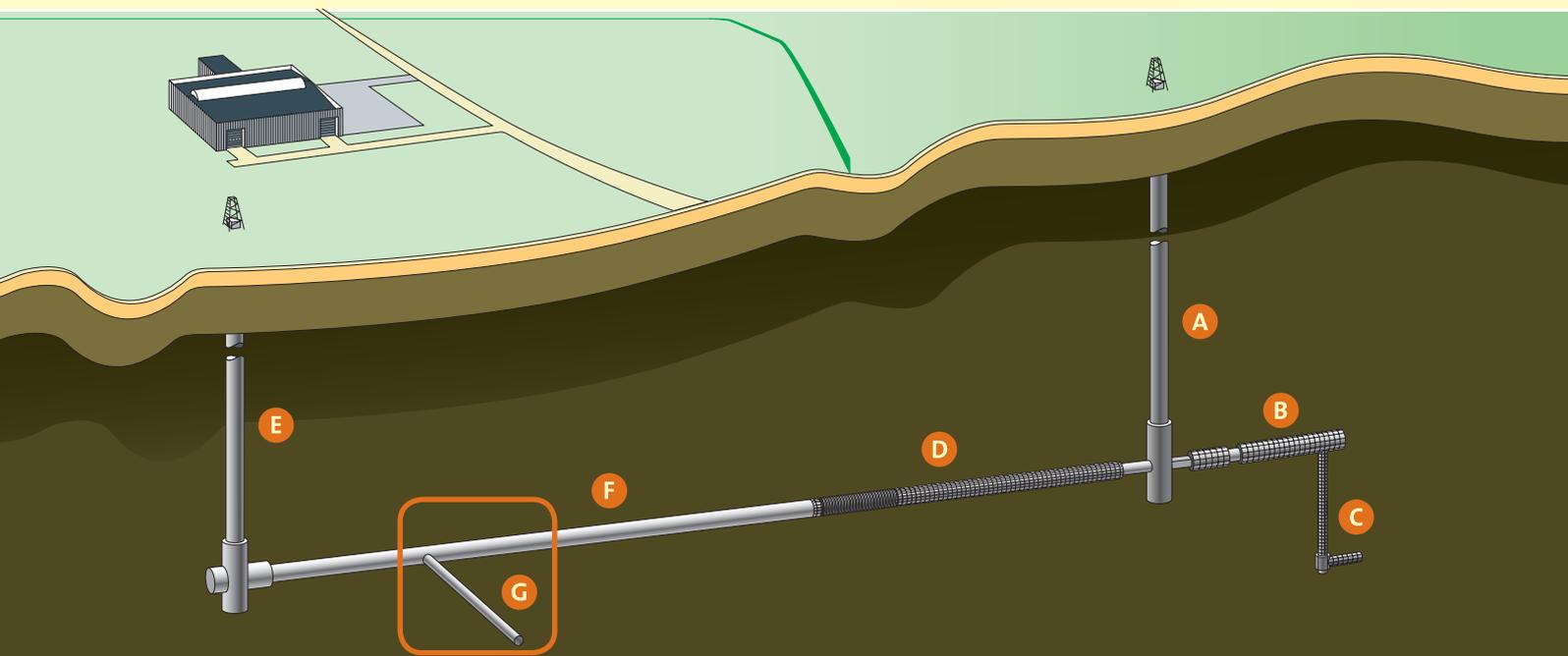


The PRACLAY experiment

The PRACLAY experiment is part of the Belgian R&D programme to assess the safety and feasibility of disposal of radioactive waste in deep clay layers. Geological disposal is an internationally recommended solution for the long-term management of high-level and/or long-lived radioactive waste. A significant part of the research in Belgium is conducted in the HADES underground research facility at Mol, which is managed by EIG EURIDICE. Since 1980, an international team of scientists, engineers and technicians have been gathering information in HADES about the possibility of disposal in deep clay formations and the interactions between radioactive waste and the clay environment. Different techniques are also being tested to construct and seal underground disposal galleries. The underground facility consists of two shafts and several galleries that have been built over the past 30 years. The PRACLAY gallery was excavated in 2007 and is part of what is known as the PRACLAY experiment.

