

Thursday, Dec 9th
Theme Sessions
2021 CO₂ Conference

Updated Horizontal San Andres Play
(Permian Basin)

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Regional Background and Current State of the Horizontal San Andres Play in the Permian Basin

- 1) The San Andres “Storybook”
- 2) The Play: Its Setting, Wells, Production, Locations

The San Andres “Storybook” - 1

The Horizontal San Andres Play Lies within the Massive Area and Thickness (900'-1300') of the Permian Age, Carbonate Shelf Formation

These San Andres reefal carbonates were oil charged by the basin sediment organics now so famously subject to the horizontal wells in the even thicker Wolfcamp and Spraberry shales.

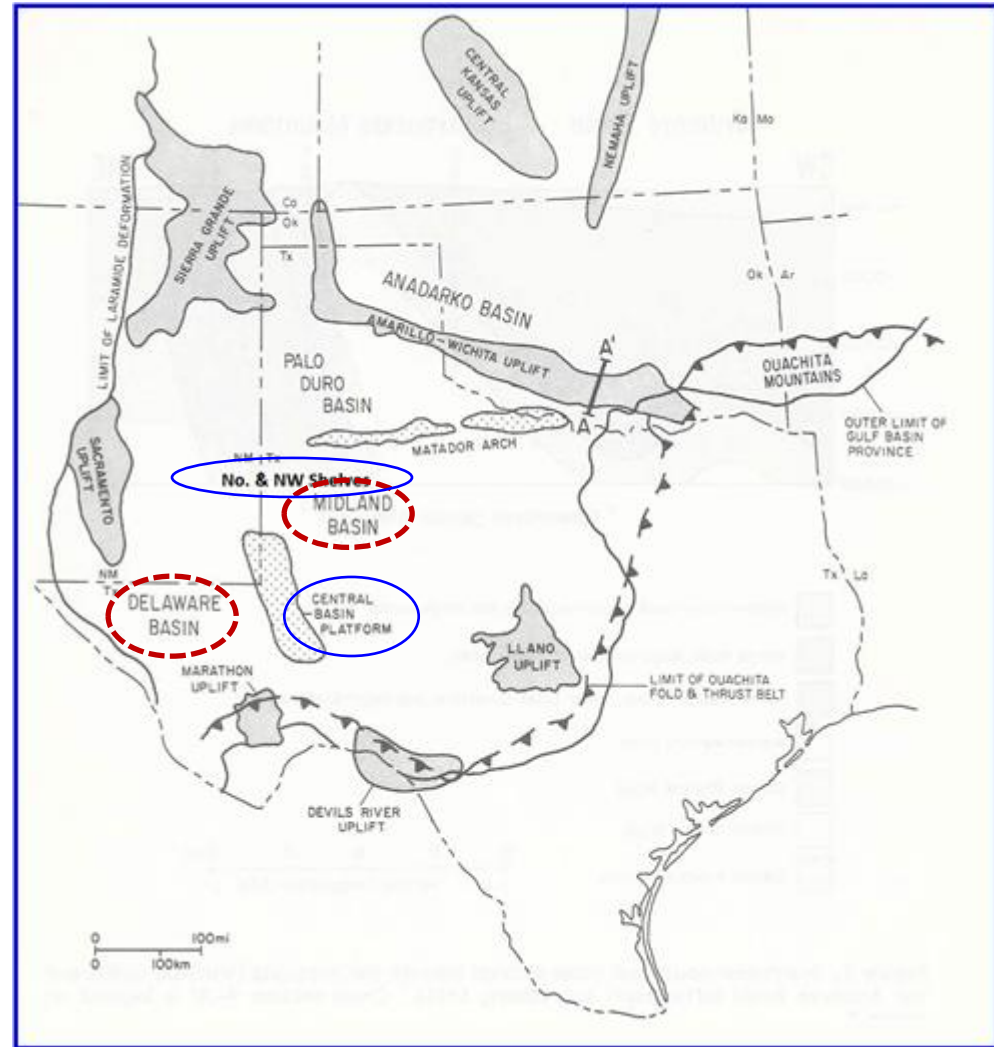


Figure from Ramondetta, et al (1)

The San Andres “Storybook” - 2

A Post-oil-entrapment Uplift in the Western Regions of the Permian Basin Created Water Influx and Water Sweep from West to East thus effected a Natural Waterflood of much of the San Andres Oil. But, like man’s waterfloods, it left behind good oil saturations while altering the Wettability (to Oil) and allowing mobilization with EOR techniques and concurrent storage of CO₂ during CO₂ EOR.

