



25th world gas conference
"Gas: Sustaining Future Global Growth"

Obstruction in a Salt Cavern: Solution is Dissolution

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CS2.3 – WOC2: Competencies & Innovative
Technologies For UGS



Patron



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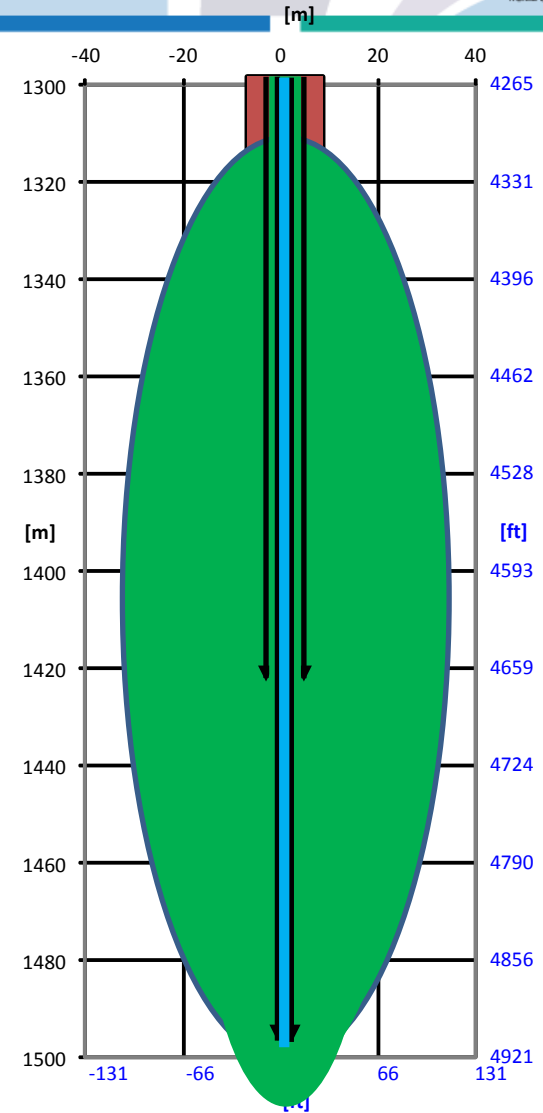


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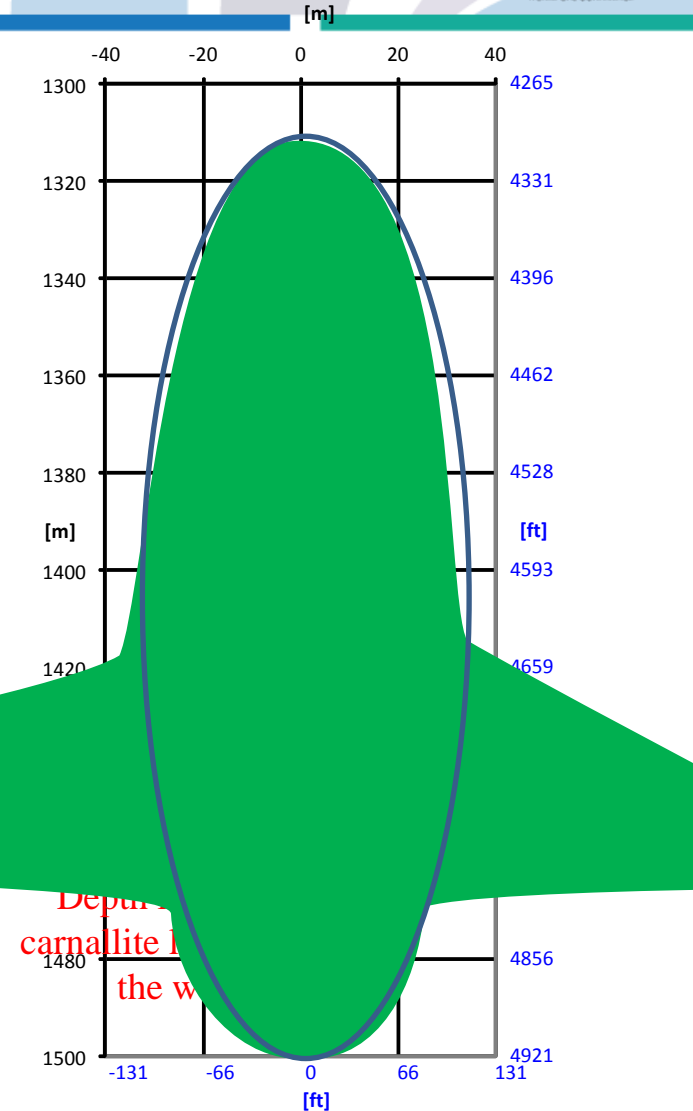
Creating a salt cavern by solution mining