The PRACLAY experiment: studying the impact of heat-emitting radioactive waste on Boom clay

High-level radioactive waste produces heat and will cause, in case of disposal, a temporary warming of the clay in the surroundings of disposal galleries. The large-scale PRACLAY experiment studies the effect of this heat on the deep clay layers. It also examines how excavation affects the behaviour of the clay layer. This knowledge is essential to determine the extent to which these changes could affect the clay's containment capacity. It is vital to ascertain that these properties will not be impaired in order to confirm that disposal of heat-emitting high-level waste in a deep clay layer is a safe solution for the long-term waste management.



HADES underground research facility:

- (A) first shaft (1980-1982)
- (B) first gallery (1983-1984)
- (C) experimental shaft and gallery (1984)
- (D) second gallery (1987)
- (E) second shaft (1997-1999)
- (F) connecting gallery (2001-2002)
- (G) PRACLAY gallery (2007)**

What exactly is the PRACLAY experiment?

The PRACLAY experiment is being carried out on a large scale, on a long-term basis and at temperatures that would be generated in the case of disposal of high-level radioactive waste. The experiment involves several phases and includes three large-scale tests, two of which have already been concluded.

Phase 1: Construction of the PRACLAY gallery (2007)

The PRACLAY gallery was constructed in 2007, demonstrating the feasibility of using industrial excavation techniques to construct disposal galleries perpendicular to a main gallery.

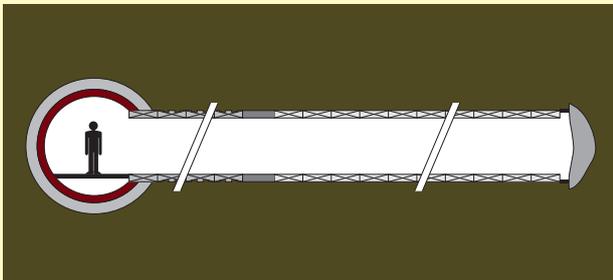


Diagram of the PRACLAY gallery. The gallery is 45 m long and has an internal diameter of 1.9 m, i.e. it is slightly smaller than an actual disposal gallery would be.

The first step was to install a steel reinforcement structure in the existing main gallery at the point where the excavation work was due to commence (shown in red in the diagram). The purpose of the reinforcement was to ensure that the main gallery would not collapse under the pressure of the soil above it when part of the wall was removed to start excavating.



The reinforcement structure at the entrance to the PRACLAY gallery.

During the excavation works, any changes in the clay layer were recorded by measuring instruments that had already been installed before the start of the excavation. This made it possible to monitor accurately any disturbances caused by excavation. The concrete wall lining of the PRACLAY gallery was also equipped with a variety of sensors to provide a constant stream of information, for instance about the pressure exerted by the clay on the wall.



The entrance to the PRACLAY gallery at the end of phase 1.

Phase 2: Installation of the heating system and sealing of the PRACLAY gallery (2008-2011)

Once the PRACLAY gallery was built, the heating system was installed. This comprises metal heating elements that are mounted on the concrete wall of the gallery and can be energised to generate heat, as in a conventional oven. Running through the middle of the gallery is a second heating system, which serves as a back-up and can take over heat production completely, if necessary.



The heating system is fixed to the wall of the PRACLAY gallery.

Once the heating system had been installed, the gallery was back-filled with sand and fully sealed from the main gallery.

The sealing of the PRACLAY gallery is not part of the disposal concept under investigation but is essential to ensure even distribution of heat and pressure in and around the heated area throughout the heating phase of the experiment. The design and installation of the metal seal structure that closes the gallery required meticulous care, as it has to be able to withstand the high temperature and water pressure. Hundreds of cables connected to the heating system and to measuring instruments in and around the gallery pass through this seal.

Phase 2 of the PRACLAY experiment was completed at the end of 2011.

