General News

Scientists offer possible explanation for how oil and gas activity may have triggered Dallas earthquakes

By Anna Kuchment

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By Anna Kuchment, Special Contributor

In a long-awaited study, researchers have offered a possible explanation for how oil and gas activity may have triggered earthquakes in Dallas and Irving last year.

The disposal of wastewater from oil and gas production and hydraulic fracturing “plausibly” set off the tremors, which shook Dallas, Irving, Highland Park and other cities from April 2014 through January 2016, said Matthew Hornbach, the study’s lead author and professor of geophysics at Southern Methodist University.

While the quakes were too small to cause much damage to buildings, they spread alarm through a

metro area unaccustomed to feeling the ground shift.

The quakes contributed to a tenfold increase in North Texas' earthquake hazard level, prompted the Federal Emergency Management Agency to warn of stronger quakes that could cause billions of dollars of damage, and moved local emergency managers to begin preparing for worst-case scenarios.

The study, posted online this week in the peer-reviewed journal *Physics of the Earth and Planetary Interiors*, is the first scientific work to offer an explanation for the Dallas and Irving quakes. It also provides new evidence that other recent quakes in North Texas' were likely induced by humans.

Such findings in recent years have prompted pushback from oil and gas companies. This week, through a trade group, they again came out swinging. Steve Everley, a spokesman for an arm of the Independent Petroleum Association of America, questioned the scientists' work. "Were they looking for media attention?" Everley said in an email. "The authors' willingness to shift assumptions to fit a particular narrative is concerning, to say the least."

The state agency that regulates oil and gas, the Railroad Commission, said in a statement that it was reviewing the report "to fully understand its methodology and conclusions."

Independent experts contacted by *The Dallas Morning News* praised the study, while cautioning that more work remains before the cause of the Dallas and Irving earthquakes can be firmly established.

"It's the single best explanation for the increase in earthquakes within the Dallas-Fort Worth basin," said Rall Walsh, a Ph.D. candidate in geophysics at Stanford University who studies human-triggered earthquakes.

Researchers have previously linked three sets of North Texas tremors to wastewater disposal wells: those that began at Dallas Fort/Worth International Airport in 2008; in Cleburne in 2009; and in Azle, northwest of Fort Worth in 2013.

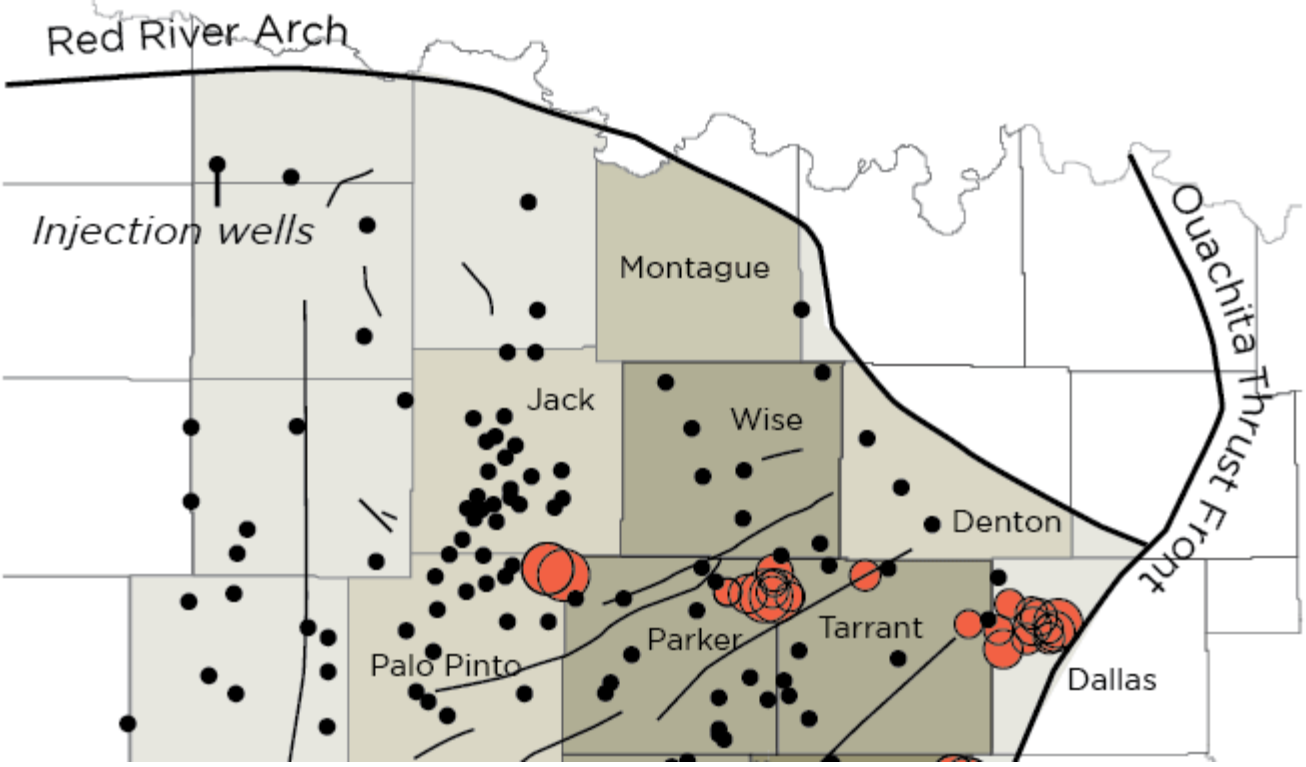
In the new paper, Hornbach and colleagues at SMU and the University of Texas at Austin chart wastewater injection rates across North Texas and estimate how those injections have increased underground pressures over time. Studies going back to the 1960s have shown that elevated pressure from wastewater injections can pry apart faults, causing them to slip and set off earthquakes.

