



UNCONVENTIONAL RESERVOIR ENGINEERING PROJECT

COLORADO SCHOOL OF MINES



Production Performance of Permian Basin Wells: Improving Hydrocarbon Recovery in Reeves and Surrounding Counties

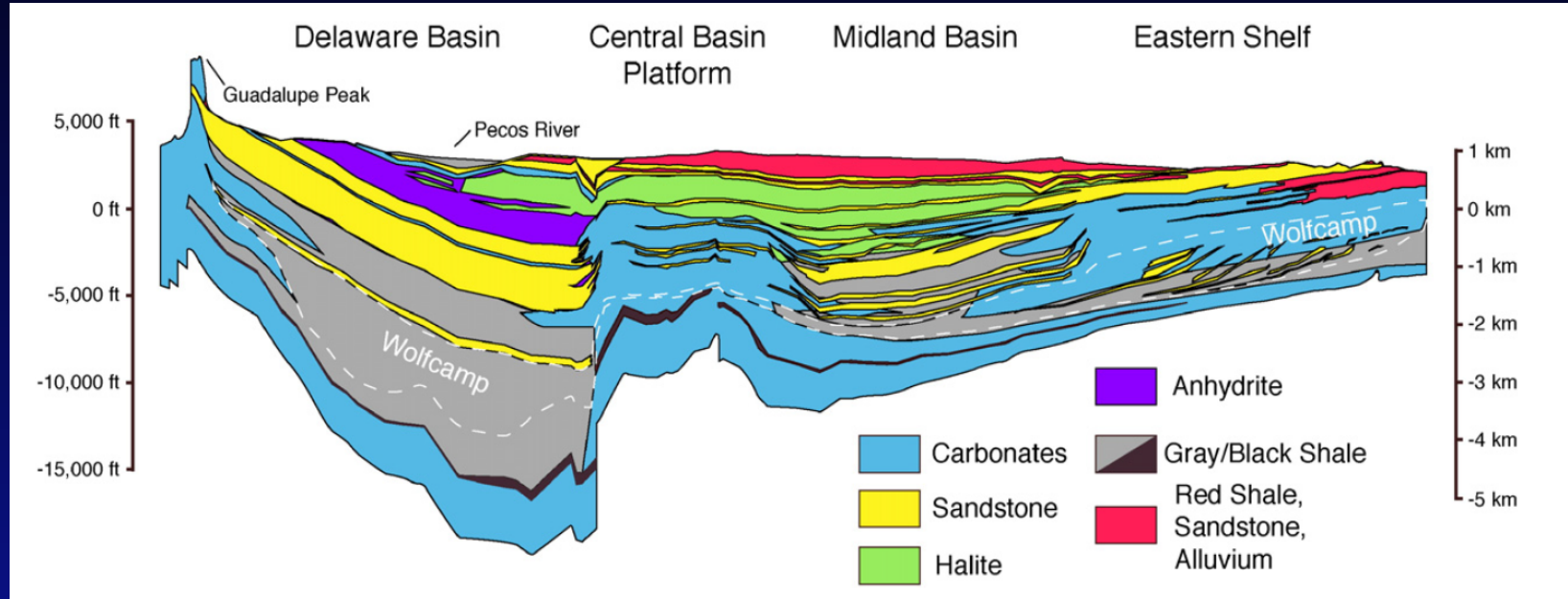
Ozan Uzun, PhD Student
Colorado School of Mines



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Advisory Board Meeting, May 3, 2019, Golden, Colorado

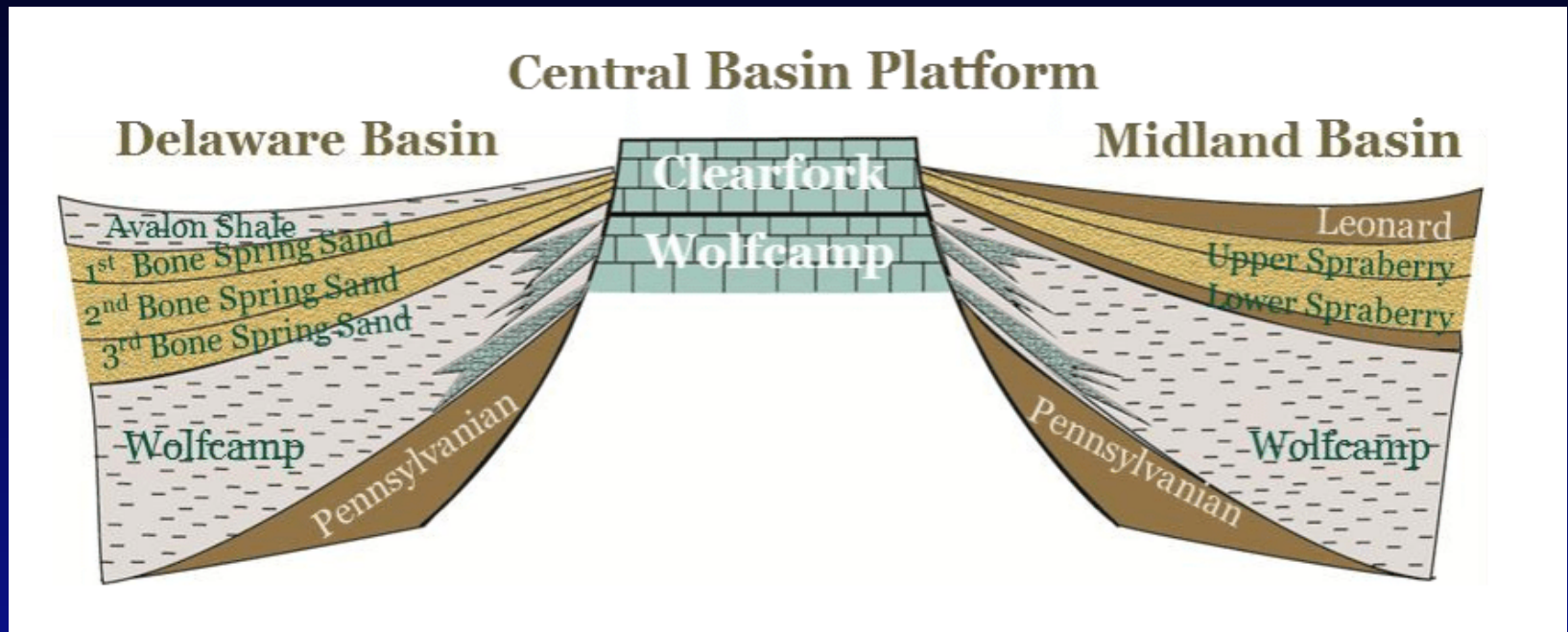
Geologic Cross-Section of Permian Basin



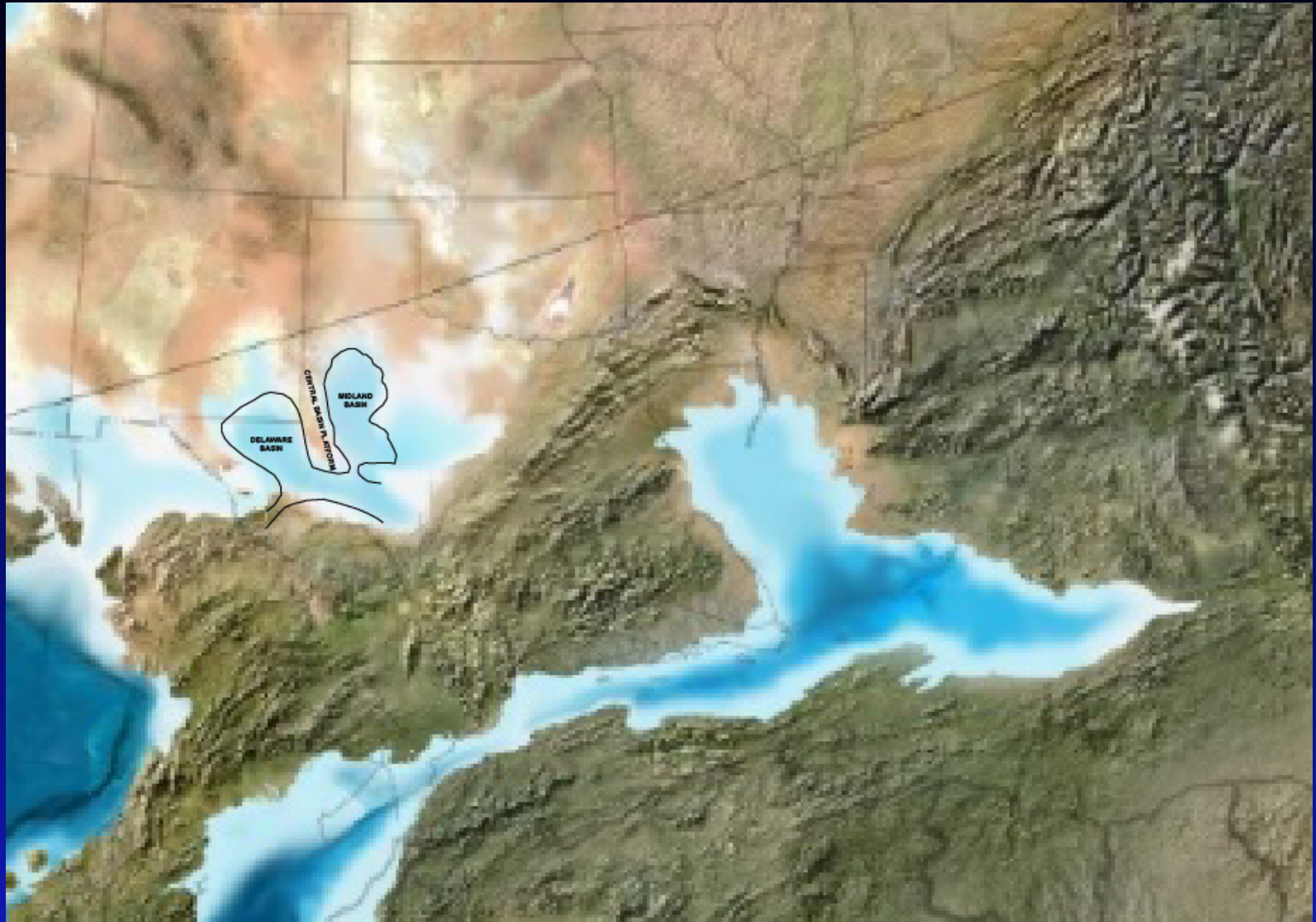
(Engle et al. 2016)



Permian: Delaware Basin, Central Basin Platform, and Midland Basin



Permian: Middle Permian – 260 Ma



- Permian Basin, spanning West Texas and Southeastern New Mexico, is one of the most prolific oil and gas producing geologic basins in the United States.
- Permian Basin has supplied more than 33.4 billion STB of oil and 118 Tcf of natural gas over 100 years.



- The following slides will shed light on what I have done so far and what I plan to do.



