BGE TECHNOLOGY NEWS

1
2024

Sandy Ridge Facility, Near-Surface Repository for Hazardous and Low-level Radioactive Waste, Australia (Source: TELLUS)

BGE TECHNOLOGY GmbH

Renewal of the Cooperation Agreement with RWMC (Japan)

Dear Readers,

The world is not at rest and we do not know which surprises await us around the next corner. But the uncertainty associated with this is particularly motivating for us when it comes to ensuring safety, especially for the things that we can influence. More specifically, this means eliminating the potential threats arising from radioactive waste for now and for all future generations, or at least reducing them to harmless levels. That this is possible has been successfully demonstrated for a long time – by us and by experts throughout the world in other disposal programmes. All that is needed is to derive special approaches from existing knowledge that take into account the specific characteristics of national programmes.

It should also be noted that it is still possible to work together in a friendly and constructive manner despite all the apparent disagreements between countries and cultures. In this newsletter, we have compiled a list of activities and projects to support this thesis. You can look forward to articles on the continuation of our fruitful collaboration with Japanese partners, the successful support of our Australian friends, and various successful research projects at European level.

These projects show that cross-border cooperation is not only possible, but can be fun, create friendships, and deliver successful results. But read on and convince yourself.

Happy Reading!

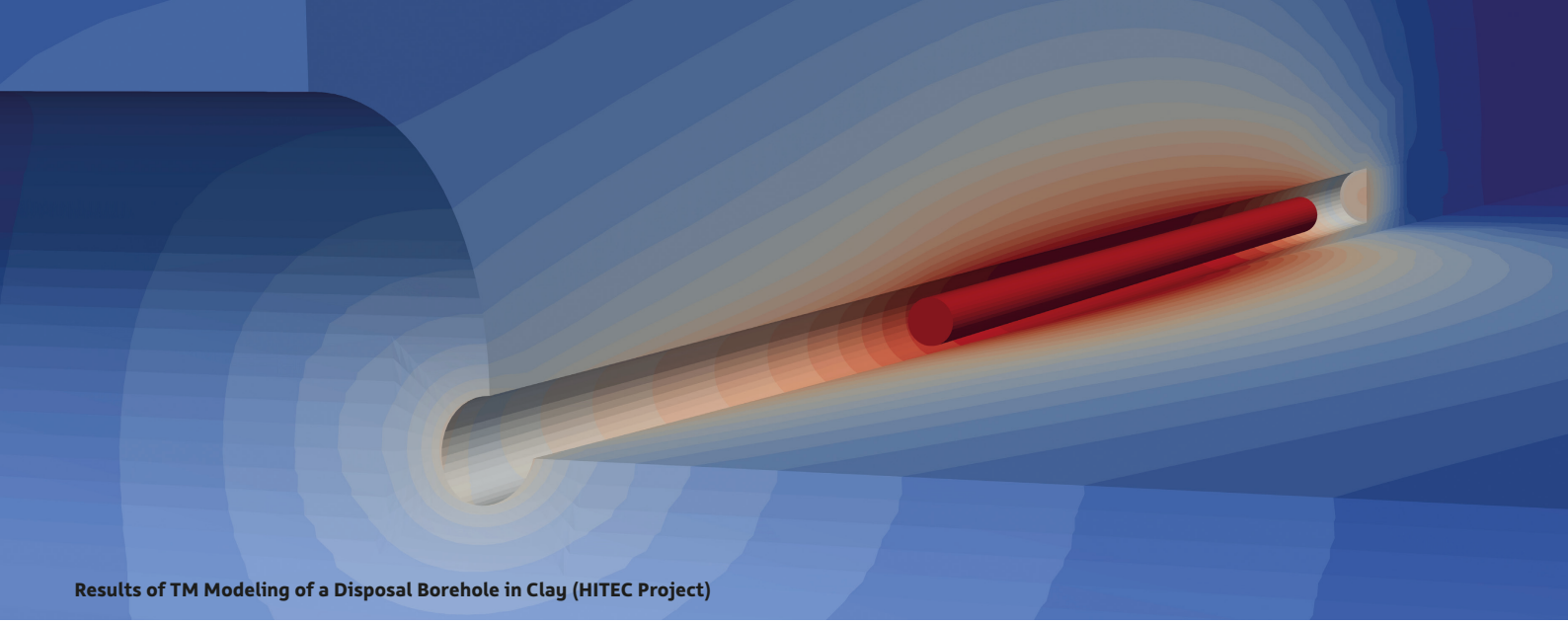
Thilo Berlepsch

Strengthening of Bonds with Japanese Organisations

The Japanese Radioactive Waste Management Funding and Research Center (RMWC) together with BGE and BGE TECHNOLOGY GmbH (BGE TEC) have held a cooperation agreement for more than twenty years. The agreement is always concluded for a five-year period, and in 2023, the current agreement would have expired. There was no question that all sides had a strong interest in continuing the successful cooperation. Thus, a continuation of the cooperation agreement was signed upon a visit of BGE TEC to Japan. At the same time, the opportunity was used to directly exchange information on the latest R&D activities of both sides and to discuss the lessons learned. BGE TEC was very interested to learn about the large-scale demonstration tests of emplacement and retrieval equipment of RMWC. Experience in lab-scale experiments and modelling approaches for thermo-hydro-mechanically coupled processes in bentonite were discussed as well.

In addition, BGE has cooperation agreements and strong relationships with the Nuclear Waste Management Organization of Japan (NUMO) and the Japan Atomic Energy Agency (JAEA) that include BGE TEC as well. Hence, the visit to Japan was also used for meetings with colleagues of both organisations as well as with other Japanese organisations like the Japan Engineers Federation. During the meeting with NUMO, the continuation of common activities was discussed. In recent years, the cooperation with NUMO was intensified especially in the field of transport and emplacement equipment for deep geological repositories. Both sides share the designs and supported each other in the further development of corresponding technologies. In the course of the discussions, several topics of interest to continue the collaboration in the next years were identified.

