PETROLEUM

Teacher Guide

including

Lesson Plans, Student Readers, and More Information

Lesson 1 - History of the Petroleum Industry

Lesson 2 - How Oil and Gas are Created

Lesson 3 - Extracting Petroleum (Lab)

Lesson 4 - Products of Petroleum (Activity)

Lesson 5 - Finding Black Gold

designed to be used as an Electronic Textbook
in class or at home

materials can be obtained from the Math/Science Nucleus

EARTH SCIENCES - PETROLEUM

Lesson 1 - History of the Petroleum Industry

MATERIALS:

reader

Objective: Students learn the importance of petroleum in today's society.

Teacher note

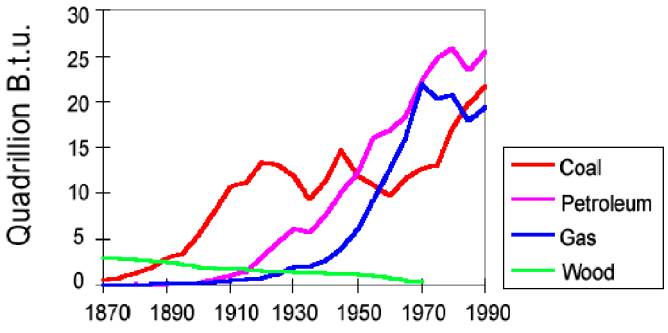
Most people today are unaware of the giant petroleum industry. They use their products every day from gasoline to polyester fibers, but rarely think of what our society was like before many petroleum products were discovered.

Crude oil and bitumen (tar) have been known since people have first walked this planet. The thick, black, smelly liquid was more a bother than a miracle chemical concoction in early times Animals, including humans would get stuck in tar pools and go to a blackened death. Today, petroleum is the basis of our world economy. There are several websites that might be helpful including:
http://www.oilhistory.com
http://little-mountain.com/oilwell/

Although oil was used to keep fires ablaze in early human history, its importance in the world economy evolved slowly. Wood and **coal** were used to heat and cook with, while **whale oil** was used for light. The black, smelly, thick liquid is referred to as tar or rock oil was only seen as a substance to avoid.

Capturing sperm whale for oil

When the whaling industry hunted the sperm whale almost to extinction and the **Industrial Revolution** needed a fuel to run generators and engines, a new source of energy was needed. In the search for new products, it was discovered that from **crude oil** or **petroleum**, **kerosene** could be extracted and used as a light and heating fuel. Petroleum was in demand at the end of the 1800's. The search for finding "black gold" was on!



Example of energy consumption in the United States

Drake's first operation in Pennsylvania

Early oil pioneers noted that oil could be found near oil seeps. As drilling equipment was developed in the 1800's, searching for water and salt, oil finders decided to drill for oil. As drilling started, they recognized that the rocks gave them clues to where the oil was trapped. They noted that sedimentary rocks, especially sandstones, would contain the black liquid. Early explorers would not only use science, but also luck.

Edwin L. Drake was just one of these early drillers. He developed a "drive pipe" that would allow people to drill with more control. In 1859, near Oil Creek in Titusville, Pennsylvania, Drake used his drill and struck oil. He used whisky barrels to capture his new wealth. Word soon spread like a wildfire, with the promise of riches, men were lured to strike it rich in the oil fields of the east.

Although Drake laid the foundation for an industry that would change the face of the world, he died in the 1880's in obscurity. But the industry he helped to find, would soon make oil finders some of the wealthiest people in the world.

John D. Rockefeller

So while young men in the United States were going west to find wealth in gold, other men sought oil. The oil industry would keep evolving to bring its participants wealth beyond their imagination. In the early years, it was individuals who became rich, but as the fortune was too much to comprehend, **corporations** would evolve to manage the unprecedented growth.

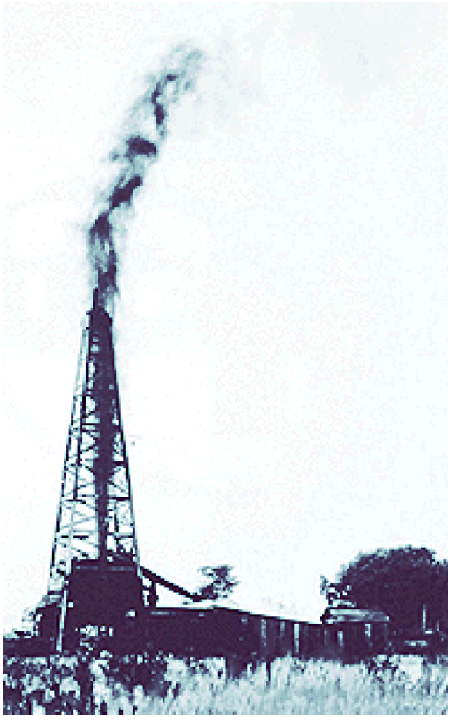
The Standard Oil dynasty is one such story. The wealthiest person of all times was John D. Rockefeller, who established Standard Oil in 1870. This company had a reputation as a "robber baron," controlling a product that was to influence the price of just about everything in the industrialized world. Rockefeller started his business on refining light oil and kerosene from crude oil.

The company was so feared that the United States government enacted the **Sherman Antitrust Act** in 1890 to break up the first **monopoly** in a democracy. Monopoly of one individual or company in a democratic society can undermine the health of that country. John D. Rockefeller died in 1937, but with his wealth he created one of the largest philanthropical charities to now make the Rockefeller name synonymous with goodwill.

J. Paul Getty, (1938)

Another giant of the oil industry in the early years is J. Paul Getty. He always claimed that his formula for success included, "Rise early. Work late. Strike Oil!" Getty was born into the oil industry, as his father was an insurance company attorney in the fledgling industry. Getty acquired oil companies in the Oklahoma oil boom. Getty based his wealth not on discovering oil, but buying and selling of oil concession. His insight and deal making won Getty many oil fields in the newly opened oil rich middle east.

He was considered the United State's first billionaire in 1957, but was noted for his "weirdness." During World War II, he spent most of his time in a concrete bunker in Tulsa, Oklahoma. But when he died in 1976, he was heralded as a symbol of the entrepreneur and master of the deal.



Oil gusher and derrick in Ohio

Oil companies attracted many people because of the excitement of finding a gusher with hopes of instant wealth. **Prospecting** for oil was hard work and dangerous. After you find oil, drilling the well to extract it may be more difficult. Funds were needed for drilling, which was then, and still is today, an expensive operation.

Oil is dangerous by its very nature. Many times it is in layers of the Earth with **natural gas**, and can create a fire storm if there is just one spark. In the movies they enacted the "There she blows!" referring to a geyser of oil shooting through a derrick. The **gushers** are under extreme pressure and difficult to cap to prevent the lost of petroleum. Specialized drilling rigs to control the flow of oil had to be developed.

