Women In STEM and the Science of Fracking

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Agenda

- Panel: Women in STEM
- Lecture
  - Energy Basics
  - Impacts of Energy on our World
  - Oil and Gas and Hydraulic Fracturing
- Workshop: Fracking with Jello

Energy as a STEM Career

- Working in Energy has challenges not faced in other Engineering Careers
    - Energy is a commodity
        - Price can fluctuate rapidly and significantly
        - Price reduction for fossil fuels hurts competition (renewable energy)
        - Price increases for fossil fuels improves opportunities for competition
    - Energy is highly regulated
        - Federal (Environmental Protection Agency, US Dept of Energy, Federal Energy Regulatory Commission, etc)
        - State (Colorado Public Utilities Commission)
        - Highly political/controversial (jobs, environment, consumer pricing)

Fossil Fuels

- Fossil fuels were once alive
  - Oil and Natural Gas
    - Created from organisims that lived in water and were buried under ocean or river sediments Oil and Natural Gas
    - Heat, pressure and bacteria “cooked” organic material
    - Oil and gas worked its way to the surface until encountering “cap rocks
  - Coal
    - Created from trees, ferns, plants that existed 300-400 millions years ago
    - Heat, pressure and bacteria “cooked” organic material
    - US East Coast coal formed from swamps covered by sea water
    - US West Coast coal formed from fresh water swamps

Coal – Pros and Cons

- Pros
  - Cheap
  - Abundant and available in industrialized countries
  - Mature industry
  - High Load Factor
- Cons
  - Non-renewable
  - Largest contributor to global warming (CO_2 per BTU)
  - High transportation cost
  - Other environmental factors (toxicity, radiation, methane)

Oil – Pros and Cons

- Pros
  - No other energy source can move vehicles faster and longer than any other energy source
  - Abundant
  - Currently cheap
  - Easy to use and transport
- Cons
  - Non-renewable
  - Environmental impact from drilling, transporting, burning
  - Dangerous

Natural Gas – Pros and Cons

- Pros
  - Abundant
  - Produces less soot than other fossil fuels
  - Abundant supply
  - Infrastructure in place
- Cons
  - Non-renewable
  - Highly flammable
  - Greenhouse gas emissions
  - Expensive pipelines

Renewable Energy

- Energy that is collected from resources that are naturally replenished on a human timescale
  - Solar
  - Wind
  - Hydroelectric power
  - Tidal
  - Biomass
  - Geothermal

Solar - Pros and Cons

- Pros
  - Renewable
  - Unlimited supply
  - No water or air pollution
- Cons
  - Not currently cost effective
  - Reliability depends on sunlight
  - Storage and backup are necessary

