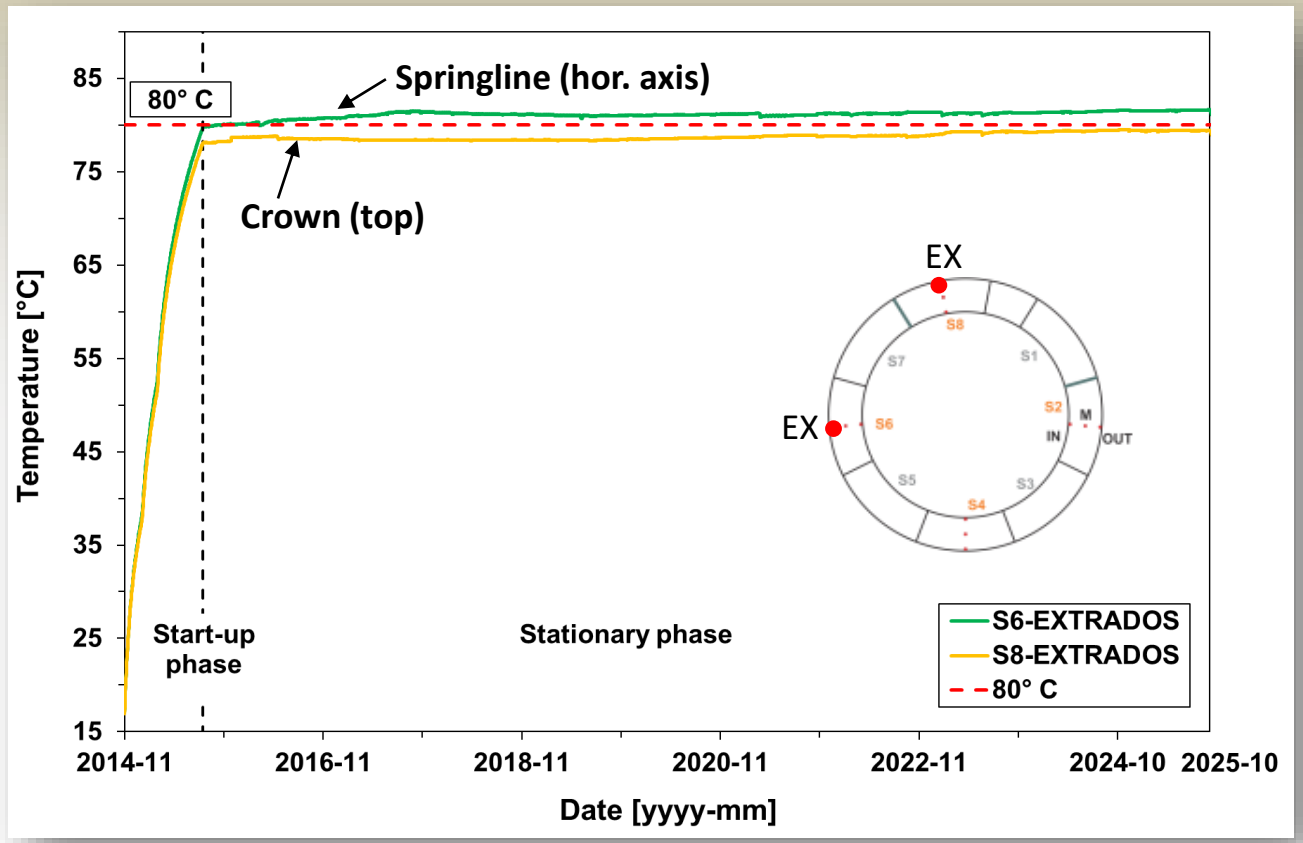




PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Stable heating at 80°C during 10 years

Temperature at the concrete/clay interface

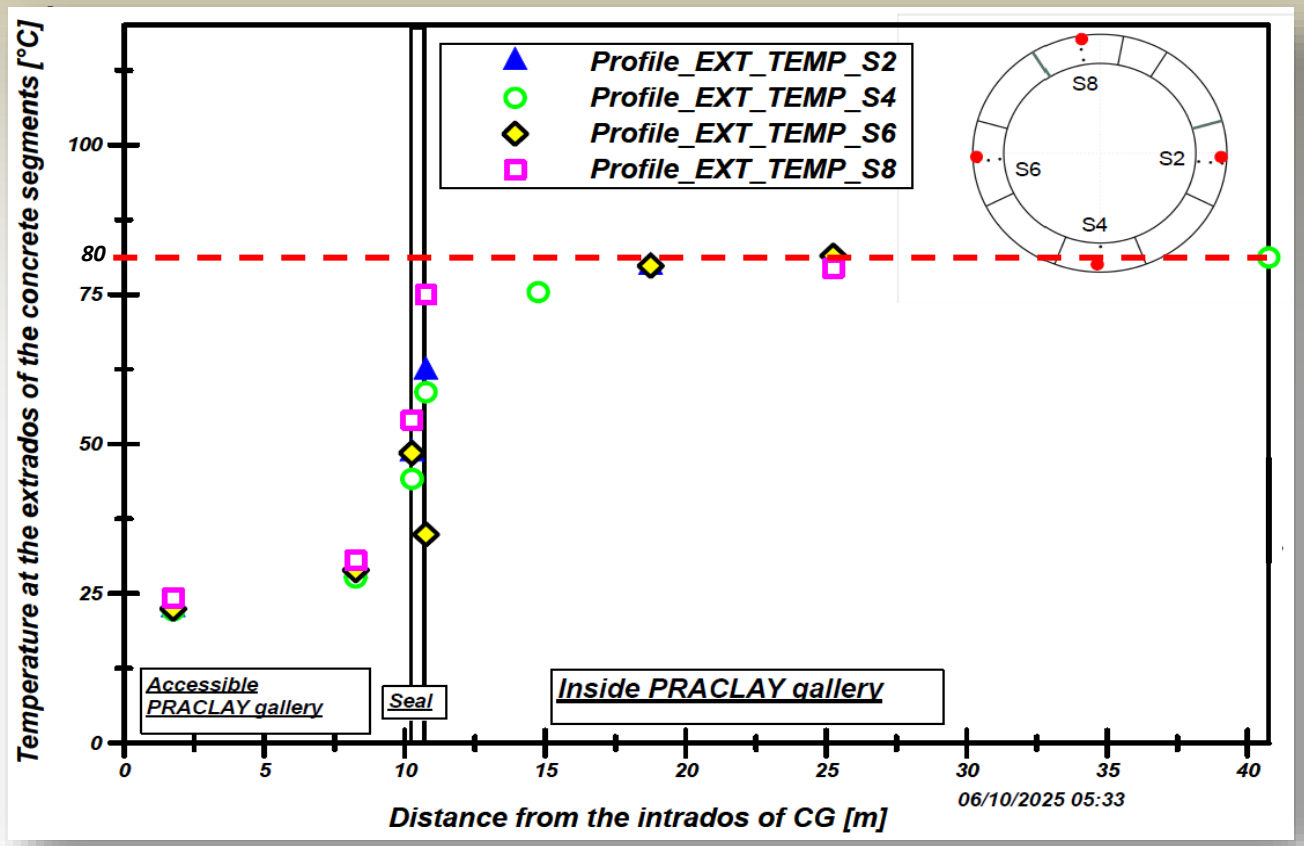


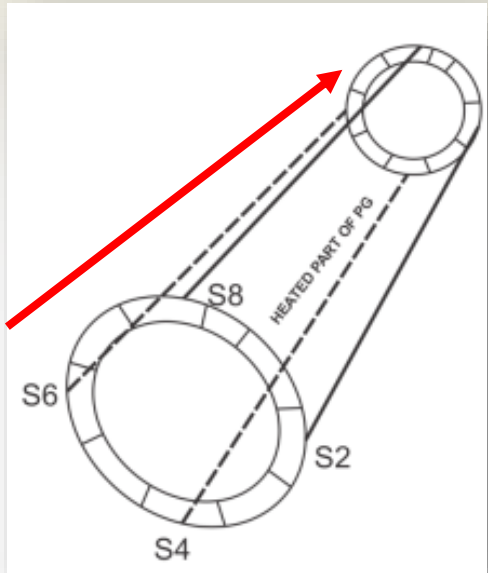
Ring 50

PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Temperature is uniform along the PG lining

Temperature profiles in concrete lining along the PG at the end of stationary heating

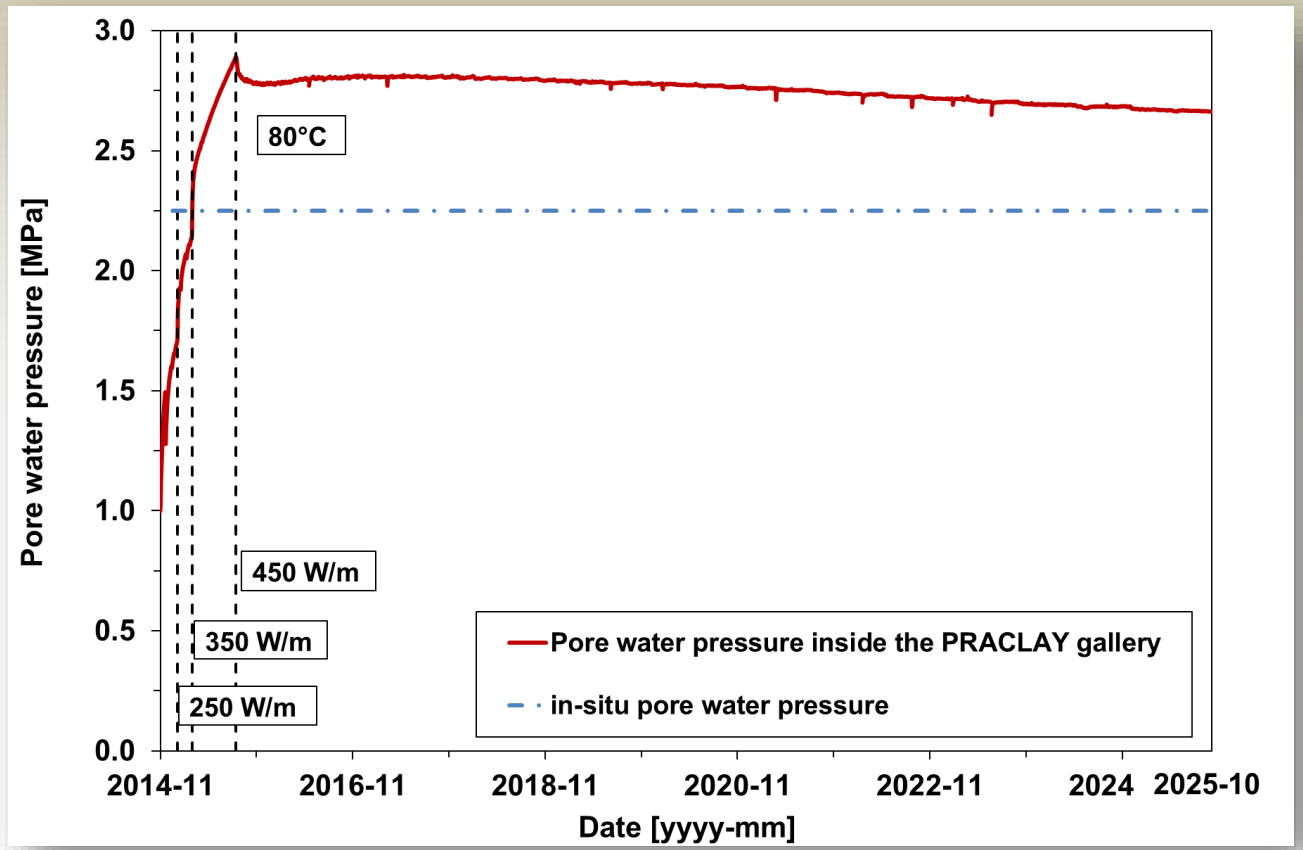


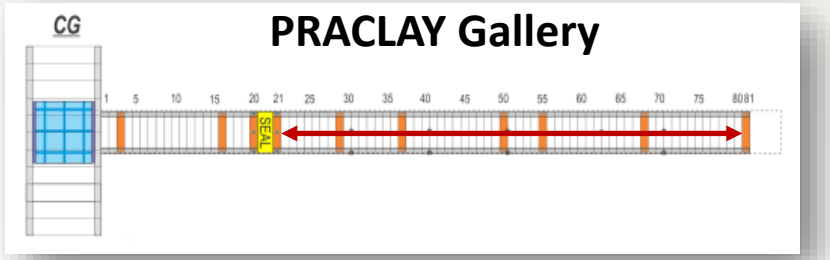


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Excess pwp induced by the thermal loading

