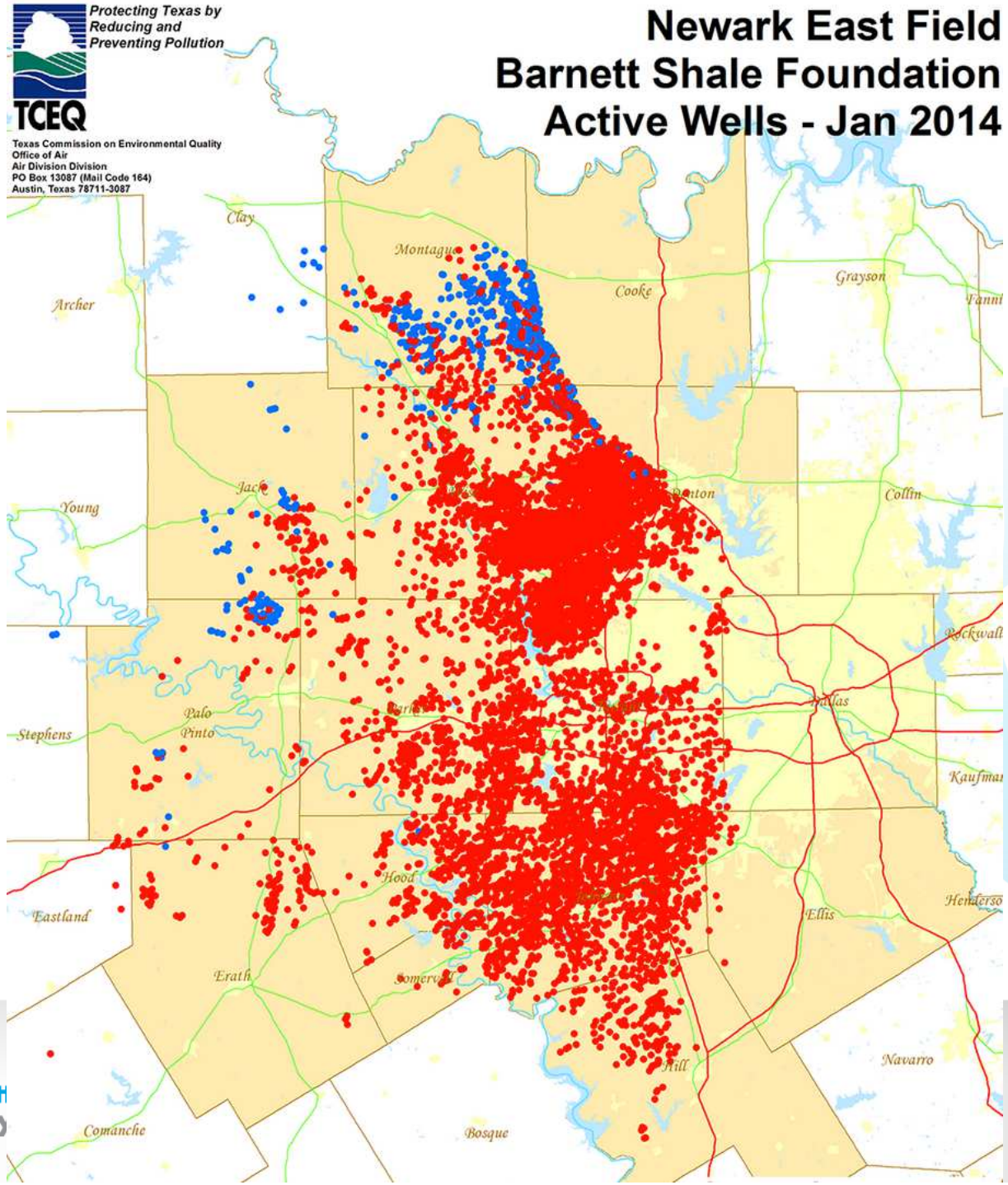
What's Shaking in the Barnett Shale?

