



Energy Minerals Division

A Division of the American Association of Petroleum Geologists *Bringing Professionals Together for the Benefit of All*

Southwest Section Annual Report May 2019

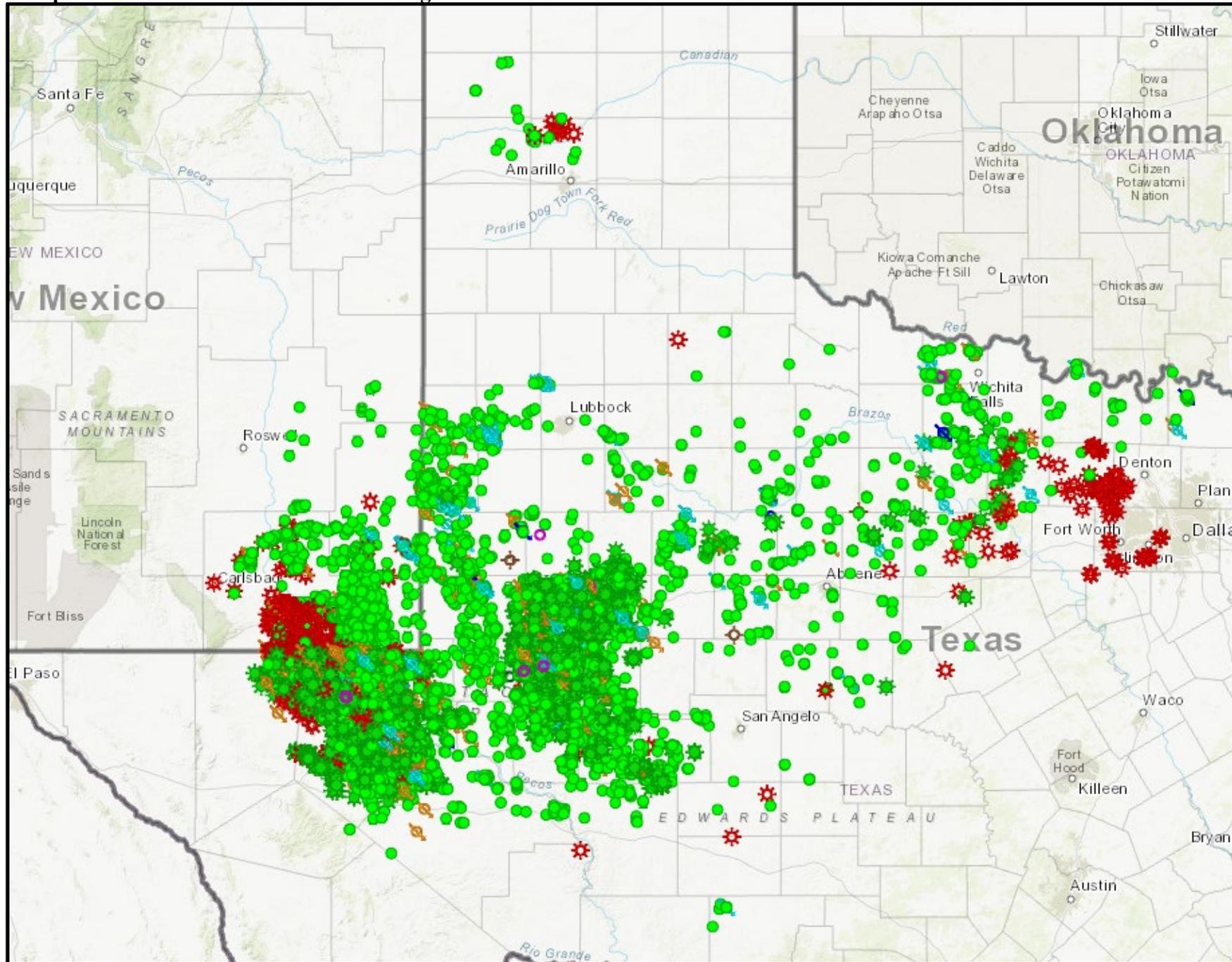
Summary

The 2019 Southwest Section (SWS) meeting was held in Irvin, TX, and the 2020 SWS meeting will be in Ruidoso, NM. This meeting will be a joint venture with the WTGS and Roswell GS. The Southwest Section active membership is currently at 1,643 members. Overall, we know the societies and activity of our members are decreasing and it's concerning. Southwest section's activity continues to be primarily focused on the Permian Basin as we're on the front lines of the world class unconventional liquids play. A large majority of the activity originates from the high TOC mudrocks of the Delaware Basin and Midland Basin. Although excitement is generating on the platforms and in the conventional plays around the Permian Basin. Carbon Capture Storage is a topic you will hear more about in the near future around the Permian Basin. The oldest active member in the SWS, Fred Stead out of Wylie, Texas since 1948!

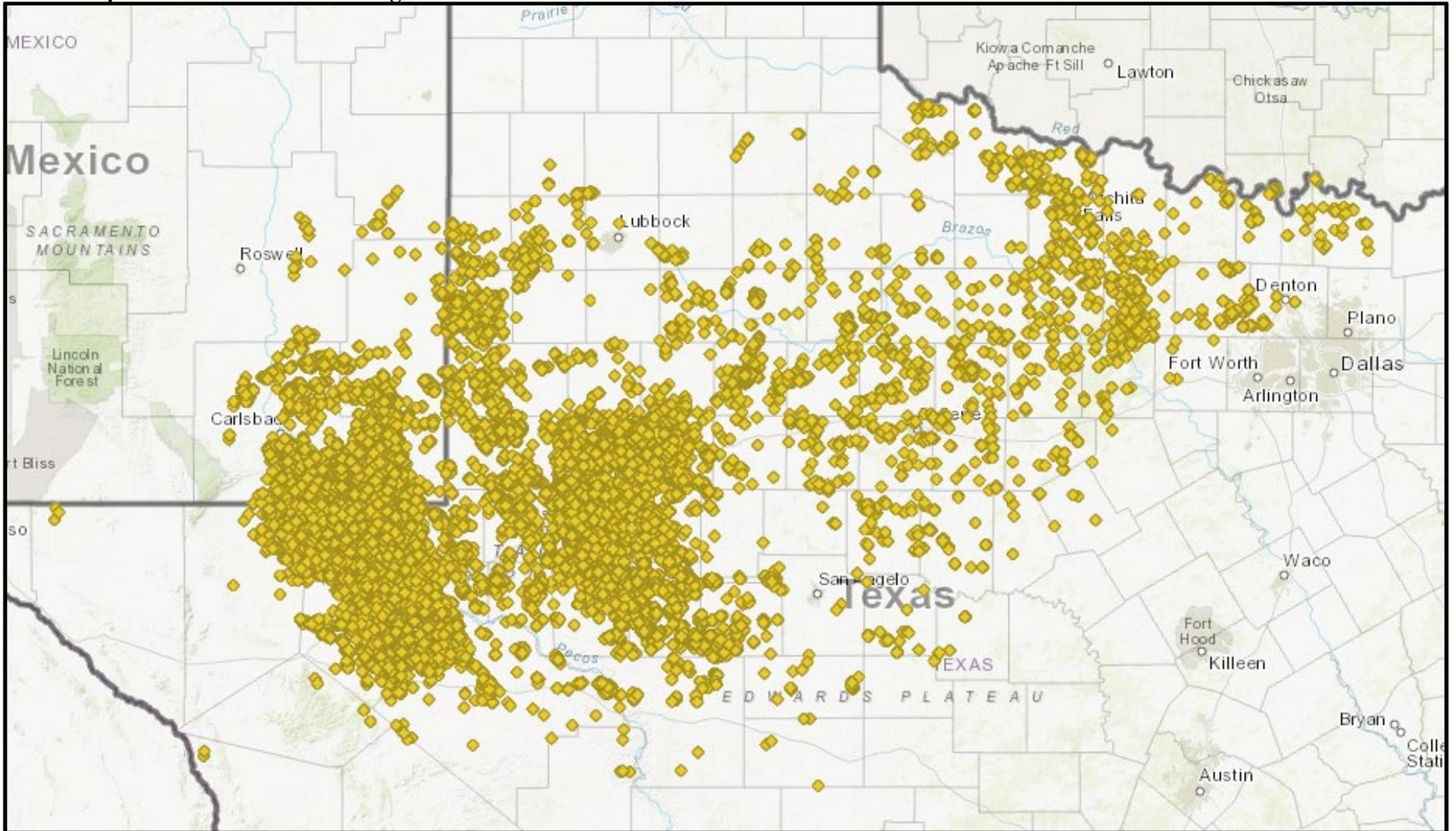
As of 5/17/2019, Drilling Info indicates 204,547 active producing oil and gas wells across the Southwest Section. CUM oil for all currently active wells is approximately 75.6 MMbbl oil, 188.7 MMcf and 549.1 MMbbl water. There are currently ~460 rigs running in the SWS with an estimated 1,841 to 2,350 DUCs in the Permian Basin. From 2018 to present day, there are 8,955 wells completed, 6,580 Horizontals, 2,105 verticals and 270 other. The amount of completions in both Hz and vertical wells in the last 6 months remains consistent. Ranging from 300 to 400 Hz and 70 to 112 vertical completions each month. A slight decline recently in the last 3 months and a total of 22,139 active permits across the SWS.

