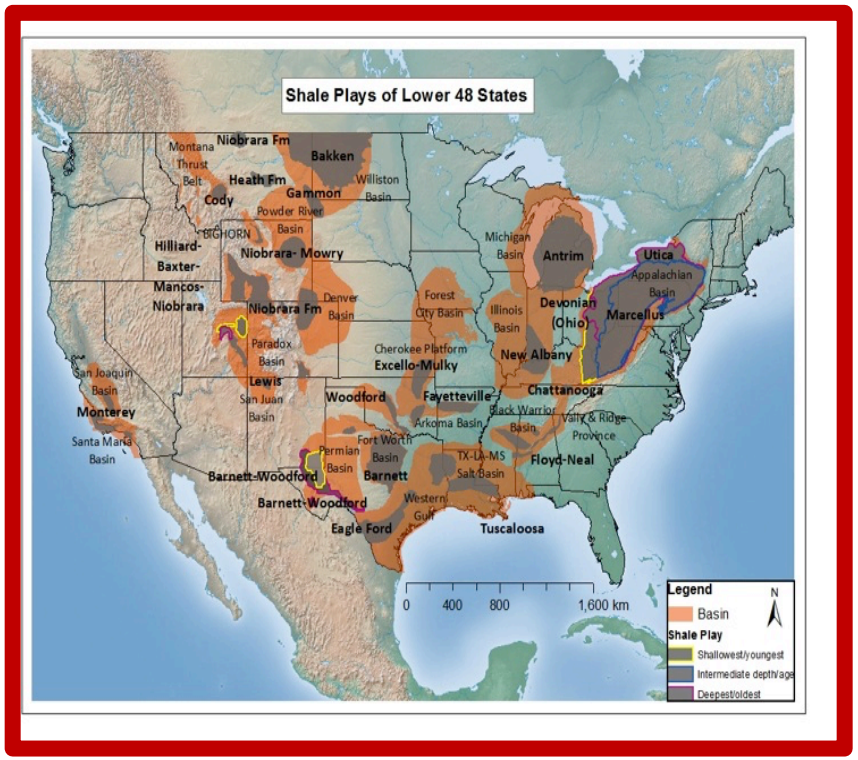
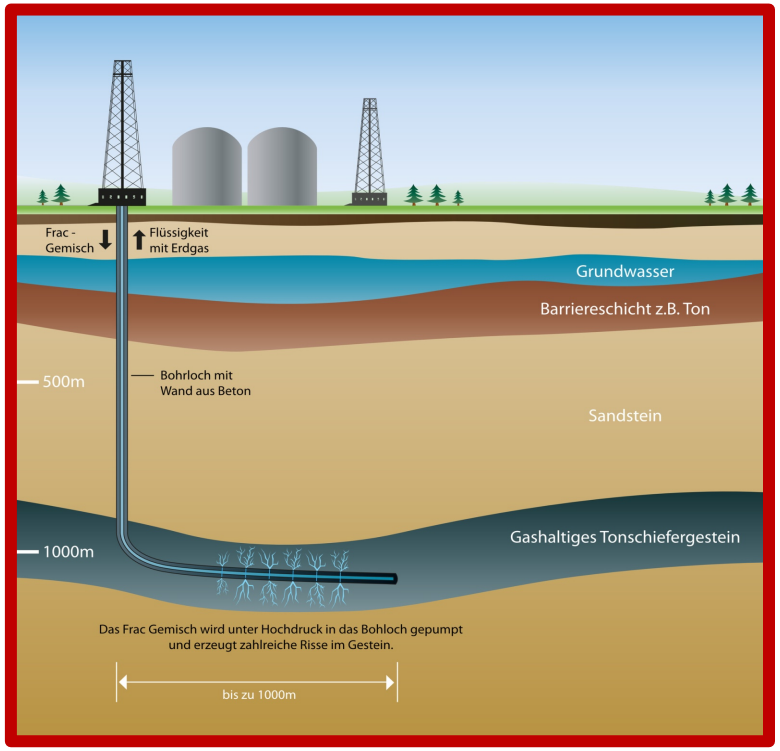
Lifetime Learning Institute, 2019





19SU16

A Whole Lot of Fracking Going On

Barry Centini, Ph.D.

barry.centini@verizon.net

McKnight"ism"

Tell them what you are going to tell them

Tell them

Tell them what you told them

WHAT I AM GOING TO TELL YOU

Geology in the News

The 4 E's

Petroleum Geology

Oil Shale versus Shale Gas

Fracking

Pros of Fracking

Cons of Fracking

Fracking and Climate Change

Discussion

Geology in the NXXXs

Geology in the News

Could the Recent California Earthquakes Set Off the San Andreas Fault?

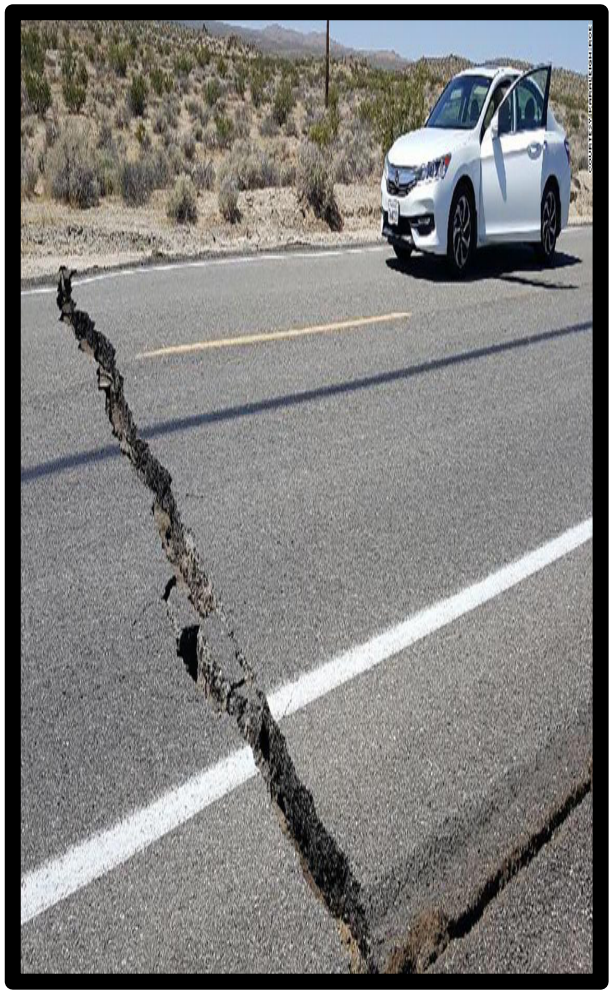
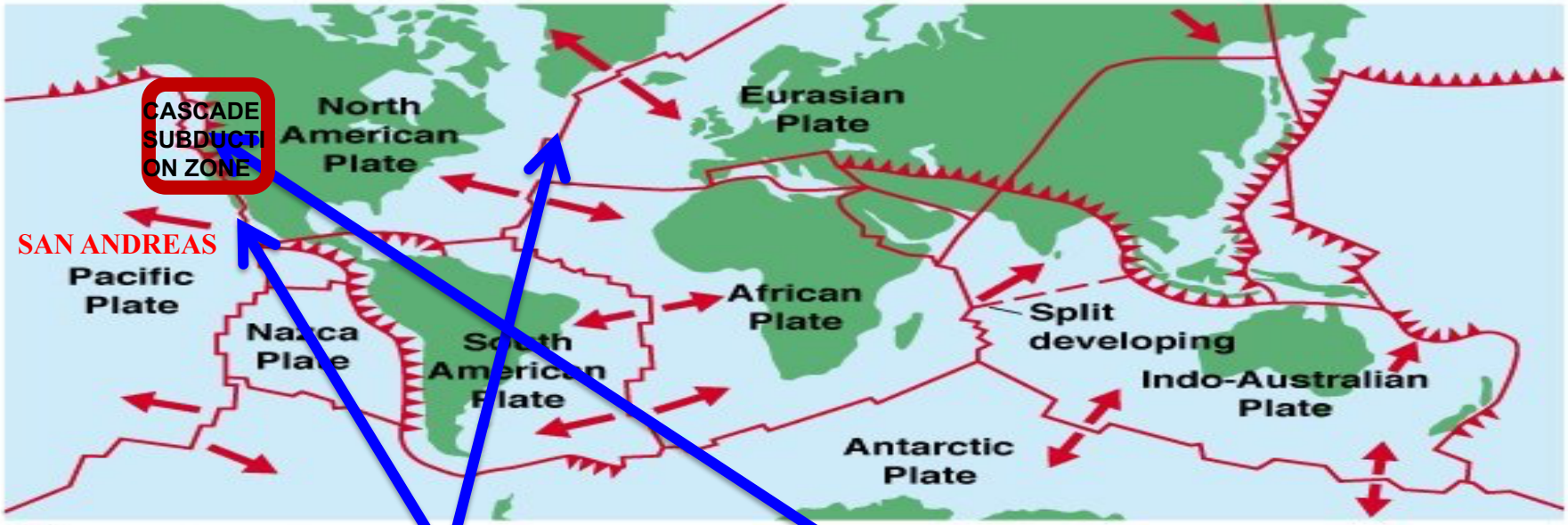
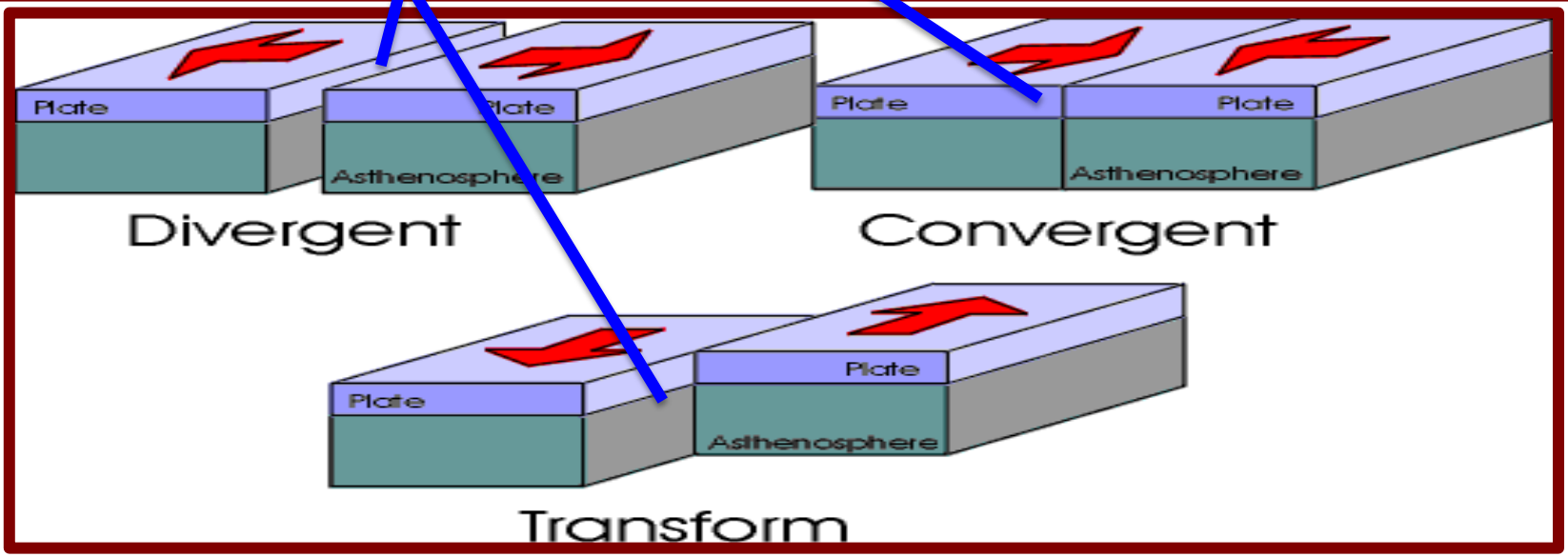
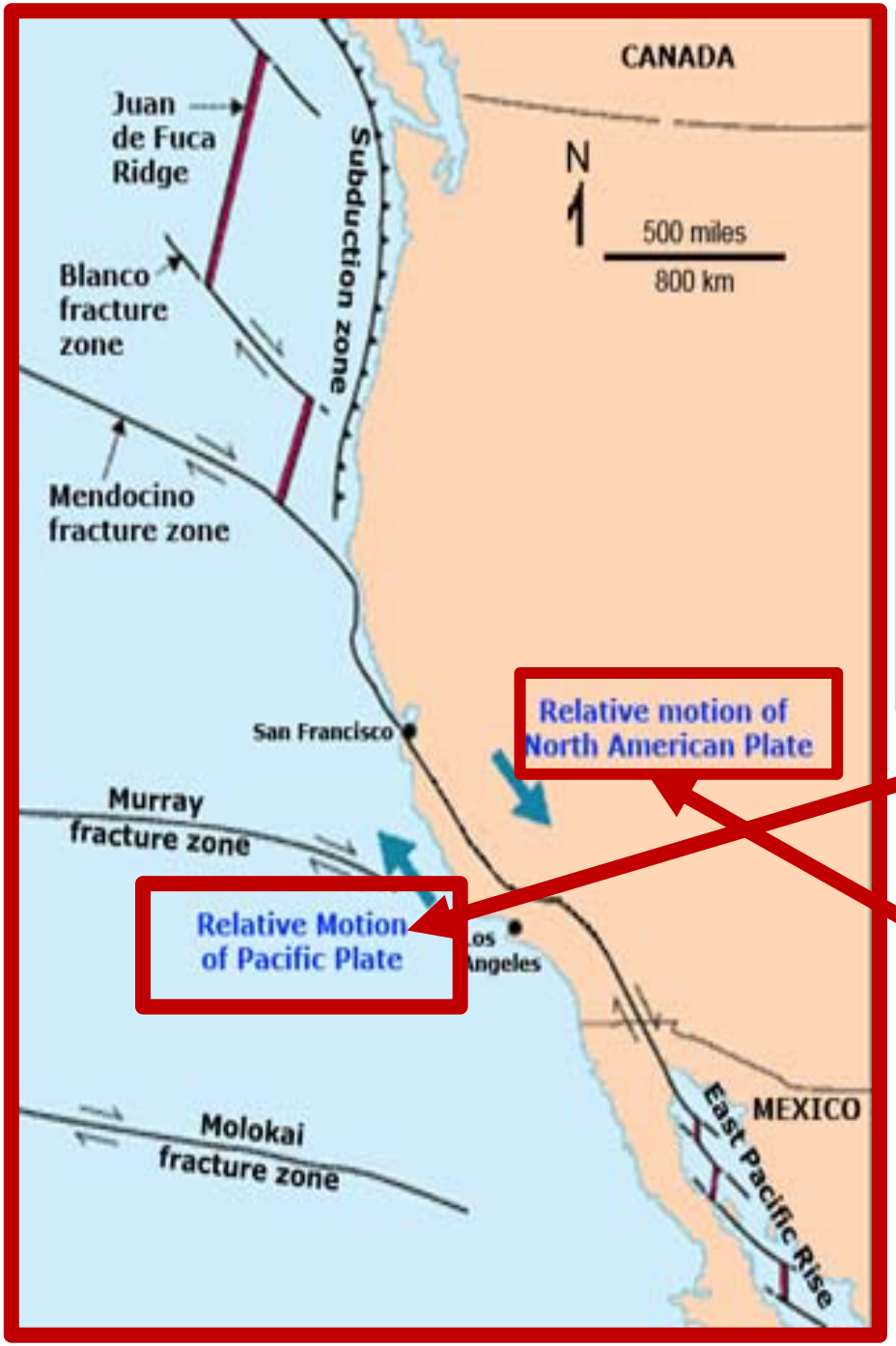


Plate Tectonic Basics

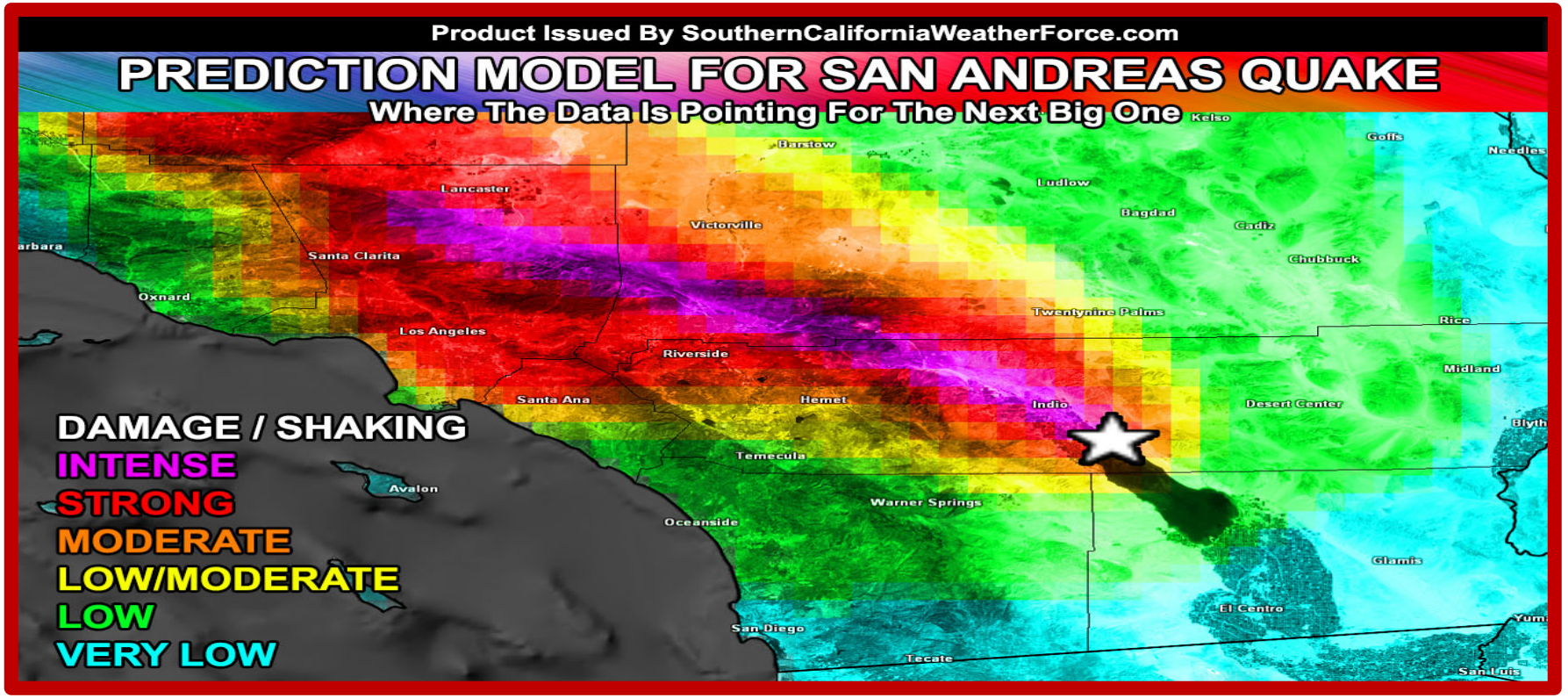






- **The Pacific Plate is moving to the northwest at a speed of between 3 to 4 inches a year.**
- **The North American plate is moving to the west-southwest at approximately 1 inch per year driven by the spreading center that created the Atlantic Ocean, the Mid Atlantic Ridge**

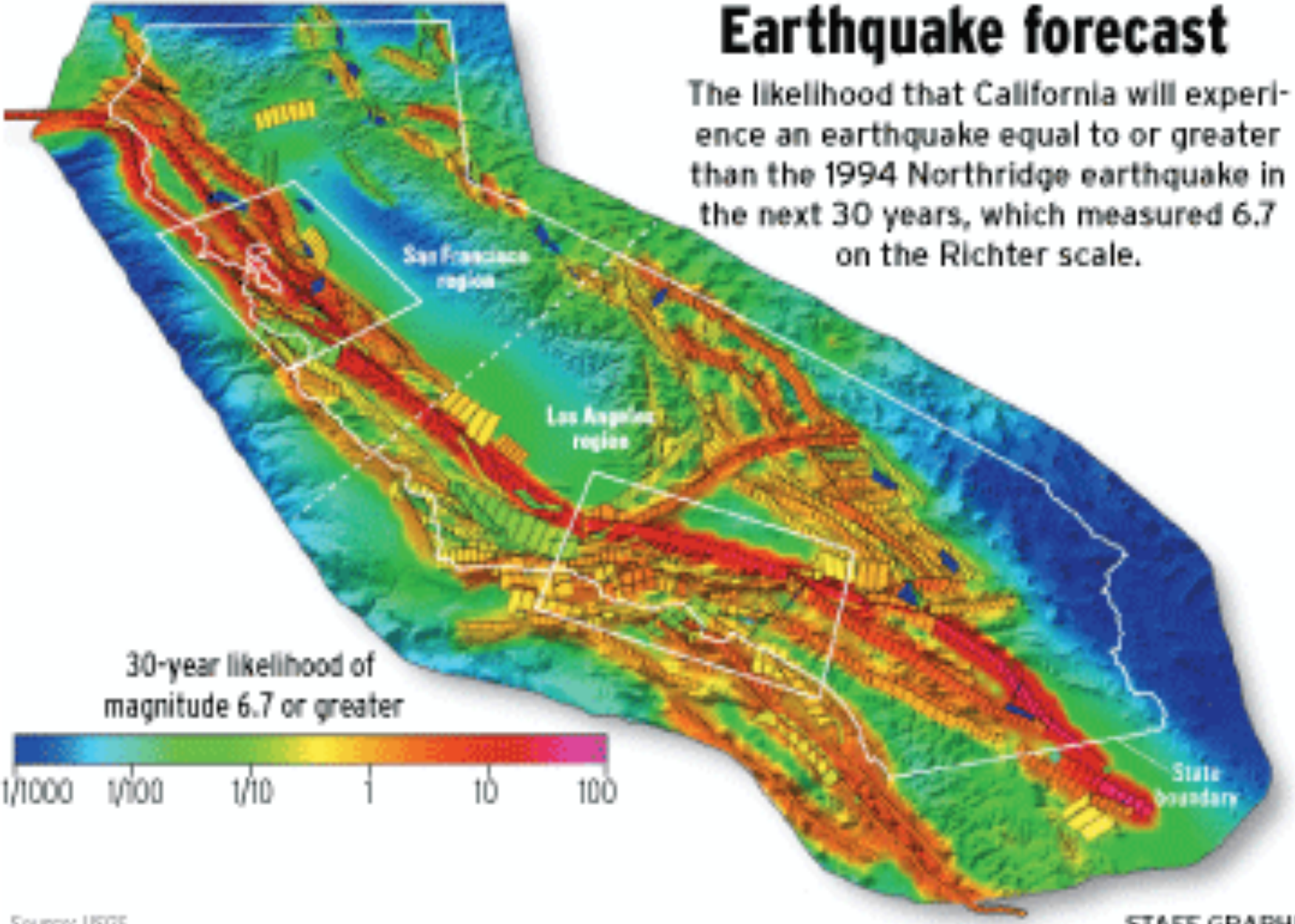
70% Chance Seismic Activity Along San Andreas Fault Could Trigger Devastating Quake by 2030



- The last major quake to occur along the San Andreas fault zone was in 1906, when a 7.9-magnitude earthquake and subsequent fire leveled parts of San Francisco and killed 3,000 people, the deadliest in US history.
- But going more than 100 years without major seismic activity along the fault zone is an anomaly, geologists say, and could portend a massive earthquake along the infamous fault.

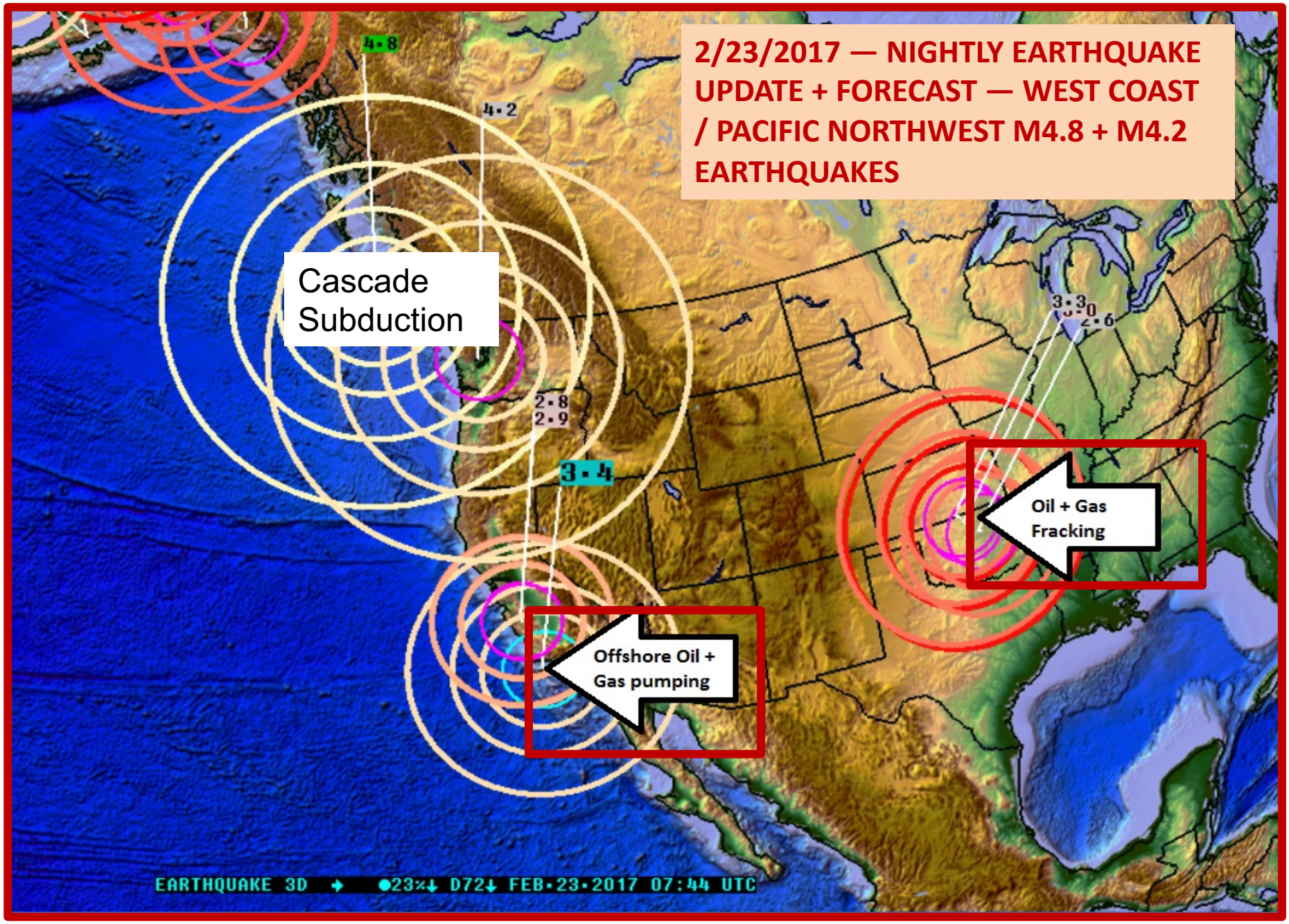
Earthquake forecast

The likelihood that California will experience an earthquake equal to or greater than the 1994 Northridge earthquake in the next 30 years, which measured 6.7 on the Richter scale.