Pore water pressure (pwp) inside the PG

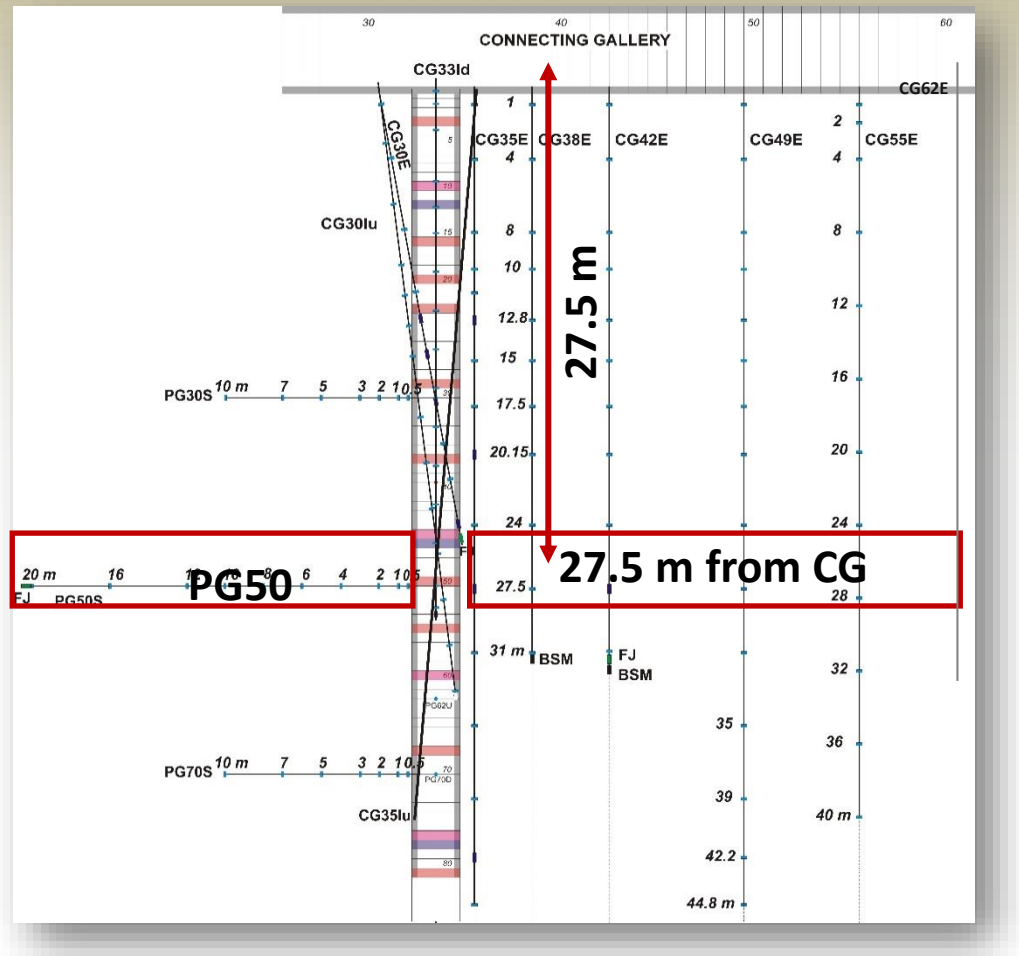




OUTLINE

- Heater Test – Steering parameters
- Observations
  - Boom Clay
  - Test set-up (Seal/ Concrete lining)
- Conclusion

What do we observe in the clay?

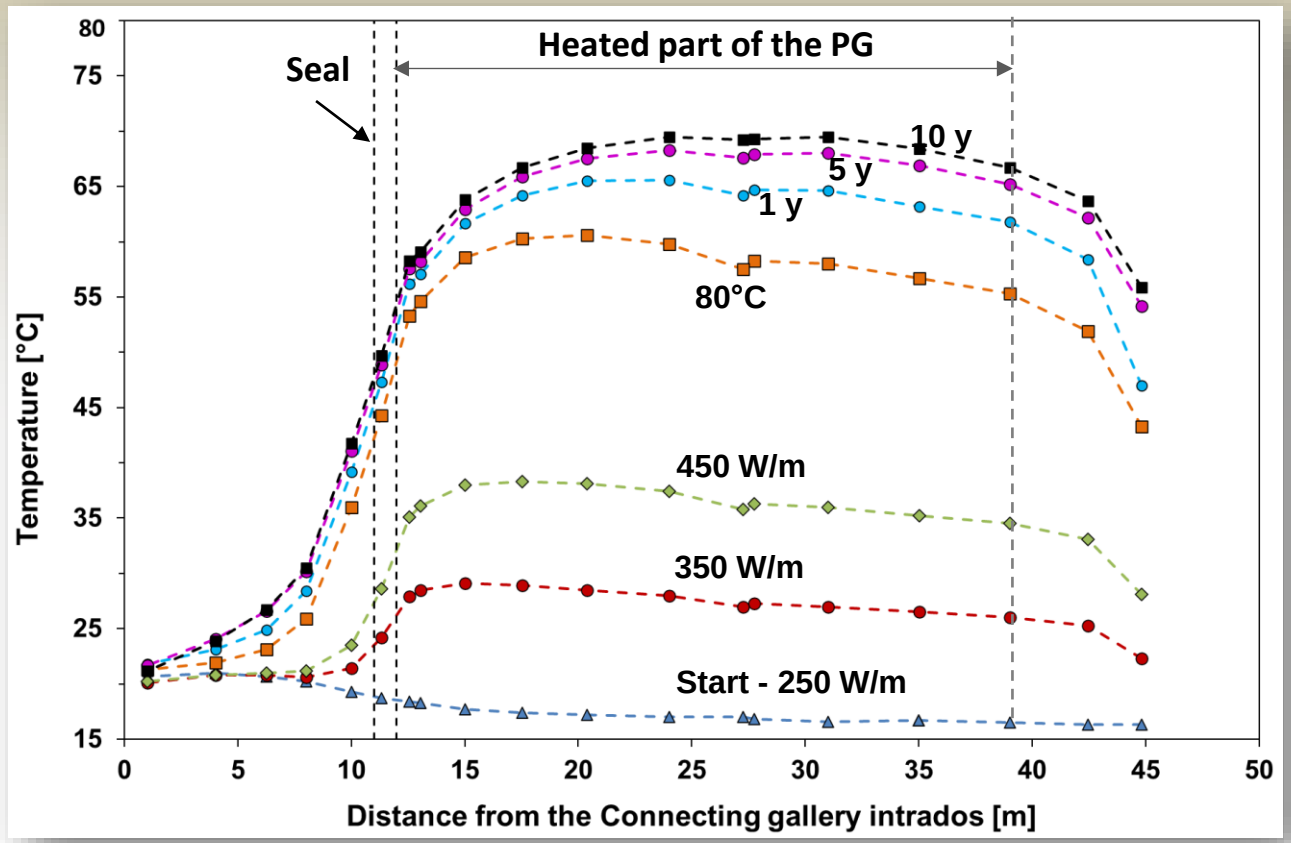


NIRAS ONDRAF EURIDICE sck cen Exploring a better tomorrow

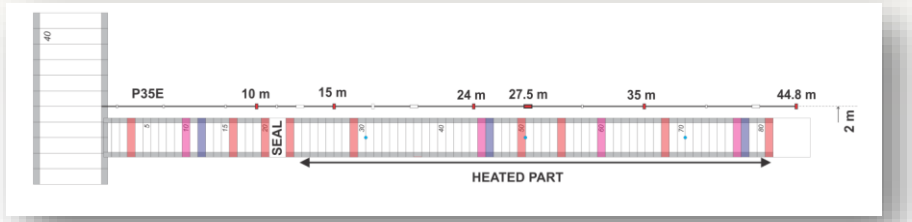
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Temperature in the Boom Clay along the PG

Temperature profiles in borehole CG35E at various times



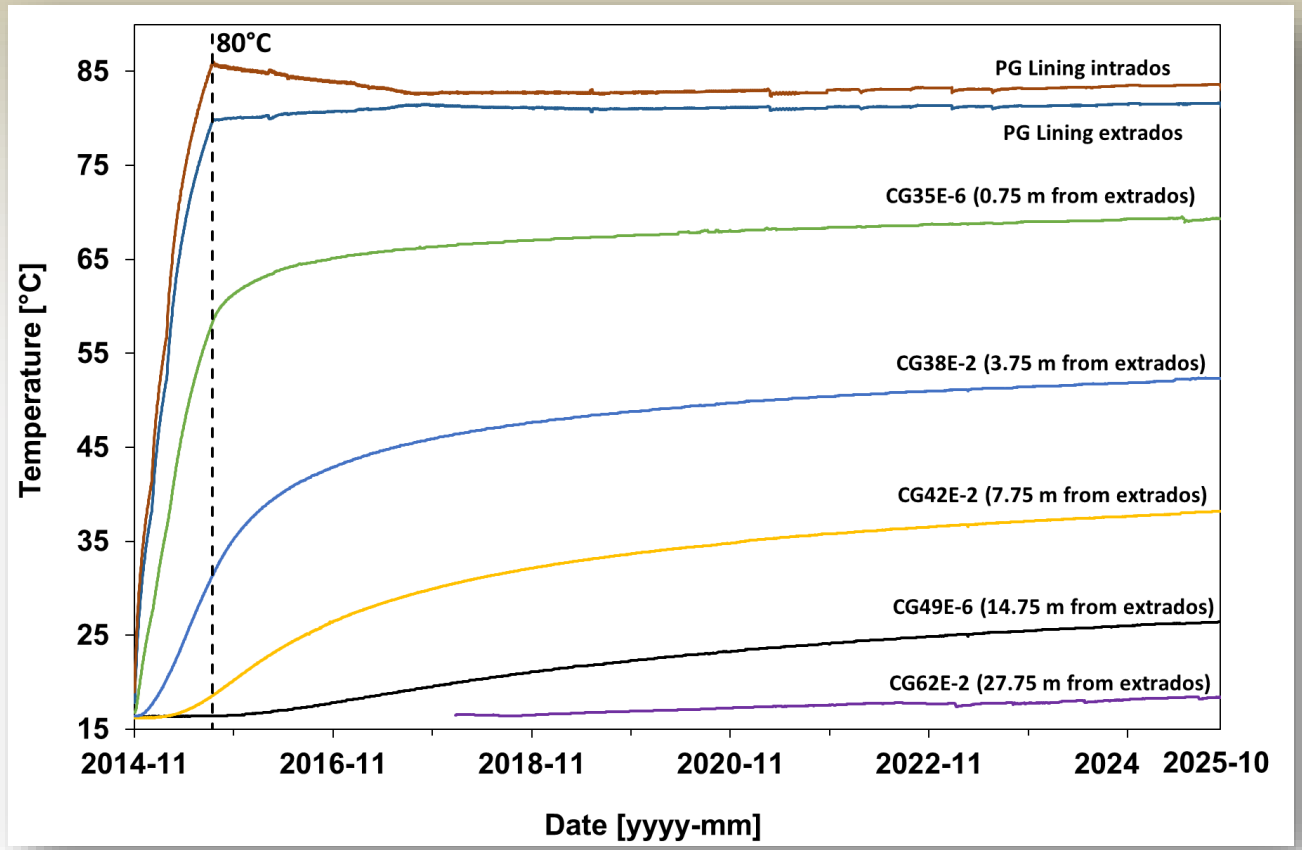
CG35E: ~2 m from PG → perturbed zone

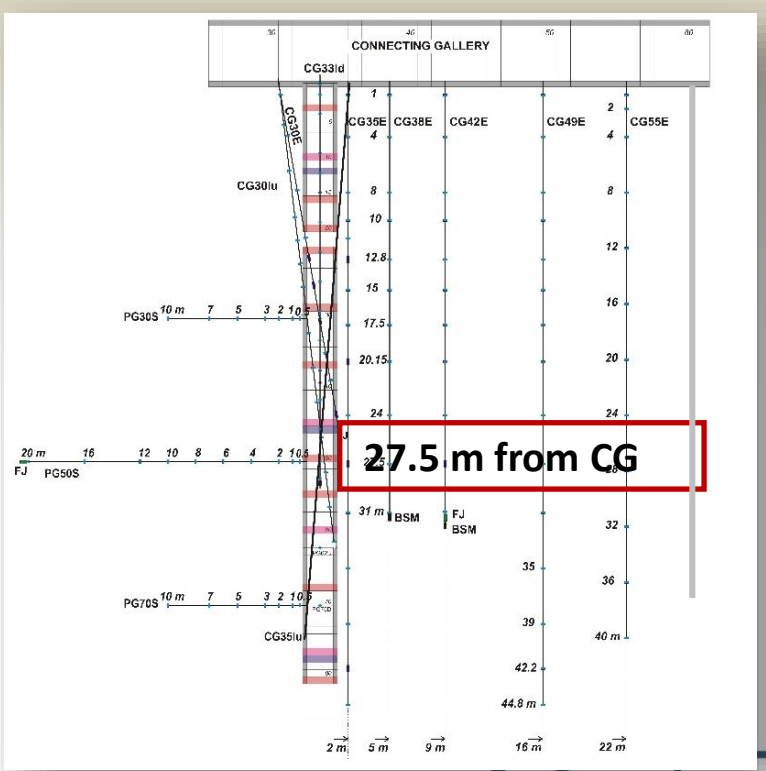


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Temperature evolution in time