- A thick layer (>100 m) of salt (NaCl)
- A drilling from surface with :
 - A tubing for brine (salty water) withdrawal
 - Another tubing for water injection
 - Blanket protection in the outer annulus
- Cavern is created in stages
- Creation of a cavern needs several years of solution mining



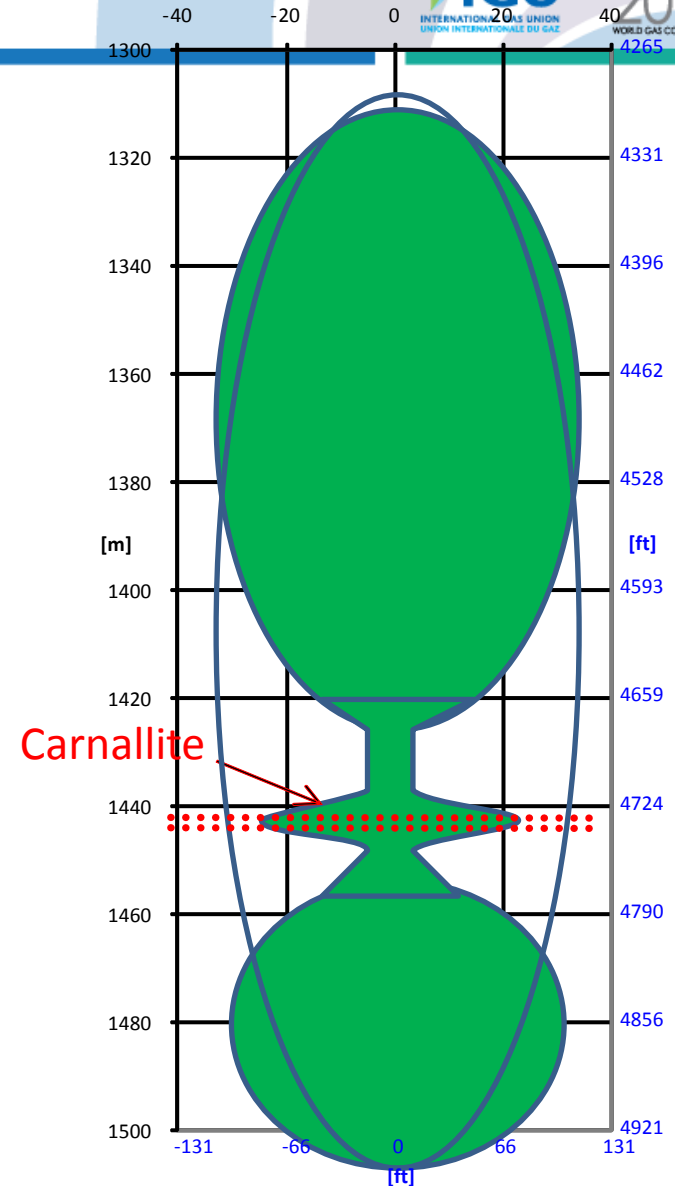
Drilling: Carnallite found

- Planned initial design
- Carnallite found while drilling
 - Only occurrence at this kind of depth in the Peckensen salt dome
 - Highly soluble salt - $\text{KMgCl}_3 \cdot 6(\text{H}_2\text{O})$
 - “Only” 2 m thick layer in well axis
- → need a new solution mining design



