

## Rock Mechanical Hazard Analyses and Filling for Salt Mines to be Abandoned

W. MENZEL, W. MINKLEY, K. SALZER

Institut für Gebirgsmechanik GmbH, Friederikenstraße 60, D-04279 Leipzig, Germany

### 1. Introduction

In the 80's and 90's of the previous century, mining potash salts was abandoned in several salt mines in eastern Germany after almost 100 years of mining activities. A significant portion of the mining fields extracted in room-and-pillar mining was not packed during its period of operation.

Because of the intensive mining of hard salt and carnallite that was done especially in the 70's and 80's, there was a significant rock mechanical hazard potential in the above-ground area influenced by the mining fields as a result of the high degree of subsidence to be expected and seismic effects that cannot be excluded (rock bursts). Therefore, a series of studies and expert opinions were commissioned to have experts and institutions examine the expediency, safety and appropriateness of necessary measures in the framework of the final operation plans to comply with the requirements of the Federal Mining Law for averting hazards to the life and health of third parties after preserving the pits.

### 2. The Objectives of Protection

The objectives of protection for preserving or securing the potash mines have been defined as follows:

- keeping the pits from drowning with its uncontrolled geomechanical consequences by means of safely sealing the shafts using suitable final sealing structures
- eliminating the danger of rock burst by packing the underground excavation structures especially in the large-area mined carnallite areas

- the above-ground subsidence is supposed to be decisively limited by placing packing, and seismic-tectonic processes induced by mining in the overlying rock with shocks on the surface are supposed to be reduced to an acceptable amount
- the integrity of the geological barriers in the roof and floor is supposed to be maintained to keep it from drowning over the pits with damaging geomechanical effects.

To guarantee these protection objectives, it was necessary to make comprehensive analyses of the geological, geotechnical and mining conditions and - deriving from that - an evaluation of the potential rock mechanical or hydrological hazard in the individual pits. The objective here was to conclude what actions would be necessary for preservation from forecasting potential hazards.

### 3. The Content of the Hazard Analyses

After 100 years of mining, the potash mines in eastern Germany have an opened deposit area of 20 km<sup>2</sup> and more. Therefore, in order to make a comprehensive evaluation of mining safety for extensive pits, it was necessary to record, compile and, to a certain extent, create a comprehensive amount of data. This concerns:

- the geological, tectonic and hydrological situation of the deposits including the sub- and suprasalinar,
- the rock mechanical characteristics of the rocks that are essentially involved in the structure of the deposit,
- a characterisation of the rock mechanical state of the mining fields and the geological barriers based upon geotechnical measurements (stress, strain, seismic registration),

- recording and evaluating the pits based upon the geological and mining plan with reference to the stability of the rooms and pillars, showing its weak points and evaluating the state of the shafts, prospect drillings and safety pillars,
- recording and evaluating catastrophic situations during the mine's operating period and the effects it has on the time after operations.

We will be preparing a geological model for the pits using these data, based upon which we can make a rock mechanical model of hazard-relevant situations in the pits. Furthermore, as a result of the simulation calculations, we will evaluate the loading parameters for their reliability from the point of view of rock mechanics and hydrology. Finally, this hazard analysis will form the basis for making decisions on the necessity, scope and required quality of actions for reconstructing or preserving the potash mines.

#### 4. Actions for Averting Hazards

We can see the following as focal points for potential dangers to public safety and therefore for subsequent preventative actions:

- carnallite mining fields in the affected zone of cities that do not have sufficient dimensioning reserves over the long term because of the softening behaviour of this rock,
- hard salt mining fields with an intensive degree of mining and large-scale mining heights (mining on several levels) in the affected zone of cities or main traffic routes,
- mining operations coming too close to the salt table or leaching subsidence troughs,
- roadways or stopes driven into areas without a sufficient protective layer against water-bearing horizons in the roof and floor.

The most important actions for averting hazards or minimising risks have proven to be subsequently placing packing using a variety of technologies and packing materials and erecting geotechnical structures (final sealings for shafts and roadway packs) to separate off areas that are endangered.

This packing work has been intensively assisted by scientific work. Comprehensive geotechnical programs for monitoring and securing evidence supply the data for evaluating the effectiveness of placing packing (Figure 1). Furthermore, the Federal Ministry for Education and Research supports research projects for erecting final sealing structures for shafts and roadways that will be safe in the long term. We will be elucidating our procedure using a potash mine in the South Harz Mountains mining area, a potash mine in the Werra mining area as well as a potash mine in the central German region.

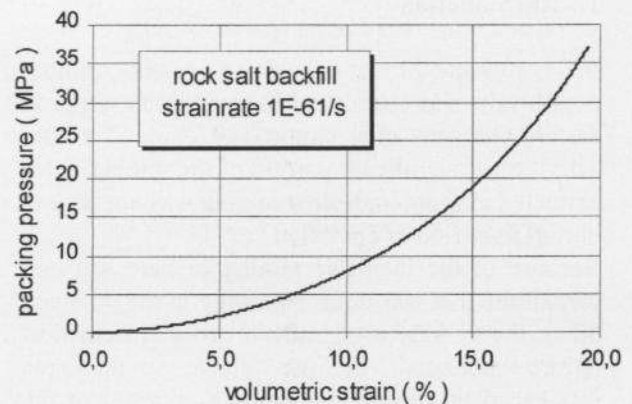


Figure 1

A packing pressure curve of moist and compacted rock salt packing.