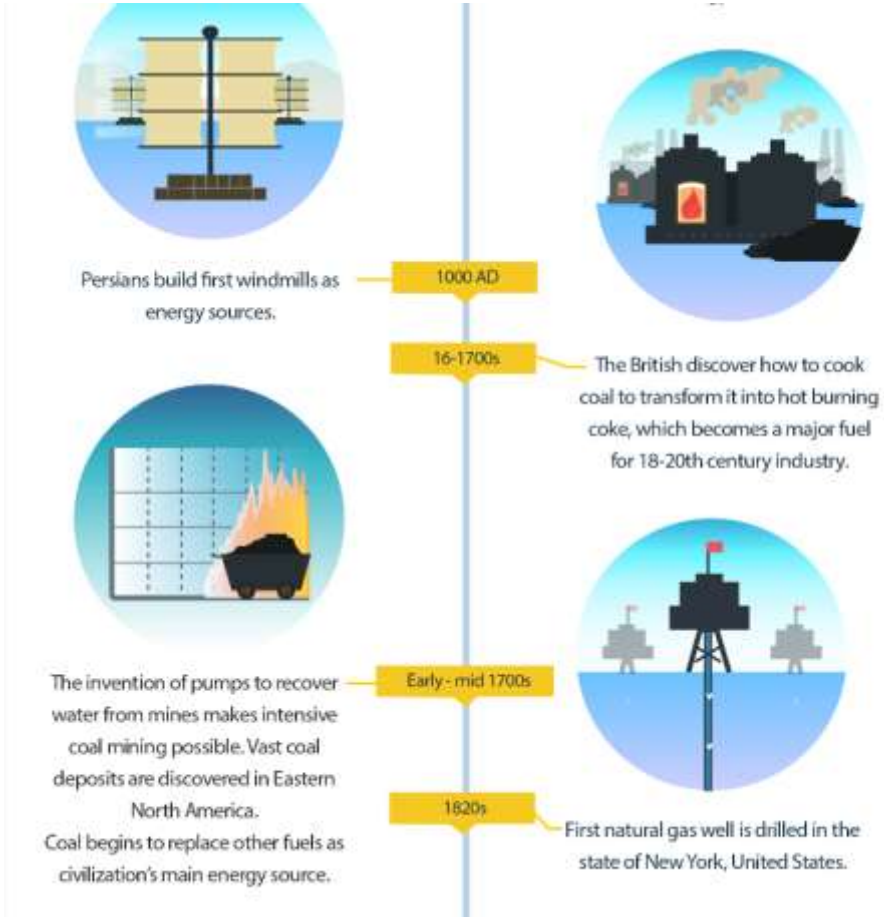
Wind – Pros and Cons

- Pros
  - Renewable
  - Produces no water or air pollution
  - Farmers can receive an income
  - Relatively cheap to build a wind farm
- Cons
  - Constant wind required
  - Visual impact of wind farms
  - Significant land needed
  - Environmental impacts to wildlife still being investigated

