Saltmines

Description: In repository concepts for the disposal of radioactive waste in rock salt formations it is planned to fill void volumes with backfill. The preferred backfill material is crushed salt. After repository closure, due to the surrounding rock pressure the residual void volume in the repository will be reduced by creep, and the backfill will be compacted. As a consequence of this compaction the porosity of the backfill material will be reduced, leading to a reduction of permeability and an increase in the backfill pressure. The increased backfill pressure results in a slow down of the convergence process and the decreased permeability of the backfill causes a reduced water flow through the repository area.

These rock mechanical processes occur over a long time scale which can not fully be covered by laboratory experiments. In this context in-situ experiments and natural analogue studies can play an important role in proving the models used in PA and in backing-up the parameters derived from laboratory experiments. In particular, the investigation of old backfill material, which was used in abandoned salt mines and which has already been compacted for several decades, can provide suitable information on the long-term compaction process.

The study presented here can only be regarded as a pilot study. It has been performed to identify the requirements for natural backfill samples and to find suitable sites in Germany, where representative backfill samples can be found and investigated. As a first step, the most important requirements for an object to be investigated from a geotechnical point of view have been compiled, namely that the material should be similar to the backfill material foreseen in the German concept for a repository in rock salt, i.e. rock salt with grain sizes < 60 mm, preferably emplaced without additional water. It is important that information about the initial state of the backfill, the history of the backfilled cavity and the geology of the surrounding area is available.

Figure 1: Final segments of a core drilled into old backfill from the 1260/1275 m floor of Riedel salt mine.

In addition to the formulation of the geotechnical requirements, model calculations for various properties and lay-outs of a site have been performed, to find the most promising examples. The aim was to identify the conditions under which a significant reduction of the backfill porosity (to about 10%), compared to an original value of about 40 % after emplacement, can be expected. The depth of the site, the moisture content of the salt backfill and the existence of supporting anhydrite layers within the rock salt are all important parameters with potential impacts on the rate of the compaction process. The results of the calculations show, that in cases where supporting

anhydrite layers are present, the convergence will be so slow that no significant compaction can be expected within the first few hundred years, i.e. such sites are not suitable. If no supporting anhydrite layers are present, backfill will be reduced to porosities below 10 % after some decades, if the backfill area is at a depth of at least 800 m. Therefore, the search has been focussed on backfilled areas at around 800 m depth or greater. Based on all this information, comprehensive research into backfilled sites in Germany and their condition has been carried out. As a result, suitable investigation targets in old salt mines at Sigmundshall, Riedel and Salzdetfurth, all in Northern Germany, have been identified, and which are detailed in the table below.

	depth	backfill	remark
Sigmundshall			difficult to access,
Lager 1398	860 m	crushed rock salt, 3-4% humidity	since 1991
Lager 1391	840 m	crushed rock salt, dry	since 1982
Riedel			
Lager 1 Süd	1260 m	crushed rock salt with residual humidity	well consolidated
Salzdetfurth			
Abbau 760/6	730-754 m	crushed rock salt with residual humidity	since 1971, compacted
Abbau 964/6	900 m	crushed rock salt	since 1957, compacted

The most suitable objects are in Salzdetfurth and Riedel in Northern Germany. In both areas initial samples have been taken, and these show that the material has - as expected - already been compacted. The backfilled areas at Sigmundshall are difficult to access and are therefore considered as a second priority. A first inspection of the backfilled areas in Salzdetfurth and Riedel shows that the compaction of the backfill has only occurred under its own weight and not by convergence due to the rock pressure. However, this is regarded as equivalent for the compaction process.

At this stage the project was completed and there has been no follow-on project to date.

Relevance: As a result of widespread uncertainty, analyses of the convergence rate as well as of the rate of backfill compaction are very important activities in integrated performance assessment. A natural analogue study can confirm the modelling approach for the compaction of crushed salt backfill and its effect on the long-term convergence rate.

Position(s) in the matrix tables: The study illustrates the process of physical integrity / alteration of salt backfill in near-field rock.

Limitations: Such studies only provide information about the compaction process and not about the convergence process.

Quantitative information: So far no quantitative information is available.

Uncertainties: At this state no uncertainties can be assessed.

Time-scale: The time-scale addressed by the study is human (about 50 years)

PA/safety case applications: There has been no PA application due to the pilot character of the study.

Communication applications: none

References:

Brenner, J.; Feddersen, H.K.; Gies, H.; Miehe, R.; Rothfuchs, T., Storck, R. (1999): Untersuchung von Altversatz als Analogon zur Konvergenz und Kompaktierung versetzter untertägiger Hohlräume im Salz über lange Zeiträume – Phase I. GRS-Bericht 147.

Added value comments: None

Potential follow-up work: currently not planned

Keywords: rock salt, backfill, convergence, porosity, permeability

Reviewers and dates: Ulrich Noseck, GRS (April, 2004)