

EXCAVATION OF A DEEP GALLERY IN BOOM CLAY: INSTRUMENTATION PROGRAMME AND PREDICTIVE MODELLING

*Barnichon Jean-Dominique and Bernier Frédéric, SCK•CEN, Waste and Disposal Department,
Boeretang 200, 2400 Mol, Belgium*
De Bruyn Didier, EIG PRACLAY, Boeretang 200, 2400 Mol, Belgium

The Belgian R&D programme on geological disposal for high-level and long-lived waste was initiated at SCK•CEN in 1974. A deep tertiary clay, the Boom Clay, was selected as a candidate host formation for experimental purposes, which led between 1980 and 1987 to the construction of the HADES underground laboratory at -223 m depth (one shaft and two galleries with a total length of 110 m). Mine-by-tests were performed during the excavation of the Test Drift (1987). They indicated a rather large extent of the hydraulic disturbance (around 1.0 MPa at a radial distance $r = 12$ m), and large values of short-term settlement (ranging between 10.7 cm at $r = 4.95$ m and 4.0 cm at $r = 8.1$ m). These results remain partly unexplained as modelling analyses do not predict such large values, particularly regarding the hydraulic disturbance extent (Côme, 1990; Mair et al., 1992). Since some excavation parameters (such as the overexcavation) were not well constrained, and due to the proximity of the first shaft, conclusions are difficult to be drawn. Therefore, new and more reliable data are required on the excavation-induced disturbance in the Boom Clay to improve the predictions.

Such an opportunity was given by the extension of the current underground laboratory (in the frame of the PRACLAY experiment) that involved the construction of a second shaft and a gallery (90 m long) connecting this new shaft to the existing Test Drift, under the management of the EIG PRACLAY (Economic Interest Grouping between NIRAS/ONDRAF and SCK•CEN).

In this context, the EC-funded CLIPEX (CLay Instrumentation Programme for the EXtension of an underground research laboratory) project was launched in January 1997 between EIG PRACLAY (coordinator), ANDRA, ENRESA, G3S, GEOCONTROL and UPM. It aims to assess the performances of mechanised excavation techniques and the corresponding reduction of the plastic zone. It consists in:

- elaborating an instrumentation programme for this extension,
- predicting the hydromechanical disturbance through a blind prediction exercise carried out by four modelling teams (G3S, GEOCONTROL, SCK•CEN and UPM),
- comparing the experimental data with predictions,
- refining the rheological models to fit as close as possible the experimental data.

The instrumentation consisted of 26 piezometric filters, 23 total pressure sensors (see Figure 1), one multi-point extensometer, two inclinometer chains and one deflectometer chain, some of these instruments being located in the zone to be excavated. Placement of the instruments has been performed in April-May 1998 from the existing Test Drift (see Figure 2). This is more than a year before the expected excavation date (during 2000), allowing to restore satisfactorily the virgin pore pressure field. The location of the instruments has been optimised from a preliminary modelling and from the experience gained in 1987 during the excavation of the

Test Drift. The foreseen semi-mechanised excavation will allow an accurate control of the excavation geometry (especially on the gap between the excavated diameter and the lining, which is a key parameter) and it should guarantee a minimum excavation rate of 2 m/day (rate at which no important time effects are expected).

The blind prediction exercise is based on the real excavation parameters (excavation rate and sequence, excavated and lining radius) and on different rheological models. Each modelling team makes its own choice to represent the hydromechanical behaviour of Boom Clay, based on its experience and on results of in-situ tests. Preliminary results of this exercise based on a Cam-clay model are presented on Figures 3-4.

The excavation phase is expected to occur in 2000, and the refinement of the rheological models and parameters will be carried out subsequently.

References

Côme B. 1990. The CEC benchmark Interclay on rheological models for clays. EUR 12791.

Mair R.J., Taylor R.N. and Clarke B.G. 1992. Repository tunnel construction in deep clay formations. EUR 13964.