Various horizontal distances from the PG

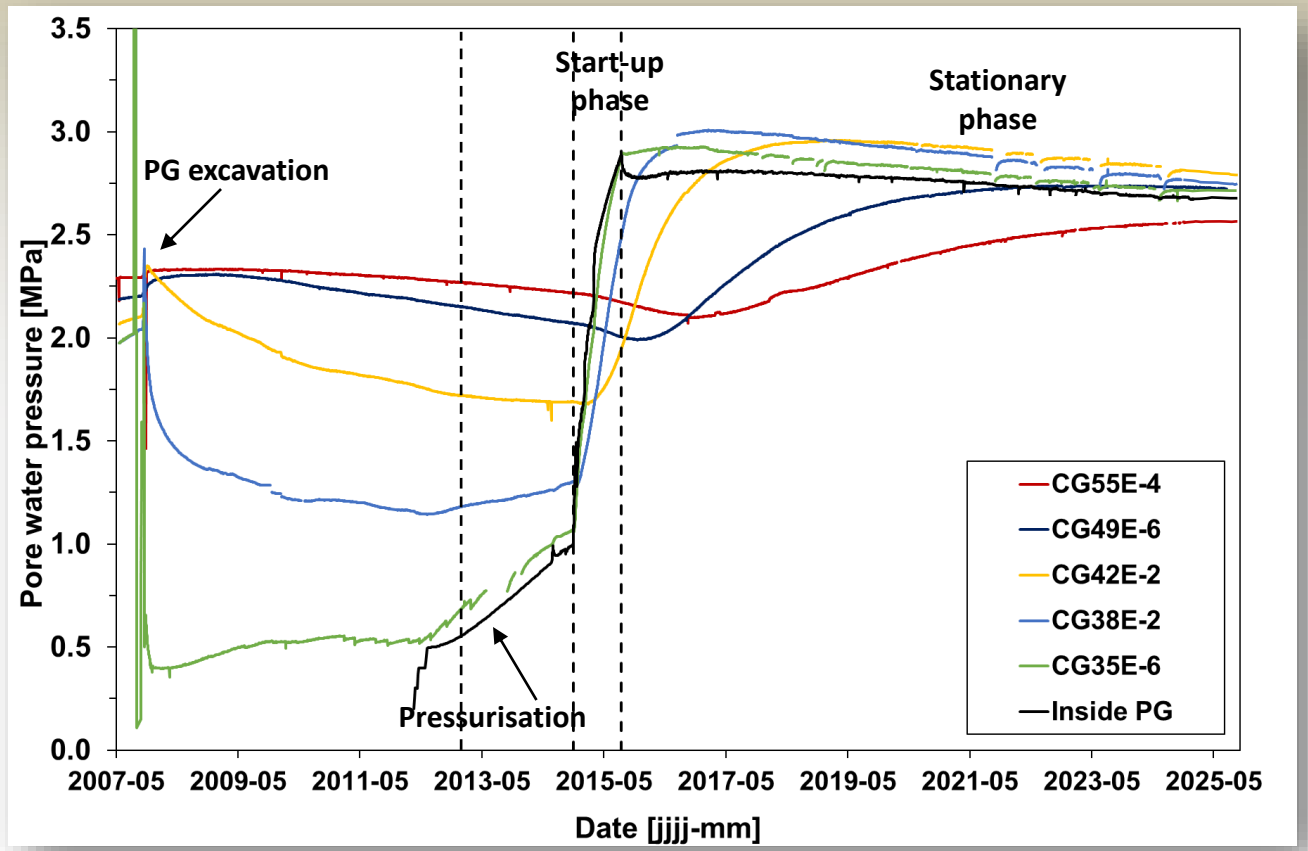


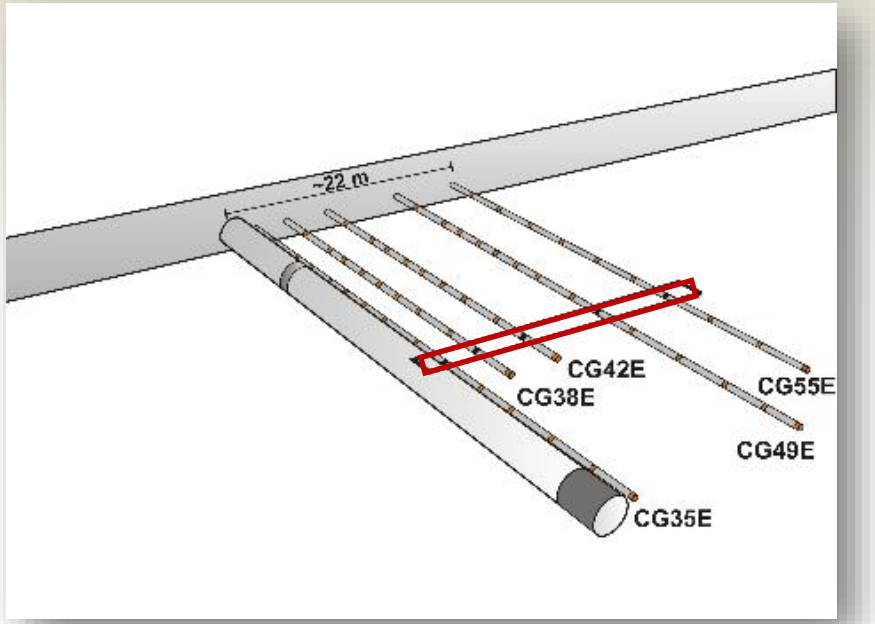


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Pore water pressure evolution

Pore water pressure in function of time

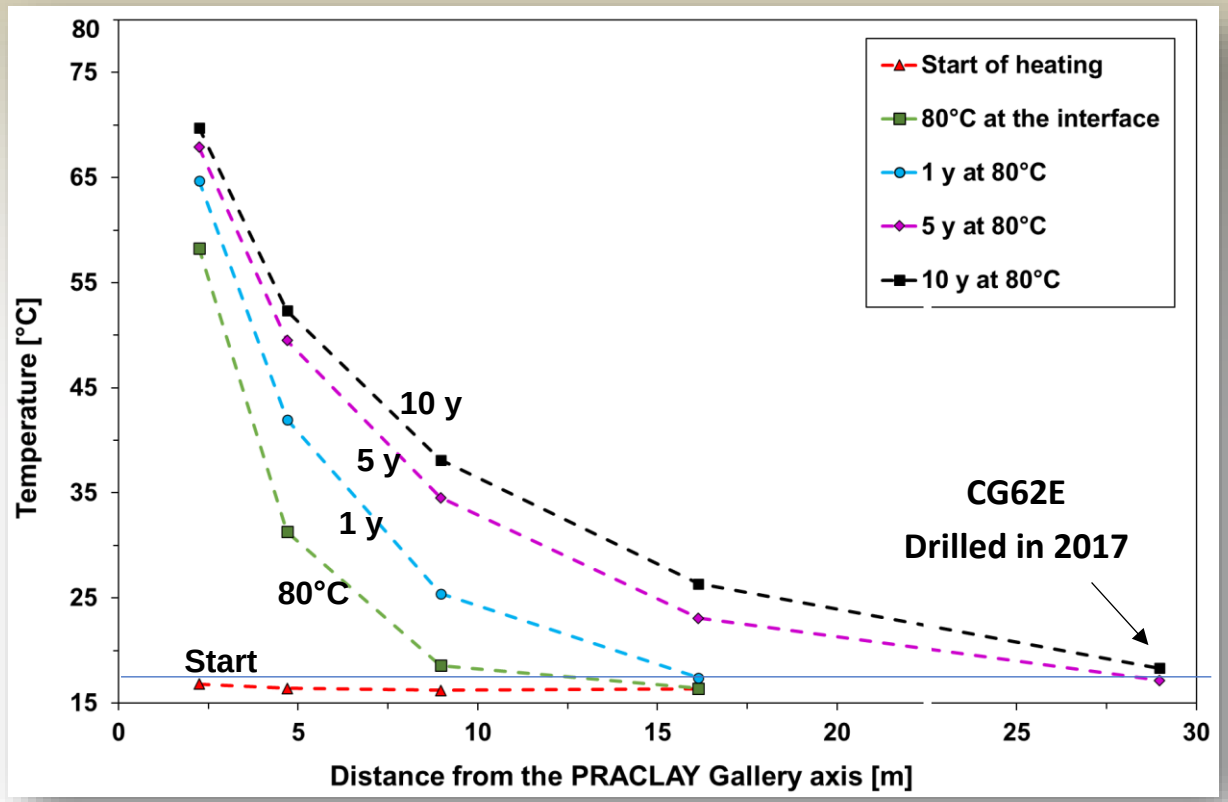




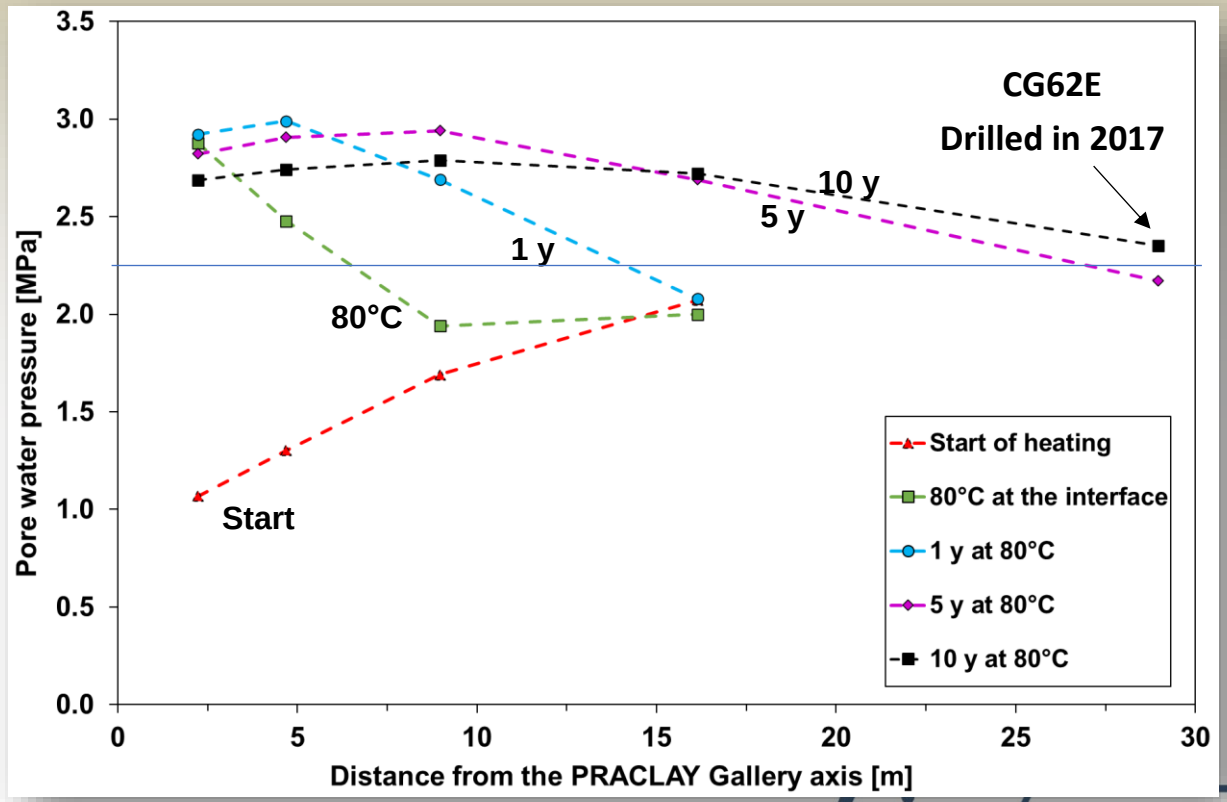
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Effects in function of horizontal distance to PG