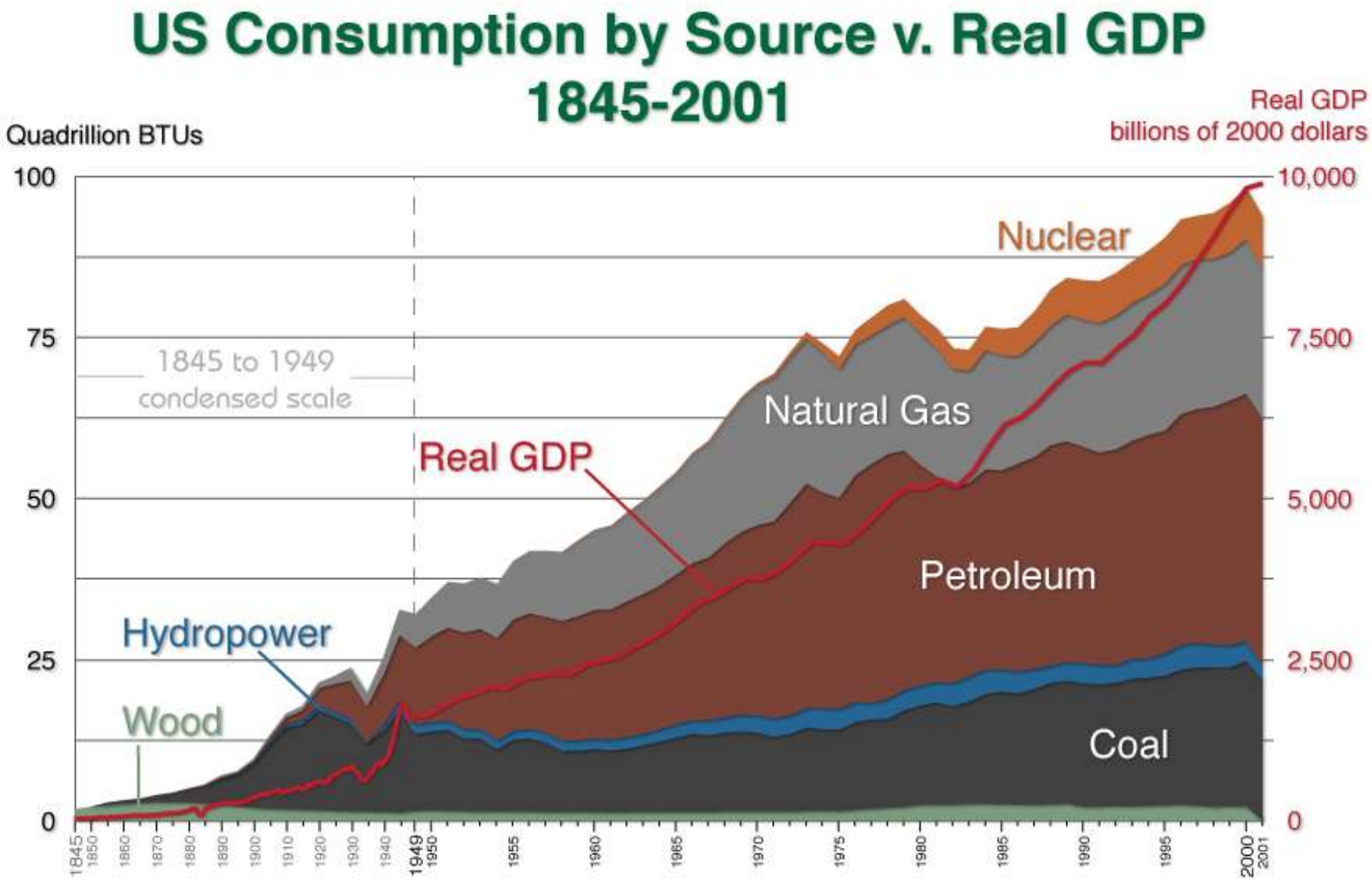
Hydroelectric Power- Pros and Cons

- Pros
  - Renewable
  - Abundant, clean and safe
  - Easily stored in reservoirs
  - Recreational benefits such as boating, fishing
- Cons
  - Significant environmental impacts (dams)
  - Can only be used near a water supply

History of Energy and Human Development



Economy


US Consumption by Source v. Real GDP
1845-2001
Quadrillion BTUs
Real GDP
billions of 2000 dollars
100
75
50
25
0
10,000
7,500
5,000
2,500
0
1845 to 1949
condensed scale
Nuclear
Natural Gas
Real GDP
Petroleum
Hydropower
Wood
Coal
1845
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1949
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2001

