

A photograph of several offshore oil rigs and a ship at sea during a sunset. The sun is low on the horizon, creating a bright orange and yellow glow that reflects on the water. The rigs are silhouetted against the bright sky. The largest rig is in the foreground on the right, with two cranes extending from its platform. Other rigs and a ship are visible in the distance to the left and center.

# Petroleum Recovery & Reserves

**Dr. Al Dushaishi**

**10/26/2018**

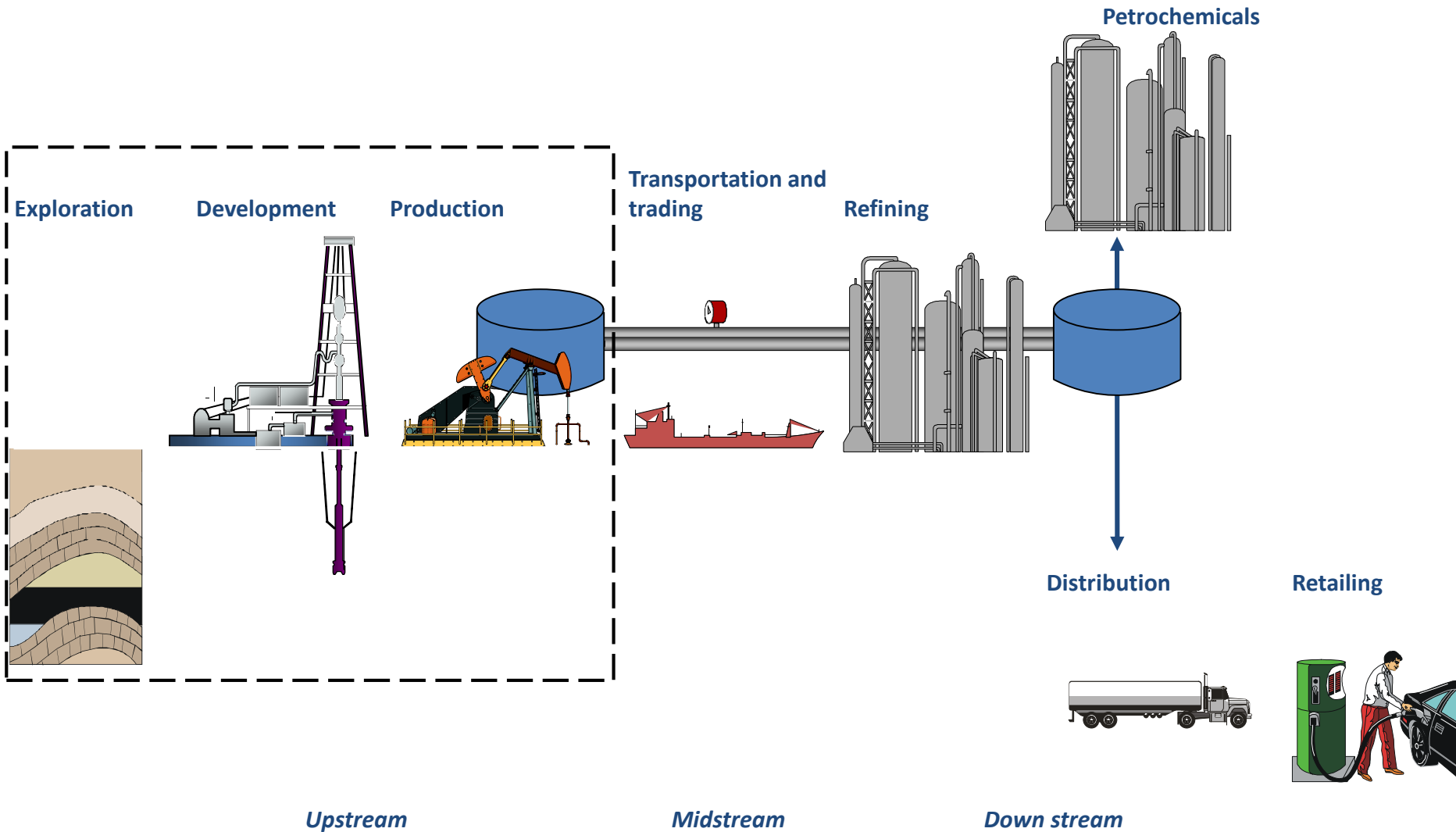


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# Outlines

- Introduction
  - The Oil and Gas Business
  - Extraction of Oil and Gas
  - The Reservoir
- Recovery
- Reserves

# The Petroleum Business System

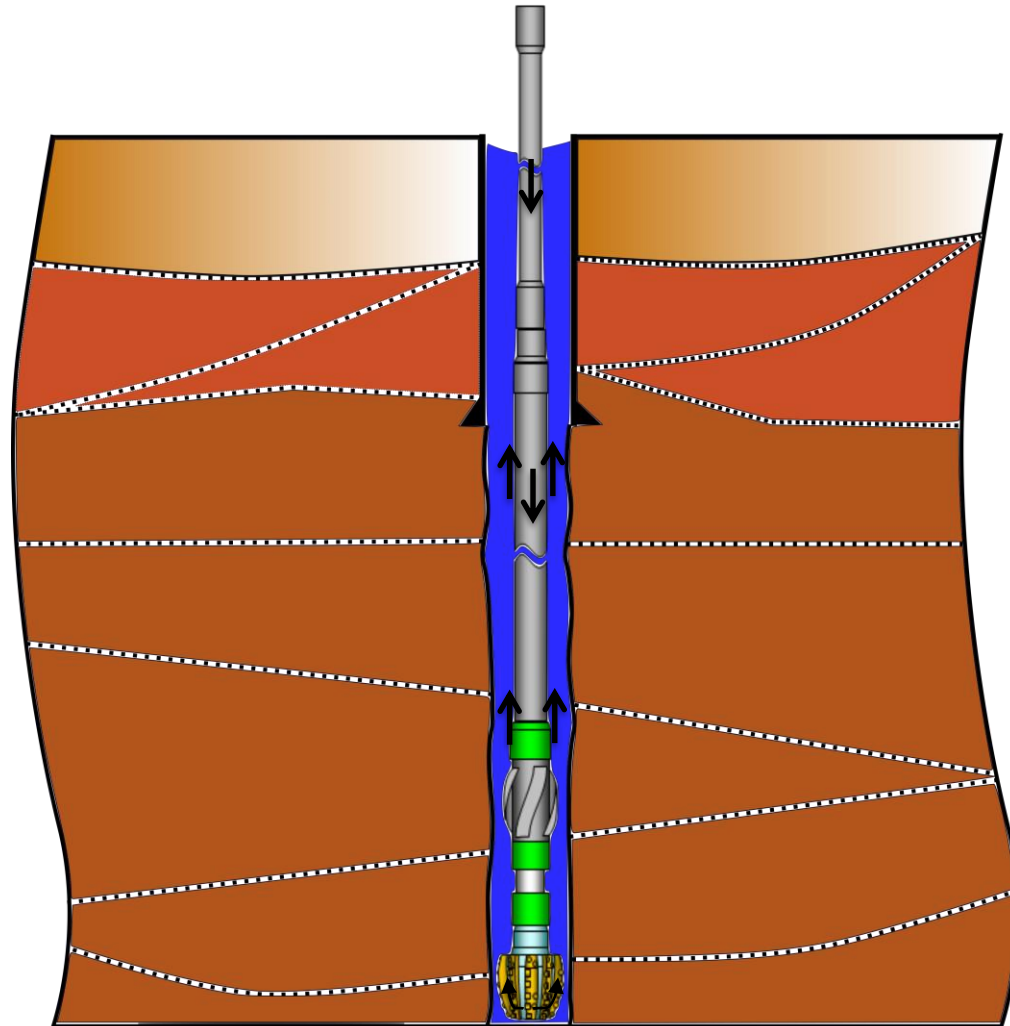




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# Extraction of Oil and Gas



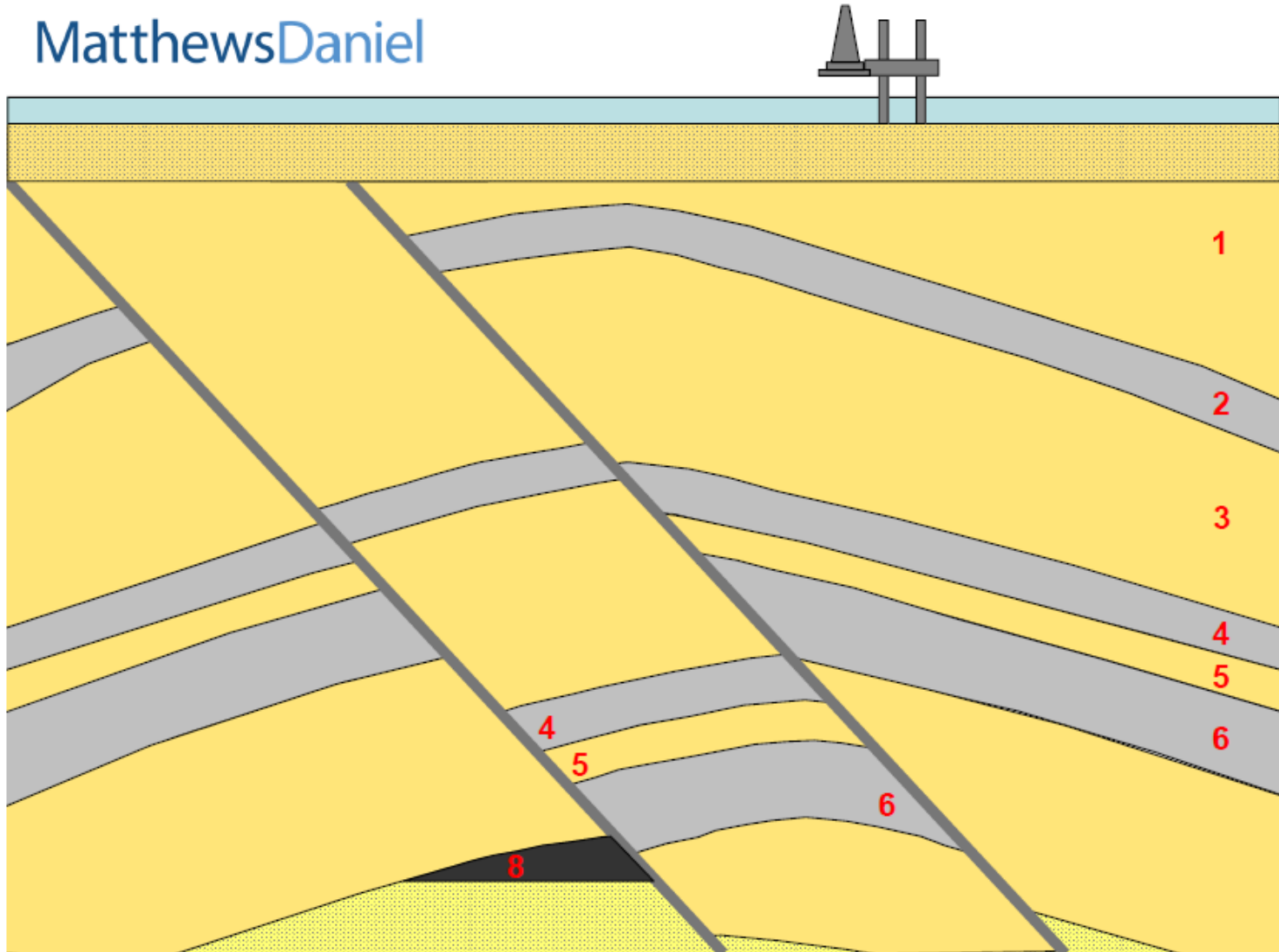
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# Personnel at Rig Site