Temperature profiles



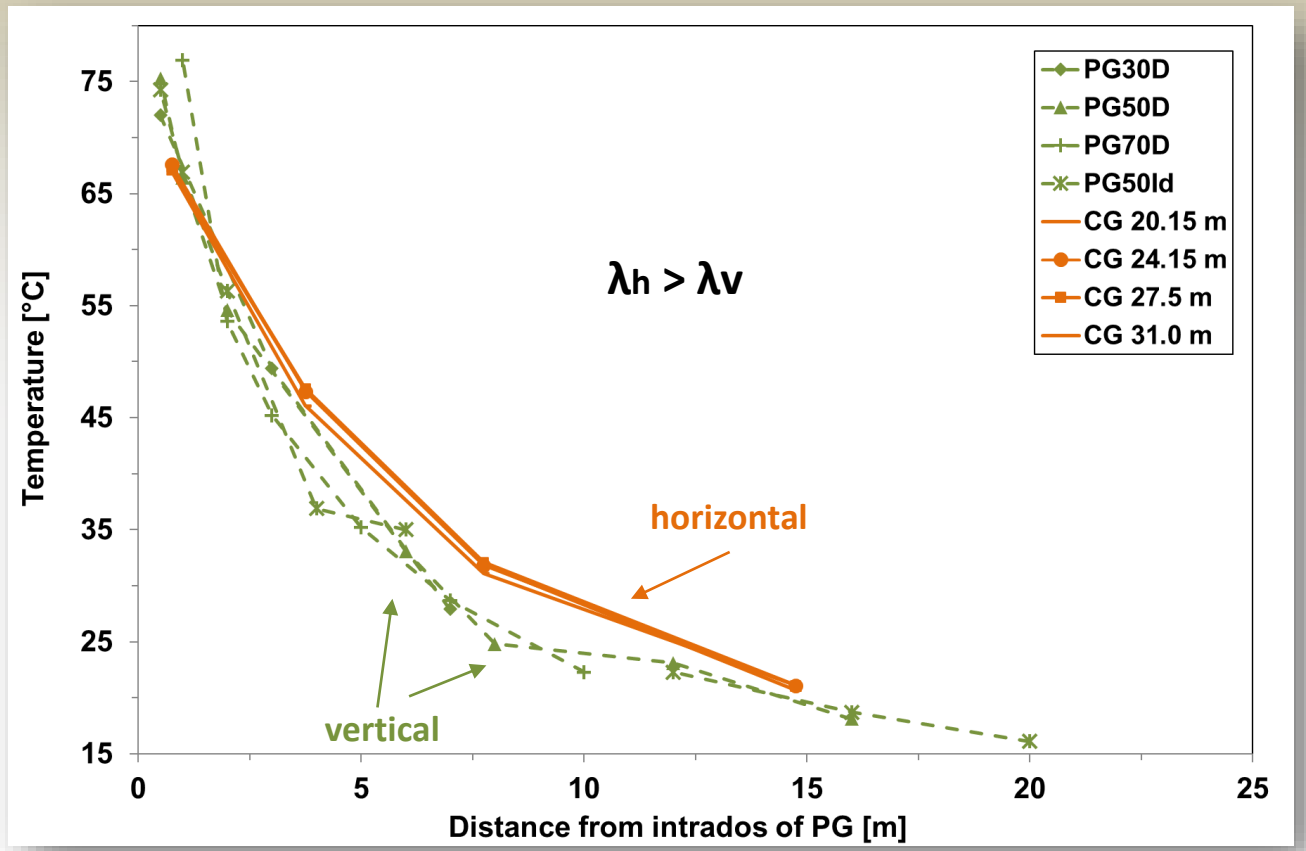
Pore water pressure profiles

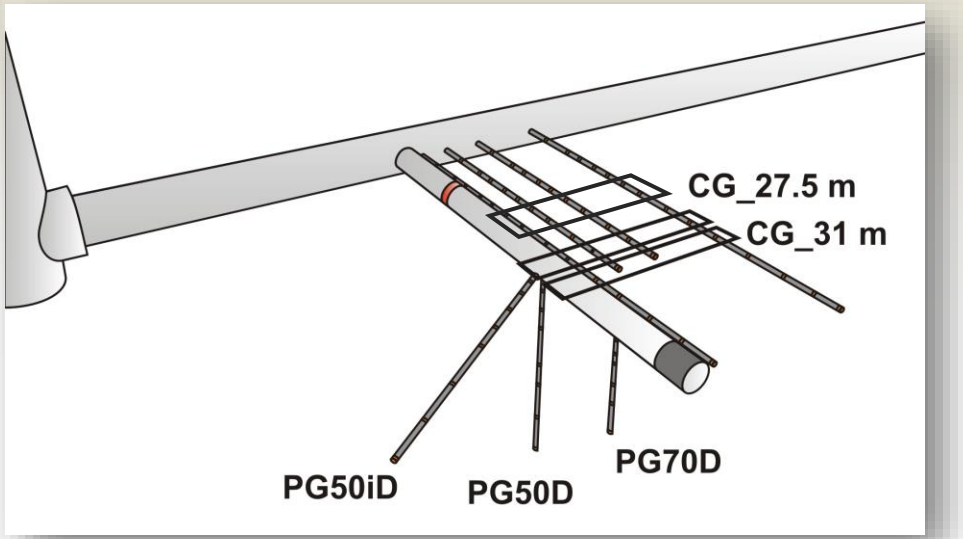


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Temperature profiles during steady state

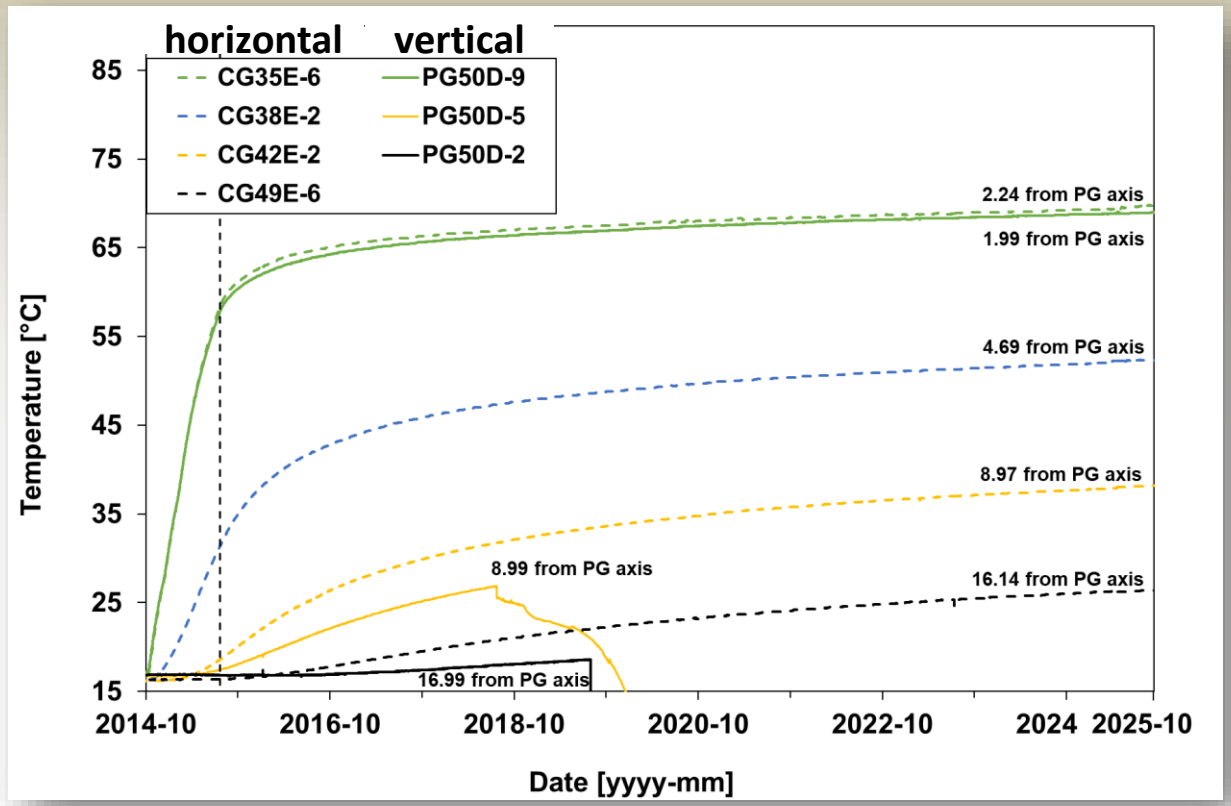
Horizontal versus vertical

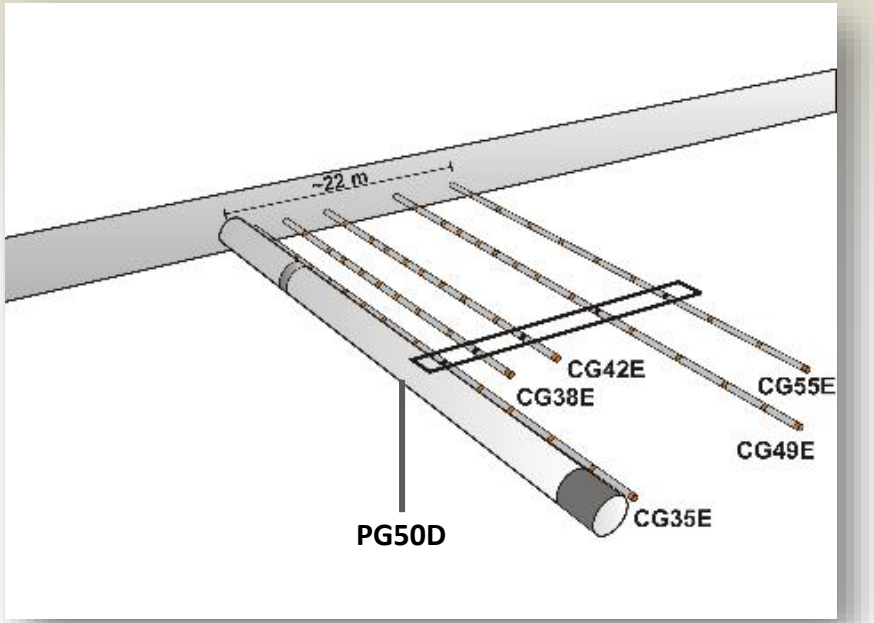




Vertical vs horizontal boreholes

Temperature evolution

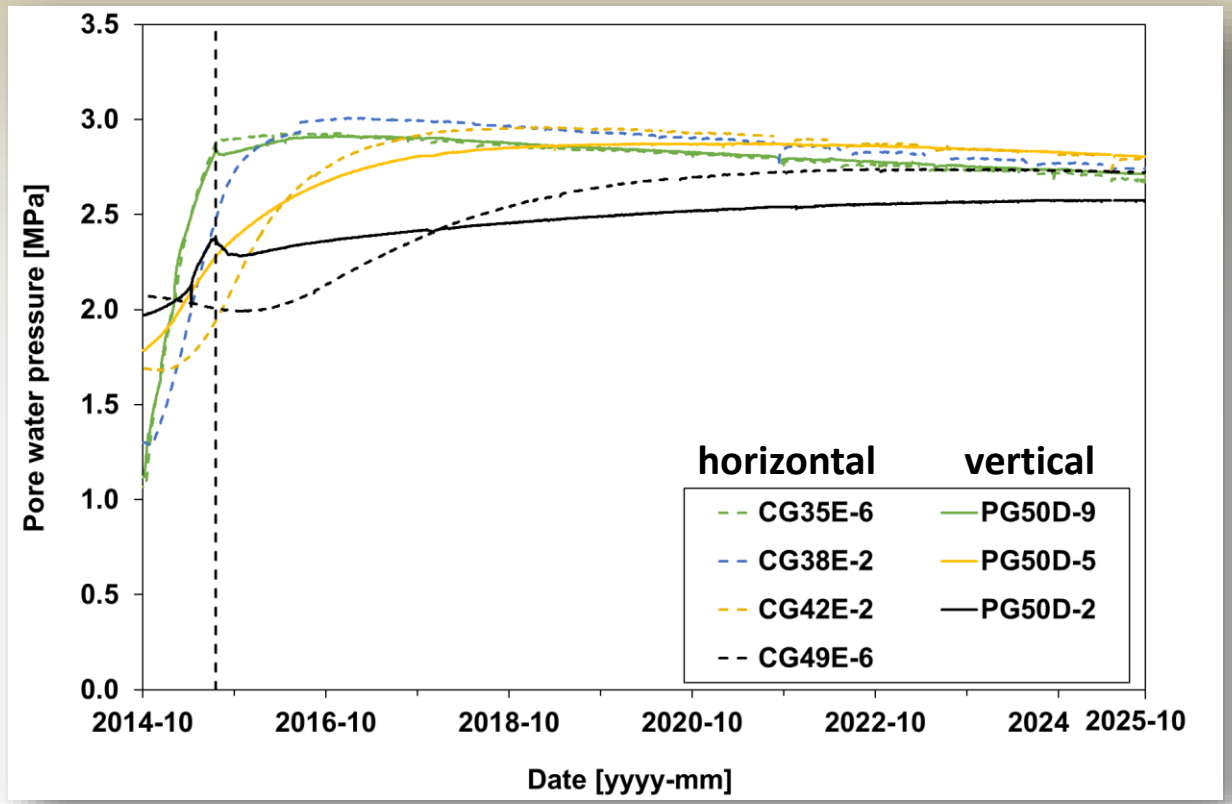


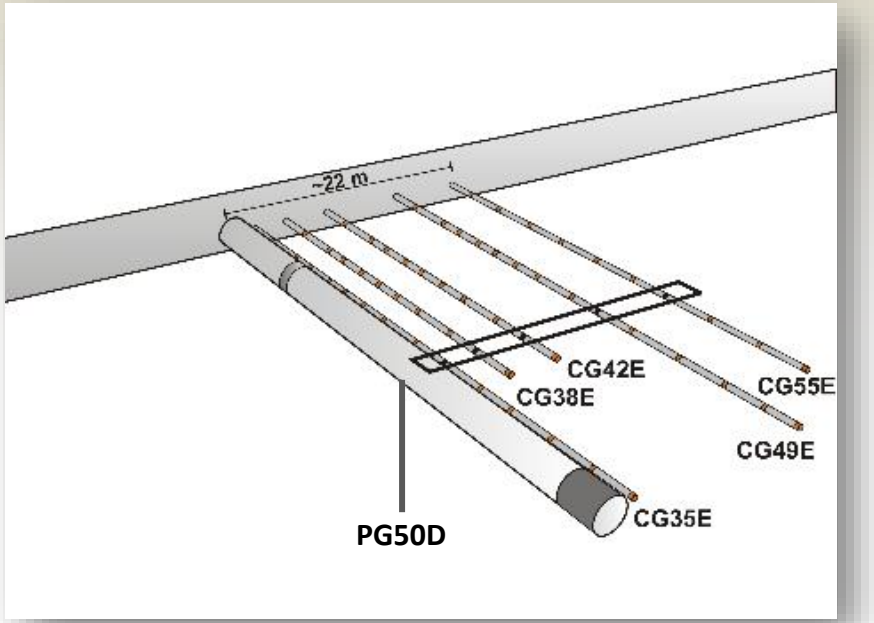


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Vertical vs horizontal boreholes