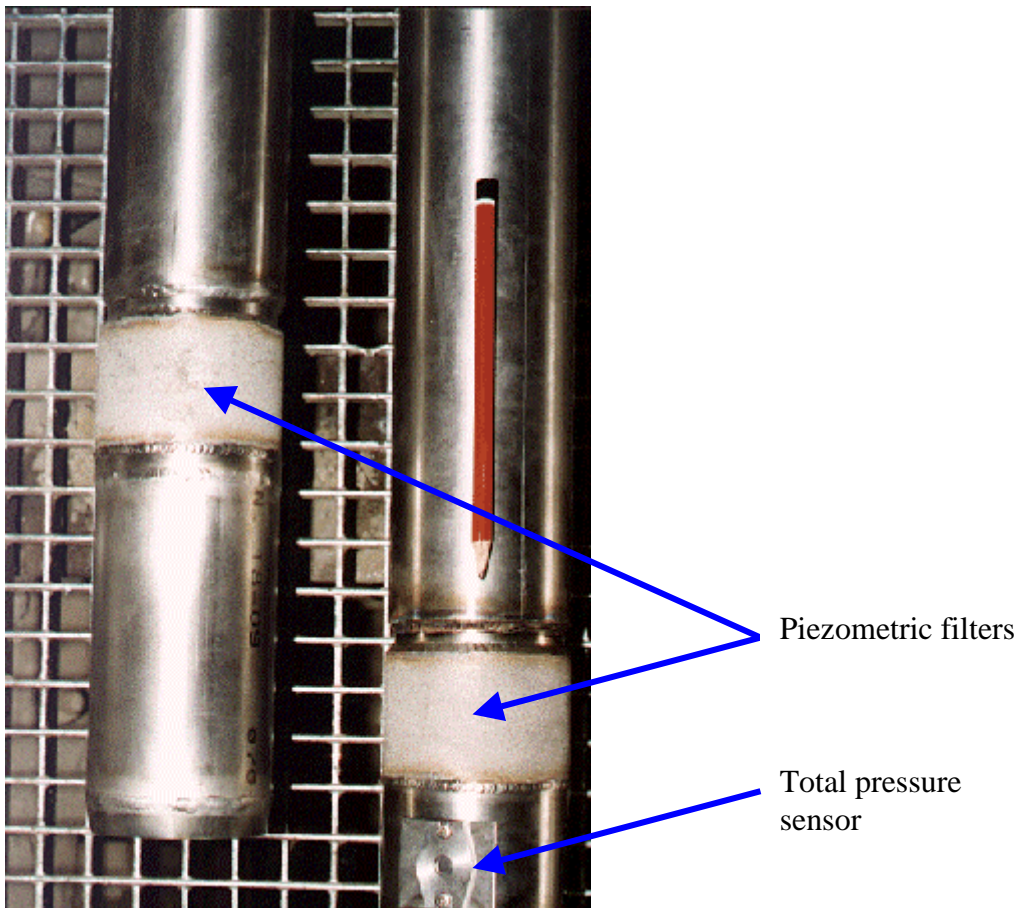


Figure 1. View of the instruments mounted on a steel casing