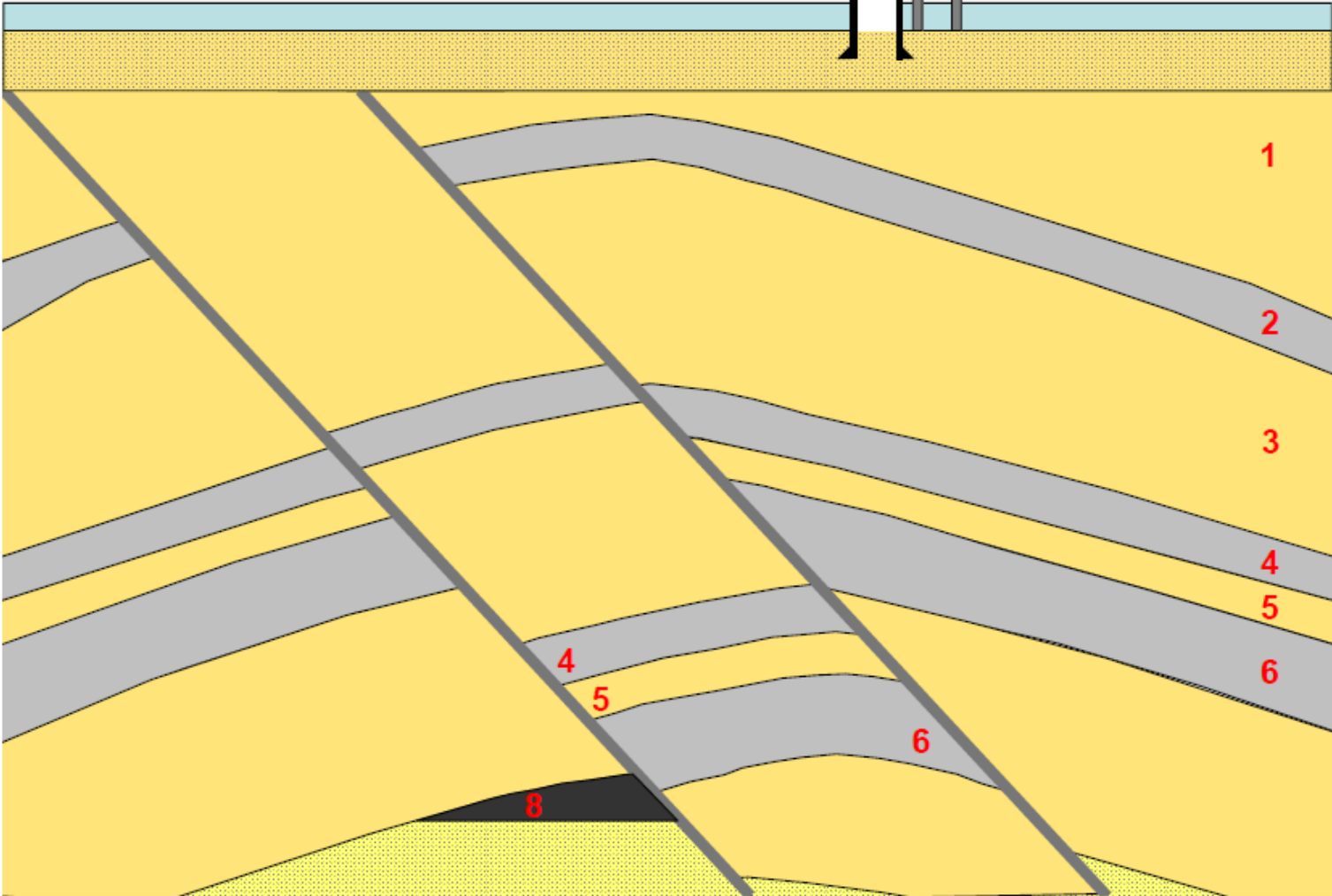
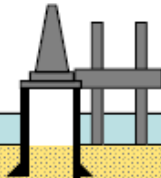


