4H • ENV • 101

Geology Project
Book 1: Beginner

Oklahoma Cooperative Extension Service
Division of Agriculture Sciences and Natural Resources
Oklahoma State University

Oklahoma Energy Resources Board

OSU EXTENSION
4-H YOUTH DEVELOPMENT

Geology Project
Book 1—Beginner

Oklahoma is a state that is geologically diverse and interesting. From the lava-covered mesas at the western tip of the panhandle to the Ouachita Mountains in southeastern corner of the state, the various landscapes make our state a unique place to live. The flatness or hilliness of our own backyard, neighborhood park or family farm are all related to geology.

Geology plays a major role in many important aspects of our lives. From the fuels we use for transportation, farming, industry or heat, to the water we need for drinking and irrigation or the soils that sustain our agricultural industry, geologic resources are critical to our existence.

The geology of Oklahoma is important to our economy. Oklahoma is a leading producer of natural gas and oil. Thousands of Oklahomans rely on the petroleum business for their livelihood. All citizens of our state benefit indirectly by the contributions that oil and natural gas companies and their employees make to education and the arts.

The soils that provide the foundation of Oklahoma's rich agriculture industry are related to the underlying bedrock. Our scenic resources are the result of the interaction of climate and geology over time. The rich rock resources of Oklahoma are mined or quarried to make building stone, cement, monuments and construction material.

The purpose of the 4-H geology project is to increase our understanding of the natural world in which we live. Through learning, we begin to appreciate the importance of this science and the enjoyment it can provide.

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Printing of the Geology Project Book is funded by the Oklahoma Energy Resources Board.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at not cost to the taxpayer of Oklahoma.

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Unit 1
Rocks, Fossils and Minerals...Oh my!

Introduction

Do you ever wonder why the landscape around where you live is flat or hilly? Did you ever ask the question, “Where does my drinking water come from?” or “Why is the dirt in my yard a certain color?” These are all questions that relate to the types of rocks in your backyard. The types of rocks, along with the climate and erosion, have shaped the surface of Oklahoma. The Oklahoma 4-H Geology program is designed to help us understand the types of rocks in our backyards and how geology influences all of our lives.

What is Geology?

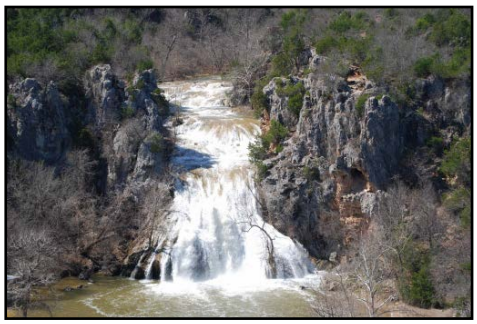
Geology is the study of Earth materials, processes and history. Earth materials are things like rocks and minerals. Earth processes include volcanoes, earthquakes, mountain building and erosion. The study of Earth’s history focuses on determining the age of rocks and how they formed. The study of fossils is an important part of understanding the history of Earth.

What Will I Learn?

In Unit 1, we take a trip around Oklahoma and learn about the kinds of rocks that are found here. For example, we will learn where to see ancient lava flows, where to find rocks that contain dinosaur fossils or footprints, where to see rocks that contain fossilized shells of sea animals or where to dig for selenite crystals or walk through a gypsum cave.

Activities

The following activities are examples of things we can do as 4-H members and volunteers to learn about the geology of our state:



Turner Falls near Davis, Murray County.

1. Collect rocks, minerals and fossils and identify them. A collection of 15 total rocks, minerals and fossils makes a fun and educational fair exhibit.

2. Visit a museum, college or university in your area. Museums and colleges display educational exhibits of rocks, minerals and fossils, as well as artifacts and items that show how geology affects our lives. A list of museums and college/ university exhibits is shown at the end of this unit.

3. Draw a poster of your favorite dinosaur and tell your local 4-H club about it.

4. Draw a poster of a volcano that explains the different parts.

5. Plan a trip to visit geologic wonders in Oklahoma or nearby states. Examples are Turner Falls in Murray County, Alabaster Caverns in Woodward County, Glass Mountains in Major County, Illinois River in Cherokee County, Talimena Drive in LeFlore County, Arbuckle Mountains in Murray County, Mt. Scott in Comanche County, and Ten Acre Rock in Johnston County.

