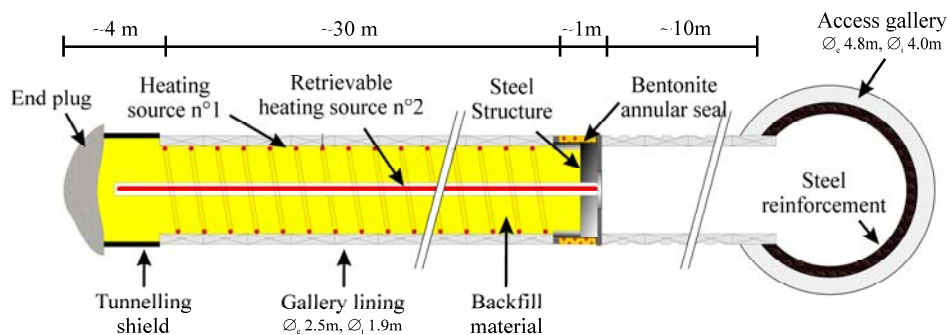


## Background

The PRACLAY demonstration & confirmation experiments contribute to the Belgian research, development and demonstration programme to assess the safety and feasibility of geological disposal of radioactive waste in Boom Clay. Within this programme, the large scale PRACLAY heater experiment aims to verify that Boom Clay is suitable to host heat emitting radioactive waste. A 35 m long section of an experimental gallery in the underground research facility HADES (at 225 m depth) will be heated up to 95°C during ten years. The heater experiment focuses on the response of the host rock to the thermal load. The figure below shows the experimental lay-out. In 2007, an important milestone was reached with the realisation of the PRACLAY gallery (45 m long, external diameter 2.5 m). The design was made by Tractebel development engineering. Following an adjudication procedure, the construction contract was awarded to SMET Tunnelling.



Overview of the PRACLAY heater experiment

## Objectives

The design of the gallery needed to meet very specific requirements related to the heater experiment:

- **Gallery crossing**  
The PRACLAY gallery was built perpendicularly to the HADES underground research facility. The existing gallery needed to be reinforced to allow for the crossing.
- **Gallery excavation**  
The aim was not to use a starting chamber for the assembly of the tunnelling equipment. This implied that all the equipment had to be assembled inside the reinforcement structure. The targeted progress rate of the construction was 2 m/24 h.
- **Gallery lining**  
The design of the lining did not only have to take into account the overburden pressure (4.5 MPa), but also the thermal load induced by the future experiment.
- **Measurements**  
In the frame of the PRACLAY heater experiment, an extensive instrumentation programme was developed. The majority of the sensors were already installed in the host rock in 2006 in order to register the hydro-mechanical response of the Boom Clay during excavation.

## Principal results

To reinforce the access gallery, a cast steel structure was placed at the crossing. Designing, manufacturing and assembling this structure was one of the important challenges of the project. Due to the limited size of the shaft and the maximum weight allowed, the reinforcement structure was composed of 11 segments, weighing over 30 tons all together. Because the structure was segmented, very strict construction tolerances and bolting procedures were imposed. After the manufacturing of the individual segments, the structure was assembled and milled to the correct dimensions as a whole. Afterwards, the structure was disassembled, painted, transported underground and re-assembled (August 2007).

The actual construction of the gallery was performed during October 2007. The excavation technique used for the PRACLAY gallery was essentially the same as the one used for the previous construction of the so-called connecting gallery. The excavation of the clay is performed under the protection of a tunnelling shield using a road header. Once all functional requirements of the equipment were successfully met during a trial assembly in the workshop, the equipment was disassembled, transported to HADES and re-assembled. Due to the small diameter of the gallery, the available working space was limited. This was reflected in a lower progress rate than achieved during the excavation of the connecting gallery. However, after a start-up zone of about 10 m, the target rate of 2 m/24 h could be reached for 90% of the time.

The construction of the gallery was a repetitive two-step process: first the clay was excavated over a length of about 50 cm and then a lining ring of prefabricated concrete segments was built. A wedge-block type of lining was used. In order to avoid damage to the lining, dilation joints were installed. Otherwise, thermal dilation of the gallery lining during the heater experiment would lead to stresses exceeding the strength of the concrete (C80/95). Materials such as compressible stainless steel foam panels, silicone rubber sheets and compressible concrete were used. As an experiment, some sections of the gallery were built without dilation joints. Special concrete with a strength over 125 MPa was used for these sections.

During the excavation, the response of the surrounding host rock was successfully monitored. Measured parameters included pore water pressure, total stress, displacements, temperature, hydraulic conductivity and seismic properties. Furthermore, fracturing processes and geological features of the rock were studied and several of the lining segments were instrumented to characterise the interaction between the lining and the host rock. The measurements were consistent with previous observations.



Reinforcement structure: milling of the structure as a whole (left) and assembly underground (right)



The left picture shows the tunnelling equipment as it is positioned into the reinforcement structure: the road header (painted red) is visible at the front of the tunnelling shield; Boom Clay is visible in the opening of the reinforcement structure. The right picture shows a view of the PRACLAY gallery under construction. The concrete wedge-block lining is visible, as are the dilation joints made of compressible stainless steel foam (painted white).

### Future work

The provisional delivery of the PRACLAY gallery took place in December 2007. All construction work was completed successfully and safely. However, the in-depth analyses of the acquired data about the host rock response during the excavation still needs to be carried out. The main work for the coming year is the further preparation and installation of the PRACLAY heater experiment. The main tasks to be completed are:

- installation of additional instruments in the host rock from the PRACLAY gallery;
- design and installation of the heater system, including the regulation;
- installation of a bentonite seal which has to seal off the heated part of the experiment hydraulically while, at the same time, allowing all cables to pass (cf. instruments and heating system).

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### Main reference

Bernier F., Demarche M., Bel J.- *The Belgian Demonstration Programme for the Disposal of High-Level and Long-Lived Radioactive Waste.*- In: Symposium Proceedings. Scientific Basis for Nuclear Waste Management XXIX, Gent, Belgium, 12-16 September 2005 / SCK•CEN, Warrendale, United States, Materials Research Society, 2006, p. 103-110.