First results PART 1

OBSERVATIONS during one and a half year of heating

20th Exchange Meeting
Mol, 4 May 2016

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SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

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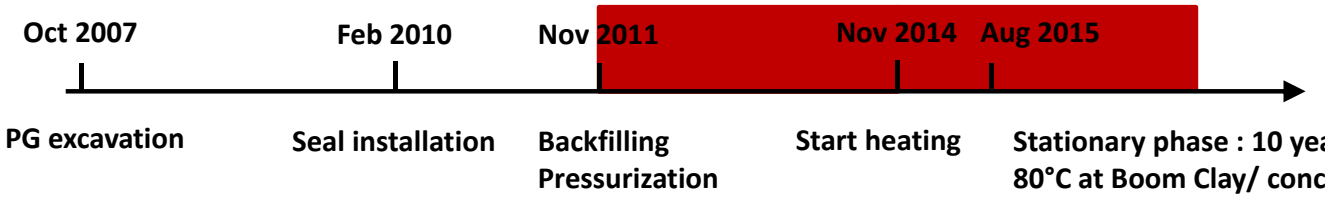
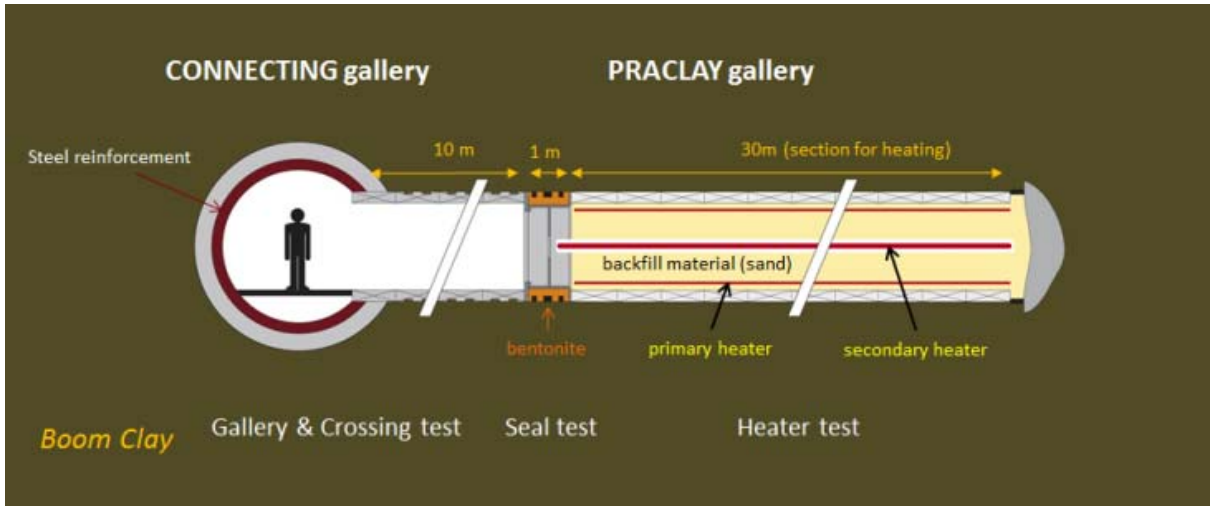
The PRACLAY Heater test





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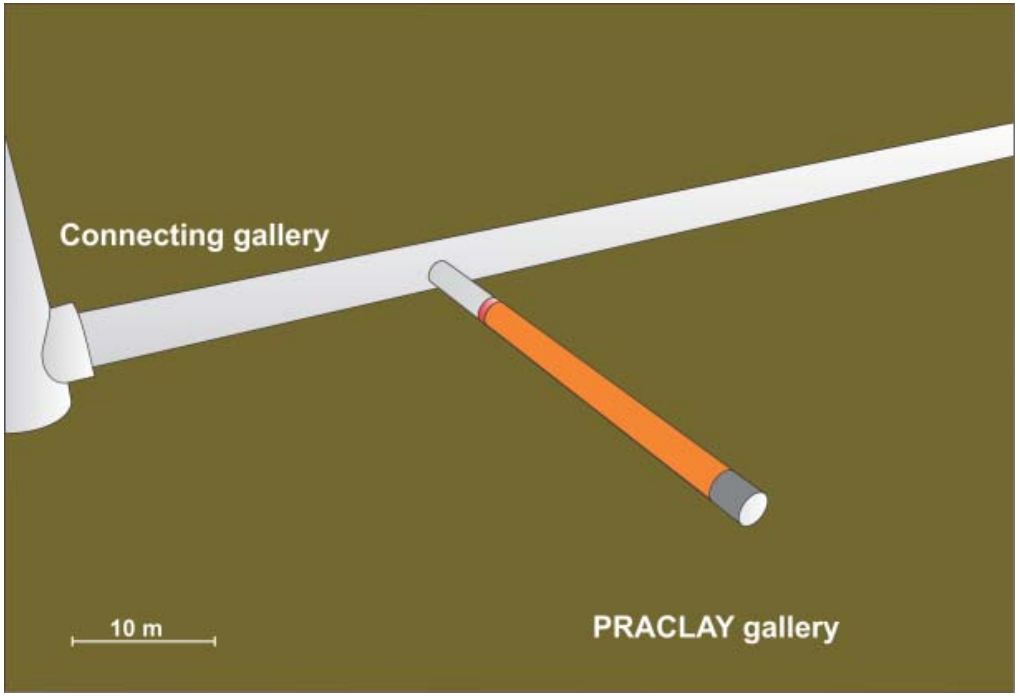
The PRACLAY Heater test

- **Monitoring network: temperature, pore water pressure, stresses…**



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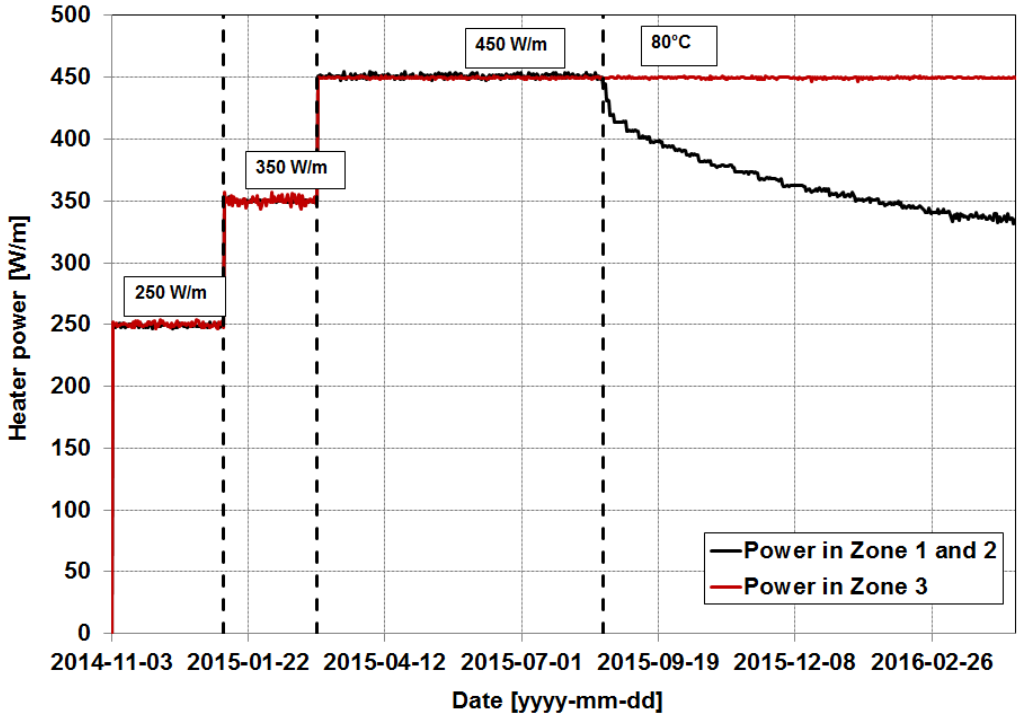
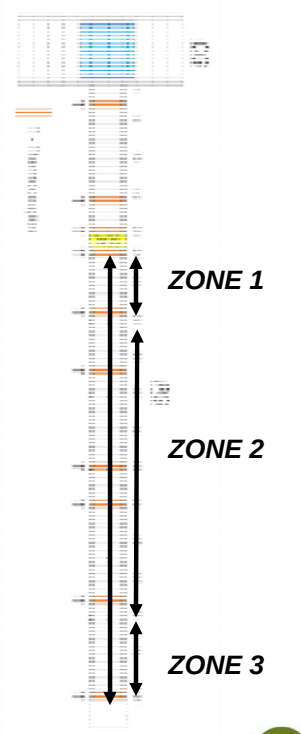
The PRACLAY Heater test

- **PRACLAY thermal loading:**
  - 3 heating steps to reach 80°C at Boom Clay/ concrete lining interface
  - 250 W/m = heat flux representative from a nuclear waste repository