With the recent Oxy/Anadarko merger, the buzz around the Permian is generally positive. The A&D market is very quiet as the industry proved the unconventional play to be very challenging and expensive over the last 3 to 5 years. Production longevity is an issue and commodity prices proved to be the economic driving factor, performance is arguably statistical, not technical. There have been unbelievable results in some cases. The Devon, Boundary Raider 6 213H had 24IP's of 12.4 Mmcf, 10,481 BO and 6,975 BW. The plays are expanding in the unconventional seen in Pecos, County could be a late bloomer in the Delaware Basin with Bone Spring and Wolfcamp reservoir targets. There is a lot of running room around the SWS to drill wells, stacked pay potential and now operators are starting to drill deeper zones on the platforms with success. NGL exploration and exploitation is becoming more and more talked about around the region and certainly with Apache's Alpine High discovery and the release of their recent investment presentation. <https://edge.media-server.com/m6/p/ueppy6cw>

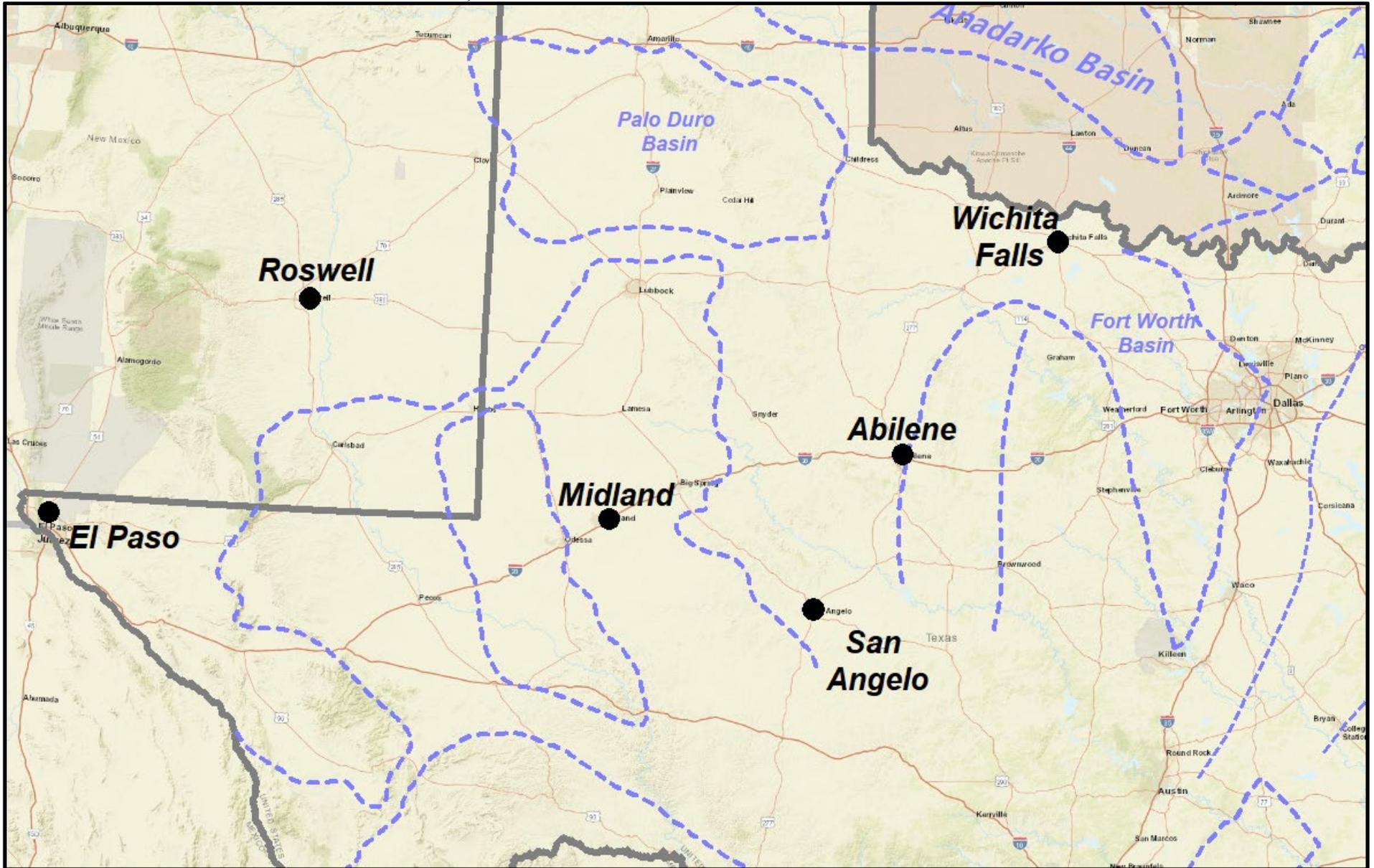
Completions since 2018 in the SWS: Drilling Info



All active permits in the SWS: Drilling Info



Southwest Section States and local societies - ~1,643 Active Members



January 1, 2018

| GRAND TOTALS | Active | Active | Active | Active | Emeritus | Emeritus | Honorary | Life | Voting | Associate | Associate | Associate | Student | Student | NonVoting | GRAND |
|----------------|-----------|--------|--------|---------|----------|----------|----------|------|--------|-----------|-----------|-----------|---------|---------|-----------|-------|
| | Full Dues | R-Half | R-Qtr | Student | Half | R-Qtr | | | | | Full | R-Half | | R-Qtr | | |
| Southwest Sect | 918 | 46 | 56 | 1 | 179 | 3 | 10 | 3 | 1,216 | 453 | 23 | 23 | 198 | 134 | 831 | 2,047 |

January 1, 2019

| GRAND TOTALS | Active | Active | Active | Active | Emeritus | Emeritus | Honorary | Life | Voting | Associate | Associate | Associate | Student | Student | NonVoting | GRAND |
|----------------|-----------|--------|--------|---------|----------|----------|----------|------|--------|-----------|-----------|-----------|---------|---------|-----------|-------|
| | Full Dues | R-Half | R-Qtr | Student | Half | R-Qtr | | | | | Full | R-Half | | R-Qtr | | |
| Southwest Sect | 883 | 26 | 57 | 2 | 181 | 3 | 10 | 3 | 1,165 | 400 | 19 | 22 | 160 | 145 | 746 | 1,911 |

July 1, 2018

| GRAND TOTALS | Active | Active | Active | Active | Emeritus | Emeritus | Honorary | Life | Voting | Associate | Associate | Associate | Student | Student | NonVoting | GRAND |
|----------------|-----------|--------|--------|---------|----------|----------|----------|------|--------|-----------|-----------|-----------|---------|---------|-----------|-------|
| | Full Dues | R-Half | R-Qtr | Student | Half | R-Qtr | | | | | Full | R-Half | | R-Qtr | | |
| Southwest Sect | 896 | 15 | 35 | 1 | 178 | 1 | 10 | 3 | 1,139 | 440 | 4 | 14 | 107 | 143 | 708 | 1,847 |



????

The AAPG and EMD need to become more helpful and vocal to the Young Professionals – We need to support the industry with new regional short courses and field trips that will allow management to send their technical teams to. Within every company there is a universal issue, how are we getting better with every well we drill? In most cases right now, we are finding out that we’re getting less and less production performance with the unconventional play. We need to embrace the challenges and motivate the industry into a focal point to get us all on the same page. There is a competitive nature in the industry that will be hard to overcome, but when we prove to make new discoveries and help the operators with their ability to predict reservoir performance, the industry will again invest and come back for the AAPG.

