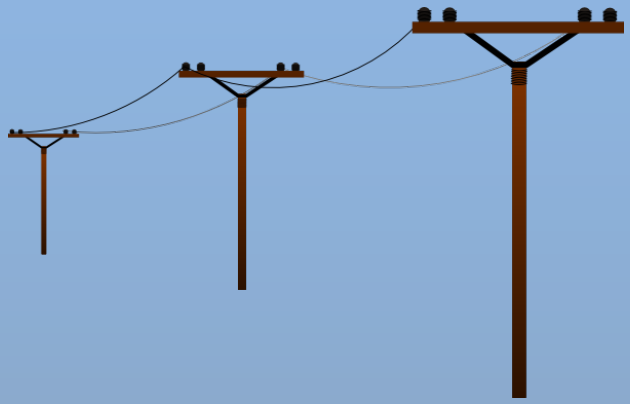
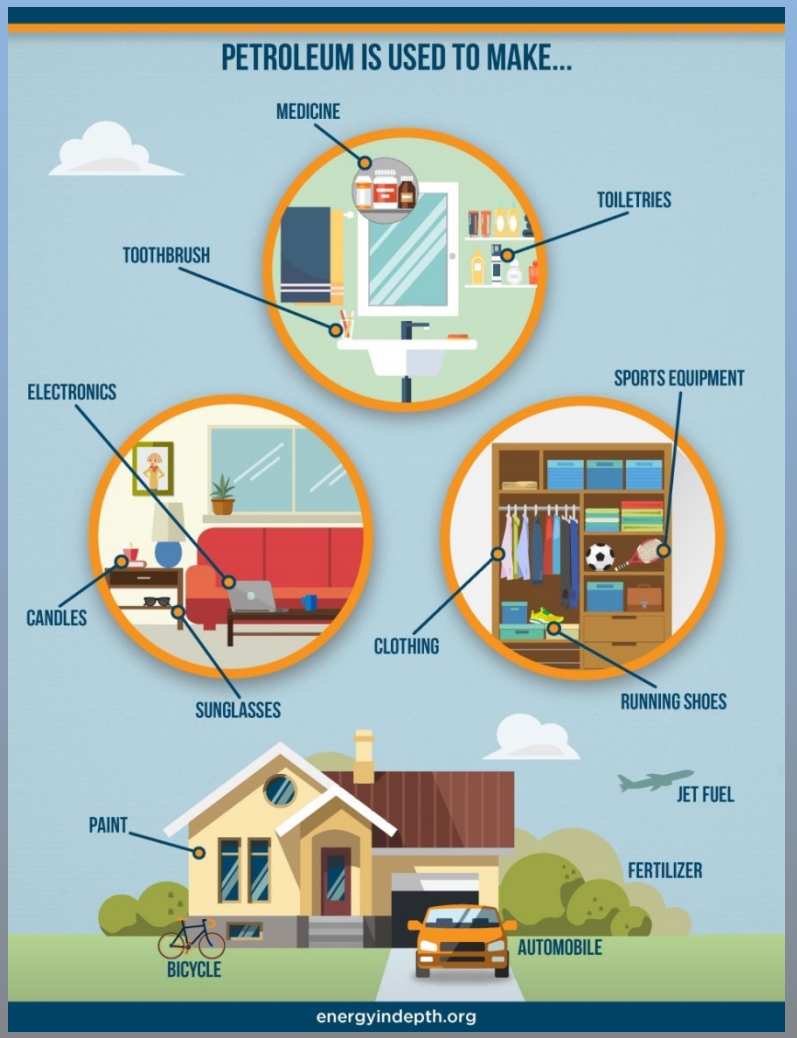
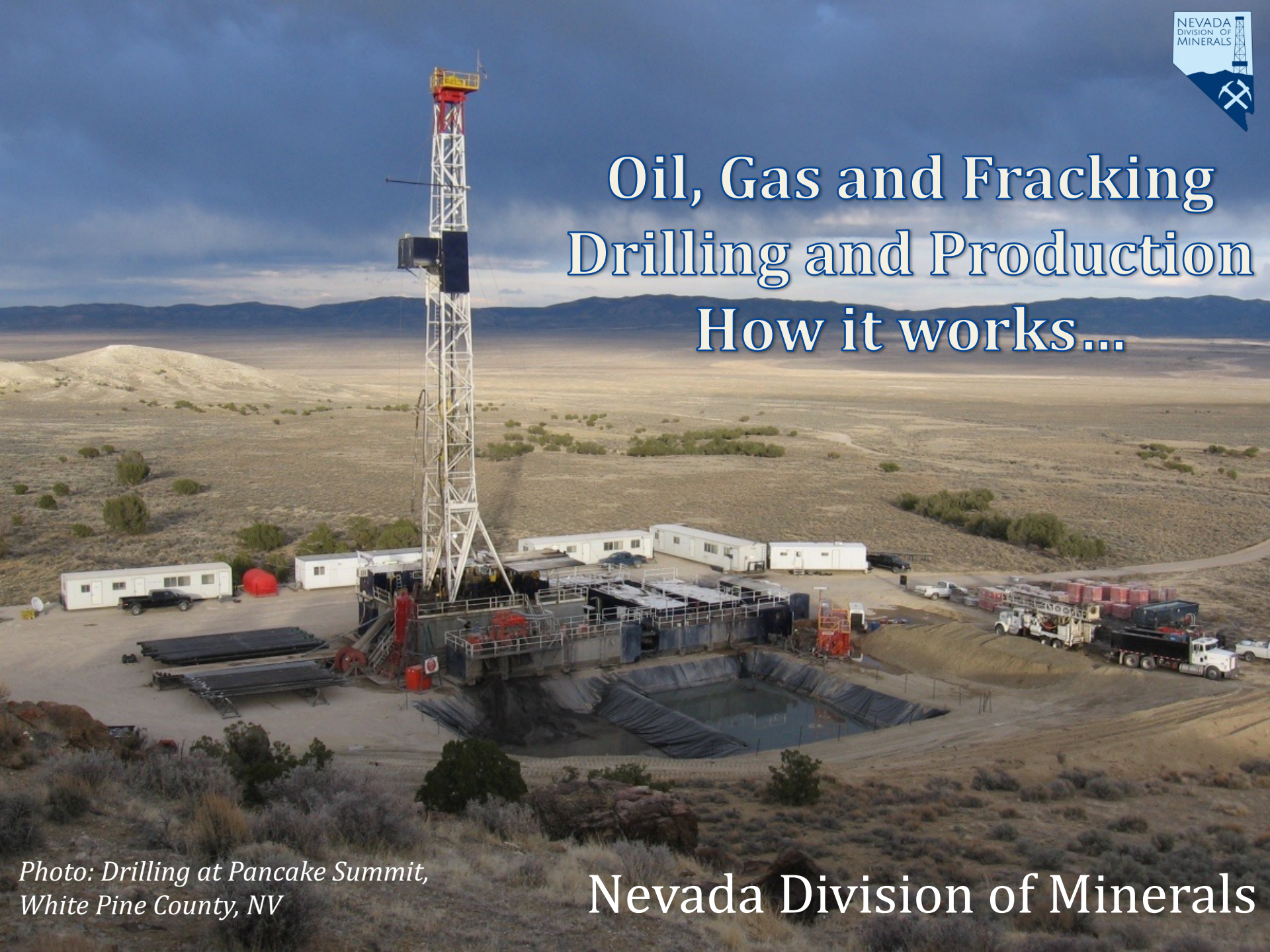
What do these items all have in common?