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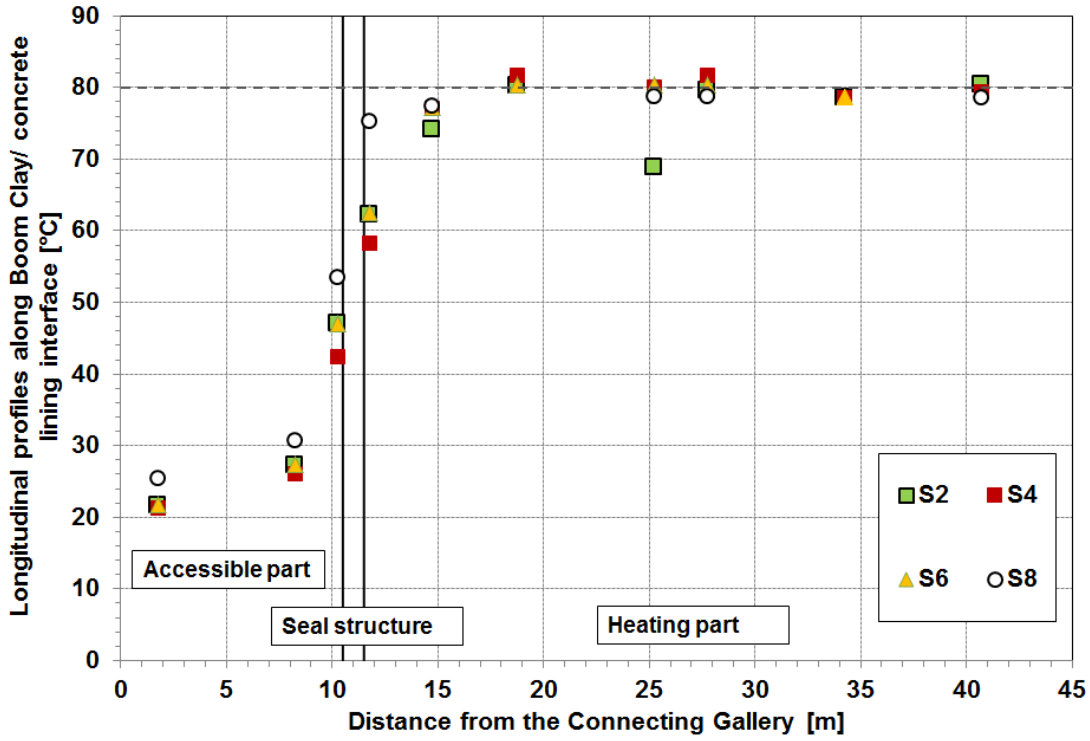
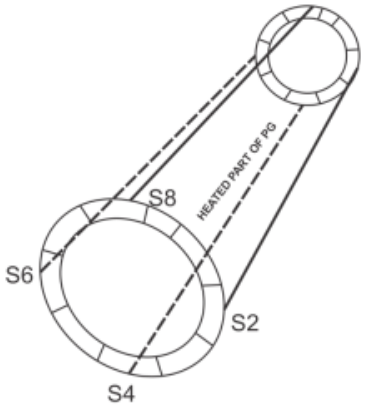
The PRACLAY Heater test

- **PRACLAY thermal loading:**
  - Increase of the temperature in the concrete lining
  - Current situation: 80°C at Boom Clay/ lining interface





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The PRACLAY Heater test

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  - Increase of the temperature in the concrete lining
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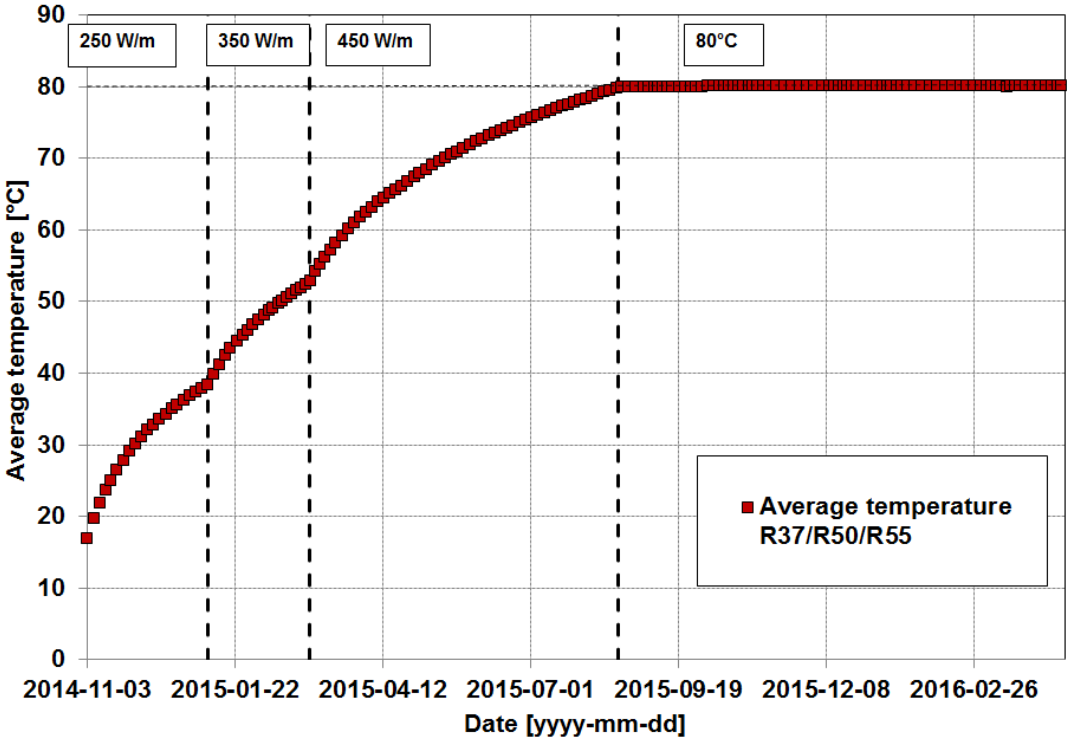

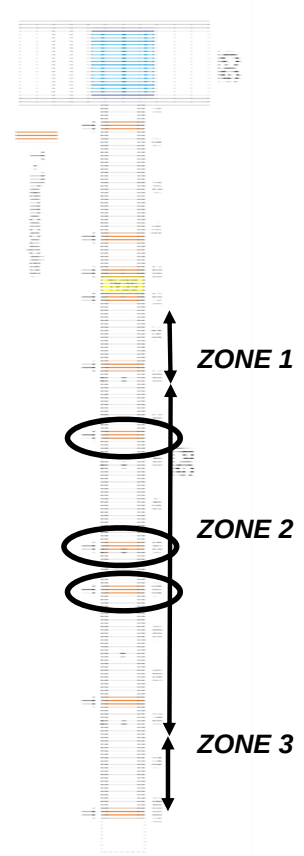

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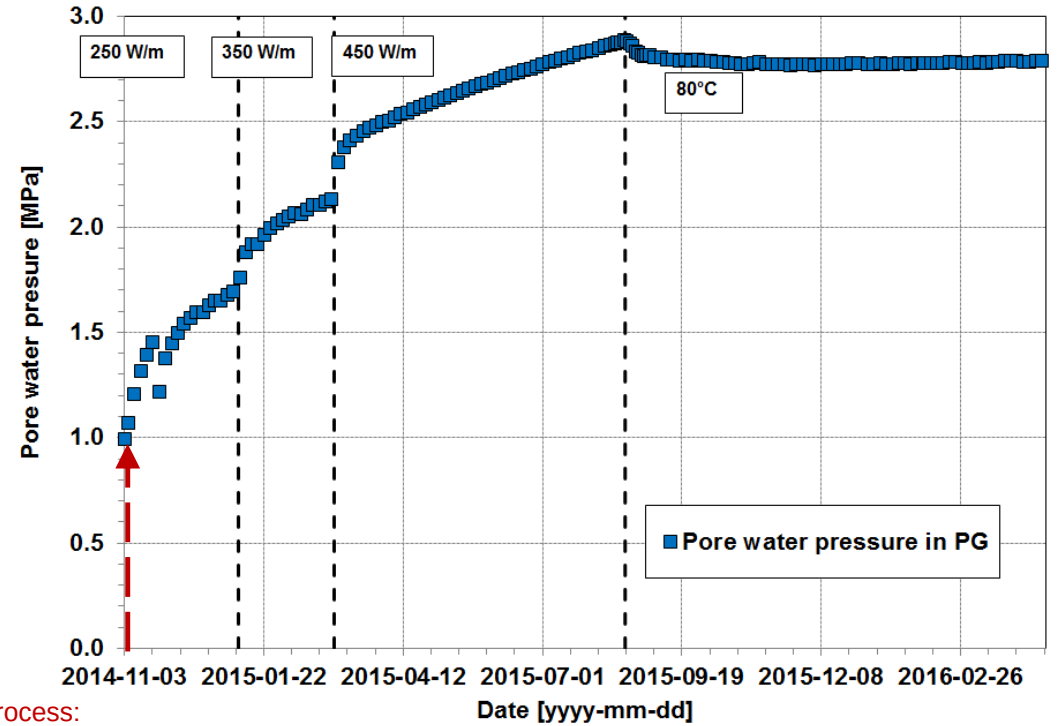
The PRACLAY Heater test

