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Suitability of flat bedded salt formations in Germany as the site for a repository for heat-producing radioactive waste

Till Popp et al.

Correspondence to: Till Popp (till.popp@ifg-leipzig.de)

IfG – Institut für Gebirgsmechanik GmbH Leipzig
Research ● Testing ● Consulting ● Expertise
Contact: Friederikenstr. 60, 04279 Leipzig
till.popp@ifg-leipzig.de

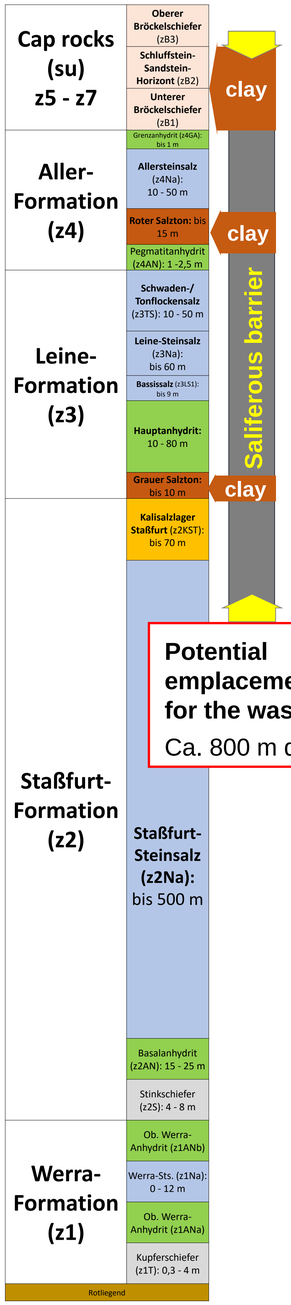
Suitability of flat bedded salt formations in Germany as the site for a repository for heat-producing radioactive waste

Till Popp, Ralf-M. Günther and Dirk Naumann

safeND Interdisciplinary research symposium on the safety of nuclear disposal practices

Zechstein salt

Stratigraphie / lithology (Central Germany / simplified)



Potential emplacement area for the waste:
Ca. 800 m depth

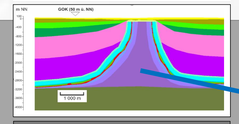
Starting position

Since 2013, the search for a site for a repository for high-level radioactive waste has started again in Germany with the entry into force of the first Site Selection Act (StandAG). For many decades, the development of repository concepts and safety analyzes for a repository in a salt dome was prioritized in Germany.

The aim of a comparative site selection process is to find a site by 2031 **that offers the best possible safety for the containment of high-level radioactive waste for a period of 1 million years.**

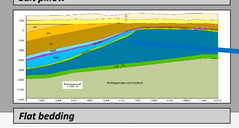
Salt structures

Salt domes – steep inclin.

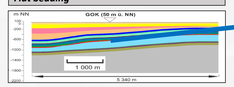


Stratiform bedding

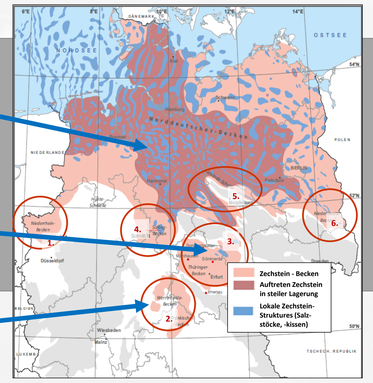
Salt pillow



Flat bedding



Regional distribution

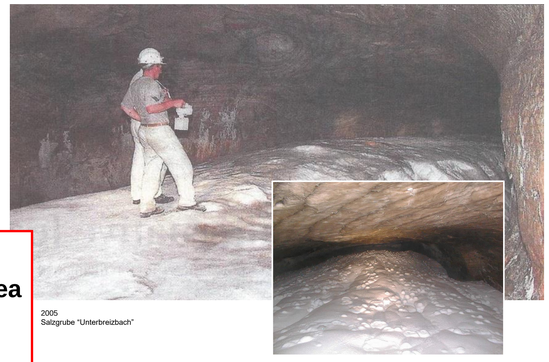


Approach / evaluation

The basic safety concept is the safe containment of radionuclides in the so-called “ewG”. The focus of demonstration of long-term safety is consequently the systematic proof of the barrier integrity. Compared to clay and crystalline rocks as well as salt rocks in "steep inclined salt", salt rocks in "flat bedded deposits“, specially as “salt pillow” have important safety advantages:

- **Sufficient thickness of the Staßfurt rock salt** (several 100m thick)
- **A natural multi-barrier system** through lithological alternation of clay / salt rocks, which is extremely robust against external influences (e.g. erosion, leaching, earthquakes).
- **Geologically simple** (easily predictable) **situation**
- **Validated verification tools for integrity analysis are available**

Safe containment of fluids in salt



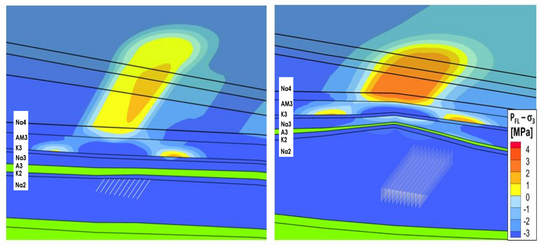
Gas accumulations in the salt mass due to the tertiary Rhön volcanism

⇒ **CO_2- glacier after an underground gas eruption**

Salt formations are tight for geological periods of time.

Geo-mechanical integrity analysis - HAW-Repository

Minimum stress criterion (after approx. 50 years) for drift storage in flat bedded salt (left) and vertical borehole storage in a salt pillow (right). – Source: KOSINA

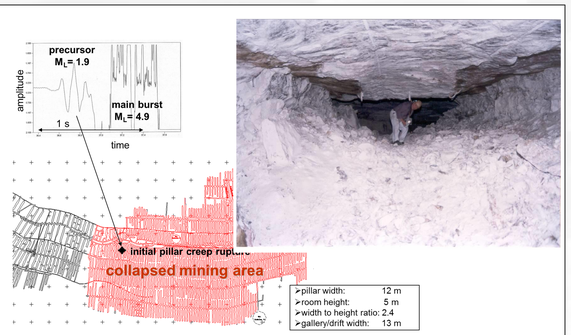


Proof of the long-term barrier integrity under the expected thermo-hydro-mechanical impacts can be reliably performed on a site-specific basis.

- **Temporary violation of the minimum stress criterion at the salt level surface: limited in time, penetration depth max. 60 m**
- **At any point in time there is always> 300 m of undisturbed barrier remaining**

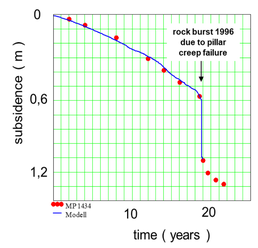
Robustness of the salt barrier against dynamic loads, i.e. earth quakes

Teutschenthal rock burst 11.09.1996, 5.36 Uhr

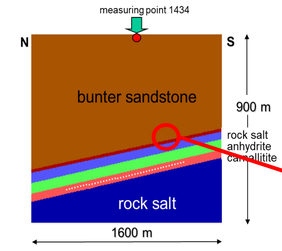


➔ **Collapse of the underground openings**

Subsidence surface



Geological situation



➔ **Subsidence jump at the surface > 0,5 m**

The rockfall had been forecast by Dr. Minkley, IfG:

- *“A rock burst will occur within the next time”, magnitude: $M_L \sim 5$*

➔ **Proof of the reliability of the numerical forecast and demonstration tools**

After the event, the fluids from the cap rocks did not enter the salt mine, although the minimum stress criterion in the rock salt was formally violated.

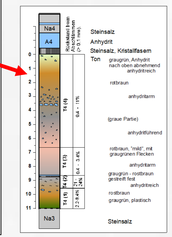
➔ The investigation of the rock salt wall barrier after this dynamic event (state of damage) did not reveal any dilatant damage, but showed the strong relief during the rockfall

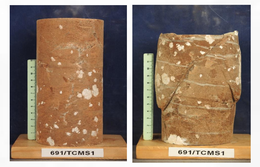
➔ **Relevancy of the Red Salt Clay**

Without the Red Salt Clay, an inflow of fluids from the overburden would probably have been admitted.

Red salt clay has a low permeability and high hydraulic fracture strength!

Red Salt Clay - lithology





Composition:
54 % clay minerals
22 % quartz
15 % anhydrite
Accessories: gypsum; halite, hematite