The Types of Rocks Where You Live

You've probably held a rock, thrown a rock or even stepped on a rock barefoot, but did you ever think, "what is it?"

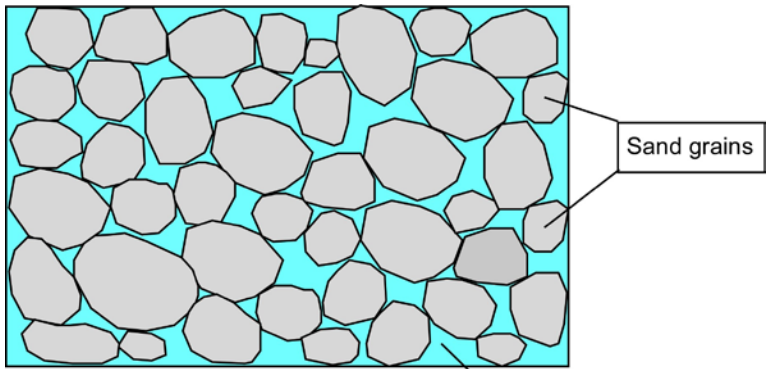
A rock is an aggregate of minerals. Now we have two new terms, aggregate and minerals. An aggregate is a group of something. Minerals are naturally occurring, non-living, solid substances with a specific chemical or molecular formula. The best way to learn the relationship between rocks and minerals is to examine several rocks and the minerals they contain. There are three types of rocks: sedimentary, igneous and metamorphic.

Sedimentary Rocks

Sedimentary rocks are composed of sediments that were lithified, which means changed to stone. Sediments are things such as sand, clay, gravel and sea shells.

Sediments can also be the salt that forms when a sea dries up, or the white lime deposits that form in your tea kettle or around the faucets in your house or apartment.

Sandstone is a sedimentary rock that is composed of grains of sand. The sand grains were sediment that was lithified to become sandstone. During lithification, the sand grains became cemented together to form a rock called sandstone. Each sand grain is a piece of a broken crystal or a mineral. Most of the grains are rounded pieces of broken quartz crystals. Each of the thousands to millions of sand grains in a large rock are minerals, the whole mass or aggregate of mineral grains is a rock.



Sandstone composed of sand grains which are cemented together

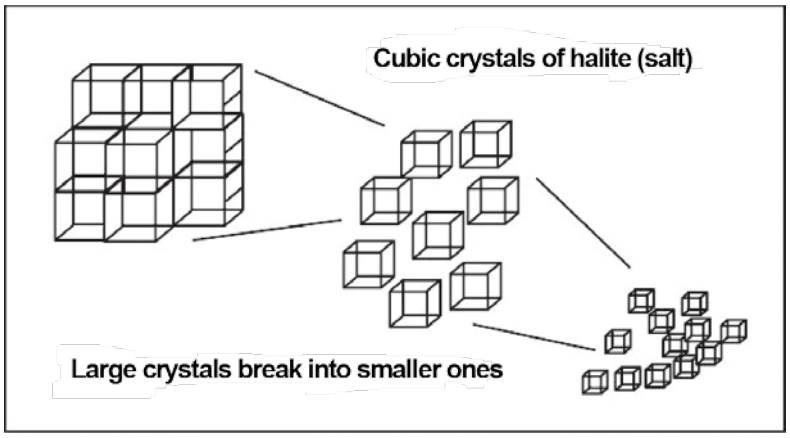
Did you know that every time you make homemade ice cream you are using a sedimentary rock? Rock salt is another type of sedimentary rock. Rock salt is composed of many small crystals of the mineral halite. Broken pieces of halite are used to fill the salt shaker in our kitchens.

Vocabulary Words

Aggregate - A group of something.

Minerals – Naturally occurring, nonliving, solid substances with a specific chemical or molecular formula.

Sedimentary - Formed by or containing sediment (Examples: Sandstone, limestone, rock salt, and shale)



Limestone is another common sedimentary rock. Most limestone contains fossil grains that are crystals of a mineral called calcite. The fossils tell us that the limestone formed from sediments that were deposited in a shallow sea.

A limestone sample from Pawnee County, Ok., contains fragments of crinoids and other marine fossils.

Shale is a sedimentary rock that is composed of very tiny particles of minerals. The grains in shale are too small to see without a microscope. Shale is lithified clay and silt, two sediments we find in mud and soil.