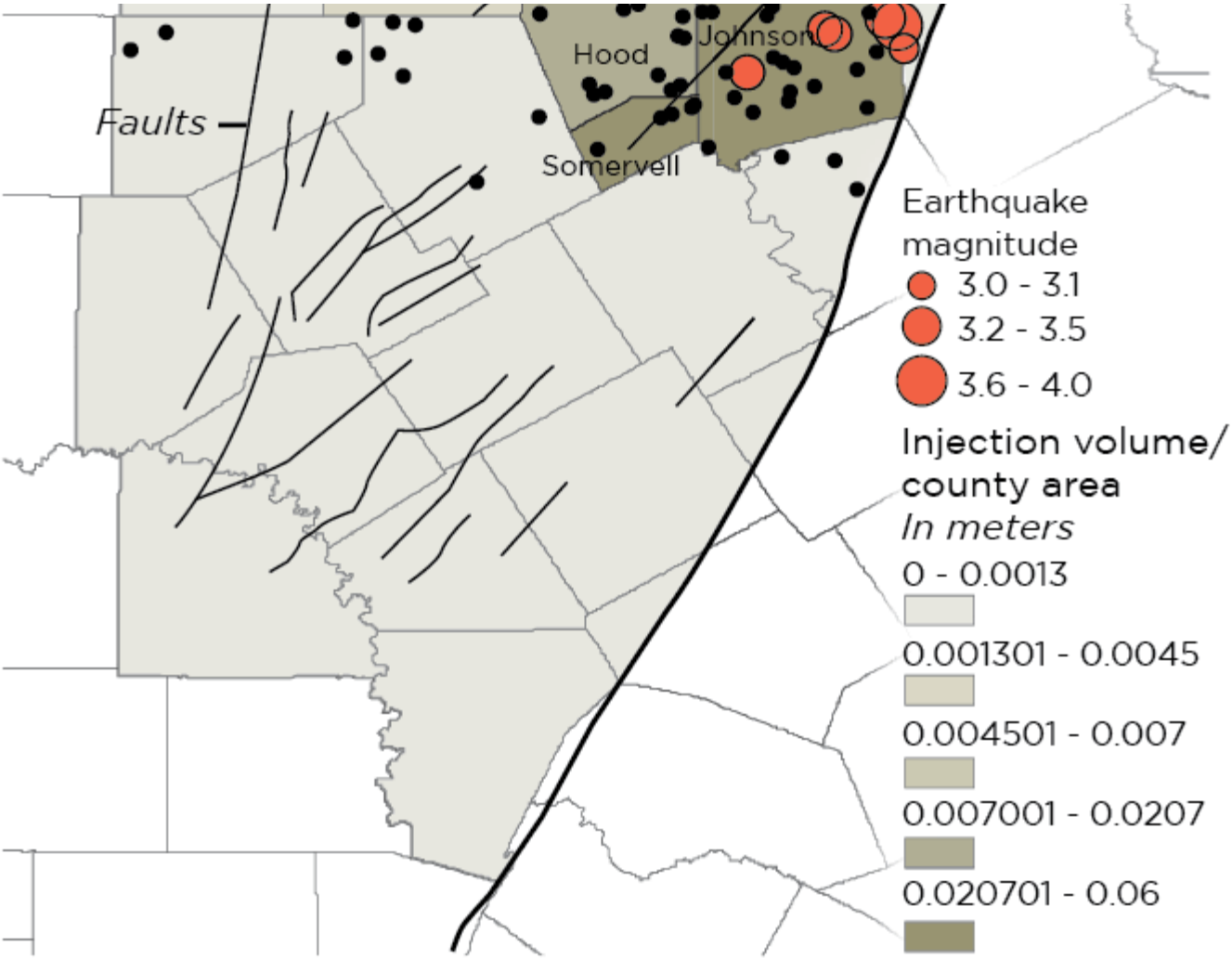
The researchers compared both injection volume and pressure increases with the location and timing of earthquakes and found that they correlated closely. Companies began disposing of wastewater in North Texas in late 2005, and the volumes rose quickly over the next three years.

