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US DOE SPR PMO, New Orleans, LA

Dear: Diane Willard, DOE-SPR

Subject: Milestone ***1.2a3: New Geomechanical Computation Analysis Evaluating Behavior of the Fault nearby BC-4***

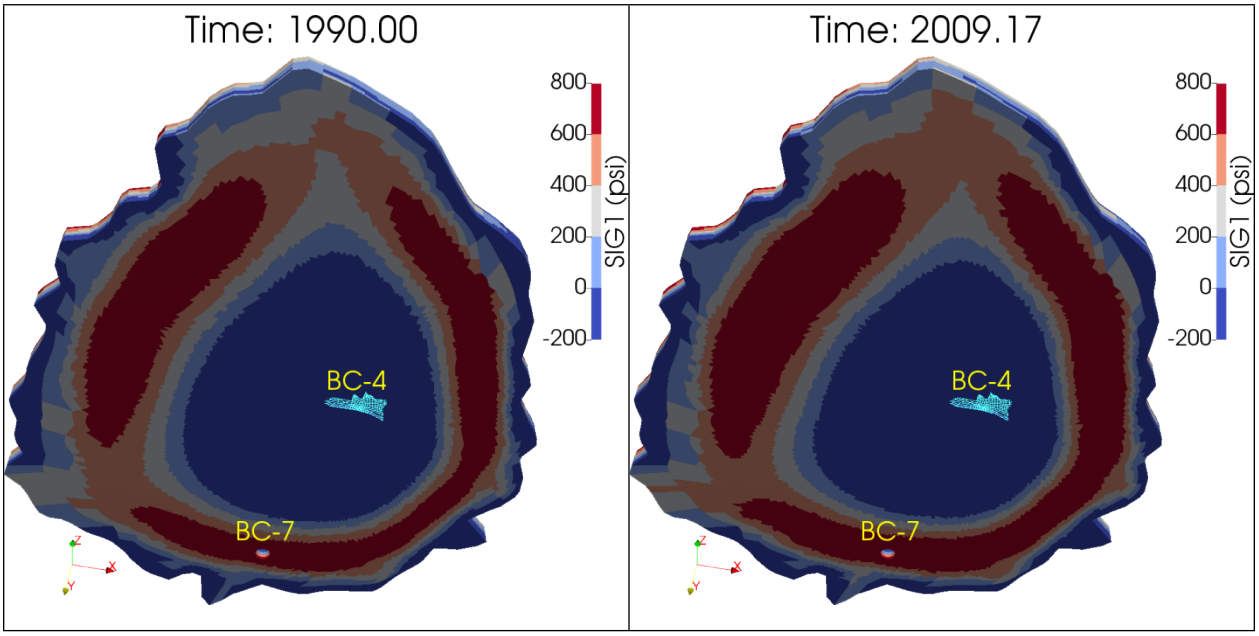
BC-4 is an abandoned brining cavern situated in the middle of the site. Its presence poses a concern for several reasons: 1) the cavern was leached up into the caprock; 2) it is similar to BC-7, a brining cavern on the northwest corner of the dome that collapsed in 1954 and now is the home to Cavern Lake; 3) a similar collapse of BC-4 would have catastrophic consequences for the future operation of the site. There exists a previously mapped fault feature in the caprock and thought to extend into the salt dome than runs in close proximity to BC-4. There are uncertainties about the true extent of the fault, and no explicit analysis has been performed to predict the effects of the fault on BC-4 stability. Additional knowledge of the fault and its effects is becoming more crucial as an enhanced monitoring program is developed and installed.

After review of both the historical evidence and current data in Task 1.1 [Lord and Roberts, 2020], it was determined that the presence of the fault is not definitive, with some evidence, such as the gas regain rates and subsidence, being refuted. There was no evidence of new logs being acquired across the salt dome itself between the original 1980 mapping and 1993 update. The preferential westward leaching of abandoned caverns 1

and 4 offer the only support and indicate the possible presence of shear zone, but not necessarily a fault within the salt.