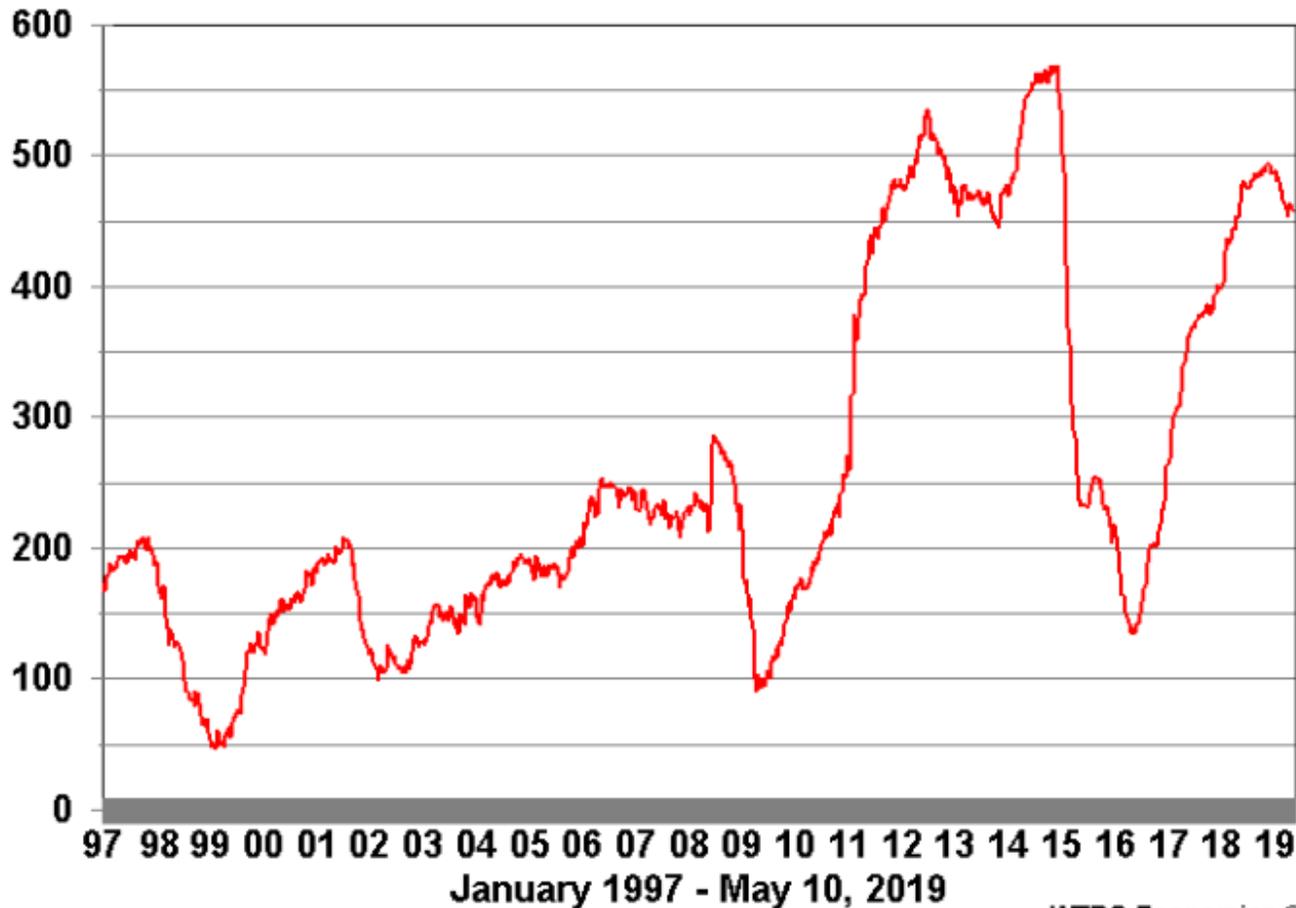
What geoscientists need to attempt to understand: What is the importance of fracture porosity vs matrix porosity? How is the rock really interacting with the completions? Which target(s) are self-sourced vs importance of a migration story? How do we get a properly imaged seismic volume? What are the explanations for the observed GOR/water cut/maturity trends? Effects of stress rotation? Timing of structural events? Sediment source locations?

We can start here as a team within the AAPG and all the members. Begin with an outline and a goal and work the solutions one day at a time together. I believe this is an easy way to motivate a large portion of our industry, the engineers and scientists to unite, innovate and improve America’s ability to produce energy.

Gas and Oil Drilling and Production Activity of the Permian Basin:

Drilling activity has flattened in the Midland Basin for the last year, while Delaware basin continues to grow. Majority of the drilling picked back up after the crash of 2015. Commodity prices focused us right back into the Permian Basin, ramping up with impressive speed and then recently flattening out with the instability of prices. Perhaps in this reflection is the concern from operators that the service providers are not responding to the commodity prices vs their service prices. Of course there are many factors to every curve.

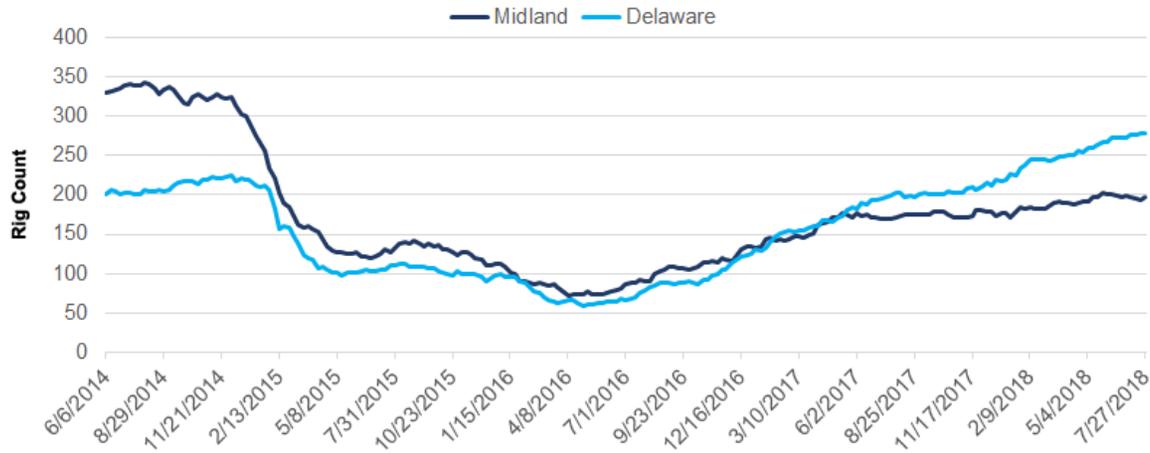
Rotary Rig Count Permian Basin



Source: Baker Hughes, WTRG Economics

WTRG Economics © 2019
www.wtrg.com
(479) 293-4081

Weekly Midland & Delaware Basin Rig Count, 6/6/2014–7/27/2018

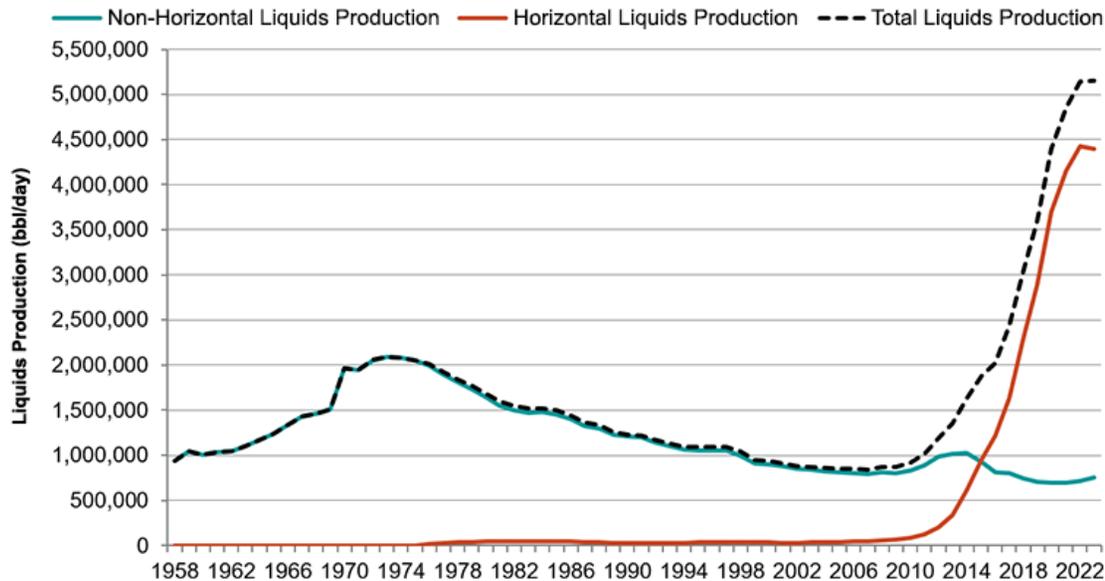


Note: NGI's Midland and Delaware Basin rig counts based on Baker Hughes data and represent the number of rigs operating in counties NGI believes to be prospective for the Midland and Delaware Basins.

Source: Baker Hughes, NGI's Daily GPI calculations

As stated above, most drilling activity in the Southwest section is in the Permian Basin. As a whole, horizontal drilling and oil production are directly affecting each other. An interesting note is to see the positive climb projected in vertical production while rig count and horizontal production flattens out.

