San Andres on the Northwest Shelf: Things You May Not Know*

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Abstract

Residual Oil Zones (ROZs) in the San Andres have gone from a “one off” a decade ago to established, economically producible reservoirs today. The science of ROZs have been documented over the past decade with DOE and RPSEA supported projects. There are now a variety of different methodologies used to produce oil from ROZs: co-mingled and separate “brownfield” ROZ and Main Pay CO₂ floods, CO₂ EOR ROZ floods peripheral to existing fields, “greenfield” CO₂ EOR ROZ floods without an associated main pay. Recently, horizontal depressuring (DUROZ) projects where horizontal wells target uneconomic classic vertical pay zones and ROZs together, have been developed on the Northwest Shelf and northern Central Basin Platform.

Despite the fact that there is now a decade of research into ROZs, and close to 20 projects producing oil for the ROZ, we need to step back and evaluate the relationship between ROZ targets and the complex depositional and diagenetic history of the San Andres to avoid the pitfalls associated with developing any new play. Assuming that the environment of deposition and diagenetic overprint are the same will lead you down that same garden path. Ditto for the fluid's properties in the ROZ.

Selected References


Budding, A. J., 1980, Geology and Oil Characteristics of Tar Sands near Santa Rosa, New Mexico: New Mexico Geology, v. 2/1, p. 4-5.


New Mexico Geologic Highway Map, Compiled by Maureen E. Wilks, 2005, New Mexico Geological Society and New Mexico Bureau of Geology and Mineral Resources, scale 1:1,000,000.


Trentham, R.C., L.S. Melzer, V. Kuuskraa, and G. Koperna, 2015, Case Studies of the ROZ CO₂ Flood and the Combined ROZ/MPZ CO₂ Flood at the Goldsmith Landreth Unit, Ector County, Texas. Using “Next Generation” CO₂ EOR Technologies to Optimize the Residual Oil Zone CO₂ Flood: DOE DE-FE0005889, 231 p.

San Andres on the Northwest Shelf: Things you may not know.

2017 SW AAPG

Bob Trentham
**Residual Oil Zone Studies and Technical Reports**


- Identifying and Developing Technology for Enabling Small Producers to Pursue the Residual Oil Zone (ROZ) Fairways of the Permian Basin, San Andres. UTPB, Melzer, ARI. DOE DE-FE0005889, Sept 2015. [NETL Website](#).

- Identifying and developing technology for enabling small producers to pursue the residual oil zone (ROZ) fairways in the Permian Basin San Andres. UTPB, Melzer, Arcadis, ARI. RPSEA 10123.17 Final Report, Dec 2015. [NETL Website](#).
Things we think we know...or should.

- Horizontal San Andres play is not the carbonate equivalent to shales
- Evidence points to likely success in Huff-n-Puff projects after horizontal depressuring: using CO$_2$ or Ethane thru Pentane?
- Movement on deep faults cause flexures in the San Andres:
  - Those flexures can result in **transmissive** fractures
  - Those fractures are a pathway for migration/sweep for oil/water/frac fluids
  - Those fractures, when healed, can alternatively be **lateral seals** to fluids and fracs.
  - The TDS in MNW is a critical element in the efficiency of sweep. Focused in fractures?
- Higher GOR’s are critical to the success of a horizontal San Andres.
- Drawing pressure down to below bubble point is essential in horizontal Depressuring.
- Going up? Going Down? Which way does the frac go?
- 2017 is an Exciting Year - ongoing case histories - open holes, smaller or no fracs?
- Are all ROZ CO2 projects going to FLOOD the same?

**The Northwest Shelf is not monolithic.**

- And by extension, neither is the Central Basin Platform.
We’ll concentrate on the Northwest Shelf today.

• The Northwest Shelf is not monolithic:
• There are exit pathways for San Andres oil to migrate out of the basin to the north.
• Correlations and facies distribution indicate the Maximum Flood was during the “P4”. This makes it equivalent to the Cutoff Formation, the “G-1”, and the McKnight Shale.
• Hot Water? Was the Slaughter Levelland Trend swept by Mother Natures “Hot Tea Flood”? 
• What happening to the Limestone in 14S?
There are exit pathways for San Andres oil to migrate out of the basin to the north.

Porosity zones in lower part of San Andres Formation, east-central New Mexico

by William D. Pitt and George L. Scott

1981

INDEX MAP SHOWING LOCATION OF STUDY AREA.
The most important oil show in the region north of the Matador Arch is represented by the Santa Rosa Tar Pit, 6 miles north of Santa Rosa and I-40, in T9N, R21E. The asphalt pit has an estimated 90 MMBO (Broadhead, 2004 quoting Budding, 1980). The oil has been typed and is believed to have migrated from the San Andres during post Triassic time.

