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Large Scale Salt Deformation: Comments on subsidence using thermal, creep and dissolution modeling to assess volumetric strain

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Abstract

The U. S. Department of Energy Strategic Petroleum Reserve (SPR) currently has over 650 million barrels of crude oil stored in 62 solution-mined caverns in four salt domes along the Gulf Coast of Louisiana and Texas. One of the challenges of operating these caverns is maintaining an understanding of salt deformation of individual caverns, as well as the salt dome. Two methods to track deformation at the SPR are subsidence measurements and analyses using thermal, creep and salt dissolution models.

Subsidence at each of the four SPR sites has been determined for the past 20 years using leveling measurements. From these measurements one can determine a crude measure of volumetric strain of the salt mass in response to cavern closure. Cavern closure is a time-dependent phenomenon, owing to salt creep in response to the ever-present imbalance of stresses once the cavern is solutioned. The geology, together with the cavern sizes, geometries, depths, and pressure/temperature histories will act to prescribe cavern closure.

As part of the cavern monitoring program, a software system called CaveMan has been developed. It includes thermal, creep and salt dissolution models and is able to predict the cavern pressurization rate based on the operational history of the cavern. Caveman allows for direct calculation of the volume change for each of the caverns, and each site.

A comparison of the volumetric strains as calculated from the subsidence data and the Caveman analysis shows a reasonable agreement at most sites, which suggests that subsidence is directly linked to underground cavern closure. However, Big Hill shows a large discrepancy; currently it is believed that this discrepancy is due to its exceptionally thick caprock and the limited areal extent of the subsidence measurements.

Key words: Strategic Petroleum Reserve, Subsidence, Rock Mechanics

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