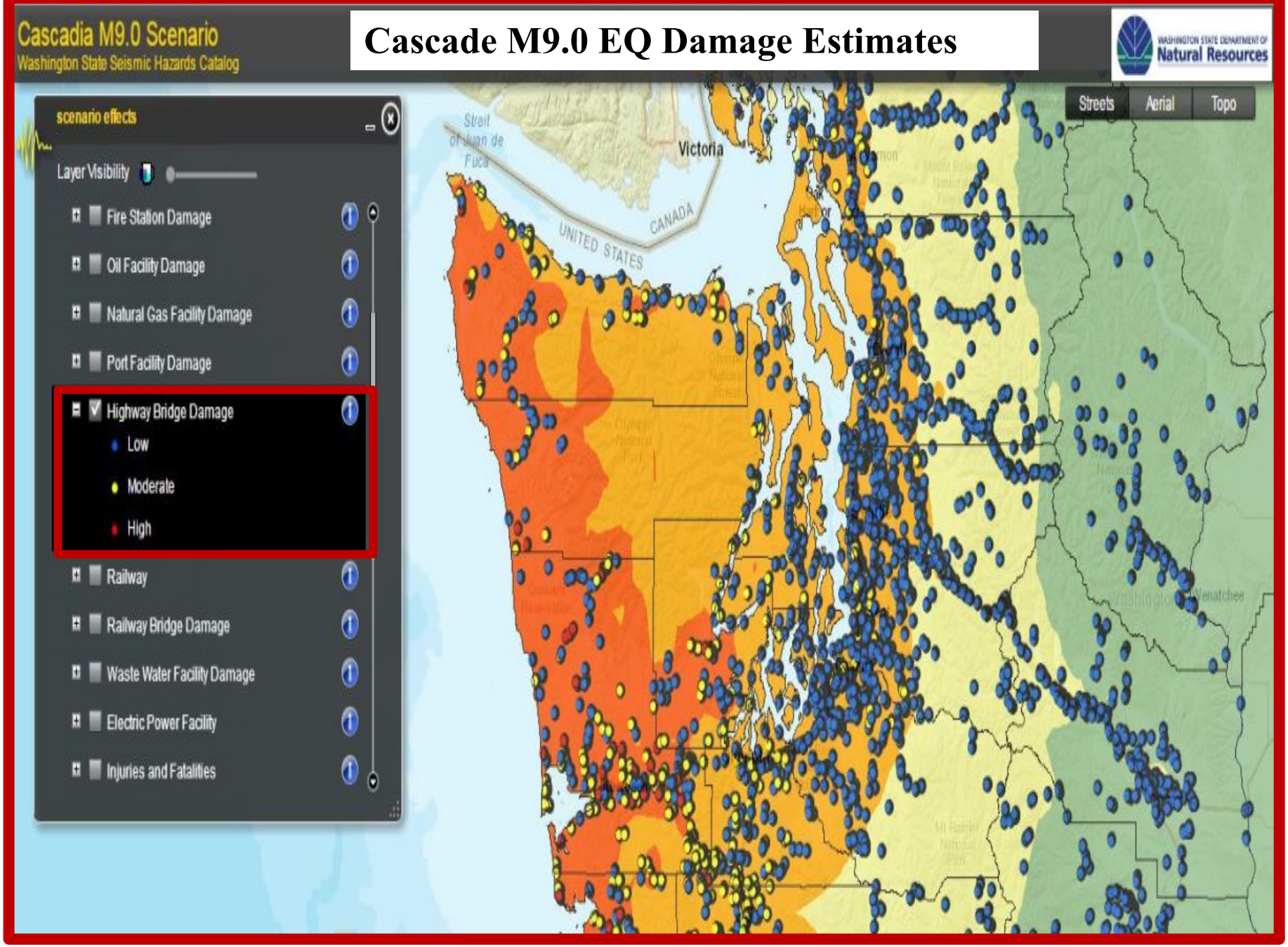


Source: USGS

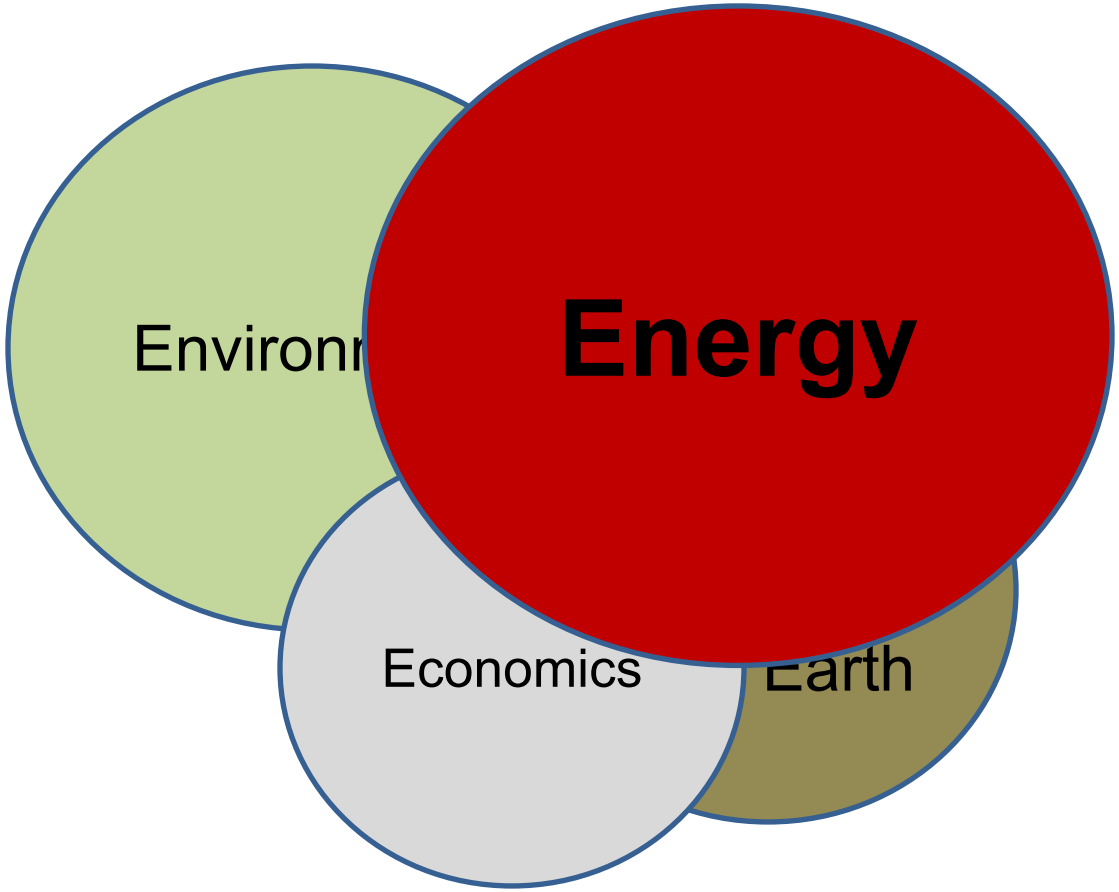
STAFF GRAPHIC


2/23/2017 — NIGHTLY EARTHQUAKE UPDATE + FORECAST — WEST COAST / PACIFIC NORTHWEST M4.8 + M4.2 EARTHQUAKES
4.8
4.2
Cascade Subduction
2.8
2.9
3.4
3.3
3.0
2.6
Oil + Gas Fracking
Offshore Oil + Gas pumping
EARTHQUAKE 3D
●23↗↓ D72↓ FEB·23·2017 07:44 UTC

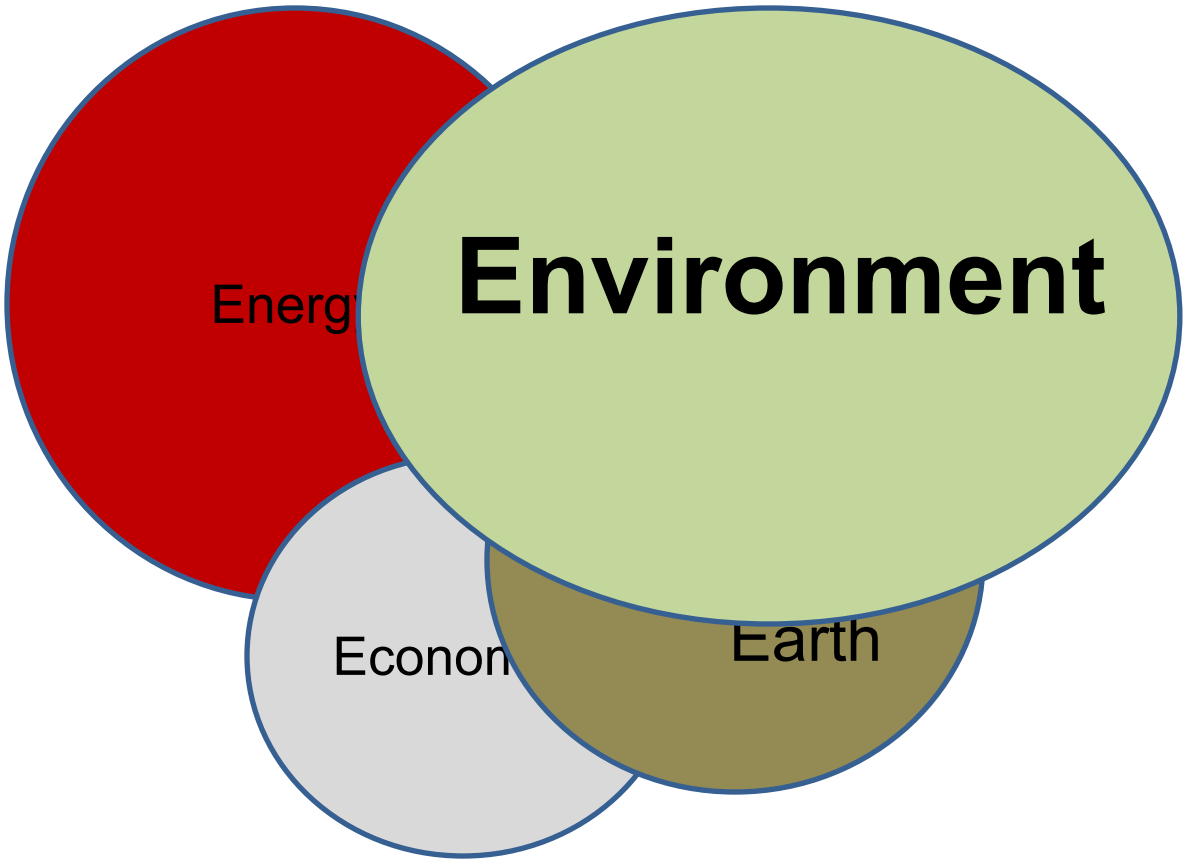
Cascade M9.0 EQ Damage Estimates



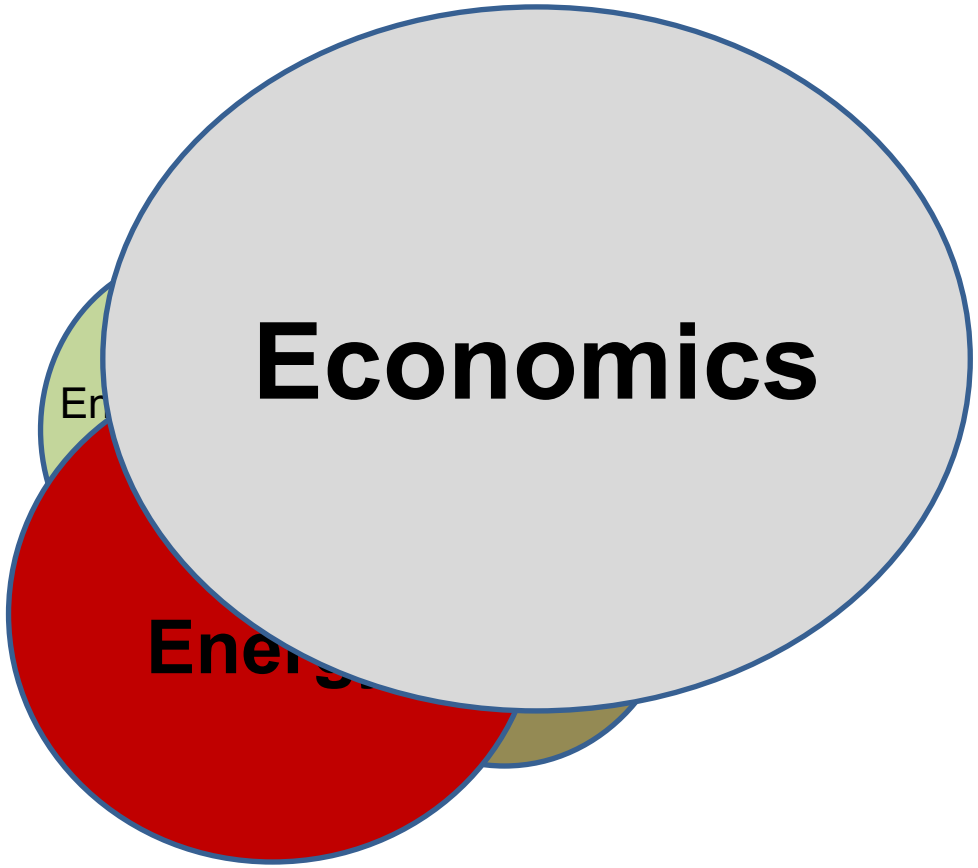
THE 4 E'S



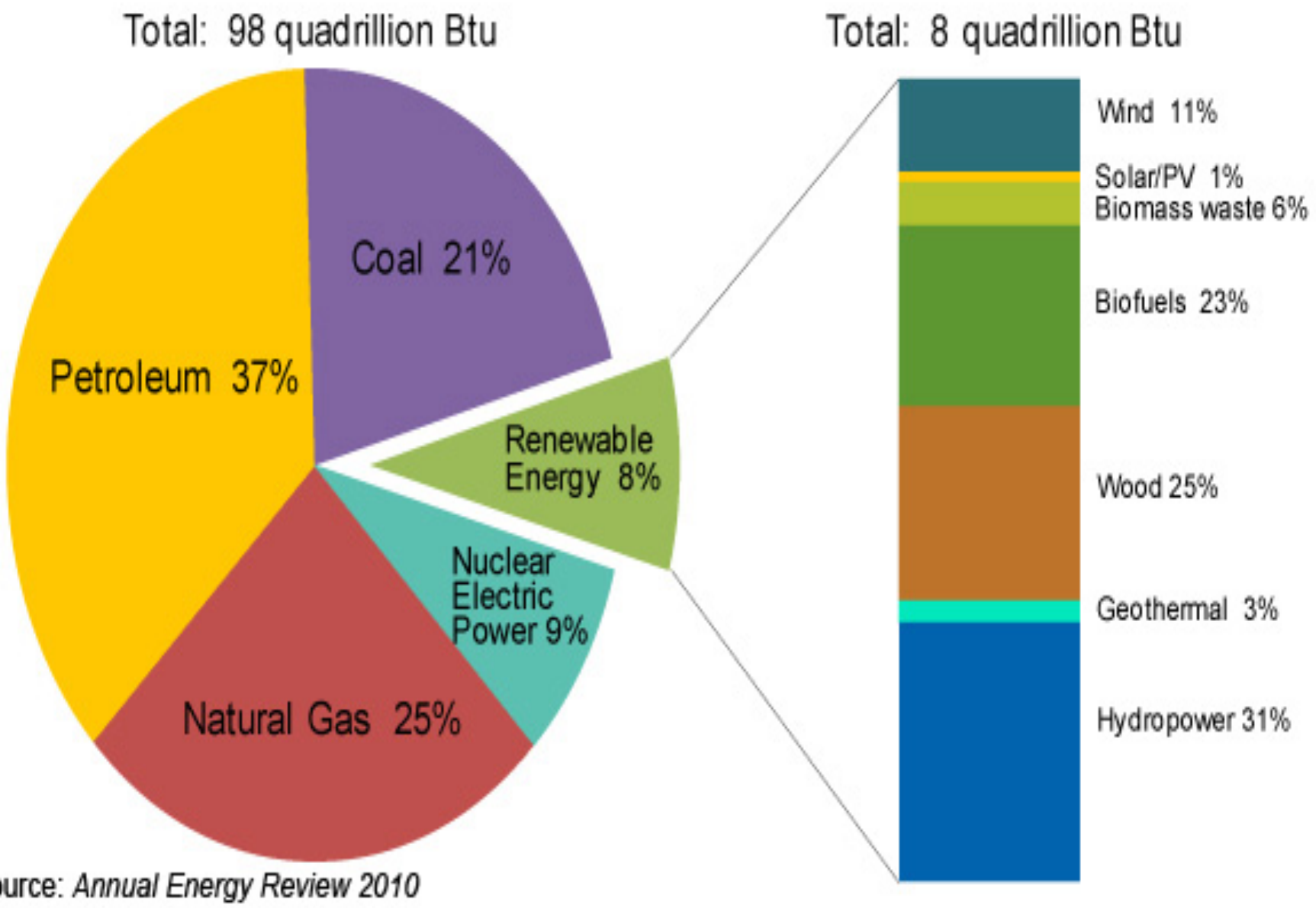
1970s

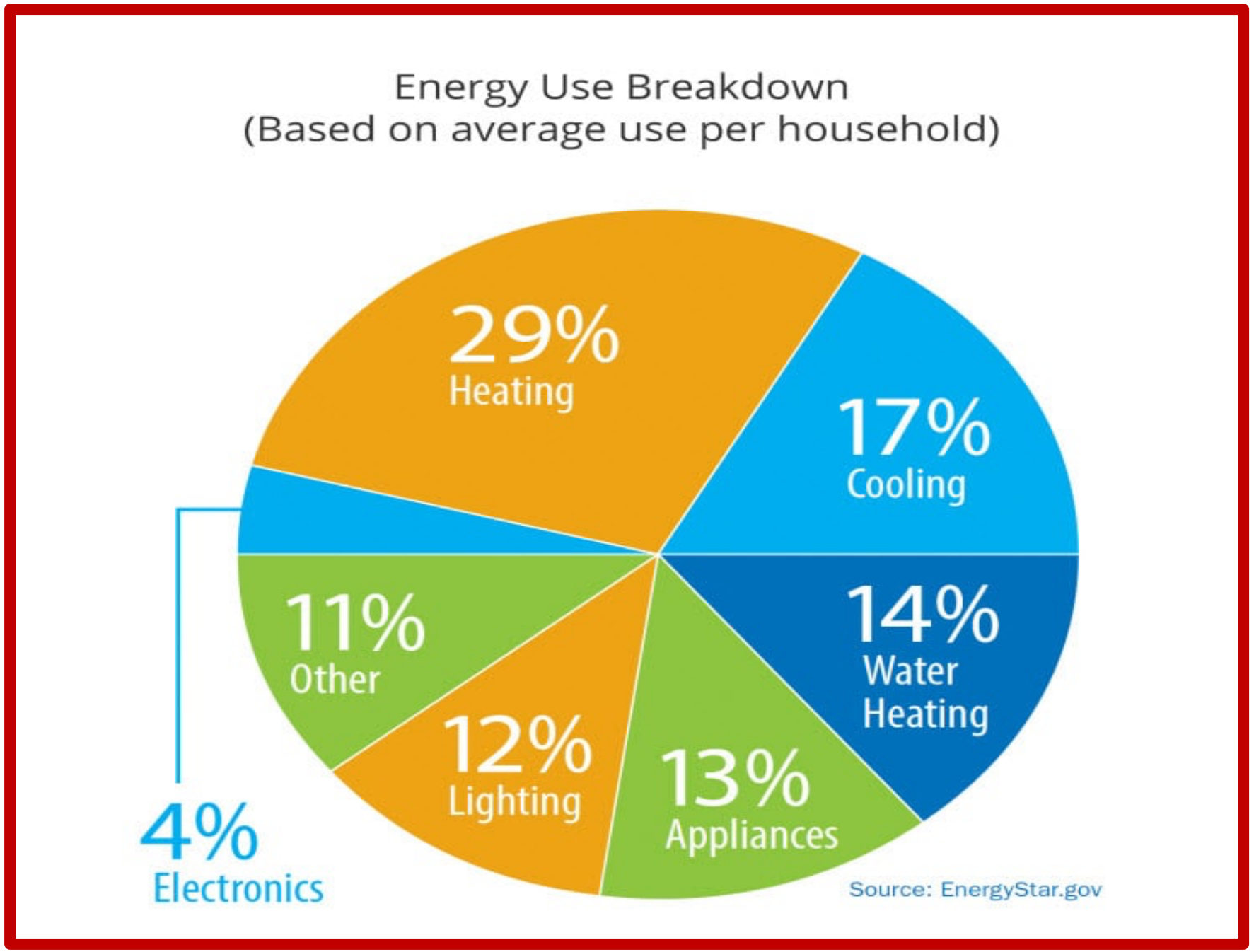


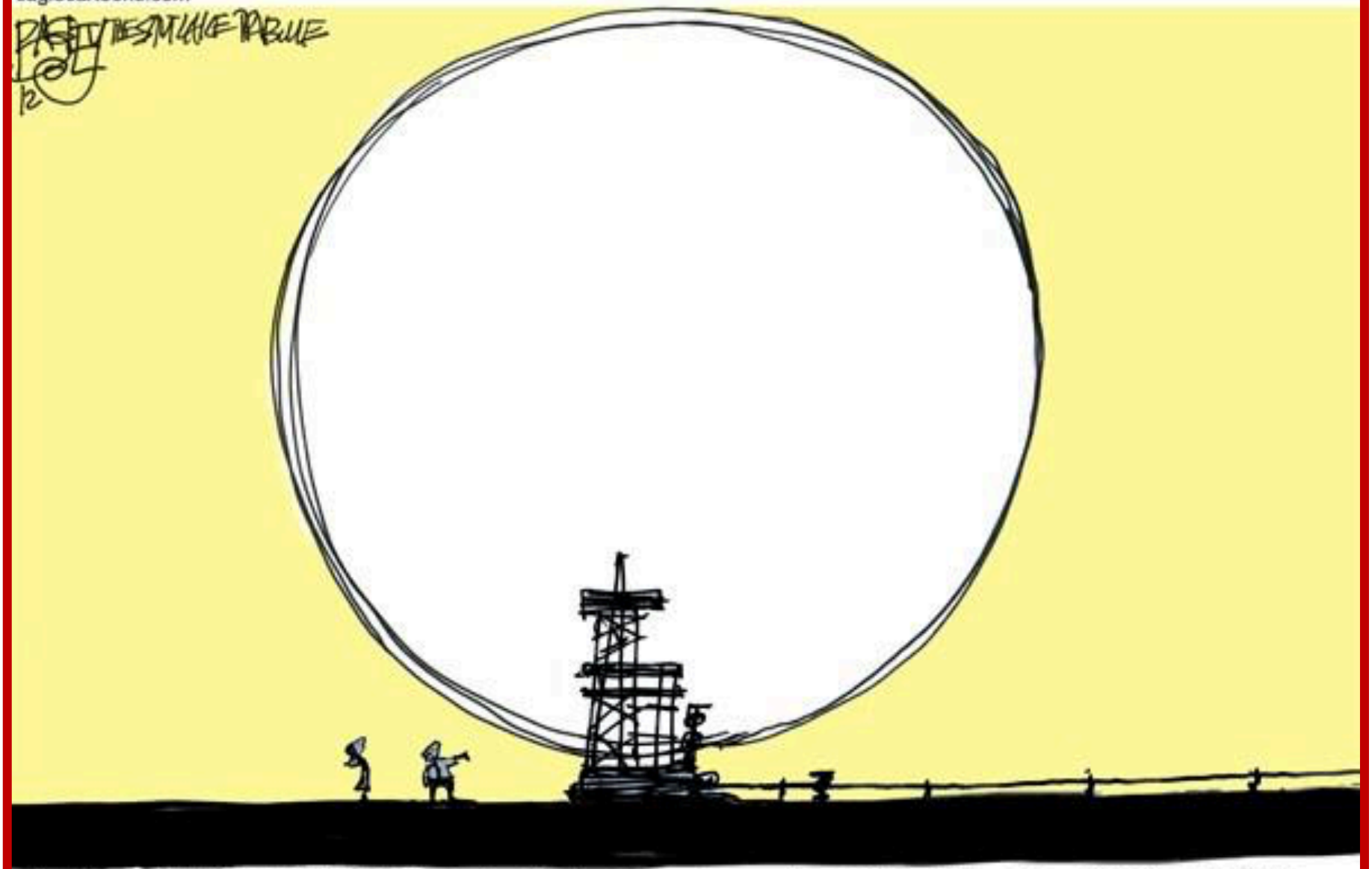
1980s



2000-20??


Total: 98 quadrillion Btu
Coal 21%
Petroleum 37%
Renewable Energy 8%
Nuclear Electric Power 9%
Natural Gas 25%
Total: 8 quadrillion Btu
Wind 11%
Solar/PV 1%
Biomass waste 6%
Biofuels 23%
Wood 25%
Geothermal 3%
Hydropower 31%
Source: Annual Energy Review 2010


Energy Use Breakdown
(Based on average use per household)
29%
Heating
17%
Cooling
14%
Water
Heating
13%
Appliances
12%
Lighting
11%
Other
4%
Electronics
Source: EnergyStar.gov



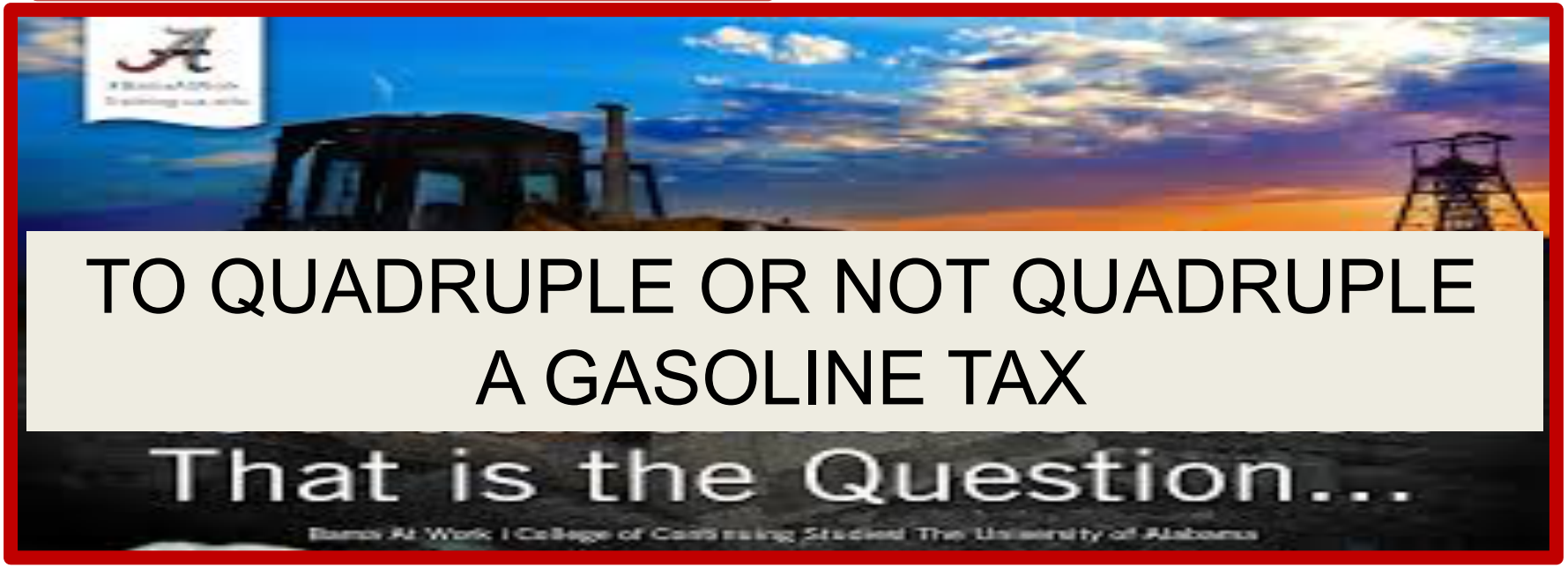
"SURE, FRACKING MAY CAUSE EARTHQUAKES AND POLLUTE GROUND WATER, BUT YOU'RE LOOKING AT THE WORLD'S BIGGEST SOURCE OF UNTAPPED ENERGY!"

Hamlet said to Ophelia

I'll makea sketch of thee

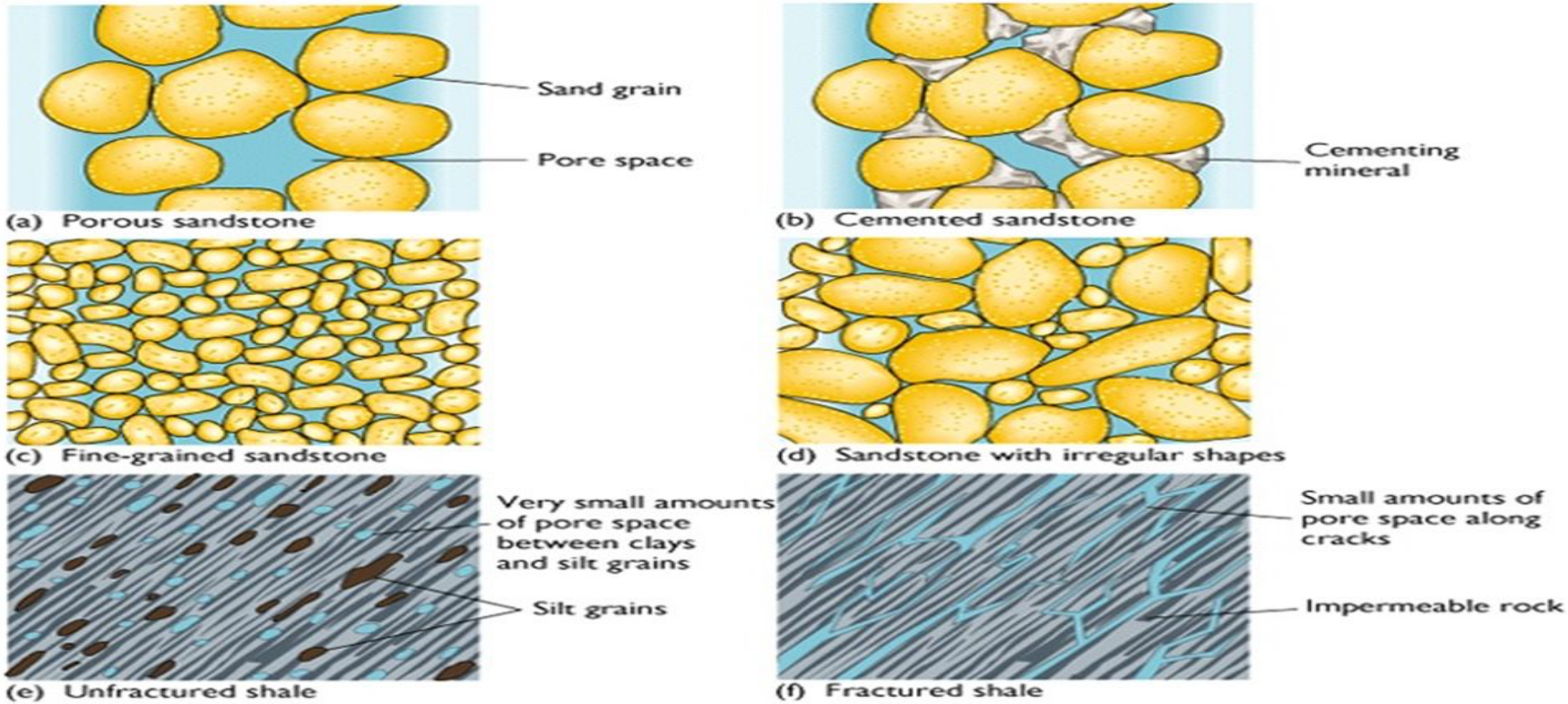
What size pencil shall I use?

