Guidon Energy's frac fleet and recycling center in the Midland Basin. *Source: Guidon Energy.*

Permian Operators Squeezed by Growing Water Pressure

Stephen Rassenfoss, *JPT* Emerging Technology Senior Editor

The rising tide of produced water in the Permian Basin is requiring operators to re-engineer how they manage water.

One big difference in the Permian is that water production from unconventional reservoirs exceeds output from most other plays, particularly in the Delaware Basin. Prolific water production has long been a given in conventional fields there, but most of that could be reinjected to maintain production, which is not an option in the ultratight rock.

Instead, billions of gallons of produced water have been pumped into saltwater disposal wells in shallow formations, such as the San Andres, significantly increasing the pressure drillers encounter, creating a hazard for drillers moving in and out of them from lower-pressure zones.

To isolate the higher-pressure zones passed on the way to the Wolfcamp, operators have increased the number of strings of casing used from three to four. The increase adds about $600,000 to the cost per well, said Andrew Hunter, drilling manager for Guidon Energy, which uses the added string to isolate two under-pressure zones.

To maximize produced water use for fracturing, Cimarex has streamlined filtration and chemical treatments of the water in the pipeline system en route to fracture sites, limiting the need for fixed facilities, said Rita Behm, Permian exploration engineering project manager for Cimarex.

Occidental Petroleum is working to manage water production while picking drilling targets. It has developed a detailed evaluation system based on a large company database that predicts production of hydrocarbons and water. High water cuts are a negative in the grading system used to choose where to spend, said John Polasek, vice president of geoscience at Occidental.

All three mentioned the water issue in their presentations at the recent AAPG Global Super Basins conference on the Permian. The comments reflected the importance of dealing with water issues for operators that need to minimize fresh water use and manage injections of produced water.

ExxonMobil's XTO Energy arm is building a system to "treat produced water and reuse it again and again" to reduce its demand for fresh or brackish water wells, said Staali Gjervik, senior vice president for Permian Integrated Development at XTO.

A Big Shift

Addressing the problem will require an industrywide shift. Even if an operator is reusing all of its water, "they can get hammered" by the injections of a nearby commercial saltwater disposal well by an operator that is not finding other uses, Hunter said. "The only way to deal with this is to work cooperatively with other operators," he said.

When drilling through higher pressures, Hunter said drillers increase mud weight to counter the higher pore pressure in that layer, and promptly adjust it back when the pressure drops.

Through drilling 48 wells in the Midland Basin, Guidon learned how to deal with the challenges associated with the higher pressure in the San Andres. Those include the risk of differentially stuck bottomhole assemblies when drilling goes below the San Andres. The sudden shift to a lower-pore-pressure zone can cause an abrupt fluid loss. That pulls the bit on to the well wall like the force of a drain when a bathtub is emptying, Hunter said.

Rather than using force, the company found that the best way to free a tool is hitting the spot with about 50 bbl of hydrochloric acid to dissolve the carbonate rock to break the seal.

"I am not happy with where this is going. On every well we drill in the future, we will have to deal with this (over-pressure) issue. It doesn't make any sense," Hunter said. "We believe the best approach is to recycle all produced water and only use deep disposal wells on a short-term basis while recycling infrastructure is being built."

Water disposal adds to the drilling issues in the Permian. The multilayered richness of the rock means drill bits travel through a century of all sorts of water-injection projects, plus the Permian Basin goes through major changes. Among those differences is a lot higher water production in the western half of the basin.

In the Delaware Basin, Cimarex wells with water cuts of 80–90% are common. For a section with 12 wells, that is 100 million bbl of water for 12 million BOE. "We will need two saltwater disposal wells to handle that peak," Behm said.