- **PRACLAY thermal loading:**
  - Increase of the pore water pressure inside PG



Pressurization process:
Initial pore pressure in PG = 1 MPa

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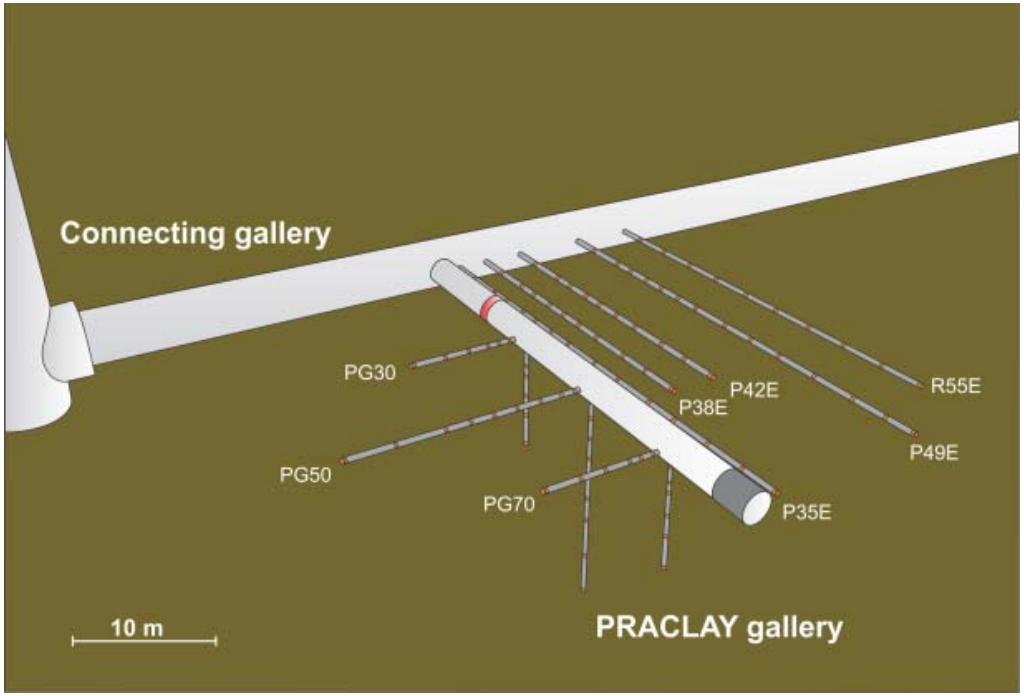
The PRACLAY Heater test - Observations

- **What do we observe in the Boom Clay?**



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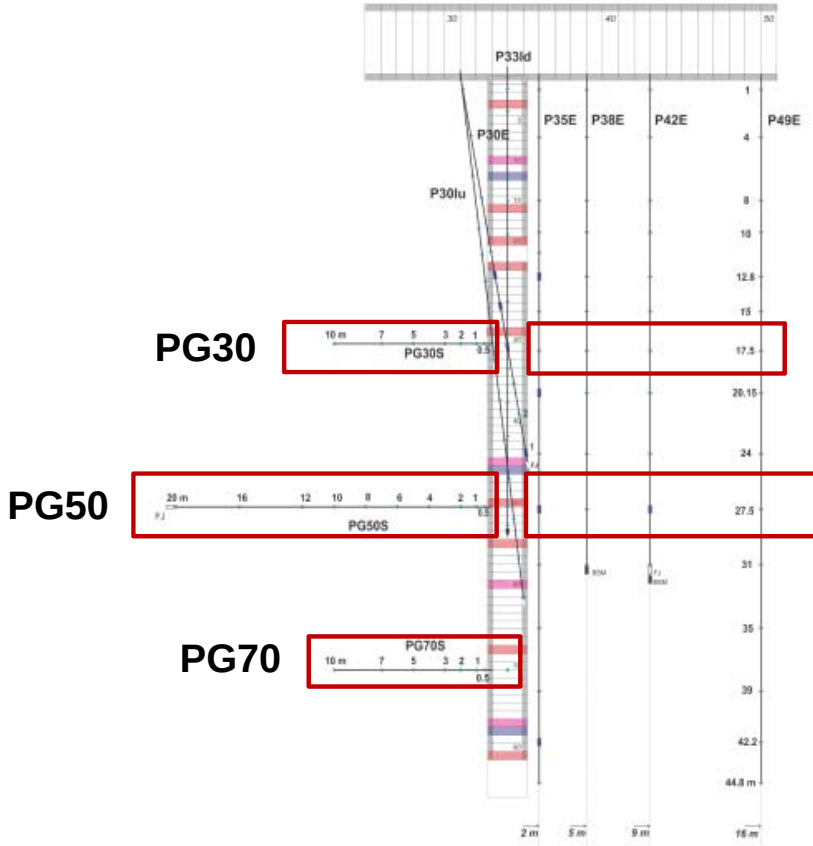

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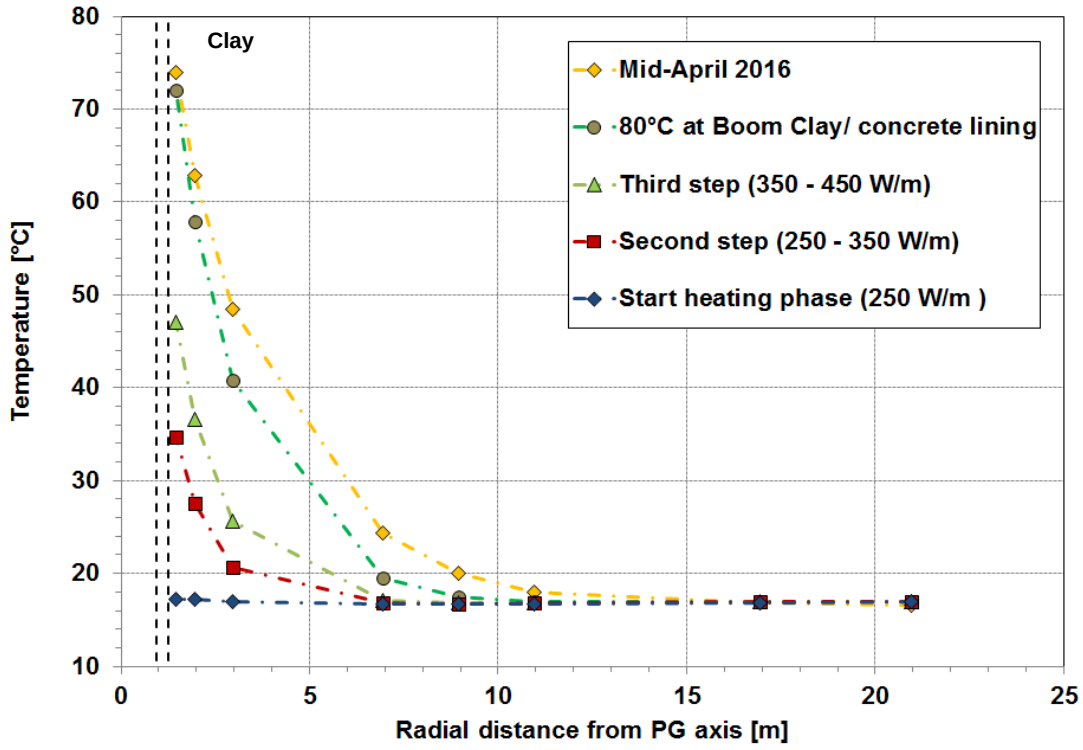
The PRACLAY Heater test - Observations

❑ What do we observe in the Boom Clay?

- ***Temperature*** profiles in the clay (PG50D)



