CCUS Conference

September 22-26, 2025

Sponsored By: The Research Council of Norway &

The Payne Institute for Public Policy Colorado School of Mines

"Whole Value Chain Carbon Capture, Utilization, and Storage (CCUS)"

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Current CO2 Perspective

in the Light of 'Energy Transition'
&
Earth, Energy, Environment and Population Growth

H. Kazemi, Professor
CSM

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Population, Energy, and Environment

H. Kazemi, CSM, Sept. 26, 2025

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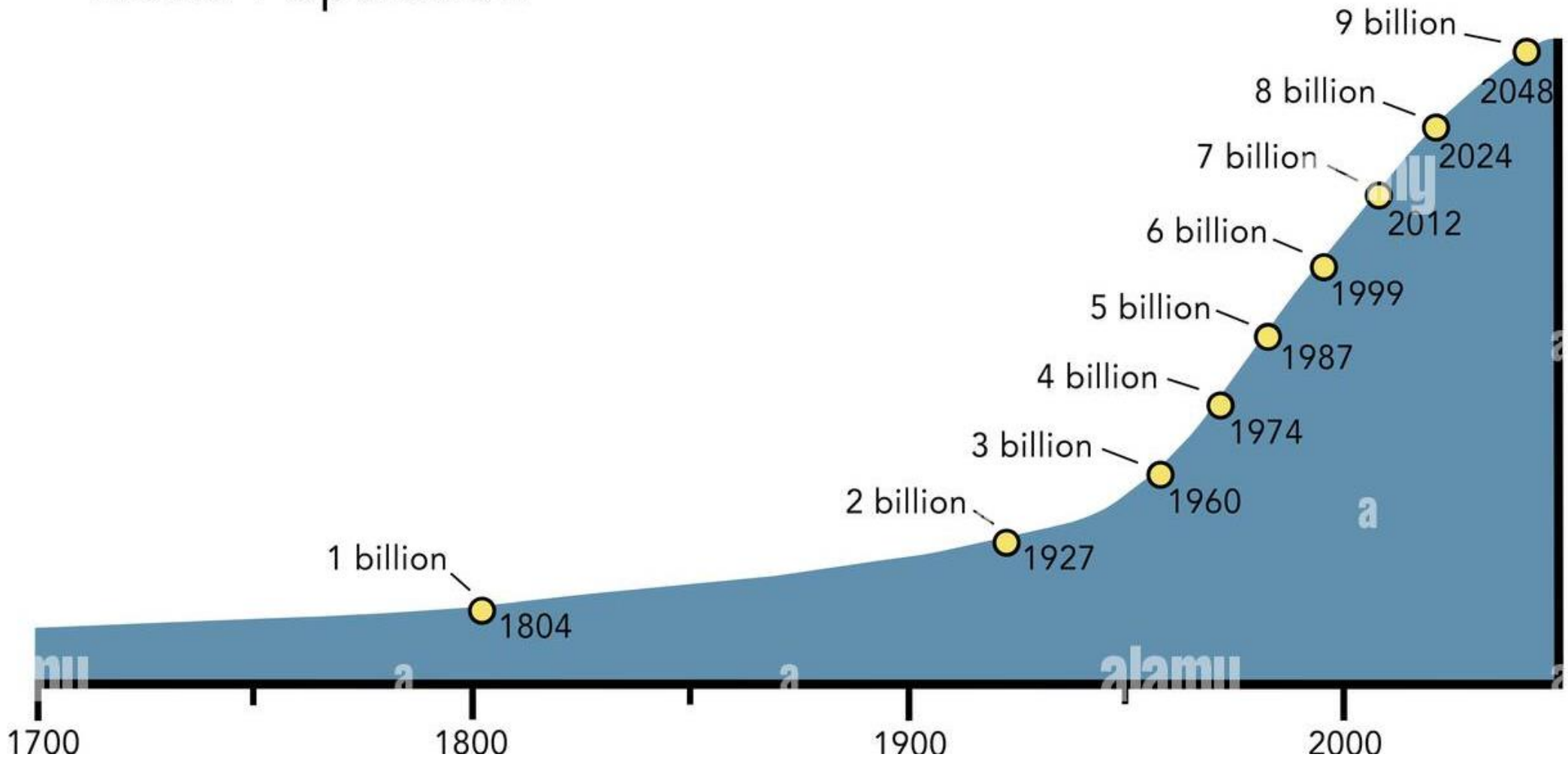
Earth and natural resources engineering

Critical resources, **water, energy fuels, critical minerals and the environment** are subjects of current discussions.

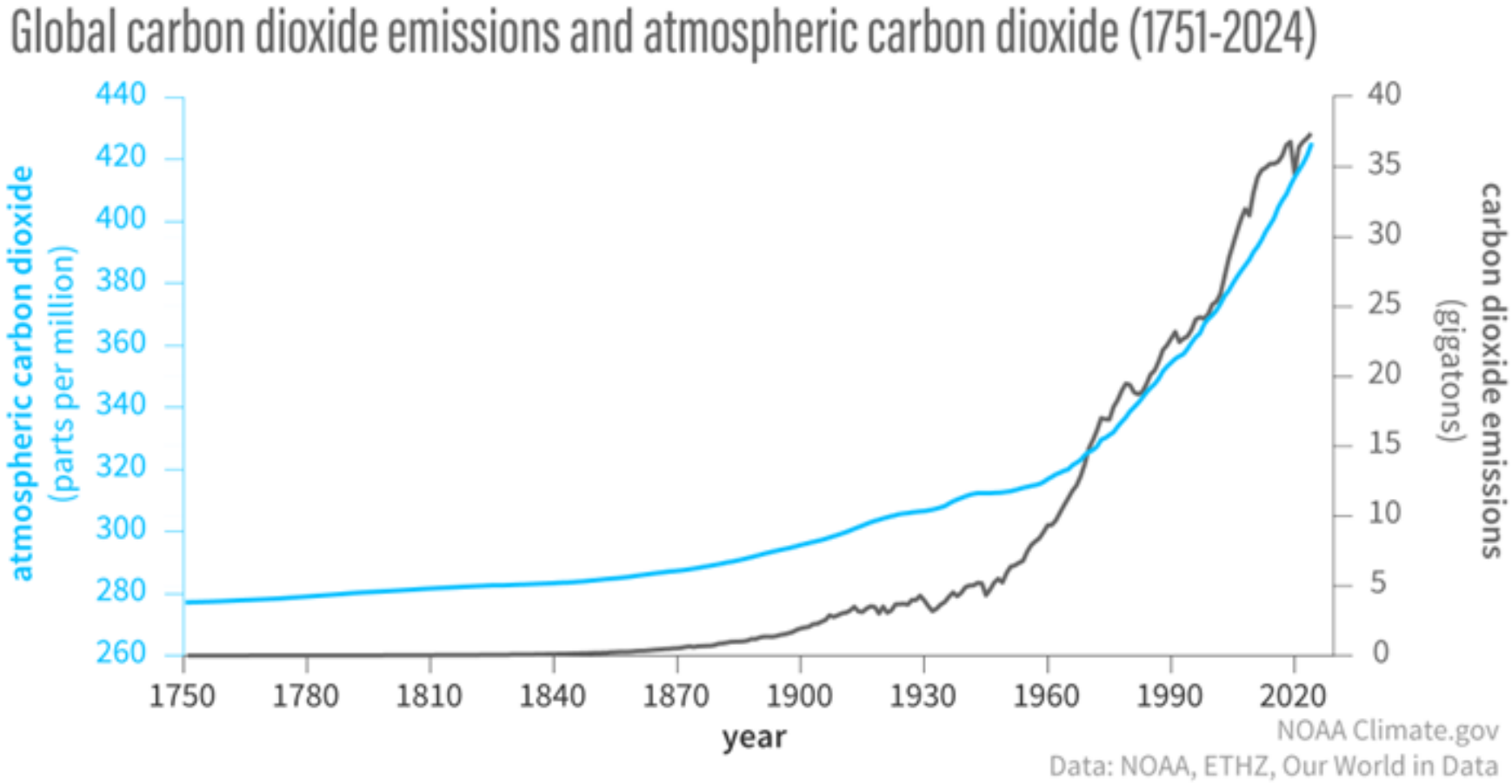
It is clear that '**population**' is not included in any of the above slogans! However, population size, in my view, is highly critical. This is where I begin my presentation.

World Population



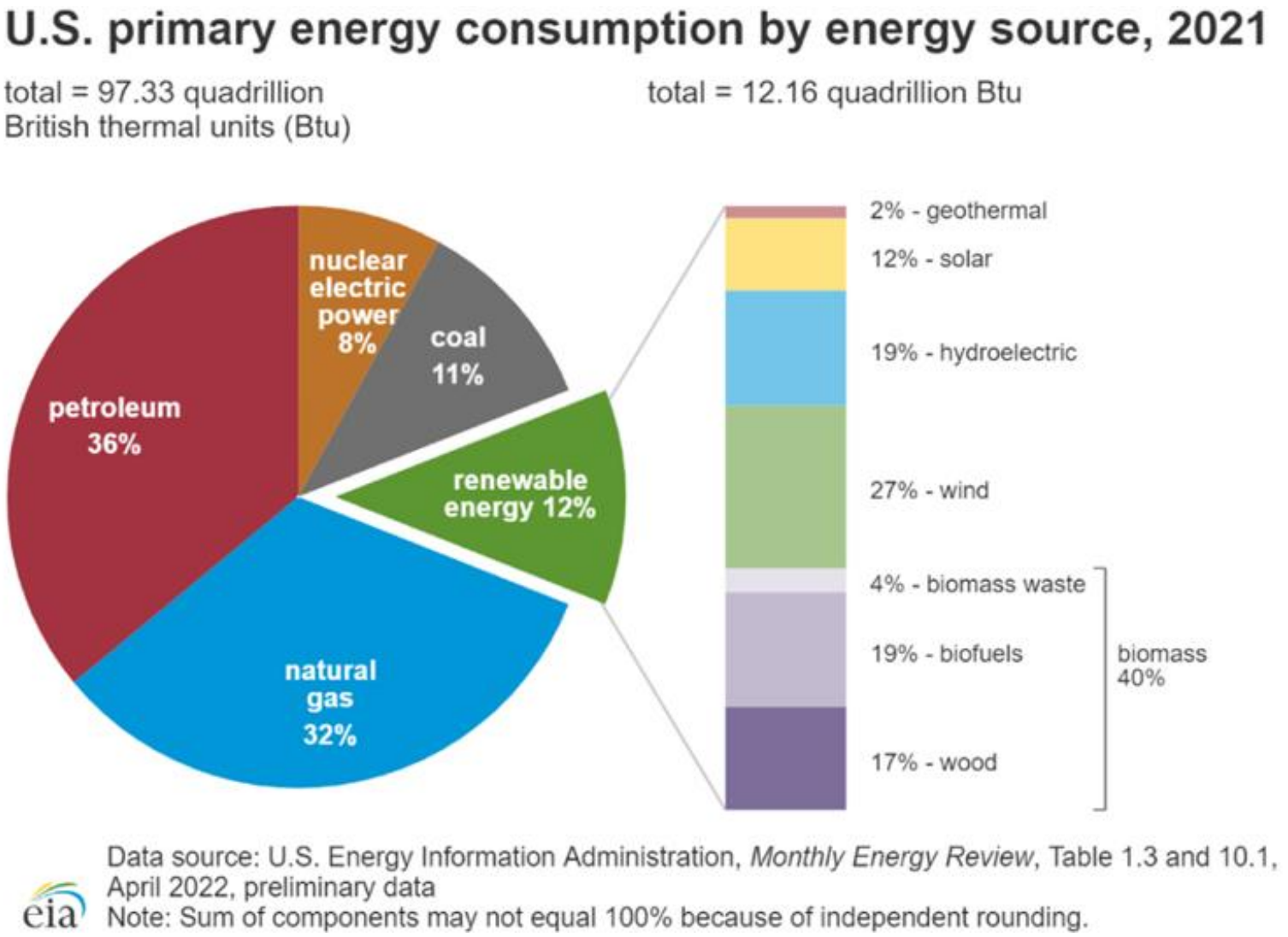
Global Carbon dioxide Emissions

(Source: NOAA)



Environment

- **Fossil Fuel and Atmospheric Emissions**
- **Nuclear**
- **Water Resources**
- **Renewables—Solar, Wind, and Geothermal**



U.S. Primary Energy Consumption by Energy Source, 2021 (U.S. EIA, 2022)

Cisterns of Crude oil and Water in a pit, Balakhani oil field, Baku, 1900-1917

Source: Swedish national museum of science and Technology, jpt, July 2024

Gas flaring of excess natural gas during oil production in southern Iraq.
Source: BBc and Chafiq Faiz, 2023

STEAM GENERATORS FOR STEAM EOR, CAPACITY OF 57 TONS/HR/STEAM BOILER, MIDDLE EAST

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Eugene Vessels checking methane levels by the abandoned Hubbard Creek mine shaft, March 17, 2021.