Adapting to Injection

Saltwater injection can cause overpressure in the shallow San Andres formation, requiring changes by drilling engineers going for deeper targets in the Midland Basin of the Permian. These can include:

- Increasing mud weight to more than 10 lb/gal in the higher-pressure zone, from 8 to 9 lb/gal elsewhere.
- Setting intermediate casing shallower than desired in the Clear Fork lime when the kill mud weight of the San Andres exceeds the 8.7 lb/gal fracture gradient of the Upper Spraberry.
- Using a drilling liner to achieve adequate shoe integrity in Wolfcamp targets because of the higher mud weight.
- Drilling Spraberry targets without the liner by keeping the production interval mud weight below its fracture gradient.

Source: Andrew Hunter, Guidon Energy.

Cimarex is maximizing reuse by making it as efficient as possible. Rather than building a large water recycling facility and storage pits, it is filtering the fluid and killing the bacteria in it while moving the water to the frac site. This reduces the facilities needed and the risk of pits leaking, which multiple speakers said can be an issue, even with good plastic liners.

Water reuse saves Cimarex the cost of fresh water for fracturing—from $0.60 to $2.50/bbl, depending on the county—but not the cost of injection, Behm said. With water production growing as more wells come on line, "it defers it [injection] by 30 to 60 days. They will have to put it in the ground."

Due to the problems associated with rising pressures in shallower zones, Guidon and Cimarex are among the companies that have added deepwater injection capacity into the Ellenburger Formation. Cimarex has two injection wells, each permitted to handle up to 90,000 B/D.

The Ellenburger is the same basement-level layer used for injection in Oklahoma, where a surge in seismic activity in certain areas forced the state to curtail high-volume water disposal.

Texas operators are taking steps to reduce the chance of a repeat. Behm said Cimarex has installed seismic monitoring equipment for its five injection wells. In addition, she said a group of operators is informally talking with Texas officials about how to manage injection to limit risks.

Major producers such as Occidental are taking advantage of their huge acreage position to select drilling targets with an eye toward reducing produced water.

Its reservoir analysis system predicts both oil and water production, Polasek said. When choosing which benches to develop, "we try to stay away from the high-water zones," he said.

Core Laboratories reported at the conference that it is working on rock analysis techniques it can use to model water production, suggesting other companies share their concern.

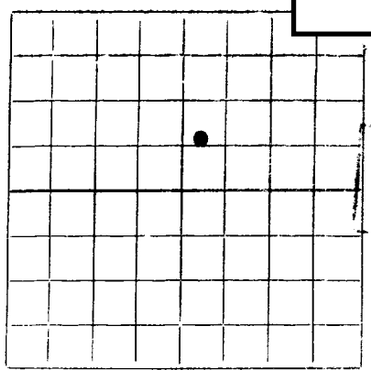
While salty water can work for fracturing, fresh water is still needed for drilling fluids. Fasken Oil and Ranch, an exploration and development company in Midland—which reuses all of its water for fracturing, injection into conventional zones, and drilling—has begun using reverse osmosis to desalinate water for drilling, said Stonie Pollock, a geologist for Fasken.

Hunter said the commitment to reuse pays off in a relatively short time, but requires a significant investment in infrastructure, manpower, and a willingness to make operational changes during the completion of the well.

Considering the costs and consequences of water disposal and fresh water use on a large scale, he pointed out that the cost of doing nothing is considerably higher. **JPT**

Case Nos. 24278, 24277, 24123, 23775, 23614-23617, and 24018-24027
OCD Exhibit No. 8B

(Form C-105)



AREA 640 ACRES
LOCATE WELL CORRECTLY

DUPLICATE

NEW MEXICO OIL CONSERVATION COMMISSION

Santa Fe, New Mexico

WELL RECORD

Mail to District Office, Oil Conservation Commission, to which Form C-101 was sent not later than twenty days after completion of well. Follow instructions in Rules and Regulations of the Commission. Submit in QUINTUPLICATE.

Gulf Oil Corperation (Company or Operator) Bertie Whitmire (Lease)

Well No. 7, in SW ¼ of NE ¼, of Sec. 8, T. 20-S, R. 37-E, NMPM.

Monument-Paddock Pool, Lea County.

