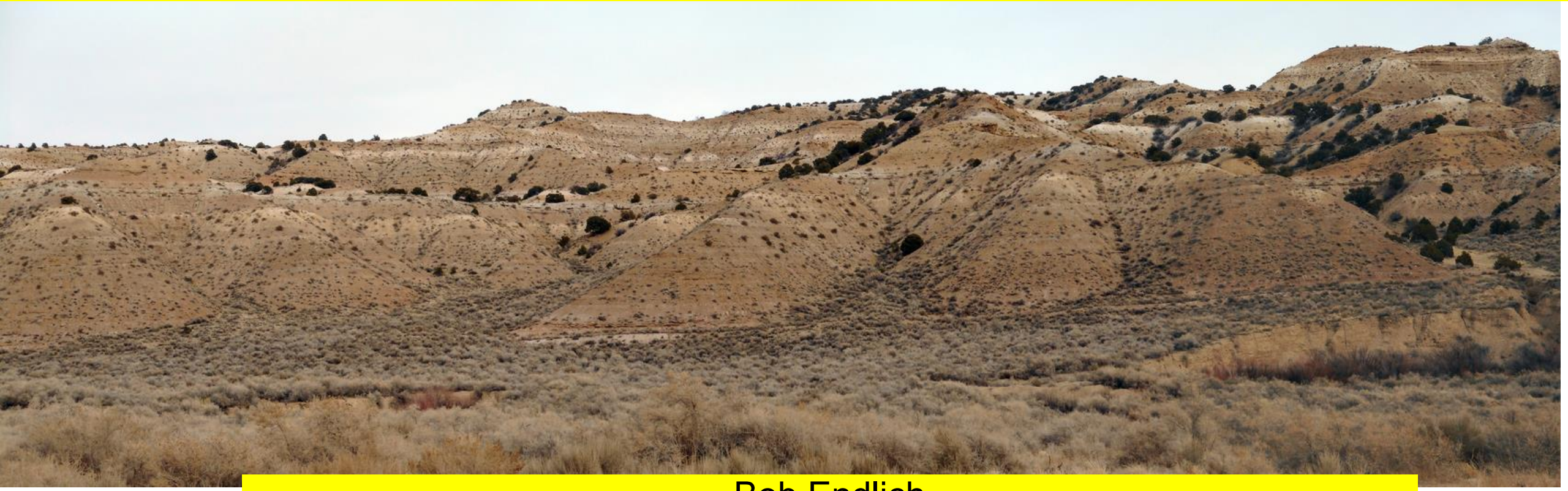
Coal, Oil, Gas, Fracking, Nuclear, "End of Oil" Energy Stories, and some estimates of Petroleum Reserves



Bob Endlich

bendlich@msn.com

Cruces Atmospheric Sciences Forum

17 Jan 2026

OUTLINE of TOPICS

INTRODUCTION

SOME GEOLOGY

COAL, OIL

SOME HISTORY

GAS

FRACKING

RESERVES and "THE END OF OIL"

Brief Remarks on NUCLEAR

UNUSUAL HYDROCARBON DEPOSITS:

ALBERTA'S TAR SANDS

THE GREEN RIVER FORMATION

INTRODUCTION

I've tried to organize the topics today so that they make sense to this audience.

However, today's topics are broad-reaching; it is difficult to encapsulate all subjects in the time allowed.

Let's get started!

https://upload.wikimedia.org/wikipedia/commons/c/c7/Transition_facies_GR_(4).jpg

Green River Formation, Utah, Colorado, Wyoming

Transition facies, unnamed upper member of the Green River Formation, along U.S. Highway 191, lower Indian Canyon, Duschesne County, Utah

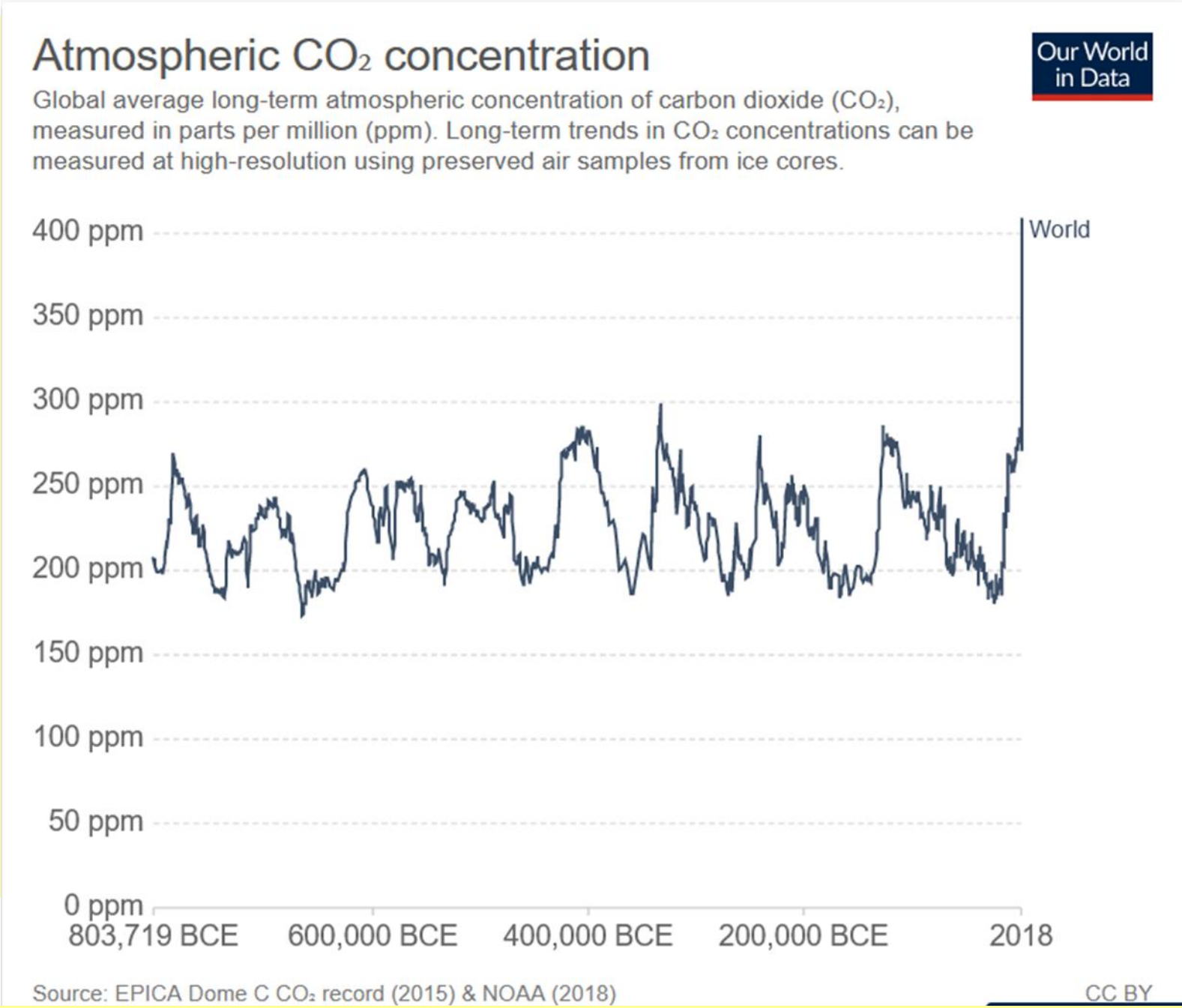
The **Green River Formation** contains the **largest oil shale deposit in the world**. Estimates are that the oil shale reserves could equal up to **3 trillion barrels** (480 billion M**3) of shale oil, up to half of which may be recoverable by shale oil extraction technologies (pyrolysis, hydrogenation, or thermal dissolution of kerogen in oil shale) (More on the **Green River Formation**, later)

This graph might look a little scary….

but it is not, if you know…

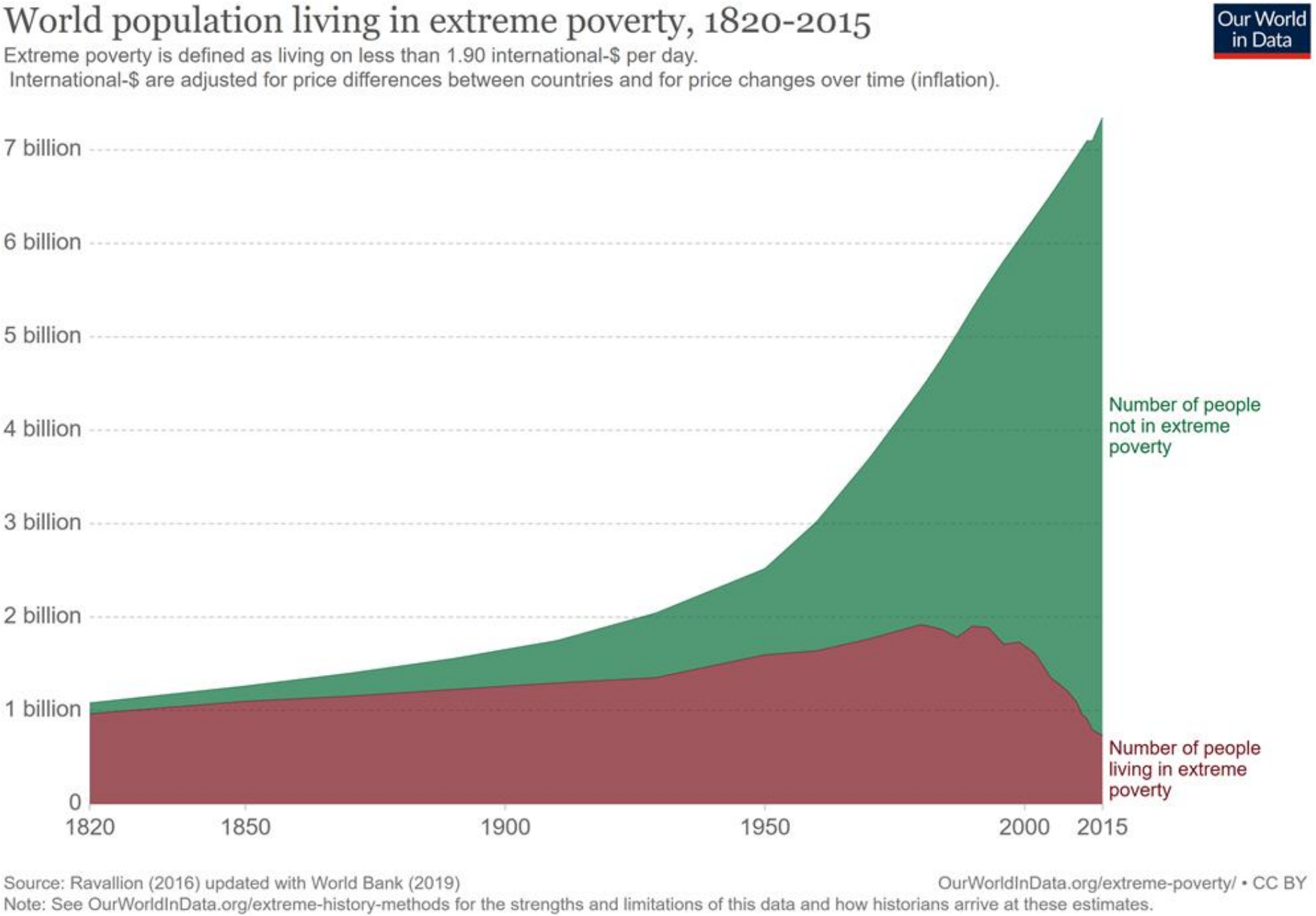
as the late Paul Harvey used to say…

“the REST of the story."



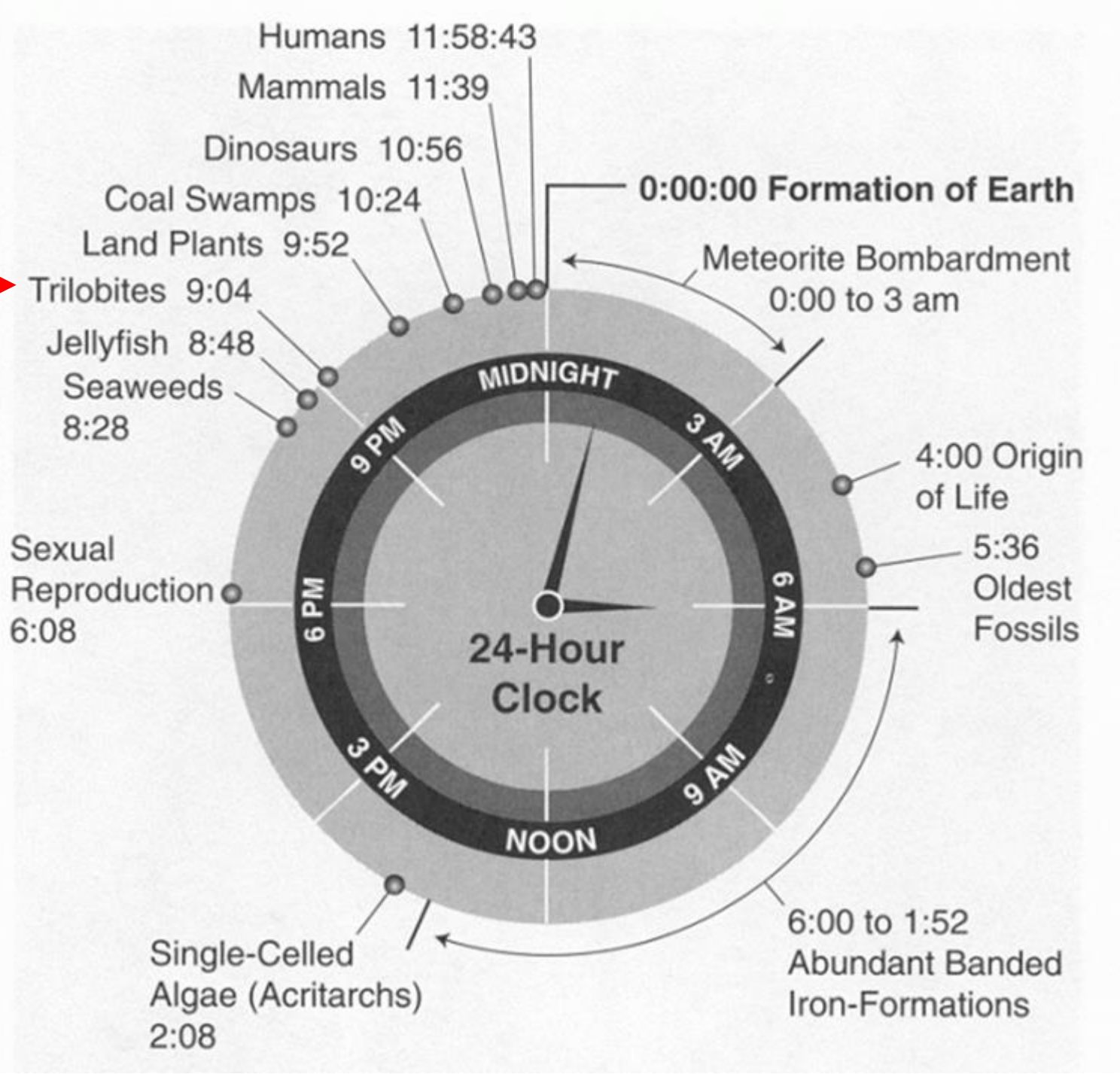
https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

https://notalotofpeopleknowthat.wordpress.com/2021/03/29/richard-betts-gloomy-milestone



One example of the scale of Geologic Time… as a 24-Hour Clock

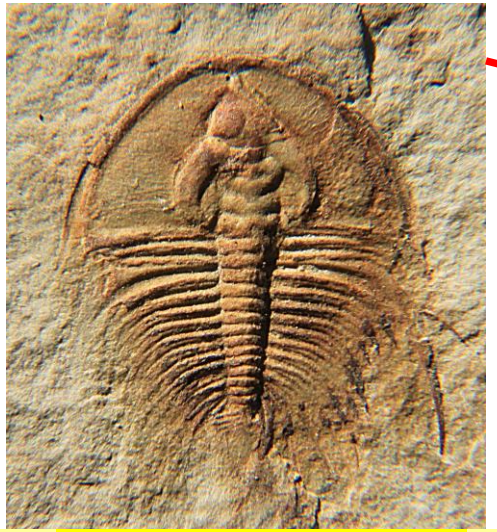
Base of the Cambrian



https://wattsupwiththat.com/2021/07/12/melting-glaciers-revealing-ancient-tree-stumps-from-a-warmer-period/

https://www.geocraft.com/WVFossils/GeolTimeScale.html

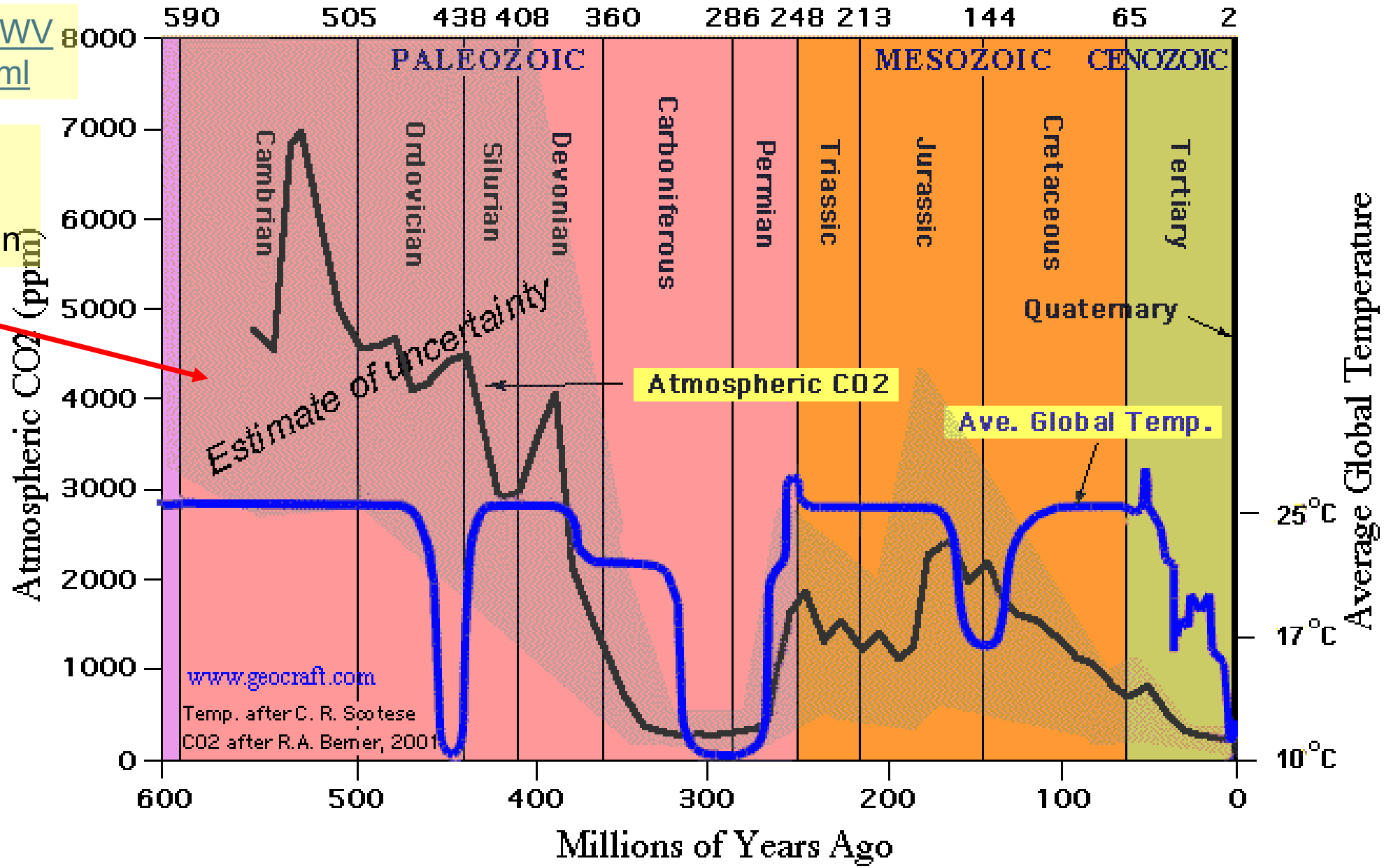
Trilobites become common beginning at the base of the Cambrian



Olenellid Trilobite

https://en.wikipedia.org/wiki/Olenellidae

Trilobites are similar to Horseshoe Crabs.



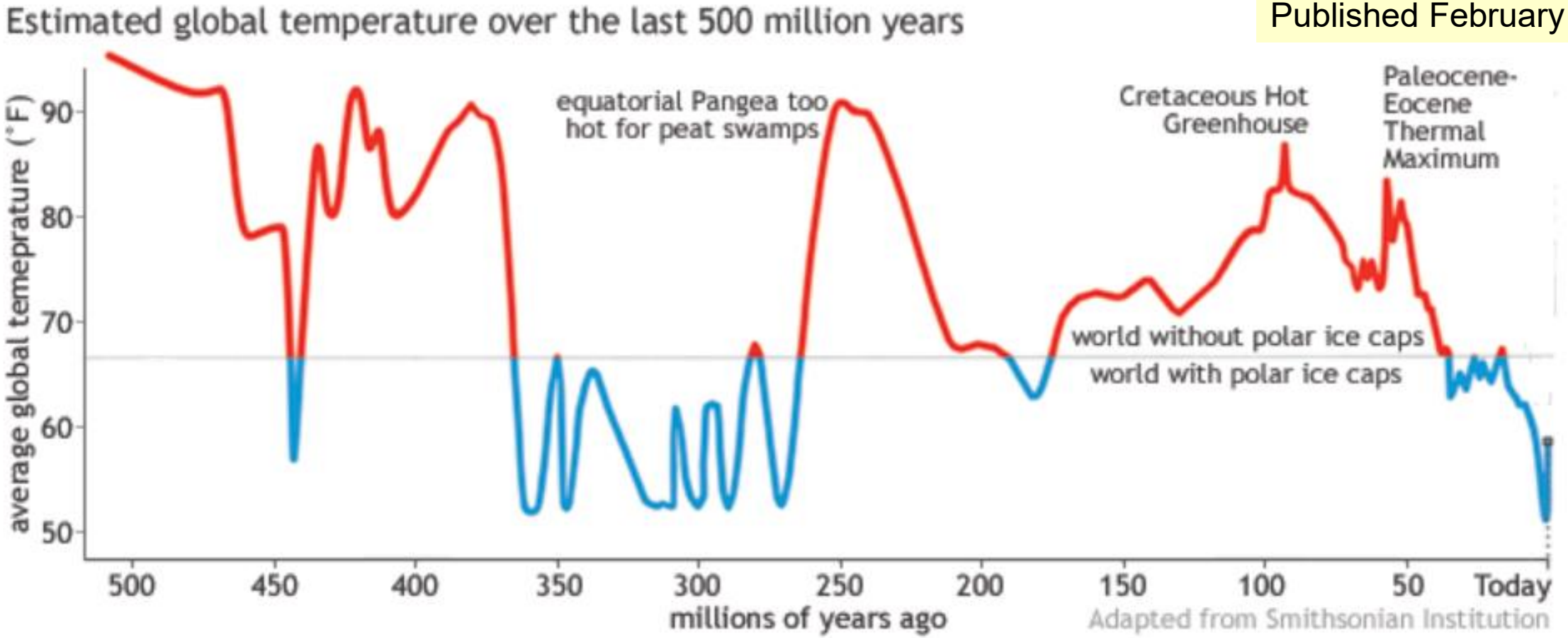
X-Axis Time: Cambrian 600 MY ago Left Present on Right

Y-Axis Blue Average Global Temperature, Scotese **Paleomap** Project **Climate** Tab

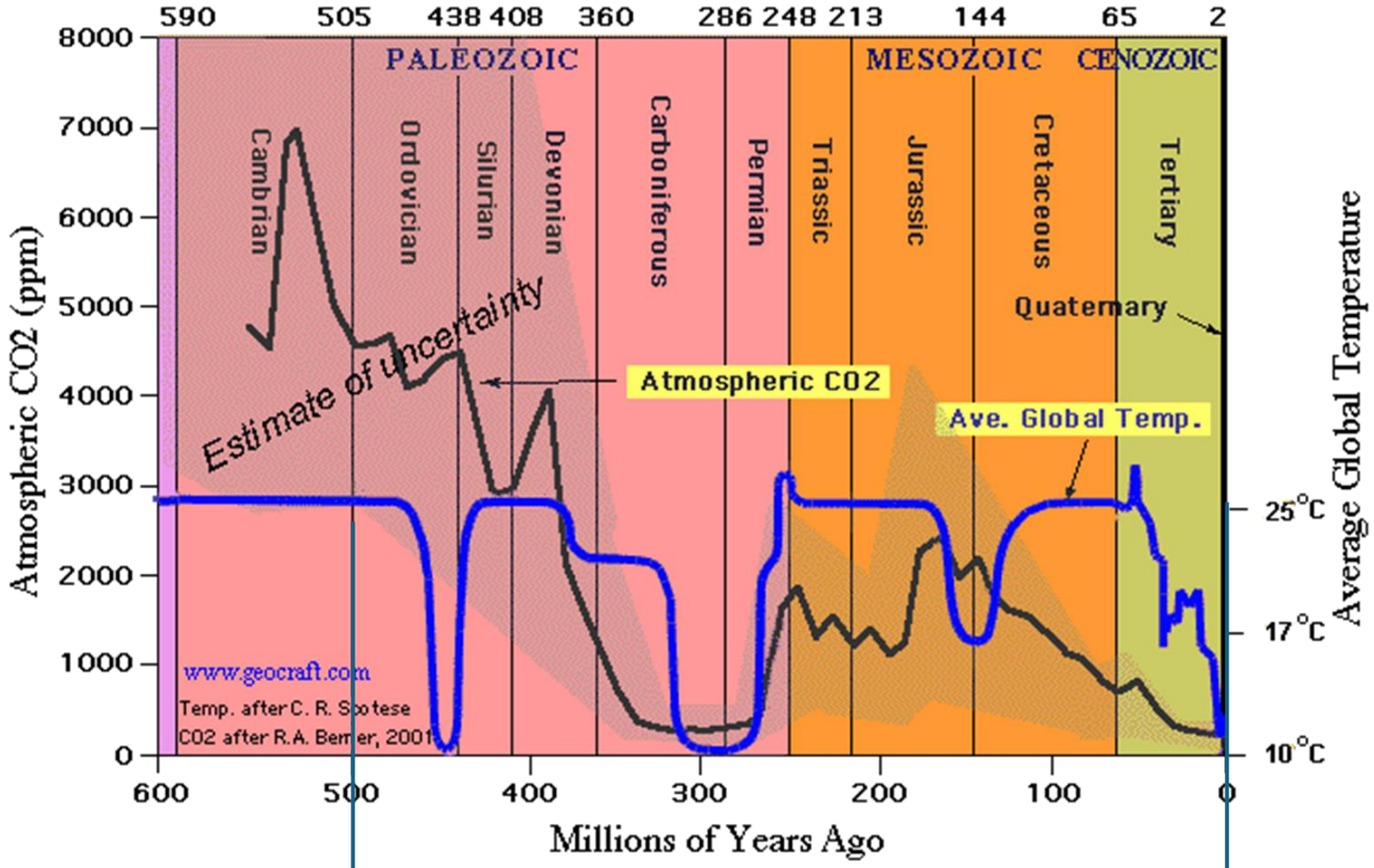
Y-Axis Black Atmospheric <CO2> Berner & Kothavala, Am J. Sci., 2001, p 182-204

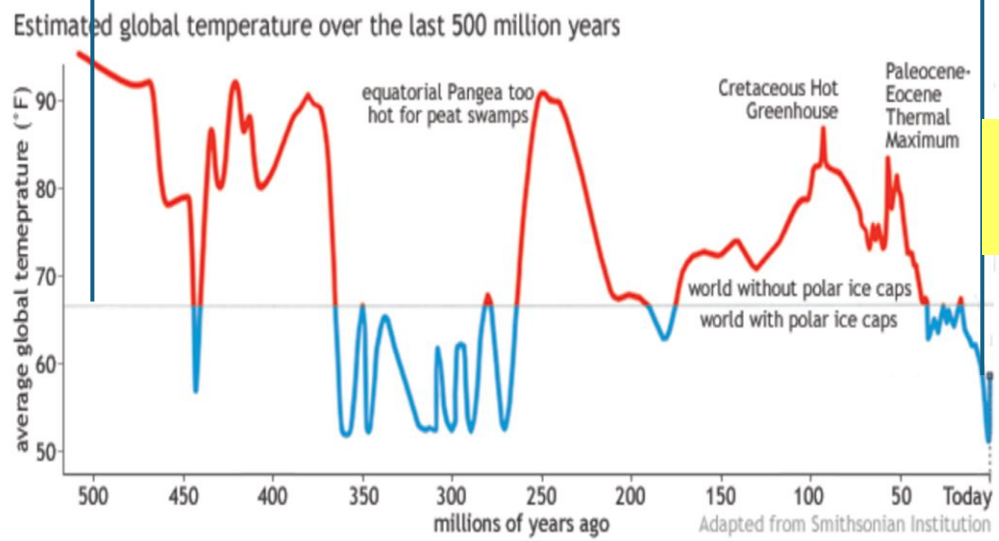
https://climate.gov/news-features/climate-qa/whats-hottest-earths-ever-been

Published February 26, 2025



Preliminary results from a Smithsonian Institution project led by Scott Wing and Brian Huber, showing Earth's average surface temperature over the past 500 million years. For most of the time, global temperatures appear to have been too warm (red portions of line) for persistent polar ice caps. The most recent 50 million years are an exception. Image adapted from Smithsonian National Museum of Natural History.





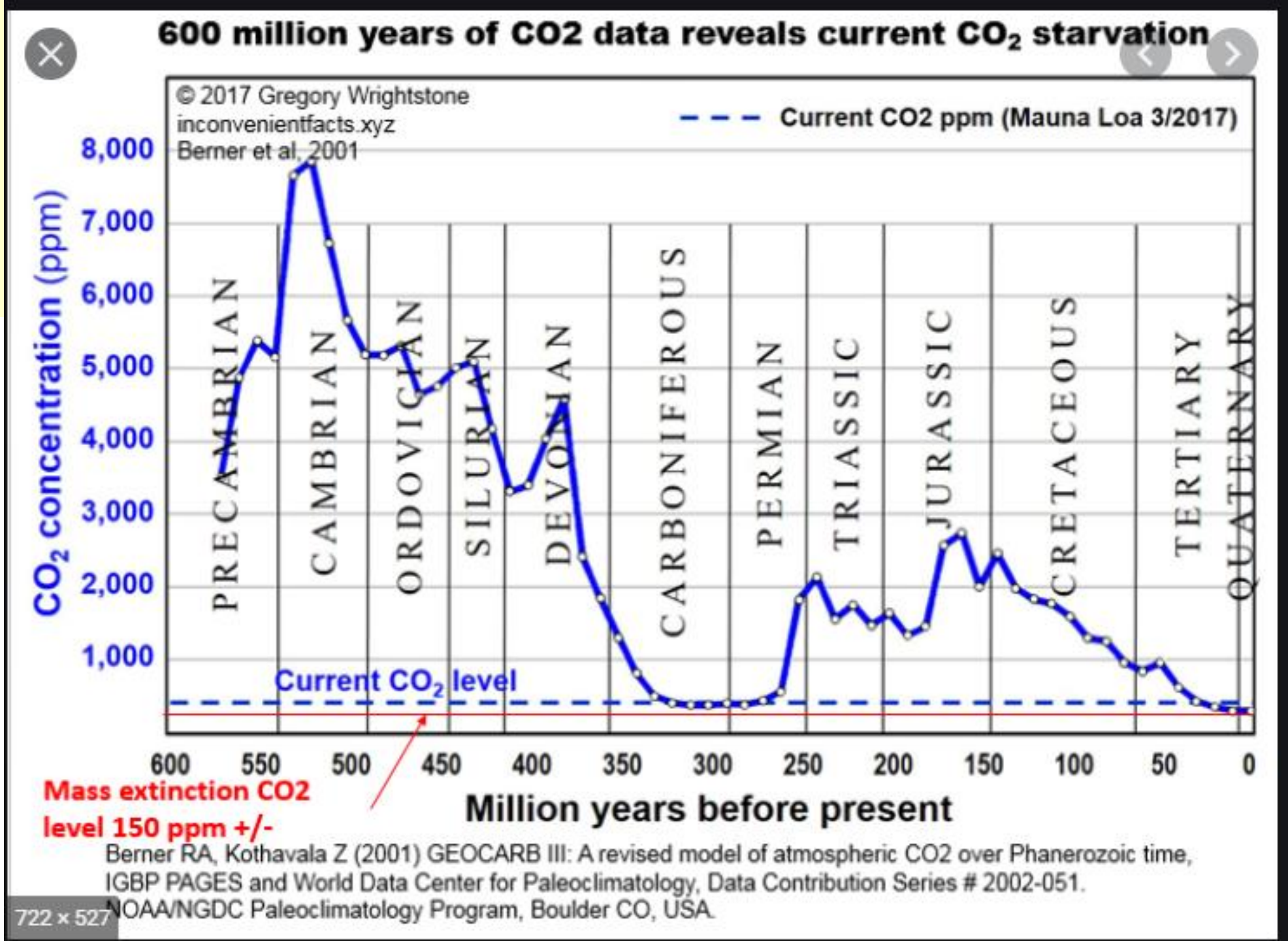
Dates from Sep 2001

https://www.geocraft.com/WVFossils/GeolTimeScale.html

Published 26 February 2025

https://climate.gov/news-features/climate-qa/whats-hottest-earths-ever-been

https://notrickszone.com/2020/12/05/in-geological-terms-todays-atmospheric-co2-concentrations-are-still-uncomfortably-low/



From my course,

“Weather, Climate, and Climate Change — What the Data Tell Us”

taught in 2019

Week Two:

https://nhm.org/site/sites/default/files/rancho_la_brea/pdf/ward,%20harris%20publicatio%20PNAS.pdf

PNAS

Carbon starvation in glacial trees recovered from the La Brea tar pits, southern California

Joy K. Ward*†‡, John M. Harris§, Thure E. Cerling¶‖, Alex Wiedenhoeft‖, Michael J. Lott†, Maria-Denise Dearing†, Joan B. Coltrain**, and James R. Ehleringer†

*Department of Ecology and Evolutionary Biology, University of Kansas, 1200 Sunnyside Avenue, Lawrence, KS 66045; †Department of Biology, University of Utah, 257 South 1400 East, Salt Lake City, UT 84112-0840; §The George C. Page Museum of La Brea Discoveries, 5801 Wilshire Boulevard, Los Angeles, CA 90036; ¶Department of Geology and Geophysics, University of Utah, 135 South 1460 East, Salt Lake City, UT 84112; ‖Forest Products Laboratory, U.S. Department of Agriculture Forest Service, One Gifford Pinchot Drive, Madison, WI 53726-2398; and **Department of Anthropology, University of Utah, 270 South 1400 East, Salt Lake City, UT 84112

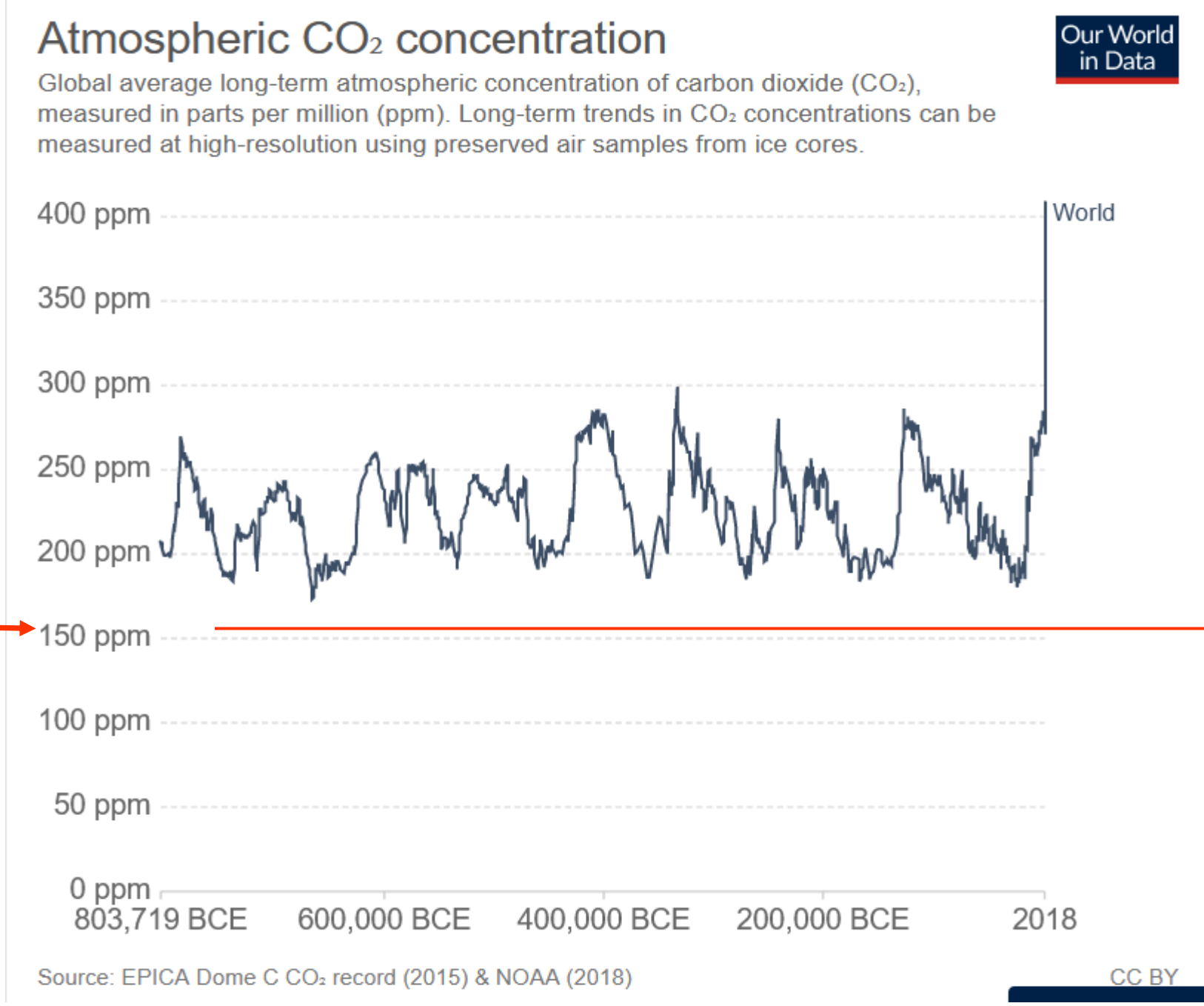
The Rancho La Brea tar pit fossil collection includes *Juniperus (C3)* wood specimens that 14C date between 7.7 and 55 thousand years(kyr) B.P., providing a constrained record of plant response for southern California during the last glacial period…

