Long Term Subsidence Prediction Above Storage Cavity Fields in Salt Layers

by

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ABSTRACT

This study deals with a comparative analysis on subsidence over two leached salt cavern storage sites in France: Tersanne and Etrez. The two fields are somehow similar, with fourteen cavities each located at a same depth. This study confirms and enhances previous conclusions of studies by the authors on Tersanne field, and finally, a long term prediction to 100 years is attempted.

In a first step, one verifies that the numerical predictions agree with the subsidence measurements done by GDF on the two sites. This is obtained when considering that mechanical parameters of rock salt are given from Gas de France calibration on cavities convergence measurements over ten years, while unknown elastic parameters for non saline strata are chosen arbitrarily in a reasonable range. In a second step, one gives a prediction up to 100 years of the surface subsidence by the numerical model.

According to a modelisation procedure already validated, the calculations for a single axisymmetric cavity serve as basis for the determination by superposition of subsidence above a 14 cavity storage field. The superposition allows to avoid the three-dimensional analysis, and is valid provided that cavities be sufficiently spaced, and cover strata be supposed linear elastic.

The subsidence over a single cavity has then to be accurately evaluated. This is not easy with classical numerical methods, given the small dimensions of the cavity compared to its depth. For this purpose, one uses a recently developed mixed finite elements and boundary elements model, which is specially adapted to the problem. The representation of infinite domains is facilitated by both using boundary elements on one hand and infinite elements on the other hand. The discretization of the elastic strata by boundary elements needs considering only the surface and interfaces with salt layers. Uni and bidimensional infinite elements contribute to a good representation of infinite boundaries.

Constitutive laws for rock salt validated over short time periods are more uncertain for a 100 years forecast. Therefore bounds may be proposed to subsidence by choosing two alternative laws, with one admitting a stationary creep. Also, the fact of not taking into account the structural geometrical modifications has for consequence providing deformations values by excess.

Given the low calculated and measured displacements, even for a prediction to 100 years, it appears that the case of Etrez does not present any serious problem of subsidence. The much lower subsidence than in Tersanne, is mainly explained by the different nature of salt rheology and, also, by the different geometrical locations of the cavities and of a different operation timetable.