Well is 2310 feet from East line and 1980 feet from North line of Section 8. If State Land the Oil and Gas Lease No. is -

Drilling Commenced 11-28-53, 1953 Drilling was Completed 1-10, 1954

Name of Drilling Contractor Rife Drilling Co.

Address Box 9447, Fort Worth, Texas

Elevation above sea level at Top of Tubing Head 3549' The information given is to be kept confidential until ....., 19.....

OIL SANDS OR ZONES

No. 1, from 5170' to 5240' No. 4, from ..... to .....

No. 2, from ..... to ..... No. 5, from ..... to .....

No. 3, from ..... to ..... No. 6, from ..... to .....

IMPORTANT WATER SANDS

Include data on rate of water inflow and elevation to which water rose in hole.

No. 1, from ..... to ..... feet. .....

No. 2, from ..... to ..... feet. .....

No. 3, from ..... to ..... feet. .....

No. 4, from ..... to ..... feet. .....

CASING RECORD

SIZE	WEIGHT PER FOOT	NEW OR USED	AMOUNT	KIND OF SHOE	CUT AND PULLED FROM	PERFORATIONS	PURPOSE
13-3/8"	48#	New	447'	HOWCO			
9-5/8"	36#	New	2885'	HOWCO			
7"	20,23#	New	5694'	HOWCO			

MUDDING AND CEMENTING RECORD

SIZE OF HOLE	SIZE OF CASING	WHERE SET	NO. SACKS OF CEMENT	METHOD USED	MUD GRAVITY	AMOUNT OF MUD USED
17-1/2"	13-3/8"	463'	475	HOWCO		
12-1/4"	9-5/8"	2900'	1500	HOWCO		
8-3/4"	7"	5709'	735	HOWCO		

RECORD OF PRODUCTION AND STIMULATION

(Record the Process used, No. of Qts. or Gals. used, interval treated or shot.)

Acidized w/3000 gals 15% NE Acid by Chemical Process from 5660-5705'

Acidize w/1000gals 15% NE Acid by Chemical Process from 5660-5705'

Acidized w/500 gals 15% NE Acid by Chemical Process from 5655-5705'

Acidized w/2000 gals 15% NE Acid by Chemical Process from 5655-5705'

Result of Production Stimulation No oil obtained from the Blinebry Pay - Plugged back to 5309' in the Paddock pay.

..... Depth Cleaned Out .....

RD OF DRILL-STEM AND SPECIAL TES

If drill-stem or other special tests or deviation surveys were made, submit report on separate sheet and attach hereto

TOOLS USED

Rotary tools were used from 0 feet to 5710' feet, and from ..... feet to ..... feet.

Cable tools were used from ..... feet to ..... feet, and from ..... feet to ..... feet.

PRODUCTION

Put to Producing February 7, 19 54

OIL WELL: The production during the first 24 hours was 600 barrels of liquid of which 100 % was was oil; - % was emulsion; - % water; and - % was sediment. A.P.I. Gravity 40.0

GAS WELL: The production during the first 24 hours was ..... M.C.F. plus ..... barrels of liquid Hydrocarbon. Shut in Pressure ..... lbs.

Length of Time Shut in .....

PLEASE INDICATE BELOW FORMATION TOPS (IN CONFORMANCE WITH GEOGRAPHICAL SECTION OF STATE):

Southeastern New Mexico		Northwestern New Mexico			
T. Anhy	1080'	T. Devonian		T. Ojo Alamo	
T. Salt		T. Silurian		T. Kirtland-Fruitland	
B. Salt	2260'	T. Montoya		T. Farmington	
T. Yates	2420'	T. Simpson		T. Pictured Cliffs	
T. 7 Rivers		T. McKee		T. Menefee	
T. Queen	3070'	T. Ellenburger		T. Point Lookout	
T. Grayburg		T. Gr. Wash		T. Mancos	
T. San Andres		T. Granite		T. Dakota	
T. Glorieta	5080'	T.		T. Morrison	
T. Drinkard	Blinebry 5660'	T.		T. Penn	
T. Tubbs		T.		T.	
T. Abo		T.		T.	
T. Penn		T.		T.	
T. Miss		T.		T.	

