

Environmental and Health Risks of Fracking

Dr. Ray Beiersdorfer
YSU Professor of Geology

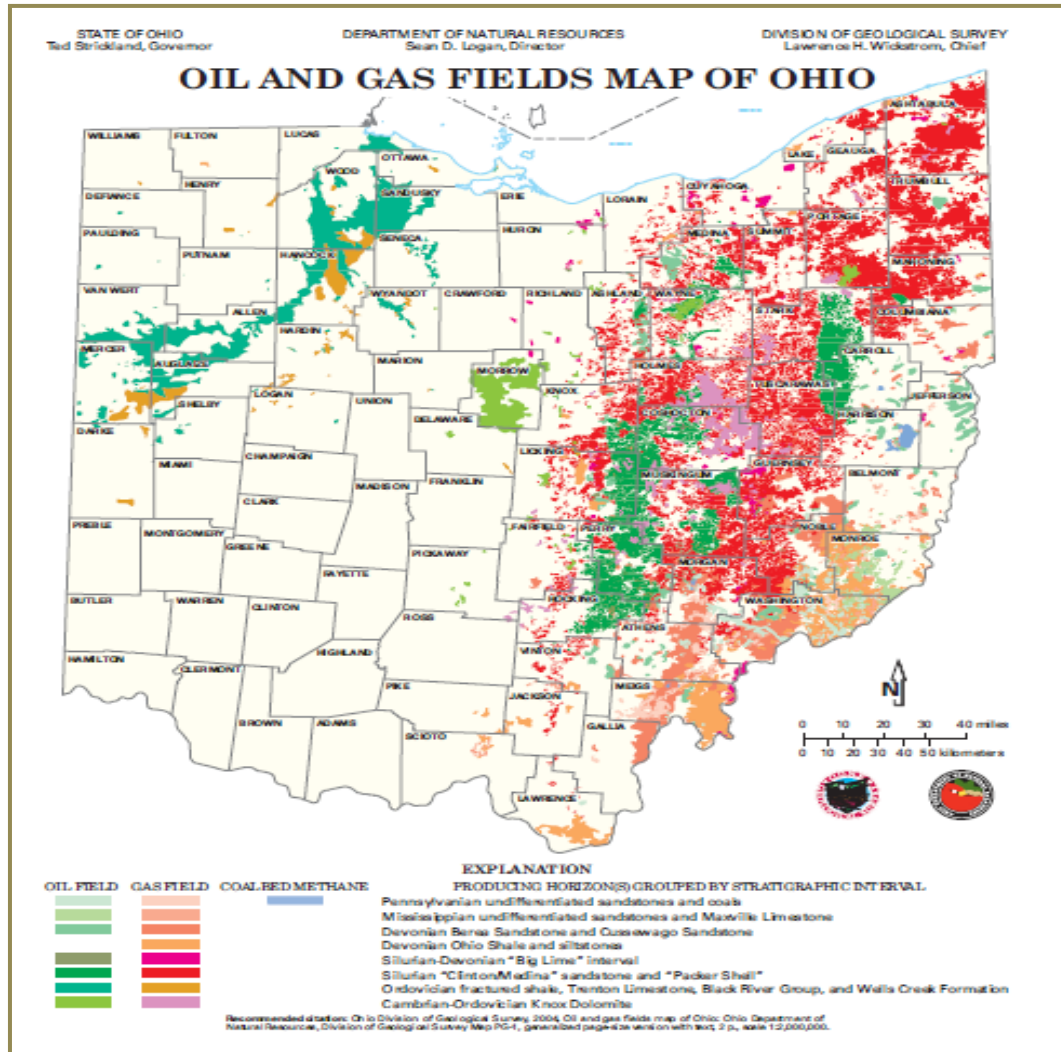
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Outline

- 1) Geology
- 2) Water
- 3) Sand
- 4) Chemicals
- 5) Gases
- 6) Legal & Economic