If the caprock is indeed faulted, then that would further support the messy broken up nature of the overlying caprock and certainly adds complexity to Cavern 4 roof's overall stability. However, the location of Cavern 4 is in approximately the center of the dome, which is generally a location of compressive horizontal stresses and low shear stresses as shown Figure 1 [Park, 2018]. These stress conditions would inhibit both mechanical failure of the intact caprock and slip along the fault.

That caprock thinness and the subsidence of salt top beneath it are the primary factors in the evolution of stress and strain in the caprock. According to the experience from the Big Hill analysis (Task 1.2a1 which will be reported on the end of September 2021), the fault in the caprock layer could affect the subsidence of salt top. The thicker the caprock, the larger the effect of the fault, i.e. it depends on the thickness of caprock. The thickness of the caprock at the Bayou Choctaw site is quite thin compared to that at the Big Hill (160 ft vs. 1320 ft) as shown Figures 2 and 3. Therefore, even if there is this presumed fault crossing the caprock, it is not expected to have a significant effect on the behavior of the caprock and salt from a geomechanical perspective. In conclusion, a geomechanical analysis model may not be required to contain the fault.



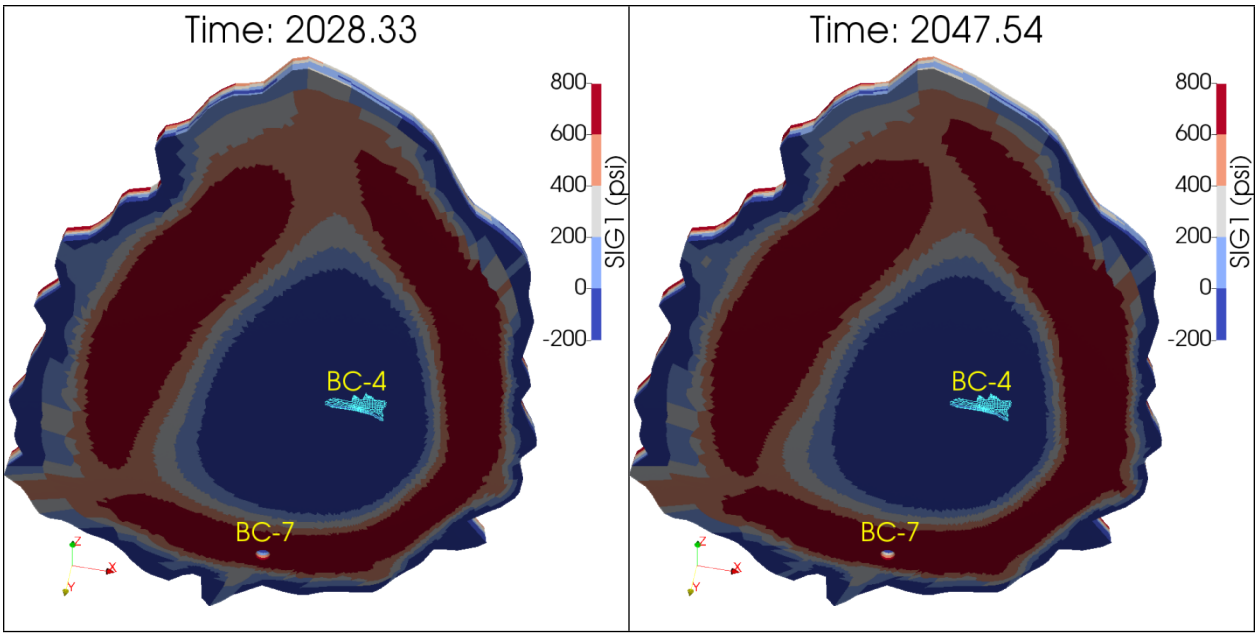


Figure 1. Contour plots of σ_1 on the base of the caprock predicted in 1990 (simulation starts), 2009, 2028, and 2047 (simulation ends) (looking the bottom of the caprock layer). The caprock overlying BC-4 is predicted to be in compressive stress state ($\sigma_1 < 0$) until the simulation ends, while the caprock surrounding BC-7 has predicted to be in tensile stress state ($\sigma_1 > 0$) since the simulation starts. The stress state in the cavern roof of BC-7 is predicted to be larger than 600 psi, i.e. large tensile stresses distribute around the perimeter of BC-7. This tensile stress in caprock, in combination with the roof of BC-7 extending into the caprock and the absence of pressurization of the cavern's brine, probably induced the tensile failure on the roof of BC-7 that caused the cavern collapse in 1954 [Park, 2018].

