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Assessing the Separation Distance Between Geologic and Engineered Features at a Gulf Coast Salt Dome

Christopher A. Rautman
Geologic Consultant to C Tech Development Corp., Albuquerque, New Mexico

Abstract

Recent (2012) events involving breaching of the flank of the Napoleonville salt dome by an abandoned underground storage cavern, and the subsequent overlying surface collapse, have generated significantly increased interest in understanding the three-dimensional geometry of both geologic and engineered features. Although the geometry of engineered features, such as a solution-mined underground storage cavern, generally is known fairly precisely, the geometry of geologic features, such as the edge of salt or boundary shear zones, is generally much less so. In fact, it is well known that almost all geological models involve substantial interpretation of data. A consequence of the interpretive/uncertain nature of the geologic framework suggests that several geometric models all may be consistent with the known data.

We have developed a procedure for analyzing the geometry of a sonar-surveyed underground storage cavern with respect to a geologic model for a salt dome of interest. The process involves mathematically “intersecting” two finite-element-like meshes that represent the different geometric features. As this distance is computed fully in three dimensions, determination of the separation distance does *not* depend upon the orientation of a particular cross section profile or level plan. The resulting distances from all points on the cavern to the salt can be mapped for visualization onto the 3-D surface mesh representing the cavern. Likewise, the distances from all points on the margin of the salt dome can be mapped onto that geometric surface.

Of course, the real-world accuracy of the closest-approach distance thus determined is almost wholly dependent upon the specific geologic model of the salt margin employed. However, one can repeat the computation using the same cavern and any number of alternative geological models. The variability of cavern-to-salt distances observed between/among different input geologic models provides one means of assessing the geologic uncertainty associated with the site.

Analyses using this same procedure may also be used to analyze the spatial differences between any set of two digital geologic models, independent of the cavern setting. Multiple comparisons among several such salt dome models may identify spatially consistent regions returning large separation distances. Again, the spatial variability of the “large” distance values among models provides a mechanism for addressing characterization uncertainty. Identifying such regions may provide a semi-quantitative basis for siting additional data collection efforts.

Key Words: Cavern design, computer modeling, Gulf Coast, leak, salt domes, seismic, sinkholes, sonar.