OIL AND GAS FIELDS OF OHIO



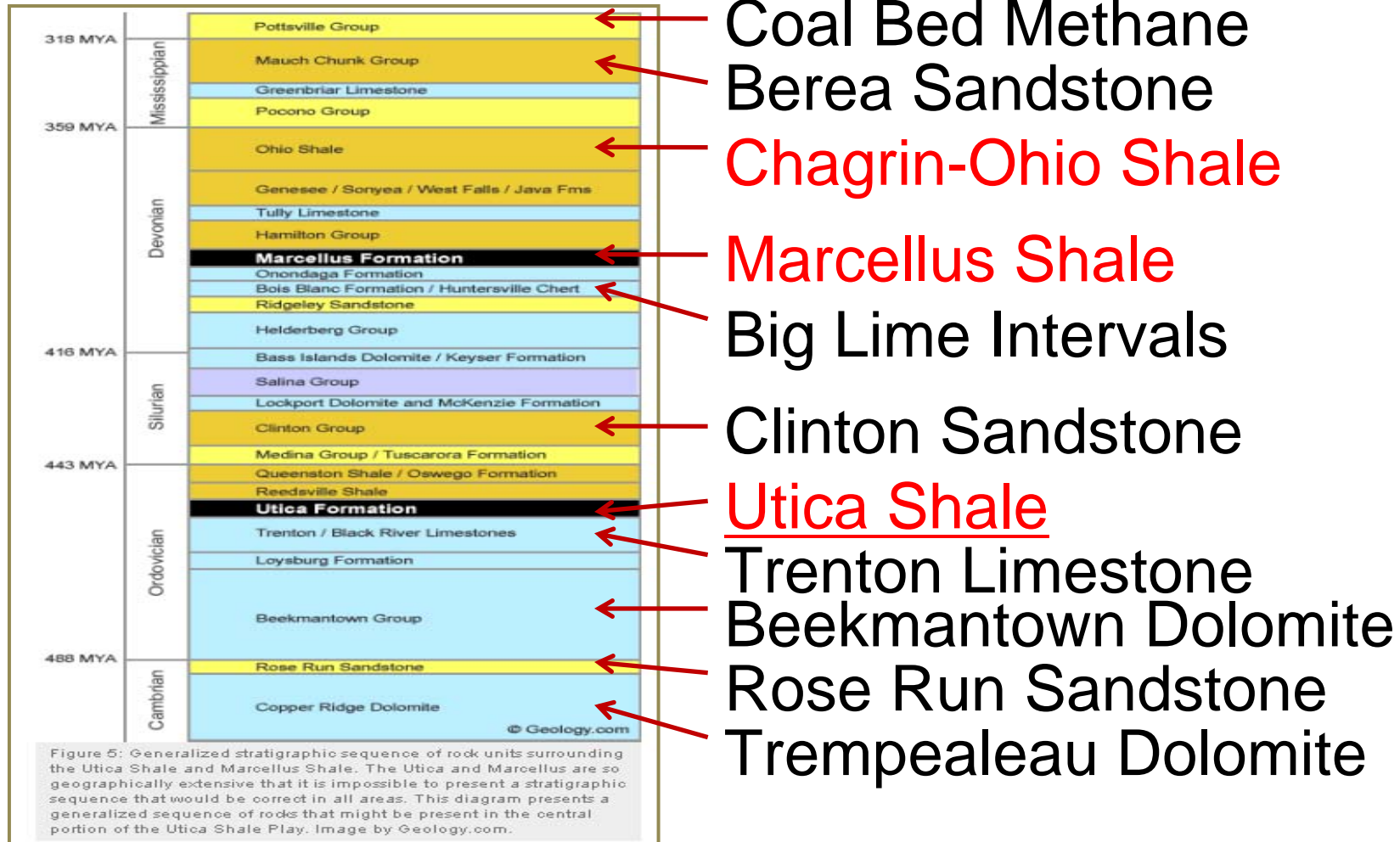
OIL

GAS

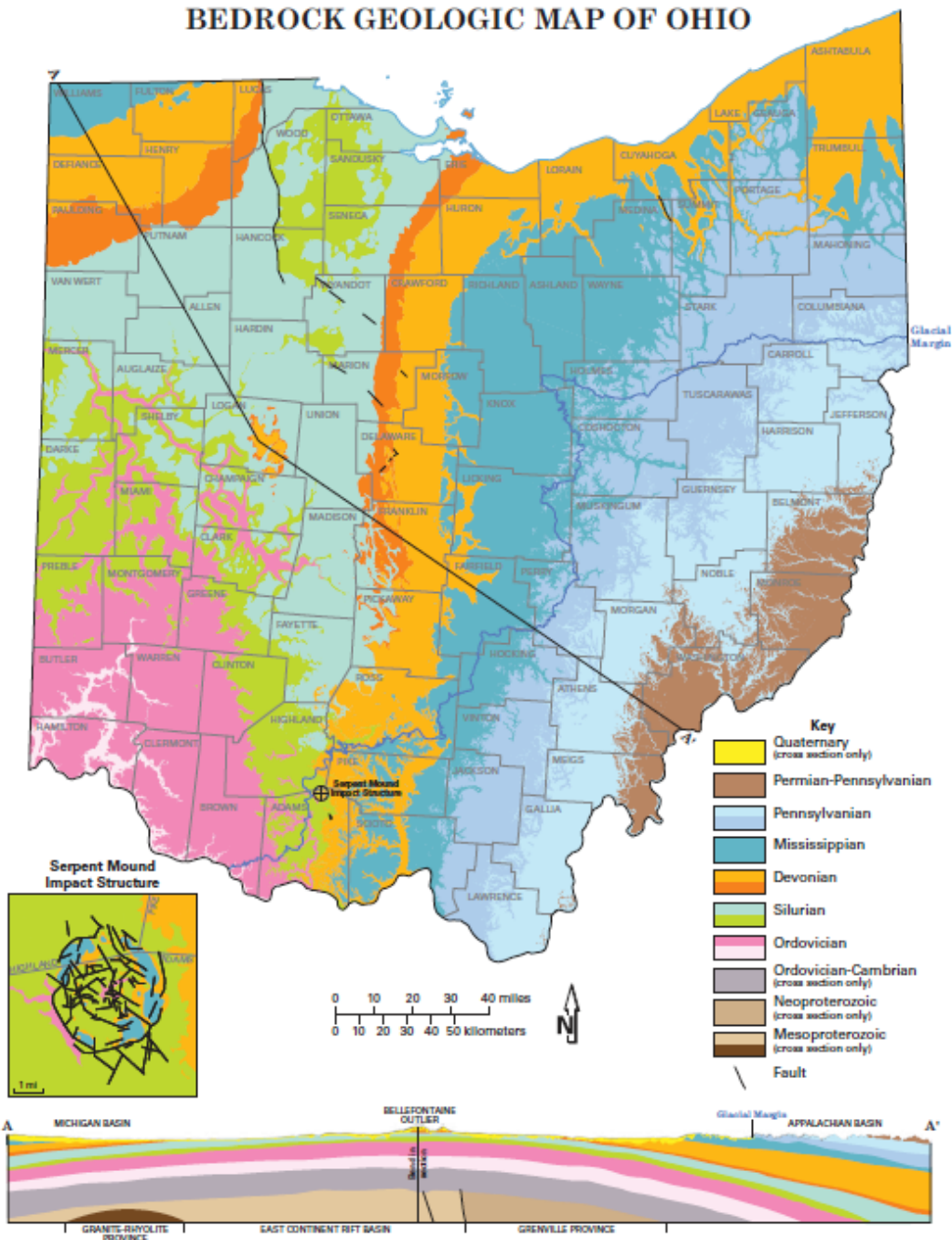
Coal Bed Methane

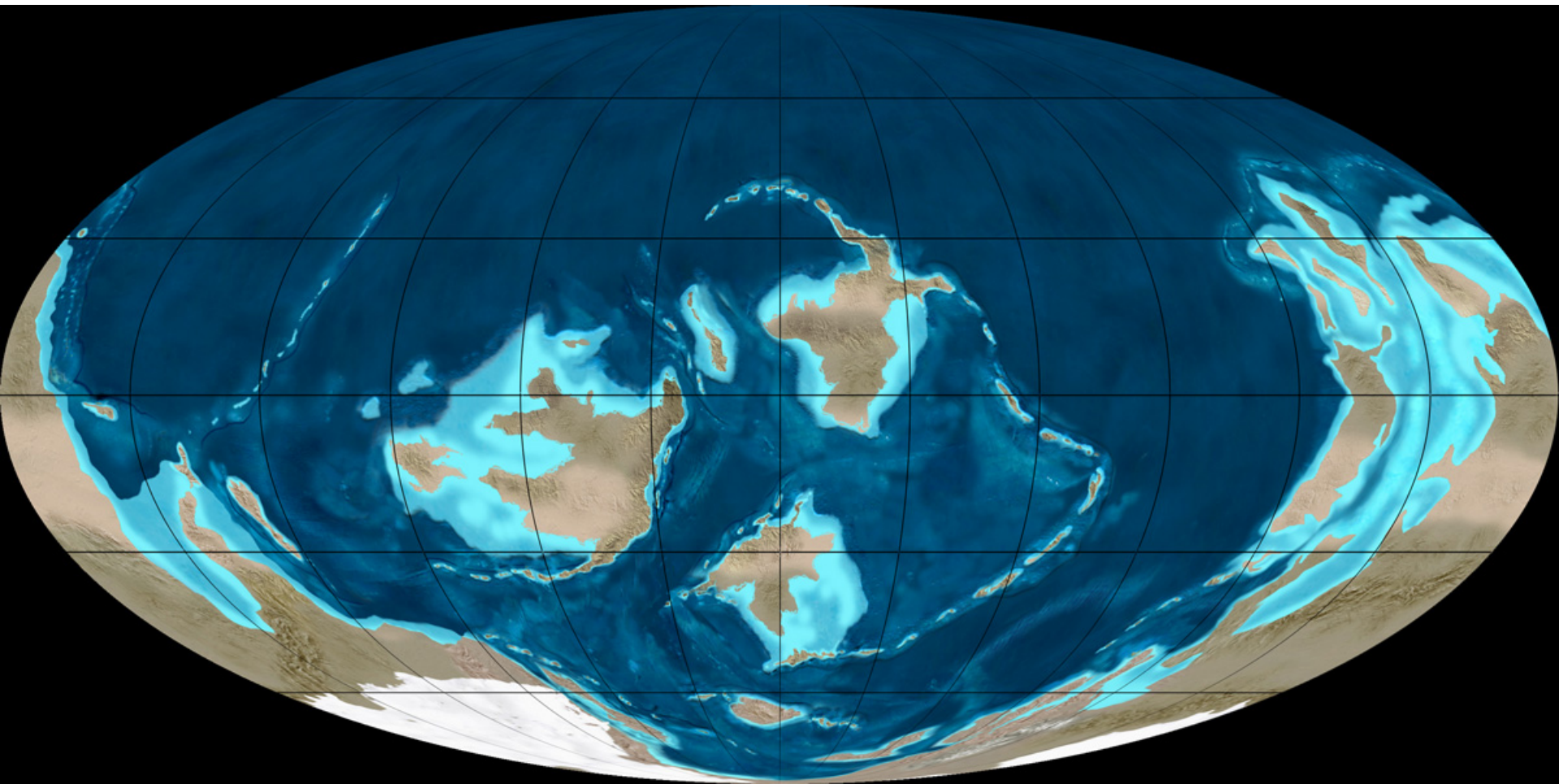
- Total Oil Production: 1.13 BBO
- Total Gas Production: 8.40 TCF
- Total # Wells: > 274,000
- Active # Wells: > 64,000