- Classic waterflooding in unconventional reservoirs is not plausible because of the small pore size and low permeability of the mudstone matrix.
- We believe the alternative is cyclic or continuous gas injection which pertains to my research for increasing oil production.
- Gas injection could be augmented with low-salinity brine and low-concentration surfactants to improve oil recovery farther—my thesis

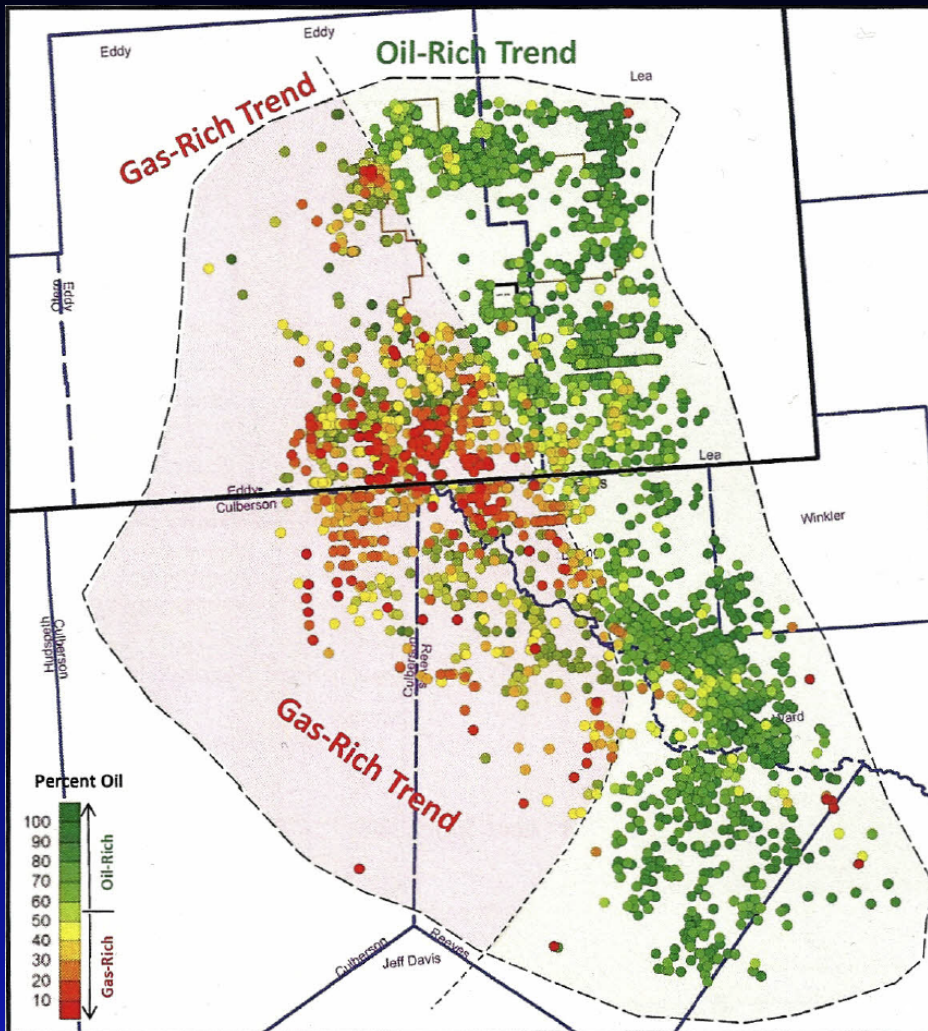


Preliminary Work

- Organized HC production data from wells drilled in Wolfcamp Formation of the Delaware Basin in the last eight years.
- Conducted decline analysis and Rate Transient Analysis (RTA) on several wells of the Delaware Basin to determine the stimulated formation permeability to assess stimulation effectiveness.



Cumulative Produced Hydrocarbon Map and Gas-Oil Trend



Ultimate hydrocarbon recovery potential is a function of:

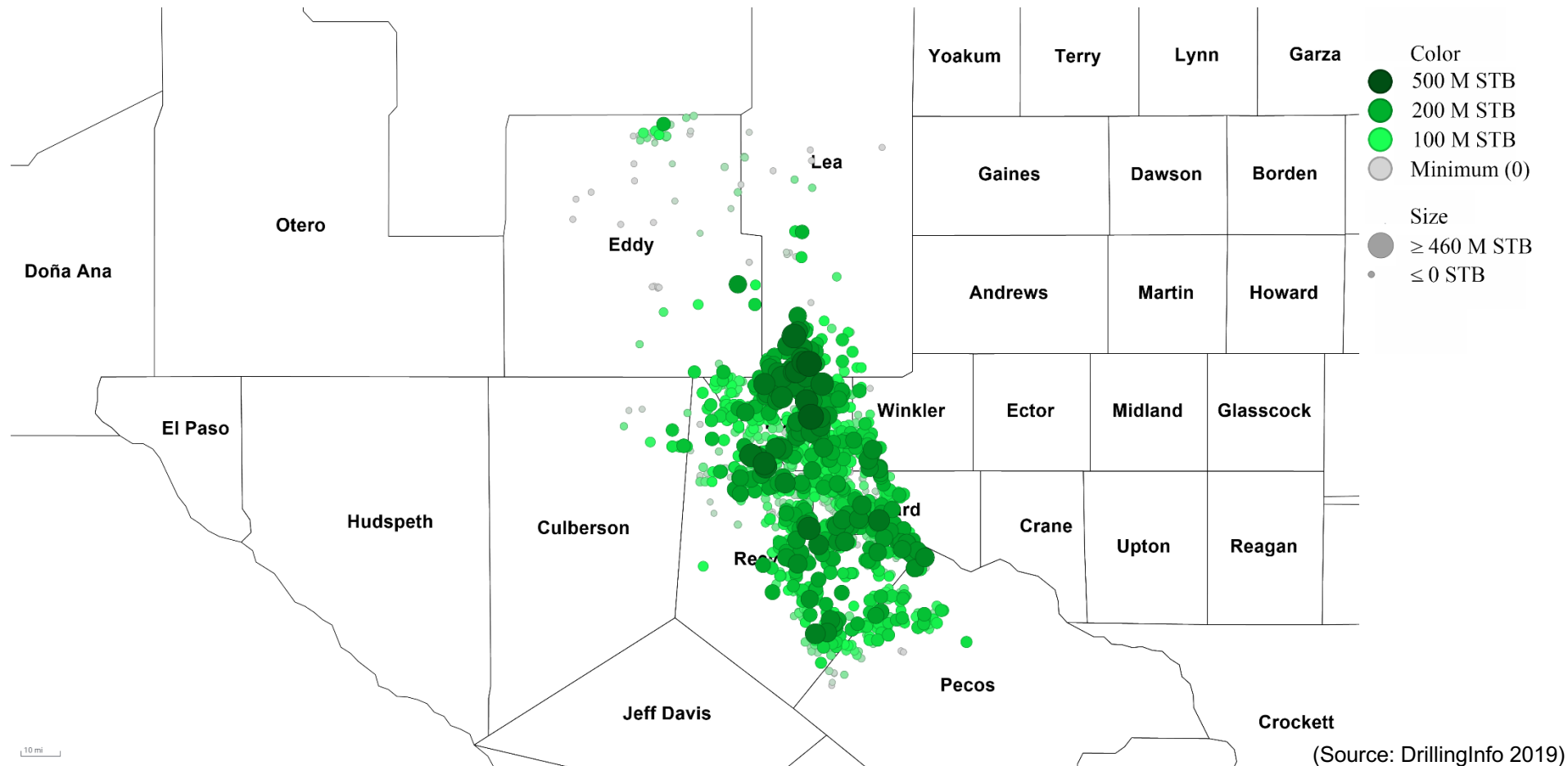
- Fluid Properties
- Lithology
- Mineralogy
- Thermal maturity
- Pore Types

(Dilli 2019)



Cumulative Oil Production from Oil Wells in Wolfcamp Formation

12 Months

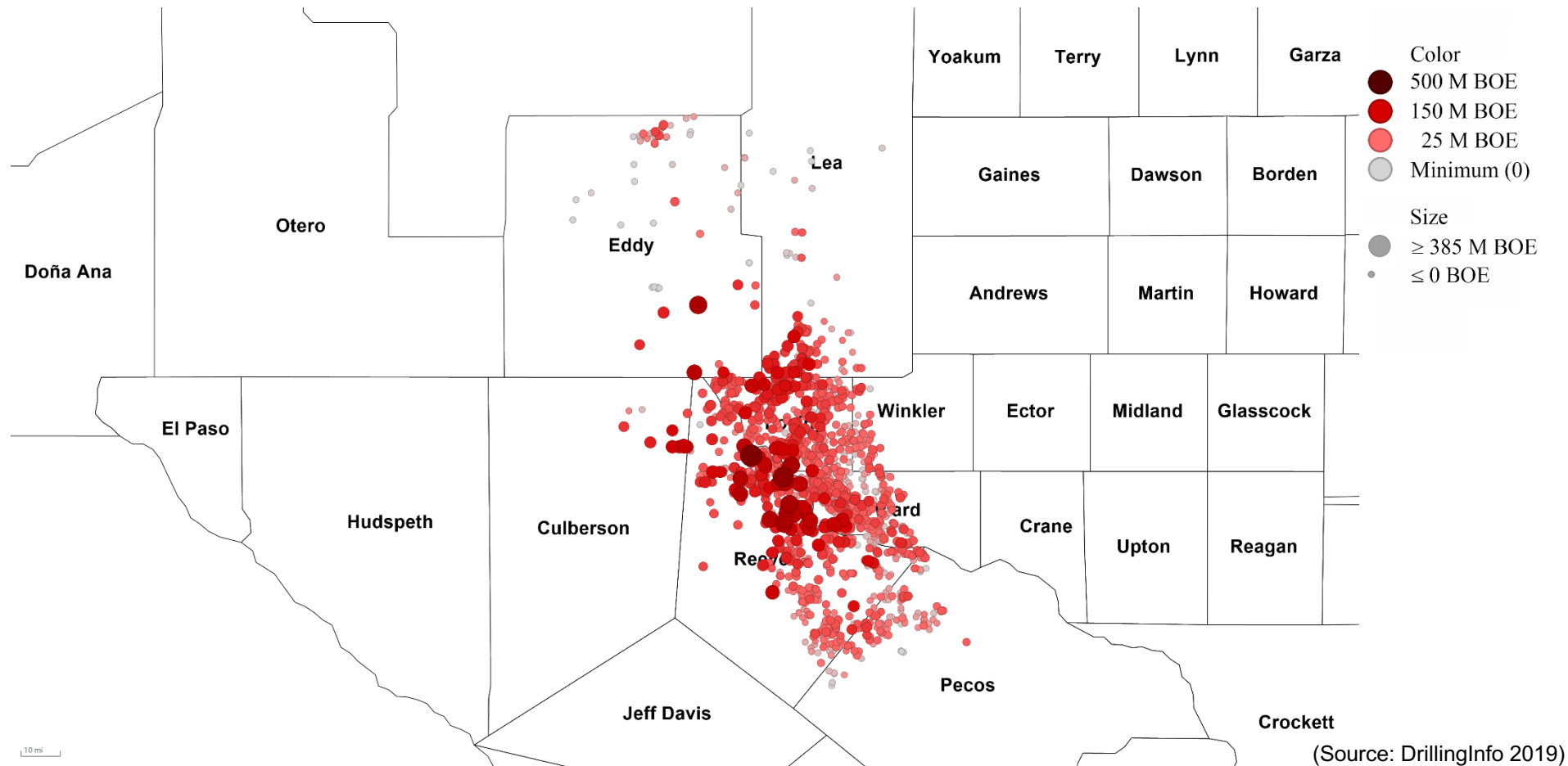


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Cumulative Gas Production from Oil Wells in Wolfcamp Formation