STEP Dallas, August 11, 2015

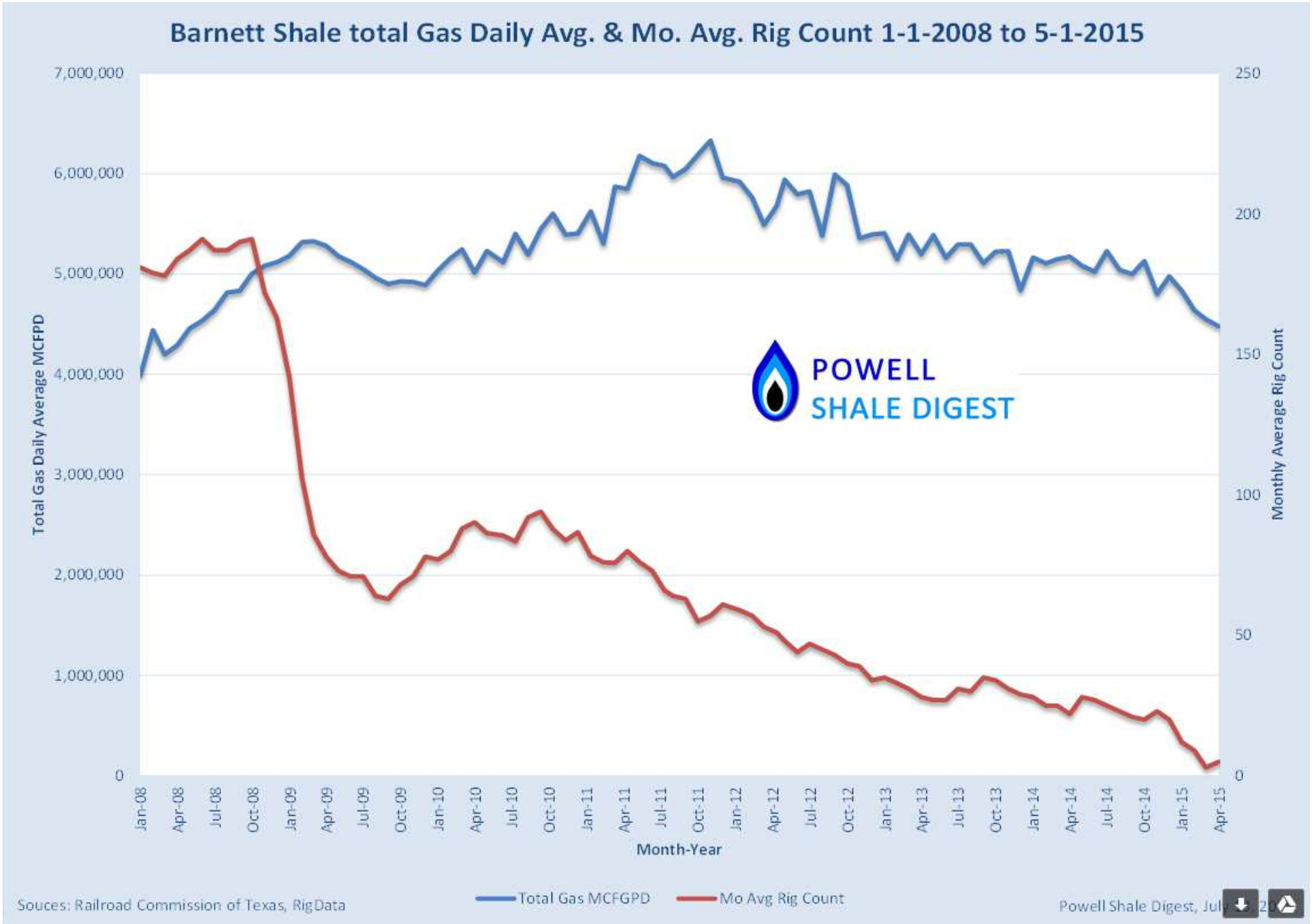
BSEEC.org @BSEEC

Barnett Shale
Energy Education Council


Protecting Texas by Reducing and Preventing Pollution
TCEQ
Texas Commission on Environmental Quality
Office of Air
Air Division Division
PO Box 13087 (Mail Code 164)
Austin, Texas 78711-3087
Newark East Field
Barnett Shale Foundation
Active Wells - Jan 2014
Clay
Montague
Cooke
Grayson
Archer
Jack
Young
Denton
Collin
Rockwall
Palo Pinto
Stephens
Dallas
Kaufman
Hood
Eastland
Ellis
Henderson
Erath
Somervell
Hill
Navarro
Comanche
Bosque

Barnett Shale Facts

- The Barnett Shale was the first energy shale to be developed and therefore is the birthplace of the shale energy revolution. Hydraulic fracturing combined with horizontal drilling are the miracle technologies that made it happen.
- The Barnett Shale covers 25 counties and 5,000 square miles in North Texas, an area which has a population of over 5 million people.
- Over 20,000 wells, mostly horizontal natural gas wells, have been drilled since 2002.
- This drilling and producing activity is a major economic engine in North Texas and the State of Texas.