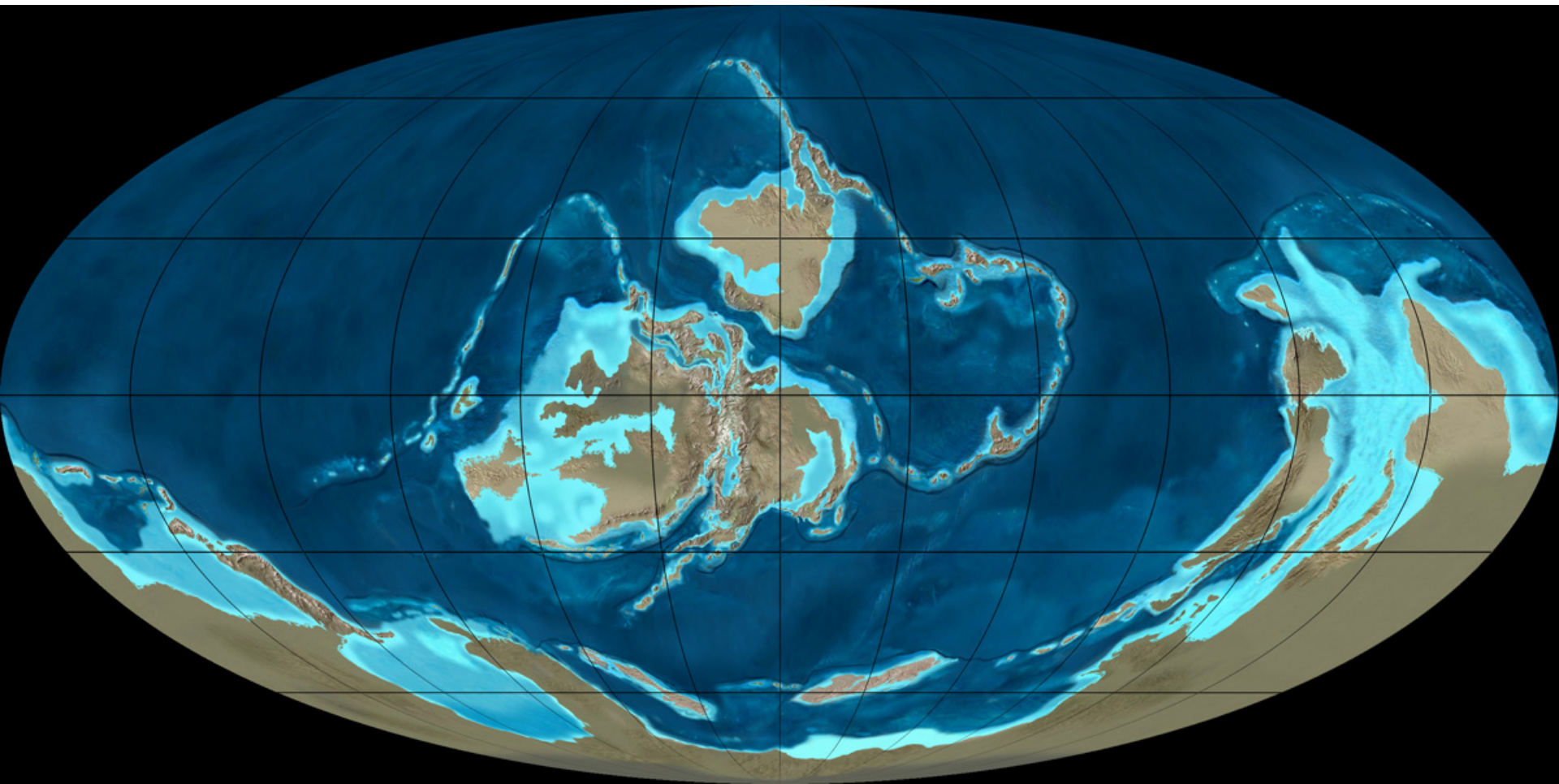
PRODUCTIVE INTERVALS IN OHIO



BEDROCK GEOLOGIC MAP OF OHIO







Utica Shale is the source of gas in the Clinton.

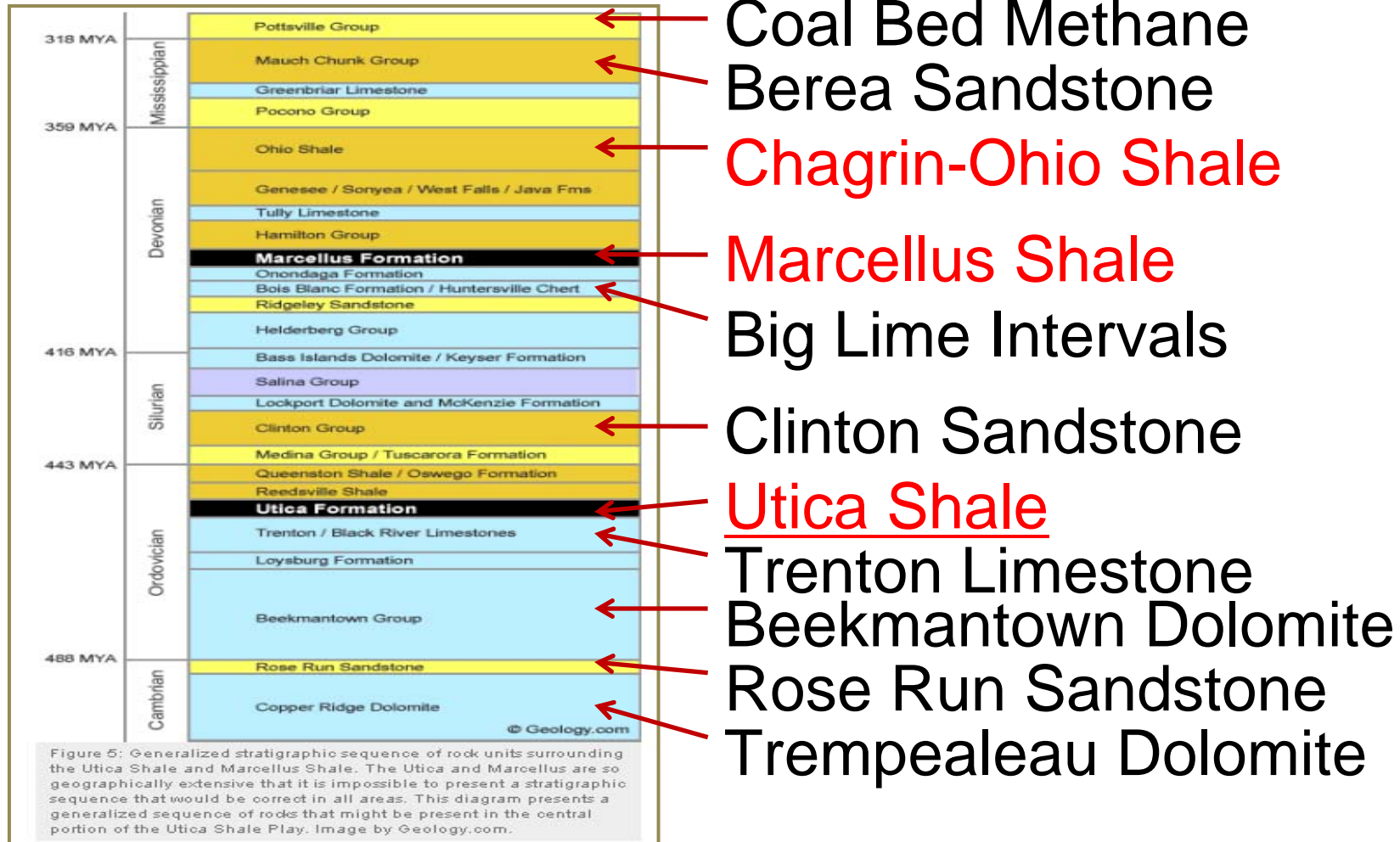
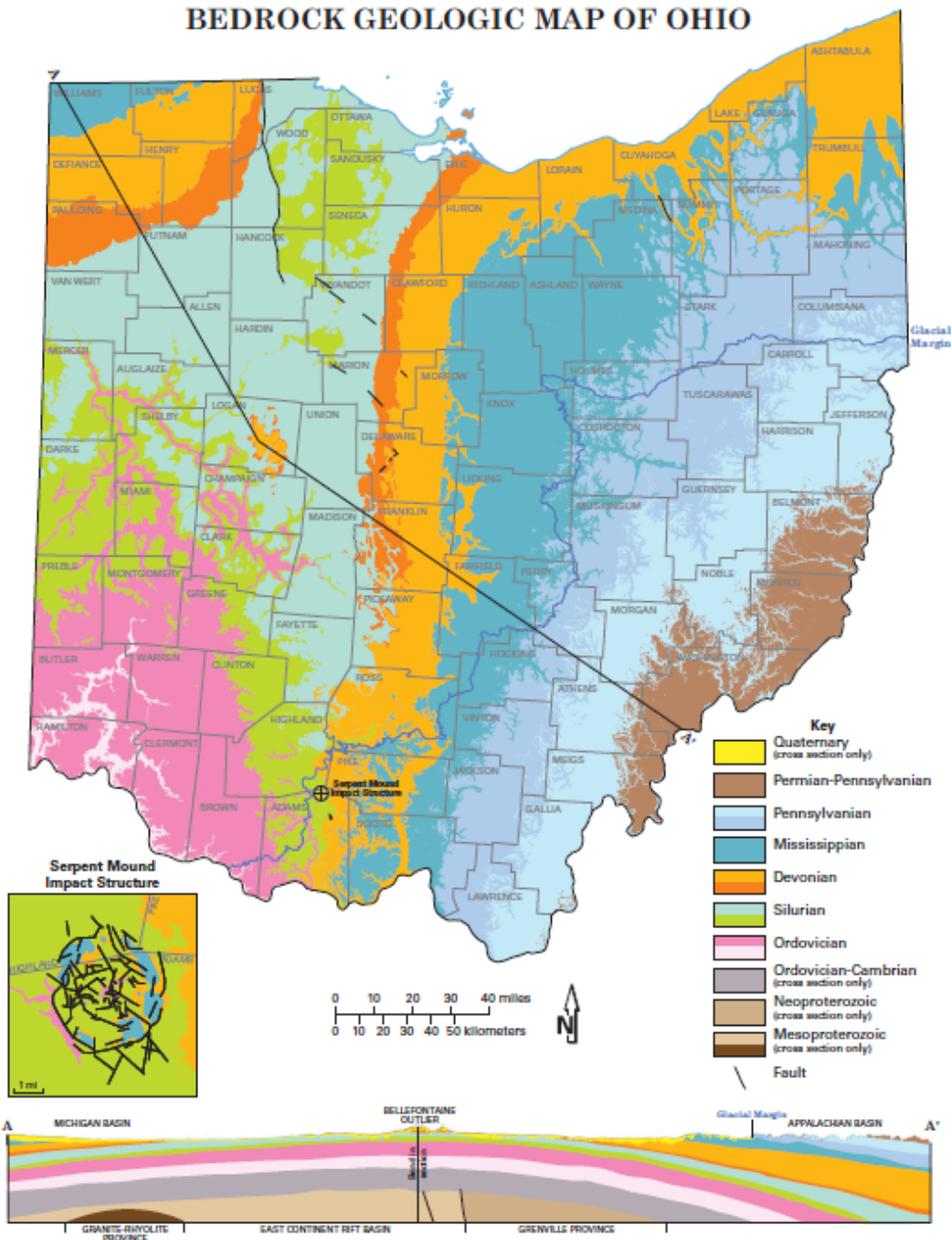


