April 9, 2015
GEOL 1010-002 (Notes)

Lecture 15—Nonrenewable Energy

Geology in the News

- Oxygen-breathing microbes found in deep sediments at the bottom of the Pacific Ocean (considered one of the "deadliest" places on Earth's surface)

Energy Resources

- Why do we care?
  - **Money**—Helps support way of life (humans dependent on it)
  - **Technology**—Advancements everyday
  - **Global politics**—Relationships with other countries

Energy Sources

- **Renewable**—Natural resources that can be replenished in a short period of time (fast time scale→usable by humans)
  - Ex. Solar, wind, water, geothermal, biomass
- **Nonrenewable**—Natural resources that can't be re-made or re-grown at a scale comparable to its consumption (or replaced slowly→too slow for human use)
  - Ex. Coal, oil, natural gas, nuclear energy
  - Once used up, you won't have more for 1000s of years

Fossil Fuels (FFs)

- Approximately 82% of energy consumption in the US and globally (2006 #s bellow)
  - Coal=22.6%
  - Oil=36.8%
  - Natural Gas=22.9%
  - Hydroelectric=6.3%
  - Nuclear=6.0%
  - All others=~1.4%

How Much Is There?

- **Reserve**—Amount of material that is immediately ready to be used
- **Resource**—Includes all material you know of whether you can use it right now or not (includes reserves)→sometimes know they're present, but can't use them (too deep, etc.)
  - Higher # than Reserve

FFs: General Advantages

- 1—Historically cheap and abundant
- 2—Technology well developed
- 3—Infrastructure built to run on them

- Need to take realistic view of finding new energy sources
  - Might have to change infrastructure

FFs: General Disadvantages

- 1—Nonrenewable
- 2—Deposits not uniformly distributed (causes conflicts)
- 3—Costs going up (people become less interested)
- 4—Environmental damage (sacrifice health for lots of energy?)

FF #1—Hydrocarbons

- Combustible H-C compounds
- Best place to form is the continental shelf (nutrient-rich)
- Requires 2 conditions to form:
  - Area of high biological productivity
    - FFs made from this (**Ex.** Plankton)
  - Relatively low oxygen in waters/sediments
    - Oxygen cause organisms to rot
      - Water deep enough to eliminate oxygen

Hydrocarbons

- Methane (AKA Natural Gas)
- Advantages
  - 1—Resources (not reserves) growing in recent years
  - 2—Burns much cleaner than other FFs
    - 30% less CO_2 emitted per unit energy compared to oil
  - 3—Price often cheaper than oil

Methane—Disadvantages

- 1—Safety issues
  - **Sour gas (contains H_2S)**—Contaminated in methane
    - Separating=More time and more money
  - NG (Natural Gas) heat system malfunctions can create CO (toxic)
  - Can cause houses to burn down
- 2—Still contributes to atmospheric CO_2 buildup

Hydrocarbons

- **Oil Window**—Window of opportunity where conditions of temperature and depth are appropriate for forming oil
  - Ex. 2-5 km, <150°C→organic compounds turn into oil

World Oil Supply

- 62% is in the Middle East
  - 22% in Saudi Arabia alone
  - 2.5% in the US

US Oil Production and Consumption

- **2010:** US had to import 61% of the oil we needed
- Cost=$337 billion
    - $640,000 per minute
    - $48 million during this class
- The gap has grown for decades
    - **1973:** Importing ~50%
    - **2004:** Importing ~66%
    - **2007:** Importing ~75%
    - ***2010:** Importing ~61%

Drop in 2010 reflects drop in usage (recession) and fracking

Fracking

- Allows oil to be extracted where the oil couldn't originally be reached
    - We're seeing a boost in production in the past couple of years due to fracking
    - Uses pressurized fluids to shatter rock below ground (creates permeability)
    - Jury still out on environmental impacts
        - **Ex.** Can fracking fluids contaminate groundwater?
        - **Ex.** Ties to seismic activity?
            - Seeing more quakes→Infrastructure, like buildings and bridges being harmed

How Much Oil Is Left?

- Debatable
- Lots!
    - Find new deposits
    - Improve technology to get more out of deposits (fracking)
- Little!
    - Existing fields producing less→could run dry
    - New oil fields being found less often

Case Study: ANWR

- Artic National Wildlife Reserve
- Original resource est.=20-30 bbls (bbls=oil barrels)
- Orig. reserve est.=4-12 bbls
- **Q:** Should we drill for oil in ANWR? Ignore Regulations?

The Pro-Drilling Side

- 1—30 bbls=enough to last the US 60 years
- 2—Lower gas prices
- 3—Tiny area affected (2,000 out of 19 million acres)

The No-Drilling Side

- 1—Only 12 bbls…that's not even enough to fuel the US for even 2 years
- 2—Spills devastate the environment