Early oil drilling in the eastern U.S.

As the industry matured, huge **multi conglomerate** oil companies were created. There were oil rights, leases, drilling, marketing, and product development that were involved in bringing products to market. The demand for oil increased steadily as nations were emerging as industrialized countries. It seemed overnight, that the coal industry was replaced by the petroleum industry.


Venezuela, 1921

Since petroleum is a **non-renewable resource**, new areas needed to be explored. The leaders in the petroleum industry were the Americans. The companies soon realized that oil was an international product. Nations like Saudi Arabia, Venezuela, Indonesia, and Russia contained vast resources, while other countries in Europe and North America used these resources. The birth of these multinational companies, were referred to as the "The Seven Sisters." These petroleum companies included Exxon, Gulf, Texaco, Mobil, Socal, British Petroleum and Shell, had influence throughout the world from the mid 1900's to the end of the 1960's.

Many oil producing nations realized that their countries could become wealthy if they controlled the price of oil. This shifting of powers from the multinational oil companies to the oil producing countries created OPEC (Organization of Petroleum Exporting Countries) which is the present power broker for crude oil.

OPEC members include Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. They produce about 40% of the world's oil and hold more than 77% of the world's proven oil reserves. These 11 countries act as a voting block to control the supply of oil, which controls the price of oil.

Today, many nations are trying to reduce their dependence on crude oil. However, the demand is still high as we look for sources of **renewable energy** like hydroelectric and solar.

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Lesson 2 - How Oil and Gas are Created

MATERIALS:

reader

Objective: Students read about how petroleum is made in nature.

Teacher note

Most adults have no idea where petroleum products come from. An oil company once used dinosaurs to help promote their product. From that one commercial many people figured dinosaurs must have produced oil. Although dinosaurs did add to the organic carbon in soil, they are not the real producers of oil.

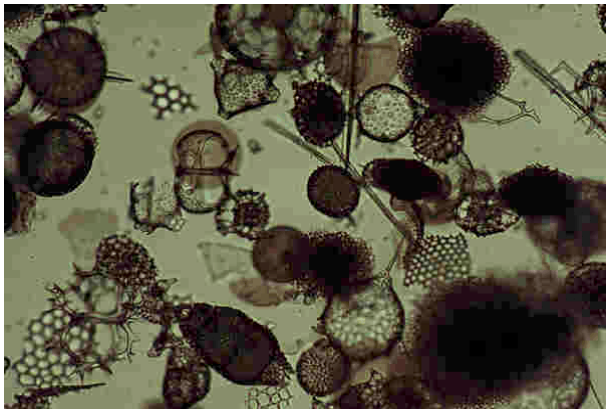
Ask your students where corn oil or olive oil comes from. Some will look at you funny, especially if you emphasize the word “corn” and “olive” when you ask the question again. Oil bodies are very common in fruits and seeds to help provide energy and carbon for the developing seedling. Yes, animals do have oil, but it is the plant kingdom from which most oil is created. Only a few animals, like the sperm whale have enough oil to produce a product.

Debate over where the hydrocarbons came from to produce crude oil was common in the early exploration. Now you can look at the chemical signatures of the oil and almost determine what the original organism matter may have been. Zones of high organic productivity like coastal areas, upwelling, and coral reefs are the likely candidates to produce enough organic material.

In many cases, diatoms, a one celled plant is a common source of the carbon and hydrogen. Bacterial decay of these masses as sediments bury them cause oil to form. Burial produces conditions that allow a transformation into organic material to crude oil. However, if the heat is higher the organic material may go directly into gas.

As students will learn, the rocks play a crucial part in the “trapping” of oil and gas. Sandstone is a noted “reservoir” rock or holder of the petroleum. If the sandstones have enough pore space and there are impermeable layers encasing it., oil or gas will remain.

So crude oil is chemically different than oil squeezed from plants. Crude oil’s chemical make-up produces other substances, that vegetable oil cannot. .

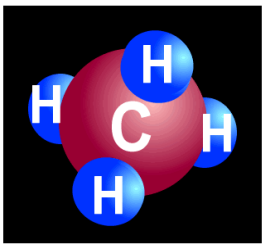


Radiolarians

The ingredients to produce crude oil are not as simple as making olive or corn oil. In living plants, oil is needed for growth, so many fruits and seeds have a ready supply of oil. The olive seed can be pressed to squeeze the oil into a ready-made product. There is no known vegetable matter that can be squeezed to produce crude oil.

Let's take a look at where we find oil to help us determine its origin. Most oil is found in rocks older than one million years but not older than 560 million years. So time seems to be a factor.

Since, oil is found only in the Phanerozoic (since life has been on our planet), the existence of life must be a factor. Crude is associated mainly with sedimentary rocks deposited in the marine environment. These deposits indicate that high productivity of organic carbon is important and contain many fossil microorganisms like **diatoms** and **radiolarians**.



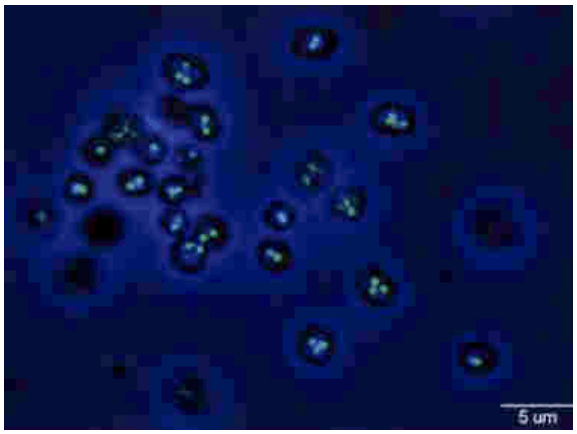
Hydrocarbon

Petroleum is an extremely complex **hydrocarbon**. The chemical components of crude oil, tar, and natural gas are given in the table below. It seems that no two crude oils are exactly the same. This is due primary to the source material and the result of its movement from the source rock to its reservoir.

The hydrocarbons arrange themselves in chains, and depending on the amount of chains will be dependant on what type of petroleum product is formed. However, nature only seems to produce **crude oil**, **tar**, and natural gas. All the other products produced by petroleum have to be created in the laboratory.

element	crude % weigh	tar (asphalt)	natural gas
carbon	82.2-87.1	80-85	65-80
hydrogen	11.7-14.7	8.5-11	1-25
sulfur	.1-5.5	2-8	trace-.2
nitrogen	.1-1.5	0-2	1-15
oxygen	.1-4.5	-	-

Today, we can create **methane gas** from decaying organic matter through bacterial **fermentation**. Fermentation is a chemical transformation by bacteria that chemically alters different substances. It is likely that the environment for petroleum production is without oxygen, as sediment covers the organic matter. This is called a **reducing environment**. It has been shown in the laboratory that reducing bacteria tend to convert organic matter into a petroleum like substance.