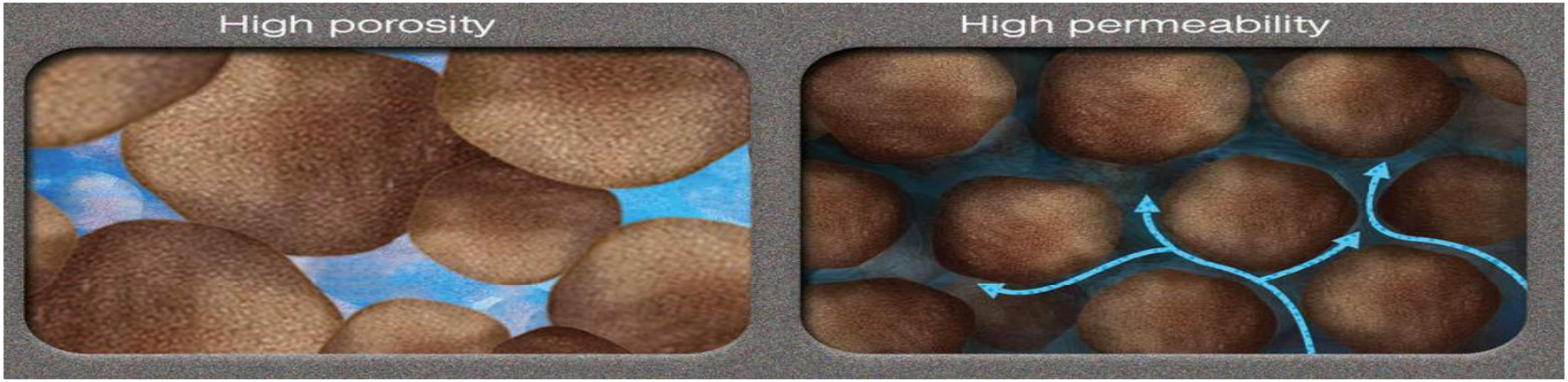
2B or not 2B



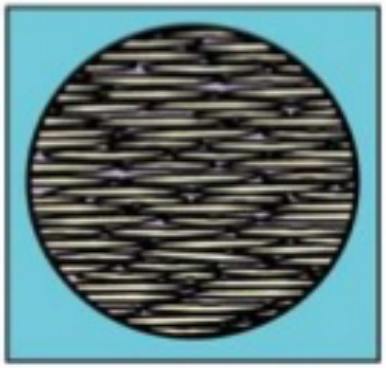
Fundamentals of Petroleum Geology

Porosity and Permeability

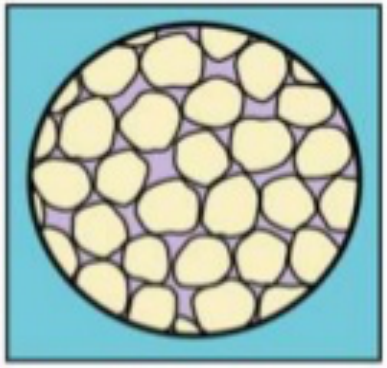




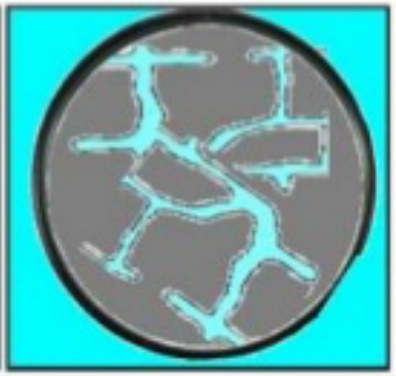
Oil and Gas are typically found in SEDIMENTARY ROCKS.



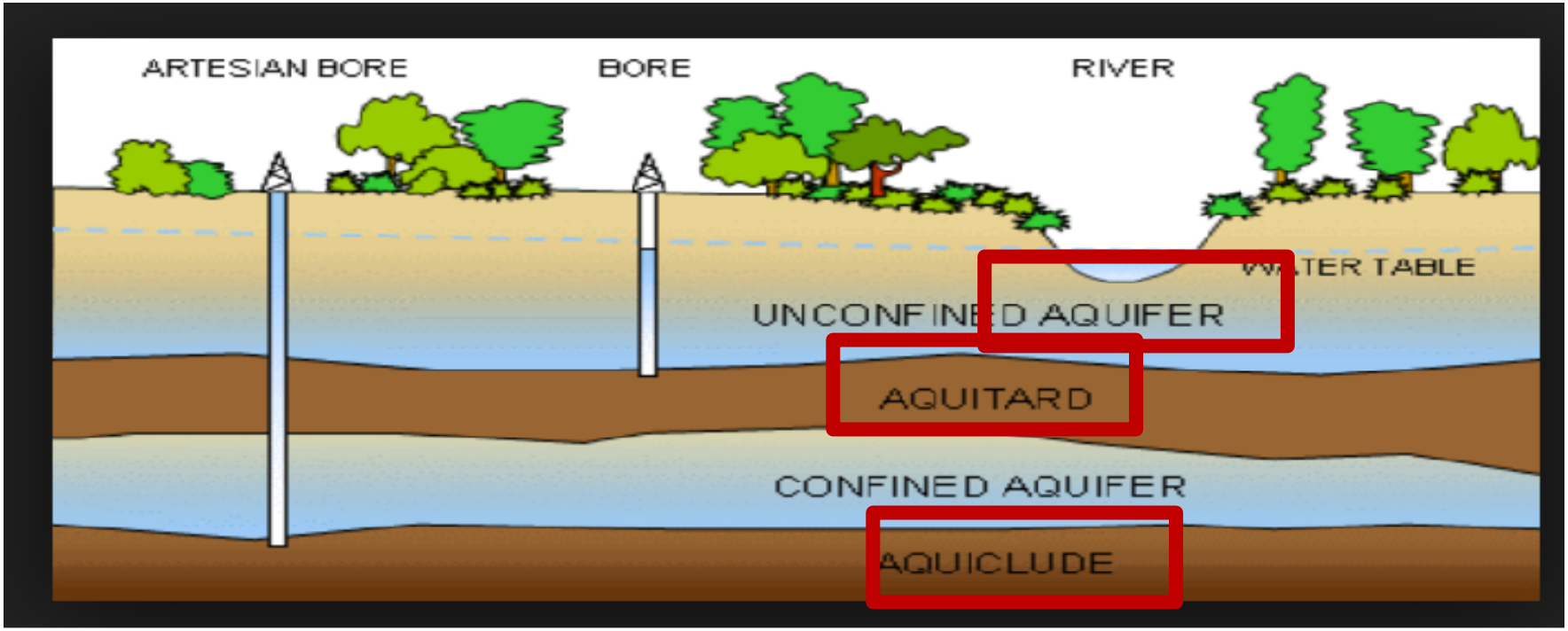
SHALE: has 'platy' particles, like decks of cards. There is ***some porosity*** but very ***little permeability***. Until recently shales were considered to be source rocks. Many shales are now considered as "unconventional reservoirs" and require fracturing (or 'fraccing') to induce oil and gas to flow.



SANDSTONE: has 'spherical' particles and typically has ***good porosity*** and ***good permeability***. The 'best' reservoirs are frequently sandstone reservoirs.

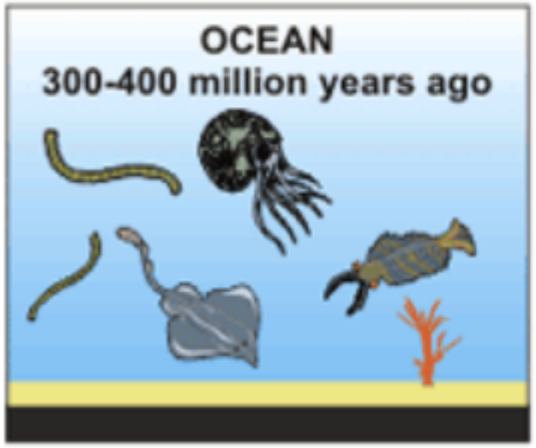


LIMESTONE: has irregular shaped particles like the shells that they are made of. The porosity is typically 'vuggy' or irregular as are the connections between the pore spaces.

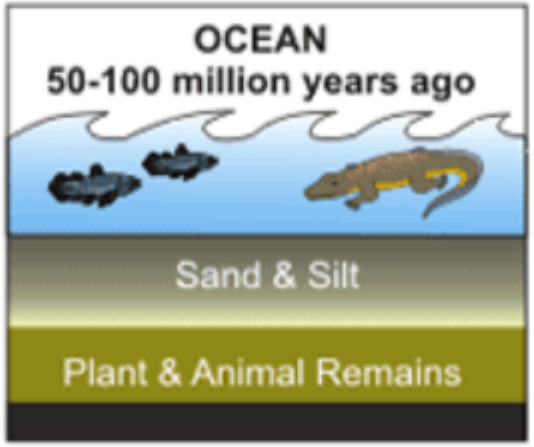


- **Aquifers are underground layers of very porous water-bearing soil or sand.**
- **An aquitard is a zone within the Earth that restricts the flow of groundwater from one aquifer to another.**
  - ✓ **Aquitards comprise layers of either clay or non-porous rock with low hydraulic conductivity.**
- **A completely impermeable aquitard is called an aquiclude or aquifuge.**

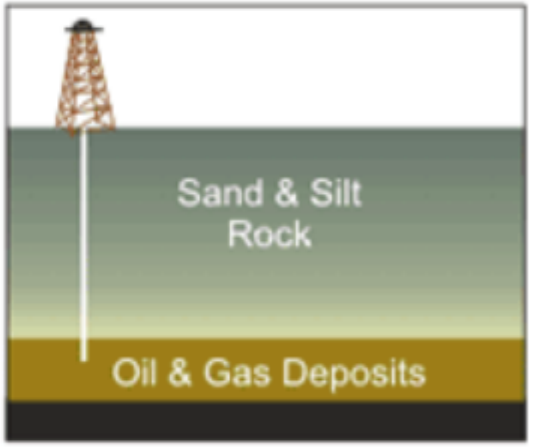
PETROLEUM & NATURAL GAS FORMATION



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.

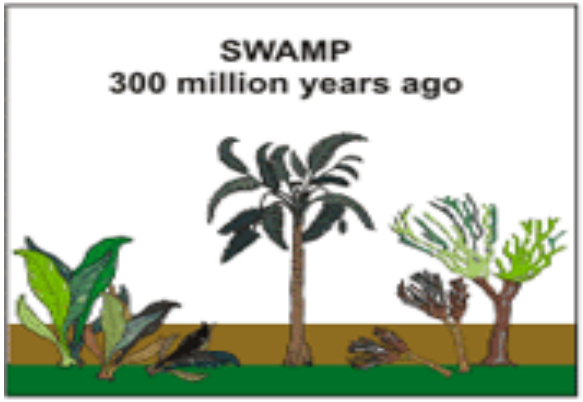


Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

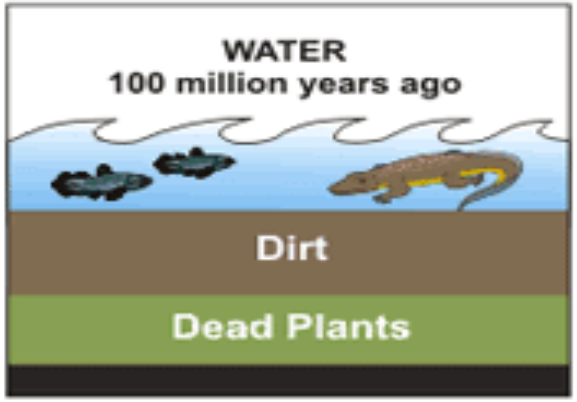


Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

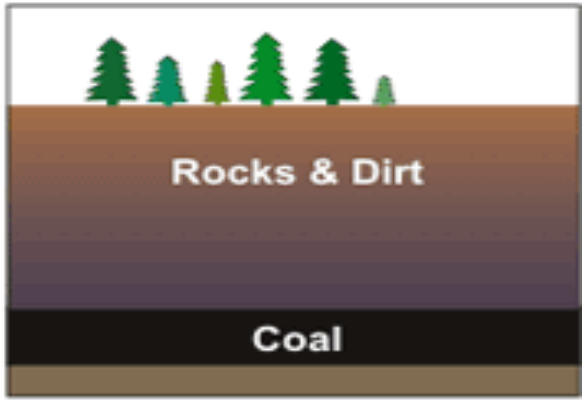
HOW COAL WAS FORMED



Before the dinosaurs, many giant plants died in swamps.



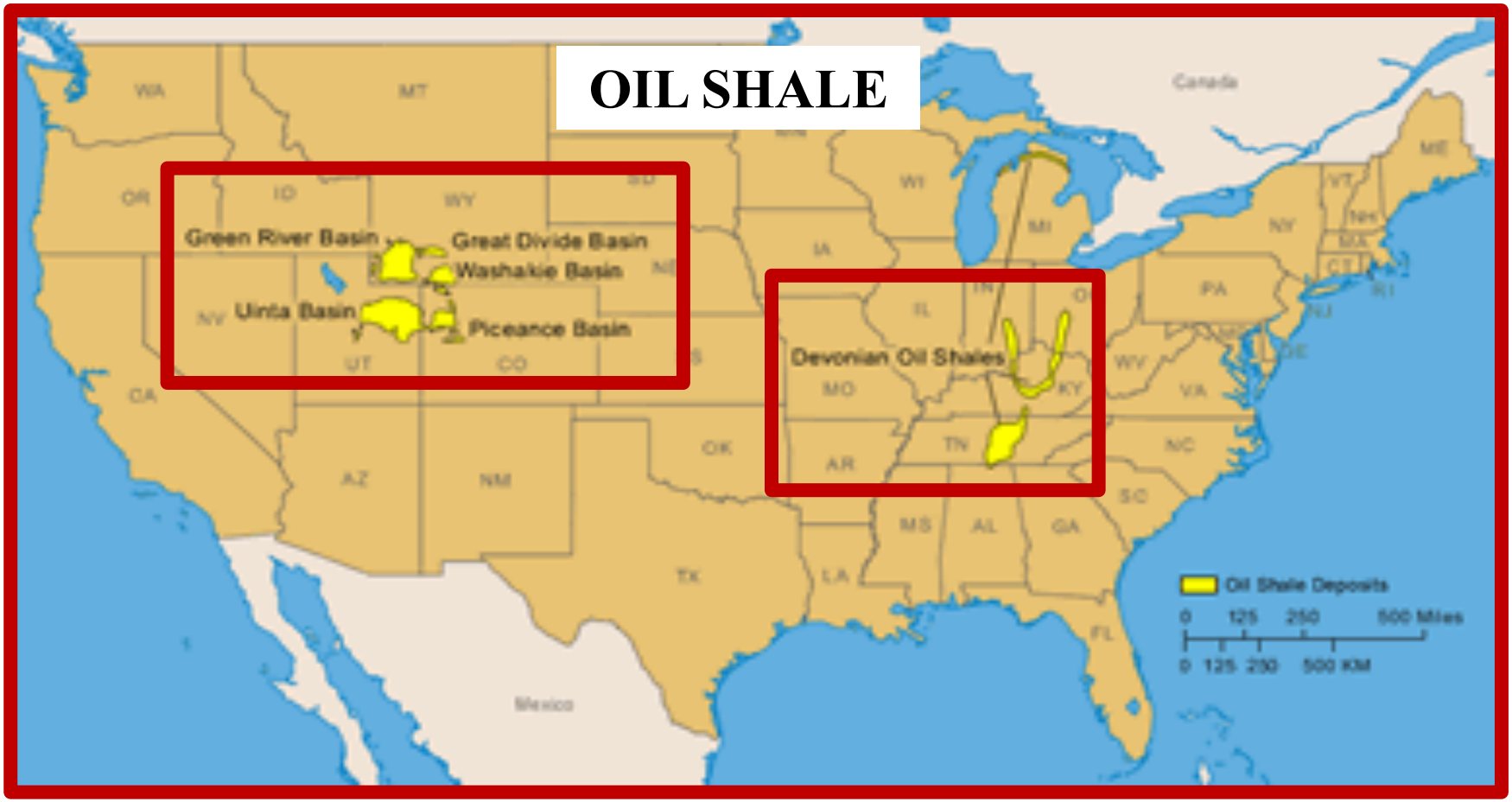
Over millions of years, the plants were buried under water and dirt.



Heat and pressure turned the dead plants into coal.

Oil Shale versus Shale Gas

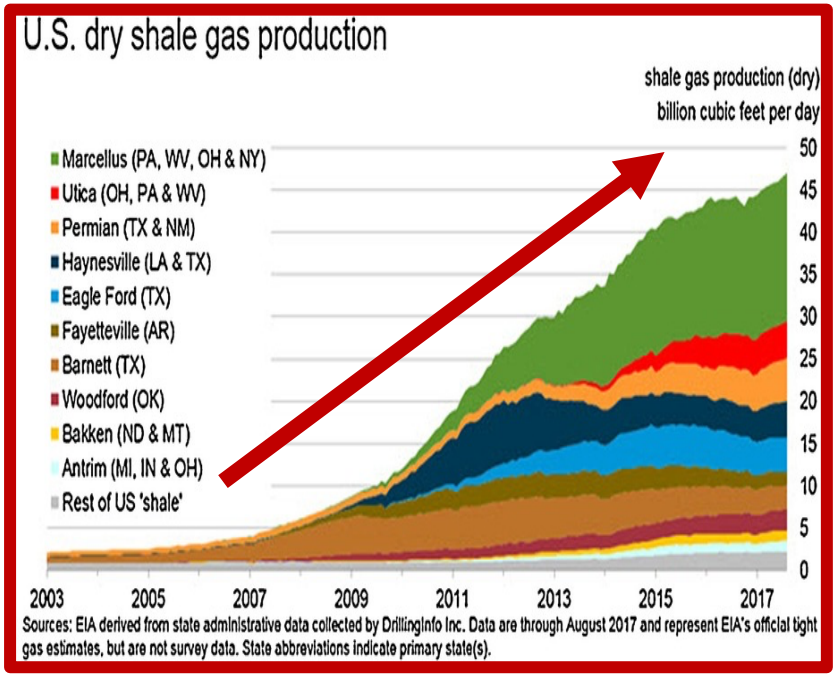
- **Oil shale is essentially rock that contains solid bits of kerogen, a precursor to oil.**
- **All oil is from organic matter that is subjected to intense heat and pressure until it breaks down into hydrocarbons.**
- **With the kerogen in oil shale, there wasn't quite enough heat to finish the job – but that, of course, can be fixed.**
- **Two methods have been developed to extract petroleum products from oil shale.**
  - ✓ **One is to mine it like the rock it is, and then heat it in the low-oxygen environment needed to turn the kerogen into oil and gas.**
  - ✓ **The other method is to heat the oil in situ, applying heat to the formation, and then pumping out the resulting oil.**
- **The major difference between these methods is that the first one requires more heat than the second.**

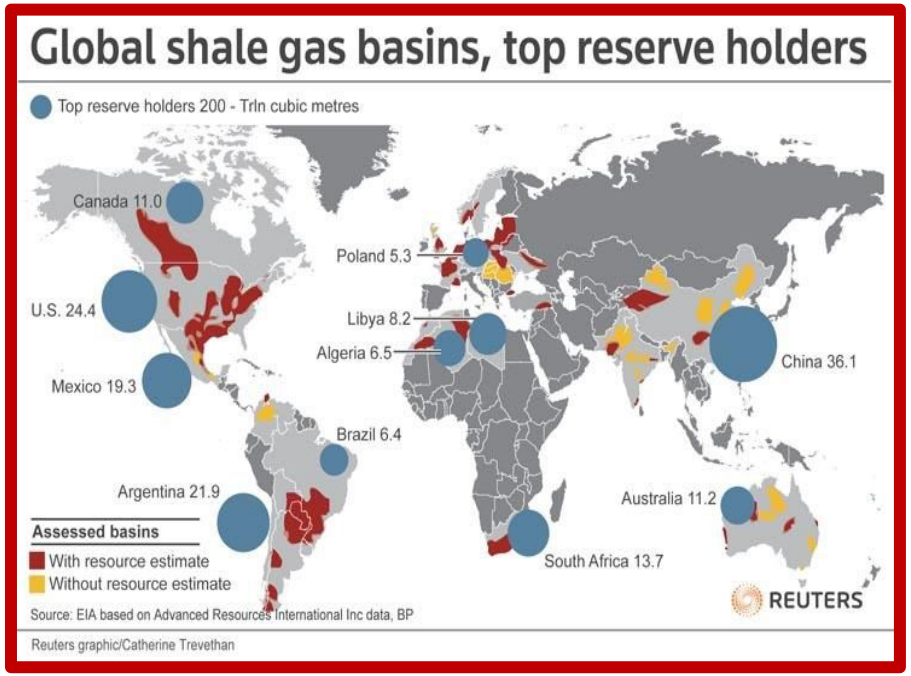


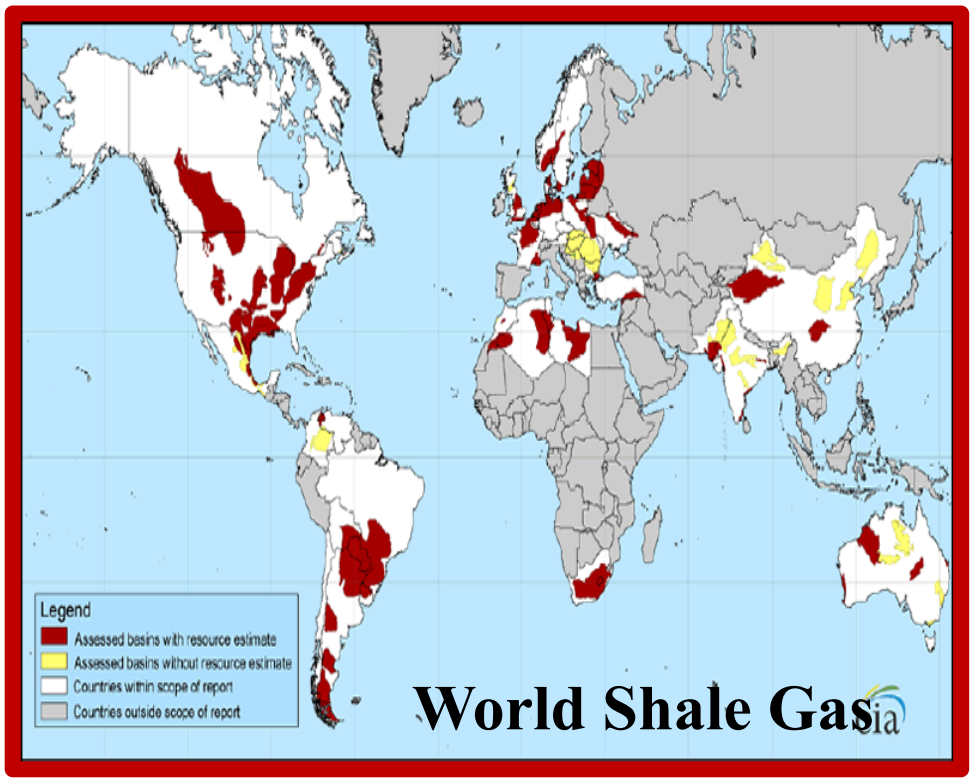
- United States: Areas underlain by the Green River Formation in Colorado, Utah, and Wyoming.
- Major areas of surface minable Devonian oil shale in the eastern United States.

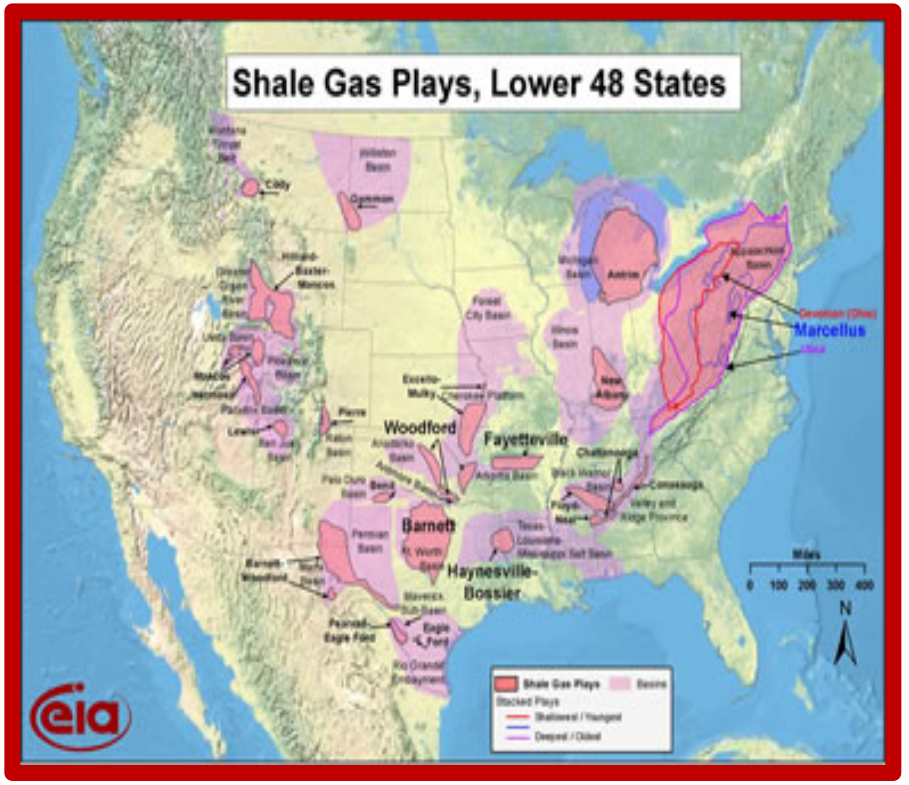
What is shale gas?

- Basically, it is natural gas – primarily methane – found in shale formations, some of which were formed 300 to 400 million years ago.
- Some of the methane that formed from the organic matter buried with the sediments escaped into sandy rock layers adjacent to the shales, forming conventional accumulations of natural gas which are relatively easy to extract. This gas has been normally extracted for many years!
- But some of it remained locked in the tight, low permeability shale layers, becoming shale gas and requiring Fracking.



