

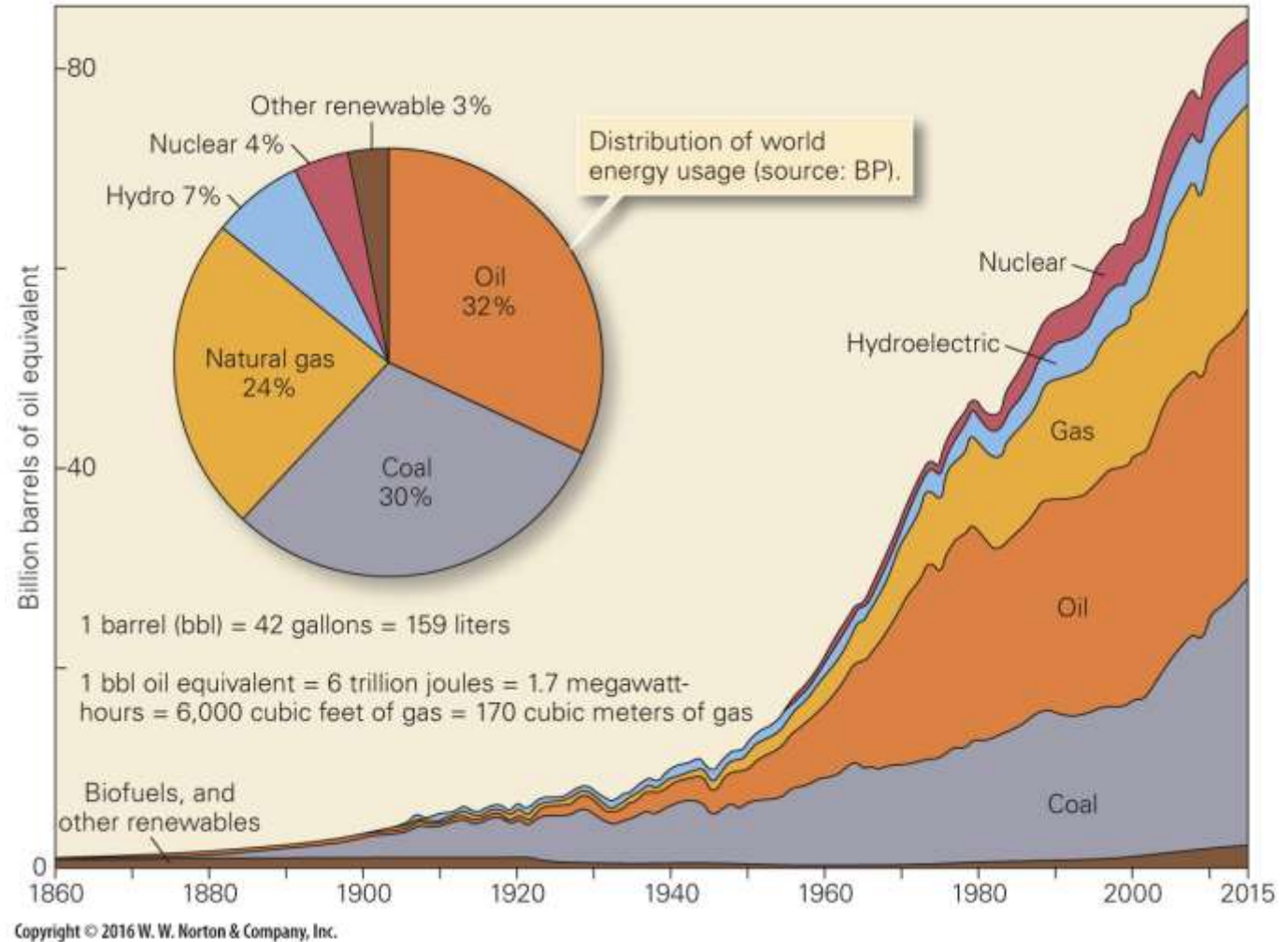
# Energy and People

What have we done so far today?

# Energy

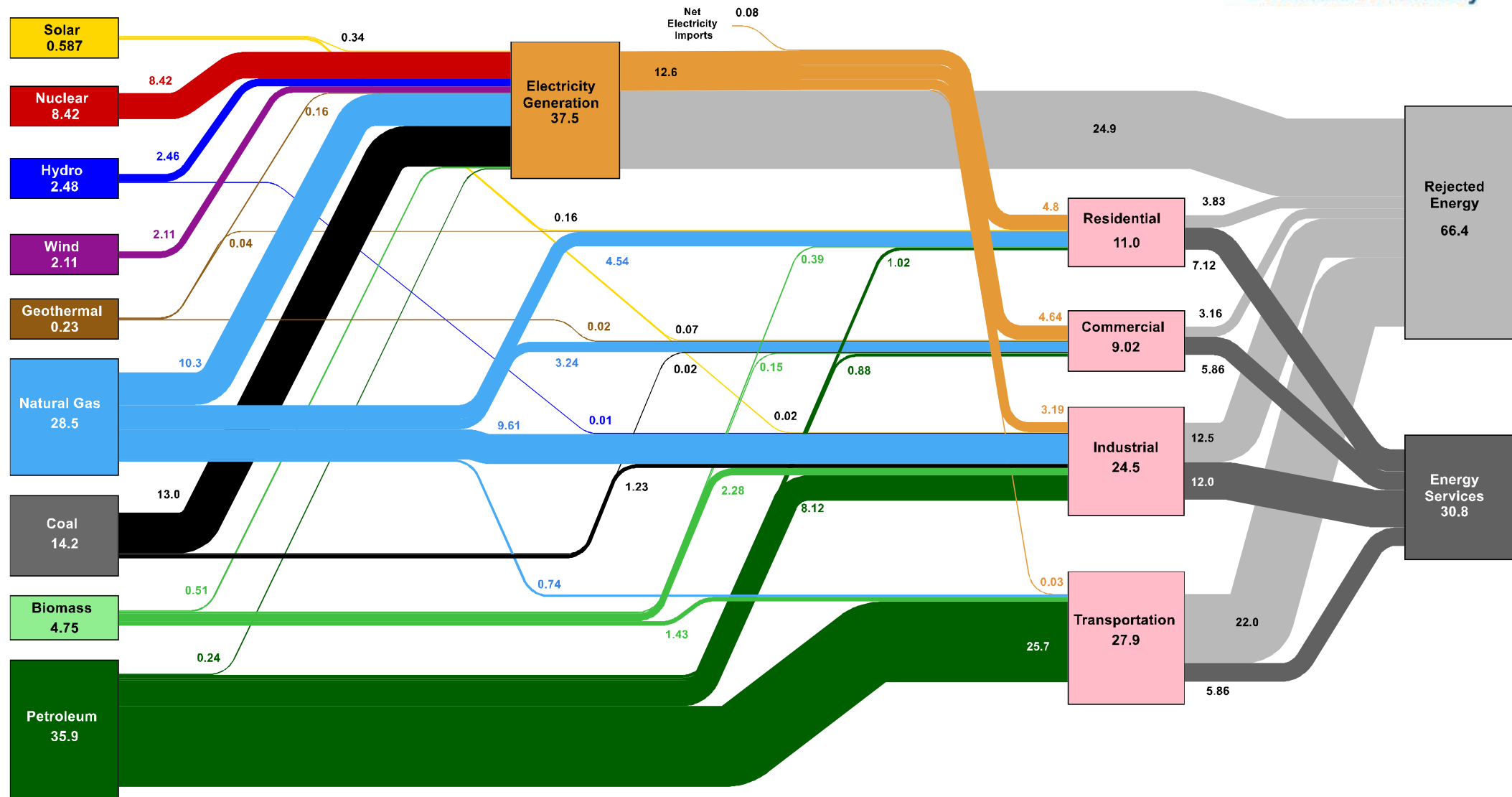
## USA

- Oil (35%)
- Natural gas (26%)
- Coal (17%)
- Nuclear (8%)
- Plants (4.3%)
- Hydropower (2.7%)
- Wind (1.4%)
- Solar (0.2%)
- Geothermal (0.2%)



<https://flowcharts.llnl.gov/>

## Estimated U.S. Energy Consumption in 2016: 97.3 Quads

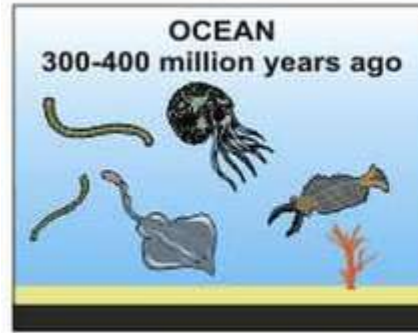
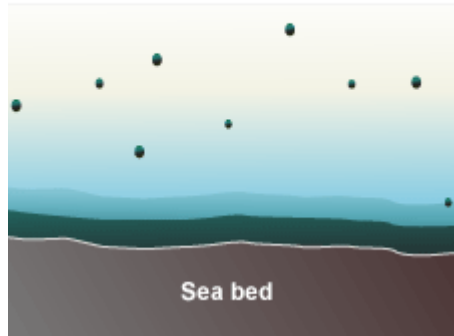


# Oil and Gas

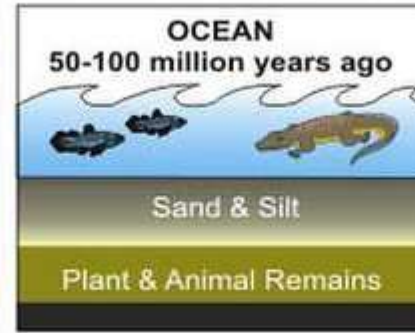
- Where does oil come from?