… Atmospheric CO2 concentration ([CO2]) ranged between 180 and 220 ppm during glacial periods, rose to 280 ppm before the industrial period, and is currently approaching 380 ppm in the modern atmosphere…

… As a result, glacial trees… indicating that glacial trees were undergoing carbon starvation.

emphasis added

Mass Extinction level ~150 PPM



https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

https://www.climatedepot.com/2021/09/01/watch-amazing-timeline-of-global-energy-production-by-source-from-1860-2019-coal-passes-biomass-oil-passes-coal-gas-nears-coal/

The L to R sequence:

Biomass (mostly wood)

Coal

Oil

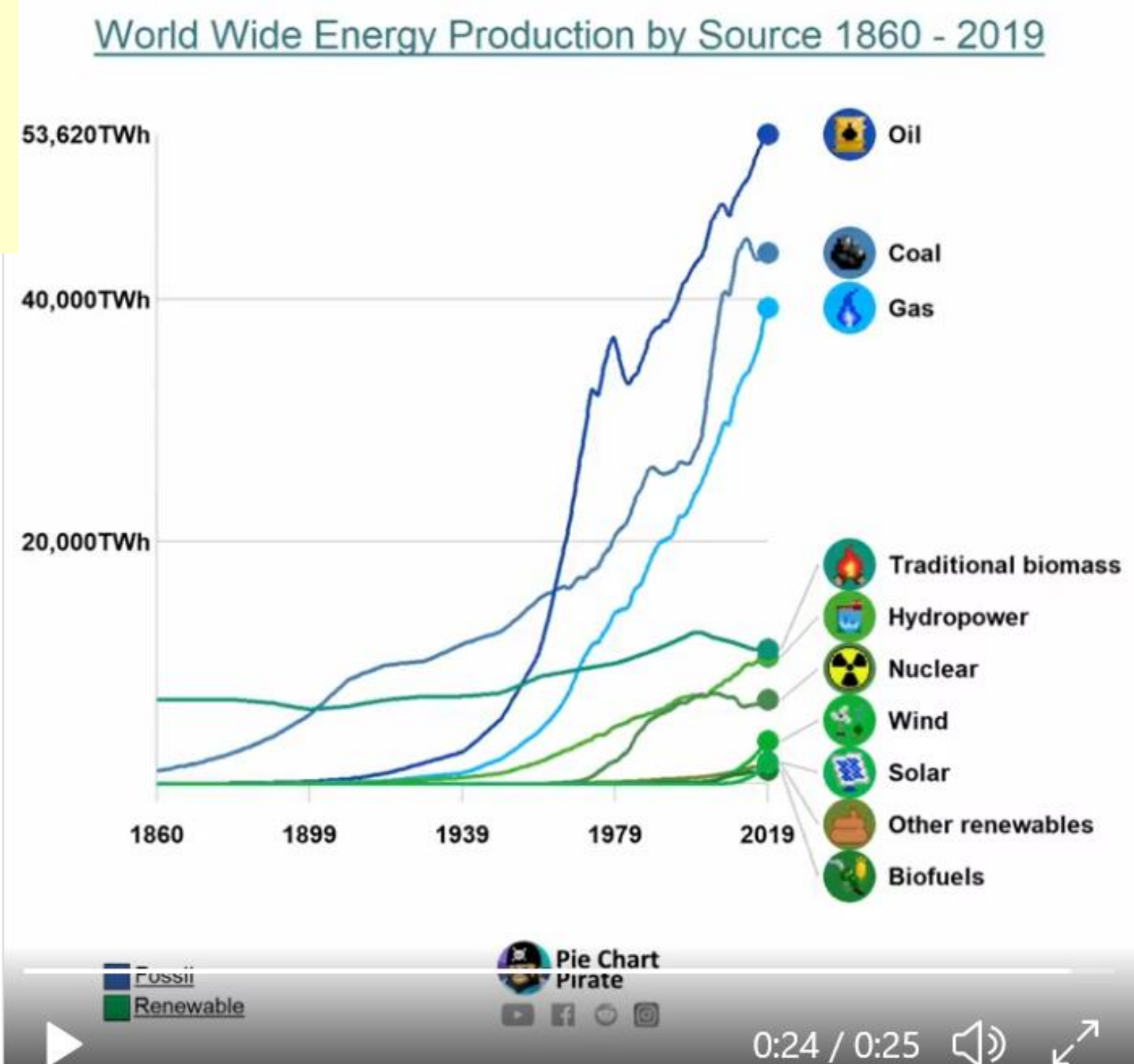
Gas

Hydropower

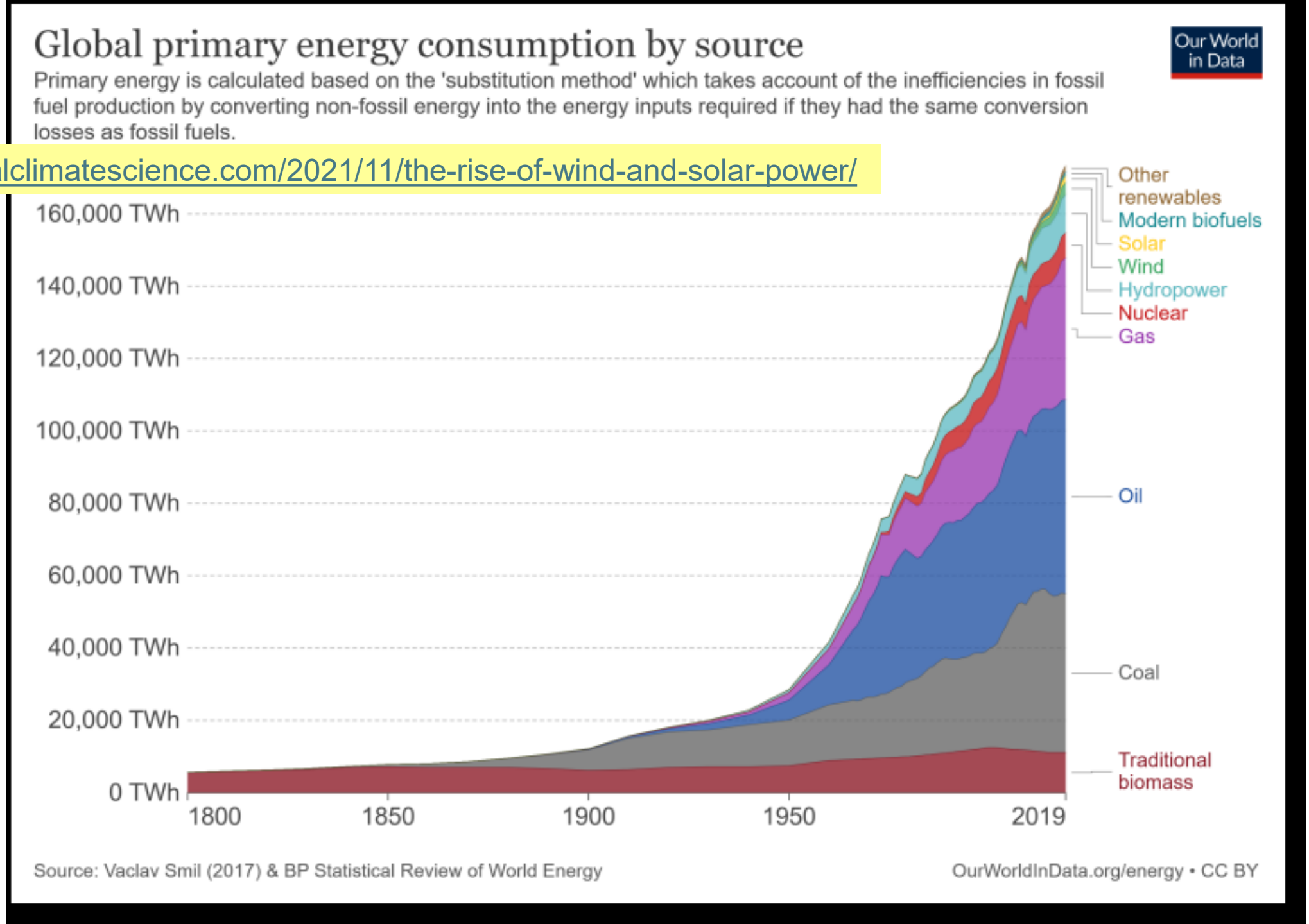
Nuclear

Wind

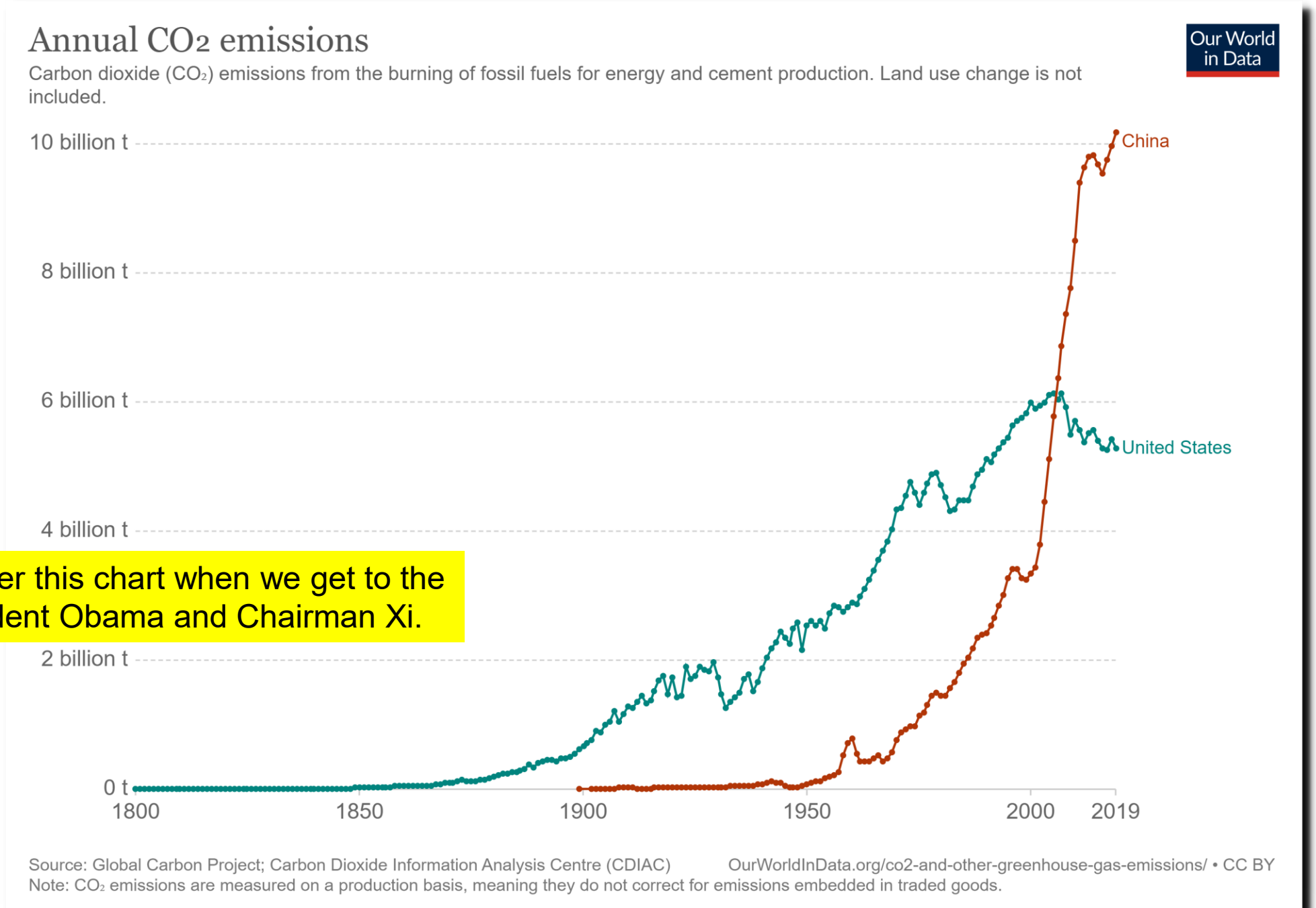
Solar



https://realclimatescience.com/2021/11/the-rise-of-wind-and-solar-power/

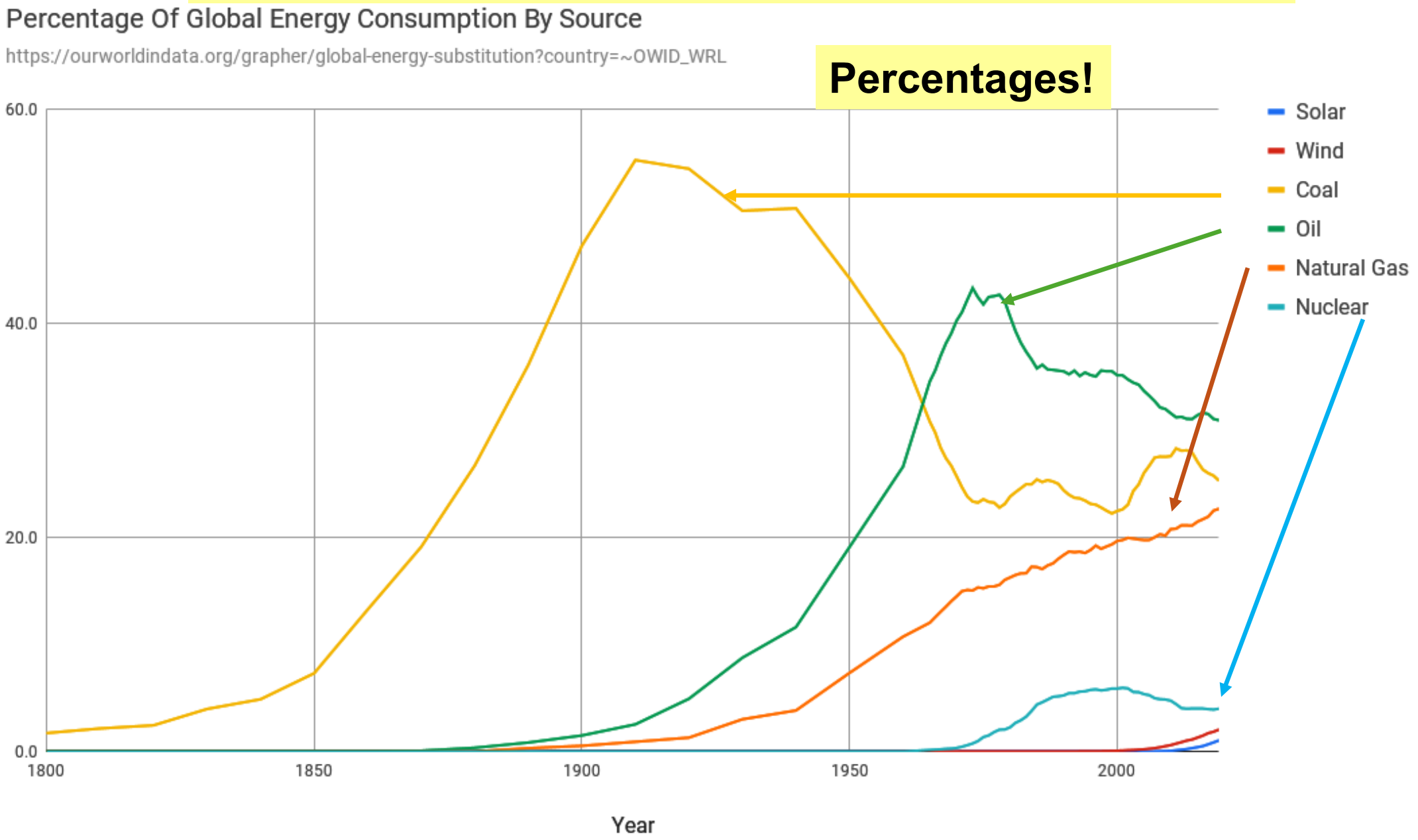


https://realclimatescience.com/wp-content/uploads/2021/04/annual-co2-emissions-per-country-1.png

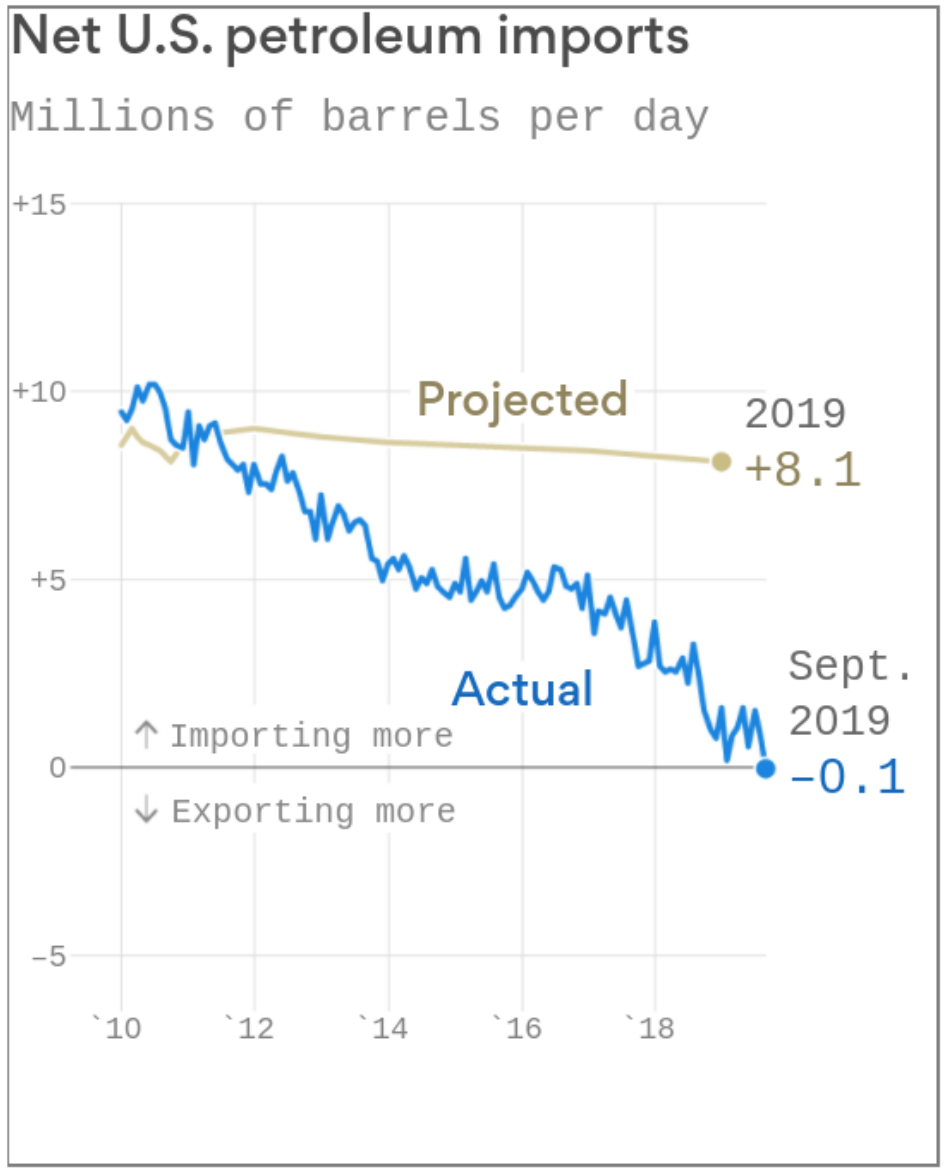


Try to remember this chart when we get to the photo of President Obama and Chairman Xi.

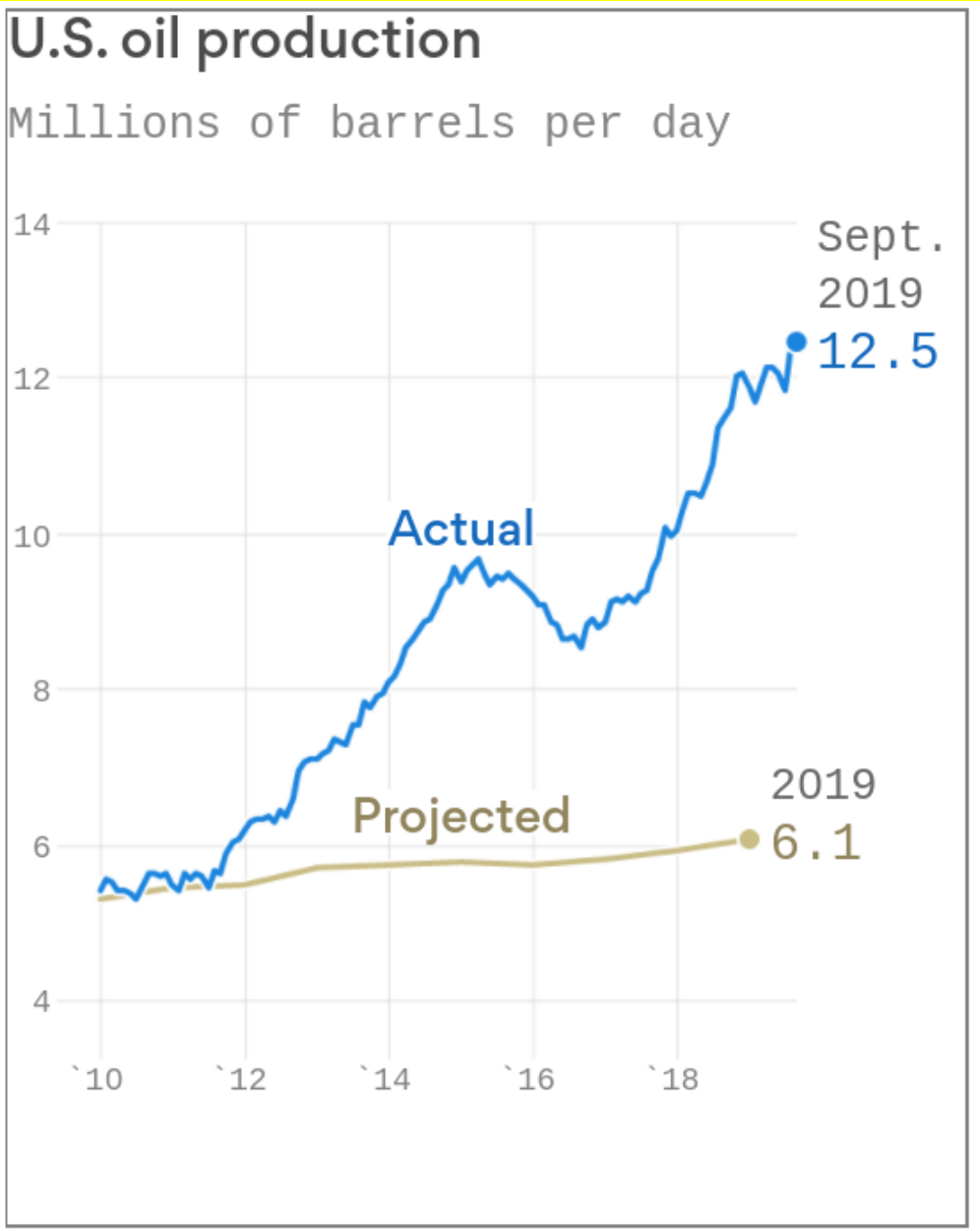
https://realclimatescience.com/2021/11/the-rise-of-wind-and-solar-power/



https://www.climatedepot.com/2019/12/23/shock-epic-fails-the-decade-that-blew-up-energy-predictions-usa-energy-boom-defied-every-prediction-see-the-charts/

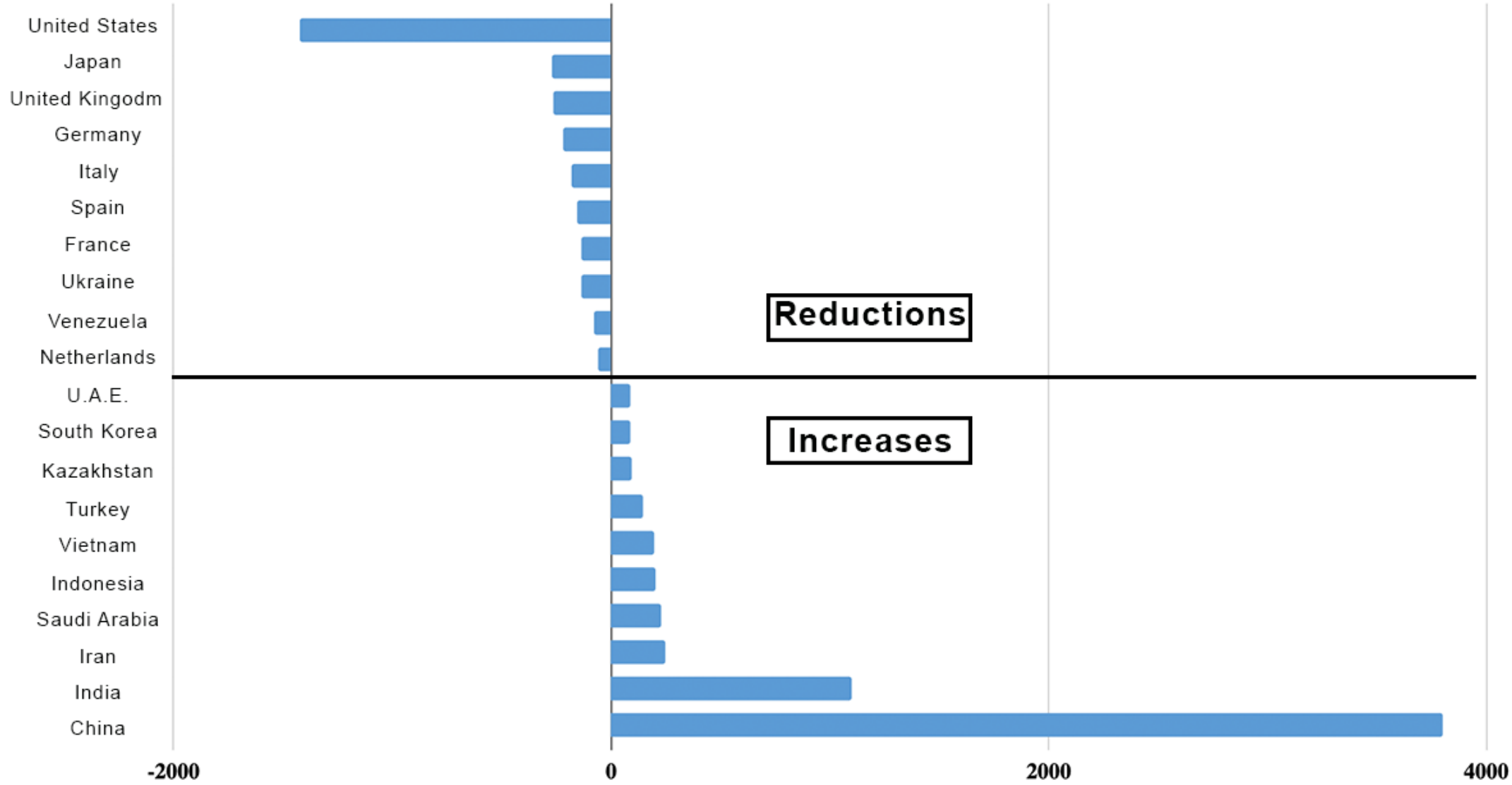


EIA actual and projected data. Chart: Andrew



EIA actual and projected data. Chart: Andrew

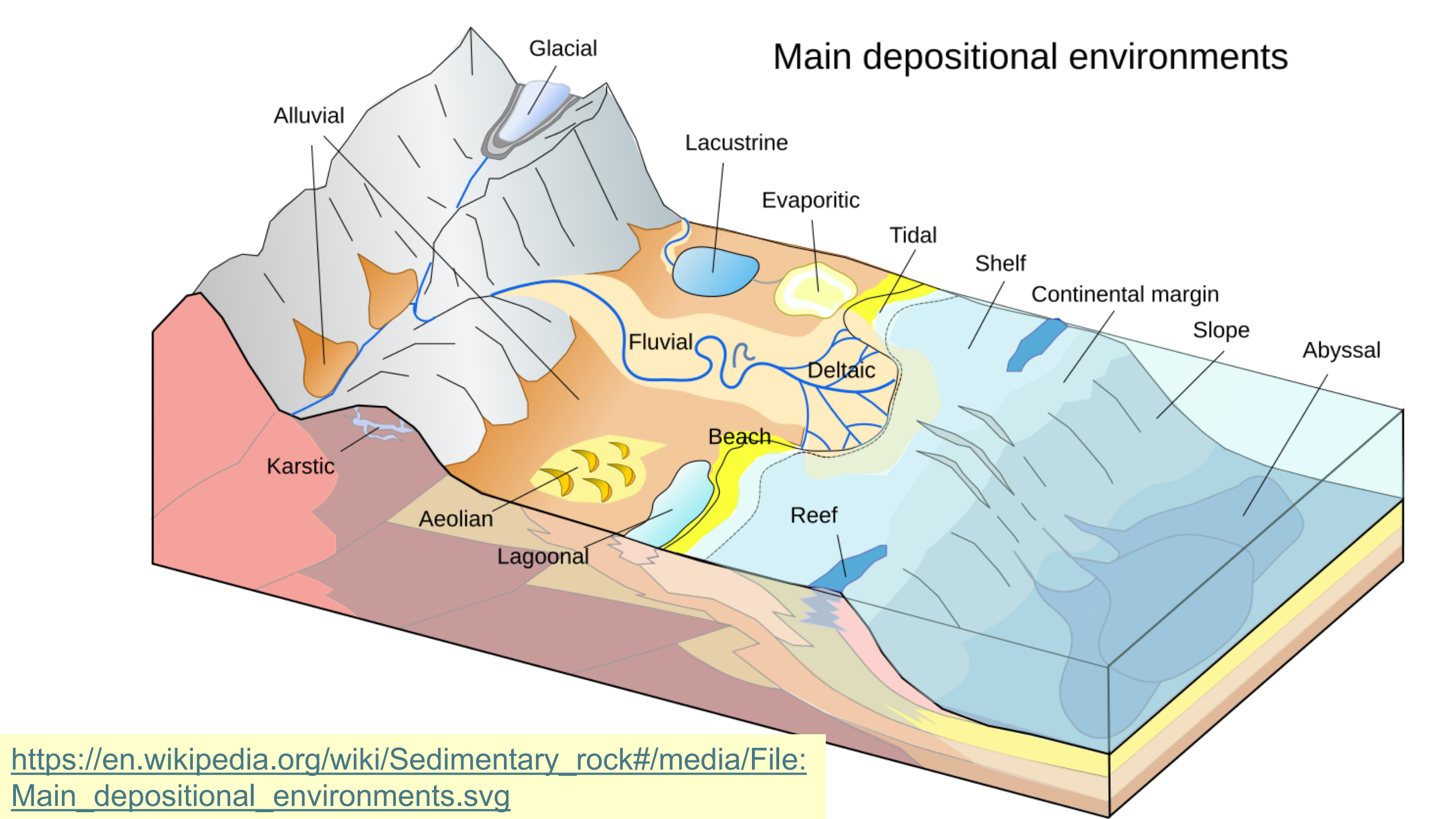
Ten Countries With The Largest Reductions and Increases in CO2 Emissions, 2005-2020 (Million Metric Tons)



Source: BP Statistical Review of World Energy

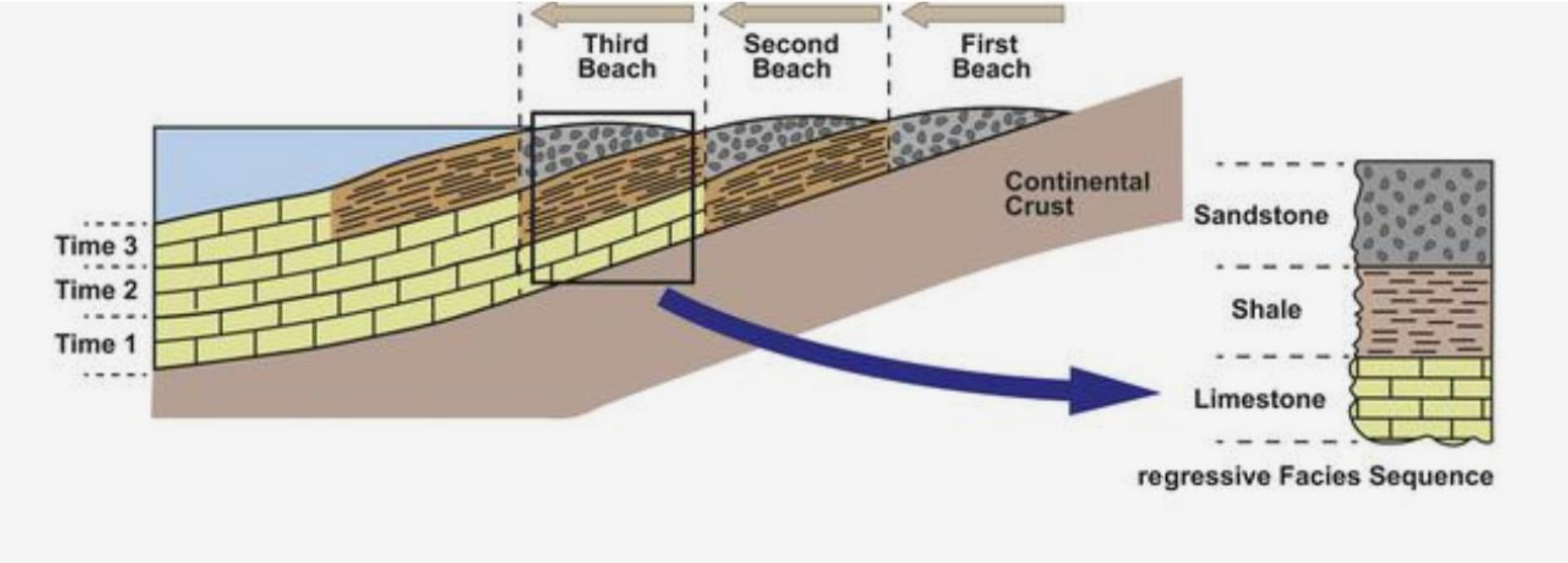
IER INSTITUTE FOR ENERGY RESEARCH

SOME PETROLEUM GEOLOGY



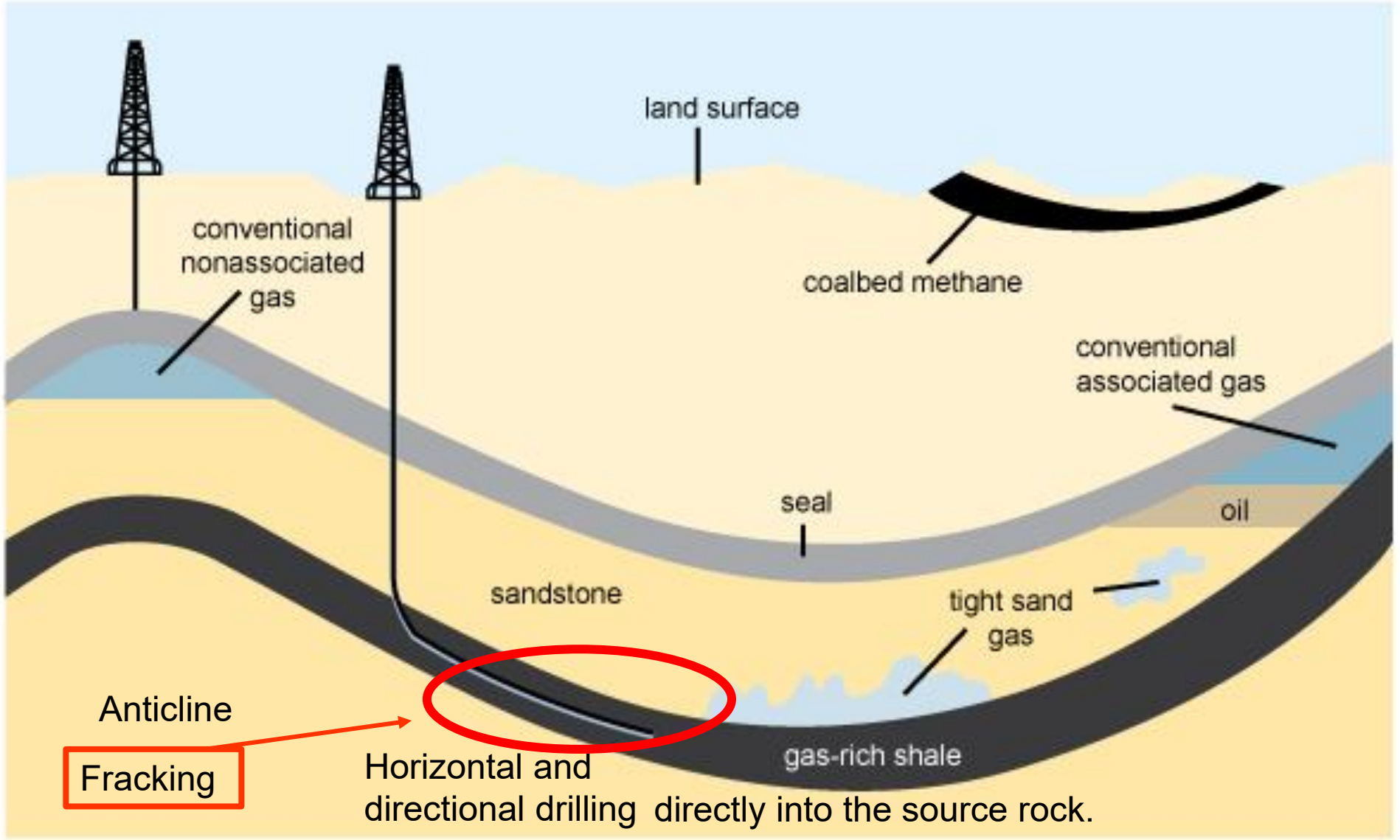
https://en.wikipedia.org/wiki/Sedimentary_rock#/media/File:Main_depositional_environments.svg

https://www.alamy.com/stock-photo/rock-erosion-diagram.html



https://www.eia.gov/energyexplained/natural-gas/where-our-natural-gas-comes-from.php

Schematic geology of natural gas resources



Impermeable layer, typically, shale.

