Bukov Underground Research Facility

The Bukov Underground Research Facility (URF), located at a depth of 550 m below the Earth's surface serves as a test site for SÚRAO for the assessment of the behaviour of the rock environment at a depth corresponding to that assumed for the construction of the future DGR for SNF and RAW. The underground facility is located near the village of Bukov, in the Žďár nad Sázavou district of the Vysočina region. As with similar facilities of its type, it makes use of a pre-existing underground infrastructure.

The underground section is located in the southern part of the Rožná uranium deposit on the 12th level of the B-1 mine. Ongoing and planned experimentation is aimed at forming an understanding of the various processes related to the long-term safety of the future deep geological repository and the demonstration of its technical feasibility.

Underground research facilities play an important role in terms of the research and development of deep geological repositories, and a number of similar facilities to Bukov are under operation throughout the world including the Grimsel (Switzerland) and Äspö (Sweden) underground laboratories which, since the 1960s, have been providing valuable data on rock mass processes and the robustness of engineered barriers and, not least, important data for the compilation of DGR safety analyses. The determination of the relevant study methodologies for the training of highly-qualified experts also makes up an important part of the research activities of such facilities. The data and experience gained play an important role in the DGR site selection and assessment process, the optimisation of the various engineering, technical and construction procedures and the enhancement of the level of professionalism applied both to national radioactive waste disposal programmes and involvement in international research cooperation.

The Bukov URF project consists of three phases:

1. Construction phase (2013–2017)

The construction phase of the Bukov URF, which lasted from 2013 to 2017, was followed by the exploratory phase that was concluded by the excavation of the BZ-XIIJ crosscut, concerning which a drilling campaign was conducted aimed at the study of the geological structure and the selection of rock blocks. The third phase concerned the excavation of spaces for the laboratories for the conducting of experiments. In order to ensure the high quality of the excavation work, the so-called contour (or controlled) blasting method was used for the construction of the laboratory facilities. The underground excavation work consisted of the construction of the BZ-XIIJ access crosscut, three drilling chambers, the laboratory crosscut and four testing chambers. The ZK-3S test chamber is destined for interaction experiments, the ZK-3J chamber for the study of corrosion and the behaviour of clay materials, the ZK-2 chamber for the study of groundwater flow dynamics and the ZK-1 chamber for the study of diffusion processes.

2. Characterisation (2015–2017)

The aim of the "Complex geological characterisation of the (underground) area" consisted of the detailed description of the rock environment of the Bukov URF for the determination of the siting of individual experiments. In addition, data was obtained that is available only following the opening of rock massifs underground. The project enabled the interpretation of the development of a range of rock environment parameters with depth and included the study of the geological structure, geotechnical properties, hydrogeological properties and seismicity, the transport properties of the rock and the construction of geological and geomechanical models of the underground area of the facility.

3. Experimental programme (2017– construction of a laboratory at the final location)

The results of the experimental work conducted at the facility will serve as a basis for assessing the rock mass and the behaviour of processes at work at deep geological repository depth with respect to the technical feasibility of construction and safety considerations. The research programme has been divided into the following sections:

1 – Characterisation and creation of geoscientific models of the rock environment

This stage includes work focusing on the collection of descriptive geological data, its storage in special databases and its interpretation in the form of 3D models, as well as the development of general methods for describing the rock environment. This stage also includes the conducting of the "Data acquisition from the deep horizons of the Rožná mine project" (2017 - 2019), the aim of which is to acquire spatial geological data from levels 12 to 24 of the Rožná I mine. The laboratory and in-situ research is focusing principally on the development of the geotechnical parameters of the rock massif and its disturbance with depth, EDZ characteristics and the determination of homogeneous rock blocks and the detailed description thereof. The overall objective of the project is to build on the understanding of the influence of major tectonic zones on the disturbance of the rock massif for the purposes of the siting and safety of the future DGR.

