

Public health impacts of hydraulic fracturing: seismic activity and potential risks

Anne-Marie Nicol, PhD

Helen Ward, PhD



National Collaborating Centre
for Environmental Health

Centre de collaboration nationale
en santé environnementale

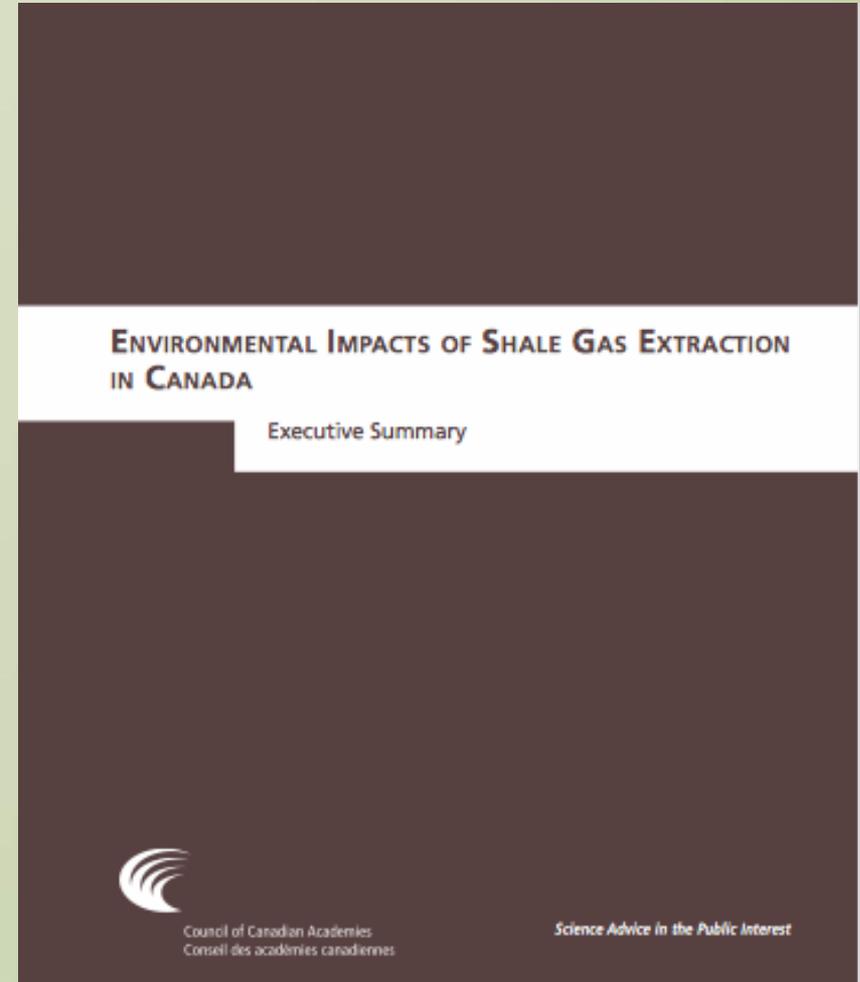


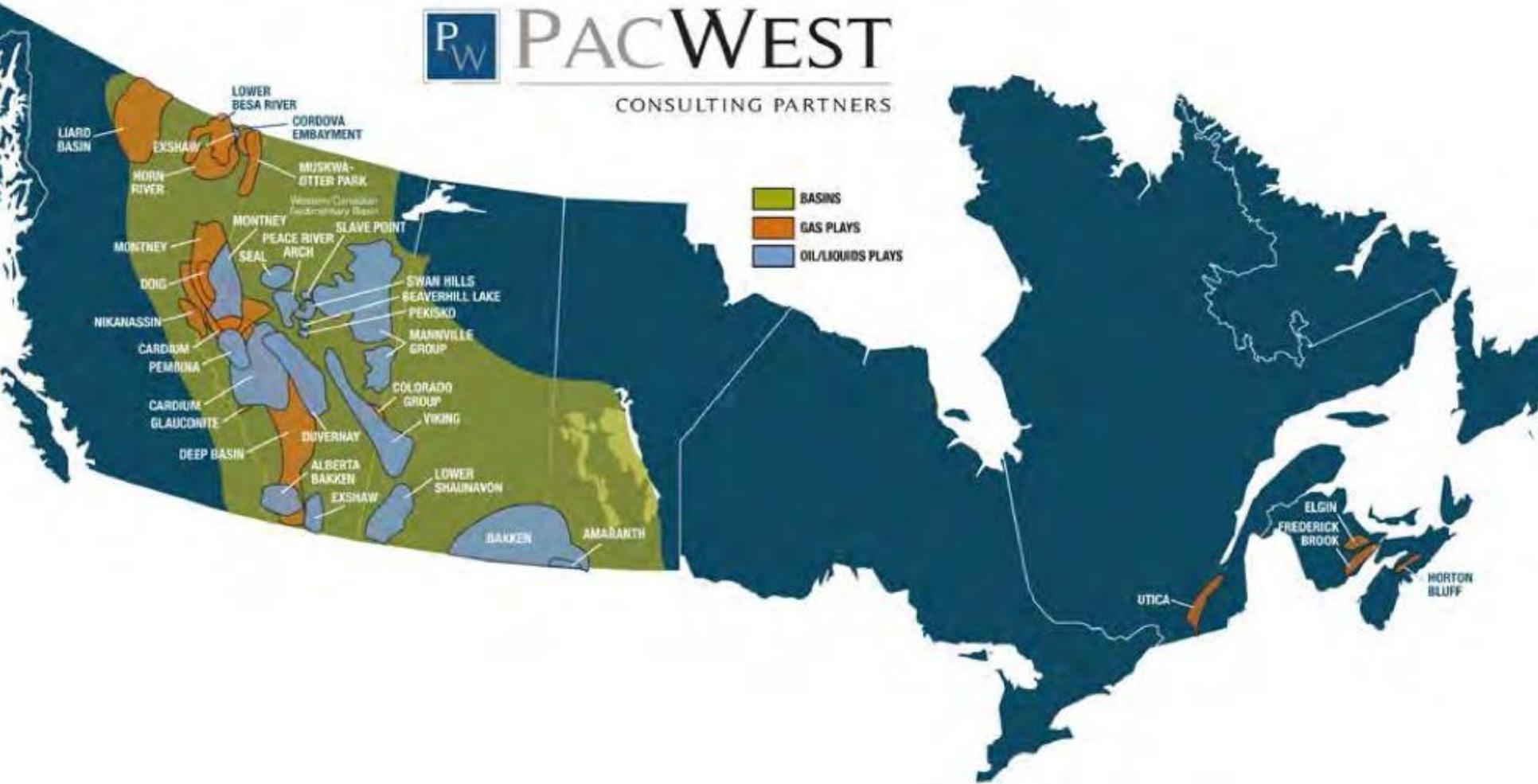
BC Centre for Disease Control
An Agency of the Provincial Health Services Authority

Initial work: Expert Opinion (2014)

Most experts judge the risk of hydraulic fracturing causing earthquakes to be low.

“Micro-seismic monitoring during operations can diminish this risk further. The risk by injection of waste fluids is greater but still low, and can be minimized through careful site selection, monitoring and management”