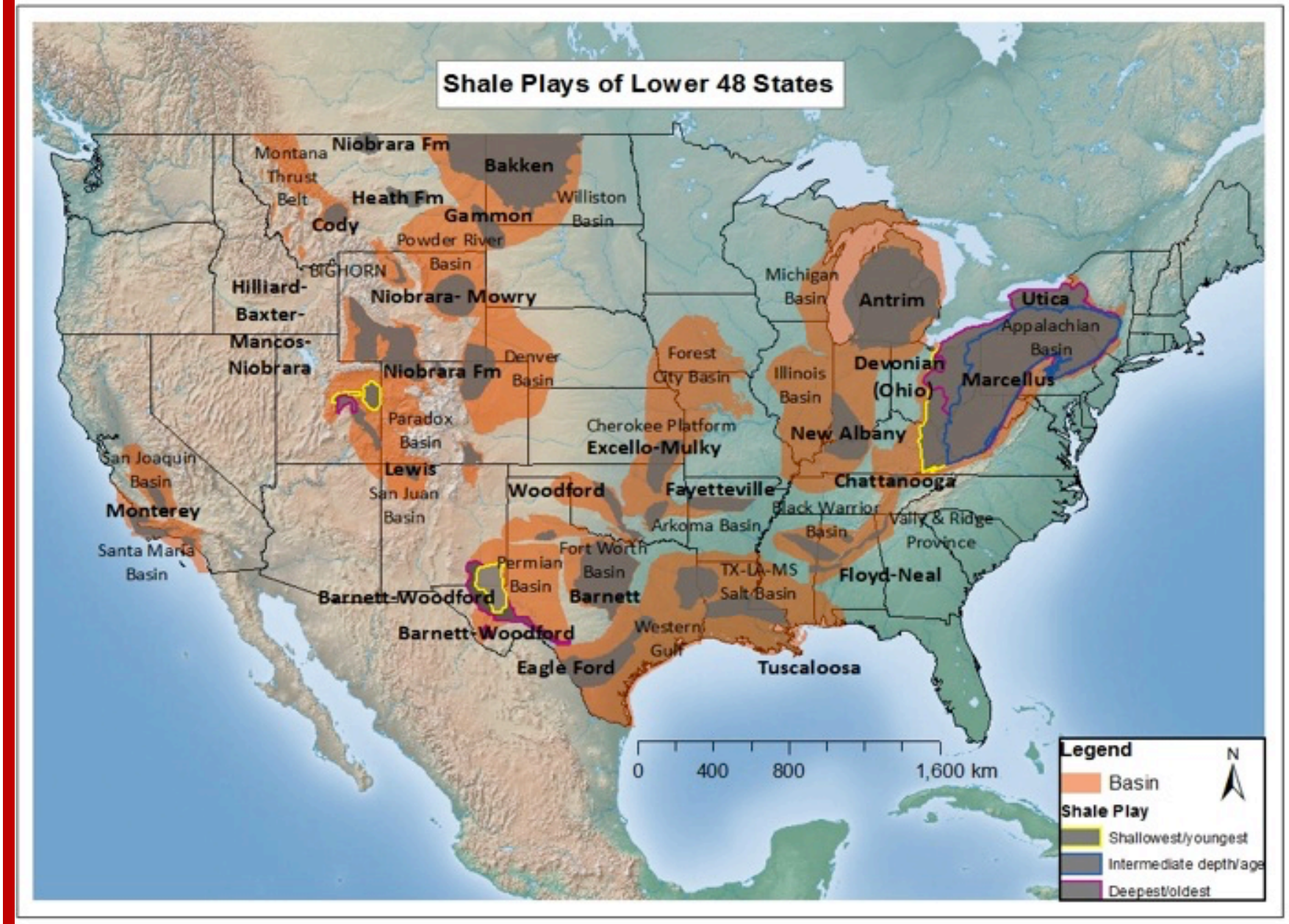




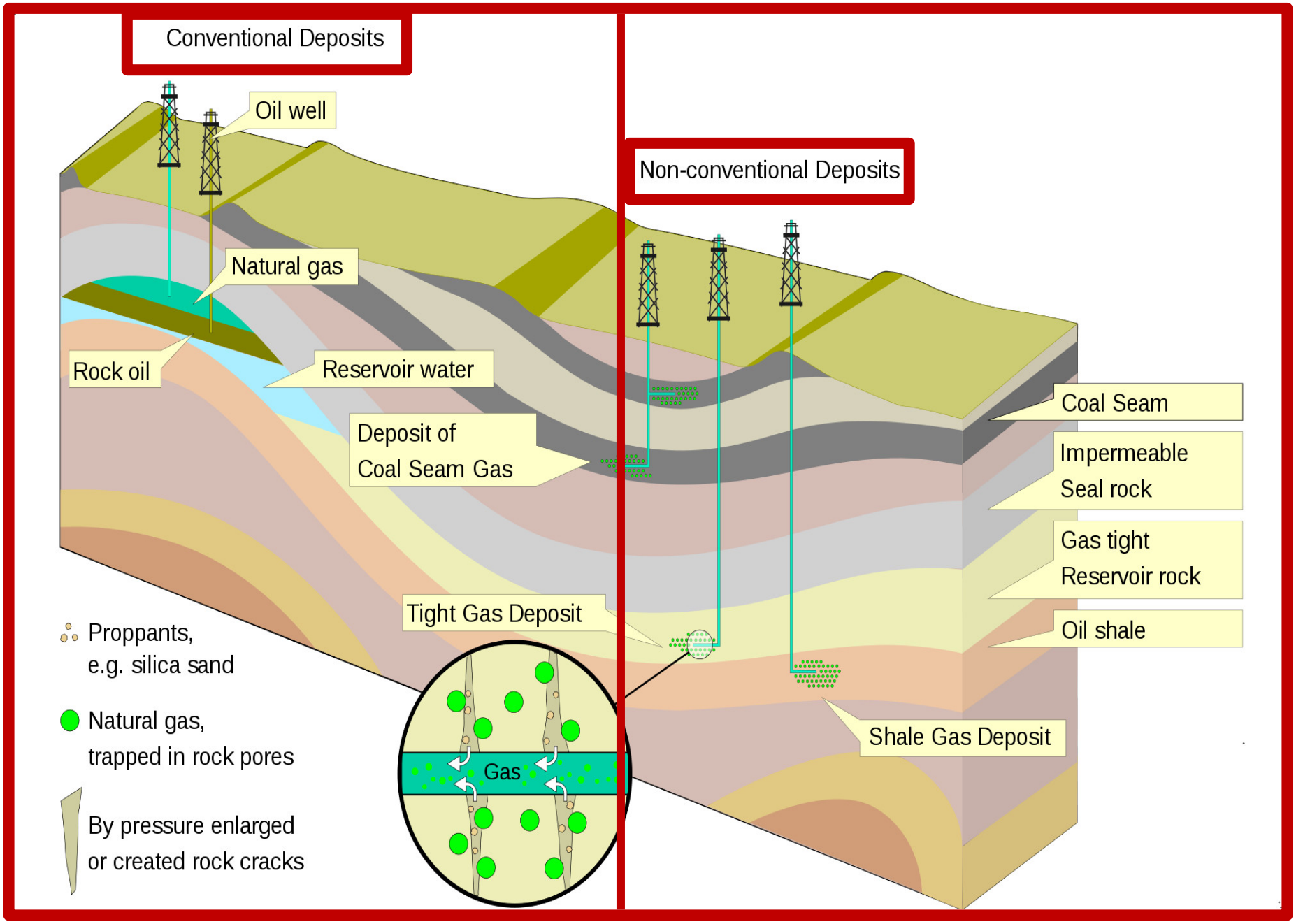


What Triggered the U.S. Shale Gas Revolution?

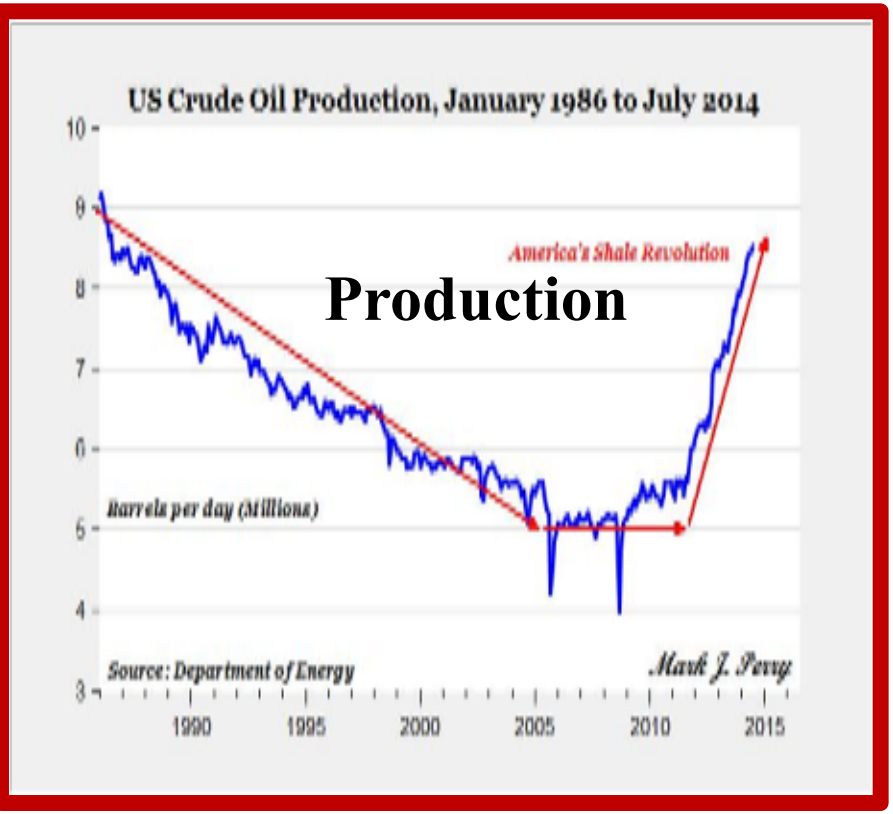
- The use of **horizontal drilling** in conjunction with **hydraulic fracturing** has greatly expanded the ability of producers to profitably produce natural gas from low-permeability geologic formations, particularly **shale** formations.
- Application of fracturing techniques to stimulate **oil and gas** production began to grow rapidly in the 1950s, although experimentation dates back to the 19th century.

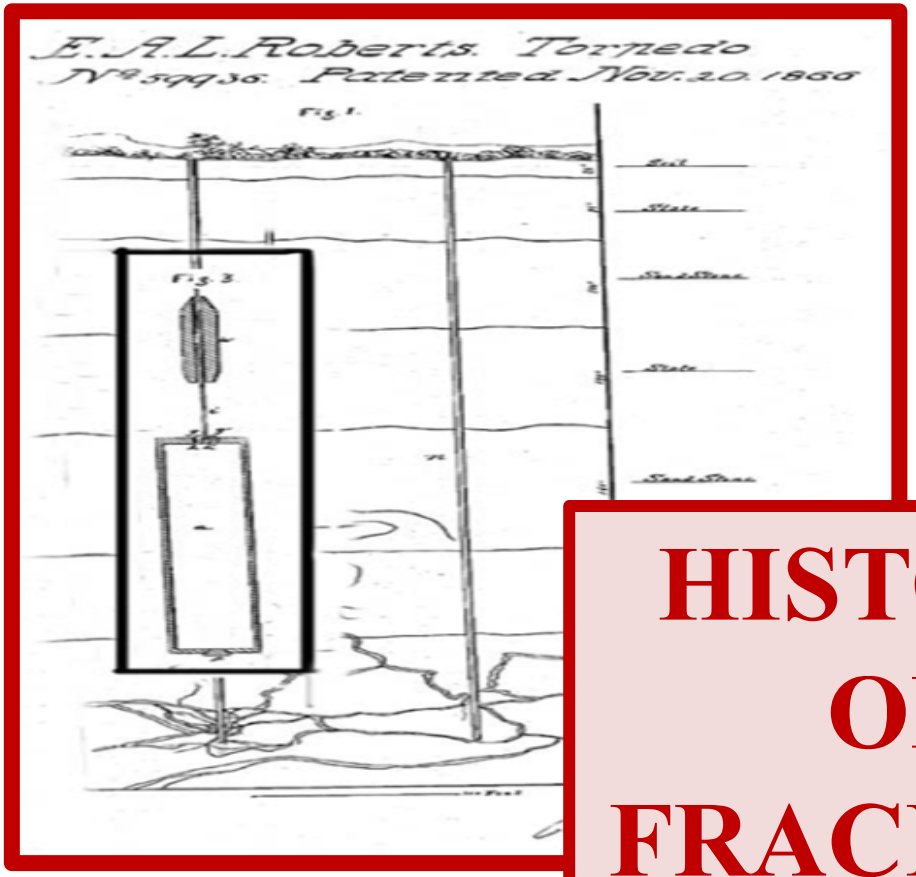

Shale Plays of Lower 48 States
Niobrara Fm
Bakken
Montana Thrust Belt
Heath Fm
Williston Basin
Gammon
Cody
Powder River Basin
BIGHORN
Hilliard-Baxter-Mancos-
Niobrara- Mowry
Michigan Basin
Antrim
Utica
Appalachian Basin
Niobrara
Niobrara Fm
Denver Basin
Forest City Basin
Illinois Basin
Devonian (Ohio)
Marcellus
Paradox Basin
Cherokee Platform
Excello-Mulky
New Albany
San Joaquin Basin
Lewis
San Juan Basin
Woodford
Fayetteville
Chattanooga
Monterey
Black Warrior Basin
Valley & Ridge Province
Arkoma Basin
Santa Maria Basin
Fort Worth Basin
Permian Basin
TX-LA-MS Salt Basin
Floyd-Neal
Barnett-Woodford
Barnett
Barnett-Woodford
Western Gulf
Eagle Ford
Tuscaloosa
0
400
800
1,600 km
Legend
N
Basin
Shale Play
Shallowest/youngest
Intermediate depth/age
Deepest/oldest

Fracking


Conventional Deposits
Oil well
Natural gas
Rock oil
Reservoir water
Deposit of
Coal Seam Gas
Tight Gas Deposit
Gas
Proppants,
e.g. silica sand
Natural gas,
trapped in rock pores
By pressure enlarged
or created rock cracks
Non-conventional Deposits
Coal Seam
Impermeable
Seal rock
Gas tight
Reservoir rock
Oil shale
Shale Gas Deposit

- Modern day fracking didn't begin until the 1990s when a new technique was created which took hydraulic fracturing and combined it with horizontal drilling.
- Hydraulic fracturing has been around for 100+ years..
- Why did this shale oil production boom occur so long after the technology was created?
- These two charts will help explain why.

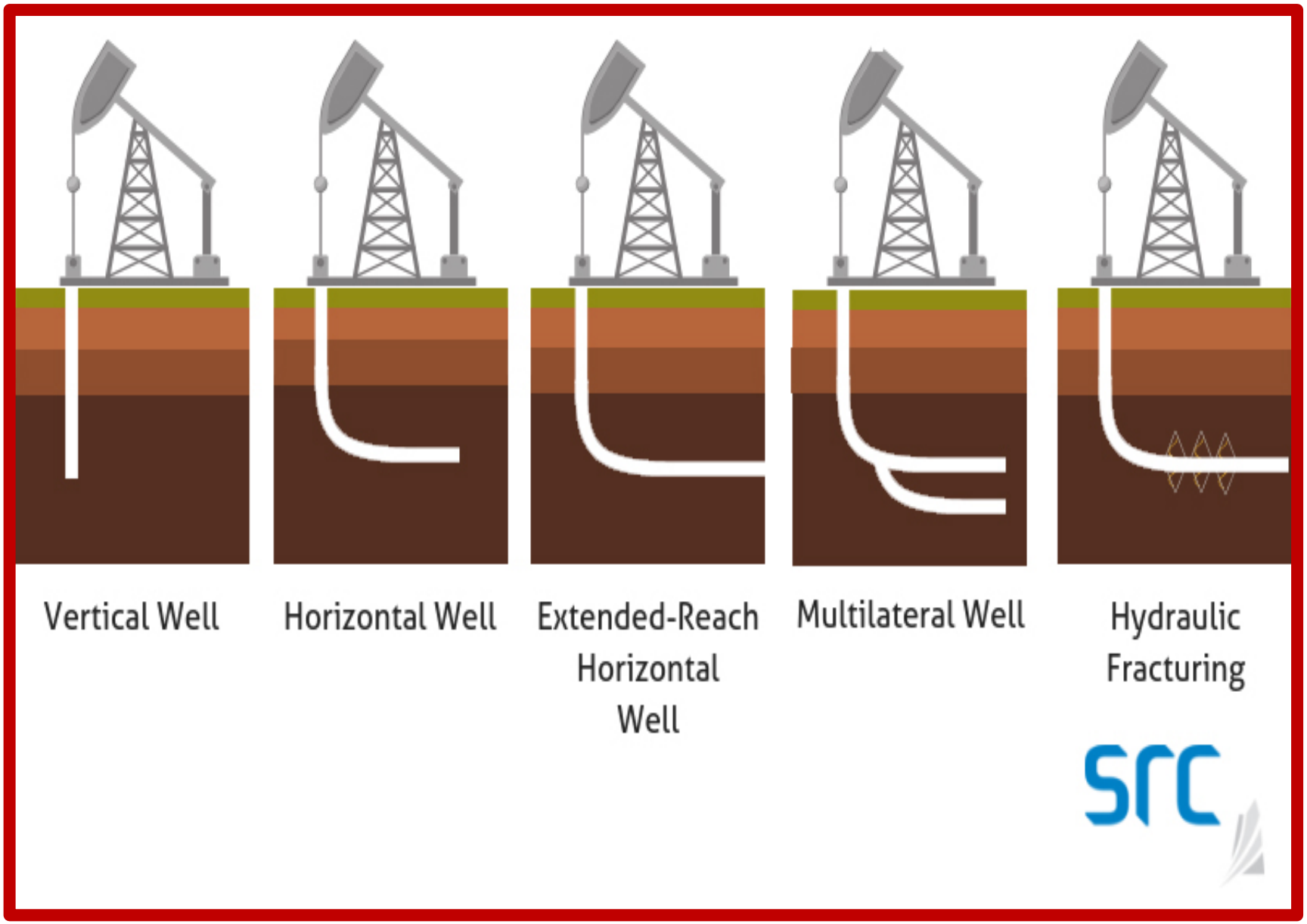


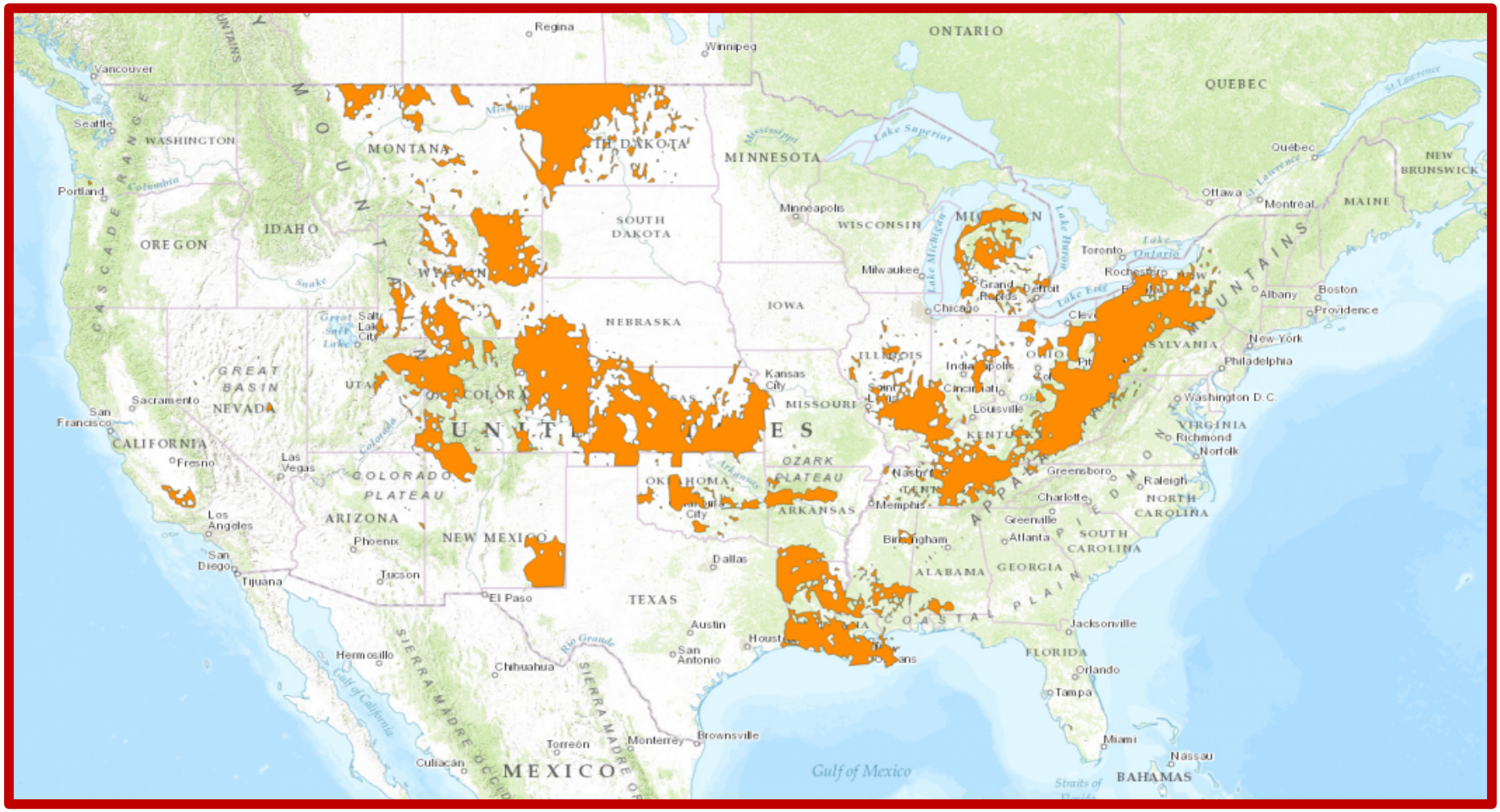


HISTORY OF FRACKING

- In November of 1866, Edward Roberts was awarded patient number 59,936, known as the “Exploding Torpedo.”
- Modern day fracking didn’t begin until the 1990s.
- This originated when George P. Mitchell created a new technique, which took hydraulic fracturing, and combined it with horizontal drilling.

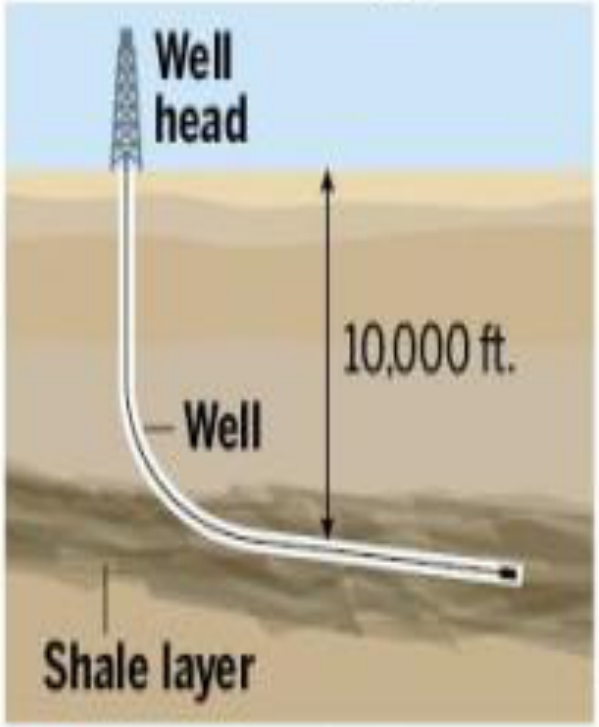
History of horizontal directional drilling

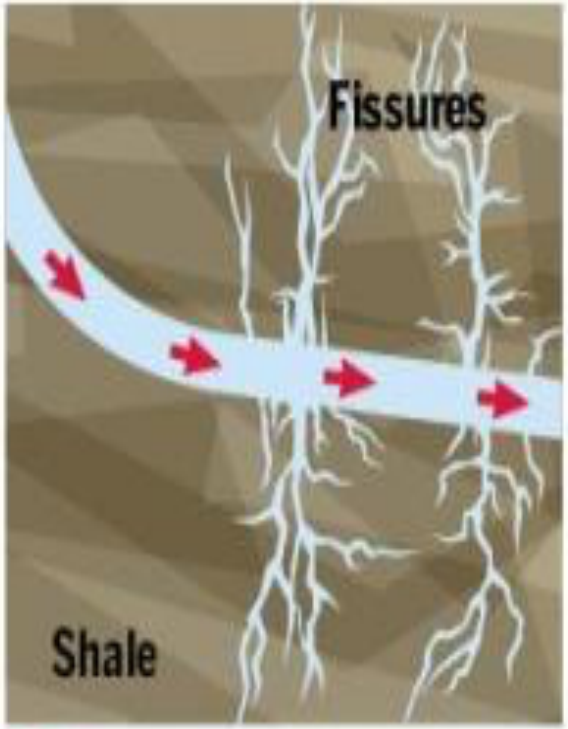


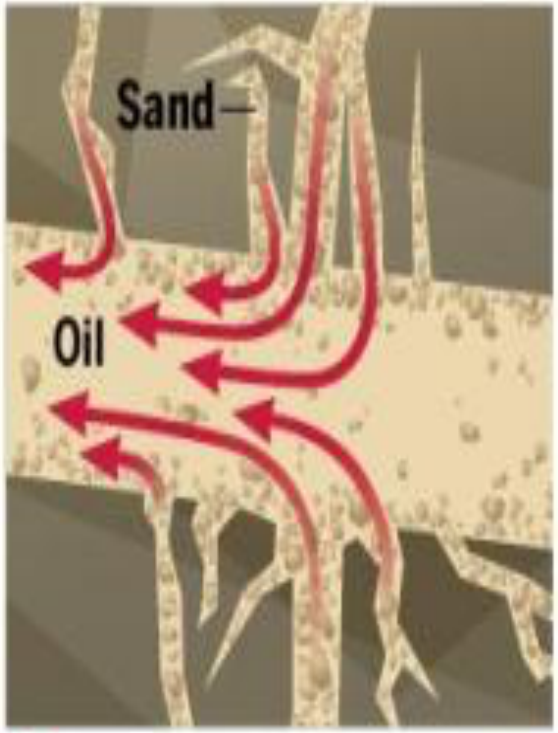


- ***Areas where America's 1.1 million oil and gas wells, both conventional and hydraulically fractured, are found are highlighted in orange.***
- ***Texas, where many of the wells are concentrated, is excluded because FracTracker was unable to publish data from the state.***

How fracking works







1. Wells are bored using directional drilling, a method that allows drilling in vertical and horizontal directions to depths of over 10,000 feet.

2. Large amounts of water, sand and chemicals are injected into the well at high pressure, causing fissures in the shale.

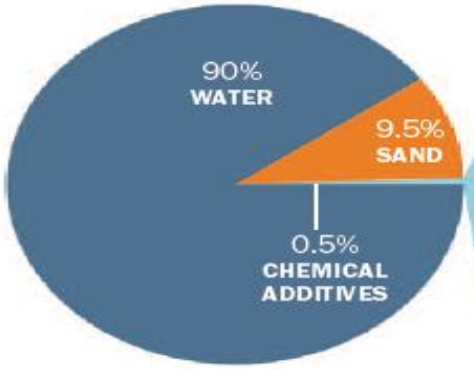
3. Sand flows into the fissures, keeping them open so that the oil from the shale can flow up and out of the well.

Sources: USC, Los AngelesTimes

McCLATCHY-TRIBUNE

- Many fracking chemicals are protected from disclosure under trade secret exemptions.
- For each frack, 80-300 tons of chemicals may be used, selected from a menu of up to 600 *different* chemicals.