# Drilling Example

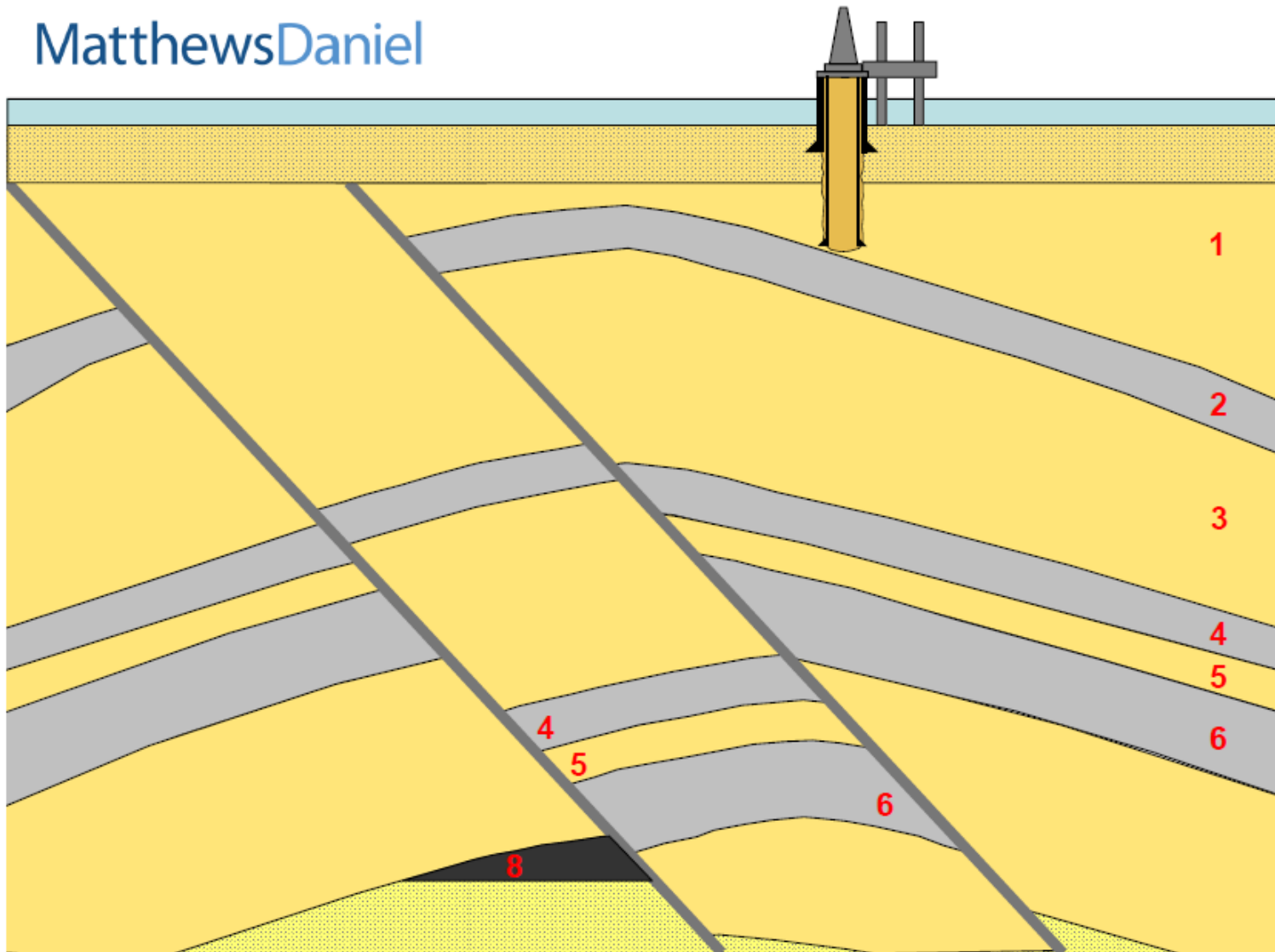
MatthewsDaniel



# MatthewsDaniel

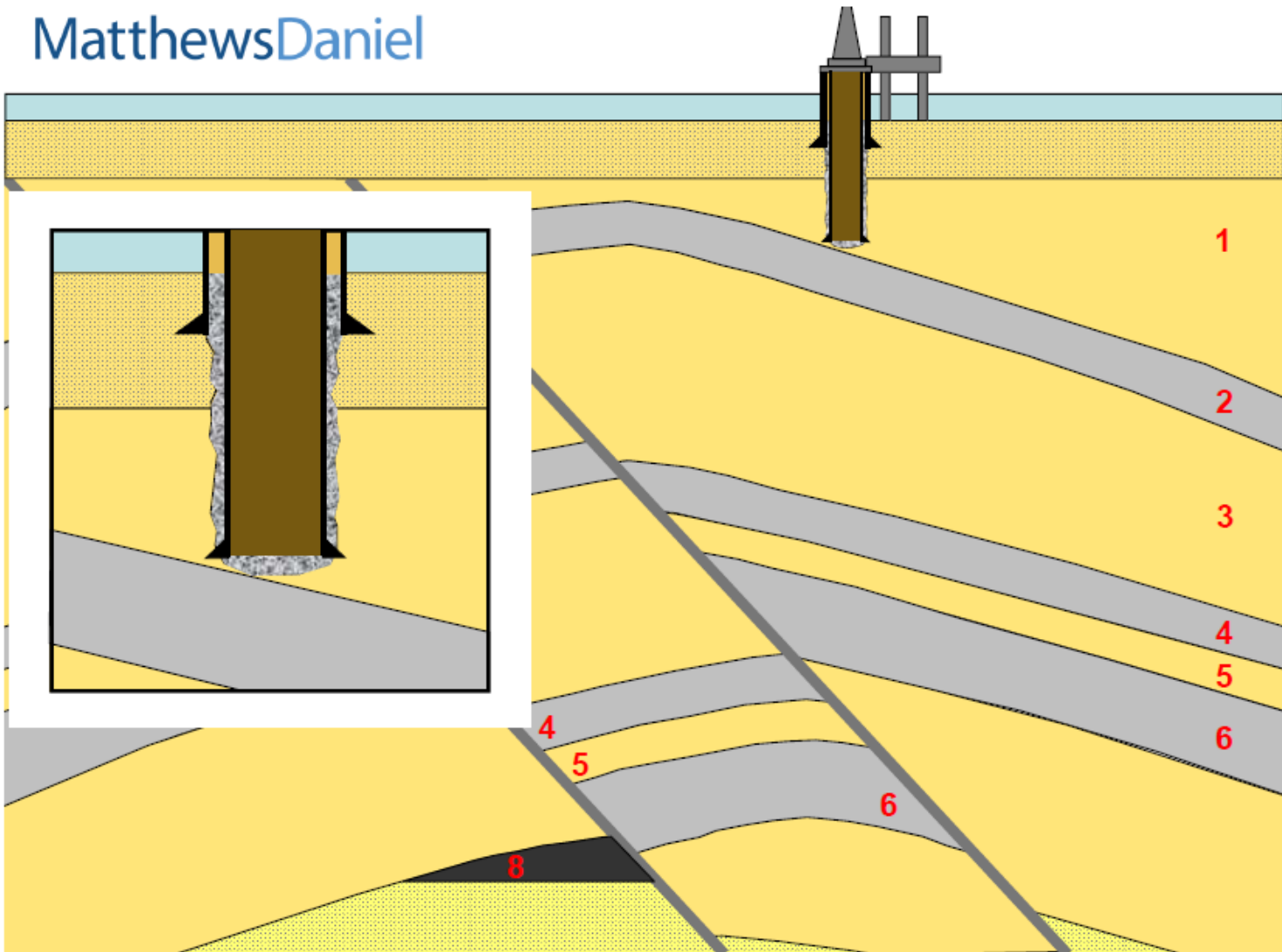


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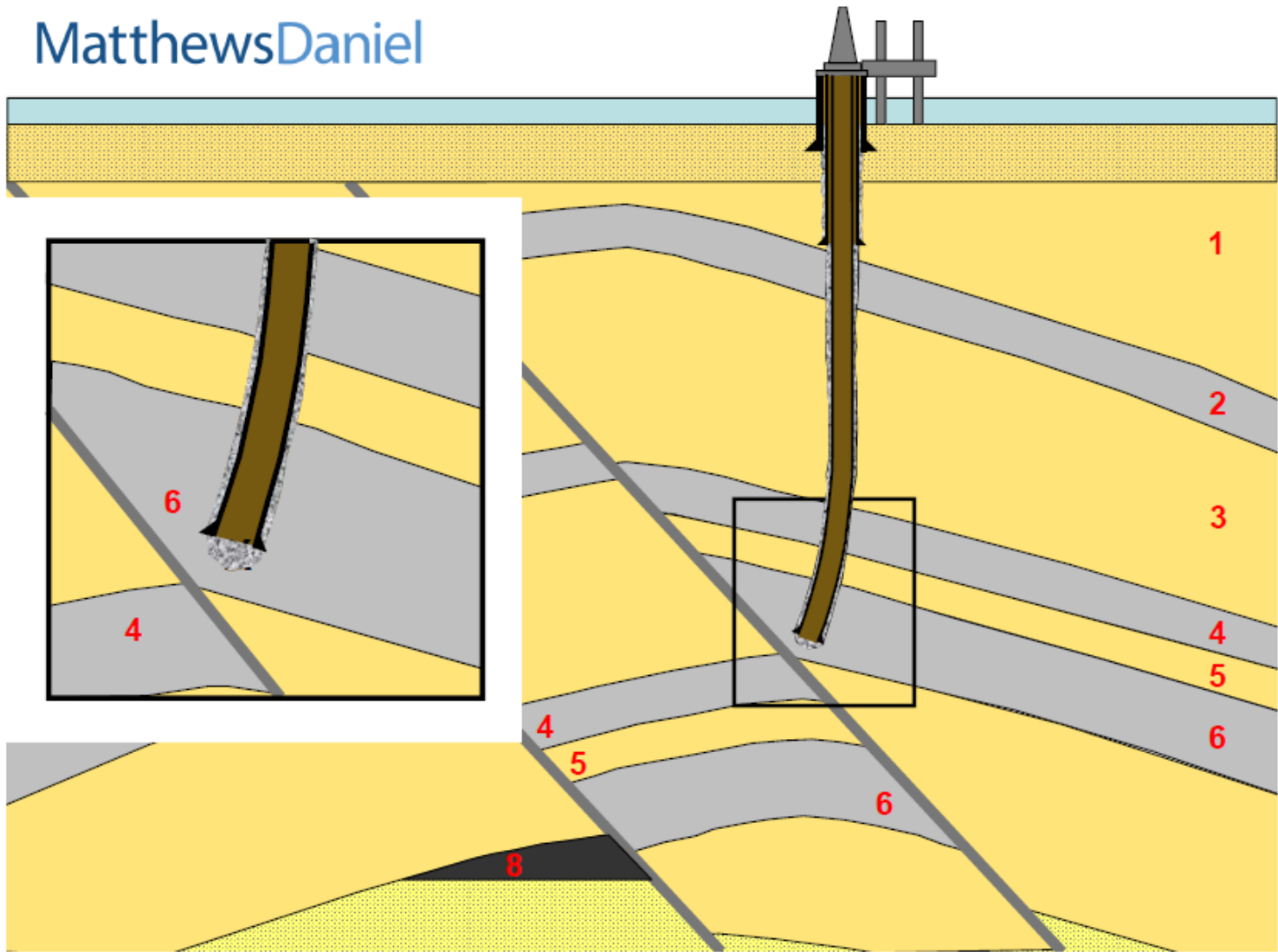