FORMATION RECORD

From	To	Thickness in Feet	Formation	From	To	Thickness in Feet	Formation
0	13		Distance from top kelly drive to top of ground				
	80		Sand & Caliche				
	129		Red Bed				
	190		Sand & Red Bed				
	865		Red Bed				
	1135		Anhydrite & Red Bed				
	1155		Anhydrite				
	2090		Anhydrite & Salt				
	2265		Anhydrite				
	2360		Anhydrite, Lime & Gyp				
	2415		Anhydrite				
	2607		Anhydrite & Lime				
	3091		Lime				
	3181		Lime & Sandy Lime				
	3287		Lime & Sand				
	3342		Lime & Gyp				
	5282		Lime				
	5324		Lime & Shells				
	5660		Lime				
	5680		Hard Sandy Lime				
	5710		Lime				

ATTACH SEPARATE SHEET IF ADDITIONAL SPACE IS NEEDED

I hereby swear or affirm that the information given herewith is a complete and correct record of the well and all work done on it so far as can be determined from available records.

February 24, 1954 (Date)

Company or Operator Gulf Oil Corporation Address Box 2167, Hobbs, N.M.

Name C F Taylor Position or Title Area Prod. Supt.

(Form C-103)
(Revised 7/1/52)

DUPLICATE

NEW MEXICO OIL CONSERVATION COMMISSION
Santa Fe, New Mexico

RECEIVED
JAN 20 1954
OIL CONSERVATION COMMISSION

MISCELLANEOUS REPORTS ON WELLS

Submit this report in TRIPLICATE to the District Office, Oil Conservation Commission, within 10 days after the work specified is completed. It should be signed and filed as a report on Beginning Drilling Operations, Results of test of casing shut-off, Notice of plugging of well, result of well repair, and other important operations, even though the work was witnessed by an agent of the Commission. See additional instructions in the Rules and Regulations of the Commission.

Indicate Nature of Report by Checking Below

REPORT ON BEGINNING DRILLING OPERATIONS		REPORT ON RESULT OF TEST OF CASING SHUT-OFF	X	REPORT ON REPAIRING WELL	
REPORT ON RESULT OF PLUGGING WELL		REPORT ON RECOMPLETION OPERATION		REPORT ON (Other)	

January 18, 1954 (Date) Hobbs, New Mexico (Place)

Following is a report on the work done and the results obtained under the heading noted above at the

Gulf Oil Corperation (Company or Operator) Bertie Whitmire (Lease)

Rife Drilling Co. (Contractor), Well No. 7 in the SW ¼ NE ¼ of Sec. 8,

T. 20-S, R. 37-E, NMPM., Undesignated Pool, Lea County.

The Dates of this work were as folows: January 12-14, 1954

Notice of intention to do the work (~~was~~) (was not) submitted on Form C-102 on ..... (Cross out incorrect words), 19.....,

and approval of the proposed plan (~~was~~) (was not) obtained.

DETAILED ACCOUNT OF WORK DONE AND RESULTS OBTAINED

Ran 165 jts 5694' of 7" OD 8 Rnd. Thd. 23 & 20# J-55 SS casing, 1 Howco shoe, 2 Howco floats, & Howco DV tool at 3553', with 13 Weatherford centralizers and 54 scratchers from 5709' to 5009' & Weatherford petal basket at 3600', set at 5709'. Cemented in two stages with 735 sacks 4% Gel & Neat cement. 1st stage with 235 sacks 4% Gel, max pressure 1700#. Circulated approximately 40 sacks. 2nd stage thru DV tool at 3553' with 450 sacks 4% Gel & 50 sacks Neat on bottom, max pressure 500#. Howco Temperature Survey failed to find cement behind 7" casing above DV tool after 8 hours.

After waiting over 30 hours tested 7" casing with 1000# for 30 min, no drop in pressure. Drilled DV tool at 3553' & tested tool with 1500# for 30 min, no drop in pressure. Ran bit to 5628', drilled cement from 5628' to 5708'. Tested 7" casing with 1000# for 30 min, no drop in pressure. Job completed 1-14-54.