Barnett Shale total Gas Daily Avg. & Mo. Avg. Rig Count 1-1-2008 to 5-1-2015
Total Gas Daily Average MCFPD
Monthly Average Rig Count
Month-Year
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
250
200
150
100
50
0
Jan-08
Apr-08
Jul-08
Oct-08
Jan-09
Apr-09
Jul-09
Oct-09
Jan-10
Apr-10
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Jan-14
Apr-14
Jul-14
Oct-14
Jan-15
Apr-15
POWELL
SHALE DIGEST
Souces: Railroad Commission of Texas, RigData
Total Gas MCFGPD
Mo Avg Rig Count
Powell Shale Digest, Jul

Technology

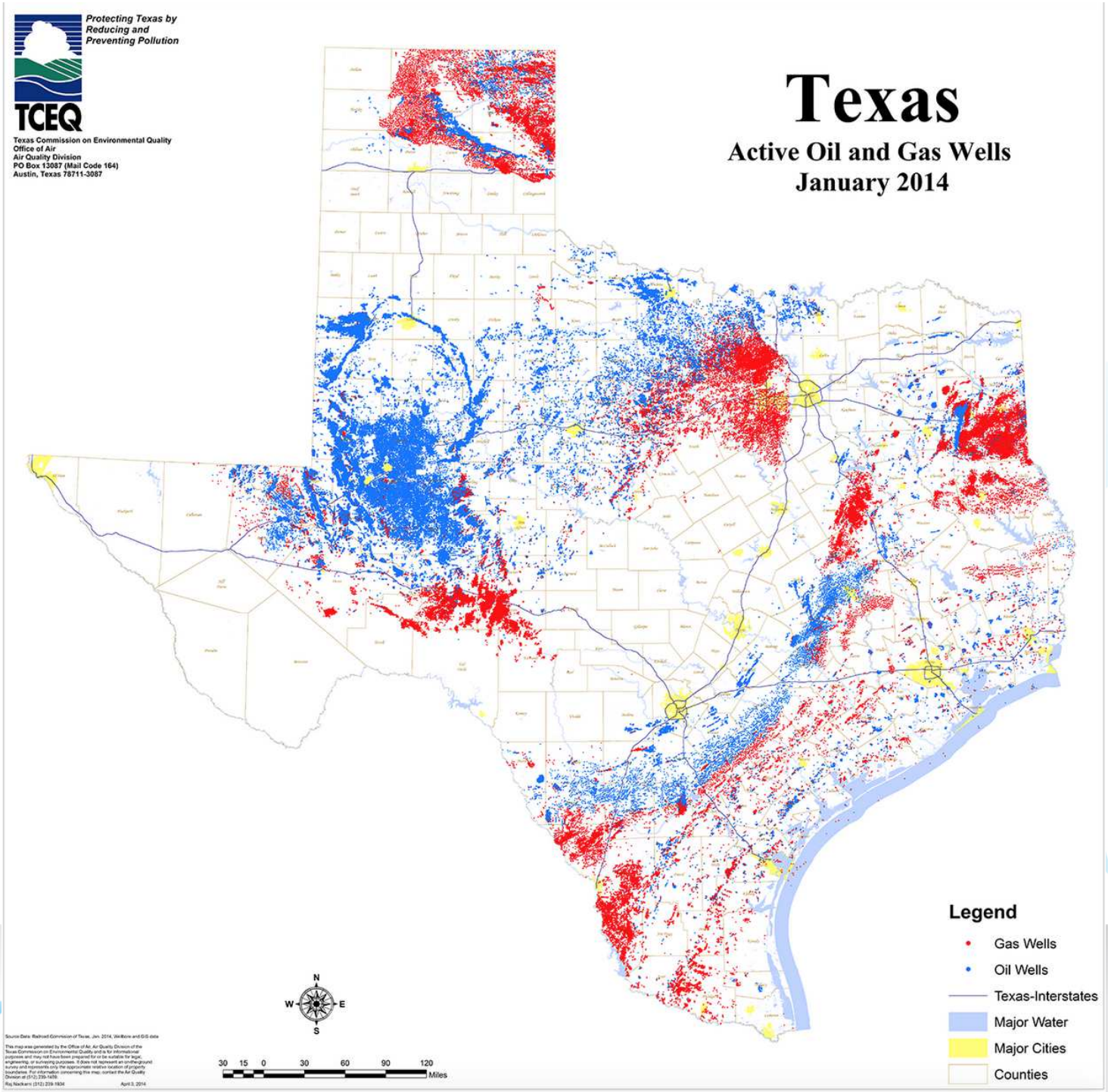
- The relatively stable production in the Barnett Shale shows that oil and gas is a technologically driven industry.
- Barnett Shale wells that were classified as “monster wells” years ago are now the norm.
- It is also interesting to note that the greatest technological gains historically come during periods of low energy prices.