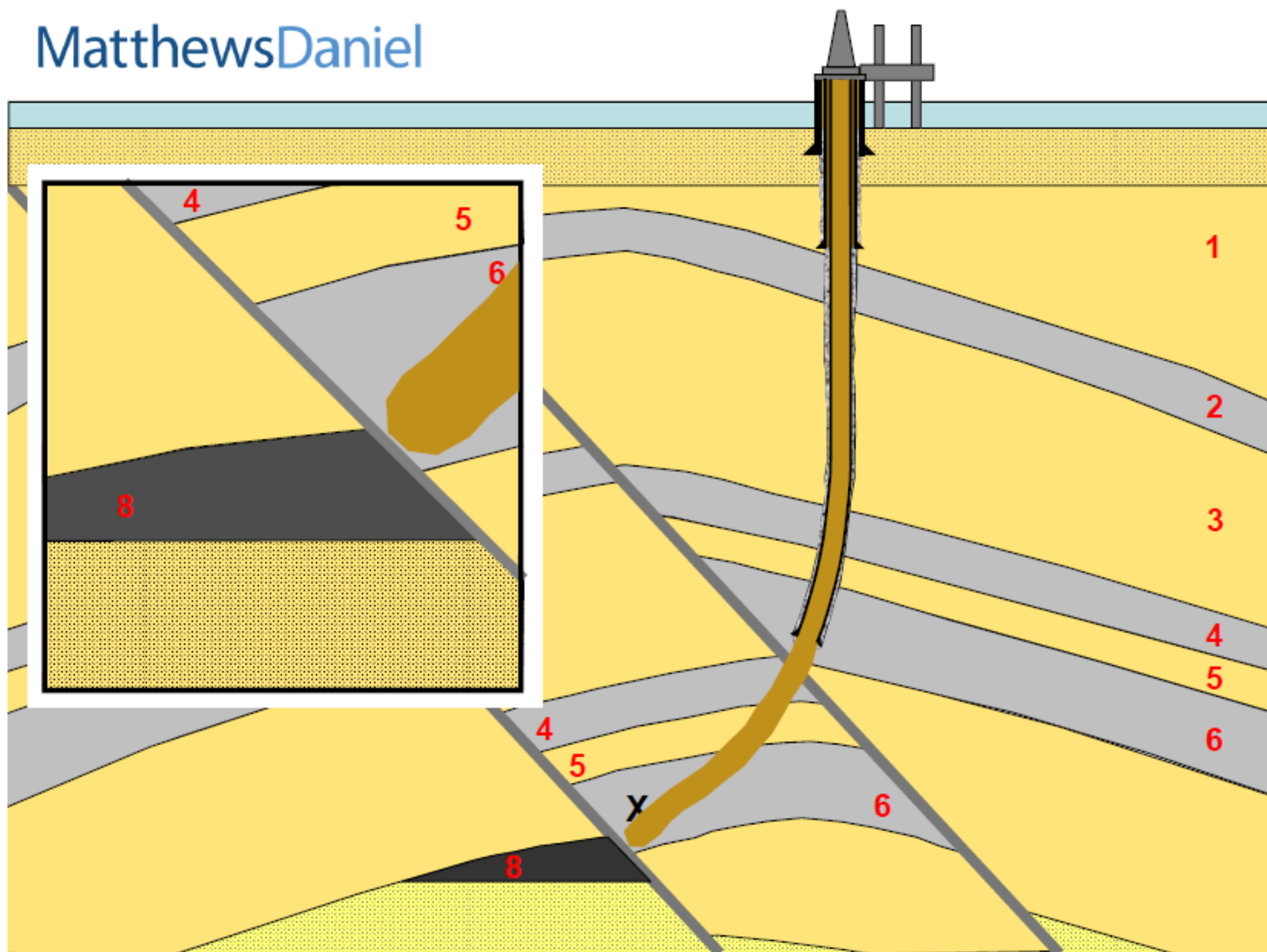
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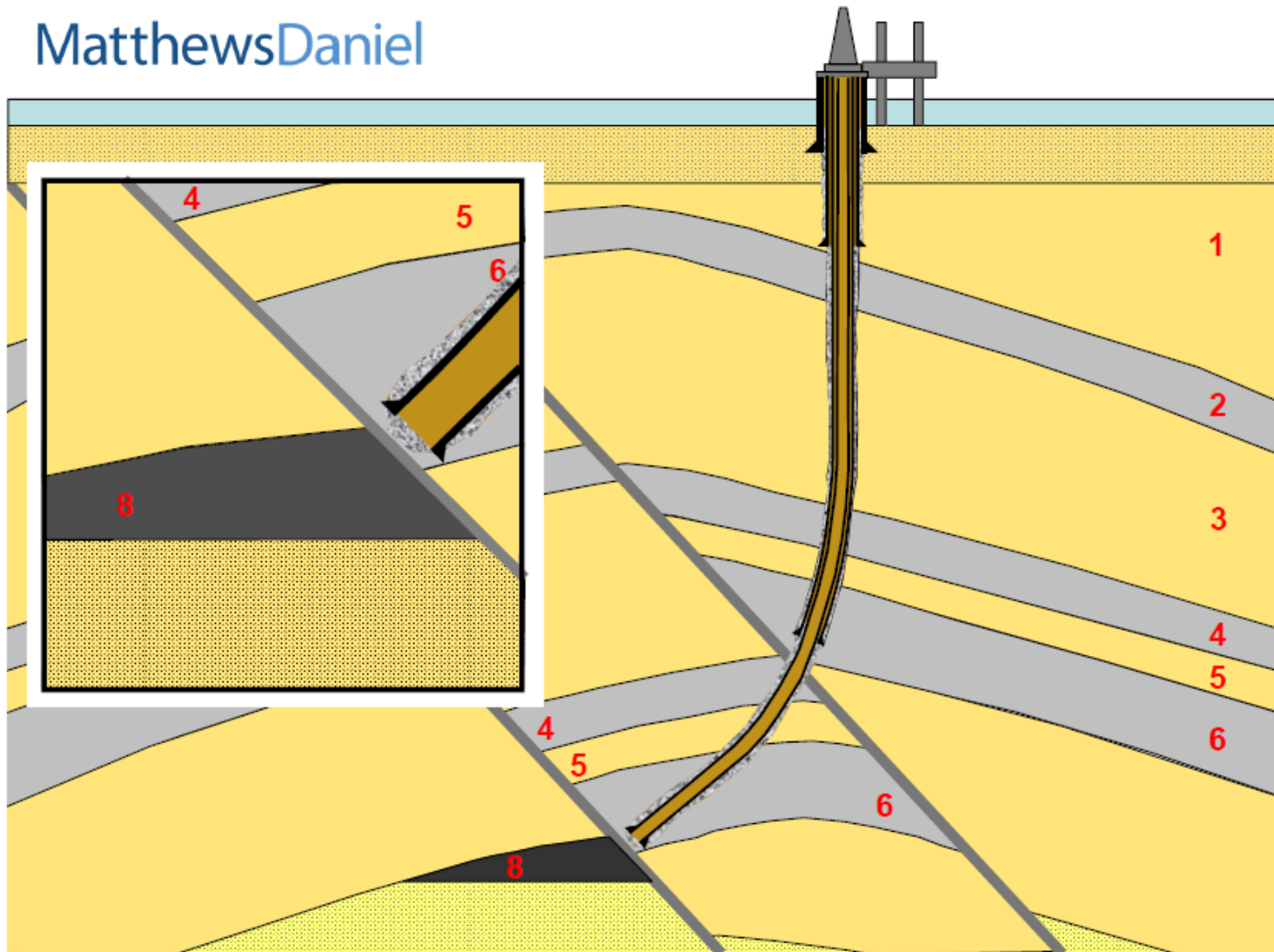
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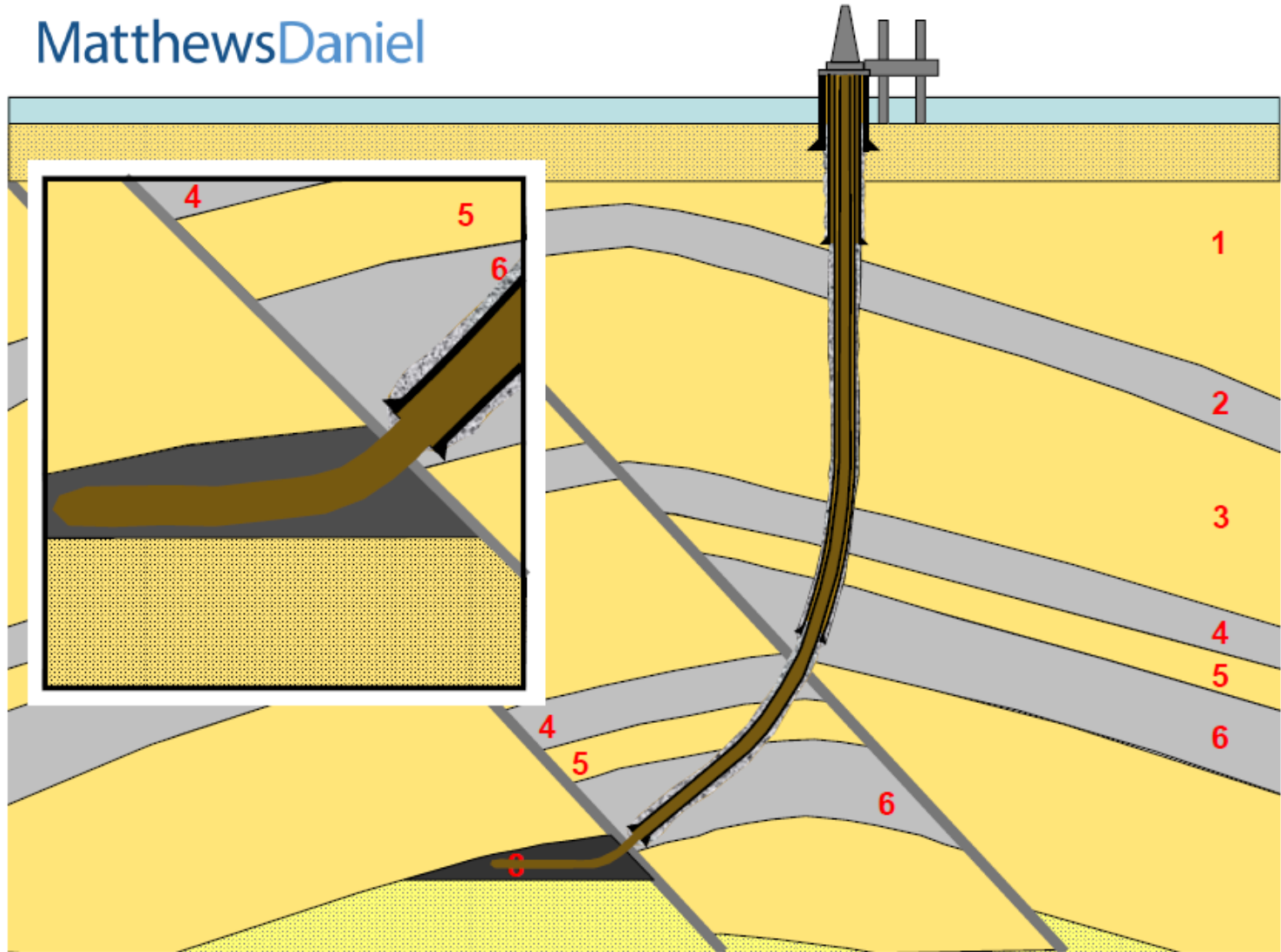
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# MatthewsDaniel