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
USA
80.1% federal land

$12,981,172
CY 2023 revenue

Revenue trend (2003 - 2023)

Commodities

Commodity	Total
Geothermal	$10,827,921
Oil	$1,750,969
Oil & gas (pre-production)	$391,998
Potassium	$10,124
Phosphate	$160

Nationwide Federal
USA
27.1% federal land

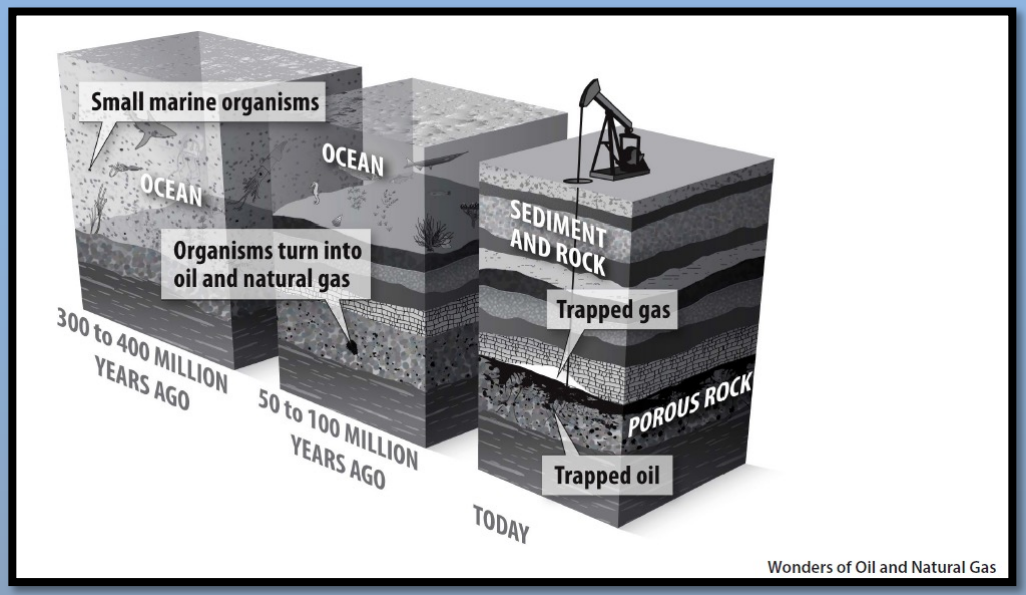
$15,987,371,600
CY 2023 revenue

Revenue trend (2003 - 2023)

Commodities

Commodity	Total
Oil	$11,648,163,514
Gas	$1,902,459,375
Natural gas liquids	$767,349,923
Wind	$600,952,111
Coal	$474,539,134
Other	$593,907,542

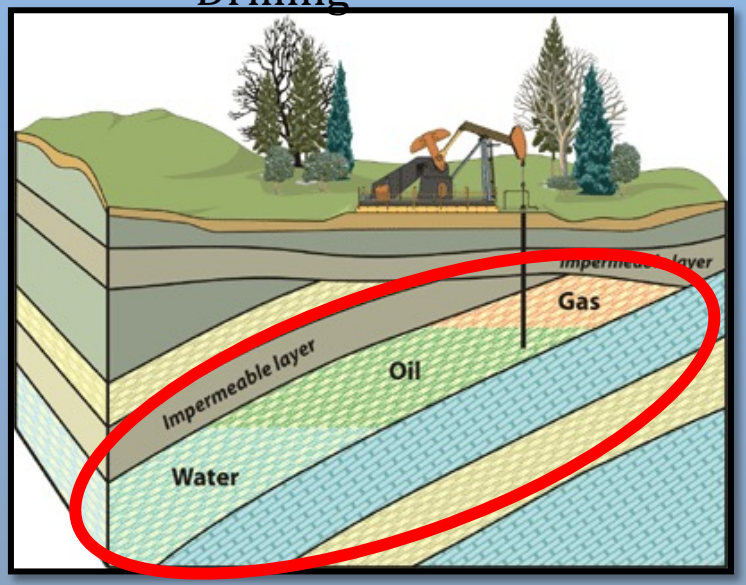
Source of Energy Resources

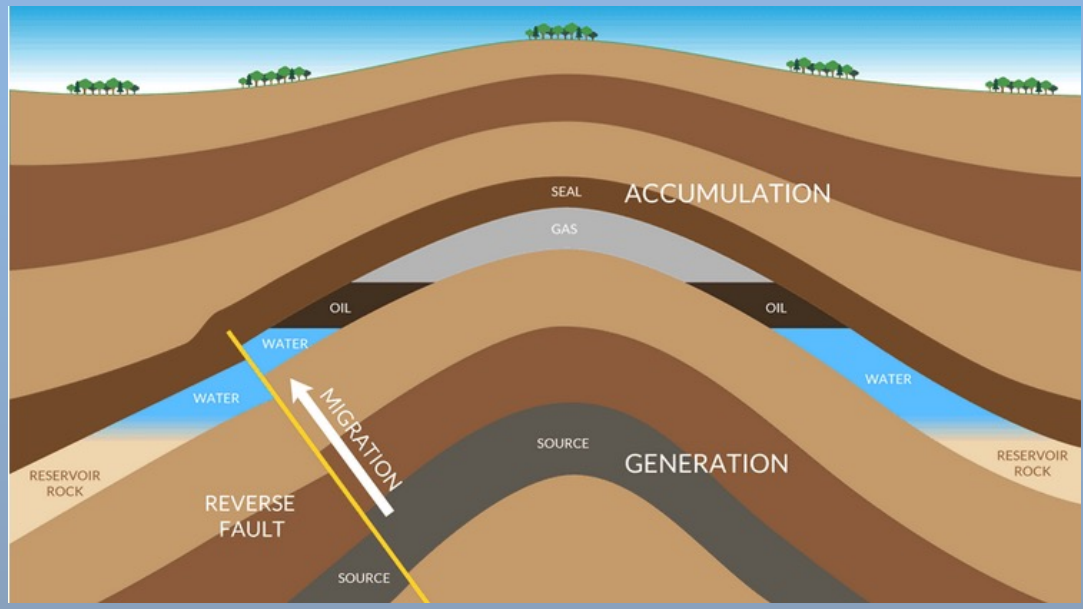


- Oil / Gas
  - Biologically rich environment = Kerogens
  - Burial of Kerogens
  - Heat and Pressure

Deposits

Drilling

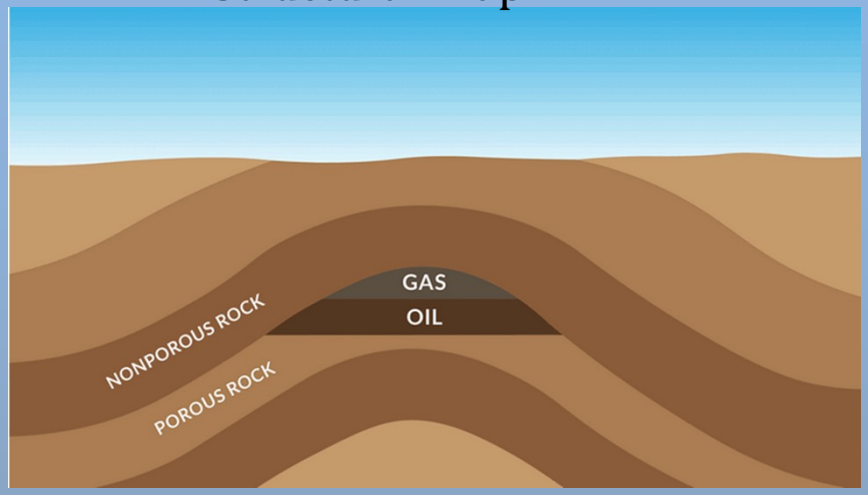




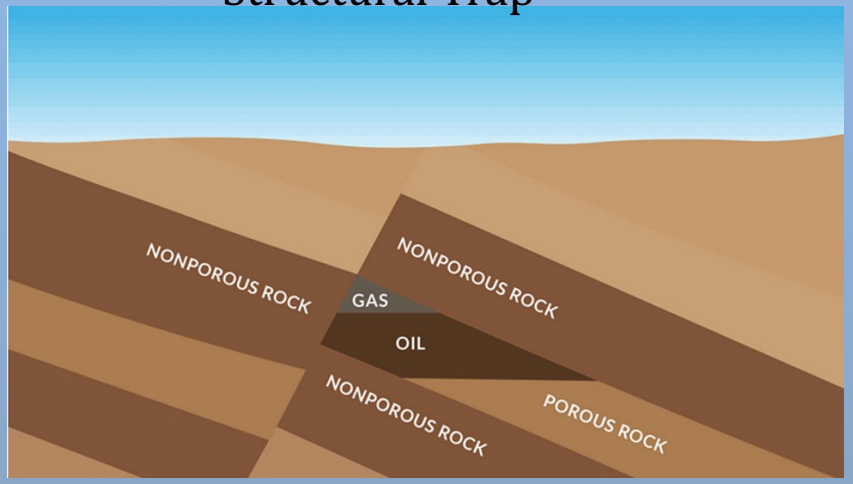
- Generation from Heat & Pressure
- Seals/Caprock: Shale, Chalk, Salt.
- Reservoir rock: Sandstone, limestone, and shale