Economic Impacts of the Barnett Shale: Perryman Study

- Current gains in business activity and tax receipts related to the Barnett Shale
  - $11.8 billion
  - More than 107,650 permanent jobs
- This economic activity generates annual tax receipts of $480.6 million to the local government entities, including cities, counties, and school districts and $644.7 million to the State of Texas
- Approximately 86% of the output and 84% of the jobs are concentrated in four “core” counties: Tarrant, Denton, Johnson and Wise

Thanks to hydraulic fracturing:

- These economic benefits are being replicated all over the United States.
  - Total economic benefits of oil and gas activities in the U. S., including multiplier effects, are estimated to include almost $1.2 trillion in gross product each year and more than 9.3 million permanent jobs.
  - When ripple effects throughout the economy are included, oil and natural gas exploration and production supports nearly 7% of the U.S. economy.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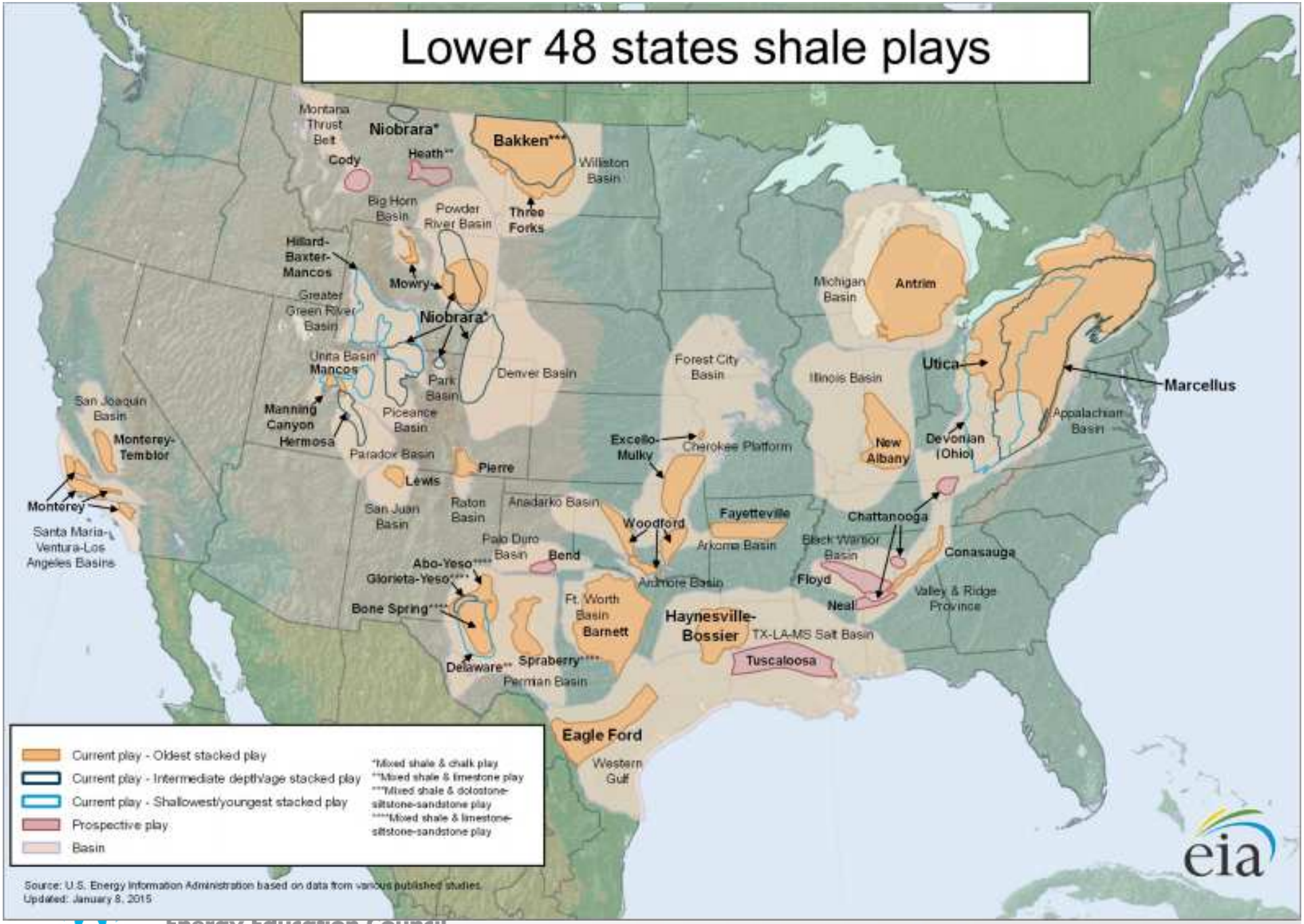
Texas
Active Oil and Gas Wells
January 2014
Legend
Gas Wells
Oil Wells
Texas-Interstates
Major Water
Major Cities
Counties
N
W
E
S
30 15 0 30 60 90 120
Miles


