Energy, Materials, Safety, and Fun

Industry jobs in Geology and the broader Geosciences

Topic of the day:

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

- Metals
- Extra shiny things
- Rare earth elements

- Natural Hazards
- Human made hazards
- Keeping humans safe

Energy

USA

- Oil (35%)
- Natural gas (26%)
- Coal (17%)
- Nuclear (8%)
- Plants (4.3%)
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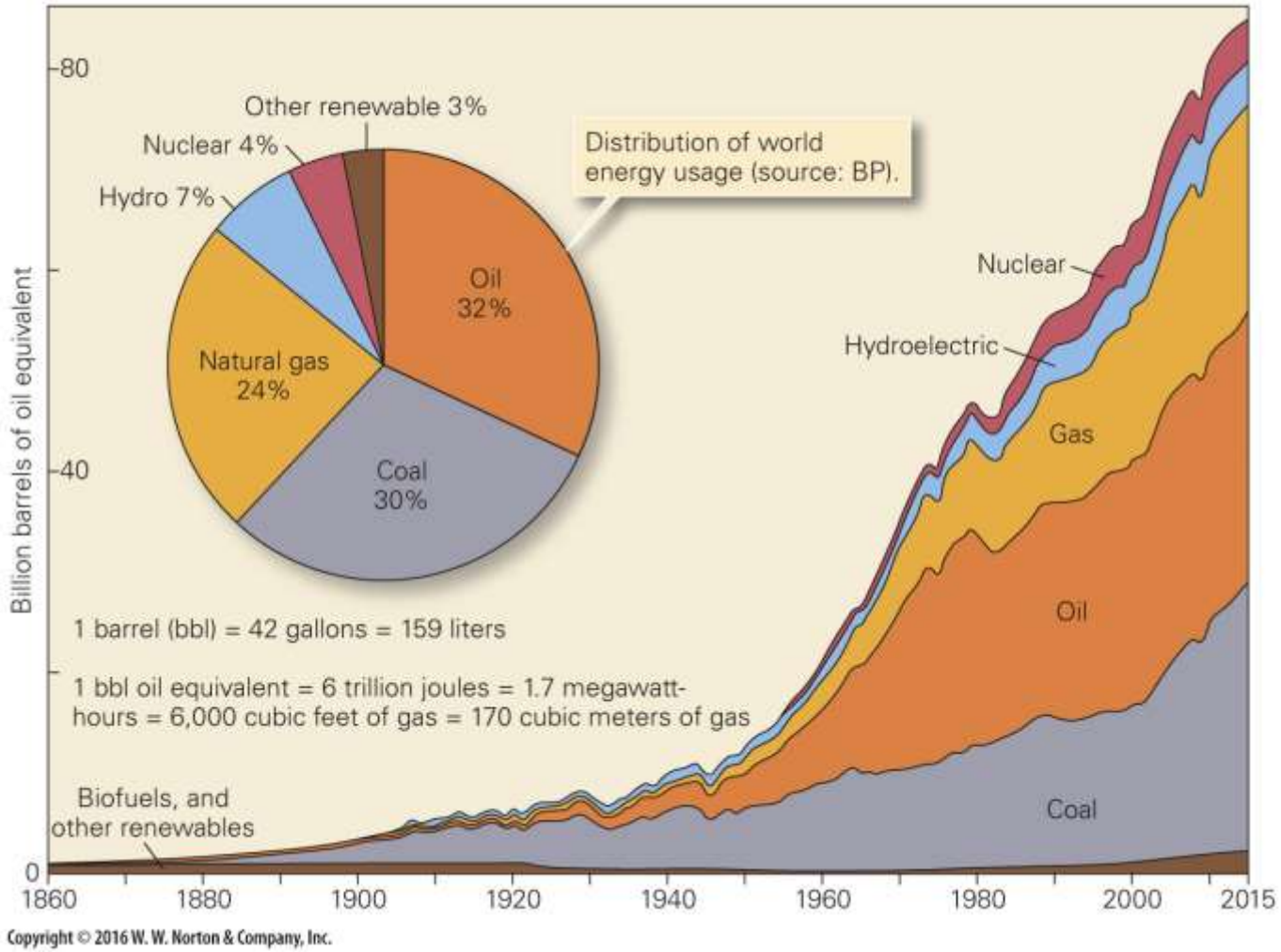
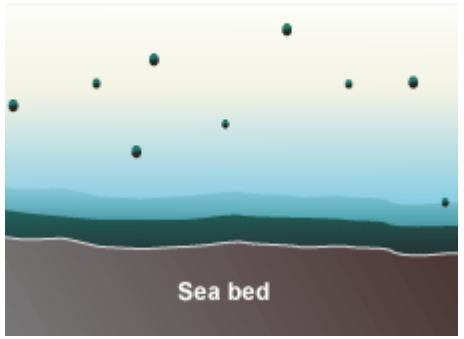


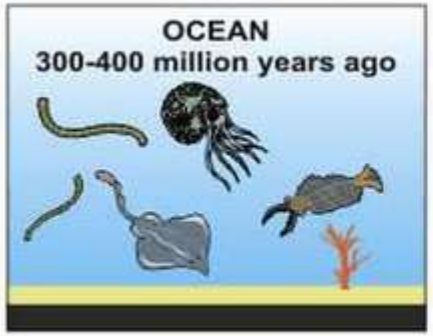
Oil and Gas

- Where does oil come from?

PETROLEUM & NATURAL GAS FORMATION

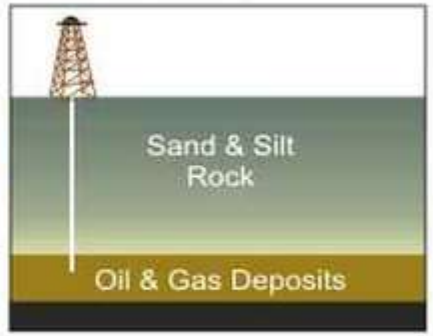
Dead animals and plants build up on the sea bed





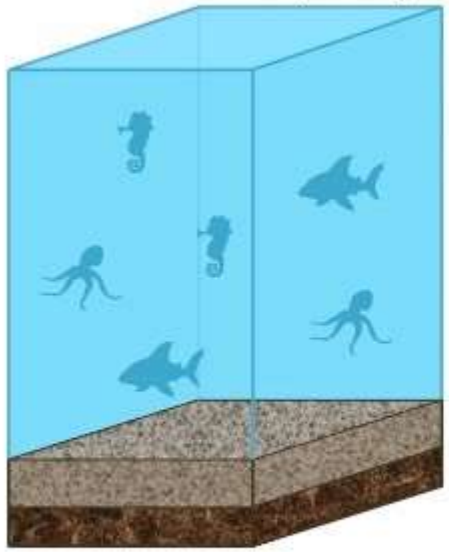
Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.

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



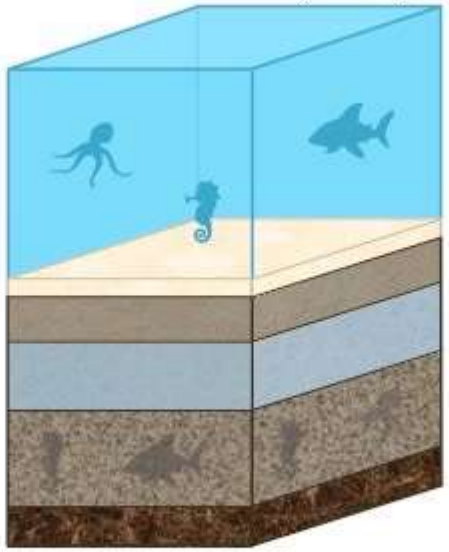
Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

~ 300 to 400 million years ago



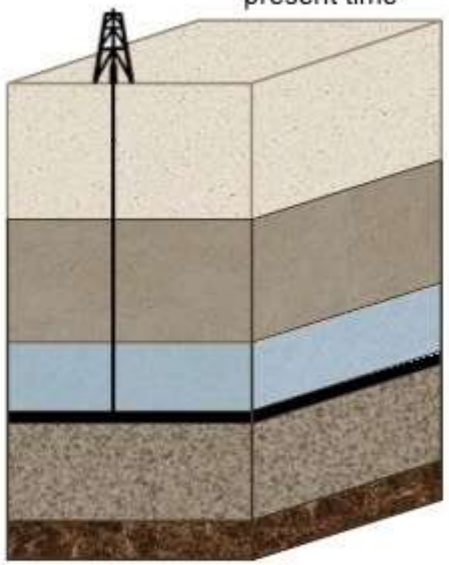
Aquatic plants and animals die and are buried on the ocean floor by layers of sand and silt

~ 50 to 100 million years ago

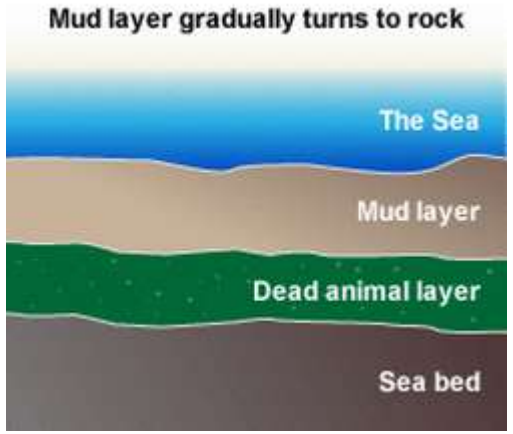


Layers of sediment are deposited above and the pressure and heat causes compaction of the remains