Environment

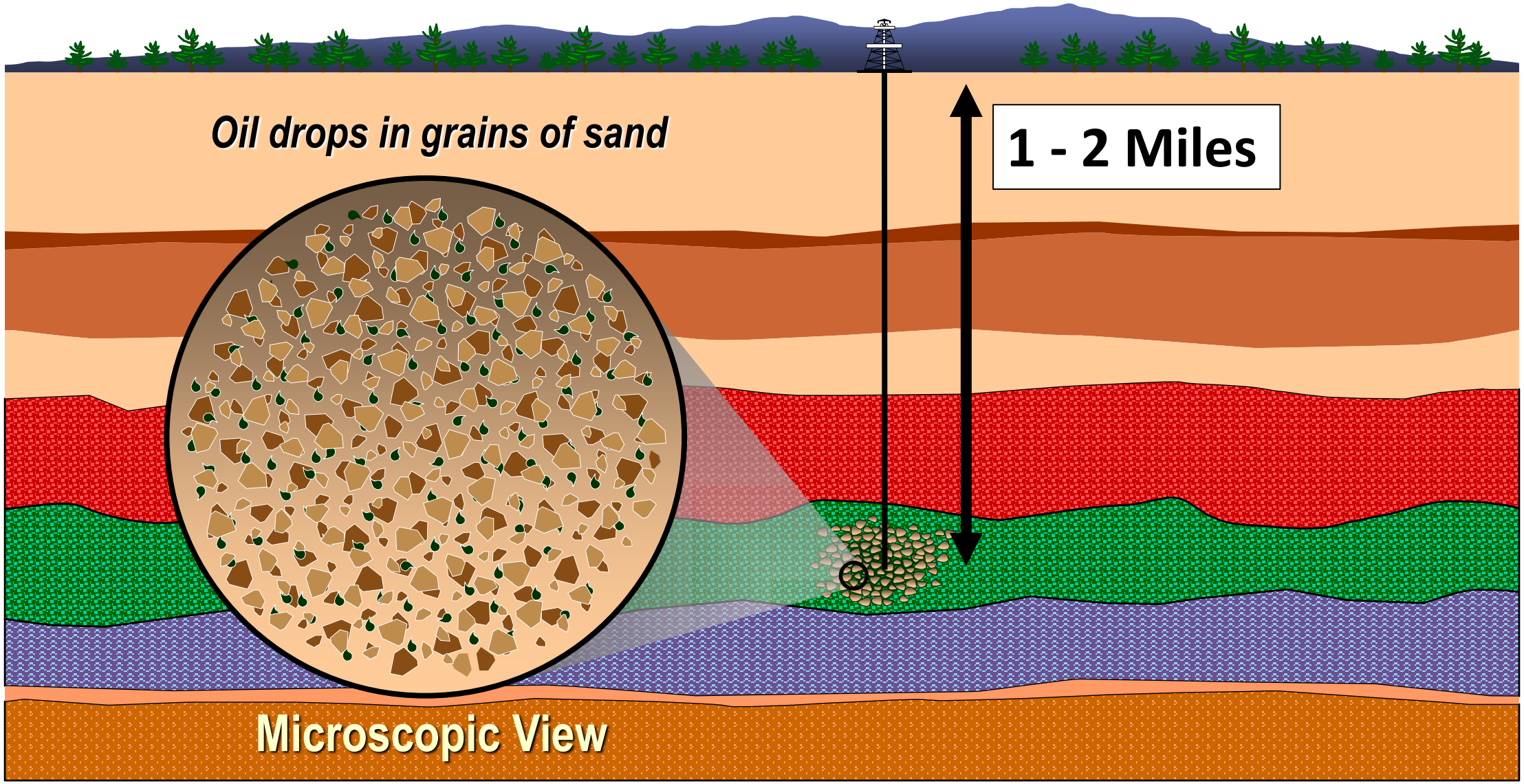
- Wood: deforestation, emissions from consumption
- Coal: aquifer contamination, mining impacts, emissions from consumption
- Hydro: fish populations, water temperature and flow changes
- Oil and Gas: aquifer contamination, spills, emissions from consumption
- Nuclear: nuclear waste, radioactive contamination, water consumption
- Wind: bird and bat populations
- Solar: land intensive, toxic production materials, water usage for maintenance
- Biomass: land intensive, water intensive, evaporative emissions
- Geothermal: siting intensive, emissions of sulfur and carbon dioxide

Politics

- Energy Planning
- Legislation on energy activities (transportation, storage)
- Legislation on energy use (energy efficiency, emissions standards)
- Fiscal policies (taxes, subsidies)
- Energy Security (international treaties, trade agreements, strategic relationships)

Where Do Oil and Gas Come From?