(Miguel Otarola, CPR News, April 21,2021)

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The power generator at the Elk Creek mine. The generator uses the captured methane to generate electricity which then goes into the power grid., March 17, 2021. **(Miguel Otarola, CPR News, April 21,2021)**

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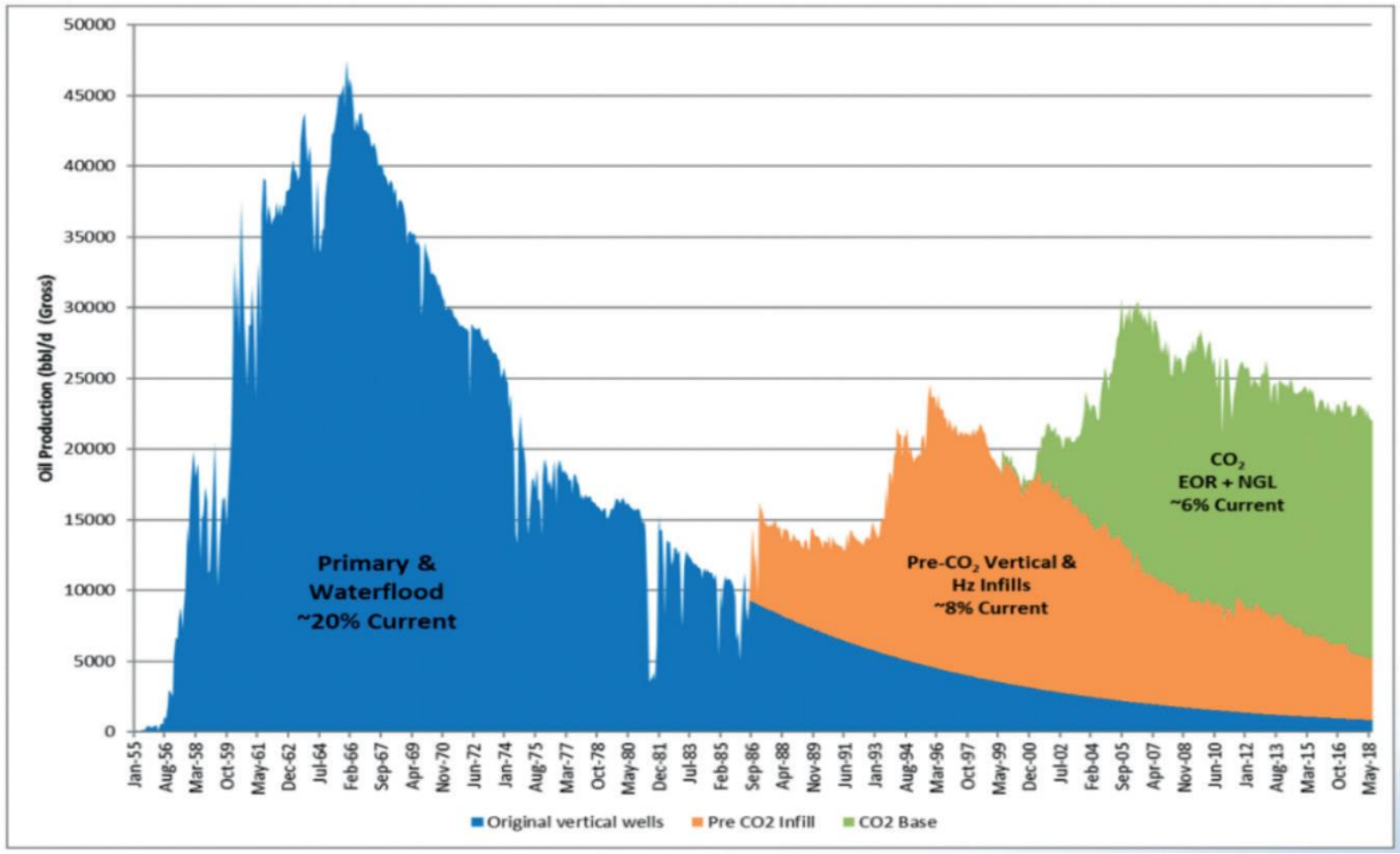

Weyburn and Midale CO_2 EOR and Sequestration, Saskatchewan, Canada

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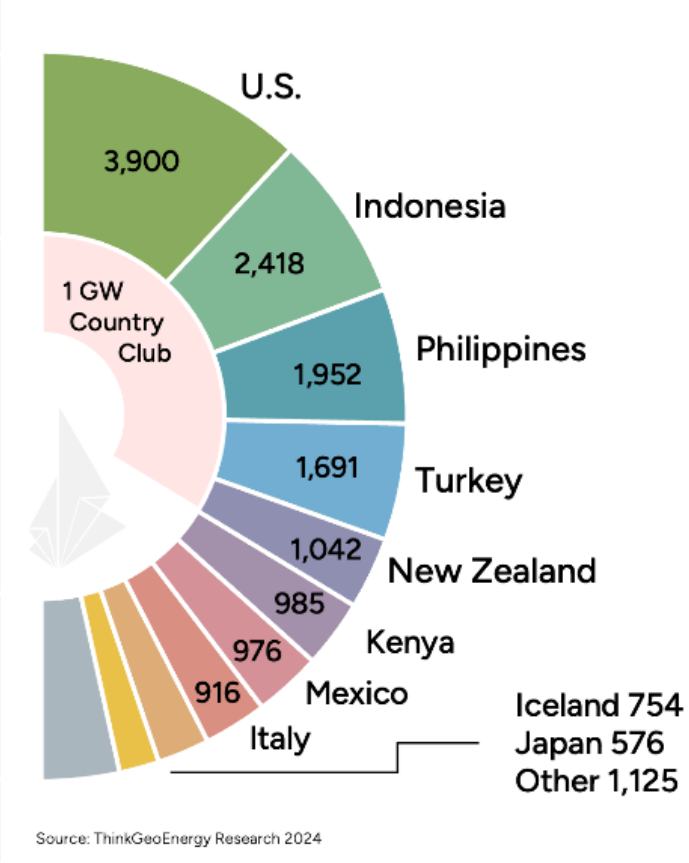
TOP 10 WORLD GEOTHERMAL COUNTRIES AS OF 2023, NOT EGS,

TINKGEOENERGY, JANUARY 2024



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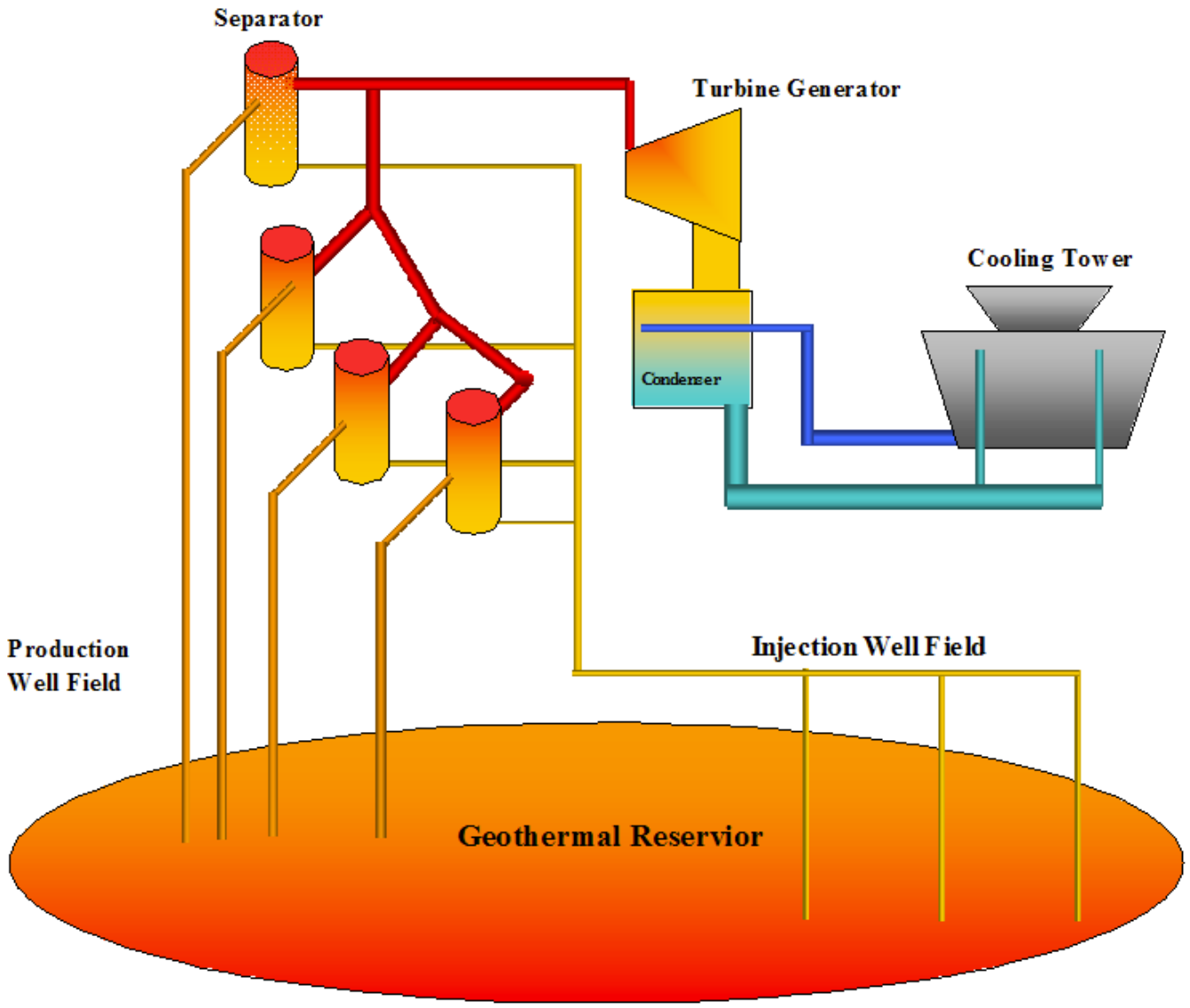
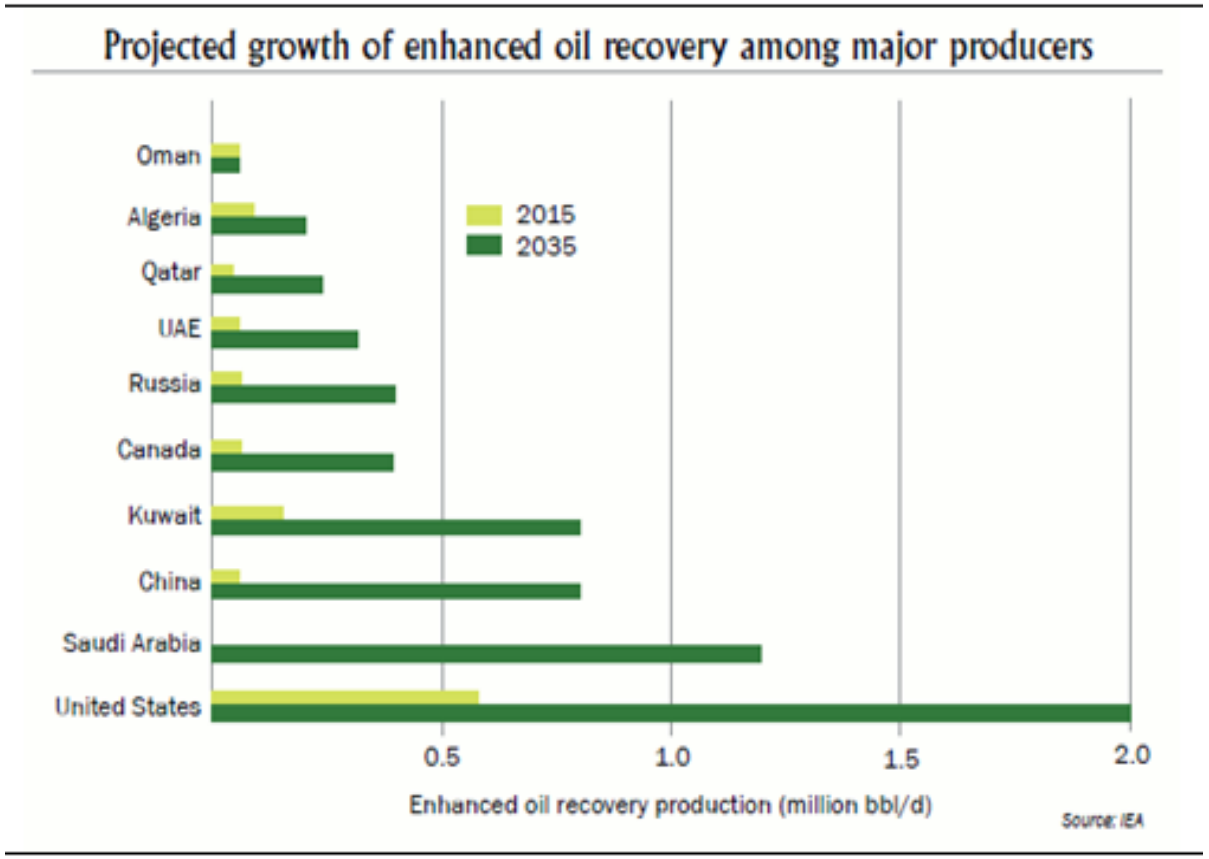