In 2008, North Texas experienced the first earthquakes ever recorded in the area. As injection volumes grew, so did earthquake rates. Between 2008 and today, North Texas had more than 200 quakes. Between 2005 and 2014, operators injected 1.7 billion barrels of fluid into 167 wells throughout the area. The study estimates that those injections could have raised underground pressures significantly enough to set off the quakes.

Injection volumes

A map showing earthquakes, wastewater injection wells and countywide injection volumes in North Texas. The counties with the highest total injection volumes are, in descending order, Johnson, Somervell, Hood, Parker and Tarrant. Earthquakes have generally occurred in the highest-volume counties and have clustered around the highest-volume wells. The earthquakes in Dallas have been something of an anomaly, but scientists have hypothesized that fluid pressure from neighboring counties may be migrating into Dallas and Irving along faults, which can form "superhighways" for fluids and fluid pressures.





SOURCE: Hornbach et al, 2016, *Physics of the Earth and Planetary Interiors*

Michael Hogue/Staff Artist

“Since Texas is not usually an active earthquake area, that strongly suggests a causal relationship [between earthquakes and wells],” said Susan Hough, a seismologist at the USGS who was not involved in the study. “The fact that the two datasets don't track exactly tells us that the processes are complicated, and more work is needed to understand them.”

Hornbach and his colleagues also found that earthquakes strike disproportionately near high-volume wells — a pattern also seen in Oklahoma, which has the highest rate of human-induced quakes in the country.

Of the 10 largest injection wells, 50 percent have had an earthquake of magnitude 3 or greater within 10 kilometers, or six miles. Of the top 20 wells, 46 percent had 3-magnitude or greater earthquakes within six miles. By contrast, only 6 percent of the remaining 147 lower-volume wells had a 3-magnitude or greater quake near them. These findings build upon previous studies showing that high-volume wells are more likely to trigger quakes and suggest that people who live near them are more likely to experience ground shaking.

“If the rate of earthquakes in a usually quiet area goes up just when injection rates and volumes go up, that tells you something,” said Hough. “If it happens in one area, one time, maybe it's a coincidence. If it happens in different areas multiple times, the possibility of coincidence does not ring true.”

The Dallas earthquakes have intrigued researchers, because they are something of an anomaly. Compared with other North Texas quakes, they struck farther away from wastewater wells — at least 8 miles from the nearest one at Dallas/Fort Worth International Airport — and that well is not a high-volume well. This led many, including Craig Pearson, then the seismologist for the Railroad Commission, to play down any links to industry. “The evidence points to no involvement of oil and gas activities,” Pearson said at a public meeting in January 2015.

At a hearing last summer on the cause of earthquakes in Azle and Reno, energy company executives also argued that the Dallas quakes were likely natural. If the Dallas quakes were natural, they said, then other quake clusters in North Texas could be natural as well.

In the new paper, Hornbach and his colleagues offer a possible explanation for how fluid pressure could have migrated over longer distances — tens of miles — from high-volume wells in Johnson and Tarrant Counties toward Dallas.