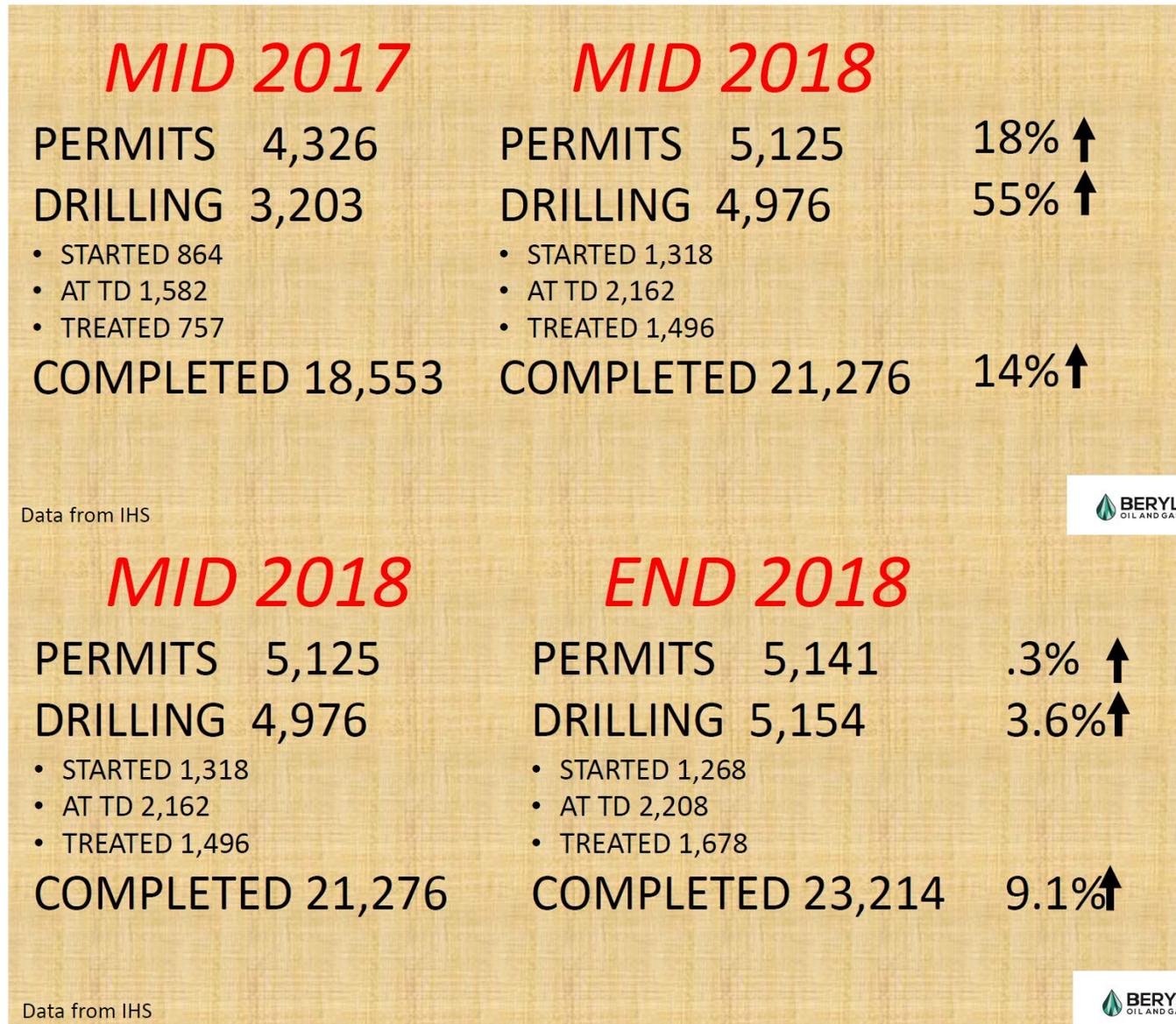
Permian Basin Reaches Second Production Peak, Eclipsing 1973 Record



Source: IHS Markit

Drilled Uncompleted Wells (DUCs) of the Permian Basin: Source is Mike Party's Super Basin Conference presentation

The number of drilled uncompleted wells (DUC's) is an interesting data point in the SWS. What he did was break down the Permits, Drilling and Completions since Mid 2017. As activity is slowing down in overall growth, it's still up going into 2019. The count of DUC's is not really straight forward with the publically available data, Mike does a great job to help us narrow down what the numbers are currently. *(source of data from Mike Party's AAPG presentation, 2019).*



END 2018

~~PERMITS 5,141~~

DRILLING 5,154

- STARTED 1,268
- AT TD 2,208

~~TREATED 1,678~~

~~COMPLETED 23,214~~

POSSIBLE DUC

Possible Total 3,476

- Less Than 30 Days 512
- Less Than 60 Days 543
- Less Than 90 Days 483
- 90-180 Days 984
- 180 Days – 1 Year 626
- 1 Year – 2 Year 231
- 2 Year – 3 Year 26
- More Than 3 Years 70

Data from IHS



POSSIBLE DUC

Possible Total **2,350**

- ~~• Less Than 30 Days 512~~
- ~~• Less Than 60 Days 543~~
- Less Than 90 Days 483
- 90-180 Days 984
- 180 Days – 1 Year 626
- 1 Year – 2 Year 231
- 2 Year – 3 Year 26
- ~~• More Than 3 Years 70~~

POSSIBLE DUC

Possible Total **1,841**

- ~~• Less Than 30 Days 512~~
- ~~• Less Than 60 Days 543~~
- ~~• Less Than 90 Days 483~~
- 90-180 Days 984
- 180 Days – 1 Year 626
- 1 Year – 2 Year 231
- ~~• 2 Year – 3 Year 26~~
- ~~• More Than 3 Years 70~~

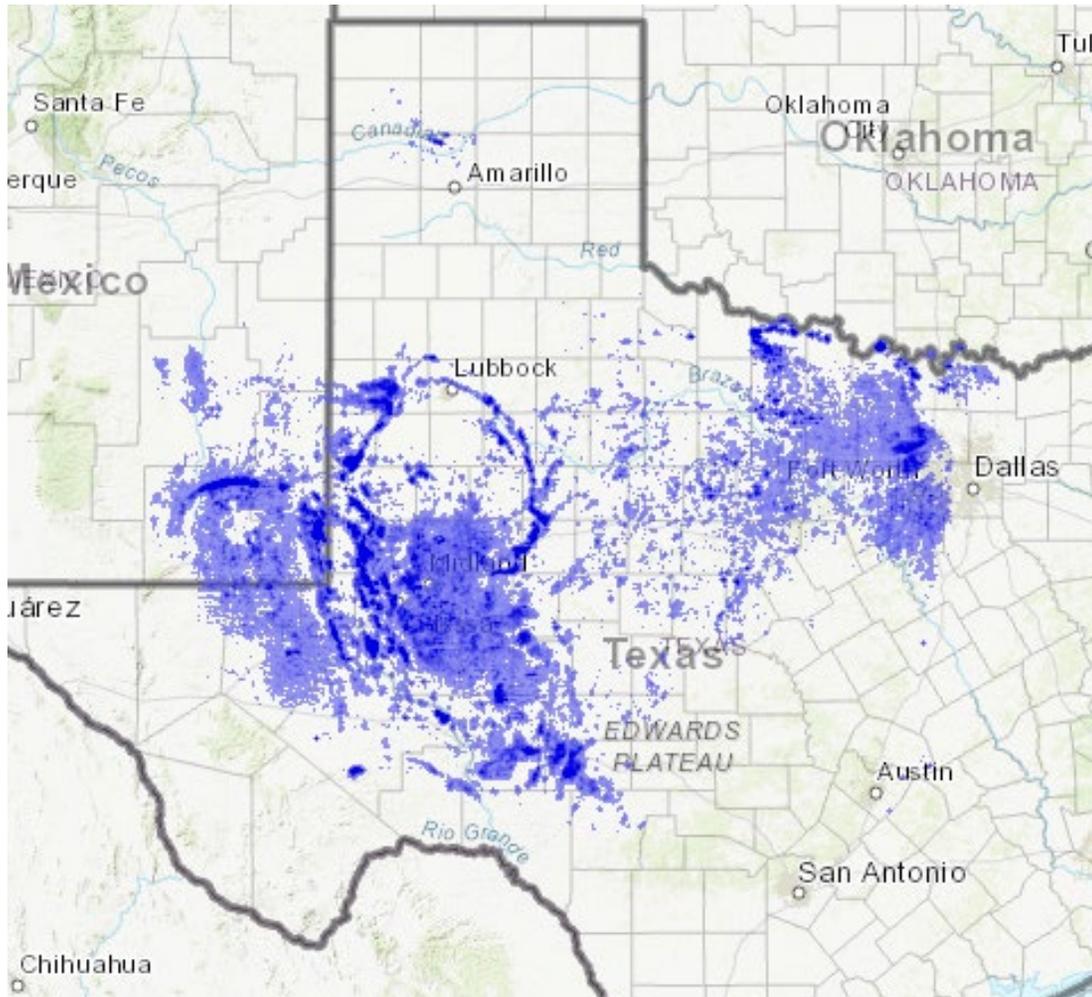
Data from IHS



Production Data

Production is growing even as prices crashed in 2015 and then stabilized a little bit over the past 6 to 12 months. The alarming problem of the Permian Basin is the water production growth. The unconventional liquid play comes with a lot of water and as we continue to drill and produce, this is becoming more and more of a problem for operators. With an increase in seismicity and SWD permits getting more difficult to get, it will be an interesting few years in the basin. *(source of data from Drilling Info, 2019).*