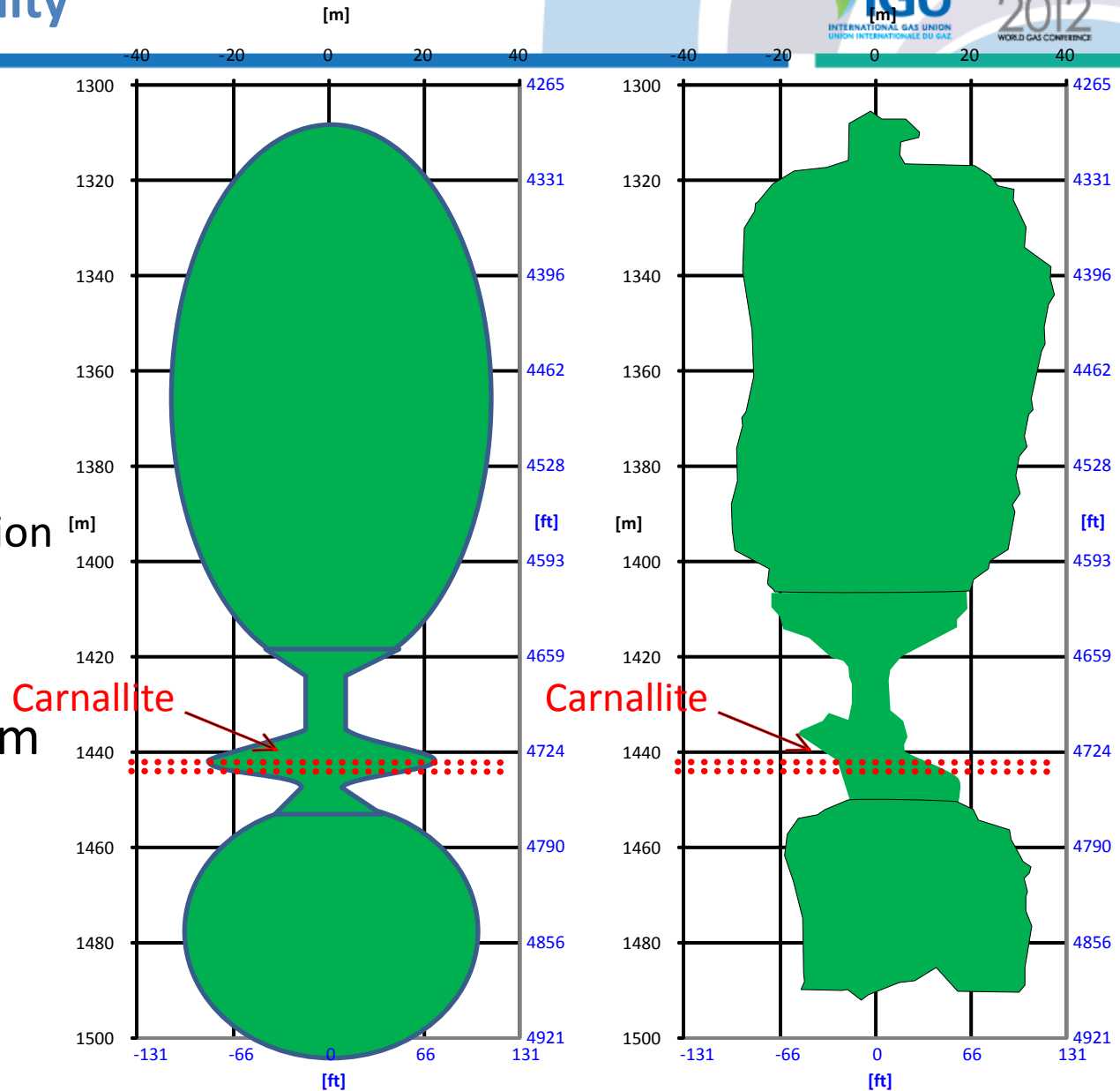
New solution mining design in 3 steps

- Upper cavern part
- 8-10 m diameter intermediate link
- Lower cavern part



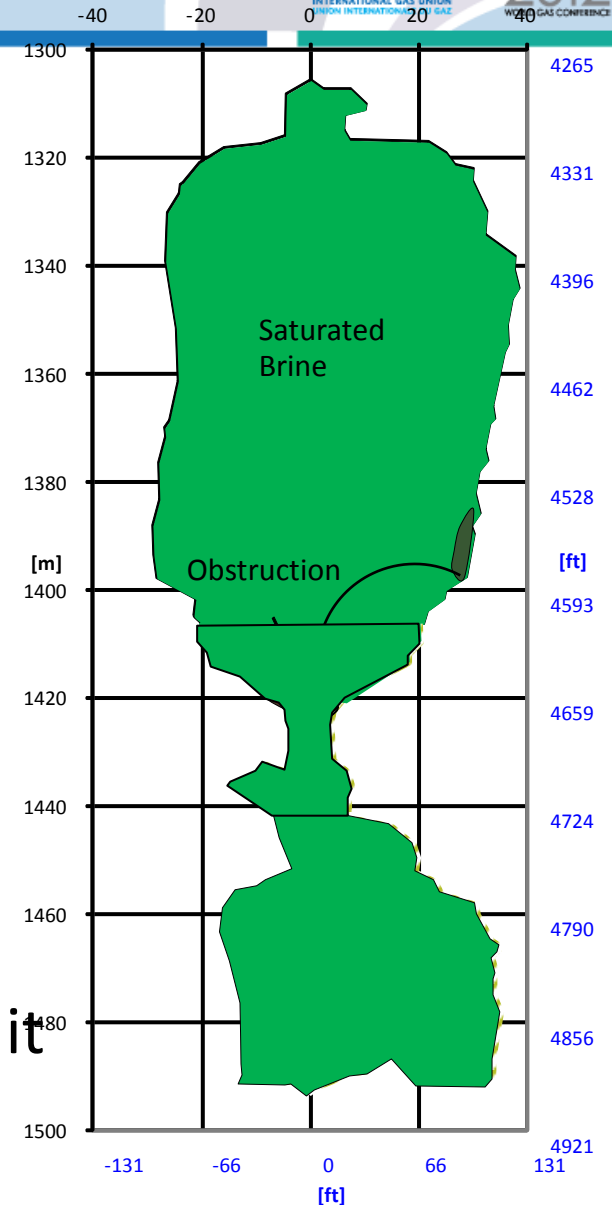
From design to reality

- Both direct and reverse leaching
- Regular extensive brine analyses
 - monitoring of carnallite dissolution
- Constant adaption of leaching program