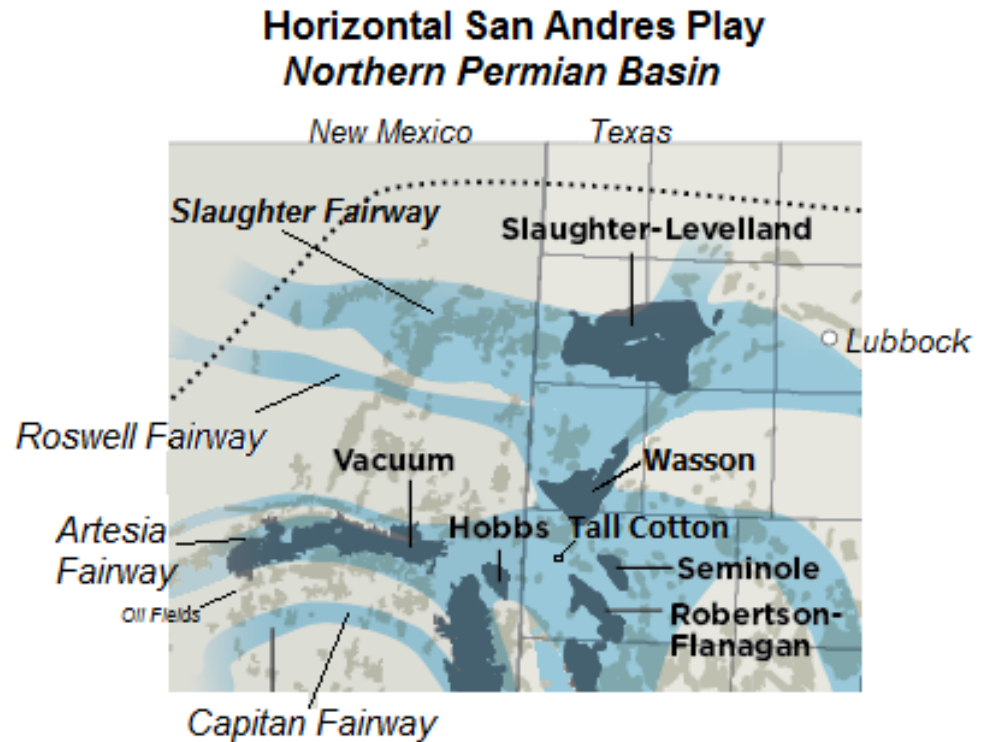


From RPSEA II: Trentham,
Melzer, Vance, Ref 2

The San Andres “Storybook” - 3

Where closures existed atop the San Andres porous zones, the main San Andres oil fields (MPZs) were found. We refer to the ROZs below the MPZs as ‘brownfields.’

Where there were no MPZ closures, we refer to those regions as ROZ “greenfields.” Those are the light blue regions, There exist huge areas with greenfield ROZ thicknesses often exceeding 200-300.’ Those regions are littered with vertical dry holes which teased many operators into well completion attempts.