Typical Shale Fracturing Mixture Makeup

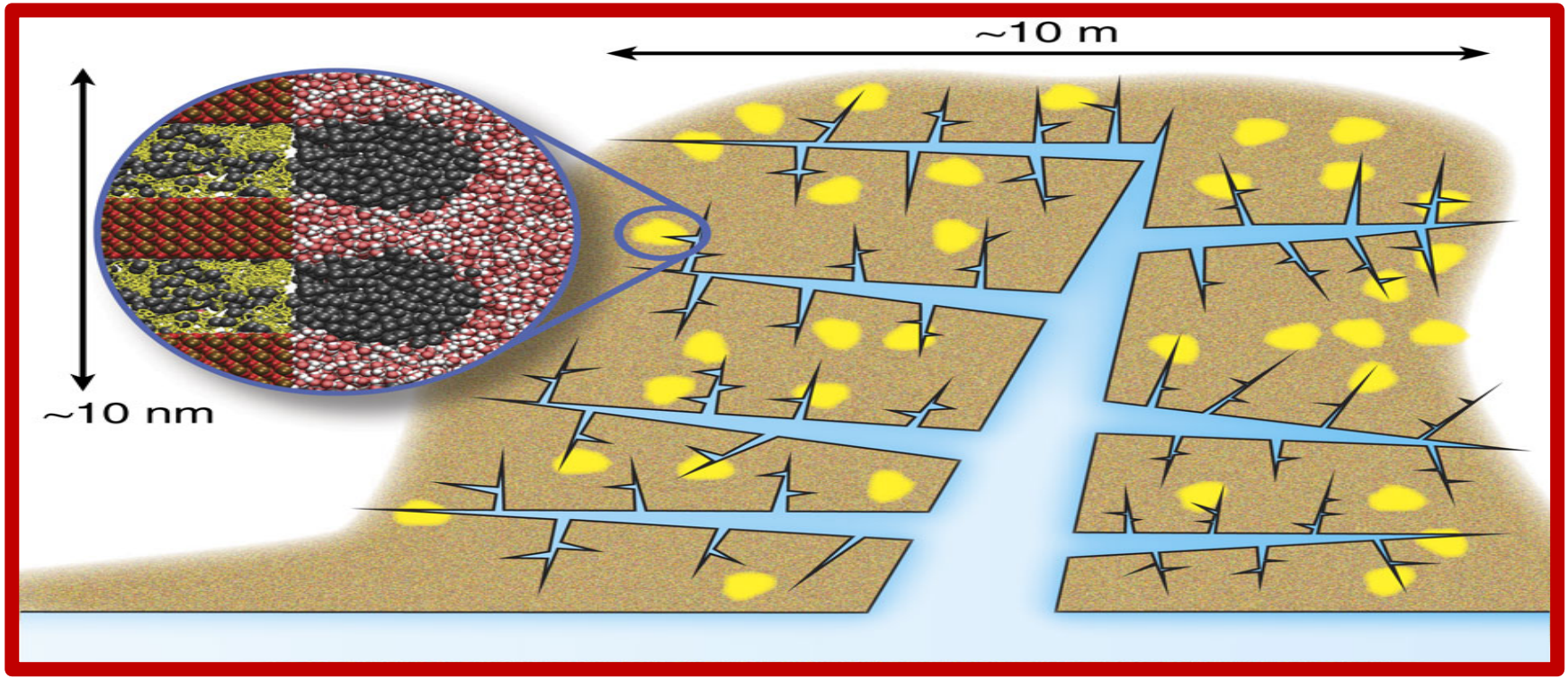


Typical Chemical Additives Used in Frac Water

Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

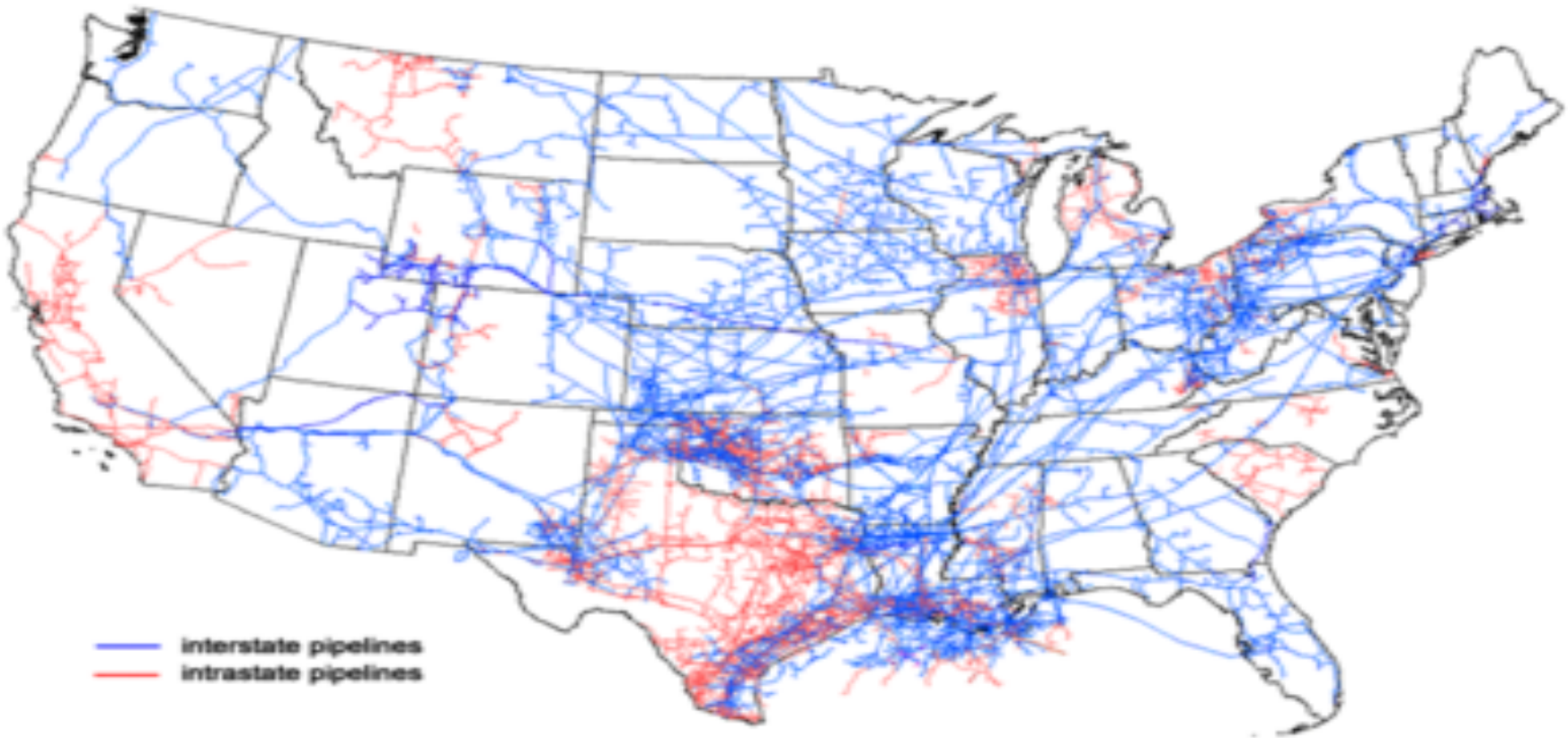
Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009).

One Way to Solve Fracking's Water Problem: Don't Use Water



- Fracking, up close: Tiny gas deposits (yellow) are distributed throughout shale rock (tan).
- High pressure breaks up the rock and water (blue) washes out the gas molecules.
- A new study suggests CO_2 may do water's job better.

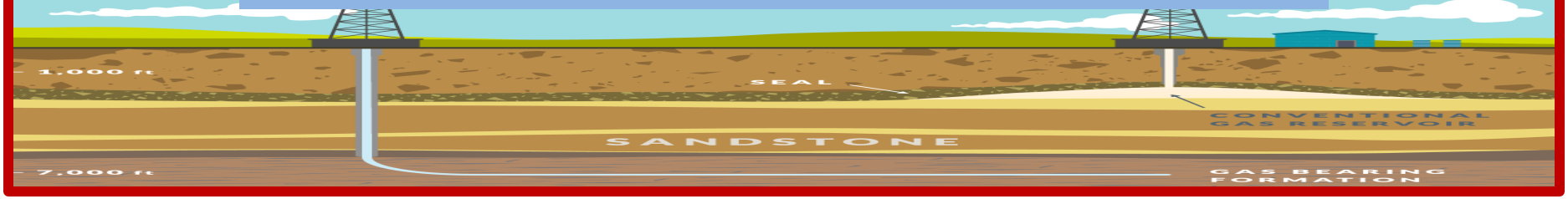
Map of U.S. interstate and intrastate natural gas pipelines



Source: U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines*

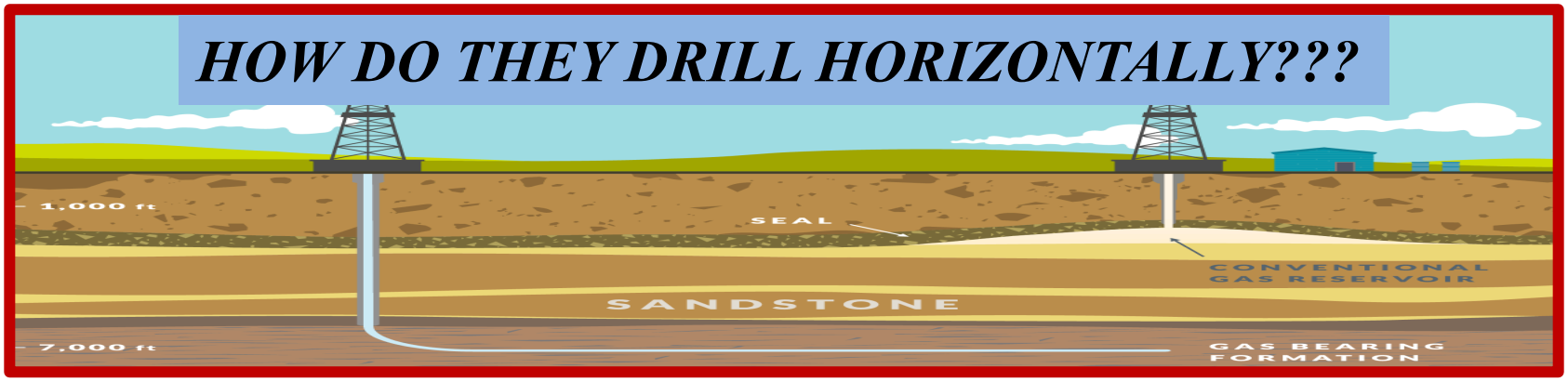
- Once natural gas is extracted, it must be transported to different places to be processed, stored, and then finally delivered to the end consumer.
- Natural gas can be transported on land via pipeline or on water via ship.

HOW DO THEY DRILL HORIZONTALLY???



- Most horizontal wells begin at the surface as a vertical well.
- Drilling progresses until the drill bit is a few 100 feet above the target rock unit.
- At that point the pipe is pulled from the well and a hydraulic motor is attached between the drill bit and the drill pipe.
- The hydra . (Why doesn't the well collapse? f drilling mud down the drill pipe.
- It can rotate the drill bit without rotating the entire length of drill pipe between the bit and the surface.
- This allows the bit to drill a path that deviates from the orientation of the drill pipe.
- Finally the bit drills a path that steers the well bore from vertical to horizontal over a distance of a few hundred feet.

HOW DO THEY DRILL HORIZONTALLY???



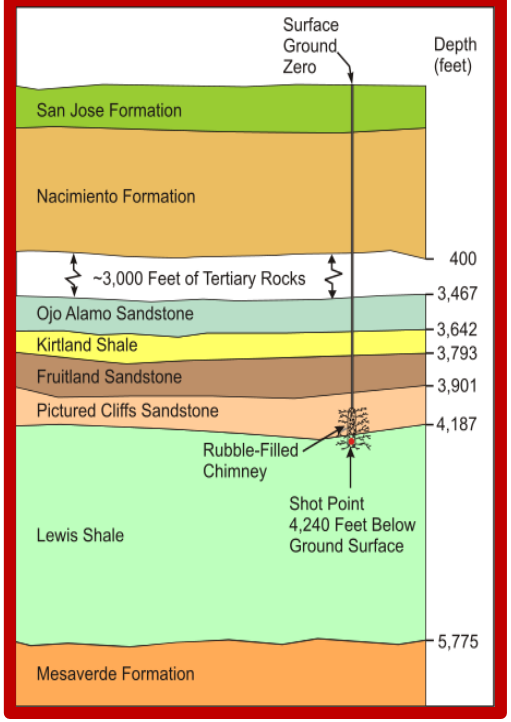
- **Once the well has been steered to the proper angle, straight-ahead drilling resumes and the well follows the target rock unit.**
- **Keeping the well in a thin rock unit requires careful navigation.**
- **Horizontal drilling is expensive. When combined with hydraulic fracturing, a well can cost up to three times as much per foot as drilling a vertical well.**
- **The extra cost is usually recovered by increased production.**
- **These methods can multiply the yield of gas or oil from a well.**
- **Many profitable wells would be failures without these methods.**

- After the fracking well is fully drilled and encased, fracking fluid is pumped down into the well at extremely high pressure.
- Large volumes of a low-viscosity, water/sand slurry is pumped into the shale to induce new fractures and augments existing fractures:
  - ✓ 2 t
  - ✓ Pr
    15,(
- The flu
  slickwater.
- It is mostly water, though it also can contain a wide range of additives and chemicals that serve an engineering purpose.
- Additives can include detergents, salts, acids, alcohols, lubricants and disinfectants.
- These chemical additives usually make up 0.5 to 2 percent of the slickwater.

6,000 PSI= The weight of 2 midsize cars (3000 lbs each) on top of one another and then concentrated down to a 1" x 1" square.

up to

ck is called



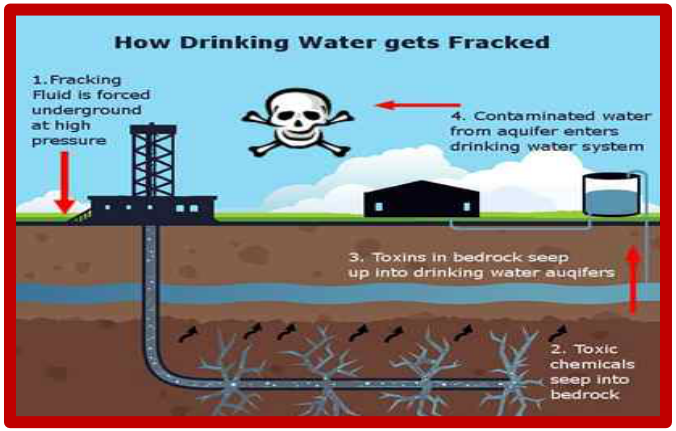
Project Gasbuggy

- It was an underground **nuclear detonation** carried out by the **United States AEC** in December 1967 in rural northern **New Mexico**.
- It was part of **Operation Plowshare**, a program designed to find peaceful uses for nuclear explosions.
- Its purpose was to determine if nuclear explosions could be useful in fracturing rock formations for **natural gas** extraction.

- Following this test, two sub …ring experiments were conducte…rt to refine the technique.
- They were **Project Rulison** …n 1973.
- In both cases the gas radioa…
- Soon after that test the ~ 15…m funding dried up.
- These early fracturing tests were later superseded by **hydraulic fracturing** technologies.

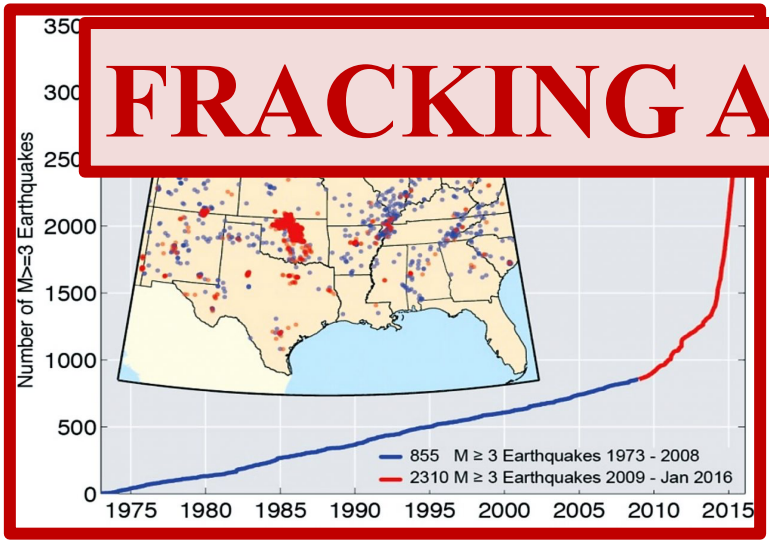
TOO HIGH?

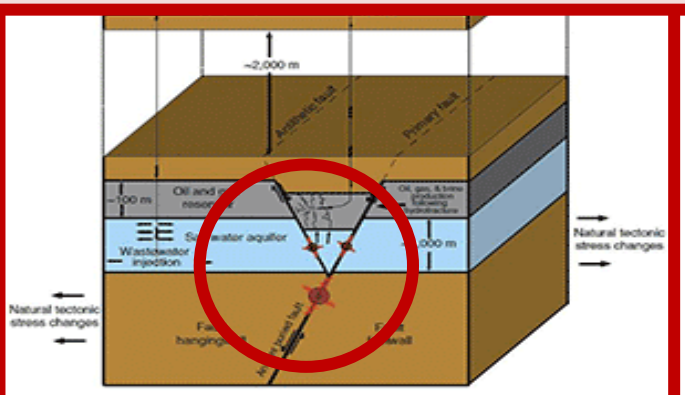
Fracking and Drinking Water



- **EPA found scientific evidence that hydraulic fracturing activities can impact drinking water resources under some circumstances:**
  - ✓ **Water withdrawals for hydraulic fracturing in times or areas of low water availability**
  - ✓ **Spills during the handling of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources**
  - ✓ **Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity**
  - ✓ **Injection of hydraulic fracturing fluids directly into groundwater resources**
  - ✓ **Discharge of inadequately treated hydraulic fracturing wastewater to surface water**
  - ✓ **Disposal or storage of hydraulic fracturing wastewater in unlined pits resulting in contamination of groundwater resources.**

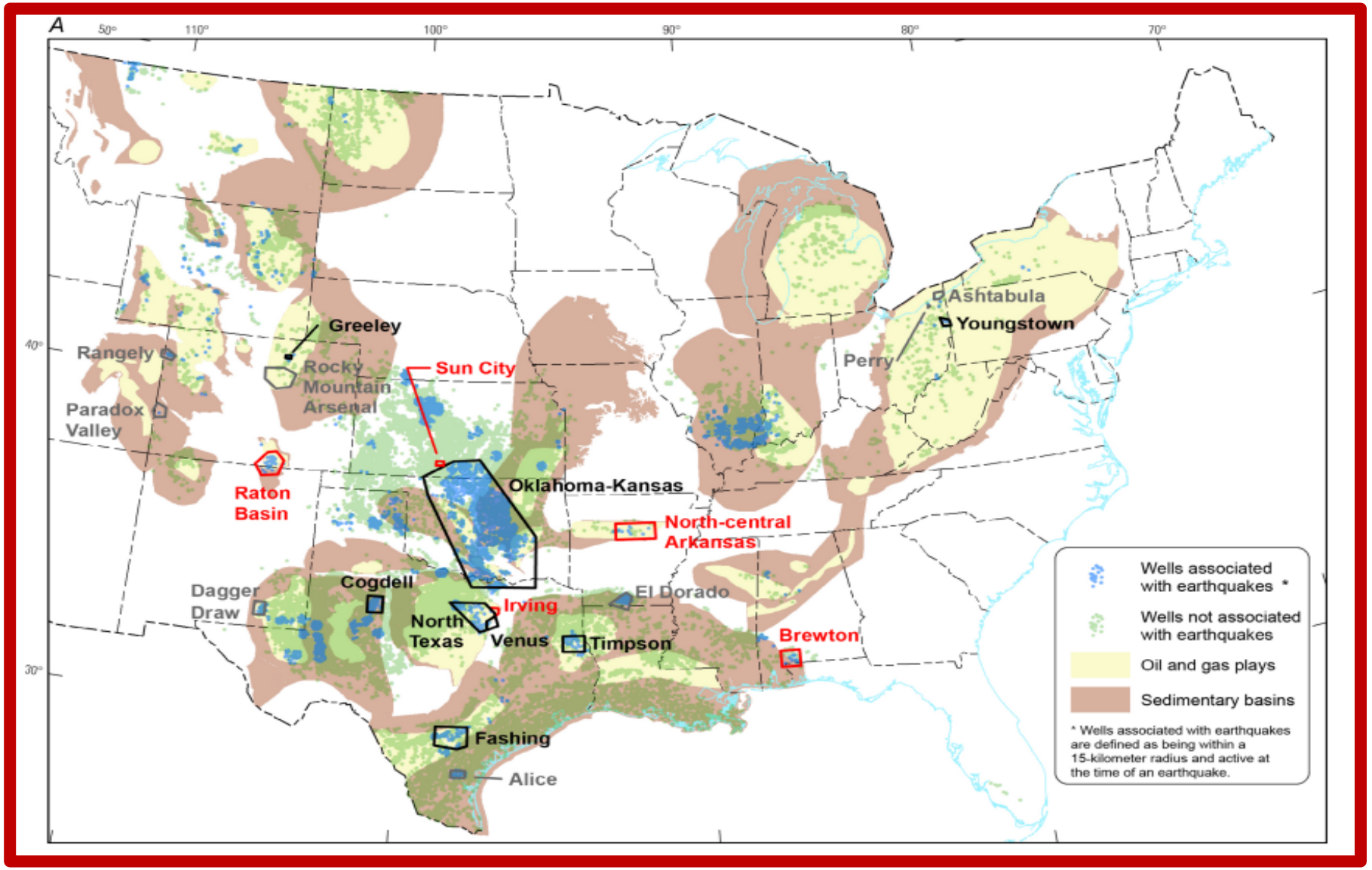
FRACKING AND EARTH QUAKES





aquifer at a depth > 7000 feet reactivated ancient faults (thick black lines) and caused earthquakes

- According to the USGS, the cause of earthquakes near fracking sites is **not** believed to be the act of drilling and fracturing the shale itself, but rather the **disposal wells**.
- There are more than 50,000 disposal wells in Texas servicing more than 216,000 active drilling wells.
- **Earthquakes with magnitudes between 4.5 and 5.0 have been induced by fluid injection in Colorado, Arkansas, Kansas, Oklahoma and Texas.**
- **However, there is evidence to indicate Fracking can cause earthquakes.**
- **There is field evidence that] hydraulic fracturing itself caused earthquakes in western Canada, by adding pressure to tectonic faults and when the pressure builds up enough, the tectonic plates slip!**



Tight association between Oklahoma natural gas wells and induced seismicity.

Proponents for Fracking

REAL ESTATE
SHIPPING

BROOKLYN DAILY EAGLE FINANCIAL

NEW YORK CITY, TUESDAY, MARCH 9, 1937

Savs U. S. Oil Supplies May Last 15 Years

Naval Affairs Group Hears This Is a Conservative Estimate

Washington, March 9 (U.P.)—Capt. H. A. Stuart, director of naval petroleum reserves, told the Senate Naval Affairs Committee today the oil supply of this country will last only about 15 years.

"We have been making estimates for the last 15 years," Stuart said. "We always underestimate because of the possibility of discovering new oil fields. The best information is that the present supply will last only 15 years. That is a conservative estimate."

Stuart said the United States produces about 70 percent of the world's oil, and when the supply is exhausted in this country the oil industry will be forced to look to South America and Mexico for its supply.

Valued at $1

He said the Government at the present time has about 700,000,000 barrels of oil in its naval reserves and that the navy annually consumes from six to seven million barrels. He valued Government holdings at $1 a barrel.

Stuart's testimony was presented as the committee began consideration of a bill proposing to give the Secretary of the Navy authority to buy and exchange land to consolidate present naval oil reserves.

Stuart said in two fields in California private oil companies own land within the Government holdings, with the result that oil beneath Government land is being withdrawn. The Navy Department combats this, he said, by leasing wells on its own land for a royalty, thus deriving an income of about $654,000 annually. Oil is sold, he said, only to prevent leakage into other hands.

To Negotiate Rail Dispute

Federation Reports Unemployment Rise

January Estimate Places Total at 10,041,000, an Increase of 1,001,000 Compared With December—Farm and Store Help Affected

Washington, March 9 (U.P.)—The American Federation of Labor estimated today that there were 10,041,000 unemployed in the country in January, as compared with 8,990,000 in December and 11,666,000 a year ago.

In reporting that 1,001,000 workers were laid off as the year 1937 began, the Federation called attention to the fact that 3,223,000 workers were added to payrolls last year—before the seasonal slack and layoffs.

"January and February are usually the low-ebb months of the year," the Federation said.

"This is the time when demands on relief begin to be heavy, when families out of work exhaust their resources so that relief need continues for the next three months.

"January is the slack month in agriculture, and this year our farms laid off about 200,000 hired workers from December to January; it is the month when retail stores lay off their Christmas help, and this year stores which had taken on 492,000 workers for the busy season laid off 552,000 in January."

Rate Limiting Approval Seen

Lehman's Power Price Proposal Certain of Committee Passing

Albany, March 9 (A.P.)—Governor Lehman's proposal to give the Public Service Commission power to limit rates of municipally-owned power plants to cost of service appeared certain of Senate committee approval today despite protests that it is "vastly unfair."

While action was withheld after a public hearing yesterday, Chairman Thomas F. Burchill of the Senate Public Service Committee indicated a favorable report in the near future.

Spokesmen for a number of municipalities opposed enactment of the measure, contending it would "kill" municipal utilities in the State, while Chairman Milo R. Maltbie of the Public Service Commission defended the proposal with the statement:

"If the municipalities don't think this bill is fair, it is up to them to

New Peak Set In Oil Output

Last Week's Production Showed Increase in All Major Areas

Tulsa, Okla., March 9 (A.P.)—The production of crude petroleum established another new high for the week ending March 6, a total of 3,308,850 barrels daily, or 12,009 more barrels daily than the week before, the Oil and Gas Journal reported today.

While most of the major producing areas showed an increase in daily production, Oklahoma declined 25,675 barrels to 578,125. East Texas increased 4,901 barrels to 460,398 daily and the total State of Texas was up 19,018 barrels to 1,350,780 daily.

Louisiana increased 3,160 barrels to 246,285, California increased 1,350 barrels to 384,500 barrels daily and Kansas had an increase of 4,175 barrels to 167,350.

Eastern States, including Michigan, increased 3,393 barrels to 150,827 daily and production in the Rocky Mountain region was up 2,760

Milk Control Lapse Favored After Survey

Price Fixing Law Due to Expire March 31—No Definite Plans

Albany, N. Y., March 9 (A.P.)—Automatic expiration March 31 of the price fixing provisions of New York's milk control law was favored by a legislative committee today as its members began drafting recommendations for future State regulation of the $2,000,000,000 dairy industry.

The committee, of which Democratic Senator George F. Rogers of Rochester is chairman, concluded here last week a series of Statewide hearings designed to sound out sentiment as to continuance, discontinuance or amendment of the law enacted in 1933 as an emergency measure.

The law expires March 31, unless re-enacted, and the committee must report by March 15.

One member who declined to be quoted said that the committee estimated approximately 80 percent of the speakers favored elimination of the price fixing clause, under which Agriculture Commissioner Peter G. Ten Eyck has authority to file prices to be paid to producers for milk and by consumers.

"A majority of the committee members feel likewise," he said.

Previously, some members suggested the price fixing provisions be continued only until Aug. 1.

Committee members were reported to favor continuation of other provisions of the law, including requirements for licensing and bonding of dealers and establishment of health and sanitary standards for the production of milk.

Aviation Outlook Found Excellent

Astonishing progress by the aviation industry during 1936 over 1935

$5 a Ton Rise In Lead Price; Copper Tense

Current Quotations Highest for Years—Demand Very Good

The price of lead was advanced 25 points, or $5 a ton today, to 7½ cents a pound, New York base, and 7.35 cents a pound, East St. Louis. The announcement was made by the St. Joseph Lead Company and was followed immediately by the American Smelting and Refining Company.

Meanwhile, the domestic copper situation was tense, with the price quited at 16.25 cents a pound, delivered Valley. This price, announced late yesterday, was a new post-depression high for the metal.

Despite this advance the domestic copper rate is still more than ½ cent a pound lower than foreign. At least one important domestic smelter believes the domestic price is still too low.

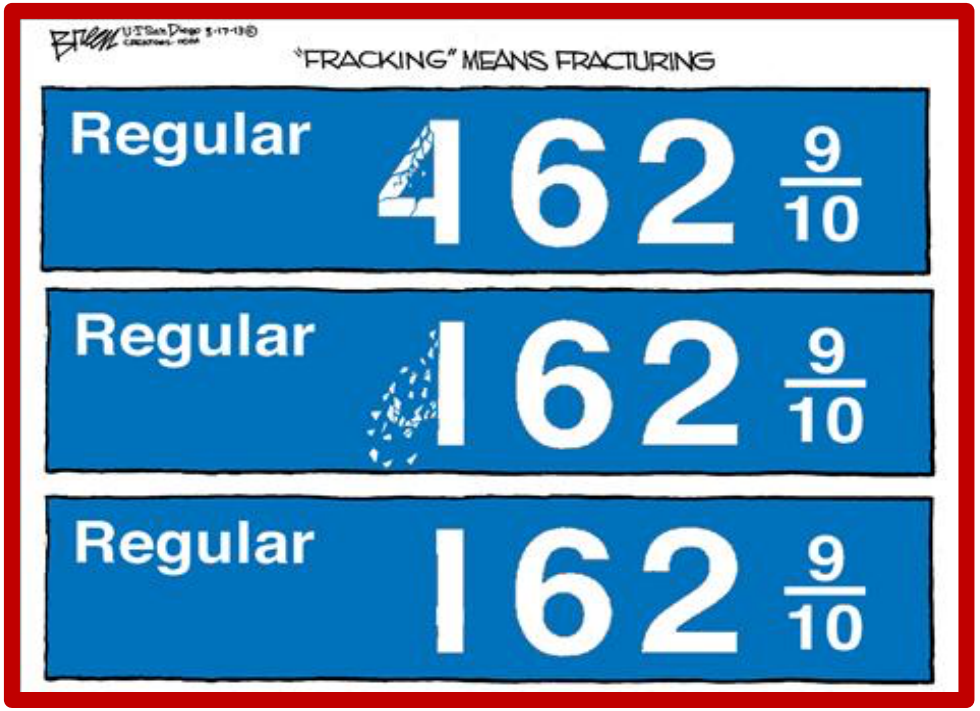
Preceding the advance in the virgin metal, domestic wire and cable makers raised their prices to conform.

Copper buying abroad was in good volume today, with the price equal to about 16.775 cents a pound, c.i.f., European base ports. This compares with 16.40 to 16.775 cents on Monday. Some sales were reported abroad at as high as 16.85 cents a pound, c.i.f.