12 Months

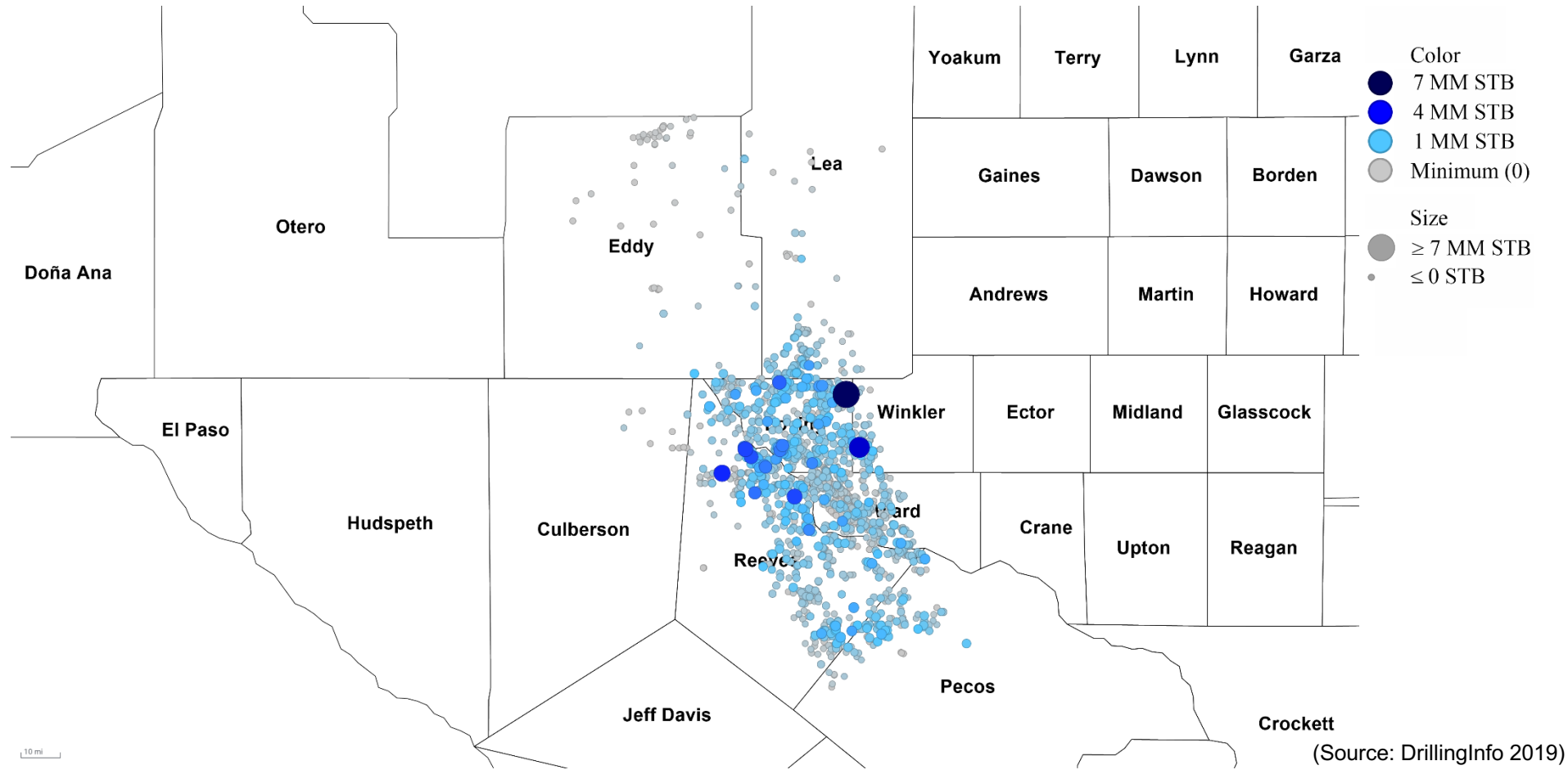


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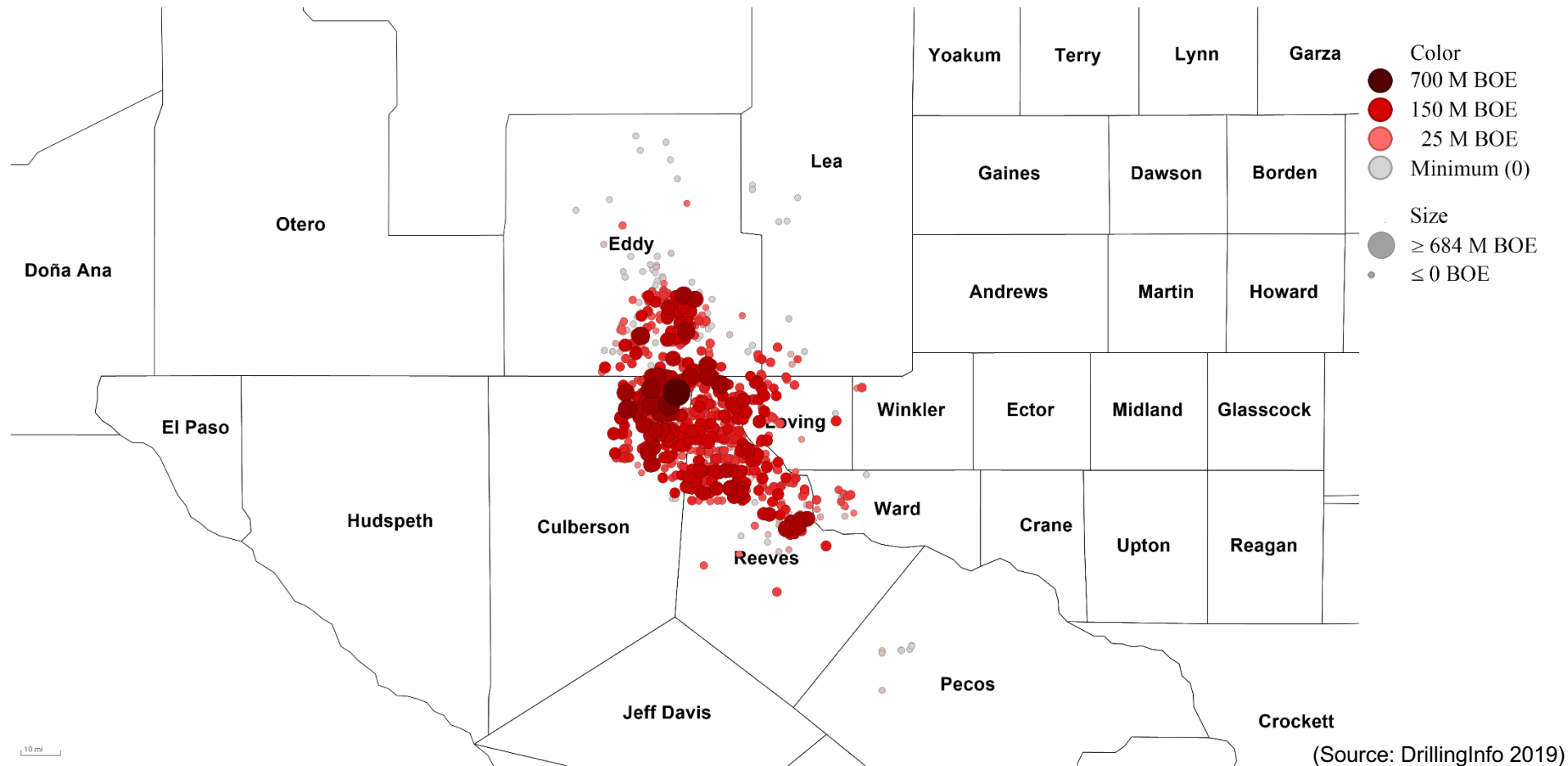
Cumulative Water Production from Oil Wells in Wolfcamp Formation

12 Months



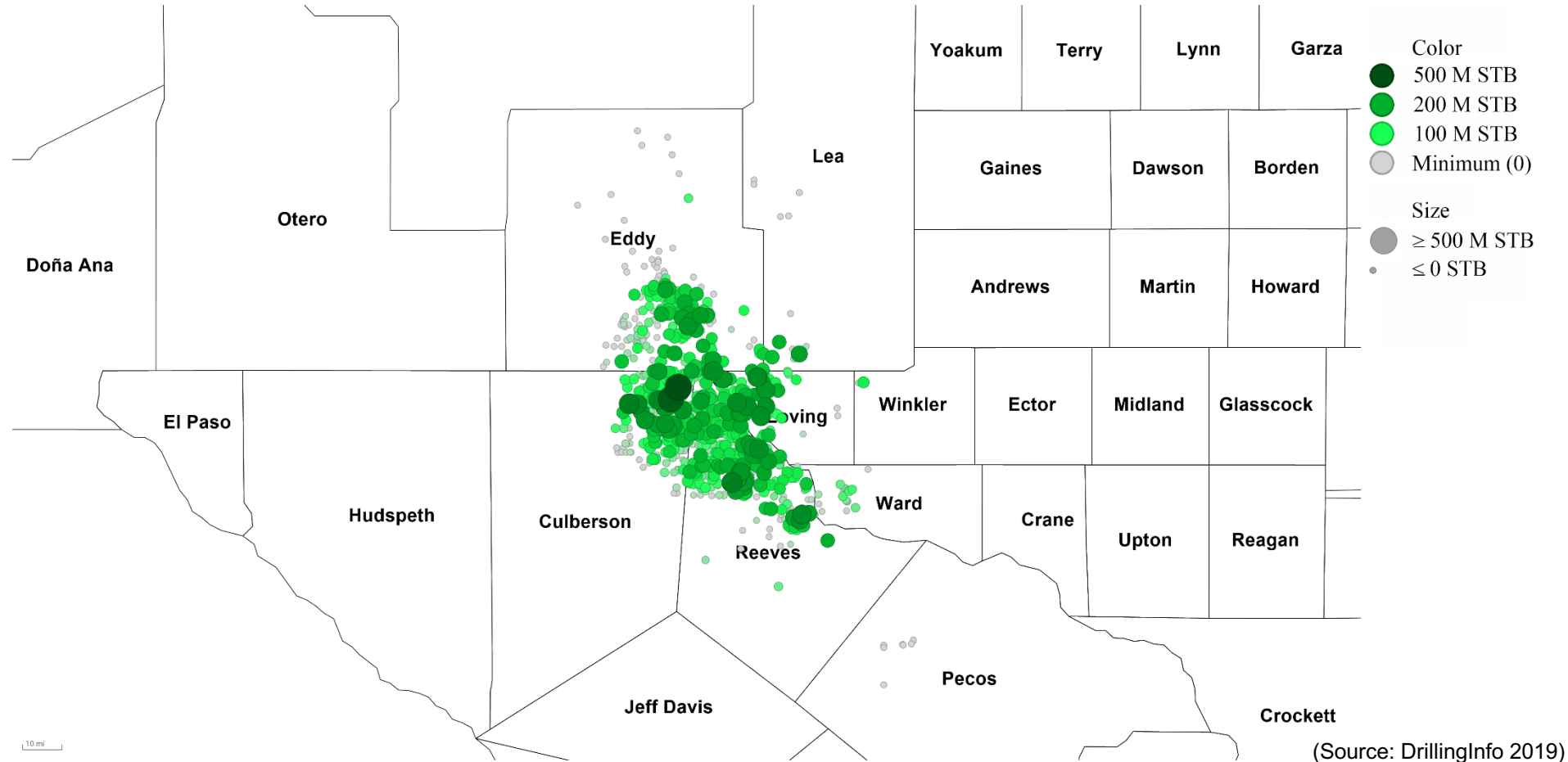
Cumulative Gas Production from Gas Wells in Wolfcamp Formation