# PETROLEUM & NATURAL GAS FORMATION

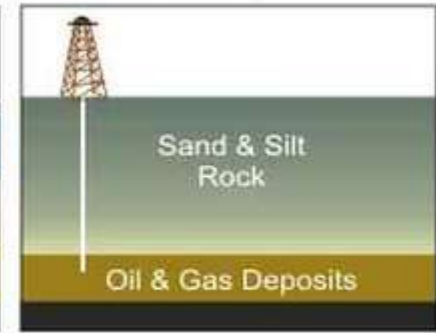
Dead animals and plants  
build up on the sea bed



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

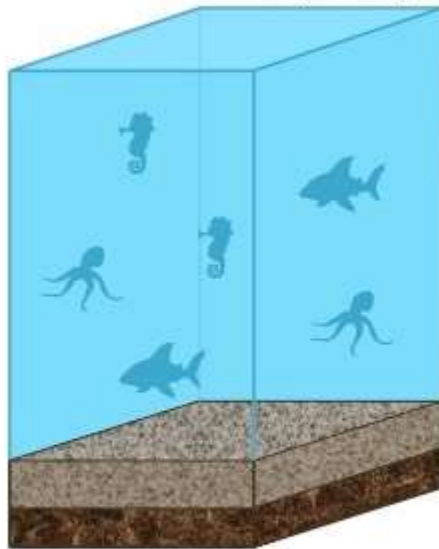


Over millions of years, the remains  
were buried deeper and deeper.  
The enormous heat and pressure  
turned them into oil and gas.



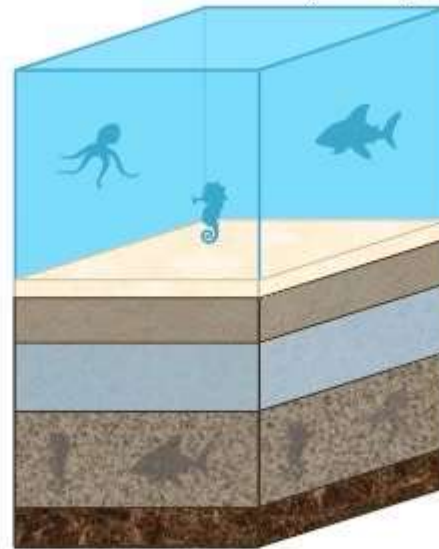
Today, we drill down through layers  
of sand, silt, and rock to reach  
the rock formations that contain  
oil and gas deposits.

~ 300 to 400  
million years ago



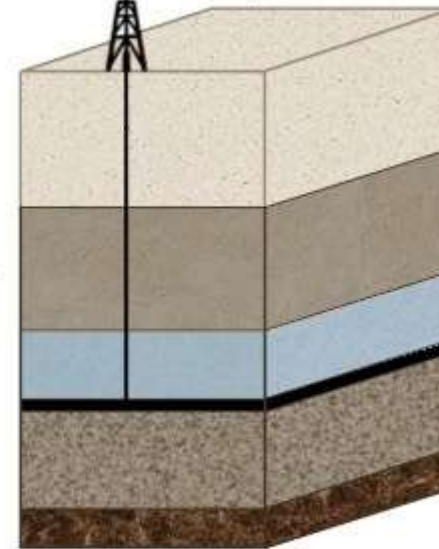
Aquatic plants and animals die  
and are buried on the ocean  
floor by layers of sand and silt

~ 50 to 100  
million years ago



Layers of sediment are deposited  
above and the pressure and heat  
causes compaction of the remains

present time



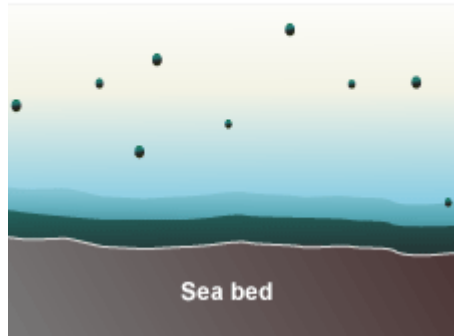
The remains become oil and gas,  
which are forced out of porous rock  
to form deposits which we drill for

Mud layer gradually turns to rock





Dead animals and plants  
build up on the sea bed



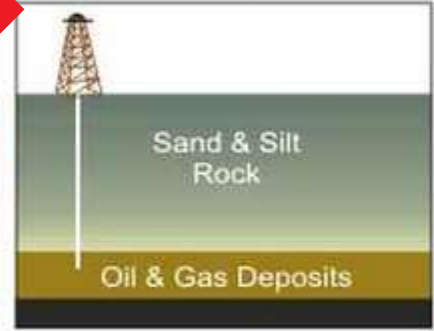
## PETROLEUM & NATURAL GAS FORMATION



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



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



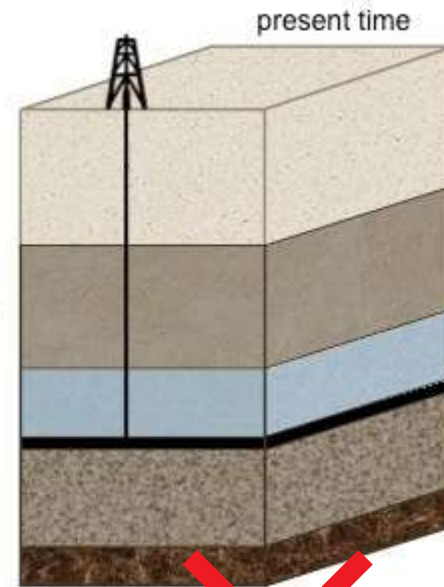
Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.



Aquatic plants and animals die and are buried on the ocean floor by layers of sand and silt



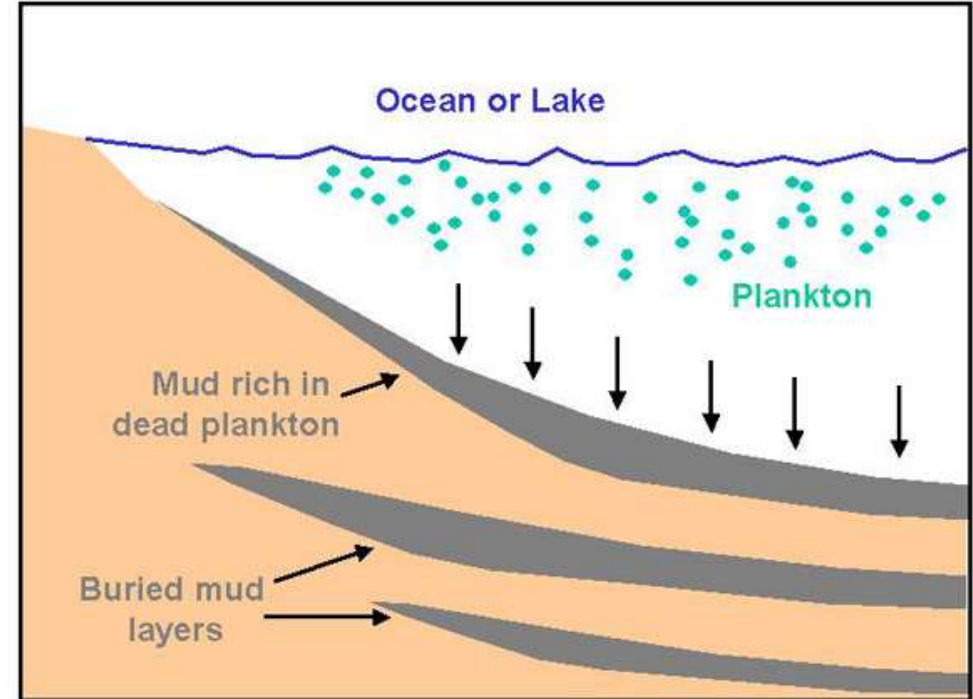
Layers of sediment are deposited above and the pressure and heat causes compaction of the remains



The remains become oil and gas, which are forced out of porous rock to form deposits which we drill for