Types of Oil Traps

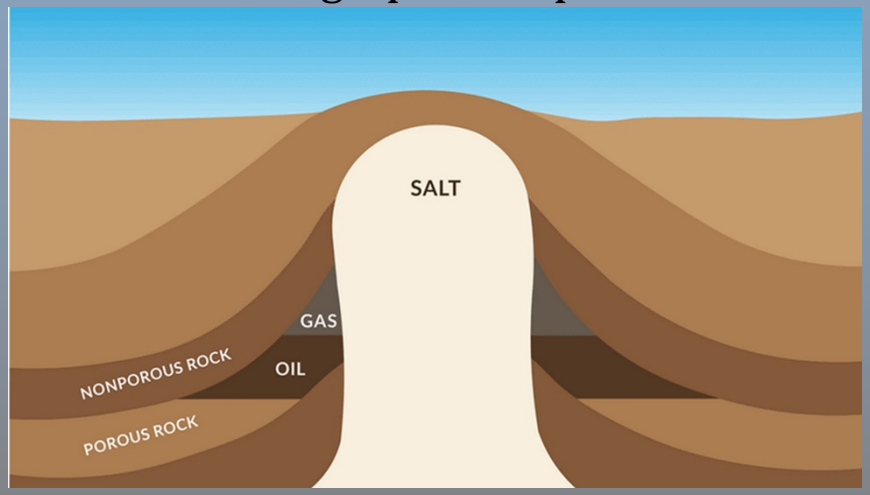
Structural Trap



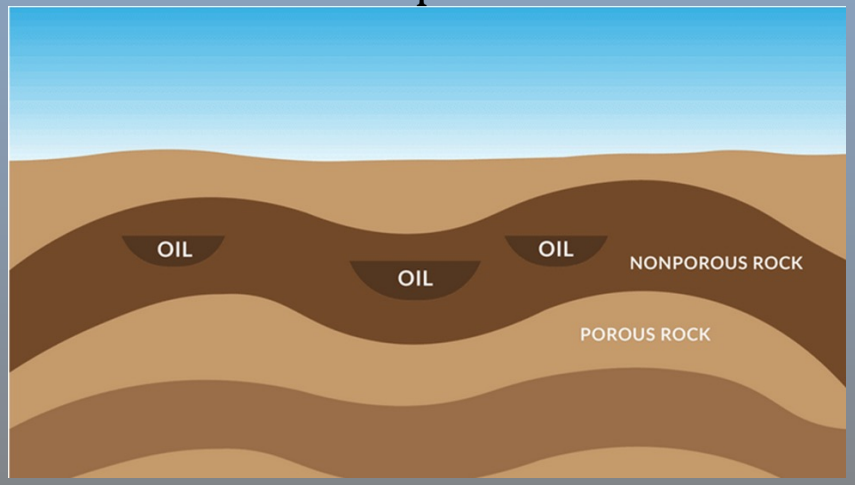
Structural Trap



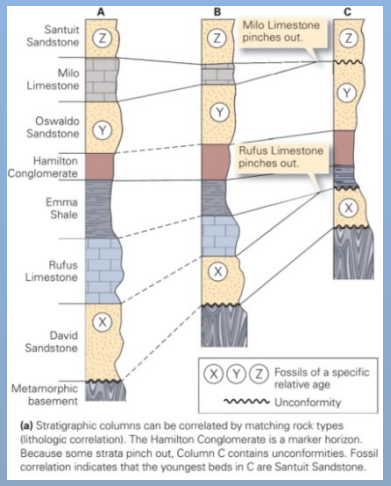
Stratigraphic Trap



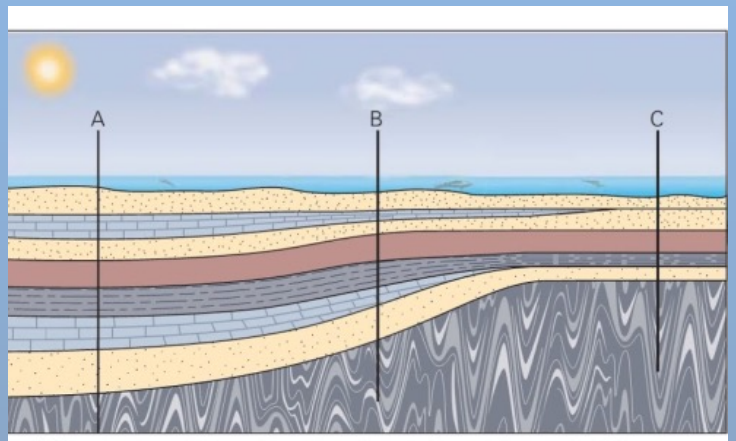
Lens Trap



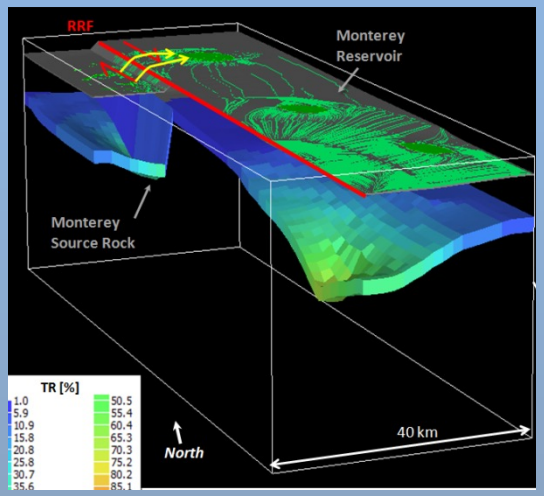
Stratigraphy Interpretations



(a) Stratigraphic columns can be correlated by matching rock types (lithologic correlation). The Hamilton Conglomerate is a marker horizon. Because some strata pinch out, Column C contains unconformities. Fossil correlation indicates that the youngest beds in C are Santuit Sandstone.



(b) At the time of deposition, locations A, B, and C were in different parts of a basin. The basin floor was subsiding fastest at A.