Extension of the thermally affected zone : around 10 m

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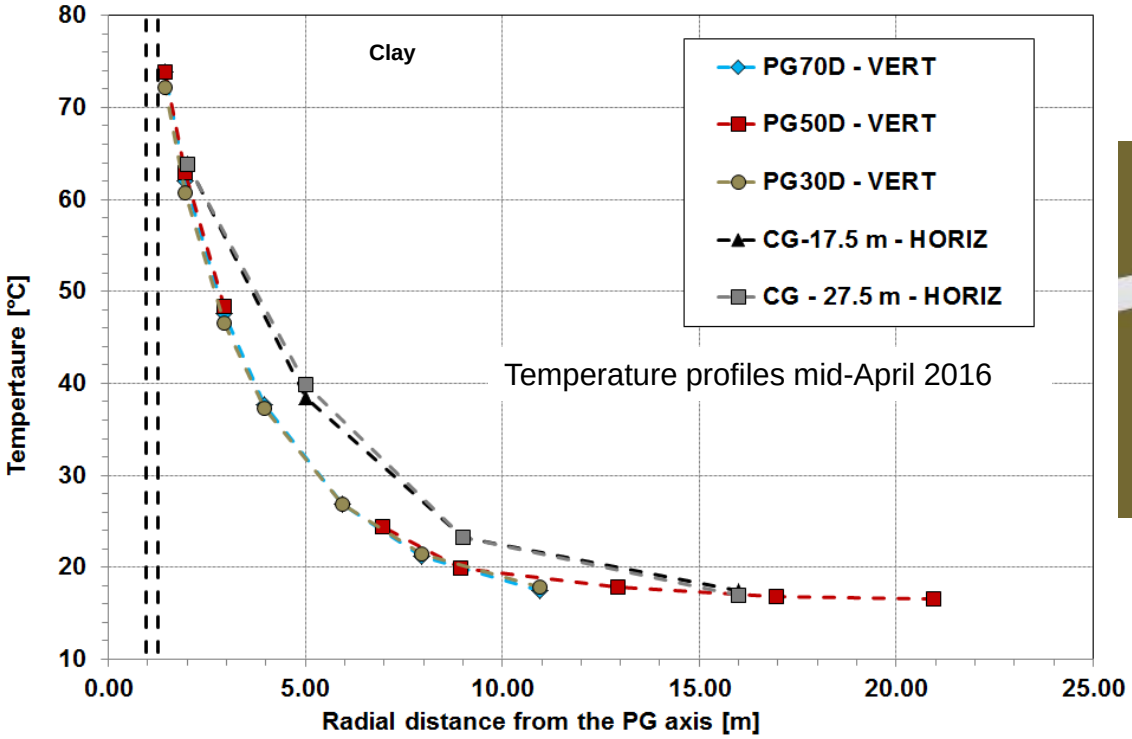
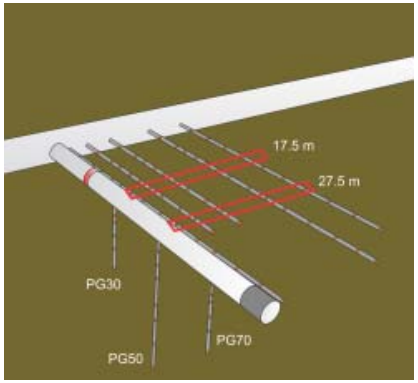
The PRACLAY Heater test - Observations

❑ What do we observe in the Boom Clay?

- ***Temperature*** profiles in the clay (Vertical/ horizontal)





Extension of the thermally affected zone : around 10 m

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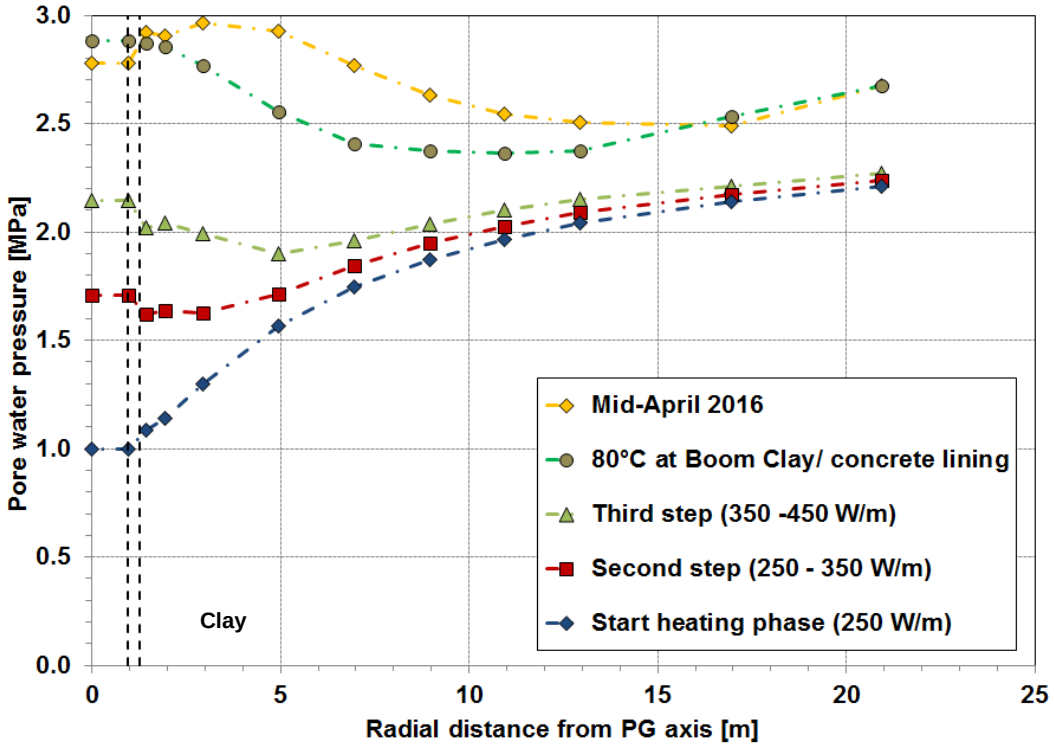
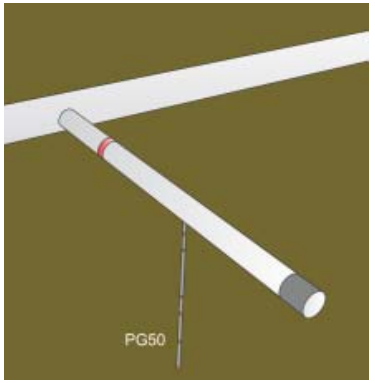
The PRACLAY Heater test - Observations

❑ What do we observe in the Boom Clay?

- ***Pore water pressure*** profiles in the clay (Vertical direction, PG50D)





Extension of the hydraulic affected zone : around 15 m

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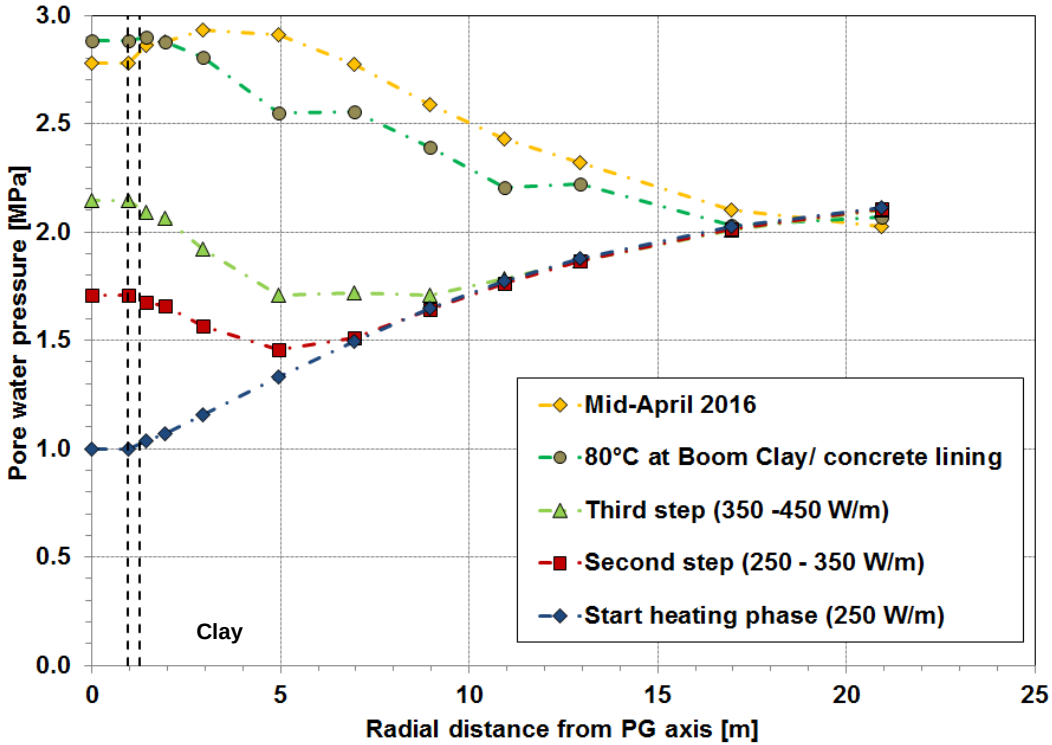
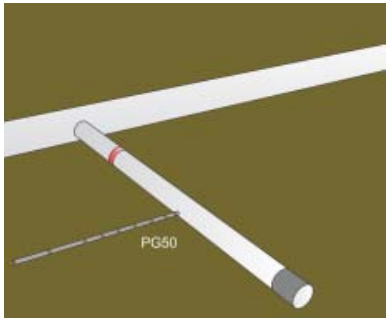
The PRACLAY Heater test - Observations

❑ What do we observe in the Boom Clay?