Reducing bacteria

Reducing bacteria are very slow, and maybe that is why geologic time plays an important part. Petroleum also has sulfur as part of its component, and a by-product of reducing bacterial is sulfur. This may be another clue about how oil is produced.

Heat combined with increased pressure aids the transformation of **organic matter** into petroleum products. But too much heat or too much pressure can prevent any oil from forming. Many geologists use petroleum formation to guide them on how much heat was in an area. For example, if oil is found, the temperature never exceeded 200° C or (392° F).

As oil is being produced in **source rocks** like diatomite or limestone, the oil and gas will move into **reservoir rocks** that can trap the oil as shown in the diagram below.

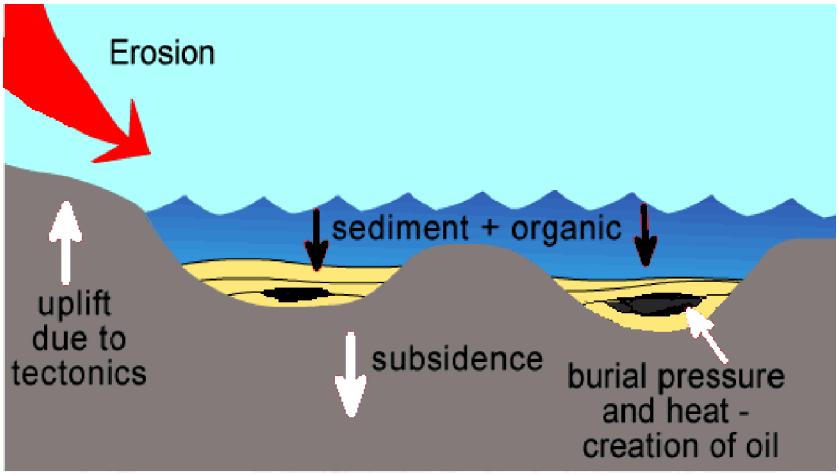
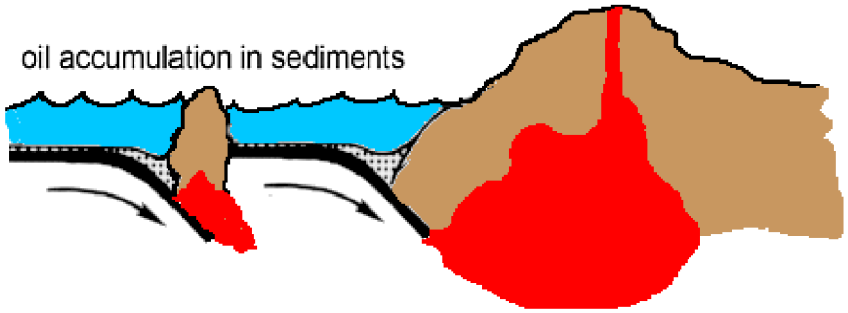
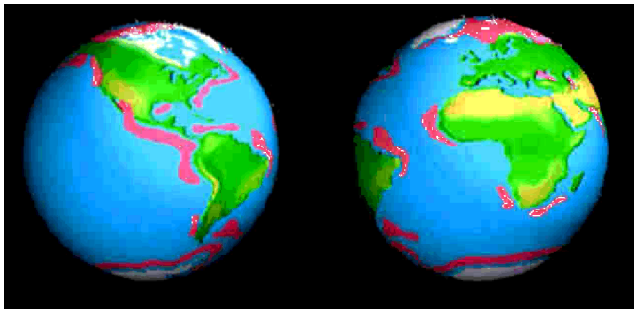


Plate tectonics creates areas that are ideal for oil accumulation. High **productivity**, especially along continental coasts, is ideal.

You can look at the oceans today and chart the areas of high productivity and compare them with areas in the past that have produced oil. Areas along continents with just the right water condition, circulation, and basin creation are shown as red in the diagrams below. Production of organic matter is key to the entire process.



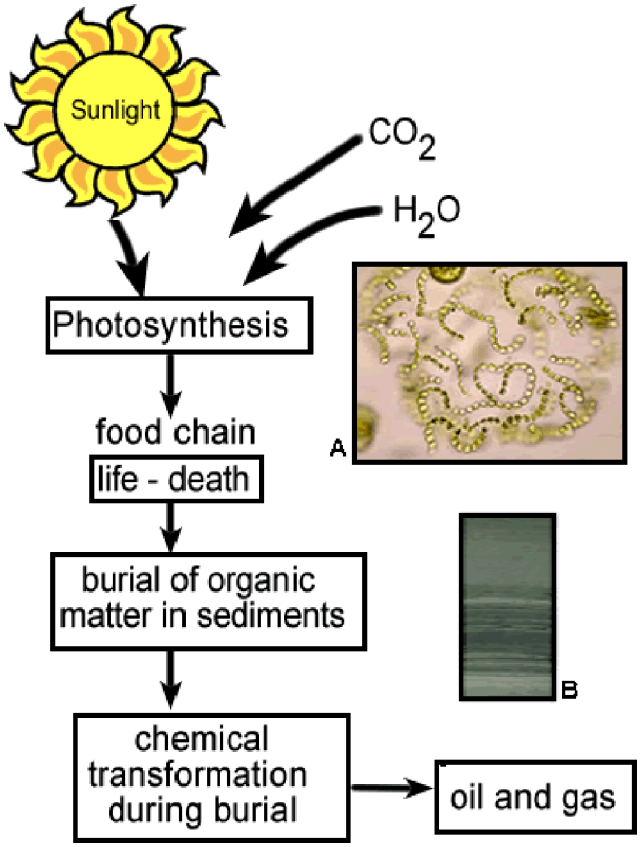
Double subduction produces basins that are ideal for oil accumulation


Zones of high productivity are in red

The process of merging hydrogen and carbon (from carbon dioxide and water) is accomplished through **photosynthesis**. Organisms like diatoms, a one celled plant, can start the process of creating organic matter ("A" in the diagram).