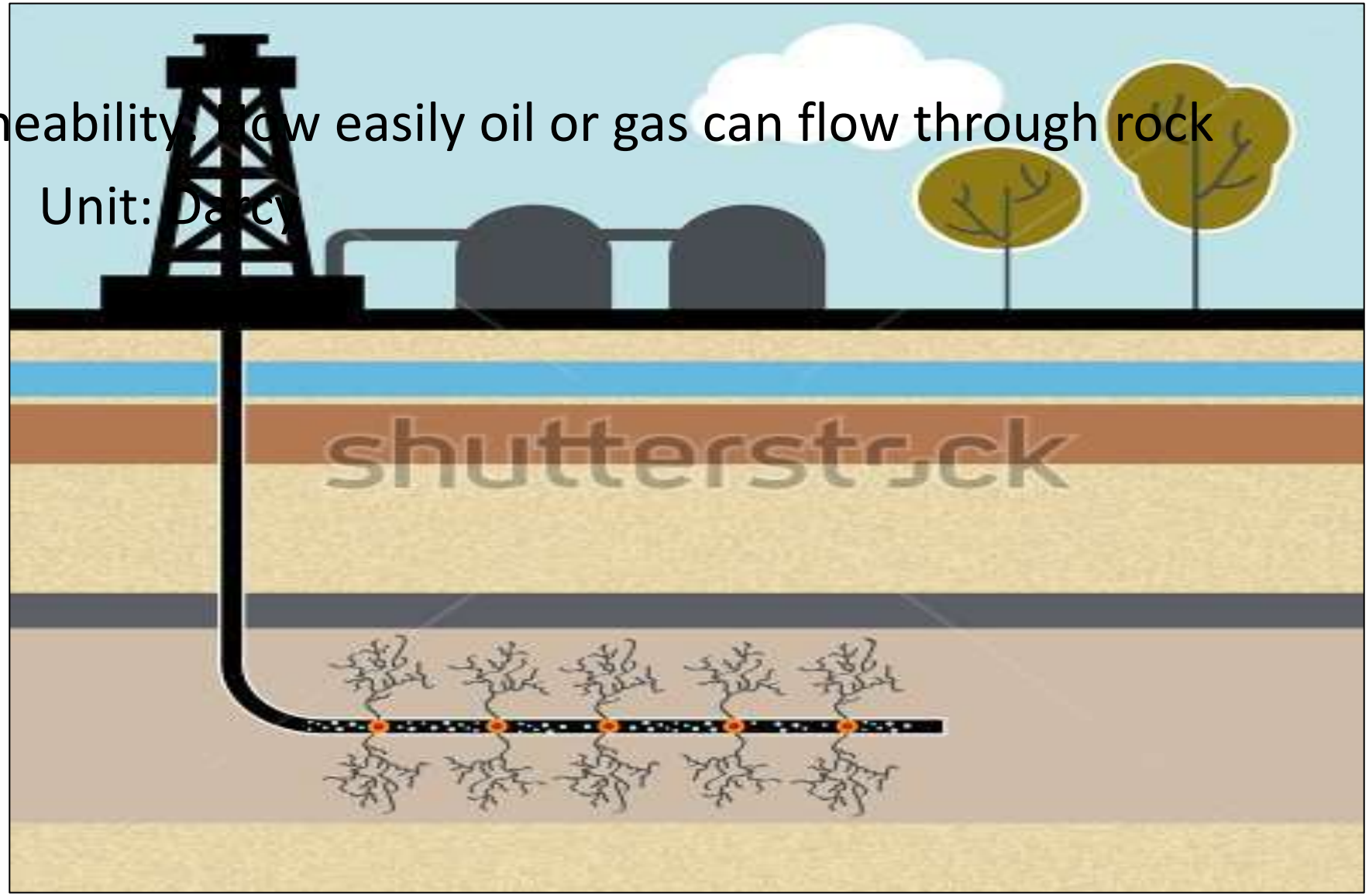
How Do We Extract Oil and Gas?



Why Do We Hydraulically Fracture Wells?