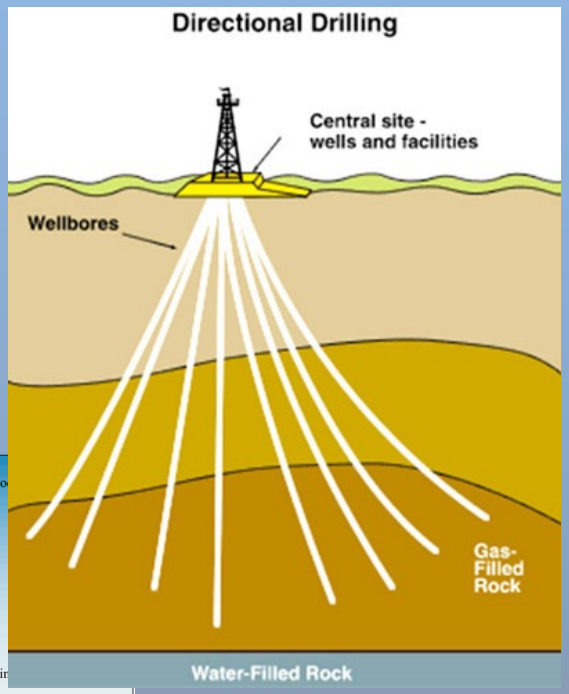
- **Strat Column**
  - Vertical sequence of rocks present at a single location
  - What comes out of the drill string
- **Cross Section**
  - Interpretation, supported by data, of subsurface geology along a profile
- **3D interpretation**
  - Connection of multiple cross sections or interpretation from geophysical techniques to calculate deposit volumes

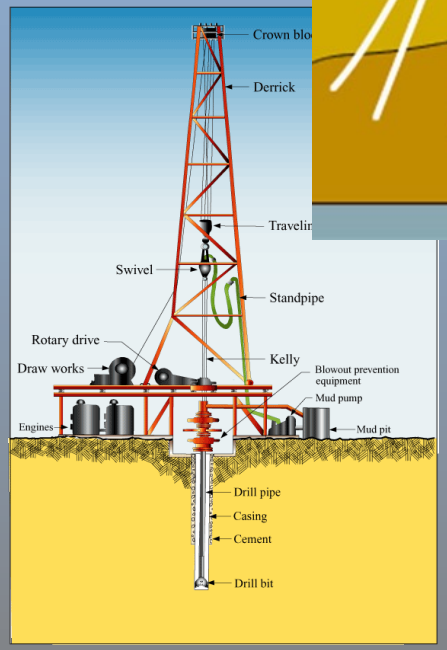
Types of Drill Rigs

- Core Rigs
  - See structure of beds
  - Slower drilling (100'/day)
- Reverse Circulation (RC) Rigs - 1000' / day

Drilling Plans

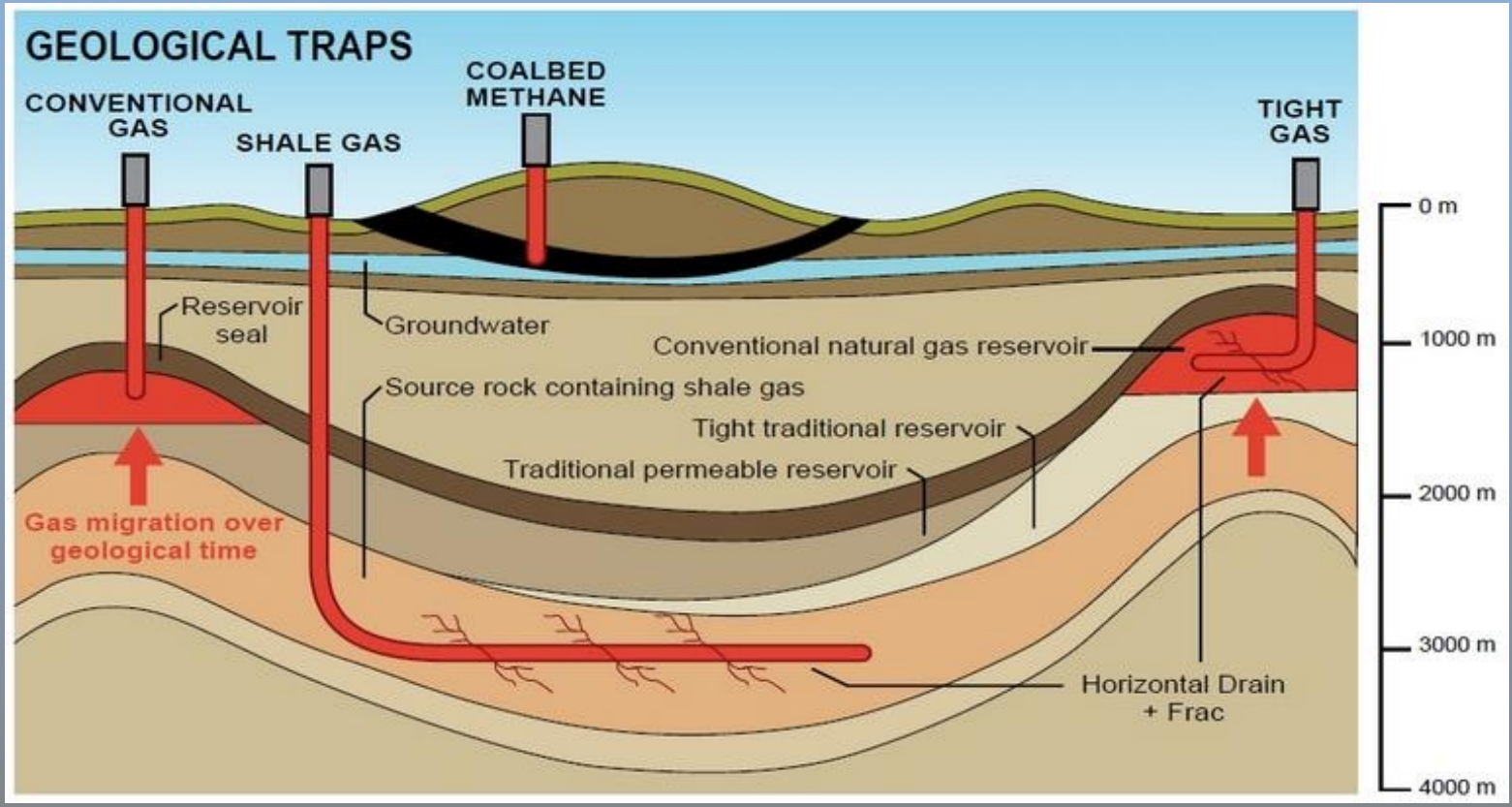
- Cut across layers too sample stratigraphy
- Or follow stratigraphy to maximize resource production