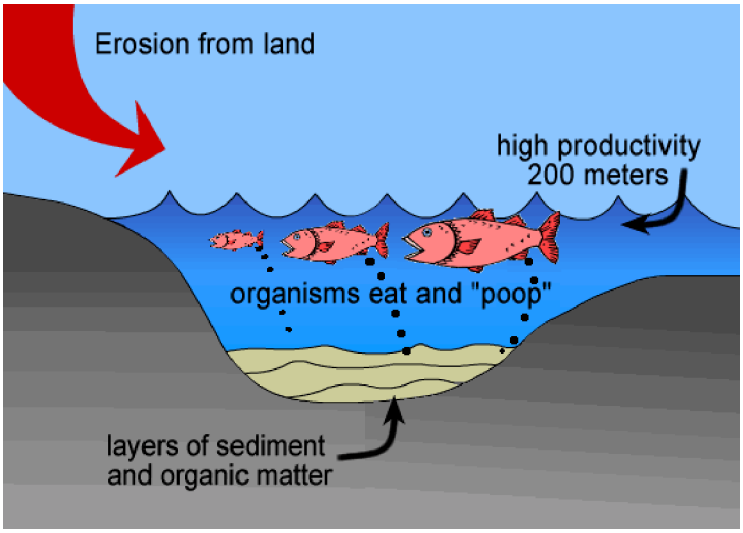
As the carbon and hydrogen are trapped in the food chain for nourishment of other organisms, crude oil is not produced immediately. However, as the death of these organisms and the burial of the organic matter in sediments is complete, crude oil will start to form (black layers in "B")

The different pathways that the organic matter will go through will determine the type of oil and gas produced.



So the story of petroleum accumulation is different depending on plate tectonics, productivity, sediment cover, temperature and bacterial decay. However, we do know that it includes a dynamic living body of water, of mainly marine origin. Organisms are living, eating, and pooping organic matter to the basins below.

Sediments cover the organic matter and through time bacterial action, heat, pressure, cause petroleum to emerge.



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Lesson 3 - Extracting Oil (Lab)

MATERIALS:

reader
graduated cylinders (100 ml)
different types of oil
straw
siphon bulbs

Objective: Students learn how density is used in oil extraction.

Teacher note

Making Italian dressing can be an uneasy experience if you don't realize that you must shake the bottle to get the oil and vinegar to mix. Many adults and children see this, but don't ask, "Why?" Density, of course is the answer.

Density is important for understanding how oil and gas are extracted. In this lab students first read about density of oil, gas, and water and how gas and oil can migrate within sedimentary rock. These substances become trapped due to impermeable layers (i.e. shale), faulting, or salt domes.

Oil traps are structures that favors large scale accumulation of oil with a combination of structure and rock types that create a barrier to upward migration. If the structures form large accumulations, this is referred to as an oil field.

There are some structures like anticlines (a downward opening fold) that are perfect oil traps. In anticlines, oil and gas accumulate at the highest part of the fold (gas higher than the oil).

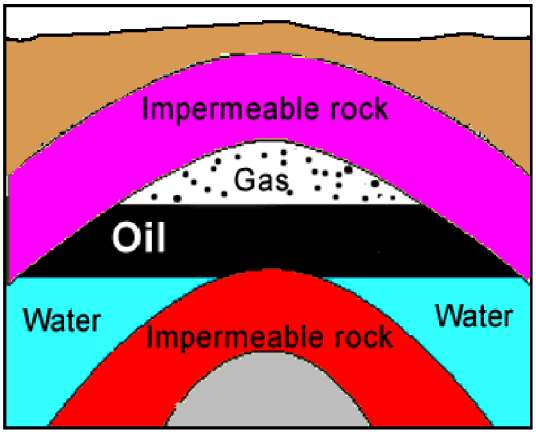
In the lab they compare the different oils that you provide. You can get different weights of motor oil, transmission oil, corn oil, olive oil, peanut oil, linseed oil, or any other oil based substance.

This would be a good time to discuss the damages caused by oil spills due to the fact that oil floats on water. Oil can coat all living creatures which interferes with their life. However, because oil floats it can be contained easily and removed. Some bacteria feast on oil which actually brings oil back into the food chain.

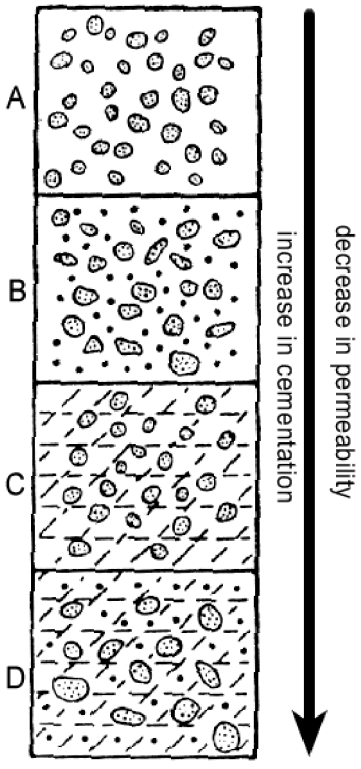
Liquids separate by density

Crude oil and natural gas are produced in source rocks. Source rocks refer to strata with a large organic component, which later turns to crude oil. Diatomite, a source rock, is a shaly rock that is composed mainly of the remains of diatoms (one celled plants) and radiolarians (protist). As the oil and gas are generated, depending on local conditions, the petroleum products will separate by **density**.

Oil is less dense than water so it will "float" on water. Gas is less dense than both and will float to the top. Petroleum produced by source rocks will migrate into a "reservoir" rock. A reservoir rock, like sandstone, is a strata that has "space" within the pores of the rock for oil to reside. Reservoir rocks need an **impermeable layer** above and below so the oil is "trapped."



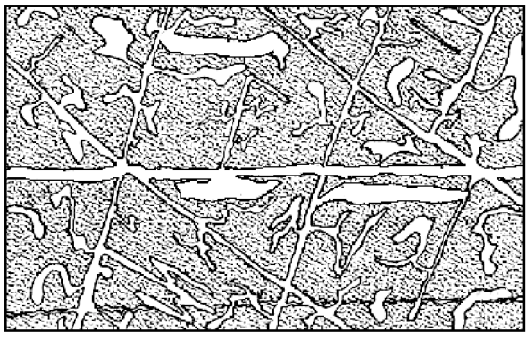
Gas, oil, and water in a reservoir rock



A. High permeability;
D. Low permeability

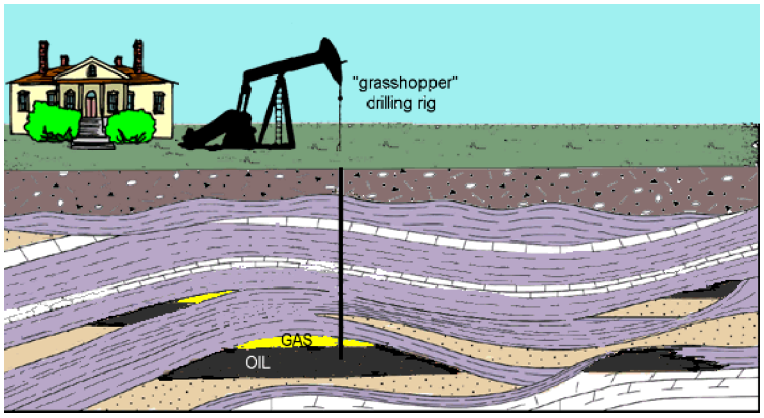
Traps are formed mainly by folding and faulting of sedimentary strata. The rocks that are above and below must be impermeable so it does not allow gas or oil to move through them.

