

Unconventional Completion Practices: Bone Springs – Delaware Basin, SE New Mexico

Lyle V. Lehman

Managing Principal Consultant

Discussion

- STRATASTIM workflow used to optimize Bone Springs
- Workflow requires we understand:
 - Reservoir properties including fluids
 - Permeability distribution
 - Stress environment
 - Investment costs
- Current state-of-the-art

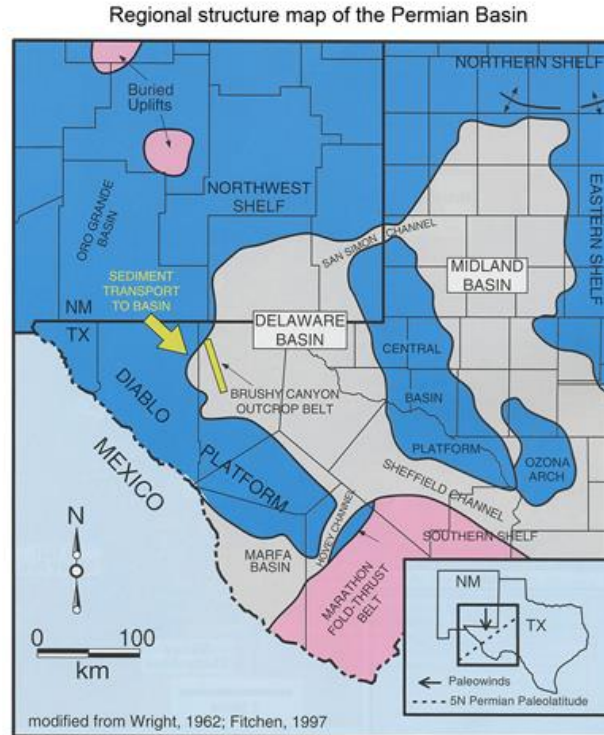


Bone Springs

- Delaware Basin - SE New Mexico, USA
- Low perm, normally pressured oil zone
- 3 Layers, range from 200 – 320' thick per layer
- Was originally a 'back out' zone when seeking the deeper Morrow and Ellenberger horizons

Delaware Basin	
	Dewey Lake
	Rustler
	Salado
	Castile
Delaware Mountain Group	Lamar
	Bell Canyon
	Cherry Canyon
	Brushy Canyon
Bone Spring	Avalon Shale
	1st Bone Spring Sand
	2nd Bone Spring Sand
	3rd Bone Spring Sand
	Wolfcamp
Pennsylvanian	Cisco
	Canyon
	Strawn
	Atoka
	Morrow

Bone Springs play – SE New Mexico USA

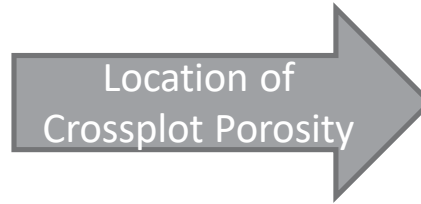


Regional structure map of the Permian Basin illustrating the major subsurface structural features of the Permian Basin during Lower Guadalupian stage. Modified by Beaubouef et al. (1999) from Wright, 1962 and Fitch, 1997).