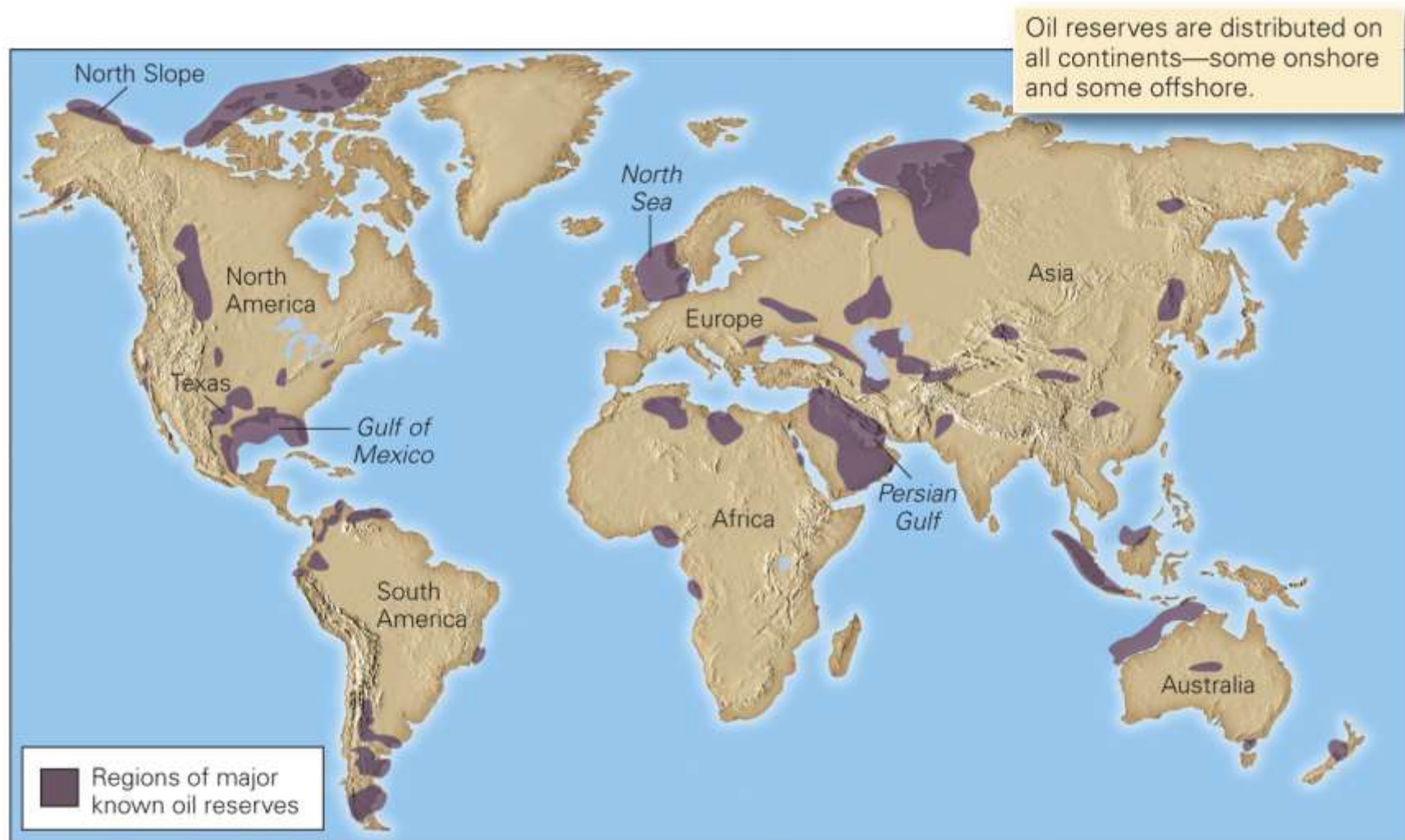


# Plankton and no oxygen



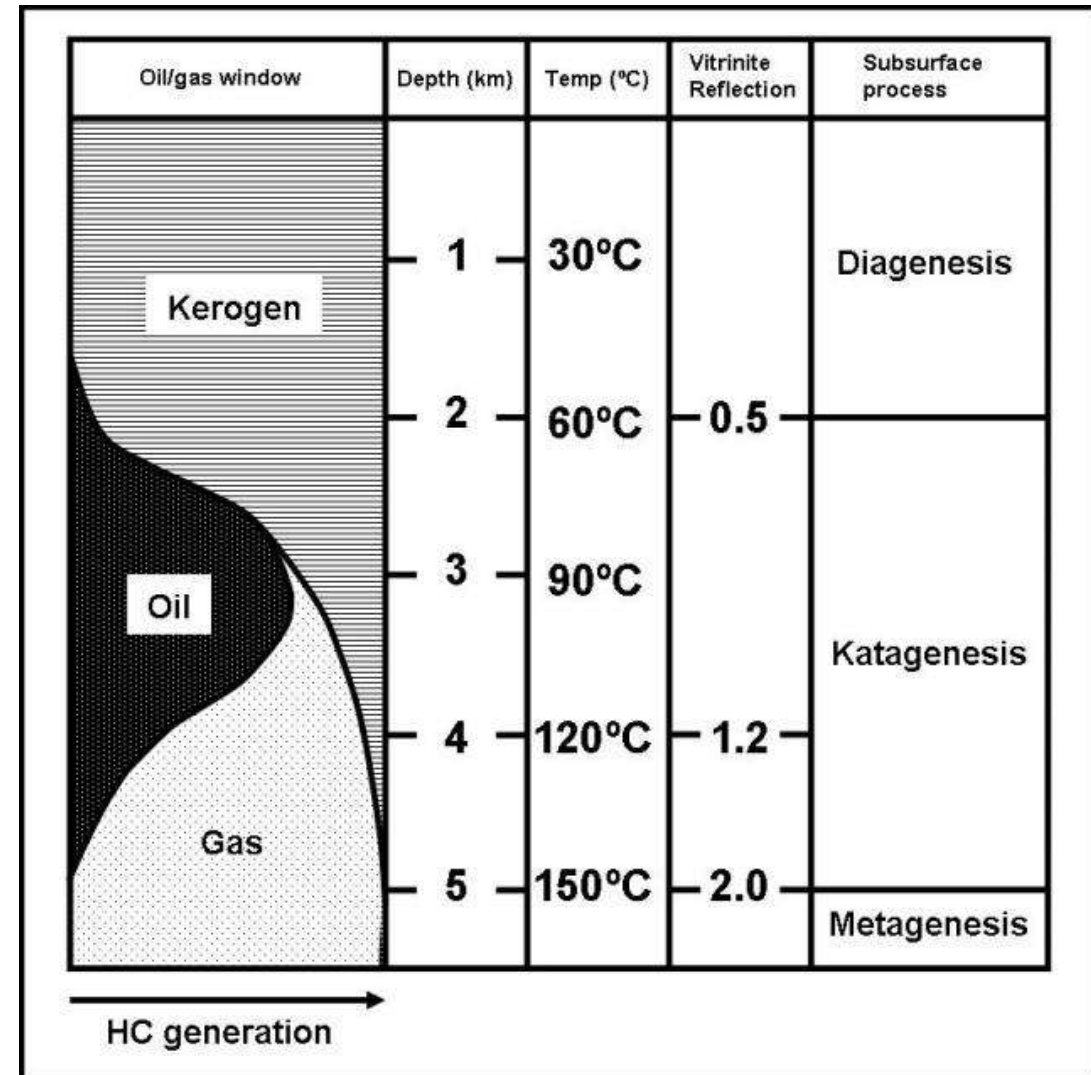
- Organic rich muds during periods of low oxygen levels
- When do/did these happen?