A sample of Woodford Shale from Carter County, Ok.

Igneous Rocks

Igneous rocks are formed by the cooling and hardening of molten rock material. Molten rock is called magma. A special kind of magma that flows out on the surface of Earth is called lava. Igneous rocks contain crystals of different minerals. The crystals in igneous rocks may be large or small. Large crystals indicate that the magma cooled slowly to form the rock. Small crystals mean the molten rock cooled quickly.

Granite is a type of igneous rock that is common to certain parts of Oklahoma. It often contains crystals of three minerals: quartz (grey), feldspar (pink) and mica (black).

Metamorphic Rocks

Metamorphic rocks are older rocks that were changed by intense heat and pressure to form new rocks. Metamorphic rocks are not common on the surface in Oklahoma. Some metamorphic rocks are found in the center of mountain ranges where the rocks were subjected to high pressure. Metamorphic rocks are found in the heart of the Ouachita Mountains in southeastern Oklahoma and in the Wichita Mountains, Comanche County.

Quartzite is an example of a metamorphic rock. The Meers Quartzite in Comanche County was once sandstone. High temperature welded the grains of sand together to form a very hard rock. Pieces of quartzite are also common along the Arkansas and Cimarron Rivers. These metamorphic rocks originated in the Rocky Mountains of Colorado and New Mexico.

Marble is another type of metamorphic rock. Marble was originally limestone. High heat caused the limestone to recrystallize into the metamorphic rock marble. When marble forms, the fossils in the original limestone are recrystallized and no longer seen.

The Rocks of Oklahoma

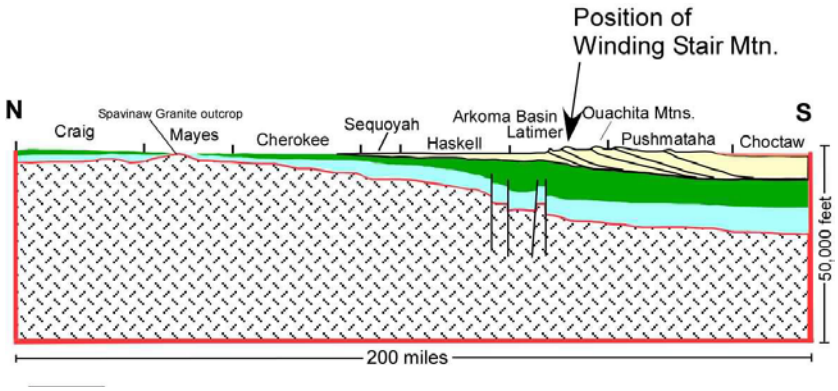
Sedimentary rocks in Oklahoma

Most Oklahomans live where there are sedimentary rocks on the surface. These layers of sedimentary rocks cover up igneous and metamorphic rocks that are buried deep beneath the surface. In some areas of Oklahoma, the sedimentary rock layers are thin and igneous rocks are exposed by erosion. In other areas, such as the Arbuckle and Wichita Mountains, mountain building processes have brought the igneous rocks to the surface.

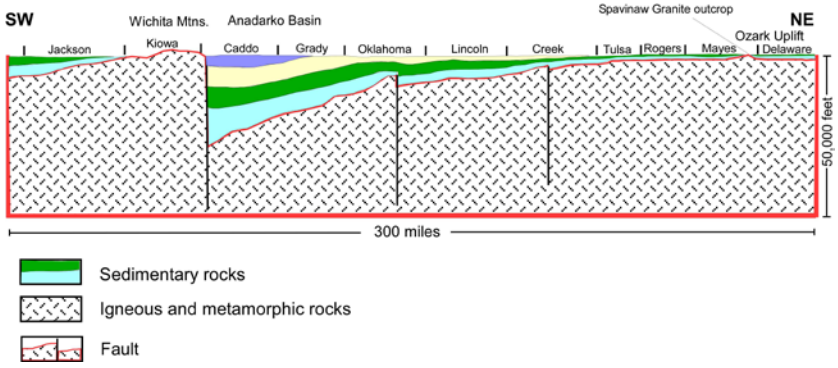
If we imagine that Oklahoma is a cake, the frosting would represent the sedimentary rock layers. In some areas, like the Anadarko basin of southwestern Oklahoma or the Arkoma basin of eastern Oklahoma, the frosting is very thick. If we cut the cake, the relationship between the sedimentary rock layers and the underlying igneous and metamorphic rocks can be seen.