Pore water pressure evolution

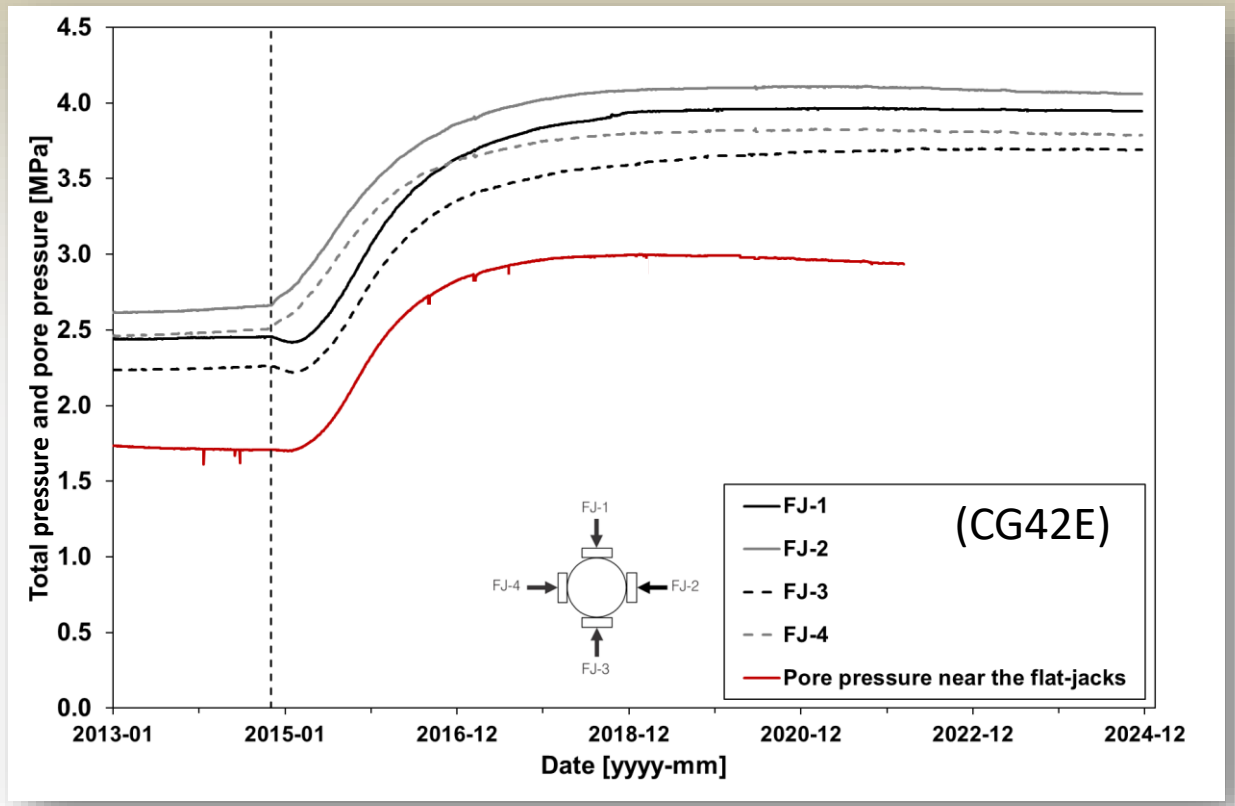




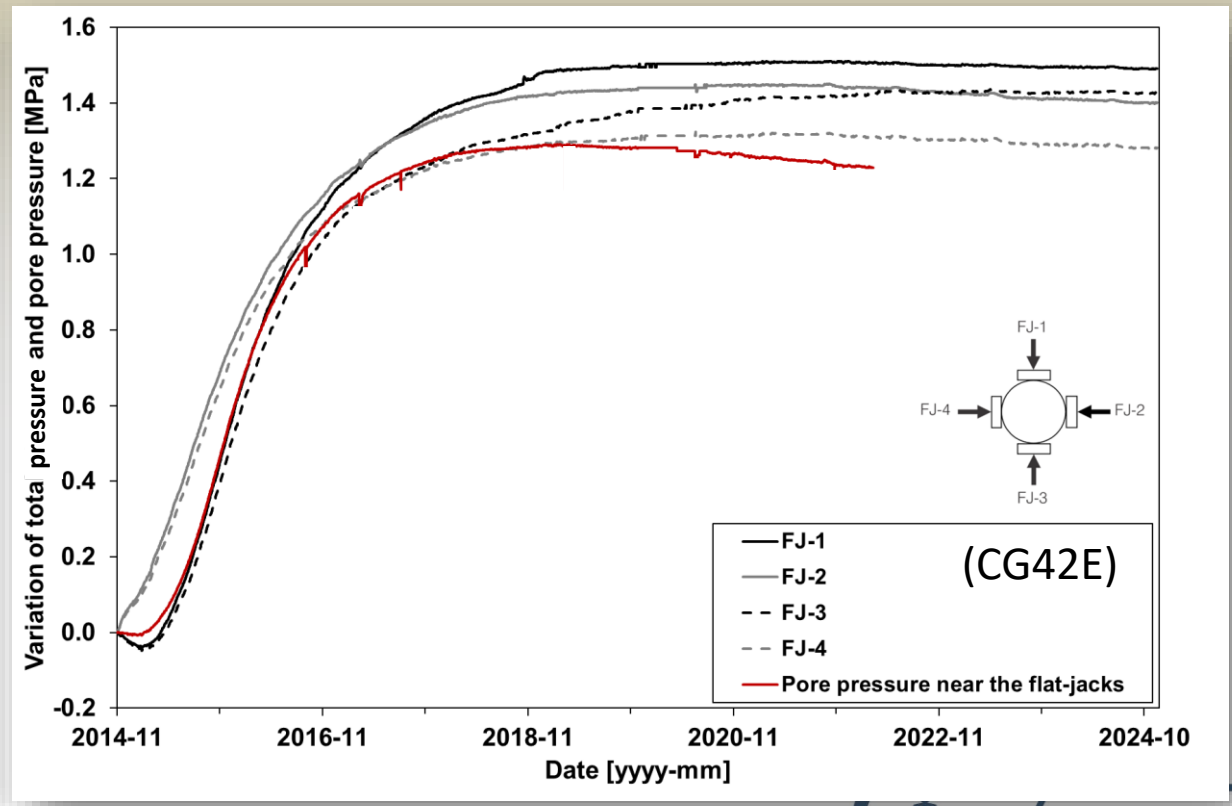
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Total pressure in the clay: 9 m from the PG

Total pressure



Variation of total pressure

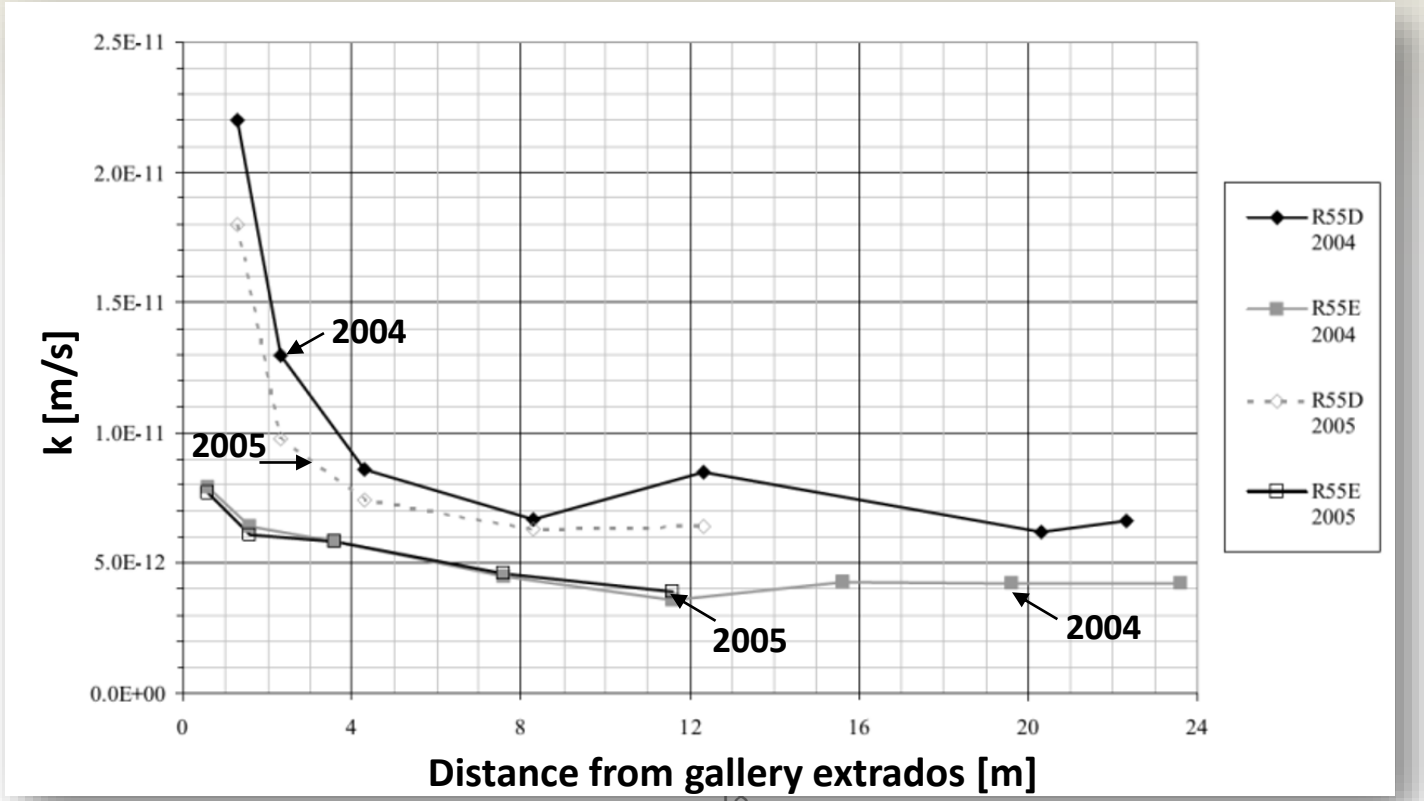


PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Does the clay withstand the thermal load?

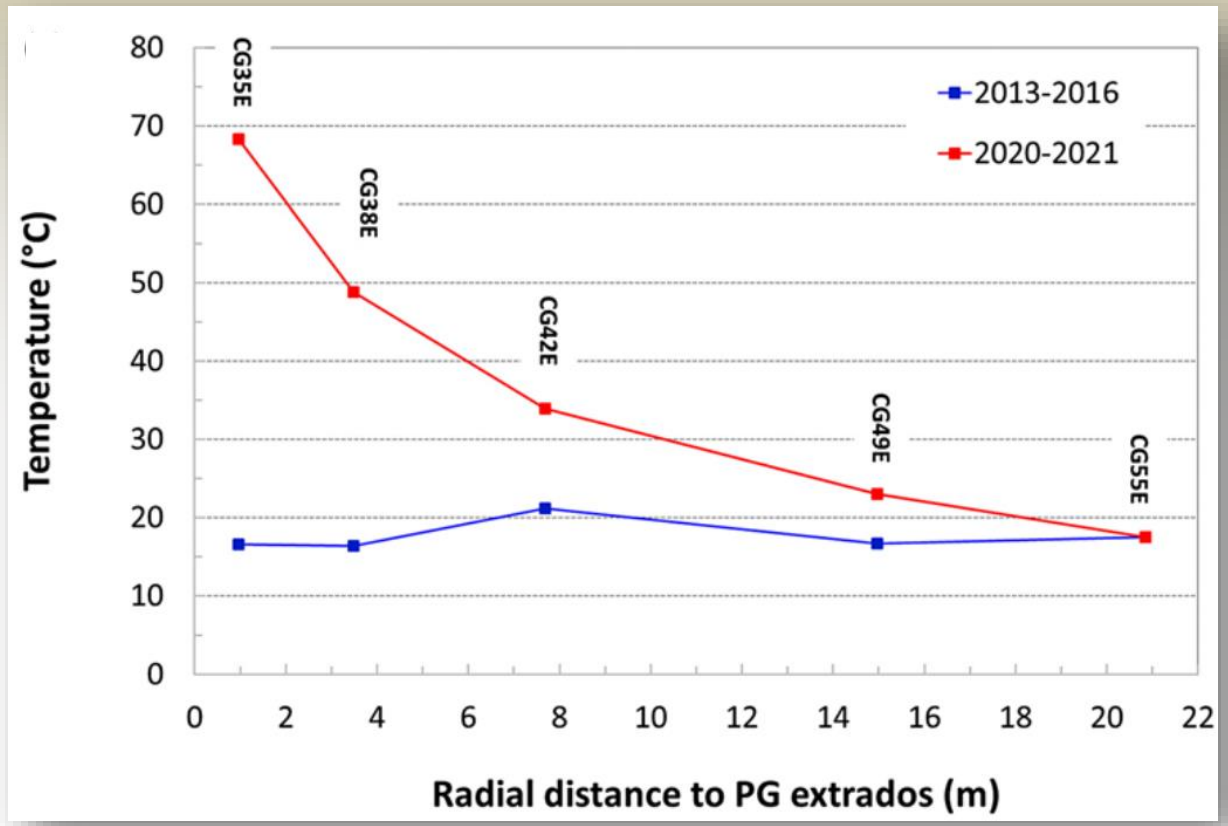
- Pore water pressure observation → no sudden changes
- Damages → modification of permeability

Permeability tests shortly after the excavation of the Connecting Gallery

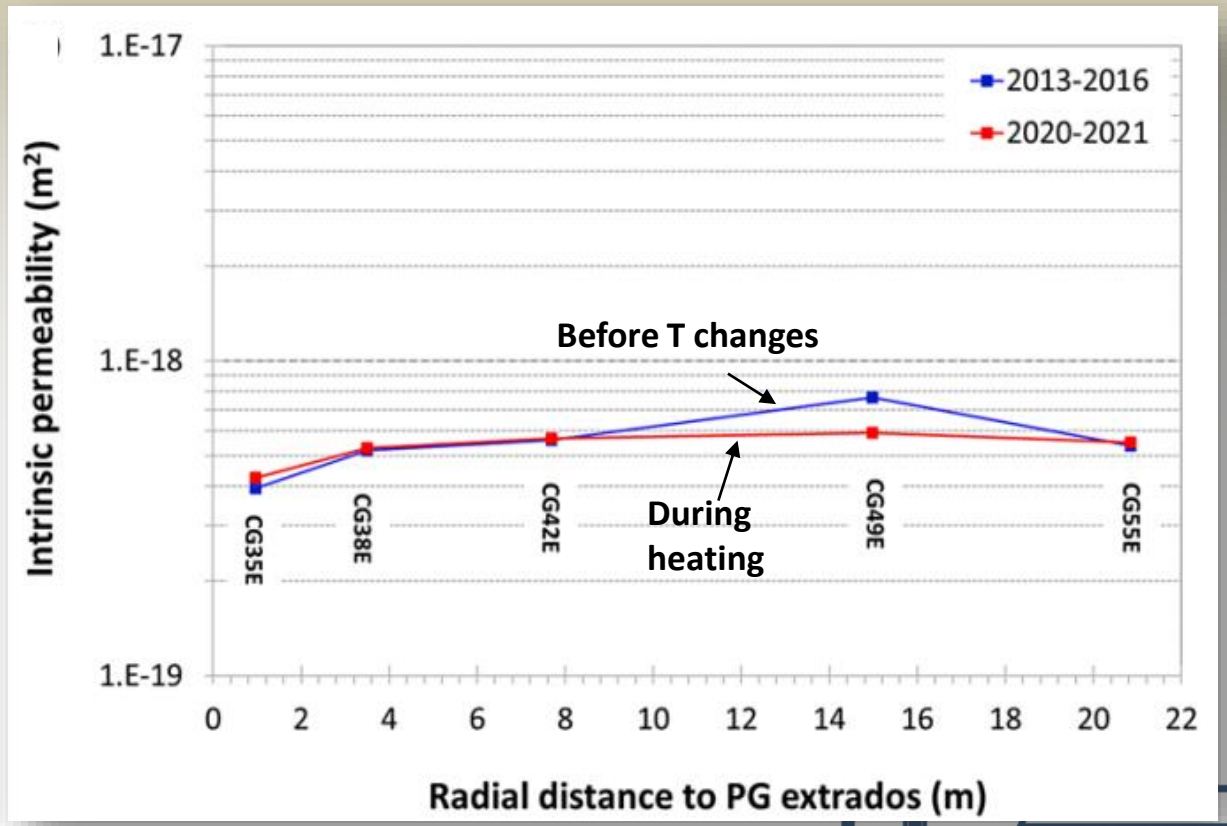


Does the clay withstand the thermal load?