Lower 48 states shale plays
Montana Thrust Belt
Niobrara*
Bakken***
Cody
Heath**
Williston Basin
Big Horn Basin
Powder River Basin
Three Forks
Hilliard-Baxter-Mancos
Mowry
Greater Green River Basin
Niobrara*
Michigan Basin
Antrim
Utica
Marcellus
Uinta Basin
Mancos
Park Basin
Denver Basin
Forest City Basin
Illinois Basin
San Joaquin Basin
Manning Canyon
Hermosa
Piceance Basin
Appalachian Basin
Monterey-Temblor
Paradox Basin
Excello-Mulky
Cherokee Platform
New Albany
Devonian (Ohio)
Pierre
Lewis
Monterey
San Juan Basin
Raton Basin
Anadarko Basin
Fayetteville
Chattanooga
Santa Maria-Ventura-Los Angeles Basins
Woodford
Palo Duro Basin
Bend
Arkoma Basin
Black Warrior Basin
Conasauga
Abo-Yeso****
Glorieta-Yeso****
Ardmore Basin
Floyd
Bone Spring****
Ft. Worth Basin
Barnett
Haynesville-Bossier
TX-LA-MS Salt Basin
Valley & Ridge Province
Neal
Tuscaloosa
Delaware**
Spraberry****
Permian Basin
Eagle Ford
Western Gulf
Current play - Oldest stacked play
Current play - Intermediate depth/age stacked play
Current play - Shallowest/youngest stacked play
Prospective play
Basin
*Mixed shale & chalk play
**Mixed shale & limestone play
***Mixed shale & dolostone-siltstone-sandstone play
****Mixed shale & limestone-siltstone-sandstone play
Source: U.S. Energy Information Administration based on data from various published studies
Updated: January 8, 2015
eia

A Whole Lot is Shaking in the Barnett Shale

Barnett Shale
Energy Education Council

A whole lot is shaking in the Barnett

- Denton banned hydraulic fracturing, Nov. 4, 2014
- TXOGA and GLO files suits challenging ban, Nov. 5, 2014
- Mansfield drilling ordinances updates, March 23, 2015
- SMU study of Azle 2013-2014 earthquakes, April 21, 2015
- HB 40 becomes law, May 18, 2015
- UTA study of water wells, June 16, 2015
- Environmental Defense Fund methane emissions studies, July 7, 2015
- EPA Clean Power Plan Final Rule, August 3, 2015