12 Months



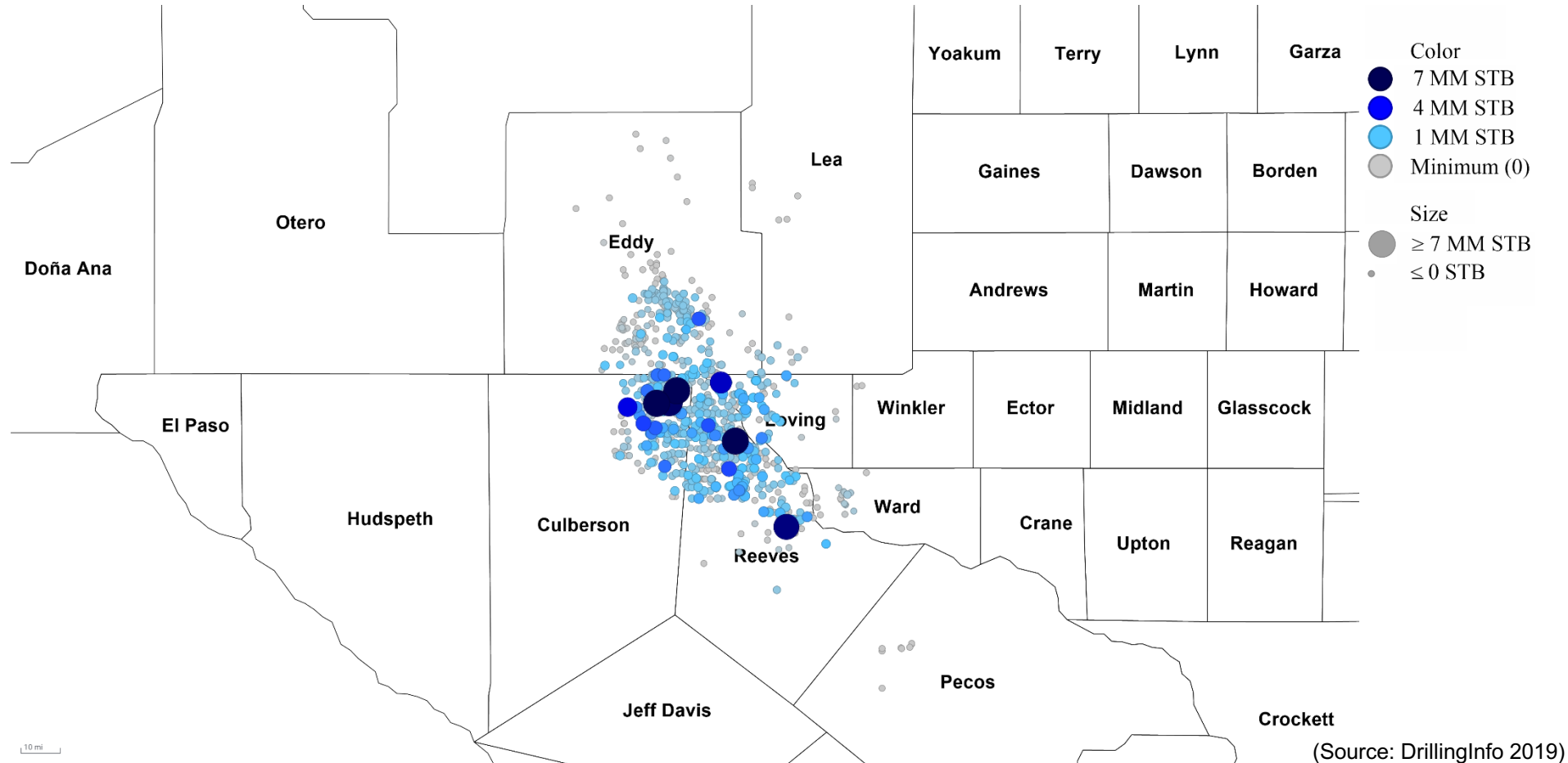
Cumulative Oil Production from Gas Wells in Wolfcamp Formation

12 Months



Cumulative Water Production from Gas Wells in Wolfcamp Formation

12 Months



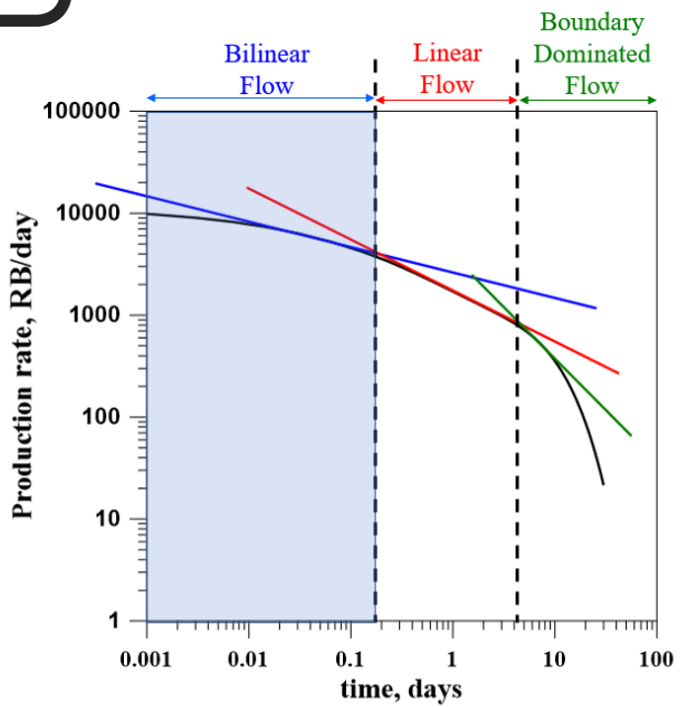
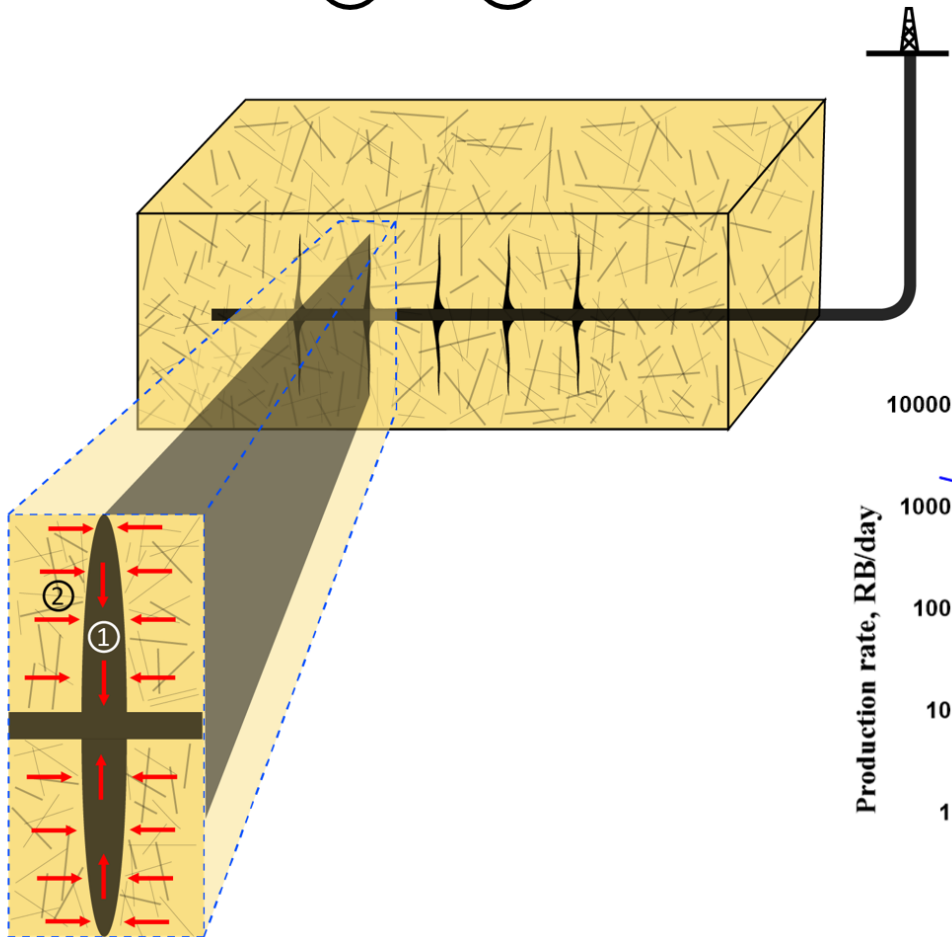
Ultimate Objective

- **Collect and analyze** a large set of Wolfcamp production data.
- Conduct laboratory experiments as a follow-up of my MS research on low-salinity oil recovery.
- The experiments will include addition of small amounts of a specialty surfactant to augment the low-salinity EOR.



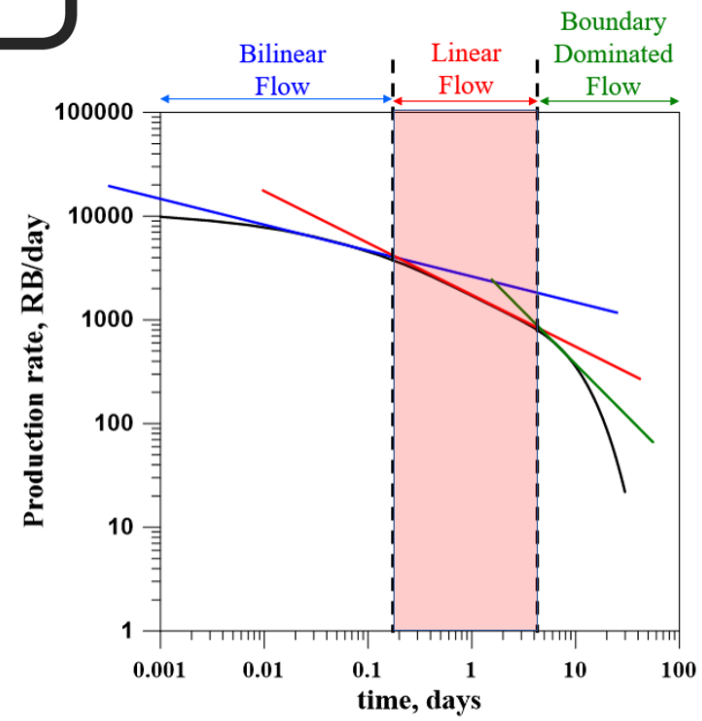
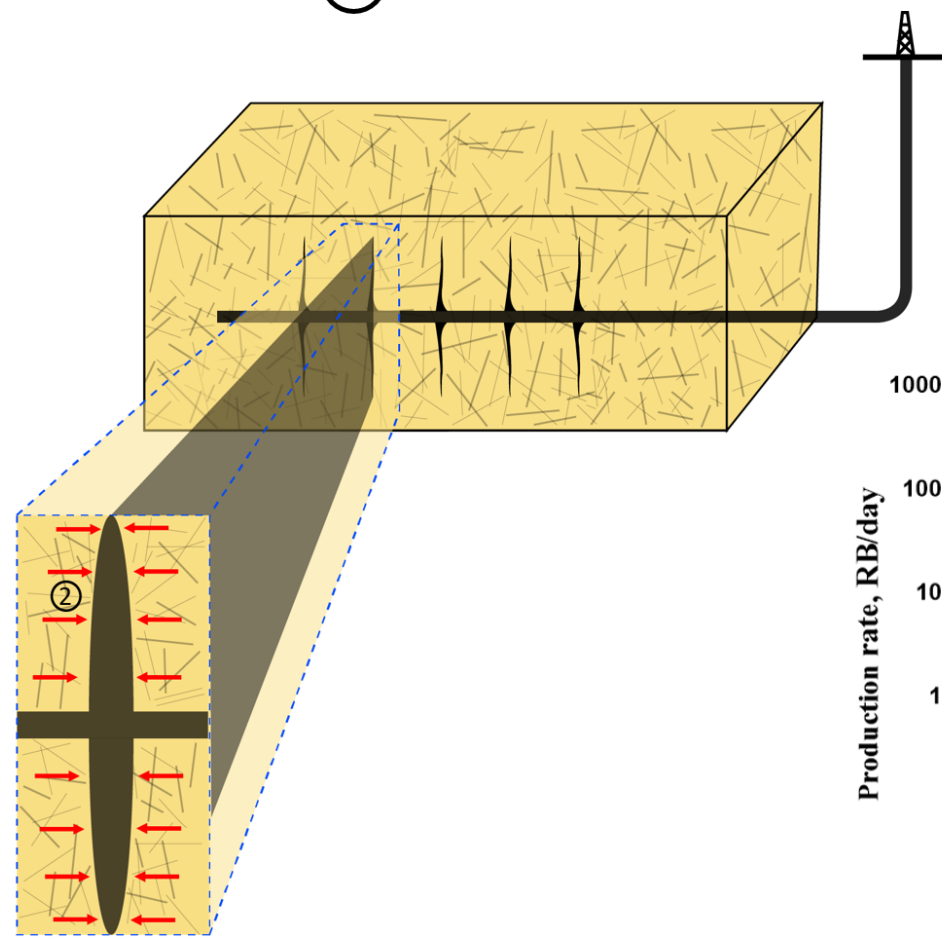
Multiphase Flow Rate Transient Analysis