Oil and gas can move through rocks if they have high **permeability**. The pore space of these rocks would be great and they would not be cemented very well. Pure sands are the best reservoirs and the oil acts as the glue to keep the sands together. When we extract oil from strata we sometimes have to "pump" another liquid, like salt water to prevent the overlying ground from sinking. Strata that is fractured can also allow oil to be trapped within the "cracks.".



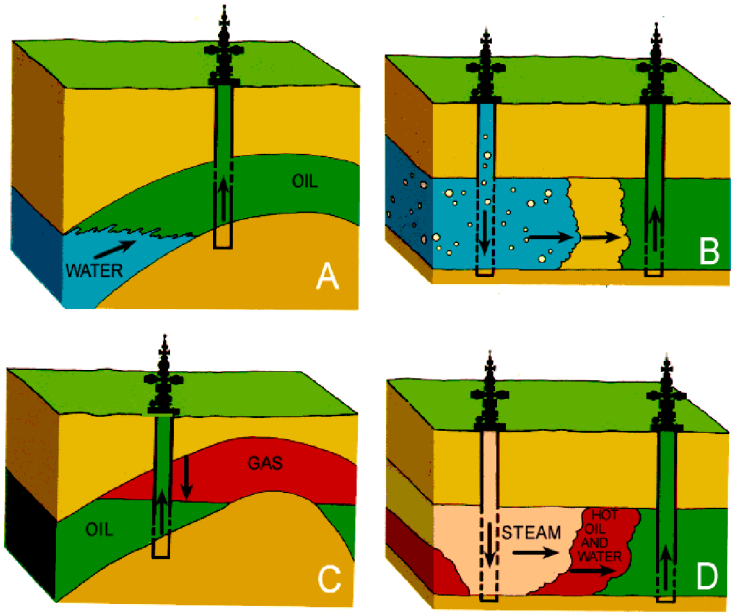
Close up of fractured reservoir

Extracting oil is not easy. Many people think that oil is just in a hole and you just drill and it will come up. Drilling toward reservoir rocks, means drilling through rocks that contain substances that may contaminate the oil. For instance, there might be water in a layer of rock. If you just drilled with an open hole, the water would come up.



Drilling requires a casing around the hole that seals off the other substances. This casing allows drilling mud to continuously circulate down the hole and back. Usually cement can be pumped in to help protect from contamination.

Oil doesn't flow like tap water from your kitchen sink. Remember oil may be trapped in some of the pore spaces or **fractures**. There are several ways in which you can move oil within the reservoir rock. In the diagram "A" illustrates how just water is used so the oil is pushed to the top. The oil can then be easily pumped. In "B" another well is drilled and forces gas to move the oil to the other well. In "C" the lighter gas will push down on the oil aiding in the movement of oil In "D" steam is forced down and pushes the oil up the well.



Simple principles are utilized to produce oil. In this lab you will explore different oils that are commonly available. You will then try and determine the relative densities of the oil. Then using a straw, you will try to extract one of the middle density oils, without mixing all the oils.

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PROBLEM: How can you extract oil and gas from different strata?

HYPOTHESIS:

MATERIALS: different types of oil (i.e., corn, oil, motor oil (different weights) and other liquids

Exercise I. List the type of oil and then describe each one.

type of oil	feel	smell	color	comments

Exercise II. Use a 100 ml graduated cylinder and pour about 5-10 ml of oil into the cylinder and see which oil is the heaviest, lightest. First pour 10 ml of water into the bottom and slowly pour the rest. Draw and label the ordering of your liquids on another sheet.

Exercise III. Use a straw and a siphon bulb (or just siphon it with your mouth) and see if you can extract one of the layers. Describe if you were successful or not.

Exercise IV. Gently shake your graduated cylinder. What happens during and after 5 minutes?

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Lesson 4 - Products of Petroleum (Activity)

MATERIALS:

reader
worksheet

Objective: Students research a specific product derived from petroleum.

Teacher note

Oil is a very important commodity in our world. It is used in many industries that make our life easier including fuels, fabric, petrochemical industries, and the plastic industry.

This student reader discusses the basic reason why the hydrocarbons that make up petroleum have so many uses. We suggest that students research the uses of petroleum in their lives at the library or the internet. The following are some suggestions that students can find out more information: nylon, plastic, fertilizer, asphalt, greasing wagon wheels, propane, gasoline, motor oil, kerosene, electrical tape, insect repellant, floor polish, crayons, tennis balls, and roller skates wheels. We suggest that students also look at early ways in which petroleum was used including embalming, fire, and waterproofing.

Greek Fire

The uses of oil are numerous and fascinating. Who would think that the gasoline that fuels our vehicles, can also provide us with **polyester fabrics** for clothes. Petroleum is one of those naturally occurring substances that can be chemically altered to create new and exciting products.

In the early days of civilizations, pools of oil were used mainly as a waterproofing substance for boats, baskets, or roofs on their homes. The early Egyptians used oil in their secret ingredients for embalming. The Greeks were feared on the high seas, because they learned how to make fire burn on water. They used a mixture of oil with sulfur, and it would burn the wooden ships of their enemies.

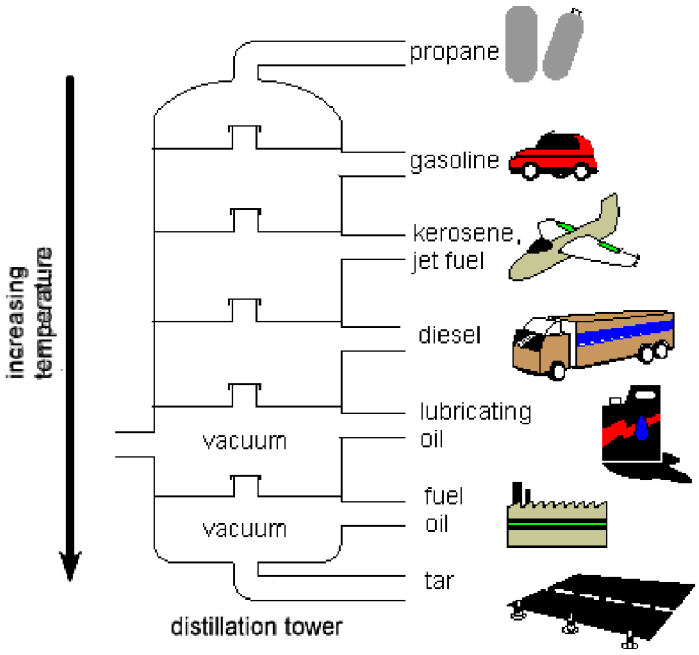
Whale Oil Lamp

Oil was even used as a medication, mainly because of the sulfur that is found in many crude oils. In the early colonial Americas, oil was peddled as a cure for all ailments from warts to rheumatism. Unfortunately, their claims were not true.