# Temperature

- 20 – 90 = Kerogen (oil sands)
- 60 – 150 C = Oil
- 150 – 250 C = Gas

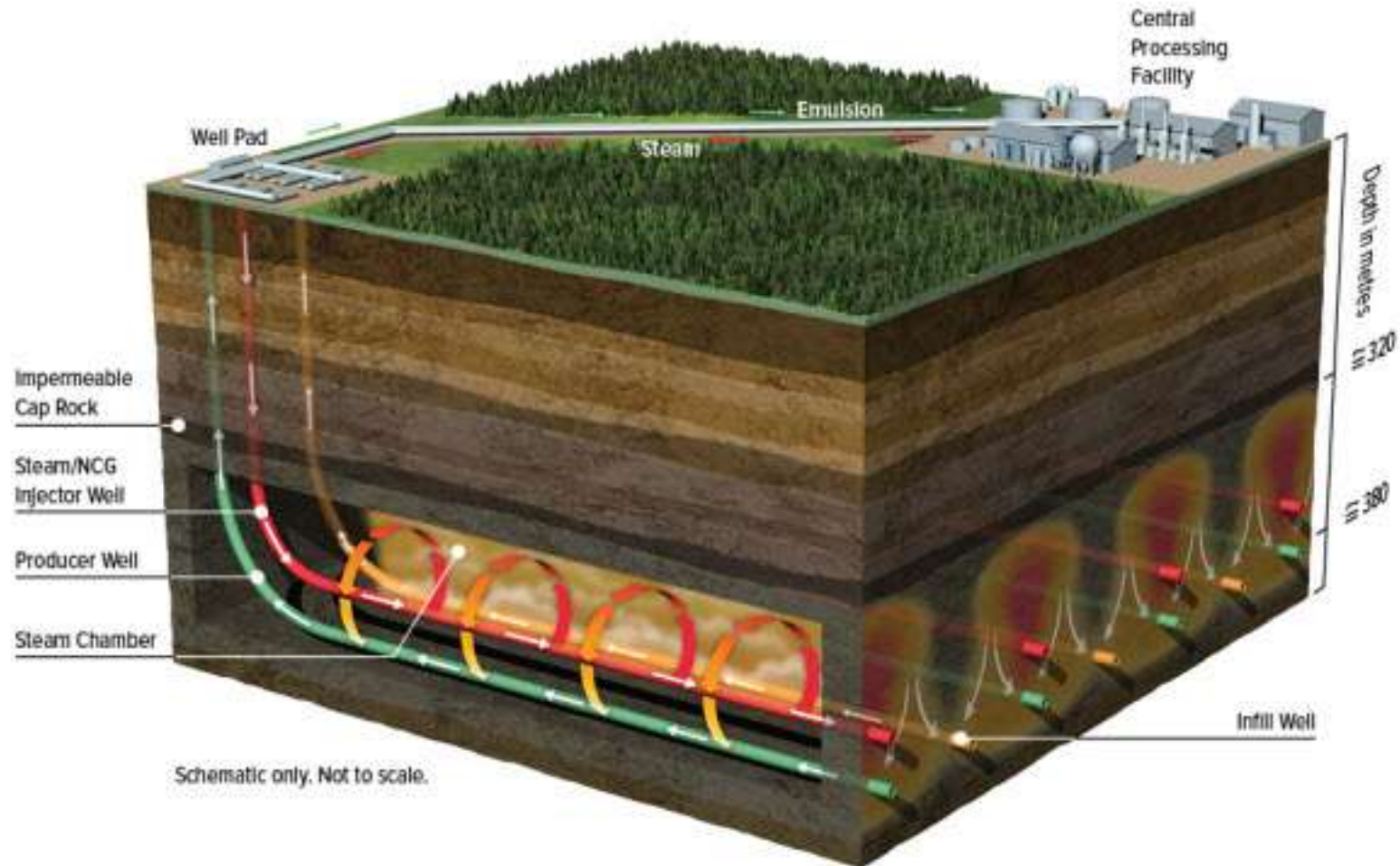


# Oil Sands (Kerogen)





# Enhanced oil recovery



# Oil Sands Suck

- Lots of work (getting it out of the ground and in making usable petroleum products out of it)
- Messy (requires large amounts of land, bad for the environment around, and all the people living/working in the area)
- Low output
- Expensive

# Oil floats

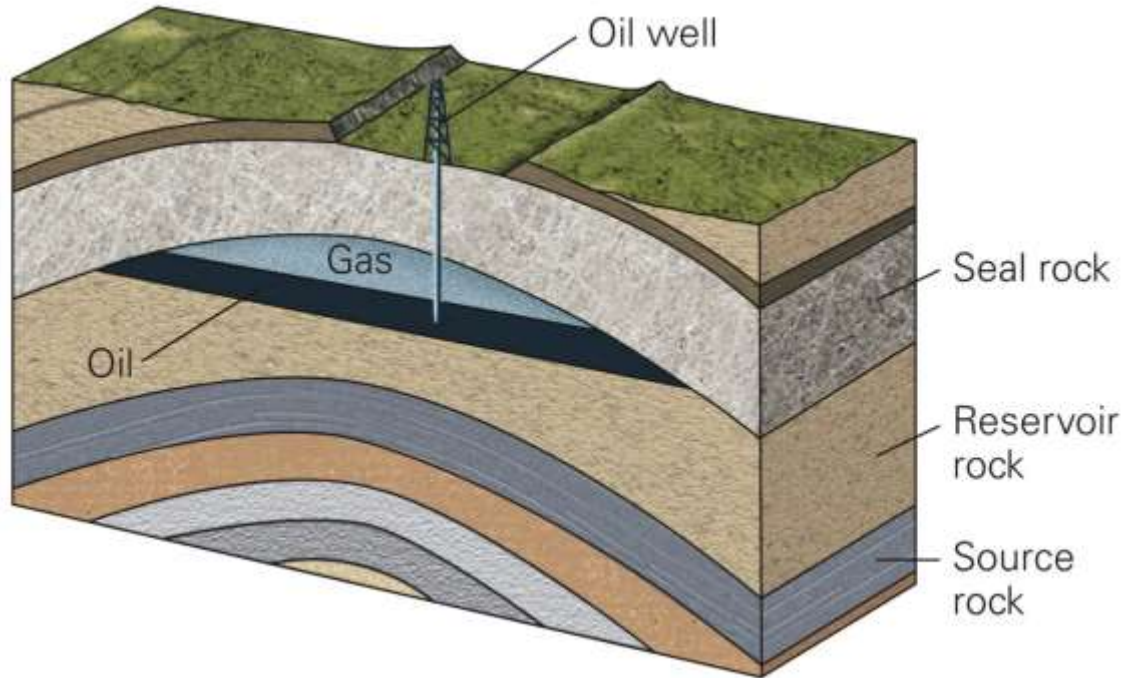
(Kerogen floats too but its too thick/slow)