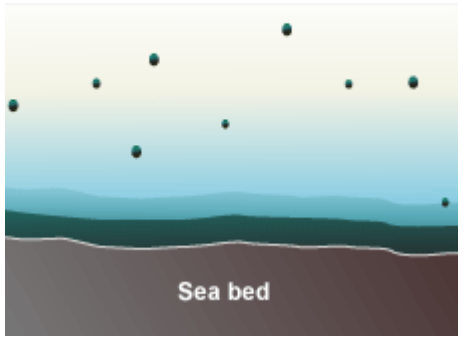
present time



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



Dead animals and plants build up on the sea bed



PETROLEUM & NATURAL GAS FORMATION

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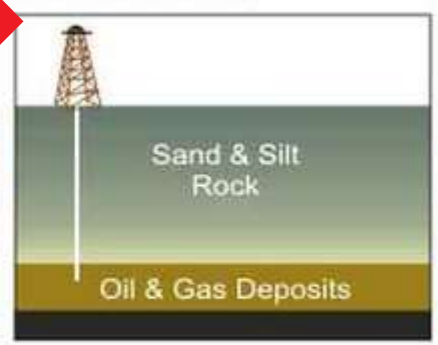
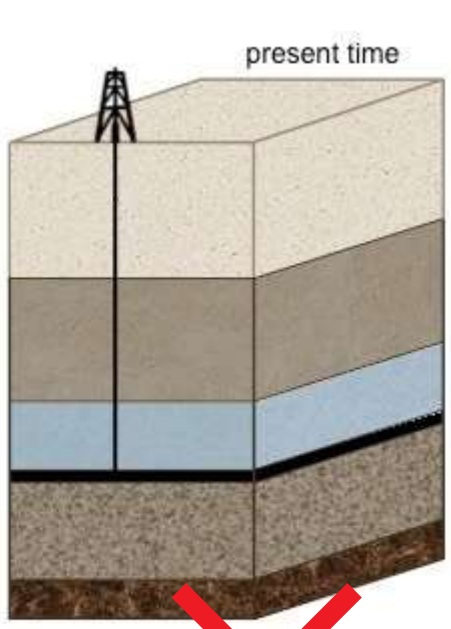


Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

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



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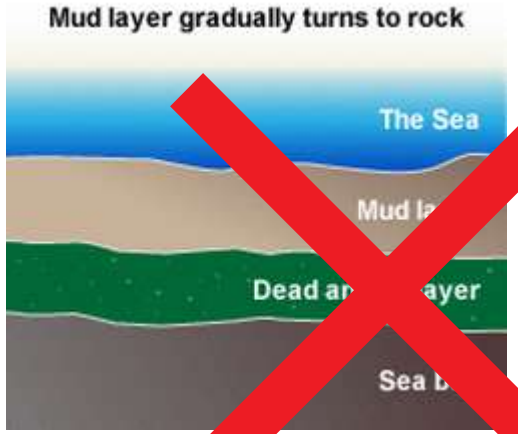
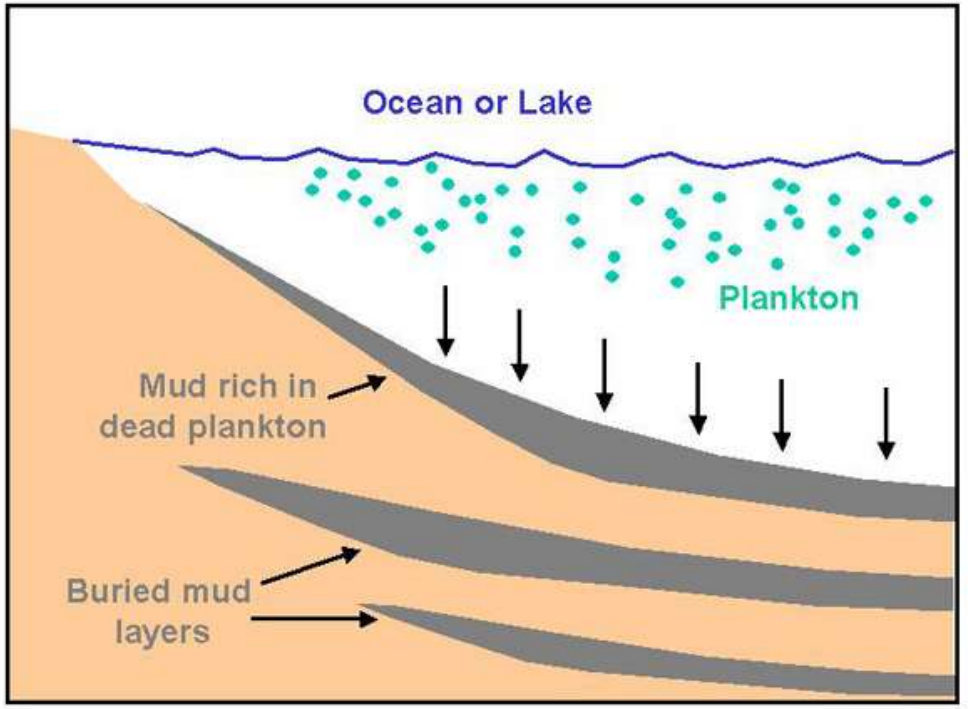
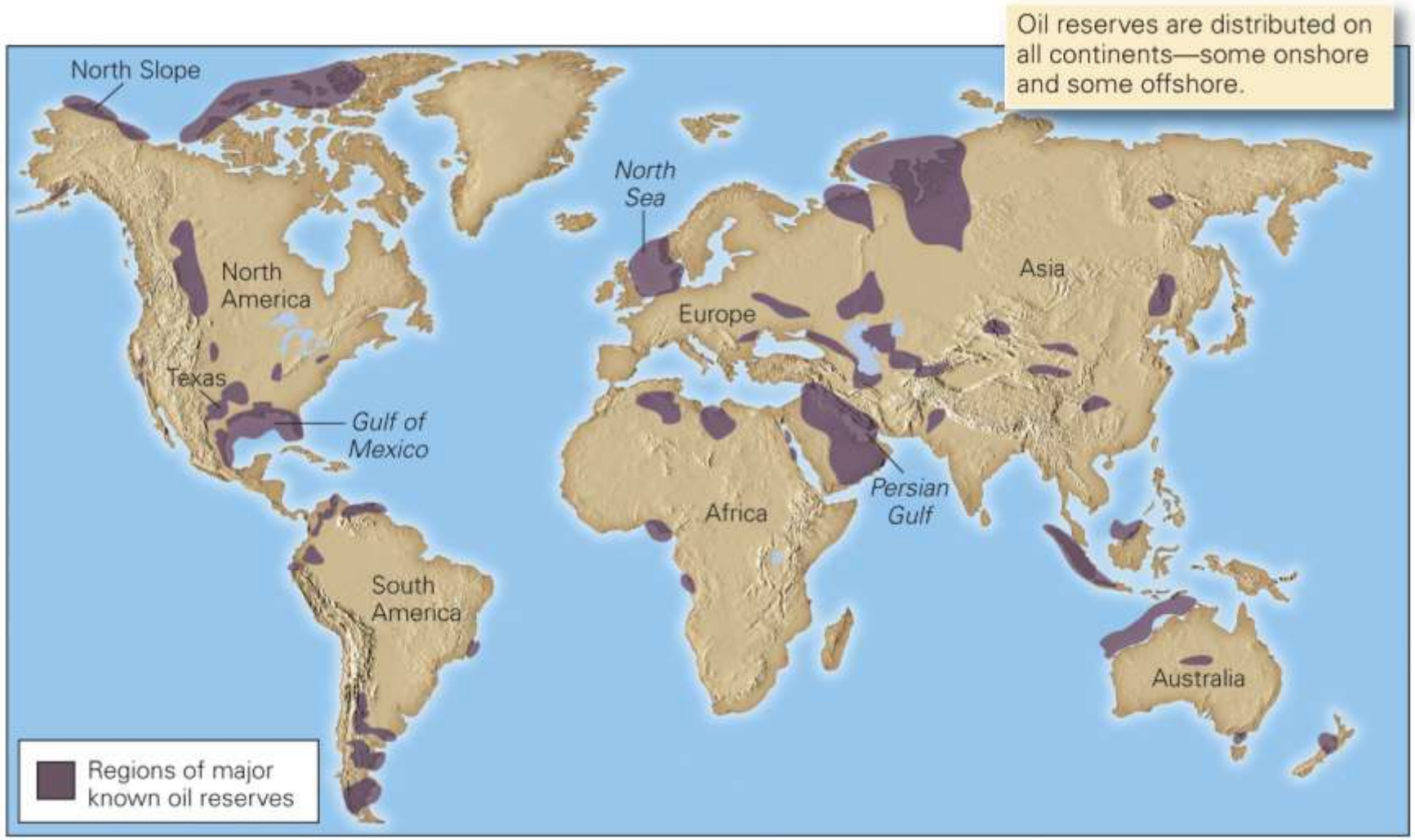