*From RPSEA II: Trentham,
Melzer Vance, Ref 2*

The San Andres “Storybook” - 4

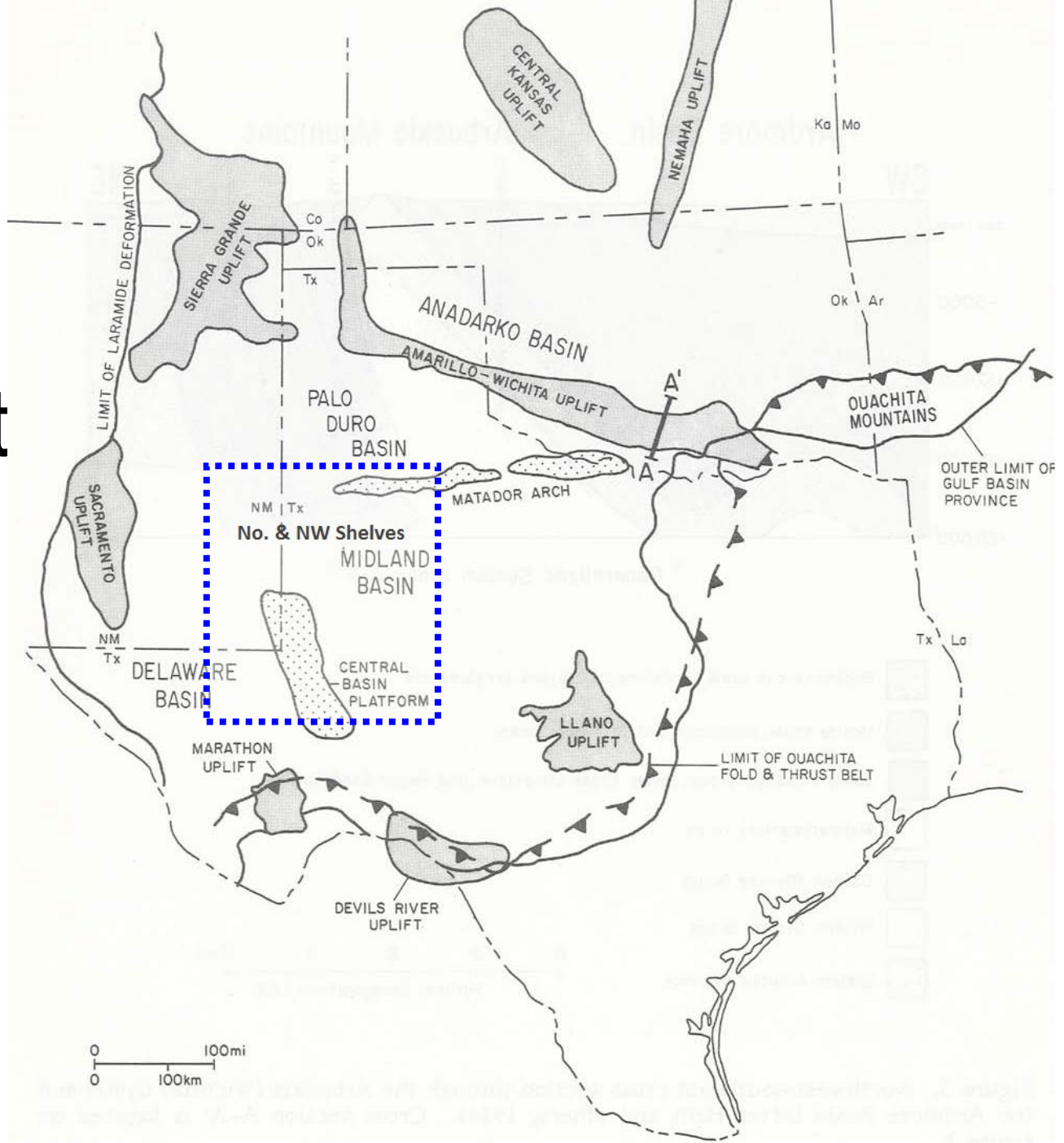
Not all of the Residual Oil remained “high viscosity light oil.” The lateral water sweep resulting in the oil losing some of its light ends due to solubility in the slow moving flushing water and microbial alteration. Thus, we believe, the retention of light oil components is primarily a function of the degree of sweep. Much of the oil column has been shown now to be miscible with CO₂ and over 20 projects have demonstrated economic recovery by CO₂ EOR. Where it did retain the light ends, the economics of reservoir depressuring (and coincident gas expansion) has also shown to be an economic process. This is the Horizontal San Andres Play or **HSA**.

So, Where on the Carbonate Shelves, are the Horizontal Wells?