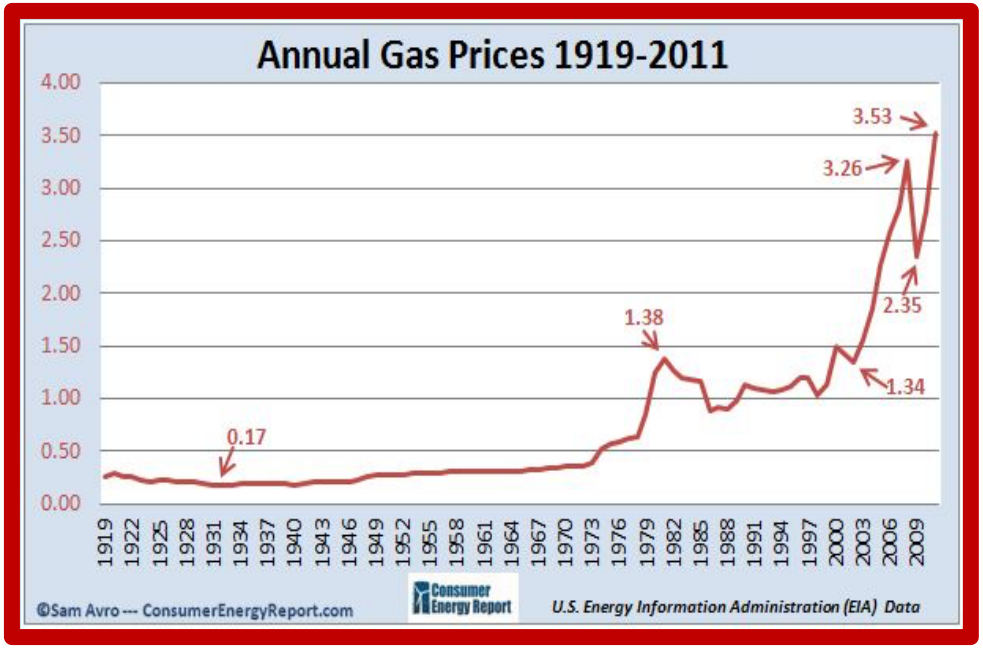
The London Metal Exchange experienced another exciting session with turnover heavy and consumers trying to cover their needs, fearing a shortage of non-ferrous metals, owing to the worldwide re-armament and industrial requirements.

Featured in trading today were tin and zinc. Turnover for tin in the first session was 900 tons at 276½ pounds on heavy overnight purchases from America coupled with general trade demand.

Contest Booming Lorillard Sales


"FRACKING" MEANS FRACTURING
Regular 4 62 9/10
Regular 1 62 9/10
Regular 1 62 9/10


TEXACO
OUR STATION HOURS
ARE REDUCED
DUE TO GAS SHORTAGE
SORRY
Fire Chief

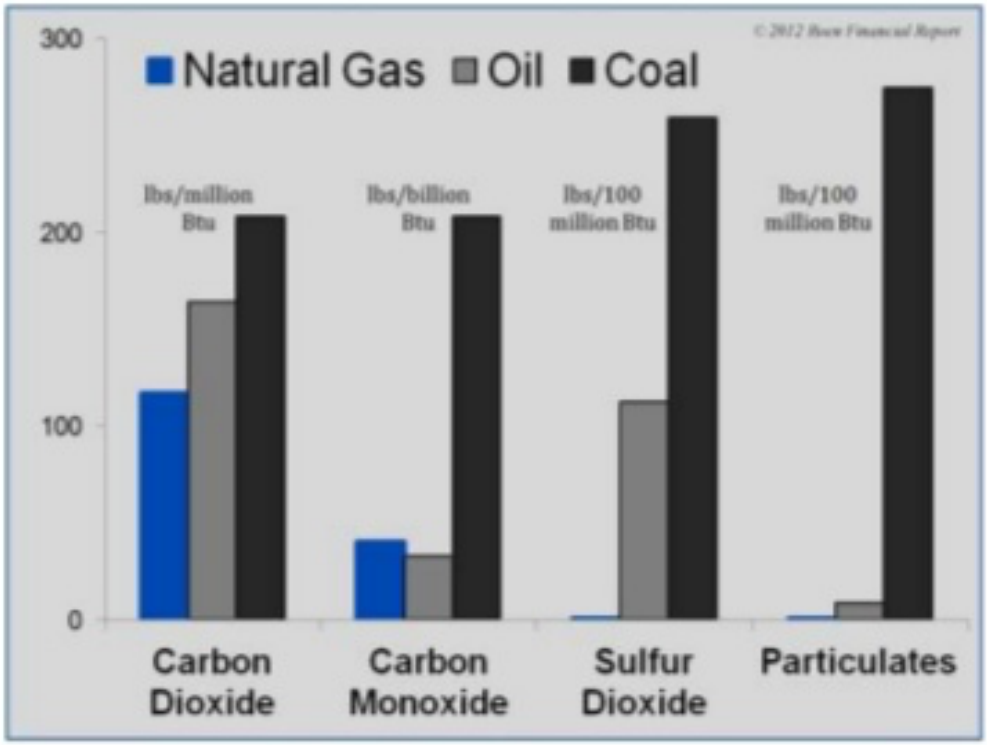

Annual Gas Prices 1919-2011
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.53
3.26
2.35
1.38
1.34
0.17
1919 1922 1925 1928 1931 1934 1937 1940 1943 1946 1949 1952 1955 1958 1961 1964 1967 1970 1973 1976 1979 1982 1985 1988 1991 1994 1997 2000 2003 2006 2009
©Sam Avro --- ConsumerEnergyReport.com
Consumer Energy Report
U.S. Energy Information Administration (EIA) Data

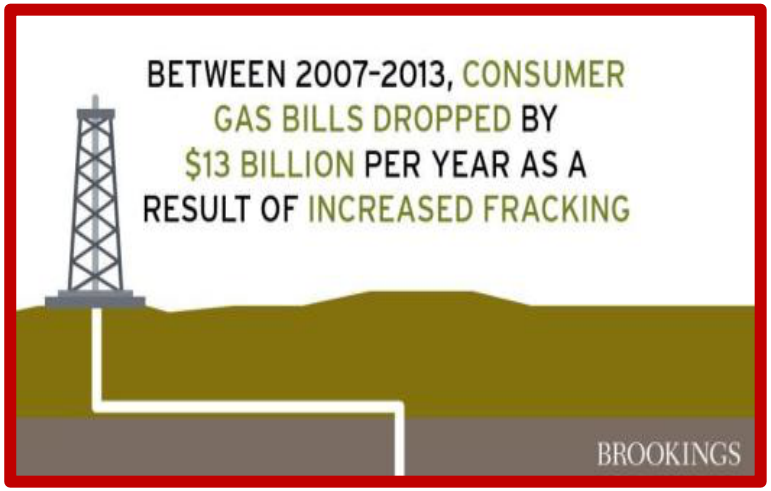
LETS HEAR IT FOR FRACKNG

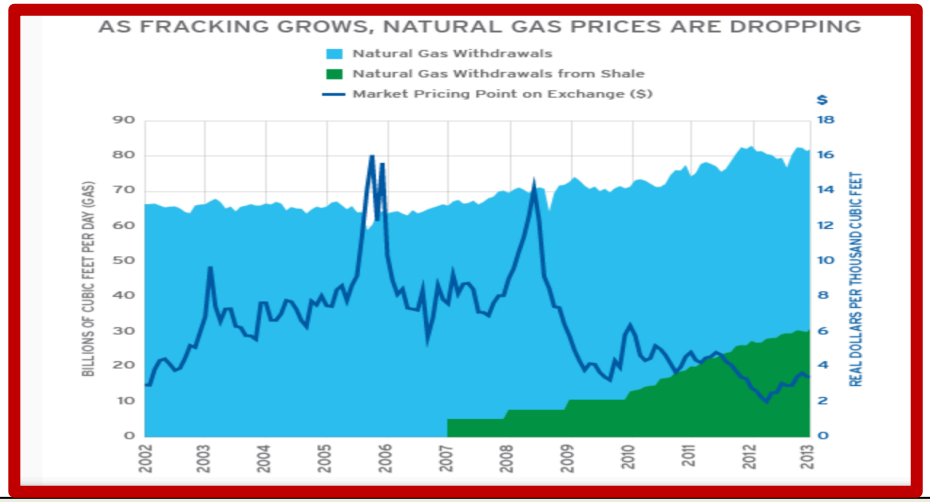
1. Fracking has greatly reduced the need for coal in the United States.
2. Technologies exist to capture potential emissions.
3. The real fracking process occurs under most groundwater tables.
4. Methane can contaminate groundwater supplies naturally.
5. The EPA testified that there are no proven cases of fracking affecting water.
6. The water intensity used for the fracking process is relatively low.
7. Fracking is a temporary process.
8. It is an extraction process that is stable. .
9. Much of the fracking process uses natural materials.
10. Domestic fracking reduces foreign reliance on energy products.
11. It allows for a return on an energy investment to occur.
12. Some households see lower property taxes because of fracking.

Cleaner Fossil Fuel

- From 2008 to 2012 U.S. carbon emissions have dropped 20%. The major factor cited is the production and use of domestic natural gas. (7)
- **Natural gas emits:**



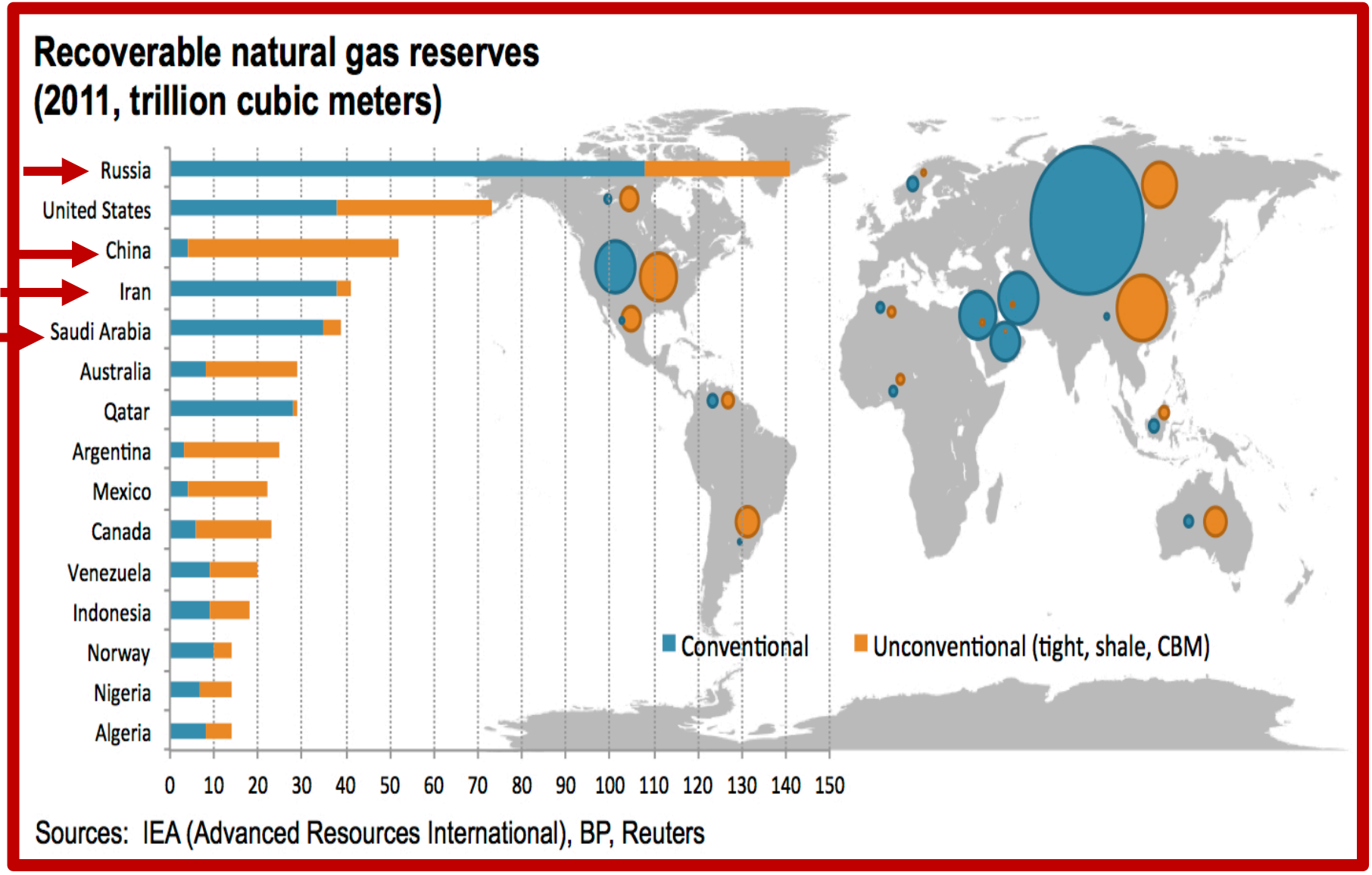




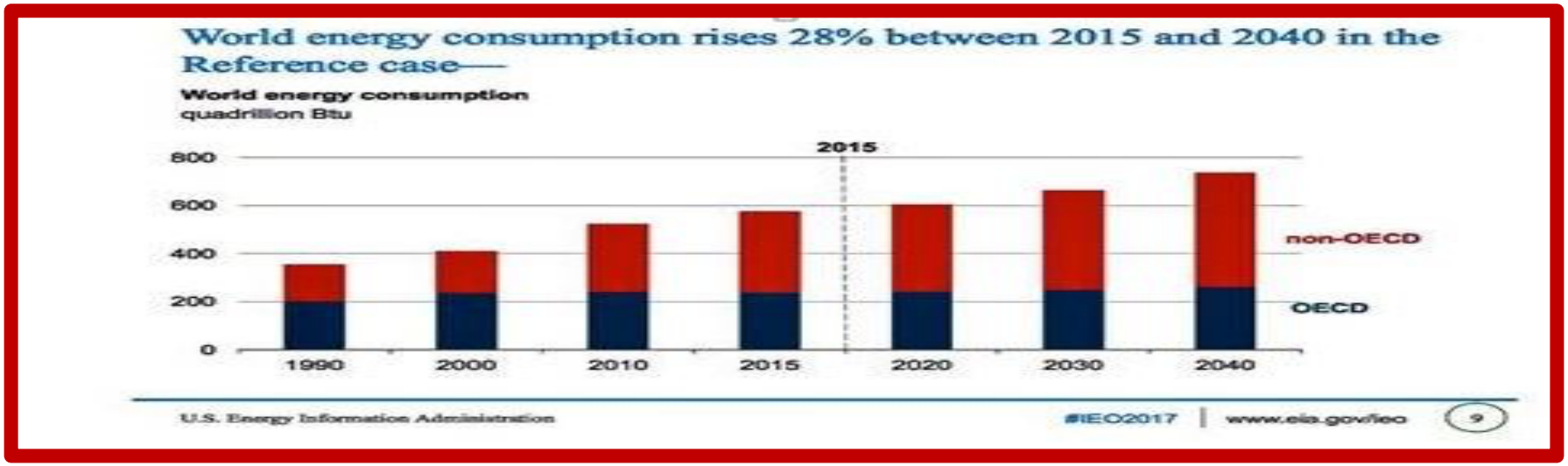
- **According to the U.S. Energy Information Administration, hydraulically fractured wells in the United States increased 1,204 percent—from approximately 23,000 hydraulically fractured wells in 2000 to approximately 300,000 wells in 2015.**
- **In 2015, hydraulically fractured wells accounted for 67 percent of U.S. natural gas production and 51 percent of U.S. crude oil production.**
- **Proponents of fracking argue that the practice produces economic benefits, such as jobs, higher tax revenue, lower energy prices, and economic growth.**

Proponents argue:

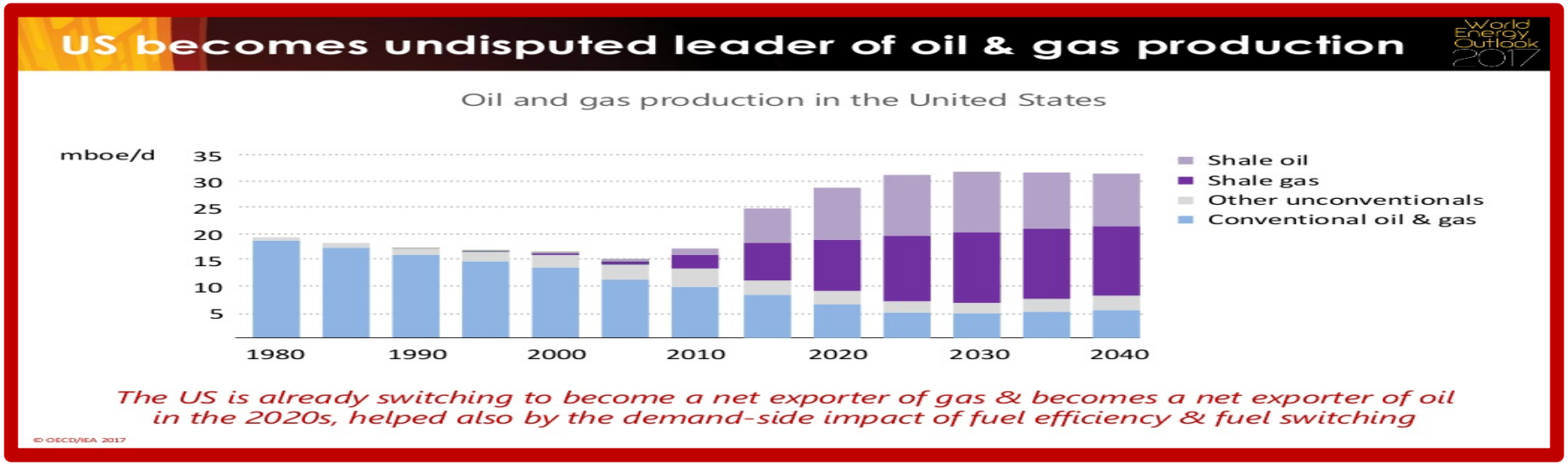
- ✓ **Fracking leads to fewer energy trade deficits and "a boom in energy-intensive manufacturing, like chemicals, steel, fertilizers, and paper."**
- ✓ **The shale industry itself is a bonanza of middle-class blue-collar jobs, and the prospect of a reindustrializing America promises many more.**
- ✓ **The oil and gas industry use specific measures during fracking and other extraction operations to prevent damage to the environment, including the installation of multiple cement and steel layers to protect drinking water sources.**
- ✓ **A 2012 study from the National Academies concluding that fracking does not pose a high risk for felt earthquakes.**
- ✓ **A national ban on fracking would reduce economic benefits for producers and consumers and would raise energy prices, reduce the global supply of oil, and cause the United States to become a natural gas importer rather than exporter.**
- ✓ **A 2016 study found that a national fracking ban would reduce U.S. jobs by 14.8 million, double electricity and gasoline prices, increase cost of living expenses by approximately $4,000, and reduce household incomes by $873 billion by the year 2022.**



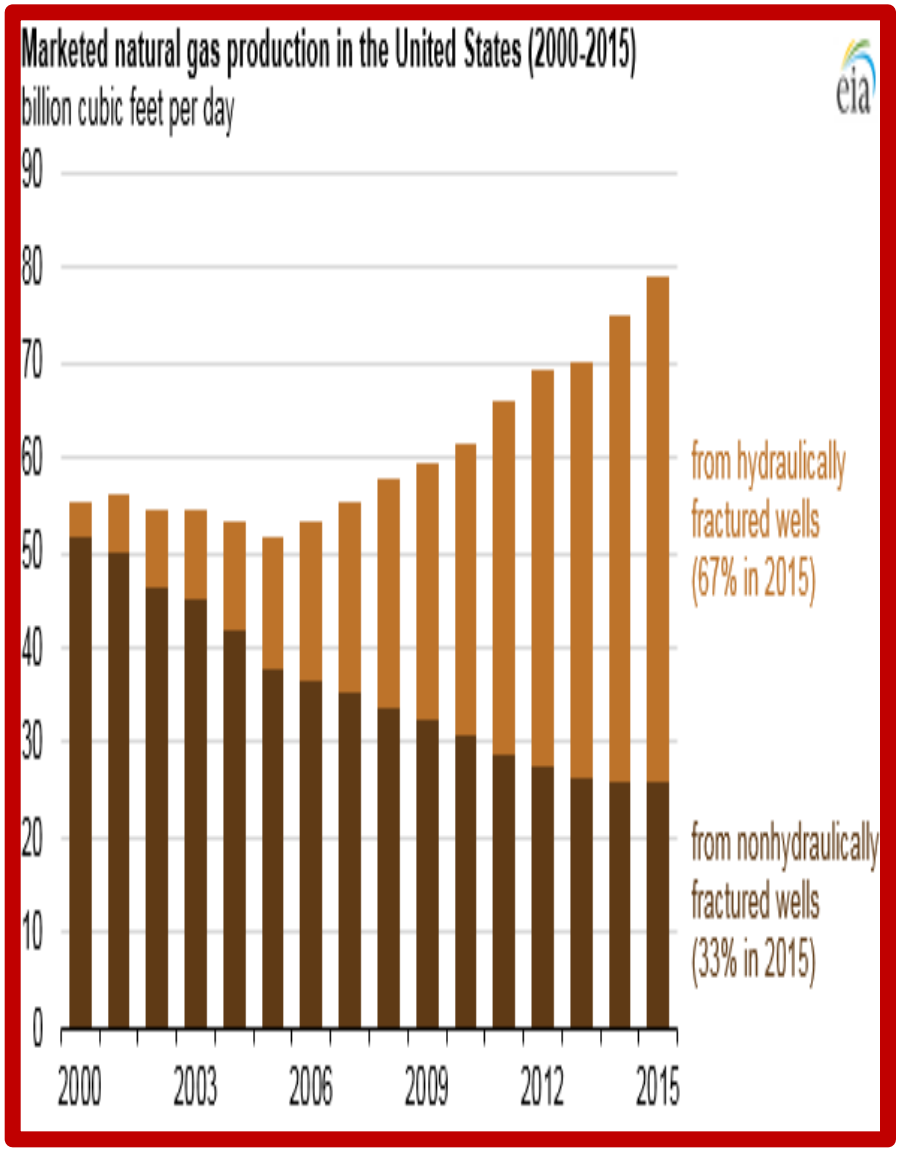
- **Natural gas production in the United States is expected to expand dramatically, climbing by 56% between 2012 and 2040,**

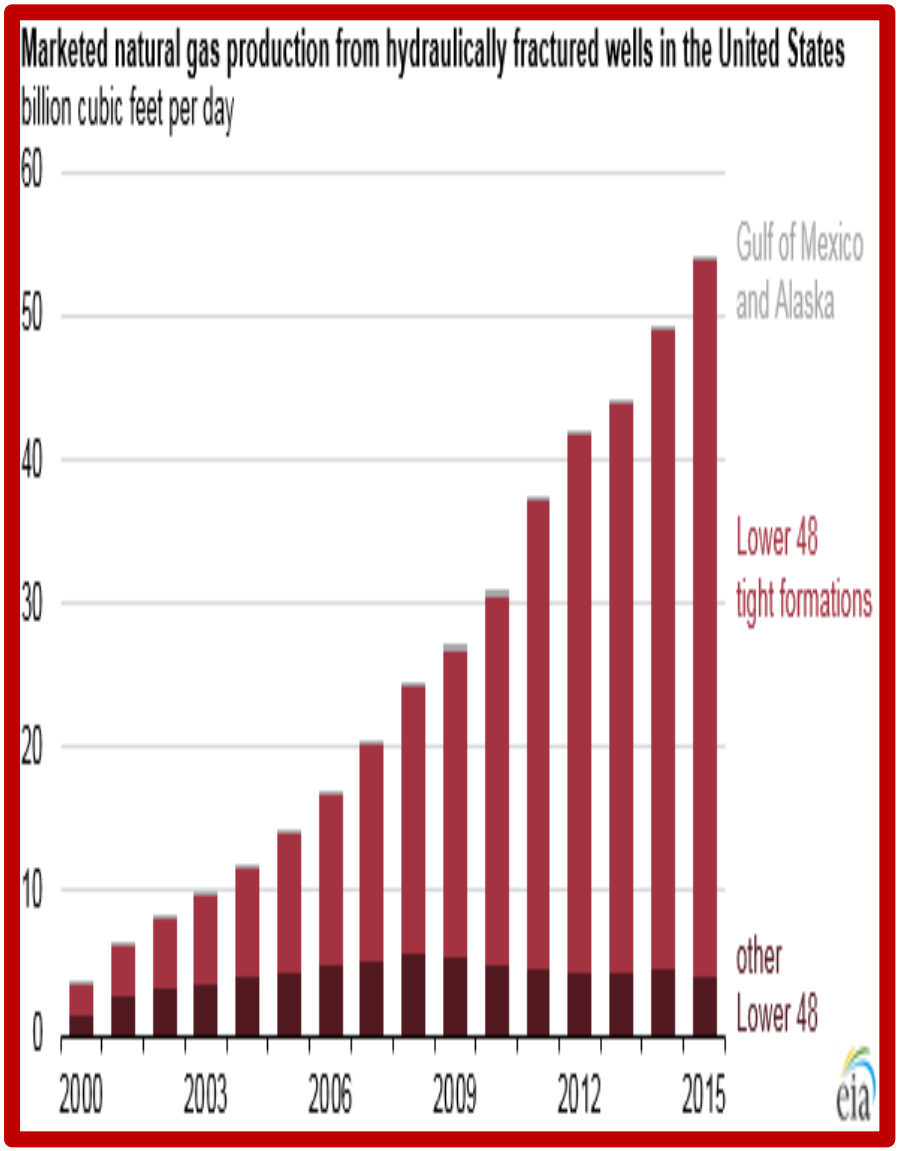


- **The *International Energy Outlook 2017* projects that world energy consumption will increase by 28% from 2015 through 2040.**