Active Hydraulic Fracturing for shale gas occurring in BC, AB, SK and Manitoba.
Exploration occurring in Ontario

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Fracking, wastewater-increase raise Ohio's quake

What's causing Texas earthquakes? Fracking 'most likely,' report says

Scientist Say Fracking Earthquakes May Pose Serious Threat



By Chris Lett and Jason
Updated 9:13 AM ET

Fracking and earthquakes: Exploring the connection

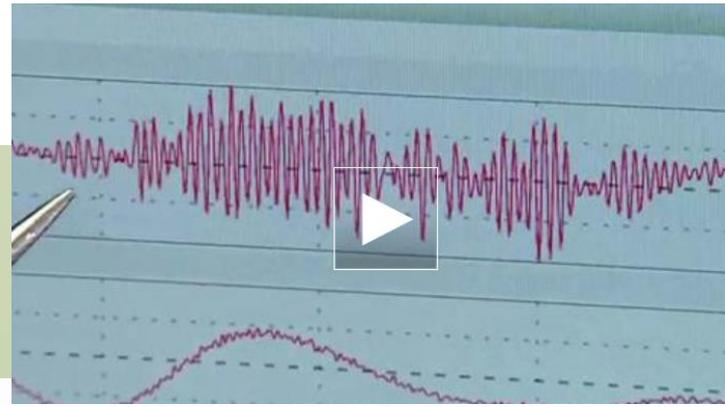
B.C. commission draws link between fracking and 231 seismic events in province