# MatthewsDaniel

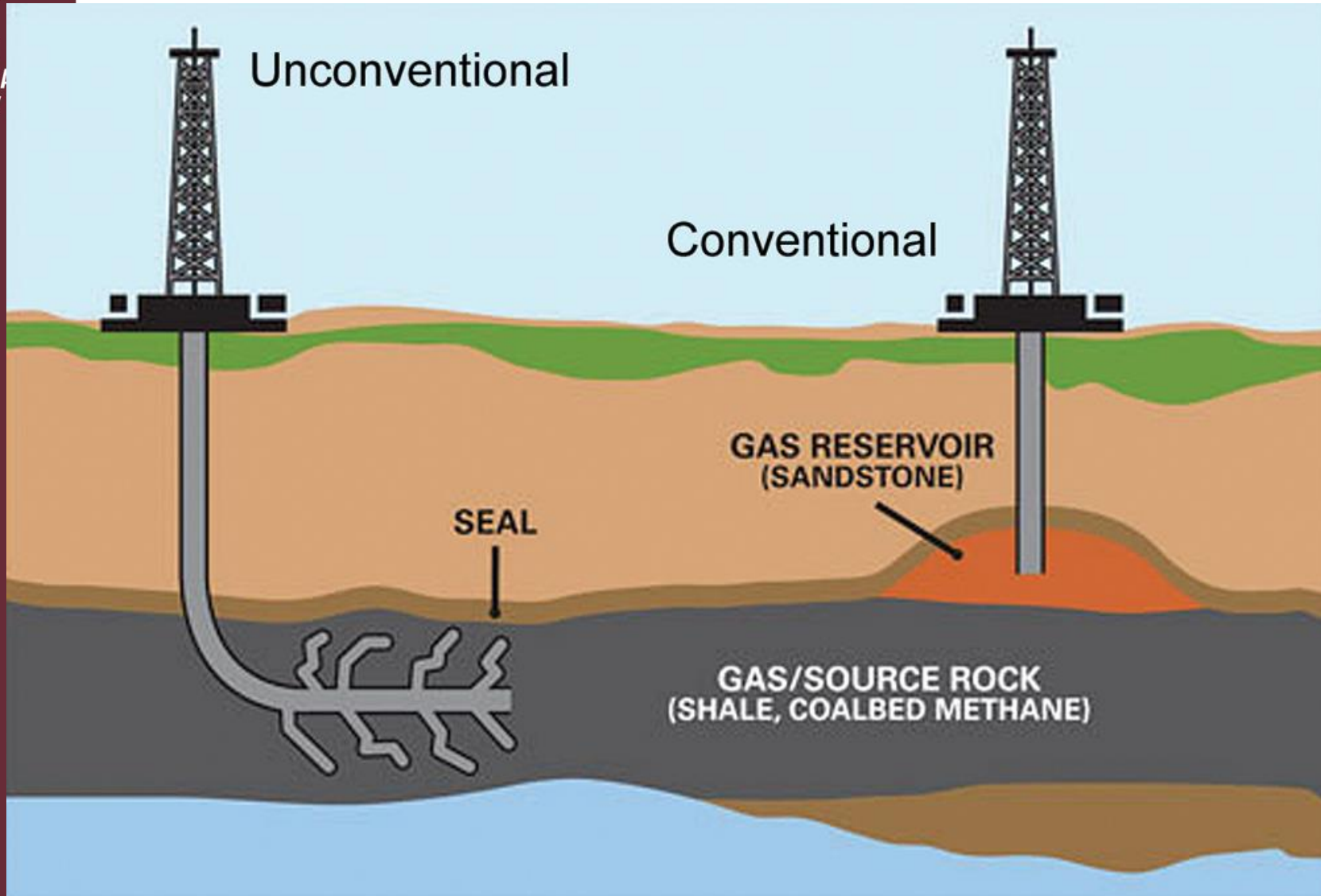


# Conventional Vs. Unconventional



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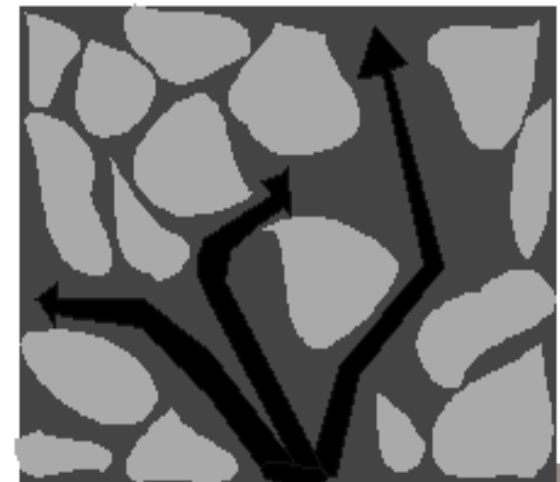
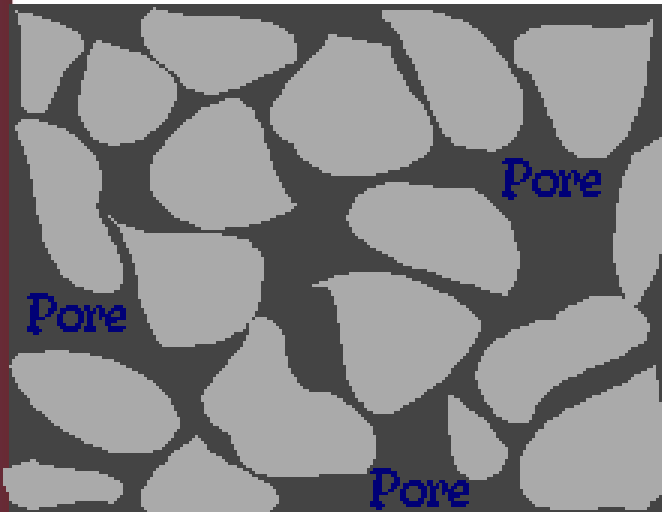


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# Reservoir

- The reservoir is the main source of pressurized fluids to the production system.
- It is the porous, permeable media in which the reservoir fluids are stored and moved through it to the wellbore.
- It is also provide the primary energy (pressure) to deliver the reservoir fluids into the wellbore.

A pore is a small open space in a rock. Connected pores give a rock permeability.



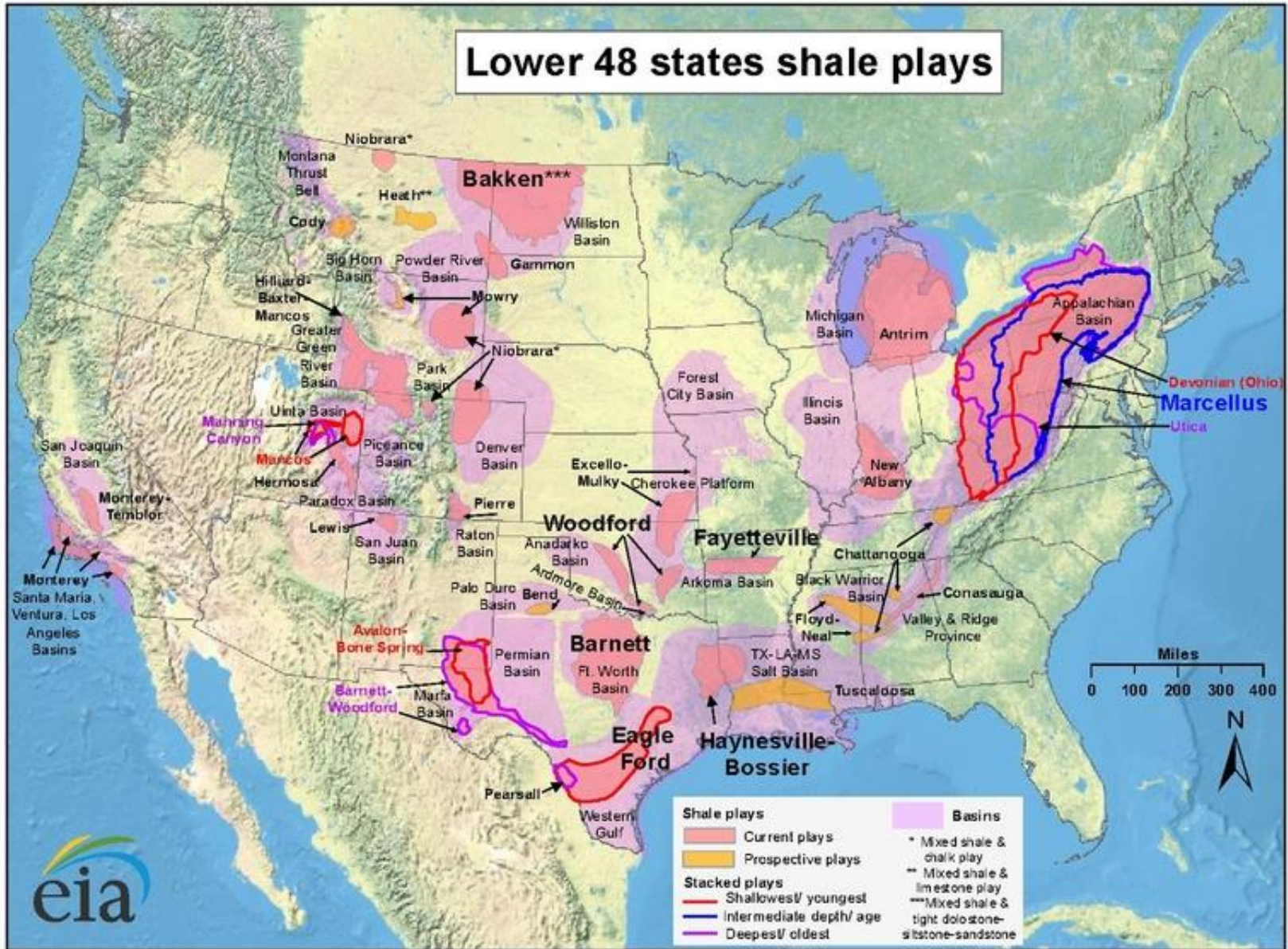
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# The USA Unconventional



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Source: Energy Information Administration based on data from various published studies.  
Updated: May 9, 2011





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Recovery



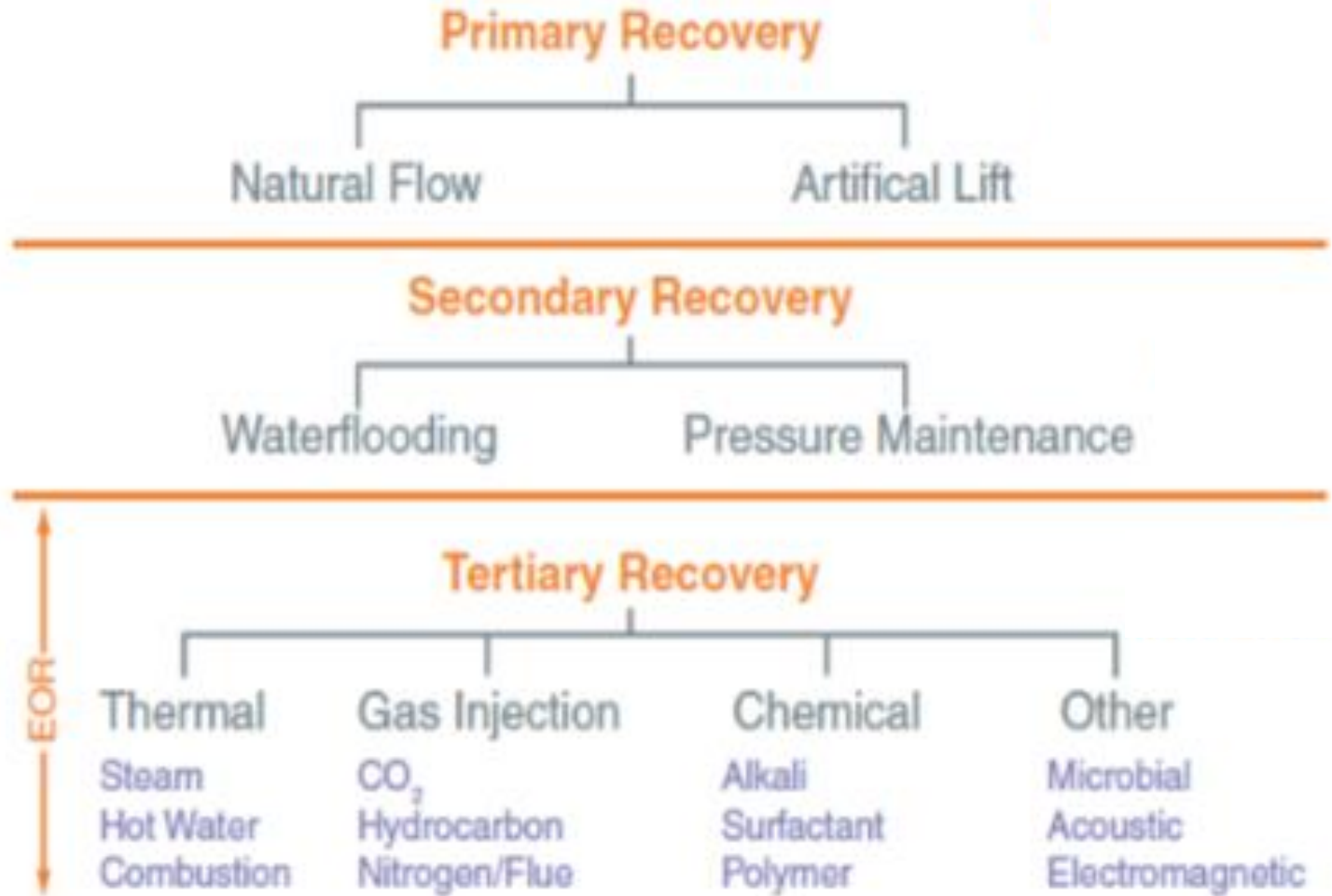
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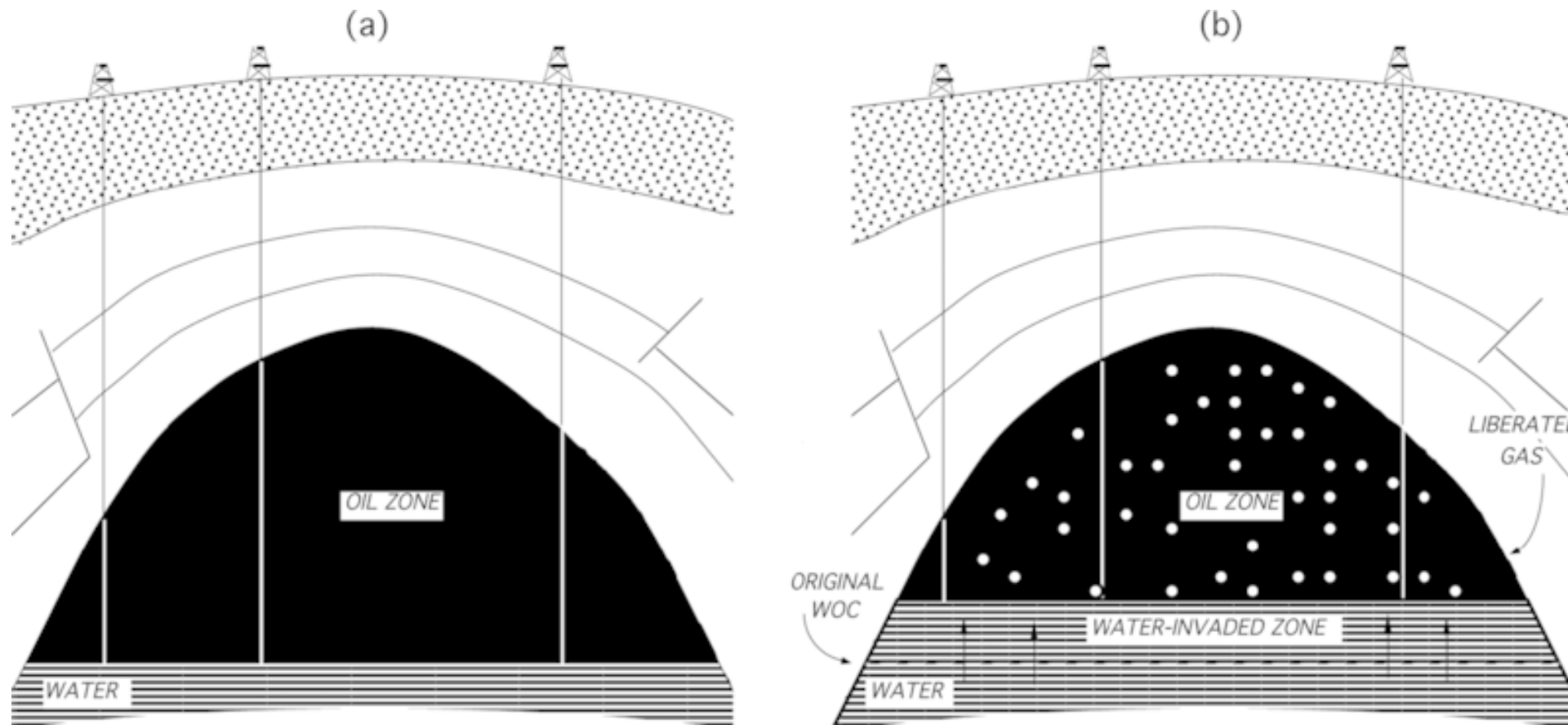
# Oil Recovery Methods