Figure 5: Generalized stratigraphic sequence of rock units surrounding the Utica Shale and Marcellus Shale. The Utica and Marcellus are so geographically extensive that it is impossible to present a stratigraphic sequence that would be correct in all areas. This diagram presents a generalized sequence of rocks that might be present in the central portion of the Utica Shale Play. Image by Geology.com.

BEDROCK GEOLOGIC MAP OF OHIO



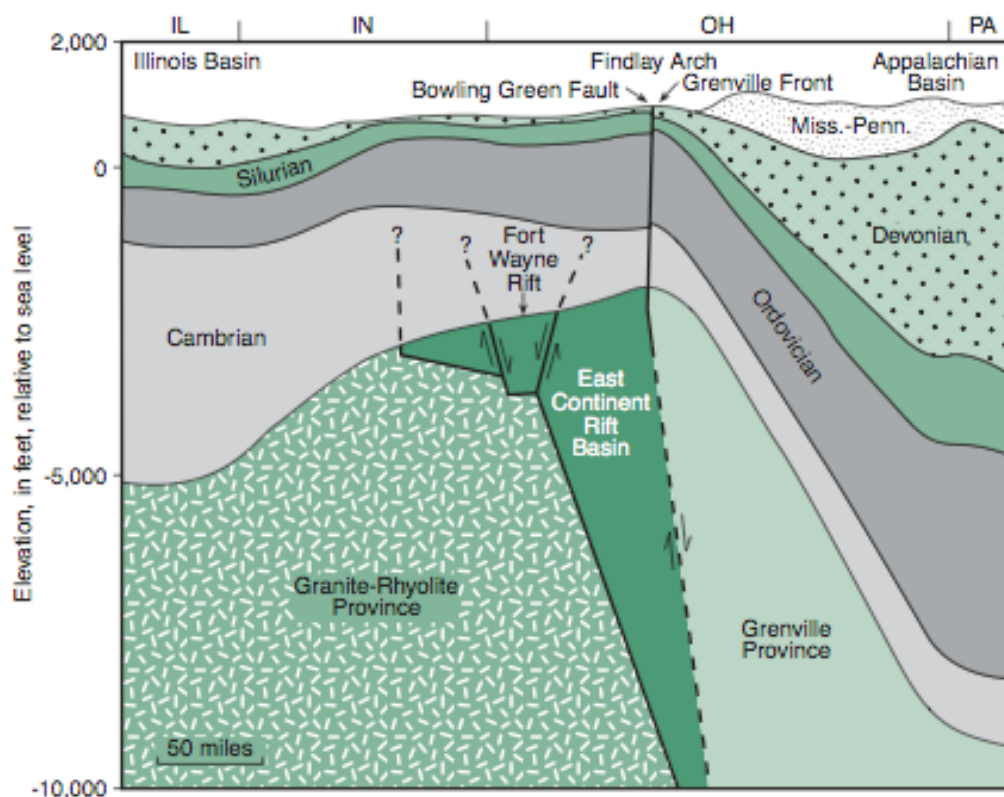
Ohio Geology

A Quarterly Publication of the Division of Geological Survey

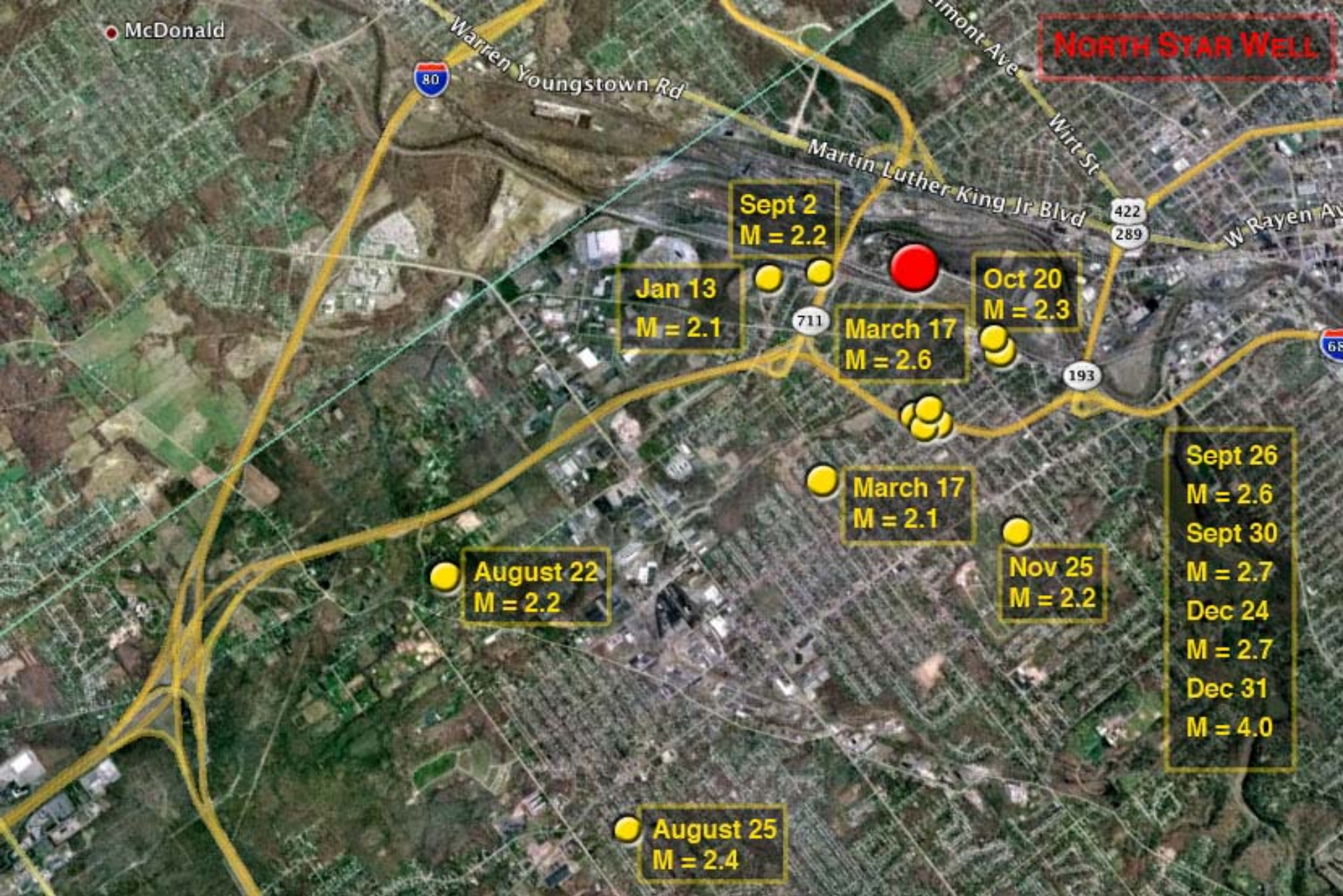
Winter 1996

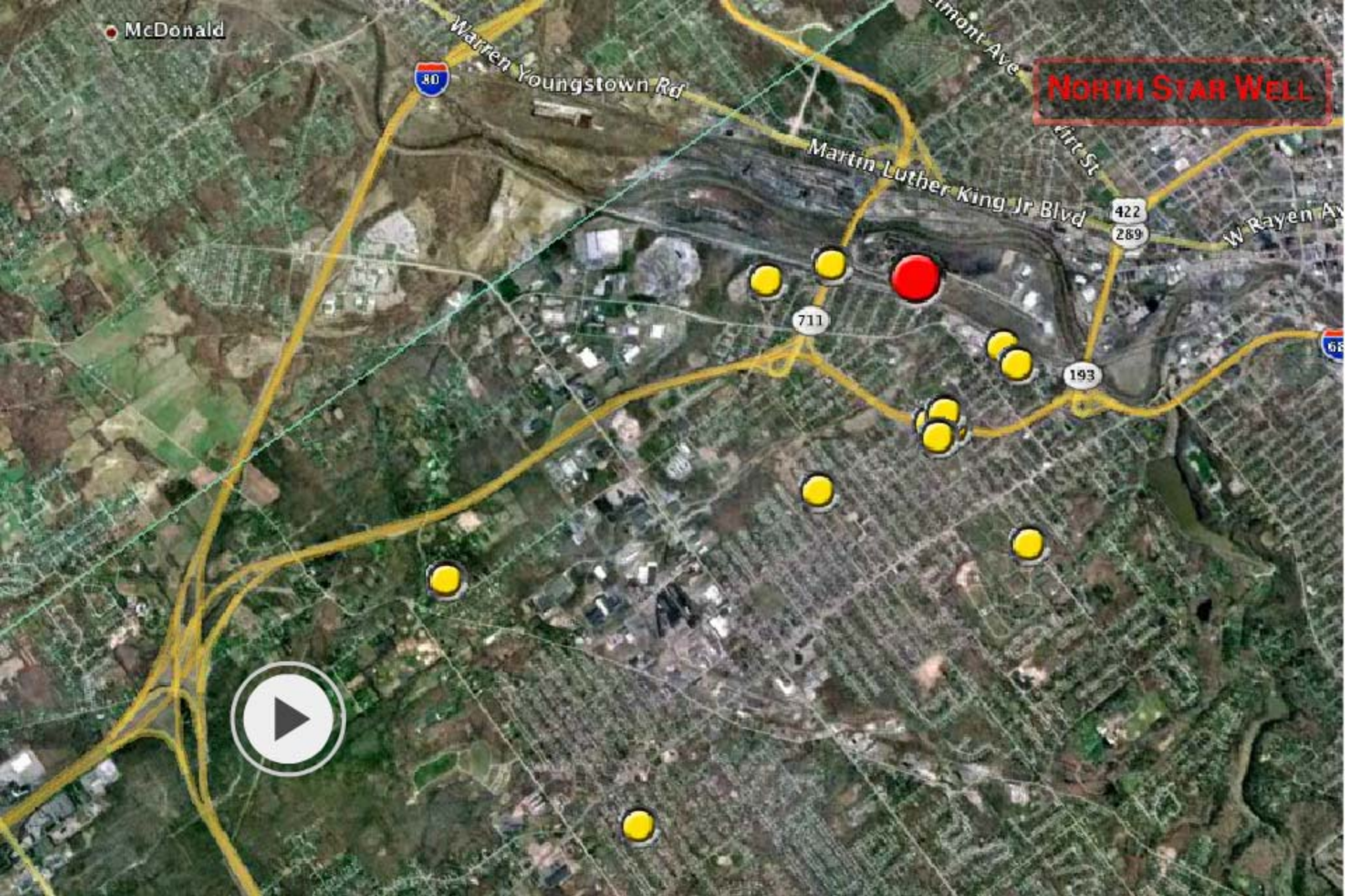
THE GEOLOGY OF OHIO—THE PRECAMBRIAN

by Michael C. Hansen



NORTH STAR WELL







OhioSeis

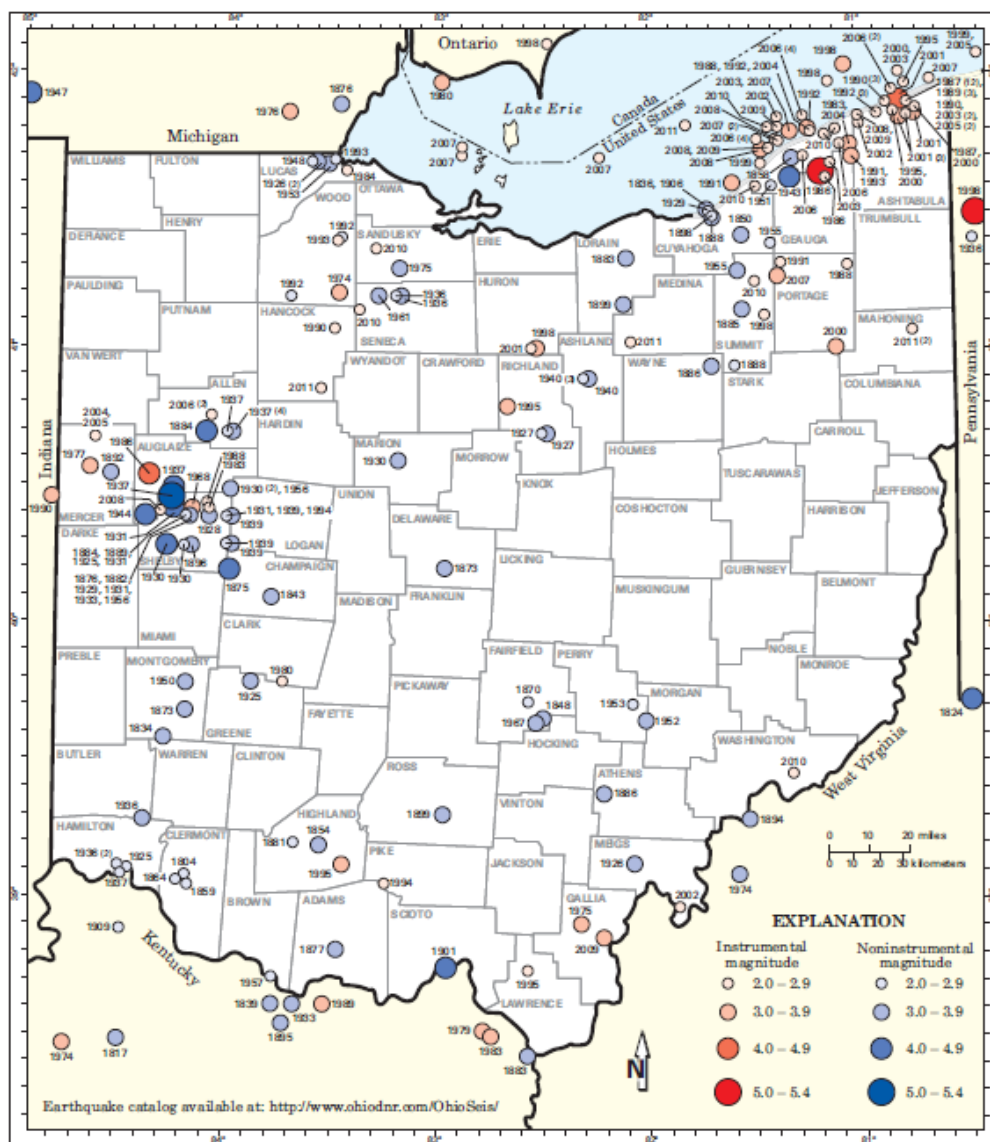
Ohio's earthquake monitoring network



Recent Ohio/Regional Earthquakes

- [Youngstown, Mahoning County, December 31, 2011](#)
- [Youngstown, Mahoning County, December 24, 2011](#)
- [Youngstown, Mahoning County, November 25, 2011](#)
- [Youngstown, Mahoning County, October 20, 2011](#)
- [Youngstown, Mahoning County, September 30, 2011](#)
- [Youngstown, Mahoning County, September 26, 2011](#)
- [Marietta, Washington County, September 04, 2011](#)
- [Youngstown, Mahoning County, September 02, 2011](#)
- [Marietta, Washington County, August 31, 2011](#)
- [Marietta, Washington County, August 31, 2011](#)
- [Youngstown, Mahoning County, August 25, 2011](#)
- [Virginia Earthquake, August 23, 2011](#)
- [Youngstown, Mahoning County, August 22, 2011](#)
- [Offshore Lake Erie, Ohio-Canada Border Region, August 13, 2011](#)
- [Offshore Lake Erie \(Cuyahoga County, Ohio\), June 15, 2011](#)
- [Medina County, Ohio, June 5, 2011](#)
- [Delaware Township, Hancock County, April 26, 2011](#)
- [Youngstown, Mahoning County, March 17, 2011 \(10:53\)](#)
- [Youngstown, Mahoning County, March 17, 2011 \(10:42\)](#)

EARTHQUAKE EPICENTERS IN OHIO AND ADJACENT AREAS



LOCALLY OWNED SINCE 1869

Vindy.com

The Vindicator

SUNDAY