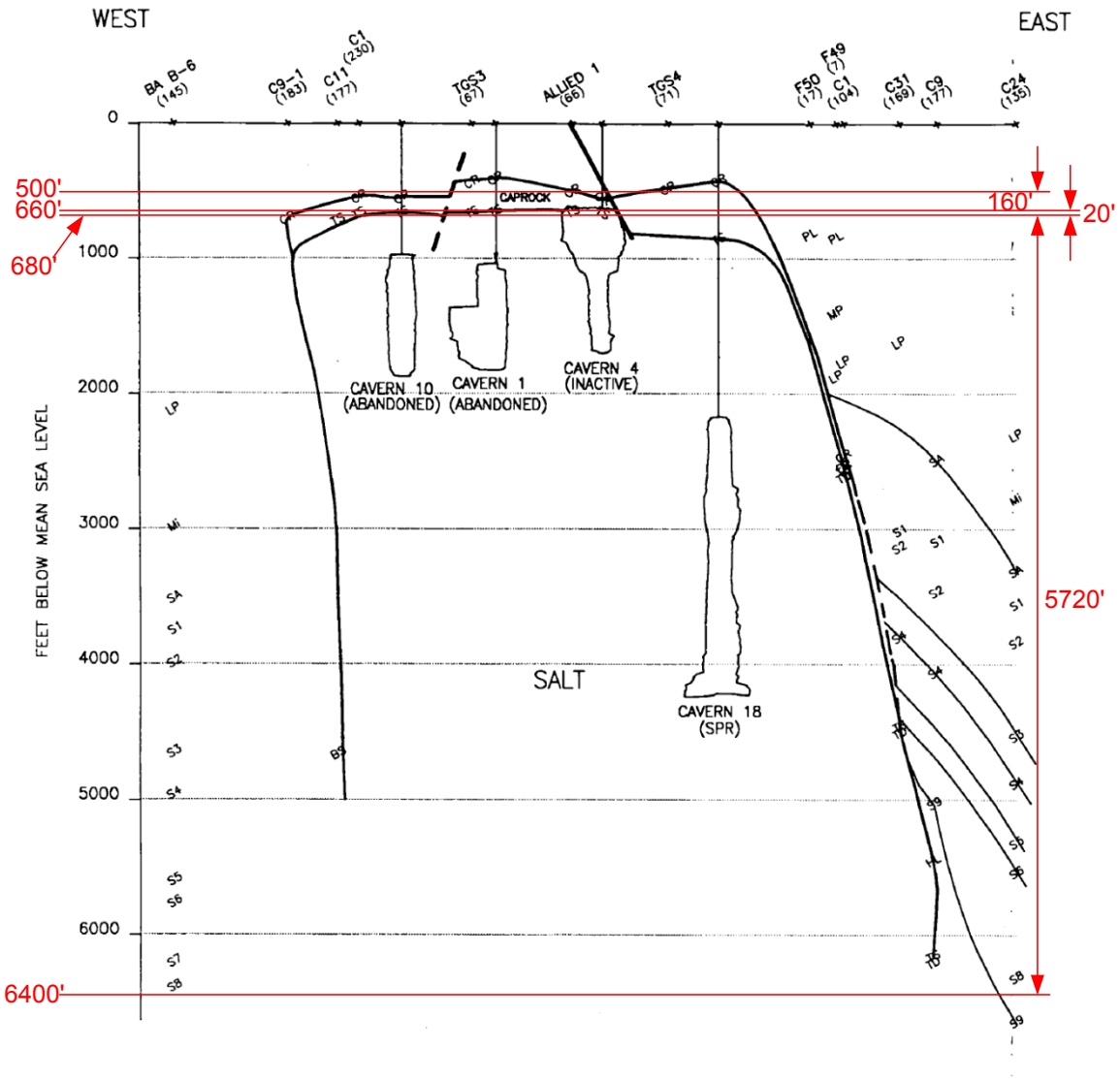


Figure 2. Stratigraphy near middle of Bayou Choctaw salt dome [Neal et al., 1993] and the thickness of each layer used for modeling. Note drawing displays a projection of the fault from out of the cross-sectional plane and does not represent an actual 3D perspective.

