

3D-Modell of a backfilled shaft with the impact of seismic waves

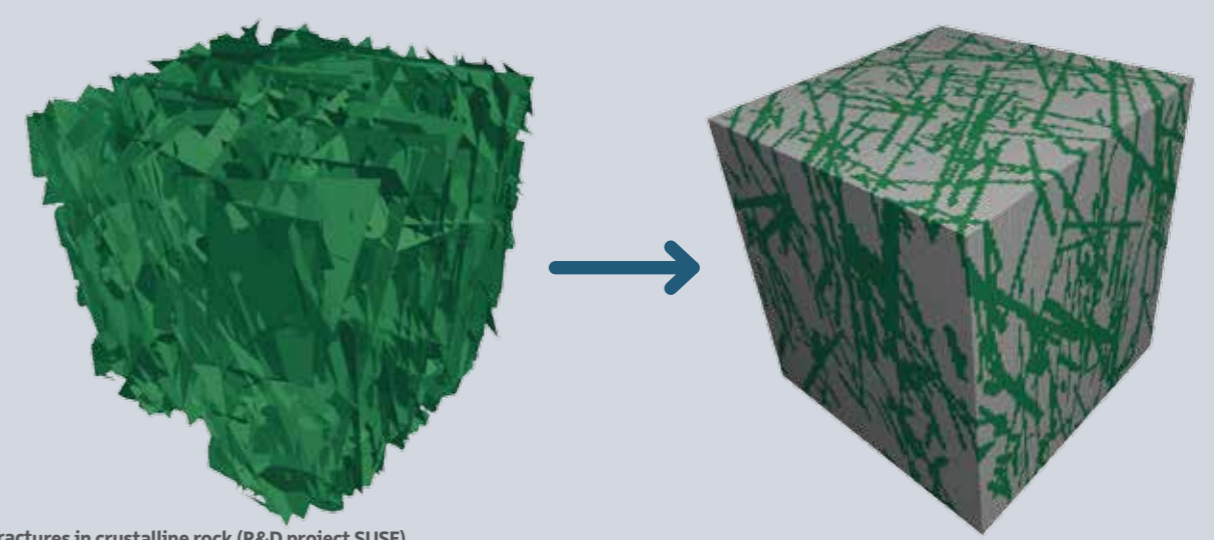


BGE TECHNOLOGY GmbH

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Russian visitors at KONRAD repository, February 2020



Modelling of fractures in crystalline rock (R&D project SUSE)



Dear Readers,

At the moment, we are all facing a challenging situation – the Corona pandemic suddenly requires modifications in beloved and effective communication and working methods in society in general but in our radioactive waste management business as well. In Germany, like in other countries, private trips, visits, and meetings are not allowed and shops and restaurants are closed for at least a couple of weeks or several months. People have to stay at home unless they are going to work or need to buy essentials. All these measures are considered necessary to slow down the spreading of the virus. Consequently, we are all seeking for alternatives to keep our private and social network alive, communication ongoing, and our business projects running. Telephone conferences are an option as are modern skype meetings and extensive email exchange. Thus, innovative ideas and creative approaches as well as prudence and flexibility are required now more than ever. Despite of this challenging situation, BGE TECHNOLOGY GmbH continues to provide you with news about our company as you are used to receive every quarter of a year.

IAEA Working Group on Monitoring

Upon request of IAEA, BGE TECHNOLOGY GmbH participates in a working group that focuses on specific aspects of repository monitoring. The question is whether and how monitoring results can and should be used to informatively support decision-making processes within the scope of a dis-

posal programme and thus make them transparent. As a result, a report will be prepared that, after discussion and agreement with all member states, will be published as a 'Technical Document' by IAEA. The aim is to provide guidance for the development and implementation of a monitoring programme.

One of our main areas of activity is related to the German geological repository projects that are implemented and operated by our parent company BGE mbH. For more than six years, we have been supporting BGE in developing a FEP catalogue and appropriate scenarios for the safety assessment concerning the closure of the Morsleben repository. A consortium of BGR and CSD Ingenieure and Zerna PP led by GRS was commissioned with compiling a comprehensive description of the repository system. Phase I of this work was completed at the end of 2019. Phase II, the update work to be carried out in an iterative manner, was launched this march 2020.