2 – Long-term monitoring of the rock environment

This stage includes the testing and development of methods for the long-term monitoring of the various processes at work at DGR depth. The following projects are currently underway:

- The microbiological screening of the Bukov URF and the Rožná mine (2017–2019). The aim of the project is to distinguish the various anthropogenic microbial communities and native settlements present and to identify the critical taxa likely to influence the degradation of the materials to be used in the future DGR.
- Hydrogeological and hydrochemical monitoring of the underground area and mine water of the Bukov URF complex (2018–2022). This project involves the long-term monitoring of the development of the extent of and changes in the chemistry of the rock block from the surface to the theoretical depth of the future repository in order to verify the impact of underground construction on the hydrogeological regime of the site. The project is providing data which will be used in the calibration of existing hydrogeological models of the candidate DGR sites.
- Monitoring of the activity of brittle structures in the Bukov URF and the Rožná mine (2018–2022). This project aims to provide a description of potential movements along brittle structures (faults) and their interpretation in relation to the predominant stress in the rock massif.
- Long-term monitoring of the Bukov URF rock massif via the application of non-destructive geophysical methods (2018–2022). The project involves the installation and testing of a system that allows for the long-term monitoring of changes in the geoelectric and seismic properties of the massif in the immediate vicinity of an underground mine working. The system includes an electrical resonance tomography system and seismic measurement equipment.

3 – Groundwater flow and the transport of radionuclides

This experimental cycle concerns the research of groundwater flows and radionuclide transport in a DGR rock environment and includes the testing and verification of modelling tools. The preparatory stage consisted of the conducting of projects that concentrated on improving the understanding of the advective transport of substances in crystalline rock fracture systems and the research of diffusion transport processes from fractures to the intact rock matrix. The research will include the construction of a network of test boreholes equipped with so-called multi-packers for the conducting of hydraulic and tracer tests in a selected rock block at the Bukov URF. All the tests will be complemented by the construction and refinement of geological and hydrogeological models of the rock block of interest which will subsequently be employed for the development of modelling tools and the simulation of the physical tests.

4 – DGR engineered barriers

The aim of the research is to verify the characteristics of the materials to be used in the DGR disposal system and the production of the waste disposal containers. The overall objective is to determine the rate of degradation of such materials and their mutual interactions under real DGR conditions. The "In-situ physical model interaction" project underway at the Bukov URF (2017–2021) which involves the study of interactions between the materials to be used for the DGR engineered barriers and their interactions with the rock environment and groundwater provides an example of the projects included in this experimental cycle. The project involves the emplacement of a total of ten physical models in specially drilled boreholes. Five of the models will be employed for the study of interactions at natural temperatures and the other five for the study of interactions at elevated temperatures of up to 200°C. The project will also focus on the research of the corrosion resistance of candidate waste container materials in granitoid environments and the influence of the corrosion of these materials on the properties of bentonite.

5 – Impact of the construction of the underground section of the DGR on the rock environment

This experimental cycle primarily concerns the description of the extent and character of the excavation damaged (EDZ) and excavation disturbed (EdZ) zones created during the construction of the DGR underground complex. A pilot project was conducted as early as during the construction of the Bukov URF ("The creation and monitoring of the EDZ during the construction of the Bukov URF" project) with the aim of obtaining the data necessary on the creation and development of the EDZ and the rock vaults in connection with the construction of the underground working. The study of the behaviour of the EDZ and rock vaults at depth provides valuable data that allows for the accurate description of the impact of excavation work on the creation and development of the EDZ and the optimisation of the technical approach to the excavation of underground facilities. A more extensive project focusing on this issue is currently in the preparation stage.

6 – DGR construction technological procedures

Certain technological procedures that require special methodology that does not apply to standard commercial excavation projects will be necessary during the construction of the DGR, i.e. special drilling techniques etc. Work in this area will, therefore, focus on the development of new techniques for the construction of the underground section of the facility in terms of their time and financial optimisation.

7 – Demonstration experiments

The experimental cycle will include the conducting of complex experiments for the testing of the behaviour of various elements of the disposal system using measurements taken from real DGR conditions. The experiments will concentrate on the testing of waste handling technology, the construction of experimental models and process monitoring.

SÚRAO

Radioactive Waste Repository Authority,
Dlážděná 1004/6, Praha 1
tel.: 221 421 522, fax: 221 421 544,
e-mail: info@surao.cz

updated 1. 1. 2019

www.surao.cz