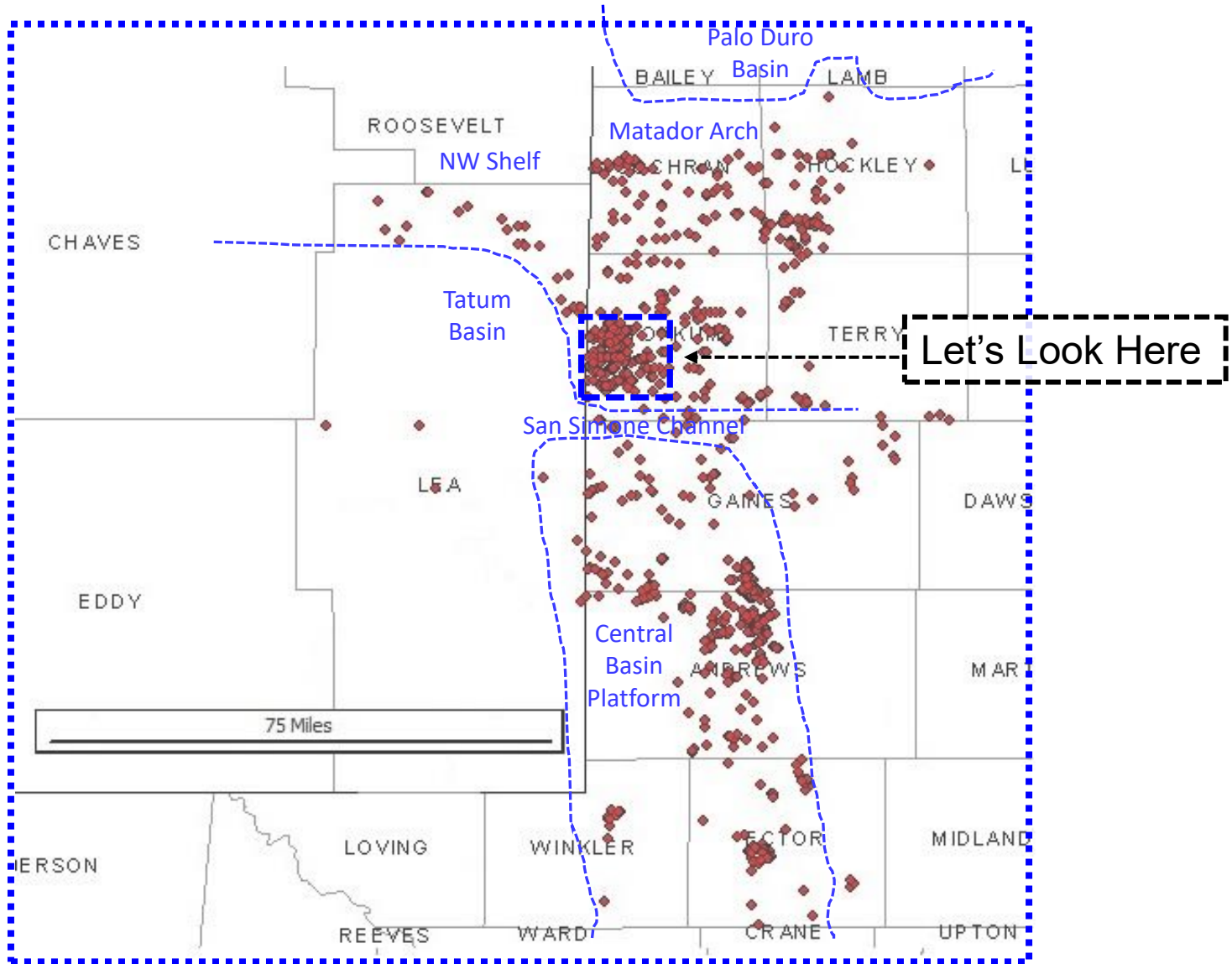


Southern Mid- Continent Regional Map

(Base Map from
Ramondetta, et al,
Ref 1)