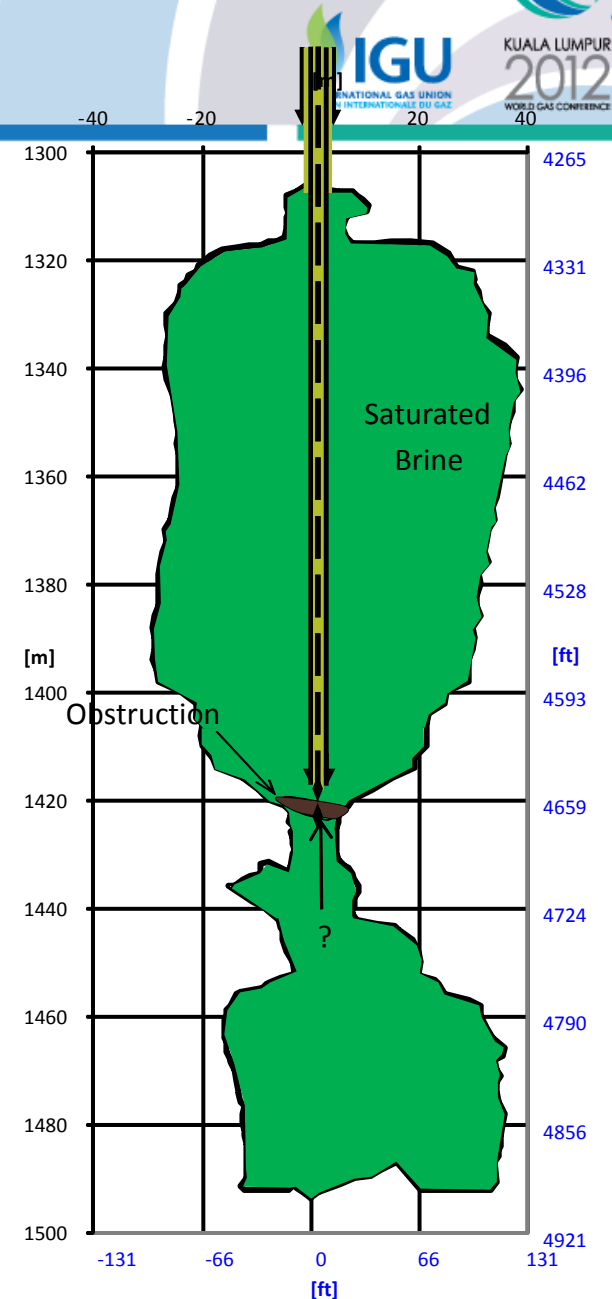
The last minute bad news

- Found during the (planned) very last sonar survey
 - Obstruction over the complete section of the cavern
 - Only upper side known
 - -> no indication on its thickness
 - Reason for obstruction:
 - probably rock falls from the side of the cavern
 - Access to lower cavern part blocked
 - about ¼ of total volume
 - What to do next ?
- drill the obstruction in order to size it



Drilling the obstruction

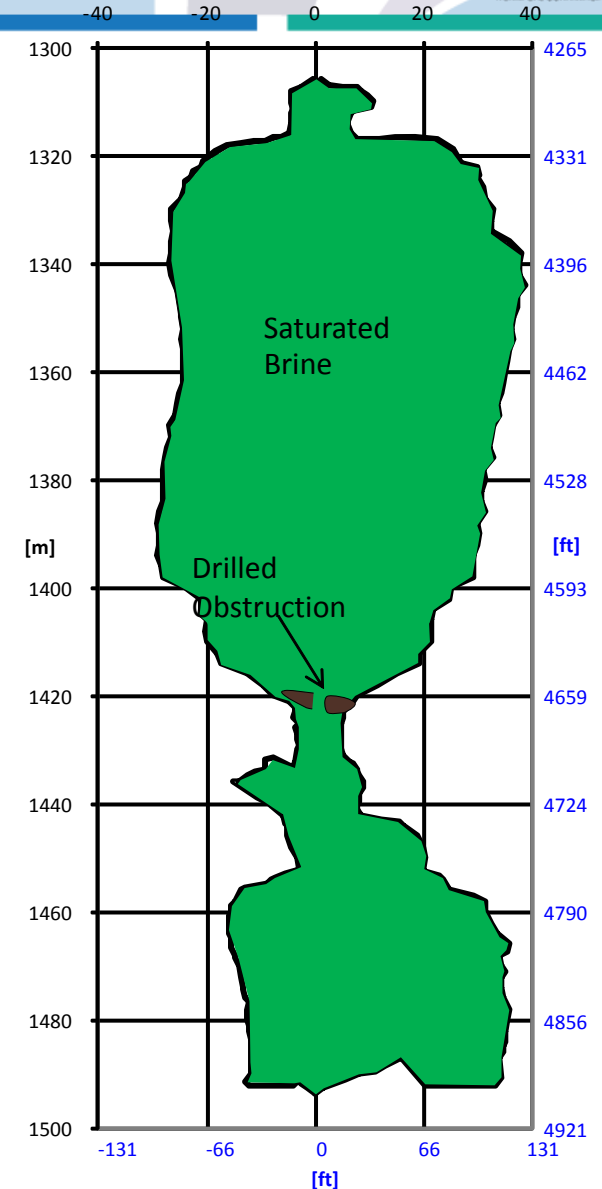
- Running in 10 ¾" outer leaching string slightly above top of obstruction
 - "Guide" for drilling process
- Drill obstruction with downhole motor