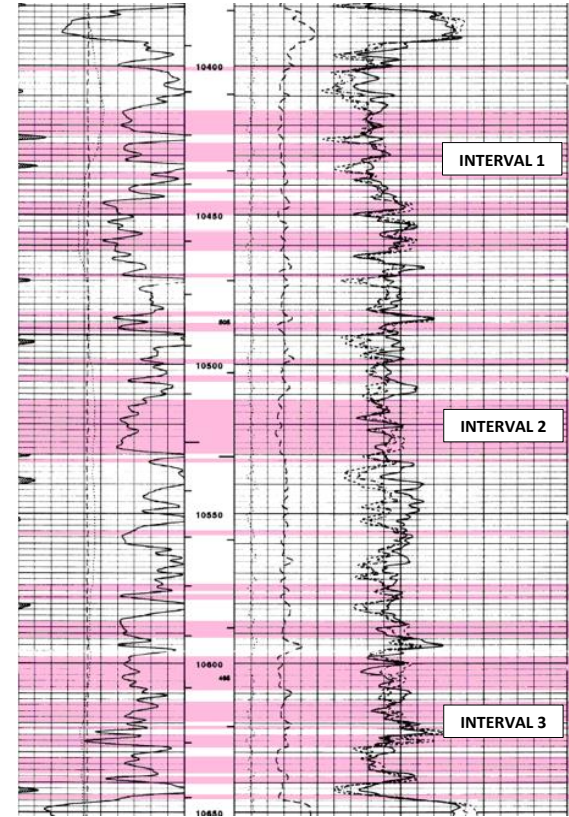
Bone Springs Column

	Formation	Reservoir Name	Prod
PERMIAN	Delaware Mtn.	Brushy Canyon	●
		Bone Spring Limestone	
		Leonard Shale	●
		Upper Avalon Shale	●
		Middle Avalon Carbonate	
		Lower Avalon Shale	●
		1 st Bone Spring Carbonate	
		1 st Bone Spring Sand	●
		2 nd Bone Spring Carbonate	
		2 nd Bone Spring Sand	●
		3 rd Bone Spring Carbonate	
	3 rd Bone Spring Sand	●	
	Wolfcamp	Wolfcamp Shale	☉
PENN	Cisco/Canyon	Penn Shale	☉
		Strawn	●

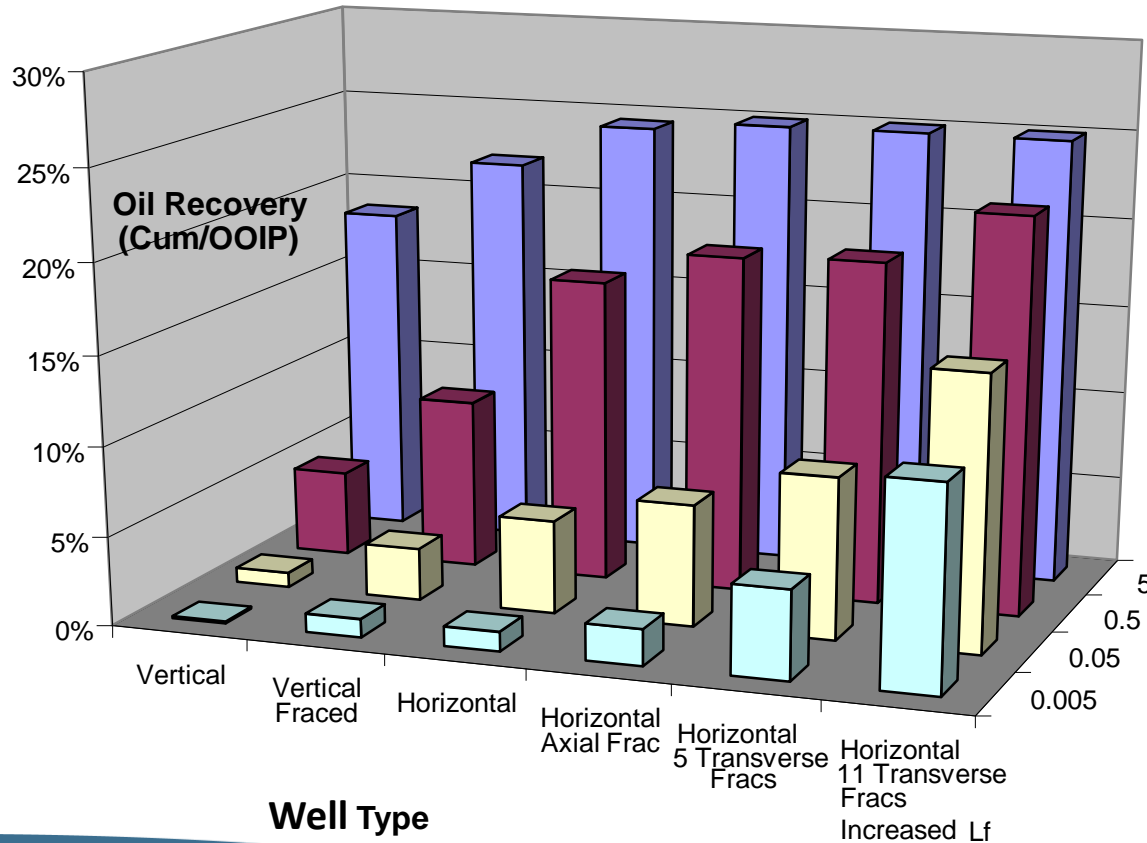
Prior to 2009, few of these zones were commercially completed with a Horizontal wellbore plan.