Long faults, which are known to cut across North Texas, can serve as fluid “superhighways,” said Hornbach. Moreover, fluid and fluid pressure pool beneath Dallas, because the city sits atop the deepest portion of the Fort Worth Basin — a bathtub-like geological formation that encompasses the natural-gas-rich Barnett Shale and the Ellenburger formation, the deep porous rock into which companies inject wastewater.

“The deepest part of the entire basin sits under Dallas and Irving,” said Hornbach. “So if you’re going to pour water in a bathtub, you can pour it in on this edge or that edge, and, if it’s permeable, it’s going to tend to flow and accumulate at the lowest gravitational point, which is below the cities of Dallas and Irving.”

Peter Hennings, principal investigator of the Center for Integrated Seismicity Research at UT-Austin’s Bureau of Economic Geology (BEG), which brings together academic and industry scientists, said the explanation for the Dallas earthquakes was a “compelling hypothesis” but that more work needed to be done to confirm the findings.

The SMU paper based its estimated pressure increases on a simple model of the subsurface.

Hennings and his group are using public data and information provided by oil and gas companies to build a more complete picture of what takes place below ground.

Soon, they will also have access to data that will be collected by TexNet, the new statewide seismometer network being installed and managed by the BEG and funded by the state. Once researchers study details such as exact fault locations and other underground structures, that could influence conclusions about how fluid pressure builds and how it migrates from wells to potentially sensitive faults. BEG will also investigate why hundreds of disposal wells in the area, and thousands of disposal wells in Texas, are not associated with earthquakes.

Mark Petersen, director of the National Seismic Hazard Mapping Project at the USGS, said he and his colleagues would decide early next year how to incorporate this new study into their work. The USGS has categorized five out of six North Texas earthquake clusters as human-induced but have not yet ruled on Dallas.

Since January 2016, the earthquakes in Dallas and Irving have faded. Hornbach suggests there are two hypotheses that could explain that. First, the accumulated stresses in the faults were likely relieved by the earthquakes. A second explanation is that wastewater disposal volumes could have fallen in neighboring counties.

Railroad Commission data on wastewater disposal volumes was complete only through late 2014 at the time that Hornbach and his colleagues submitted their paper. “I think it would be really interesting to know what the injection volumes have been since late 2014,” he said.

Online data from the Railroad Commission does show that volumes fell since 2014 in at least two wells near the 4-magnitude earthquake that shook Venus, in Johnson County, in May 2015.

What does the future hold for Dallas earthquakes? Hornbach and his colleagues say that if wastewater injections continue at the same rates as in 2008 to 2014, North Texas residents can expect more quakes in Dallas and perhaps to the north, in cities like Denton, as more injectors have come online in this region and pressure from the injections continues to migrate.

In order to stay ahead of the problem, Texas needs to do a better job of monitoring subsurface pressures, say many researchers.

Hornbach and his colleagues have been asking for this type of data from the Railroad Commission for the past few years. In its statement to *The News*, the RRC said, “The commission takes the issue of induced seismicity very seriously and has in place some of the most stringent rules on disposal

wells.”

Staff writer Steve Thompson contributed to this report. Anna Kuchment can be reached at anna.kuchment@gmail.com.

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Employment Rates Reach 40-Year Record High

Carter_Copeland 13 days ago

The "science" is somewhat misleading in the article. The generalizations with regard to the volume injected versus injection pressure gradient versus average reservoir pressures is extremely muddled in the article. The SMU team needs to have some petroleum engineering department participants that offer broader insights than just the geophysical perspectives. Pursuing regional geophysical hypotheses before more basic engineering considerations have been addressed borders on questionable research.

Like Reply

Ken_Marx Jul 25, 2016

Pretty much a no-brainer. Greedy 3rd party disposal companies inject wastewater at rates and pressures that the receiving formation cannot readily absorb. Solution- more disposal wells, lower injection rates.

Like Reply

enerjazz Jul 23, 2016

The science is solid. Any politicians or appointed industry hacks who can't or won't understand should be jettisoned from office for incompetence.

Like Reply

rjhalltech @rjhalltech from Twitter 23 Jul

@KatyBlakeyNBC5 @dallasnews Its been proven for years in other states. Not just plausibly. Unfortunately laws here are controlled by oil.

1 Like Reply

JimSchermbeck Jul 22, 2016

Steve Everley never agrees with the findings of any studies he doesn't pay for.

Like Reply