# Primary Recovery

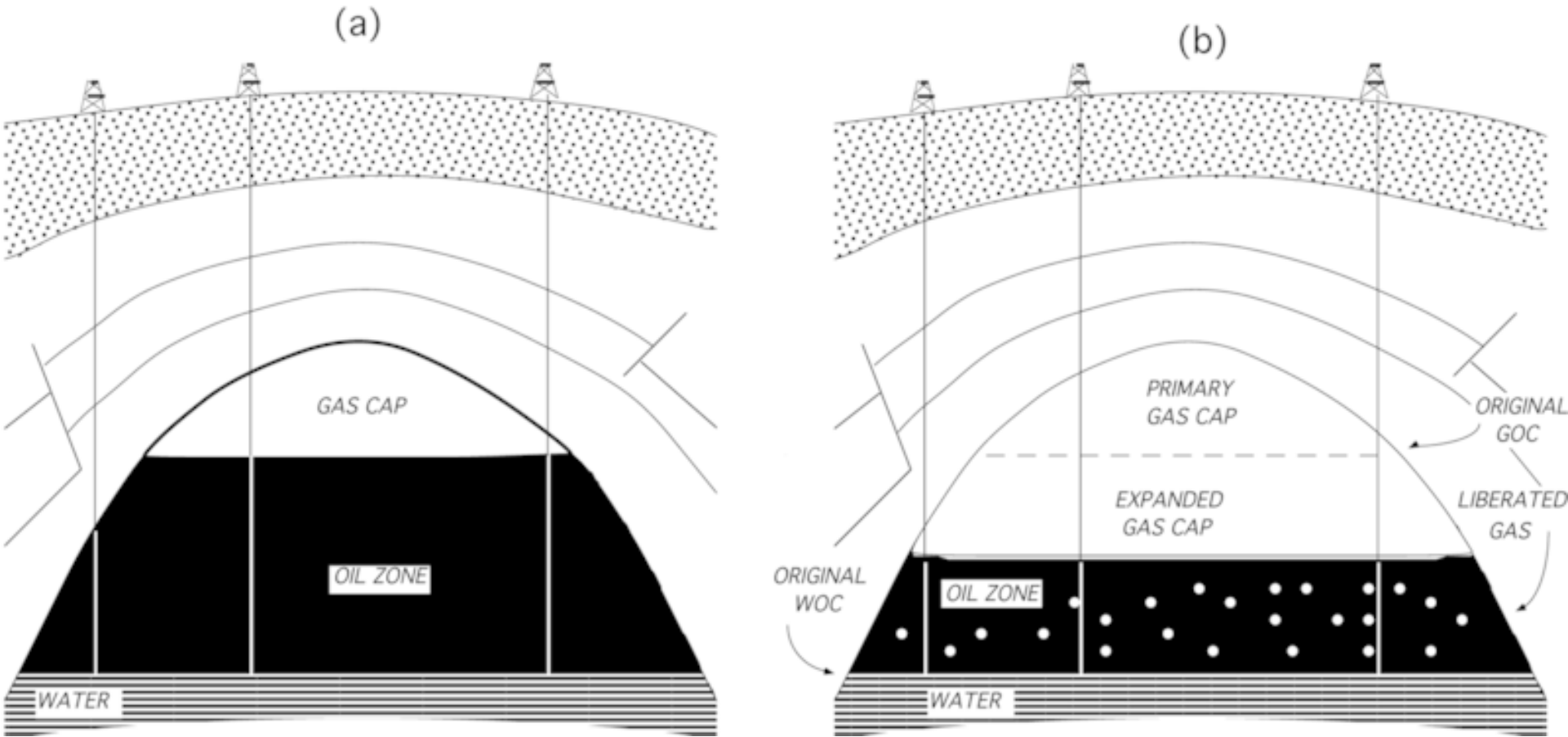
- The hydrocarbon flows into the well naturally due to the natural reservoir energy such as (water drive, gas drive, and gravity drainage)

Water drive (Water displacement) recovery method



# Primary Recovery

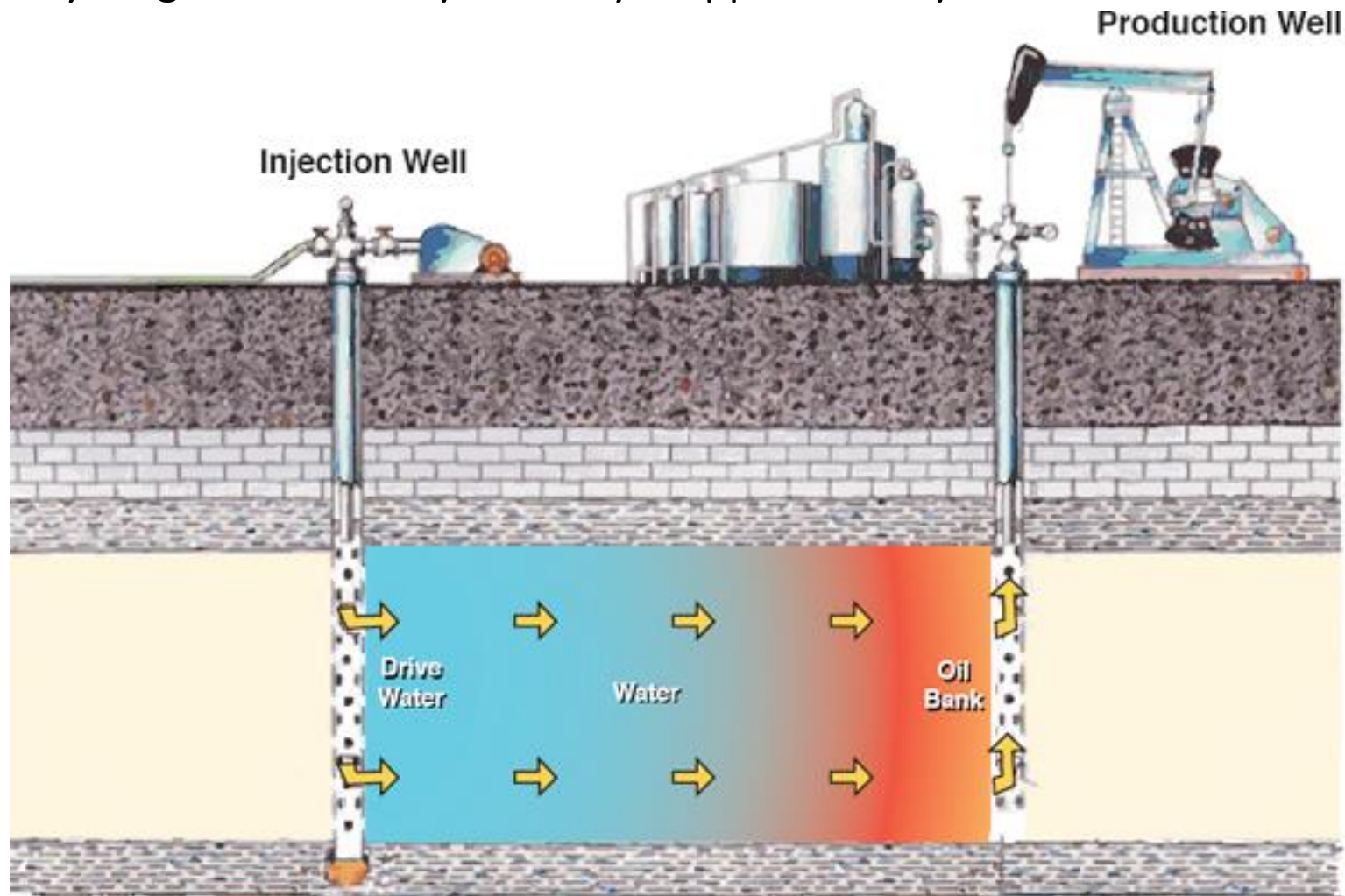
Gas drive (Gas expansion) recovery method



- Recovery range of the primary recovery method ranges from 5-15%.