UTAH BLUNDELL GEOTHERMAL WELL, SINGLE FLASH HEAT EXCHANGER (1984):
FOUR WELLS, INLET T 450 ^{O}F, 2.25 MILLION POUNDS/HR OF GEOTHERMAL BRINE, 4 SEPARATORS FLASH 400,000 LBS STEAM PER HOUR, 26 GROSS MW OF ELECTRICITY (**23 NET MW**) BECAME OPERATIONAL IN 2007.

BACK TO EOR

EOR by All Techniques Is a Small Fraction of the Daily Total Oil Production (Global Water Intelligence)



Source- Global Water Intelligence

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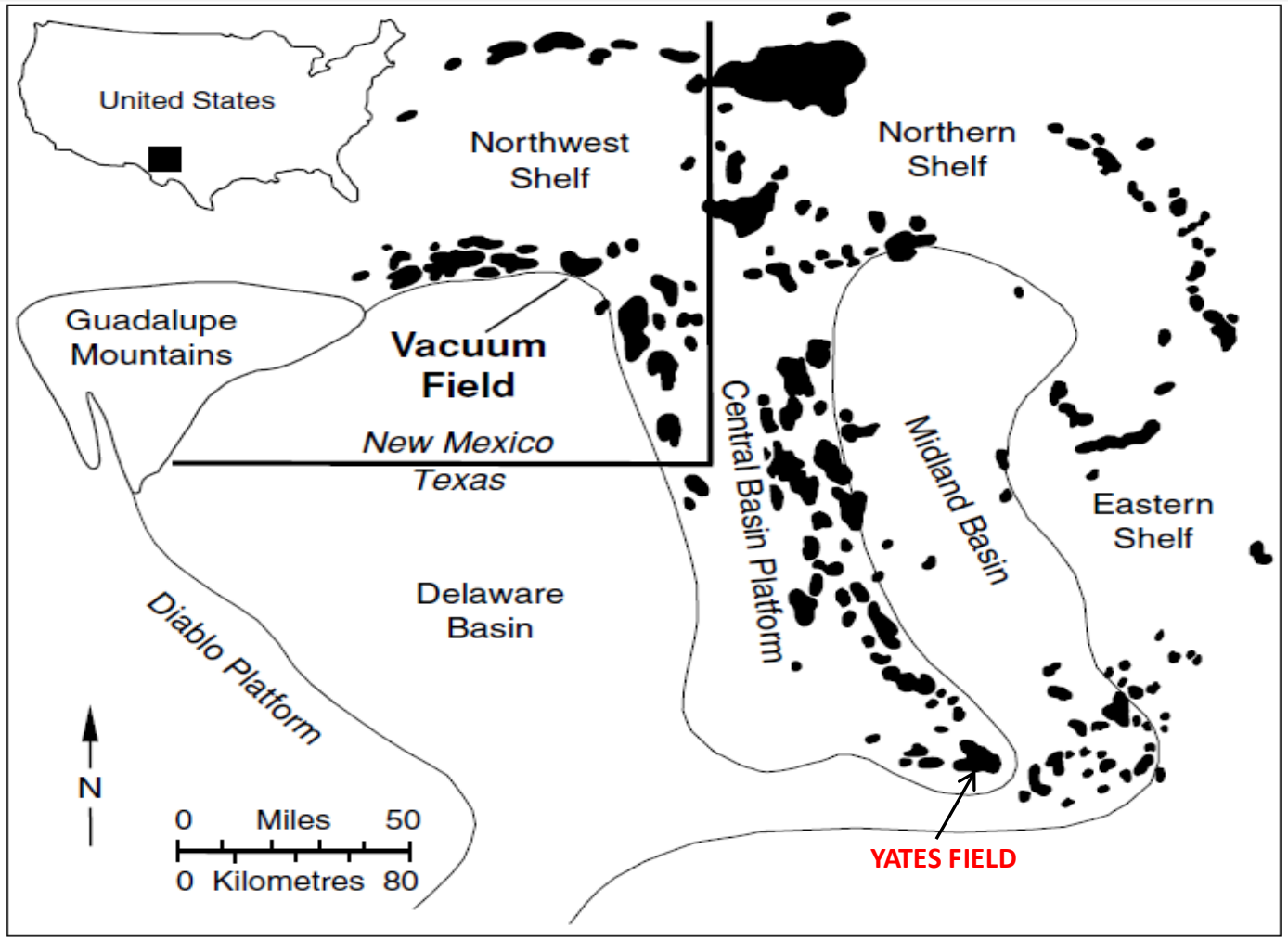
Delaware & Midland Basins

(Pranter, et al: *Petroleum Geoscience*, 10, 2004, Adopted from Hills, J. M., *AAPG Bulletin,* 68, 250–267, 1984)



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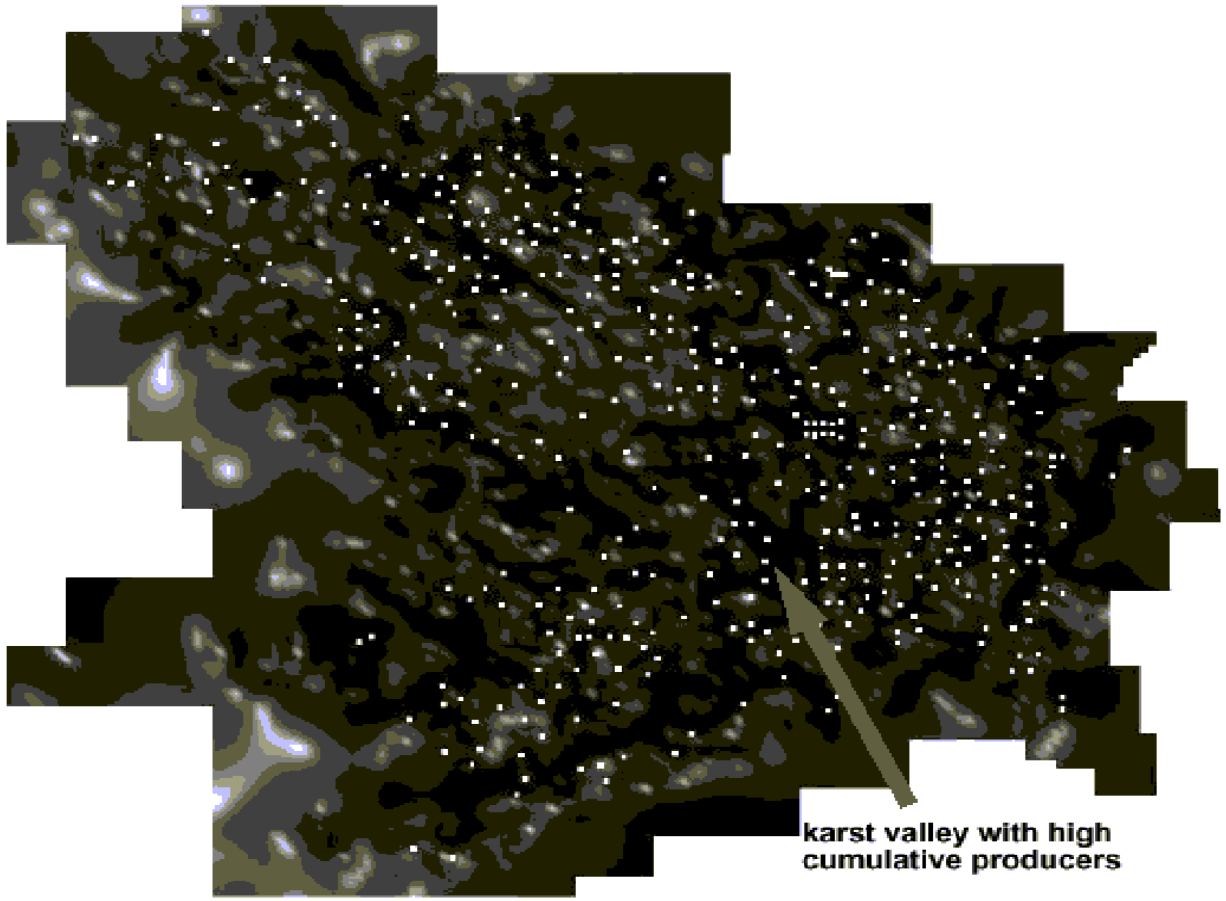
Yates Field

White Squares Are Wells with Large Cumulative Production (Campanella et al., SPE 58996, 2000)