If the Morrow or Ellenberger were not commercially productive, completed Bone Springs with 20,000# 20/40 Brown Sand



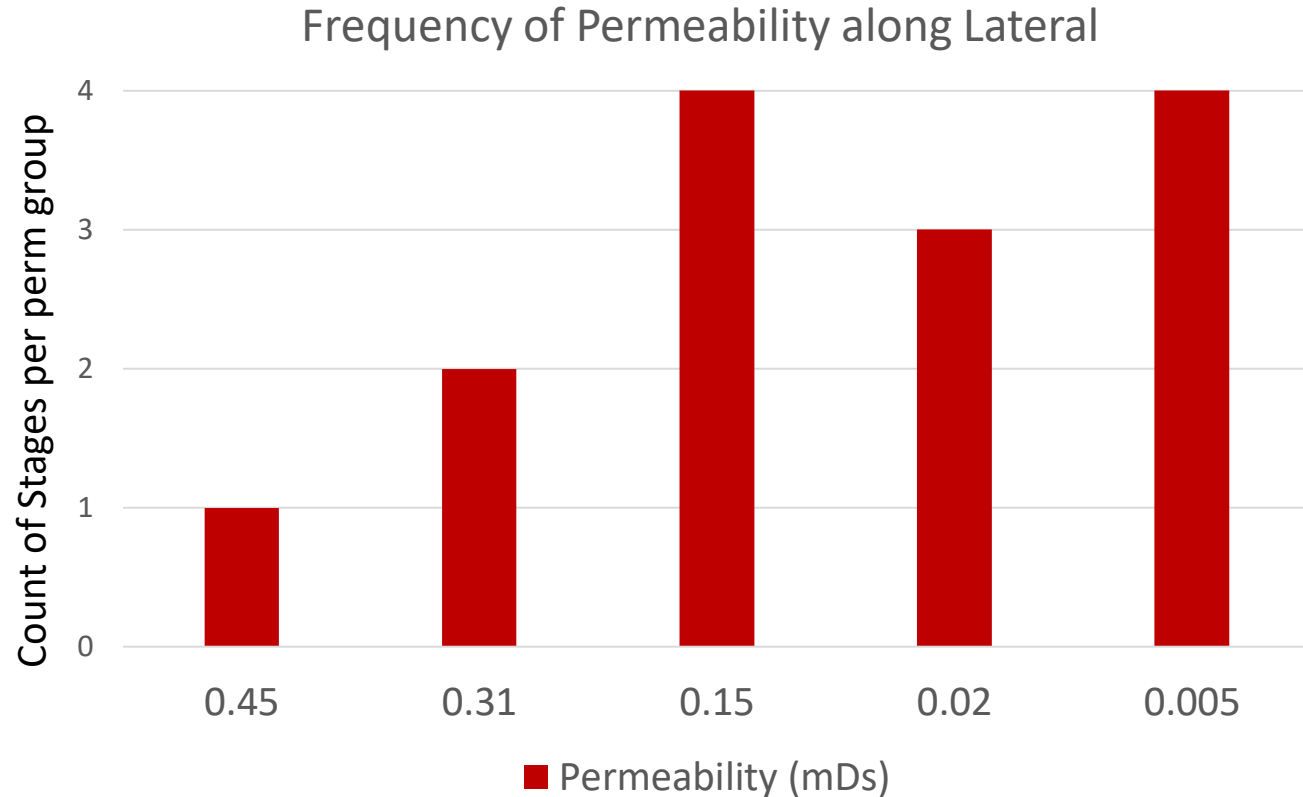
Contacting the Bone Springs



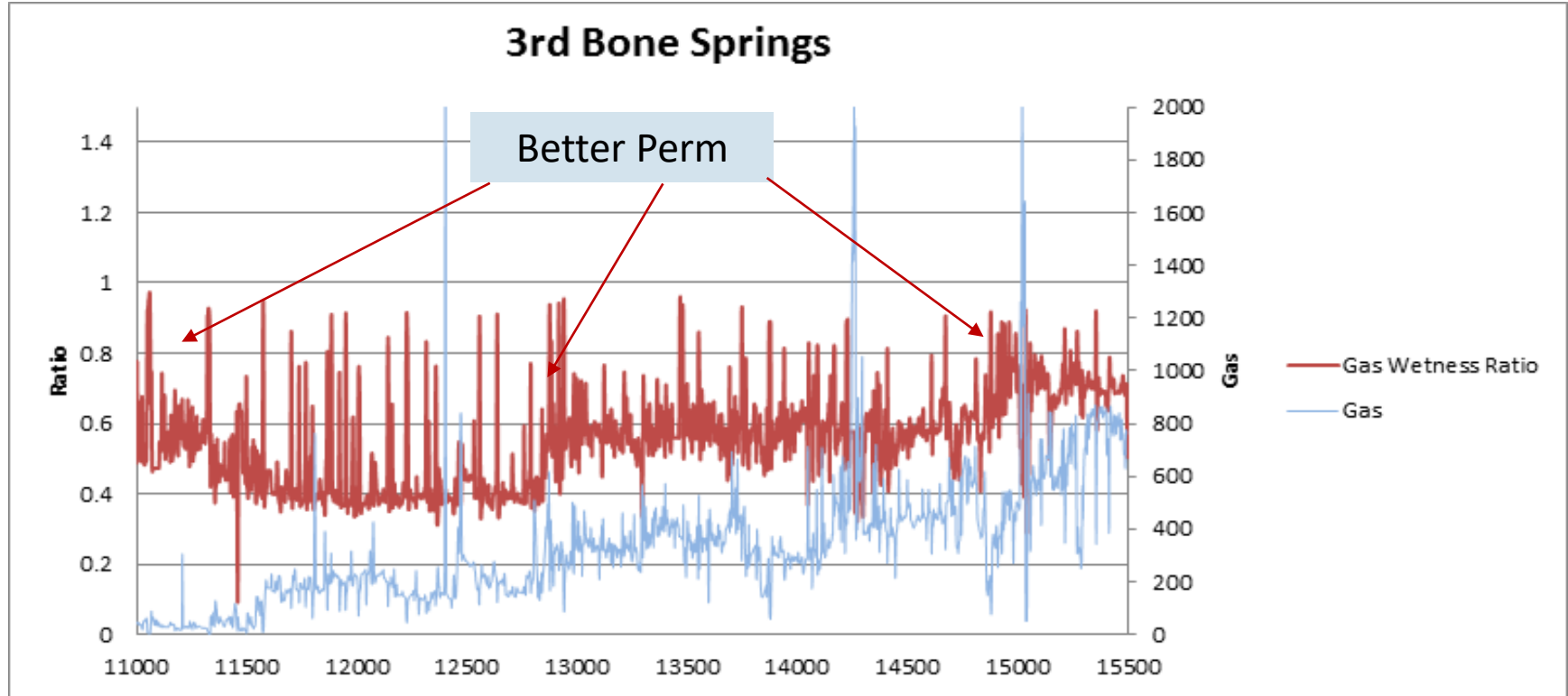
**Permeability
md**