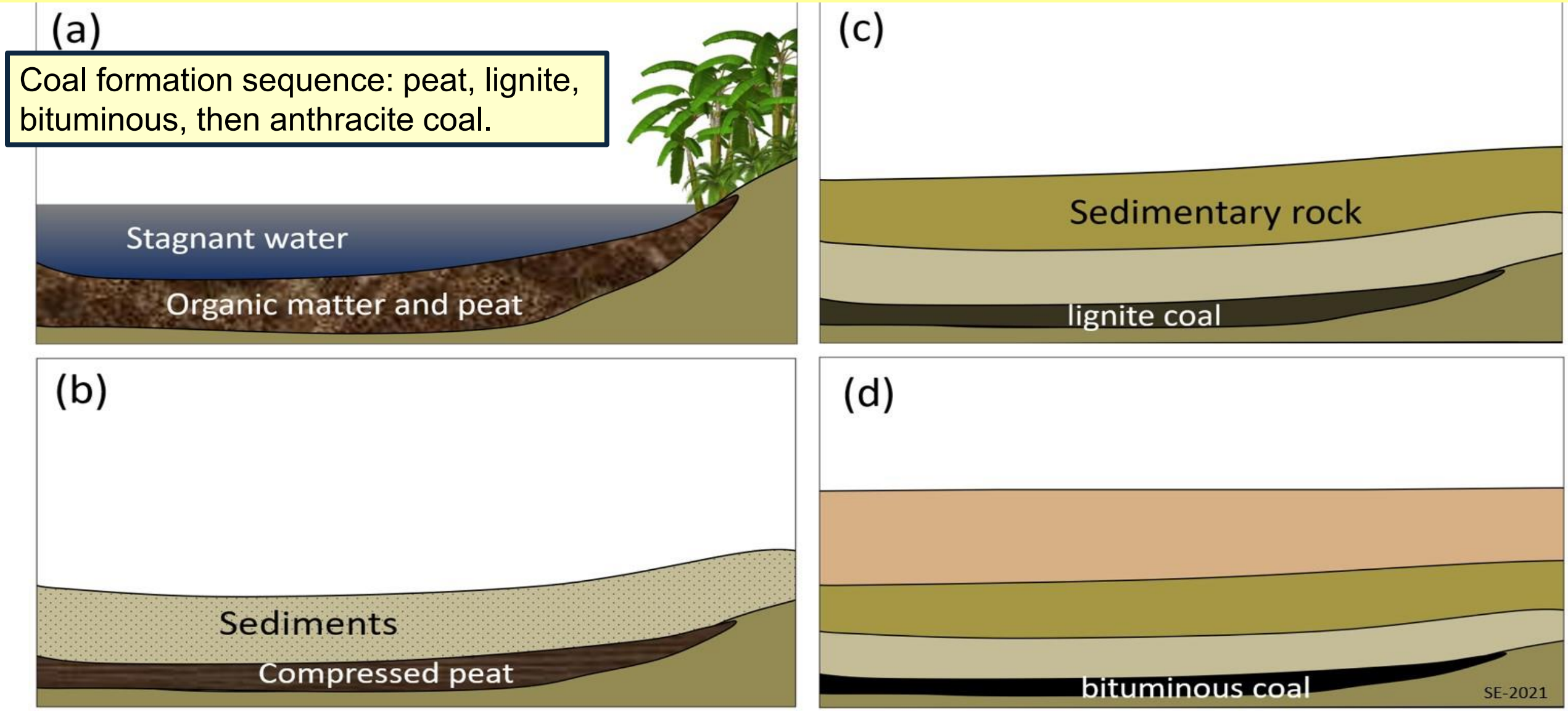
Anticline

Fracking

Horizontal and directional drilling directly into the source rock.

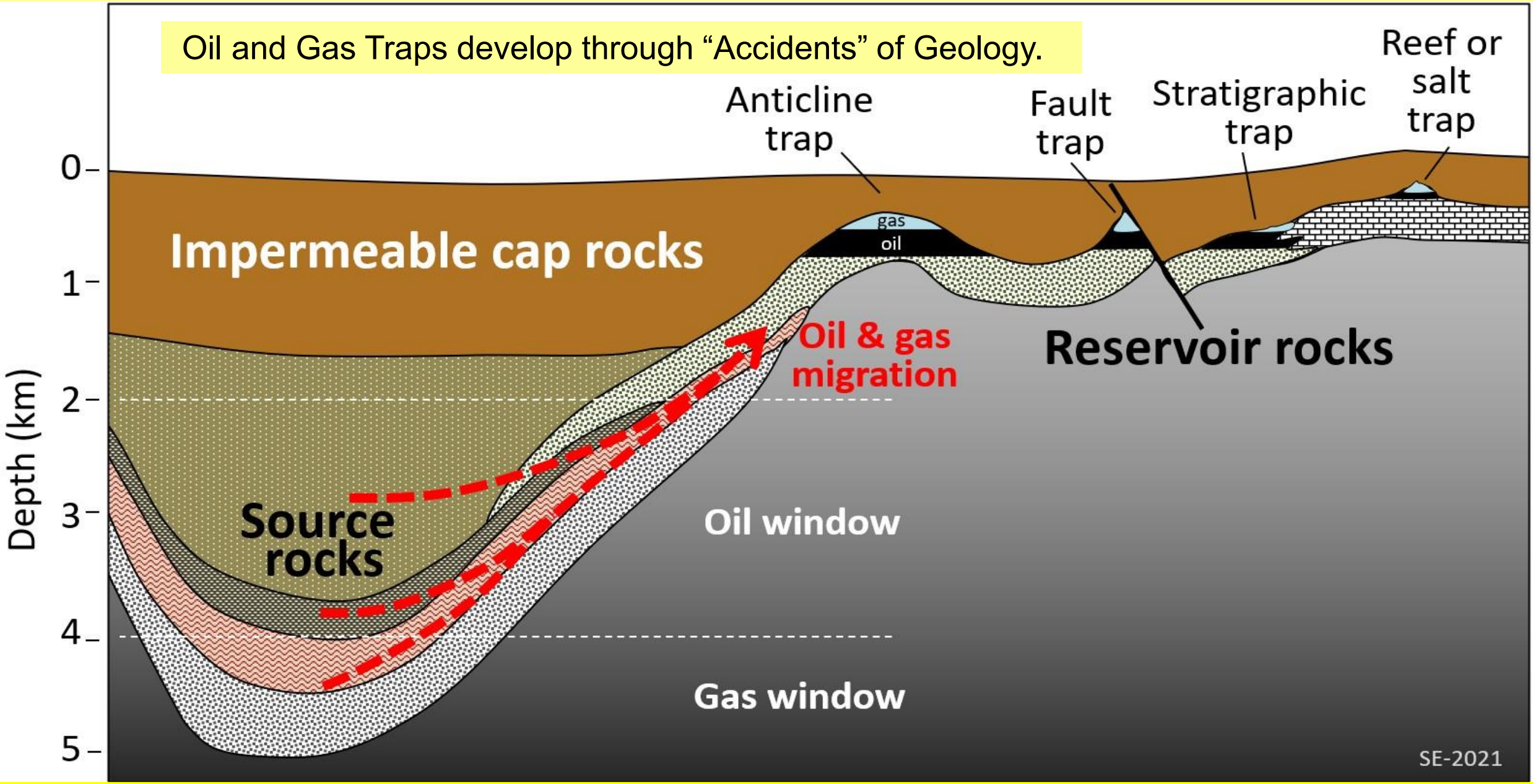
Data source: Adapted from *United States Geological Survey factsheet 0113-01* (public domain)

https://environmental-geology-dev.pressbooks.tru.ca/chapter/fossil-fuels/



Formation of Coal. (a) Accumulation of organic matter within a swampy area, (b) the organic matter is covered and compressed by deposition of a new layer of clastic sediments, (c) with greater burial lignite coal is formed, and (d) at even greater depths bituminous (and eventually anthracite) coal are formed.

https://environmental-geology-dev.pressbooks.tru.ca/wp-content/uploads/sites/73/2021/07/oil-gas-migration.jpg



Migration of Oil and Gas from Source Rocks into Traps in Reservoir Rocks

Each derrick shows a different type of extraction method.

https://www.wsgs.wyo.gov/docs/wsgs-web-reservoir-types.pdf

Limestone

Dune Sand

Impervious Shale

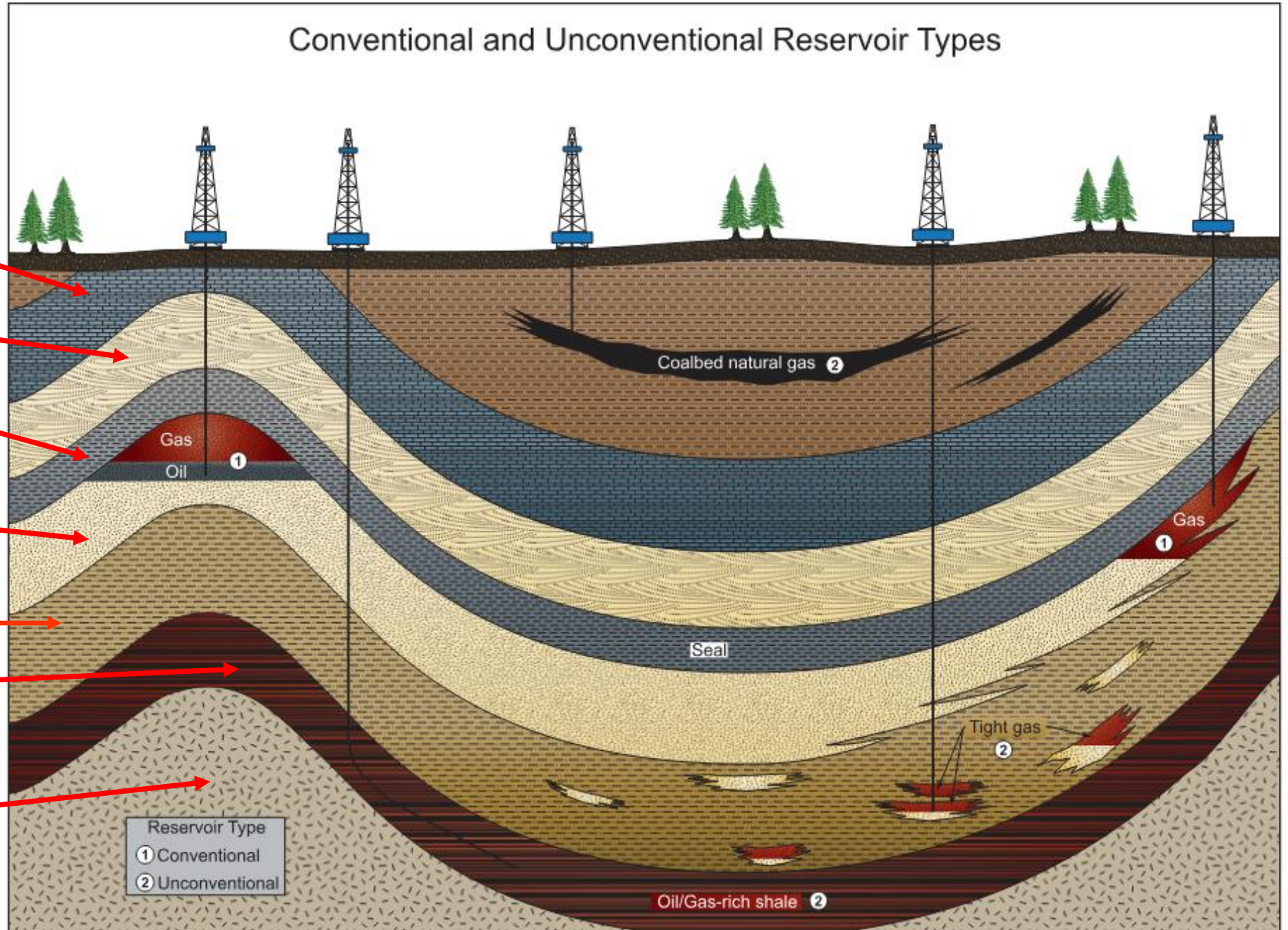
Sandstone

Shale

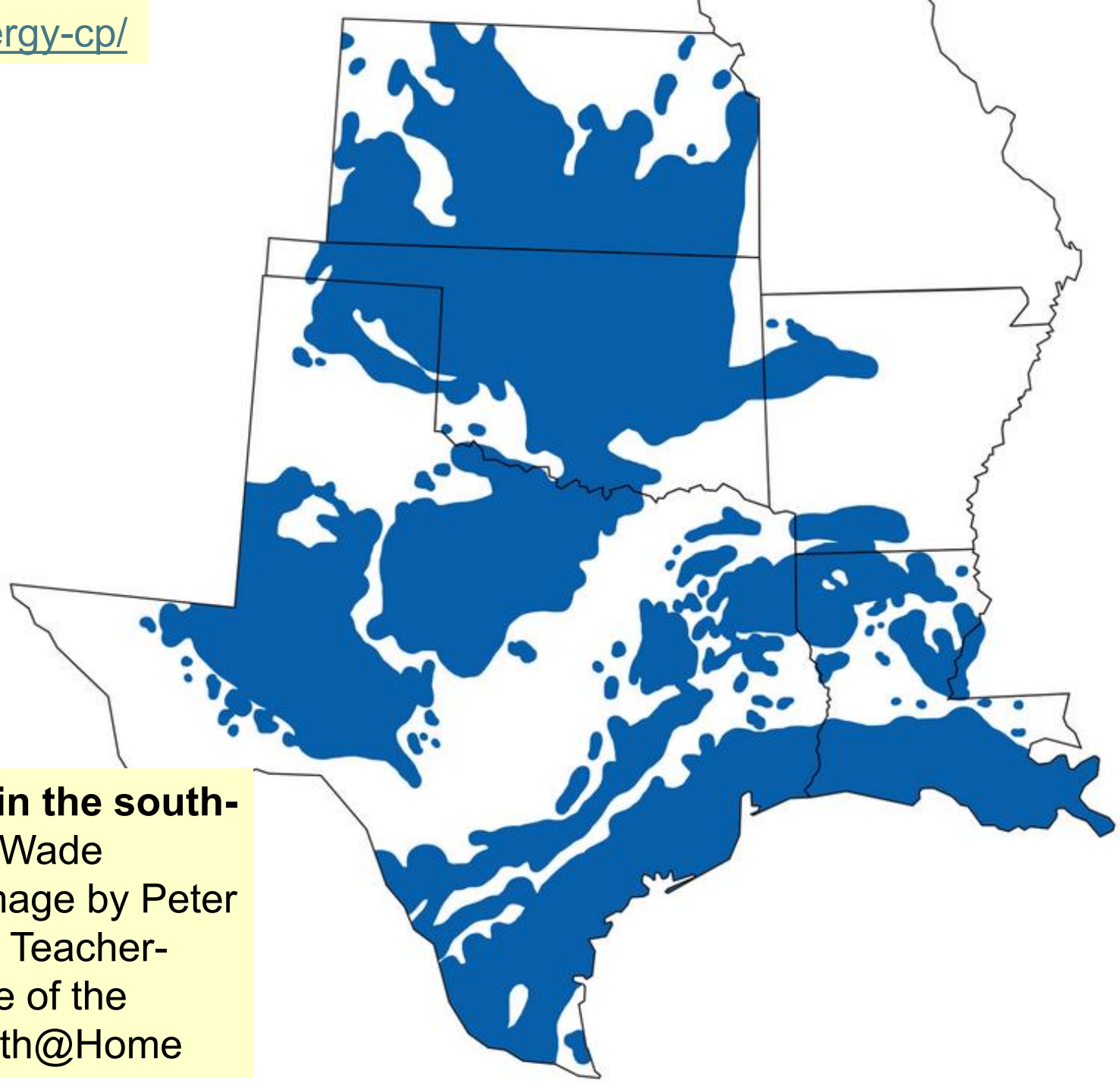
Oil/Gas-Rich Shale

Igneous (~Granitic)

"Basement Rock"



https://earthathome.org/hoe/sc/energy-cp/



Areas of oil and gas production in the south-central states of the U.S. Map by Wade Greenberg-Brand (adapted from image by Peter Nester), originally published in The Teacher-Friendly Guide to the Earth Science of the South Central US, modified for Earth@Home

https://en.wikipedia.org/wiki/Permian_Basin_(North_America)

The Permian Basin is a large sedimentary basin in the southwestern part of the United States. It is the highest-producing oil field in the US, producing an average of 4.2 million barrels of crude oil per day in 2019. This sedimentary basin is located in western Texas and far-southeastern New Mexico.

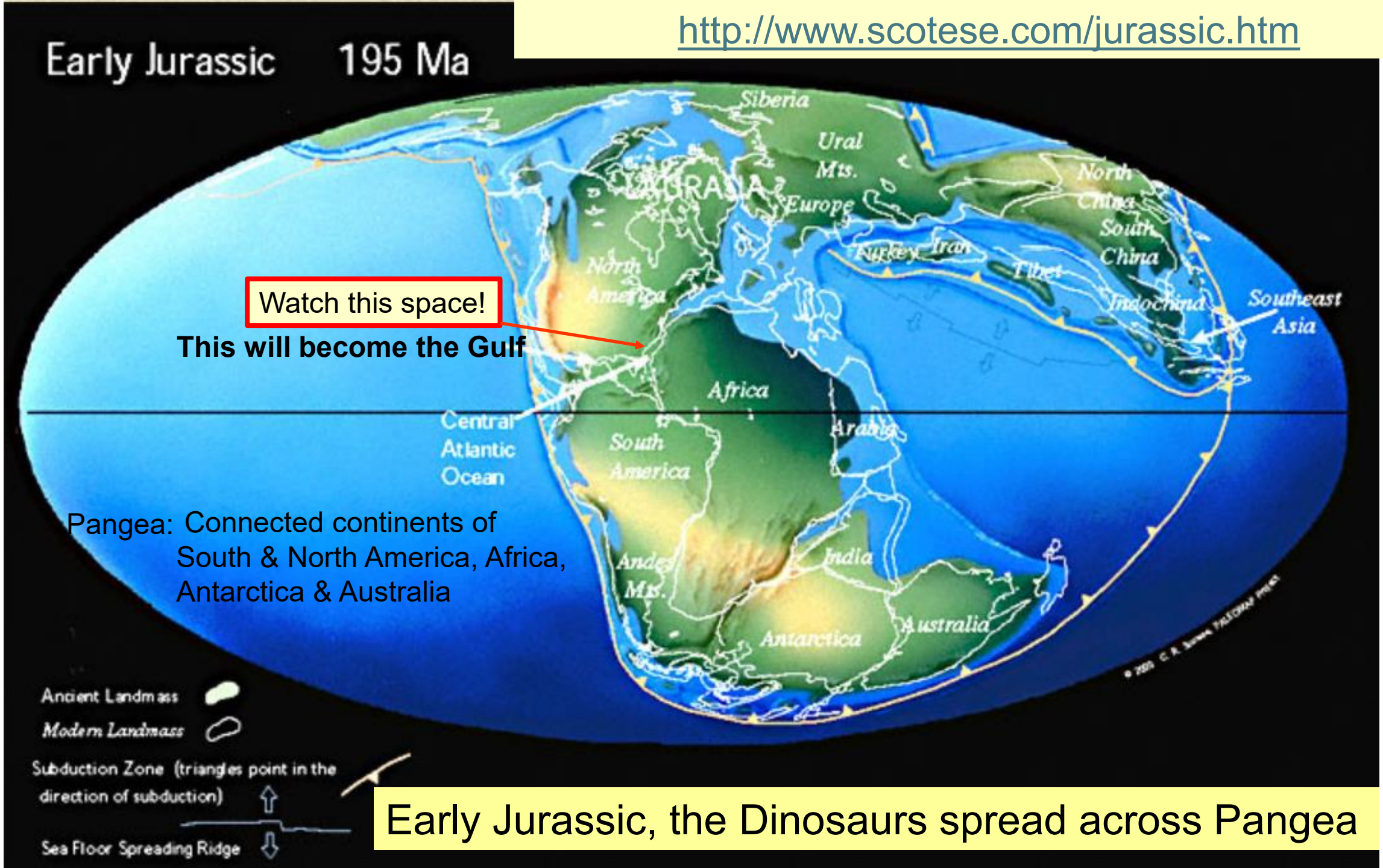
SIDEBAR: The Louann Salt and plate tectonics of Pangea.

https://www.aapg.org/distinguished-lectures/abstract/articleid/64423

The Louann Salt & Plate Tectonics of Pangea

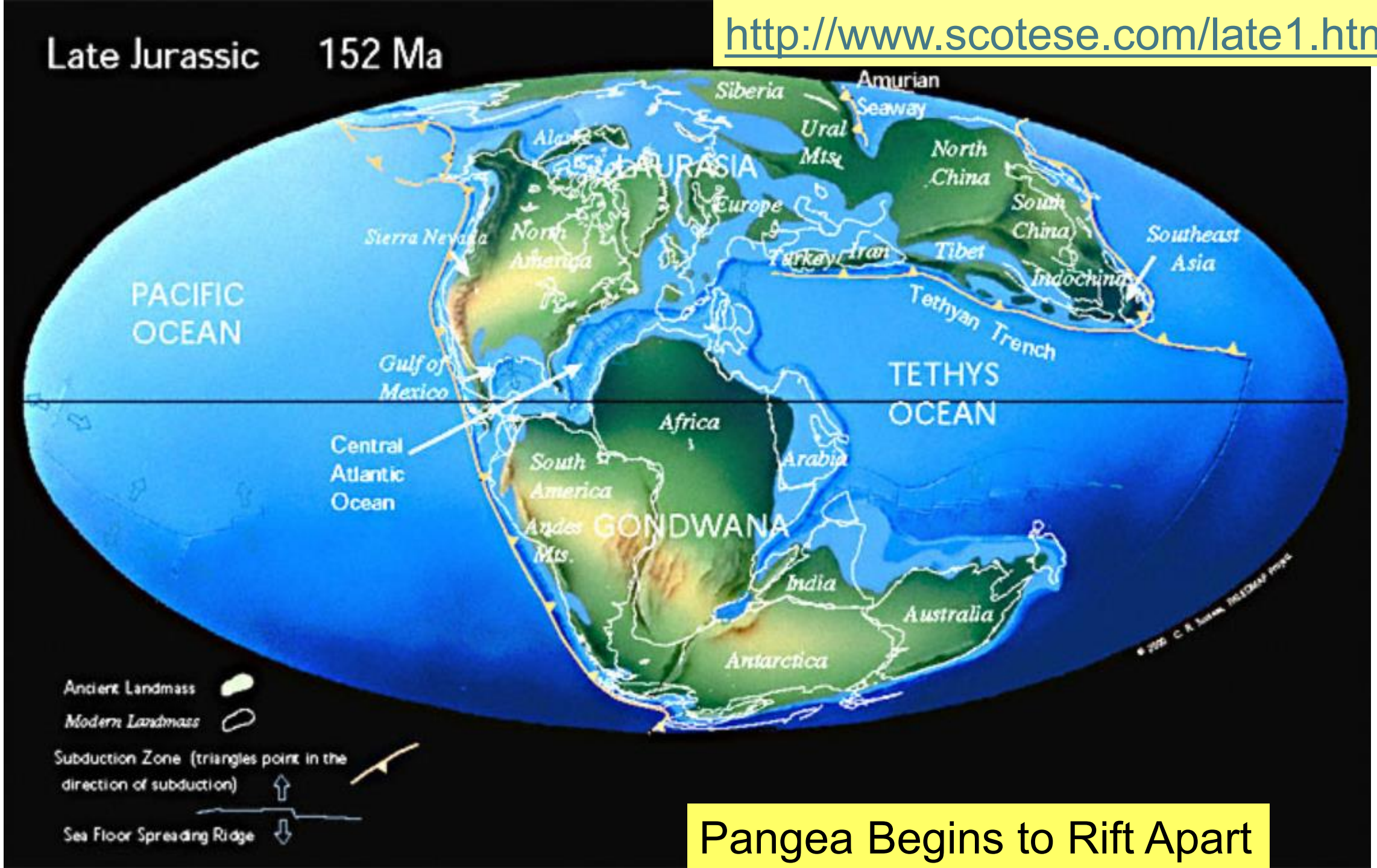
Around 170 million years ago, the Gulf of Mexico basin flooded catastrophically, and the pre-existing landscape, which had been a very rugged, arid, semi-desert world, was drowned beneath an inland sea of salt water. The drowned landscape was then buried under kilometers of salt, perfectly preserving the older topography. Now, with high-quality 3D seismic data, the salt appears as a transparent layer, and the details of the drowned world can be seen in exquisite detail, providing a unique snapshot of the world on the eve of the flooding event. We can map out hills and valleys, and a system of river gullies and a large, meandering river system. These rivers in turn fed into a deep central lake, whose surface was about 750m below global sea level. This new knowledge also reveals how the Louann Salt was deposited. In contrast to published models, the salt was deposited in a deep water, hypersaline sea. We can estimate the rate of deposition, and it was very fast; we believe that the entire thickness of several kilometers of salt was laid down in a few tens of thousands of years, making it possibly the fastest sustained deposition seen so far in the geological record.

http://www.scotese.com/jurassic.htm

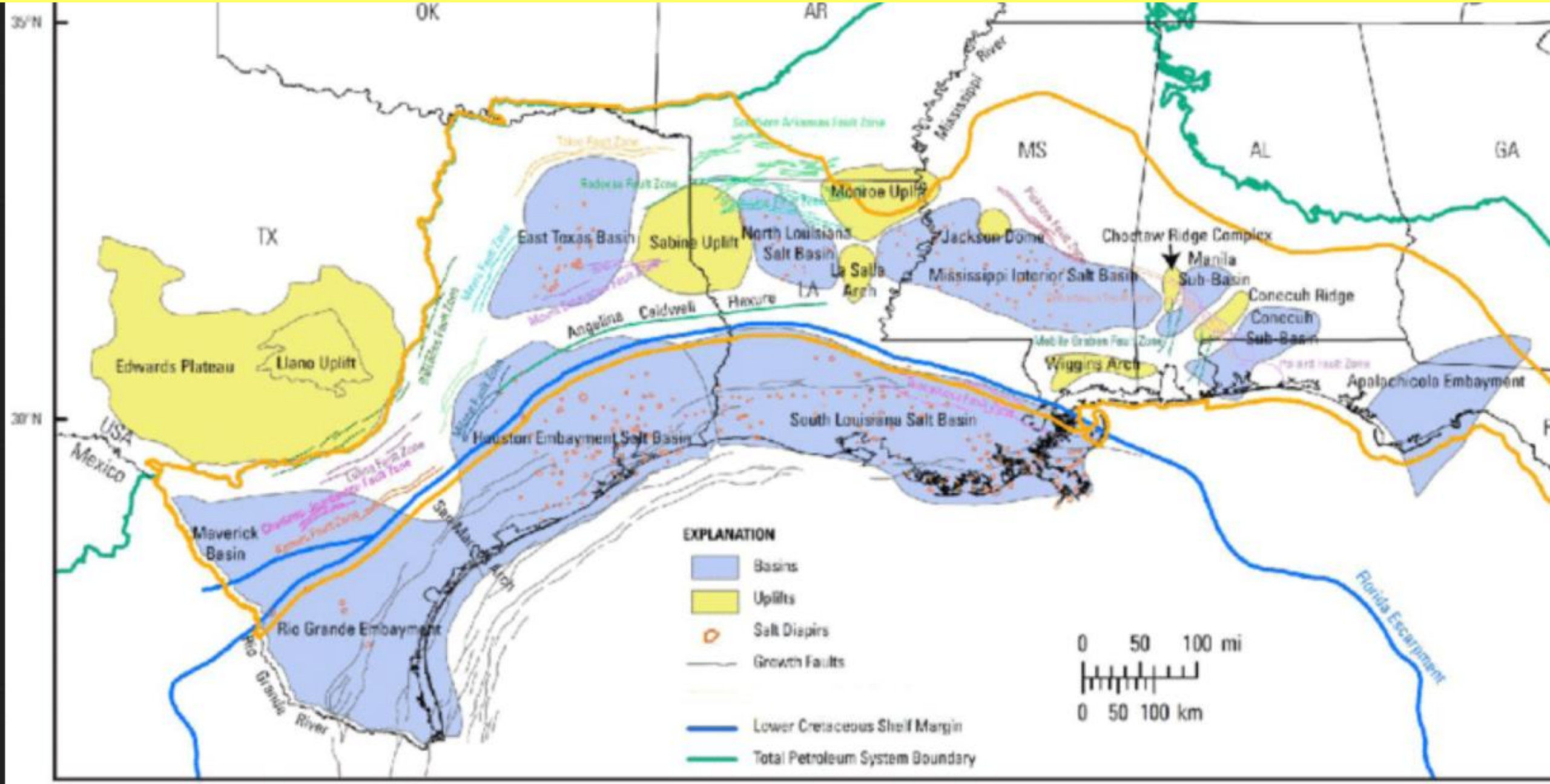


Pangea: Connected continents of South & North America, Africa, Antarctica & Australia

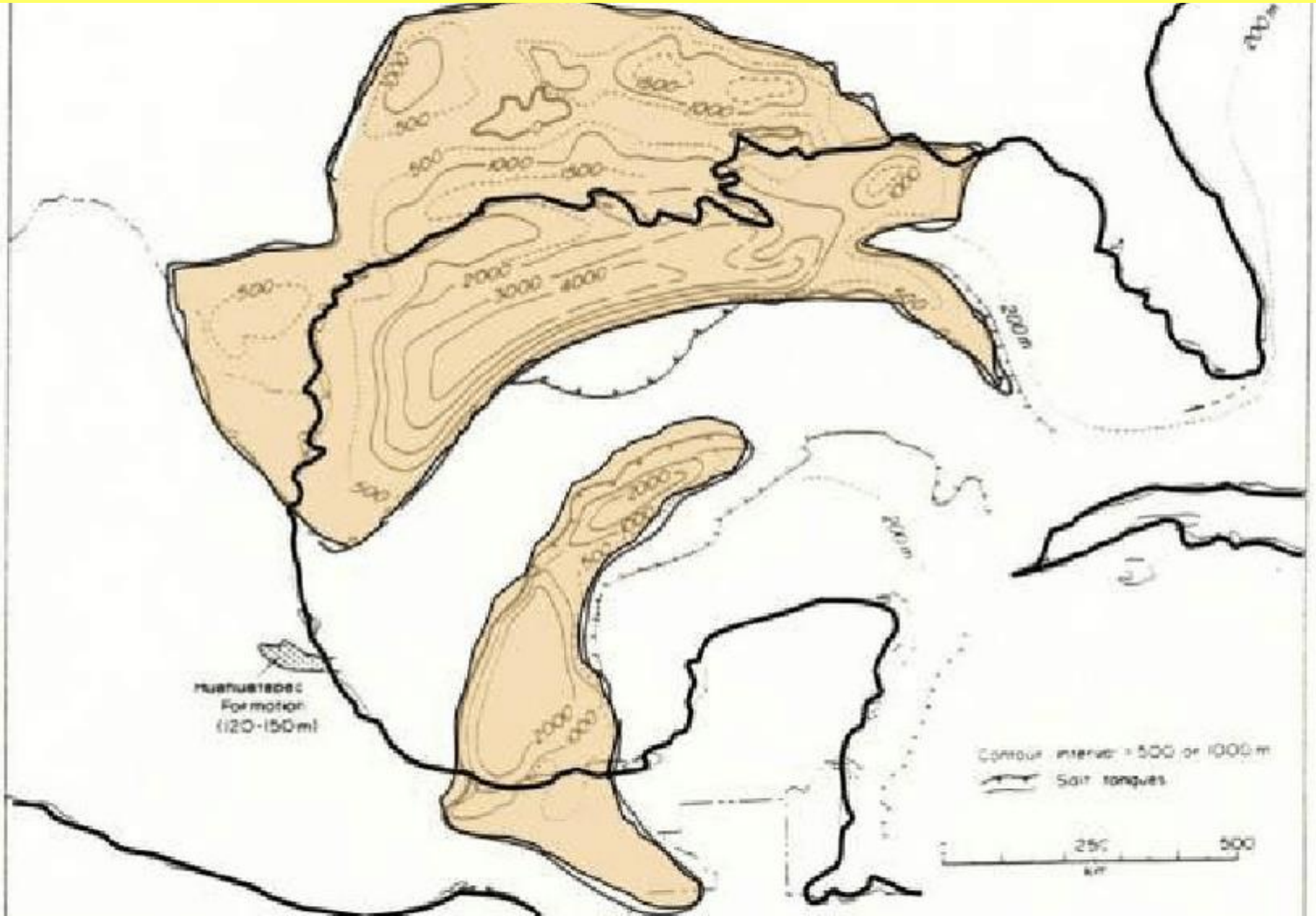
Early Jurassic, the Dinosaurs spread across Pangea


Late Jurassic 152 Ma
http://www.scotese.com/late1.htm
Siberia
Amurian Seaway
Ural Mts.
LAURASIA
North China
South China
Europe
Tibet
Turkey
Iran
Indochina
Southeast Asia
Sierra Nevada
North America
PACIFIC OCEAN
Tethyan Trench
TETHYS OCEAN
Gulf of Mexico
Central Atlantic Ocean
Africa
Arabia
South America
Andes Mts.
GONDWANA
India
Australia
Antarctica
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge
Pangea Begins to Rift Apart

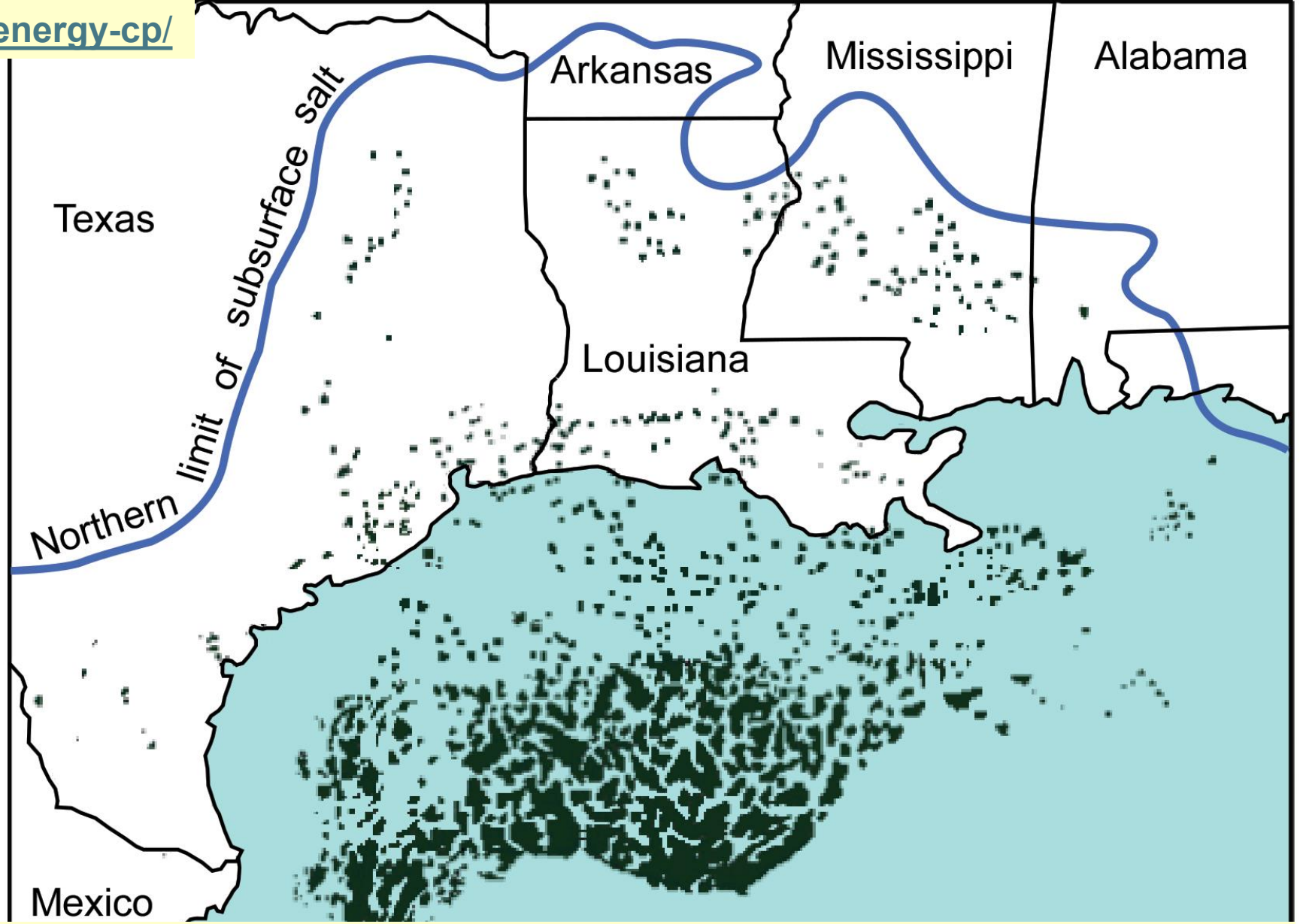
https://www.researchgate.net/profile/Jaehong-Ko/publication/283438927/figure/fig5/AS:669492665384970@1536630898780/Structure-map-of-the-northern-Gulf-of-Mexico-Basin-showing-basins-uplifts-and-other.png



https://www.researchgate.net/figure/Sketch-map-showing-distribution-and-thickness-the-Louann-Salt_fig9_283438927

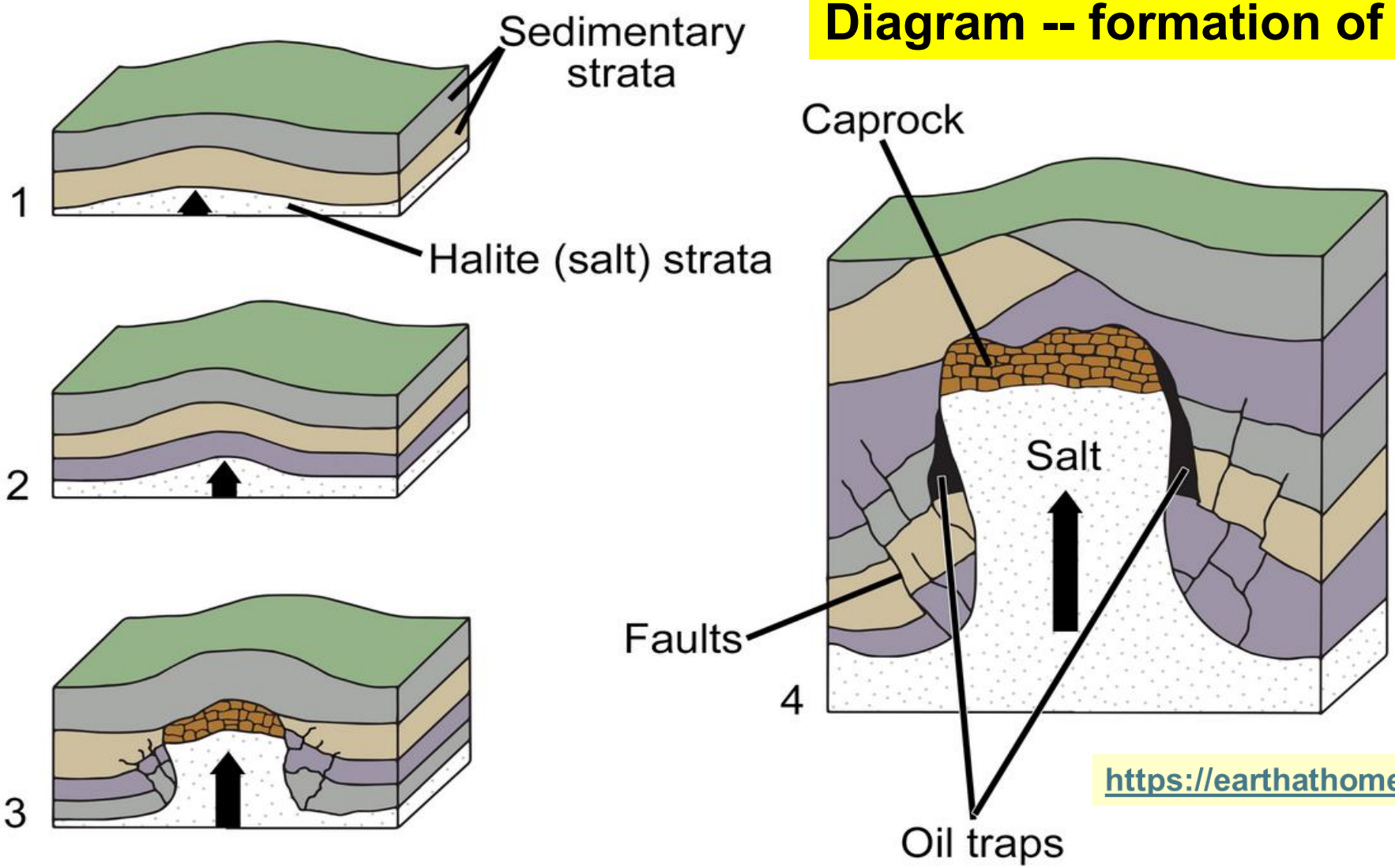


https://earthathome.org/hoe/sc/energy-cp/



The Louann Salt Formation extends under the surface of the Coastal Plain to the blue line. Black "blobs" are known salt structures where the salt layer has been deformed. Image modified from original by Peter Nester for the Earth@Home project.