# Secondary Recovery

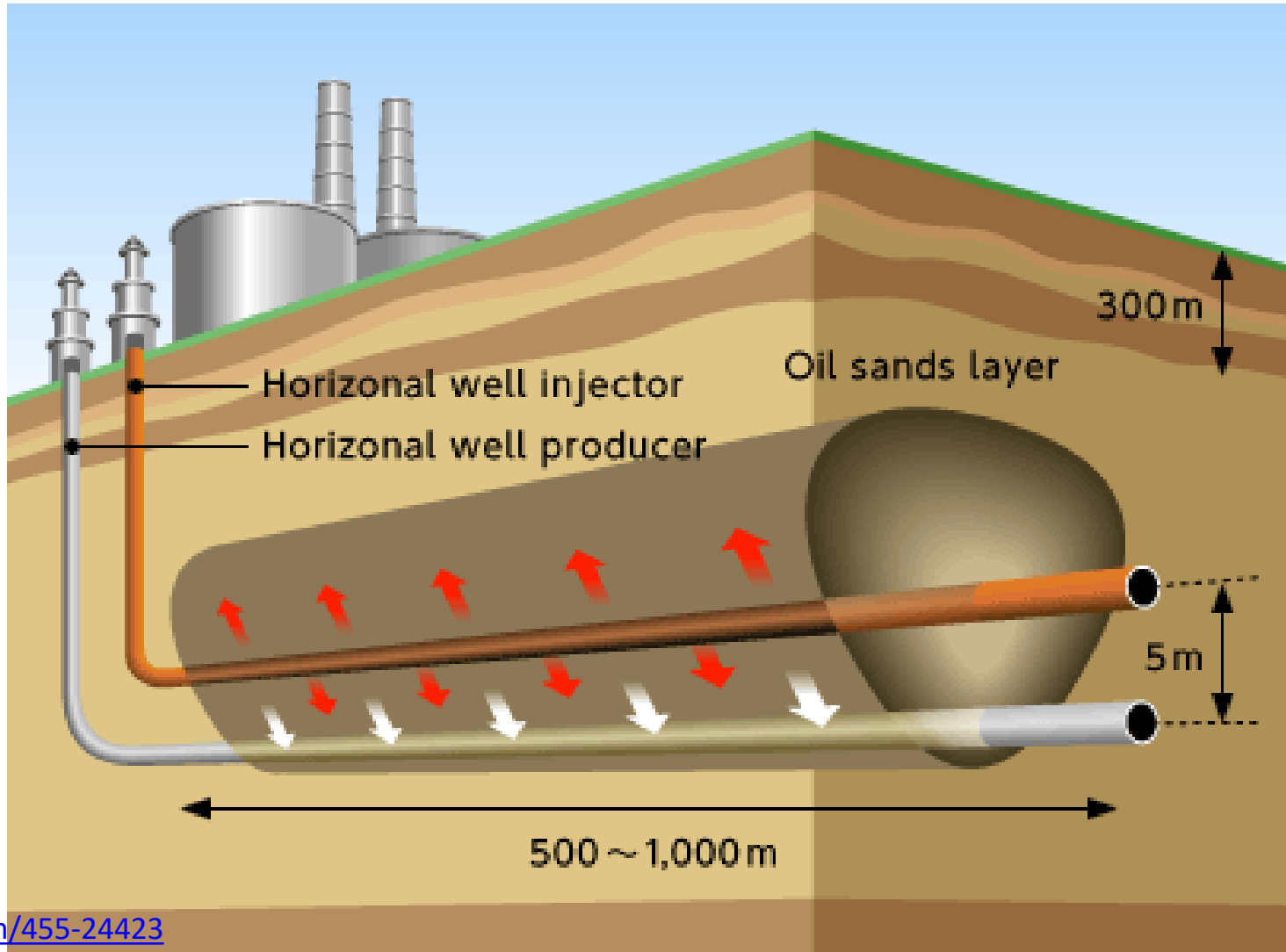
- Is define as the injection of fluids, after the production rates have approached the limits of profitable operation, due to pressure decline.
- Recovery range of secondary recovery is approximately 30%.



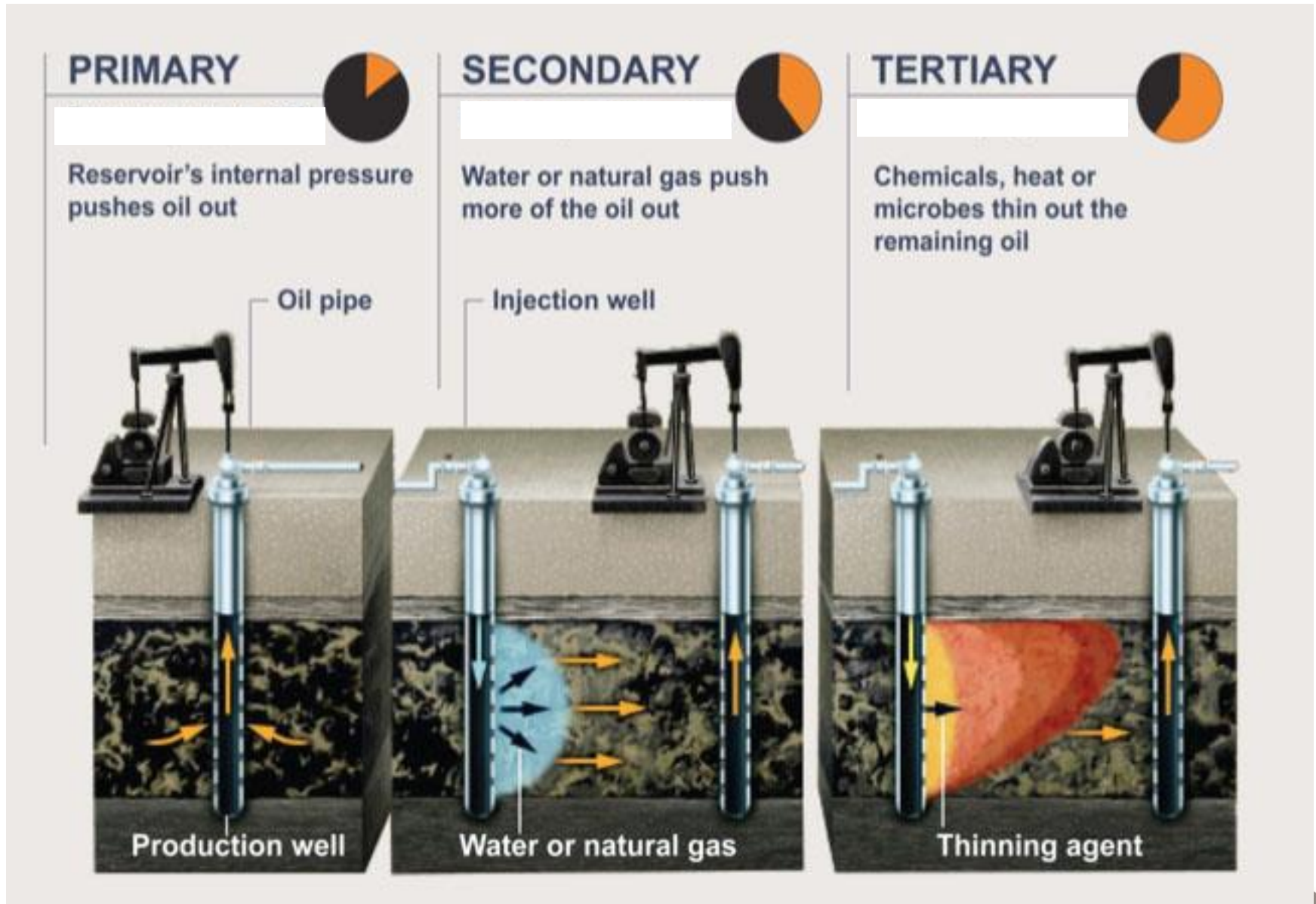
# Enhanced Oil Recovery (EOR)

- Is defined as the use of thermal (heat) energy to increase the production by decreasing the oil viscosity.

The EOR recovery factor ranges from 10-60%



# Summary of Oil Recovery



# Well Stimulation and Hydraulic Fracturing

- Well stimulation is another method used to increase production
- Well stimulation is a well intervention performed on an oil or gas well to increase production by improving the flow of hydrocarbons from the drainage area into the wellbore
- Hydraulic fracturing is an example of well stimulation





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# Fracturing operations in 1949



Roughly 200 tanker trucks deliver water for the fracturing process.

A pumper truck injects a mix of sand, water and chemicals into the well.

Natural gas flows out of well.

Recovered water is stored in open pits, then taken to a treatment plant.

Storage tanks

Natural gas is piped to market.



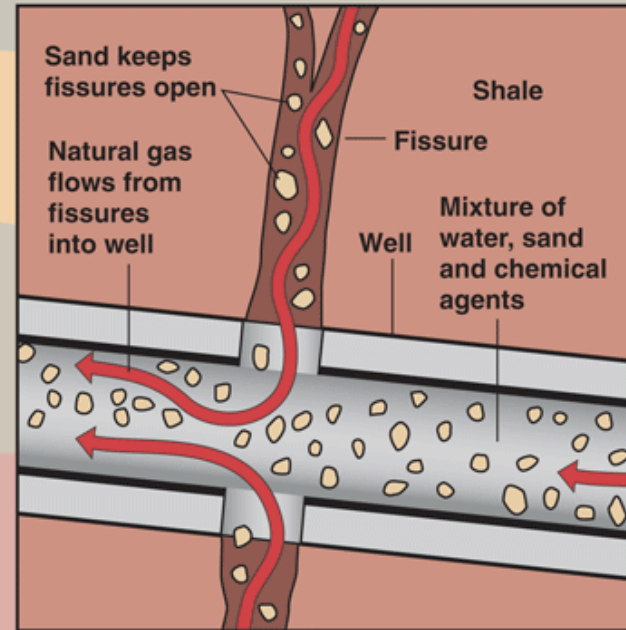
0 Feet  
1,000  
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5,000  
6,000  
7,000

Water table

Well

### Hydraulic Fracturing

Hydraulic fracturing, or "fracing," involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.



Sand keeps fissures open

Natural gas flows from fissures into well

Fissure

Shale

Well

Mixture of water, sand and chemical agents

Fissures

Well turns horizontal

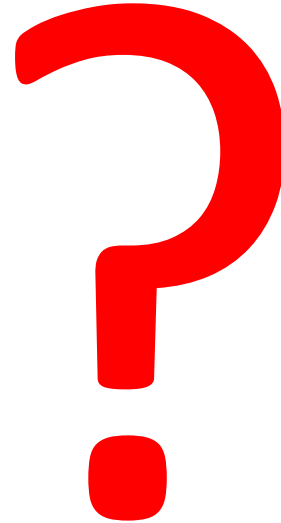
Marcellus Shale

The shale is fractured by the pressure inside the well.