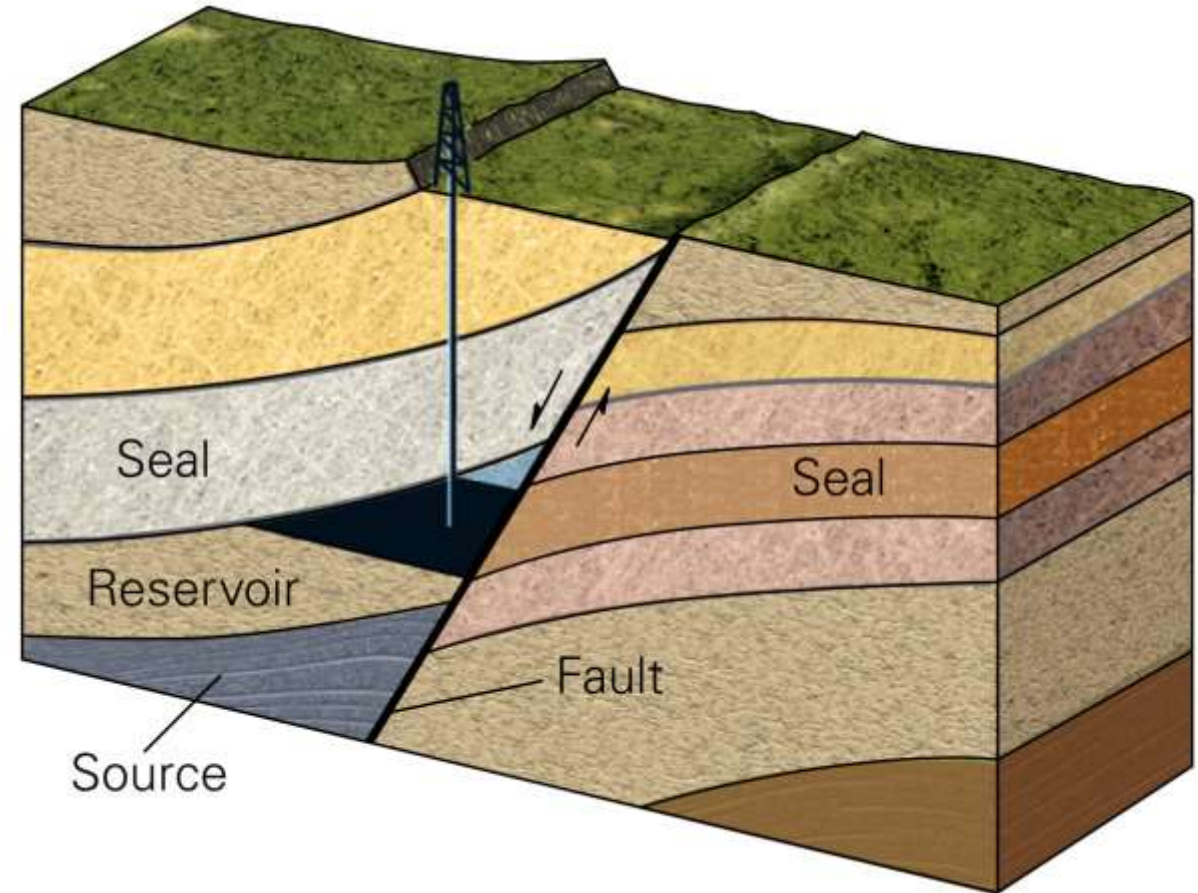




# Need a geologic trap to contain it



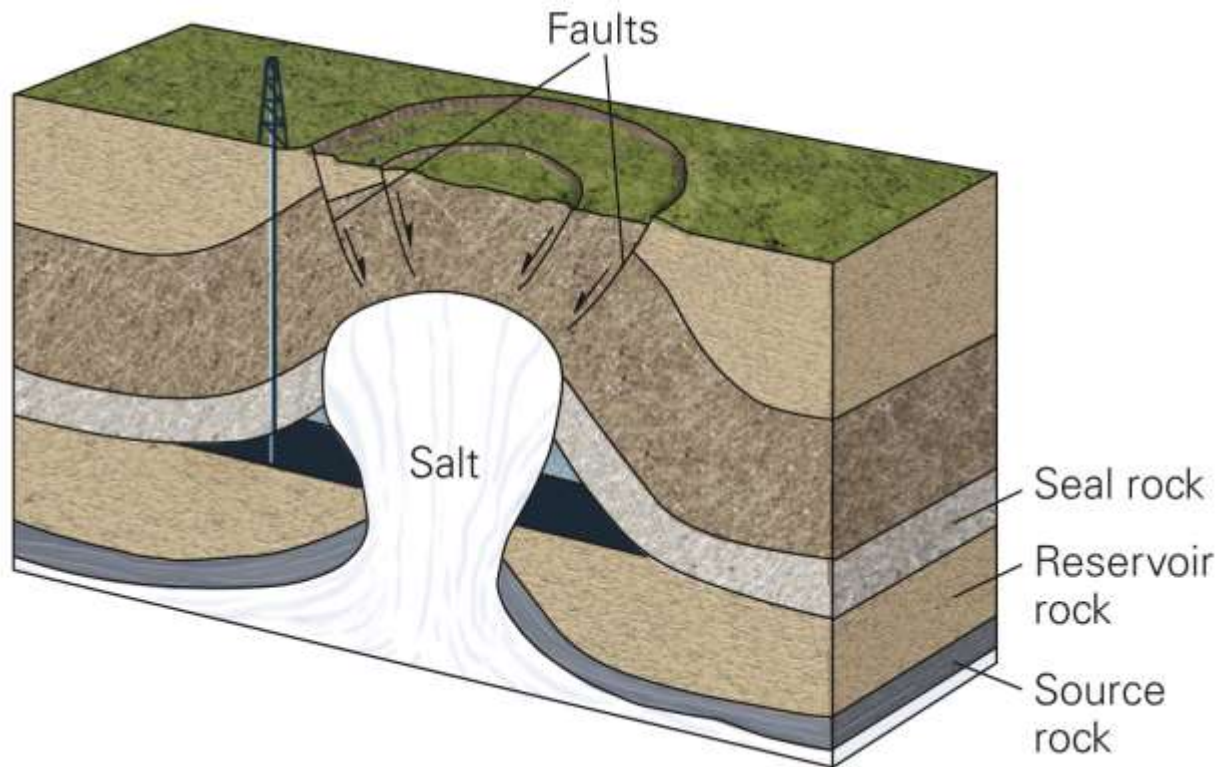
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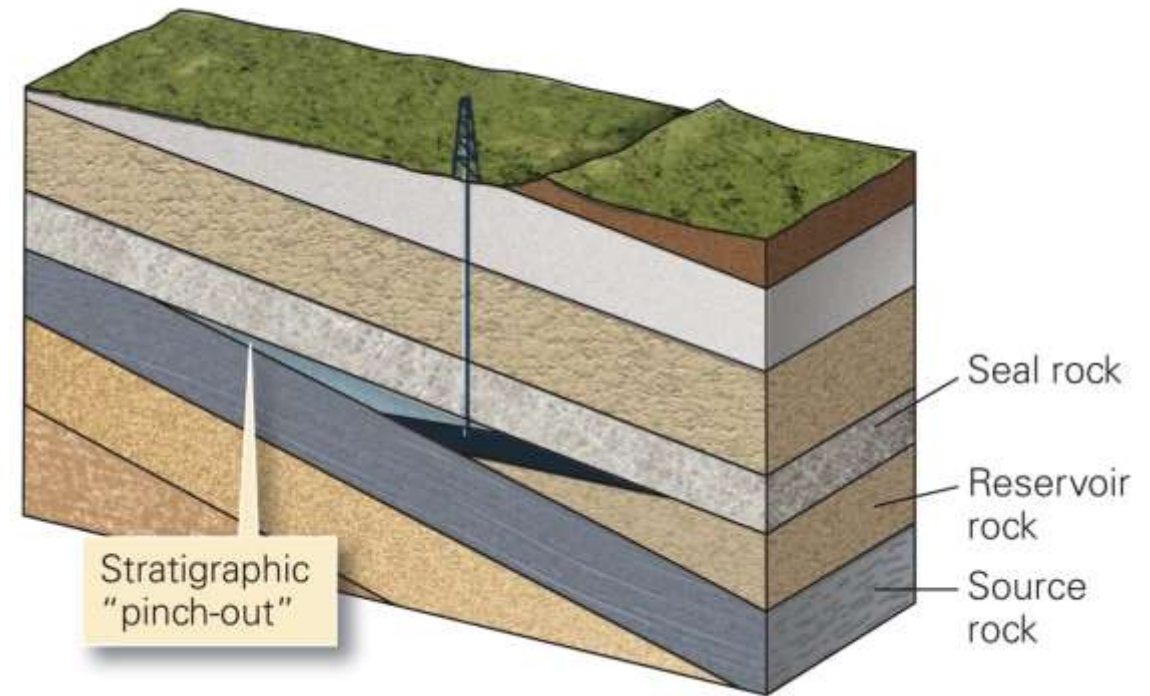
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# Gas and Oil are often mined at the same time



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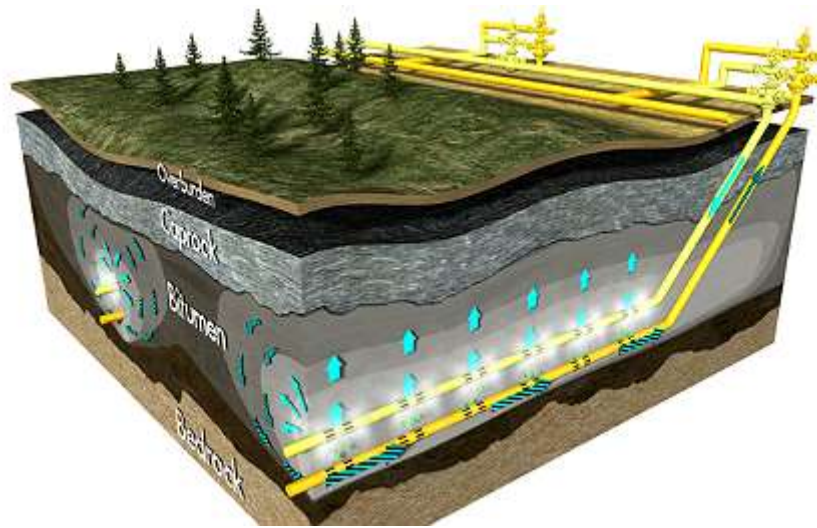
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Pumping gets 20-30% oil out

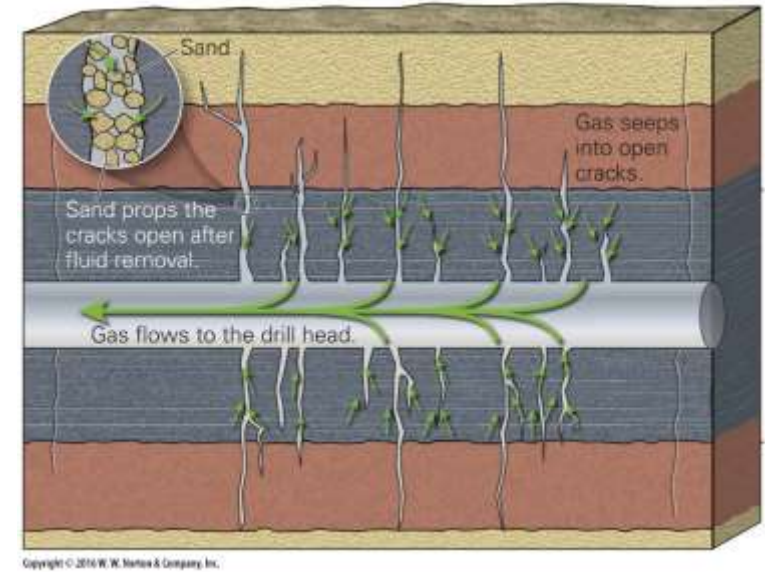
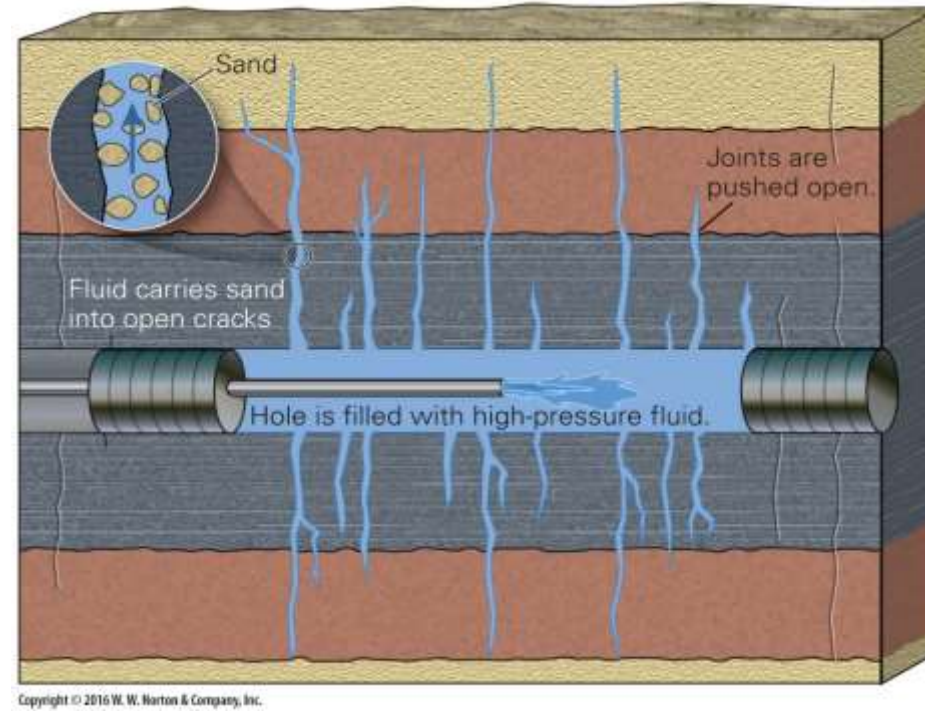
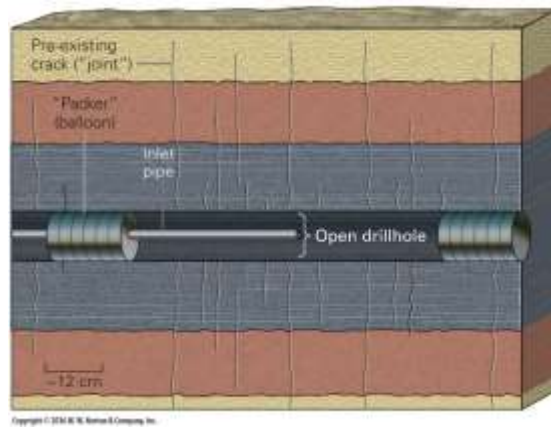




