What do these items all have in common?
**Oil & Gas Provide:**

- Energy
- Gasoline & natural gas (cars & homes)
- Waxes
- Plastics (everything!)
- Synthetic Fibers (like polyester)
- Dyes
- Detergents
- Asphalt

**Jobs!**
- Over the course of well drilling it is estimated that ~430 people from 150 occupations are employed in some part of the process.
Oil, Gas and Fracking
Drilling and Production
How it works...

Photo: Drilling at Pancake Summit,
White Pine County, NV

Nevada Division of Minerals
Overview of Energy Exploration

- Oil, Gas and Resources
- Nevada-based Exploration Activity

Nevada Division of Minerals
minerals.nv.gov
Carson City (775) 684-7040
Las Vegas (702) 486-4343

Drilling for Energy in Nevada
Geothermal Oil & Gas

Commodities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>$10,827,921</td>
</tr>
<tr>
<td>Oil</td>
<td>$1,750,969</td>
</tr>
<tr>
<td>Oil &amp; gas (pre-production)</td>
<td>$391,998</td>
</tr>
<tr>
<td>Potassium</td>
<td>$10,124</td>
</tr>
<tr>
<td>Phosphate</td>
<td>$160</td>
</tr>
</tbody>
</table>

Commodities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>$11,648,163,514</td>
</tr>
<tr>
<td>Gas</td>
<td>$1,902,459,375</td>
</tr>
<tr>
<td>Natural gas</td>
<td>$767,349,923</td>
</tr>
<tr>
<td>Natural gas liquids</td>
<td>$600,952,111</td>
</tr>
<tr>
<td>Wind</td>
<td>$474,539,134</td>
</tr>
<tr>
<td>Coal</td>
<td>$593,907,542</td>
</tr>
<tr>
<td>Other</td>
<td>$600,952,111</td>
</tr>
</tbody>
</table>
• Oil / Gas
  – Biologically rich environment = Kerogens
  – Burial of Kerogens
  – Heat and Pressure
• Generation from Heat & Pressure
• Seals/Caprock: Shale, Chalk, Salt.
• Reservoir rock: Sandstone, limestone, and shale
Types of Oil Traps

- Structural Trap
- Stratigraphic Trap
- Lens Trap
• **Strat Column**
  – Vertical sequence of rocks present at a single location
  – What comes out of the drill string

• **Cross Section**
  – Interpretation, supported by data, of subsurface geology along a profile

• **3D interpretation**
  – Connection of multiple cross sections or interpretation from geophysical techniques to calculate deposit volumes
Types of Drill Rigs

• Core Rigs
  – See structure of beds
  – Slower drilling (100’/day)

• Reverse Circulation (RC) Rigs - 1000’/day
Drilling Plans

• Cut across layers too sample stratigraphy

• Or follow stratigraphy to maximize resource production
Production Methods

- Drilling Plan based on reservoir characteristics & low environmental impact
Flow driven by natural pressure difference
  – high pressure at depth and low at surface
May include simple pumping of fluids
  – Pump Jacks
  – Left over footprint is quite small

Production Methods – Conventional

https://www.youtube.com/watch?v=SFJFiyXT0a0
Production Methods – Non Conventional

- **Hydraulic Fracturing**
  - Increases permeability of rock
  - Occurs after well casing has been set

- Opens existing fractures in rock by pressurizing well
  - **Proppant** - Sand or other bead-like material are introduced with the injected fluids that keep fractures open

- Development of this technology occurred in response to oil crisis of 1973
  - Eliminated US dependence on foreign oil and gas
Risks and Benefits of Hydraulic Fracturing “well stimulation”

- Hydraulic fracturing happens a great depths (~5,000 – 10,000 feet)
  - Not at the fresh water table – migration unlikely unless well is not operating properly

- Induced seismicity is rare and deep – Caused by waste water injection
  - Ground needs to at critical stresses to induce
  - May affect timing of earthquakes, but not occurrence
  - Can be controlled by controlling rate of injection

- Uses a lot of water, recycling becoming more popular for conservation
- Chemicals used must be approved and makes up less than 1% of total fluids
Risks and Benefits of Hydraulic Fracturing (or well stimulation for geothermal)

- Natural gas creates electricity that is 50% or more cleaner (in terms of CO2) as compared to coal
- Exploration is getting quieter and more efficient with new technology – use of a single drill pad and horizontal drilling has helped reduce the environmental impact of drilling
- Without this process we wouldn’t have access much of the world’s hydrocarbon or geothermal resources!
- Risks can be minimized with regulations – well construction, casing specs and limiting rate of reinjection
Hydraulic Fracturing Activity

- Taken from the National Science Foundation’s Make a Fracturing Model Activity (www.airwatergas.org) and The National Energy Education Development Project’s Wonders of Oil and Gas Activity Book (www.NEED.org).

  - **Key components of well:**
    - open hole, which must remain open to allow fluid to flow through
    - well casing, which keeps the well open and protects the rock formation and natural fluids from contamination

  - **Fraking of the well:**
    - Gelatin represents the rock formation
    - straw is the well casing
    - plaster is the hydraulic fracturing fluid with proppant
    - syringe is the drill string.
Follow Up Discussion:

- Location & well we looked at is site of discovery & current producer of oil
Joanna Limestone

- Fossil types include echinoderm, bryozoans, foraminifera, algae, and crinoids

Hosts mineralization within deposits (post Carboniferous-age)
Why do we have oil?
Nevada Cross Section

- Many stages of mountain building events that built the west
- Basins fill as they deepen with sediments from mountain range uplift
- Often basins covered by large inland seas which were filled with organic material
Great Basin Shales

- Nevada’s oil reserves consist of limestone from the inland seas and associated shales
Railroad Valley

- 1954 - First oil discovered in RRV (by Shell)
  - 1949 PhD thesis paper by Walt Younquist, that found oil pockets while studying cephalopods in the shales here
- Now the basin has 9 recognized oil fields have produced 47 million barrels of oil
- The Joanna Limestone is the underlying (bottom) member of the reservoir rocks and are surrounded by the source and trap shales

From: Oil Fields in Railroad Valley Nevada* Louis C. Bortz1 Search and Discovery Article #20376 (2016)** Posted December 19, 2016

Nevada’s Oil/Natural Gas Resources

Nevada Oil

2022 Production:
- 234,685 barrels
- -12% vs. 2021
- 1955-2022 cumulative production 55,207,809 barrels
Nevada’s Oil/Natural Gas Resources

- Cost of oil and resource size/production levels greatly affect feasibility of Nevada’s Oil Fields
Follow up & other resources

- Energy Resource Activities – all ages/grades
  - [http://oogeep.org/teacher-students/educational-materials/](http://oogeep.org/teacher-students/educational-materials/)
- Hydraulic Fracturing activity
  - [https://www.airwatergas.org/resources/curriculum/make-a-fracking-model-activity/](https://www.airwatergas.org/resources/curriculum/make-a-fracking-model-activity/)
- Wonders of Oil & Natural Gas Activity

Kilograms of metals & minerals needed per MW of capacity