BILINEAR FLOW : ① + ②



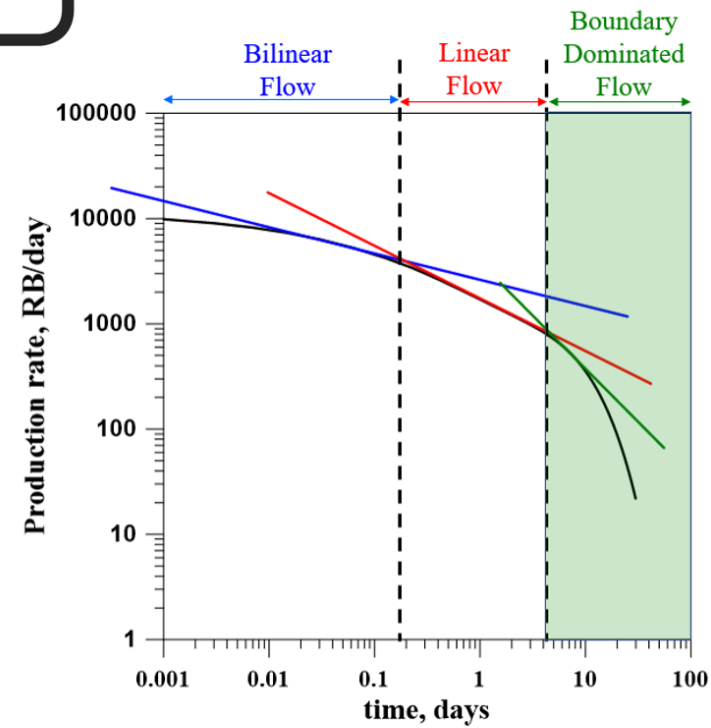
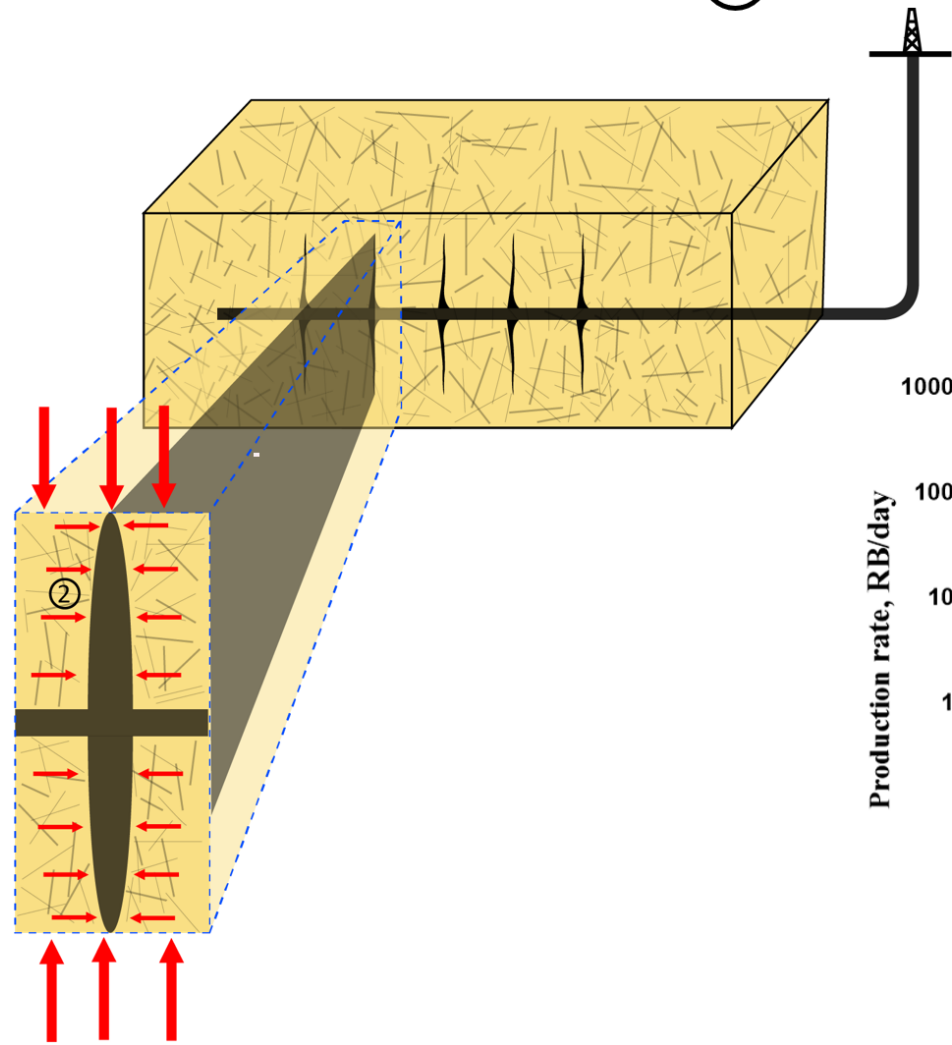
Multiphase Flow Rate Transient Analysis