- ***Pore water pressure*** profiles in the clay (Horizontal direction, PG50S)





Extension of the hydraulic affected zone : around 15 m

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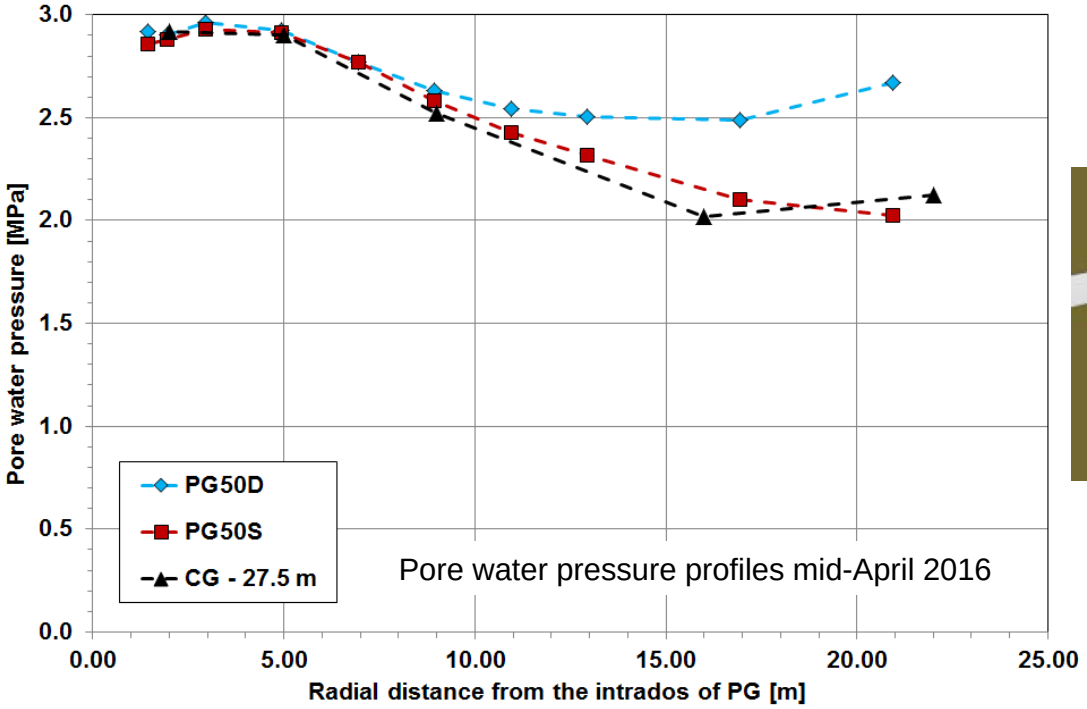
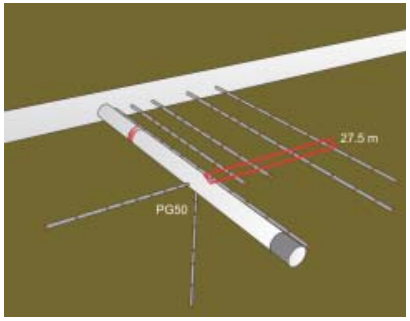
The PRACLAY Heater test - Observations

❑ What do we observe in the Boom Clay?

- ***Pore water pressure*** profiles in the clay (Vertical/ Horizontal)





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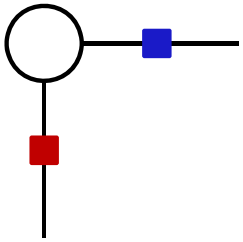
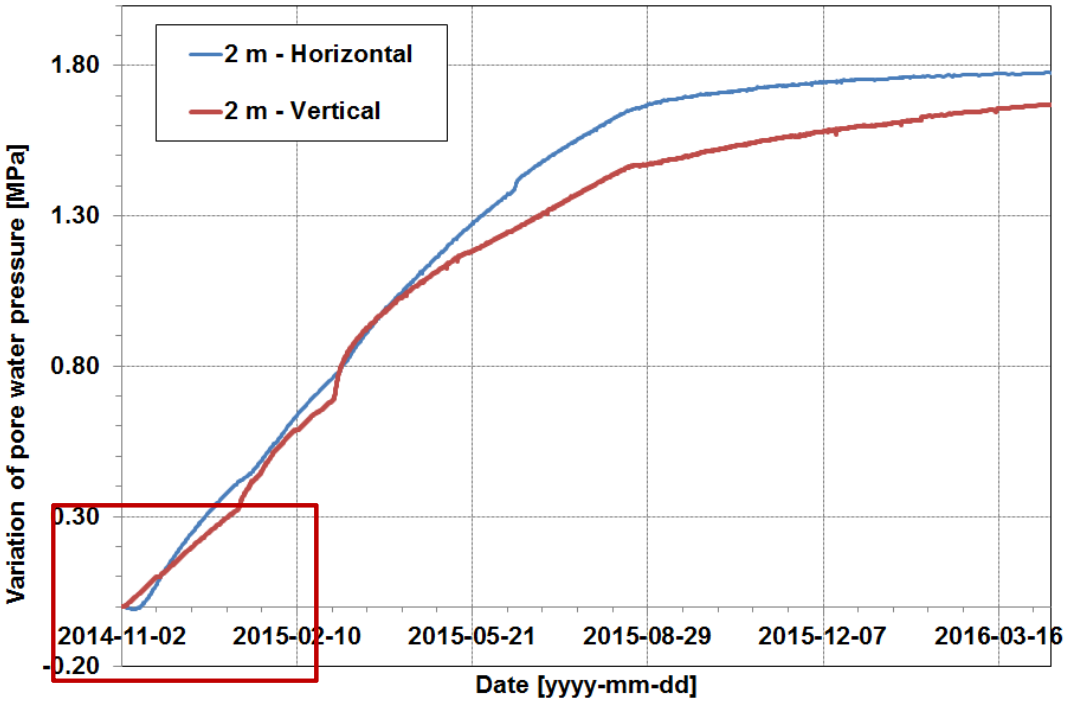
The PRACLAY Heater test - Observations

- **What do we observe in the Boom Clay?**
  - ***Pore water pressure*** variation in the clay (vertical vs horizontal)

PG50





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The PRACLAY Heater test - Observations

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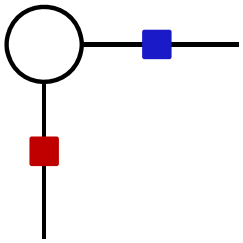
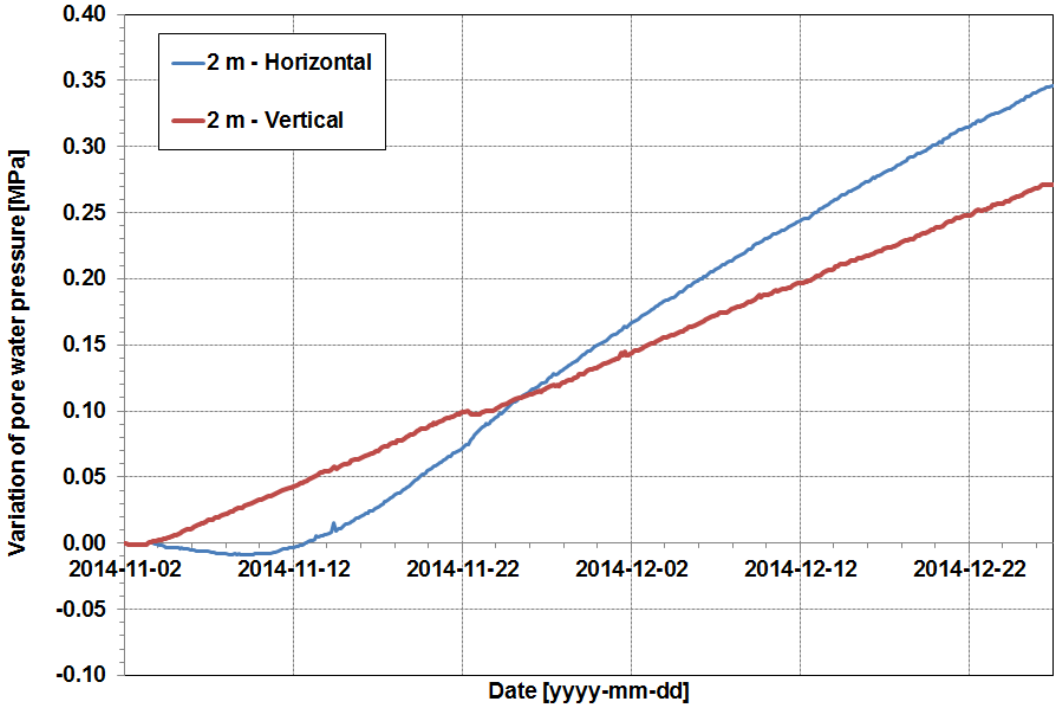
- ***Pore water pressure*** variation in the clay (vertical vs horizontal)