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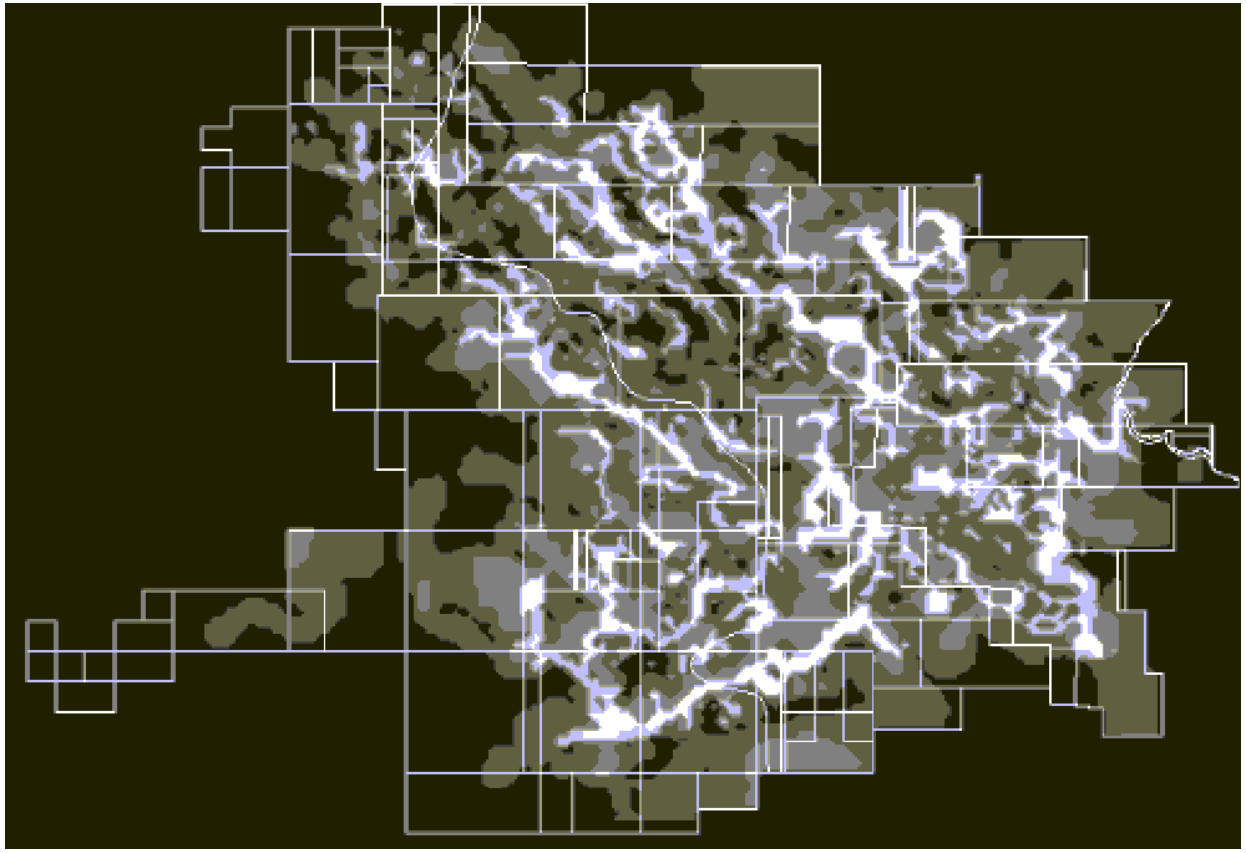
Connection Probability Map

Karst Surface of San Andres: The white areas have the highest probability of connection to major flow features. SPE 58996 – Campanella et al. (2000)



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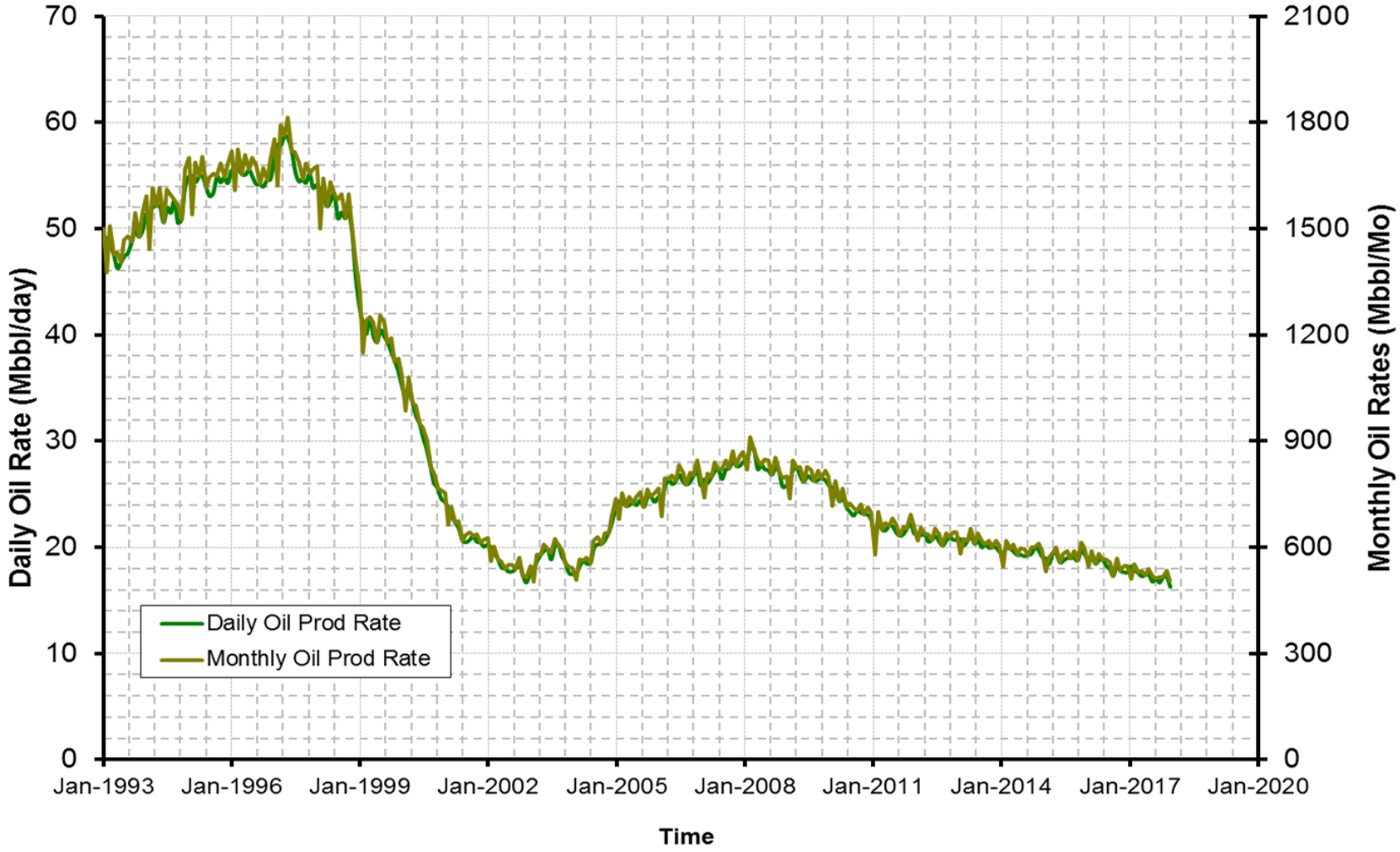
Yates Field Oil Production Rate



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Oil Production By Brine Gravity Infiltration

Yates Field 82-mD Sucrosic Core after 6 Days Of Exposure

TEST (Series 3) RO Water	T3-Core C	YFU 2433 L5 1535.0 ft.	5/31/00
Core Status	Water/Oil saturated	Core Type	Sucrosic
Porosity (%) = 20.8	PV (cc) = 53.6	Permeability (md)	82.44
S_{oi} =	0.57	Imbibition Fluid	40% SRO-60% SYB
Total Imbibition Time	6 days	% Oil Recovery	na

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119-mD Berea Sandstone Surrounded By Brine

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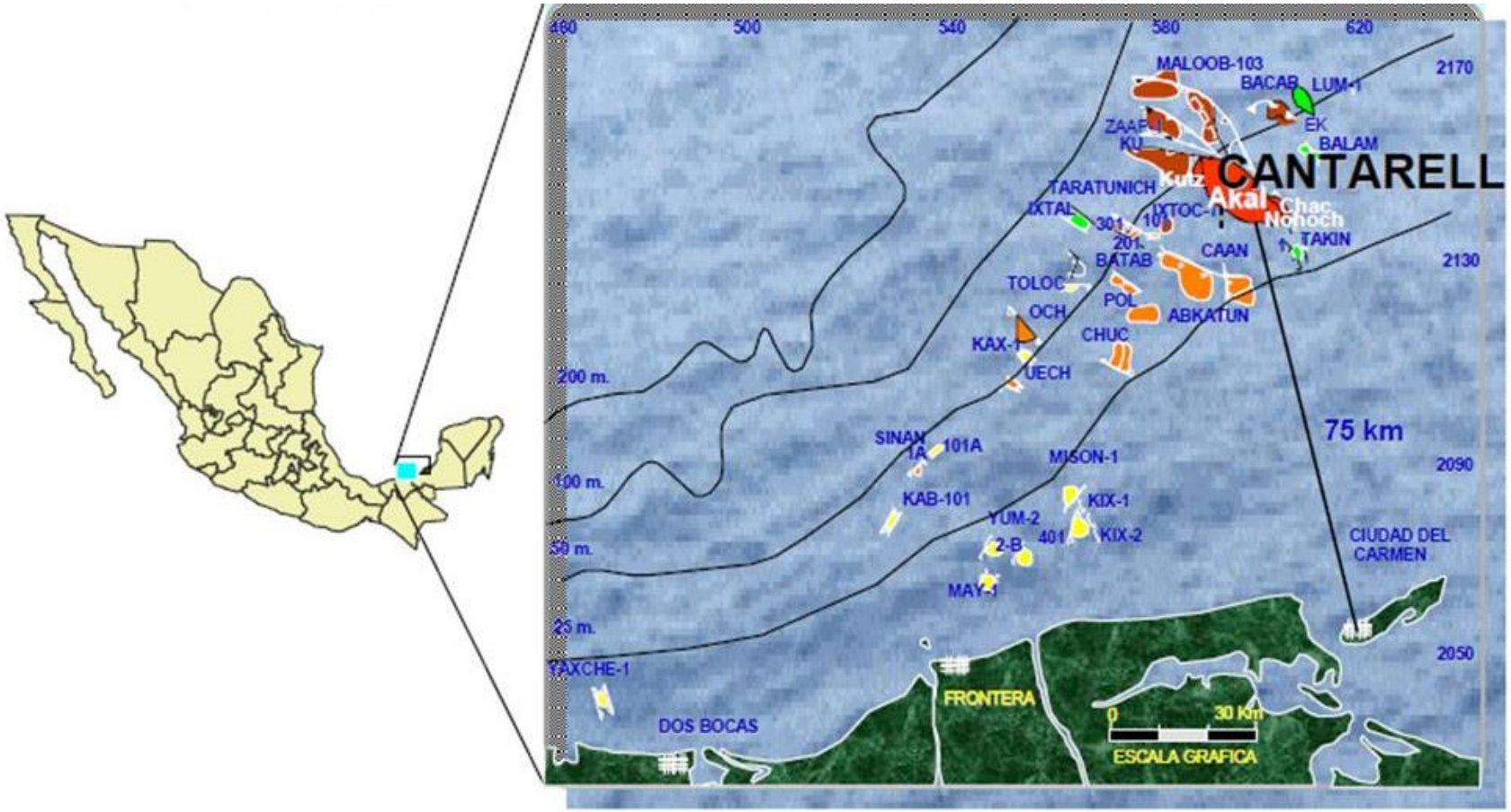
Cantarell Map and Location in Gulf of Mexico