The Obstruction

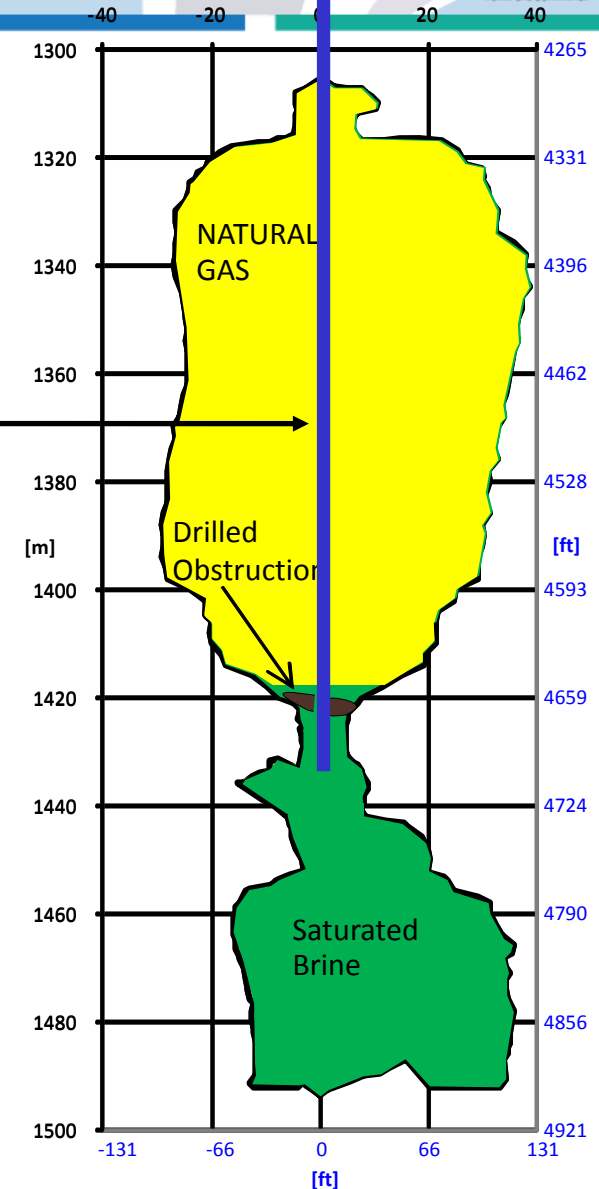
■ Size :

- 10 m x 15 m x 5 m --- 30 ft x 45 ft x 15 ft
- 150 m² x 5 m --- 1350 sqft x 15 ft
- ~ 1 500 t of salt



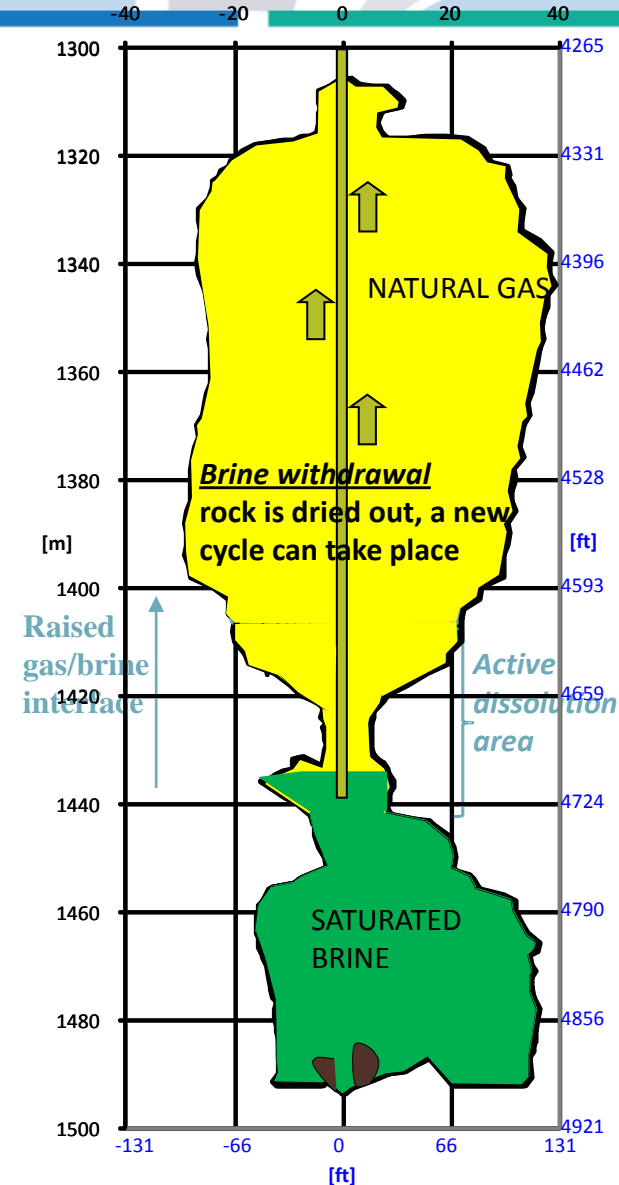
Local solution mining to specifically mine obstruction (1/2)