All active wells in the SWS –



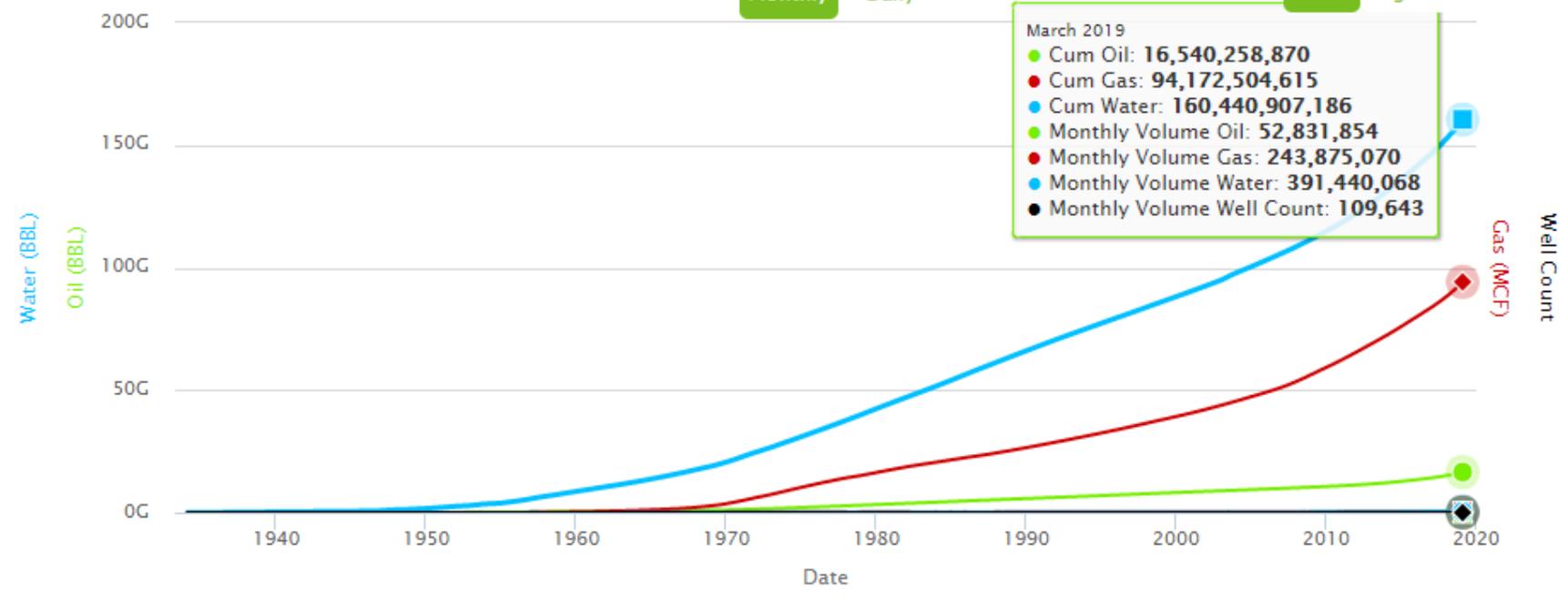
Historical Production

Click and drag in the plot area to zoom in

Monthly Daily Linear Logarithmic

March 2019

- Cum Oil: 16,540,258,870
- Cum Gas: 94,172,504,615
- Cum Water: 160,440,907,186
- Monthly Volume Oil: 52,831,854
- Monthly Volume Gas: 243,875,070
- Monthly Volume Water: 391,440,068
- Monthly Volume Well Count: 109,643



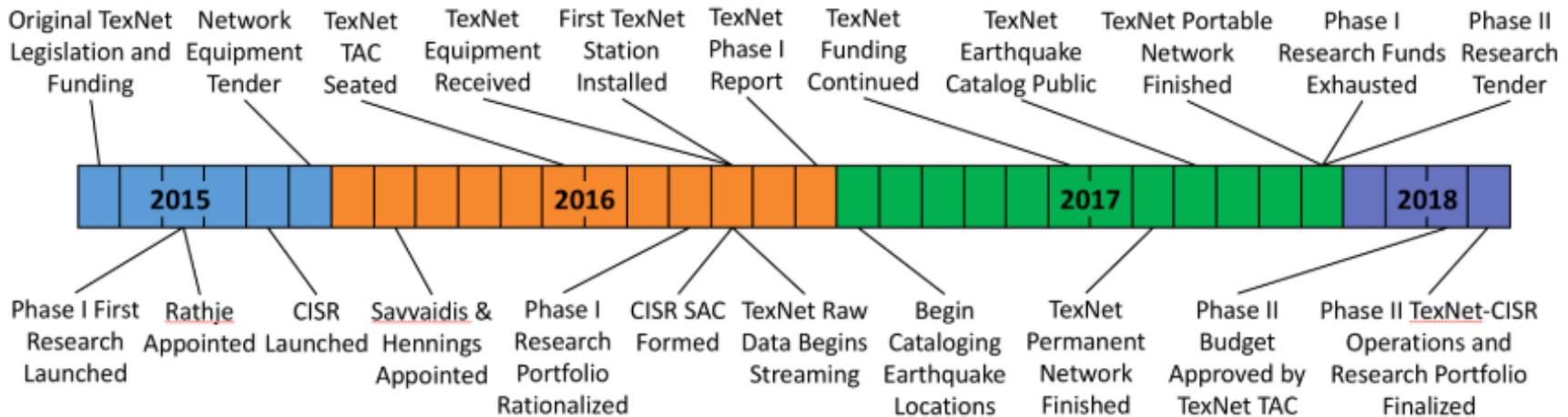
Cum Oil Cum Gas Cum Water Oil Gas Water Well Count

Seismicity news over the past year: TexNet and the Center for Integrated Seismicity Research (CISR) working together to better understand the issues with production, injection and seismicity of the SWS. The main concept behind the research is to better differentiate natural seismicity vs induced. Funds and efforts started in 2015 and are in full support today. SWD permits are more difficult to get approved by the RRC as operators in certain areas have to report and integrate the seismic studies into their permit process. This has been a very impressive program so far, integrating a lot of data and good geology. We need to be very cautious with assumptions and interpretations and it's in our best interest to identify these criteria as well as identifying the data points that lead to them. For reference: <http://www.beg.utexas.edu/texnet-cisr> and https://scits.stanford.edu/sites/default/files/3702_tss_lundsnee_v2.pdf

Active research areas include:

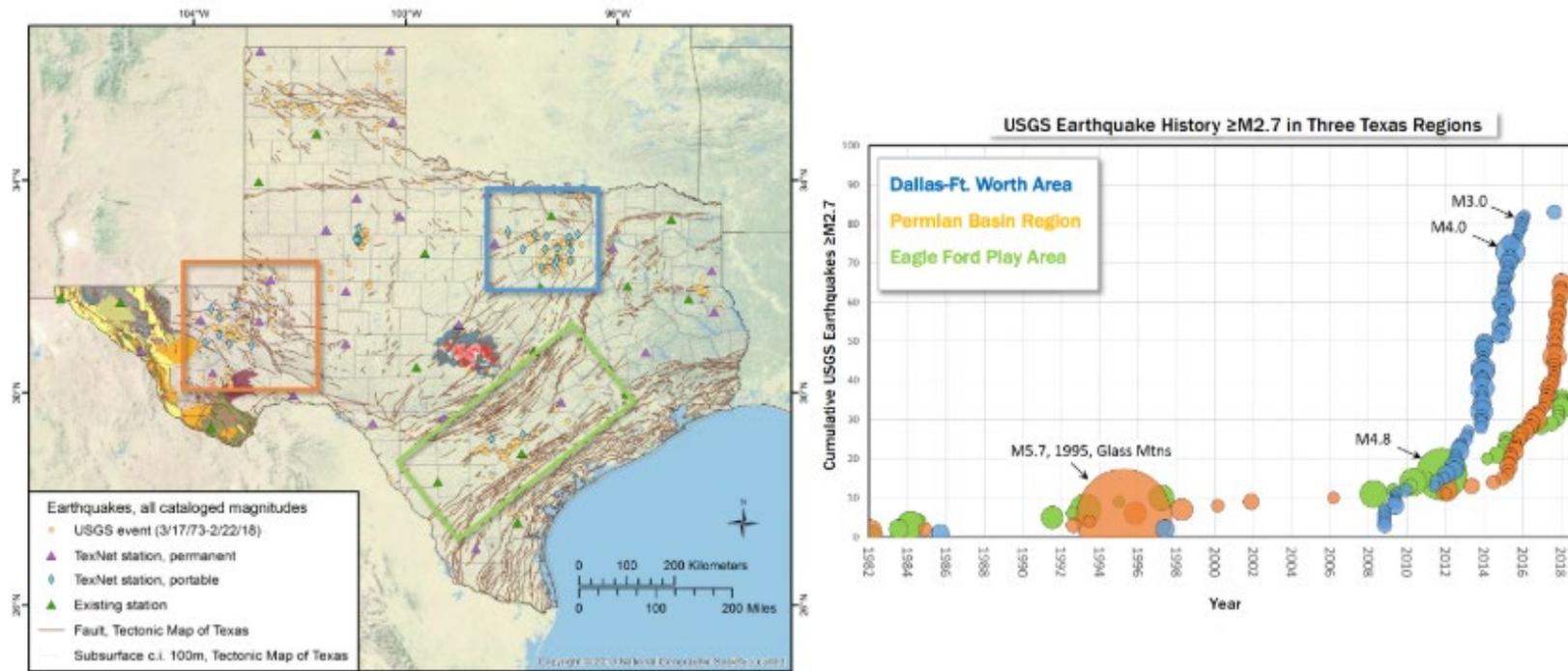
- Seismicity Monitoring and Cataloging
- Seismological Analysis
- Subsurface Geological Characterization
- Fluid Flow and Pore Pressure Modeling
- Hazard and Risk Assessment
- Integrated Analyses
- Information Dissemination