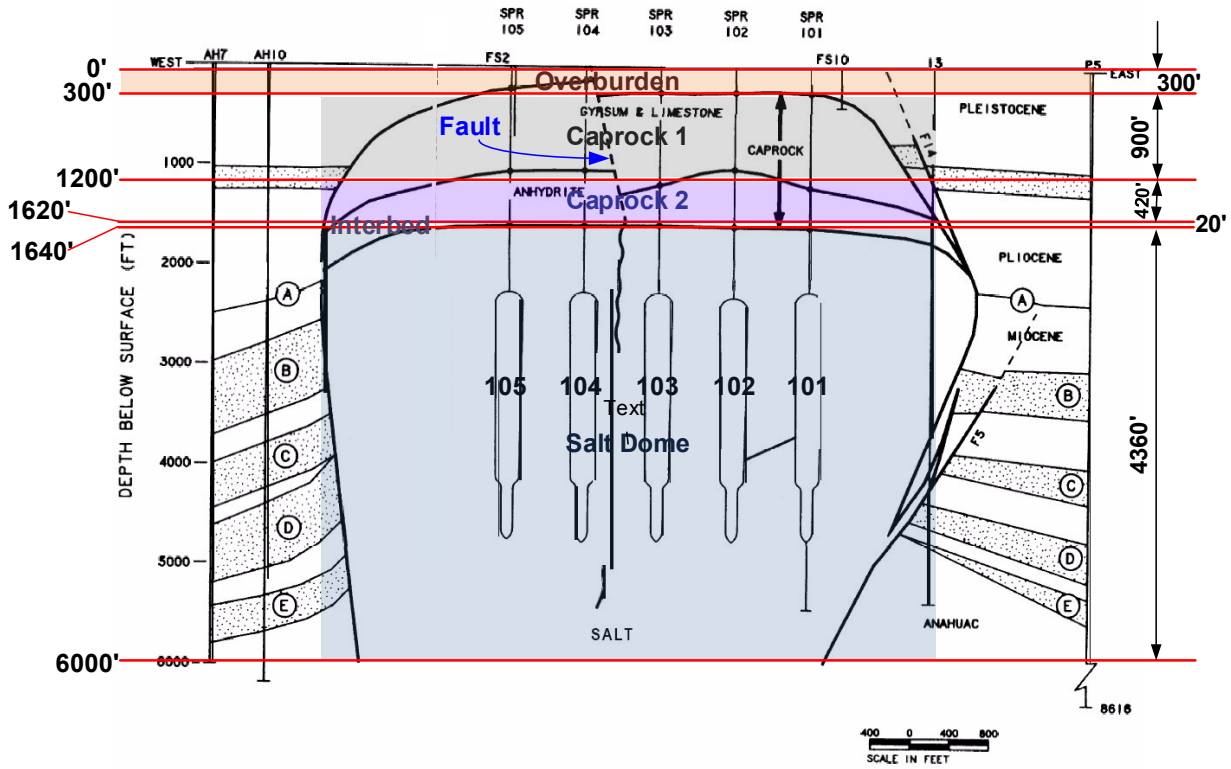


Figure 3. Cross-section near middle of Big Hill salt looking North dome [Magorian and Neal, 1988] and the thickness of each layer used for modeling.

Sincerely,

Byoung Yoon Park

cc: Lionel Gele, DOE
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