



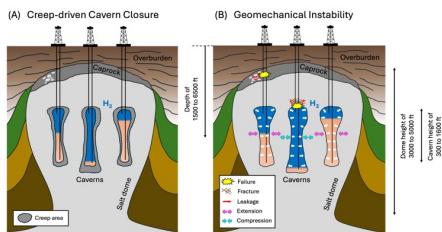
## MODELING BASED ASSESSMENT OF SALT CAVERN PERFORMANCE FOR UNDERGROUND HYDROGEN STORAGE

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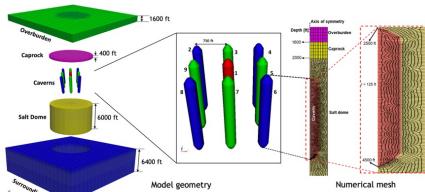
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### PROBLEM

- Underground caverns in salt formations can store hydrogen ( $H_2$ ) because of salt's **extremely low permeability and self-healing behavior**.
- However, there is a gap in research to understand geomechanical behaviors of salt driven by **frequent operation cycles of  $H_2$** .

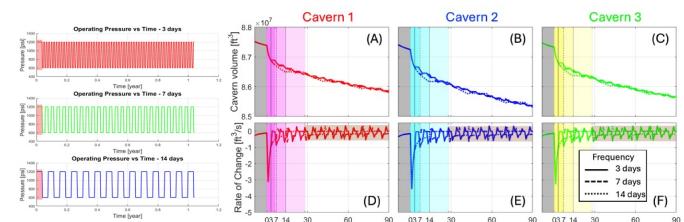


### MODEL SETTING



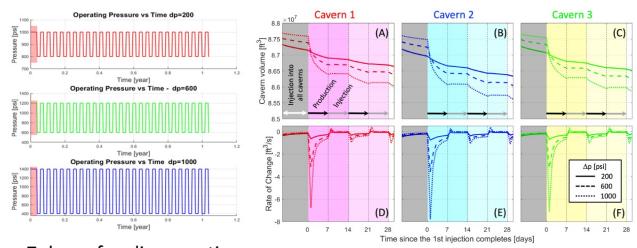
- Finite Element Simulation : SNL's Sierra/SolidMechanics
- Munson-Dawson creep model for salt
- Elastic behaviors in all layers
- 1001 yr (equilibrium) + 1 yr (leaching) + 14 d (pre-injection) + 1 yr (cyclic operation)

### Frequency of Cycle



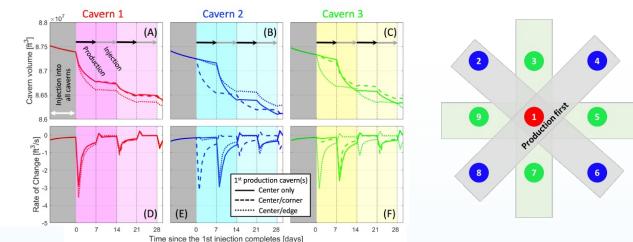
- 3, 7, and 14 days of cyclic operations
- Pressure difference of 600 psi
- After 30 days, the effect of cycle frequency on cavern volume stabilizes within a certain range for all caverns, indicating a **consistent rate of creep closure**

### Operation Cavern Pressure

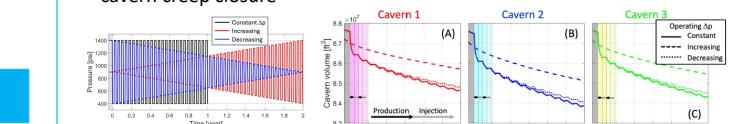


- 7 days of cyclic operation
- Differential pressure ( $\Delta p$ ) of 200, 600, and 1000 psi
- Higher differential pressure ( $\Delta p$ )** leads to increase and accelerate cavern creep closure

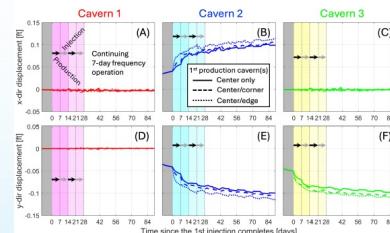
### Sequential Order of Operating Cavern



- 7 days of cyclic operation
- Pressure difference of 600 psi
- Operating **closer** caverns can **accelerate creep closure** due to stronger lateral creep (Figure A; case of production first from center and edge (green) caverns)



- Gradually **increasing  $\Delta p$**  during operation significantly **reduces** initial and subsequent **cavern closure**, suggesting that starting with a **lower  $\Delta p$**  can mitigate the **geomechanical effects of cyclic operations** on salt creep and deformation



- Cavern Interactions:** The center cavern (Cavern 1) shows minimal lateral deformation due to surrounding caverns, while the corner cavern (Cavern 2) deforms significantly in the direction free of neighbors.