PG50





Phenomenon already observed during ATLAS experiment

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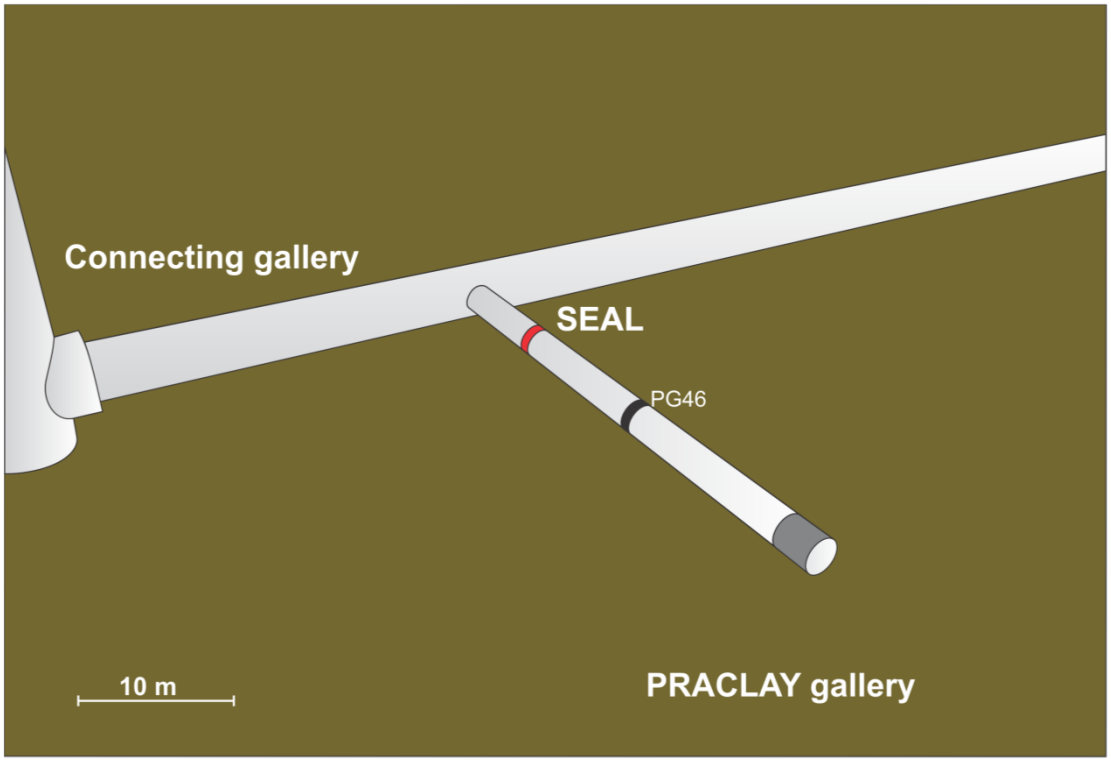
The PRACLAY Heater test - Observations

- **What do we observe in the seal/ concrete lining?**
  - Pore water pressure, total stress and displacement



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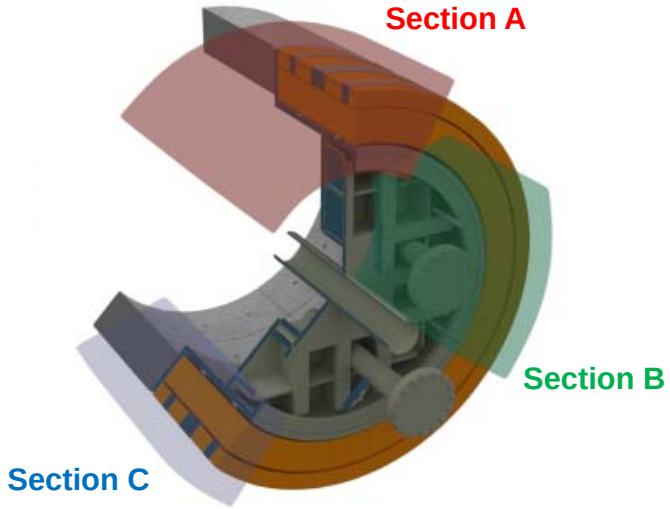

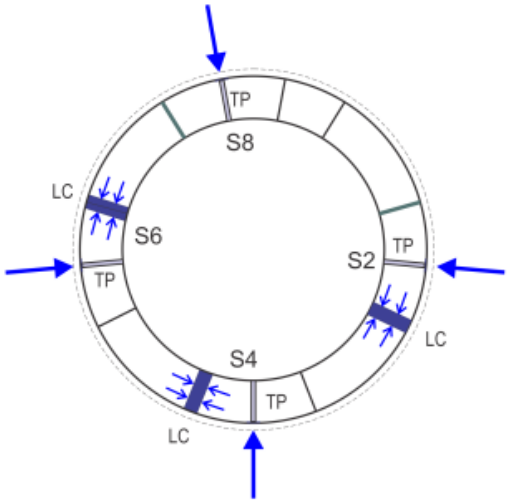

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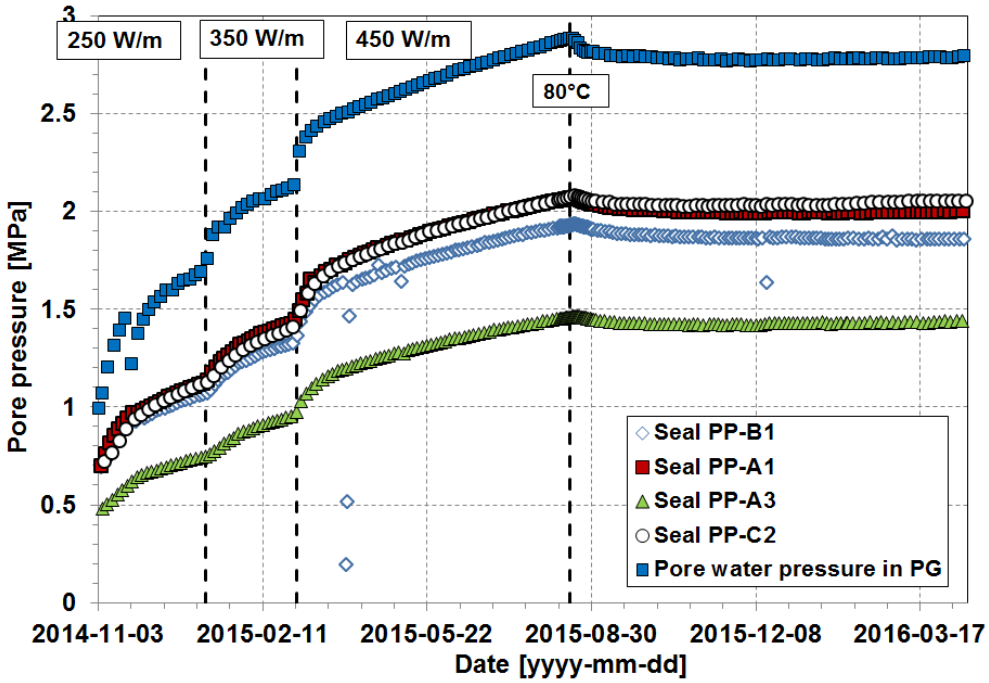
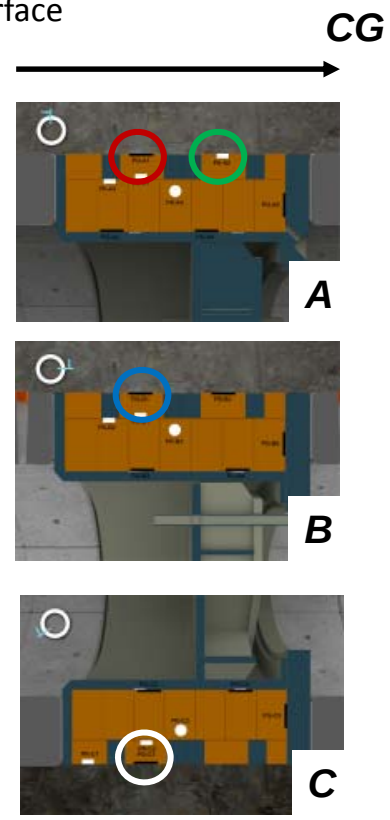
The PRACLAY Heater test - Observations

❑ What do we observe in the seal?

- Pore water pressure evolution at Boom Clay/ bentonite interface





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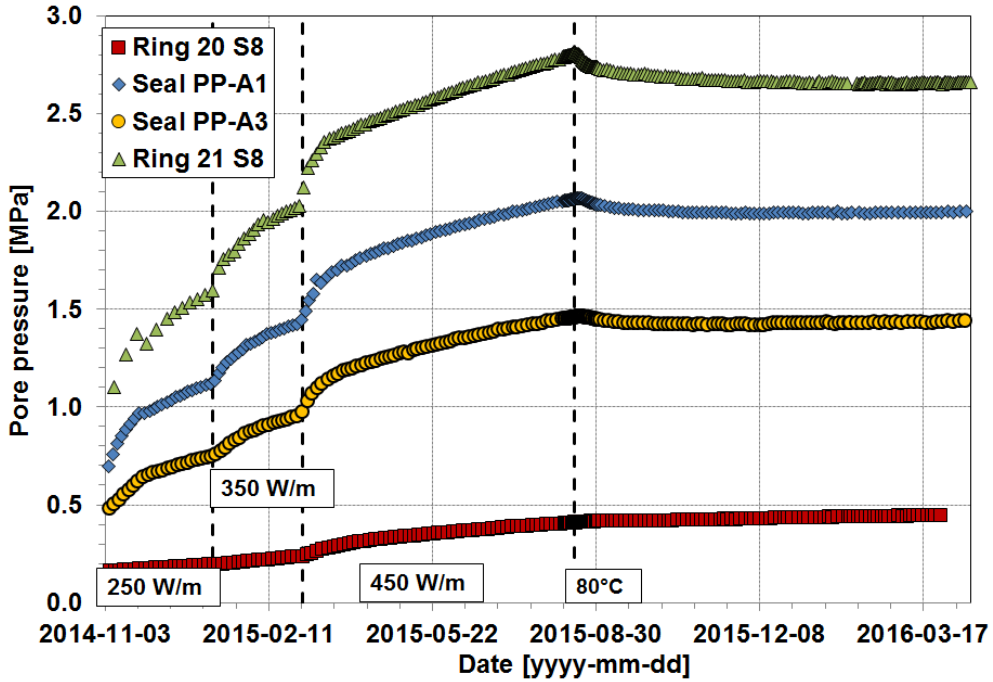