Plankton and no oxygen



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



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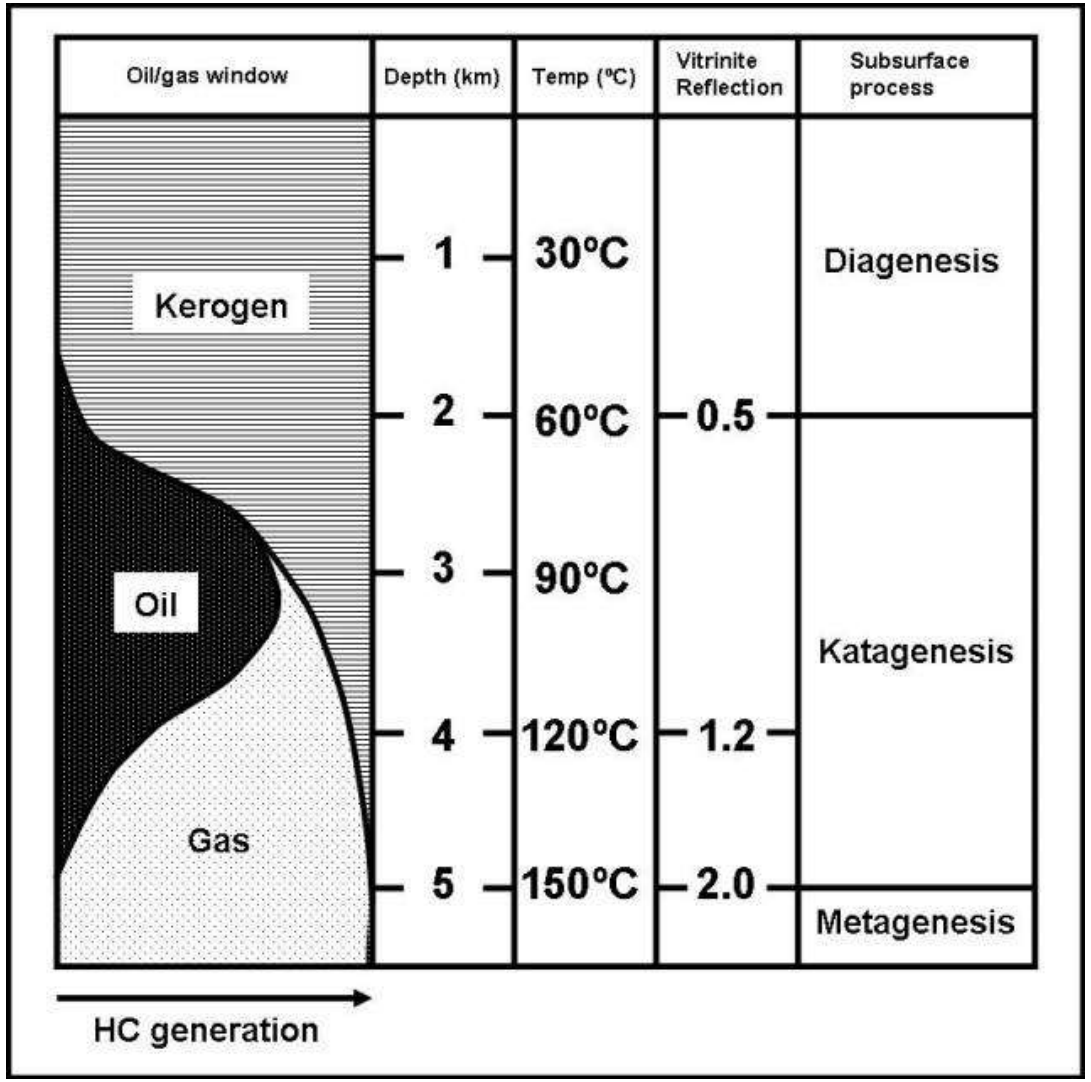
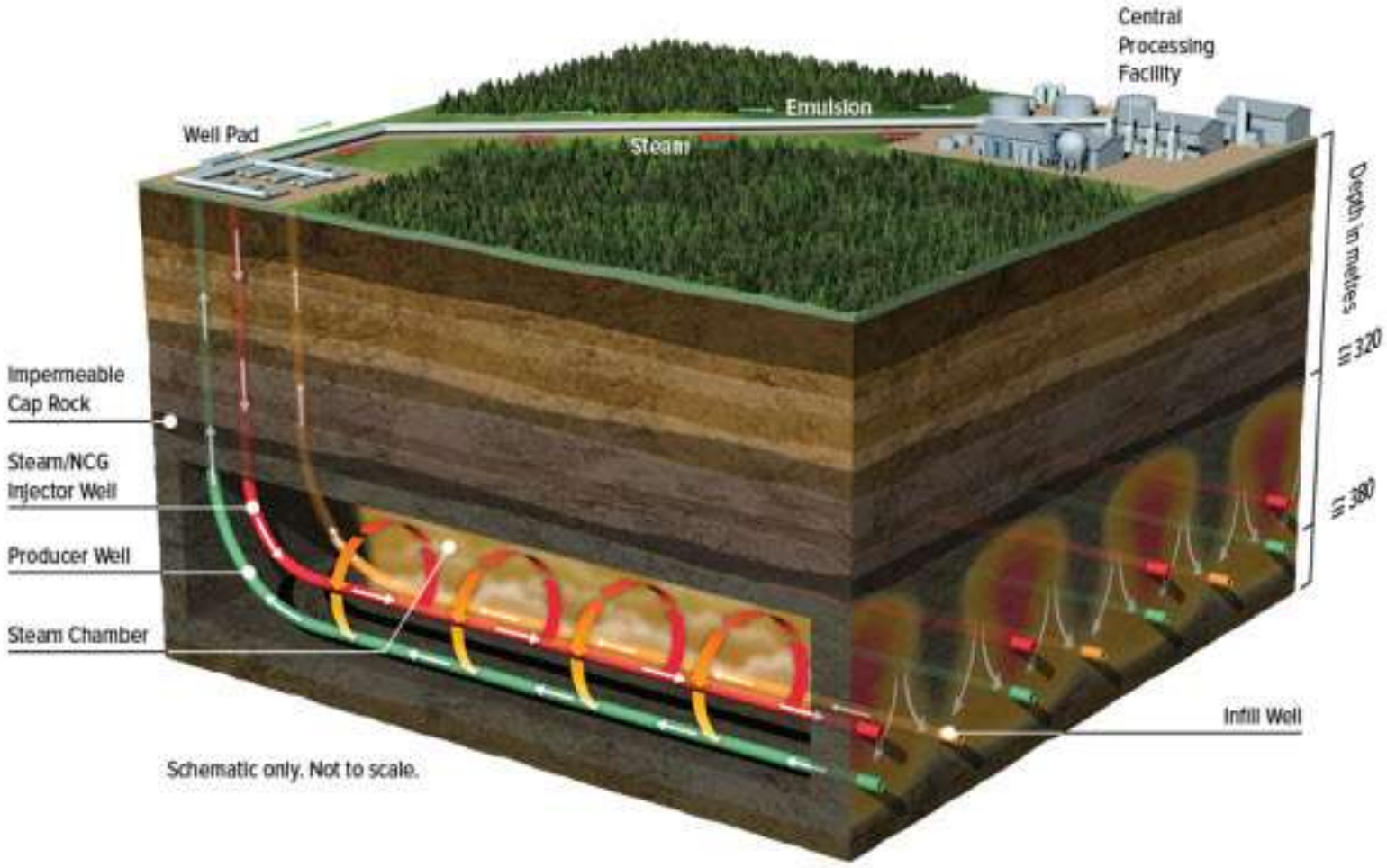
Temperature

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



Oil Sands (Kerogen)

Enhanced oil recovery



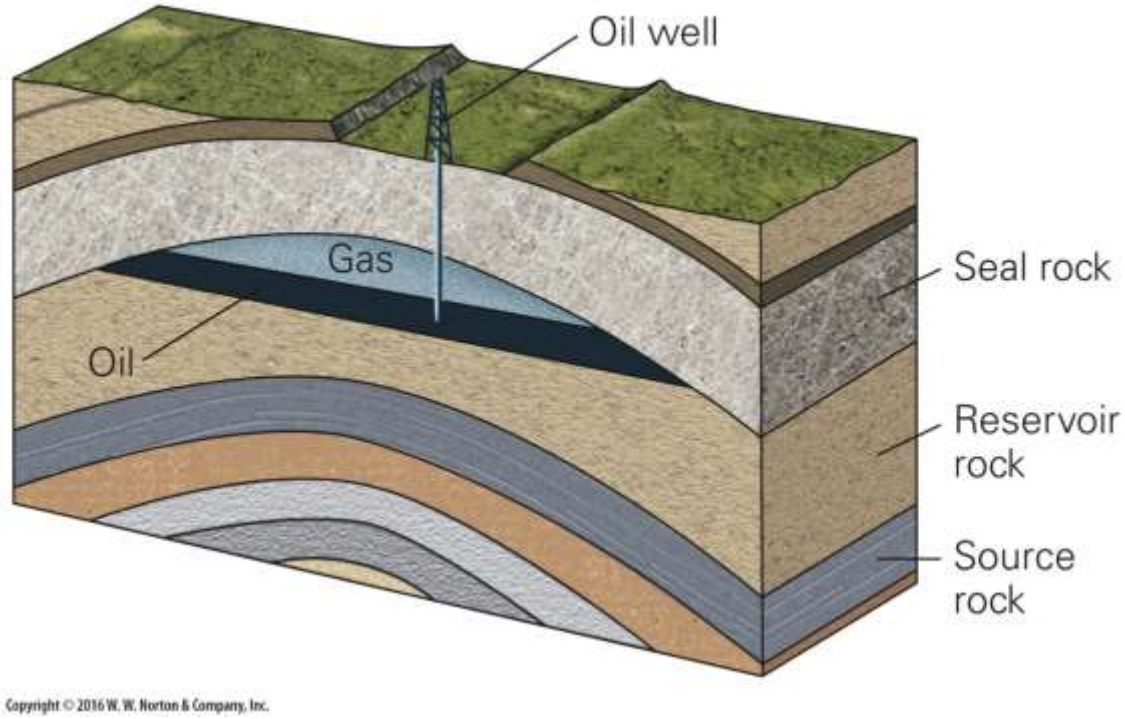
Oil Sands Suck

- 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)