Terry Reith, Briar Stewart **CBC News**

Posted: Apr 16, 2015 3:16 PM ET
Last Updated: Apr 17, 2015 4:26 PM ET

Earthquakes Linked To Fracking Activity Are On The Rise, U.S. Government Says

BY **EMILY ATKIN** POSTED ON APRIL 24, 2015 AT 12:17 PM



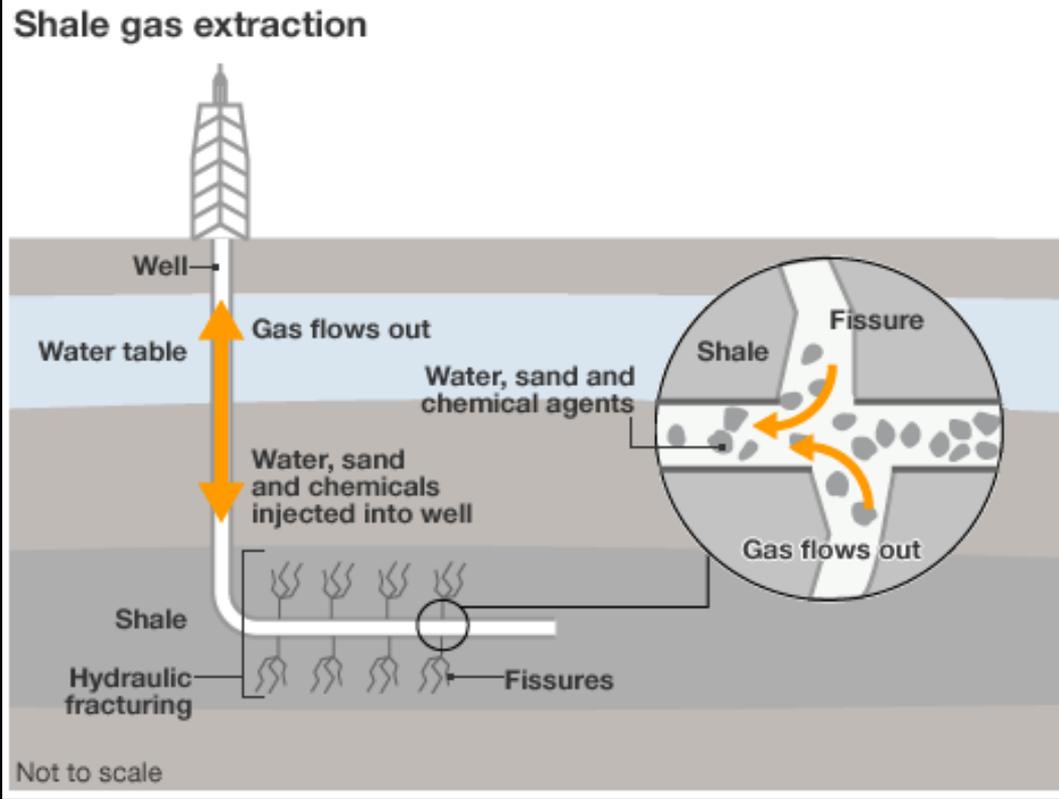
'Swarms' of earthquakes strike Oklahoma

Trevor Hughes 2:47 p.m. EST March 5, 2015

What is Hydraulic Fracturing?

Hydraulic fracturing, “fracking”

- One step in the process of shale gas extraction
- Horizontal drilling used in unconventional oil and gas production
- A mixture of water, proppant and chemicals is pumped under high pressure into the ground
- The fractures are kept open by the proppant



Can HF induce earthquakes?

Yes: Micro-earthquakes (magnitudes <2) are routinely generated

- USA/Canada research has linked HF to (>3 magnitude) earthquakes

How: Slips on dormant or unknown fault can be triggered due to changes in the stress regime and/or increases in pore pressure

Recent BC and Alberta research (2015)

- HF linked to an **increase in the number** of earthquakes, some up to magnitudes 4 – 5
- Earthquakes **continue after HF stops**
- Over time, the **earthquake magnitude in the studied region is increasing**

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ARTICLE

Investigation of regional seismicity before and after hydraulic fracturing in the Horn River Basin, northeast British Columbia