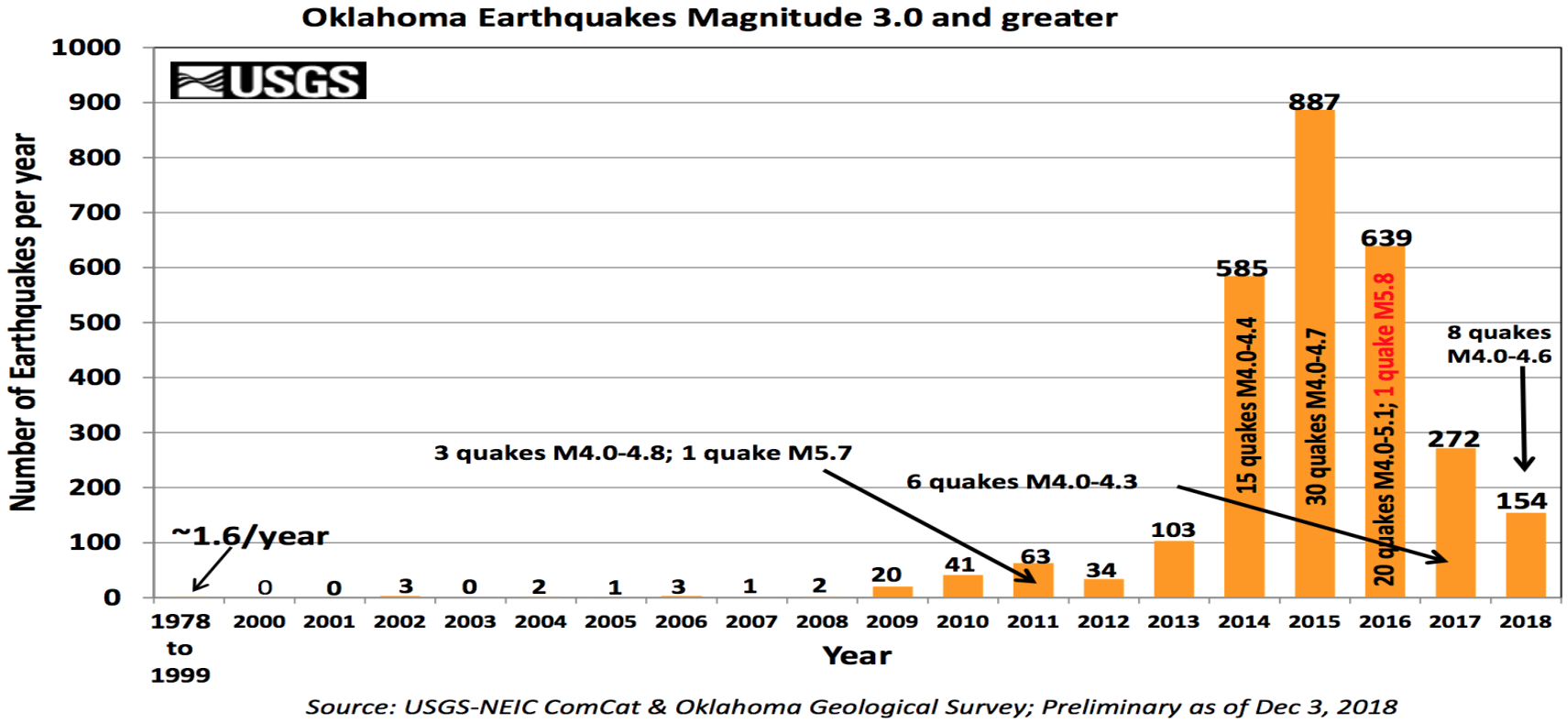


Hydraulically fractured wells provide two-thirds of U.S. natural gas production

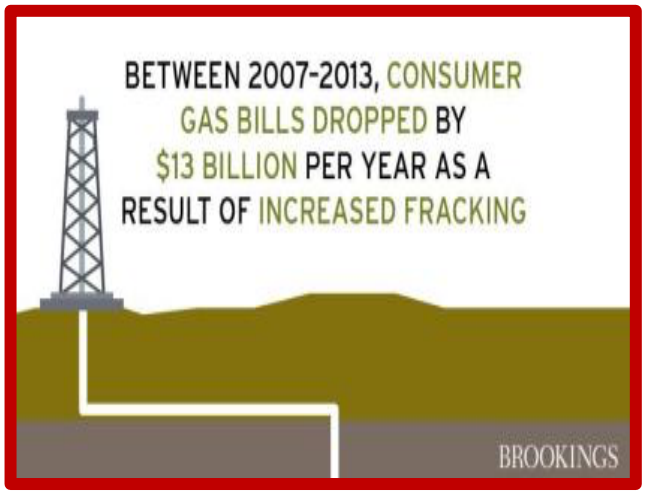


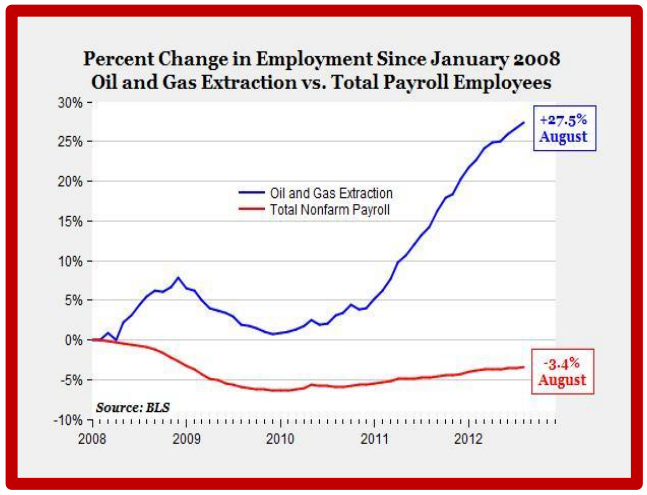


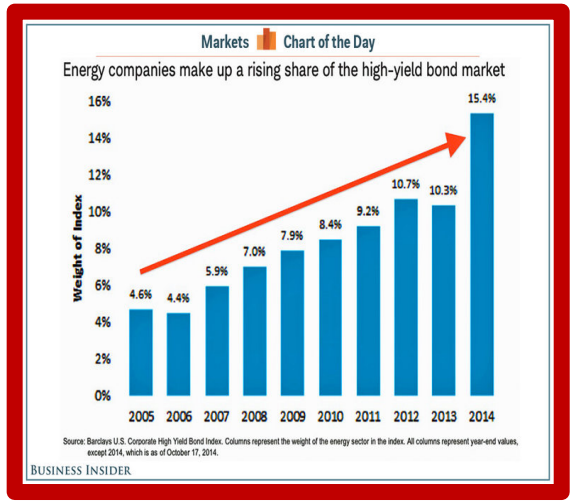
Earthquakes continue to decrease in Oklahoma for third straight year

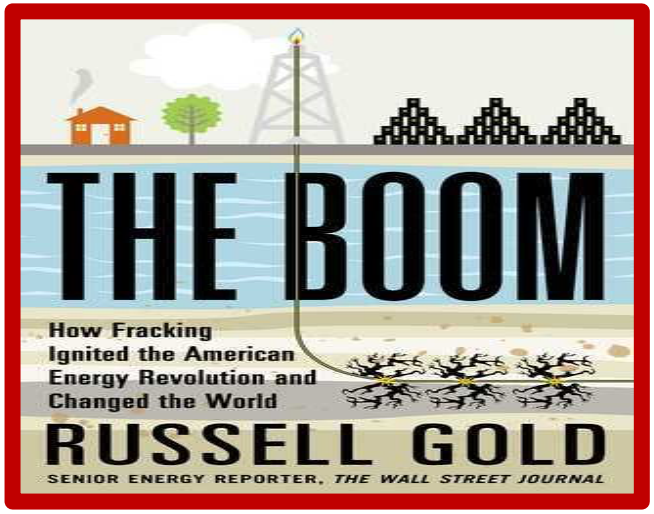


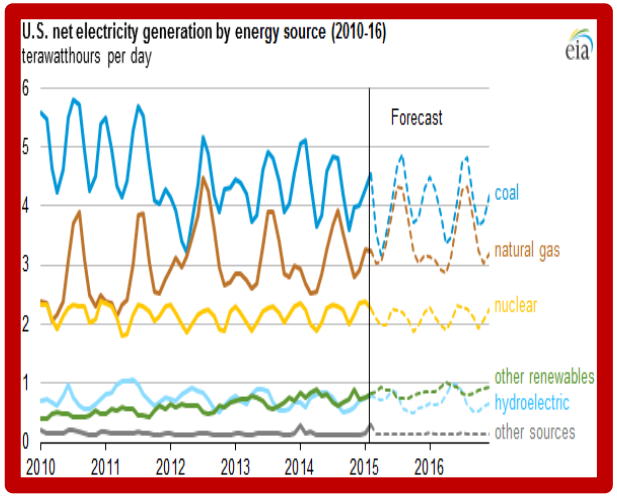
- The risk of human-made earthquakes due to fracking is greatly reduced if high-pressure fluid injection used to crack underground rocks is 895m away from faults in the Earth's crust, according to new research.











- ❑ **PRO FROFRACKING: We know that, at the power plant level, natural gas produces only somewhere between 44 and 50 percent of the greenhouse gas emissions compared with burning of coal.**
- ❑ **This is known for certain; it's basic chemistry.**

OPPOSITION TO FRACKING

Fracking FOR DUMMIES

NEW

Speeds up climate change

Produces hazardous pollutants that can damage health

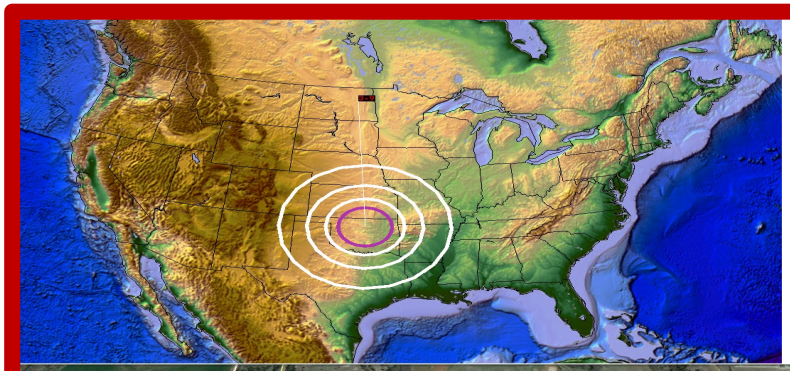
Blights roads & countryside with mass lorry movements

Not needed as transitional fuel

Overrides local planning decisions

A web of financial interests links Tory politicians & fracking co's.

Support Kirkby Misperton and Preston New Road camps



M3.9 - 2km S of Perry, Oklahoma

V DYFI? IV ShakeMap

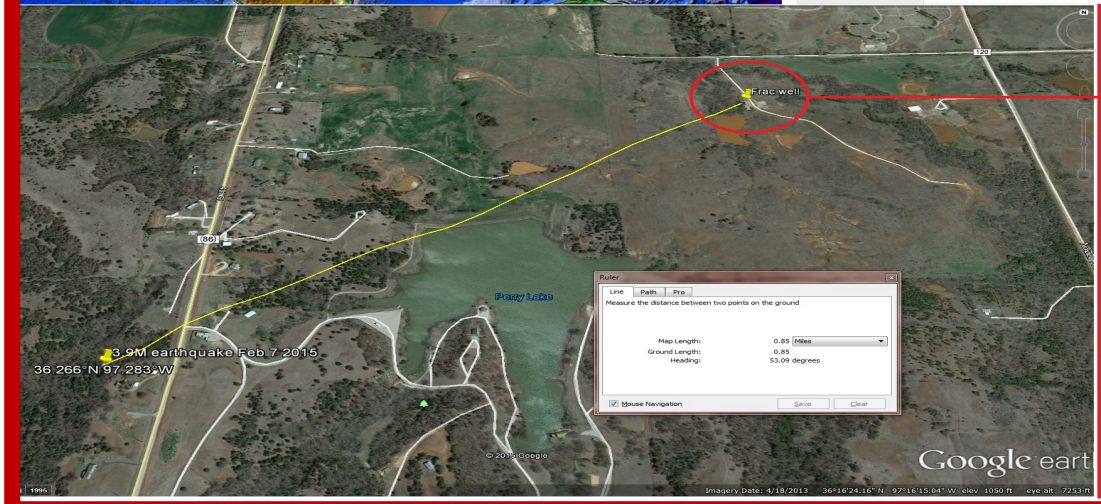
Scientific - Summary

Origin

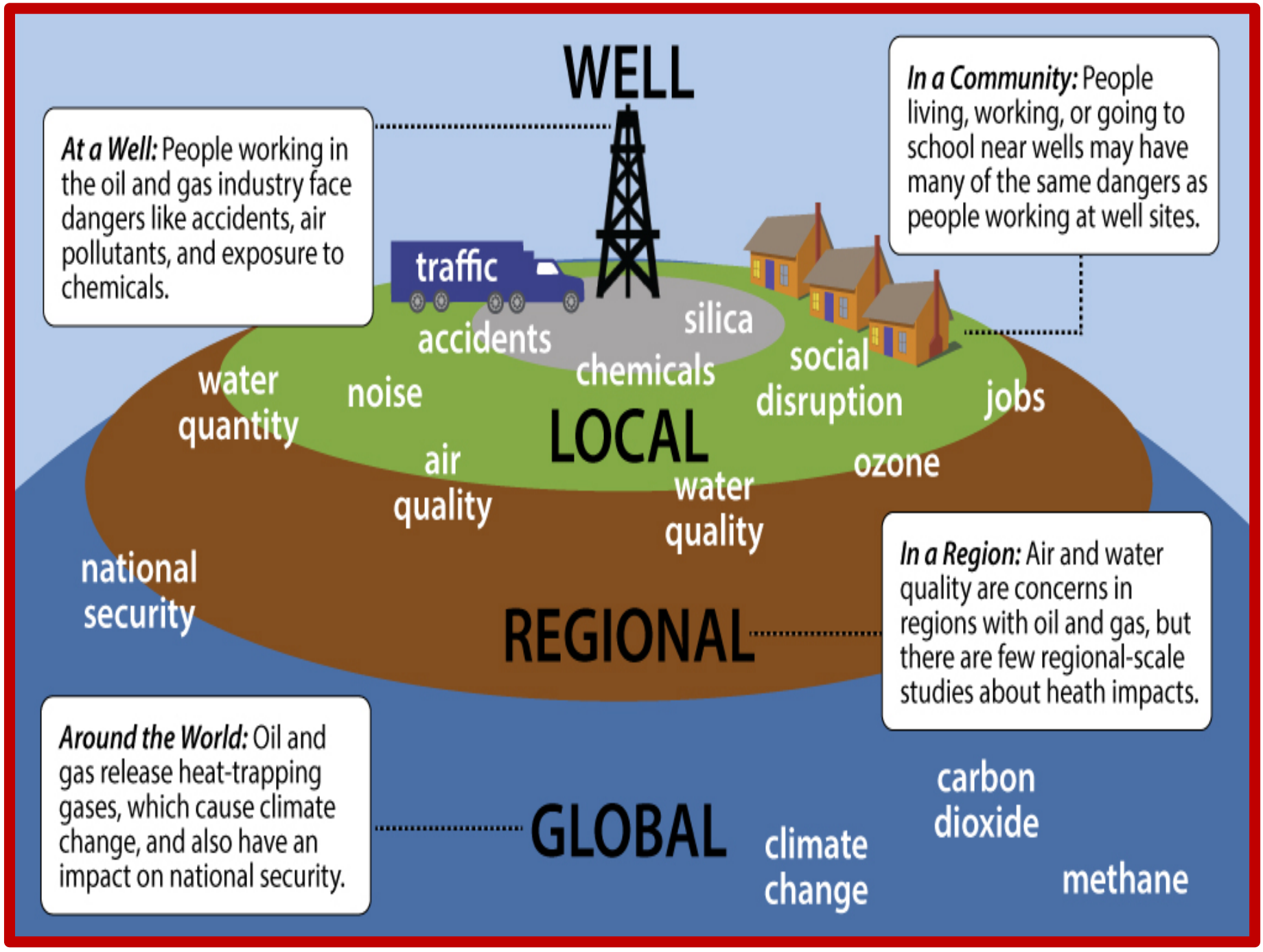
Magnitude (uncertainty)	3.9 mb_lg ± 0.0
Location (uncertainty)	36.266°N 97.283°W ± 1.6 km
Depth (uncertainty)	2.8 km ± 7.1
Origin Time	2015-02-07 18:40:49.620 UTC
Number of Stations	–
Number of Phases	129
Minimum Distance	52.77 km (0.47°)
Travel Time Residual	0.63 sec
Azimuthal Gap	18°
FE Region	Oklahoma (499)

February 7, 2015

Another noteworthy fracking earthquake strikes Central Oklahoma - 0.8 miles from nearest well. Operation looks to be an older rusted out well



If terrorists poisoned the water...
you'd be outraged.
STOP FRACKING, NOW.

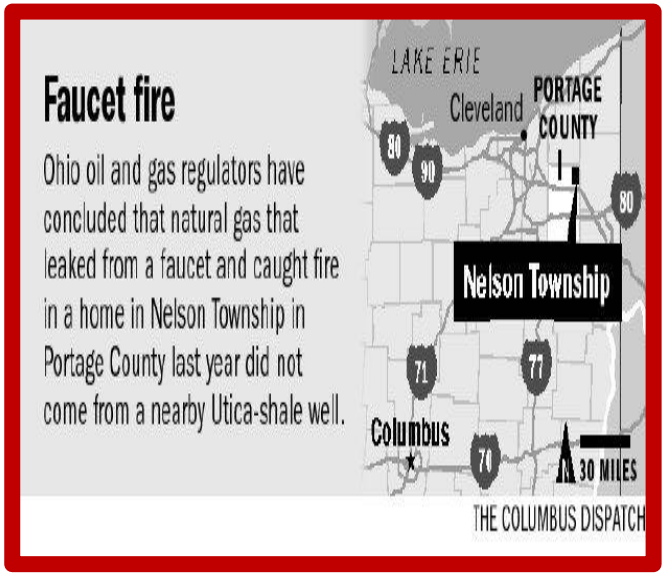

WELL
At a Well: People working in the oil and gas industry face dangers like accidents, air pollutants, and exposure to chemicals.
In a Community: People living, working, or going to school near wells may have many of the same dangers as people working at well sites.
traffic
accidents
silica
chemicals
social disruption
jobs
water quantity
noise
LOCAL
air quality
ozone
water quality
national security
REGIONAL
In a Region: Air and water quality are concerns in regions with oil and gas, but there are few regional-scale studies about heath impacts.
Around the World: Oil and gas release heat-trapping gases, which cause climate change, and also have an impact on national security.
GLOBAL
carbon dioxide
climate change
methane

NO FRACKING

ONLY YOU
CAN PREVENT
FAUCET
FIRES.

Scientific Study Links Flammable Drinking Water to Fracking

- For the first time, a peer-reviewed scientific study has linked natural gas drilling and hydraulic fracturing with a pattern of drinking water contamination so severe that some faucets can be lit on fire.
- **HOWEVER**: Methane may also occur in a water well due to natural conditions or may enter due to human activities besides gas well drilling: including coal mining, pipeline leaks and landfills.



Smokey the Bear Recruited to Fight Fracking: Forest Service Not ...

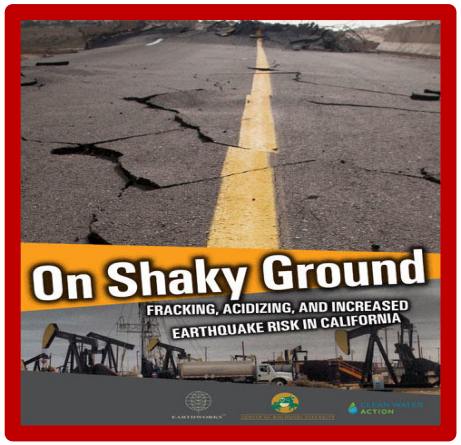
AAAS Become a Member

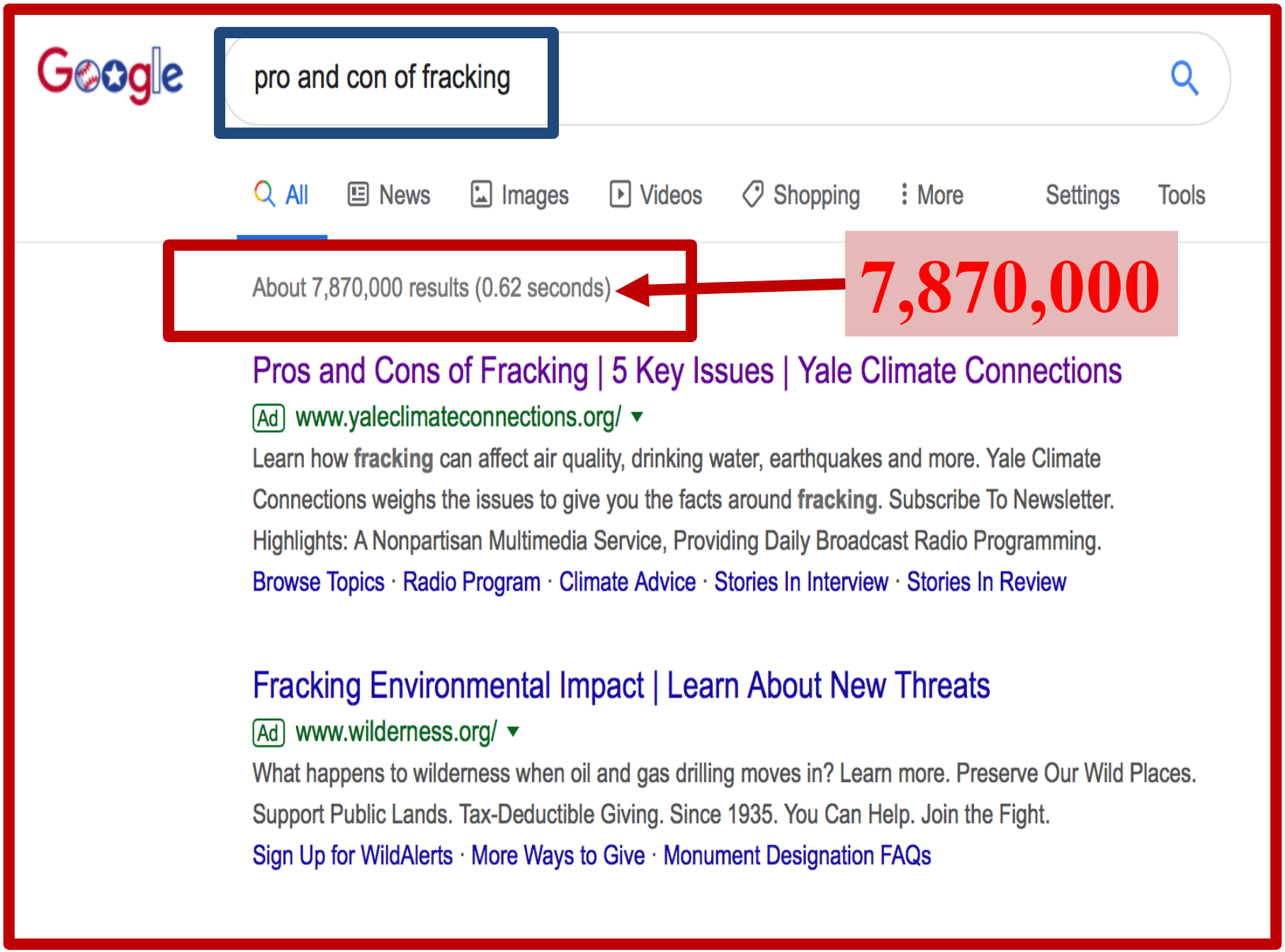
Science Contents News Careers Journals

Methane in drinking water unrelated to fracking, study suggests

- Fracking doesn't appear to be allowing methane to seriously contaminate drinking water in Pennsylvania, a new study finds—contrary to some earlier, much publicized research that suggested a stronger link.
- But the lead authors of the two bodies of research are sparring over the validity of the new results.
- The new study of 11,309 drinking water wells in northeastern Pennsylvania concludes that background levels of methane in the water are unrelated to the location of hundreds of oil and gas wells that tap hydraulically fractured, or fracked, rock formations.

- ✓ *The Case for a Ban on Gas Fracking*,
- ✓ *Exposing the Oil and Gas Industry's False Jobs Promise for Shale Gas Development:*
- ✓ *How Methodological Flaws Grossly Exaggerate Jobs Projections*, *False Promises and Hidden Costs:*
- ✓ *The Illusion of Economic Benefits from Fracking*,
- ✓ *Fracking: The New Global Water Crisis*
- ✓ *Fueling Extinction: How Dirty Energy Drives Wildlife to the Brink*
- ✓ *U.S. Energy Insecurity: Why Fracking for Oil and Natural Gas Is a False Solution*
- ✓ *WASTE: The Soft & Dirty Underbelly of Fracking*




Google
pro and con of fracking
All
News
Images
Videos
Shopping
More
Settings
Tools
About 7,870,000 results (0.62 seconds)
7,870,000
Pros and Cons of Fracking | 5 Key Issues | Yale Climate Connections
Ad www.yaleclimateconnections.org/
Learn how fracking can affect air quality, drinking water, earthquakes and more. Yale Climate Connections weighs the issues to give you the facts around fracking. Subscribe To Newsletter. Highlights: A Nonpartisan Multimedia Service, Providing Daily Broadcast Radio Programming.
Browse Topics · Radio Program · Climate Advice · Stories In Interview · Stories In Review
Fracking Environmental Impact | Learn About New Threats
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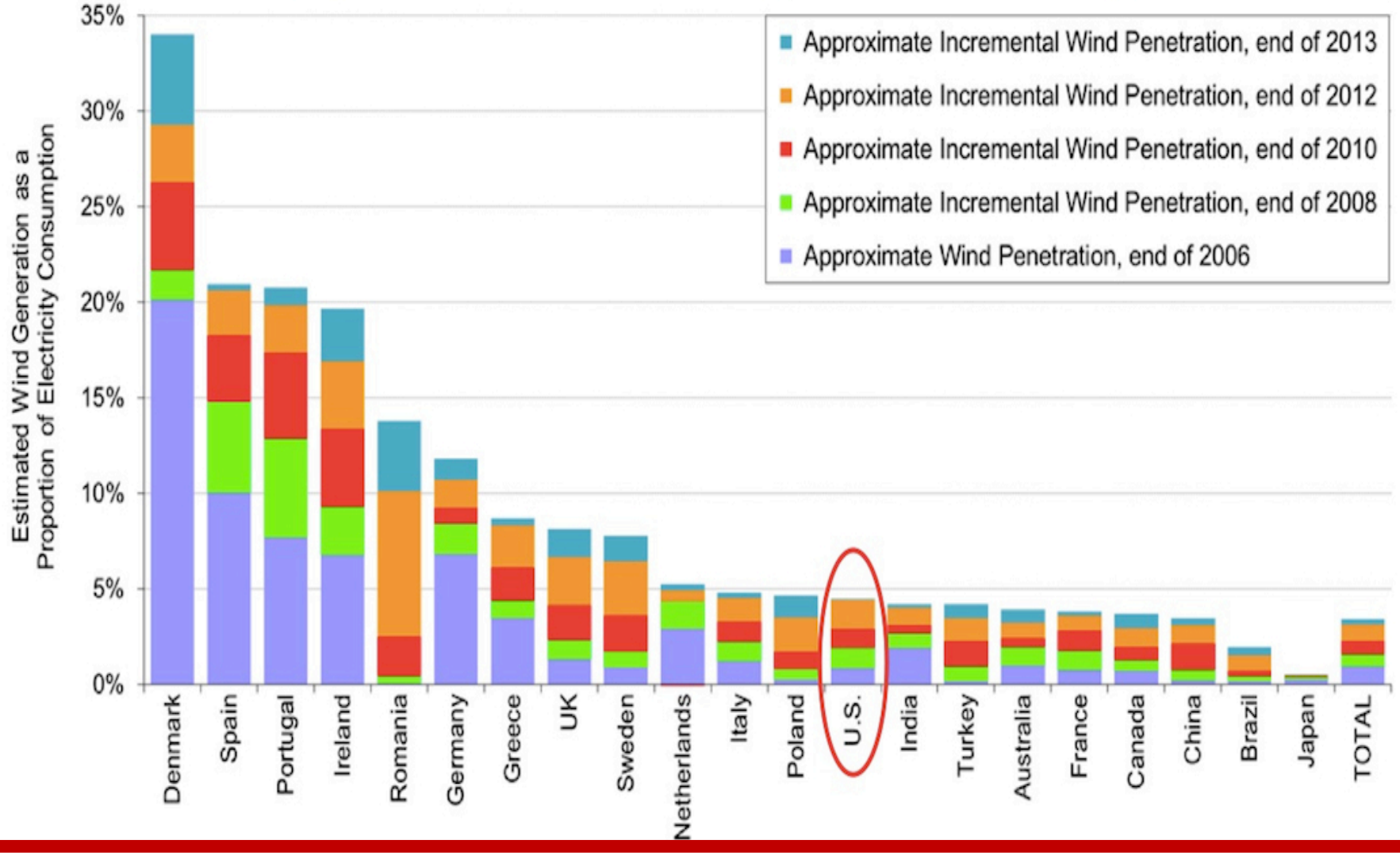
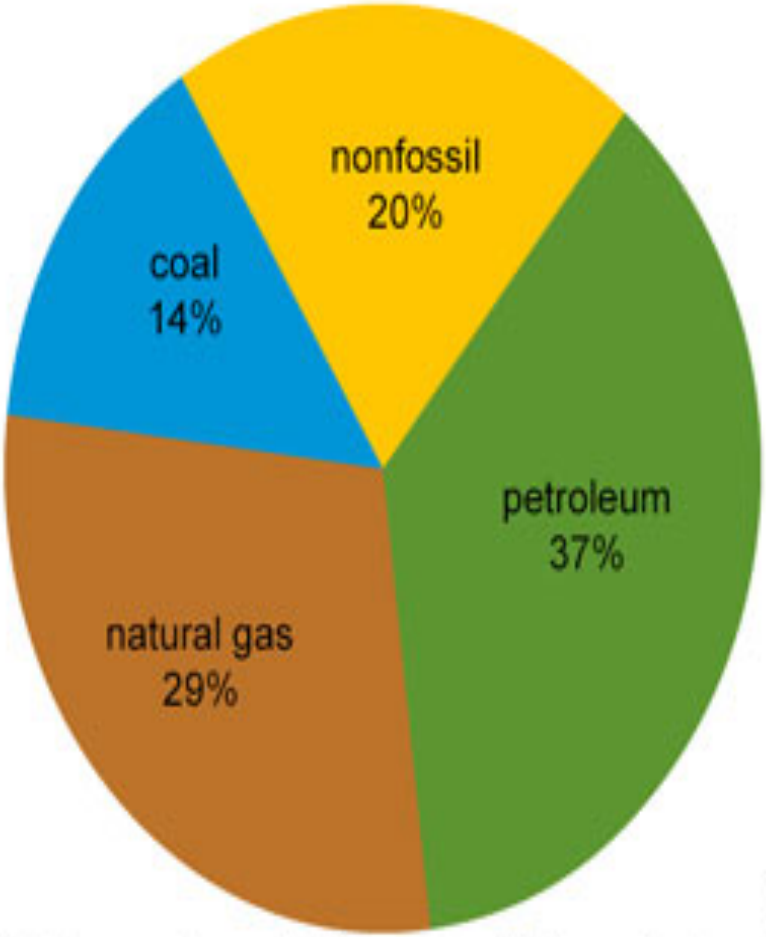
What happens to wilderness when oil and gas drilling moves in? Learn more. Preserve Our Wild Places. Support Public Lands. Tax-Deductible Giving. Since 1935. You Can Help. Join the Fight.
Sign Up for WildAlerts · More Ways to Give · Monument Designation FAQs

