BGE TECHNOLOGY NEWS

3
2022

Team of BGE TECHNOLOGY GmbH

BGE TECHNOLOGY GmbH

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Analysis of drill cores at URL Bedretto

Dear Readers,

As head of the newly established Numerical Modelling Department, it is a pleasure for me to refer in this editorial to the article on the geotechnical calculations being carried out for the Morsleben repository. It gives an insight into the great work being done by the Numerical Modelling Department for our parent company, BGE.

Work for BGE has always been a major part of our activities. In the past, such work concerning HLW disposal was restricted to projects about disposal in salt as host rock formation. In the past two decades, we have also carried out projects for the development of disposal concepts in clay and crystalline, but only in the framework of national R&D projects financed by the government or in international projects.

With the new German site selection process implemented by BGE taking up momentum, we are also increasingly engaged in projects for our parent company that are related to HLW disposal in crystalline or clay as host rock. Two interesting examples are described in this newsletter: project PRECODE, which addresses the closure of fractures around emplacement locations in crystalline rock, and ELB-Rock, which is dedicated to the development of disposal canisters for crystalline environments.

Another interesting line of research, which has recently gained increasing importance for our international activities, is the disposal of HLW and SNF in deep boreholes (DBD). We started the corresponding work 10–15 years ago with an R&D project on the disposal of such waste in 300-m-deep boreholes, coming from the disposal level of a geological disposal facility. In recent years, our activities have newly focussed on this disposal concept in the framework of projects carried out for NND (Norwegian Nuclear Decommissioning) and CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), which also led to our participation in a respective IAEA workshop, where we shared our experience concerning DBD concepts with other interested organisations.

Closing, I would like to repeat our standing general invitation to contact us should you be interested in learning more about our technical skills and experience, should it concern the topics briefly described in this flyer or in general.

Happy Reading!