Witnessed by J. E. Snead (Name) Gulf Oil Corperation (Company) Drilling Foreman (Title)

Approved: OIL CONSERVATION COMMISSION

L. G. Stanley (Name)

Engineer District 1 (Title) JAN 25 1954 (Date)

I hereby certify that the information given above is true and complete to the best of my knowledge.

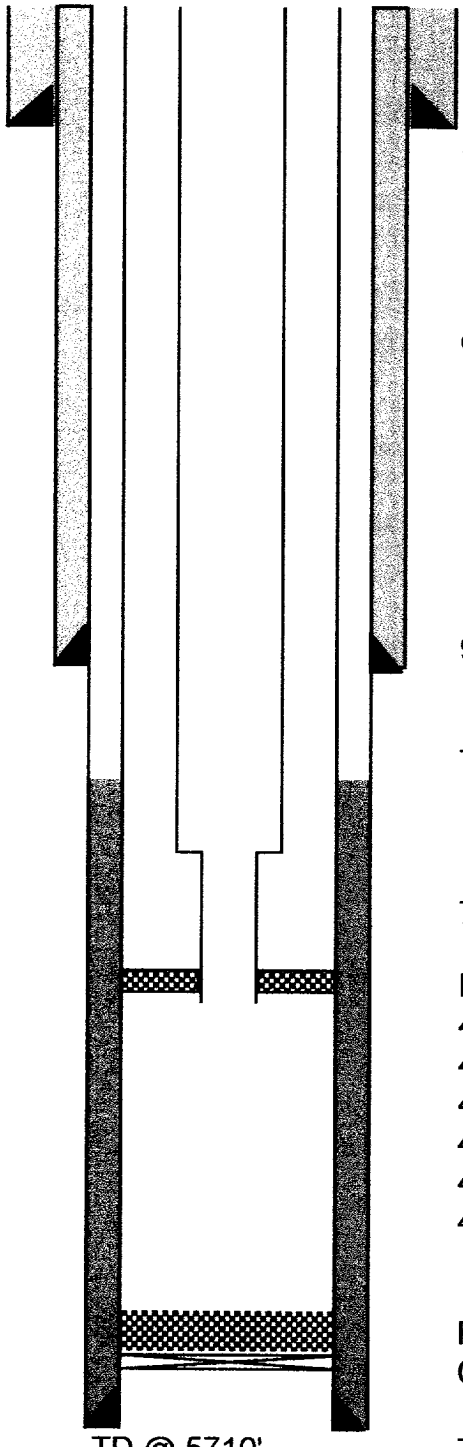
Name C. F. Jay

Position Area Prod. Supt.

Representing Gulf Oil Corperation

Address Box 2167, Hobbs, N. Mex.

EME SWD Well G-8



17 1/2" hole
475 sx

T/Anhydrite 1080'

B/Salt 2260'
T/Yates 2420'

12 1/4" hole
circulated
1600 sx

T/Queen 3070'

500 sx
DV Tool @ 3553'
235 sx

8 3/4" hole

T/Glorieta 5080'
T/Blinebry 5660'

TD @ 5710'

KB 3562
GL 3549'

13 3/8" 48#
csg @ 463'

1980' FNL & 2310' FEL
SEC 8- 20S 37E

API # 30-025-06017

Casing annulus filled with Champion PKR FLD

120 jts 5 1/2" DuOline Tbg
15 jts 3 1/2" DuOline Tbg

9 5/8" 36# CSG @ 2900'

TOC @ ?