U.S. Lagging Other Countries in Wind As a Percentage of Electricity Consumption

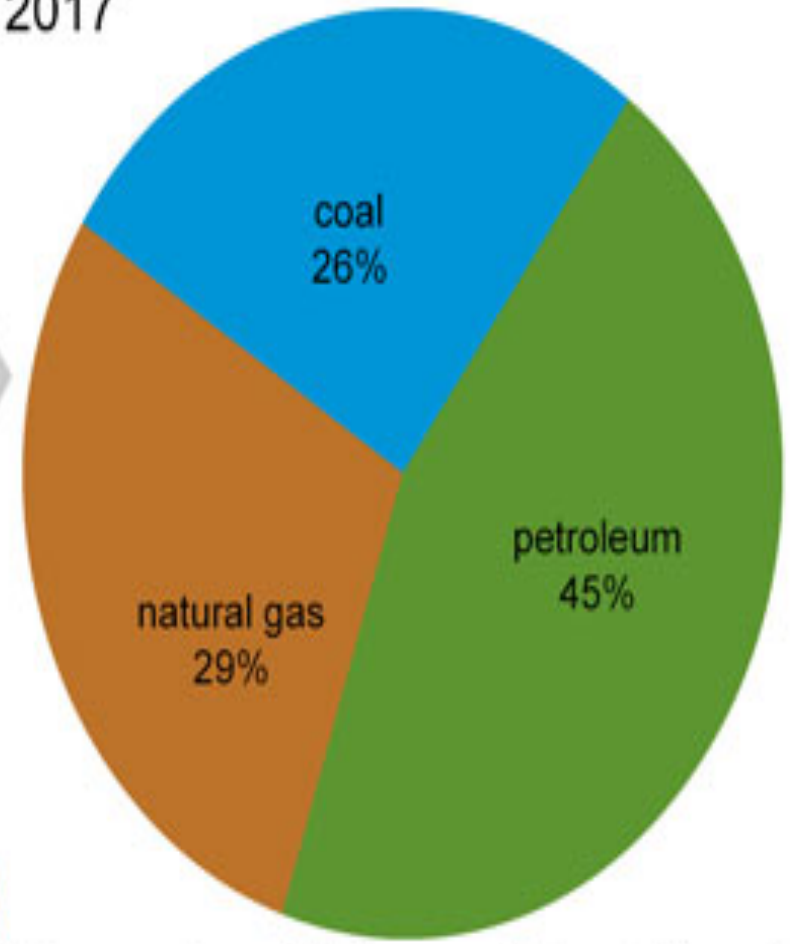


U.S. energy consumption by major fuel type, 2017



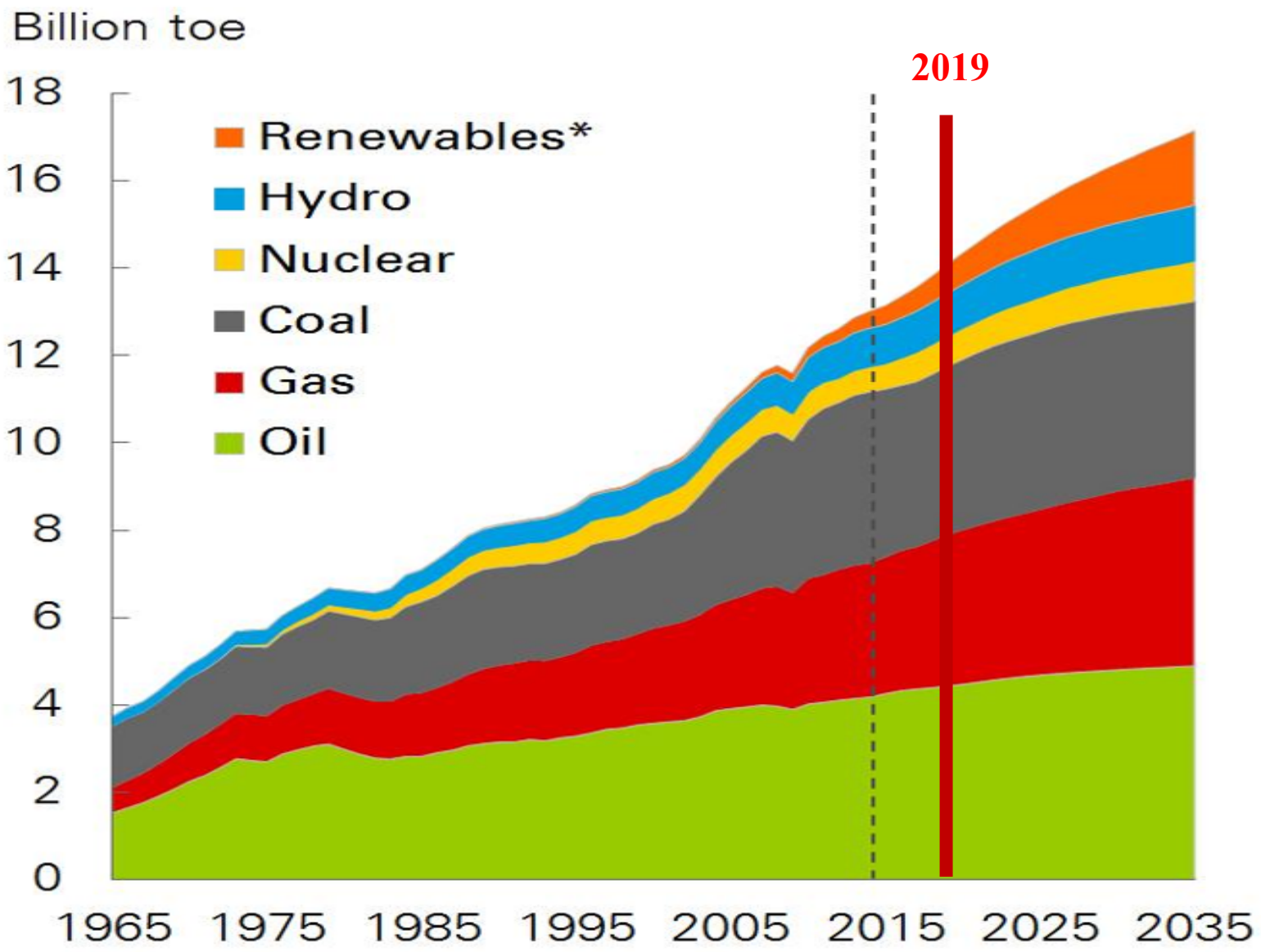
Totals may not equal 100 because of independent rounding.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3, June 2018, preliminary data

Resulting U.S. energy-related carbon dioxide emissions by major fuel type, 2017



Totals may not equal 100 because of independent rounding.
Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 12.1, June 2018, preliminary data

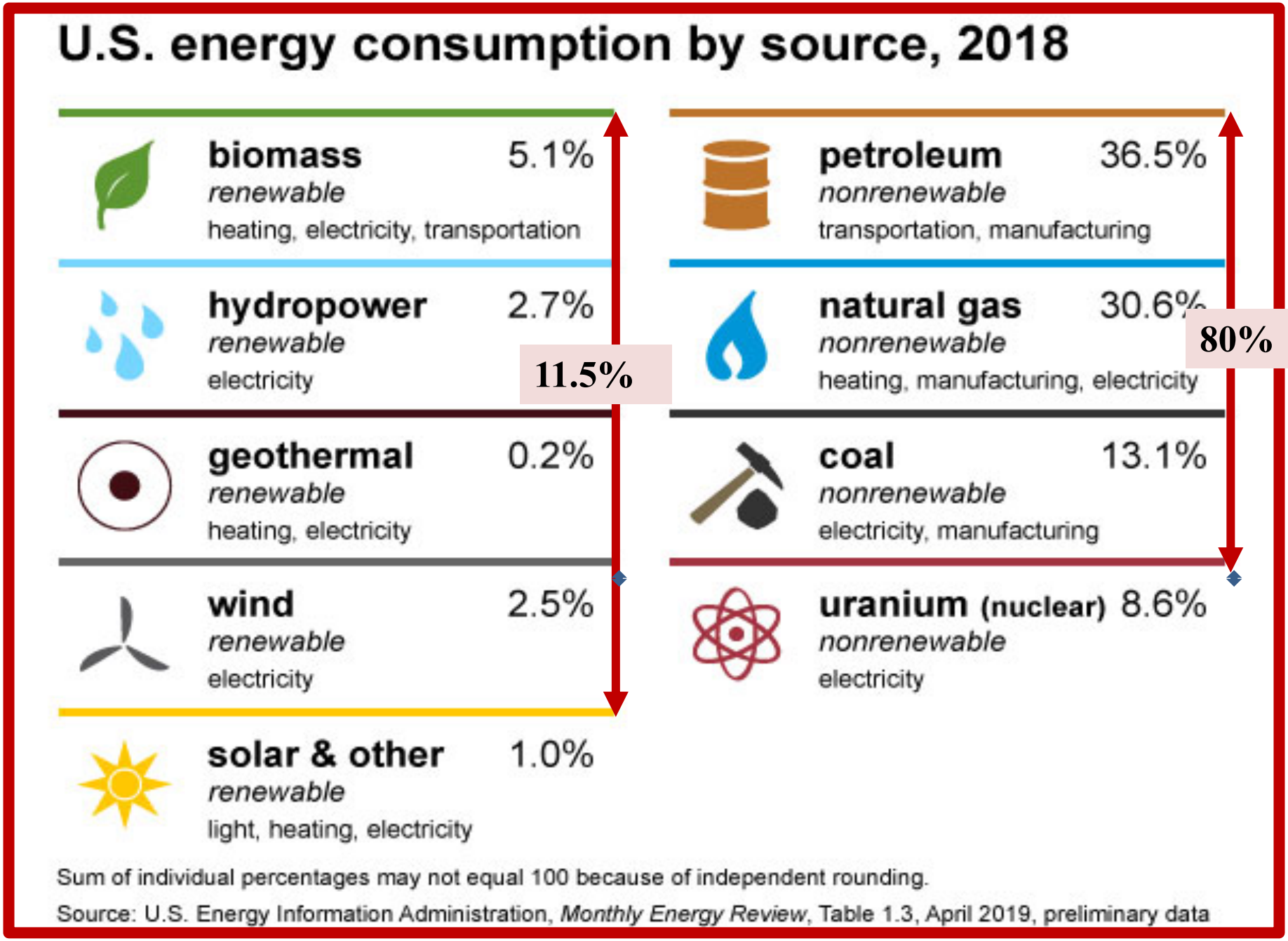
Primary energy consumption by fuel



Fracking
And
Climate Change

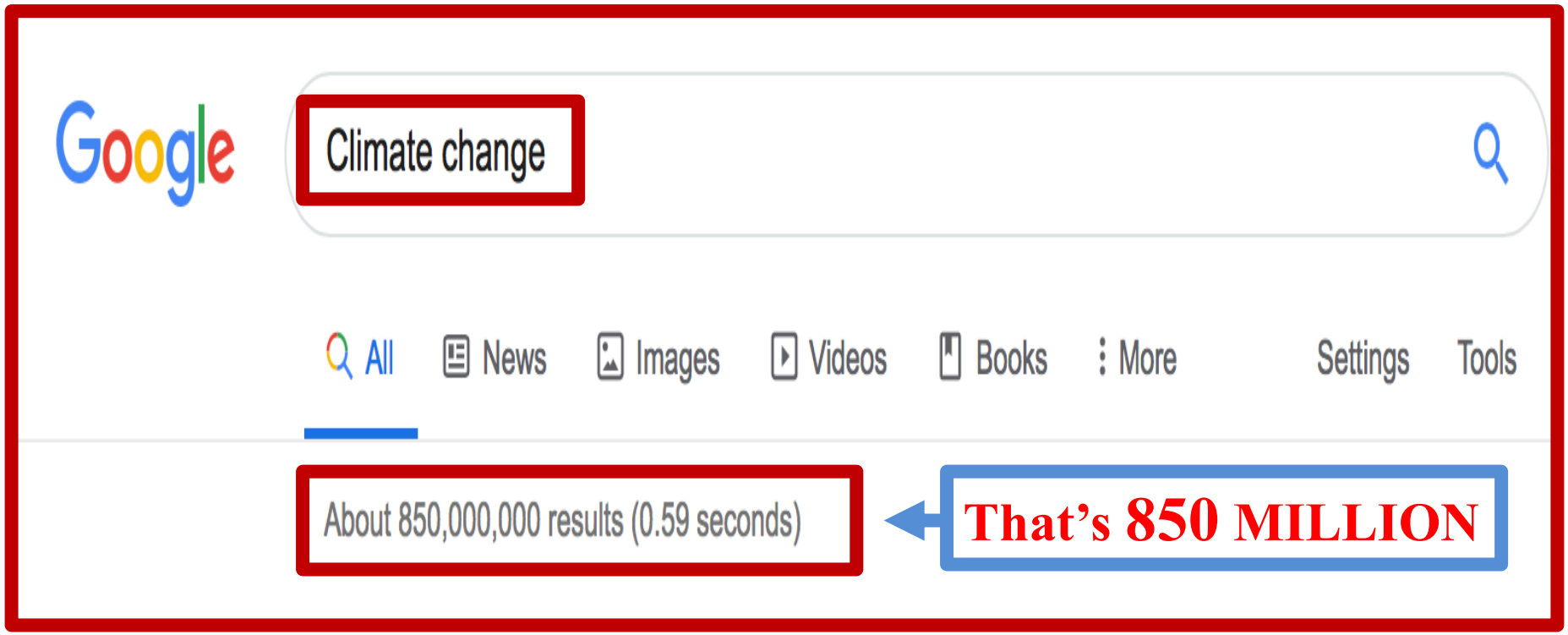

AKRON BEACON JOURNAL ©06
OHIO.COM
HAVE SOME MORE BEANS, BESSY.
GLOBAL WARMING AXIS OF EVIL

U.S. energy consumption by source, 2018



Sum of individual percentages may not equal 100 because of independent rounding.

Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3, April 2019, preliminary data



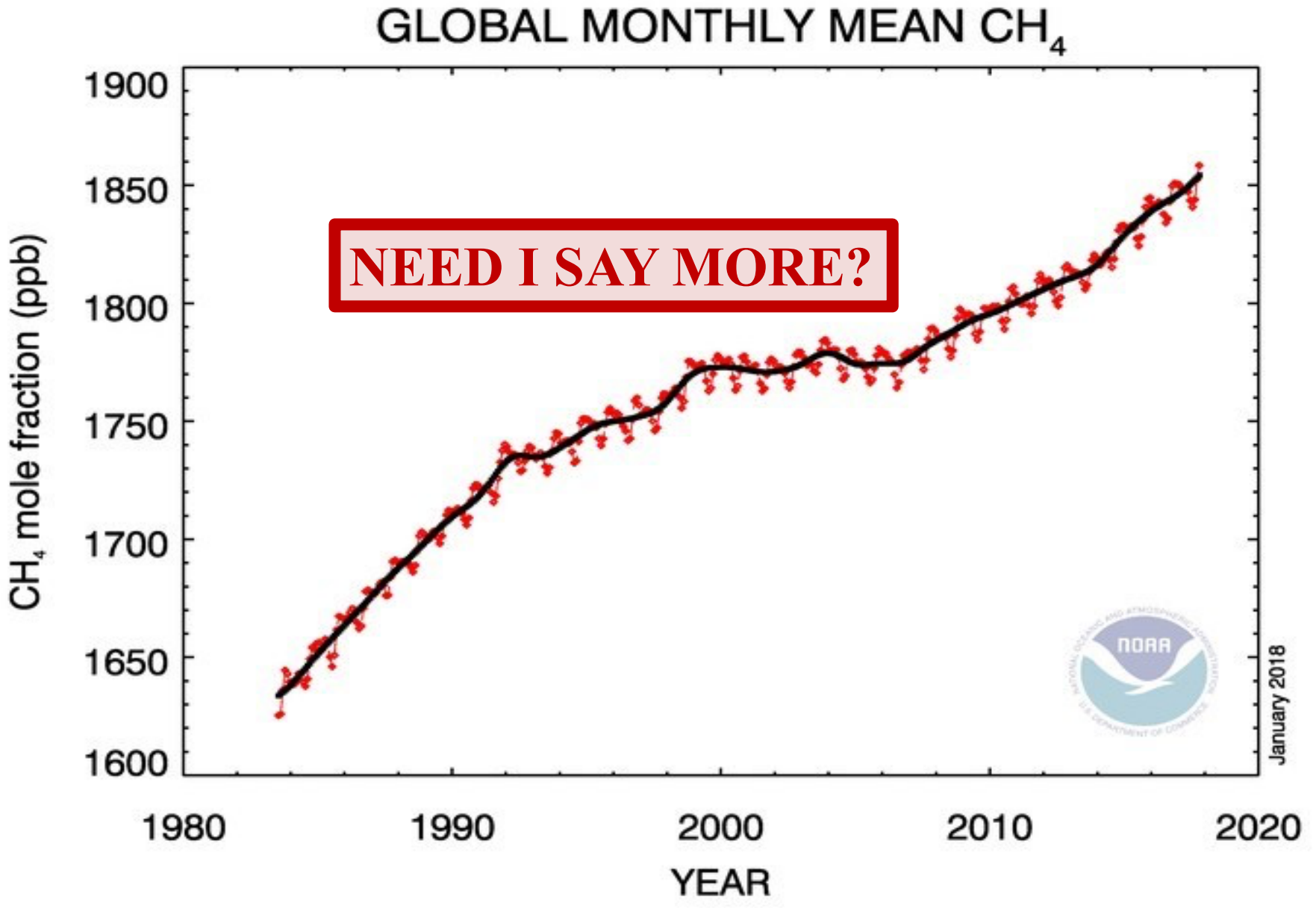
THE PERMANENT PEOPLES' TRIBUNAL

Session on Human Rights, Fracking and Climate Change

Overview and Opening Arguments

Presented by Evan Hamman & Revel Pointon

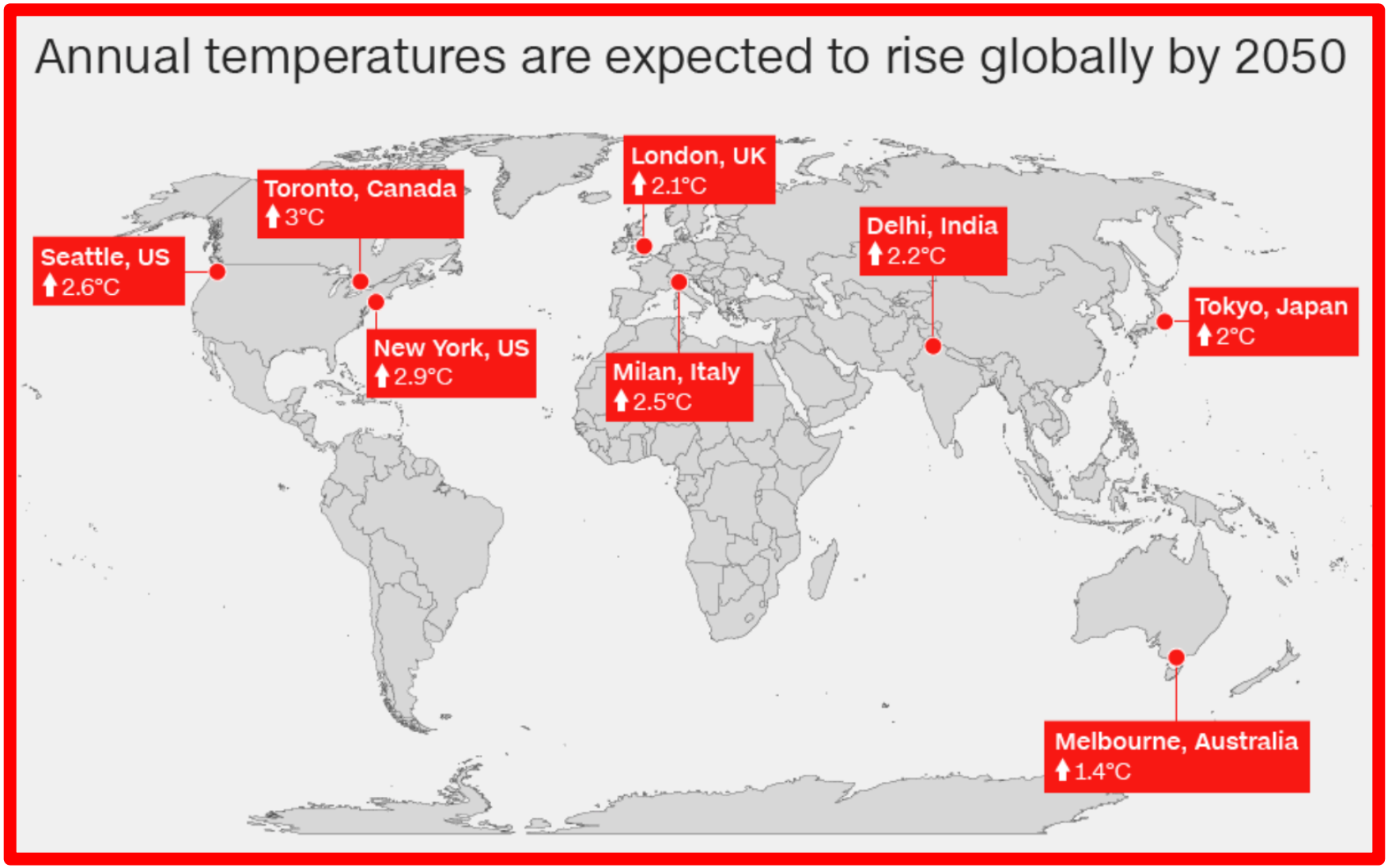
May 14, 2018


GLOBAL MONTHLY MEAN CH_4
NEED I SAY MORE?
CH_4 mole fraction (ppb)
1900
1850
1800
1750
1700
1650
1600
1980
1990
2000
2010
2020
YEAR
NOAA
January 2018

- **Many studies have estimated that leaks from oil and gas production, particularly fracking, are a major driver of rising methane emissions.**
- **Other research groups have estimated that the rise in methane emissions was due to a rise in "microbial production in wet tropical environments like marshes and rice paddies."**
- **The two explanations both seemed right, yet could not both actually be right. Or could they?**
- **After a very deep dive into multiple ground and satellite datasets, NASA determined that a third source of methane emissions — global fires — had been *declining* much more rapidly than previously realized..**

- With wildfire emissions way down, it was now possible for both fossil fuel emissions and wetland emissions to be up.
- Significantly, the huge rise in fossil fuel methane emissions "found here is ***substantially larger*** than in previous literature."
- The recent jump in methane emissions from oil and gas production appears to be a whole lot bigger than we previously thought.
- And that is a bombshell finding.
- After all, methane (CH_4) traps 86 times as much heat as CO_2 over a 20-year period.
- That's why countless studies find that even a very small leakage rate of methane from the natural gas supply chain can have a large climate impact — enough to gut the entire benefit of switching from coal-fired power to gas for a long, long time.

By 2050, London's climate will be as warm as Barcelona's, says new study



- **For years, the IPCC, governments and environmental organizations they influence have told the public:**
  - ✓ **that global warming is still manageable**
  - ✓ **that global warming consequences will occur gradually**
  - ✓ **that global warming consequences will remain generally mild until about 2100**
  - ✓ **the very worst consequences of global warming will occur after 2100 long after most of us living today are gone.**

- **Nothing listed in items 1-4 above could be farther from the truth!**
  - ✓ **the public has no idea that we have managed global warming *so incredibly poorly* for the last 35 plus years that it has probably now become *out of our meaningful control* for at least *another* 30-50 years with horrific and unavoidable consequences arriving *far sooner* than almost any of us are prepared to deal with.**
  - ✓ **It's also far worse than just now *unavoidable* horrible consequences. What we do now until 2025 will be critical in determining if we are able to avoid the *likelihood* of extinction.**

America is building another big wall. This one will protect New York

- By 2025, New York's Staten Island will be fortified by a towering seawall running 5.3 miles along the coast, an engineering feat designed to ward off a growing threat.
- The climate crisis is predicted to create more powerful and extreme weather systems all over the world, and coastal engineers are racing to respond with structures to reduce their impact.

Global Warming Consequences Destabilizing our Climate and Lives

Moving Beyond Carbon

- **To help address the mounting climate change crisis, Michael. Bloomberg launched Beyond Carbon, the largest-ever coordinated campaign against climate change in the United States**

Transition to 100% clean power

Replace oil burning cars and trucks with electric vehicles

Phase out polluting building equipment

Modernize industry and infrastructure

Repay our debt to coal producing communities

WHAT WE TALKED ABOUT

Geology in the News

The 4 E's

Petroleum Geology

Oil Shale versus Shale Gas

Fracking

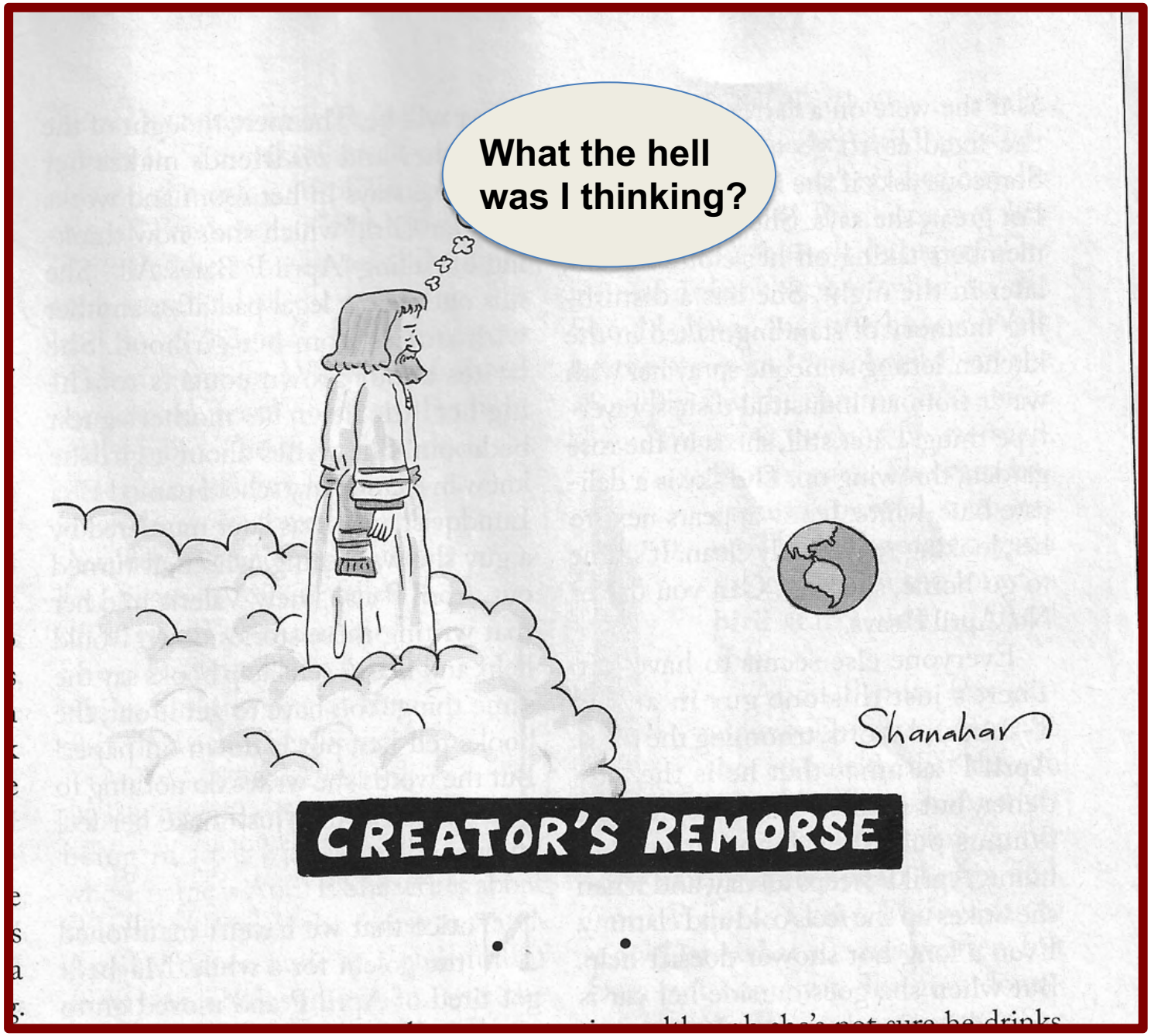
Pros of Fracking

Cons of Fracking

Fracking and Climate Change

Discussion

"Have you tried turning it off and on again?"


What the hell was I thinking?
Shanahan
CREATOR'S REMORSE

The Day the Dinosaurs Died
October 7, 2019

Geology and Geopolitics
Spring, 2020

END