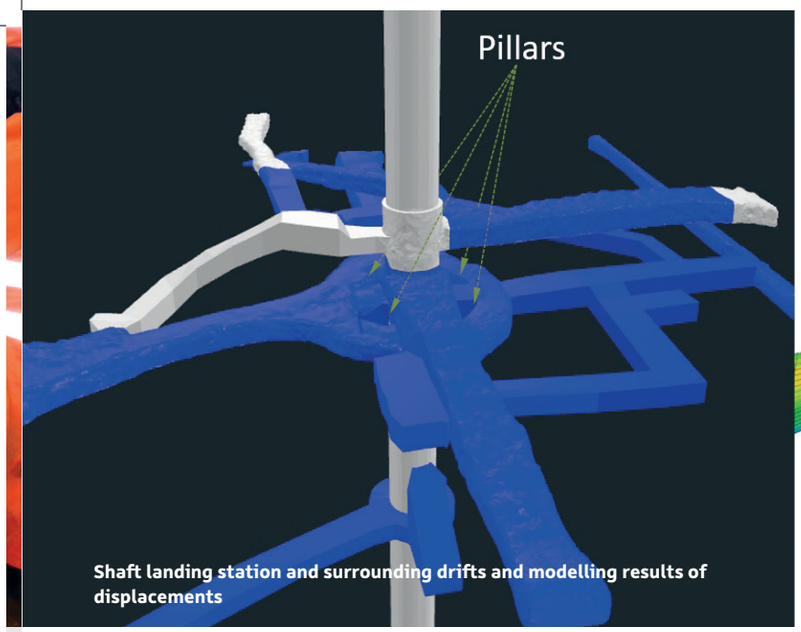
Bernt Haverkamp

Understanding the Hydraulic Behaviour of a Fractured Crystalline Rock

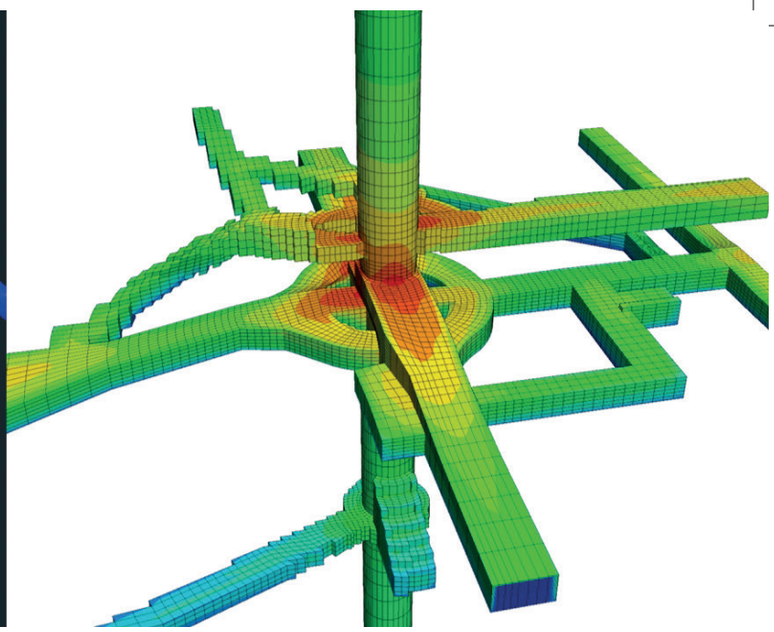
In May 2022, BGE TECHNOLOGY GmbH carried out water pressure tests on the hydraulic behaviour of the Rotondo Granite at the Bedretto Underground Laboratory for Geosciences and Geoenergies (BULGG) in Switzerland, the granite being used as an example for a fractured crystalline rock mass. The work is part of the joint project PRECODE, funded by BGE, where BGE TECHNOLOGY GmbH pursues to create near-natural fracture fillings in a crystalline rock mass in order to reduce its permeability in the long term (compare newsletter 4/2021). The investigation contributes to the current development of suitable injection materials and related injection process parameters. For this purpose, three 10-m-long boreholes were core drilled perpendicular to the tunnel axis with a slight decline to intersect with the anticipated fracture network at multiple positions. The location, which had been selected based on data from ground-penetrating radar, drift scans, and a fracture survey, turned out to be suitable as each of the holes cut through natural joints and furthermore, even delivered a constant water flow.

The fact that dry fractures at the tunnel walls and wet fractures just behind them existed in parallel, underlines the challenge to distribute injection materials in the fracture network. Irrespective of their actual water bearing, wet and dry fractures are potential pathways and thus, should be minimised around a future emplacement hole.

Core samples and borehole videos helped to identify the locations of the natural fractures in the host rock. Then, step by step, a double packer system, consisting of two packers with an intermediate testing space, was pushed to the respective location in a borehole to seal it before and behind individual or groups of fractures, depending on their spacing. Finally, a high-pressure pump delivered a



Shaft landing station and surrounding drifts and modelling results of displacements



controllable flow of water into the testing space and the connected fractures, which resulted in a characteristic dynamic pressure development. The tests give a first impression of the hydraulic behaviour of the rock mass from elastic deformation to the widening of fractures, up to the reopening of closed fractures. Although the processing of the measurement data is still ongoing, based on the positive impressions from the first tests, the three boreholes will be used again to test injection materials under realistic conditions.

Stability Assessment of the Landing Station of Shaft Marie

Shaft "Marie", which is the discharge ventilation and rescue shaft of the ERAM LILW repository, celebrated its 125th birthday this year. In August 1898, the shaft, named after the mine owner's wife, was completed by miners working with shovels, pickaxes, and buckets. It is 522 m deep and has a diameter of 5.8 m. In search of potash salt, a shaft landing station was established on the first level at a depth of 360m. This station is located in the main rock salt of the Stassfurt series. The four drifts branching off the shaft and a surrounding bypass drift form low thickness pillars. Recently, deformation has been observed in the area of the masonry between the pillars. Prior to a comprehensive renovation of the shaft landing station, it is necessary to identify the causes for this deformation and to analyse the situation of its extended area. Therefore, a stability assessment is carried out, which combines geotechnical measurements and numerical analyses. Together with BGE's Department of Geotechnics, a monitoring concept has been designed, which consists of convergence stations and long extensometers that monitor the vulnerable areas in the form of long measuring chains. Each of the magnetostrictive extensometers measures the displacements with high precision (resolution: 70µm) at 20 measuring points along a 5-metre-line. Fissurometers are installed as well. BGE TECHNOLOGY GmbH currently conducts stability investigations based on a 3D numerical model. Incoming measurement data are used to verify the model.

Development of HLW Containers for Disposal in Crystalline Rock

In spring of 2022, BGE TECHNOLOGY GmbH and Gesellschaft für Nuklearservice mbH (GNS) started the joint project ELBRock on behalf of BGE. Within the scope of this project, which is led by GNS, up to three different waste container concepts for high-level and heat-generating radioactive waste or spent fuel will be developed for BGE´s site selection department. These waste container concepts will be especially designed for disposal in crystalline rock.

