BGE TECHNOLOGY NEWS

4
2022

Konrad Shaft Landing Station

BGE TEC
BGE TECHNOLOGY GmbH

- IAEA WORKSHOP ON CONSULTING ARGENTINA IN IMPLEMENTING THE SITE SELECTION PROCESS FOR A HLW REPOSITORY
- METHODICAL APPROACH FOR PLANNING SEALING SYSTEMS FOR DEEP BOREHOLES
- DEVELOPMENT OF SUSTAINABLE MINING TECHNOLOGIES – BACKFILLING MEASURES WITH LOW CO_2 FOOTPRINT
- 12TH US/GERMAN WORKSHOP ON SALT REPOSITORY RESEARCH, DESIGN, AND OPERATION
- DEVELOPMENT AND TESTING OF A CONSTITUTIVE MODEL FOR CRYSTALLINE ROCK (R&D PROJECT BARIK)

IAEA Workshop on Site Selection Procedure in Buenos Aires (Argentina)

Dear readers,

It is time for some good news: In Switzerland, Nagra, the National Cooperative for the Disposal of Radioactive Waste, has proposed a site for a repository for high-level radioactive waste. Somewhat surprisingly for some, it is one of the three sites left in the final round of the search process that were to be investigated in detail. The process lasted almost 15 years, was always supported by politicians, and was characterised by a continuous and constructive dialogue with the Swiss Federal Nuclear Safety Inspectorate (ENSI) and with the public concerned. Eventually, Nördlich Lägern was identified as a site suitable for a repository that provides safety for the next one million years.

This demonstrates once again that it is possible to solve complex, cross-generational, and controversial problems if the public listens and discusses without ideology, if authorities and operators enter into a constructive dialogue, and if politics actively supports the efforts. There are several countries that are successfully advancing their repository projects on this basis. In Finland, a repository is already being constructed and is taking concrete shape. A construction permit for a repository was granted in Sweden earlier this year. France is in the final stages of the licensing process. And Canada was able to concretise its timeline on the basis of progressing work and announces the selection of a site for 2024, while the start of construction continues to be 2033. I am confident that our parent company, BGE, has set out to be similarly successful in finding a site for a repository for high-level radioactive waste.

Meanwhile, we continue to make our small contribution to ensuring that radioactive waste can be disposed of safely internationally. We are very happy that it is possible to meet again for face-to-face discussions on this. Knowledge exchange and transfer is often more effective in person than virtual, as the US/German workshop in Germany and the site selection workshop in Argentina showed. In addition, we were able to continue working on exciting tasks, which we would like to share with you in this newsletter. Sustainability is on everyone's lips, and, accordingly, we are developing methods for sustainable mining. The careful sealing of deep boreholes, in this case for the disposal of radioactive waste, is a similarly important task. In order to make reliable predictions about the behaviour of the underground rock, suitable material models must be developed and implemented in numerical tools.

But I would rather let the activities be reported from more competent sources and let our experts have a word. So please enjoy our newsletter!

Happy Reading!

Thilo Berlepsch

IAEA Workshop on Consulting Argentina in Implementing the Site Selection Process for a HLW Repository

From 12–16 September 2022, an IAEA workshop on "implementing the site selection process for a HLW repository" took place in Buenos Aires, Argentina.

The Argentinian waste management organisation CNEA (Comisión Nacional de Energía Atómica) had already started, and then stopped, a previous site selection programme. The current focus of the Argentinian DGR programme is on planning the siting process and reviewing all previous work, on establishing selection criteria, and starting an early site screening. Many lessons have been learnt, and there is a fair amount of site characterisation data available, including in-situ data from the GASTRE area (crystalline rock) as well as nation-wide desktop study information. As the site selection process is being developed based on available international experience, different approaches on siting that reflect the specific differences between the countries, geologies, geographic characteristics, etc. are noted.

To restart the DGR programme, IAEA was asked to organise several workshops on the corresponding key issues in order to learn from the knowledge and experience of countries with advanced DGR programmes. For the site selection workshop, radioactive waste management organisations from Finland, France, and Germany were asked to share their experience. The workshop was structured following the requirements and expectations of CNEA:

- Initiating the site selection process – political, social, and scientific strategies
- Early siting stages in various programmes


Exploration Drilling Rig Asse Mine

- Strategies to manage site investigation and selection; use of site selection criteria
- The use of geophysical methods throughout the siting process
- Integration of site investigation, stakeholder engagement, and safety case, as overall guidance to progressing disposal development

A representative of BGE TECHNOLOGY GmbH (BGE TEC) reported on the knowledge and experience of BGE and BGE TEC and contributed to the discussion on the issues of the workshop agenda with CNEA. CNEA thanked IAEA and the experts on their inputs to the workshop and stated that the workshop was very helpful for CNEA's work on their site selection programme. Further cooperation with IAEA is scheduled.

Methodical Approach for Planning Sealing Systems for Deep Boreholes

The Finnish MITTA Group together with sub-consultants AINS Group of Finland, VTT Technical Research Centre of Finland, and BGE TECHNOLOGY GmbH (BGE TEC) of Germany are currently working with Norwegian Nuclear Decommissioning (NND) on the concept development and technical design for NND's disposal solutions for radioactive waste in Norway.