Furthermore, during the meeting with JAEA, the future work in the Horonobe International Project (HIP), which has been organised under the auspices of OECD/NEA, was discussed and ideas were shared.



Results of TM Modeling of a Disposal Borehole in Clay (HITEC Project)

Consultancy for the Sandy Ridge Deep Borehole Research Project

Tellus Holding LTD sought design and engineering assistance for the Sandy Ridge Deep Borehole Project, with the objective of drilling a demonstrative deep borehole. A potential site for the demonstration project will be in the West of Australia. BGE TECHNOLOGY GmbH assisted Tellus Holding LTD on their way to submit the required documents to the responsible authorities for approval.

Generally, drilling deep, large-diameter holes, not only for radioactive waste disposal, involves a multi-step process with interdependent parameters. The geological characteristics significantly influence the borehole design and drilling techniques. Furthermore, the borehole's purpose, the rock formation type, and the rock strength dictate the choice of drilling technique.

When designing a borehole, various parameters must be taken into account in order to ensure a successful drilling process and to achieve the desired result in the end. In this case, the depth and diameter are predefined, however, geological conditions play a crucial role in deciding casing strategies for example. Based on assumptions about of the geological stability, a two-casing design with surface and intermediate casings has been proposed, which aligns with the disposal objectives.

Additional aspects like the selection of the right casing materials and wall thickness in order to minimise load on the drilling rig while ensuring borehole stability are indispensable.

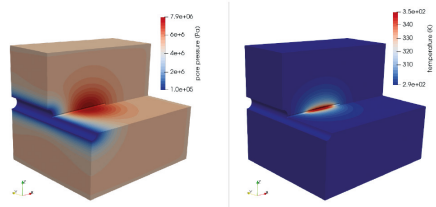
During the post-drilling phase, demonstration tests related to radioactive waste disposal, sealing, and surface facility restoration are planned, however, no detailed test plans are available at the present time. Especially the complex sealing approaches that are required for boreholes designated for radioactive waste disposal are a potential research area to have a closer look at in the future. It is crucial to achieve a low permeability to isolate waste effectively. In order to meet this objective, the removal of foreign materials, such as casing strings, may be necessary to enable direct contact between sealing material and the formation.

In summary, drilling deep, large-diameter boreholes for radioactive waste disposal requires careful planning, drilling technique selection, and post-drilling operations. The choice of drilling technique depends on factors such as geological conditions and contamination risks. Sealing and restoration processes are tailored to meet the specific objectives of each borehole, ensuring the safe and efficient disposal of radioactive waste.

R&D Project HITEC: Analysis of High Temperature Effects on Clay Host Rocks

As mandated German Waste Management Organisation, BGE is contributing beneficiary of the European Joint Programme on Radioactive Waste Management (EURAD) and, among others, involved in the R&D work package HITEC. In this work package, the influence of temperature on clay host rock and clay buffer materials is investigated. BGE TECHNOLOGY GmbH (BGE TEC) assisted BGE in this task by developing, verifying, and validating numerical tools that are necessary for carrying out safety analyses for repositories in clay formations.