Production Methods

- Drilling Plan based on reservoir characteristics & low environmental impact



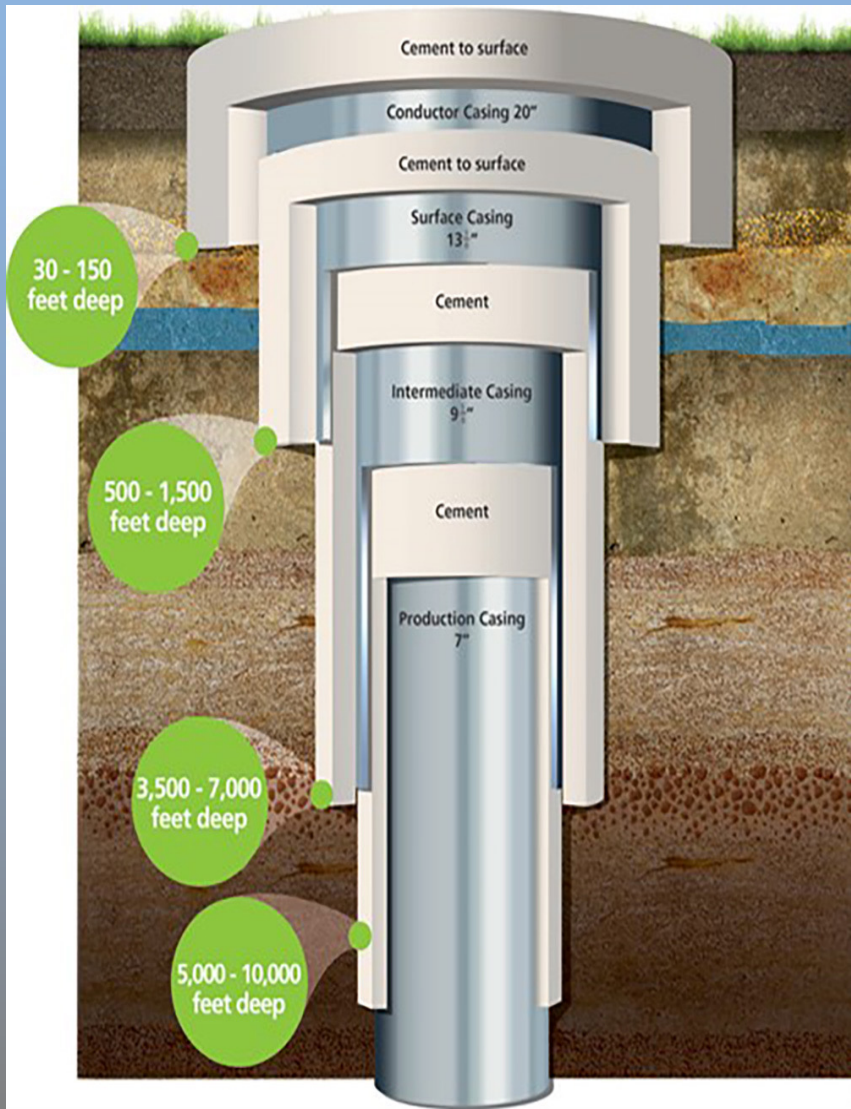
Production Methods – Conventional

- 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

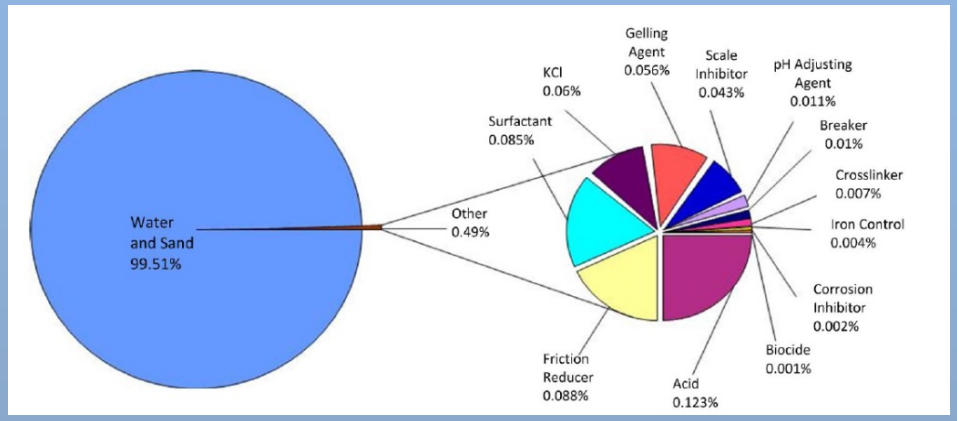
videoplayback.mp4 https://www.youtube.com/watch?v=SFJFiyXTOa0

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)

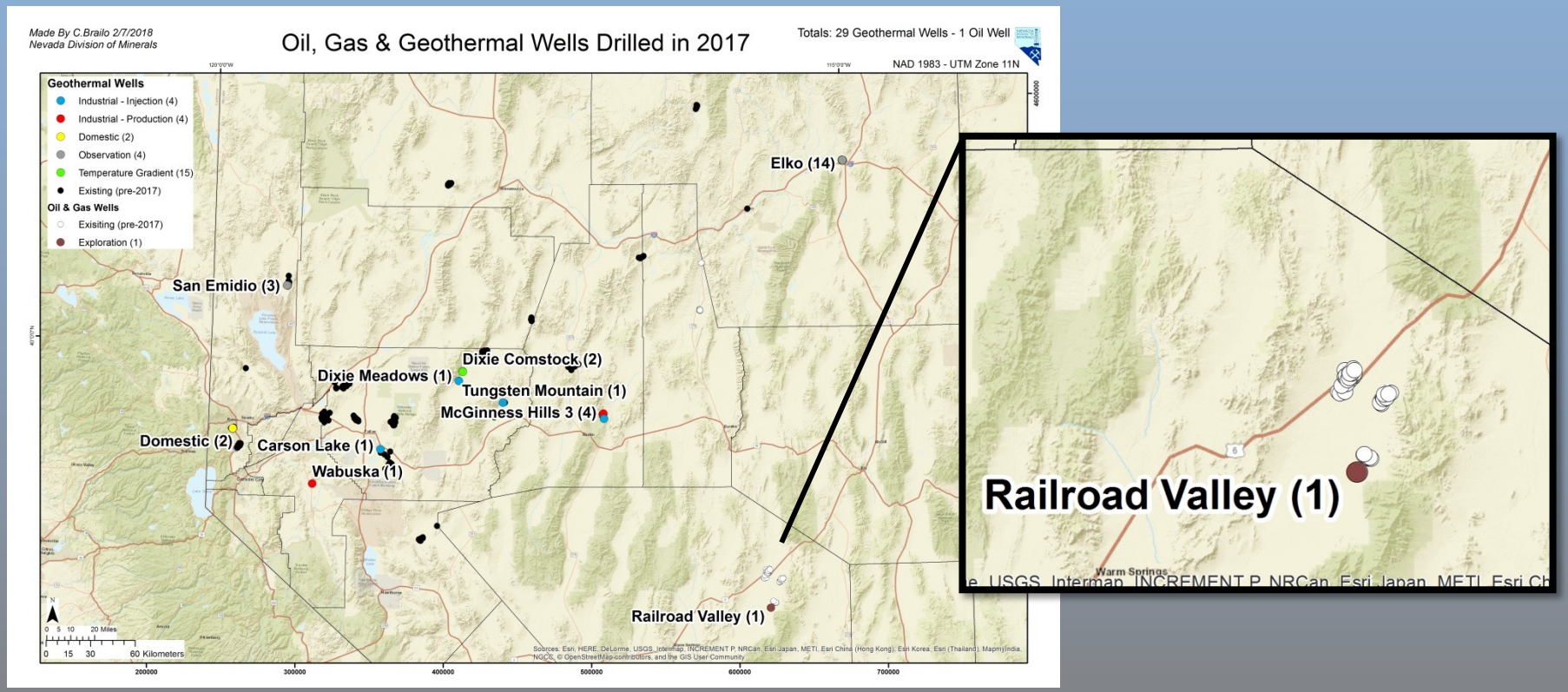
- **Natural gas creates electricity that is 50% or more cleaner (in terms of CO2) as compared to coal**
- **Exploration is getting quieter and more efficient with new technology – use of a single drill pad and horizontal drilling has helped reduce the environmental impact of drilling**
- **Without this process we wouldn't have access much of the worlds 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.**

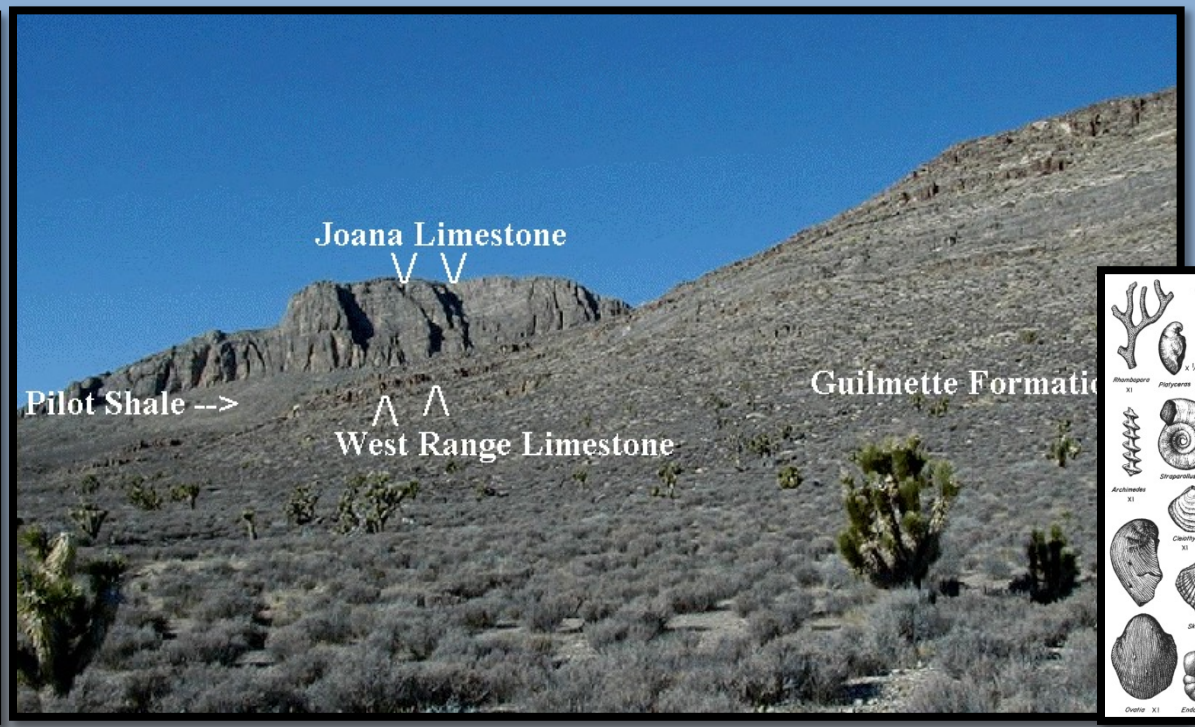
Follow Up Discussion:

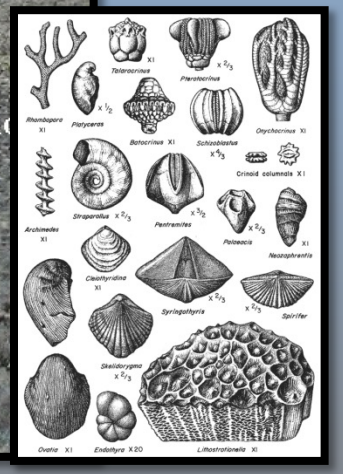
- Location & well we looked at is site of discovery & current producer of oil



Joanna Limestone

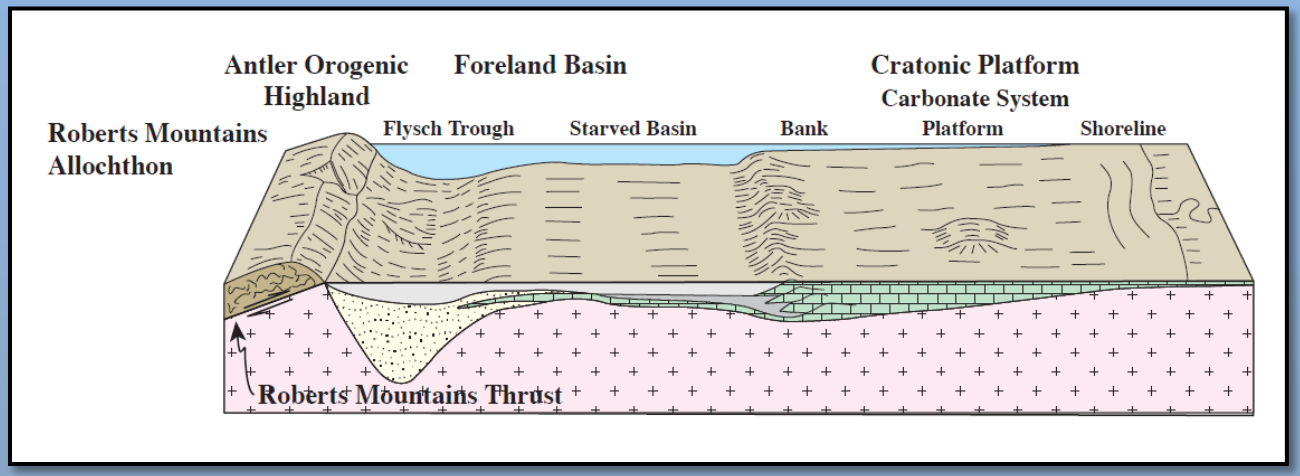
- Fossil types include echinoderm, bryozoans, foraminifera, algae, and crinoids

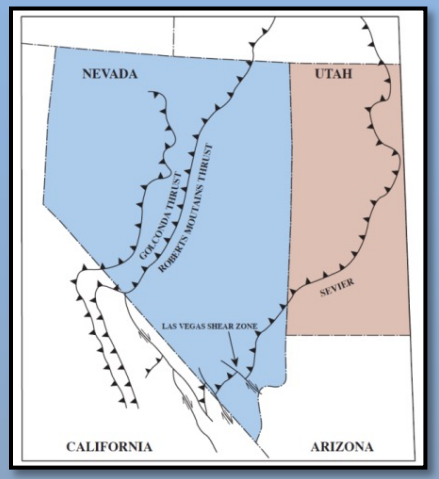




Hosts mineralization within deposits (post Carboniferous-age)

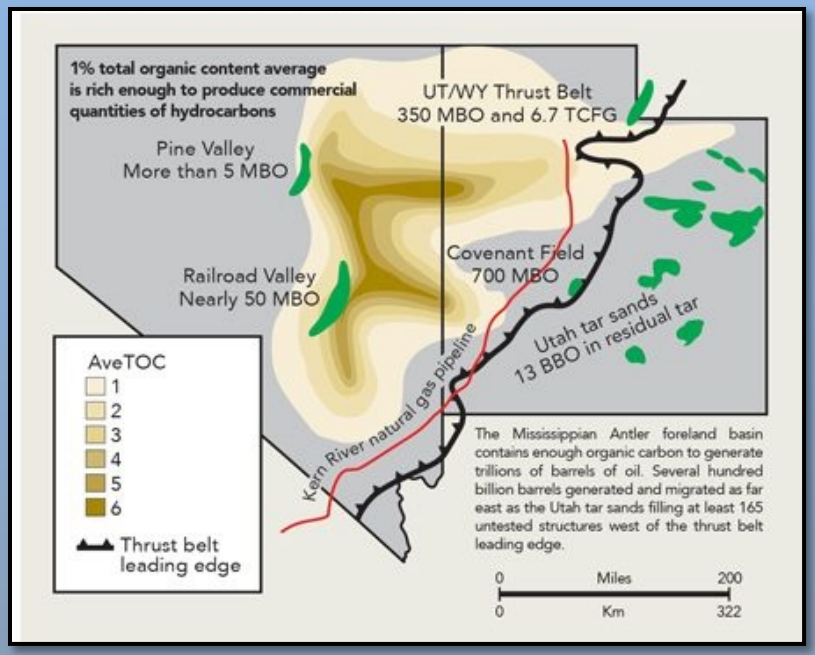
Why do we have oil?
Nevada Cross Section

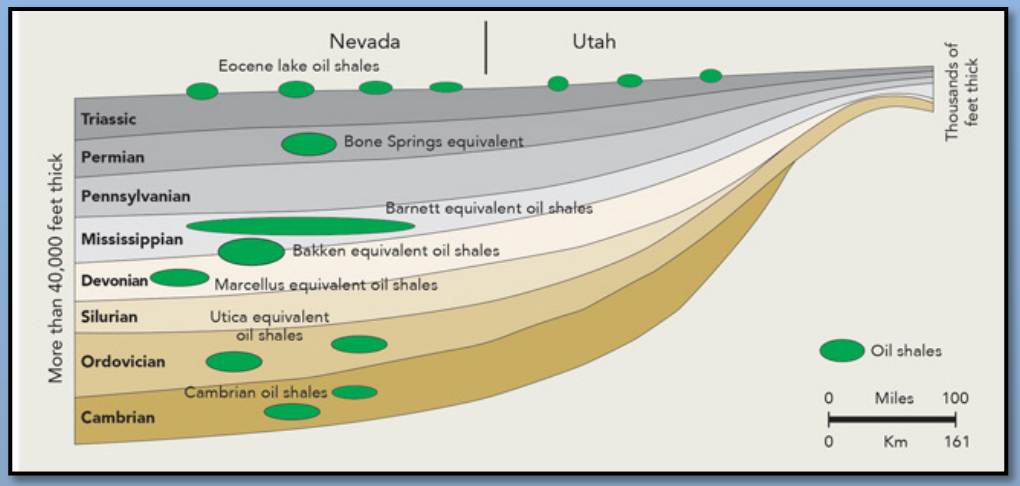




- Many stages of mountain building events that built the west
- Basins fill as they deepen with sediments from mountain range uplift
- Often basins covered by large inland seas which were filled with organic material