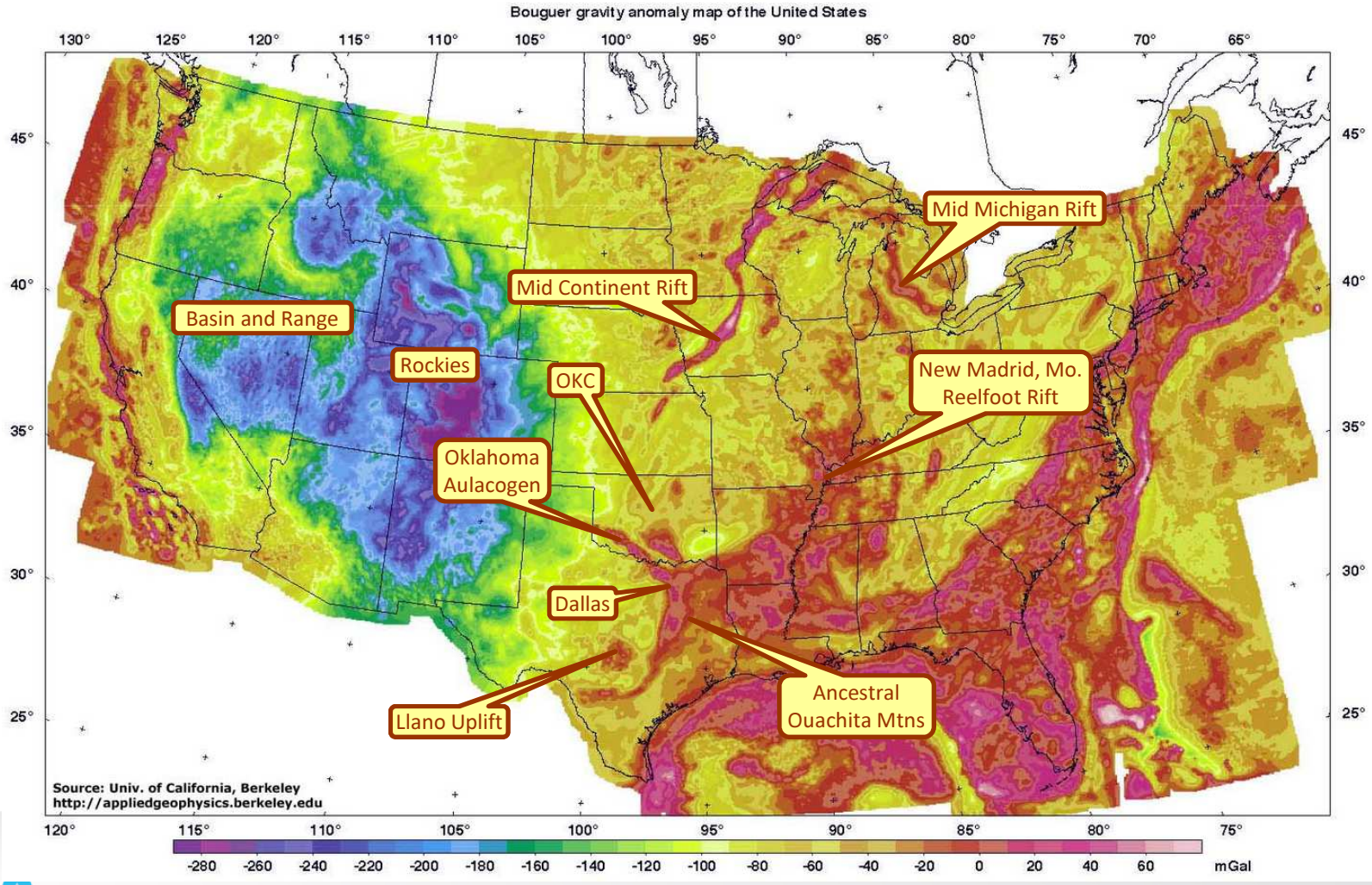
Seismic Activity

Recent Earthquake activity across US

Contact Information:
U.S. Department of the Interior, U.S. Geological Survey
Office of Communications and Publishing
12201 Sunrise Valley Dr, MS 119
Reston, VA 20192