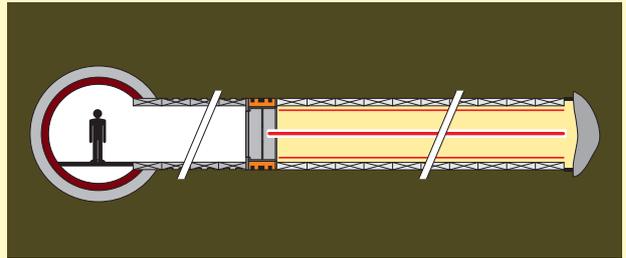
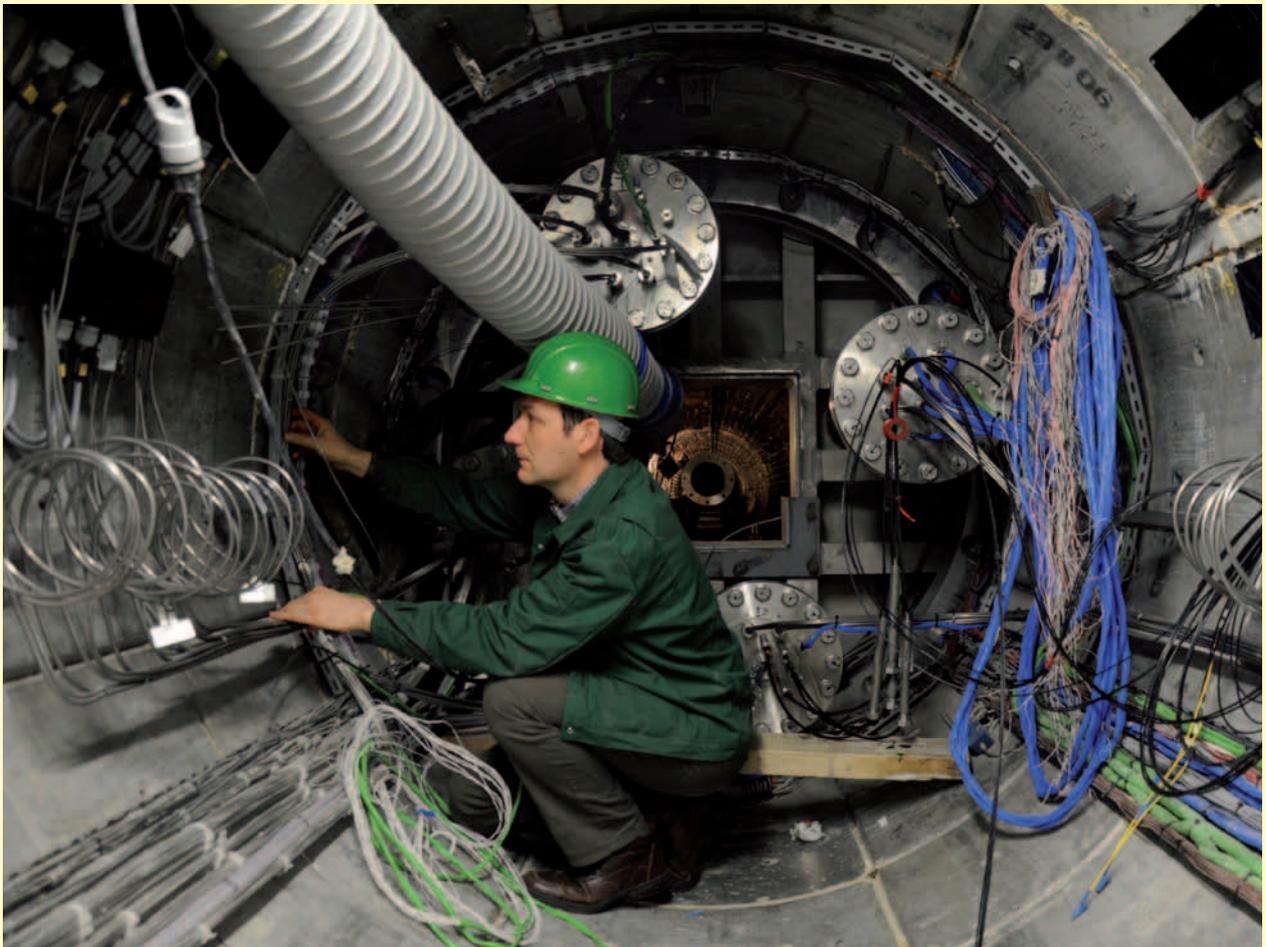


Diagram of the PRACLAY gallery after the heating system was installed (red lines), the gallery backfilled with sand (yellow) and the heated section sealed with a metal structure (between the orange blocks). The total length of the section to be heated is 35 metres.