Great Basin Shales





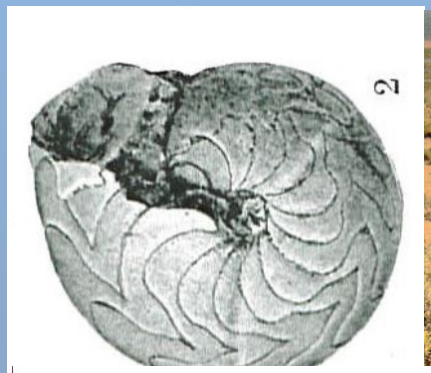
Oil & Gas Financial Journal, Jan. 2017

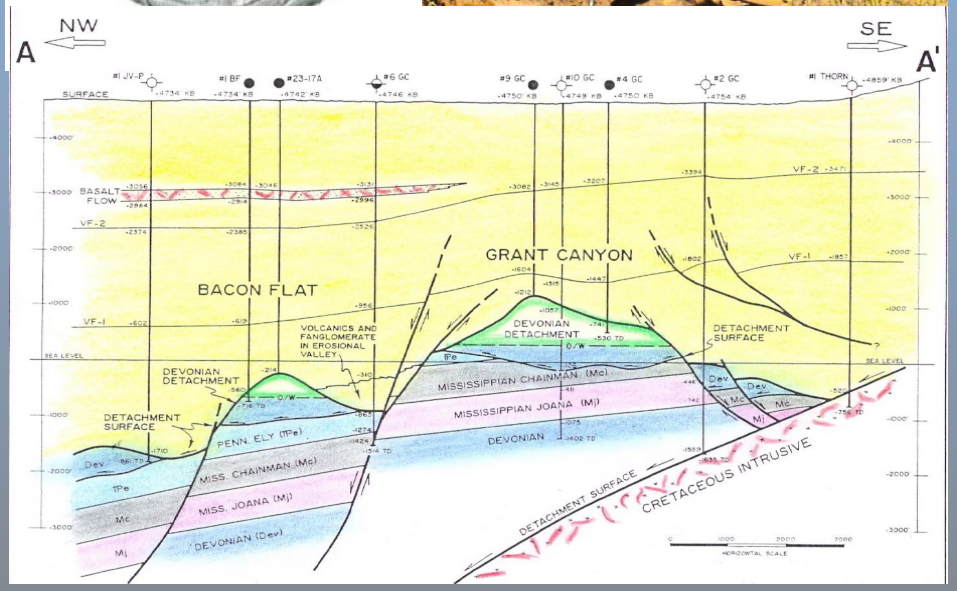
- Nevada's oil reserves consist of limestone from the inland seas and associated shales

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 47million 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*





Johnson, E.H., 1994, Geologic and Seismic Analysis of the Bacon Flat-Grant Canyon area, Nye County, Nevada: in Oil fields of the Great Basin, Nevada Petroleum Society, Reno, Nevada, p. 227-240.

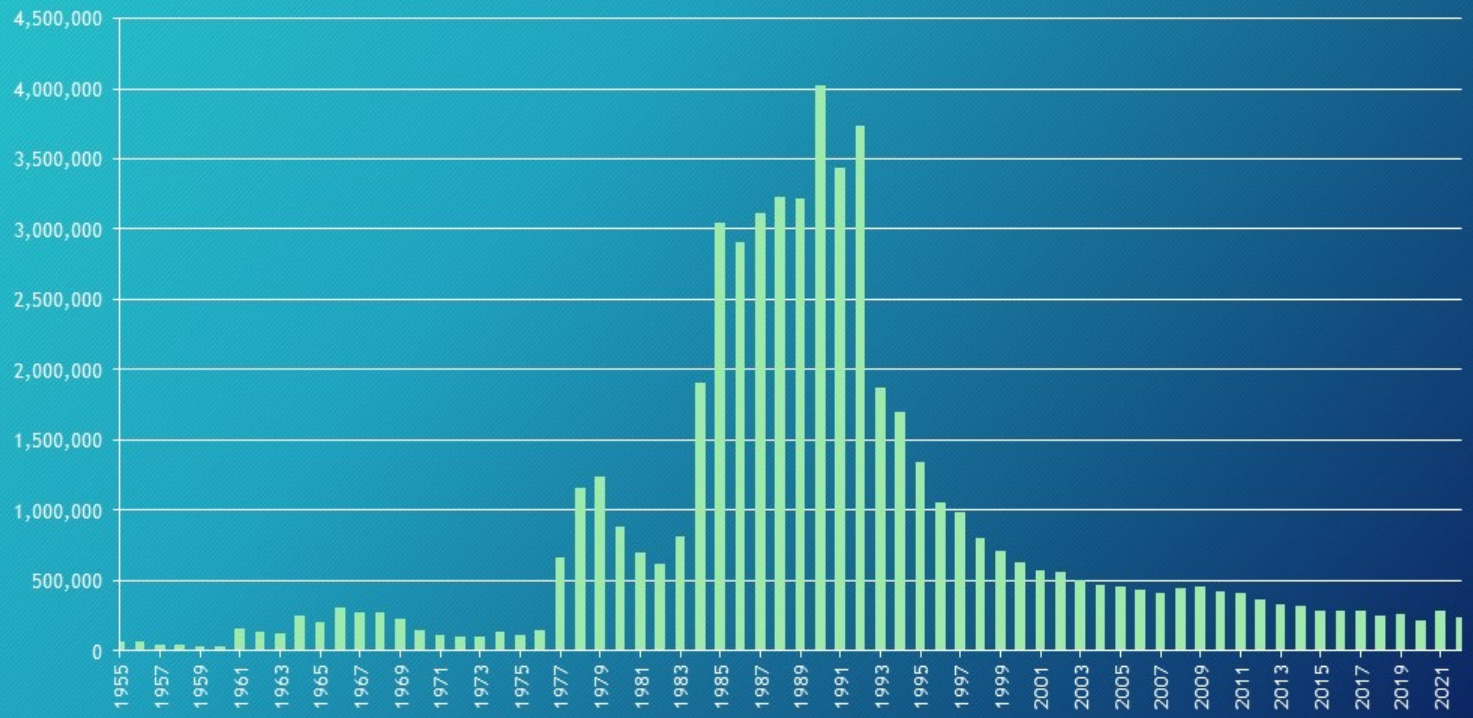
Nevada's Oil/Natural Gas Resources

All data is preliminary and is subject to change

Nevada Oil

2022 Production:

- 234,685 barrels
- -12% vs. 2021
- 1955-2022 cumulative production 55,207,809 barrels



Nevada's Oil/Natural Gas Resources

OIL PRODUCTION IN NEVADA BY PRODUCING FIELDS 1954 TO 2019 (IN BARRELS)