OCTOBER 30, 2011
\$1.50

Did brine well trigger 6 Valley earthquakes?

By KARL HENKEL
khenkel@vindy.com

YOUNGSTOWN

The Mahoning Valley has experienced seven minor earthquakes since March — the only quakes ever recorded with epicenters in the Valley.

The sudden occurrences have experts now examining a brine-water injection well near Salt Springs Road and state Route 711.

The Ohio Department of Natural Resources is looking into the correlation between the 18-month-old well and the earthquakes.

Injection wells are a back-end process in the hydraulic-fracking industry. In the fracking process, water, chemicals and sand are blasted through pipes into rocks thousands of feet below the ground to unlock natural gas and oil. That liquid is returned to the surface as brine waste-

water, which ultimately is flushed underground by injection wells.

Some wells, such as the one in Youngstown, go 9,000 feet below the earth's surface.

Of the seven earthquakes, six had epicenters near the injection well on Youngstown's West Side, just off the Salt Springs Road exit and Ohio Works Drive.

See QUAKES, A14

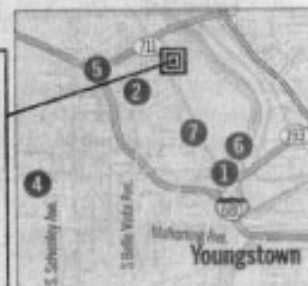
QUAKE & WELL LOCATIONS

AREA EARTHQUAKES

- ① March 17: magnitude 2.6
- ② Aug. 22: magnitude 2.2
- ③ Aug. 25: magnitude 2.4 (near Decamp Rd. in Austintown)
- ④ Sept. 2: magnitude 2.2
- ⑤ Sept. 25: magnitude 2.6
- ⑥ Sept. 29: magnitude 2.7
- ⑦ Oct. 20: magnitude 2.3

Source: 2008, U.S. Geological Survey

The epicenter of six of the seven earthquakes this year coincidentally is near a brine injection well on Ohio Works Drive.



THE VINDICATOR

QUAKES

Continued from A1

"There's definitely a coincidence," said Jeffrey Dick, geology department chairman at Youngstown State University.

"But whether or not there's a link, nobody has enough data quite yet."

ODNR has oversight of the process, and Dick said ODNR has contacted him about geological maps in response to the quake.

But Heidi Hetzel-Evans, an ODNR spokeswoman, said the agency stands by its regulations that permit the well operations.

