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Technical Conference Paper

The abandonment of large caverns and underground Hydrogen storage in salt– views and lessons from a mining authority

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Abstract

State Supervision of Mines (SSM) has gathered knowledge and experience on cavern abandonment over the last years through initialized research projects, other scientific publications, and (near-)incidents that happened during salt mining and gas storage projects worldwide.
In this contribution, we aim to integrate these individual learnings. Better understanding of all these open research topics may help determine the rules to which underground hydrogen storage (UHS) caverns may be safely operated and abandoned. State Supervision of Mines aims to trigger critical thinking and open discussion on how to ensure a safe energy transition.

It is becoming increasingly clear that a 'simple' high pressure cavern shut-in is no longer always applicable, specifically for deep and/or very tall caverns. During high pressure shut-in the wells are plugged-off, and the cavern is left to reach an equilibrium pressure. From that point onward there is competition between pressure-increasing processes (creep and brine warming), and bleed-off of brine into the surrounding. It is often assumed this bleed-off happens through diffuse permeation. However, over the years we have seen hydraulic fracturing in salt, cases where caverns have become hydraulically connected through a preferential leakage pathway, and recorded seismicity inside a salt dome, near caverns. Many of these cases have also been published at the SMRI (e.g. Smit et al., 2019, Duquesnoy et al., 2019, Bosq et al. 2020).
These incidents and research results show that we do not yet fully understand the fundamentals of salt behavior. Furthermore, on a geological or production and abandonment timescale, they also raise questions about one of the future directions of our industry; underground hydrogen storages (UHS). Obviously, these storage caverns need to be re-brined and abandoned at some point. However, the expected operating conditions of UHS caverns are such that it will expose them to conditions that may lead to integrity issues during their lifetime.
For the hydrogen storage caverns, recent publications further point to possible integrity challenges and possible product loss (and the creation of toxic and corrosive gases) that are not fully understood yet.

Key words: rock salt, gas storage, salt caverns, cavern abandonment, rock mechanics, hydrogen storage, salt heterogeneity, brine leakage mechanism, salt creep mechanism