- SPE 133985, Shelley et al

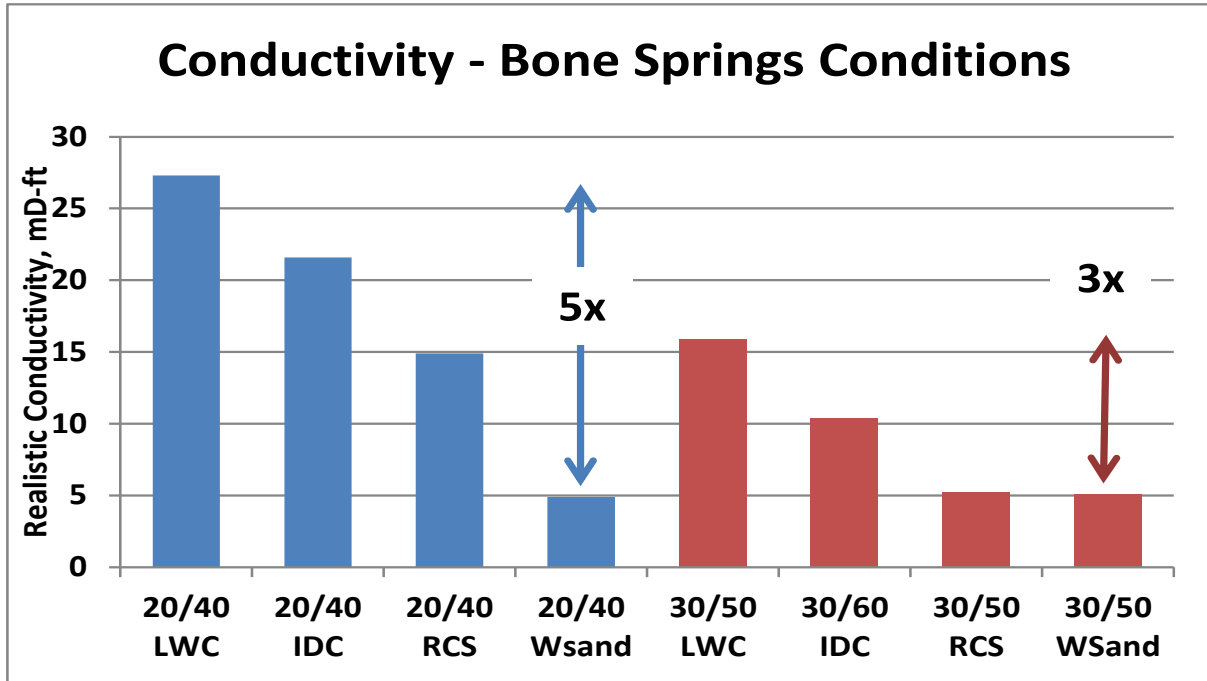
Distribution of permeability in the wellbore