"[ODNR has] not seen any evidence that shows a correlation between localized seismic activity and deep injection well disposal."

The well, completed months before the first 2011 quake by D&L Energy and-gas exploration company.

"There's no evidence at the well to establish a link," said Nick Paparodis, president of operations for Youngstown D&L.

"We've complied with all of [ODNR's] recommendations."

D&L's Youngstown site has had a daily injection average of 2,000 barrels, or 84,000 gallons, of wastewater. That's 504,000 gallons each week, based on the site's six-day operating schedule. Through the first six months of 2011, it has injected 7.6 million gallons.

Those averages could grow, because in May, ODNR approved an increase in the daily load level. Six of seven earthquakes occurred after the increase.

THE INJECTION PROCESS

In the deep injection process, wastewater passes

through the Marcellus Shale, Clinton Sandstone and Utica Shale formations.

Wastewater pumped into the well isn't as heavily pressurized as it is during

DICK SAID.

During the injection process, the water continuously increases in volume and becomes a part of the ecosystem. It is at that point the water can cause strain on a previously undiscovered fault line — which possibly

Another is in Girard, also on 422, near the V&M Star plant.

Both wells have been drilled but won't accept wastewater for four to six more months, Paparodis said.

EARTHQUAKE CONNECTION?

The correlation between earthquakes and deep-well injections is not new.

Dick said in only one

GEOLOGIC EXPERTS ARE CONCERNED — AND CONVINCED — INJECTION WELLS ARE

quakes.

But earlier this year in Arkansas, the state Oil and Gas Commission banned some injection wells near a fault line after the area experienced 1,100-plus small earthquakes similar in magnitude to those felt

The quakes initially subsided but have since started to pick back up, said David Johnston, earthquake geologist at the Arkansas Geological Survey.

