Subsidence Potential of the Hengelo Brine Field (Part I)

Physico-chemical deterioration and mechanical failure of salt cavern roof layers

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Abstract:

In the Hengelo brine field and in several brine fields elsewhere serious surface subsidence is brought about by upward migration (stoping) of an overmined salt solution cavity by subsequent failure of roof layers. With regard to failure of roof layers spanning a brine-filled cavity, not only mechanical – but also physico-chemical processes must be considered.The physico-chemical processes act under the influence of water or brine and include different types of swelling, dissolution, slaking due to compression of entrapped air and a general reduction of rock strength due to moisture.
On the other hand, the fluid, often under hydrostatic pressure, affects the stability of roof layers in a purely mechanical way. This applies to the concept of effective stress inside the roof layers and the supporting- and loading effect of a fluid below and above a roof layer (the Archimedes principle).

It is important to assess the significance of each individual physico-chemical and mechanical process. If physico-chemical deterioration proves to be dominant for a certain brine field, then already overmined cavities could be protected from the adverse effects of brine by the application of an oil blanket.

Here the various physico-chemical- and mechanical effects are outlined and their significance is evaluated for the Hengelo brine field in The Netherlands. Strong evidence exists that mechanical failure is here the principle factor for roof deterioration.

1. Introduction

In the Hengelo brine field, The Netherlands, the near-horizontal salt deposit of about 50 m thickness is situated at about 350 to 400 m depth. It is overlain by about 20 m of anhydrites with claystone interbeds, and 200 to 300 m of friable claystones. These Mesozoic rock formations are covered by about 100 m of clayey Tertiary and Quaternary soil units. If, in case of overmining, the uppermost salt layers have been leached, a salt solution cavity starts to migrate upwards eventually, as a result of subsequent failure of roof layers. Migration in the claystones occurs intermittently, at an average rate of 10 to 14 m/year [1,2]. In the anhydritic layer migration is often arrested at a certain level for a relatively long time, sometimes for more than 25 years. Cavities, which did penetrate the anhydritic layer, showed average migration rates of just 0.5 to 2 m/year. The cavity diameter generally ranges from 50 to 150 m. Serious surface subsidence (a trough of some m depth or a sinkhole) develops if a cavity is capable of reaching the base of the ductile soil mass despite the bulking effect.