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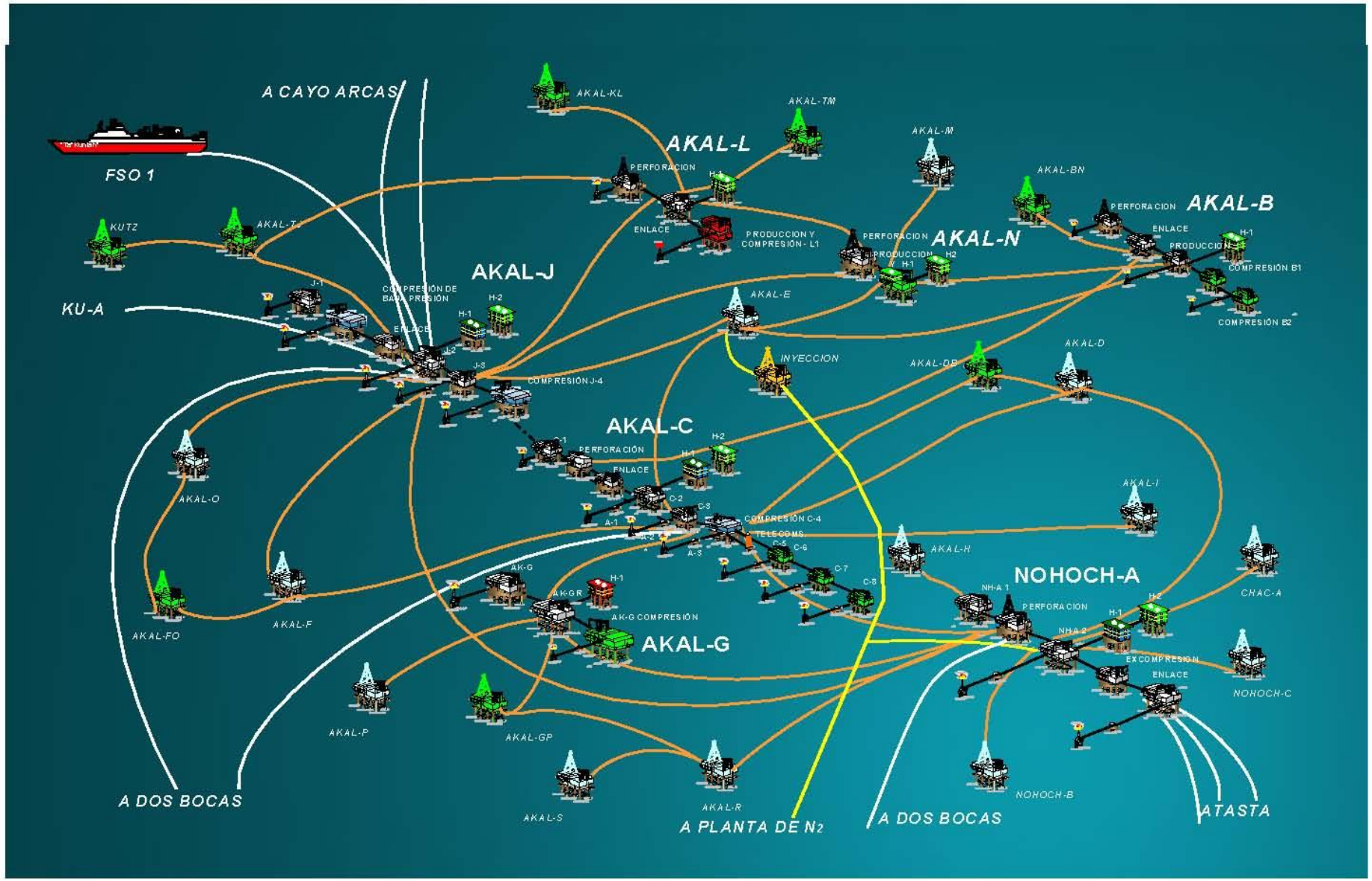
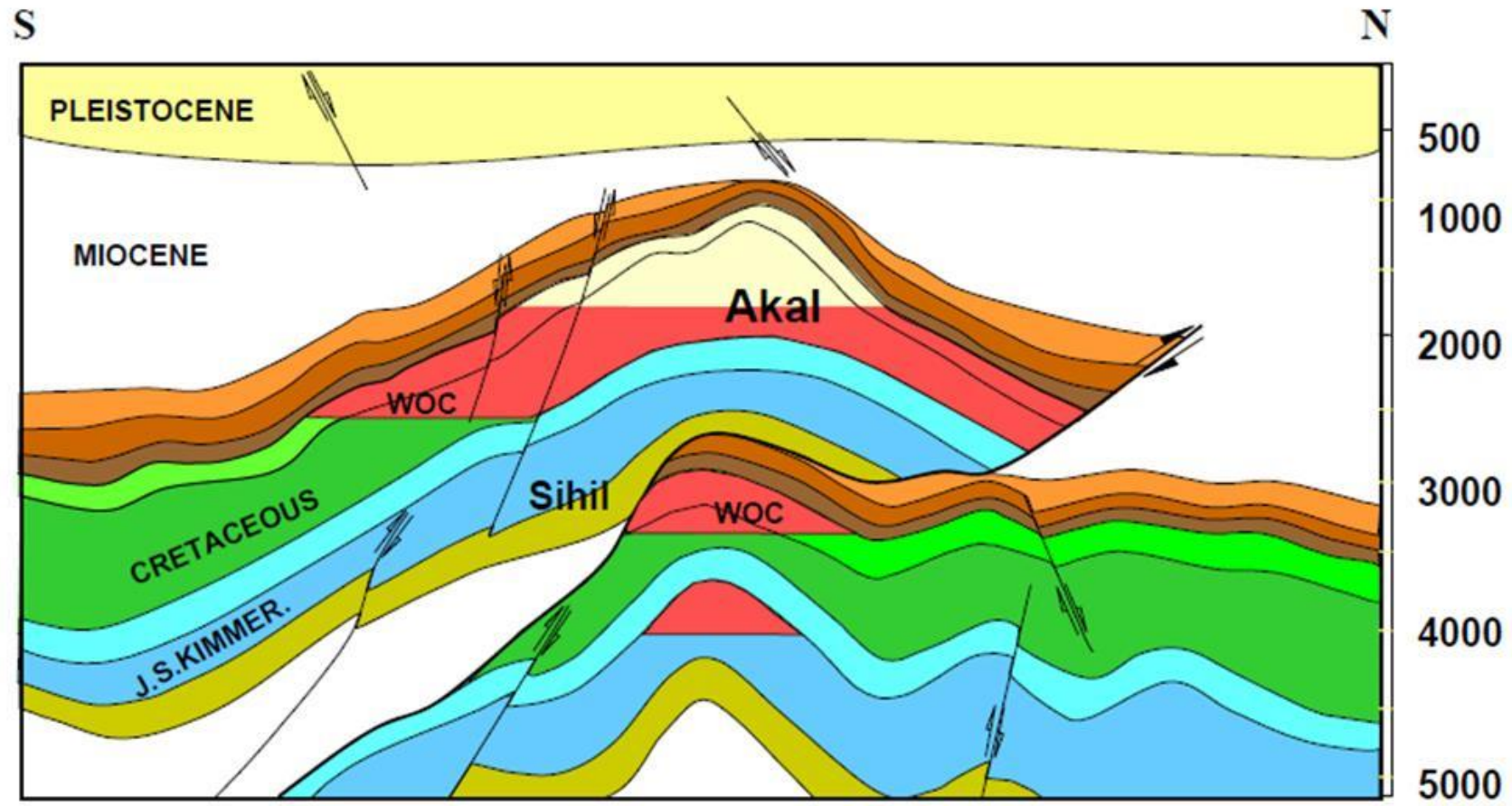
Cantarell Complex Oil Facilities

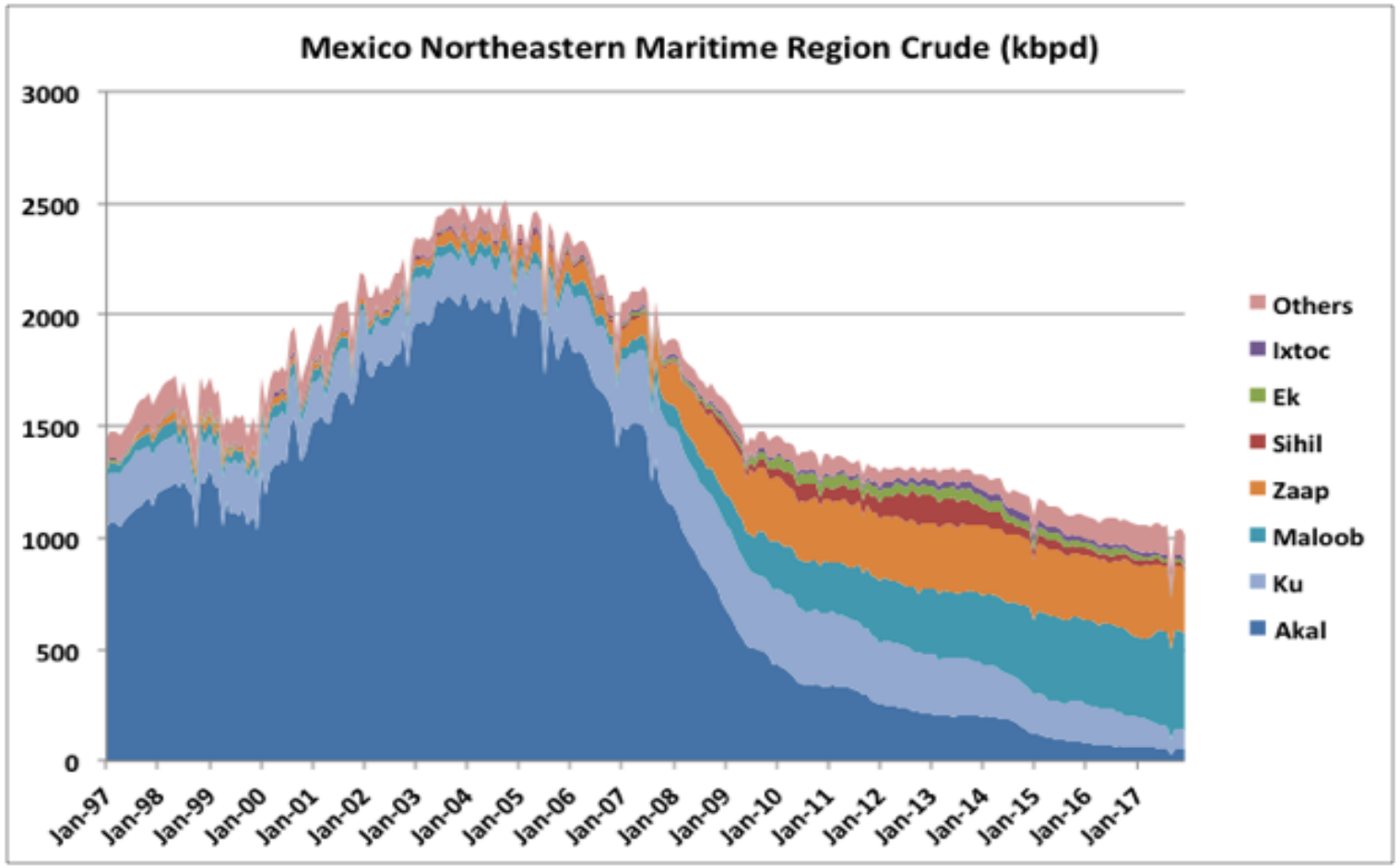


Cantarell Field Cross Section



Cantarell Akal Production History

(Kaplan, G.: Peak Oil Barrel, March 1, 2018)



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Meteoric History of Cantarell Field

By: Scott Weeden, E&P Magazine (2015)

“Its meteoric rise in production began with an asteroid impact. The meteor caused the Chicxulub Crater. The reservoirs are formed from carbonate breccia of Upper Cretaceous age that was rubble from the impact.”