Diagram -- formation of a salt dome.



https://earthathome.org/hoe/sc/energy-cp/

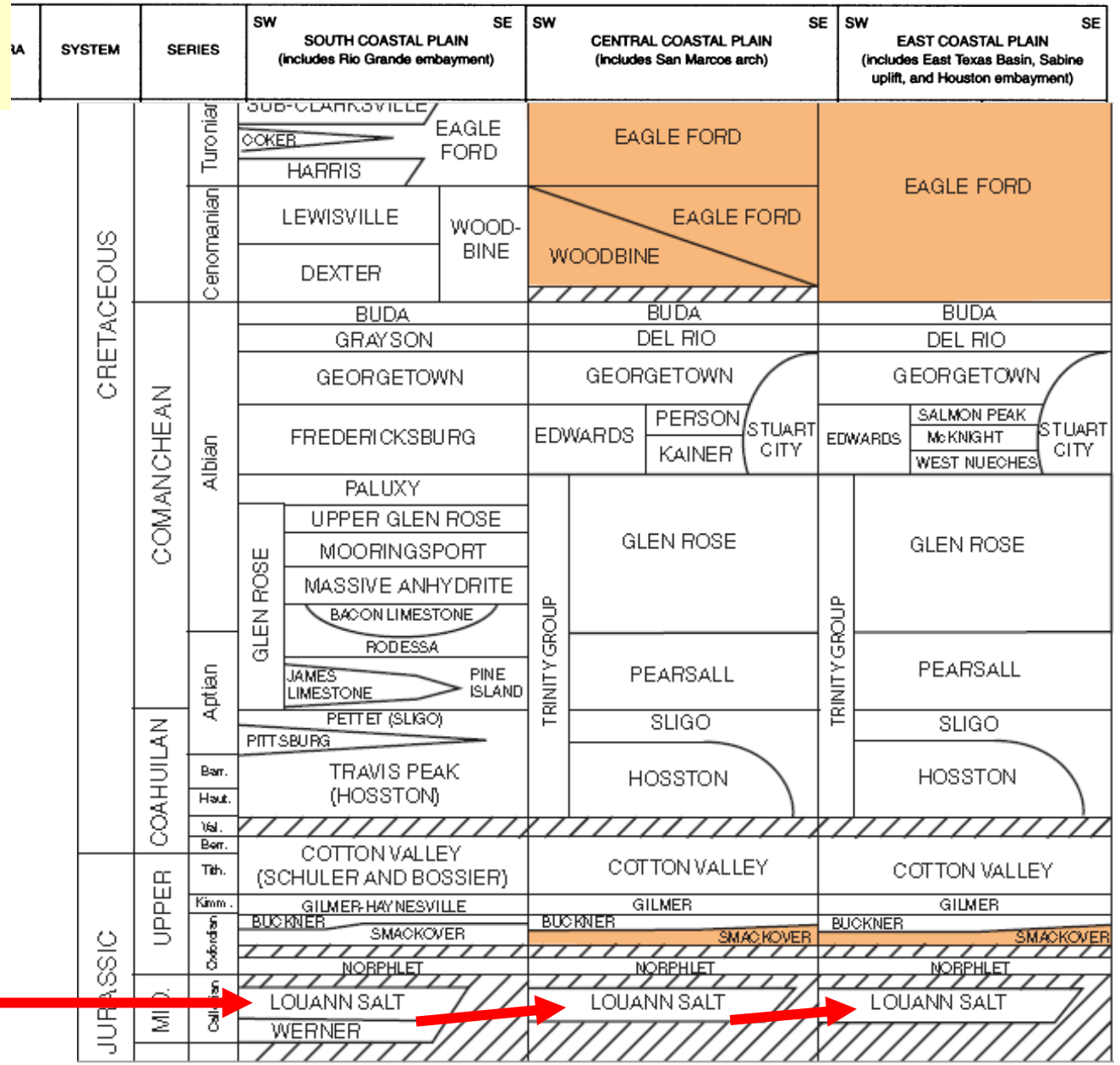
In images 1 to 3, a salt layer deforms, pushing upward through the rock layers above it until it is impeded by a caprock (a hard or dense rock layer). In image 4, the deformation of overlying layers by the salt has formed gaps where oil or gas has accumulated. Image modified from original by Wade Greenberg-Brand (after an image by Britannica online for kids) for the Earth@Home project.

Location of the Louann Salt in Texas' Stratigraphic column.

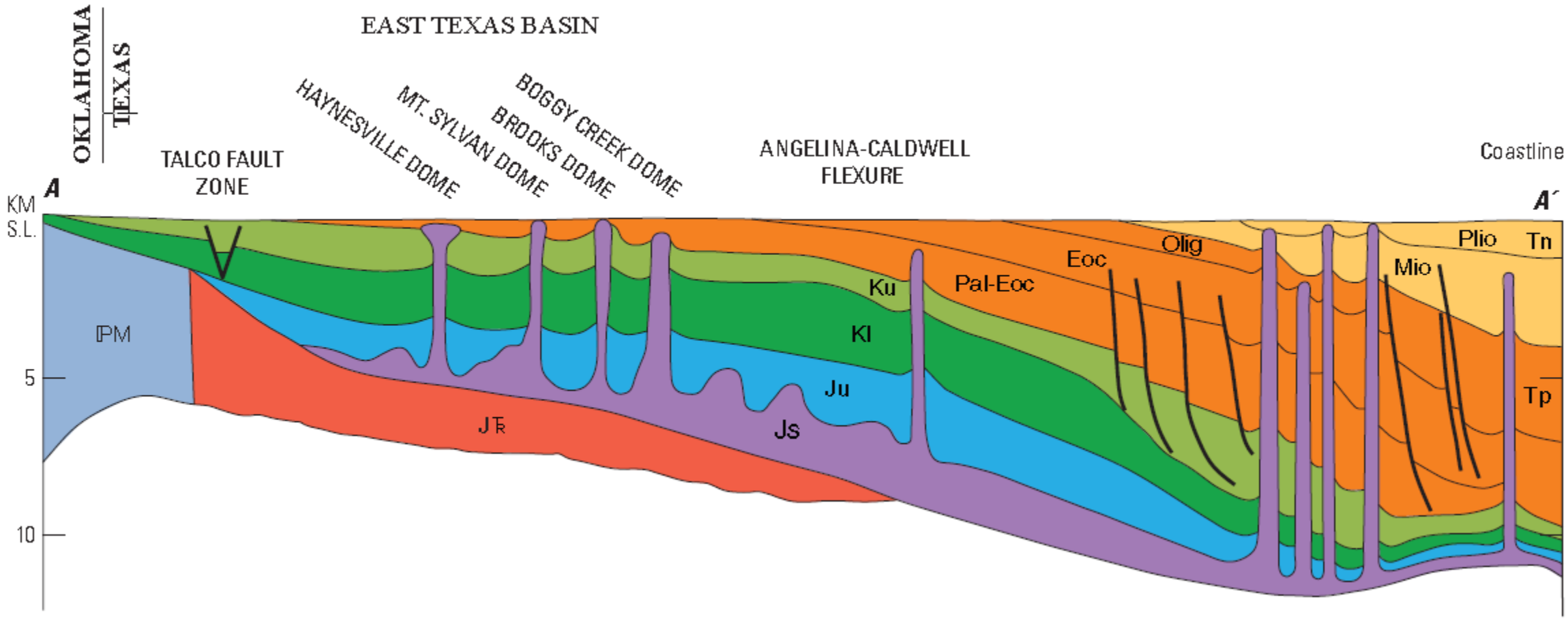
https://upload.wikimedia.org/wikipedia/commons/5/59/Louann_Salt_stratigraphic_column_for_Texas.png

Tan shading: fossil fuel source rock.

Louann Salt, 170 million years ago



North-South Cross section of East Texas showing the deformation of the **Jurassic salt <Js>** into domes, structures which act as traps for oil.



https://commons.wikimedia.org/wiki/File:East_Texas_Basin_cross_section.png

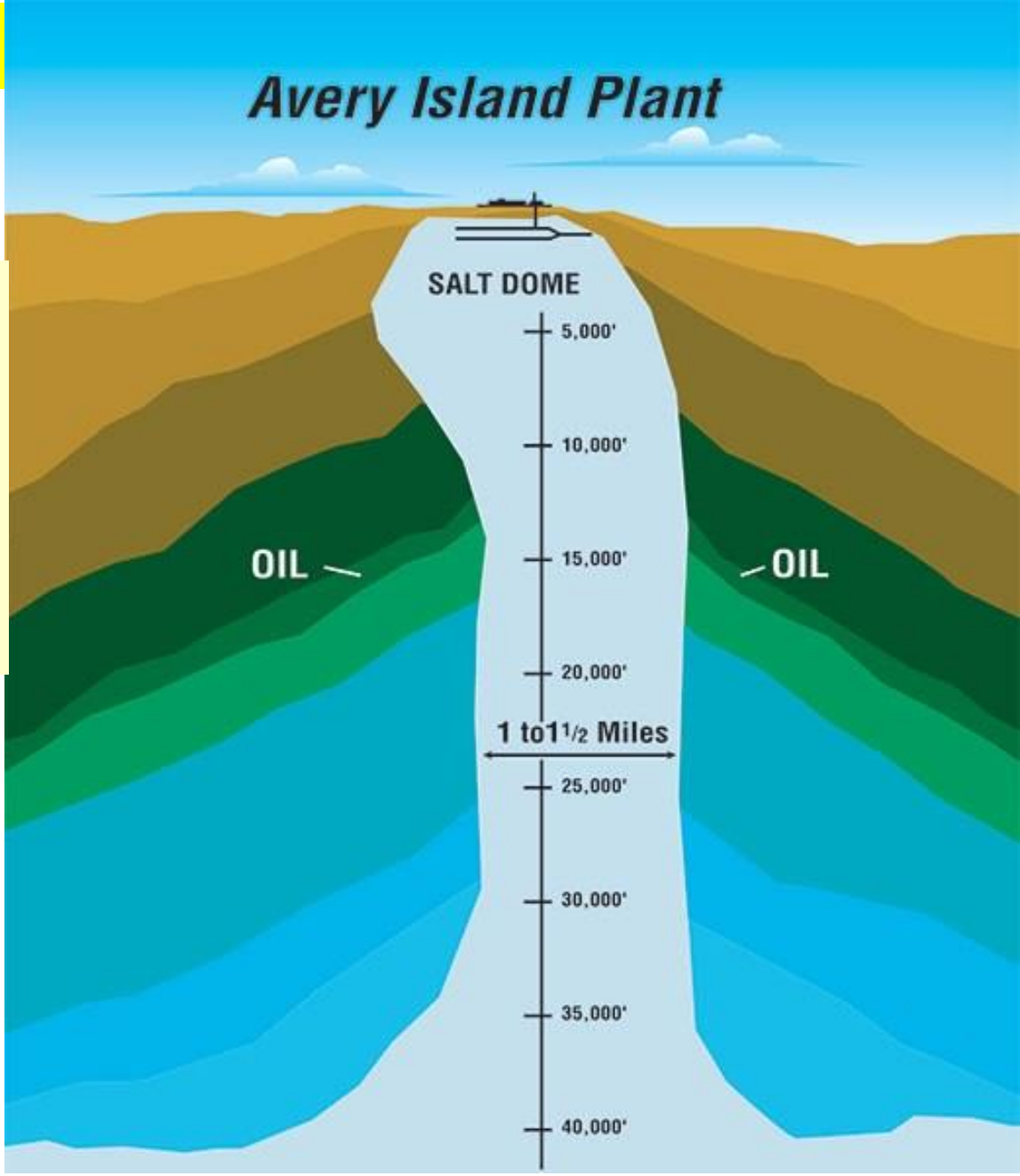
East Texas Basin cross section, where PM is Pennsylvanian-Mississippian, J TR are Triassic "red beds" and volcanics, **Js is Middle Jurassic salt**, Ju is Upper Jurassic, Kl is Lower Cretaceous, Ku is Upper Cretaceous, Tp is Paleogene, <Paleocene, Eocene and Oligocene> and Tn is Neogene <Pliocene, Miocene>.

Geology of Avery Island, Louisiana

https://www.aapg.org/news-and-media/details/explorer/articleid/19750/geology-spices-avery-island

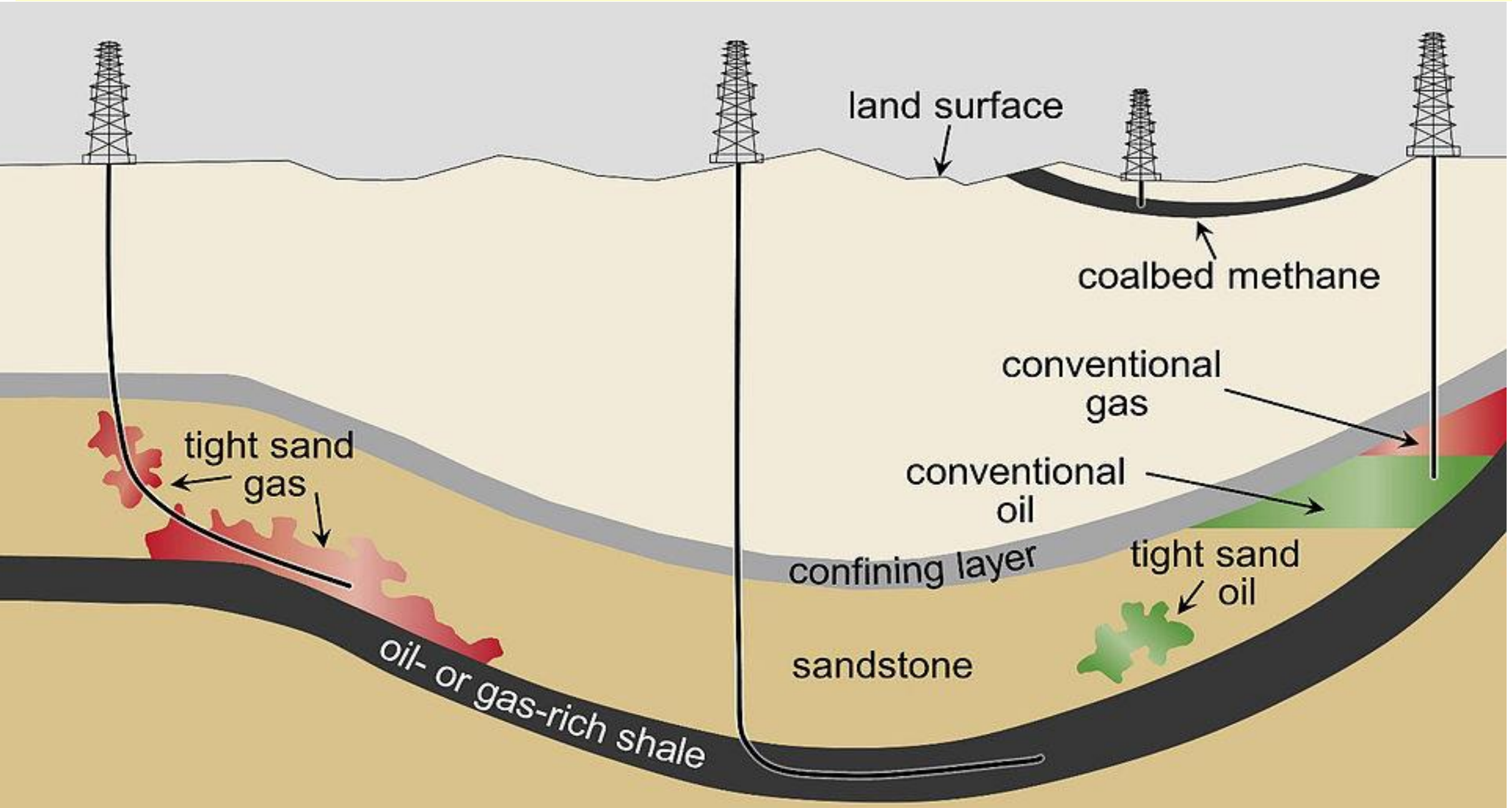
If you've ever used Tabasco Sauce, you might know that it comes from Avery Island, Louisiana.

The "Island" is a pushed-up area of earth in what is mostly a swamp. Source of the lifting comes from the Jurassic age Louann Salt, a salt dome.



End Sidebar on the Louann Salt

https://en.wikipedia.org/wiki/Tight_oil



https://en.wikipedia.org/wiki/Tight_oil

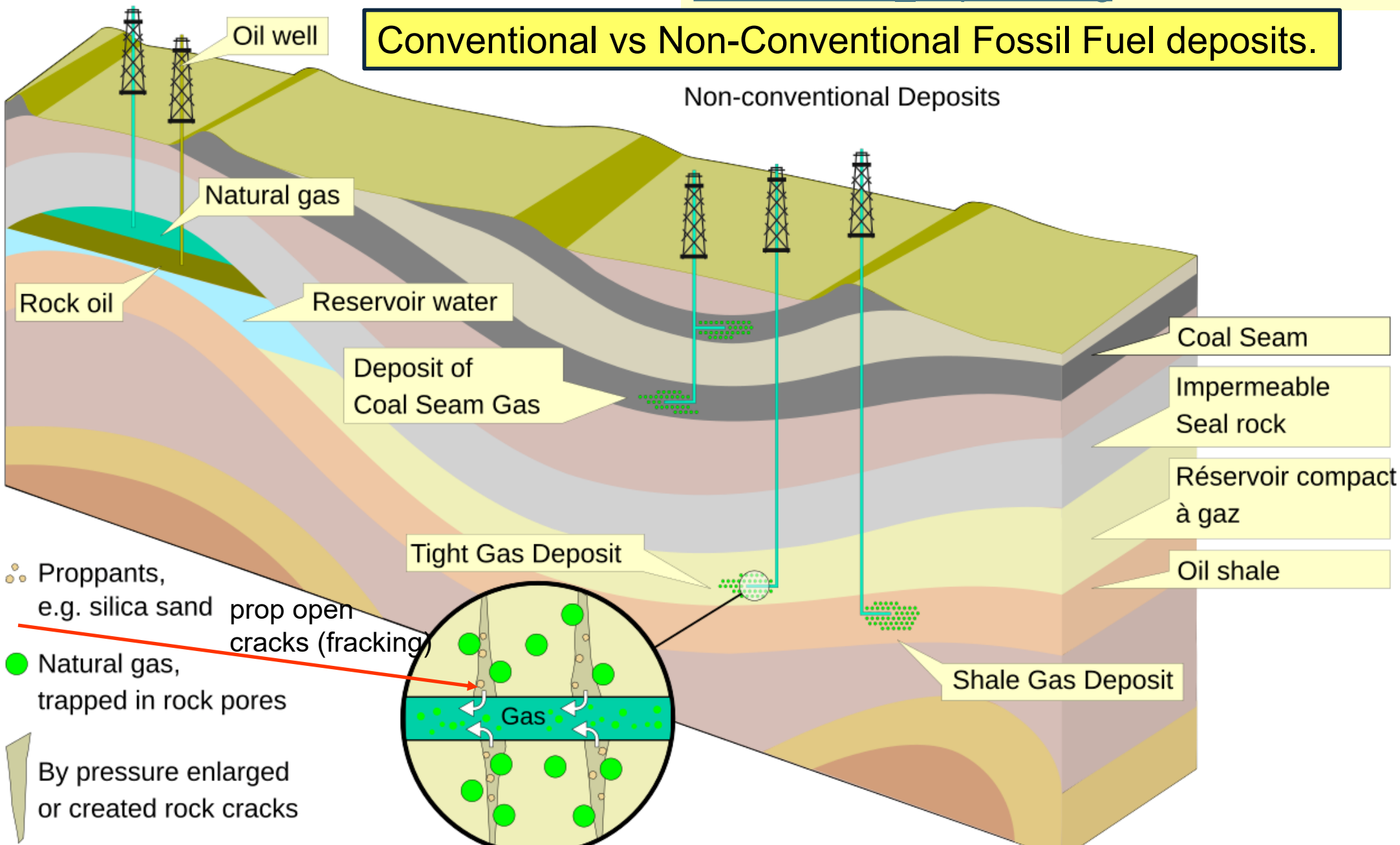
Tight oil (also known as shale oil, shale-hosted oil or light tight oil, abbreviated LTO) is light crude oil contained in unconventional petroleum-bearing formations of low permeability, often shale or tight sandstone.

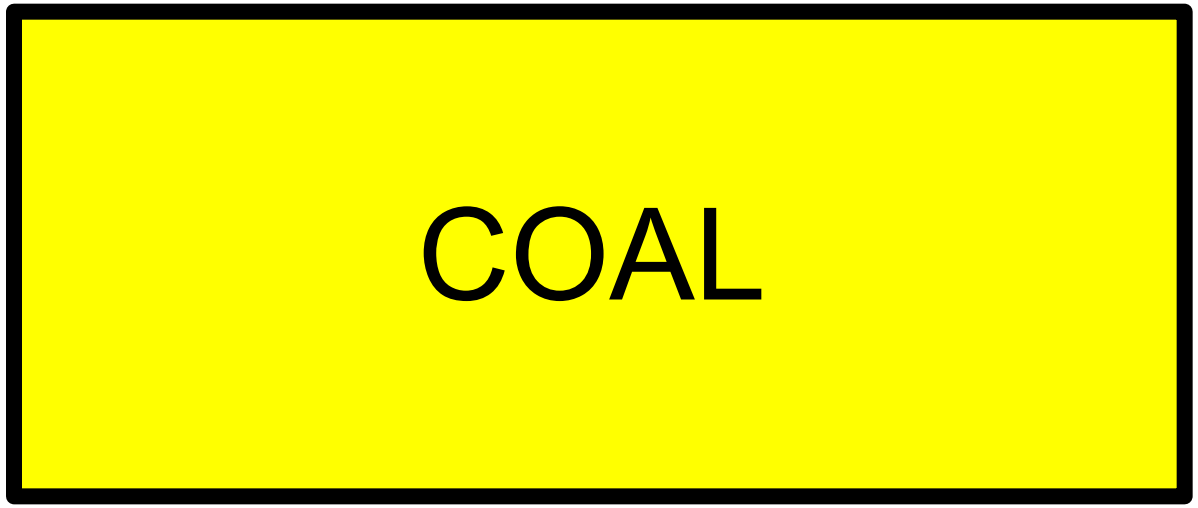
Economic production from tight oil formations requires the same hydraulic fracturing and often uses the same horizontal well technology used in the production of shale gas. While sometimes called **"shale oil"**, tight oil should not be confused with oil shale (shale rich in **kerogen**) or shale oil (oil produced from oil shales).
(…a complex fossilized organic material, found in oil shale and other sedimentary rock, which is insoluble in common organic solvents and yields petroleum products on distillation.)

Therefore, the International Energy Agency recommends using the term "light tight oil" for oil produced from shales or other very low permeability formations, while the World Energy Resources 2013 report by the World Energy Council uses the terms "tight oil" and "shale-hosted oil".

https://en.wikipedia.org/wiki/Tight_gas#/media/File:(Non)_Conventional_Deposits.svg

Conventional vs Non-Conventional Fossil Fuel deposits.

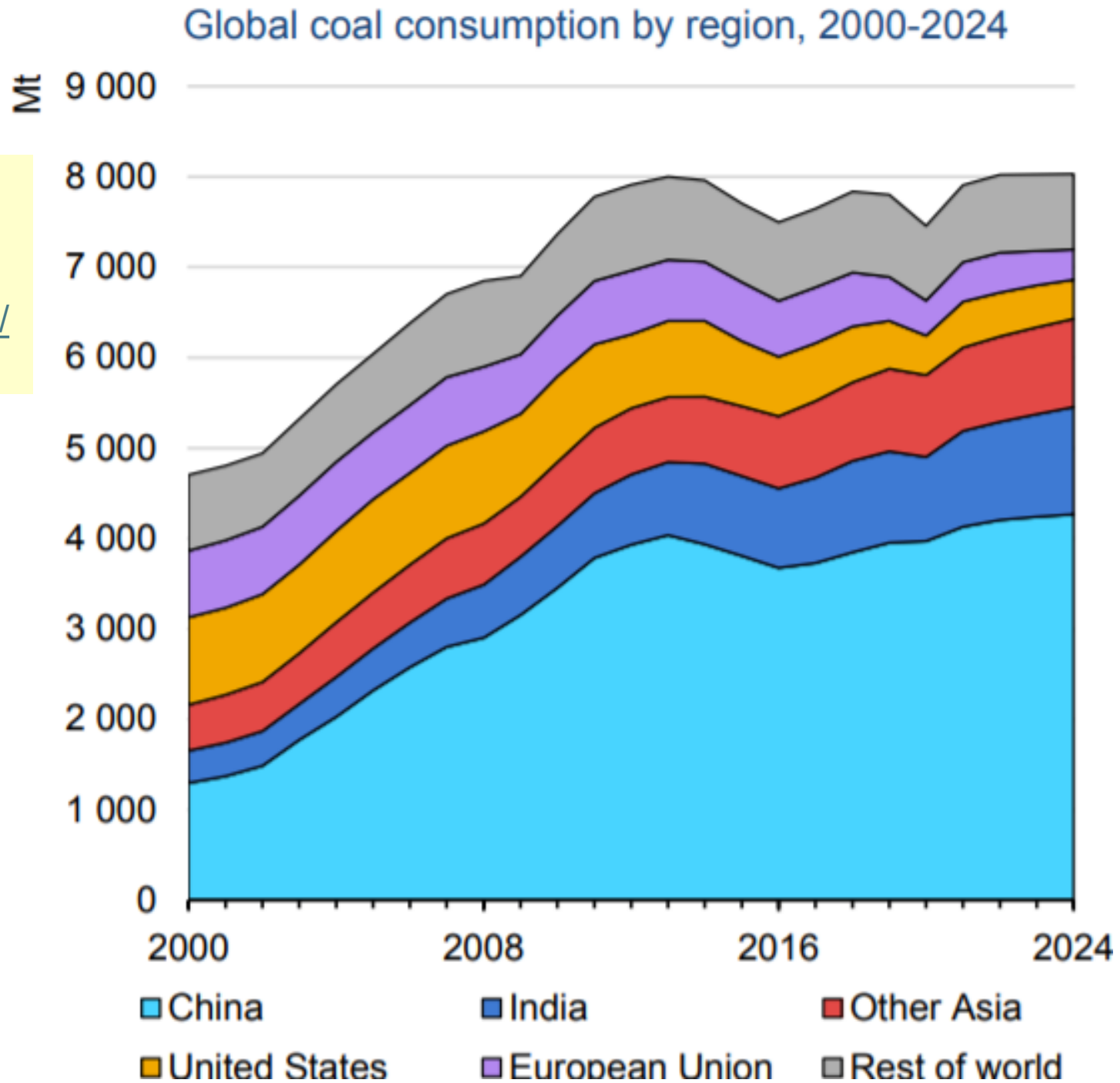



COAL

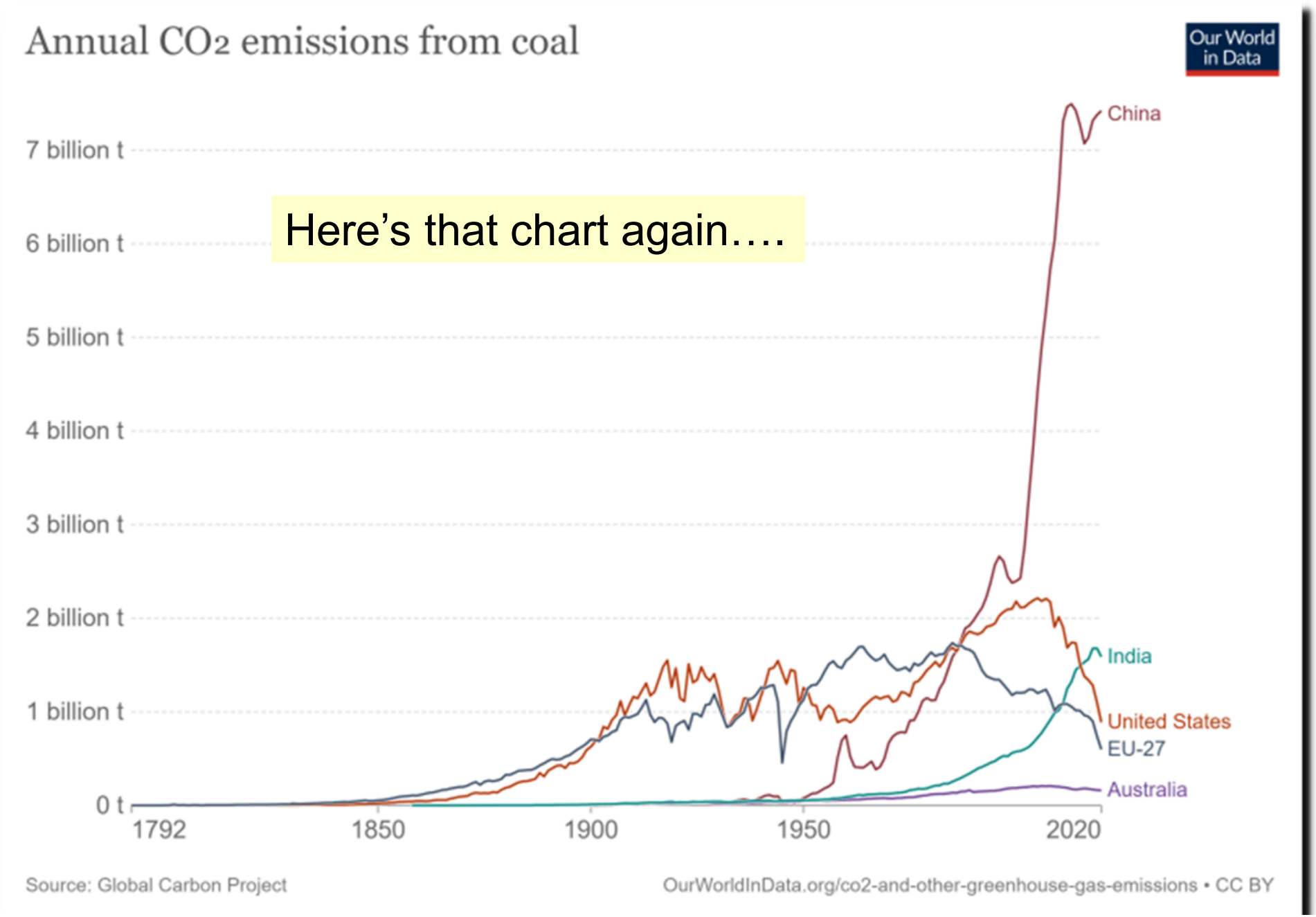
https://en.wikipedia.org/wiki/History_of_coal_mining#/media/File:Tiangong_Kaiwu_Coal_Mining.gif

Chinese coal miners in an illustration of the Tiangong Kaiwu Ming Dynasty encyclopedia, published in 1637 by Song Yingxing

https://notrickszone.com/2022/01/23/global-coal-conmsumption-reaches-a-new-record-high-in-2021-china-india-cosuming-two-thirds/



Is Amazon this stupid or is this faux advertising?


Annual CO2 emissions from coal
Our World in Data
Here's that chart again….
7 billion t
6 billion t
5 billion t
4 billion t
3 billion t
2 billion t
1 billion t
0 t
1792
1850
1900
1950
2020
China
India
United States
EU-27
Australia
Source: Global Carbon Project
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

September 3, 2016 https://br.usembassy.gov/u-s-china-climate-change-cooperation-outcomes

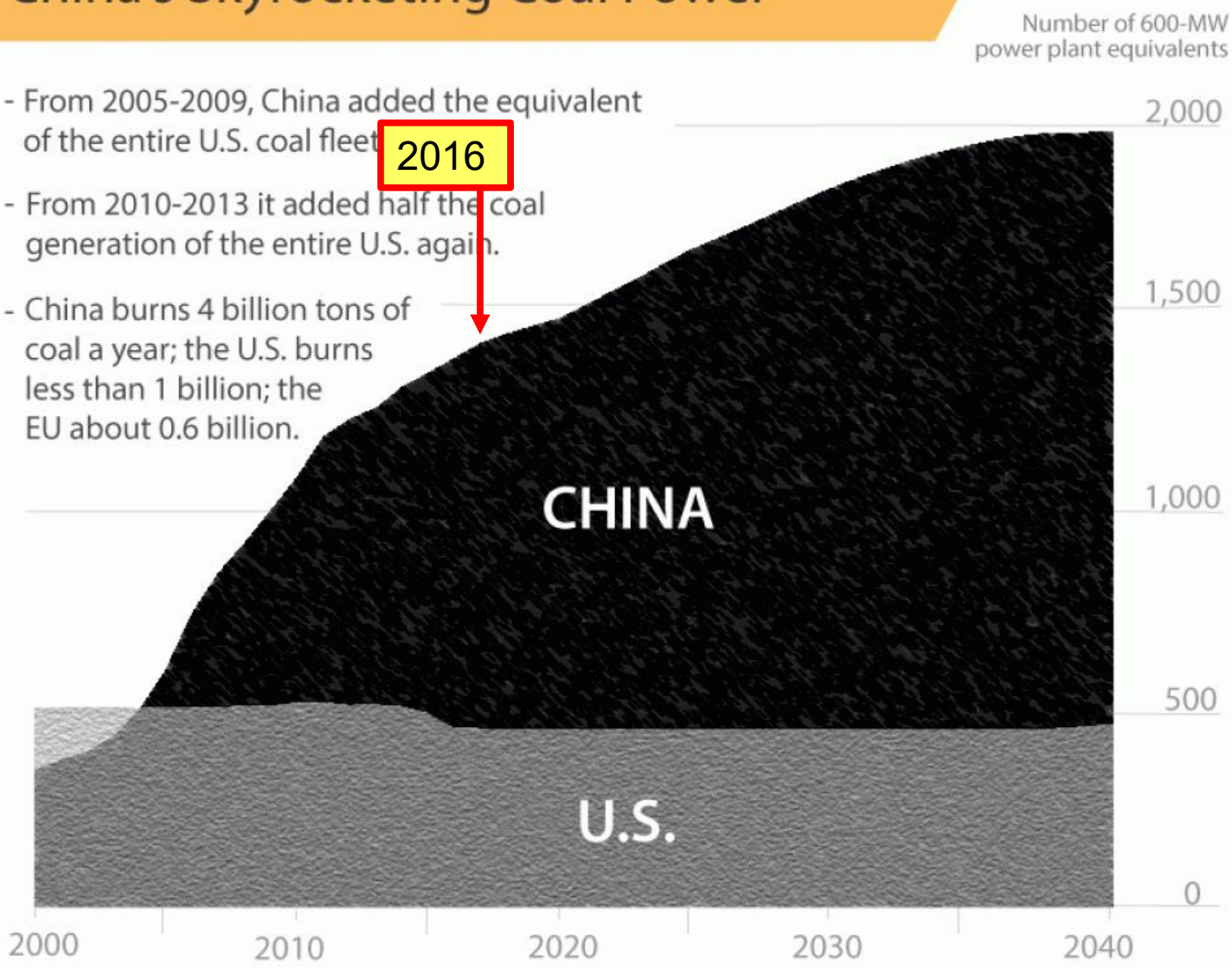
"President Barack Obama and President Xi Jinping have forged a historic partnership between the United States and China to lead in combatting climate change. From the Sunnylands meeting in 2013, to the landmark November 2014 Joint Announcement on Climate Change and the September 2015 and March 2016 Joint Presidential Statements on Climate Change, leadership by the United States and China has galvanized global action to build a green, low-carbon, and climate-resilient world and was a major contributor to achieving the historic Paris Agreement. Climate change has formed a central pillar of the bilateral relationship between the two countries. Both sides are committed to implementing the three presidential joint statements on climate change and will continue to deepen and broaden bilateral climate change cooperation, building on the concrete progress and productive outcomes achieved thus far."

COMMENT: The notion that humans can "galvanize global action to build a "green, low carbon and climate resilient world," and the rest, is fantasy.

CLIMATE CENTRAL

China's Skyrocketing Coal Power

- From 2005-2009, China added the equivalent of the entire U.S. coal fleet
- From 2010-2013 it added half the coal generation of the entire U.S. again.
- China burns 4 billion tons of coal a year; the U.S. burns less than 1 billion; the EU about 0.6 billion.



https://www.nytimes.com/2017/07/01/climate/china-energy-companies-coal-plants-climate-change.html

CLIMATE

The New York Times

As Beijing Joins Climate Fight, Chinese Companies Build Coal Plants

THE TIMES

https://www.thetimes.co.uk/article/2500-new-coal-plants-will-thwart-any-paris-pledges-ctx3t7thnf7

2,500 new coal plants will thwart any Paris pledges

The new plants will emit 6.5 billion tonnes of carbon dioxide a yea

https://globalenergymonitor.org/wp-content/uploads/2020/06/China-coal-plant-brief-June-2020v2.pdf

Global Energy Monitor

BRIEFING: JUNE 2020

CREA
Centre for Research on Energy and Clean Air

A New Coal Boom in China

NEW COAL PLANT PERMITTING AND PROPOSALS ACCELERATE

Summary

After years of the government putting the brakes on the amount of coal plants newly proposed and permitted for construction, Chinese coal industry is trying to step on the gas again, according to a survey of coal plant development in China from January 1 to June 15, 2020, by Global Energy Monitor and the Centre for Research on Energy and Clean Air.

coal plants, indicating that the surge in new projects is happening mainly on paper, for now.