Generic R&D work in the field of radioactive waste disposal, a second main area of our activity, is still necessary in Germany because of the restart of the search for a site for a repository for high-level waste and spent fuel in 2013. In particular safety and repository concepts for other host rocks than rock salt have to be investigated in detail to provide sufficient data for the envisaged comparison of repository systems in different host rocks. In this context, we would like to acquaint you with two R&D projects. The first one, the multi-partner project SUSE (a consortium with BGR, GRS, and Russian partners led by BGE TECHNOLOGY GmbH), deals with the application of numerical tools to describe fluid flow and mass transport processes in a repository in crystalline rock and its complex fracture network. The second R&D project (ELSA II) focuses on the safety function of the shaft seal – mainly to prevent fluid inflow into a

repository mine – for repositories in rock salt as well as for those in claystone. In this context, integrity demonstrations are of uppermost importance.

Our third main area of activity is to transfer and apply our knowledge and expertise to repository projects of customers abroad. Two examples are described in this newsletter. Norwegian Nuclear Decommissioning NND is responsible for developing a safe and effective solution for the disposal of all Norwegian radioactive waste. A consortium of A-Insinööri together with VTT Technical Research Centre of Finland and BGE TECHNOLOGY GmbH will support NND in this challenging task. The second example refers to an IAEA monitoring project. BGE TECHNOLOGY GmbH participates in a working group that intends to provide guidance for the development and implementation of a repository monitoring programme. The results will be compiled in a publication of IAEA 'Technical Documents'.

We all know that the Corona pandemic has a direct impact on our private lives and on our business as well. Nevertheless, we are convinced that continuity in communication – in particular in situations like today – helps to strengthen trust and to develop new perspectives.

Happy Reading!

Wilhelm Bollingerfehr

Head of Research & Development Department
BGE TECHNOLOGY GmbH

combined with a quality assurance and management programme for the construction of geotechnical barriers, a monitoring programme can be an important component to gain confidence in the predicted repository evolution. There is a significant but useful overlap between monitoring and site characterisation as well as scientific understanding. A monitoring program also covers parts of these aspects.

One important aspect will be to explain the general possibilities of monitoring, but also which limitations exist in its applicability. It is important to clarify the possibilities and limitations in order to avoid the impression that monitoring could lead to complete control over the safety of a repository.

Impact of Earthquakes on Shaft Seals

BGE TECHNOLOGY GmbH and the Technical University Bergakademie Freiberg were commissioned by the Project Management Agency Karlsruhe with the development of shaft sealing concepts for repositories in salt and claystone formations within the R&D project ELSA II. The safety function of a shaft seal is to prevent fluid flow into and out of an underground repository. The integrity demonstration for these barriers has to take into account various safety-relevant scenarios, i.a. the impact of an earthquake. Gravel can be implemented in several sections of the shaft sealing elements to act as abutment. For an integrity demonstration, it is necessary to determine by means of numerical modelling how much a gravel column settles as a result of an earthquake.

To realistically simulate the mechanical properties of gravel particles, representative particle samples of different sizes were generated based on a grain size distribution of track ballast. Calibration tests were carried out to determine the relevant input parameters of the constitutive model.

The validation of the particle model was done by simulating the gravitational settling behaviour, the silo effect of a 50-meter-high gravel column, the

recalculation of the Salzdetfurth in-situ test, and by comparison with an analytical solution. The results showed that the simulations of the processes that are responsible for the silo effect are realistic.

For a realistic simulation of the rock mass surrounding the gravel column, i.e. the far field, the PFC3D particle code was coupled with the continuum code FLAC3D. The seismic load applied at the model boundaries was transferred to the gravel column. This approach allows a realistic absorption of seismic waves at the model boundaries. For the investigations, an earthquake impulse of 5s length was generated using seismological parameters from northern Germany. Furthermore, P-waves and S-waves were stimulated at the lower boundary of the model. First results show that the earthquake impulse is too low to cause a critical settlement of the gravel column.

Safety Analyses on Repository Systems in Crystalline Rock

SUSE is a joint project of BGE TECHNOLOGY GmbH, GRS, and BGR in cooperation with Russian colleagues that is based on an agreement for German-Russian cooperation on international research and development work regarding the disposal of high-level radioactive waste (HLW) in crystalline rock.