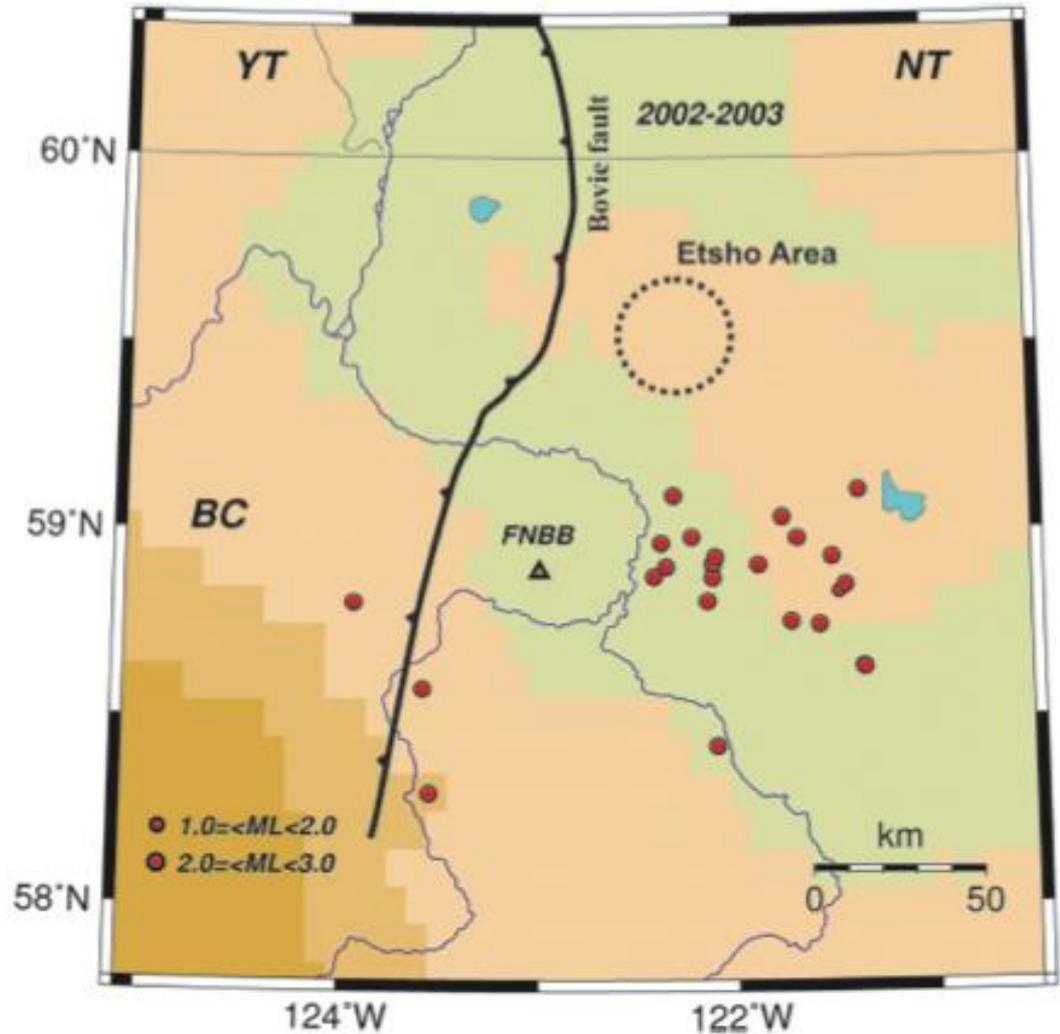
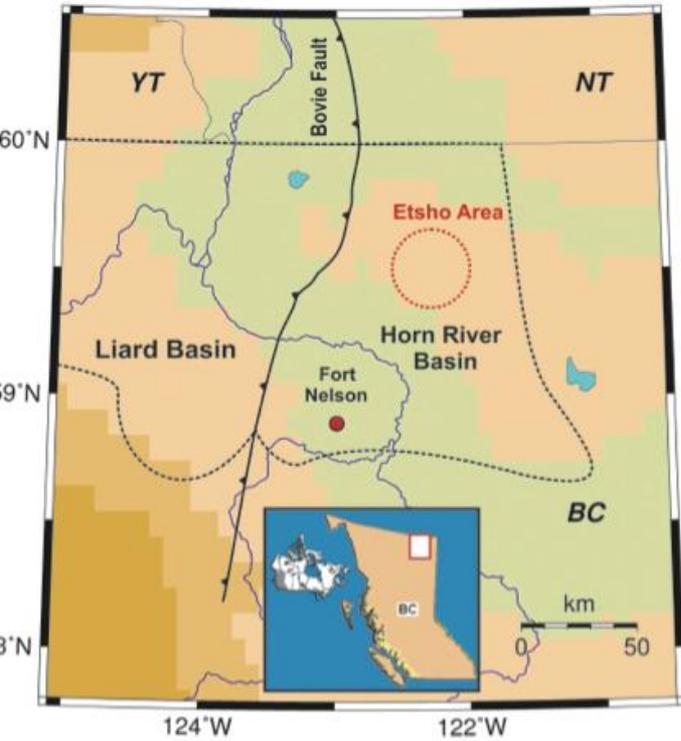
Amir Mansour Farahbod, Honn Kao, Dan M. Walker, and John F. Cassidy

How do we measure earthquakes?