To achieve this goal, BGE TEC was involved in two sets of assignments in WP HITEC. First, the participation in a benchmark initiative aiming at verifying different numerical codes for THM safety assessments. As a result, the good agreement between all codes involved in the benchmark has been demonstrated in the context of a verification and validation procedure. In a second step, BGE TEC worked on the validation of its numerical tools by performing the simulation of an in-situ heater experiment. This experiment was carried out in the BURE underground research laboratory in France and aimed at investigating the THM response of the clay host rock due to heat flow resulting from the HLW disposal waste packages.



Pore pressure and temperature distribution in the model 2,000 days after the beginning of heating

The temperature distribution in the model clearly shows the heat propagation from the heater into the rock. The effect of the heating is replicated in the pore pressure distribution, where a maximum overpressure is observed near the borehole. An analysis of the consequences on the access drift shows a pore pressure decrease over time. The modelling results were in line with the experimental data. Remaining discrepancies will be the subject of further studies.

11th HotBENT Partner Meeting in Brunswick

From November 28 to 30, 2023, the annual meeting of the HotBENT project (High-Temperature Bentonite Enhancement Technology) took place in the his-

Model of the In-situ Test of a Clay Barrier, Grimsel Test Site (HotBENT Project) (Source: GTS)

torical city of Brunswick, Germany, hosted by BGE and BGE TECHNOLOGY GmbH (BGE TEC). This international gathering brought together leading experts in bentonite research from the Czech Republic, Germany, Japan, South Korea, Spain, Switzerland, the UK and USA.

The HotBENT project, an international research initiative, focuses on advancing the safe disposal of high-level radioactive waste by studying the high-temperature performance of bentonite-based materials in engineered barrier systems (EBS). Key objectives of the project include conducting an in-depth analysis of bentonite behaviour under extreme thermal conditions in deep geological repositories. Through a combination of laboratory experiments and a large-scale in-situ test at the Grimsel URL (Switzerland), the HotBENT project aims at demonstrating the robustness of bentonite-based seals, thus ensuring the safety and effectiveness of nuclear waste disposal.

The meeting in Brunswick provided an invaluable platform for discussing the latest results of the partners and the status of the field experiment.

BGE TEC is involved on behalf of BGE in the modelling of the in-situ experiment and will also further develop a constitutive material model that is to be capable to predict the THM response of different kinds of bentonite. This will be carried out together with the French Alternative Energies and Atomic Energy Commission (CEA), Charles University Prague, and with the technical assistance of the Geotechnical Institute of the Technical University Bergakademie Freiberg.

R&D Project PRECODE: Quantification of the Dilatancy and Fluid Pressure Criteria in Crystalline Rock Formation

BGE TECHNOLOGY GmbH works jointly with RWTH Aachen on the project funded by BGE. The main objectives of this project are: (i) to improve the understanding of EDZ formation in crystalline rock, (ii) to test methods for near-natural fracture filling by injection to reduce rock permeability, and (iii) to develop a method to quantify the dilatancy and fluid pressure criteria in crystalline host rock for safety assessments. The following text presents several results of BGE TECHNOLOGY GmbH's numerical modelling of mechanical rock behaviour to achieve the latter objective.

Crystalline rock formations are anisotropic and heterogeneous due to the presence of fractures. Therefore, the incorporation of fractures and their orientations is a crucial step in the numerical modelling of crystalline rock when it comes to performing integrity analyses of the geosphere. For this purpose, a fracture continuum modelling approach is proposed. A ubiquitous joint model explicitly represents the fractures and an isotropic Mohr-Coulomb model depicts the rock matrix for a more realistic description of crystalline rock behaviour. Simulations of a host rock model with three predefined structural geological fractures demonstrate the applicability of the modelling approach. Through the integrity analyses, it has to be shown that the expected stresses are below the dilatant strength and fluid pressure limits. Discrete element simulations, which have been widely used to study the mechanical behaviour of fractured media, are used to validate the proposed approach.

To establish a greater connection to reality, stochastically generated discrete fracture networks (DFN) with fractures of different sizes, orientations, and connections, will be used in future models. The input parameters for the DFN generation come from real exploration data of a tunnel. The integrity evaluation of the geosphere is important for the long-term safety assessment of a repository.

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

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