Temperature profiles



Intrinsic permeability profiles



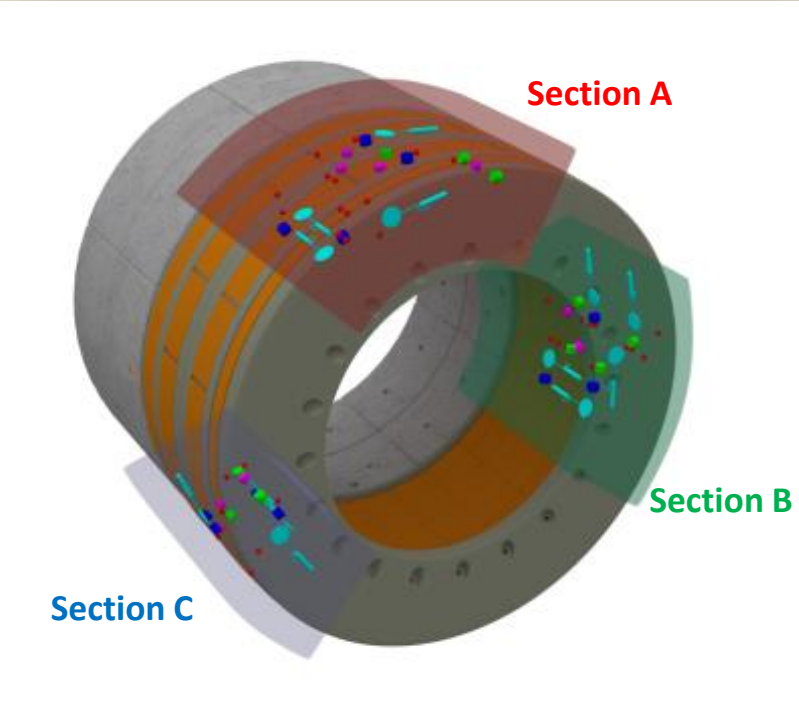
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

OUTLINE

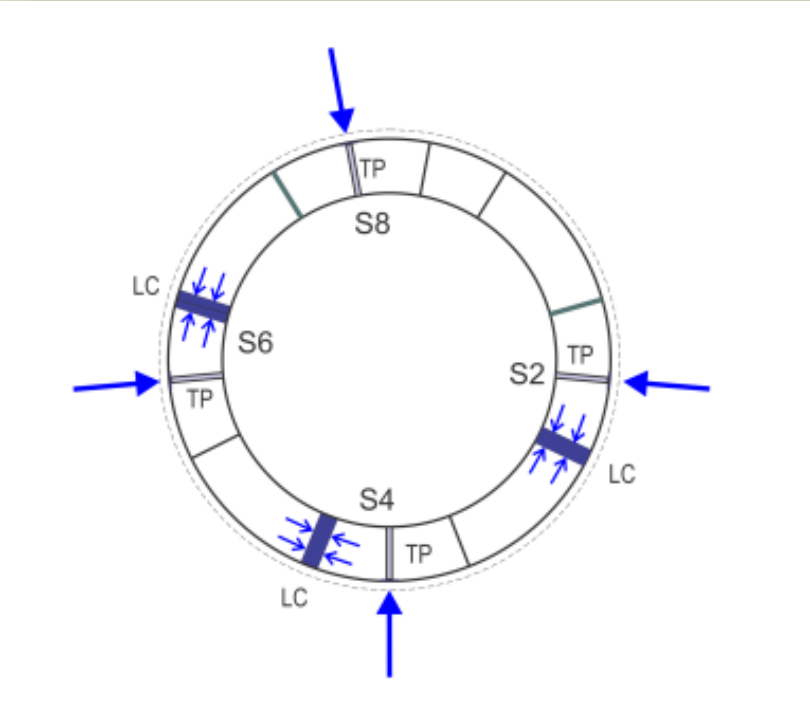
- Heater Test – Steering parameters
- Observations
  - ➢ Boom Clay
  - ➢ Test set-up (Seal/ Concrete lining)
- Conclusion

What do we observe in the seal and the concrete lining?

Seal

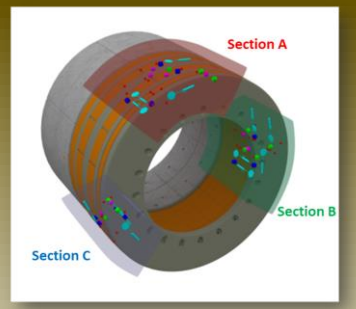


Concrete lining

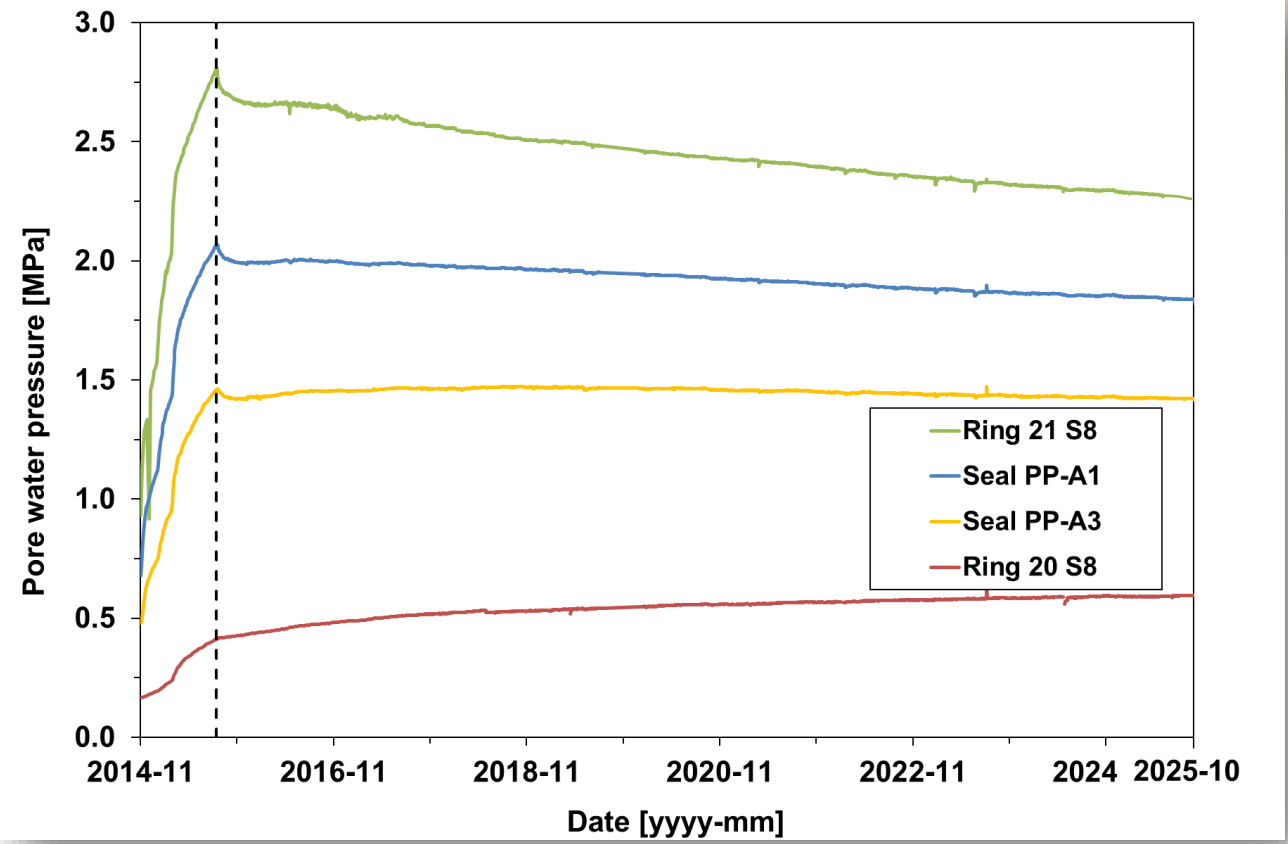


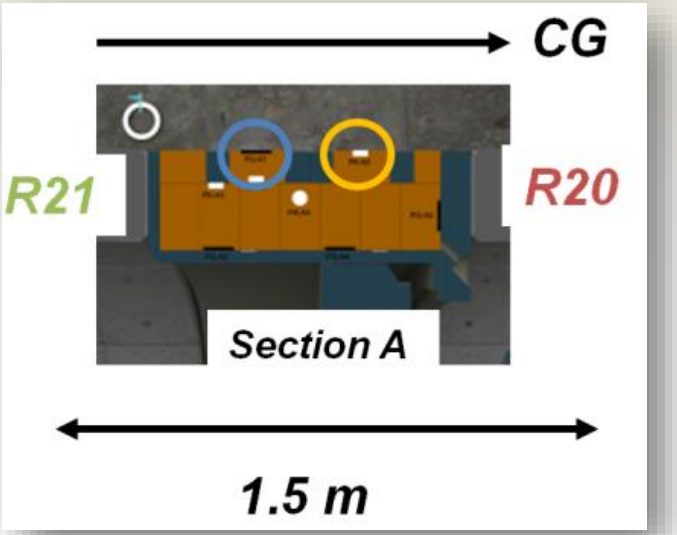
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Pore water pressure evolution in the seal