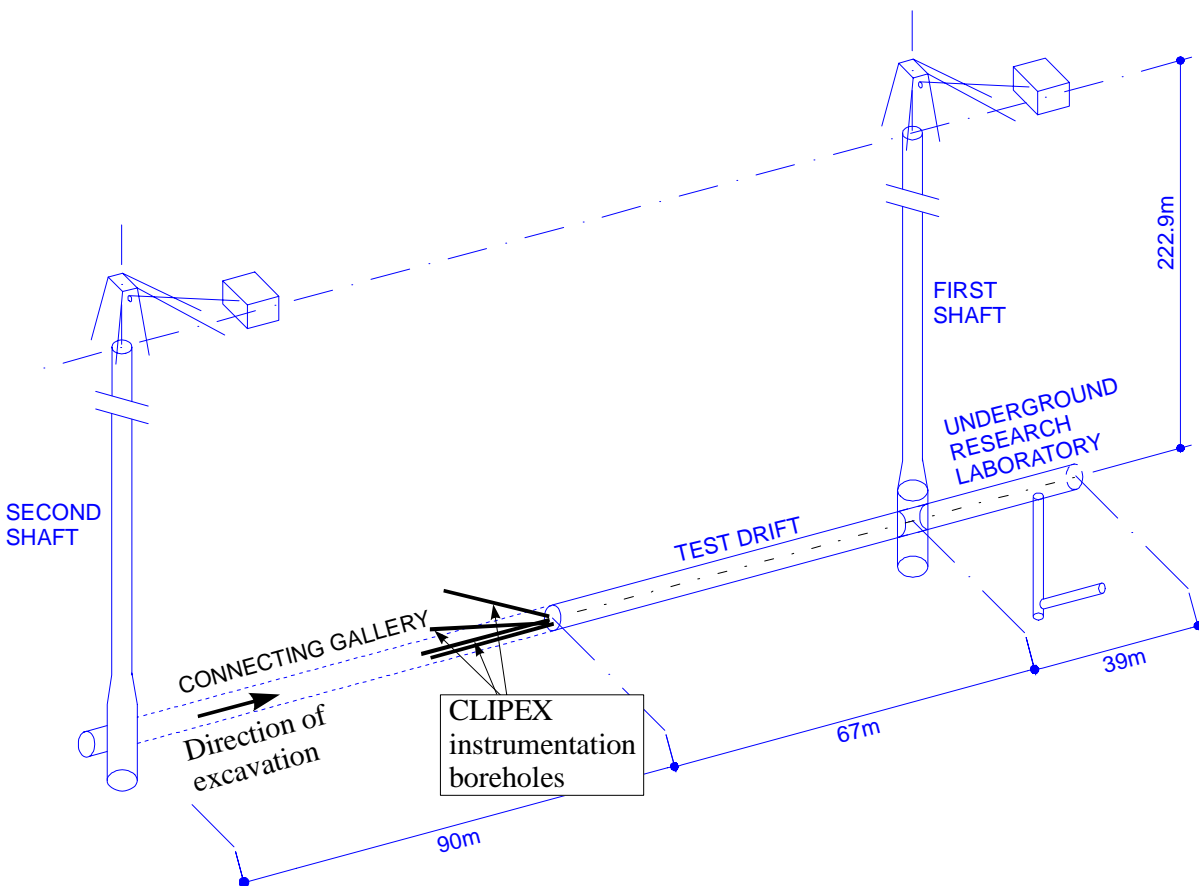


Figure 2. The extension of the underground laboratory at Mol (Belgium)