Light oils and kerosene were needed to light homes. Prior to the mid 1800's the one major source of oil for home needs, was the sperm whale. The whaling industry's main product was oil. Unfortunately the need for oil, was greater than all the sperm whales in the oceans. Whalers almost hunted sperm whales to their extinction.

The demand for oil increased in 1800's as the Industrial Revolution was reaching its peak. The invention of the gasoline engine and its use to fuel the new machinery increased demand on oil and natural gas. Large quantities of energy were now required to operate equipment in industry but also homes required heat and light.

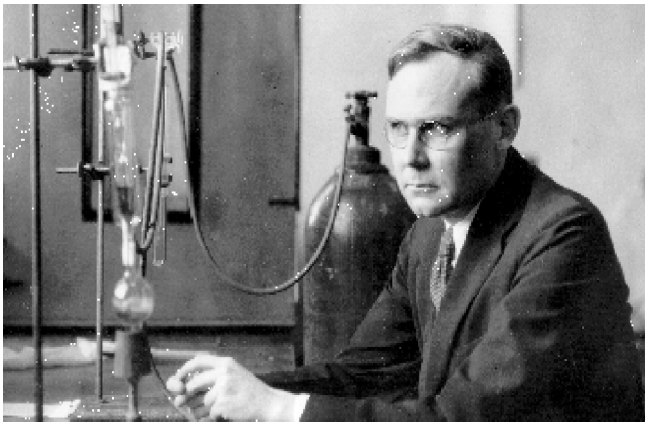
As new sources of crude oil became available, scientists started to look for other products. Crude oil needs to be refined to produce products, unlike natural gas which could be used untreated. The heating of crude causes different products to be distilled in a tower. Crude oil which is just hydrocarbons (hydrogen and carbon) have different boiling points. Kerosene and diesel require higher boiling points than gasoline, which requires lower temperatures.



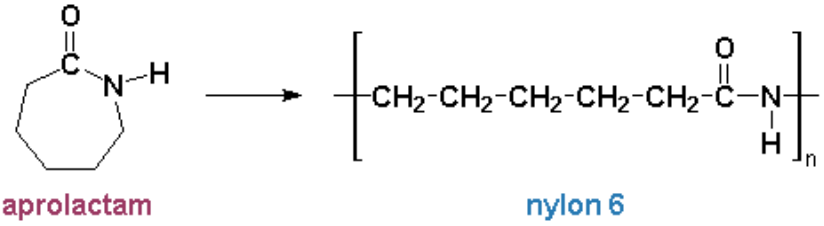
This has to do with the ability of hydrocarbons to form **chains** of hydrogens and carbons. Different lengths of the chains will create different products through distillation. It was also realized that distillation in a vacuum will also cause chains to produce new products. Chemical processes like "cracking" of crude oil breaks long hydrocarbons into shorter chains which produce gasoline. "Reforming" of different by-products with heat, pressure and catalysts, will make chains start chains to create branches. These will also produce new products.

The products from petroleum seemed endless as scientists started to understand the chemistry of the hydrocarbons and how they react under different chemical techniques.

The DuPont Corporation was a center for many chemists to "invent" products. In the 1930's Walter Carothers invented the first human-made textile fabric prepared entirely by new materials derived from petroleum products. Nylon was born.


Walter Carothers

Carothers used the new field of **polymer** chemistry, which are large molecules consisting of repeated chemical units called "mers" joined together in a line. Carothers found that six links of a CH_2 would produce nylon-6. It was strong, clear, and had a stretchy fabric. The first use of nylon was the bristles in a toothbrush, but it was soon learned of all its other uses as a fabric.



Nylon 6

Petroleum products are very diverse. Asphalt is another product that we use to line all of our streets with. Coca farmers use gasoline to soak coca leave to remove their color. The gasoline is then used, after a few more steps, to make an off-white base that artist use around the world.


Asphalt

Other products from petroleum products include plastic, fertilizers, transparent tape, tennis balls, and even roller skate wheels.


Using gasoline and coca leaves to make paint

Use the information provided in this reader as a stepping stone to research more uses of the petroleum. Conduct either a book or internet search, and write two paragraphs on one product that is used today or in times long ago.

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ACTIVITY

On the internet or at a library, do a search on petroleum, crude oil, gasoline, products and find a product that you would like to learn more about. You may want to look at individual oil or chemical companies for more information. Write a short 2 paragraph summary of the use of that product in either our present society or past.

Product:

References:

1.

2.

3.

Uses:

EARTH SCIENCES - PETROLEUM

Lesson 5 - Finding Black Gold

MATERIALS:

reader

Objective: Students learn about different oil exploration techniques.

Teacher note

Finding petroleum throughout the world requires a knowledge of geology. The ability of oil and natural gas to migrate and get trapped into reservoir rocks make oil difficult to find. Three dimensional computer modeling from seismic stratigraphy aids in geologists' understanding.

There is no certainty that oil will be found by drillers using these techniques. The success or failure of a geologist's prediction will ultimately be whether the driller finds oil or not. Luck is also a factor.

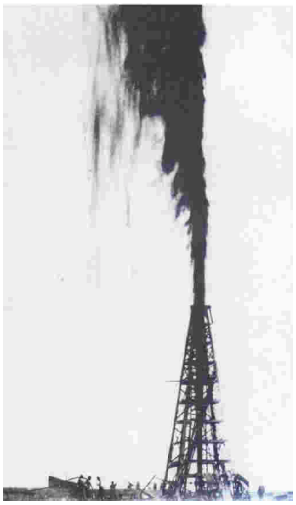
The importance of oil in the world economy has given oil the status of "black gold." The oil and gas industries produce 60 percent of the world's energy sources. So it follows, that finding oil is important. You just don't dig a hole and oil will flow. Understanding the geology of an area will help drill for oil more successful, but does not guarantee an oil find.