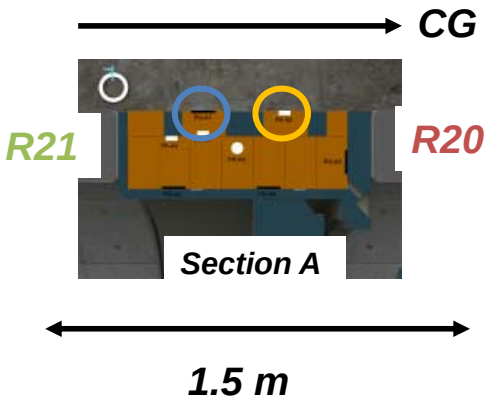

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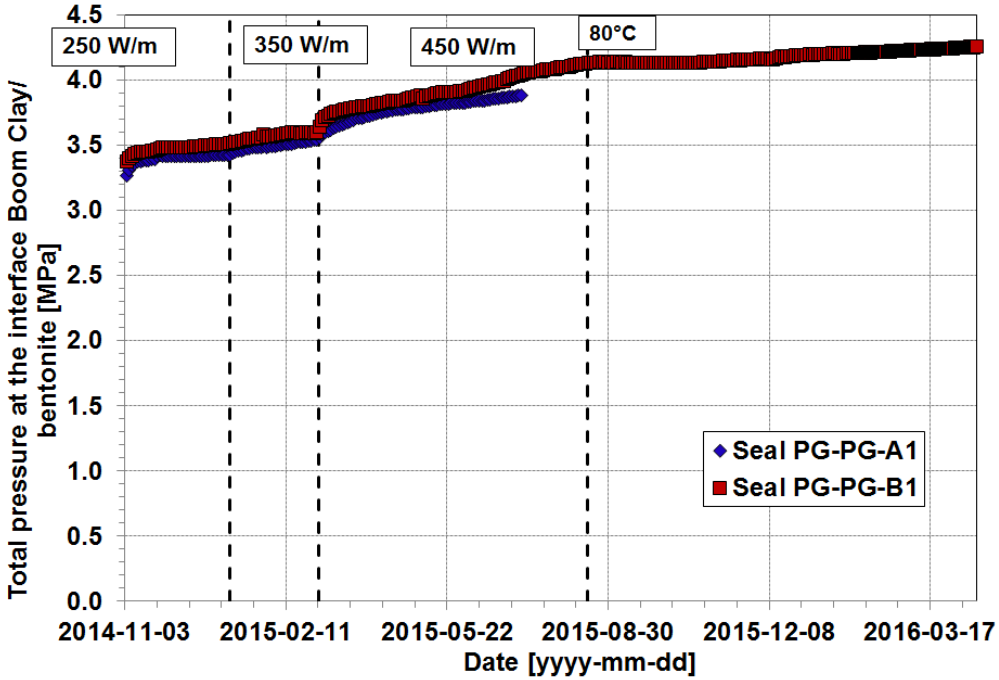
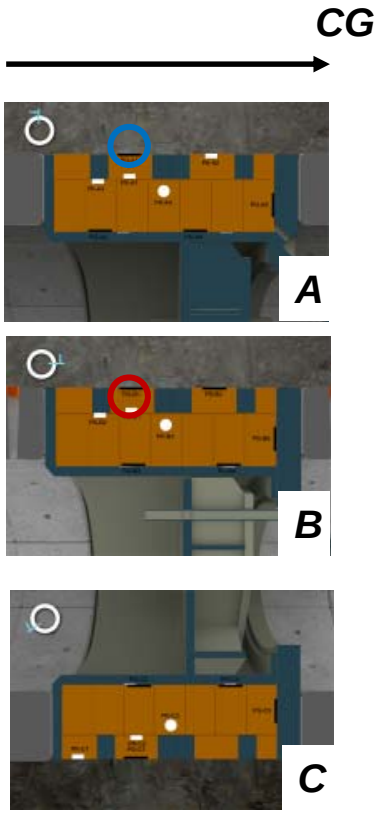
The PRACLAY Heater test - Observations

❑ What do we observe in the seal?

- Total pressure at Boom Clay/ bentonite interface





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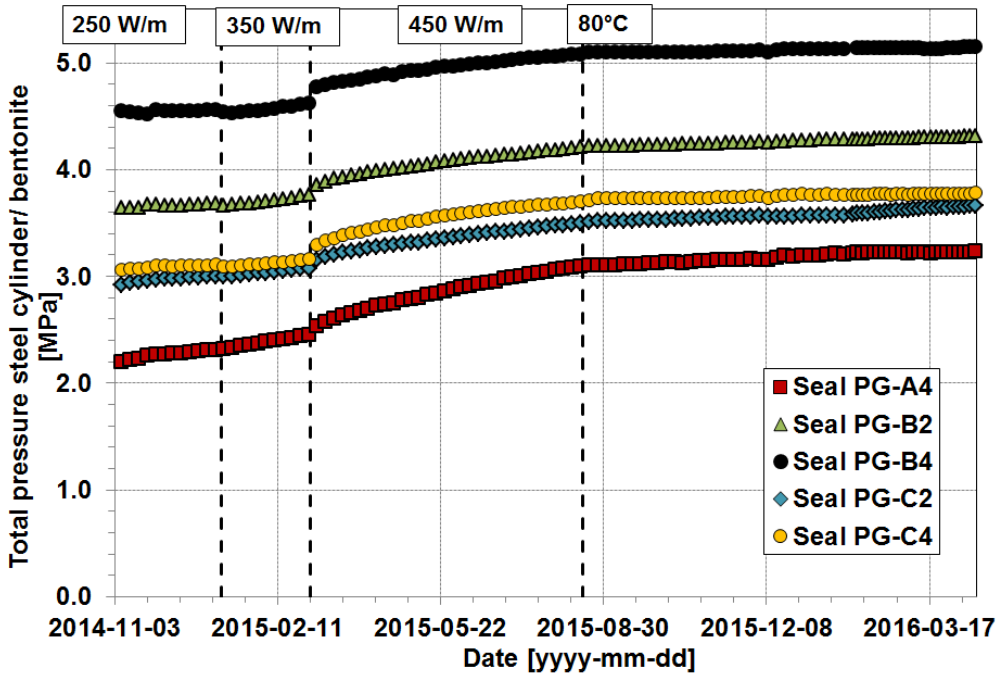
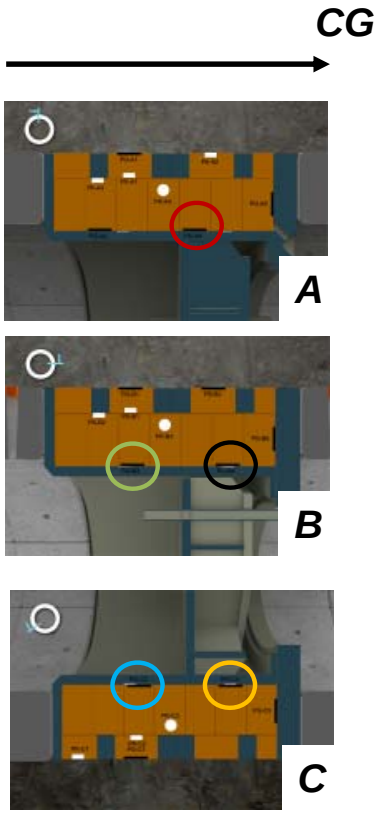
The PRACLAY Heater test - Observations

❑ What do we observe in the seal?