In Germany, crystalline rock, e.g. granite, is to be taken into account as potential host rock for the disposal of high-level radioactive waste. Crystalline rock has several favourable properties for the disposal of radioactive waste; e.g., high mechanical and thermal stability. However, crystalline rock is characterised by

fracture networks of varying formations in the underground, which lead to increased permeability. This aspect needs to be taken into account in numerical safety analyses. A major goal of SUSE is thus to optimise numerical codes for the description of flow and mass transport processes in fracture networks of crystalline host rock. In literature, a number of approaches on how fractures can be modelled numerically have been described. Currently, an approach is being pursued that is based on mapping fracture networks onto continuum numerical models. The required input parameters, e.g. regarding geology or retention, are developed in cooperation with the Russian colleagues or determined in laboratory investigations. The implemented approach will be compared qualitatively and quantitatively with other approaches in the future. This is to identify model uncertainties that arise both from the transformation of the geological model to the numerical model as well as from the calculation approach itself.

SUSE is funded by the Project Management Agency Karlsruhe on behalf of the Federal Ministry for Economic Affairs and Energy.

Safety Assessment for the Closure of the Morsleben Repository

On behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the German Nuclear Waste Management Commission (ESK) assessed the methodology of the safety assessment for the closure of the Morsleben repository in terms of its consistency with the current state of the art in science and technology (reference is the methodology



Signature of contract with NND in Halden, Norway: from left: Toivo Wanne (BGE TEC), Suvi Karvonen (VTT), Tmo Saanio (AINS), Pål Mikkelsen, Director at NND, and Antti Ikonen (AINS). (Source: NND/Nils Böhmer)

tested and applied in the Preliminary Safety Analysis for the Gorleben Site (VSG)). In January 2013, ESK recommended an update of the safety assessment by the applicant. In this context, a comprehensive FEP catalogue was to be prepared as a basis for a systematic and transparent scenario development.

Led by GRS gGmbH, a consortium formed by BGE (supported by BGE TECHNOLOGY GmbH), BGR, CSD Ingenieure, and Zerna PP started to perform the corresponding work in November 2013. The FEP catalogue is based on the large data set of the Morsleben repository. The objective was to get a comprehensive description of the repository system including all processes and events occurring in the past, today, and in the future. Based on the information of the FEP catalogue and following a systematic approach, probable scenarios, less probable scenarios, and improbable scenarios were developed.

Phase I was completed in spring 2019, but work on geological issues (optimisation of salt structure model and overburden model), optimisation of the closure concept, and other open questions continued. Thus, the FEP catalogue and scenario development have to be updated in an iterative process. Work on phase II started in March 2020.

Support of Norwegian National Disposal Facility for Radioactive Waste

Two Norwegian research reactors, in Halden and Kjeller, were permanently taken out of operation several years ago. Norwegian Nuclear Decommissioning (NND) was founded in 2018 as an agency under the Ministry of Trade, Industry and Fisheries in Norway. They are responsible for decommissioning the research reactors and other nuclear infrastructure in Norway. NND is also responsible for developing the final disposal solution for the radioactive waste in Norway.

Norway's inventory of radioactive waste mainly consists of high-level waste from the research reactors. In addition, there will be low and intermediate level waste from the planned decommissioning of the reactors and other nuclear facilities. There are also small quantities of institutional waste.

NND contracted a consortium led by Finnish AINS Group and further consisting of VTT Technical Research Centre of Finland and BGE TECHNOLOGY GmbH of Germany. The contractor group will assist NND with the concept development and technical design for a possible final disposal solution. The agree-

ment was signed at NND's headquarters in Halden, Norway, on January 20, 2020. The work covers extensive technical assistance in the coming years.

One of the main concepts that are to be evaluated in an upcoming "concept choice-study" is to dispose radioactive waste in an extensive Norwegian National Facility. This concept facility is planned to consist of geological repository facilities (one or several components) and a landfill-type surface repository mainly for non-radioactive decommissioning waste. The recently started first phase of the project conceptualises the possible final disposal solutions. The first phase is expected to be completed by the end of summer 2020. The conceptual design and facility descriptions cover the implementation, operation, decommissioning, and closure phases of the various components in the disposal facility. The work will look into a geological repository for intermediate-level waste and a review of options for disposing high-level waste in either a deep geological repository or in a deep borehole solution.

During the first phase of the project, BGE TECHNOLOGY GmbH's team will provide its expertise in the development of a borehole disposal concept for the Norwegian case.

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



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