Even China's state-owned holding company SDIC, which said in 2019 that it planned to exit the coal industry, sponsored 3.2 GW of new coal plants in 2020 – in what appears to be an unstated reversal in policy.

https://notalotofpeopleknowthat.wordpress.com/2021/08/24/china-to-build-43-new-coal-fired-power-plants/

TIME

WORLD • CHINA

China Is Planning to Build 43 New Coal-Fired Power Plants. Can It Still Keep Its Promises to Cut Emissions?

https://www.bloomberg.com/news/articles/2021-08-05/china-to-restart-coal-mines-amid-climate-versus-growth-debate

Bloomberg

Markets

China Will Restart Coal Mines Including in Xinjiang as Power Demand Surges

Bloomberg News

August 4, 2021, 10:15 PM MDT

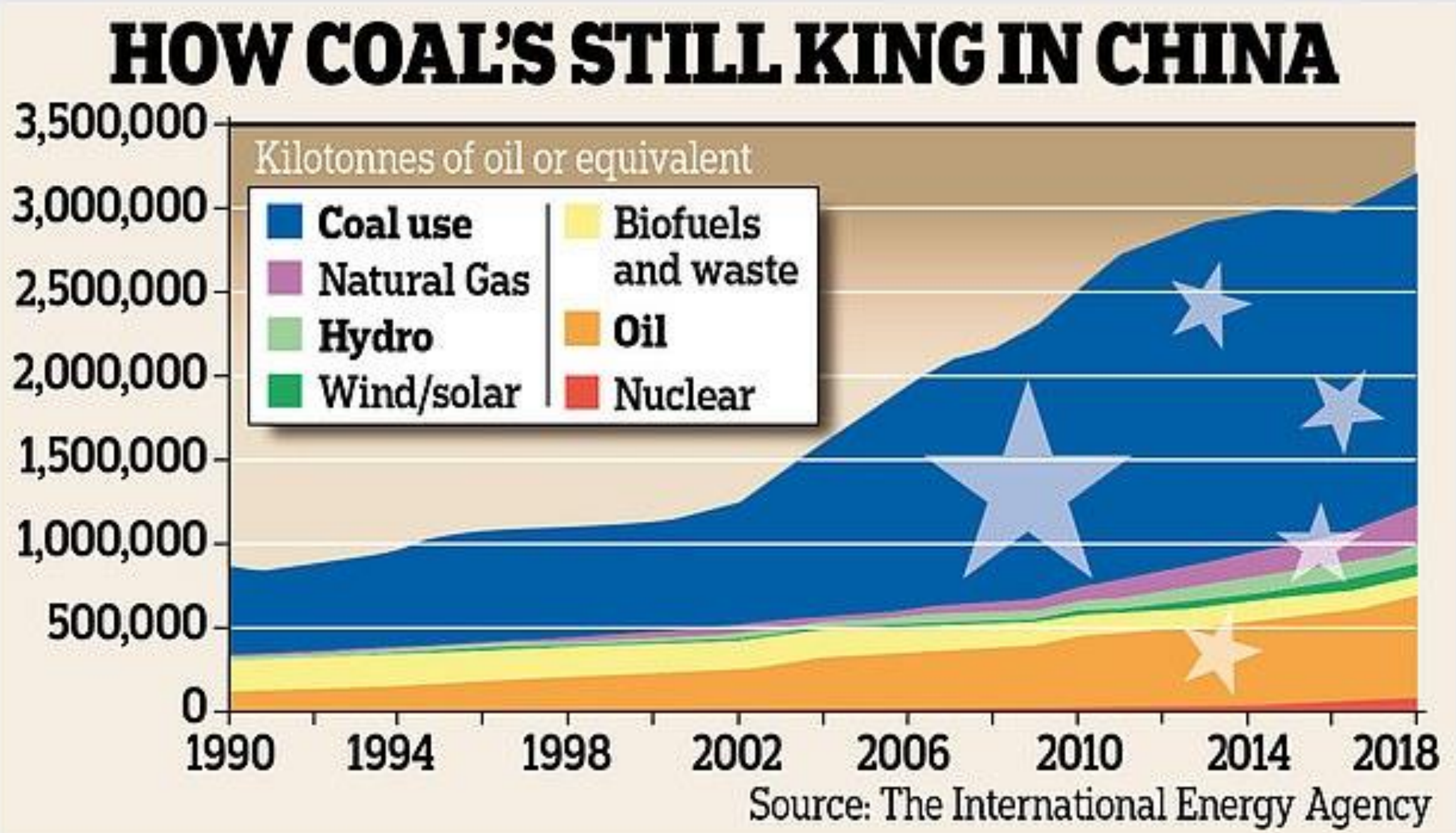
- Operations to resume at 53 sites in latest restart approvals
- Move follows Politburo's call to relax push to cut emissions

LISTEN TO ARTICLE

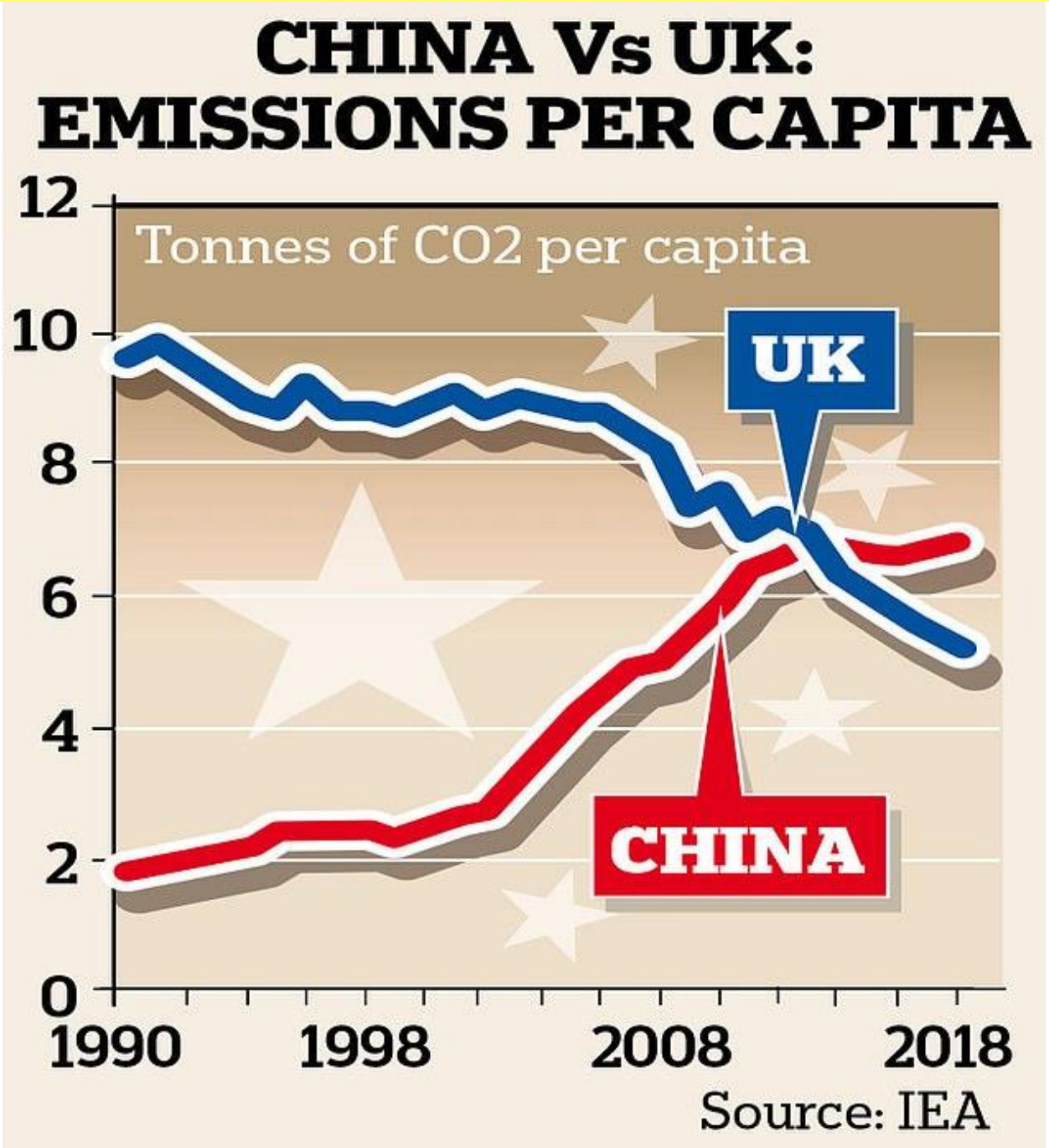
▶ 1:25

China's top planning authority authorized more shuttered coal mines to restart production as key policymakers seek to balance progress on climate goals against still surging power demand.

https://www.dailymail.co.uk/news/article-10026335/Chinas-dirtiest-secret-1-000-coal-fired-power-stations-climbing.html



https://www.dailymail.co.uk/news/article-10026335/Chinas-dirtiest-secret-1-000-coal-fired-power-stations-climbing.html



3 days before COP 26 in Glasgow, Scotland, 1 Nov 2021

REUTERS®

World Business Legal Markets Breakingviews Technology Investigations Sp

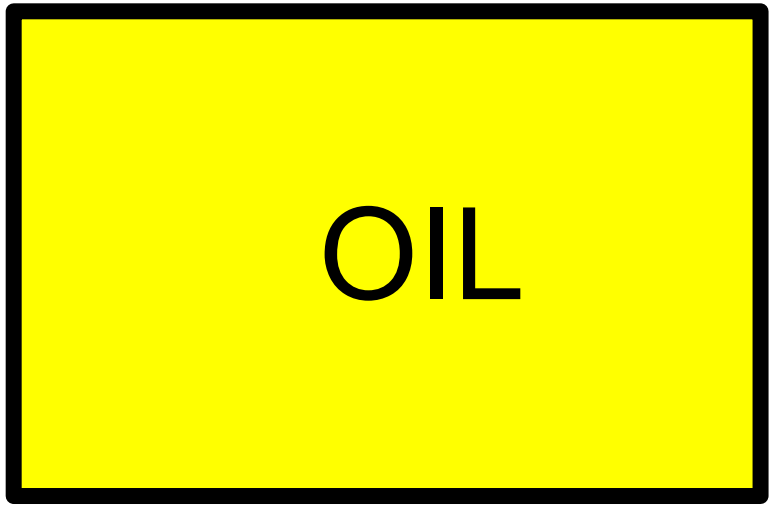
October 29, 2021
10:54 AM BST
Last Updated 5 hours ago

Energy

COP26 aims to banish coal. Asia is building hundreds of power plants to burn it

6 minute read

By Sudarshan Varadhan and Aaron Sheldrick


OIL

SOME HISTORY

https://glasscollection.cmog.org/objects/34828/whale-oil-lamp

1835

whale oil lamp

Object Name: Whale Oil Lamp

Manufacturer: Bakewell, Page & Bakewells (1827-1832)

Made From: Glass, metal

Date: 1835-1845

Place Made: United States, PA, Pittsburgh

Technique: Blown, pressed, assembled, engraved

Size: Overall H: 24.8 cm, W: 9.7 cm, D: 9.7 cm

Accession Number: 2008.4.42

Credit Line: Purchased with funds from the Gladys M. and Harry A. Snyder Fund

Curatorial Area(s): Modern

On View: American Gallery

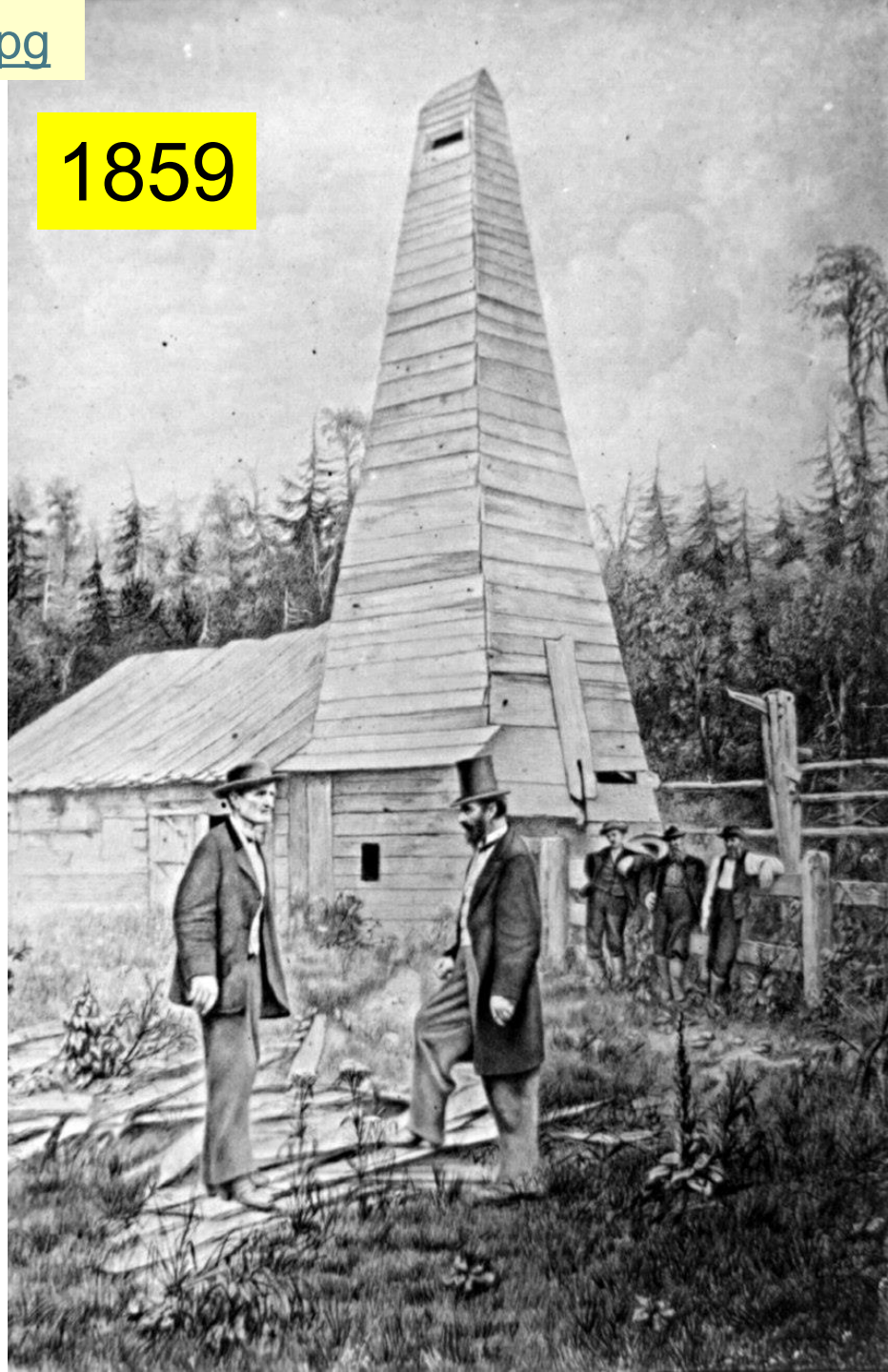
https://en.wikipedia.org/wiki/Drake_Well#/media/File:First_Oil_Well.jpg

The **Drake Well** is a 69.5-foot-deep (21.2 m) oil well in Cherrytree Township, Pennsylvania, the success of which sparked the first oil boom in the United States. The well is the centerpiece of the Drake Well Museum located 3 miles (5 km) south of Titusville.

Drilled by Edwin Drake in 1859, along the banks of Oil Creek, it is the first commercial oil well in the United States. Drake Well was listed on National Register of Historic Places and designated a National Historic Landmark in 1966. It was designated a Historic Mechanical Engineering Landmark in 1979. The well was designated a National Historic Chemical Landmark in 2009, on the sesquicentennial of the strike.

The Drake Well is often referred to as the first commercial oil well, although that title is also claimed for wells in Azerbaijan, Ontario, West Virginia, Myanmar, Persia, Arabia, Sichuan and Poland.

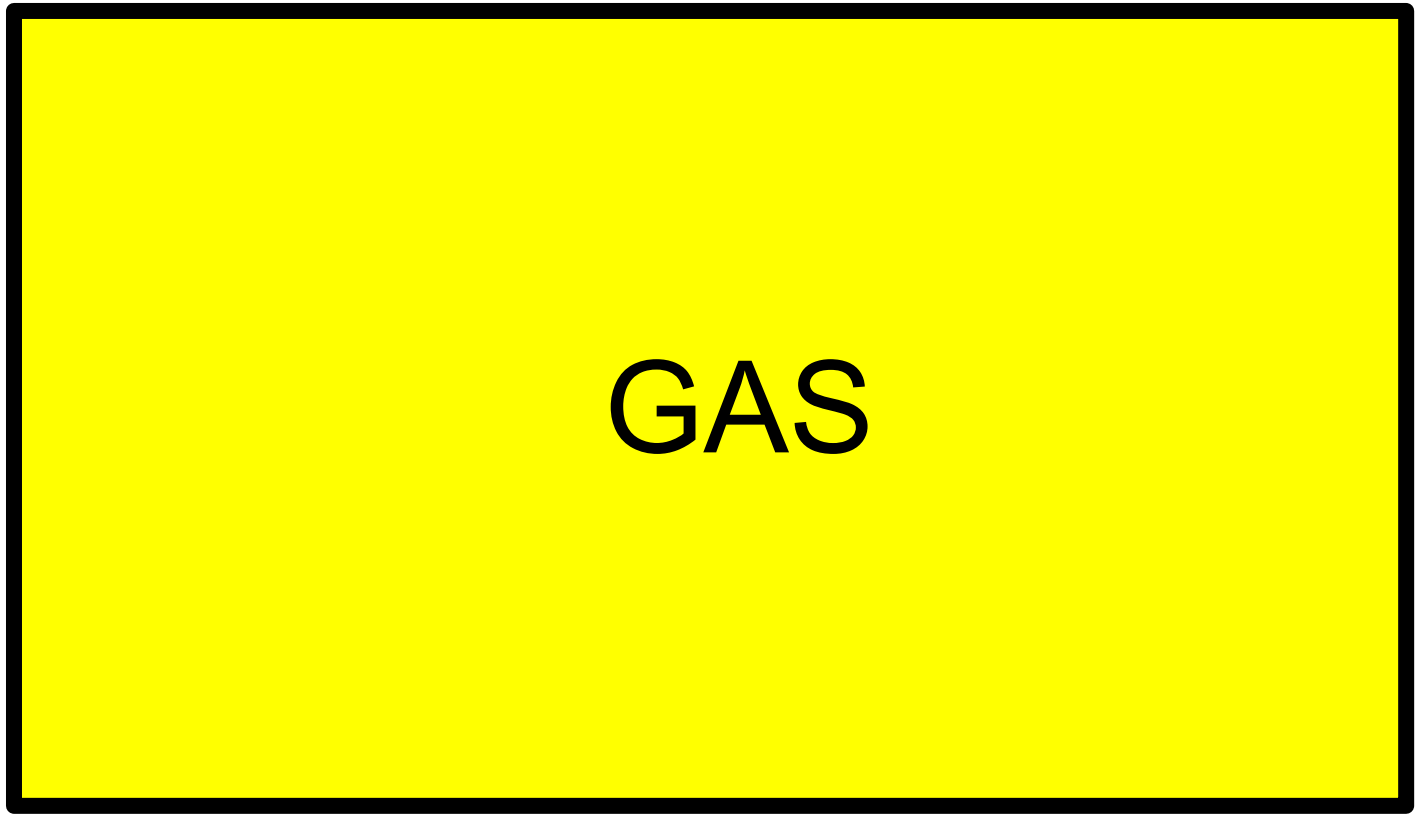
In the United States before the Drake Well, oil-producing wells were wells that were drilled for salt brine, and produced oil and gas only as accidental byproducts. An intended drinking water well at Oil Springs, Ontario found oil in 1858, a year before the Drake Well, but it had not been drilled for oil. Historians have noted that the importance of the Drake Well was not in being the first well to produce oil, but in attracting the first great wave of investment in oil drilling, refining, and marketing:



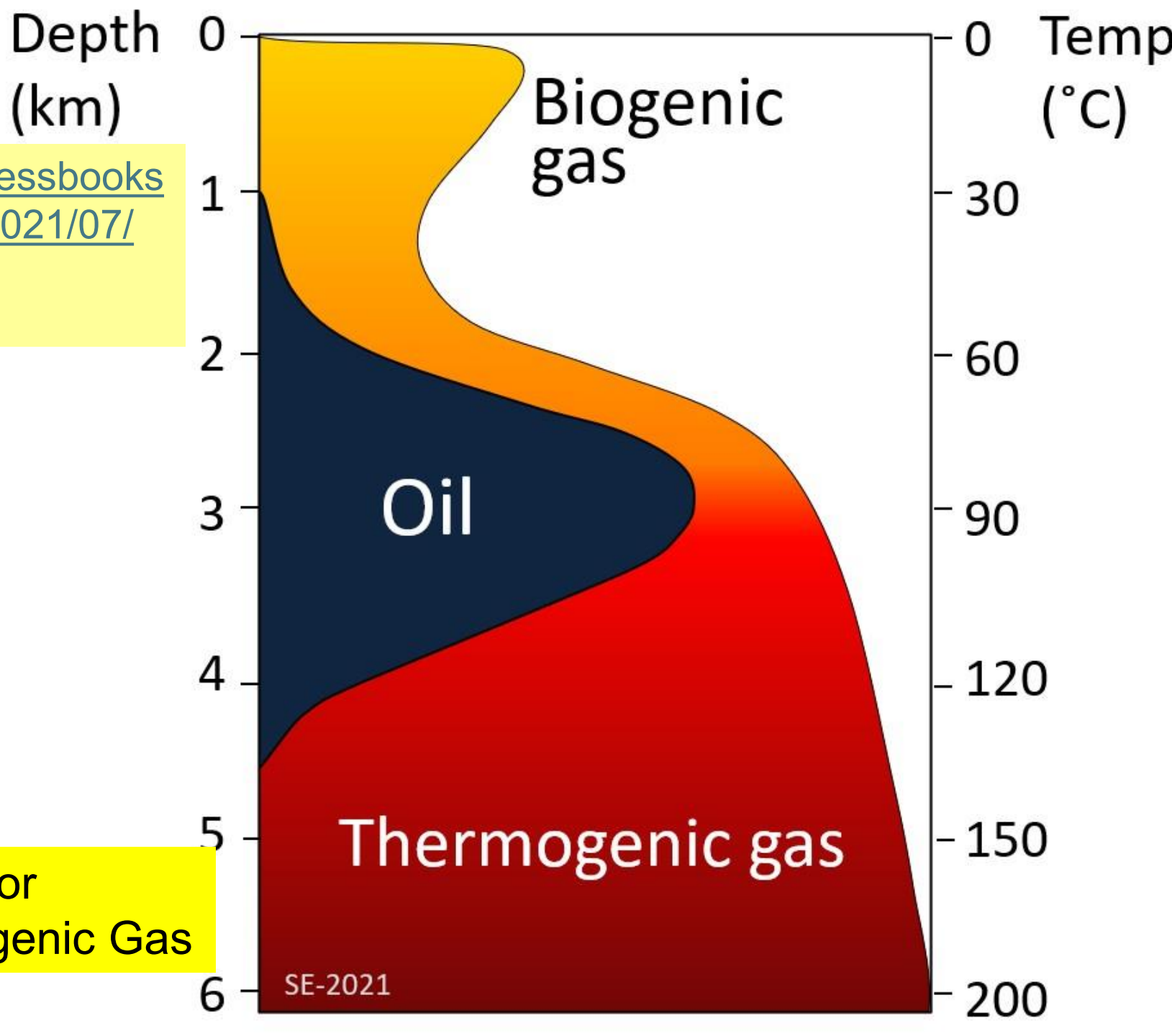
https://en.wikipedia.org/wiki/Drake_Well

History [edit]

Petroleum found along Oil Creek was known to Native Americans for hundreds of years through natural seeps.[4] Europeans became aware of the existence of petroleum in the 1600s. At the time, this "mineral-oil" was used primarily for medicinal purposes and was reputed to cure many ailments, including rheumatism and arthritis.[6] Around 1848, Samuel Kier realized the potential of the medicinal oil as an illuminant. Kier distilled the oil to make it more suitable in lamps by removing the odor and impurities that created soot when burned.[7] A sample of oil was brought to Dartmouth College by Francis B. Brewer from the Watson, Brewer and Company Farm on Oil Creek around 1853. The sample was acquired by George Bissell who, along with Jonathan G. Eveleth purchased the farm for $5,000.[7] Bissell and Eveleth took another sample of oil to Benjamin Silliman at Yale University in 1855 for further investigation. Silliman's report confirmed the quality of the petroleum and described the distillation processes needed to produce kerosene.[7] The Pennsylvania Rock Oil Company was incorporated and the farm transferred to the company.[8]


GAS

https://environmental-geology-dev.pressbooks.tru.ca/wp-content/uploads/sites/73/2021/07/oil-gas.jpg



Depth and Temperature Limits for Biogenic Gas, Oil, and Thermogenic Gas

Bloomberg Green

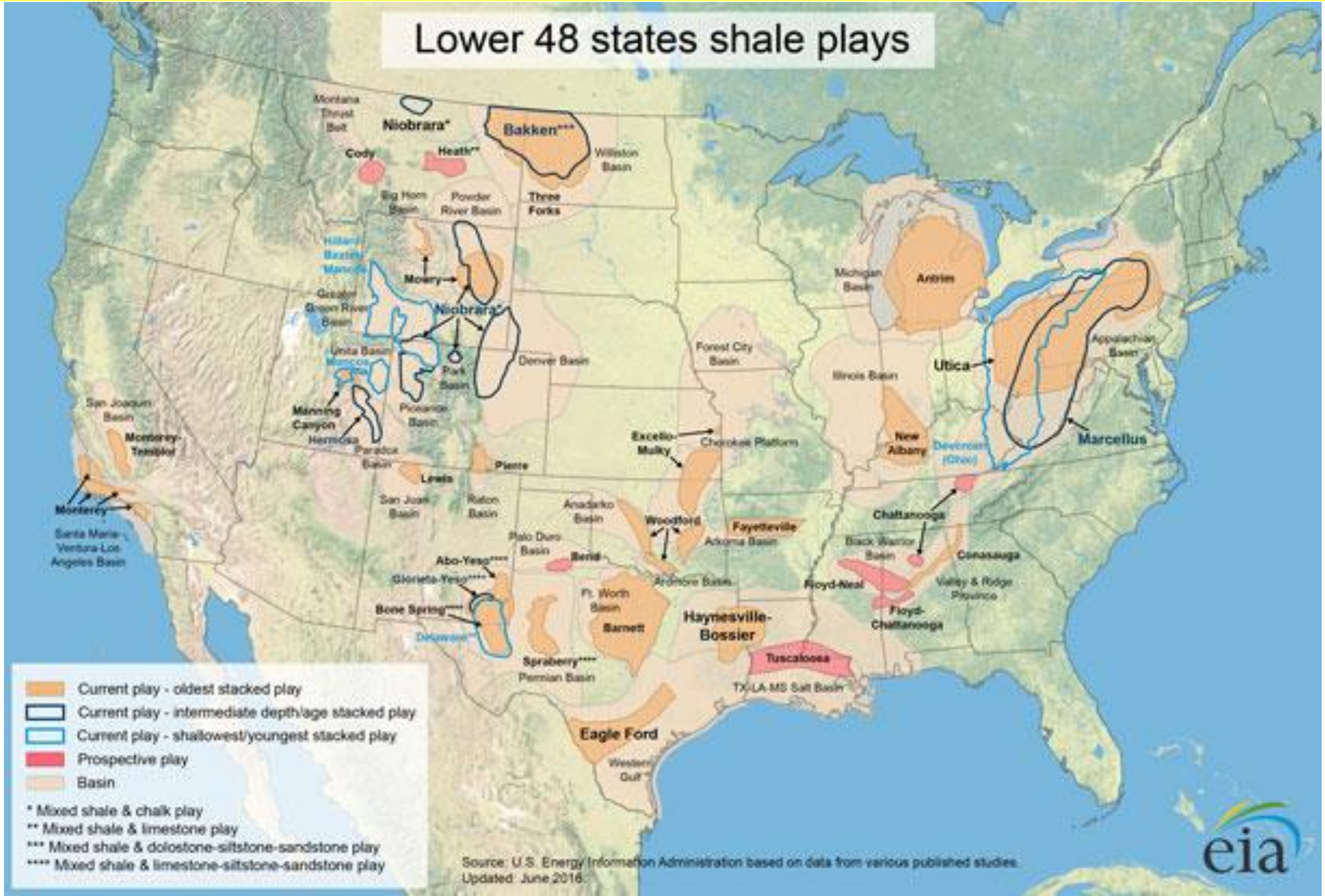
Energy & Science

California to Build Temporary Gas Plants to Avoid Blackouts

By Mark Chediak and Naureen S Malik
19 August 2021, 23:07 BST

- State has resisted efforts to expand natural gas-based power
- Governor declared state of emergency for grid last month

https://www.eia.gov/energyexplained/natural-gas/where-our-natural-gas-comes-from.php



VIDEO: How Do Oil Rigs Work? Drilling, Casing, Mud & Blowout Prevention

https://www.youtube.com/watch?v=a2pud3kD1e8

This informative video covers many topics:

Differences between water and oil/gas wells.

Horizontal drilling.

Casings to prevent water from getting into the oil and gas well.

Different drill heads.

The different casings.

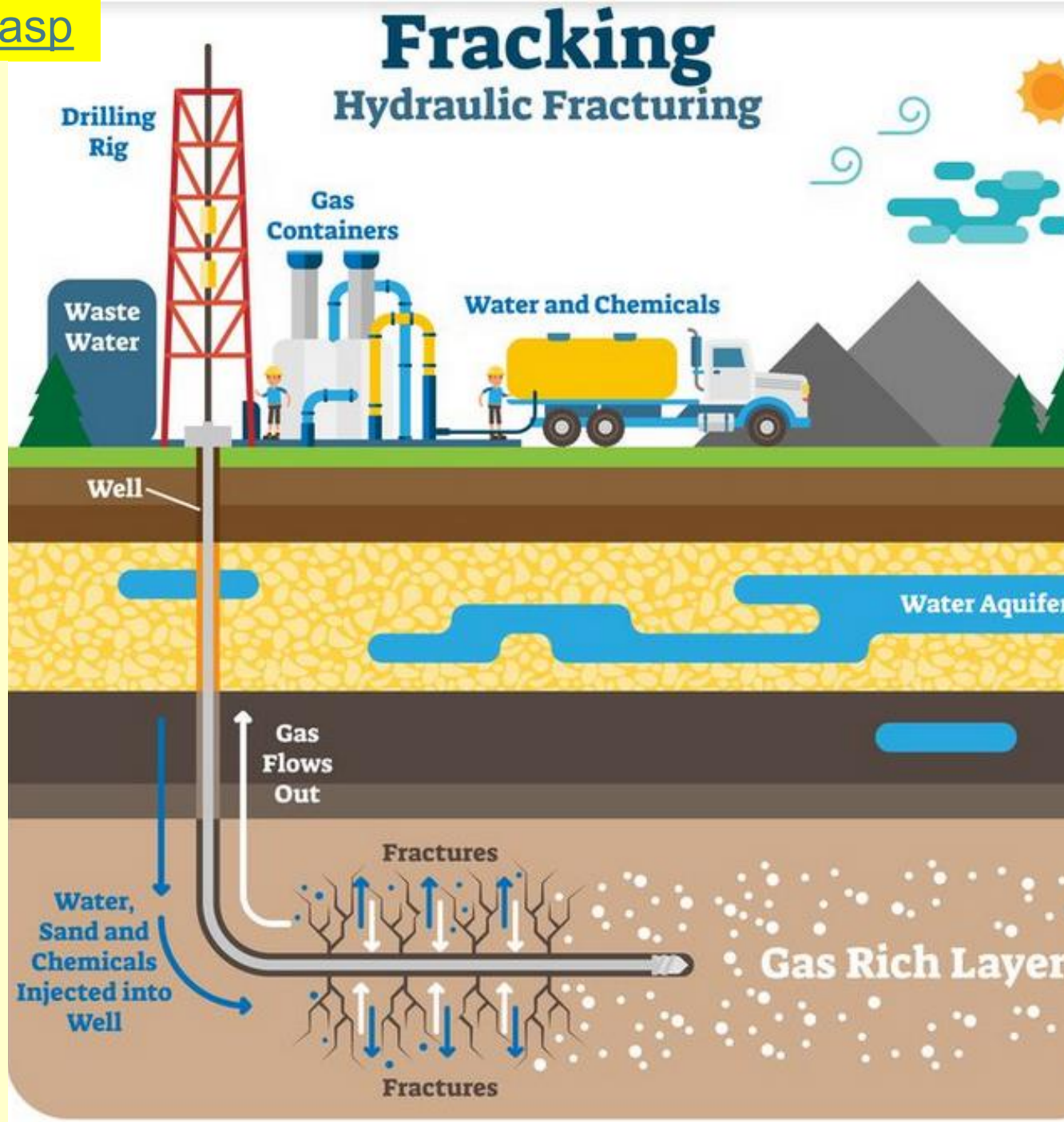
FRACKING

https://www.investopedia.com/terms/f/fracking.asp

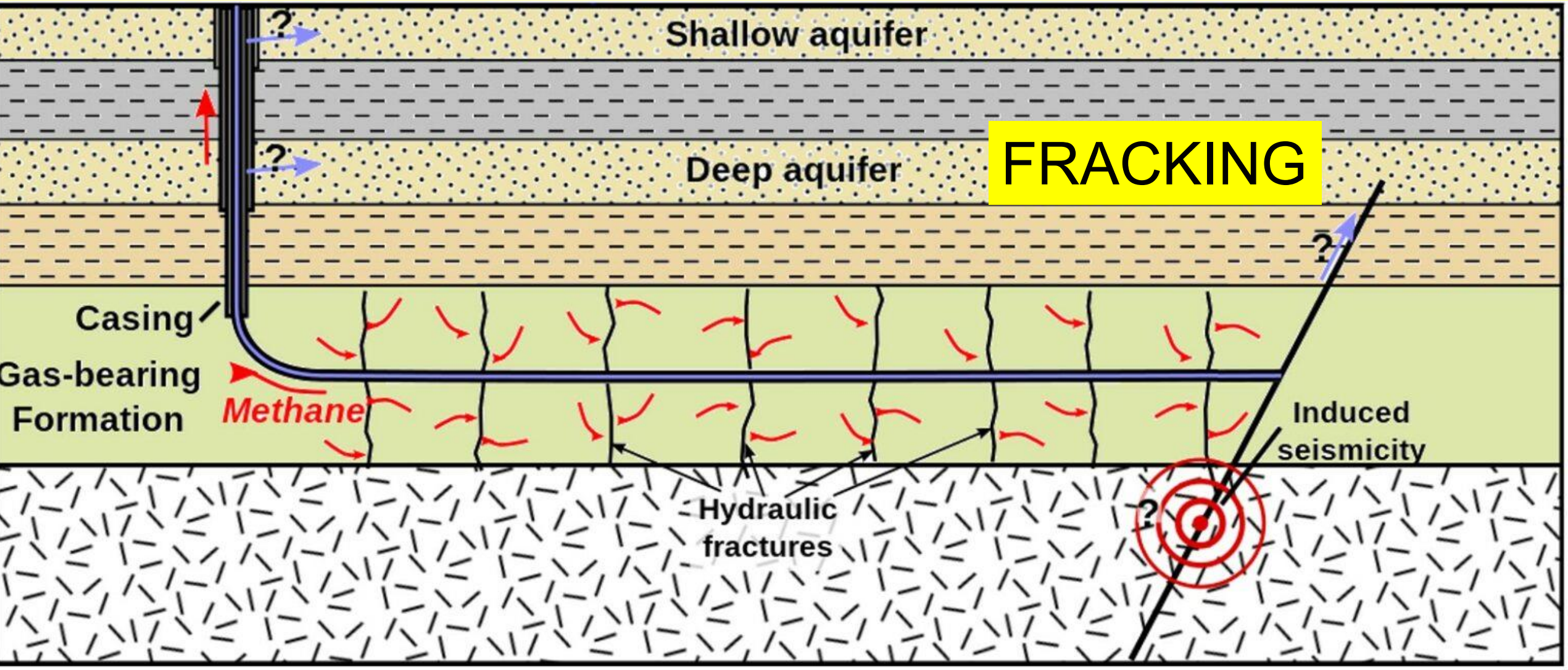
Fracking (also known as **hydraulic fracturing**, **fracing**, **hydrofracturing**, or **hydrofracking**) is a well stimulation technique involving the fracturing of formations in bedrock by a pressurized liquid.

The process involves the high-pressure injection of "fracking fluid" (primarily water, containing sand or other proppants suspended with the aid of thickening agents) into a wellbore to create cracks in the deep-rock formations through which natural gas, petroleum, and brine will flow more freely. When the hydraulic pressure is removed from the well, small grains of hydraulic fracturing proppants (either sand or aluminium oxide) hold the fractures open.[1]

Fracking, using either hydraulic pressure or acid, is the most common method for well stimulation. Well stimulation techniques help create pathways for oil, gas or water to flow more easily, ultimately increasing the overall production of the well.