TexNet-CISR Timeline June 2015 - April 2018



“The figure below shows the history of earthquakes in key areas of Texas as cataloged by the USGS. The cumulative graph shows the rate of earthquakes of magnitude of 2.7 and higher.”

Earthquake Trends in Key Texas Operational Areas



The research collaboration is broad spanning:

- Texas Bureau of Economic Geology (numerous groups)
- UT Department of Civil, Architectural and Environmental Engineering
- UT Institute for Geophysics
- UT Department of Petroleum and Geosystems Engineering
- SMU Department of Earth Sciences
- Texas A&M Department of Petroleum Engineering
- University of Houston Department of Earth and Atmospheric Sciences
- University of Texas at Dallas Department of Geosciences
- Southwest Research Institute
- Stanford Center for Induced Seismicity Research
- Golder Associates

It's important to have a good working relationship between all of the entities noted above and the AAPG.

TexNet-CISR Organization

Governor – Legislature

| Technical Advisory Committee | | |
|------------------------------|---------------|--------------|
| Robie Vaughn (Chair) | Dana Jurick | Dan Hill |
| Chris Hillman | Hal Macartney | Brian Stump |
| Aaron Velasco | Kris Nygaard | Scott Tinker |

Bureau Directorate Scott Tinker, Michael Young

TexNet-CISR Research
 Peter Hennings, PI Subsurface Integration and Industry Liaison
 Ellen Rathje, PI Earthquake Hazard and Risk
 Alexandros Savvaidis, PI Seismology and TexNet Manager

CISR Science Advisory Committee

| SAC Representative | Organization |
|-----------------------|----------------|
| Peter Hennings | UT-BEG |
| Ellen Rathje | UT-CAEE |
| Alexandros Savvaidis | UT-BEG |
| Cody Comiskey | Anadarko |
| Cal Cooper | Apache |
| Rongmao Zhou | BHP |
| Jeff Nunn | Chevron |
| Michael DeShazer | Cimarex |
| Seth Busetti | ConocoPhillips |
| Rod Gertson | Devon |
| Robert Kidney | EOG |
| Tim Tyrell | ExxonMobil/XTO |
| Klaas Koster | Occidental |
| Kevin Woller | Pioneer |
| Ulrich Zimmer | Shell |
| Tony Lupo | SM-Energy |
| Beatriz Garcia-Fresca | StatOil |

TexNet Seismic Network
Alexandros Savvaidis^B
Bissett Young^B
 Caroline Breton^B
 Poe Chen^B
 Greg Stephens^B
 Stephany Whittaker^B
RSA Seismologist TBD^B
Clay Templeton^B
 Patricia Martonne^B

Seismology
 Alexandros Savvaidis^B
Seismologist RA TBD^B
Dino Huang^B
 Cliff Frohlich^I
 Jake Walter^I
 Ellen Rathje^C
 Heather DeShon^S
Louis Quinones^{S,2}
Paul Ogwarj^{S,1}
Oner Sufri^{S,1}
 Aibing Li^H
 Hejun Zhu^D

Geologic Characterization
Peter Hennings^B
Casee Lemons^B
 Katie Smye^B
 Robin Dommissie^B
 Lily Horne^B
 Chris Zahm^B
 JP Nicot^B
Rebecca Gao^B
 Guin McDade^B

Geomechanics and Reservoir Modeling
Reservoir Eng TBD^B
 Jon Olson^P
Mohsen Babazadeh^{P,2}
 Peter Eichhubl^B
Mahdi Haddad^{B,1}
 Zhiqiang Fan^{B,1}
 Akhil Datta-Gupta^T
 Michael King^T
 Jihoon Kim^T
Rongqiang Chen^T
 Xu Xue^T
 Jaeyoung Park^T
 Hyun Yoon^T

Seismic Hazard and Risk Assessment
 Ellen Rathje^C
Jason Grigoratos^{C,2}
 Brady Cox^C
Michael Yust^{C,2}
 Patricia Clayton^C
Jennifer Kurkowski^{C,3}

^B Bureau of Economic Geology
^I UT Institute for Geophysics
^P UT Petroleum Geosystems and Engineering
^C UT Civil, Arch, and Envir Engineering
^T Texas A&M Petroleum Engineering
^S SMU Seismology
^H University of Houston Seismology
^D University of Texas at Dallas
¹Post Doc ²PhD student ³MS student
 gray = transitioning out of TexNet-CISR
 underlined = ~full-time TexNet-CISR