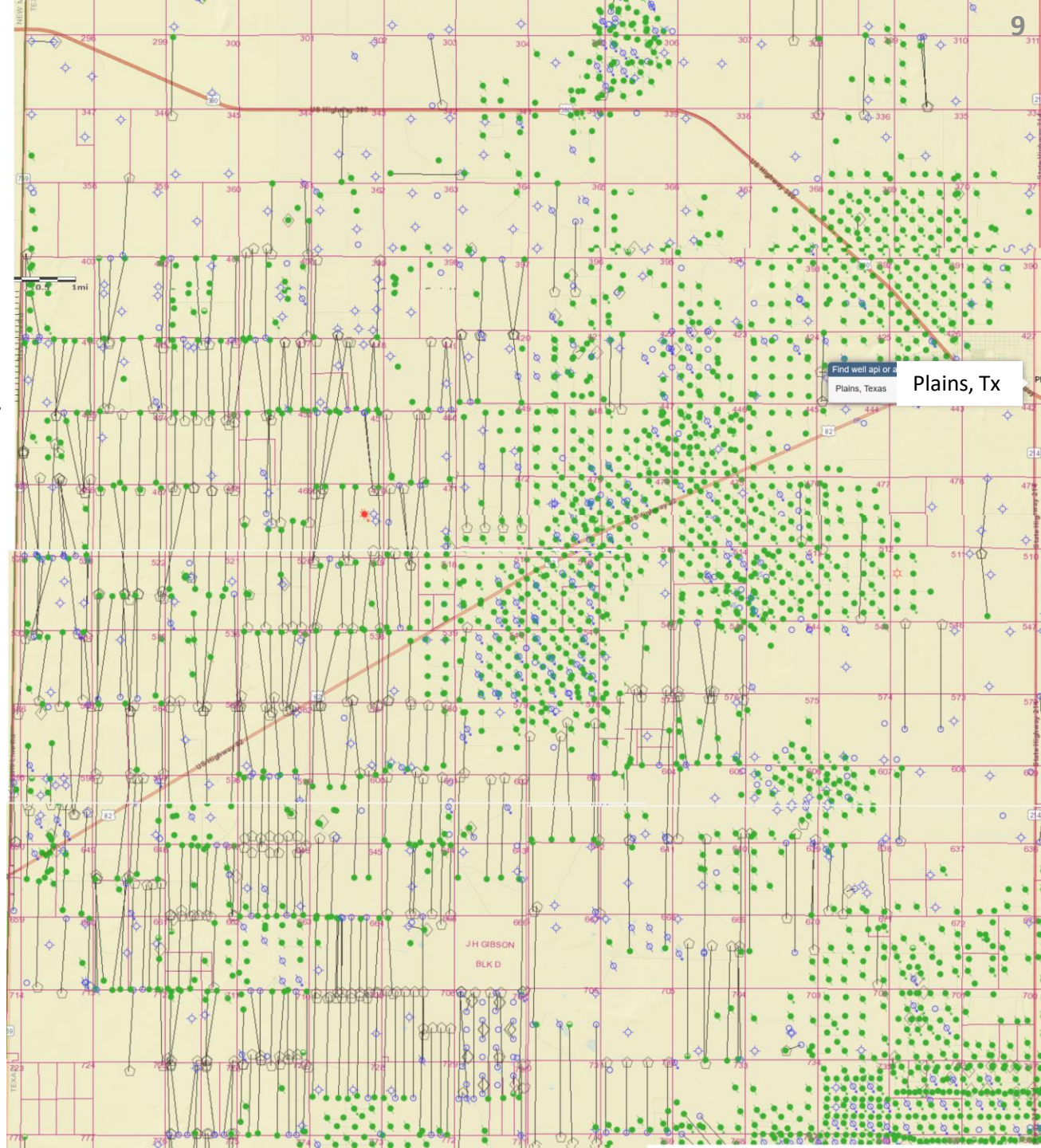
The Permian Basin Horizontal San Andres (HSA) Wells* (All Located on the North Shelf and Central Basin Platform)



* Surface Locations

Western Yoakum County Horizontals (as of 10-31-21)

Tx/NM Line



The Horizontal San Andres (HSA) Carbonate Play - 1

- First Wells ~10 Years Ago
- First Started in the Southern Central Basin Platform (Originally Conceived as the Carbonate Equivalent to the Shale Plays) - Technically Successful but Economic Results (even at \$100 oil prices) were Spotty
- Play Concept Spread North Illustrating it to be a Broad Regional One
- Western Yoakum County Laterals Became the Hot Spot, Slowed Down in 2020 but Continued even Through the 2020 Crash in Oil Prices
- Technology has Rapidly Moved Forward Helping Well Economics

The Horizontal San Andres (HSA) Carbonate Play - 2

- The HSA Play Produces 40,000 bopd Today and 70 mmcfpd from 700 wells – Now is Recovering from Saudi Oil Tanker ‘Flotilla’ and Covid ‘Hammer’ in 2020
- Has Produced Almost 80 million Bbls of oil and 100 billion cf of Gas
- Much Like the Shales, Wells rely on Depressuring a long section of the Formation & Letting the Gas Move the Oil
- Much Like the Shales, the Oil Recovery Factors are in the high Single digits
- Unlike the Unconventional Shales, the Reservoirs are More “Conventional in Nature and are Already Demonstrated to be EOR Flood Candidates
- And, Unlike the Unconventional Shales, All Wells are Drilled and Operated by Independents

The Unconventional Plays are the Large Independents and Some of the Majors

This HSA Play is for the Smaller Independents (Below)