EOR (Enhanced oil recovery) = 10-20% more



# Fracking





Oil drilling back then:  
<https://vimeo.com/124053021>









# Huntington Beach



# Long Beach today





# Coal



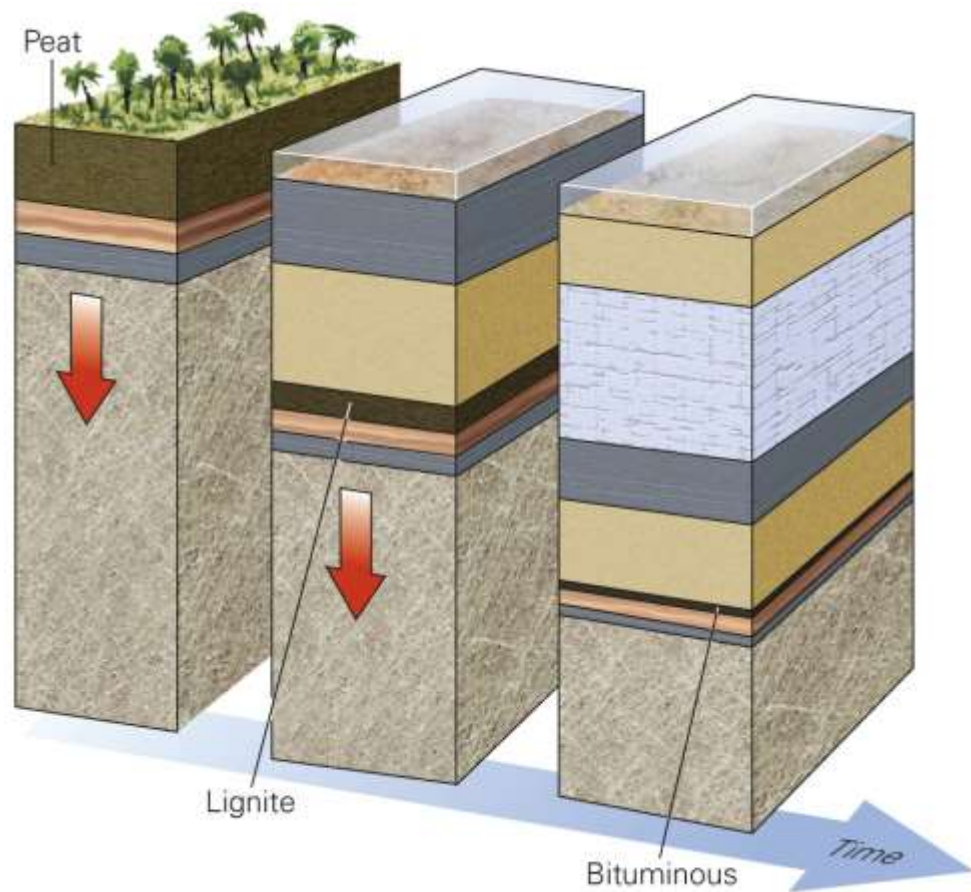
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# Where did it come from?



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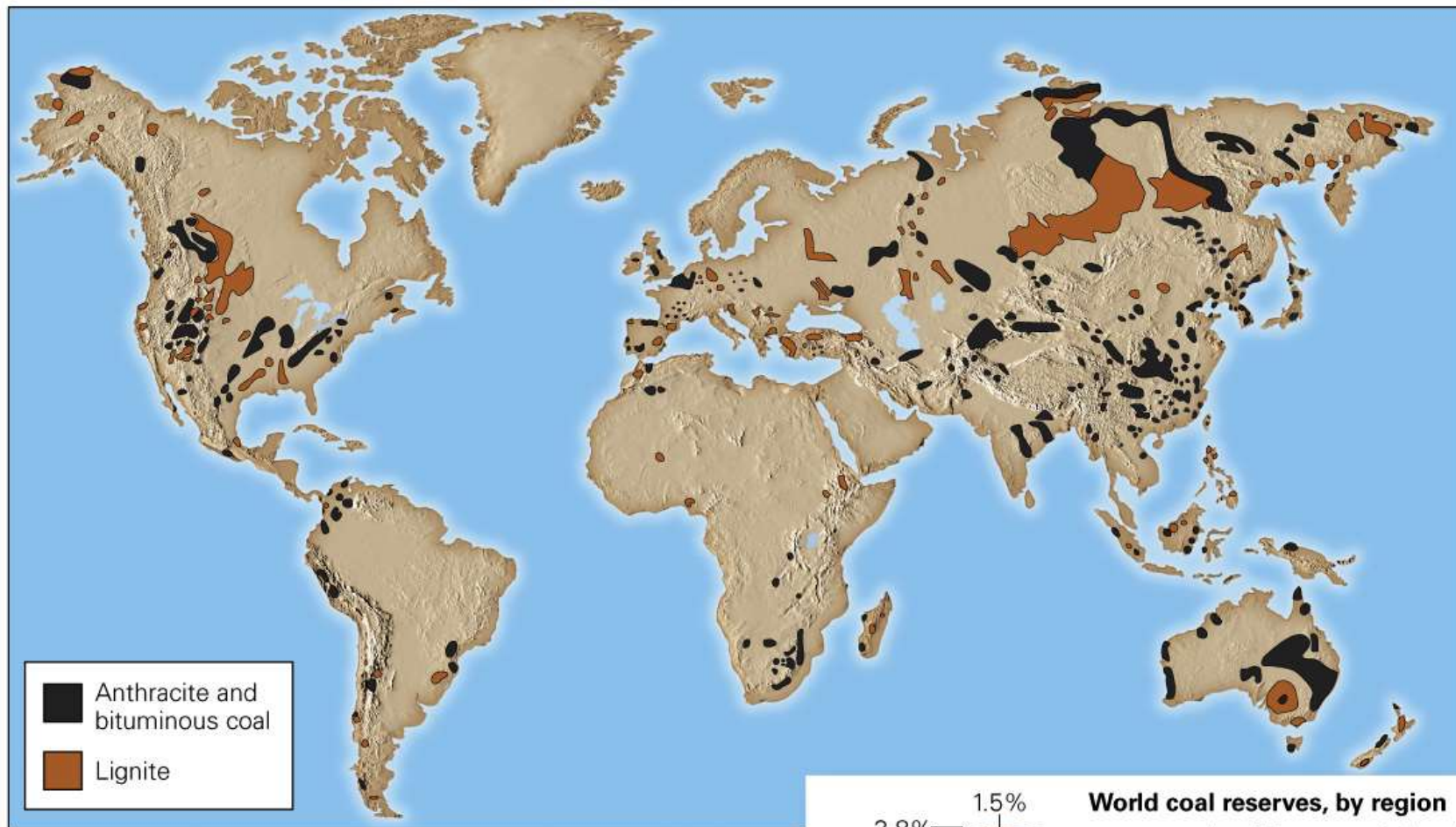


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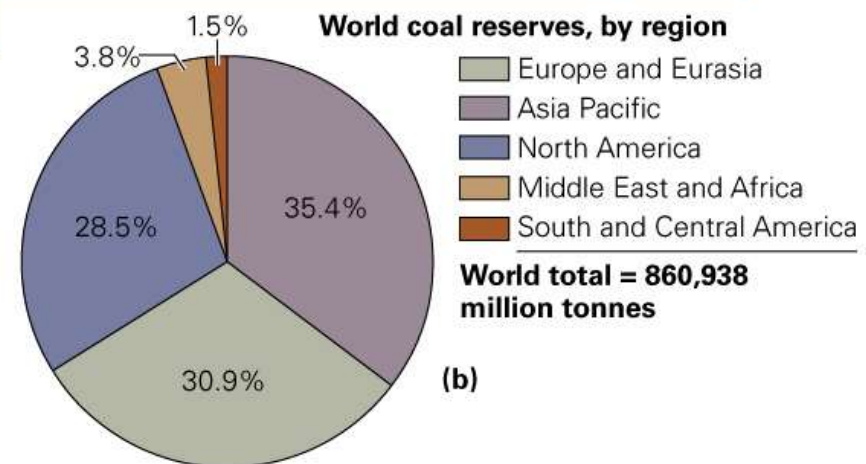