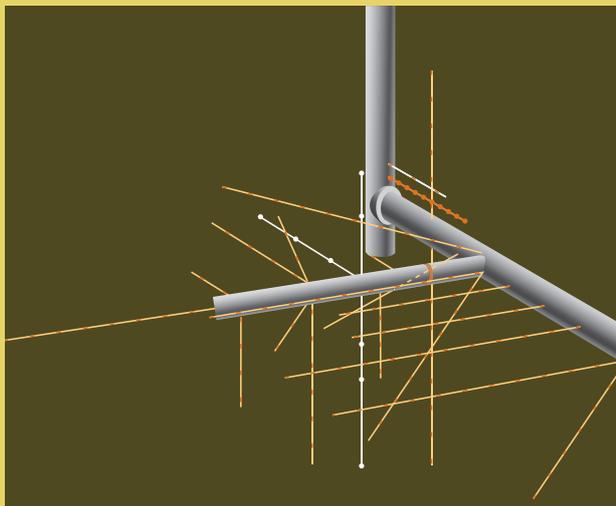
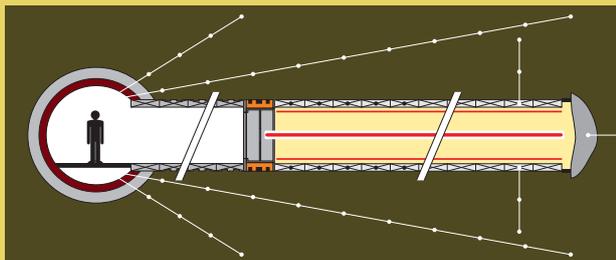
A researcher checks the measuring instruments near the metal structure sealing the gallery.

Phase 3: The heating phase (starting in 2013)

To investigate how the properties of Boom clay are affected, the gallery will be heated for ten years during this phase at a constant temperature of 80°C (measured at the point of contact between the concrete wall of the gallery and the clay), which is consistent with the temperature that will be generated in case of high-level waste disposal. The aim is to confirm and refine existing knowledge on the behaviour of clay. Scientists want to demonstrate that the models developed on the basis of earlier, small-scale experiments are still valid in conditions that are representative of an actual disposal facility. Research has shown that ten years is long enough to make reliable statements on the effect of heat on the stability of the clay. Scientists will already be able to make the first important conclusions after 2 years of heating.

During this phase of the PRACLAY experiment, it will also be possible to study how the gallery lining behaves over a prolonged period at an elevated temperature and in contact with Boom clay. This is important if the option of retrieving the waste from the repository after a certain period of time is to be considered.

What is measured in the PRACLAY experiment, and how?



The measuring instruments in and around the PRACLAY gallery measure not just temperature, but also the water pressure in the clay pores, total pressure and the chemical properties of the clay. To install these sensors, boreholes were drilled into the clay, sometimes as much as 20 metres deep, from inside the underground research facility. The instruments are connected to the facility via thin cables, and the measurements are recorded and transferred to the surface for processing. Scientists then use these measurements to develop, refine and – if necessary – improve their models of clay behaviour.

What does the future hold?

Once the heating phase is over (probably around 2023) and the entire experiment has been dismantled, scientists will spend time analysing all the data and drafting their final conclusions. The results of the PRACLAY experiment will refine the existing knowledge about the behaviour of the Boom clay during heating. The main goal is to confirm that the clay's favourable properties to contain and isolate the radioactive waste are not impaired. From this perspective the experiment is an important step towards building a real repository.

EIG EURIDICE is an Economic Interest Grouping involving the Belgian Nuclear Research Centre SCK•CEN and the Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS). It manages the HADES underground research facility and carries out safety and feasibility studies for the disposal of high-level and/or long-lived radioactive waste in a clay host rock.



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