Oil and gas refinery

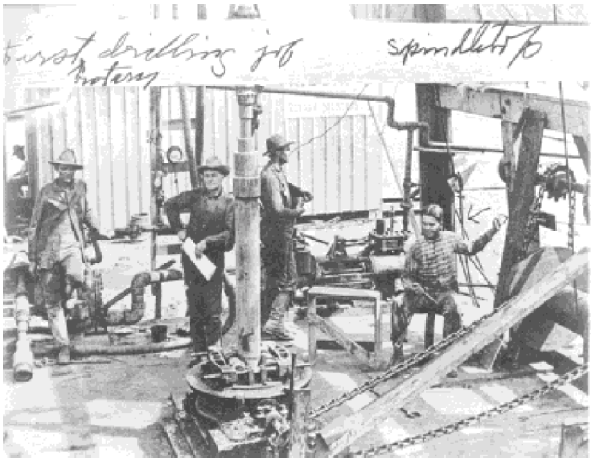
The steps in finding oil are similar throughout the world. We will take a look at one of the classic oil booms in the United States as a model of how many other countries find oil.

Texas, the second largest state in the United States, has long been known as the heart of the oil industry. Even today, corporate buildings in Houston are almost a shrine to the wealth and prosperity of oil in today's society. But how did it begin?

Pattillo Higgins visited the oil fields in Pennsylvania and learned that wildcatters looked for surface signs of oil. He would take his Sunday school students for picnics at Spindletop Hill, and realized there were signs of oil. However, after drilling the area, he found no oil.


Spindletop Hill, Texas

Entered into the picture was Anthony Lucas, who felt that oil was under this land. He bought leases to the area. After four dry wells the disheartened group hit another disaster when 6 tons of pipe just blew up, with muddy water and gas bursts. When all was calm, Lucas and his crew went to clean it up. They looked down the well hole and noticed that oil was moving up and down, almost as if it was breathing.

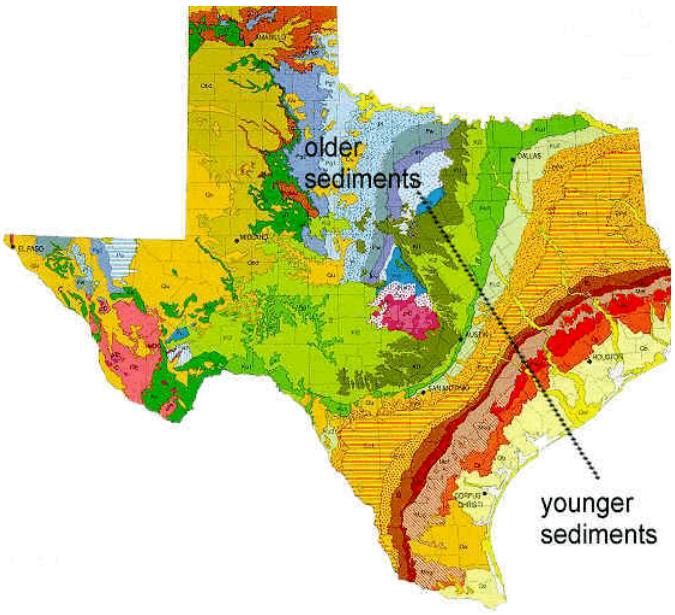


Anthony Lucas and drilling crew

Then a long breath became the symbol of the oil industry. The Lucas Gusher went up to 150 feet changing the Texas landscape forever. Stories like this became common in Texas.

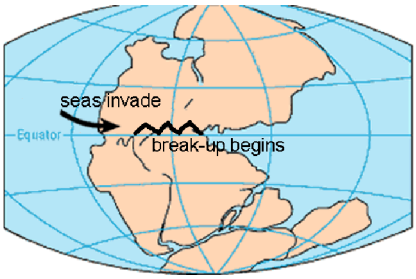
Why was there oil under Texas and was there more? **Wildcatters** would come to Texas and drill hole after hole. Some became rich, but some lost everything. The area that we now call Texas, has accumulated oil many times since the Paleozoic. Invading seas created **coral reefs**. These broad shallow **shelves** created conditions ideal for oil accumulation from the Paleozoic to Cenozoic.

So, even though drillers were finding oil, the oil was not from the same sources. For example, the oil in East Texas was caused mainly by Mesozoic (green colors on the map) to Cenozoic (yellow to orange) sediments. In West Texas, the oil is mainly from late Paleozoic reef and limestone structures. The geology of the state is important to reconstruct where the oil was formed and where the oil is today.

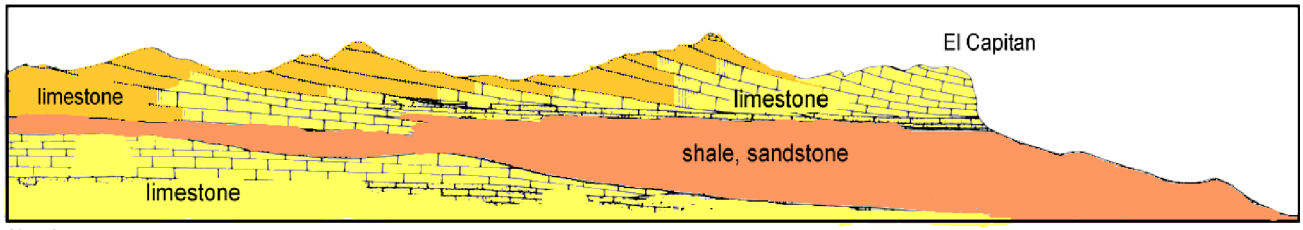


El Capitan

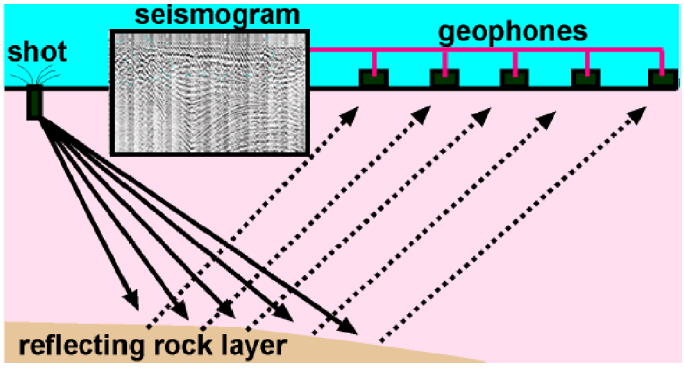
The West Texas area, during the Permian was a large coral reef structure. The diversity of organisms is similar to the organisms living in the Great Barrier Reef in Australia. The ocean to the west invaded the area and arched through the Gulf Coast states including parts of Mexico. Reefs are considered very productive zones. Slowly as conditions changed, the limestones were the perfect source rocks and the sandstones were the perfect reservoir rocks. This area is still producing oil today.