Reservoir quality indicator for Bone Springs

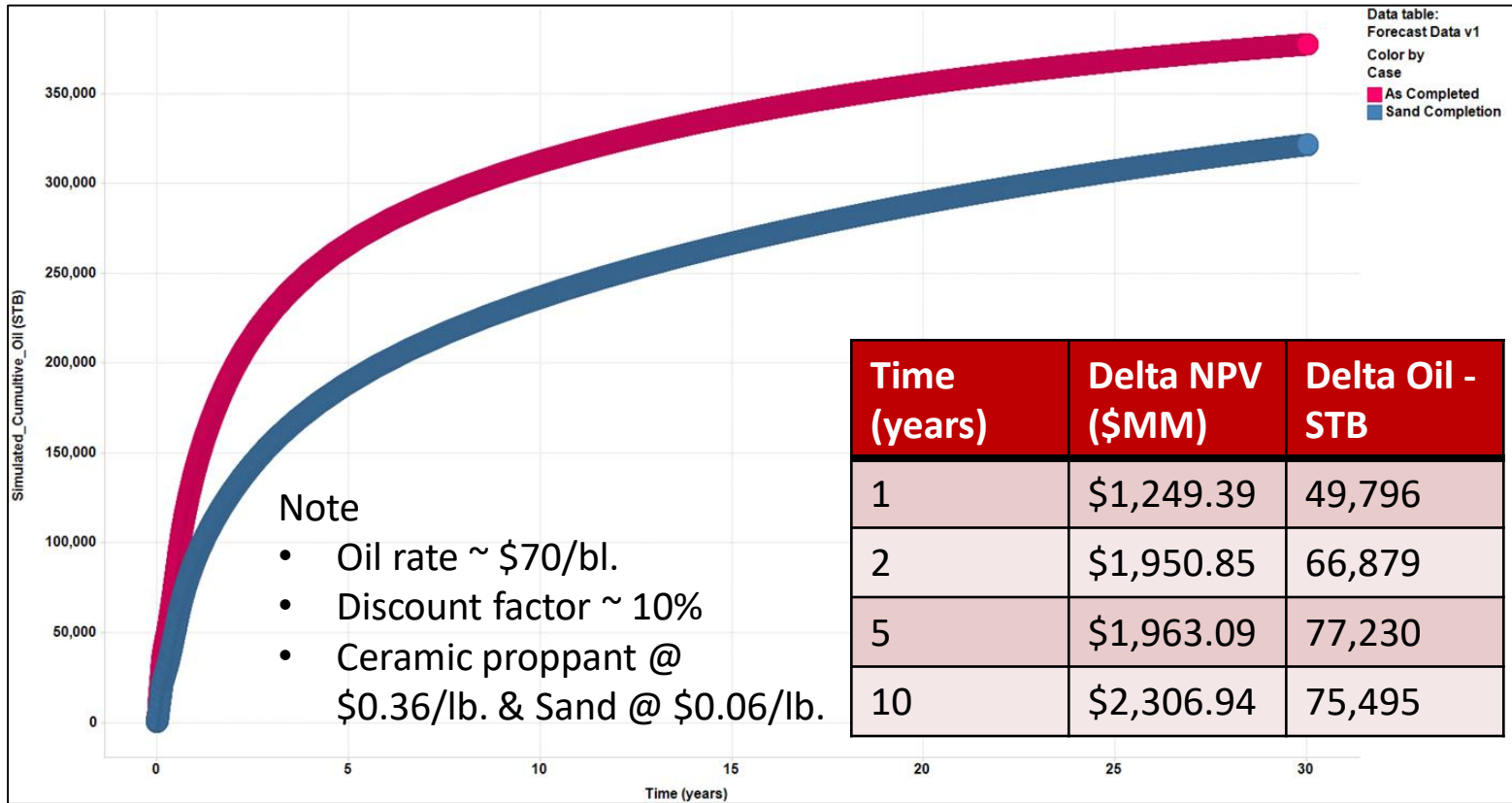


Conductivity in the Bone Springs



Notice that in the case of the Bone Springs stress conditions, a premium lightweight ceramic has three to five times the conductivity as white sand.

Conductivity in the Bone Springs



Completion design



- Goal is to Complete the well so that the reservoir is drained as uniformly as possible in an Economical manner
- Knowing reservoir perm, stress environment, etc. allows us to custom design each wellbore to accomplish this goal

Current best practices - STRATASTIM

- Contact
 - Lateral Depth 55 - 65% of total expected frac height
 - Fracture spacing dictated by mud log response
 - Prefer fewest perforation clusters possible per stage
- Conductivity
 - Lightweight ceramic proppant
 - Use Embedment testing to determine 20/40 or 30/50 as main proppant - Lead-in with 40/70 is OK
 - Thin frac fluids + Nano-surfactant + Ceramic = Great ROI

SPE 154308, Penney et al

Thank you!

QUESTIONS?