Program Coordinator Margo Grace^B

TexNet-CISR Research Matrix

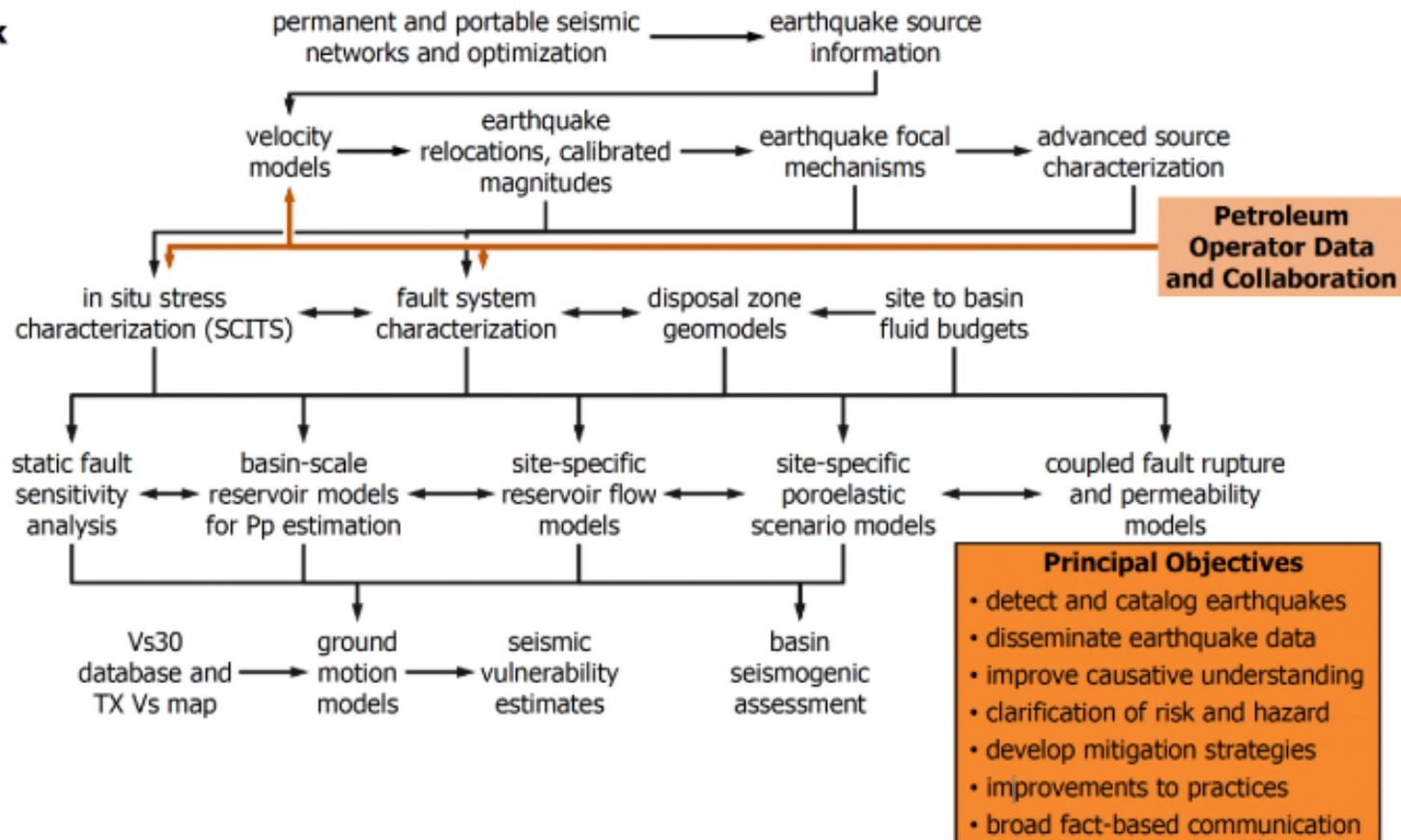
TexNet Network

Seismology

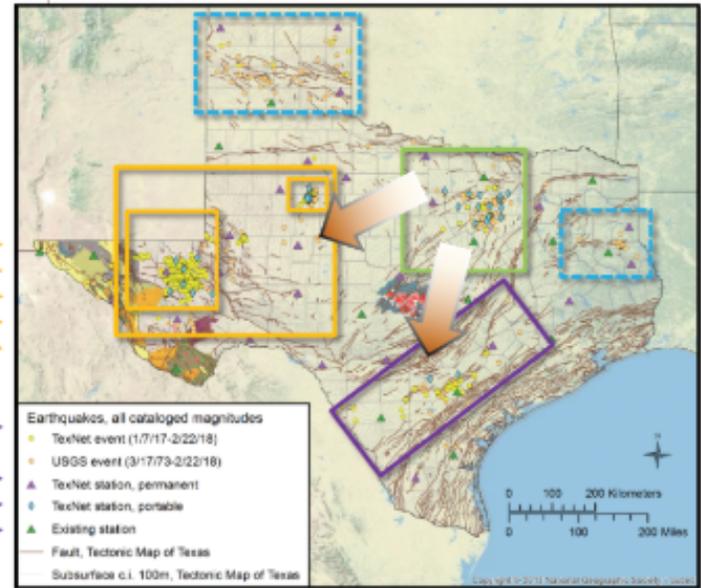
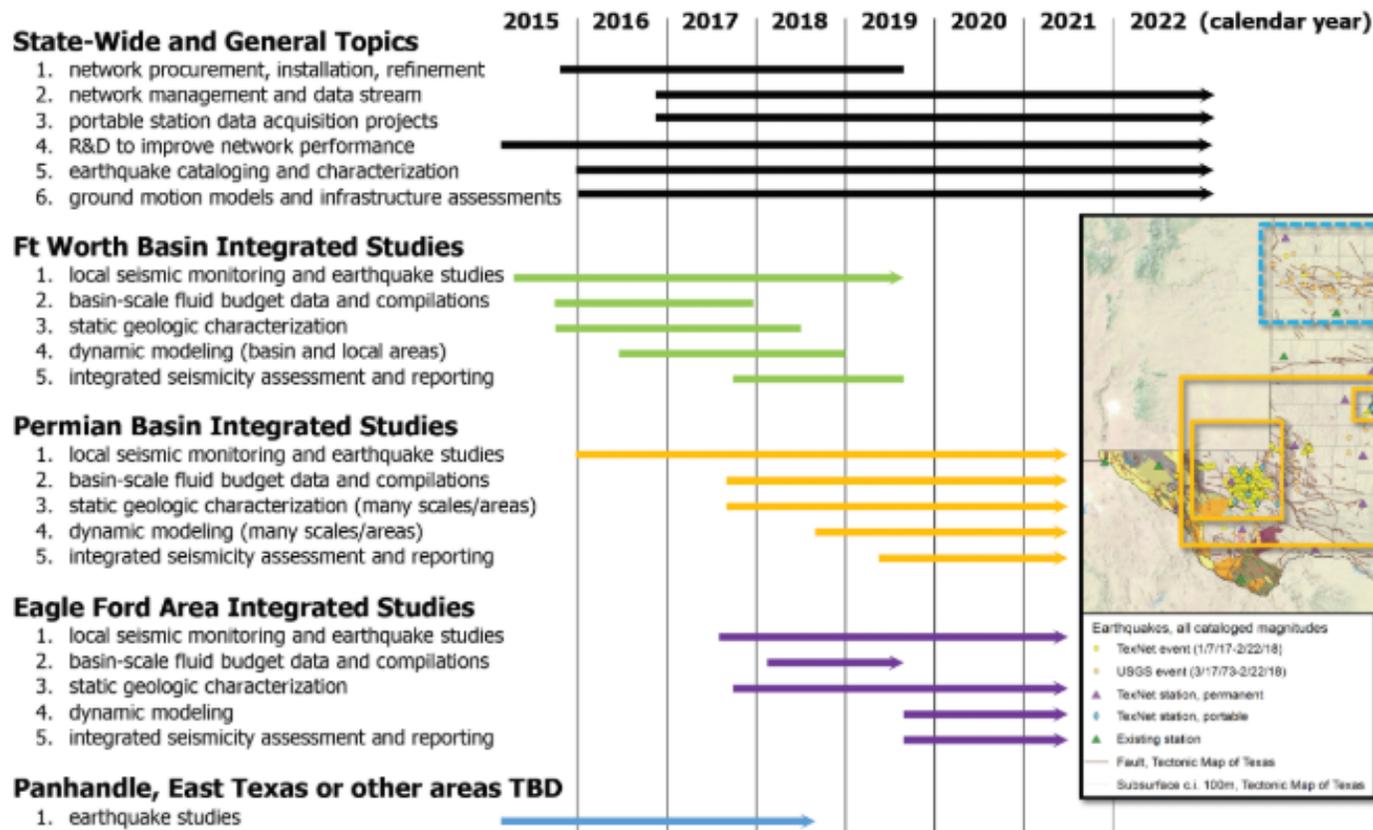
Geologic and Hydrogeologic Description