Need a geologic trap to contain it



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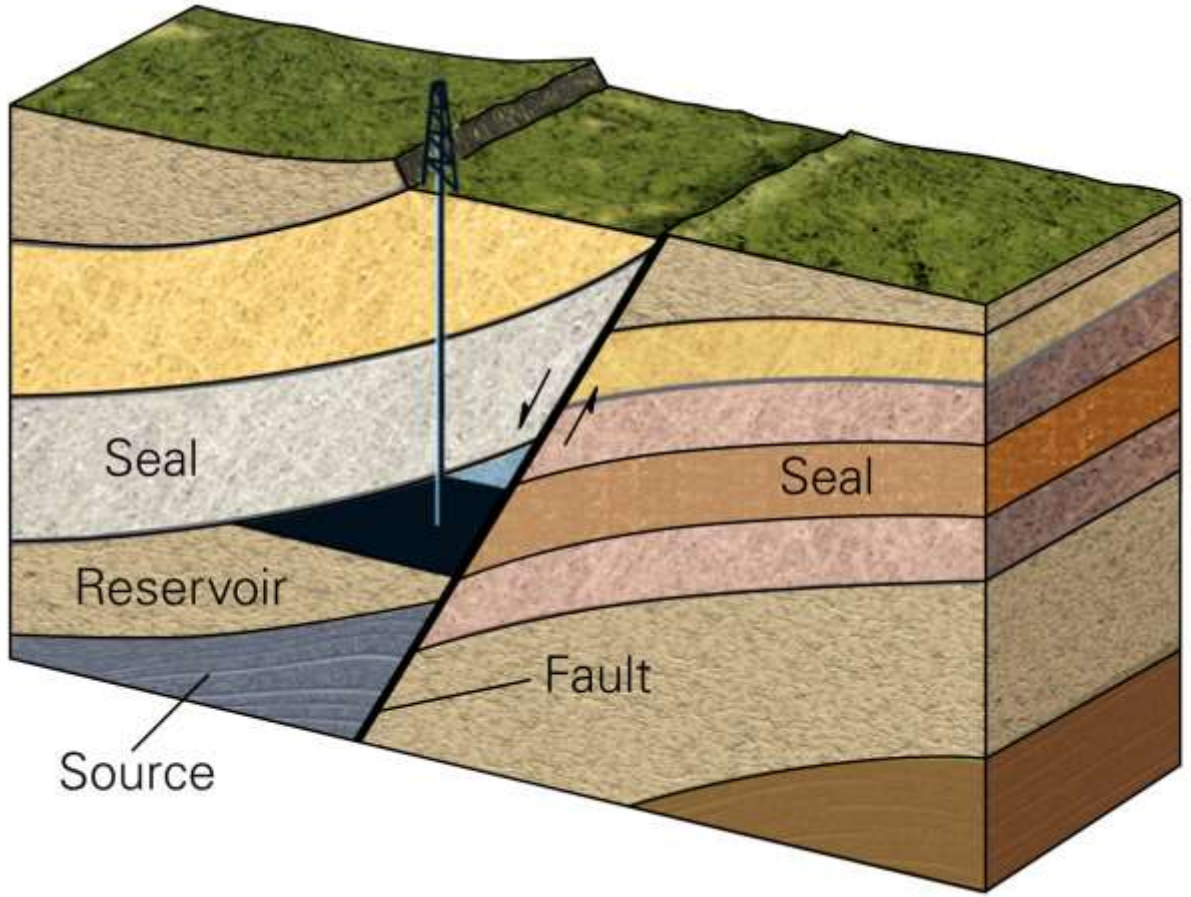

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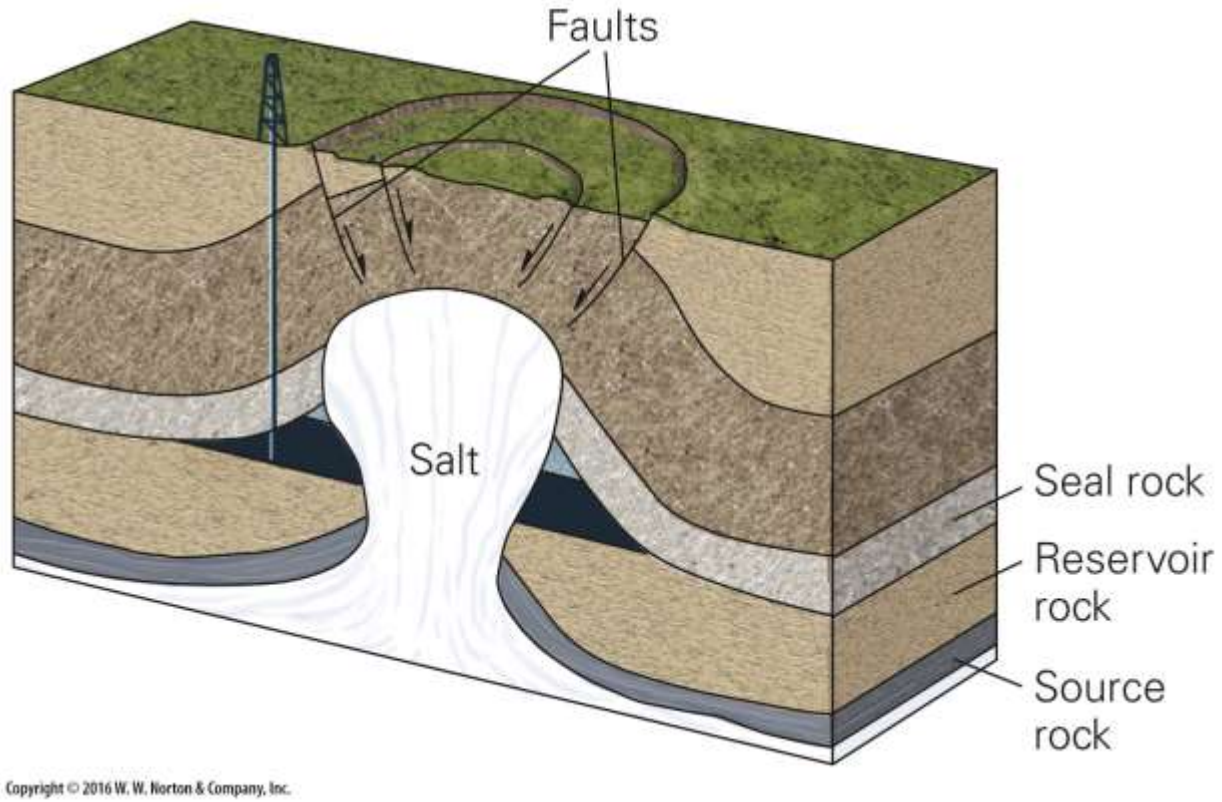
Gas and Oil are often mined at the same time



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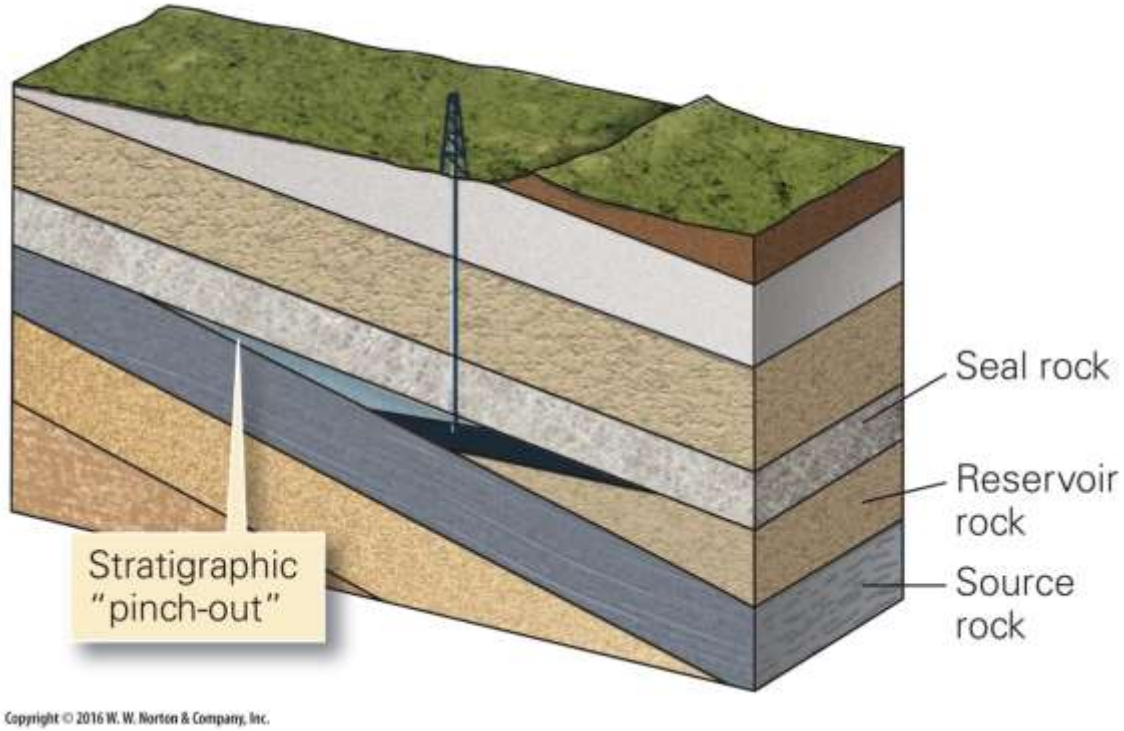