"Most of them have been pretty small in a 1.5 to 3 range, and most of them

four injection wells near the switchboard of the earthquake; the Valley has only one.

Central Arkansas has

had two other "earthquake swarms" — one in the early 2000s and the first in the 1980s, according to geologic records, both of which pre-date the drilling activities

A DEFINITIVE ANSWER

One way to detect a correlation between earthquakes and well injections is by pinpointing the depth of an earthquake.

Michael Hansen of the U.S. Geological Survey said network stations are not close enough to pinpoint a quake alone. Precise location requires at least three stations to pinpoint a

Temporary seismic stations are a possibility but not for ODNR. Hansen said the U.S. Geological Service has such devices, which cost about \$5,000 and take about six months for delivery.

Also must be in the area. The system ties the ties between wells and also could be used to determine the depths of earthquakes, Hansen said.

Look at this in various ways indirectly to determine a depth," he said. "Most of these events are shallow, right around that depth."

"There's definitely a coincidence, but whether or not there's a link, nobody has enough data quite yet."
Dr. Jeffrey Dick, YSU

"ODNR has not seen any evidence that shows a correlation between localized seismic activity and deep injection well disposal" Heidi Hetzel-Evans, ODNR

"Injection induced seismicity in Youngstown is a valid and testable scientific hypothesis."

Ray Beiersdorfer, Pers. Com.

North Star #10 Construction Details

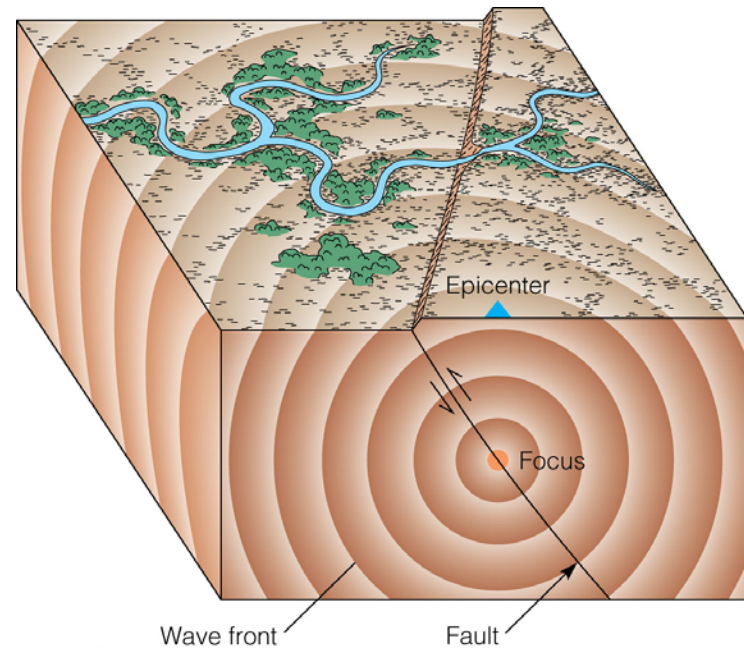
- **9,192 feet Deep**
- **204 foot “rat hole” into Precambrian basement rocks (1.2 BYO igneous and metamorphic)**
- **Casing depth = 8,215 feet**
- **“Open hole” completion; no casing from 8,215’ to 9,192’ (977 feet total)**
- **Injection Formations: Cooper Ridge Dolomite, Conasauga Fm, Rome Fm, Mt. Simon Sandstone and Precambrian Basement**
- **Commenced injection December 2010**

ODNR Report March 2012

Injected 495,622 barrels (over 20 million gallons)

Fault is around 2.2 to 2.3 miles below the surface.

Foci of the earthquakes are around
4,000 ft laterally
2,500 feet below
the bottom of the well.



ODNR Report March 2012

2011 Timeline

March 14th request increase in pressure

March 16th get permission granted

March 17th 2 earthquakes

March 19th they increase the pressure

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- 2) Water**
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HYDRAULIC FRACTURING EXAMPLE

Chesapeake Neider 3H Well: Carroll County

- UTICA COMPLETION with 4,152 ft horizontal leg
- 14 stage frac completion, 7 days
- 60 perforations per stage (approximately 250 ft)
- **5,947,872 gallons of water**
- 3,060 tons of sand
- Reported peak production: 1,615 BOE per day
- Casing Record: Conductor (20" to 80 ft),
Surface (13.375" to 466 ft)
Intermediate (9.625" to 1,728 ft)
Production (5.5" to 12,503 ft)

WATER USE AND OHIO PRECIPITATION

- APPROX 38 INCHES PER YEAR
- APPROX 4 MILLION ACRES UNDER LEASE
- EQUIVALENT OF 4.13×10^{12} GALLONS WATER
- IF ONE PERCENT USED FOR DRILLING:
41 BILLION GALLONS WATER/YEAR
- AT 5 MILLION GALLONS/WELL, THERE IS
ENOUGH WATER FOR 8,000 WELLS/YEAR

Source: Dr. Jeff Dick



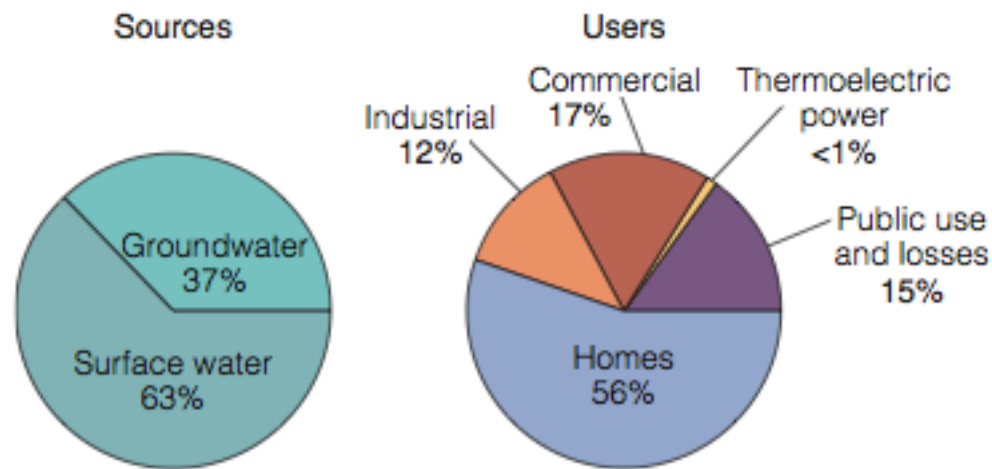
Fracking vs Faucets: Balancing Energy Needs and Water Sustainability at Urban Frontiers

Matthew Fry,^{†,*} David J. Hoeinghaus,[‡] Alexandra G. Ponette-González,[†] Ruthanne Thompson,[‡] and Thomas W. La Point[‡]

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[‡]Department of Biology, University of North Texas, Denton, Texas 76203, United States



Dallas-Fort Worth (DFW) Metroplex, Texas
Municipalities ~86%
Fracking <3% (18.5 Billion gallons)