“The breccia is from a shelf failure [underwater landslide] when the meteor hit. The 950-ft [289.6-m] thick rubble became the reservoir for one of the largest fields in the world. The lowermost part of the field is a Lower Cretaceous dolomitic limestone. The field is made up of a number of sub-fields or fault blocks,” according to Glenn Morton in an August 2004 article.

Denver-Julesburg (DJ) Basin

West-east and south-north cross section of Denver basin aquifers (USGS)

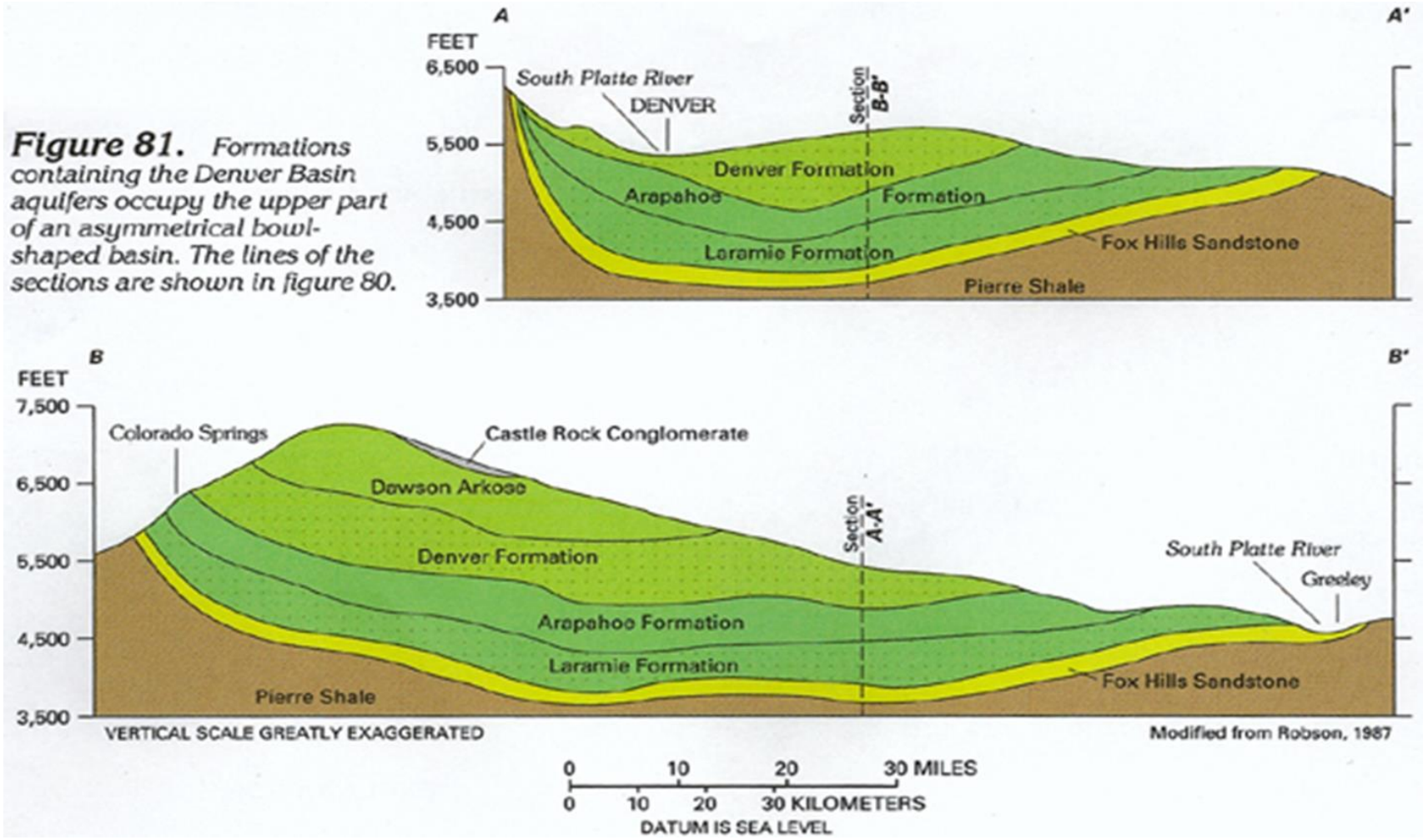
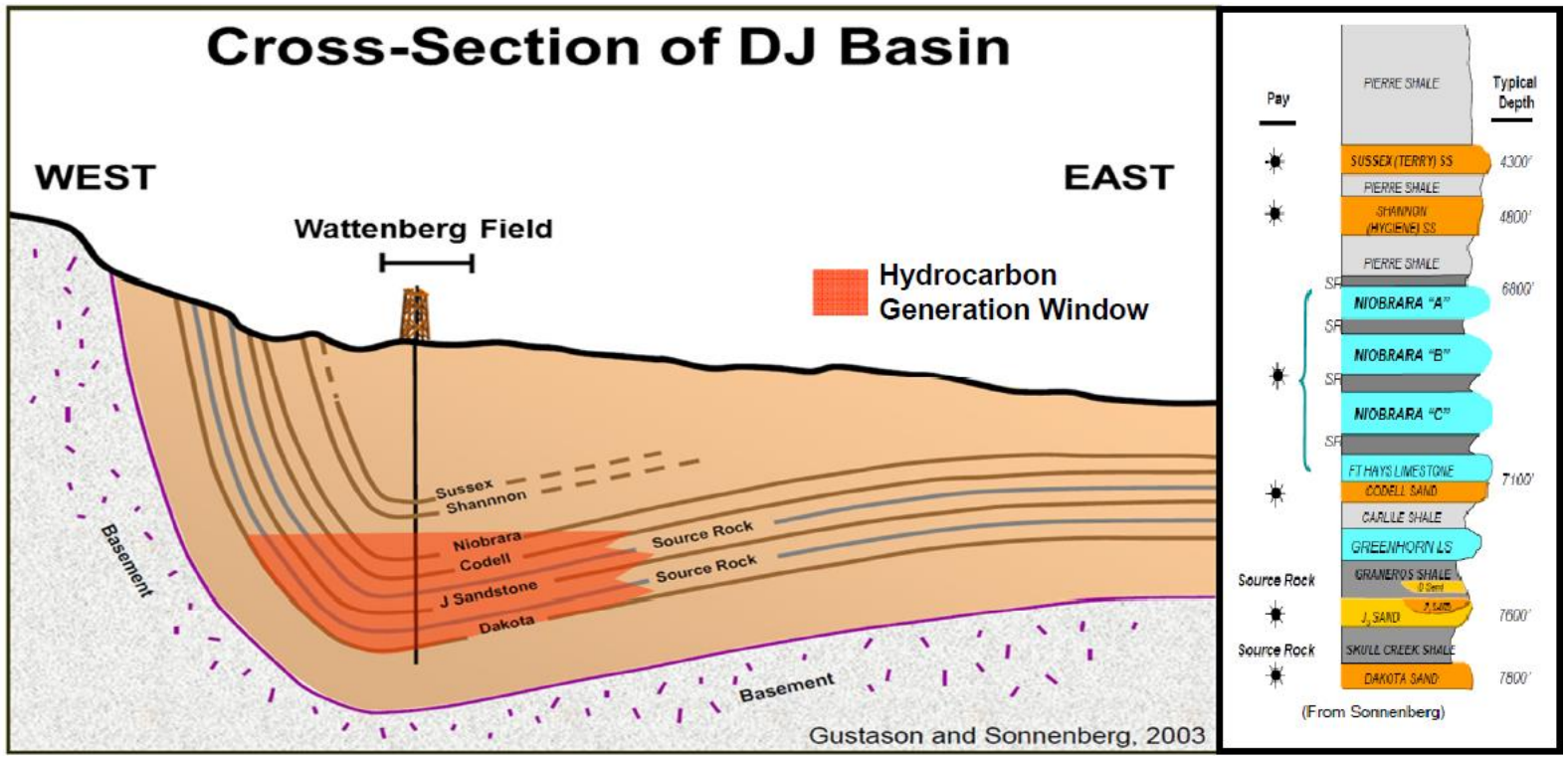


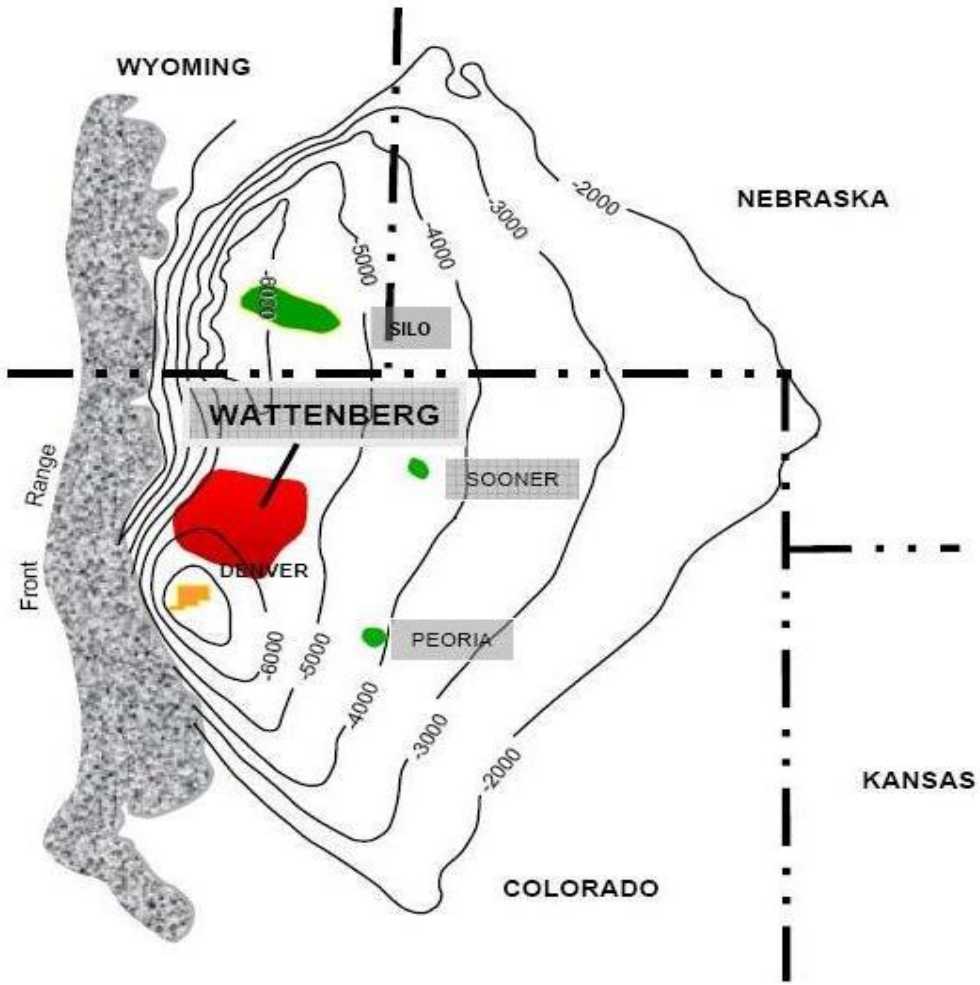
Figure 81. *Formations containing the Denver Basin aquifers occupy the upper part of an asymmetrical bowl-shaped basin. The lines of the sections are shown in figure 80.*