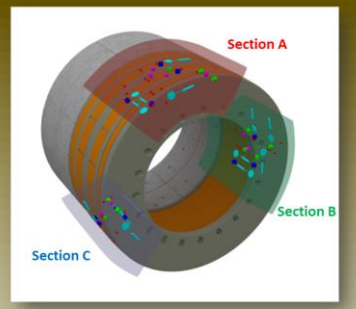
At Boom Clay/ bentonite interface



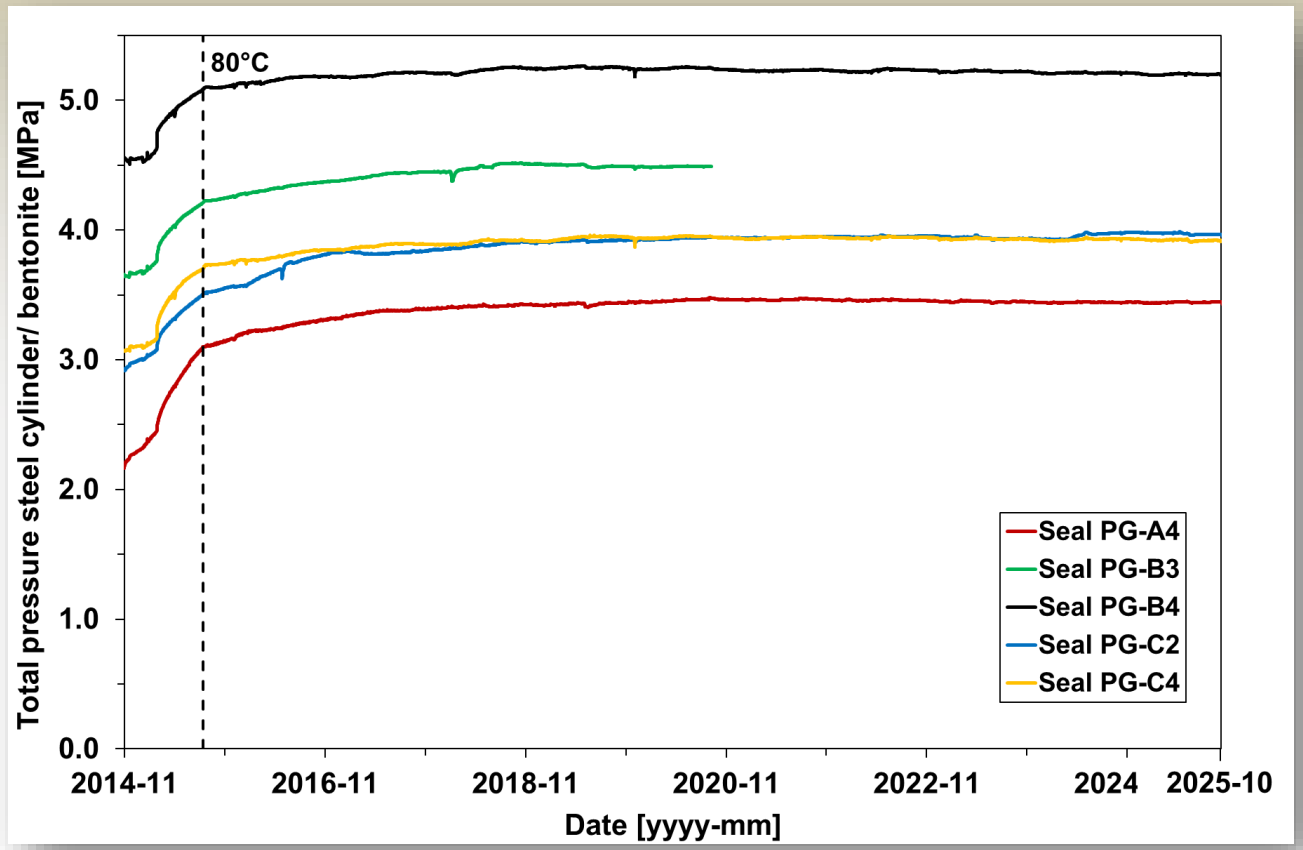


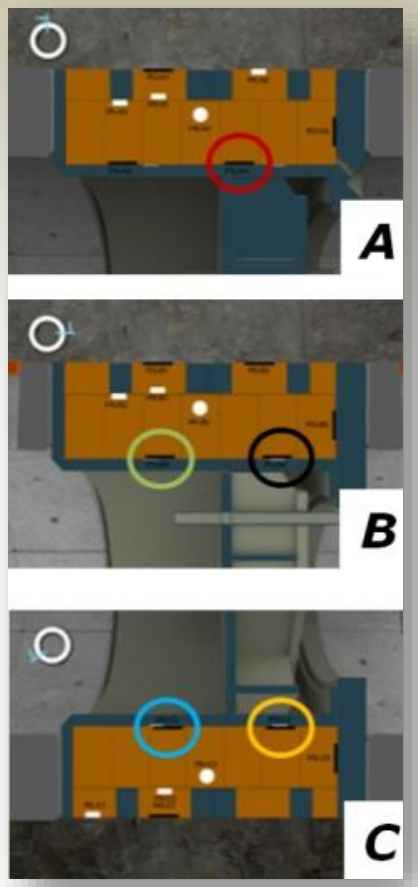
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Total pressure evolution at in the seal



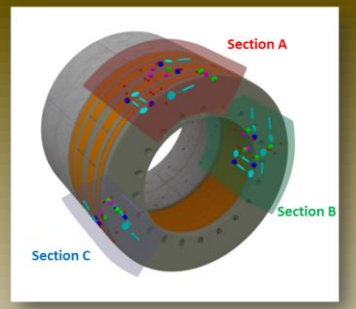
At Boom Clay/ bentonite interface



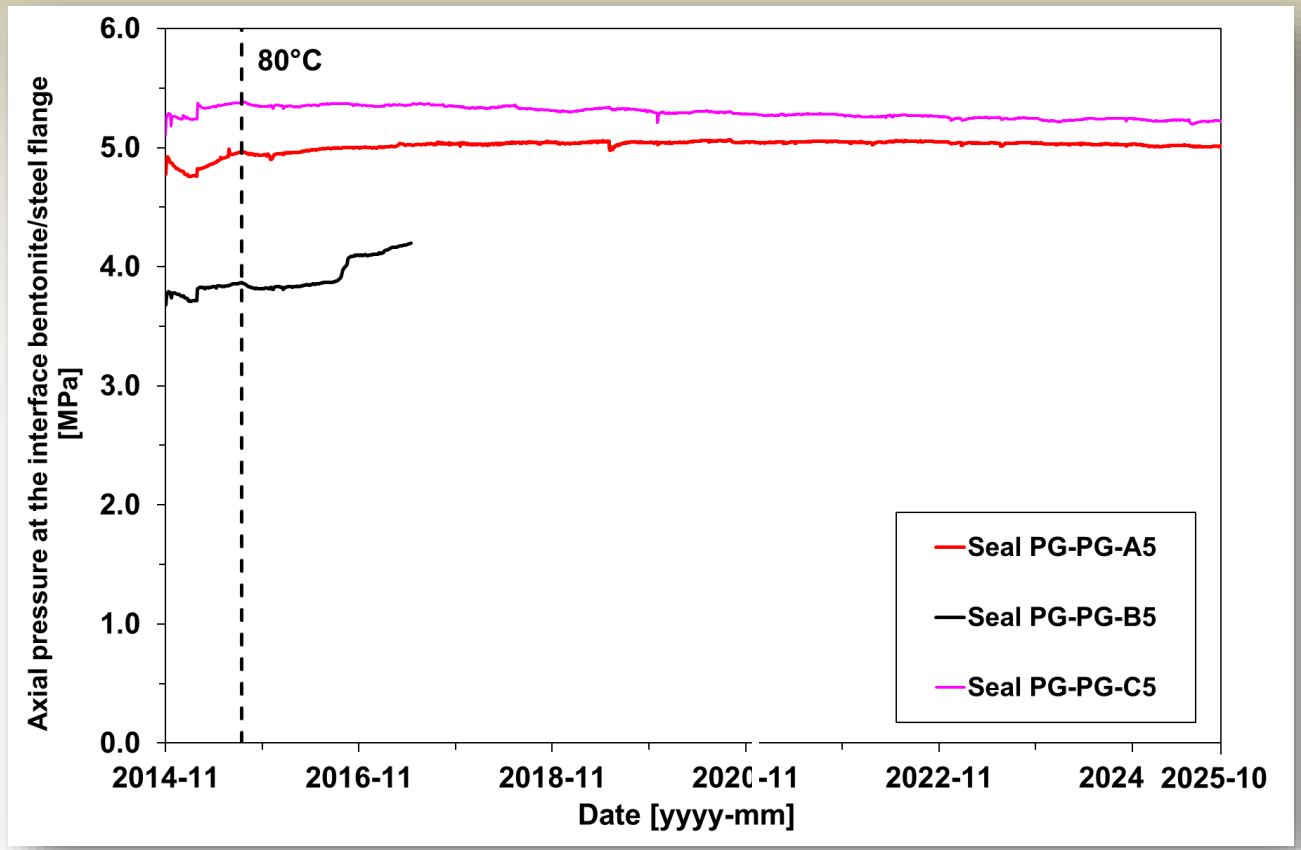


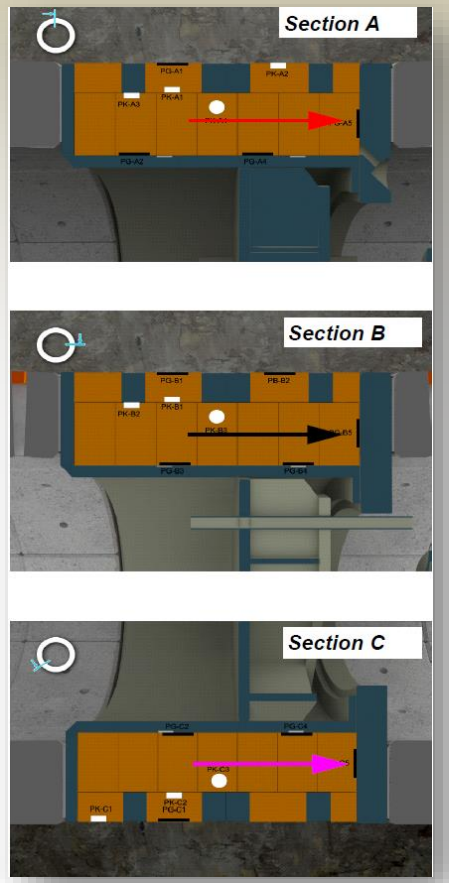
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Axial pressure evolution in the seal