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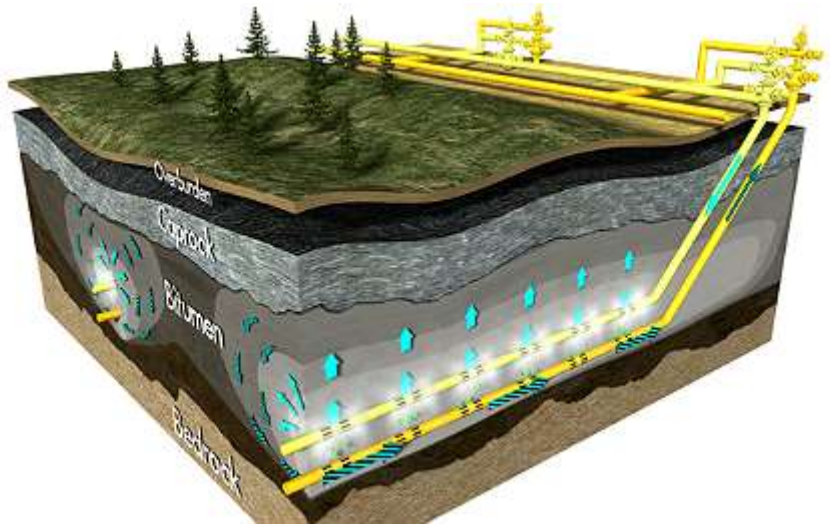
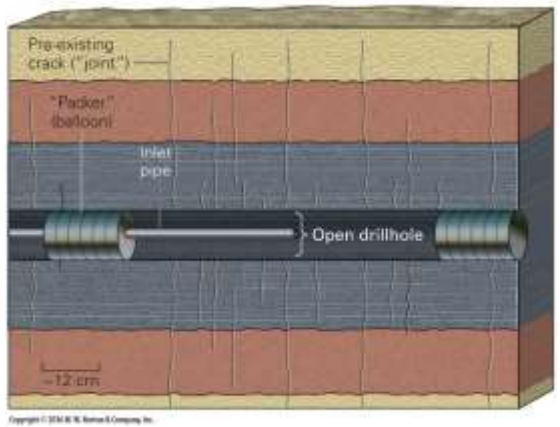
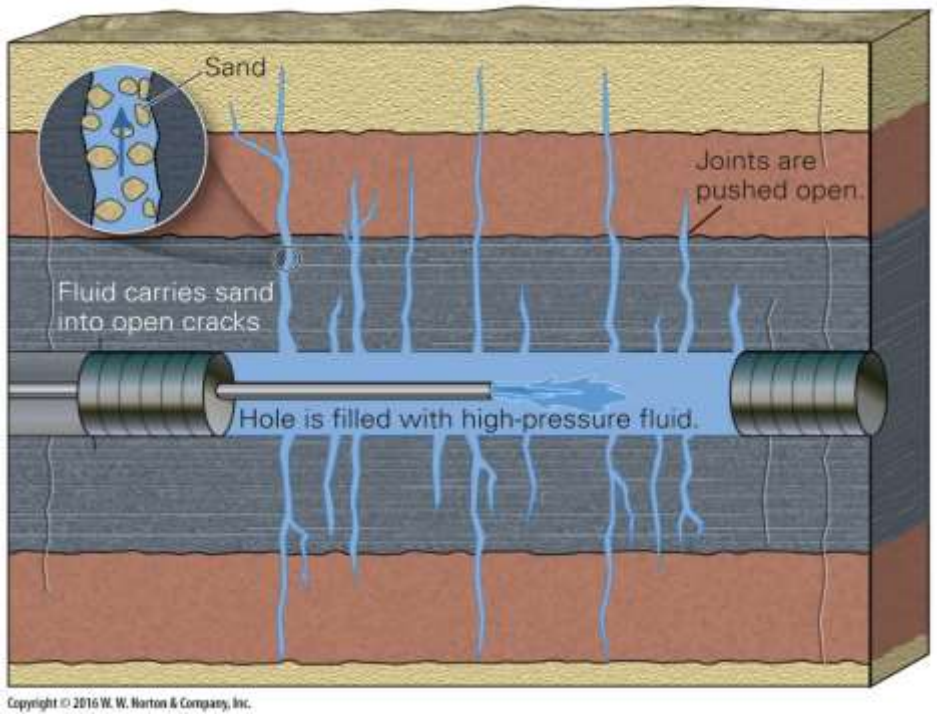
Pumping gets 20-30% oil out

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



Fracking





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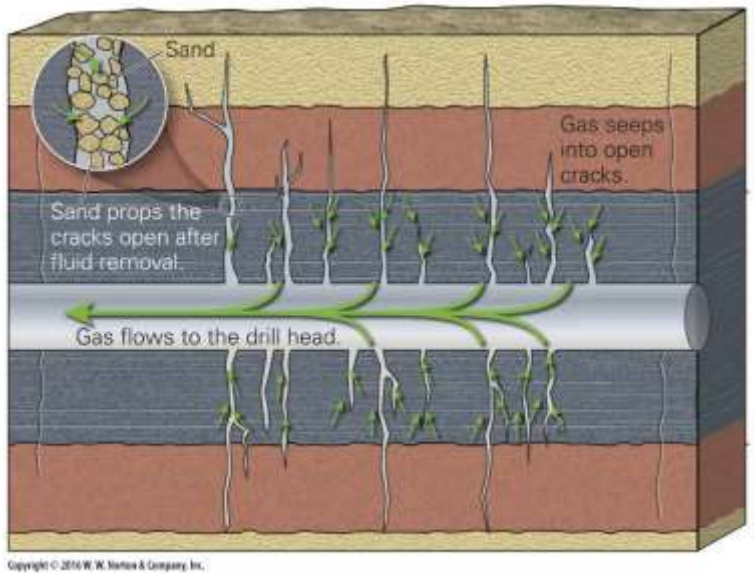

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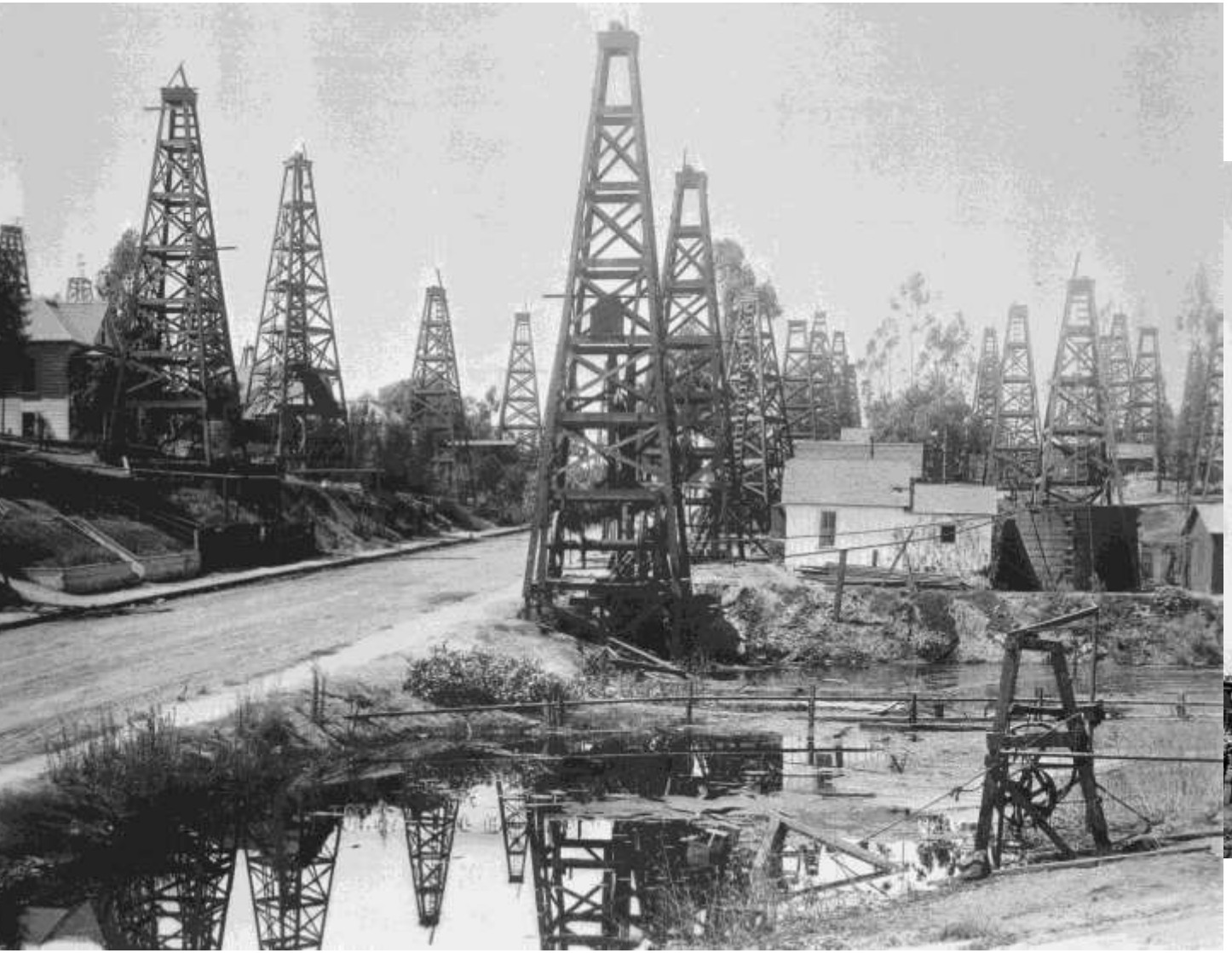
Oil drilling back then: https://vimeo.com/124053021



Huntington Beach

Long Beach today

Coal

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Where did it come from?

