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Geomechanical Evaluation of the Stability of Abandoned Cavern 4 in Bayou Choctaw Salt Dome

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Abstract

Abandoned Cavern 4 on the Bayou Choctaw dome (BC-4) sits within the U.S. Strategic Petroleum Reserve property and requires monitoring and periodic assessments of stability. The cavern was originally drilled for brine production in 1935 and abandoned in 1954 following the collapse of the nearby Cavern 7. The abandoned cavern presents several present-day problems that the U.S. Department of Energy must contend with: (i) its roof currently extends into caprock (ii) it has never held pressure at the wellhead, (iii) it is centrally located at the Bayou Choctaw dome adjacent to surface infrastructure, (iv) it exhibits a number of similarities to cavern 7 prior to its collapse in 1954 to form current-day Cavern Lake, and (v) state regulations require a monitoring plan (even though it is abandoned) given its proximity to edge of salt. This paper evaluates the structural stability in BC-4 through the geomechanical analyses using a numerical model capturing realistic geometries of the site. The results from the analysis indicate that the cavern roof in the caprock layer has no predicted risk of structural stability in the form of tensile failure through 2047. However, the compressive stressed area surrounding BC-4 does gradually decrease with time. This trend is likely to continue over the years as the BC caverns close and resulting subsidence accumulates. The computational model somewhat idealizes the condition of the caprock in the roof of BC-4, so uncertainty will always exist in its condition. Therefore, even as the model provides justifiable reason to believe that a roof collapse of BC-4 is not imminent, we need to continue monitoring the cavern roof integrity. In addition, the salt surrounding BC-4 is predicted to have experienced tensile and dilatant damage from the simulation. The potential for salt falls is important for the overall integrity of the cavern. Because these salt falls will likely occur from the near-roof portions of the cavern, they may over time degrade the roof and accelerate the transition from compressive to tensile stresses in the caprock roof. In conclusion, the model indicates that any sort of roof collapse for BC-4 is not imminent; however, the uncertainty due to salt falls and their effects illustrates the importance of continued monitoring of the area around BC-4 for behavior such as subsidence and tilt which may indicate a change in the cavern's integrity status.

Key words: Numerical Modeling, Salt Behavior, Caprock Roof, Cavern Stability