Geologists name the layers of sedimentary rocks after places such as towns, streams and rivers. For instance, a prominent sandstone that outcrops in western Oklahoma is called the Rush Springs Sandstone after Rush Springs in Grady County. The Hartshorne Coal is named for the town of Hartshorne in Pittsburg County. The Woodford Shale is named for the town of Woodford in Carter County. The Spavinaw Granite, which is shown on the slices of Oklahoma, is named for the town of Spavinaw in Mayes County.

SW to NE slice through Oklahoma that shows the relationship between the sedimentary rock and older igneous and metamorphic rocks.



N to S slice though Oklahoma that shows the relationship between the sedimentary rocks and the underlying igneous and metamorphic rocks.



Vocabulary Words

Igneous - Formed by the solidification (becoming solid) of magma. (Examples: Granite, quartz, feldspar and mica)

Metamorphic - Occuring because of a change effected by pressure, heat, and water that results in a more compact and more highly crystalline conditon. (Examples: Quartzrite and Marble)

Sedimentary Rocks Commonly Found in Oklahoma

Chattanooga Shale (black) near Jay, Delaware County.

Rush Springs Sandstone (red) and thick brown soil, near Anadarko, Caddo County.

Limestone ledges of the Arbuckle Group form "tombstone topography" in the Arbuckle Mountains, Murray County.

Description of common sedimentary rocks found in Oklahoma

Sediment type: original material	**Rock** that forms by lithification	**Features:** how it looks
Mud	Shale	Usually soft, breaks into very thin **sheets** or **crumbles**. Often forms mud when wet. Surface feels **smooth.**
Silt	Siltstone	Breaks into thin, **hard layers**. Surface feels **gritty** like very fine sandpaper.
Sand	Sandstone	Breaks into **sand grains.**
Gravel	Conglomerate	Rock contains **pebbles.**
Lime mud & fossils	Limestone	Usually **light grey** and brown colored. Often contains the **fossil** remains of marine animals **(shells)**.
Gypsum	Gypsum	Forms even **white** to pink layers. This is a soft rock that **breaks and powders** easily.
Plant material	Coal	Forms **black** layers. Often plant fossils are seen in nearby rocks. Coal contains thin layers of **shiny** black material.

Igneous Rocks in Oklahoma

Igneous rocks, mostly granite and rhyolite, are found in the Wichita Mountains in Comanche, Kiowa and Greer Counties and the Arbuckle Mountains in Johnston and Murray Counties. A small outcrop of granite occurs in Spavinaw, Mayes County. A famous outcrop of igneous rock occurs on Black Mesa in Cimarron County.

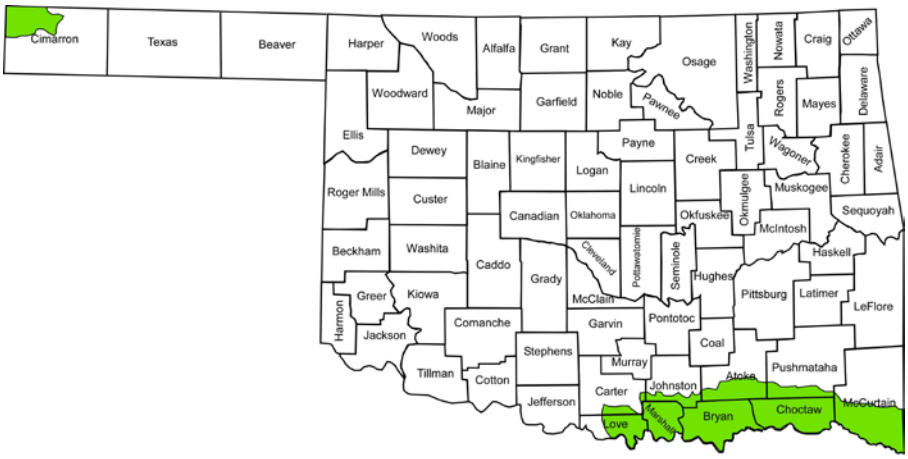
Metamorphic Rocks in Oklahoma

Outcrops of metamorphic rocks are rare in Oklahoma. Quartzite (metamorphosed sandstone) is found near Meers in Comanche County. Metamorphic rocks are also found in the Ouachita Mountains in McCurtain County.