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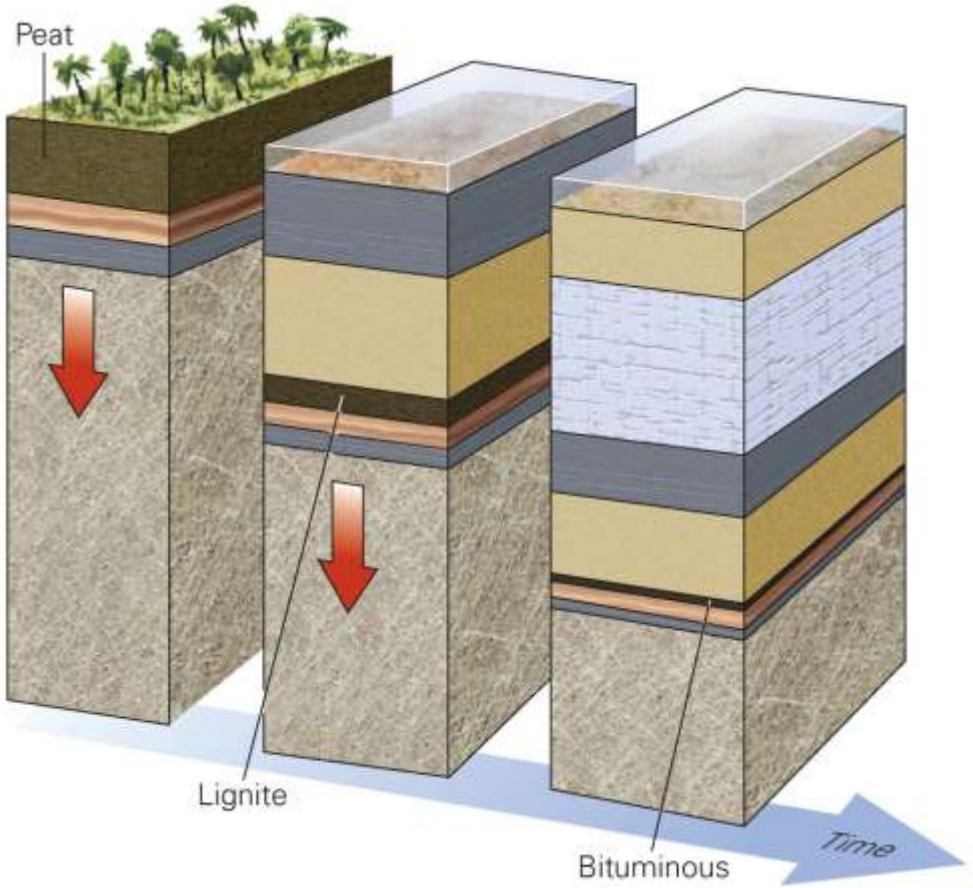

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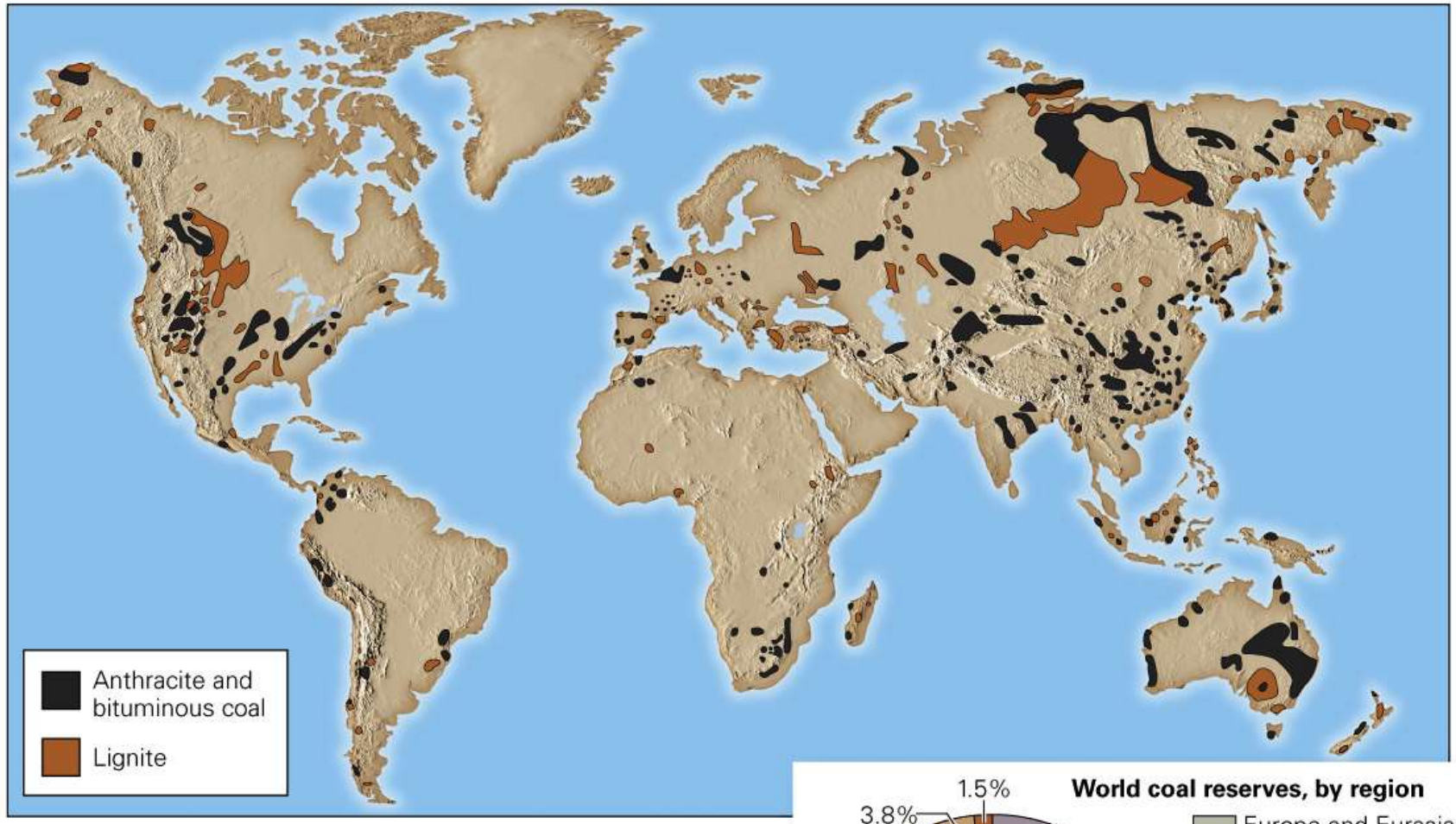
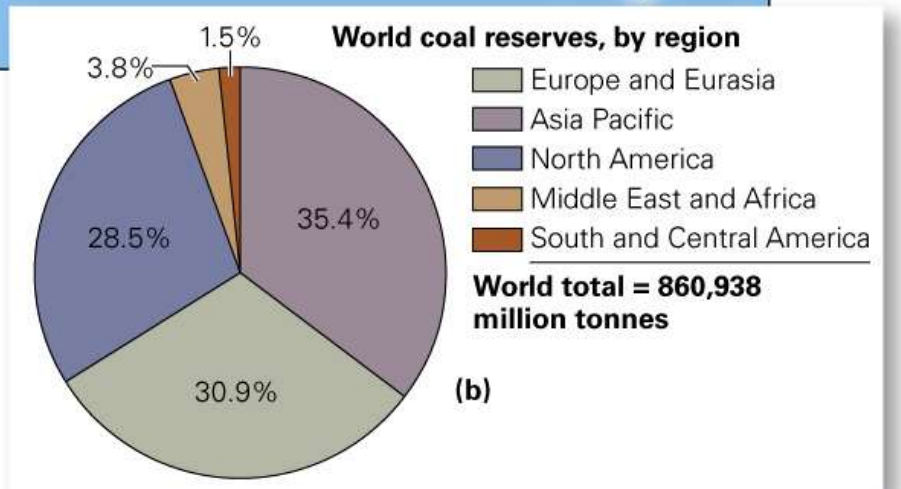
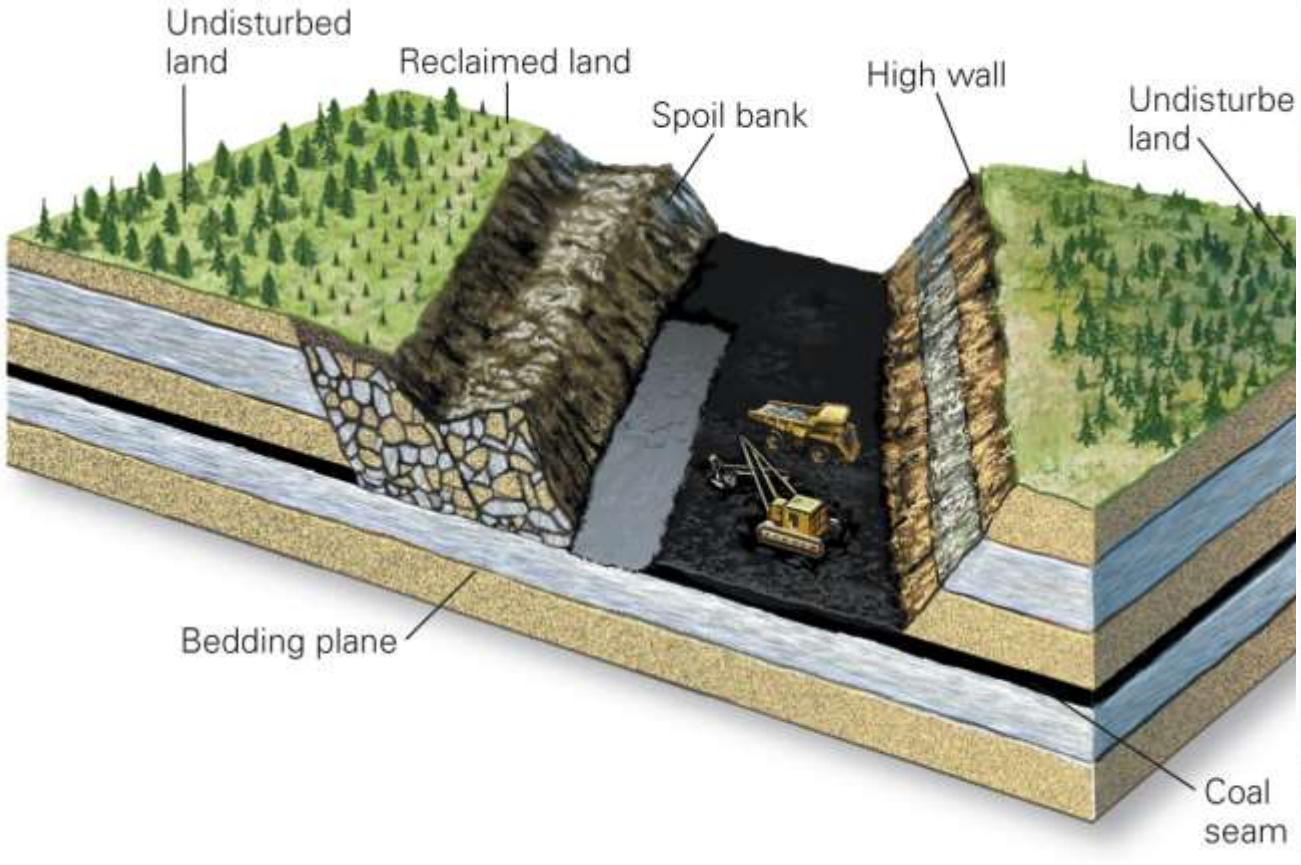