Permeability: How easily oil or gas can flow through rock

Unit: Darcy



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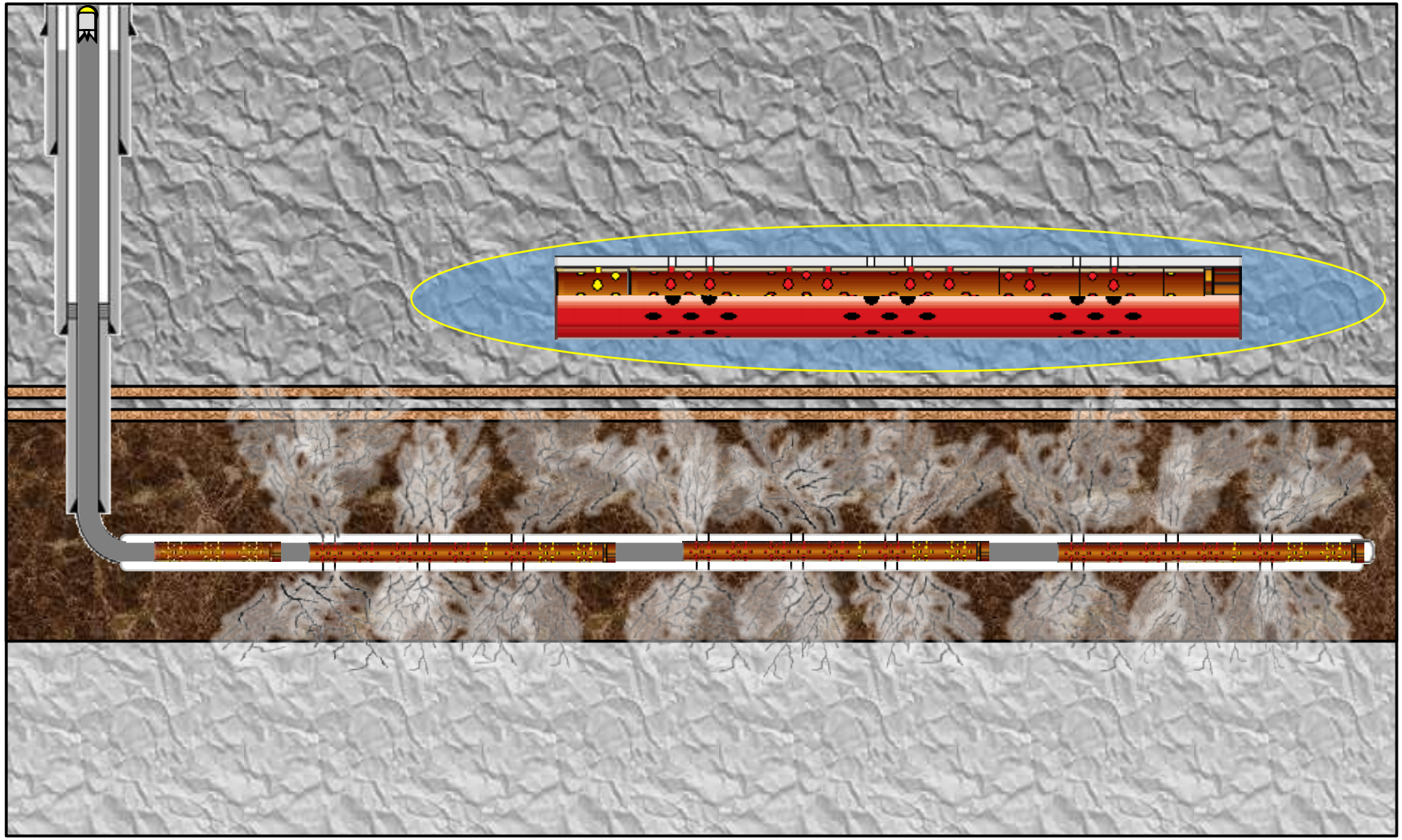

How Do We Hydraulically Fracture Wells?

Workshop Introduction

- Understand the process of hydraulic fracturing
- Form a hypothesis of what will happen to the jello when injected with syrup
- Observe the fracture pattern and any variations that may change it
- Understand why the syrup in jello may behave differently from a hydraulically fractured underground rock

Next

- Move into cafeteria
- Split into groups of 4-5