The most common occurrence of metamorphic rocks is along the major rivers that flow across Oklahoma from west to east. Quartzite pebbles are common along the paths of the Arkansas and Cimarron rivers. The quartzite is not from Oklahoma. These sediments were carried to Oklahoma from the Rocky Mountains in New Mexico and Colorado.

Dinosaurs in Oklahoma?

Yes, many years ago dinosaurs roamed across Oklahoma. We know this because they left tracks in the soft mud and sand near Black Mesa in Cimarron County. These tracks were covered with other sediment and preserved. In addition to tracks, dinosaur bones are found in Oklahoma. Many bones have been found in the rocks of Cimarron County. Others have been found in Atoka and McCurtain Counties. One of the dinosaurs from southern Oklahoma is named *Acrocanthosaurus Atokensis,* nicknamed “Fran”. This large, meat-eating raptor had tremendous jaws to catch and crush its prey. Another dinosaur whose bones were found in southern Oklahoma is *Tenontosaurus*. This plant-eating dinosaur may have been eaten by Acrocanthosaurus.



Outcrops of rocks in Oklahoma that contain dinosaur fossils

Volcanos in Oklahoma?

When we think of volcanoes, usually places like Hawaii and Mount St. Helens come to mind, but, did you know that lava from ancient volcanoes flowed across areas of Oklahoma? The first lava flows that we can visit today occurred more than 500 million years ago in southern Oklahoma. These ancient lavas are located in the middle of the Arbuckle Mountains and in the Wichita Mountains. In both areas, the lava is a red to brown dense rock called rhyolite (ri'-oh-lite).

Another lava flow occurred much later in the history of Oklahoma. This lava flowed from volcanoes located in New Mexico. It is dark gray to black basaltic lava that hardened in Cimarron County. Black Mesa, the highest point in Oklahoma is named for this lava.

Basalt sample from the Black Mesa area, Cimarron county (sample is 4 inches in length).

Rhyolite from near Mount Scott, Wichita Mountains, Comanche County.

Ancient Life in Oklahoma

Ancient Marine Animals in Oklahoma

Oklahoma has been covered many times by shallow seas. As the animals that lived in these oceans would die, their shells would become part of the sediment that ultimately became the rocks that outcrop in Oklahoma. As these rocks are exposed and weather at the surface today, the fossils are often freed from the rock and available for collecting. Some of the more common fossils are shown in the following photographs.

Crinoid: This animal is a relative of the sea lily. This fossil is common in central, northeastern and southern Oklahoma.

Brachiopods: This animal is recognized by the symmetry of its shell (the right one-half is identical to the left one-half). Brachiopods are common in northeastern, central and southern Oklahoma. These examples are from Pawnee, Pontotoc and Murray counties.

Gastropods or snails are common fossil in the northeastern, central and sourhern Oklahoma. These examples are from near Ada in Pontotoc County and Pawnee in Pawnee County.

Cephalopods: These fossils are from straight-shelled cephalopods, which are related to the modern coiled nautilus. These examples are from Pontotoc and Tulsa Counties.

Ancient Plants of Oklahoma

Fossilized wood and other plant remains are common in Oklahoma. Eastern Oklahoma contains many plant fossils that are associated with coal deposits. More common types are fossil rushes (*Lepidodendron*, Sigallaria and *Calamites*) and ferns.

Fossil stem of *Calamites* from near Heavener in LeFlore County

Fossil stem of *Lepidodendron* from near Stigler in Haskell County

Oklahoma Museums, Parks & Universities

Alabaster Cavern State Park
Freedom, OK
(580) 621-3381

Anadarko Basin Museum of Natural History
204 N. Main
Elk City, OK 73644
(580) 243-0437

Black Mesa State Park
Kenton, OK
(580) 426-2222

Boiling Springs State Park
Mooreland, OK
(580) 256-7664

Cimarron Heritage Center & Museum & Information Center
1300 N. Cimarron
Boise City, OK

Dobson Museum and Memorial Center
110 A Street SW
Miami, OK

Drumright Historical Society Museum
301 E. Broadway
Drumright, OK
(918) 352-3002

Gilcrease Museum
1400 Gilcrease Museum Road
Tulsa, OK
(918) 596-2700

Glass Mountains Conservation Area
C/O Little Sahara State Park
Rt. 2 Box 132
Waynoka, OK
(580) 227-2512