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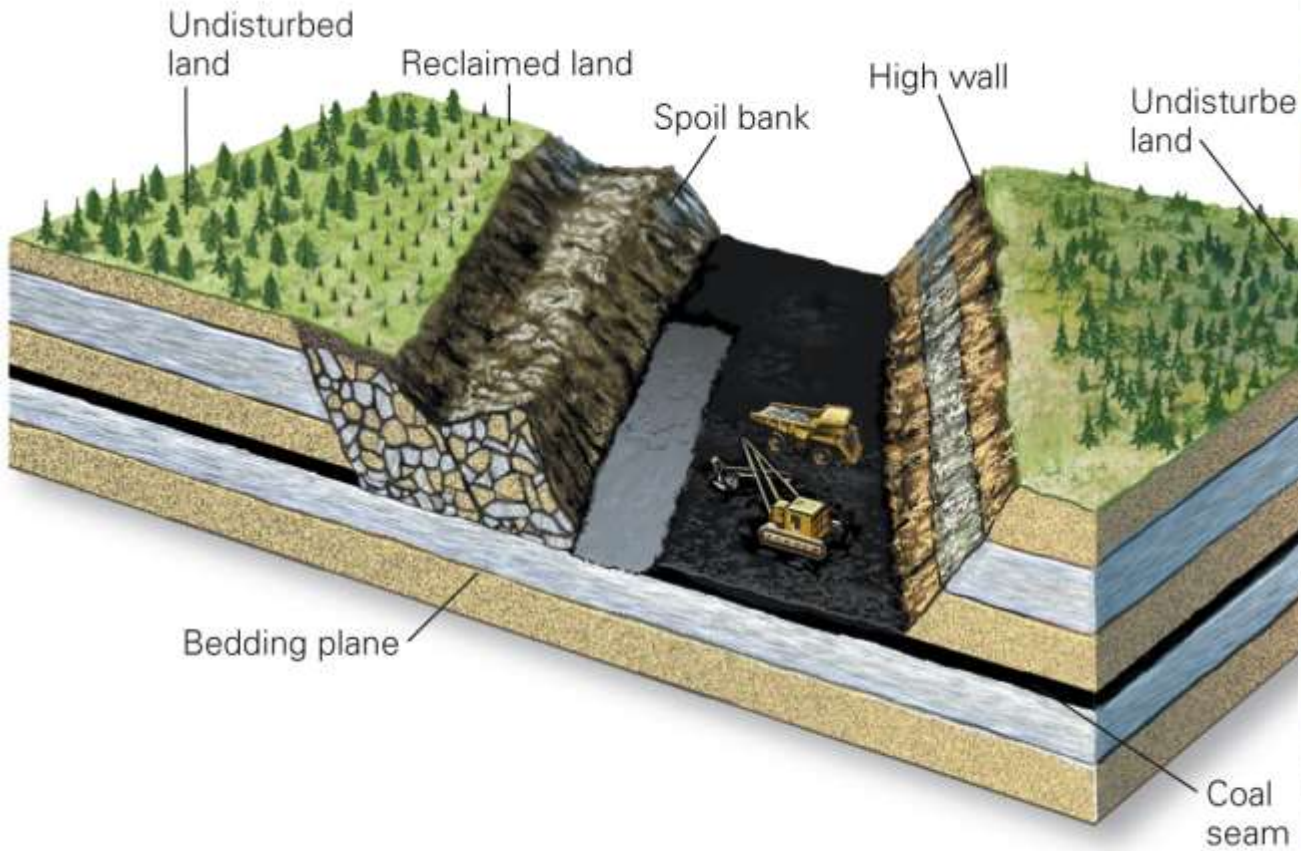


(a)



(b)

# Work along a coal seam



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<https://www.youtube.com/watch?v=Iwuy4hH03YQ>

- “Video killed the radio star”
- What is killing off the coal miner jobs that featured so prominently in the 2016 elections?



# Modern mining equipment



# Economic geology/mineralogy changes



Also we have a world of 7.4 billion people. What will we all do when we have automated most of our jobs?

# Hydropower





# Surface and ground water linked





# New base level changes recreation, and habitat



# New amount of sediment





# Nuclear

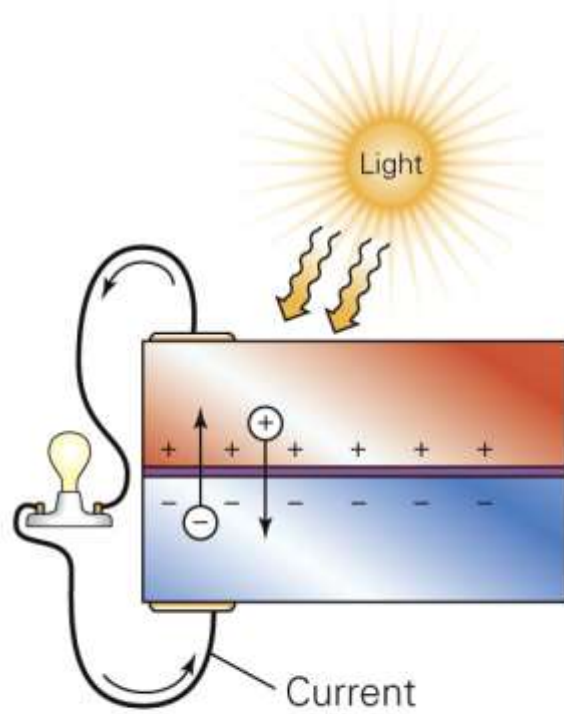


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- Large number of west coast sites shut down because they were located on faults!







# Reality with energy:

- The reality is a bit too extreme for current civilization but we have 4 options (or a combination of them might work too):
  - 1) We need to use less energy per person
  - 2) Or have one hell of a party in the next 50 to 200 years
  - 3) Create technology which allows us to do number 1
  - 4) Have less people

Actually option 2 is off the table...  
we have too many grumpy politicians that we can  
have the party, but its not going to be any fun.





# Shiny things!

- What metals do we need?
- Where does it come from?





Want to do the least amount of work, and get  
the highest reward



(a)

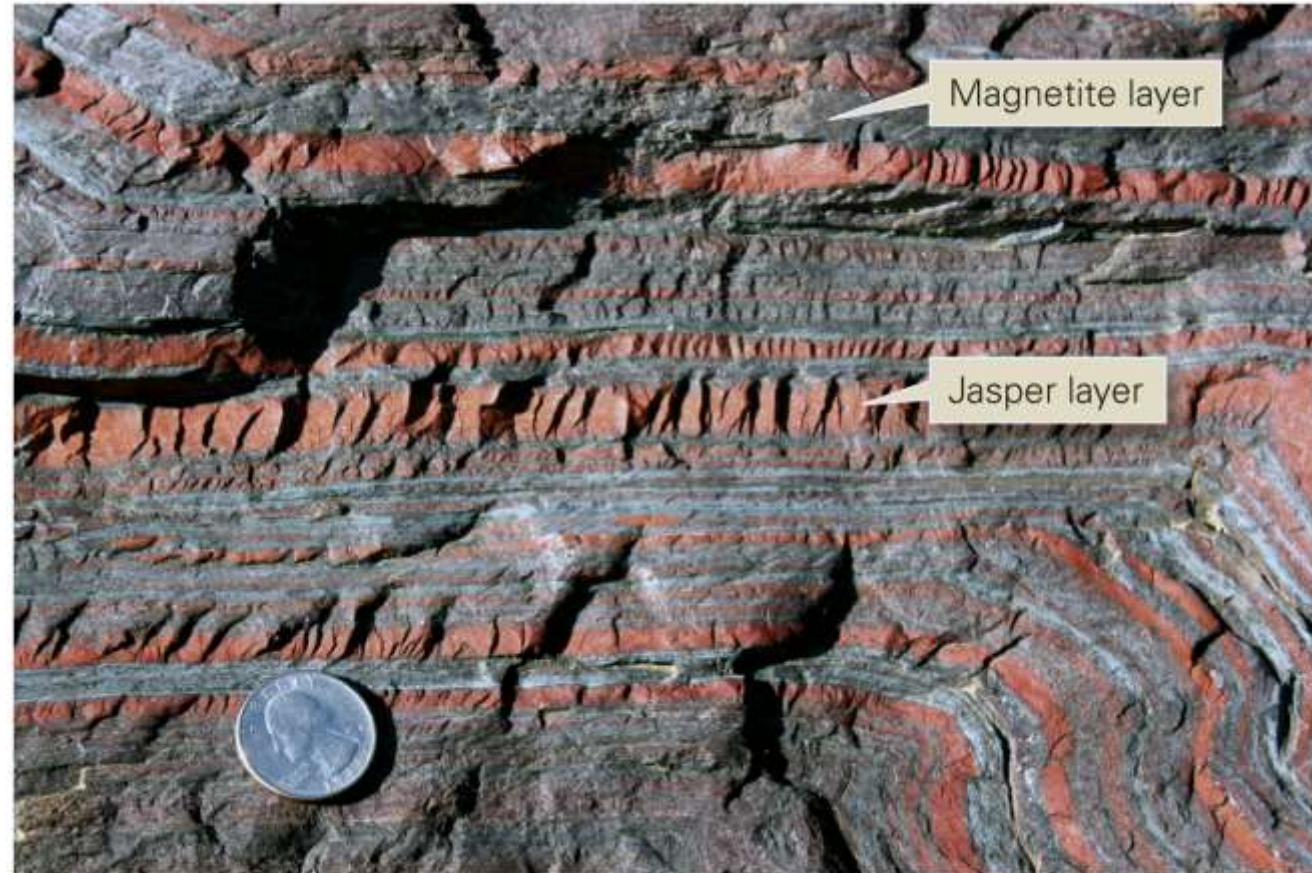
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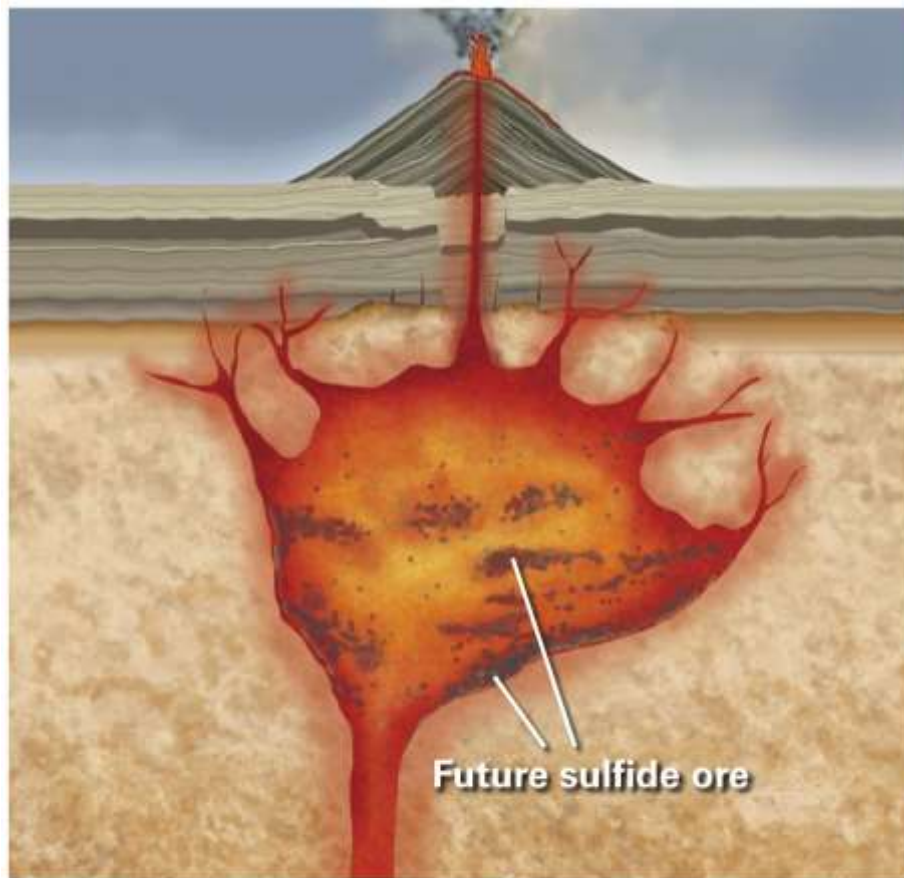
(b)