153,000 million liters (40,400 million gallons) per day

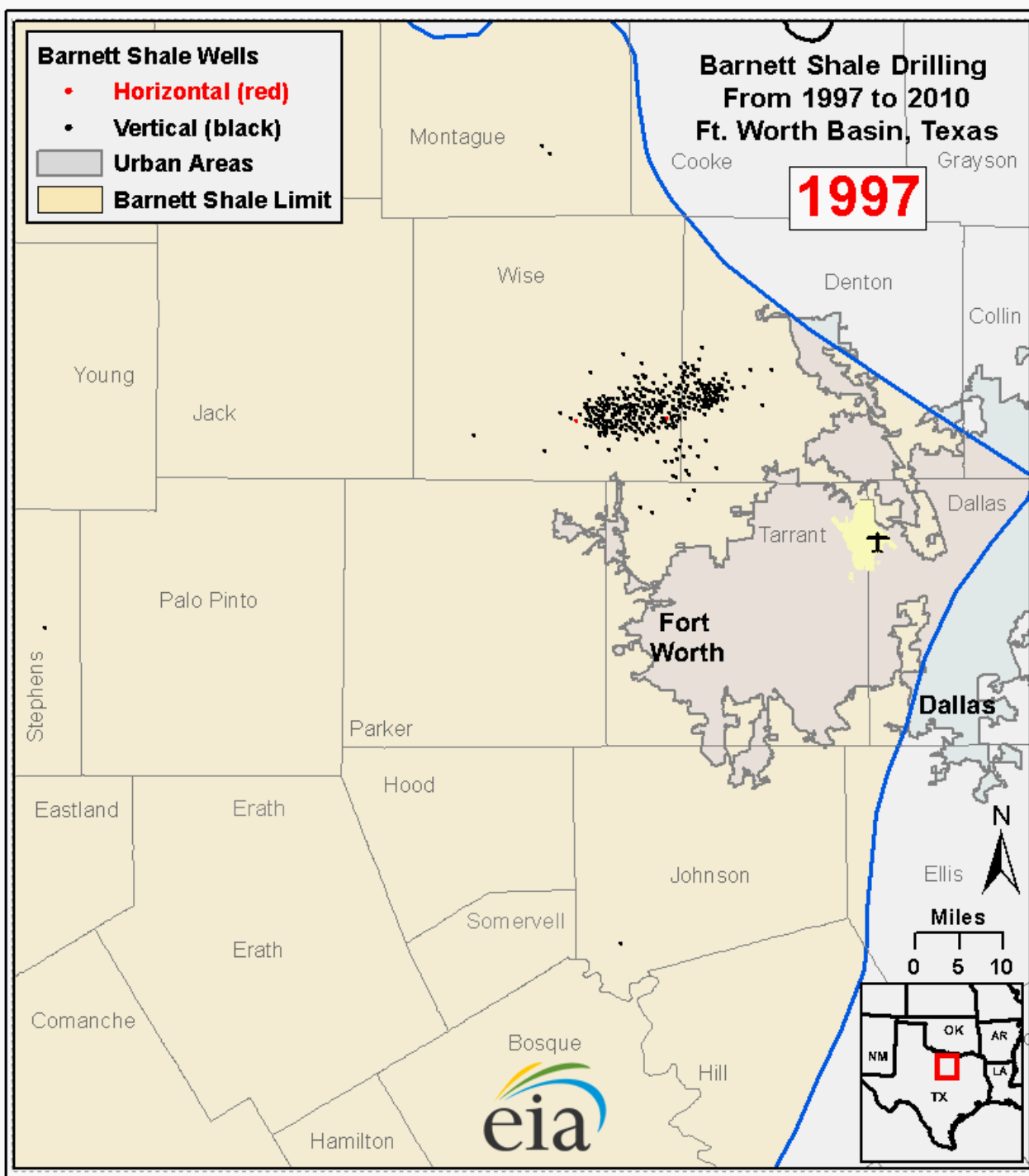
Figure 8.3 The sources and users of the U.S. public water supply in 1995. This does not include freshwater supplied for agricultural use or water that is self-supplied.

- *Consumptive use*—water that evaporates, transpires, or infiltrates and cannot be used again immediately. Forty-four percent of all water that is withdrawn is used consumptively, and agriculture accounts for about 90% of that.
- *Nonconsumptive use*—water that is returned to streams with or without treatment so that it can be used again downstream. Domestic (household) water is used nonconsumptively: It is returned to the cycle through sewers and storm drains.

- Barnett Shale Wells**
- **Horizontal (red)**
 - **Vertical (black)**
-  **Urban Areas**
-  **Barnett Shale Limit**

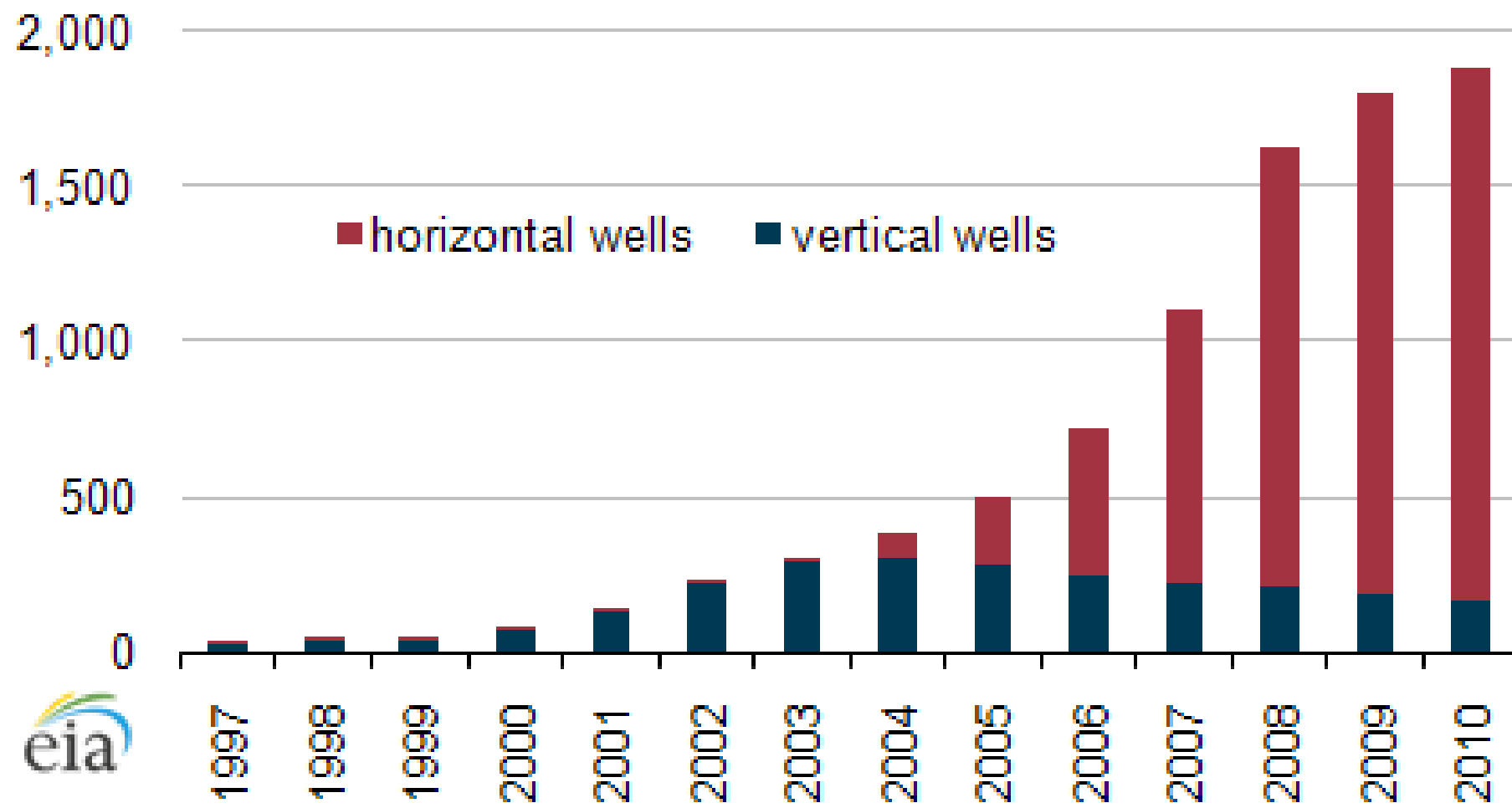
**Barnett Shale Drilling
From 1997 to 2010
Ft. Worth Basin, Texas**

1997





Annual Barnett shale natural gas production by well type billion cubic feet (Bcf)



Dr. Tony Ingraffea

November 7, 2012 7:30 p.m.

Youngstown State University

Williamson College of Business
Administration Conference Center
(Room 1171)

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Superior Mine WI

45.1348, -91.6045

www.thepriceofsand.com

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