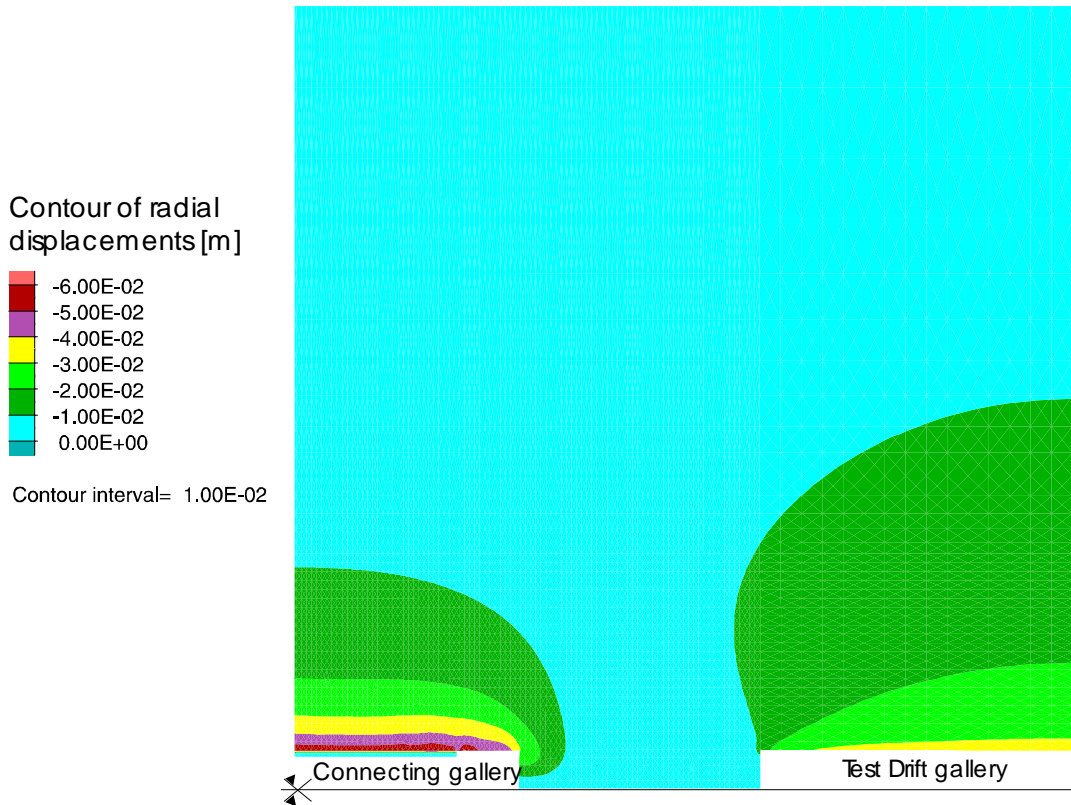


Figure 3. Predicted displacement field after the excavation of the connecting gallery.

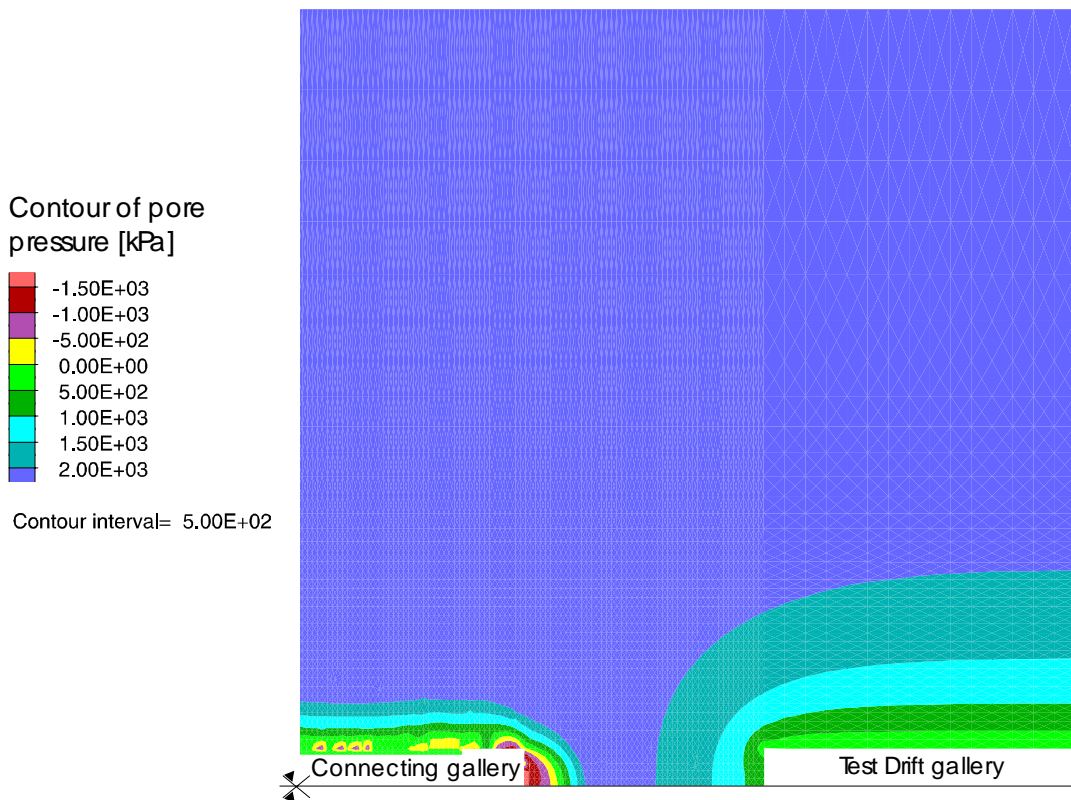


Figure 4. Predicted pore pressure field resulting from the excavation of the Test-Drift gallery followed by 11 years of water flow (with a permeable lining), and of the connecting gallery under undrained condition.