LINEAR FLOW : ②

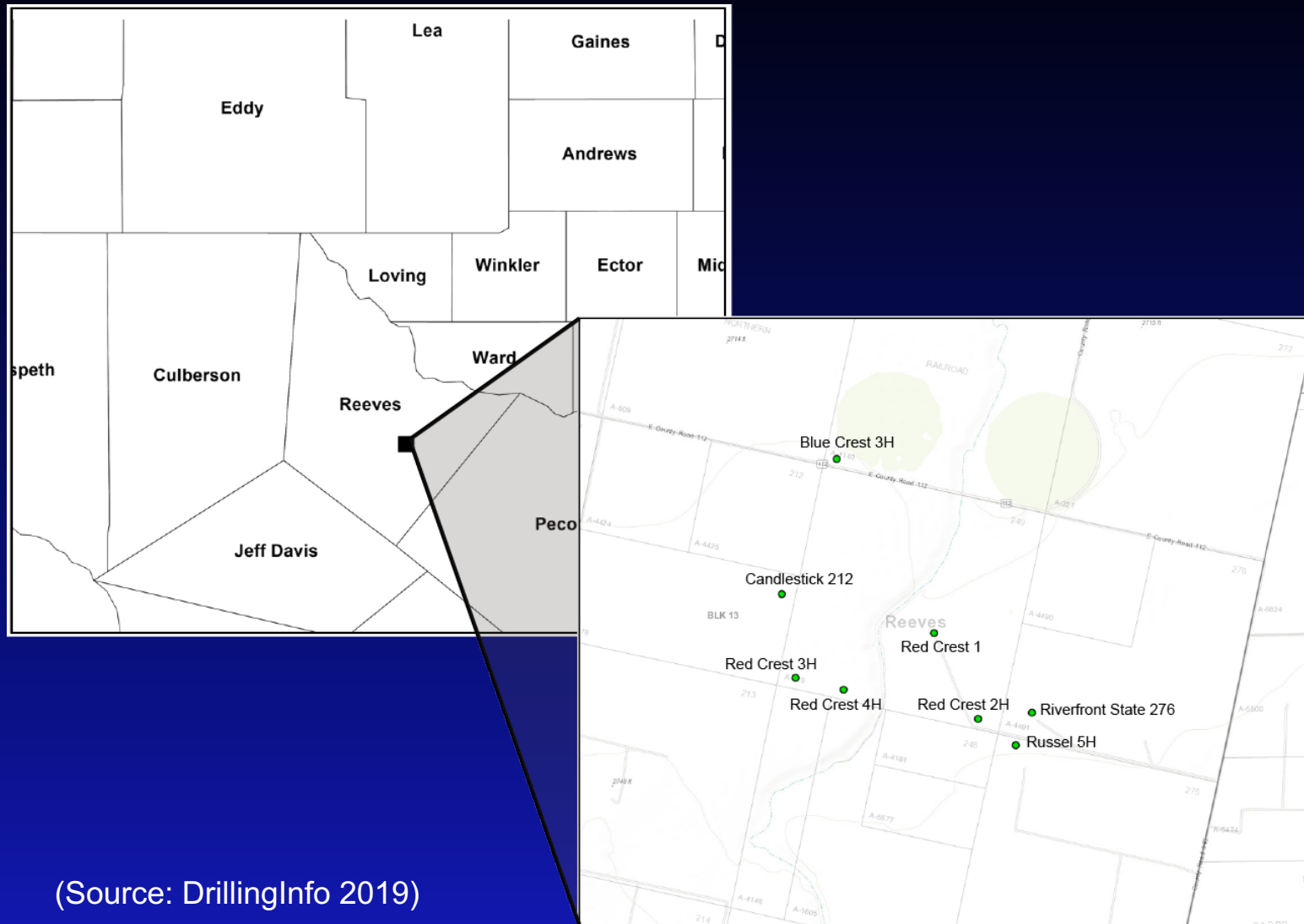


Multiphase Flow Rate Transient Analysis

BOUNDARY DOMINATED FLOW: ②



Wells Selected and Analyzed using RTA



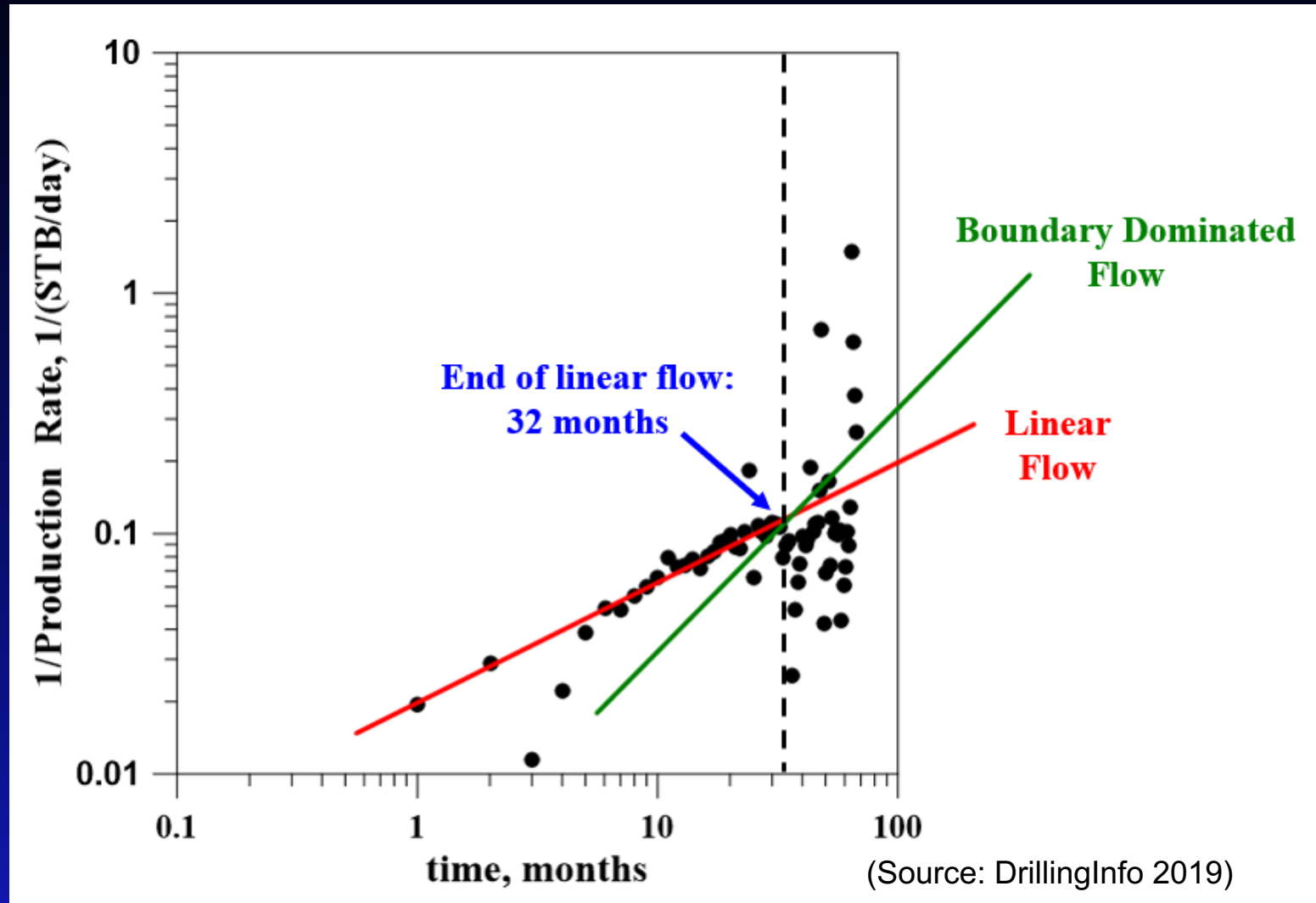
(Source: DrillingInfo 2019)



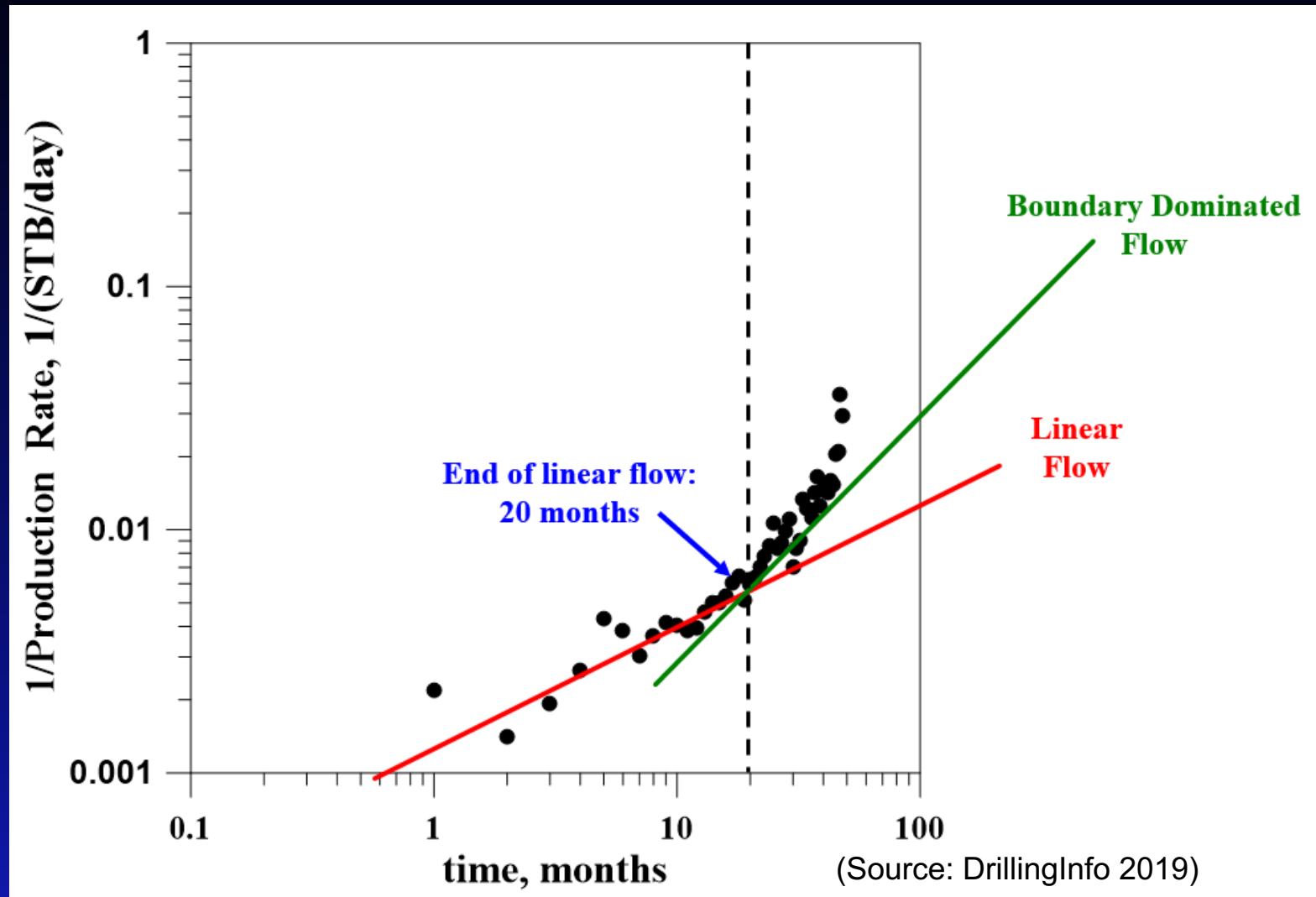
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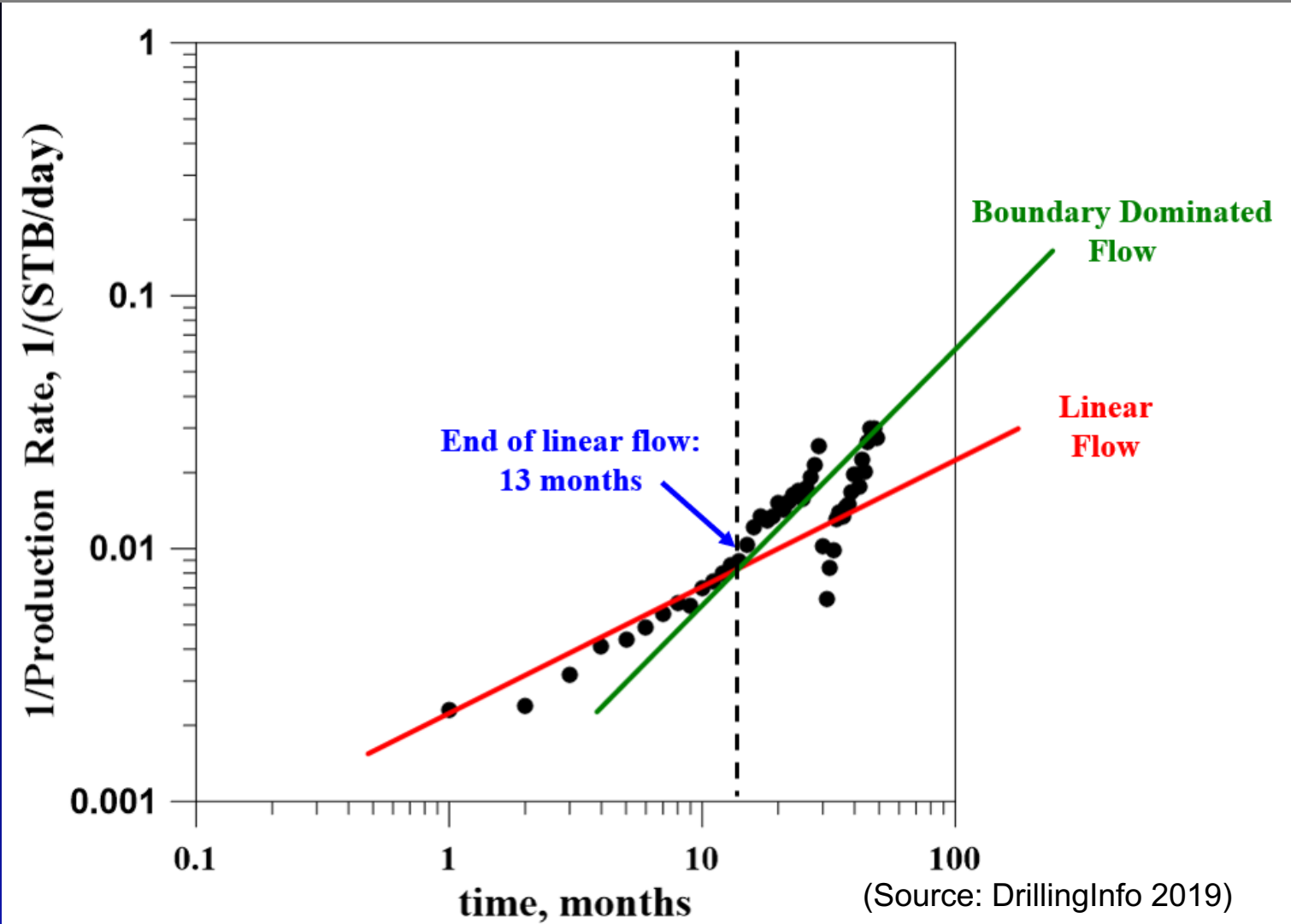
Diagnostic Plot for Red Crest 1



