Geoscientific Exploration of a Candidate Waste Disposal Site in Rock Salt

Sandra Fahland, Peter Vogel & Stefan Heusermann
Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany

The Gorleben salt dome has been investigated since 1979 for its suitability as a repository for the disposal of high-level radioactive wastes. The geoscientific surface exploration was followed by underground exploration of the site beginning in 1983: underground excavation work included the sinking of two shafts from 1986 to 1994, the excavation of the infrastructure area and of drifts located in the first exploration area EB1 within the following years. The exploration was interrupted for ten years from 2000 to 2010 as part of a moratorium. After the expiry of the moratorium in March 2010, the geoscientific underground exploration at the Gorleben site was resumed. The investigations were interrupted again in autumn 2012 due to a political decision. The exploration programme included extensive geoscientific investigations: geological exploration, geophysical investigations, mining exploration and mining observation, laboratory tests, in-situ geotechnical measurements, geological modelling and numerical model calculations. To analyse and interpret the results of the in-situ measurements and mining observation geomechanical, thermal and thermo-mechanical model calculations were carried out. Parallel to the continuation of the site investigation a preliminary safety analysis was carried out including extensive numerical model calculations to assess the long-term integrity of the salt barrier under thermal loading caused by HLW and under ice age scenarios.

One of the main elements of the in-situ geotechnical investigations were high-resolution geothermal measurements performed in boreholes used for geological exploration and geotechnical tests. The geothermal measurements are used to evaluate several geotechnical findings, e. g. drift closure, rock deformation, stress change, and are completed by thermal model calculations to analyse and interpret the results of in-situ measurements and mining observation. The model calculations have been carried out using the special purpose JIFE code. To consider the whole exploration mine with the adjoining host rock as well as the successive excavation of drifts and boreholes in detail a three-dimensional finite-element model was developed. The model calculations are used to analyse the cooling-off of the surrounding rock of the drifts caused by ventilation. The cooling-off of the surrounding rock is an ongoing process affecting the results of further geotechnical measurements in the near field of the drifts. Thermal model calculations are necessary to predict a realistic time and space dependent distribution of the temperature field of the host rock within the exploration area which is influenced by ventilation. Comparing the calculated temperature field with the in-situ determined rock mass temperature field within the exploration area EB 1 the results show a sufficient agreement. Furthermore there is very good correspondence, both qualitatively and quantitatively, between the experimental and the calculated findings regarding the temperature profiles including the effects of excavation and ventilation of the drifts.