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AN *IN SITU* CREEP TEST IN ADVANCE OF ABANDONING A SALT CAVERN

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Abstract

The Carresse facility is located in the southwest of France and was operated by Total E&P France as a LPG storage for 40 years. Four caverns were created on this site: three were used for LPG storage, and the fourth was used for brine saturation. These cavities are relatively shallow (300-400 meters deep for SPR1,2,4 and 700 meters deep for SPR3) and small (9,100 to 24,200 m^3).

In 2002, Total E&P France decided to abandon this facility. Since then, extensive geomechanical and hydrogeological investigations have been performed to assess the long-term behavior of these caverns after abandonment. One objective of the geomechanical studies was to determine the Carresse salt-creep parameters values to be used in numerical simulations.

For this purpose, Total E&P France asked the Laboratory for Solids Mechanics of Ecole Polytechnique (LMS) to perform a set of laboratory tests and asked Brouard Consulting, with Ecole Polytechnique and Geostock, to organize a long-term *in situ* creep test for the SPR3 cavern. This cavern was selected because it had been kept idle for years, and the brine located in it no longer exhibits thermal expansion. Moreover, as this cavern is the deepest one, it has the greatest magnitude of salt creep.

During the testing program, the SPR3 cavern experienced several cavern pressure steps changes (lasting about 1 month) from relatively high pressure (3 MPa above halmostatic pressure; i.e., pressure resulting from the weight of the brine column) down to low pressure (below halmostatic). The pressure build-up, and/or the naturally expelled brine flow, was monitored precisely and continuously during the test.

Assuming a Norton-Hoff law for secondary creep, a back-analysis allowed estimation of the creep parameters values. The SPR3 salt creep appears to be noticeably faster than the *in situ* creep observed at other sites. The results also show that the long-term equilibrium pressure (which is reached when the cavern convergence rate caused by salt creep exactly balances the brine permeation rate) would be far below geostatic pressure. Another test result was an estimation of the average value of salt formation permeability, which seems to be relatively high (5-9 $x10^{-19}$ m^2). Well integrity was checked carefully: well leakage (via casing shoe, casing and cementing) is estimated to be extremely small — of the order of a few liters per day (a few dozens of bbls per year).

Key words: Abandonment, *In situ* test, Creep, Permeability, Tightness