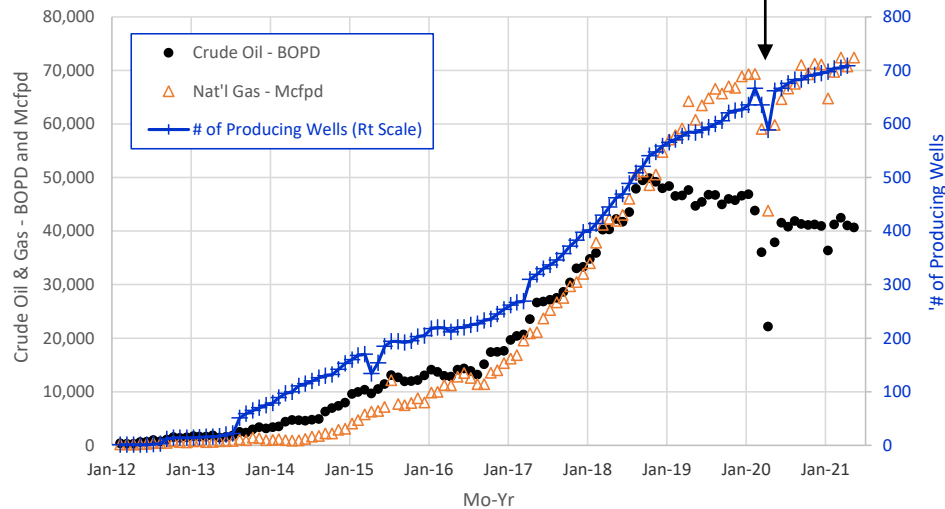
18	BURK ROYALTY CO.	5	QUIEN SABE OPERATING, LLC
1	CAMBRIAN MANAGEMENT, LTD.	1	RAW OIL & GAS, INC.
1	CLARK, JOHN M., INC.	7	RIDGEWAY ARIZONA OIL
2	CUSTER & WRIGHT OPERATING, INC.	39	RILEY EXPLORATION, LLC
1	D.W.R. OIL PROPERTIES, INC.	107	RING ENERGY
1	DELRAY OIL, INC.	1	ROCK FISH OPERATING LLC
1	DP PERMIAN OPERATOR, LLC	4	SABINAL ENERGY OPERATING, LLC
5	E R OPERATING COMPANY	1	SADDLEBACK EXPLORATION, LLC
1	EOG RESOURCES	1	SAGUARO PETROLEUM, LLC
15	FLEUR DE LIS ENERGY	1	SCOUT ENERGY MANAGEMENT LLC
1	FORTUNA RESOURCE DVLPMNT, LLC	10	SILVER CREEK PERMIAN OP CO, LLC
2	GUNGOLL CARL E EXPLORATION LLC	1	SLOAN PETROLEUM INC
2	ICA ENERGY, INC.	2	SPECIAL ENERGY CORP.
1	JILPETCO, INC.	33	SPUR ENERGY PARTNERS LLC
7	JOINT RESOURCES COMPANY	63	STEWART ENERGY II, LLC
2	LIBERTAD OPERATING LLC	1	TAMAROA OPERATING, LLC
31	LIME ROCK	11	TEXLAND PETROLEUM, L.P.
22	MACK ENERGY CO	9	THRESHER ENERGY, INC.
1	MAMMOTH EXPLORATION LLC	1	UNITEX OIL & GAS, L.L.C.
3	MANZANO LLC	2	VERDUGO-PABLO ENERGY LLC
3	MARSHALL & WINSTON INC	1	WALKABOUT OPERATING, LLC
1	MITO RESOURCES LLC	1	WHITING PETROLEUM
1	PALADIN PETROLEUM III, LLC	2	WTG EXPLORATION
12	PARALLEL PETROLEUM LLC	1	YUCCA ENERGY, INC.

HSA Carbonate Production History

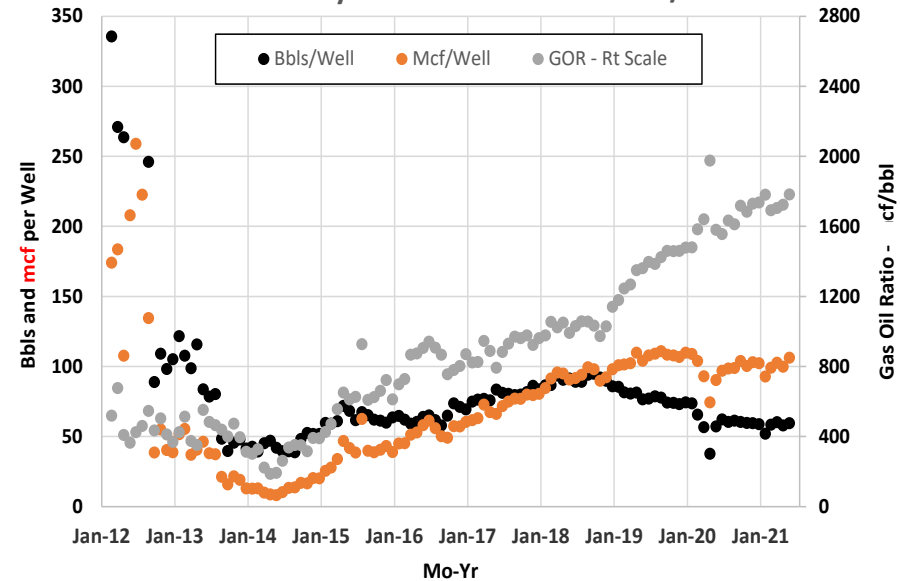
We all know about
the 2nd Quarter
2020 "Hiccup"