- Total pressure at bentonite/ steel cylinder interface





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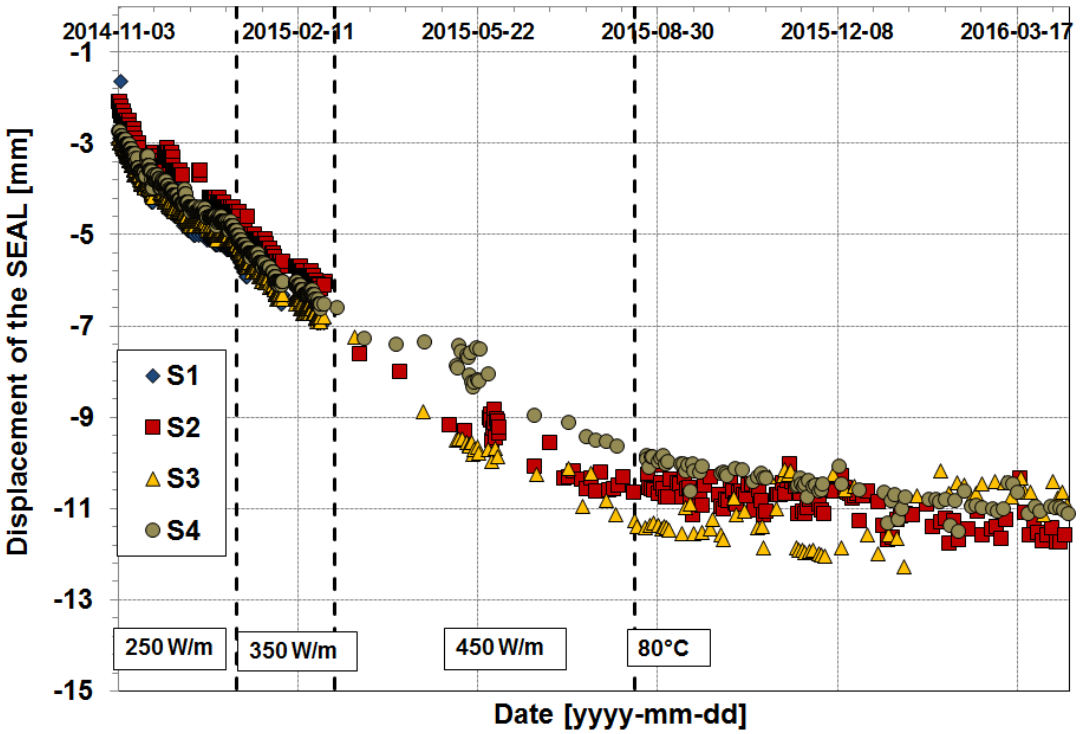
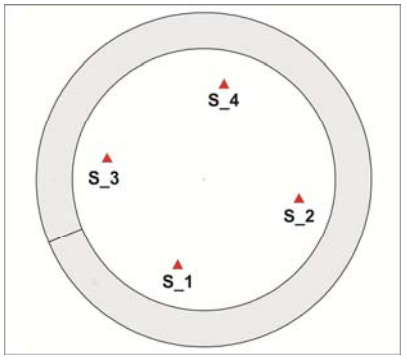
The PRACLAY Heater test - Observations

❑ What do we observe in the seal?

- Displacement of the SEAL towards the Connecting gallery





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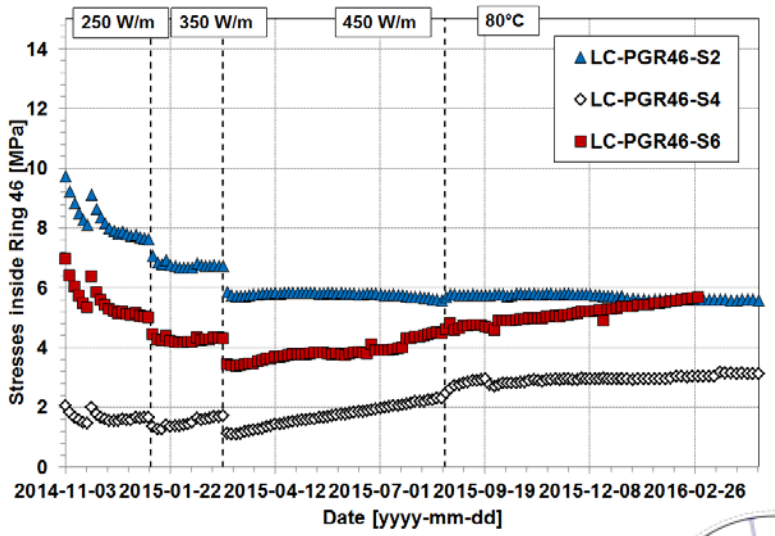
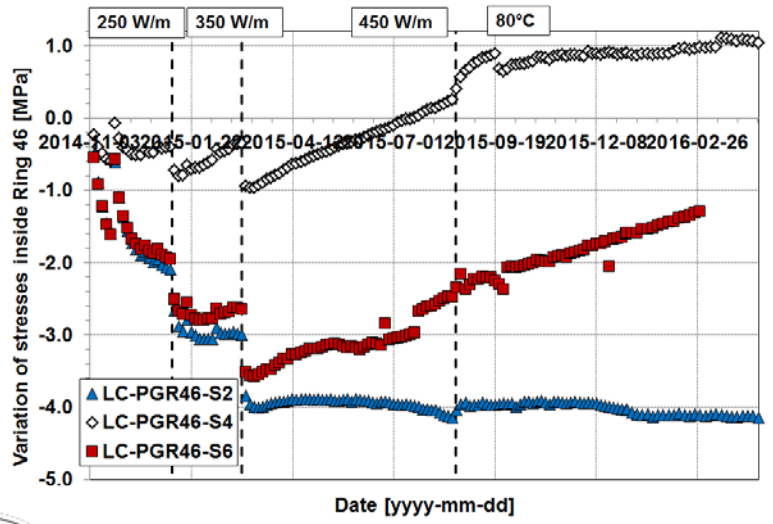
The PRACLAY Heater test - Observations

❑ What do we observe in concrete lining?

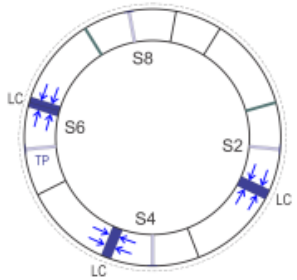
- Stresses and variation of stresses between the concrete lining segments



Mean circumferential stress



Variation of the mean circumferential stress



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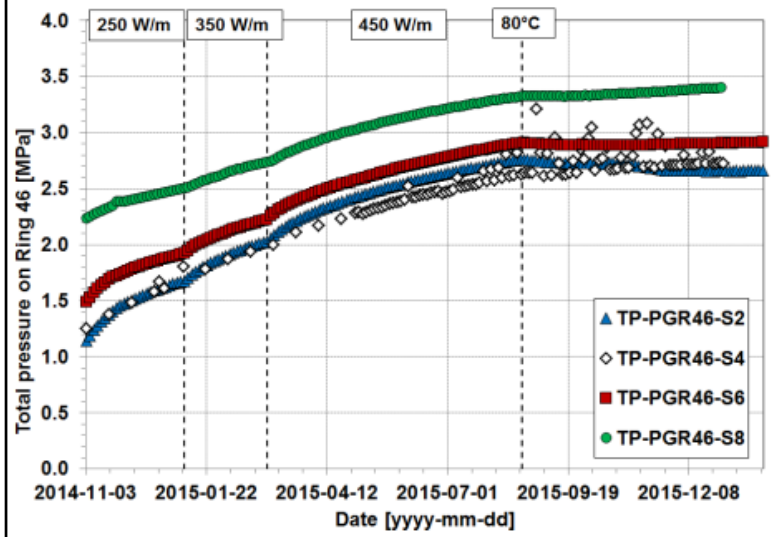
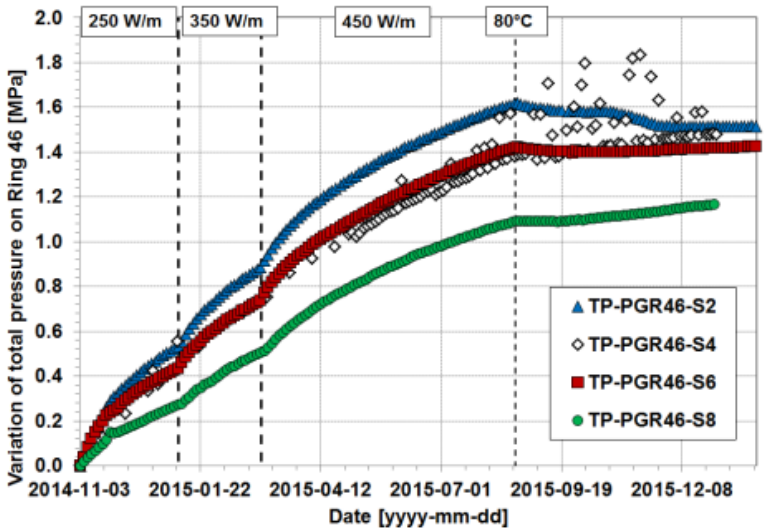
The PRACLAY Heater test - Observations

❑ What do we observe in the concrete lining?

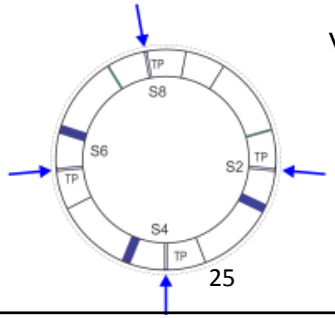
- Pressure and variation of pressure on the concrete lining segments (PG46)



Total pressure on the lining



Variation of the total pressure on the lining



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The PRACLAY Heater test - Conclusion

18 months after the switch-on, the experimental set-up and the Boom Clay are generally behaving as expected (start-up phase: 9½ months to reach 80°C)

- **Boom Clay** (after 18 months):
  - Temperatures affected up to a radial distance of about 10 m
  - Pore pressures affected up to a radial distance of about 15 m
  - Anisotropic responses, as expected (vertical vs horizontal profiles)
  - No indication at this point of large displacements, hydraulic fracturing, liquefaction or drastic changes of properties

- **Seal**: plays its role as a hydraulic cut-off
- **Concrete lining**: evolution of the stresses and of total pressure acting on it remains within the expected range (compared with the design value).

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