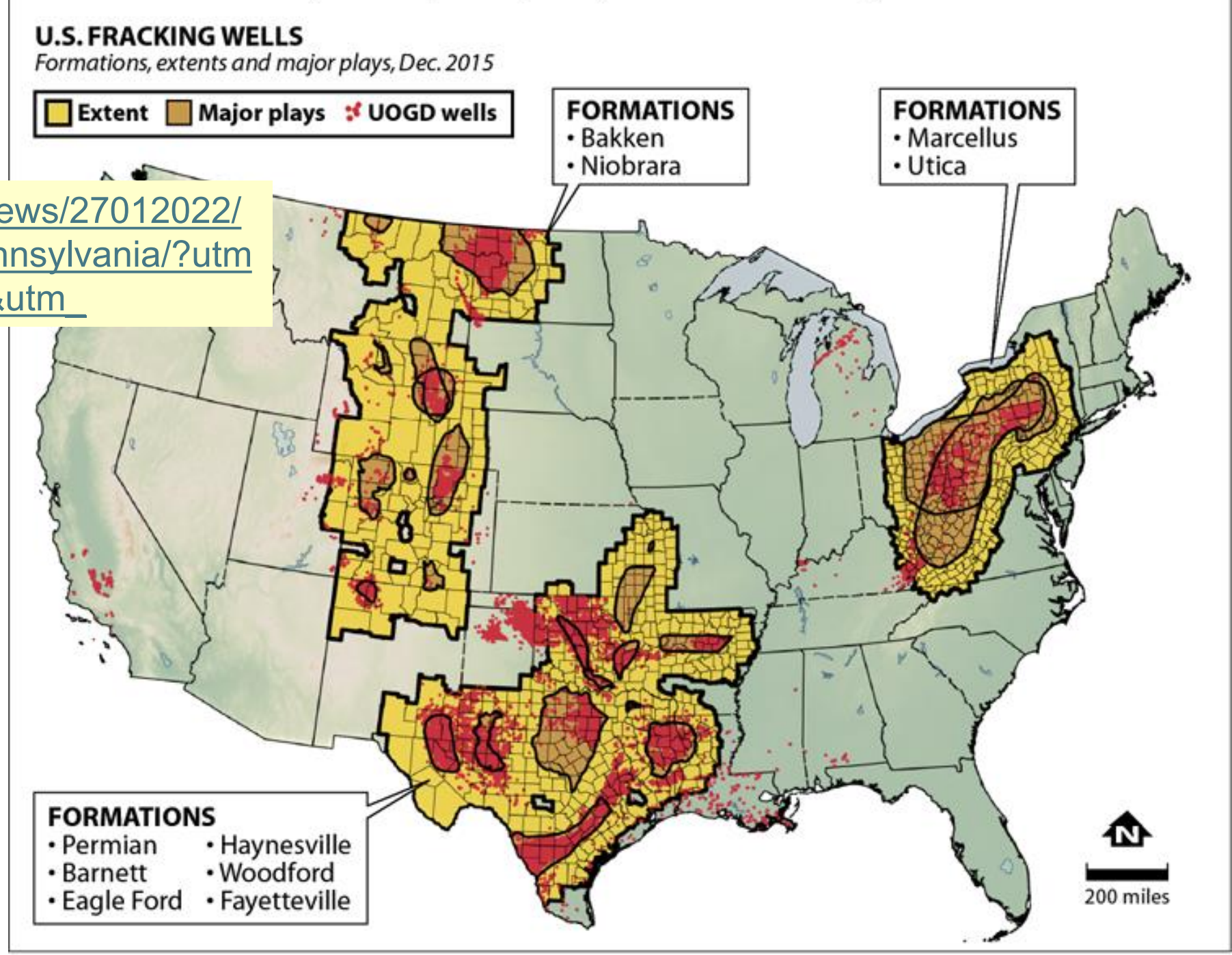
https://environmental-geology-dev.pressbooks.tru.ca/chapter/fossil-fuels/



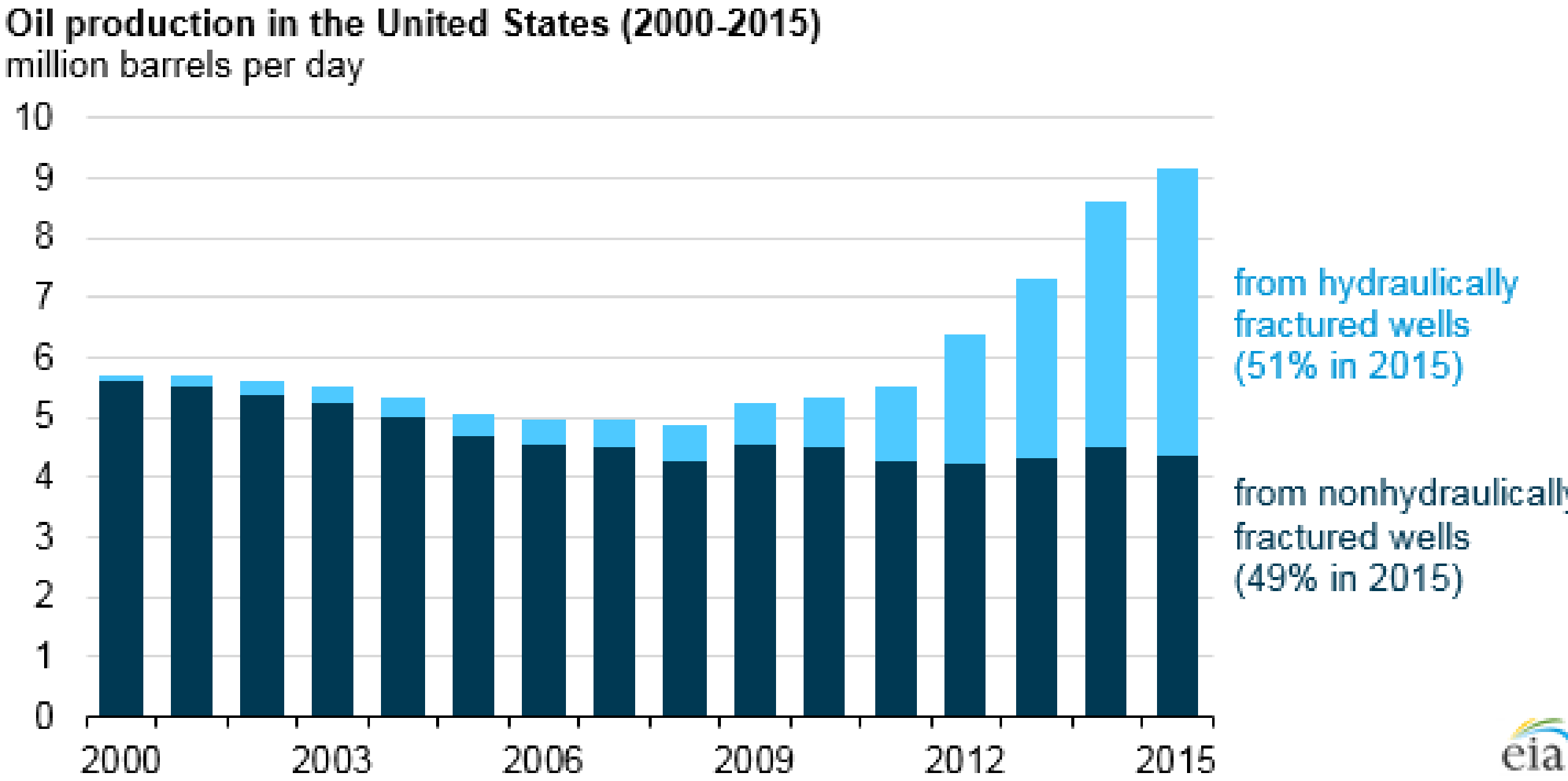
Red arrows depict the flow of Methane though the fractured country rock to the bore hole and the surface.

Depiction of the Process of Directional Drilling and Fracking to Recover Gas From Impermeable Rocks. The light blue arrows represent the potential for release of fracking chemicals to aquifers.

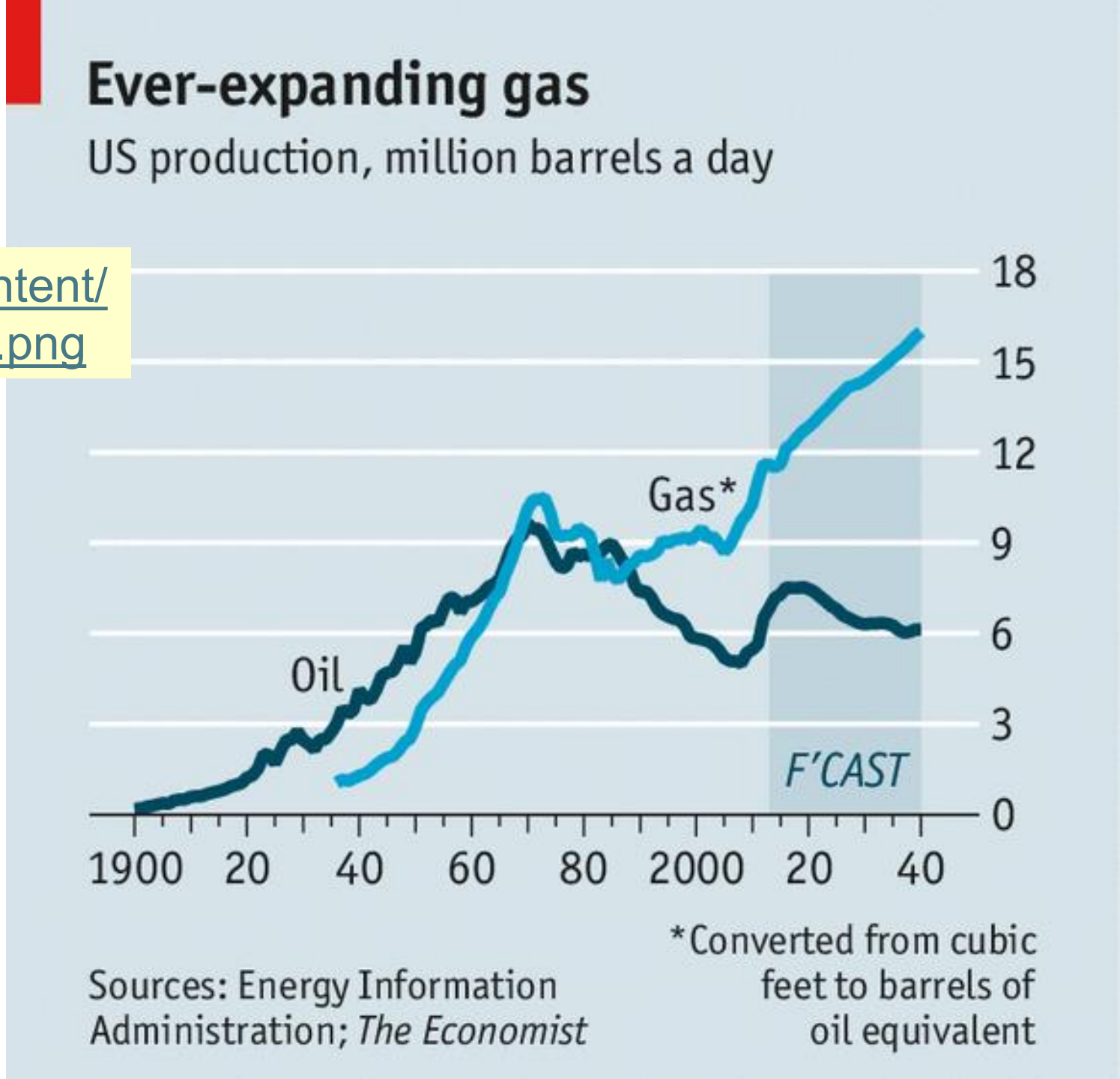
https://insideclimatenews.org/news/27012022/fracking-air-pollution-health-pennsylvania/?utm_source=InsideClimate+News&utm_



https://www.eia.gov/todayinenergy/detail.php?id=25372

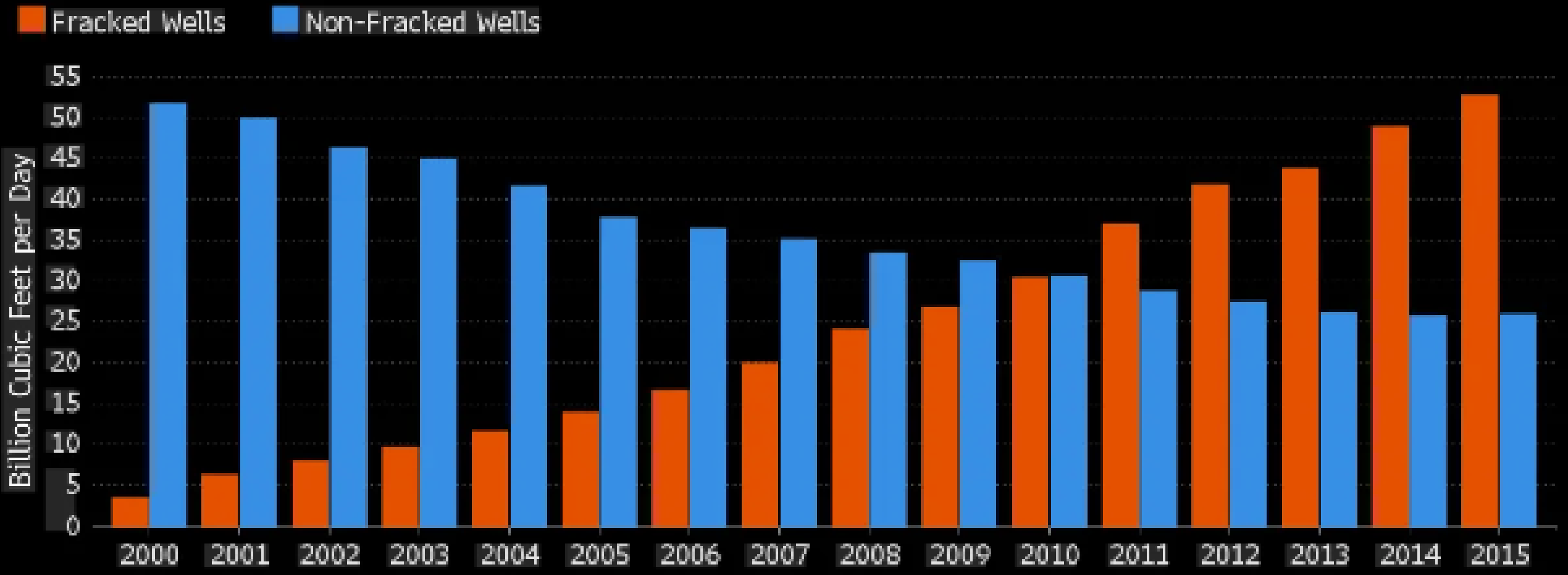


https://bambooinnovator.com/wp-content/uploads/2013/11/20131116_wbc785.png



Shale Revolution

Natural gas from hydraulic fracturing accounts for most of U.S. supply



Source: U.S. Energy Information Administration, IHS Inc., Drillinginfo Inc.

Bloomberg

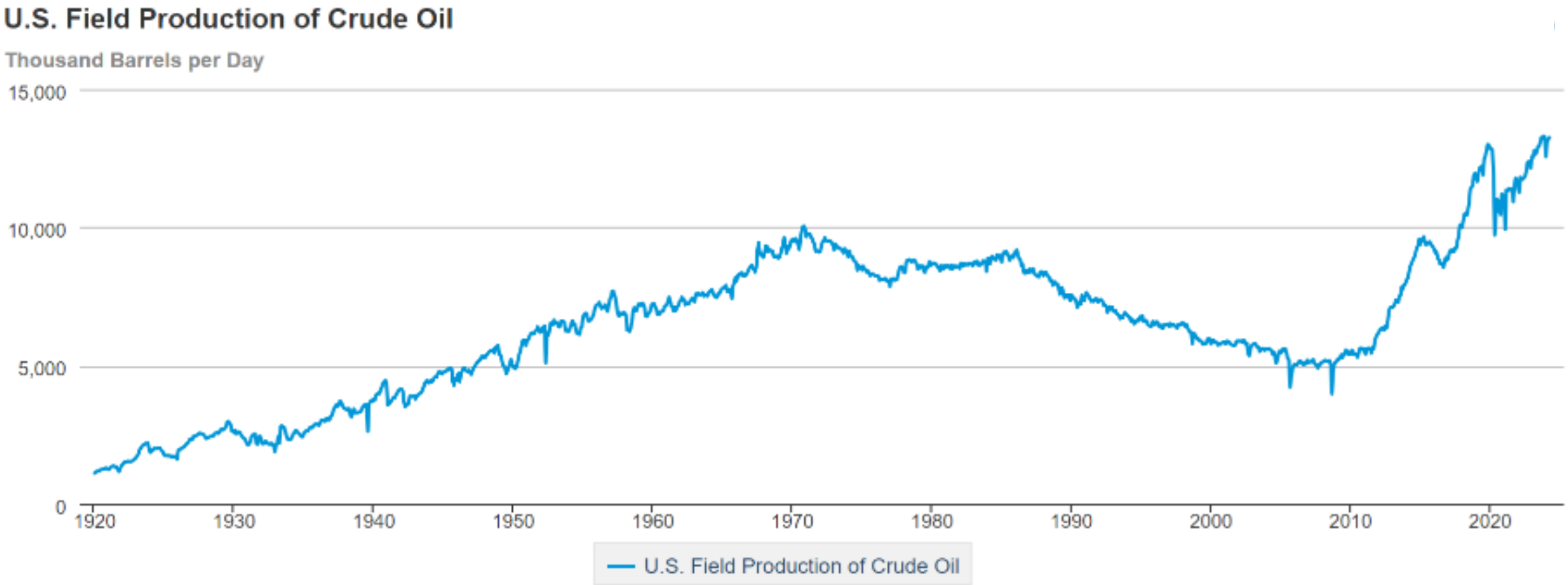
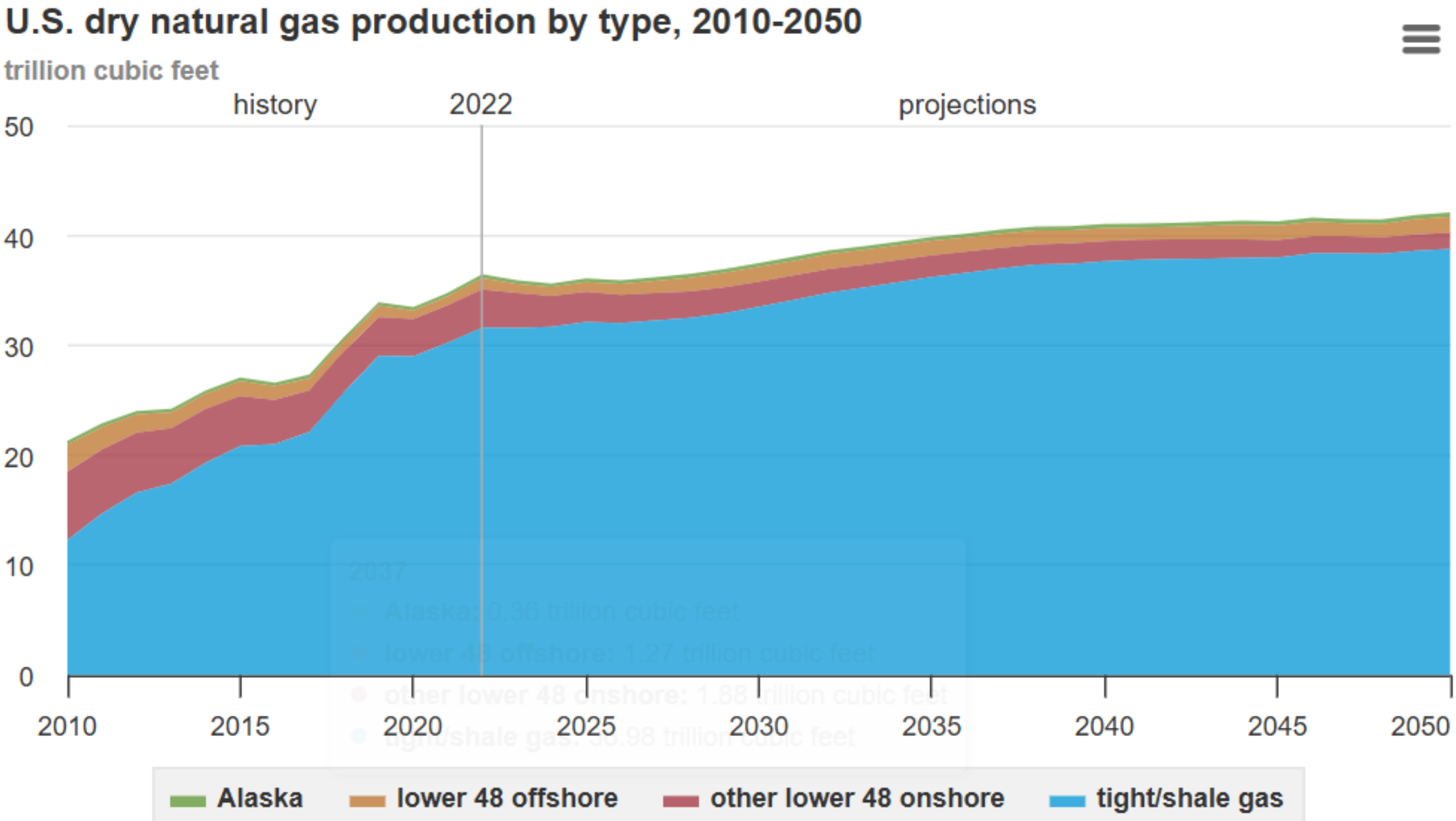


Figure 1 - U.S Field Production of Crude Oil (EIA, 2024)

https://www.eia.gov/energyexplained/natural-gas/where-our-natural-gas-comes-from.php



“THE END OF OIL”

https://www.economist.com/special-report/2024/03/11/the-end-of-oil-then-and-now

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil#/media/File:Estimates_of_Peak_World_Oil_Production.jpg

36 Estimates of the Time of Peak World Oil Production (There Are More)

Published	By	Peak Year/Range	Published	By	Peak Year/Range
1972	ESSO	About 2000	1999	Parker	2040
1972	UN	By 2000	2000	Bartlett	2004 or 2019
1974	Hubbert	1991-2000	2000	Duncan	2006
1976	UKDOE	About 2000	2000	EIA	2021-2167; 2037 most likely
1977	Hubbert	1996	2000	IEA (WEO)	Beyond 2020
1977	Ehrlich, et al.	2000	2001	Deffeyes	2003-2008
1979	Shell	Plateau by 2004	2001	Goodstein	2007
1981	World Bank	Plateau around 2000	2002	Smith	2010-2016
1985	Bookout	2020	2002	Campbell	2010
1989	Campbell	1989	2002	Cavallo	2025-2028
1994	Ivanhoe	OPEC Plateau 2000-2050	2003	Greene, et al.	2020-2050
1995	Petroconsultants	2005	2003	Laherrère	2010-2020
1997	Ivanhoe	2010	2003	Lynch	No visible peak
1997	Edwards	2020	2003	Shell	After 2025
1998	IEA (WEO)	2014	2003	Simmons	2007-2009
1998	Campbell/Laherrère	2004	2004	Bakhitari	2006-2007
1999	Campbell	2010	2004	CERA	After 2020
1999	Odell	2060	2004	PFC Energy	2015-2020

Historical estimates for the "End of Oil" have proven incorrect for over a century due to a fundamental flaw in the "peak oil" theory: the estimates failed to account for advances in extraction technology and the discovery of new reserves.

The predictions often confused the peak production of a specific type of oil (such as conventional crude) with the total available resource.

https://manhattan.institute/article/running-out-of-oil-history-technology-and-abundance

Commentary
By Max Schulz

Running Out of Oil? History, Technology and Abundance

"….The Kern River Field near Bakersfield, California, for instance, pumped nearly 30,000 barrels per day throughout much of the first decade of the 20th century. After 1910, production declined for the next 40 years. The field was nearly abandoned.

Innovations like pressurized steam and hot water injections changed that. Production at the Kern River field steadily ramped up after 1960, and the field has produced more than 125,000 barrels of oil per day since 1980. Recent estimates suggest Kern River still holds an additional one billion barrels of recoverable reserves."

Following came from my 3 Dec 2025 Internet Search on

<"End of Oil" estimates throughout history>

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

1880s…

Economist and oil analyst Daniel Yergin notes that the first predictions of imminent oil peaks go back to the 1880s, when some American experts believed that exhaustion of the Pennsylvania oil fields would kill the US oil industry. Another wave of peak predictions occurred after World War I.[3]

> "... the peak of production will soon be passed, possibly within 3 years. ... There are man well-informed geologists and engineers who believe that the peak in the production of natural petroleum in this country will be reached by 1921 and who present impressive evidence that it may come even before 1920."
>
> - David White, chief geologist, United States Geological Survey (1919)[4]

> "The average middle-aged man of today will live to see the virtual exhaustion of the world's supply of oil from wells,"
>
> - Victor C. Anderson, president of the Colorado School of Mines (1921)[5]

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

Next two graphics are more readable…

"Petroleum consumption enormous", article in Tractor and Gas Engine Review, 1918.

Petroleum Consumption Enormous

W. D. HORNADAY.

THERE has been considerable discussion of late as to the possible length of time that the petroleum supply of the United States and the world will hold out. With the development of the automobile and other motor vehicles and engines, the use of petroleum and its products for fuel has become of first importance from an industrial standpoint. J. S. Cullinan of Houston, Texas, has been prominently identified with the petroleum industry for more than forty years. He has seen the production of the world grow from a little more than ten thousand barrels a day to approximately one million barrels a day. He knows every phase of the industry. It is Mr. Cullinan's belief that the United States Government should adopt a vigorous and far-reaching policy of conserving the crude petroleum supply of this country in order to have on hand a reserve of the fuel for the Navy in future years. In discussing the petroleum industry Mr. Cullinan said:

"When we exhaust the last oil pool the lights will go out in over two hundred million homes, labor will stand idle, investments aggregating billions of dollars will be thrown into the scrap heap, and a large mass of the most ingenious and likewise some of the most stupid legislation ever written in the statute books will become a dead letter. Petroleum directly enters into the life of every civilized human being, and there is no line of business that does not at some point demand petroleum or its products, for it lights the pathway for the poor, furnishes joy rides for the rich, lubricates most every wheel in commerce, and propels a large percentage of them, and during the last quarter of a century it has produced more materials for writers, orators and speakers than any other known product of the world. There is no greater tragedy in the life of a people than the extermination or exhaustion of a useful and dependent natural resource. The problem is one that merits the most careful and painstaking examination of the capitalist, the laborer, the tradesman, the manufacturer, the housewife and every man and every woman.

"A brief review of the industry can not fail to convince the most indifferent of the tremendous importance of the subject. The first oil well in the world was completed near Titusville, Pennsylvania, by Colonel Drake, in August, 1859. This well was drilled by hand labor, using a spring pole. It was completed at a depth of sixty-eight feet. Down to the year of 1870 benzine, the lighter product obtained in refining petroleum, from which the naphtha series and gasoline are now manufactured, was considered a useless product. In order that it might be utilized as much as possible, it was frequently mixed with kerosene up to the year 1900. Internal combustion engines were developed commercially in 1885, the first using natural gas as a fuel. It may be interesting to note here that while approximately sixty per cent of the mechanical horse power of the United States, other than hydroelectric power, is now of the internal combustion type, up to the year 1884 the textbooks and scientists declared the principle on which the internal combustion engine is operated to be impossible. The automobile was developed commercially in the year 1900. We now have upward of five million commercial and pleasure vehicles in the United States, which are estimated to consume upward of thirty million barrels of gasoline per annum. The manufacture and operation of trucks and automobiles is now understood to give employment to upward of 1,250,000 of our population, the national annual outlay representing in investment and expense nearly double the total Government outlay for rivers and harbors since 1776.

"The total marketed petroleum production of the United States in ten year periods beginning with 1875 in round numbers follows: In 1875, 8,800,000 barrels; 1885, 21,900,000 barrels; 1895, 52,900,000 barrels; 1905, 134,700,000 barrels; 1915, 290,000,000 barrels. The total marketed petroleum production of the United States from 1895 to 1915, inclusive, is 3,627,720,593 barrels. It will be noted from the above tabulation that the production more than doubles each ten year period. After a careful study and investigation made by the United States Geological Survey a few years ago, the total petroleum deposits in the United States were estimated to not exceed twenty-five million barrels. The commercial development of petroleum has taken place entirely within my lifetime. It is just possible, so far as the United States is concerned, that the development and the exhaustion of the supplies may occur within the course of one human life. It is certain that unless radical changes from present methods are applied promptly, all sources of supply within the range of known drilling methods will be exhausted during the life of your children and mine. Modern civilization as developed is absolutely dependent upon petroleum; yet today, I dare say, there is not a man living who has a remote idea of a satisfactory substitute, all of which would seem to demand action, and not oratory, on the part of those responsible for the welfare of the United States and perpetuating the race. All nations depend largely upon the United States for petroleum supplies in the form of fuel oil, lubricants or gasoline. Petroleum is going to be as much a factor in determining naval battles as vessels and armament, and this point should not be overlooked. The nation that controls the oil fields will have a superior navy, if indeed it does not render obsolete the battleships of the other nations, for fuel is as necessary as steel in fighting battles at sea.

"We had as well dismiss from discussion any hope that nature will replenish the supply of petroleum during the life of the present fields. Scientists tell us that it is probable that the hydro-carbons of which fuel is composed may be restored by the processes of nature every twenty-six thousand years, during which period we are told the position of the earth in relation to the north and south poles may be completely reversed, and fuel will be again created in the land portion of the earth's surface. But there is no speculator in oil sufficiently bold to deal in futures quite that far away. Certainly the present generation need not consider it."

Petroleum in the East Indies

During the last twenty years the petroleum industry in the Dutch East Indies has undergone a complete change. Prior to 1901 kerosene was the only product of importance; now benzine, liquid fuel, lubricating oil, asphalt, and paraffin wax are produced. The output of crude petroleum in 1915 was 1,616,645 tons and 1,569,216 tons in 1914.

Oil-driven engines of moderate power are being called for in increasing numbers by English farmers. Some of these are made in England and others are imported. Engines of about 2½-horse power are being installed for the operation of mechanical milkers and other purposes, while for what is known as "barn work" (pulping, chaff cutting, etc.) many engines of somewhat larger capacity are being sold.

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

"Petroleum consumption enormous", article in *Tractor and Gas Engine Review*, 1918.

Petroleum Consumption Enormous

W. D. HORNADAY.

THERE has been considerable discussion of late as to the possible length of time that the petroleum supply of the United States and the world will hold out. With the development of the automobile and other motor vehicles and engines, the use of petroleum and its products for fuel has become of first importance from an industrial standpoint. J. S. Cullinan of Houston, Texas, has been prominently identified with the petroleum industry for more than forty years. He has seen the production of the world grow from a little more than ten thousand barrels a day to approximately one million barrels a day. He knows every phase of the industry. It is Mr. Cullinan's belief that the United States Government should adopt a vigorous and far-reaching policy of conserving the crude petroleum supply of this country in order to have on hand a reserve of the fuel for the Navy in future years. In discussing the petroleum industry Mr. Cullinan said:

"When we exhaust the last oil pool the lights will go out in over two hundred million homes, labor will stand idle, investments aggregating billions of dollars will be thrown into the scrap heap, and a large mass of the most ingenious and likewise some of the most stupid legislation ever written in the statute books will become a dead letter. Petroleum

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https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

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https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

Early 20th century

Following the discovery of oil in Pennsylvania in 1859, a new era of energy consumption began.

- **1874:** The state geologist of Pennsylvania, then the nation's leading oil producer, warned the U.S. had enough oil to last just four years.
- **1914:** The federal government estimated the U.S. only had a 10-year supply left.
- **1921:** The president of the Colorado School of Mines predicted that the "average middle-aged man of today will live to see the virtual exhaustion of the world's supply of oil from wells".

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

Mid-20th century

As oil consumption continued to soar, so did the predictions of its imminent end.

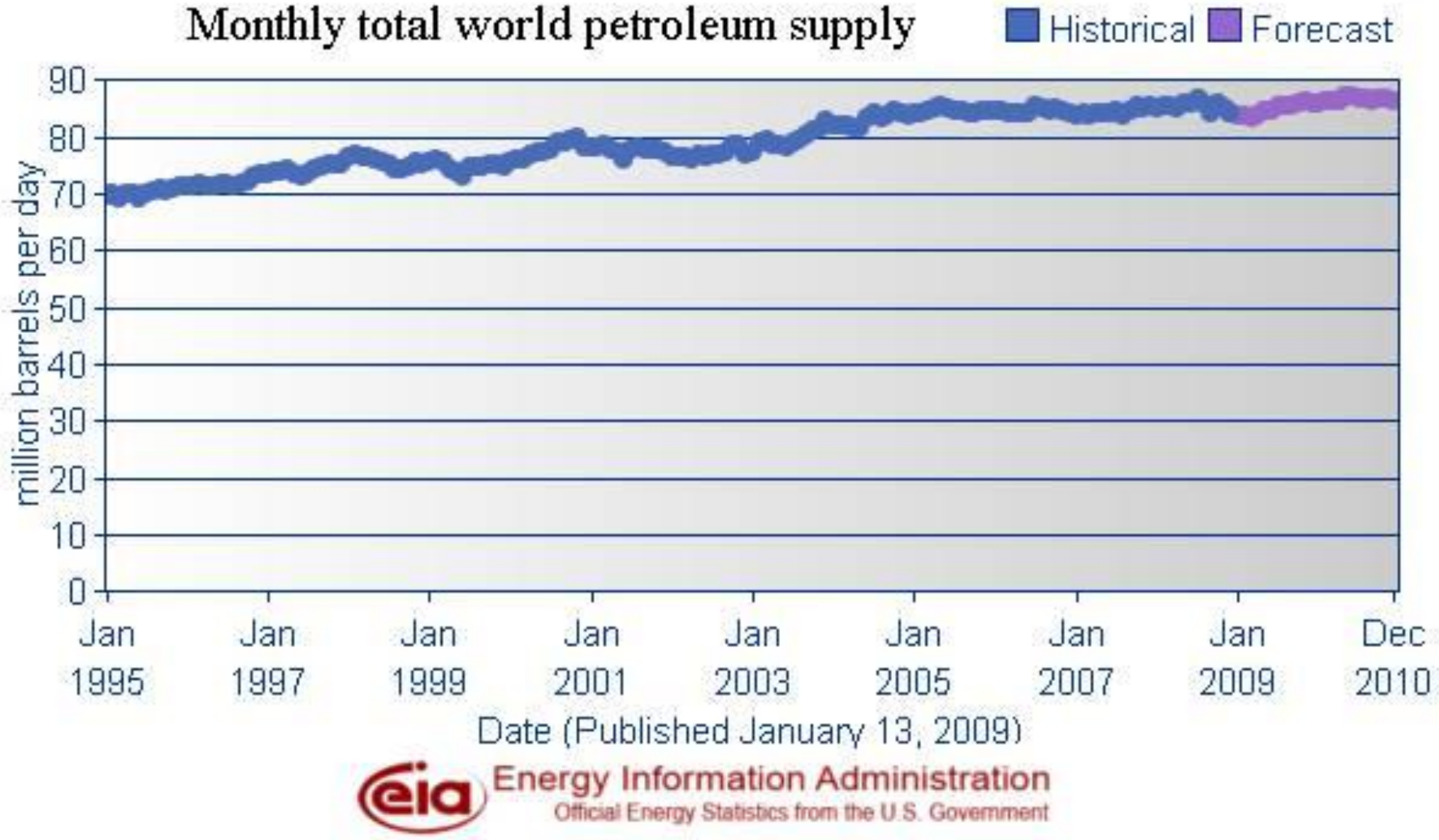
- **1940:** The U.S. government announced that oil reserves would be depleted within a decade and a half.
- **1956:** Geophysicist M. King Hubbert, an early and influential peak oil theorist, created a bell-shaped curve to predict that U.S. oil production would peak between 1965 and 1970. His model was widely seen as proven when U.S. oil production peaked in 1970.
- **1970s:** After the 1973 oil crisis, the "End of Oil" theory gained wider acceptance. Organizations like the Club of Rome made similar claims about impending resource exhaustion.

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil

Late 20th century to early 21st century

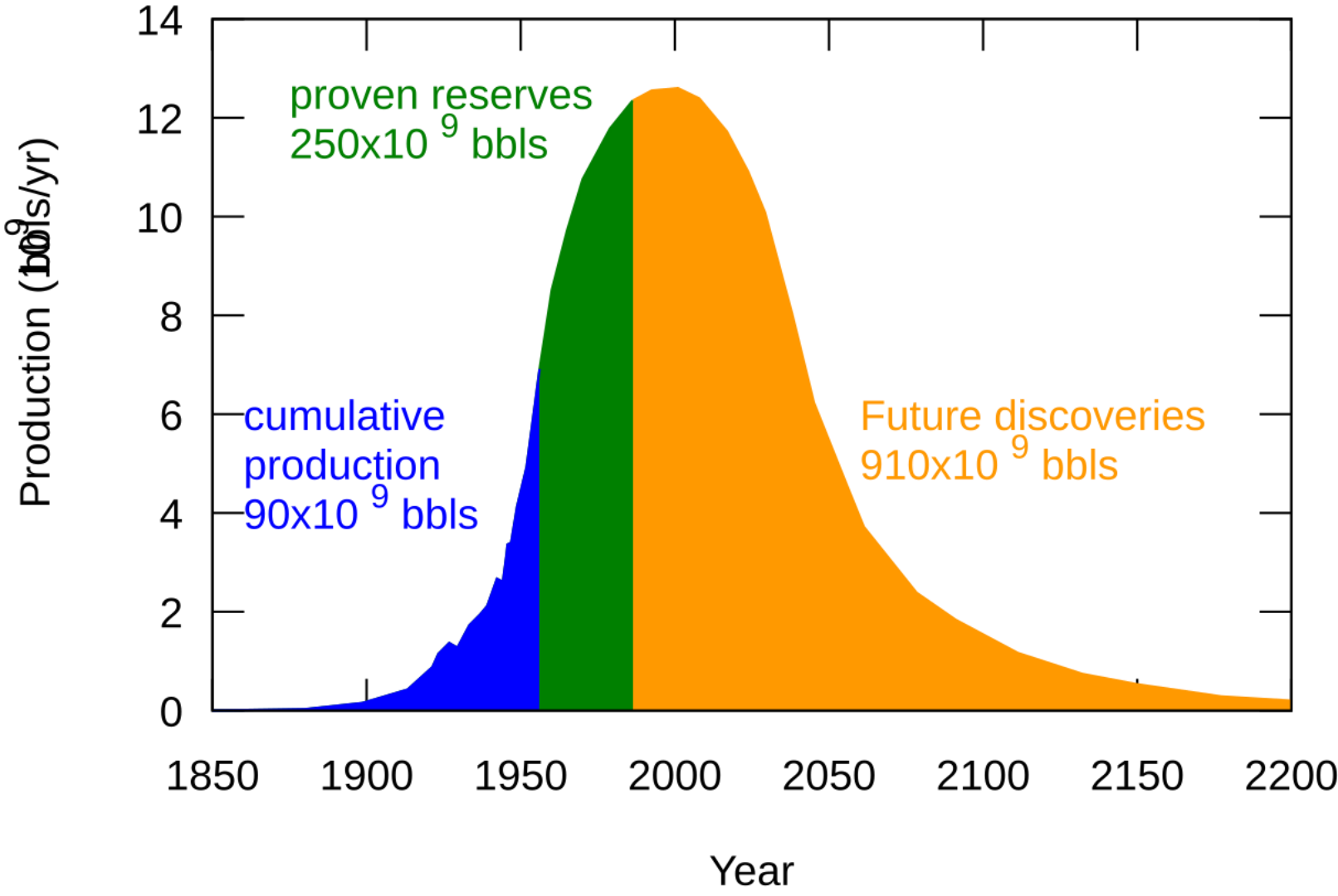
Despite ongoing predictions, including some by Hubbert himself, new technology continued to make more oil available.

- **1990s and 2000s:** Peak oil predictions were frequently revised, with many experts in the early 2000s predicting a global peak around 2010.
- **2005:** The U.S. began a massive increase in oil production thanks to new technologies like hydraulic fracturing and horizontal drilling, invalidating Hubbert's original curve.
- **2008:** The Association for the Study of Peak Oil and Gas (ASPO) revised its peak oil forecast, moving the projected date to 2007, an estimate that was later contradicted by sustained global oil production.
- **2019:** The U.S. surpassed its 1970 production peak, proving earlier peak oil models flawed.

