JOI (JIFE – openGeo – INCA)

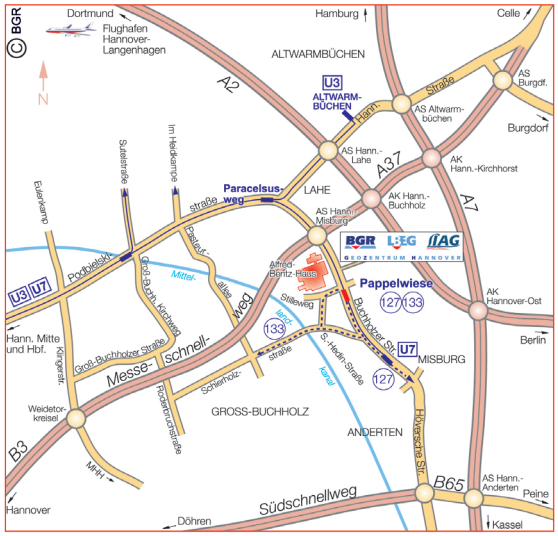
The crust of the earth is a very complicated structure that has developed in parts over the course of more than three billion years. Folds and thrusts in many areas around the world characterise the structure of the underlying geology, and numerous faults cut through the layers of rock. Even highly experienced geologists do not always find it easy to depict all of these overlapping effects as a basis for decision making on the potential uses of the subsurface realm and to provide a reliable basis for model calculations.

Things have become easier though for scientists in recent years: three-dimensional geological models enable them to delve virtually into the earth's crust. The models graphically present and evaluate the data collected during geological exploration. The models can help scientists cut open a mineral deposit for instance at any position as well as to generate virtual boreholes.

3D presentation in the media room of the BGR

Three-dimensional geological models of specific rock sequences are also particularly important for doing research on geologic repositories. They form the basis for the subsequent numerical calculations which are used to verify the long-term safety of a geologic repository.

Contact



Stadtbahnlinie / Tram line U7

Buslinie / Bus line 127 133

Stadtbahn- und Bushaltestelle / Tram and bus stop Pappelwiese

Ab Hauptbahnhof Stadtbahnlinie **U7** Richtung **Schierholzstraße** bis Haltestelle **Pappelwiese**

From main railway station, take tram no. **U7** direction **Schierholzstraße** to station, **Pappelwiese**

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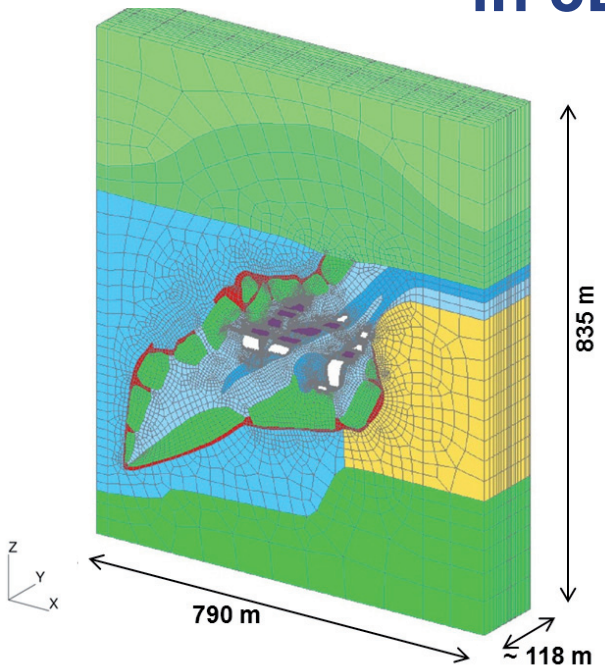
Repositories

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

GEOZENTRUM HANNOVER

Geology and geomechanics in 3D



A geologic repository for radioactive waste has to be safe for many thousands of years. BGR scientists are developing new methods to verify the long-term safety of potential repository sites. One of the most important instruments is three-dimensional geological modelling. It forms the basis for calculating thermal and mechanical influences on salty, clayey or granitic rocks arising from the storage of radioactive waste.

JIFE

From exploration to geological model

Industrial partners developed the openGEO software package in recent years on behalf of and in very close technical co-operation with BGR. This program helps create particularly complicated geological 3D models for zones such as the tightly folded parts of salt domes. The program can use all types of basic data such as maps, terrain models, core photographs, the results of mapping, or geophysical and geochemical surveys. BGR is one of the main users of open GEO and therefore had a significant influence on the further development of the program. The use of the software is guaranteed for many years to come by the acquisition of special rights to the source code.