Permian



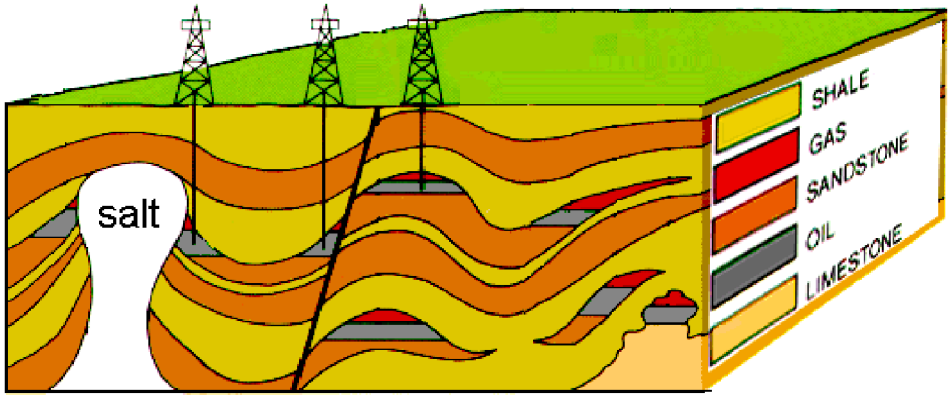
Rock types of the Permian reef



Geology is important in finding oil. Surface and subsurface geology provides clues to where oil is hiding. As the crust moves because of **subsidence**, faulting, and other plate tectonic mechanisms, oil can get stuck in "traps." To "see" these structures, seismic stratigraphy provides us data to interpret what the strata looks like.

Creating seismic profiles in a suspected oil field, a charge or "shot" is set off that produces waves. The waves will then reflect differently on diverse rock strata. The waves are reflected back to the surface and recorded using geophones, which then translates the information into seismograms. Today, computers are used to create three-dimensional models which can recreate the **subsurface features**.

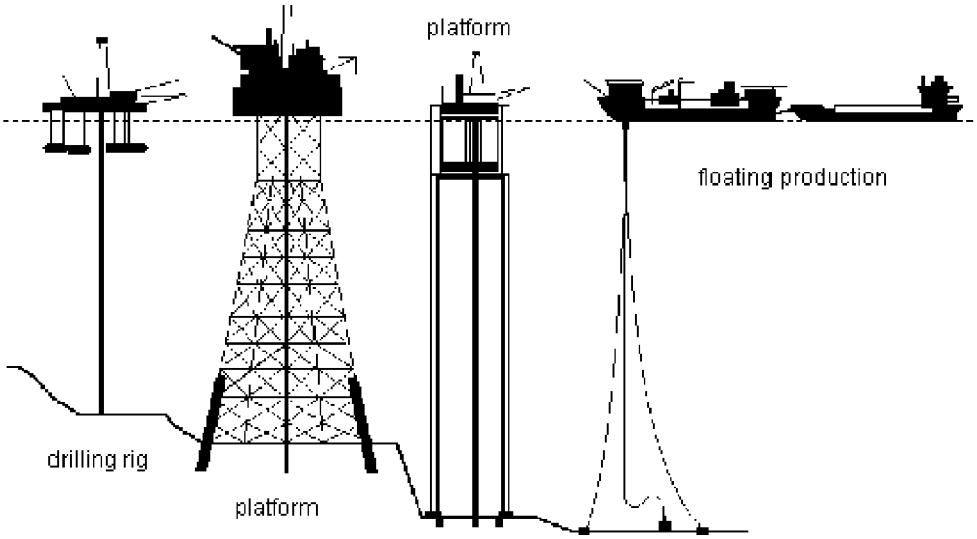
Seismic stratigraphy will not create as clear-cut pictures as in the diagram below. Interpretation is the key to finding these pools of oil and gas.



Petroleum geologists will use the stratigraphic principles discussed in the previous chapters to find areas where the oil may be. Faults on the surface can be followed into the strata to determine how to drill into a trap. Salt domes show very nicely on seismic profiles and traps can be found along its sides.

Finding oil is like a three dimensional puzzle. Completing this puzzle correctly can bring wealth, even today.

Once you find oil, you must drill for it. Drilling on land is difficult enough, but drilling offshore where much of the oil is located is even more difficult. In the figures below it shows several ways to drill the ocean bottom.



Discovering a producing well is the goal of interpreting the geologic and seismic information. Petroleum geologists try to make the most accurate and precise locations to drill a producing well. But sometimes it comes down to, whether you were lucky or not.

Offshore well in the North Sea

Earth Science - Petroleum - Unit Test

Part I. Definitions: Match the number of the term or concepts in Column 1 with the letter of the correct definition in Column 2.

Column 1	Column 2
1. gasoline	a. tar
2. Greek fire	b. hydrogen and carbon are major components
3. gusher	c. rocks reflecting high productivity
4. asphalt	d. water cannot put out fire
5. trap	e. the first U.S. billionaire
6. J. Paul Getty	f. product of crude oil
7. source rocks	g. produced at low temperature
8. hydrocarbons	h. oil can be found
9. nylon	i. a component of petroleum
10. natural gas	j. geyser of oil

Part II. Multiple Choice Choose the best answer to complete each statement.

1. Which group controls the price of oil today?
    a. OPEC
    b. Seven Sisters
    c. Rockefeller
    d. Getty

2. Prior to the use of crude oil, people got their energy from
    a. coal
    b. wood
    c. whale oil
    d. all of the above

3. The birth of the oil industry began in which country?
    a. Nigeria
    b. United States
    c. Venezuela
    d. India

4. Oil will float on water because
    a. of oil's high density
    b. water's low density
    c. oil has a lower density than water
    d. water has a lower density than oil

5. A source rock
    a. reflects high productivity
    b. is igneous
    c. is usually a sandstone with impermeable layers above and below
    d. is created by plate tectonics

6. A reservoir rock
    a. reflects high productivity
    b. is igneous
    c. is usually a sandstone with impermeable layers above and below
    d. is created by plate tectonics

7. Crude oil from Texas is from what age?
    a. Paleozoic
    b. Mesozoic
    c. Cenozoic
    d. all of the above

8. Which of the following is not a possible oil trap?
    a. anticline
    b. lake
    c. fold
    d. fault

9. Migration of oil can occur in
    a. shale
    b. an oil pool
    c. pore spaces and fractures
    d. limestone

10. Crude oil cannot be formed by
    a. diatoms
    b. corals.
    c. dinosaurs
    d. radiolarians

Answers:

Part I.

1. G
2. D
3. J
4. A
5. H
6. E
7. C
8. B
9. F
10. I

Part II

1. A
2. D
3. B
4. C
5. A
6. C
7. D
8. B
9. C
10. C