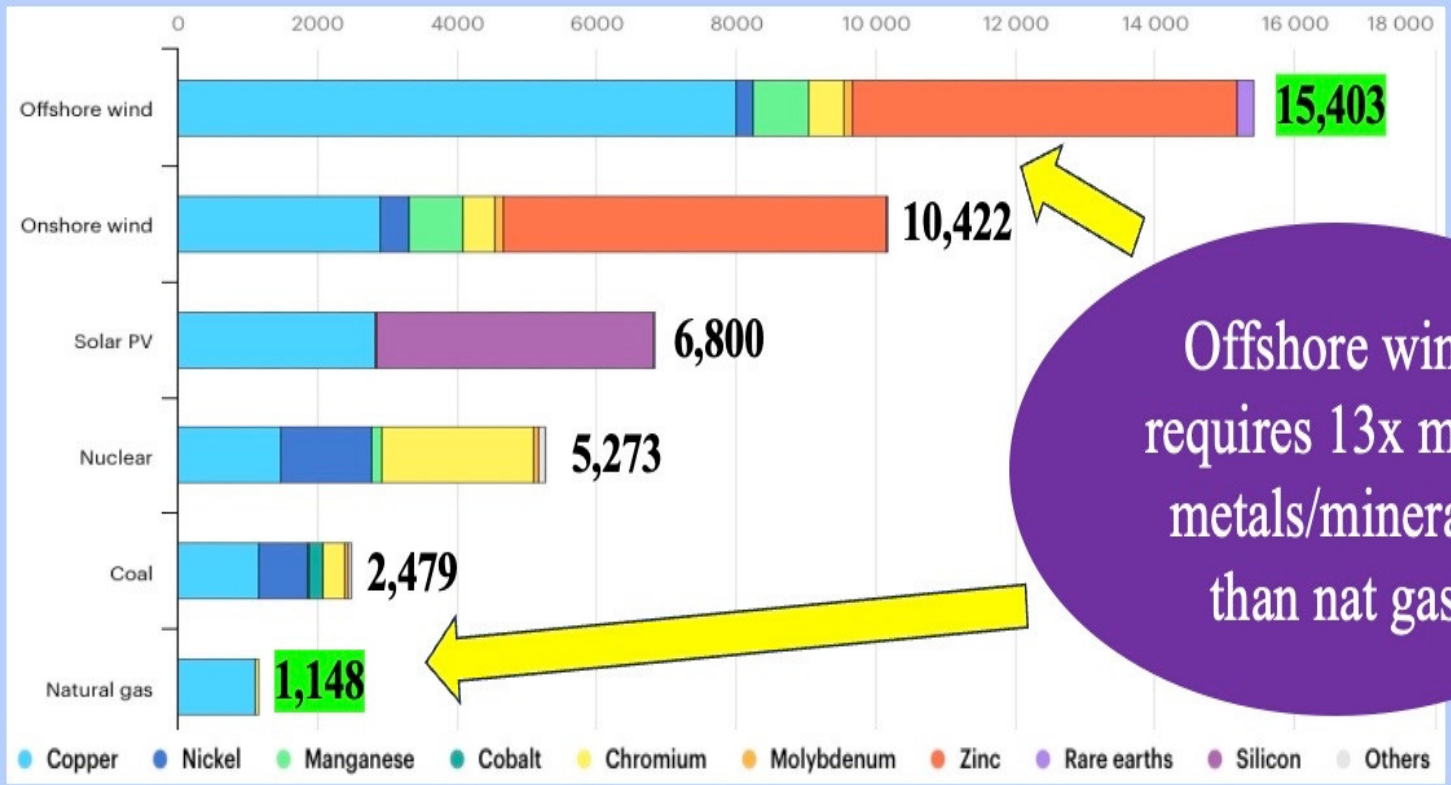
YEAR	EAGLE SPRINGS	TRAP SPRINGS - MUNSON RANCH	CURRANT	BACON FLAT	BLACKBURN	GRANT CANYON	KATE SPRING	TOMERA RANCH	N WILLOW CREEK	THREE BAR	DUCK-WATER	SAN SPRING	GHOST RANCH	DEAD-MAN CREEK	SAND DUNE	TOANA DRAW	HUMBOLDT	HUNTINGTON	TOTAL PROD.
1954-1989	3945917	7901672	641	314660	1905504	11838587	271148	6478	13493										26,198,100
1990	41609	939910	0	0	238240	2345858	434349	2605	3169	3601	3095								4,012,436
1991	42043	690697	0	0	203023	2124021	324207	3067	2365	17684	4190								3,411,297
1992	43691	554410	0	178845	231719	2499831	203274	2295	4491	362	2764								3,721,682
1993	7075	427150	0	102030	599857	495934	150309	2140	3928	1961	2256	69478							1,862,118
1994	66565	378829	0	192601	576853	308709	122544	1970	3737	229	1269	44279							1,697,585
1995	162296	362985	278	43057	435975	202129	104574	1405	6419	0	655	22174							1,341,947
1996	171638	306858	0	28891	239934	168163	87789	387	3619	0	433	17228	34166						1,059,106
1997	137278	288686	202	22465	151151	143707	76280	659	1478	0	168	45001	113016	109					980,200
1998	111562	257921	230	18757	112008	126128	69768	574	1502	0	491	21759	65370	258	12465				798,793
1999	82067	263566	28	16849	89400	112715	65315	398	123	0	93	11127	49348	0	15122				706,151
2000	59394	246725	55	14766	78136	102113	57644	488	146	0	116	6990	41454	0	12624				620,651
2001	67024	218198	33	13898	66899	92899	55198	0	144	0	968	6356	36173	0	13461				571,251
2002	67908	206424	21	12647	62412	85722	53408	11901	573	0	869	5532	31814	0	14211				553,442
2003	57946	193191	23	11763	54623	79293	49698	1981	349	0	436	4775	26129	0	13123				493,330
2004	45176	181937	9	10612	51372	73879	45656	124	377	0	200	4169	36423	0	13124				463,058
2005	54362	170896	3	7556	45369	68944	44288	0	2064	0	185	3324	37874	0	11878				446,743
2006	54708	163299	0	8112	41491	70158	41124	0	2552	0	122	3265	30255	0	10618				425,704
2007	56992	159821	81	8301	39477	62236	38411	0	1256	0	150	2971	26070	0	10562	1916			408,244
2008	58683	196089	108	7968	43600	56247	36863	0	56	0	120	2407	23615	0	10467	48			436,271
2009	53851	181320	111	7764	77730	60036	38347	0	0	0	120	1419	24011	0	9883	0			454,592
2010	57394	175352	109	7427	57260	68927	33825	0	0	0	118	1493	21630	0	3687	0			427,222
2011	58900	166415	119	6358	43198	77683	32719	0	0	0	115	1404	18605	0	2483	0			407,999
2012	44422	156991	159	5690	38004	58897	30833	11705	0	0	117	1498	17022	0	2656	0			367,994
2013	39818	143909	194	6447	40392	50517	29402	3757	0	0	119	1318	17232	0	2567	0			335,671.48
2014	34217	136651	143	6223	32217	46263	28934	2016	0	0	124	1604	15564	0	7467	0	2756	2248	316,426.28
2015	32675	120762	25	5000	31605	42810	26672	1224	0	0	45	1268	15106	0	2606	0	0	1584	281,382.39
2016	26872	118847	0	5261	44180	41631	26486	961	0	0	0	246	13914	0	201	0	0	854	279,453.22
2017	26716	129104	0	5325	40767	38861	27287	854	0	0	0	1567	14345	0	121	0	0	9	284,956.23
2018	27035	125262	0	5000	24625	32126	26102	385	0	0	0	1437	12959	0	37	0	0	0	254,968.00
2019	35205	125540	0	4623	22559	33495	25428	372	0	5910	0	1148	12592	0	0	0	0	0	266,872.00
TOTAL	**5,771,039**	**15,689,417**	**2,572**	**1,078,896**	**5,719,580**	**21,608,519**	**2,657,882**	**57,746**	**51,841**	**29,747**	**19,338**	**285,237**	**734,687**	**367**	**169,363**	**1,964**	**2,756**	**4,695**	**53,885,646**

- 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/
- Hydraulic Fracturing activity
  - https://www.airwatergas.org/resources/curriculum/make-a-fracking-model-activity/
- Wonders of Oil & Natural Gas Activity
  - http://www.need.org/files/curriculum/guides/wondersofoilandgas.pdf

Iron Law of Power Density: The Lower The Power Density, The Greater The Resource Intensity



Kilograms of metals & minerals needed per MW of capacity

Source: IEA, https://www.iea.org/data-and-statistics/charts/minerals-used-in-clean-energy-technologies-compared-to-other-power-generation-sources