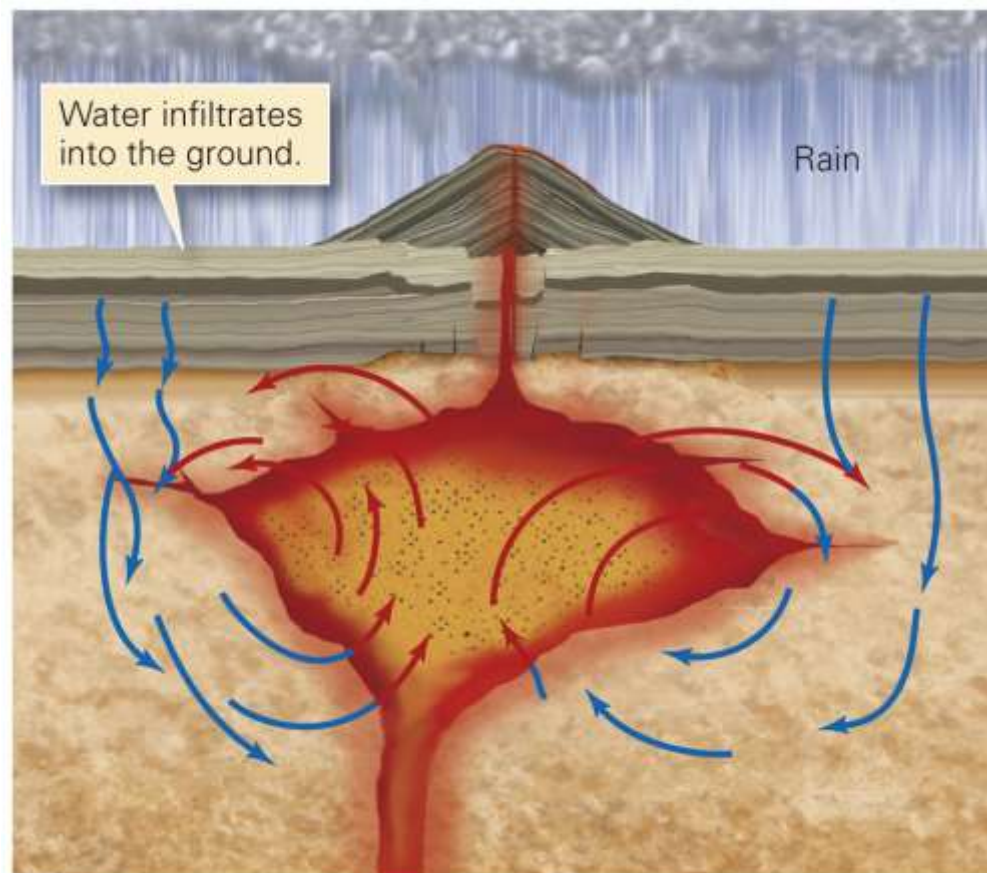
# Iron ore: BIF



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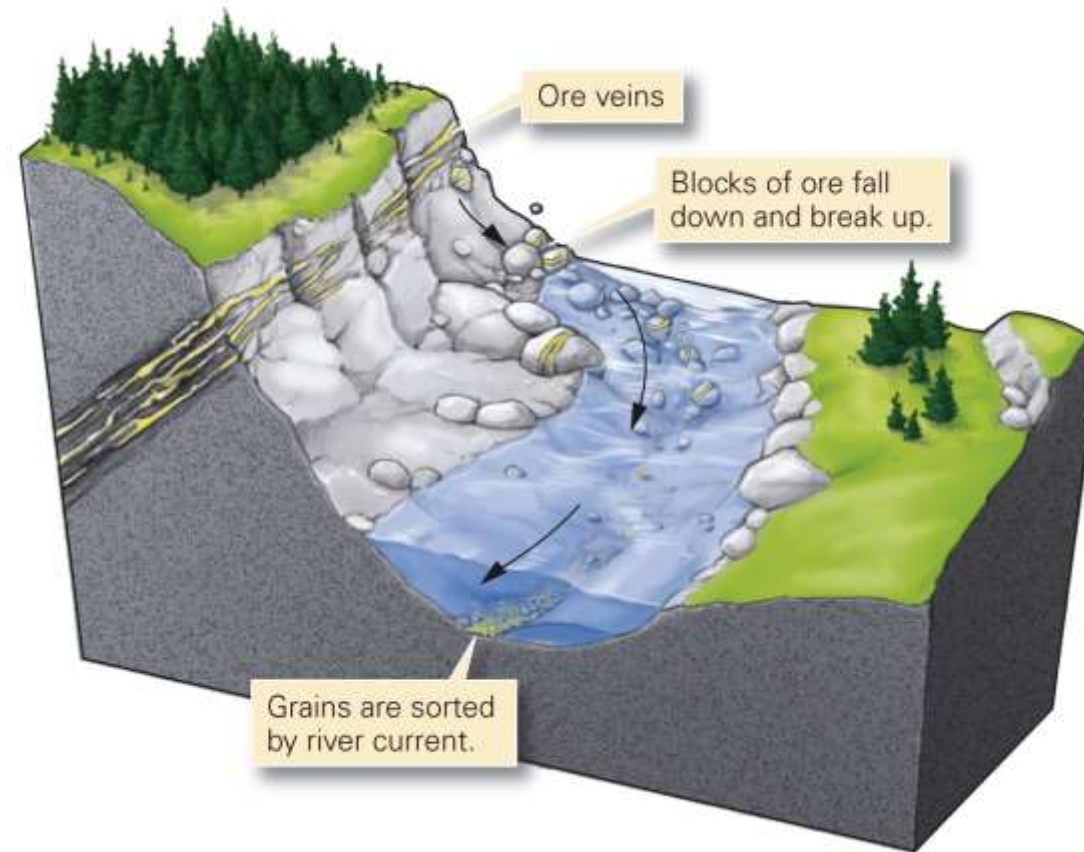


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# Placer deposits and veins



# Placer deposit mining





“Motherlode” type mining is over in the north  
most mining is of low concentrations



Africa still rich with some motherlode type deposits, Greenland rich too!





Low concentration means lots of earth  
needed





# Rare Earth Elements

- And associated semiconductor or magnet driven elements



# Mountain pass mine (only active REE mine in USA)





Dangers: expose minerals to the surface





# Weathering





# Ore refining putting elements into the air



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# Not too dangerous or bad: dimension stone, building materials



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## Cement