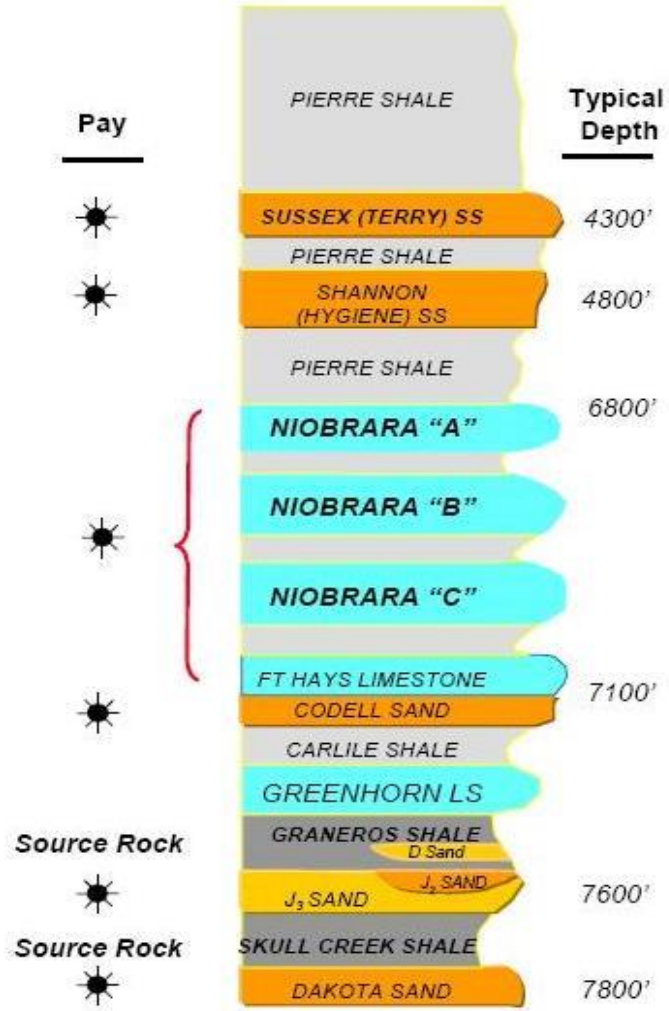
West-East Cross-Section of DJ Basin

Form: Gustason and Sonnenberg, 2003



Denver Basin

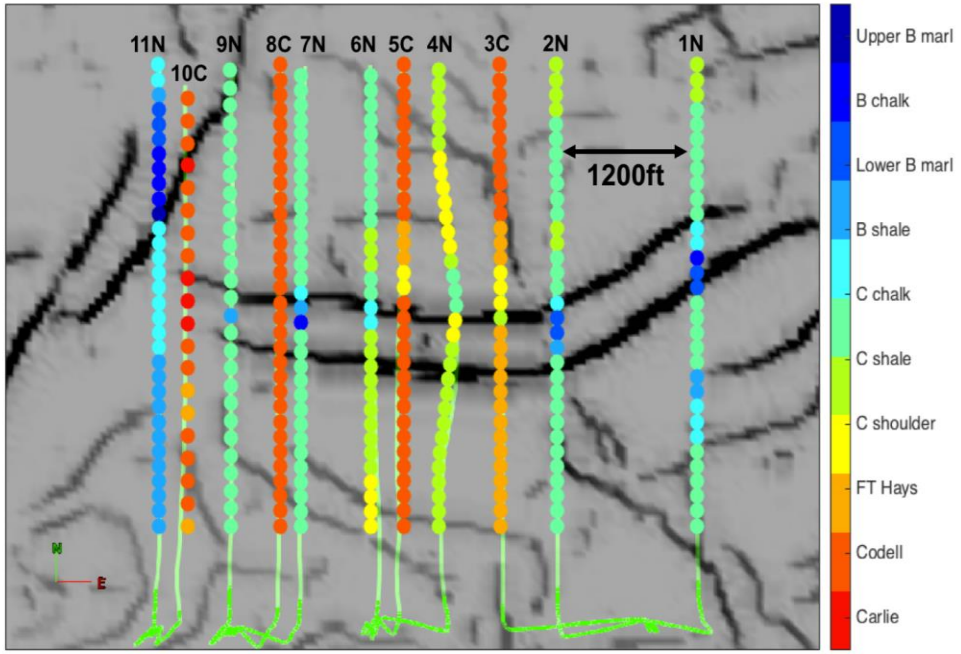


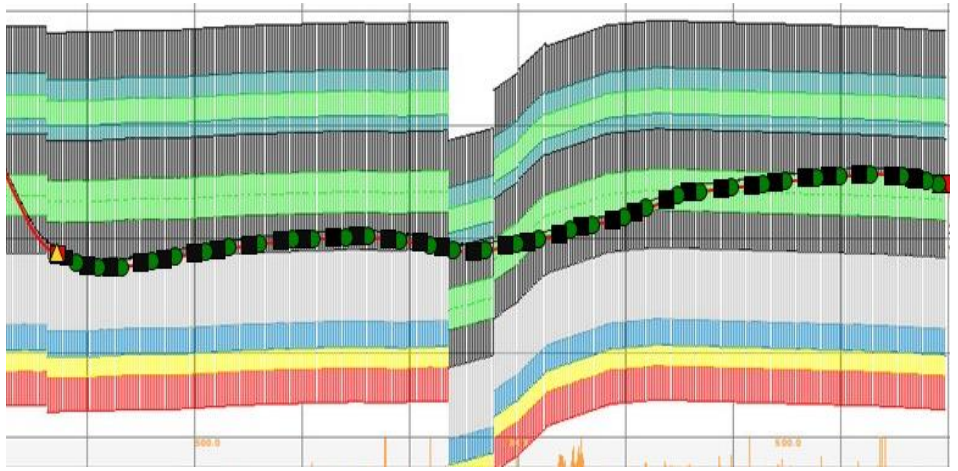


Shale Oil and Gas Blog (April 1, 2011)

Eleven Wells in the One-Square Mile Study Area and A Well Path Trajectory

(Yanrui Ning, CSM, PhD Thesis, 2017)

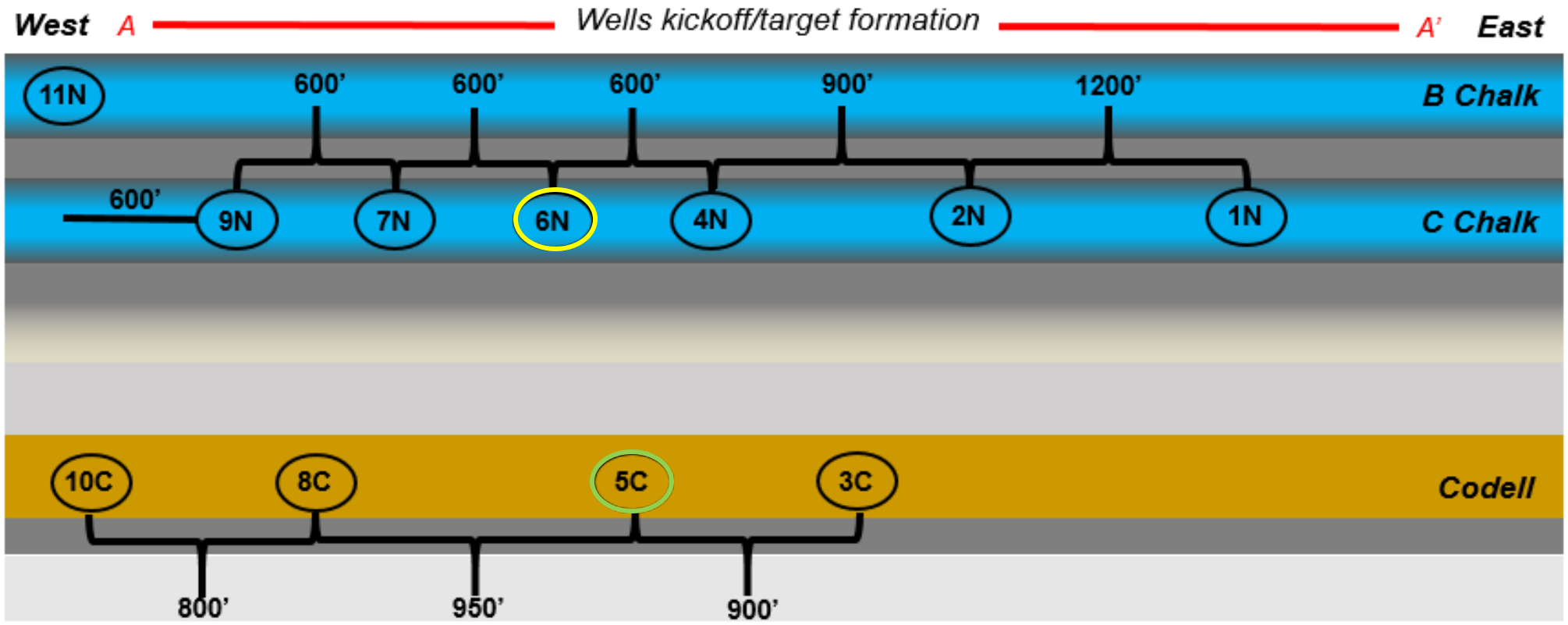




(Pitcher, 2015)

Niobrara Outcrop

Well 6N was converted to an injector after 5 years of production when the oil rate was 20 bbl/day. After gas injection, oil production from surrounding wells, such as Well 5C, increased



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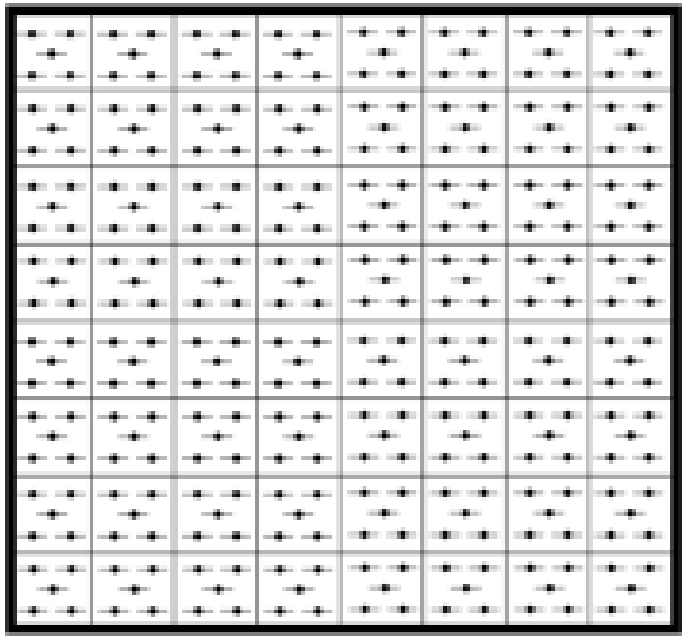
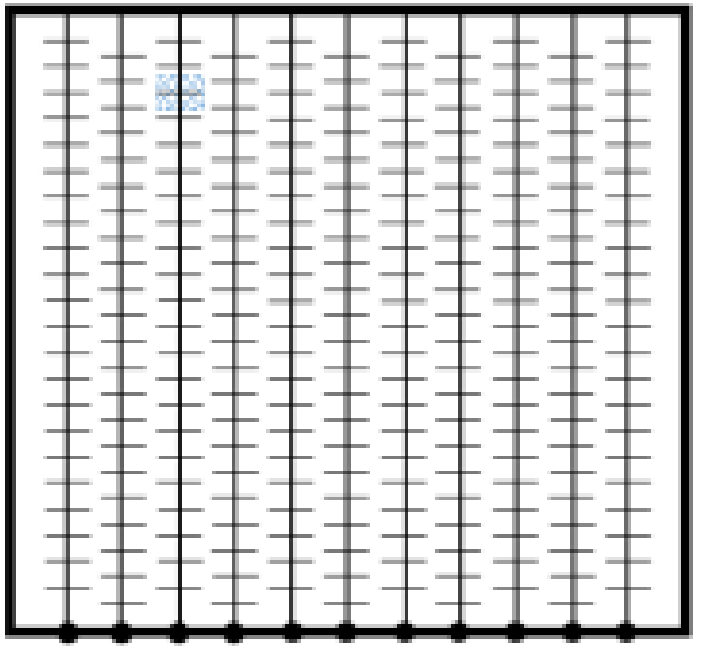
Hydraulic Fractures Placed in One Square Mile in DJ Basin Compared with Equivalent Vertical Well Placements in the Same Area