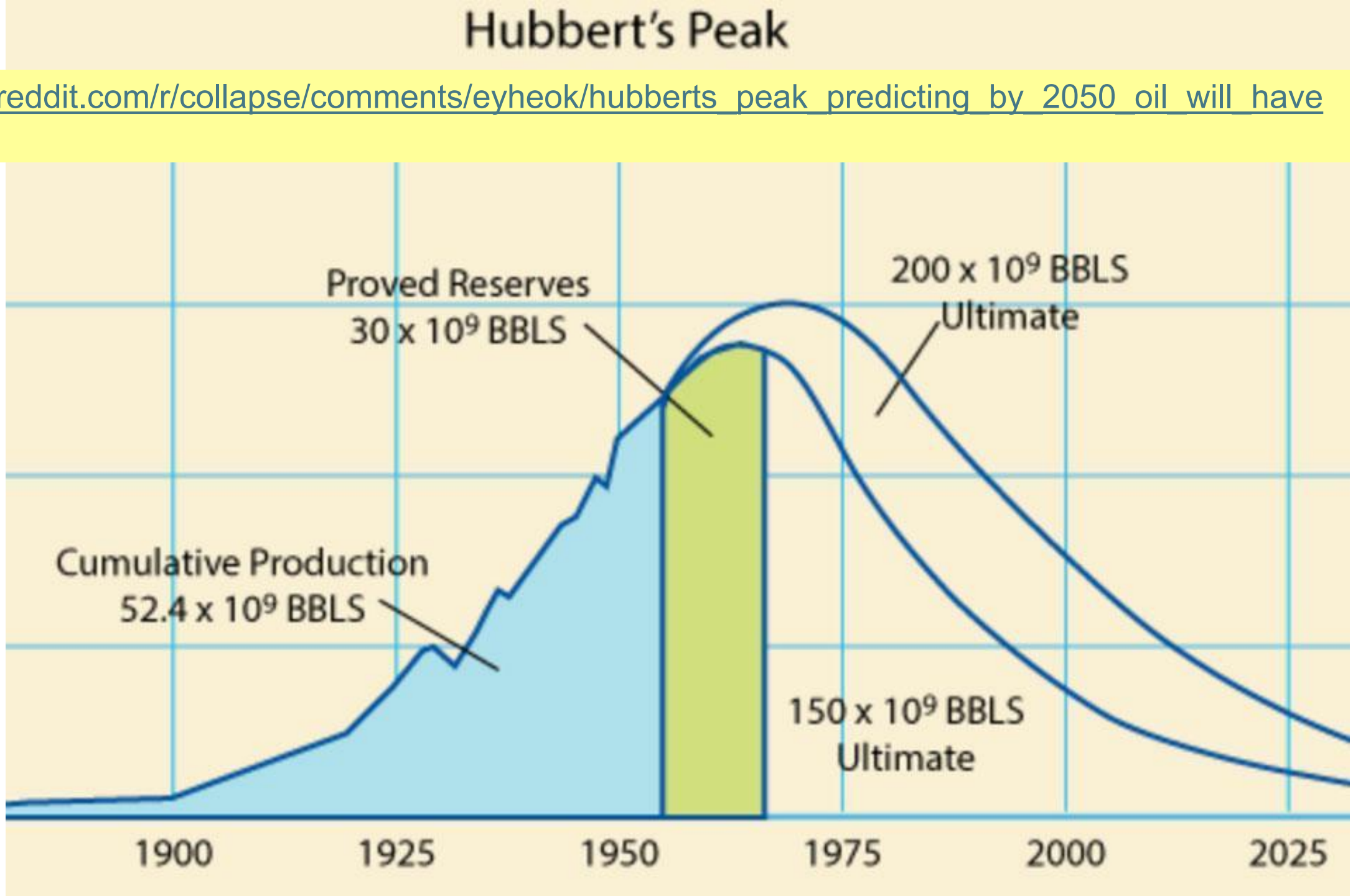

Monthly total world petroleum supply
Historical
Forecast
million barrels per day
90
80
70
60
50
40
30
20
10
0
Jan 1995
Jan 1997
Jan 1999
Jan 2001
Jan 2003
Jan 2005
Jan 2007
Jan 2009
Dec 2010
Date (Published January 13, 2009)
Energy Information Administration
Official Energy Statistics from the U.S. Government

https://en.wikipedia.org/wiki/Predicting_the_timing_of_peak_oil#/media/File:Hubbert_peak_oil_plot.svg

A logistic distribution shaped world oil production curve, peaking at 12.5 billion barrels per year about the year 2000, as originally proposed by M. King Hubbert in 1956



https://www.reddit.com/r/collapse/comments/eyheok/hubberts_peak_predicting_by_2050_oil_will_have/#lightbox



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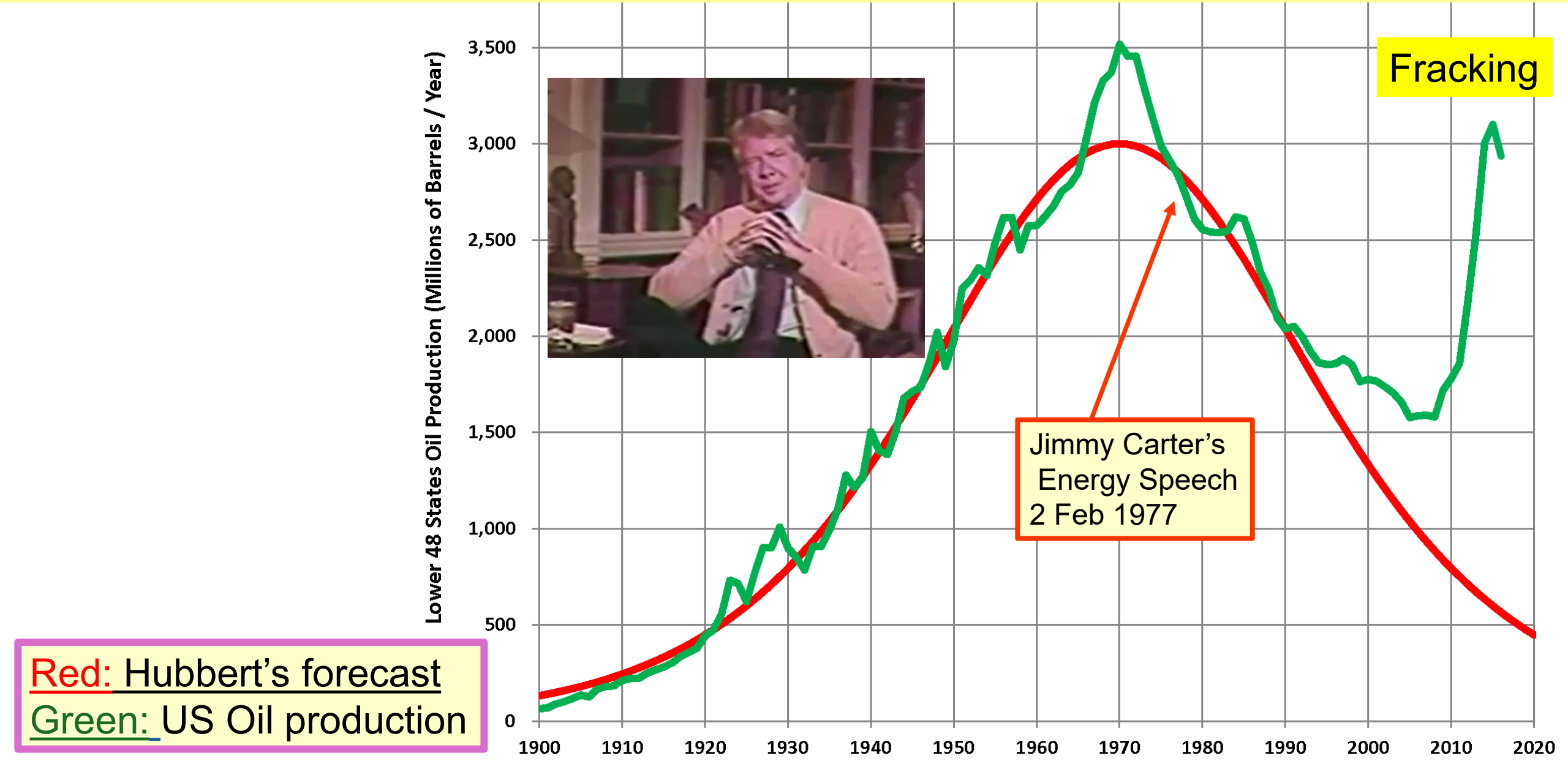
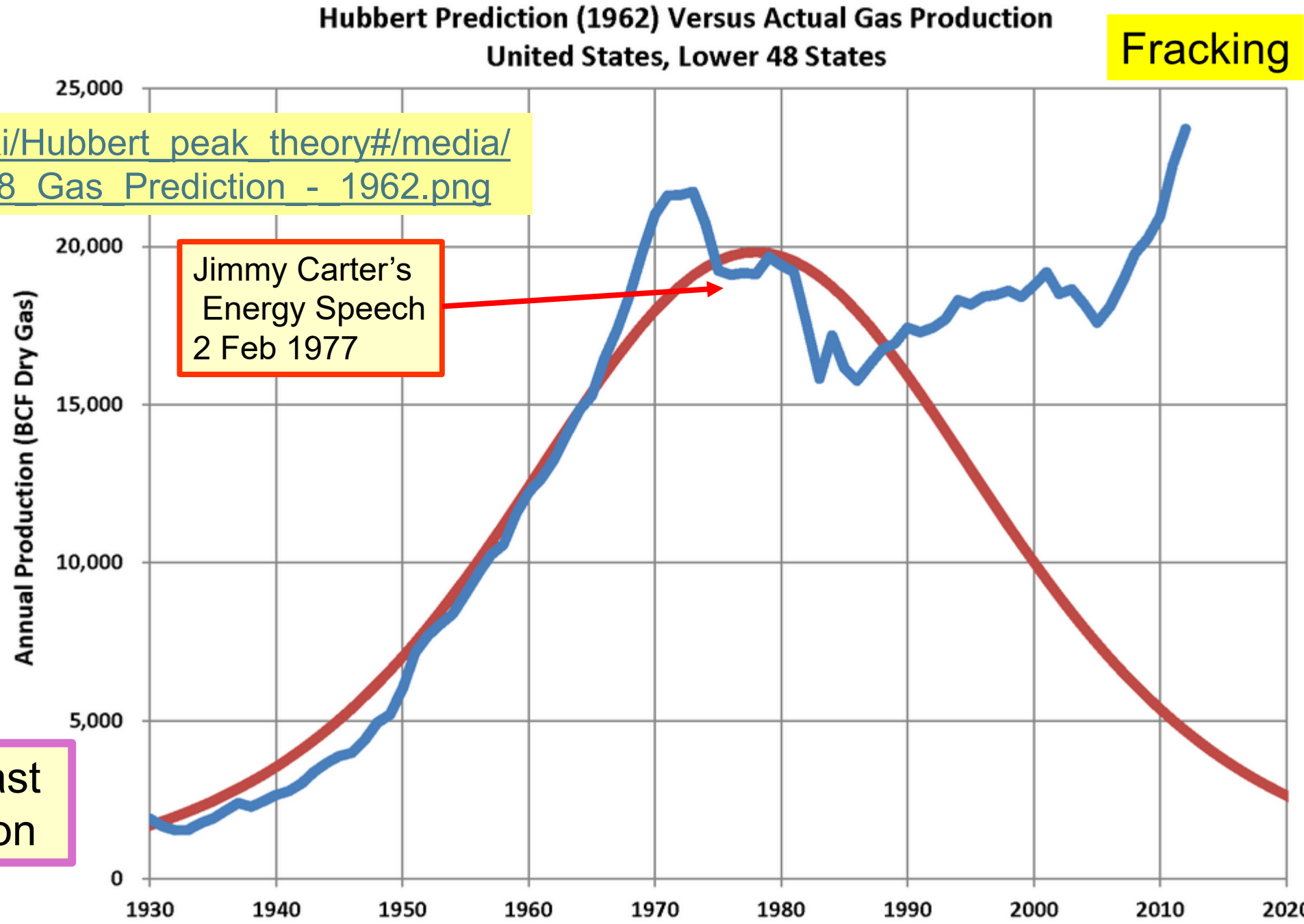
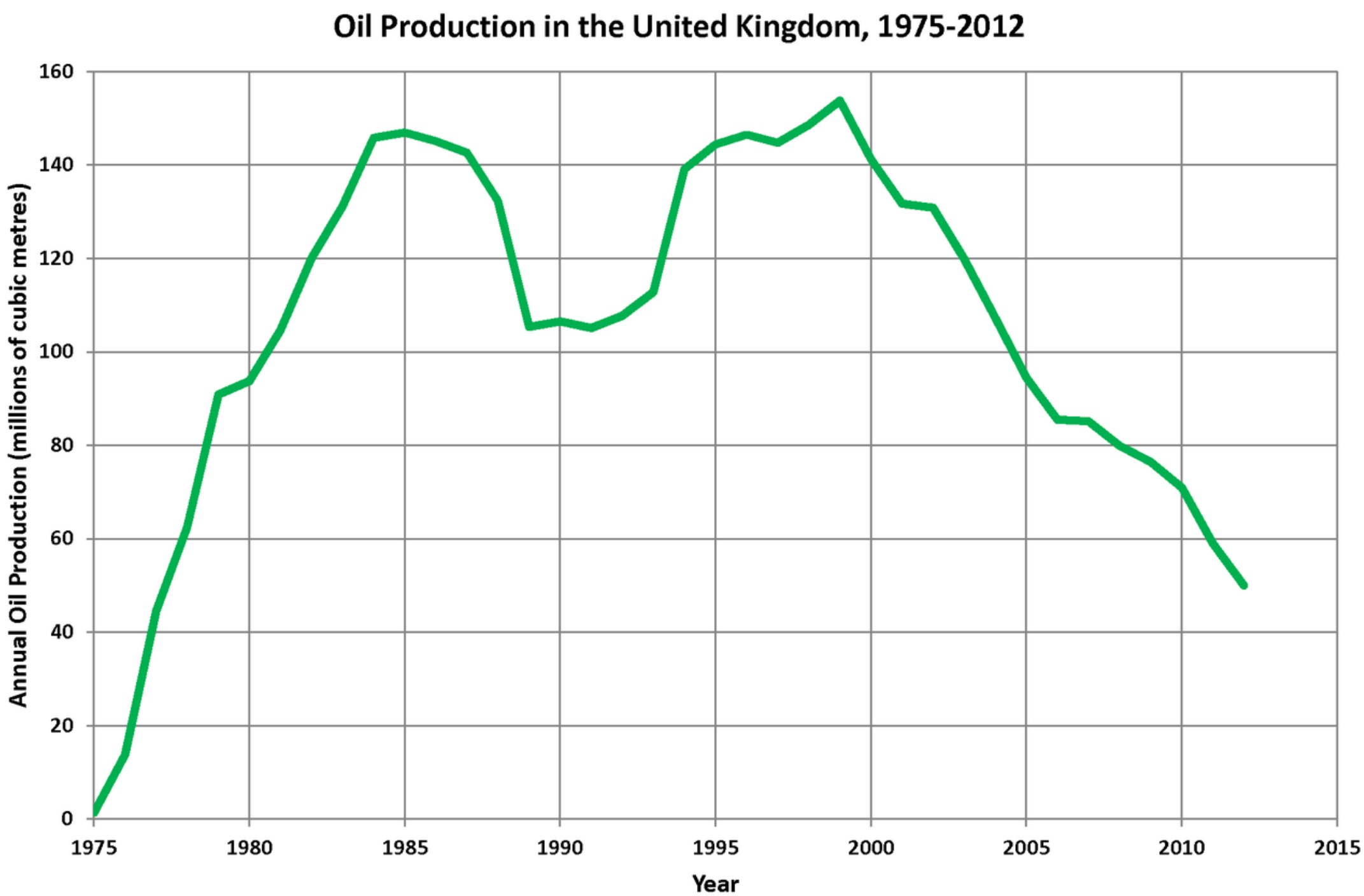


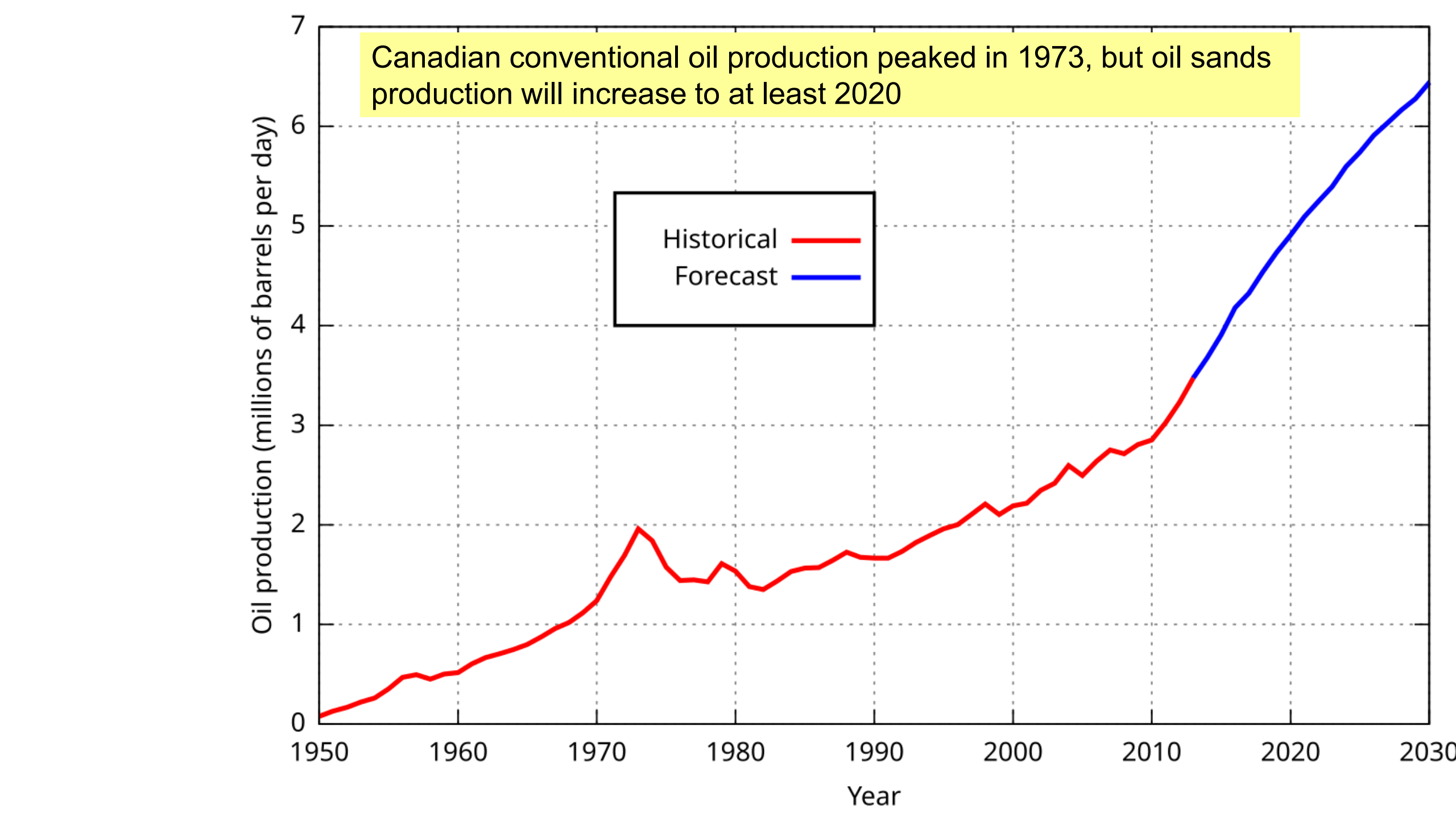
Red: Hubbert's forecast
Green: US Oil production

https://en.wikipedia.org/wiki/Hubbert_peak_theory#/media/File:Hubbert_US_Lower_48_Gas_Prediction_-_1962.png

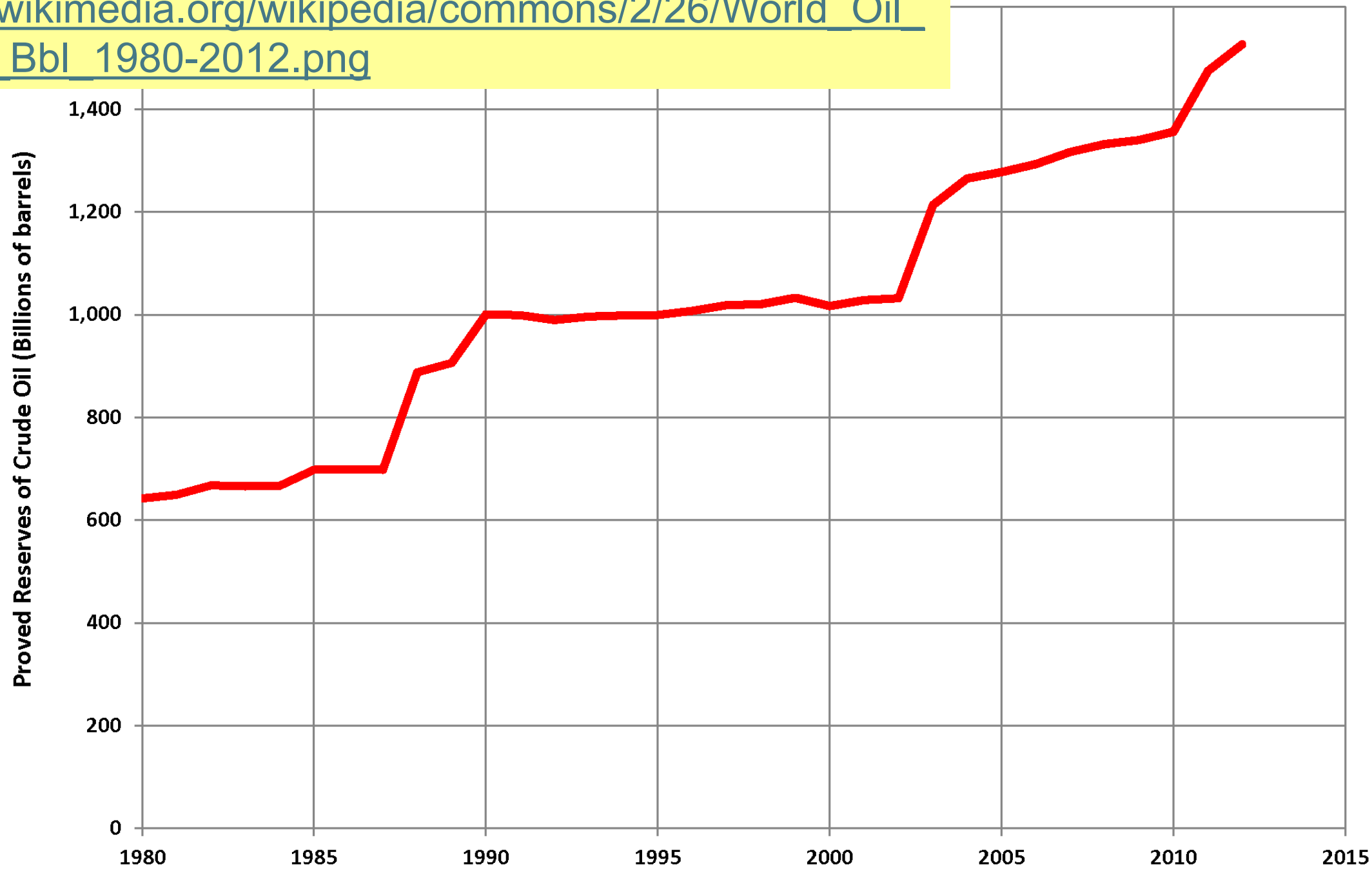
Red: Hubbert's forecast
Blue: US Oil production



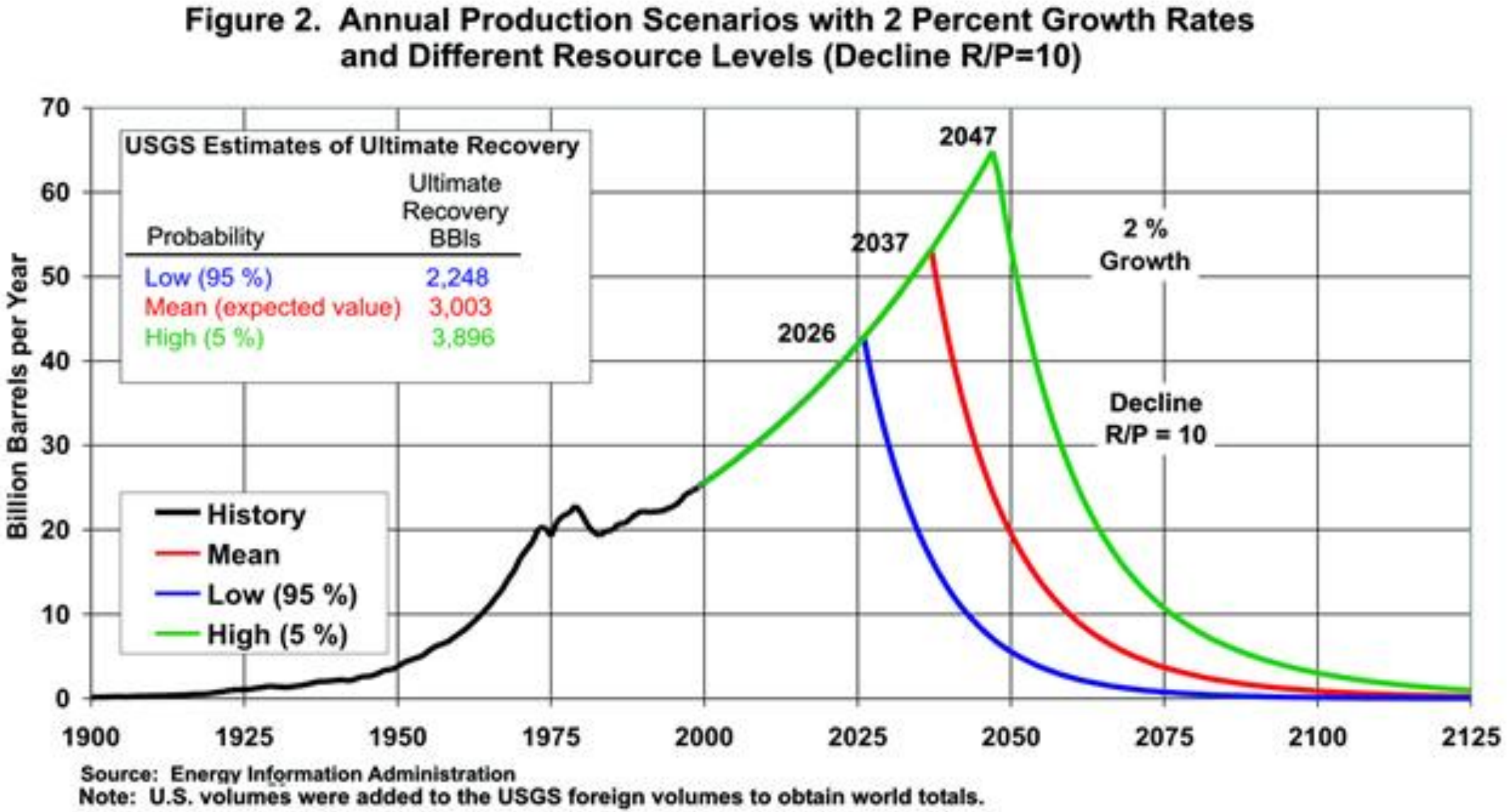

Oil Production in the United Kingdom, 1975-2012
Annual Oil Production (millions of cubic metres)
160
140
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year


Canadian conventional oil production peaked in 1973, but oil sands production will increase to at least 2020
Historical
Forecast
Oil production (millions of barrels per day)
0
1
2
3
4
5
6
7
1950
1960
1970
1980
1990
2000
2010
2020
2030
Year

https://upload.wikimedia.org/wikipedia/commons/2/26/World_Oil_Reserves_Bill_Bbl_1980-2012.png



https://upload.wikimedia.org/wikipedia/commons/b/b2/EIA_2004_-_Peak_World_Oil.jpg



Additional Topics

The Green River Formation of Colorado, Utah, Wyoming

The Athabasca Oil Sands of Alberta

Green River Formation, Utah, Colorado, Wyoming

https://upload.wikimedia.org/wikipedia/commons/c/c7/Transition_facies_GR_(4).jpg

Green River Formation, Utah, Colorado, Wyoming

Transition facies, unnamed upper member of the Green River Formation along U.S. Highway 191, lower Indian Canyon, Duschesne County, Utah

https://www.aei.org/carpe-diem/200-year-supply-of-oil-in-green-river-formation/

200 Year Supply of Oil in Green River Formation

By Mark J. Perry **May 12, 2012**

"The Green River Formation—an assemblage of over 1,000 feet of sedimentary rocks that lie beneath parts of Colorado, Utah, and Wyoming—**contains the world's largest deposits of oil shale.**

USGS estimates that the Green River Formation contains about 3 trillion barrels of oil, and about half of this may be recoverable, depending on available technology and economic conditions.

The Rand Corporation, a nonprofit research organization, estimates that 30 to 60 percent of the oil shale in the Green River Formation can be recovered.

At the midpoint of this estimate, almost half of the 3 trillion barrels of oil would be recoverable.

This is an amount about equal to the entire world's proven oil reserves."

Spacing, Bolds added. The issue is, ***how to make it economically viable to extract?***

Oil Shale from the Mahogany Zone of the Green River Formation, Colorado. Weathered surface on right; fresh surface on left.

The Green River Formation, Utah, Colorado, Wyoming

Nahmavis, a bird from the Green River Formation with preserved feathers

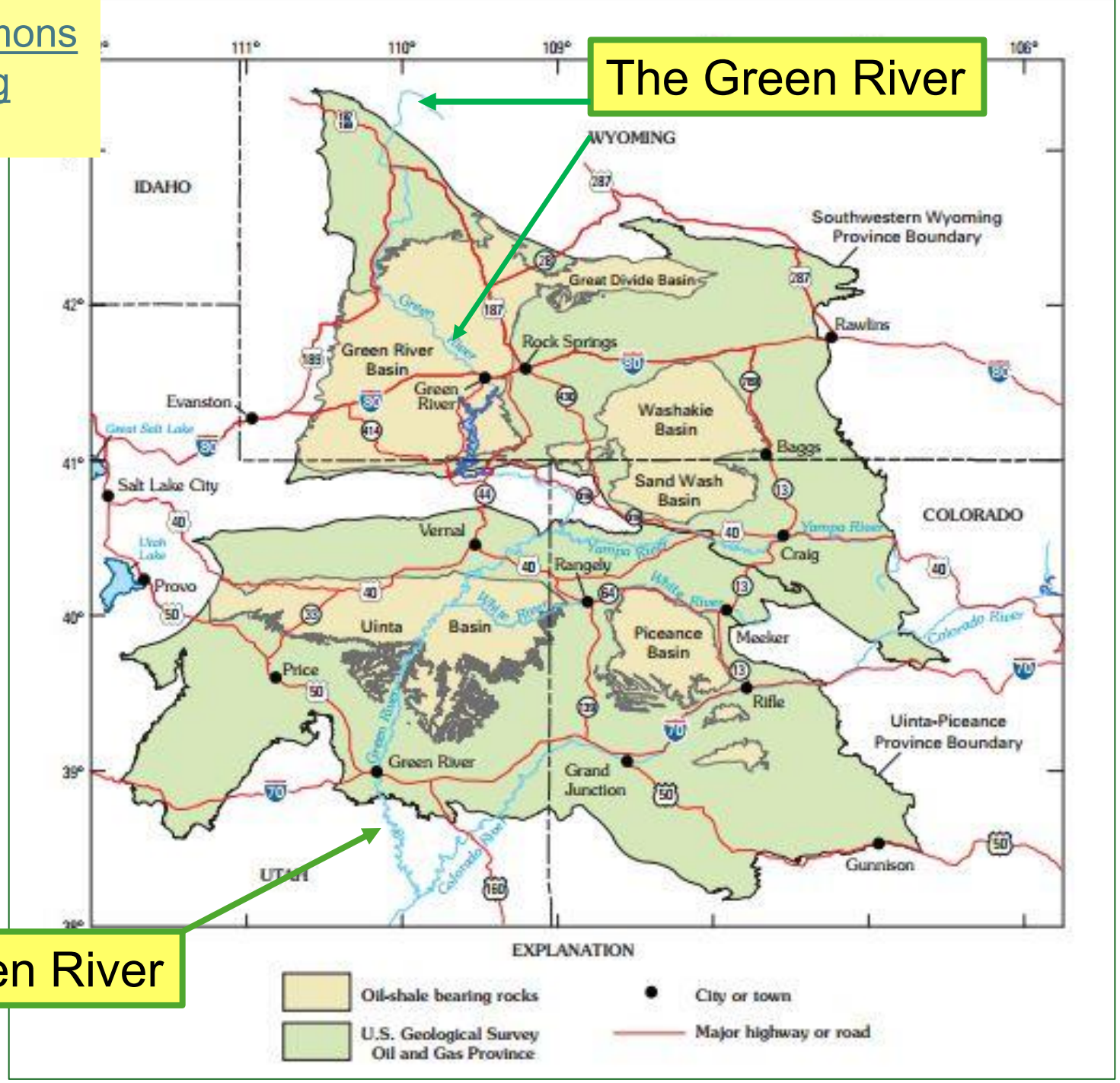
Heliobatis radians (stingray), Green River Formation, Fossil Butte National Monument

https://en.wikipedia.org/wiki/Green_River_Formation#:~:text=The%20Green%20River%20Formation%20cor
20the%20largest,back%20in%202013%2C%20by%20geophysicist%20Raymond%20T

.

The Green River Formation contains the largest oil shale deposit in the world. It has been estimated that the oil shale reserves could equal up to 3 trillion barrels (480 billion cubic metres) of shale oil, up to half of which may be recoverable by shale oil extraction technologies (pyrolysis, hydrogenation, or thermal dissolution of kerogen in oil shale).[13][14][15][16][17] However, the estimates of recoverable oil has been questioned, back in 2013, by geophysicist Raymond T. Pierrehumbert, who argued that the technology for recovering oil from the Green River oil shale deposit had not been developed and had not been profitably implemented at any significant scale.

https://upload.wikimedia.org/wikipedia/commons/5/59/Green_River_Fmn_Oil_Shale_Map.jpg



The Green River

Unnamed middle member, Green River Formation along U.S. Highway 191 near Indian Canyon Summit, Duchesne County, Utah

https://en.wikipedia.org/wiki/Shale_oil_extraction

Shale oil extraction is an industrial process for unconventional oil production. This process converts kerogen in oil shale into shale oil by pyrolysis, hydrogenation, or thermal dissolution. The resultant shale oil is used as fuel oil or upgraded to meet refinery feedstock specifications by adding hydrogen and removing sulfur and nitrogen impurities.

Shale oil extraction is usually performed above ground (ex situ processing) by mining the oil shale and then treating it in processing facilities. Other modern technologies perform the processing underground (on-site or in situ processing) by applying heat and extracting the oil via oil wells.

The earliest description of the process dates to the 10th century. In 1684, England granted the first formal extraction process patent. Extraction industries and innovations became widespread during the 19th century. The industry shrank in the mid-20th century following the discovery of large reserves of conventional oil, but high petroleum prices at the beginning of the 21st century have led to renewed interest, accompanied by the development and testing of newer technologies.

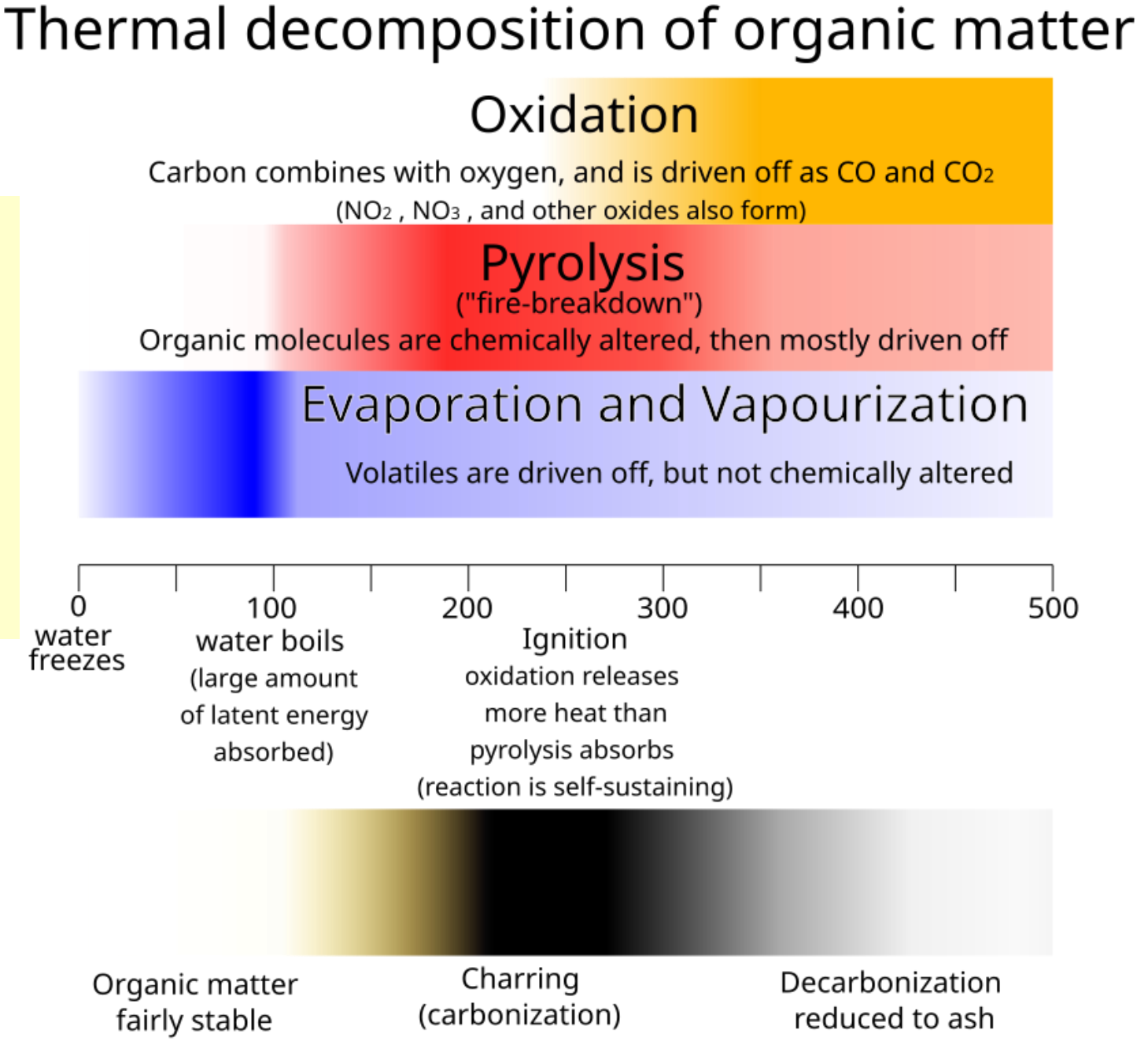
Shale oil extraction

Shell's experimental *in situ* shale oil facility, Piceance Basin, Colorado, United States

Process type	Chemical
Industrial sector(s)	Chemical industry, oil industry
Main technologies or sub-processes	Kiviter, Galoter, Petrosix, Fushun, Shell ICP
Feedstock	Oil shale
Product(s)	Shale oil
Leading companies	Royal Dutch Shell, Eesti Energia, Viru Keemia Grupp, Petrobras, Fushun Mining Group
Main facilities	Fushun Shale Oil Plant, Narva Oil Plant, Petrosix, Stuart Shale Oil Plant

Pyrolysis

The same process is used in changing wood to charcoal.



https://en.wikipedia.org/wiki/Fischer%E2%80%93Tropsch_process

Hydrogenation using the Fischer–Tropsch process

The Fischer–Tropsch process (FT) is a collection of chemical reactions that converts a mixture of carbon monoxide and hydrogen, known as **syngas**, into liquid hydrocarbons. These reactions occur in the presence of metal catalysts, typically at temperatures of 150–300 °C (302–572 °F) and pressures of one to several tens of atmospheres. The Fischer–Tropsch process is an important reaction in both coal liquefaction and gas to liquids technology for producing liquid hydrocarbons.

