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Long-term Behavior of Salt Caverns in the Matacães Solution Mining Concession in Portugal – In Situ Measurements and Numerical Modeling

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Abstract

Since 1954, the Solvay company has operated, by isolated caverns, a salt dome in the Matacães con-cession in Portugal (Torres Vedras region, 40 km north of Lisbon). A total of 22 caverns were created for a production of nearly 19 million tons of salt in 60 years. In a perspective of securing the cavern before final closure, Solvay asked Ineris to deepen knowledge of their current conditions and to predict evolutions before and after their closure. To this end, numerical modeling was implemented, based on field meas-urements and tests (thermography, volumetry, brine purges, creep tests).
The analysis of purges first enabled an evaluation of the compressibility factor of the caverns and the identification of possible hydraulic communications between caverns. The analysis of the temperature profiles led to distinguishing caverns that are already at thermal equilibrium and those that are not. Finally, the salt creep parameters were estimated from the pressure rise measurements between 2 purges and the well discharge measurements obtained during the creep tests. The results show a certain variability of creep parameters, probably reflecting a certain heterogeneity of the salt dome.
2D-axi models show that the current state of mechanical stability of caverns is not of concern as no critical zones were identified. The simulation of the long-term evolution after well plugging highlights the absence of critical evolution for most caverns. However, for some caverns, a risk of roof failure was characterized by the fact that the brine pressure locally becomes larger than the lithostatic stress. The most critical situations are obtained for the most elongated or highly thermally unbalanced caverns.
The simulations carried out have highlighted the high sensitivity of the results to the value of salt per-meability and to the waiting time before well plugging. It appears that the lower the salt permeability, the greater the pressure peak and the risk of salt failure at the roof of the cavern. Moreover, the increase in waiting time before well plugging reduces the thermal imbalance, and therefore the value of the maximum pressure in the cavern. It therefore leads to a reduction in the risk of failure. It remains to specify the value of the permeability and then the conditions of closure for the most critical caverns. An abandonment test is planned soon to help in this purpose.

Key words: post-mining, salt caverns, in situ measurements, numerical modeling.