Per Well

Horizontal San Andres Play History
from first wells in 2012 thru 6/21



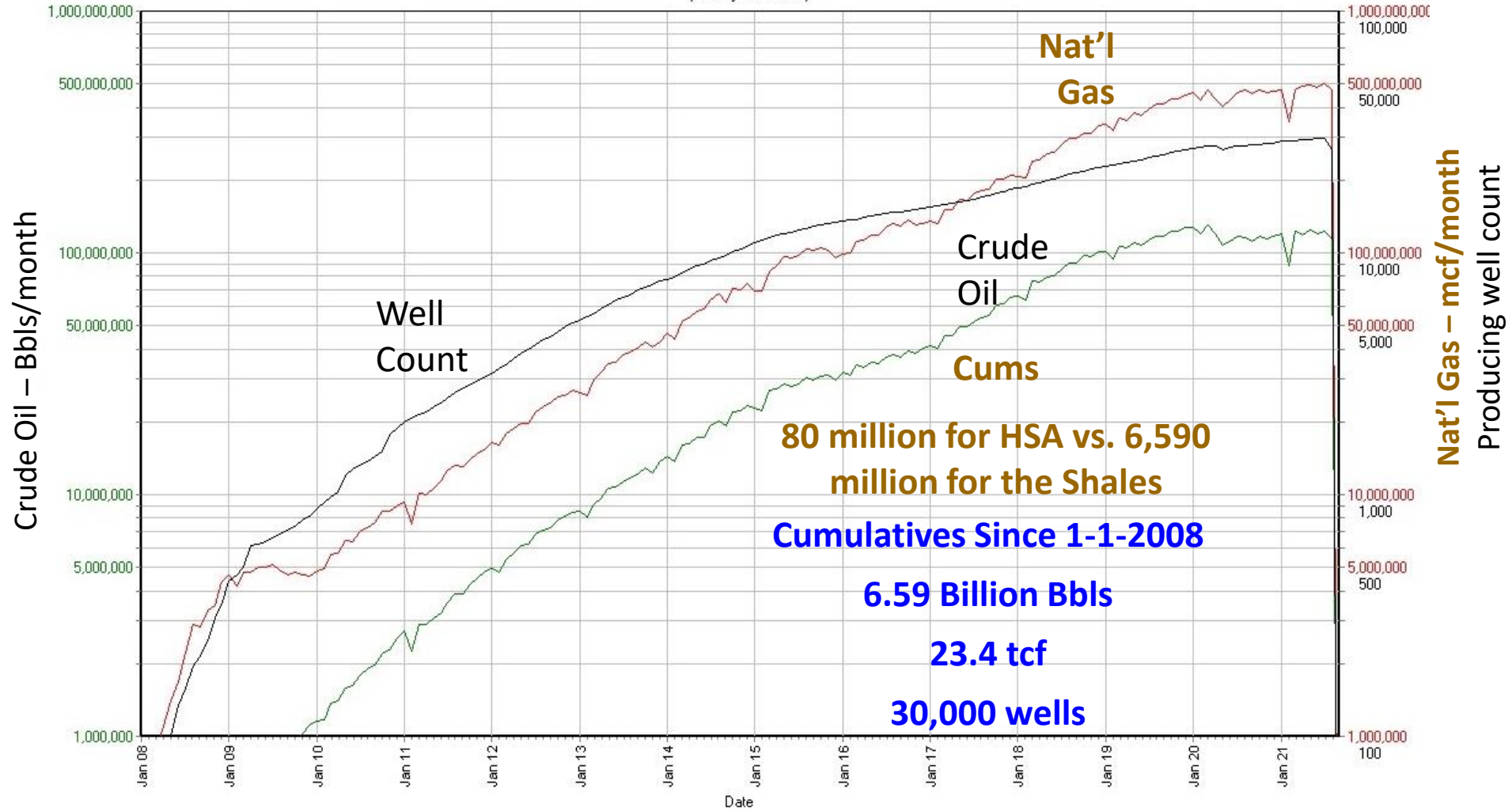
Hor SA Play - Production Stats thru 6/21



Some of you might be wondering why you haven't heard about the
HSA play, let's just guess what gets all the headlines in the PB?