Newkirk oil field in NE Guadalupe County contains heavy oil at depths of 400–800 ft; (Broadhead, 2004 quoting Martin 1983; McKallip 1984). Estimated resources are 62 million bbls of oil in place (Broadhead, 2004, quoting Scott and Joy, 1983).
The northern limit of correlation of the lower San Andres P-3, P-4, and P5 is coincident with the northern margin of the Tucumcari Basin. What exploration there has been in the Tucumcari has “Bombed-Thru” the San Andres looking for Penn clastics.
We’ll look at P-3, P-4, & P-5
P-3, P-4, and P-5 are typically not productive and are LIMESTONE to the south and LIMESTONE and DOLOMITE to the north.

FIGURE 5—TYPICAL LITHOLOGIC SEQUENCE OF LOWER SAN ANDRES DEPOSITIONAL CYCLES.

Pitt & Scott, 1981
The cross sections show limestone as far north as TWN 8N.
P-1 and P-2 are EVAPORITIC to the North.
Where P-1 & P-2 are evaporitic, P-3, P-4, & P-5 are Limestones and Dolomites.

Modified from Pitt & Scott, 1981
Comparison of northern extent of P4 porosity and production from the Slaughter-Levelland trend (P1 and P2)

P4 is proposed to have been the “Maximum Flood” for the lower San Andres.

Greater than 10% porosity in P-4.

Modified from Pitt & Scott, 1981

Dutton, et.al., 2005
The **Gulf #1 N. E. Elida Unit**, is in sec 1, 4 S, 32 E in Roosevelt County. Oil was seen on the pits, and it was expected that this would be a new field discovery, cores were taken and DST’s run but it was determined that there was insufficient cause to set pipe and attempt to complete.
Although there is a greater thickness of P-5 further north, the Thickness of >10% is found in P-4 in the Tucumcari Basin.
P-3 is significantly thinner in the Tucumcari Basin and is evidence of the “turnaround” and initiation of the highstand.
Our work extended these correlations to TWN 15 S and west to the Sacramento Mountains to tie into the San Andres outcrops.

Sacramento Mtns
Measured Section, Elliott, 1988

From CNL LDT X Section 05S_14S Cartoon
• Based on the extent of deep water limestone in the P-4, and assuming therefore, that the P4 is the maximum flood, can we also assume that the P4 is equivalent to the El Centro Member of the Cutoff Formation and the McKnight Shale on the Central Basin Platform?

• To quote Willis Terrell (2011, WTGS): “The El Centro Member of the Cutoff is a good time marker being only slightly younger than the world standard base of the Guadalupian Series”.

Pitt & Scott, 1981
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<th>Guad Mts.</th>
<th>Downdip Northwest Shelf</th>
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San Andres outcrop (light Blue) is the present day extent of the recharge area for the meteoric water that sustains the tilted oil water contacts in San Andres reservoirs. Railroad Mountain Dikes in blue box.
The dikes in the region (including Railroad Mountain and Jones Camp) lie on the WNW trending **Capitan Lineament**. The Capitan lineament extends from the Matador arch in west Texas, westward to Socorro, NM. The period was late Tertiary (30 to 26.5 Ma) during which mafic alkalic dikes and granite plutons were emplaced along the Capitan lineament and minor granites were intruded into the Sierra Blanca complex. This later period is associated with the early stages of Rio Grande rifting. Constantopoulos, 2017 pers. Comm.
Evidence of “Railroad Tracks” flushing along the Slaughter Levelland Trend? Low API gravity oils in the San Andres fields.

There are other theories as to why the API gravities in this trend are so low (Ramondetta, 1980…but the “Hot Tea” flood certainly needs to be evaluated.

Anybody have Water Chemistry we can have?
The API gravities in the western Slaughter Levelland Trend are so low, the portion of the trend should be considered different.
The TWN 14S line. What is going on?

Modified from Northwest Shelf
San Andres fields. Dutton, 2004
Between the north side of TWN 13S and the south side of TWN 15S, the +/- 500’ of Limestone in the P3, P4 and P5 is reduced to 0’. What’s going on? Will this impact the success of Horizontal San Andres wells?

Limestone interval
Where did all the limestone go? The reduction of Limestone is not smooth, but is significant.
Things we think we know...or should.

• Horizontal San Andres play is not the carbonate equivalent to shales
• Evidence points to likely success in Huff-n-Puff projects after horizontal depressuring: using CO\(_2\) or Ethane thru Pentane?
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Appreciation

• Thanks to:
• Steve Melzer, Melzer CO_{2}nsulting
• David Vance, Arcadis
• KinderMorgan
• Chevron
• And all others who engaged in necessary conversations about ROZ’s.
References

• Kerans, Charles, 2006, Bureau of Economic Geology, PGGSP Annual Meeting, Austin, TX
• New Mexico Geologic Highway Map, Compiled by Maureen E. Wilks, 2005. NMBG&MR and NMGS.
Thanks!

Questions?