Diagnostic Plot for Blue Crest 3H



Diagnostic Plot for Red Crest 3H

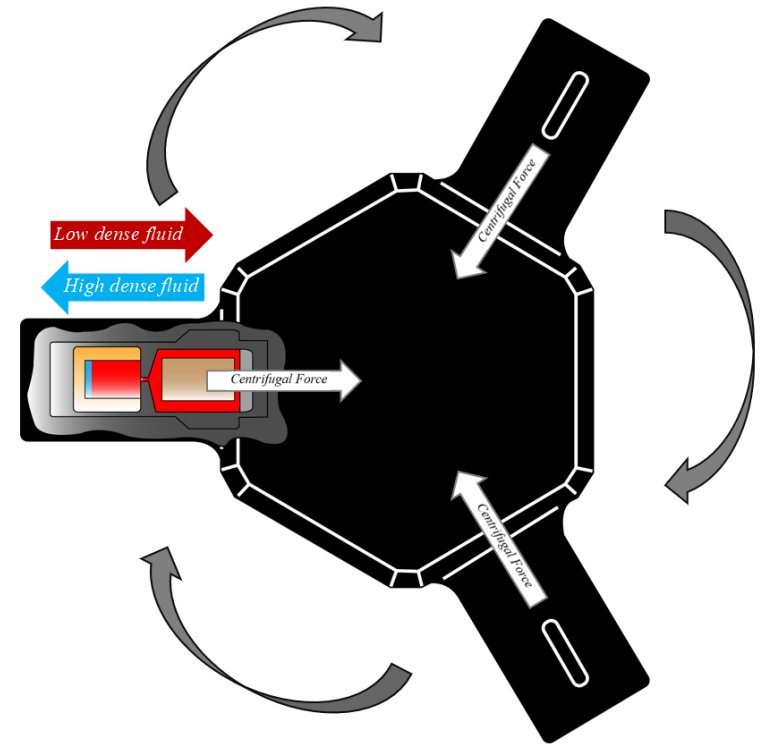
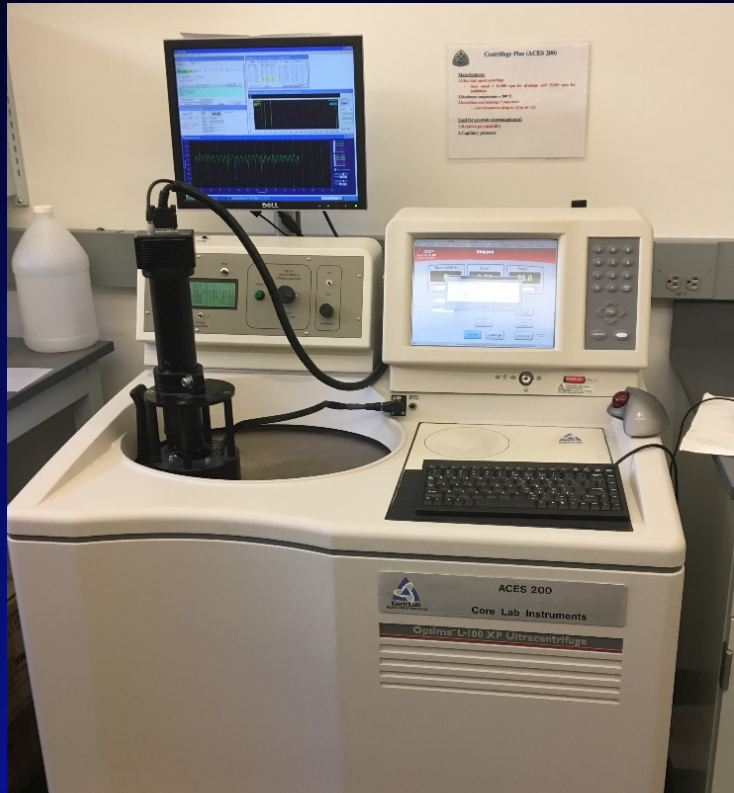


RTA Summary

Well Name	Drill Type	End of Linear Flow Regime (months)	Cumulative Production End of Linear Flow (STB)
Red Crest 1	V	32	17,631
Riverfront State 276	V	31	50,019
Russel 5H	H	19	88,142
Candlestick 212	H	24	93,750
Red Crest 4H	H	7	84,941
Red Crest 3H	H	13	87,695
Red Crest 2H	H	12	148,148
Blue Crest 3H	H	19	166,682

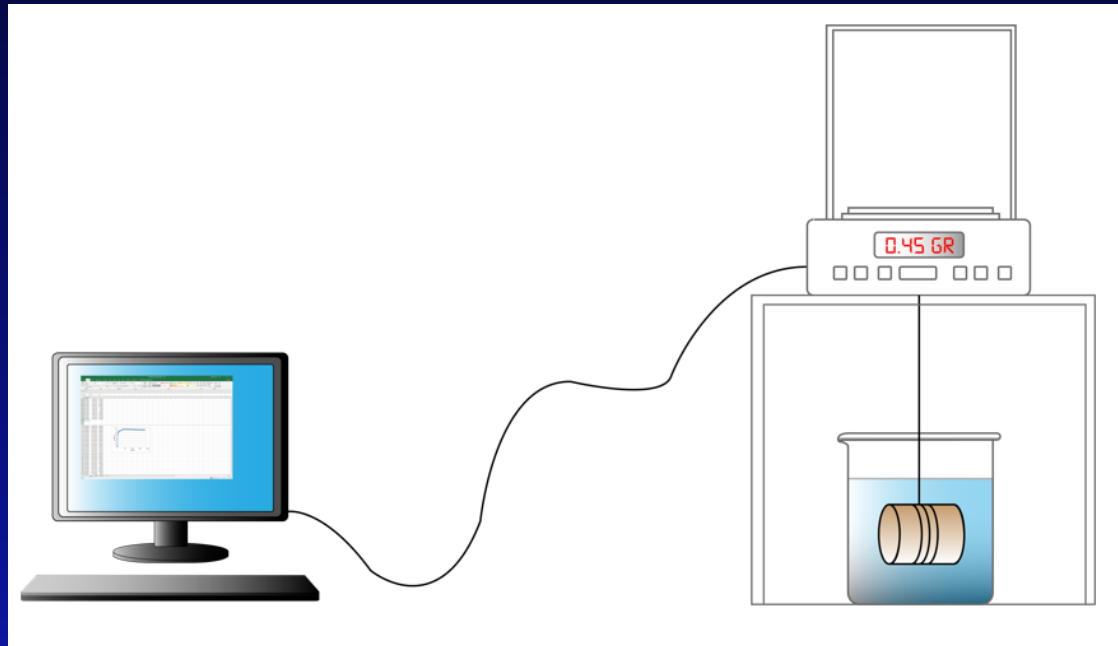


High-Speed Centrifuge For Capillary Pressure Measurement



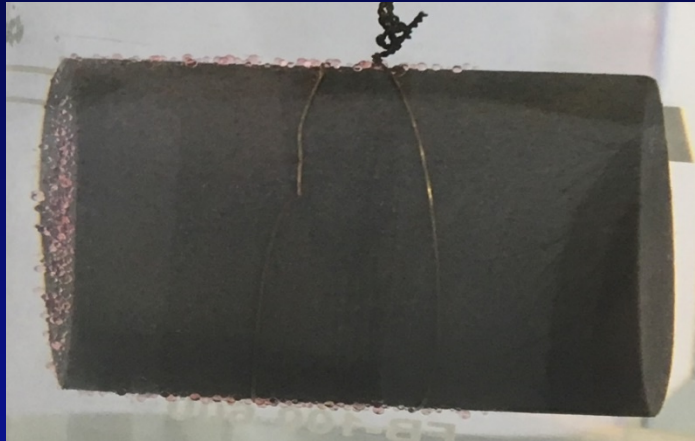
Osmotic Pressure Measurement Apparatus

This device is used to measure capillary and osmotic imbibition oil recovery from cores by mass measuring scale

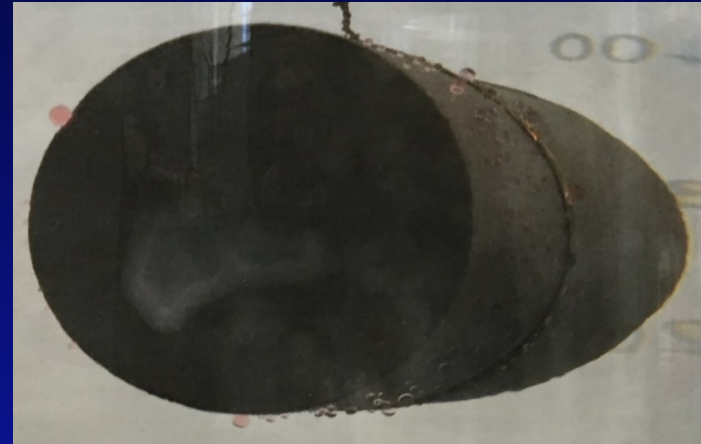


Codell Sandstone Experiments at Two Different Salinities (Ozan Uzun, CSM 2018)

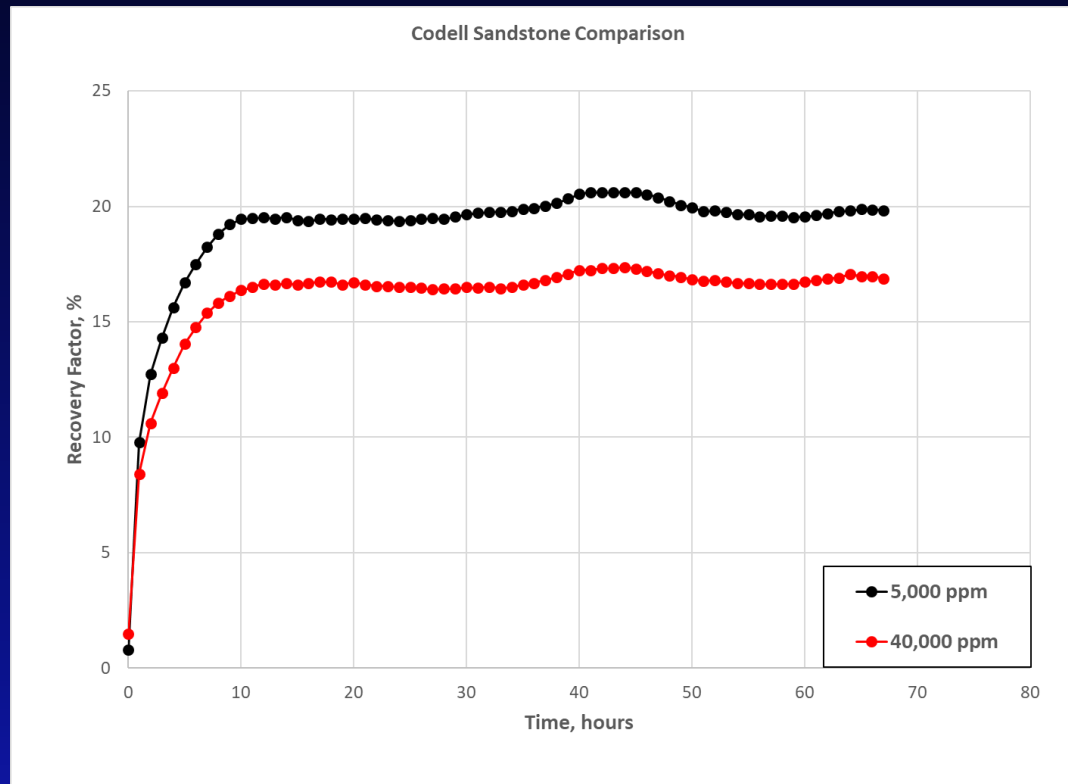
5,000 ppm



40,000 ppm

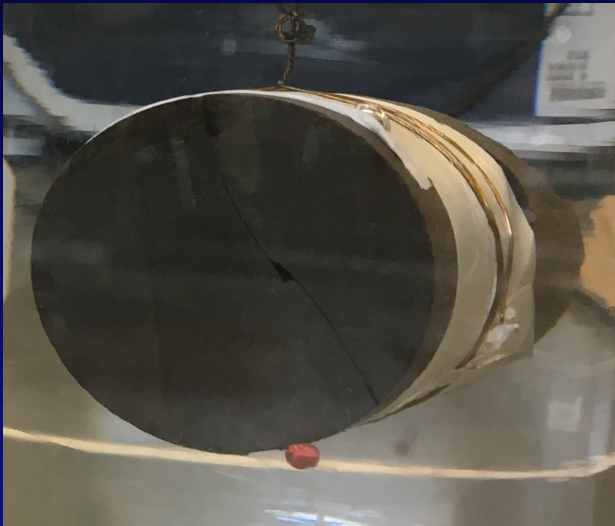


Oil Recovery from **Codell Sandstone** by Low-Sal Osmosis (Ozan Uzun, CSM 2018)