7" Weatherford PKR @ 4200'

Lower San Andres Perfs:
4300-80
4445-70
4553-61
4740-60
4780-4800
4822-4852

PBTD @ 4958'
CIBP @ 5010'

7" 20 & 23# CSG @ 5709'

Drawn	By
9/27/00	CDH

RICE OPERATING COMPANY
122 WEST TAYLOR
HOBBS, NM 88240

EME G-8
1980' FNL & 2310' FEL
SEC 8- 20S 37E
LEA COUNTY, NM

Case Nos. 24278, 24277, 24123, 23775, 23614-23617, and 24018-24027
OCD Exhibit No. 8C

From: Kautz, Paul, EMNRD
To: Goetze, Phillip, EMNRD; Rose-Coss, Dylan H, EMNRD; Murphy, Kathleen A, EMNRD
Cc: Cox, Scott, EMNRD
Subject: RE: CBL Log
Date: Monday, July 13, 2020 1:31:08 PM

Hello Everyone,

Talked to Scott Curtis with Rice. The first CBL log was run at about 20 hours after running cement. They will be running another CBL tomorrow and will e-mail the second CBL for OCD review.

Paul Kautz
Hobbs District Geologist
Energy Minerals Natural Resources Dept.
Oil Conservation Division
1625 N. French Dr.
Hobbs, NM 88240
575-393-6161 ext. 104

From: Goetze, Phillip, EMNRD <Phillip.Goetze@state.nm.us>
Sent: Friday, July 10, 2020 3:45 PM
To: Kautz, Paul, EMNRD <paul.kautz@state.nm.us>; Rose-Coss, Dylan H, EMNRD <DylanH.Rose-Coss@state.nm.us>; Murphy, Kathleen A, EMNRD <KathleenA.Murphy@state.nm.us>
Cc: Cox, Scott, EMNRD <Scott.Cox@state.nm.us>
Subject: Re: CBL Log

My comment: Your call is accurate as usual - 2450 is the start of accumulation and 2550 is where the acoustics start showing cement that is sealing. Sad cementing probably due to flows in the SA from all that disposal. I concur with your recommendation to bradenhead. But you might want to warn them that the cement has to get to the shoe of the surface casing or it's perf and squeeze next. Or maybe P&A. Another future project for the group - is the SA flowing so much that a new design is necessary? Thanks Paul and have a good weekend. PRG

Get Outlook for iOS

On Fri, Jul 10, 2020 at 12:59 PM -0600, "Kautz, Paul, EMNRD" <paul.kautz@state.nm.us> wrote:

> Hello Phil, Dylan and Kathleen,
>
> Please see the attached CBL. The operator has not filed nay paperwork on this well. It is obvious that cement on the production string did not tie back into the surface casing. I would like to recommend that they do a breadenhead squeeze and running enough to cover the back side of the production casing. I believe that the top of cement at approximately 2450

to 2550.

Paul Kautz
Hobbs District Geologist
Energy Minerals Natural Resources Dept.
Oil Conservation Division
1625 N. French Dr.
Hobbs, NM 88240
575-393-6161 ext. 104

-----Original Message-----
From: Scott Curtis
Sent: Friday, July 10, 2020 9:10 AM
To: Kautz, Paul, EMNRD
Subject: [EXT] FW: CBL Log

Mr. Kautz,
Hope all is well. Here is a cbl that we ran on the N-11 swd well last night. Obviously we did not circulate cement on our production string.

We are discussing different options. I spoke with Kerry this morning and he deferred to you.

I will try to call you in a few minutes.

Thx Sir

-----Original Message-----
From: rtaylor@grandecom.net
Sent: Friday, July 10, 2020 2:27 AM
To: Scott Curtis ; Hayden Holub ; Roy Haynes
Cc: Lucas Sheward ; Nick Hines
Subject: CBL Log

scott,
attached is the CBL log for your review.

Case Nos. 24278, 24277, 24123, 23775, 23614-23617, and 24018-24027
OCD Exhibit No. 8D

From: Rose-Coss, Dylan, EMNRD
To: Nathan Alleman; Goetze, Phillip, EMNRD
Cc: Tom Tomastik; Nick Wofford; Steve Drake; Kautz, Paul, EMNRD; Gebremichael, Million, EMNRD
Subject: RE: [EXTERNAL] Goodnight - Andre Dawson SWD #1 Question
Date: Wednesday, December 21, 2022 1:59:40 PM

Nate,

After internal discussion, it was decided that it would be best if Goodnight could go ahead and perform a remedial perf and squeeze cement job. The primary objective would be to cap the contact with the Glorieta, but any additional cement up the annulus would be a benefit.