320 fraced vertical wells in one square mile



11 zipper fraced horizontal wells in one square mile

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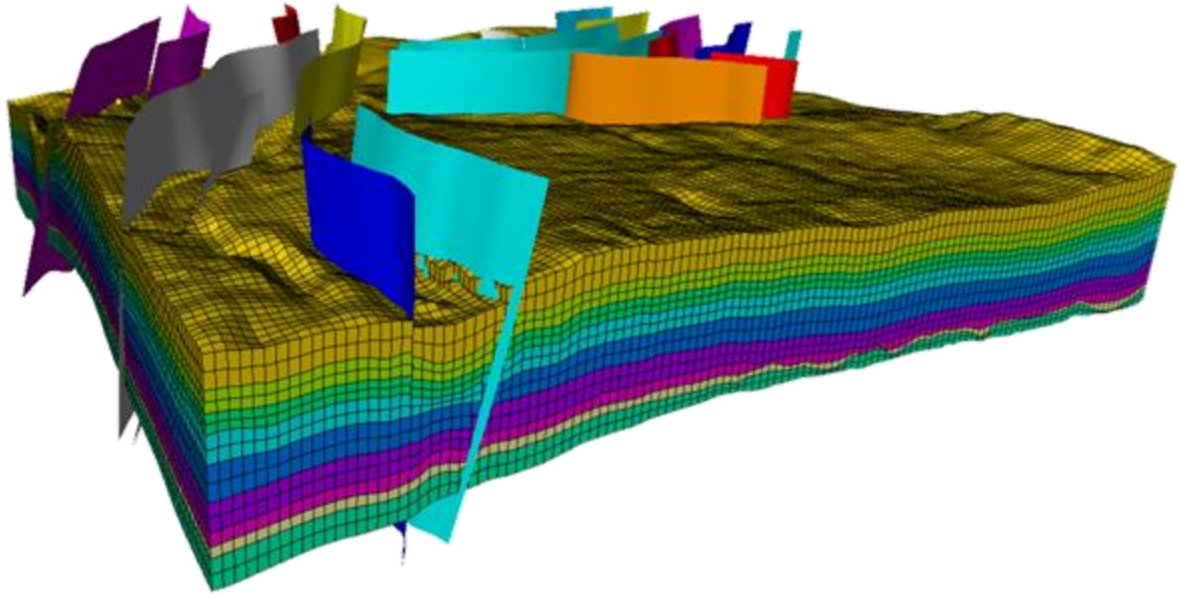
Reservoir Simulation Model of Niobrara

(Yanrui Ning, CSM, PhD Thesis, 2017)

- One square mile
  - 16 layers
  - 10 faults
- Eleven horizontal wells
  - 7 Niobrara well
  - 4 Codell wells
- Dual-porosity model
  - Fracture & matrix



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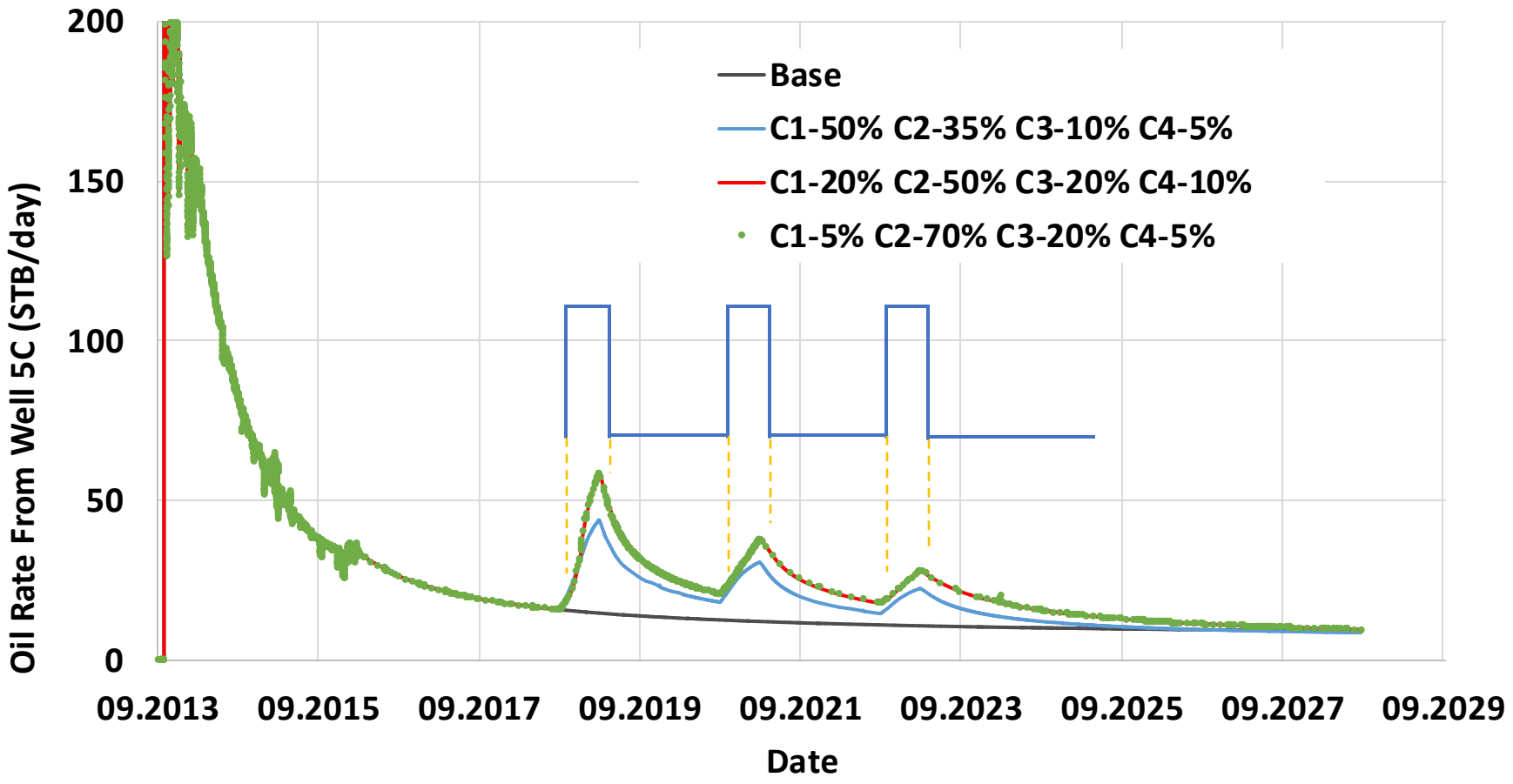
Performance of Wishbone Well 5C, after Gas Injection in Well 6N at 1.0 MMscf/D



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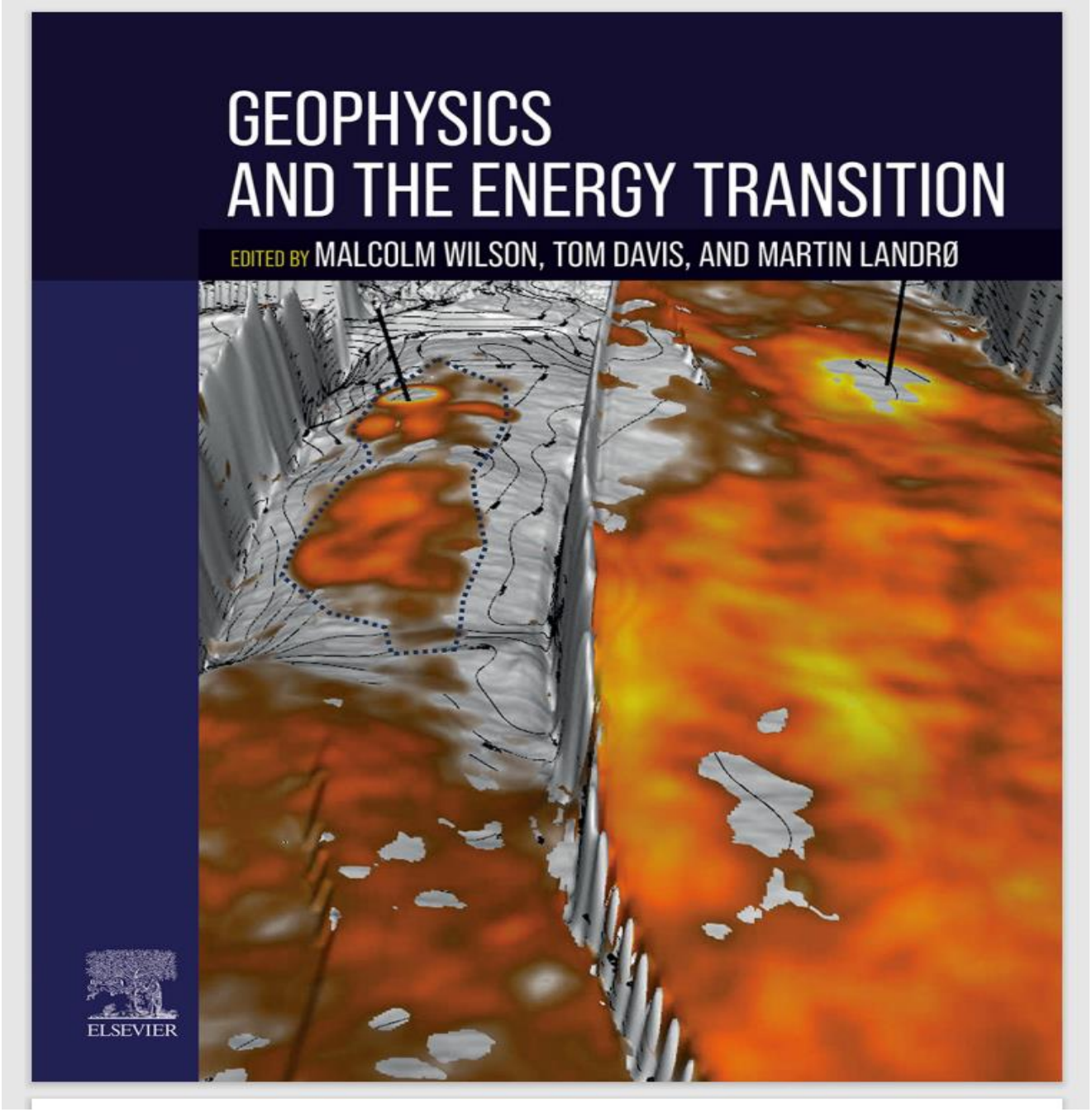
Reference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