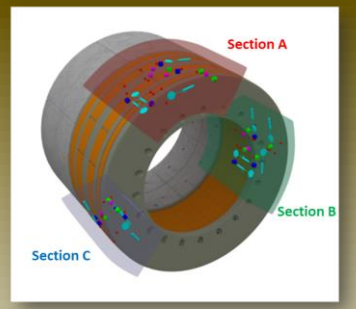
At bentonite/steel cylinder interface



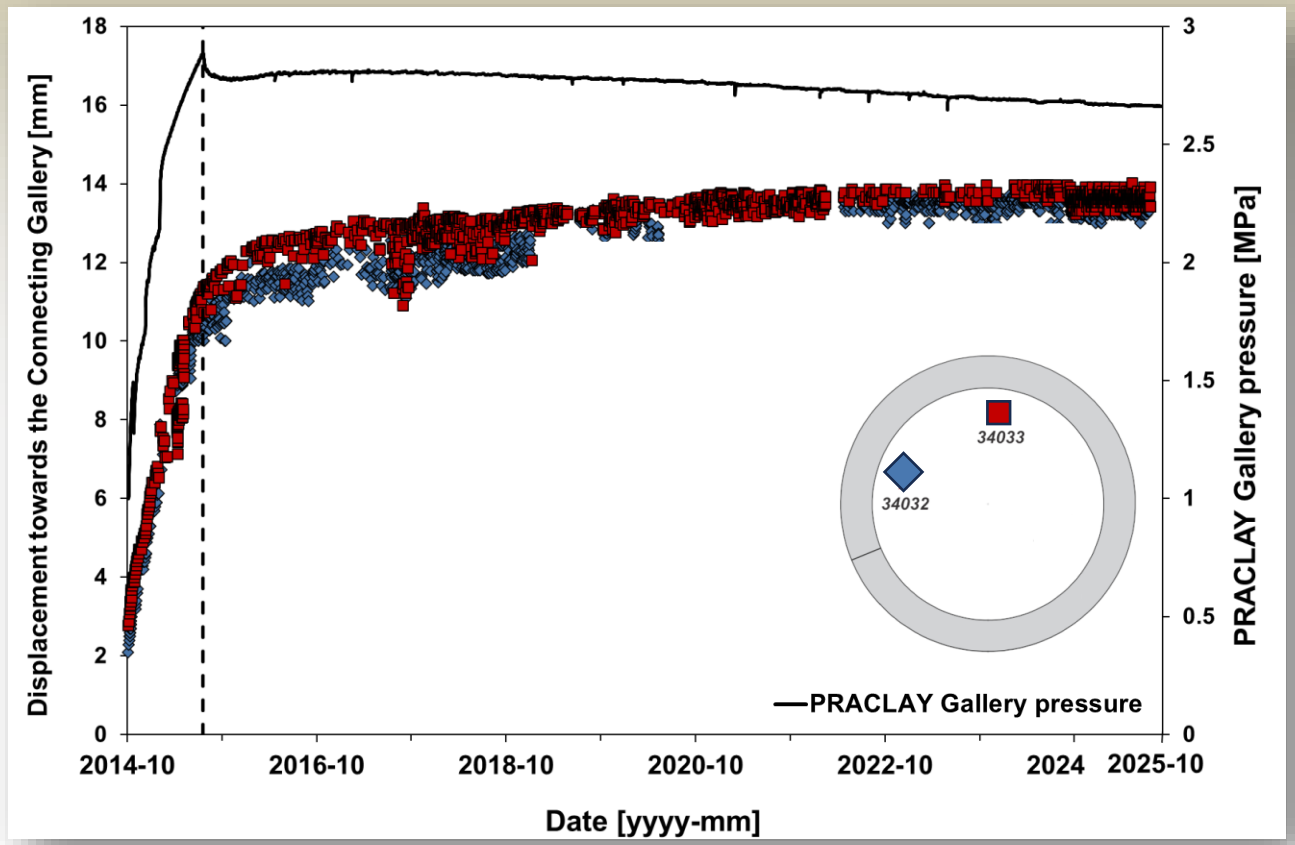


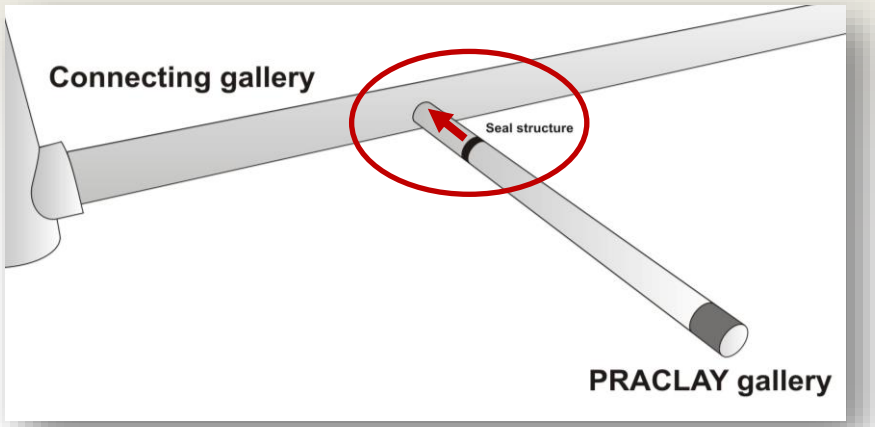
PRACLAY 2025
CLOSING THE HEATING CHAPTER, OPENING THE COOLING PHASE

Displacement of the seal

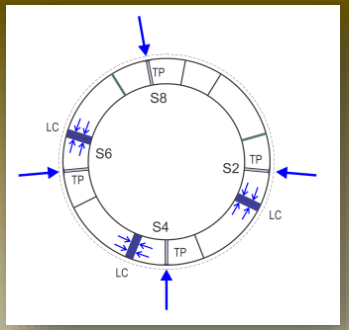


Towards the Connecting Gallery

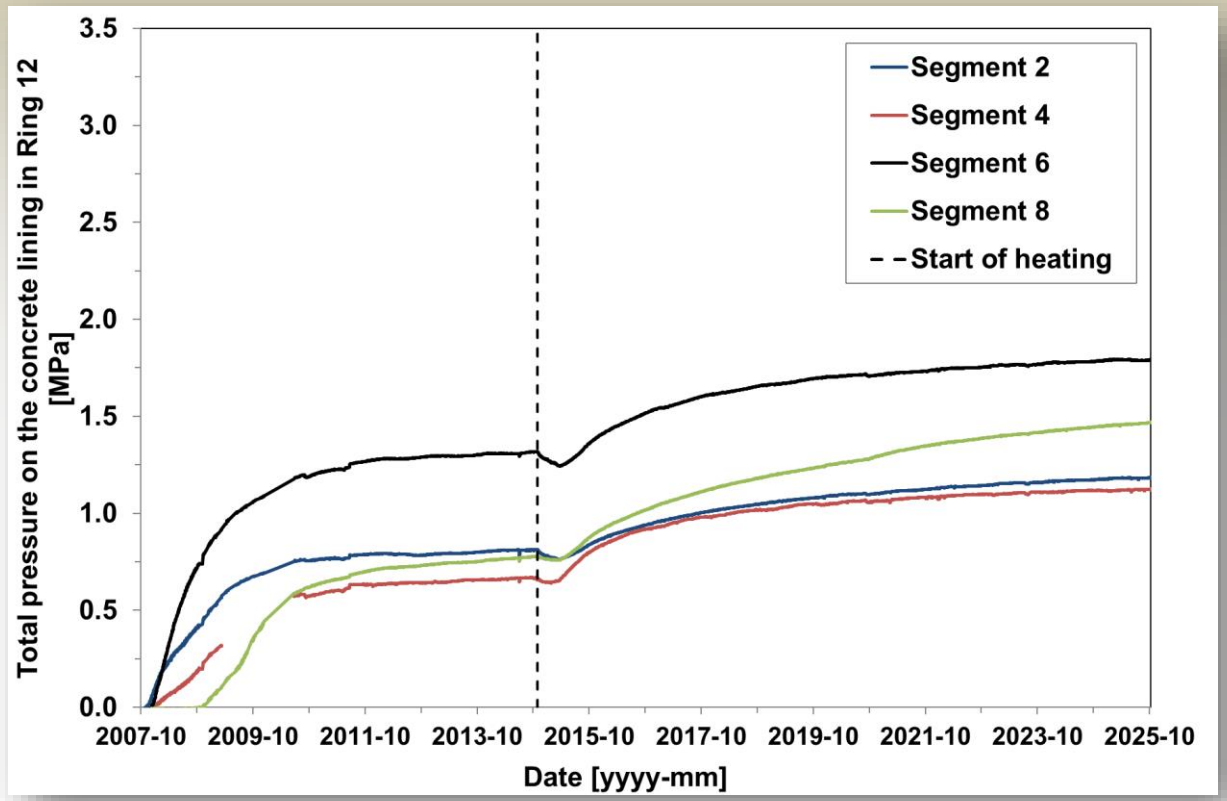




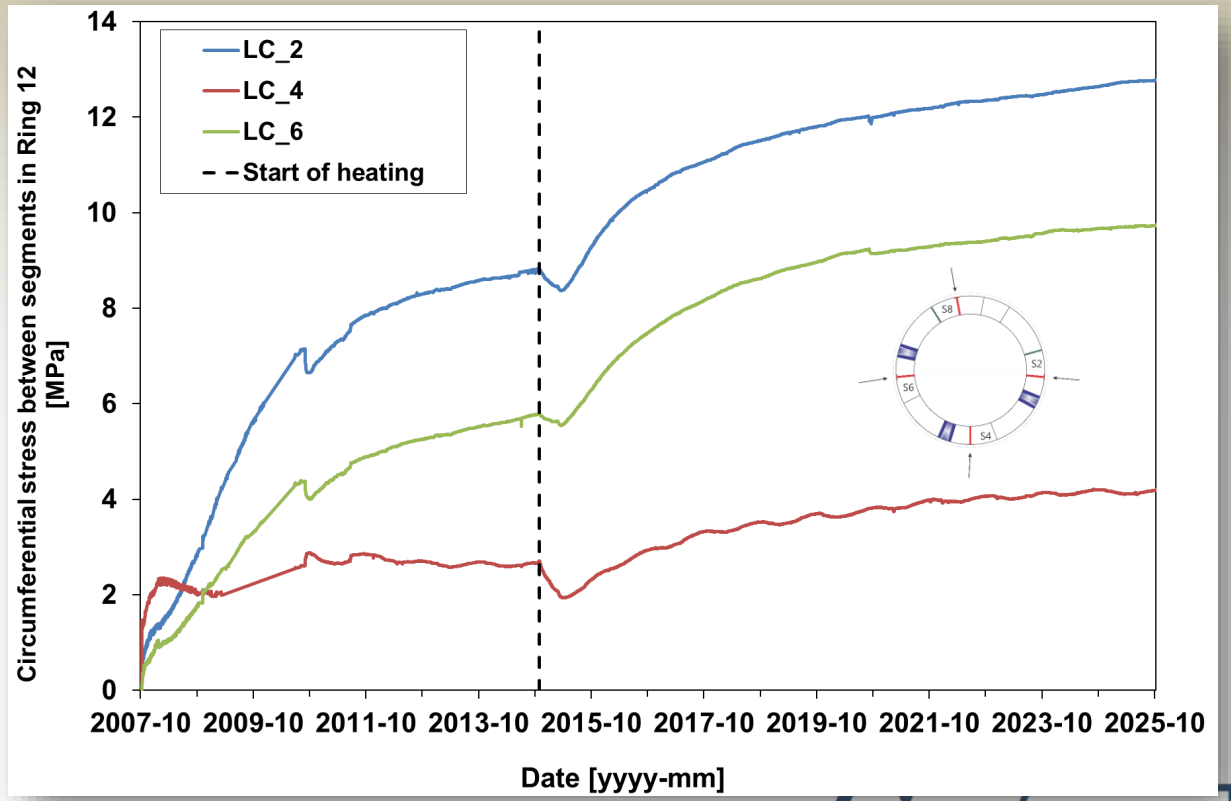
Observations in the lining: non-heated part



Total pressure in the non-heated part (Ring 12)

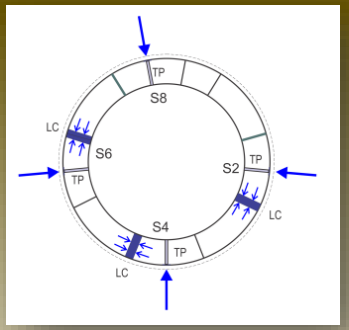


Circumferential stress in the non-heated part (Ring 12)

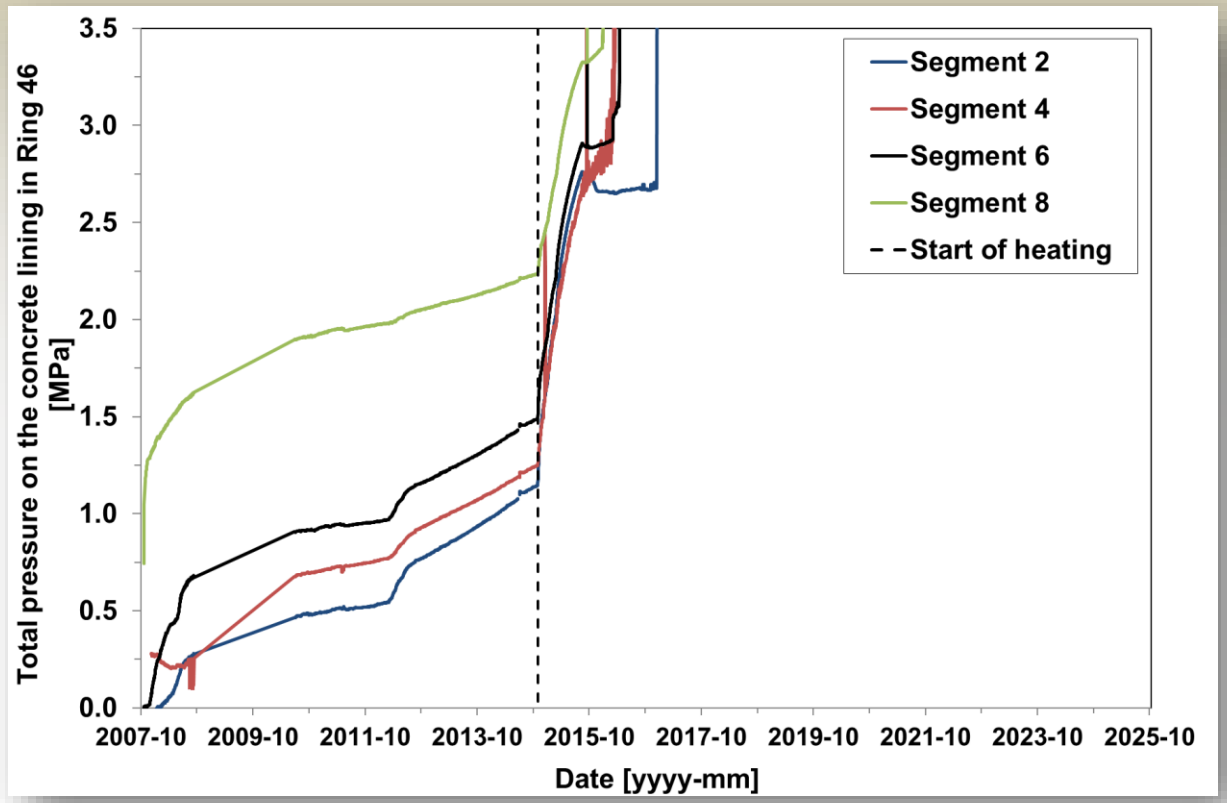


Concrete lining: C80/95

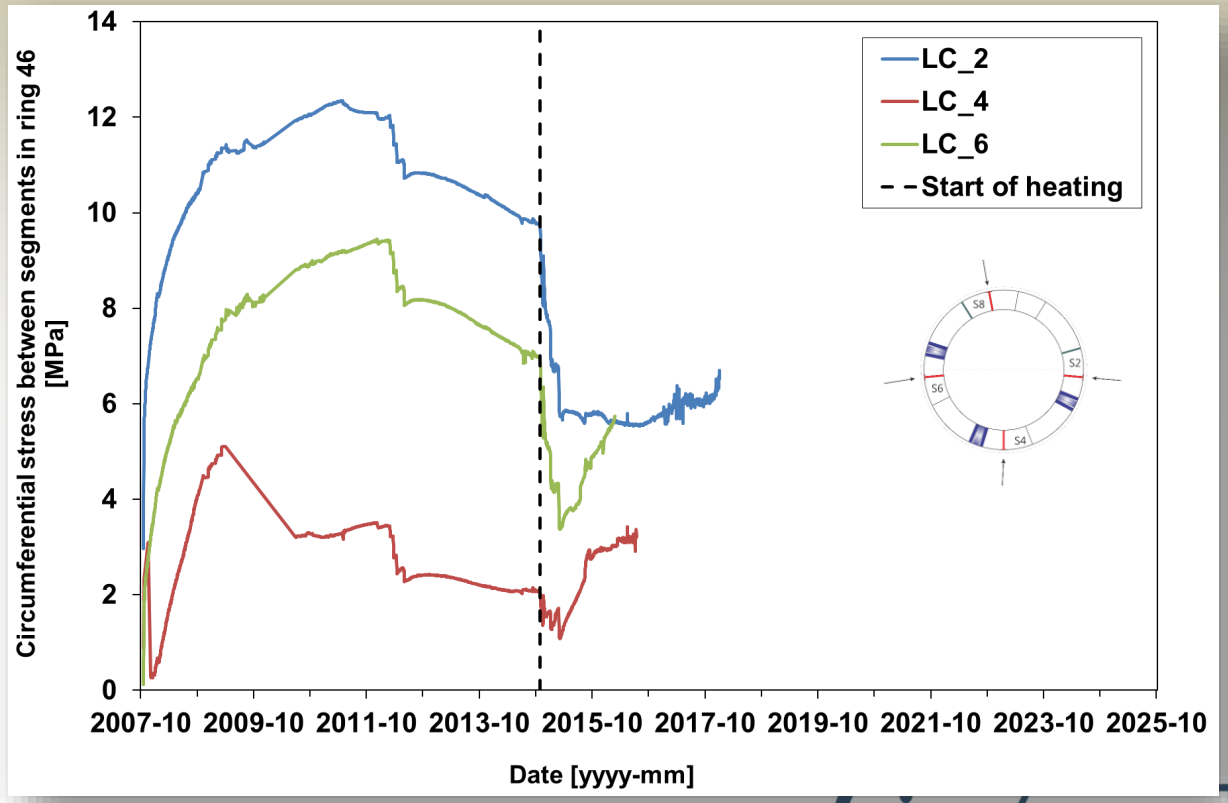
Observations in the lining: heated part



Total pressure in the heated part (Ring 46)



Circumferential stress in the heated part (Ring 46)



Concrete lining: C80/95

OUTLINE

- Heater Test – Steering parameters
- Observations
  - Boom Clay
  - Test set-up (Seal/ Concrete lining)
- Conclusion

CONCLUSIONS

- No interruption of the heater system

→ good performance of the test set-up

- Boom Clay is able to withstand the thermal loading
  - ✓ No indication of abrupt changes in pore water pressure nor large displacement
  - ✓ No changes in the intrinsic permeability
  - ✓ Anisotropic responses, as expected (vertical vs horizontal profiles)
- Seal fulfils its role as a hydraulic cut-off
- Stresses in the lining remain well below the ultimate strength

→ **Important input for THM** knowledge and repository design

THANK YOU TO THE WHOLE PRACLAY TEAM