Geomechanics and Reservoir Modeling

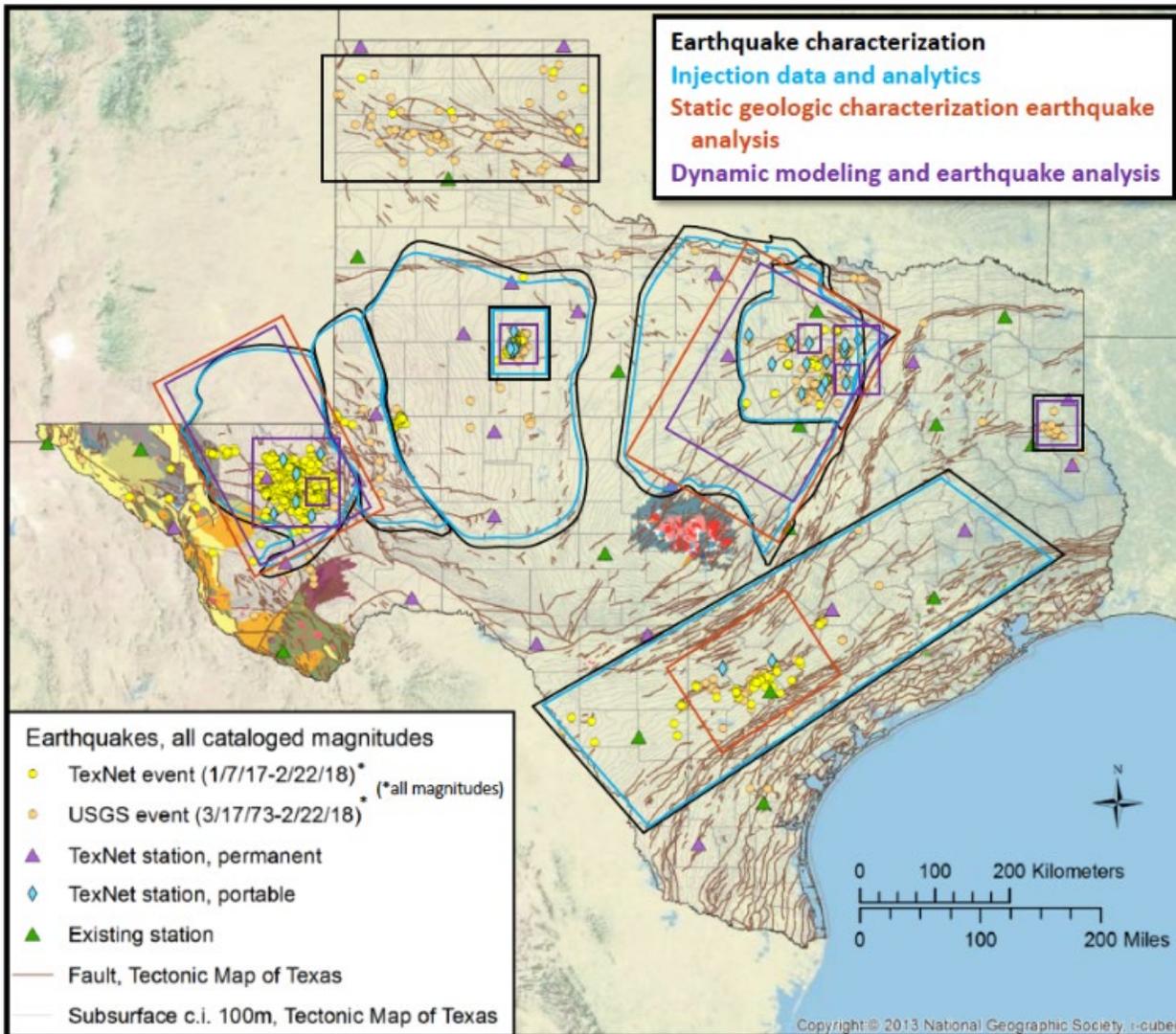
Seismic Hazard and Risk Assessment



Geographic Timing of Operations and Research Emphases

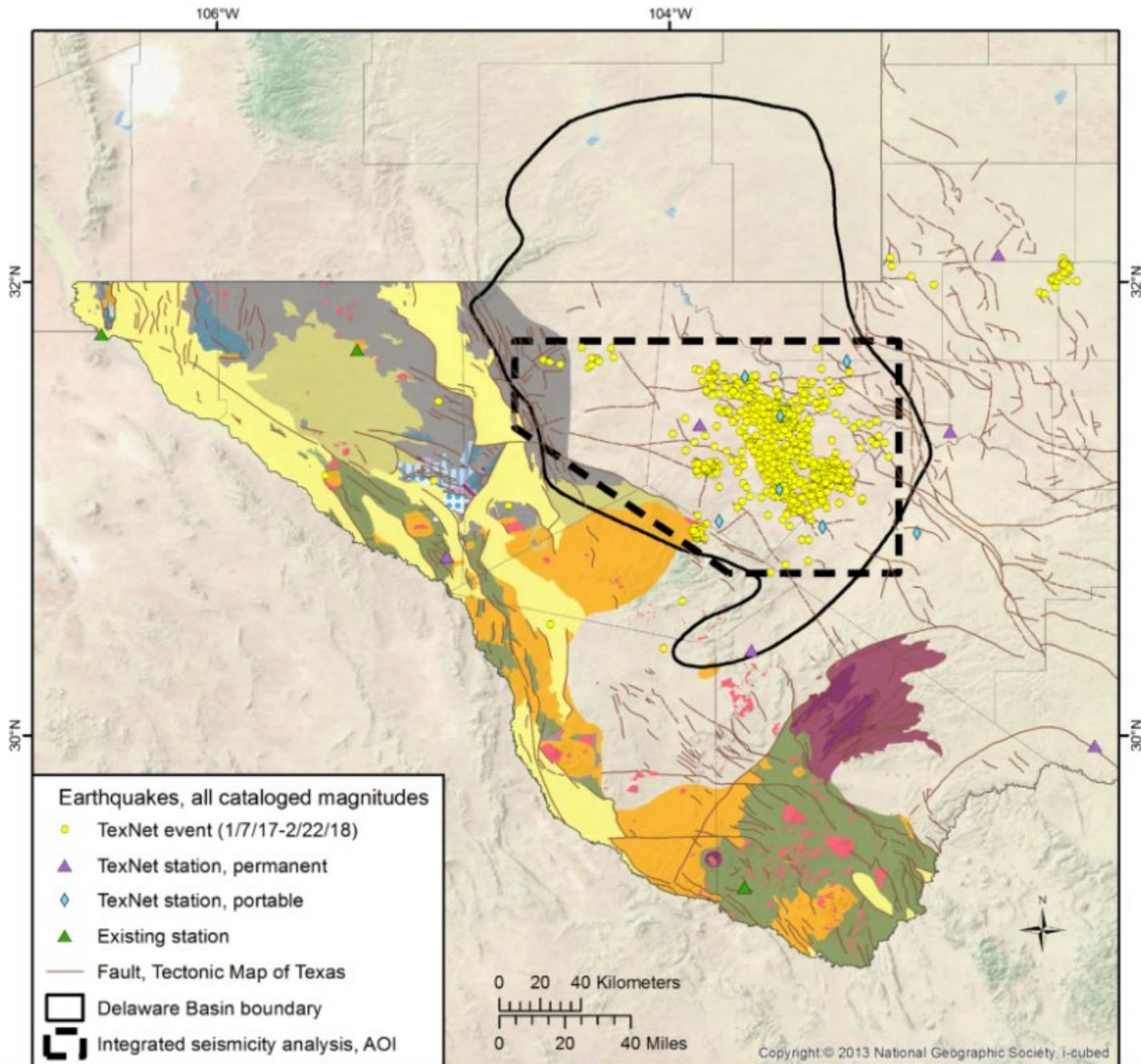


Integration Footprint of TexNet-CISR Project Areas



As this topic becomes more and more apparent around Texas, what does it mean? Our ability to better understand the seismicity and its importance on the future of our industry could be better supported and highlighted by the AAPG. Drilling and plans to exploit the basin are not slowing down, but are most likely being held back by commodity prices. It's now the time we should be studying and developing a safe plan forward as we prepare for ramping up drilling and producing in the Permian Basin. The work and results up to this point are incredibly impressive and detailed. We must continue to be involved and supportive of the work being done.

TexNet-CISR Southern Delaware Basin Integration AOI



Significant News for oil and gas drilling in the Permian Basin over the past year:

April, 2018 – “Admiral Permian Resources Closes Acquisition of 59,000 Net Acres in West Texas” <https://www.marketwatch.com/press-release/admiral-permian-resources-closes-acquisition-of-59000-net-acres-in-west-texas-2018-04-23>

May, 2018 – “Permian Growth Is Reaching Its Limits” <https://oilprice.com/Energy/Energy-General/Permian-Growth-Is-Reaching-Its-Limits.html>

June, 2018 – “Apache: The Most Undervalued Permian Producer?” <https://seekingalpha.com/article/4182937-apache-undervalued-permian-producer>

July, 2018 – “How EOG Uses Data To Stay Ahead Of The Crowd In Shale” <https://www.investors.com/research/the-new-america/eog-resources-shale-production/>

Aug, 2019 – “Cimarex Has Value As Huge Permian Wells Increase Oil Output” <https://seekingalpha.com/article/4200036-hartstreet-cimarex-value-huge-permian-wells-increase-oil-output>

Sept, 2018 – “SandRidge Energy Concludes Strategic Review Process and Will Move Forward with Company Development and Growth Plan” <https://www.prnewswire.com/news-releases/sandridge-energy-concludes-strategic-review-process-and-will-move-forward-with-company-development-and-growth-plan-300710020.html>

Oct, 2018 – “Marketed: ConocoPhillips Operated Permian Properties, Ector County, Texas” <https://www.hartenergy.com/news/marketed-conocophillips-operated-permian-properties-ector-county-texas-118370>

Nov, 2018 – “Encana announces strategic combination with Newfield Exploration Company” <https://www.encana.com/news-stories/news-releases/details.html?release=17221>

Dec, 2018 – “USGS: Permian's Wolfcamp is largest potential oil and gas resource ever assessed” <https://www.houstonchronicle.com/business/energy/article/USGS-Permian-s-Wolfcamp-is-largest-potential-oil-13447556.php>

Jan, 2019 – “Cloudy Outlook For Well Stimulation?” <https://www.hartenergy.com/exclusives/cloudy-outlook-well-stimulation-31683>

Feb, 2019 – “Shareholders sign off on \$7.7 billion Encana, Newfield merger” <https://newsok.com/article/5622743/shareholders-sign-off-on-77-billion-encana-newfield-merger>

March, 2019 — “Texas oil production fell in January as pipeline bottlenecks prompted cutbacks” <https://www.worldoil.com/news/2019/3/31/texas-oil-production-fell-in-january-as-pipeline-bottlenecks-prompted-cutbacks>

April, 2019 – “Chevron to buy Anadarko in \$33B mega deal” <https://www.chron.com/business/energy/article/Chevron-to-buy-Anadarko-in-33B-mega-deal-13762129.php>

May, 2019 – “Chevron bid `dead' after Buffett backs Occidental, investor says” <https://www.bloomberg.com/news/articles/2019-04-30/chevron-bid-dead-after-buffett-backs-occidental-investor-says>

Submitted – Troy Tittlemier
Southwest Section Councilor – EMD
TroyTittlemier@gmail.com