The first step in the project ELBRock is to summarise the necessary boundary conditions and inputs for the subsequent development of waste containers. Therefore, the geologic characteristics of crystalline rock and the waste inventory to be considered will be detailed first. In a second step, the state of the art of relevant inputs and boundary conditions like disposal concepts and emplacement technologies, waste container materials and spent fuel treatment will be summarised. In a next step, the respective results and the state of the art will be used to derive the necessary waste container requirements and the impacts that have to be considered in container design. Following these first ideas, new or adaptable waste containers will be generated and evaluated. Up to three waste container ideas will then be further developed to waste container concepts. At the same time, corresponding safety assessments have to be prepared for these container concepts. Here, two aspects – operational and long-term safety – have to be taken into account. The key aspects of the ELBRock project are:

- Summarising the state of the art of final disposal in crystalline rock
- Compiling a list of waste container requirements
- Designing up to three different waste container concepts
- Describing the container-relevant aspects for a future safety case

In the first steps of the ELBRock project, BGE TECHNOLOGY GmbH will focus on describing the geologic conditions of crystalline rock and on summarising the state of the art regarding disposal in this type of rock.

Closing the Emplacement Chambers of the Konrad Repository

In Germany, non-heat-generating, radioactive waste is to be disposed of in the Konrad repository. The waste packages are to be stacked in emplacement chambers that are up to approx. 1 km long. The packages will be placed in sections of 50 m length. Then, shotcrete will be applied to the last stack of packages, thus creating a wall that allows backfilling of the section with a high-flowable mortar. At the entrance to the emplacement chambers, there are areas for reloading packages and for turning vehicles. Large ventilation boreholes open into these areas. These areas and boreholes are also to be backfilled.

Tests of backfill material with a pipe viscometer

At the chamber entrances, however, it is not possible to apply shotcrete to waste packages. The task was therefore to compile options for a support and to evaluate the technical feasibility of its construction in the controlled area of the repository and to assess whether the construction can be integrated into the work processes. The support materials must not be combustible and must be transportable underground and to the place of use in sufficient amounts. It must be possible to erect the support in a short time, with little effort, and with existing equipment. After shotcrete has been applied, all walls must meet the static requirements and be solution-tight.

For example, empty containers (dummy containers), formwork blocks, mobile formwork systems, and the creation of walls with flexible plastic tubes were considered. The options were evaluated by BGE TECHNOLOGY GmbH based on a specially developed evaluation matrix with weighted factors. In this context, our extensive practical experience gained in the context of backfilling and sealing measures was of great benefit. In the end, reference solutions were selected in cooperation with mining engineers from the site. This way, another cornerstone was laid for the smooth execution of the emplacement operations in the Konrad repository.

IAEA Workshop on the Feasibility of Borehole Disposal

Deep borehole disposal (DBD) allows efficient isolation of small volumes of all kinds of radioactive waste from the biosphere. A simple basic concept can be adapted to the waste inventory and the geologic and hydrogeological conditions. This increases the probability of being able to use a host rock with optimum properties. Moreover, the footprint of a facility and the possibility of human intrusion are very small. Due to these facts, many countries are considering this disposal option. So far, disused sealed sources have been disposed of in boreholes. For the realisation of deeper borehole projects, an exchange of experience between experts is essential.

The International Atomic Energy Agency (IAEA) promotes the exchange of knowledge and experience gained. Working meetings are to identify and coordinate research needs. A recent meeting at the IAEA headquarters in Vienna offered many countries the opportunity to present their statuses of work. BGE TECHNOLOGY GmbH has extensive knowledge in the design of transport and disposal containers, of borehole disposal in geological disposal facilities, and has already carried out studies on DBD projects around the world. At the IAEA meeting, options for transporting and emplacing containers as well as a corresponding hoisting system were presented, the performance and reliability of which have already been proven. In addition, a procedure for developing sealing systems that have a very high level of reliability due to the selection of long-term stable materials and the concept of redundancy and diversity was described. The findings of quality assurance measures are an essential basis for demonstrating functionality. For this reason, BGE TECHNOLOGY GmbH presented the structure of a proven programme that was developed for sealing boreholes. This way, the expertise of BGE TECHNOLOGY GmbH significantly contributes to the success of borehole disposal projects.

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For further information, visit www.bge-technology.de or scan the QR code below.

Published by:	BGE TECHNOLOGY GmbH Eschenstraße 55 · D-31224 Peine www.bge-technology.de July 2022
Edited by:	Dr. Andree Lommerzheim
Layout and print by:	Druckhaus Giese & Seif, Peine