Thanks,

Dylan Rose-Coss

Petroleum Specialist
Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

C: (505) 372-8687

From: Nathan Alleman <nalleman@all-llc.com>
Sent: Tuesday, December 20, 2022 2:23 PM
To: Goetze, Phillip, EMNRD <phillip.goetze@emnrd.nm.gov>
Cc: Rose-Coss, Dylan, EMNRD <DylanH.Rose-Coss@emnrd.nm.gov>; Tom Tomastik <ttomastik@all-llc.com>; Nick Wofford <nwofford@goodnightmidstream.com>; Steve Drake <steve.drake@goodnightmidstream.com>; Kautz, Paul, EMNRD <paul.kautz@emnrd.nm.gov>
Subject: [EXTERNAL] Goodnight - Andre Dawson SWD #1 Question

links or opening attachments.

Mr. Goetze,

Thank you for joining us on the call this afternoon regarding Goodnight's Andre Dawson SWD #1. To summarize … Goodnight just finished drilling the Andre Dawson SWD #1, but wanted to get some regulatory guidance from OCD before moving forward with completing the well and setting tubing and packer.

Pertinent Details:

- **Injection Interval:** The Andre Dawson SWD #1 is a cased-hole completion using the San Andres Formation (4,287 ft – 5,590 ft) as the injection interval.
- **Well Depth:** The well was drilled to a TD of 5,743 ft. Logs ran after drilling indicated that the top of the underlying Glorieta Formation is at 5,643 ft, so the well is drilled 100 ft into the Glorieta.
- **Lower Cement:** After setting casing and pumping cement, the CBL showed there are numerous cement stringers isolating the Glorieta, but it didn't achieve complete cement bonding as expected. Based on the amplitude curve on the CBL, it is unlikely that remedial squeeze cementing could be accomplished on this section. ***See attached full CBL and snip of the CBL at the bottom of the injection interval.***
- **Upper Cement:** Based on the analysis of the radial cement bond log (attached), the top of good cement above the proposed top perforations in the San Andres Formation is at approximately 2,586 feet with proposed top perforation at 4,287 feet.
- **Remedial Cementing:** If remedial cementing is attempted, it is unlikely to succeed due to the presence of cement stringers and amplitude curve on the radial CBL. Additionally, if we perforate and squeeze cement in an attempt to remediate, we will have lost integrity of our production casing in the Glorieta since we would perforations in the Glorieta Formation. Additionally, even if remedial squeeze cementing is accomplished, squeeze perforations are notorious for leaking and not holding pressure.
- **Geologic Confinement:** There are several shale layers (total thickness of about 20 feet) between the lowest planned perforations (5,505 ft - 5,525 ft) and the top of the Glorieta (5,643 ft). These shale layers will act as lower confinement and prevent injection fluid migration downward out of the permitted San Andres injection zone. ***See attached neutron log snip***.
- **Production Casing Pressure Test:** The production casing was pressure tested to 1,000 and the test was good.

Based on the presence of shale layers below the perforations in the San Andres (and above the top of the Glorieta Formation) and the presence of cement stringers and steel casing isolating the Glorieta from injection fluids, ALL Consulting is confident that the injection will be confined to the San Andres injection zone and will not result in injectate migrating out of zone into the Glorieta. However, we wanted to get OCD's direction on how we should proceed before moving forward with running tubing and packer.

Question: What are OCD's thoughts on how Goodnight should proceed? Are they cleared to go ahead and run tubing and packer or is further discussion/data necessary?

As always, we're happy to jump on a call to discuss in more detail at your earliest convenience.

Thank you for your prompt attention to this matter!

Nate Alleman
Energy & Environmental Consultant
ALL Consulting
1718 South Cheyenne Avenue
Tulsa, OK 74119
Office: 918-382-7581
Cell: 918-237-0559