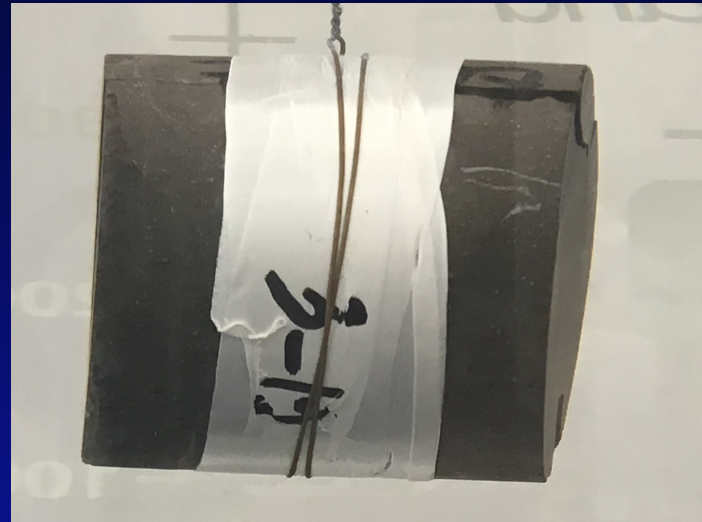


Niobrara B-Chalk Experiments at Two Different Salinities (Ozan Uzun, CSM 2018)

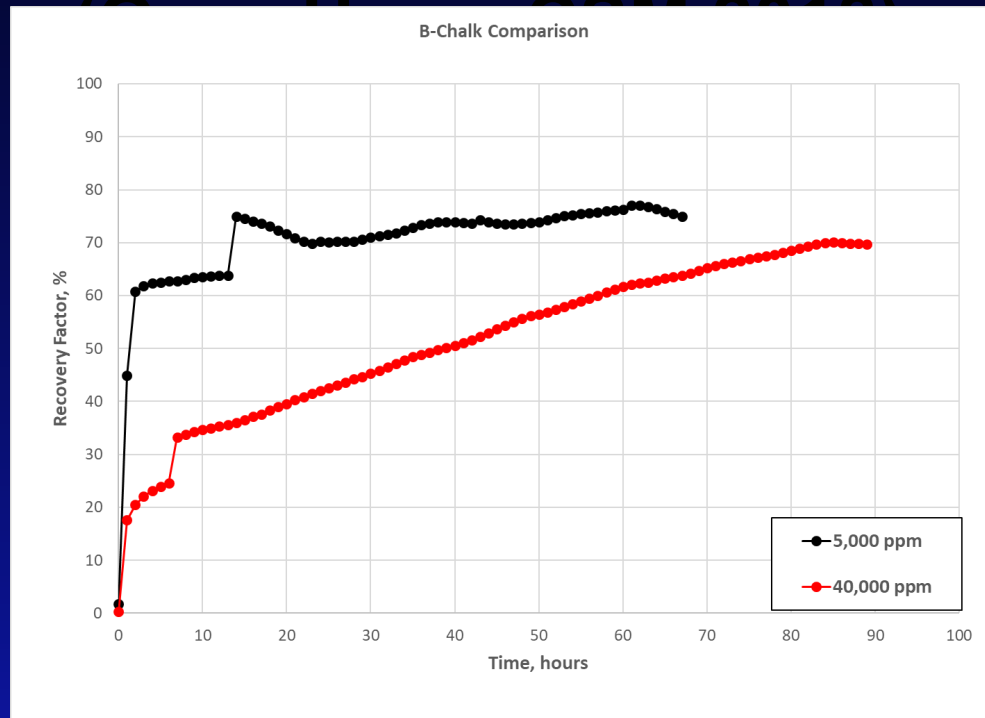
Salinity = 5,000 ppm



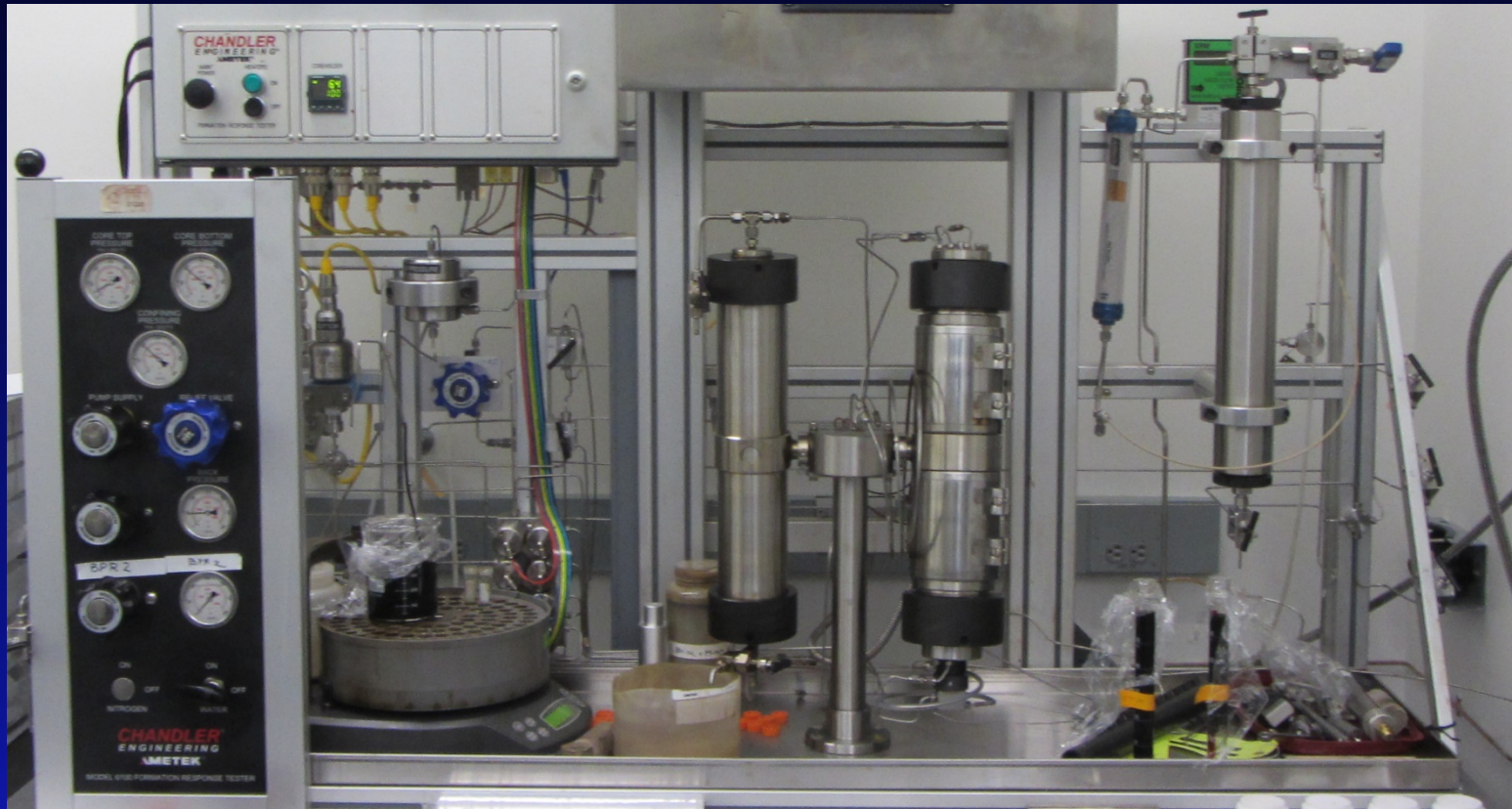
Salinity = 40,000 ppm



Oil Recovery from **Niobrara B-Chalk** by Low-Sal Osmosis



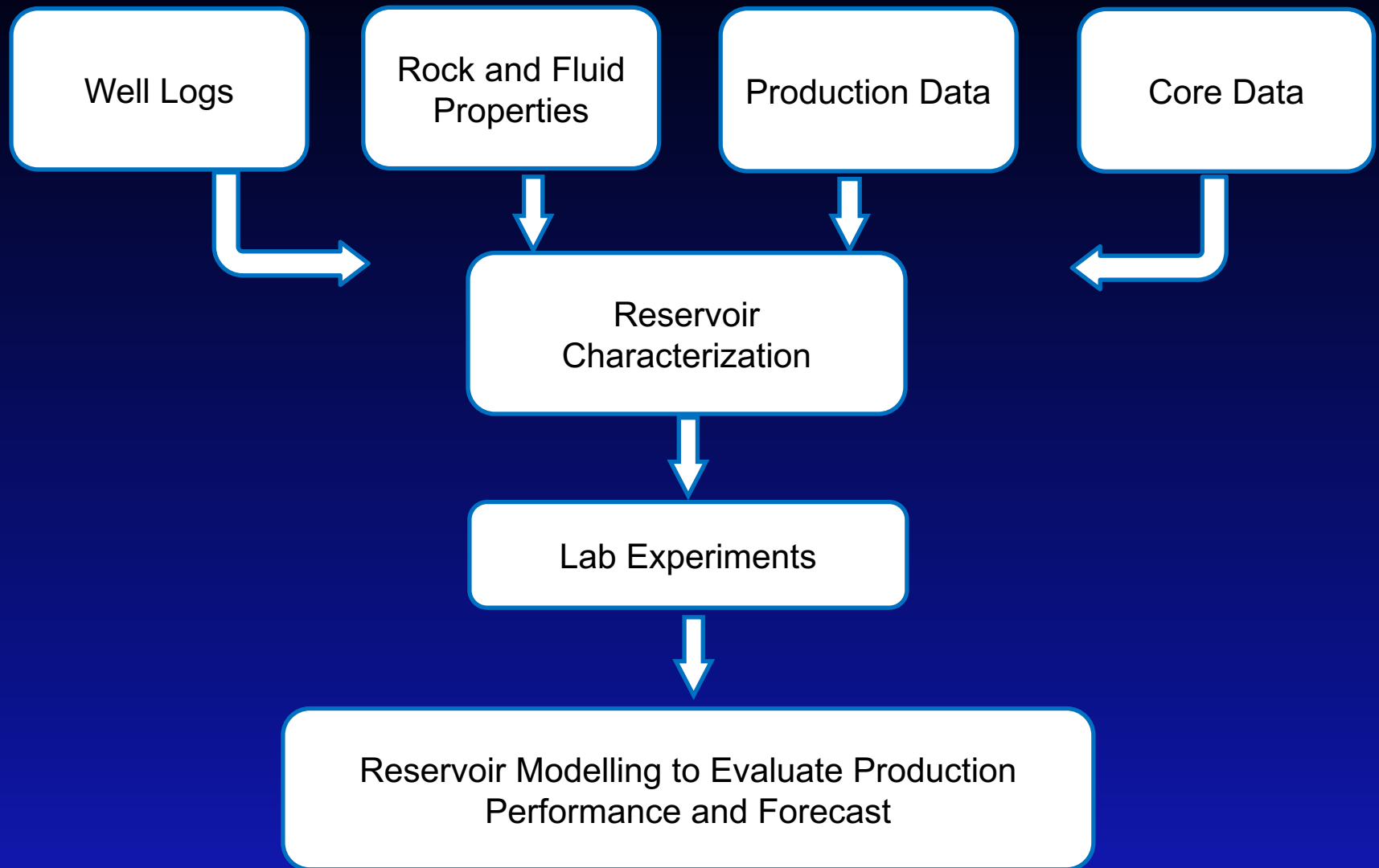
FRT-6100 for Gas Injection Measurement



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FUTURE WORK



Questions?

Thank you