Here Are the Stats from the PB's Horizontal Unconventional ('Shale') Play

Drill Types: H; First Prod >= 1/1/2008; Counties: ANDREWS (TX), BAILEY (TX), BORDEN (TX), BREWSTER (TX), CHAVES (NM), ...; States: NM, TX; (Monthly Production)



— Liquid (bbls) — Gas (MCF) — Wells

Liquid (bbls): Current Cum: 6,586,516,078 Total: 6,586,516,078
 Gas (MCF): Current Cum: 23,383,956,673 Total: 23,383,956,673

ARI Shale Basin CO₂ Storage Study with Incidental Oil Production (ARI USEA, Ref 3)

Shale Basin/Formation	Resource In-Place (MMB)	Incremental Oil Recovery from CO ₂ EOR (MMB)	Storage of CO ₂ (MMmt)
1. Williston Basin/Bakken Shale	90,820	3,760	1,510
2. South Texas/Eagle Ford Shale	139,300	7,670	1,840
3. Permian Basin			
▪ Midland Basin/Wolfcamp Shale	509,110	14,250	6,560
▪ Delaware Basin/Wolfcamp Shale	575,720	21,850	10,050
Total	1,314,950	47,530	19,960

San Andres ROZ “Fairway” Resources: Twelve Counties of the Permian Basin

In-Place San Andres ROZ "Fairway" Resource: Twelve-County Area of West Texas

County	In-Place Resource		
	Total	Higher Quality*	Lower Quality**
	(B Bbls)	(B Bbls)	(B Bbls)
Gaines	45.5	35.4	10.1
Yoakum	20.7	16.1	4.6
Terry	17.9	10.6	7.3
Dawson	27.8	14.6	13.2
Andrews	37.1	31.2	5.9
Martin***	6.7	4.8	1.9
Winkler	9.5	8.0	1.5
Ector***	7.0	5.6	1.4
Three Southern Tier***	19.2	8.7	10.5
Midland (Grayburg ROZ) Only***	-	-	-
Total (San Andres ROZ)	191.4	135.0	56.4

The San Andres ROZ “fairway” in the twelve-county area of the Permian Basin, West Texas holds 191 billion barrels of oil in-place.

Much of this in-place resource (135 billion barrels) is “higher quality”, offering promise for commercially viable development with “significant” opportunities for by-product storage of CO₂.

*Porosity greater than 8% and oil saturation greater than 25%.

**Porosity less than or equal to 8% and/or oil saturation less than or equal to 25%.

***Counties with Grayburg ROZ “fairways”.

ARI Shale Basin CO₂ Storage Study with Incidental Oil Production with added San Andres ROZ Targets

Shale Basin/Formation	Resource In-Place (MMB)	Incremental Oil Recovery from CO ₂ EOR (MMB)	Storage of CO ₂ (MMmt)
1. Williston Basin/Bakken Shale	90,820	3,760	1,510
2. South Texas/Eagle Ford Shale	139,300	7,670	1,840
3. Permian Basin			
▪ Midland Basin/Wolfcamp Shale	509,110	14,250	6,560
▪ Delaware Basin/Wolfcamp Shale	575,720	21,850	10,050
▪ San Andres Greenfield ROZ*	191,400	38,280	40,000
Total	1,314,950	47,530	19,960
Revised Total	1,506,350	95,080	59,980

* Using assumptions of a Recovery Factor of 20% of post-waterflood OIP
and a Net Utilization Factor of 20 mcf/Bbl (~1 Metric ton of CO₂/Bbl)

References

1. Gustavson, T. C., Ramondetta, P.J. et al (1981), "Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle," Geological Circular 81-3, Unkibv Tx Bur Econ Geology, 1981
2. (RPSEA II) Trentham, R.C. Melzer, L.S., & Vance, D. (2016), Identifying and Developing Technology for Enabling Small Producers to Pursue the Residual Oil Zone (ROZ) Fairways in the Permian Basin San Andres Formation, Research Partnership to Secure Energy for America and U.S. Dept of Energy Final Report, www.netl.doe.gov/file%20library/research/oil-gas/10123-17-final-report.pdf
3. ARI USEA Presentation, Kuuskraa, V, (2021),

Introduction

Doug Standart, Sr. Geologist, Riley Exploration