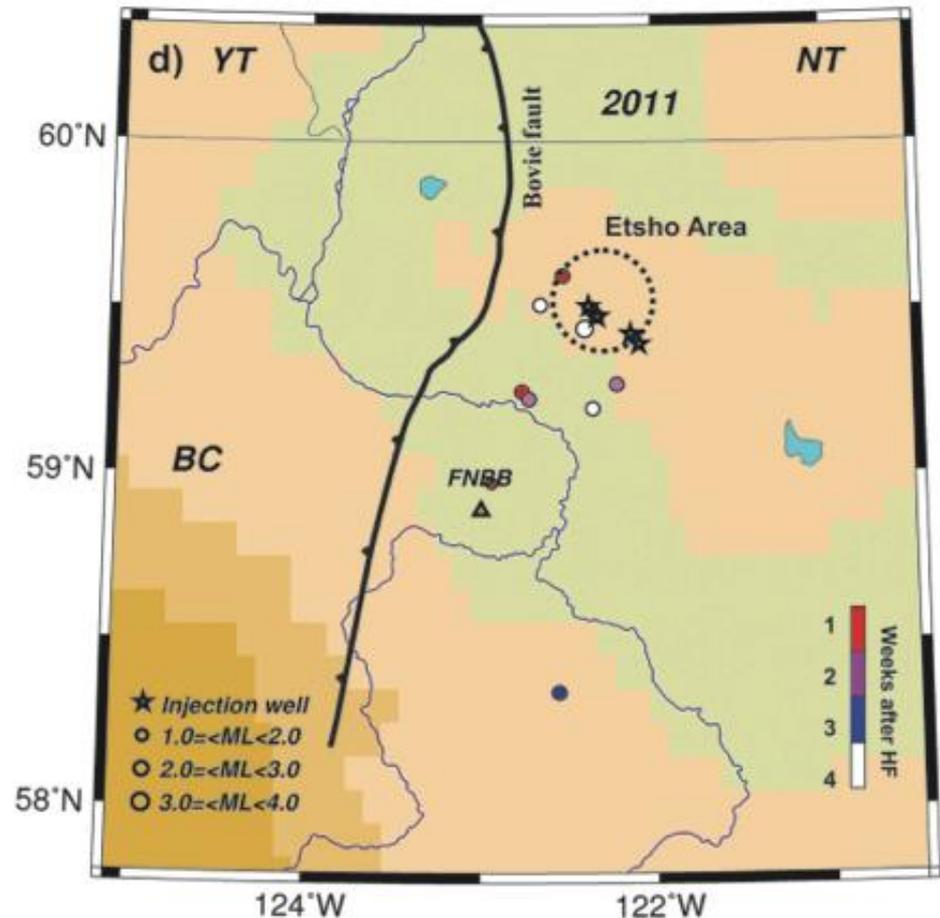
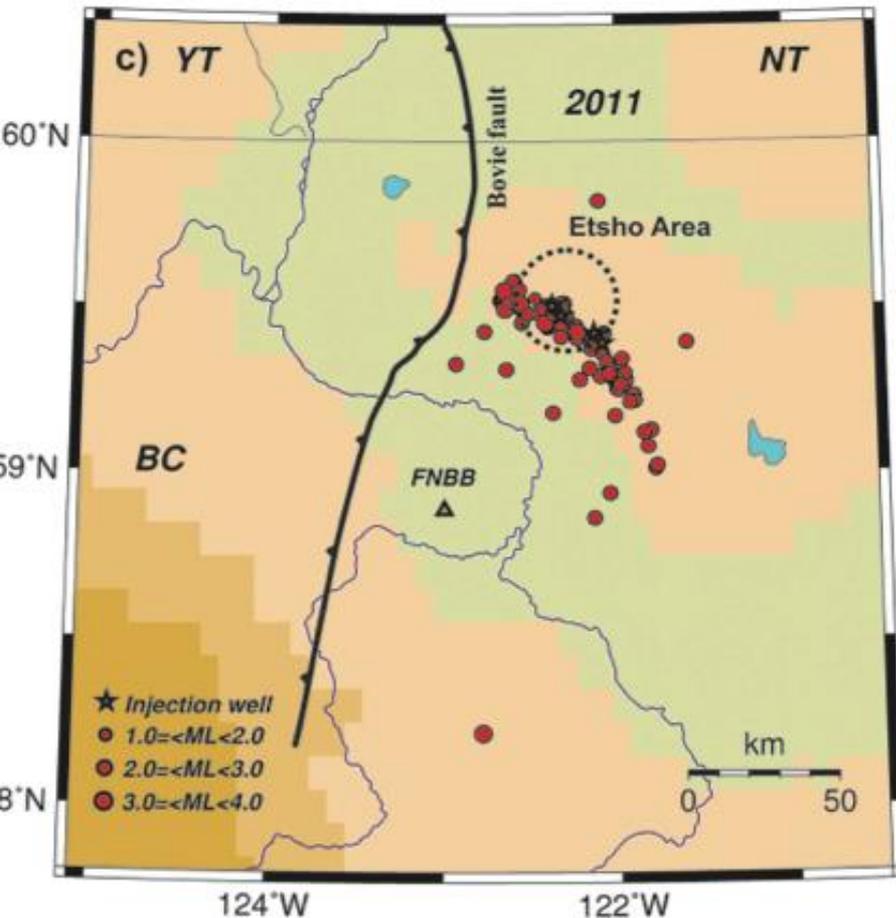
Modified Mercalli Scale vs. Richter Scale

Category	Effects	Richter Scale (approximate)
I. Instrumental	Not felt	1-2
II. Just perceptible	Felt by only a few people, especially on upper floors of tall buildings	3
III. Slight	Felt by people lying down, seated on a hard surface, or in the upper stories of tall buildings	3.5
IV. Perceptible	Felt indoors by many, by few outside; dishes and windows rattle	4
V. Rather strong	Generally felt by everyone; sleeping people may be awakened	4.5
VI. Strong	Trees sway, chandeliers swing, bells ring, some damage from falling objects	5
VII. Very strong	General alarm; walls and plaster crack	5.5
VIII. Destructive	Felt in moving vehicles; chimneys collapse; poorly constructed buildings seriously damaged	6
IX. Ruinous	Some houses collapse; pipes break	6.5
X. Disastrous	Obvious ground cracks; railroad tracks bent; some landslides on steep hillsides	7
XI. Very disastrous	Few buildings survive; bridges damaged or destroyed; all services interrupted (electrical, water, sewage, railroad); severe landslides	7.5
XII. Catastrophic	Total destruction; objects thrown into the air; river courses and topography altered	8

Fig. 6. Background seismicity within 100 km from station FNBB during the period of July 2002 – July 2003. This time window is more than three years before the start of any hydraulic fracturing operations in the Etsho area (dashed circle) of the Horn River Basin. Local earthquakes scattered in the southern part of the Horn River Basin and to the west of FNBB, but no events were detected near Etsho.