earthquake.usgs.gov/earthquakes/states/texas/images/Texas-seis.pdf

US Gravity Map



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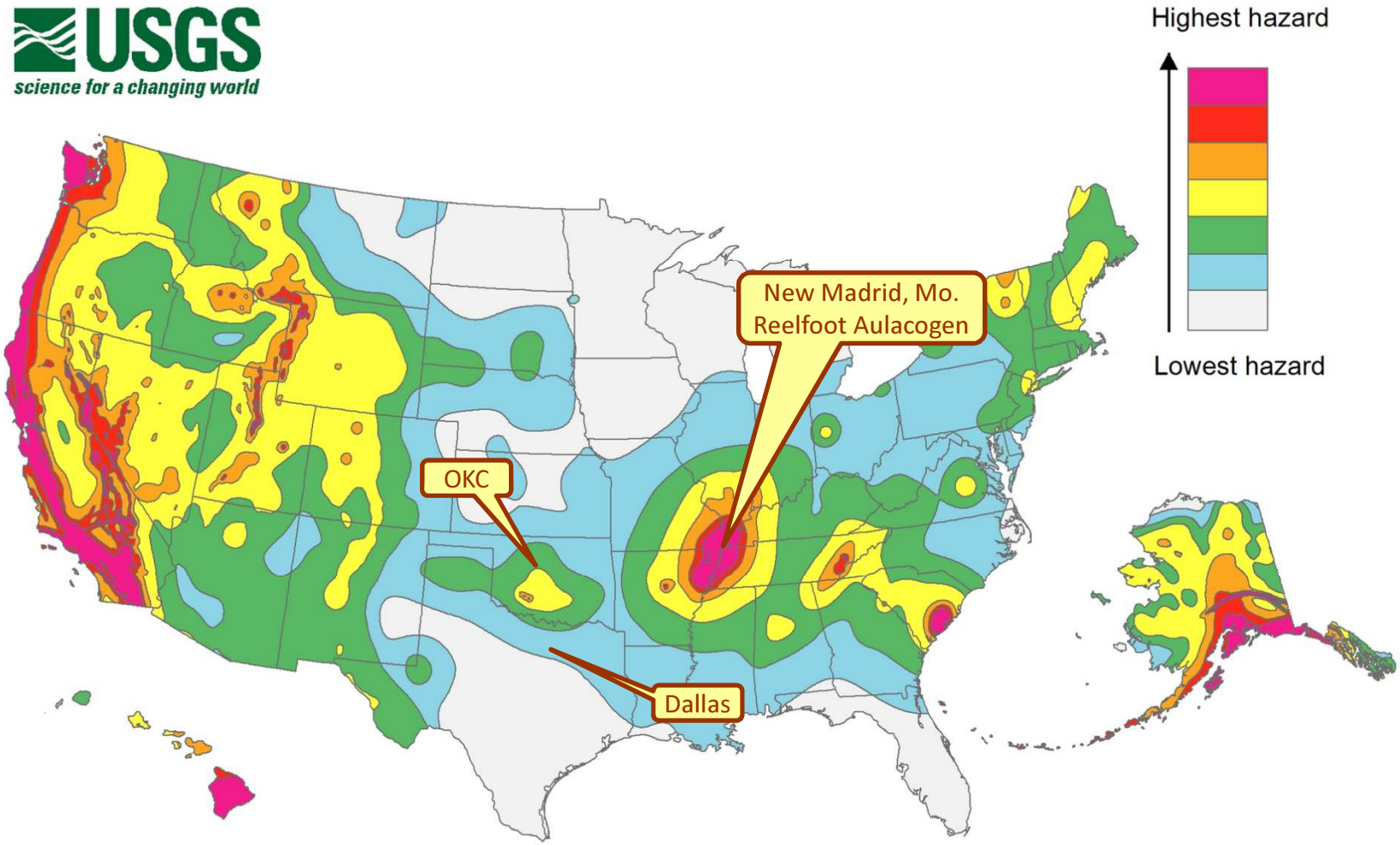
USGS Earthquake Hazard Map