This is how the Germans fueled their WW2 war machine after the Allies destroyed the refineries at Ploesti, Romania.

Fluidized bed gasification with FT-pilot in Güssing, Burgenland, Austria. Operated by SGCE and Velocys.

Thermal dissolution is
an industrial process for extracting oil from oil shale by using solvents at elevated temperatures and pressures to break down and dissolve the organic matter (kerogen), which increases the oil output. This process, along with pyrolysis and hydrogenation, is a primary method for shale oil extraction.

Process Overview

Kerogen is a solid, insoluble organic material tightly bound within the mineral matrix of the shale rock. Unlike conventional oil, which flows naturally, this kerogen must be converted into liquid hydrocarbons (shale oil) to be extracted.

Thermal dissolution specifically involves:

Heating the oil shale in the presence of a solvent, sometimes a hydrogen-donor solvent, at temperatures generally lower than those used for traditional pyrolysis alone.

Applying Pressure to the system.

Catalytic Cracking the dissolved organic matter to produce oil.

Athabasca Oil Sands
Alberta, Canada.

https://en.wikipedia.org/wiki/Athabasca_oil_sands

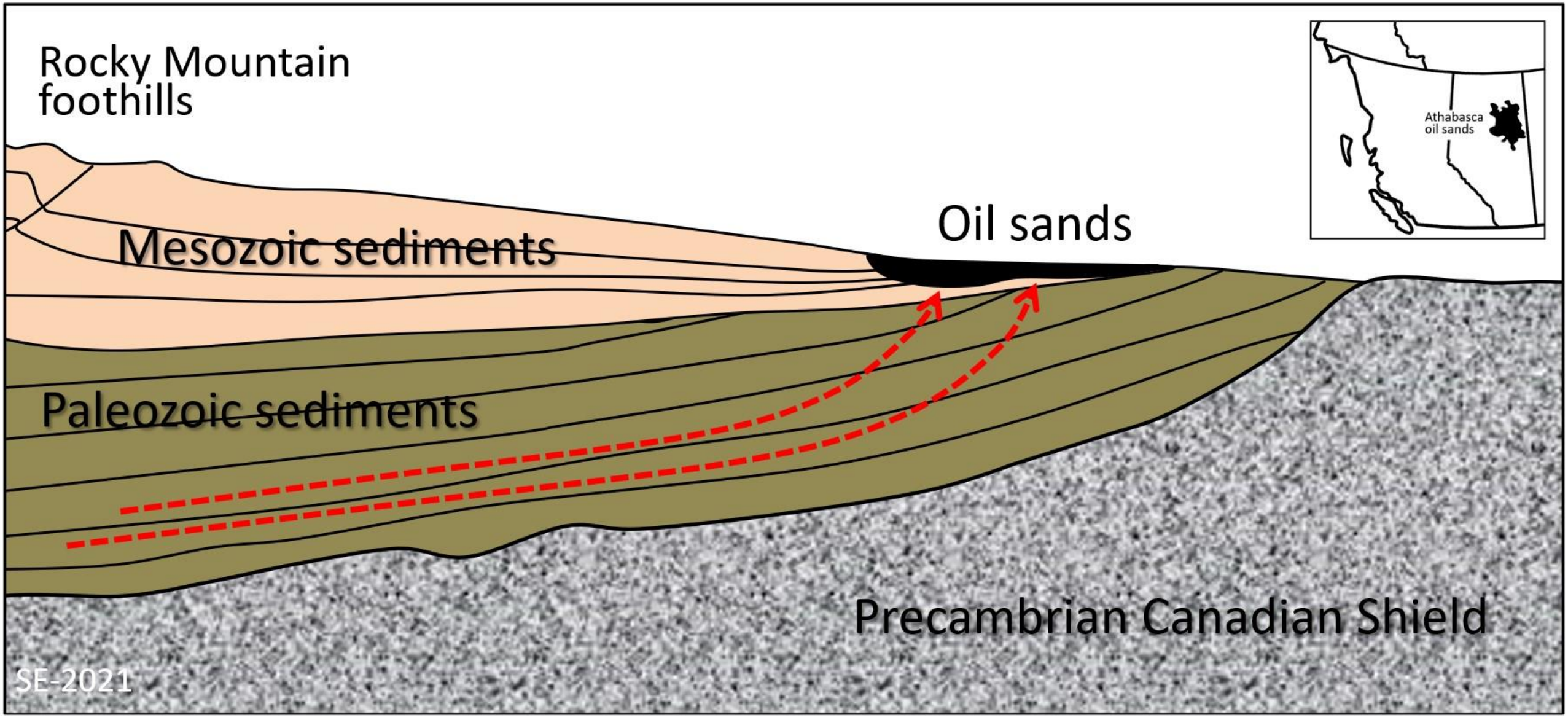
Athabasca Oil Sands

The Athabasca oil sands, also known as the Athabasca tar sands, are large deposits of oil sands rich in bitumen, a heavy and viscous form of petroleum, in northeastern Alberta, Canada.

These reserves are one of the largest sources of unconventional oil in the world, making Canada a significant player in the global energy market

The Athabasca oil sands, along with the nearby Peace River and Cold Lake deposits oil sand deposits lie under 141,000 square kilometres (54,000 sq mi) of boreal forest and muskeg (peat bogs) according to Government of Alberta's Ministry of Energy, Alberta Energy Regulator (AER) and the Canadian Association of Petroleum Producers (CAPP).

https://environmental-geology-dev.pressbooks.tru.ca/wp-content/uploads/sites/73/2021/07/oil-sands-1.jpg



Schematic Cross-Section of Northern Alberta Showing the Source Rocks and Location of the Athabasca Oil Sands

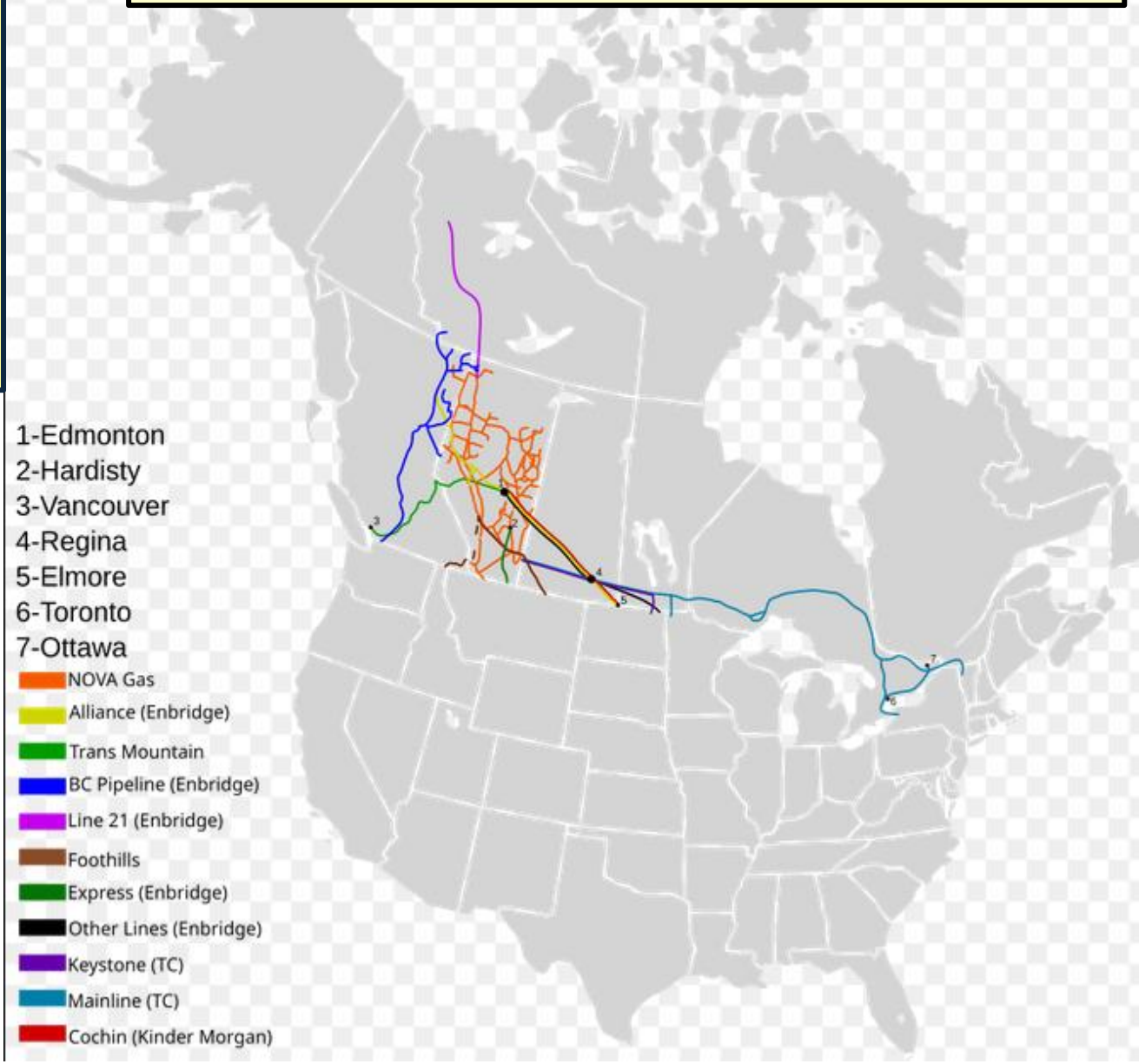
Mining operations in the Athabasca oil sands. Image shows the Athabasca River about 600m from the tailings pond. NASA Earth Observatory photo, 2009

Syncrude's Mildred Lake mine site and plant

The oil sands, which are typically 130 to 200 ft thick, sit on top of relatively flat limestone, and are relatively easy to access. They lie under 3 ft to 9 ft in of waterlogged muskeg, and up to 246 ft of clay and barren sand.
As a result of the easy accessibility, the world's first oil-sands mine was in the Athabasca oil sands.

The true size of the Canadian oil sands deposits became known in the 1970s. The Syncrude mine is now the largest mine (by area) in the world, with mines potentially covering 54,000 sq mi.
(Although there is oil underlying 54,900 sq mi, which may be disturbed by drilling and in situ extraction, only 1,900 sq mi may potentially be surface mined, and 349 sq mi has to date been mined.)

Map of all pipelines regulated by the Canadian Energy Regulator that originate from Alberta.



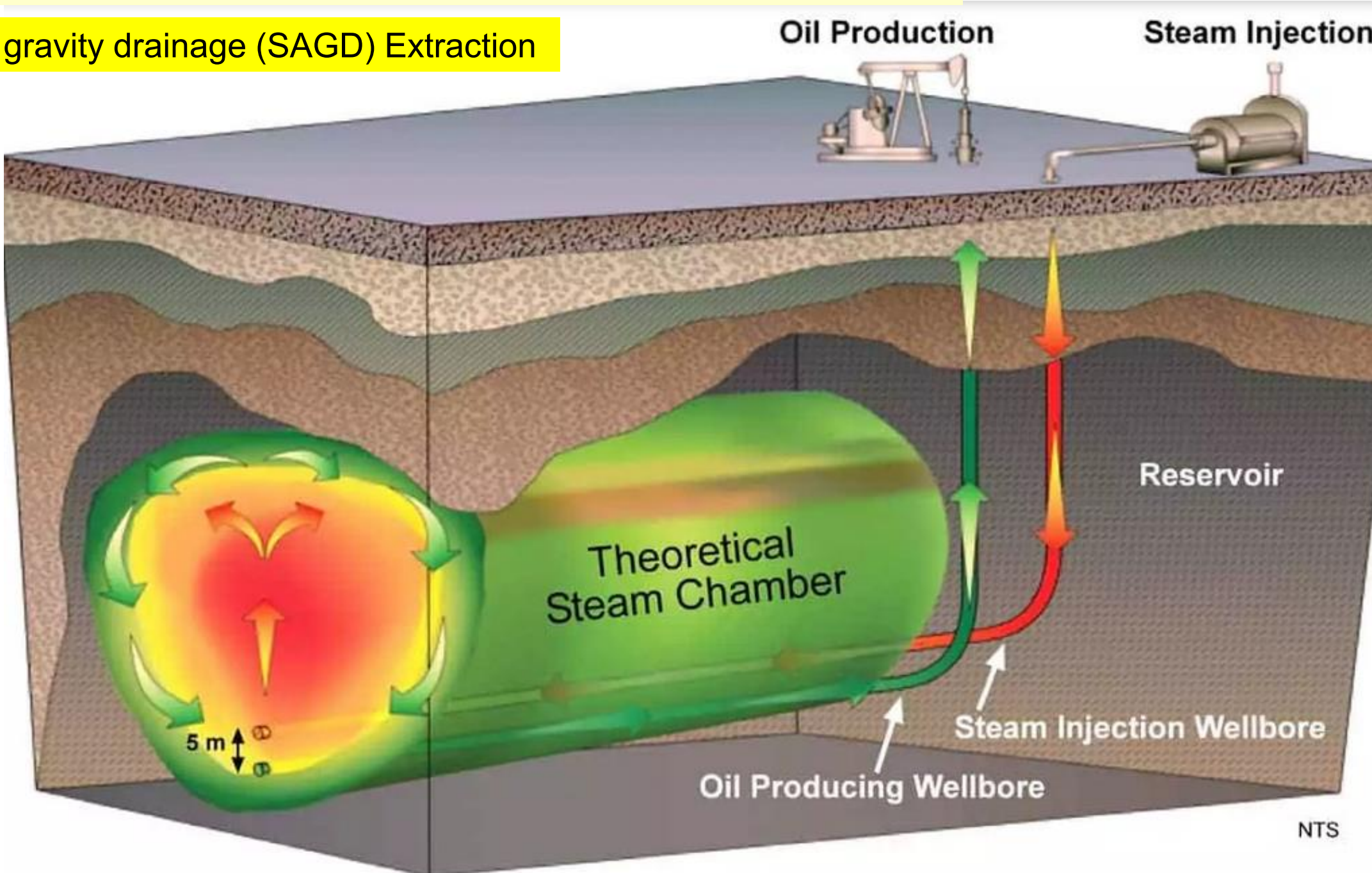
Since Great Canadian Oil Sands (now Suncor) started operation of its mine in 1967, bitumen has been extracted on a commercial scale from the Athabasca Oil Sands by surface mining. In the Athabasca sands there are very large amounts of bitumen covered by little overburden, making surface mining the most efficient method of extracting it. The overburden consists of water-laden muskeg (peat bog) over top of clay and barren sand. The oil sands themselves are typically 130 to 200 ft deep, sitting on top of flat limestone rock. Originally, the sands were mined with draglines and bucket-wheel excavators and moved to the processing plants by conveyor belts.

Athabasca oil sands on the riverbanks ~1900

These early mines had a steep learning curve to deal with before their bitumen mining techniques became efficient. In the intervening years, more effective in-situ production techniques were developed, particularly **steam-assisted gravity drainage (SAGD).** In-situ methods became increasingly important because only about 20% of the Athabasca oil sands were shallow enough to recover by surface mining, and the SAGD method in particular was very efficient at recovering large amounts of bitumen at reasonable cost.

https://www.vistaprojects.com/solvent-technology-promises-oil-sands-benefits/

Steam-assisted gravity drainage (SAGD) Extraction



https://www.youtube.com/watch?v=j0HZV30EI5E

This is a 14-minute video on the Athabasca Oil Sands from 2004.

There is a lot of material…

They speak of the amount of High Technology employed by the numerous companies working the Sands.

The flip side of this seems to be that the challenges in attempting to get the extraction of the hydrocarbon product to the point where it is economically viable…. during periods of time when market price determines whether or not the pain is worth the economic gain.

The Amazing Athabasca Oil Sands

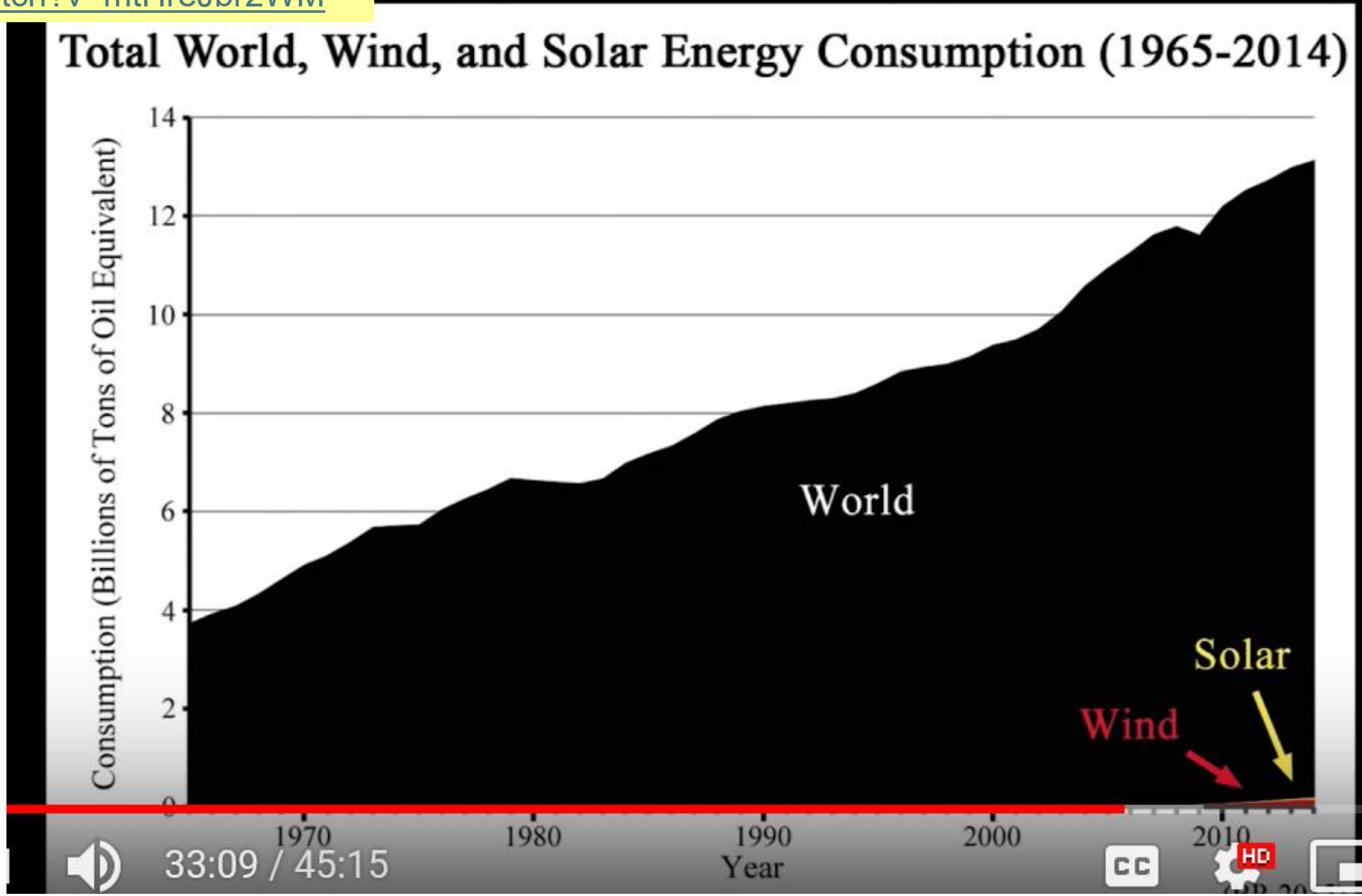
https://www.youtube.com/watch?v=nJzseWUFE4g

Another word for “Bitumen” is Asphalt.

This quite informative video describes the various ways the bitumen in the Athabasca Oil Sands is mined, extracted, processed, & transported to market in Canada & the USA

https://www.youtube.com/watch?v=mtHreJbr2WM

Wind, Solar, and the Energy Mountain



Brief Remarks:

NUCLEAR

Britannica

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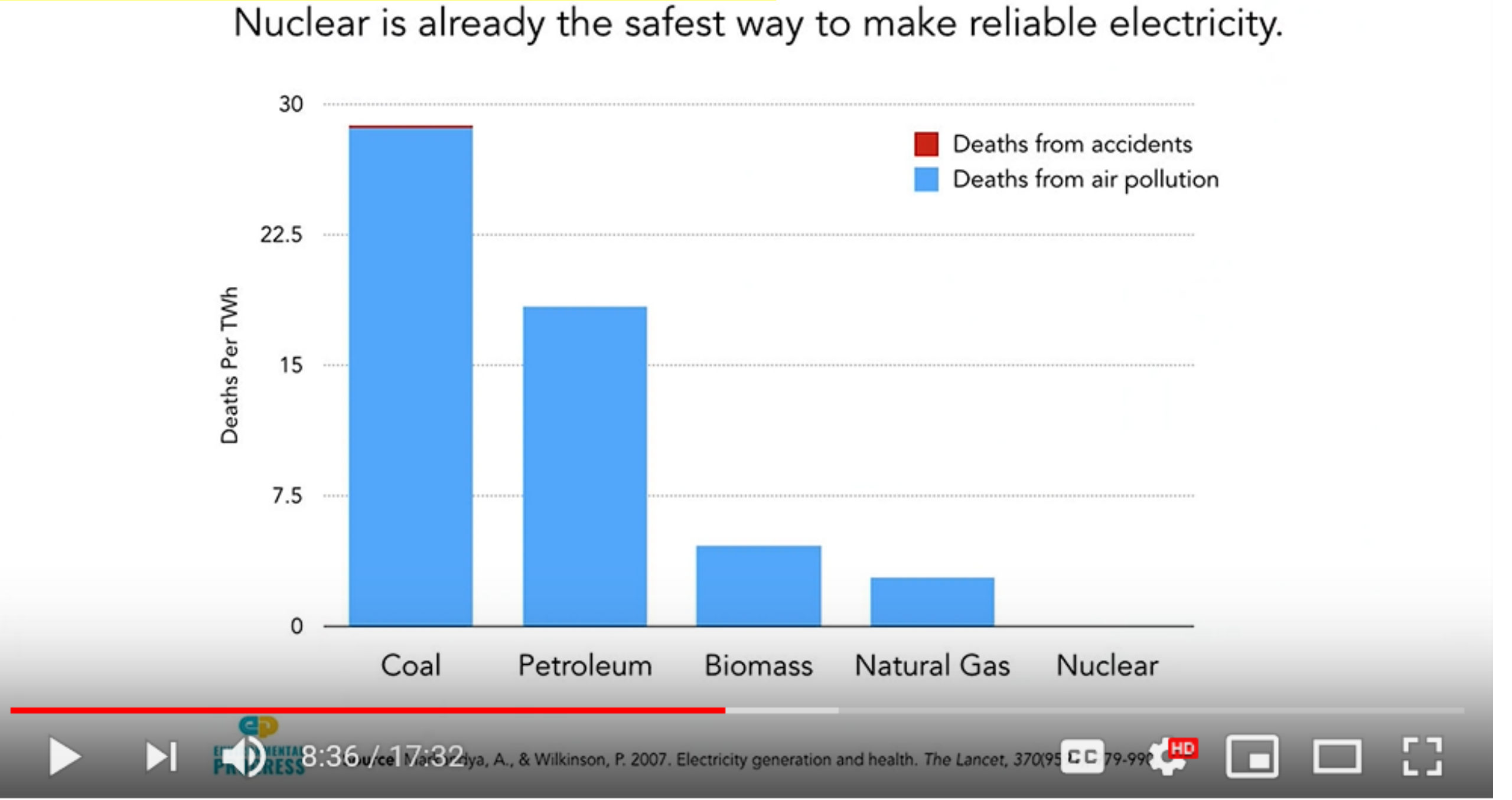
Did anyone die as a result of the Fukushima accident?

More Actions

The Editors of Encyclopaedia Britannica

Nobody died as a direct result of the Fukushima nuclear disaster. However, in 2018 one worker in charge of measuring radiation at the plant died of lung cancer caused by radiation exposure. In addition, there have been more than 2,000 disaster-related deaths. This classification includes deaths caused by suicide, stress, and interruption of medical care.

https://www.youtube.com/watch?v=N-yALPEpV4w



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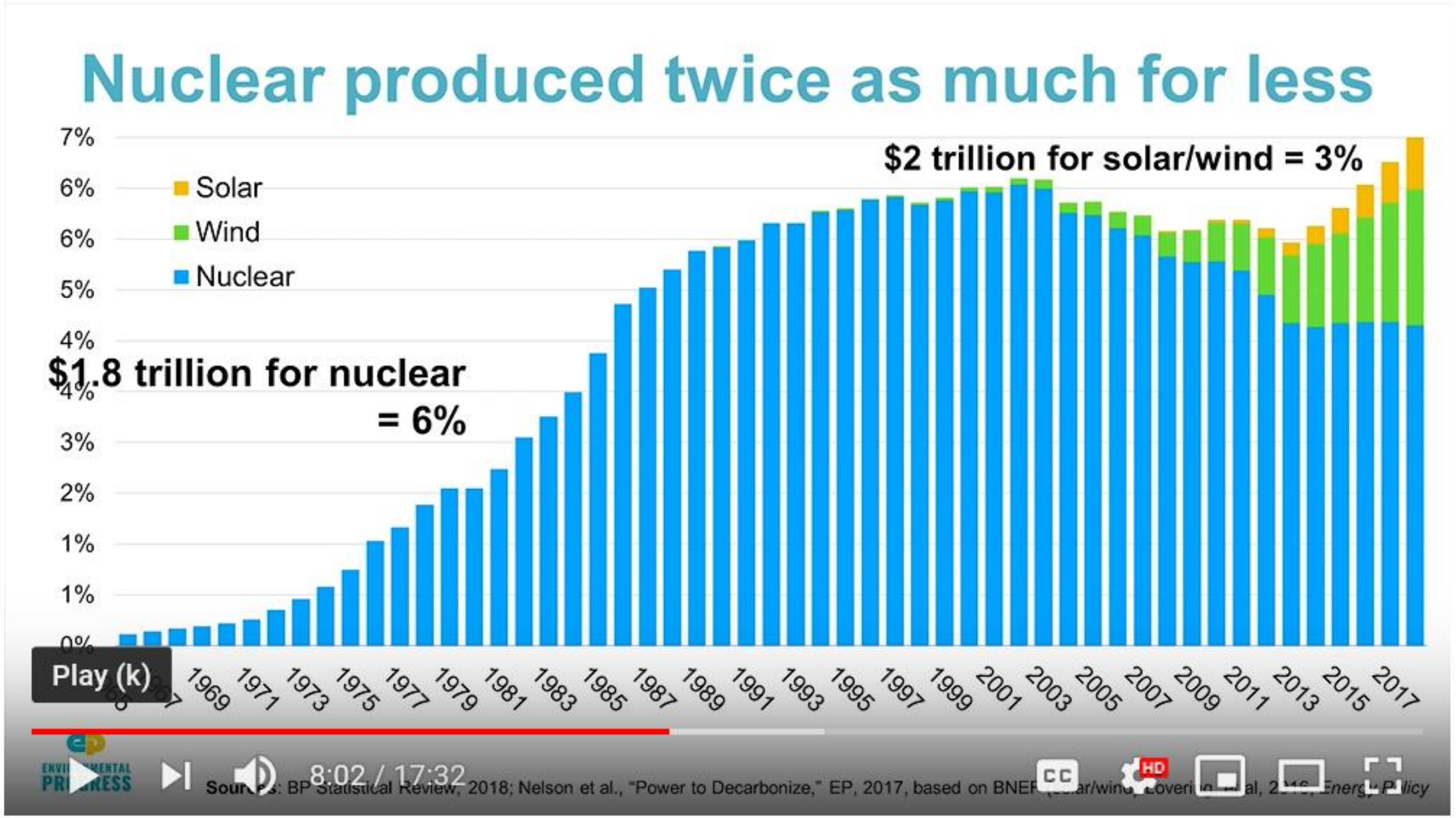


https://www.youtube.com/watch?v=N-yALPEpV4w

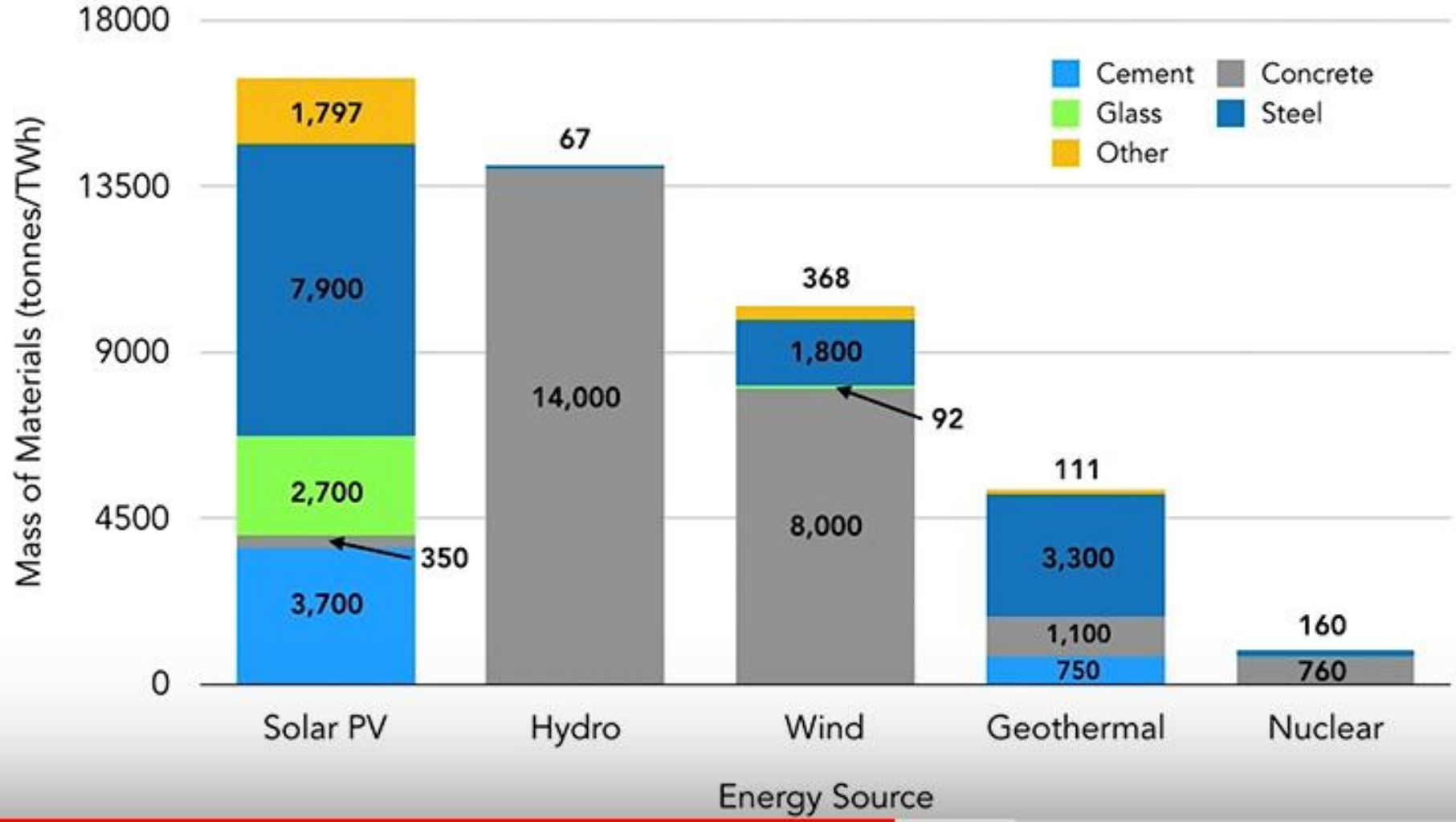
Why renewables can’t save the planet | Michael Shellenberger | TEDxDanubia

https://www.cnbc.com/2023/04/18/germany-shuts-down-last-nuclear-power-plants-some-scientists-aghast.html

16 April 2023, Baden-Württemberg, Neckarwestheim: The Neckarwestheim nuclear power plant. The era of commercial power generation with nuclear power plants in Germany came to an end on Saturday with the separation of the Isar 2, Neckarwestheim and Emsland nuclear power plants from the power grid.

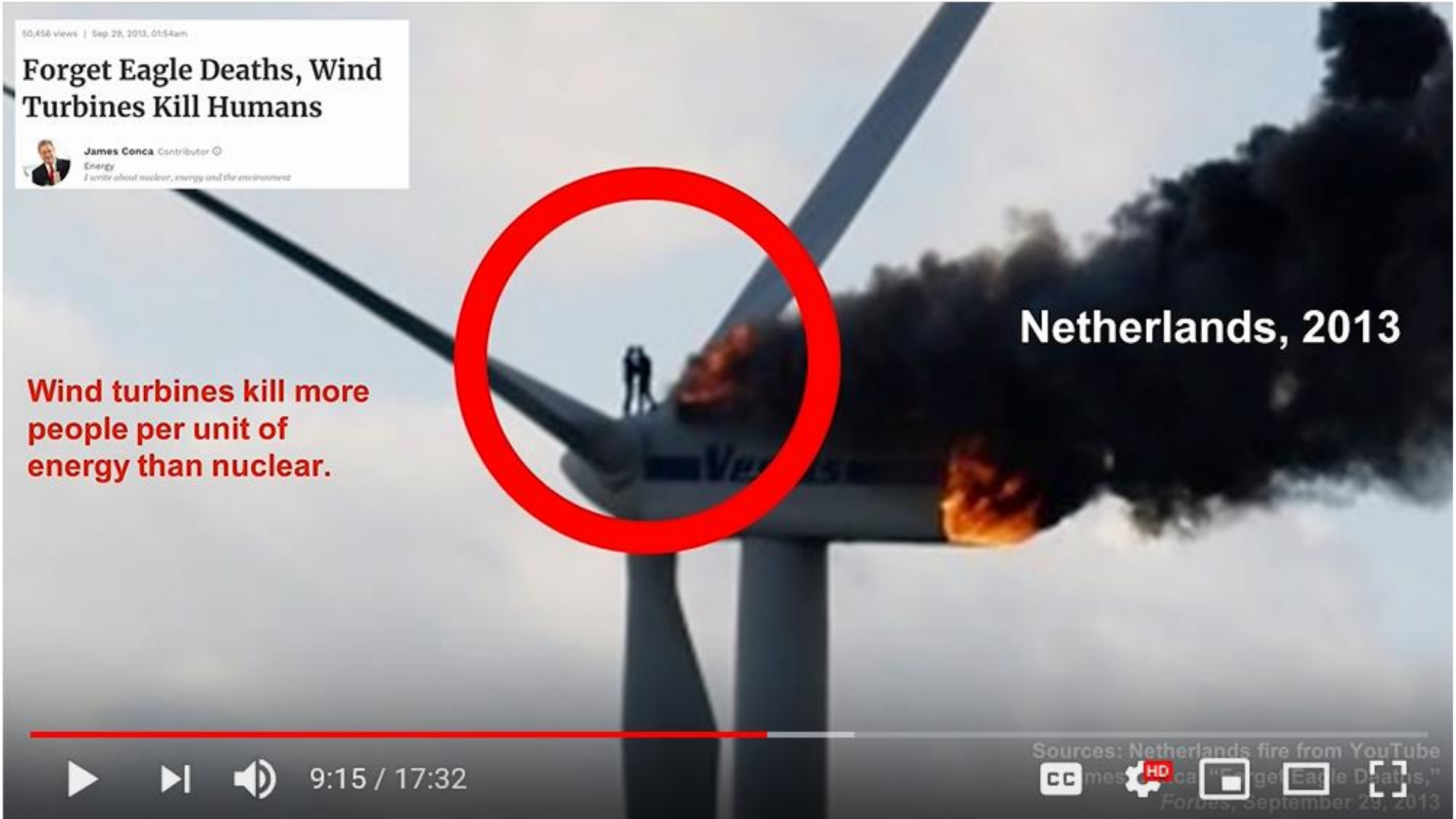
https://www.youtube.com/watch?v=N-yALPEpV4w

Materials throughput by type of energy source



"Quadrennial Technology Review: An Assessment of Energy Technologies and Research Opportunities." Table 10. September 2015. United States Department of Energy. Nuclear and hydro require 10 tonnes/TWh and 1 tonne/TWh of [illegible] materials respectively but are unable to be labeled on the graph.

https://www.youtube.com/watch?v=N-yALPEpV4w



Finally, a sobering news story from Europe…

https://notrickszone.com/2025/11/23/a-sobering-reality-global-fossil-fuel-demand-continues-to-rise/

A Sobering Reality: Global Fossil Fuel Demand Continues to Rise

By P Gosselin on 23. November 2025

Recent News from Europe

Blackout News…reports that despite ambitious international climate targets and the promise of a rapid energy transition, we are witnessing a paradoxical development: Global demand for fossil fuels has not fallen but continues to increase.

The world economy's growing hunger for energy directly clashes with political expectations, and the so-called "Peak Demand" for oil and gas, once predicted by experts, is currently not in sight.

Just a few years ago, there was optimism when the International Energy Agency (IEA) announced an impending peak in fossil fuel demand. This confidence supported many climate strategies. However, rising economic risks and political headwinds led many governments to revise their strategies. The consequence:

The energy transition lost momentum while real demand increased.

Earlier forecasts thus have become obsolete, and the expected rapid electrification of the economy is progressing more slowly than planned.

Fossil fuels are not being replaced

Summary

We've seen evolution in our use of energy-bearing substances:
Wood, Coal, Oil, Gas, Hydropower, Nuclear. Now, Wind and Solar <subsidies>

The "End of Oil" has been predicted for well over a century.

Hydraulic Fracturing, **Fracking**, has given us access to petroleum source rock in addition to conventional sources from trapped oil & gas.

The energy transformation "energiewende" in Europe seems far away.

Athabasca Oil Sands have been economically productive for ~50 years.

The **Green River Formation** is not economically productive now but offers a huge <200-year> source possibility.