Anthracite and bituminous coal
Lignite

(a)


World coal reserves, by region
1.5%
3.8%
35.4%
28.5%
30.9%
Europe and Eurasia
Asia Pacific
North America
Middle East and Africa
South and Central America
World total = 860,938 million tonnes

(b)

Work along a coal seam



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https://www.youtube.com/watch?v=Iwuy4hHO3YQ

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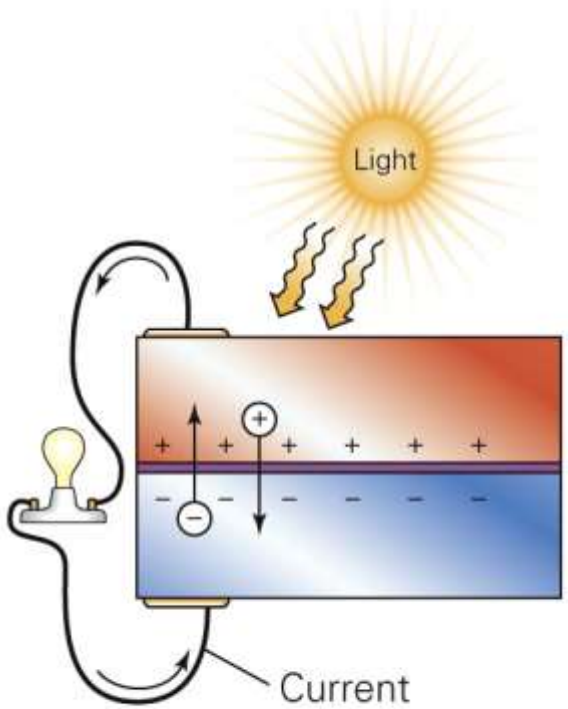
- Large number of west coast sites shut down because they were located on faults!



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Reality with energy:

- The reality is a bit too extreme for current civilization but we have 3 options (or a combination of them might work too):

1) We need to use less energy to extend it for a really long time
2) Or have one hell of a party in the next 50 to 200 years
3) Create

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)

(b)

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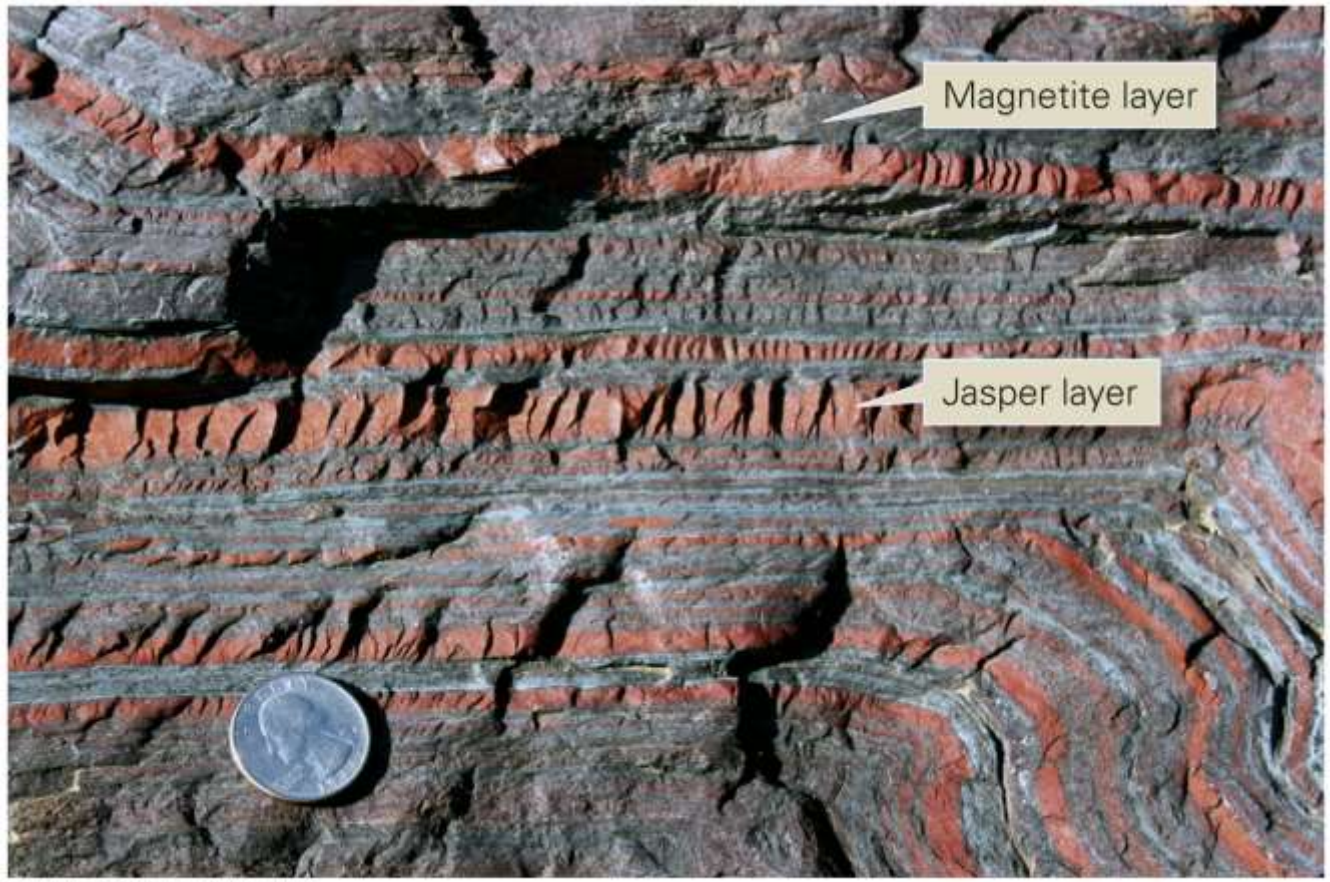