One concept is the implementation of the National Facility as a combination of different types of disposal facilities. A deep borehole disposal (DBD) facility for SNF and/or HLW could be part of such a solution. Deep borehole disposal enables the disposal of radioactive waste in deep rock formations that have properties favourable for long-term isolation. Boreholes are preferred pathways for fluids, which could mobilise radionuclides in the disposal zone, and for contaminated fluids. For this reason, seals that separate the disposal zone from the areas near the earth's surface play an important role. BGE TEC developed a methodical approach for planning sealing systems that are to restore the integrity of the host rock. This approach is based on the experience that BGE TECHNOLOGY GmbH has gained in the course of the planning and construction of seals in mine shafts, underground drifts, and exploration boreholes. Its main aspects are the

- Identification of necessary preparation work inside the borehole, e.g. removal of casings and cementations, or the injection of damaged rock zones
- Selection of sealing elements with different functionality that provide redundancy of the overall sealing function
- Selection of sealing materials adapted to thermal, hydraulic, chemical, and mechanical conditions to be expected in the borehole
- Definition of locations and lengths of individual sealing elements, taking into account static and dynamic loads as well as hydrogeological conditions, and, especially the locations of tectonic faults

The work is part of several tasks carried out by BGE TEC that are related to the development of a DBD concept for NND.

Development of Sustainable Mining Technologies – Backfilling Measures with Low CO_2 Footprint

In Germany, the Federal Company for Radioactive Waste Disposal (BGE) operates deep, geologic repositories that have large void volumes on multiple levels. Due to the fact that the stability of the unfilled cavities is limited in time, backfilling measures are required for stabilisation.

BGE's aim is to make its sites climate neutral. Backfilling measures are particularly affected by this effort because of the large material volumes required and the greenhouse gas emissions that are released during material transport and during the entire chain of material production. Bulk materials that are produced from the rock debris of the respective mine have the smallest carbon dioxide (CO_2) footprint. Accordingly, voids of the Konrad mine have been backfilled with rock material during its conversion into a repository. However, numerous cavities in the mines can only be backfilled with flowable and self-hardening materials. In order to obtain sufficient strength, these materials contain binders. According to the type of binder, cement-based backfill materials and magnesia binders can be distinguished.

Due to the extensive experience in the development of backfill materials and emplacement technologies, BGE has entrusted BGE TECHNOLOGY GmbH with the optimisation of the procedures for backfilling and the development of backfill materials with the lowest possible CO_2 footprint. Thus, raw materials and supply chains have been evaluated and are improved with regard to their environmental performance, taking into account all aspects of transport and logistics. The CO_2 footprint of mixtures with cement increases primarily with the proportion of Portland cement clinker. As a result, recipes that contain high proportions of supplementary cementitious materials such as pozzolan and latent hydraulic additives have been developed. The classic approach to produce magnesia binders is to use magnesium oxide as binder, which is obtained by $MgCO_3$. A lot of energy is required for this process, and the carbon dioxide content of the magnesite is released. In order to reduce the CO_2 footprint, the current focus of work is the development of magnesia binders with natural brucite. The measures show that BGE and BGE TECHNOLOGY GmbH are on the right

US/German Workshop

track to protect man and the environment through the safe disposal of radionuclides and the realisation of sustainable, future-oriented technologies.

12th US/German Workshop on Salt Repository Research, Design, and Operation

In the past two and a half years, the collaboration between Germany and the US in the field of Salt Repository Research, Design, and Operation – like many other activities – was affected by the Covid pandemic. Joint projects were limited to virtual interactions, and in 2020, the US/German Workshop had to be cancelled for the very first time since its inception. In 2021, the workshop took place as an online-only event. All participants were thus more than happy that the 2022 event was again held in presence. Sandia National Laboratories, Project Management Agency Karlsruhe (PTKA), and BGE TECHNOLOGY GmbH were proud to host the workshop as well as the OECD NEA Salt Club Meeting in Braunschweig (Germany).

In good tradition of the previous workshops, the event enabled discussions of the latest developments in the different national repository programmes as well as of the results of R&D activities. Engineered Barrier Systems and backfilling material, numerical modelling, and geochemistry were three of the session topics. Within these sessions, special emphasis was given to the joint projects of both nations, such as WEIMOS, RANGERS, and KOMPASS II. The session called "exploration" was an excellent example of mutual exchange. Experts from both national programmes explained what was done in the past and what can be learned for future exploration activities.

The importance of the workshop was underlined by the participation of experts from countries other than Gemany and the US. Members from the Waste Management Organisations of the Netherlands, Romania, and Australia gave contributions to the workshop. In addition, representatives of the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), of the US Department of Engery as well as of the IAEA attended. Thus, the tradition of the previous workshops was continued, and it became evident once again that interest in the activities is growing steadily.

Development and Testing of a Constitutive Model for Crystalline Rock (R&D Project BARIK)

A sound basis for safety demonstrations are predictive model calculations based on known and validated constitutive models and the corresponding rock parameters. Part of this approach is a so-called dilatancy criterion that, for crystalline rock, is based on the constitutive model of Hook & Brown. However, this constitutive model currently still has the disadvantage that it is an isotropic material model. This is where the BARIK research project, which is a joint project with TU Bergakademie Freiberg, steps in. The main objective is the development and testing of an extended Hoek-Brown constitutive model, which is able to take into account anisotropic strength behaviour both within the intact rock matrix and in a crystalline rock body intersected by several fractures with different dip angles. The principle structure of the material model consists of a mechanical part and a hydraulic part. The mechanical part can be divided into anisotropic elastic deformation behaviour, anisotropic failure behaviour, and variable strain-softening in the phase of plastic deformation. These processes are mutually dependent. According to the constitutive model, the matrix behaviour and the crack behaviour are considered separately. This means that each component (matrix, fissures) is based on its own failure criterion with explicit strength properties. The overall rock behaviour results from the superposition with regard to the respective lowest strengths. Project results are expected in mid-2023. The project is financed by BMUV through the Project Management Agency Karlsruhe.

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

BGE TECHNOLOGY GmbH

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