CHARACTERIZATION OF GROUNDWATER FLOW IN THE ENVIRONMENT OF THE BOOM CLAY (CAMPINE, BELGIUM)

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In Belgium, the Boom Clay formation is considered as reference host rock for the geological disposal of radioactive waste. Aquifers surrounding the Boom Clay play a passive role in the context of the disposal safety whereby the radionuclides are diluted by groundwater flow. The groundwater flow in these aquifers has been studied since decades. This research involves observations of groundwater levels in the regional and local piezometric networks, several site investigations including geophysics and core-drilled boreholes and groundwater modelling. In this context, groundwater modelling represents the integration of the site characterization efforts and provides a comprehensive tool for constraining the models used in the safety assessment of the geological disposal.

Since 1985, groundwater levels are observed monthly in the regional piezometric network. It consists of 142 filters monitoring the groundwater levels at 45 sites. Along with the observed groundwater levels from the local piezometric network (concentrated around the Mol-Dessel site for surface disposal), these data provide an excellent insight into the evolution of the groundwater levels. Moreover, they represent a calibration (validation) dataset for groundwater flow modelling.

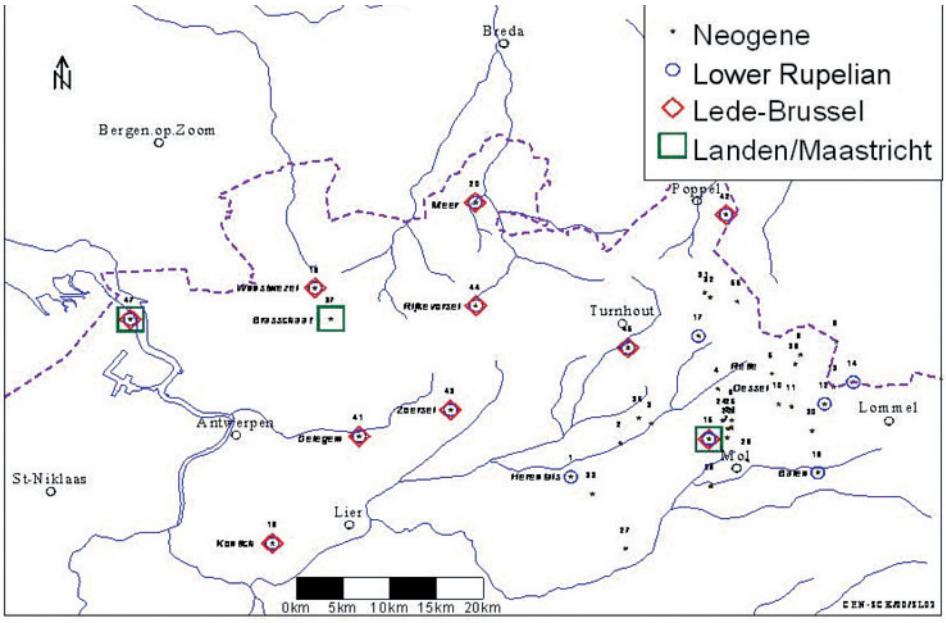

Figure 1: Position of the monitoring objects of the regional piezometric network.

The groundwater system forming the environment of the Boom Clay host rock was characterized during several site investigation campaigns, within which seven core-drilled boreholes were realized, whereby hydraulic parameters and hydrostratigraphy of the groundwater system could be collected. The dataset obtained from the above mentioned campaigns was complemented by archived data on hydraulic testing

in the aquifers in order to build a comprehensive groundwater model integrating these data into a single numerical representation of the groundwater system.

Three regional groundwater models have been developed integrating the site characterization data collected in the north-east of Belgium.

The North-eastern Belgium model (NEB-2002) represents the second update of previous regional models of the north-eastern Belgium aquifer system for the reference site at Mol-Dessel dating from 1984 and 1992. It aimed at modelling the groundwater system both above and below the Boom Clay. Since the groundwater regimes differ substantially above and below the Boom Clay, the modelling results were conceptually divided into one representing the original and one representing the evolving state of the aquifers below the Boom Clay. This division was based on existence of excessive pumping of the aquifers below the Boom Clay that has caused continuous decrease of the groundwater levels during the last 50 years. Since such transient situation occurs in the aquifers below the Boom Clay a steady-state model cannot be used to describe the long-term equilibrium of the aquifer system.

The Deep aquifer pumping model (DAP model) focuses on the transient behaviour of the confined parts of the aquifers located below the Boom Clay. The aim of the model was to reconstruct the history of pumping in the aquifers below the Boom Clay and fit the simulated heads to the observed values. It is, of course, impossible to precisely predict the evolution towards the future; however, the results indicate a possible extent of hydraulic gradient change induced by pumping.

The Neogene aquifer model (NAM model) simulates the groundwater flow in the aquifers above the Boom Clay. The NAM model is enclosed by the natural no-flow boundaries of the river catchments. The Nete catchment is simulated with two principal rivers: Kleine Nete and Grote Nete rivers. The modelled area is smaller in respect to the NEB-2002 model, which allows more detailed schematisation. The vertical division of the Neogene aquifer model allows for later incorporation of a more detailed scale model simulating transport of radionuclide contamination. The NAM model is numerically optimised to overcome the problem of pinching-out hydrostratigraphic units and huge aquifer thickness differences between different parts of the model. It runs in a steady-state and satisfactorily reproduces the observed groundwater levels and performs well when compared to the observed fluxes into rivers.

The aquifer systems in the environment of the Boom Clay provide for a passive dilution safety role in the geological repository design. The characterization programme along with the numerical modelling represents a sound basis for estimation of the safety assessment parameters, the derivation of the boundary conditions for the local and transport models and assessing the effects of the climate and other events.