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# Hydraulic fracturing, is it good or bad?



# Hydraulic fracturing, is it good or bad?

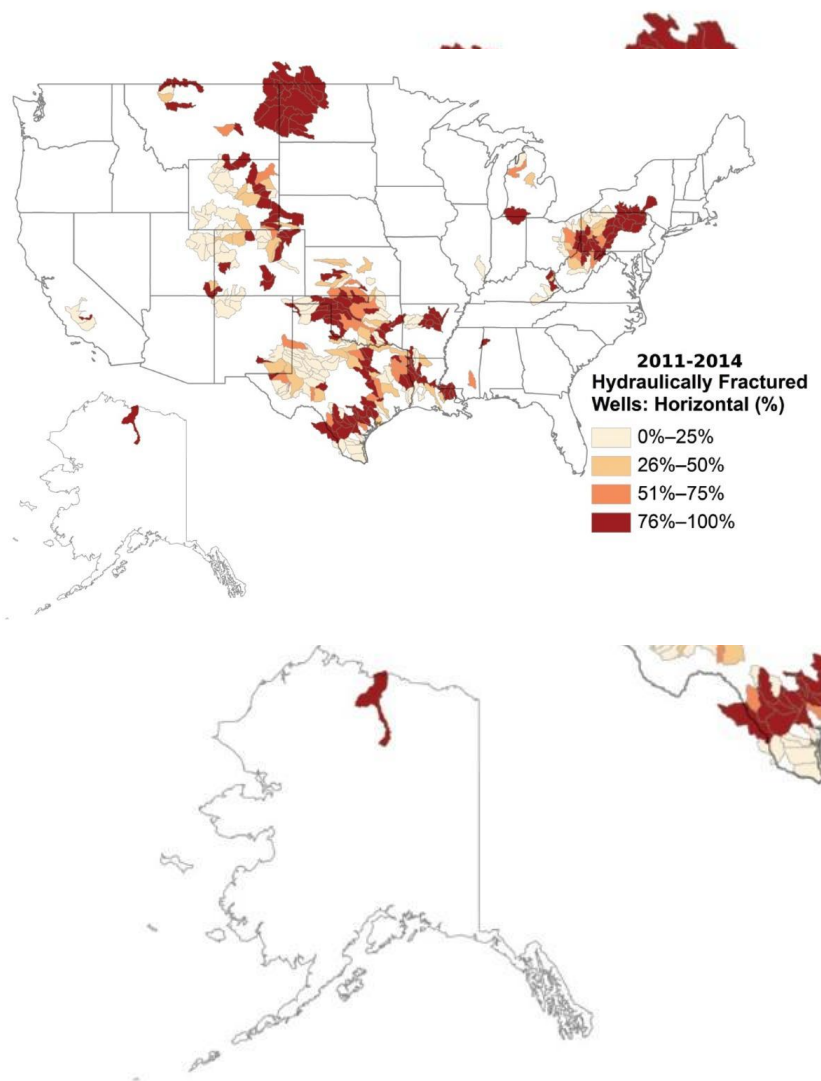
## Advantages

- Reduce energy dependence on Middle East
- New development supported 600,000 jobs in 2011
- Cheap natural gas = more manufacturing in USA
- Future exporter of energy ??
- Reduced generation of greenhouse gas due to replacement of coal with natural gas:
  - In 2000 16% of power generated with natural gas
  - In 2030, 30% use predicted

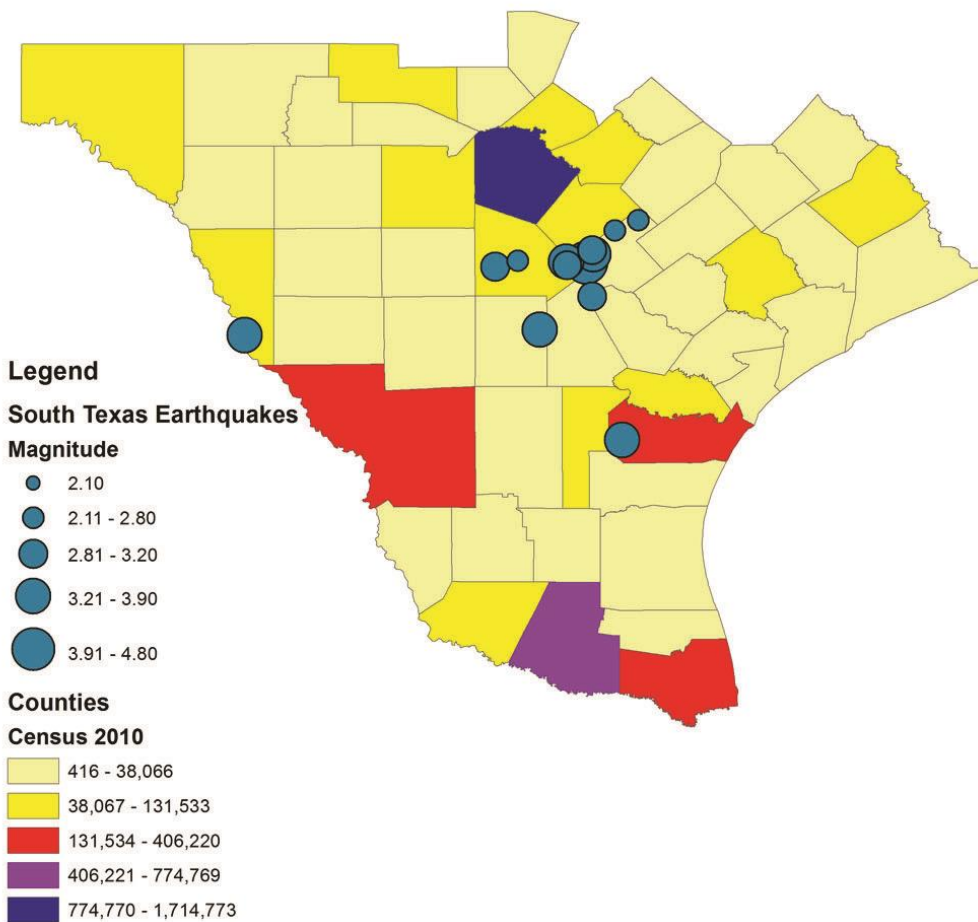
## Disadvantages

- Huge water demand
- Huge amount of wastewater generated
- Limited regulation
- Potential for cross-contamination of drinking water aquifers with fracturing chemicals
- Induced seismic activity from deep injection wells
- Extend our reliance on fossil fuels

# Hydraulic Fracture Wells & Earthquakes



Texas Earthquakes 2005-2014



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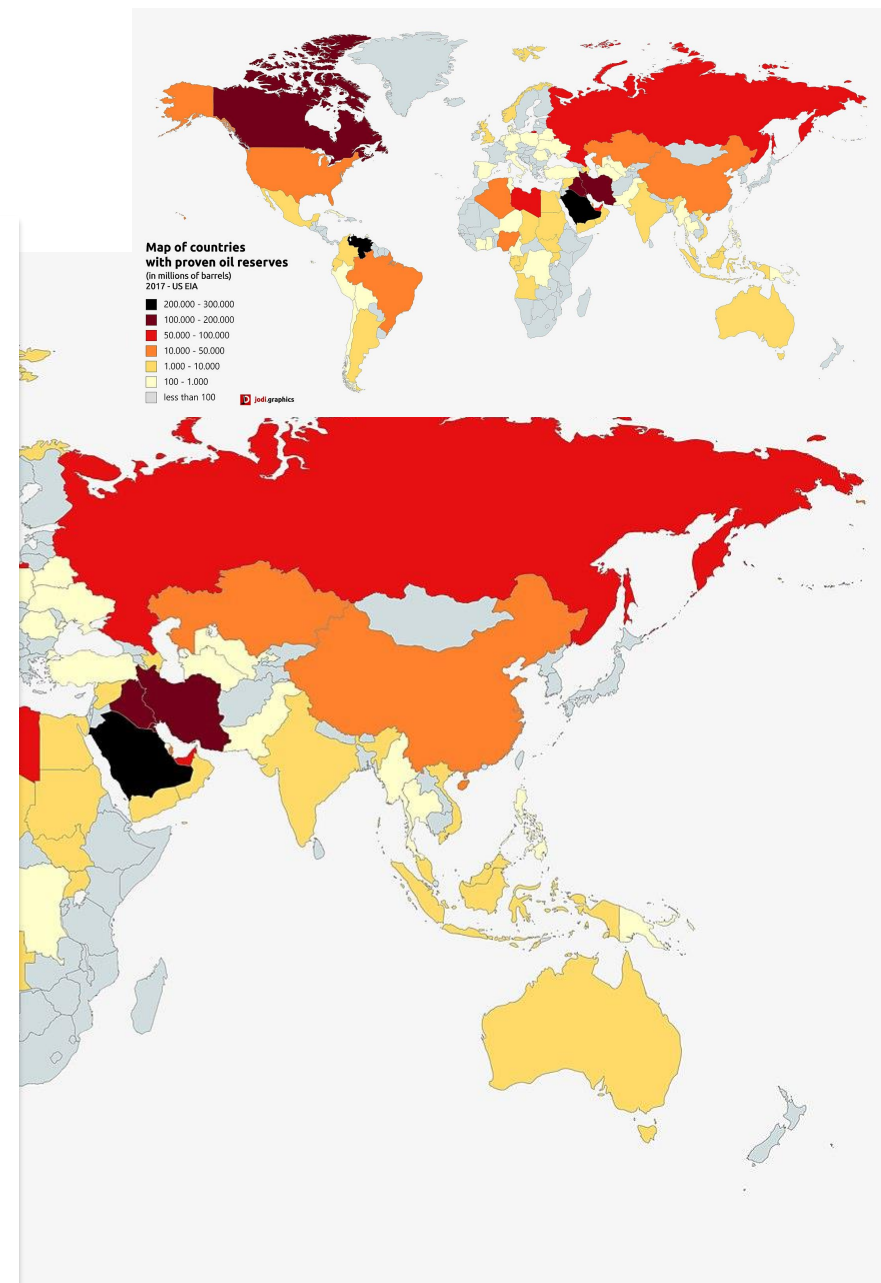
# Reserves



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# Oil Reserves

- The estimated total world oil reserve is 1.665 trillion barrel
- Top countries with highest oil reserves are:
  1. Venezuela (300.9 billion)
  2. Saudi Arabia (266.5 billion)
  3. Canada (169.7 billion)
  - 
  - 
  - 
  7. USA (97.8 billion)
  8. Russia (80 billion)





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# What I didn't mention

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**Thank you**

**Dr. Al Dushaishi**

**10/26/2018**