- The number of local earthquakes per month during HF days increased from 24 in 2002-3 to 131 in 2011 (Farahbod 2015)
- Average magnitude increased from 2.9 to 3.6
- Rate during non-HF days increased more than 3 times as well. The dramatic variation in earthquake occurrence rate seems to suggest a link to local HF operations.



Ohio

Fracking activities in 2011 linked with 100s of small tremors

- Very few earthquakes recorded in this region previously

More recently, 77 earthquakes (1-3 magnitude) recorded in Poland Country between March 4th and 12th 2014

Comments from Government Officials: THIS IS A PART OF OHIO WHERE WE HAVE OLD INFRASTRUCTURE, WATER SYSTEMS AND SEWERS AND LOTS OF OLD BRICK BUILDINGS. IT IS REALLY NOT SET UP FOR DEALING WITH SEISMICITY, EVEN SMALL SEISMICITY."

« News Home

BREAKING NEWS | ODNR halts shale drilling in Poland after earthquakes

17 Comments Print Email

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Published: Mon, March 10, 2014 @ 3:19 p.m.

POLAND — The Ohio Department of Natural Resources has ordered Hilcorp to halt all operations in Poland Township after two earthquakes shook the area today.

The first occurred at 2:26 a.m. at 40.017 N, 80.537 W at a depth of 1.2 miles in Lowellville, according to the U.S. Geological Survey. USGS initially recorded that quake at a magnitude of 2.8, but later updated it to a 3.0 magnitude.

The epicenter was directly below property owned by Republic Services' Carbon Limestone Landfill, where Hilcorp Energy Co. has one well actively producing and a number of others being drilled.

Deep well injection

Injection wells are a common disposal option for waste water from hydraulic fracturing

- Uses more pressure than fracturing itself
- Injection rate and total volume of injection may be factors

