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An Updated Three-Dimensional Geologic-Genetic Model of the Big Hill Salt Dome and Strategic Petroleum Reserve Site

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Abstract

A revised and updated geological model of the Big Hill salt dome in southeastern Texas has been constructed to support continued operation and potential expansion of the existing U.S. Strategic Petroleum Reserve (SPR) facilities at this site. The new model uses finer stratigraphic intervals and makes use of well data from substantially farther away from the salt diapir than earlier studies. The result is a much more detailed and comprehensive geologic model of the salt and adjacent strata. The resulting model provides significant insight into the emplacement history of the salt dome and into the subdivision of the dome into a number of individual spines and spine complexes.

The modeling approach is twofold. First, both direct and indirect well control have been used to infer the configuration of the top-of-caprock and top-of-salt surfaces. The collective data argue strongly for the definition of individual caprock highs that most likely record differential salt-spine movements. This same reasoning also allows the identification of the much-subdued protuberances on the underlying top of salt.

The second aspect of the recharacterization effort involves detailed subdivision of the largely deltaic, Miocene and younger sediments that enclose the dome to depths corresponding to those of the SPR storage caverns. These subdivisions have been correlated around and onto the dome, and they allow creation of interval-thickness maps that reveal local variations in sediment deposition caused by the near-surface presence of the salt mass through time.

In summary, the model indicates that the Big Hill salt dome was emplaced by a combination of active diapirism, resulting in a large number of spines and spine complexes, and by passive sediment down-building. Evidence for piercement emplacement is preserved both in the caprock and in the sediments adjacent to the salt. Continued salt movements or differences in salt properties and behavior along the boundaries between spines may markedly affect the stability and operation of the SPR storage caverns.

Interpreting the salt-movement history provides a basis for better understanding the internal structure of the salt mass and the influence which that structure may have on cavern placement, cavern design and shape, and the variations in the mechanical properties of the salt that may exist within a cavern field that affect creep rates, salt falls, or contamination of products. State-of-the-art three-dimensional computer graphics allow the complex geologic model to be visualized readily by those not accustomed to subsurface geologic map suites. The model has implications for continued operations of the Strategic Petroleum Reserve caverns at the Big Hill site and potential for possible future expansion caverns.