- Work program for completion for first filling resumed
 - Running in gas production tubing (10 ¾")
 - Running in debrining string (5 ½") set 2 m (6.5 ft) below top of obstruction through the drilled hole
- First filling upper cavern part
 - down to 2 m (6.5 ft) above top of obstruction
 - This took several months (as usual)



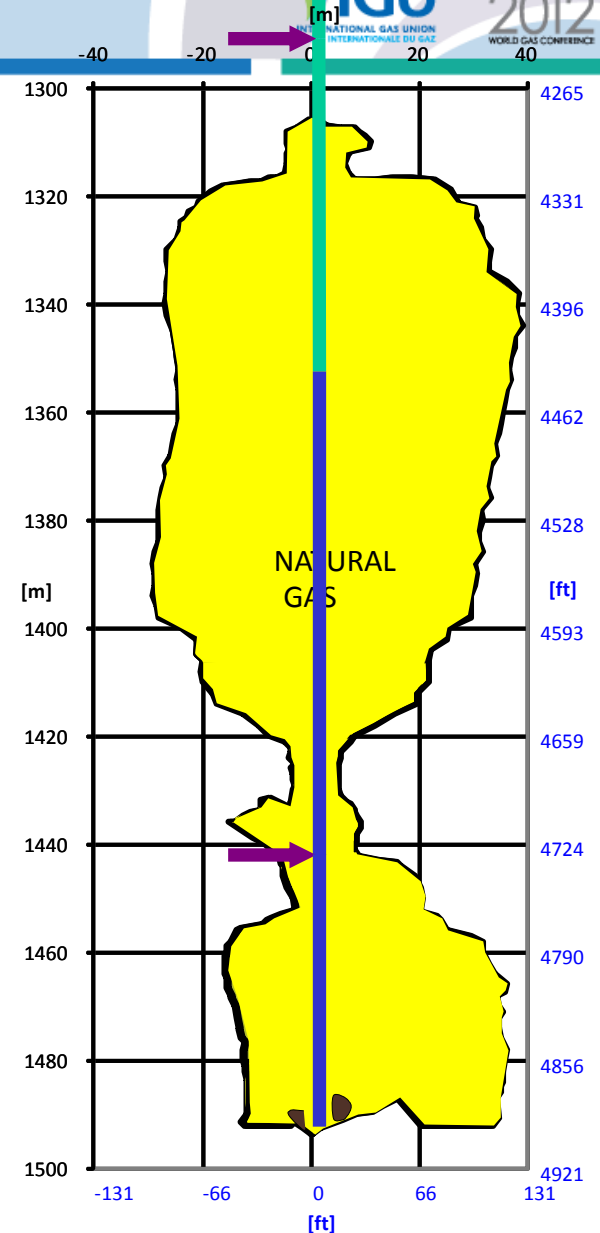
Local solution mining to specifically mine obstruction (2/2)

- Discontinuous leaching with
 - half-cycles of water injection
 - half-cycles of brine withdrawal
 - gas/brine interface being moved within a cycle
- After some cycles the obstruction finally fell to the bottom of the cavern




Finish cavern debrining

- String run in to cavern bottom
- Gas first filling lower cavern part
- Pulling out debrining string: snubbing operation
 - Cut in the cavern + Rest snubbed out
- Final works before storage operation
 - Final sonar survey
 - Setting subsurface safety valve
 - Cavern ready for storage operation



Conclusions

- Challenging and very specific problem
 - Innovative drilling and leaching techniques / tools
 - Short term implementation
 - Step by step decision making process
 - Adaption to new information and changing situation
 - Successful team work (**storengy**+ )
- Entire cavern volume can be now used without any restriction for storage operation.

■ Questions ?