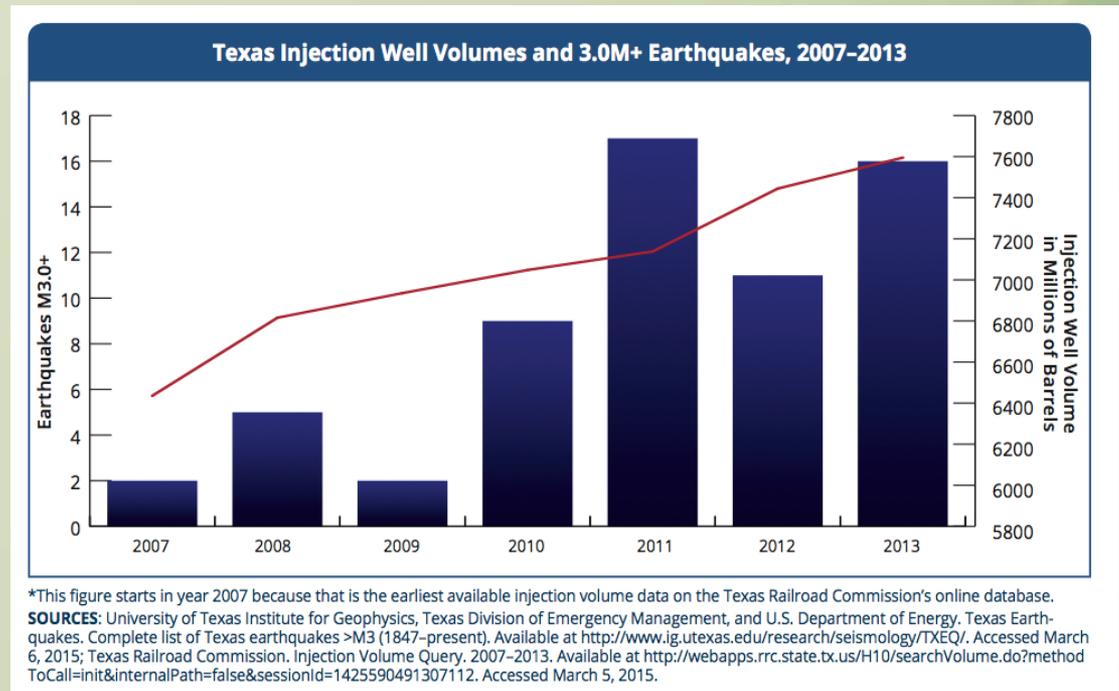
Texas research

8x more quakes

- 2007-2013

Injection volumes

- Increased 18%
- 2007-2013



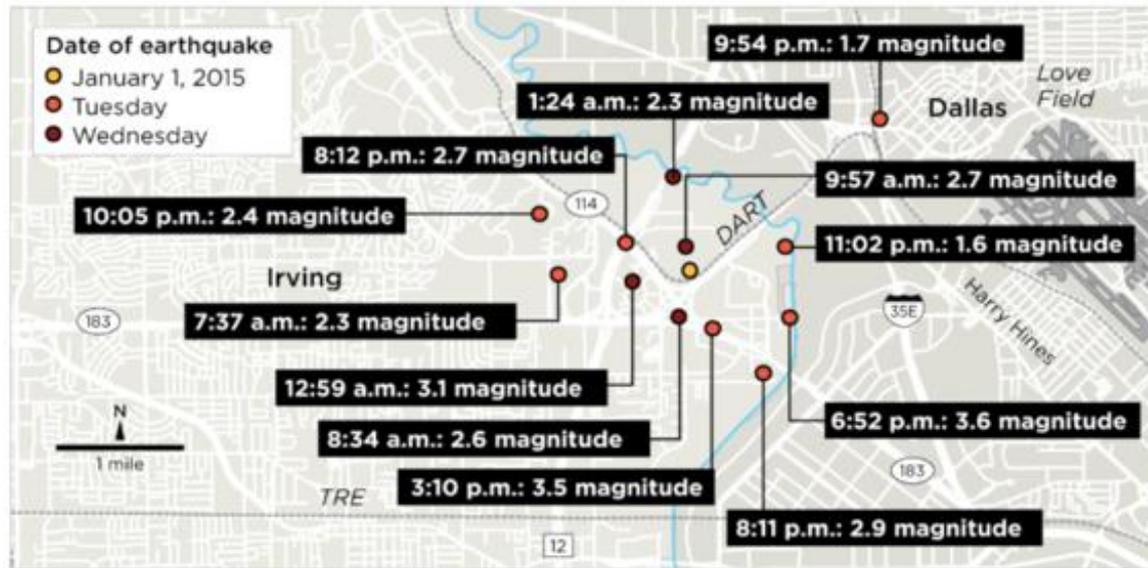
Texas

Previously almost no seismic activity, but there were 38 earthquakes since 2014, with magnitudes >3

- 13 earthquakes in one week in Jan 2015

Irving-area earthquakes

Thirteen earthquakes have been recorded near State Highways 114 and 183 in Irving since the beginning of 2015.



SOURCE: U.S. Geological Survey

Note: As of 5 p.m. Wednesday

Staff Graphic

Heavily populated with many “urban drilling” operations

Once earthquakes are felt, officials deploy fire and rescue to canvas region for damage (Texas Railroad commissioner, January 2015)

Thirteen earthquakes strike Dallas County between January 1 and 7, 2015 Credit:

Dallas Morning News Graphic using USGS data

Oklahoma

Earthquake “swarms”

- Many little earthquakes in clusters
- 20 earthquakes of magnitude 4-4.8 have struck since 2009, largest magnitude 5.6

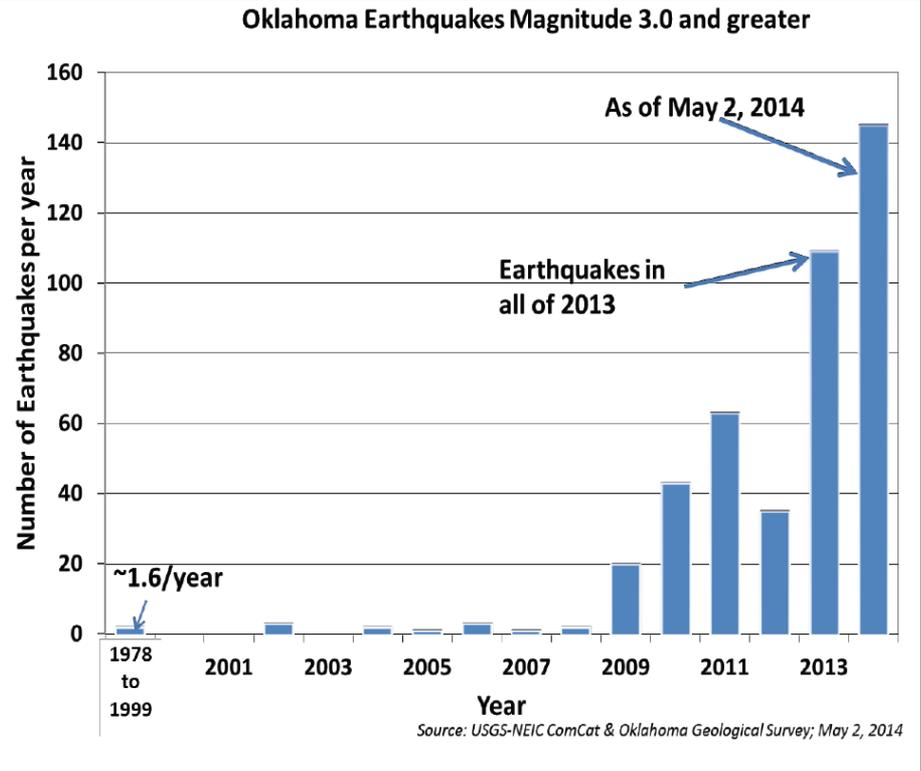
“The more small earthquakes we have, it just simply increases the odds we’re going to have a more damaging event,” USGS geoscientist explained in 2015,