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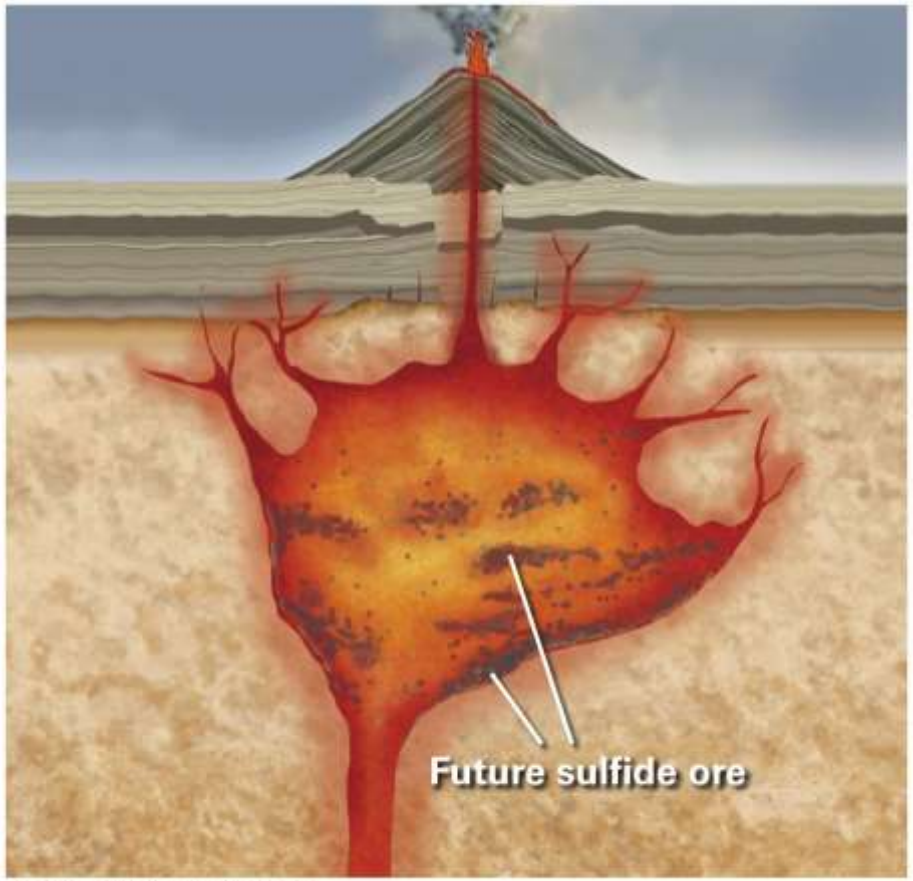

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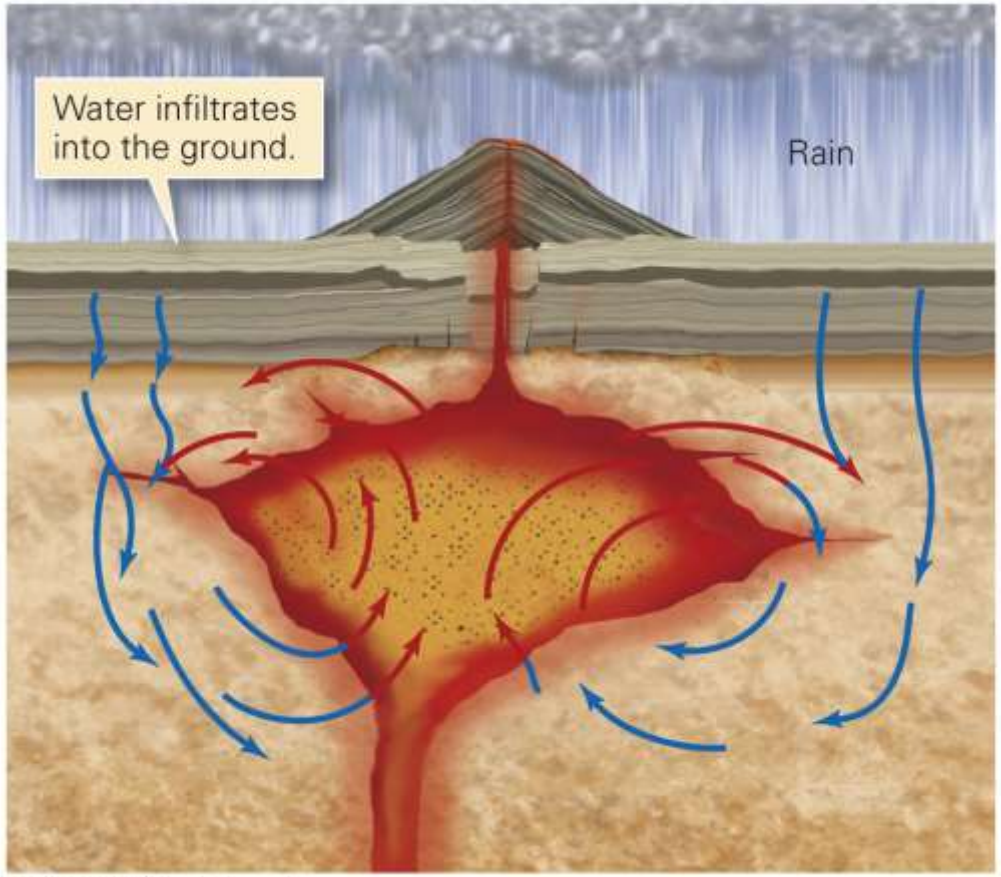

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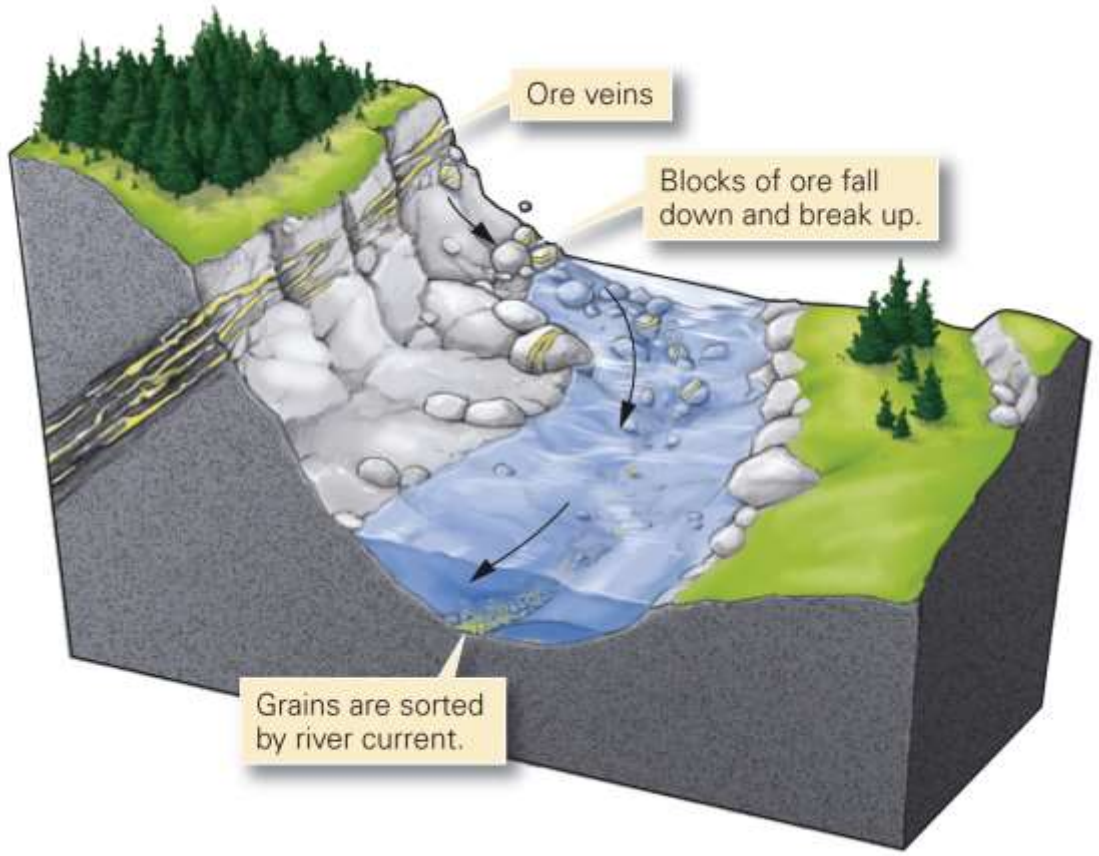
Placer deposits and veins



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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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Safety and Regulation

- Federal level
- State level
- City level

- Environmental/Geosciences consultants
  - Making things safe in the first place (rare unfortunately)
  - Determining how big a mess is afterwards
  - Cleaning up the mess
  - Lawsuits
  - Figuring out the best way to build something

Tunneling though Pasadena area

Case Study: Flint Michigan

2014

- April, Flint Michigan switches to local river water.

  (switch to river source from lake source = new chemical conditions, new pressure, new temperature)

2015

- February 26, EPA (Environmental Protection Agency) detects lead in the water of 1 home.
- June 24, EPA writes a memo with work from Virginia Tech scientists showing the lead in water from 4 homes.
- Main EPA whistle blower (Miguel Del Toral) hushed up

Case Study: Flint Michigan

2015

- July 9, The mayor responds to the EPA by drinking water from Flint on local TV show that the water is safe.
  (Note, a politician doing something doesn't mean that it is safe)
- July 13, Michigan Department of Environmental Quality (MDEQ) tells residents to relax about water.

- ***Throughout 2015, as the public raised concerns and as independent studies and testing were conducted and brought to the attention of MDEQ, the agency's response was often one of aggressive dismissal, belittlement, and attempts to discredit these efforts and the individuals involved. We find both the tone and substance of many MDEQ public statements to be completely unacceptable…***

Regardless of your major/job, its ok to be humble

The public landscape

- Politicians
- Planners and Public Policy Managers
- Scientists and Engineers
- Activists/Advocates
- Public

- Medical Doctorate: 4 years school + 1 year residency
- Scientific Degree: master: 2 years, PhD 4-8 years. Postdoc 1-3 years