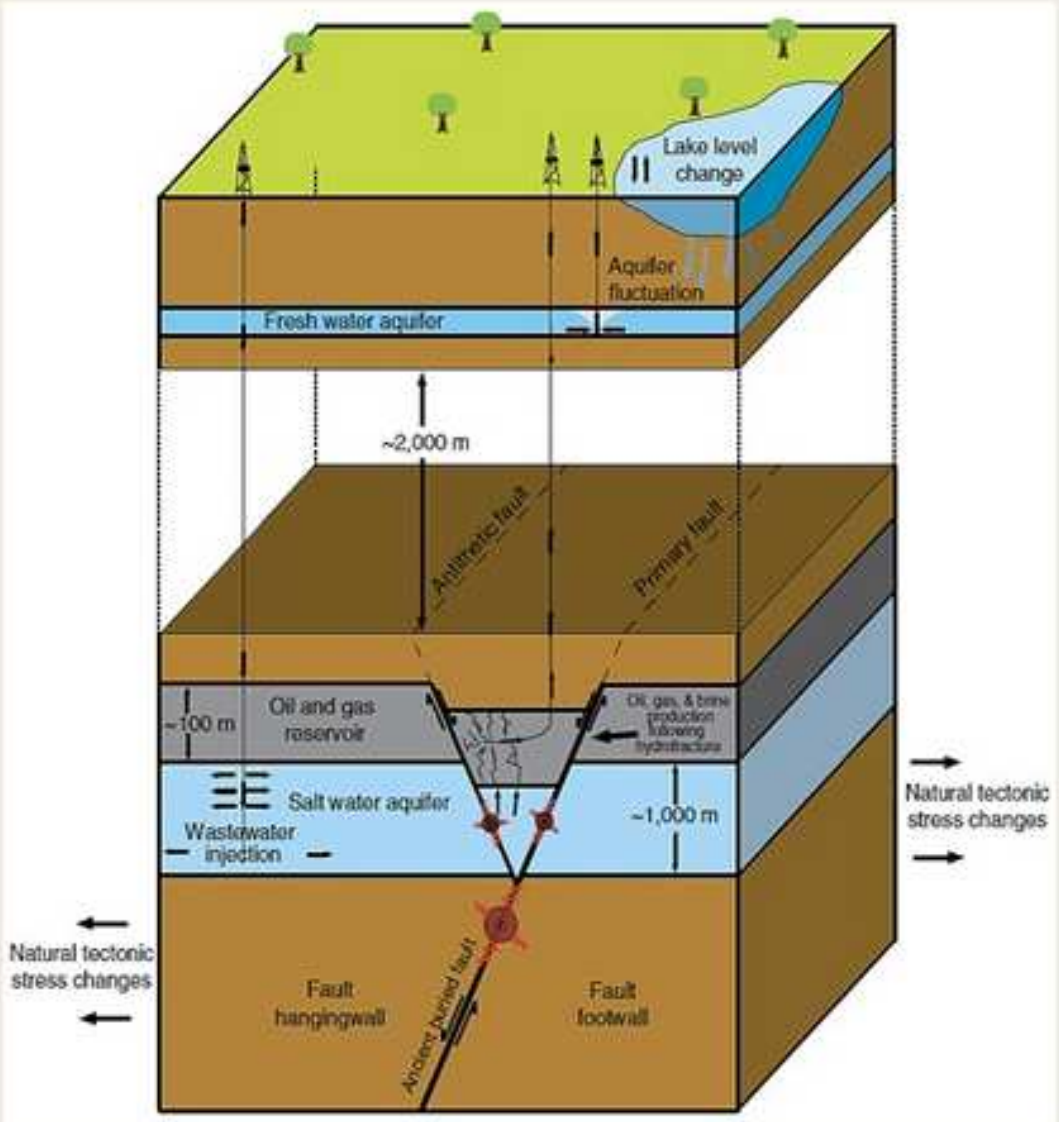
SMU Study of Azle Seismic Activity from 2013-2014

- "Seismic activity began in Nov. 2013 along a mapped ancient fault system near Azle, Texas"
- "On the basis of modeling results and the absence of historical earthquakes near Azle, brine production combined with wastewater disposal represent the most likely cause of recent seismicity."

SMU Study of Seismic Events near Azle, Texas

- "The model shows that a pressure differential develops along one of the faults as a combined result of high fluid injection rates to the west and high water removal rates to the east."
- "When we ran the model over a 10-years period through a wide range of parameters, it predicted pressure changes significant enough to trigger earthquakes on faults that are already stressed."
- "Model-predicted stress changes on the fault were typically tens to thousands of times larger than stress changes associated with water level fluctuations caused by the recent Texas Drought."

Natural and man-made stress changes that cause earthquakes



Natural and anthropogenic stress changes that may trigger earthquakes in the Azle area. Several natural and anthropogenic (man-made) factors can influence the subsurface stress regime resulting in earthquakes. Read more in the full report.

SMU Azle Seismic Study

- “Tens of thousands of currently active injection wells apparently do not induce earthquakes or at least not earthquakes large enough to be felt or recorded by seismic networks.”
- The paper noted that seismic activity and potential correlations need to be assessed carefully since most wastewater injection activities have no connection to seismicity.

EnerVest Geophysicist Exposed a Major Flaw in the SMU Study

- Analysis showed that the larger seismic sequence began deeper than 20,000 feet below the surface.
- The smaller events identified by SMU's monitors began in the Ellenburger formation which at about 8,000 ft.
- The largest recorded earthquake was a magnitude 3.6, which occurred on Dec. 8, 2013, or several days before SMU's local monitoring network was in place.

Other Comments

- EnerVest spokesman said the SMU team modeled the wrong fault, and used a groundwater model of a closed system that did not account for dual porosity and permeability in the Ellenberger formation, where EnerVest injected wastewater.
- Andree Griffin, XTO's Vice President of Geology and Geophysics, said "it looks to me like we're in a period of natural tectonism," which is causing earthquakes in Irving, Azle and other areas in north Texas.
- Google "Earth's tectonic plates have doubled their speed"

Thank You!

Barnett Shale
Energy Education Council