OIL AND GAS

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Oklahoma goes from two 3.0 quakes a year to two a day

Morgan Brennan | @MorganLBrennan
Tuesday, 21 Apr 2015 | 1:00 PM ET



Record Number of Oklahoma Tremors Raises Possibility of Damaging Earthquakes

Updated USGS-Oklahoma Geological Survey Joint Statement on Oklahoma Earthquakes

Originally Released: 10/22/2013 1:07:59 PM; Updated May 2, 2014



What is being done in Canada

- **More comprehensive monitoring**
 - Exploring link between seismic activity, shale gas extraction and wastewater disposal.
 - Geoscience BC consortium
 - Canadian Association of Petroleum Producers, NRCan and the BC Oil and Gas Commission) will continue to study the Alberta Fox Creek region and seismic activity until 2017.
 - Examining relationships between depth, radius and damage
- **Moratoriums on Hydraulic Fracturing and prohibition of deep waste disposal wells**
 - Quebec, New Brunswick, Newfoundland and Labrador, and Nova Scotia

Public Health Issues

Concerns around proximity to communities

- Phenomenon of urban drilling in the USA
- Fault slips can cause impacts many kilometers away
- Larger earthquake possibility very real

Should Public Health have a larger role in regulating or intervening in HF?

Who pays for earthquake related damage?

- Current class action lawsuits in the US

Insurance commissioner advises Oklahomans buy earthquake coverage

Commission John D. Doak responds to report noting “swarm” of Oklahoma earthquakes.

by [Brianna Bailey](#) Modified: October 29, 2013 at 9:30 pm • Published: October 29, 2013



by **Brianna Bailey**
BUSINESS WRITER



Public Health Planning

Preventing earthquake damage

- How well are the building codes applied for current and future HF regions?
- Community plans for earthquake resilience
- Inventories of sensitive infrastructures
 - Dams, hospitals, older brick structures, churches

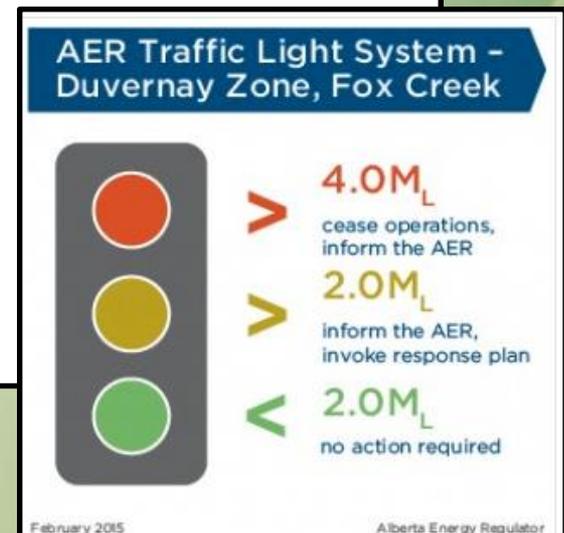
Anticipating the future

“...events of $M > 5$ are relatively likely to occur due to hydraulic fracture activities in this environment, assuming that faults exist to host such events.

Our conclusion is that in certain areas where the activation probability is high, the hazard may be greatly amplified by hydraulic fracturing activity.” (*Atkinson et al 2015 on Fox Creek AB*)

Conclusion

- Hydraulic fracturing and deep well injection of wastewater increase the risk of earthquakes
 - Generally these are small earthquakes
 - However, evidence suggests, in some regions, larger magnitude earthquakes are occurring
 - Earthquakes occur even after fracturing operations or deep well injection ends
 - Public health issues can arise from this potential risk
- Recommendations to reduce risk
 - Microseismic monitoring ;
 - Use of “traffic-light “ systems
 - Siting in low density population areas



Acknowledgements

Thank you to:

Drs. Lydia Ma and Tom Kosatsky at the
NCCEH for their support and

Dr. Andy Calvert for reviewing the
presentation

Now Arriving at Pittsburgh International: Fracking

By MATTHEW L. WALD AUG. 11, 2014

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For salvation, airport off quiet runways, it turns o whole state of Pennsylv Energy [will drill its first](#)

How Pittsburgh Airport Will Frack for Gas Under Active Runways



Sarah Zhang
Filed to: FRACKING 8/12/14 3:21pm

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