In a similar way to the preparation of geological maps and cross-sections, the program is used to construct the model along horizontal and vertical horizons. The models can precisely recreate even the most complex geological structures such as the complicated flow folds typical of salt domes, or branching fracture structures in magmatic rocks. The structural models elaborated with openGEO can be coupled with any exploration results incorporated in databases. This enables the visualisation and query-controlled evaluation of specific investigation results within 3D space.

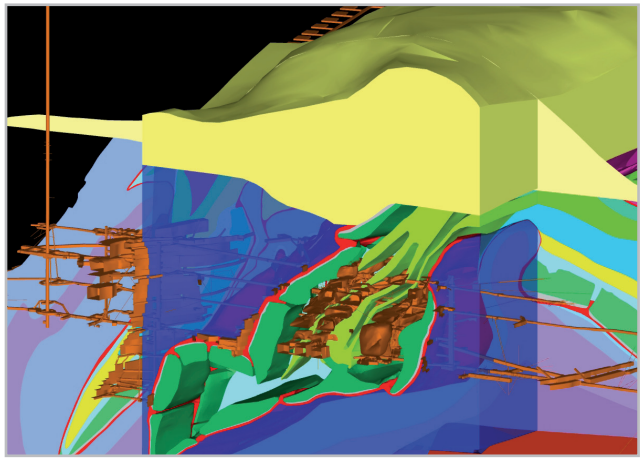
BGR not only uses openGEO to evaluate the results of geological and geophysical exploration for potential geologic repository sites, but also to explore locations for the storage of natural gas/crude oil or renewable energy sources in caverns, as well as to forecast surface subsidence or mining damage occurring in areas close to abandoned mines. The 3D models generated by openGEO are also used as planning instruments for mining measures in still operating mines.

Calculating the future with JOI

The 3D geological models are not only used for mere visual analysis. The processed data can also be input into numerical models to calculate aspects such as underground flow or the stability of a mine.

openGEO

The models therefore provide a means of investigating the long-term safety of e.g. a geologic repository, an underground disposal site, or a cavern. This is necessary because a great deal can happen underground over a long period of time: in a geologic repository holding radioactive waste for instance, temperatures can rise for a certain length of time, salt can deform, and chemical reactions can take place. These complex, mutually interacting processes are expressed in physical equations and then calculated using computer-based numerical methods. Very important aspects in this context are the mechanical behaviour of the host rock, and the potential transport of dissolved constituents, such as radioactive substances in particular. Both of these processes have to be modelled in a dependable way.



Detail of a 3D model for a salt mine in North Germany

BGR scientists are continually further developing the JIFE numerical simulation program (Java Interactive Finite Element code) in collaboration with an engineering office in Berlin. The aim is to enable high performance mainframe computers to carry out extremely complex three-dimensional numerical simulations of underground facilities. They are also working on methods to quickly and comprehensively display the findings in a graphic form.

INCA

This program will be intensively further developed in the coming years reflecting the state-of-the-art of science and research. The main priority the BGR scientists have set themselves is integrating the JIFE program directly with openGEO via the INCA software system (Integrated Nonlinear Coupled Analysis). This work is being carried out as part of the JOI project (JIFE – openGEO – INCA). The ultimate objective is to largely automatically convert the geological models into numerical simulation models.

BGR in good shape for the future

In geologic repository projects, every working step from elaborating the geological and numerical models, all the way to saving the data, must be undertaken on the basis of standardised procedures. This is why BGR had the INCA software system developed at the beginning of the 1990s. It supports scientists during the whole process from model development to calculation, evaluation and archiving.

INCA has been continually further developed over the years and optimised for new challenges. BGR scientists pay a great deal of attention here to quality assurance. This not only concerns the data used as input for the openGEO and JIFE programs, but also the programs themselves. All of the further developments have to be transparent. All of the changes and additions to the output data and program changes are therefore centrally archived in a database so that they can be accessed for many years into the future. Automatic testing regularly determines whether selected program modules behave today in exactly the same way as they did in the past. A user manual and version administration round off the project. BGR scientists profit enormously from the meticulous documentation of every working step. INCA provides them with an important tool and supports them in their modelling activities and handling the endless strings of numbers.