Gloss Mountains State Park
Highway 412
Fairview, OK
(580) 227-2512

Goddard Museum
Davis, OK
(580) 993-3335

Harmon County Historical Museum
102 N. Broadway
Hollis, OK
(580) 229-0900

Healdton Oil Museum
315 E. Main St.
Healdton, OK
(580) 229-0900

Jasmine Moran Children's Museum
Seminole, OK
1-800-259-Kids

Little Sahara State Park
Waynoka, OK
(580) 824-1471

Marland Mansion and Museum
901 Monument Road
Ponca City, OK 74604
1-800-422-8340

NW OSU Museum of Natural History
Northwestern Oklahoma State University
Alva, OK
(580) 327-8513

Oklahoma History Center
State Capitol Complex
Oklahoma City, OK
(405) 522-2491

Picher Mining Field Museum
508 N. Connell
Picher, OK
(918) 673-1192

Richard O. Dodrill's Museum of Rocks, Minerals & Fossils
123 S. Cleveland
Cushing, OK
(918) 225-0662

Robber's Cave State Park
Highway 2 N.
Wilburton, OK
(918) 466-2565

Sam Noble Museum of Natural History
2401 Chautauqua
Norman, OK
(405) 325-4712

Selenite Crystal Digging
Great Salt Plains National Wildlife Refuge
April 1 - October 15
1-800-654-8240

Seminole Oil Museum
1800 Wrangler Boulevard
Seminole, OK
(405) 382-1500

Spavinaw State Park
Highway 82 S.
Spavinaw, OK
(918) 589-2651

Tulsa Geoscience Center
610 S. Main St.
Tulsa, OK
(918) 392-4556

Timberlake Rose Rock Collection
419 S. Highway 77
Noble, OK
(405) 872-9838

Triangle Heritage Oil and Historical Museum
Highway 64W
Cleveland, OK
(918) 358-9292

Woolaroc
Near Bartlesville, OK
(918) 336-0307

Universities:
Oklahoma State University
Stillwater, OK

University of Oklahoma
Norman, OK

University of Tulsa
Tulsa, OK

Unit 2
Collecting, Wellsite and Mine Safety

Introduction

You might be wondering what could be so dangerous about collecting rocks or about playing around crude oil or natural gas lease locations. In actuality, there really isn't a lot to be concerned about, if you play it safe. The more awareness that you and your friends have about the dangers of playing around crude oil and natural gas leases, the less chance you have that you or your friends will get hurt.

What Will I Learn?

In Unit 2, we are going to discuss some basic things that you can do to be safe when collecting rocks or when venturing out into rural areas or urban areas where crude oil and natural gas leases are located. These skills will help you to also talk to your friends about some of these dangers.

Activities

1. Participate in Well Site Safety Day by entering a poster that shows the concerns of well site safety.

2. Enter this poster in the Oklahoma Energy Resources Board (OERB) Well site Safety contest from February-March.

3. Participate and help show the safety video provided by the OERB to your school when the class discusses well site safety.

4. Give an illustrated presentation to your 4-H Club or enter the Illustrated Presentation contest over safety.

The Rock, Fossil & Mineral Collecting Safety

Although this is probably one of the most fun parts of this project, there are some safety tips that you will need to remember before you venture out to collect. The following tips will help to make your experience a very enjoyable and fun time.

Crude Oil & Natural Gas Lease/Well Site Safety

This is an area that you may or may not be familiar with yet. The OERB (Oklahoma Energy Resources Board) has been providing teachers with materials to discuss the crude oil and natural gas industry and well site safety, but your school may not be a participant. We are going to discuss a few safety tips.

Although crude oil and natural gas leases or well sites look very interesting and fun, they can also be very dangerous. Each piece of equipment on the site, including the pumping unit and storage tanks, could cause serious injury or even death if you are not cautious. Even if a site looks abandoned, you still need to be very careful. The site could contain pipes and other pieces of equipment that could cause injury, and this is no joking matter.

Sometimes a pumping unit, the equipment that pumps the crude oil and natural gas out of the ground, is set on a timer. Even though it appears to be shut off, it could start at any time and very seriously hurt you or your friends. At times a storage tank could look like a great place to view an area or play on stairs. These tanks are very dangerous. If you climb to the top and inhale some of the fumes, they could knock you out or even kill you. Also, these tanks are not meant to be used as lookouts or for hunting of any kind. The tank's contents are very flammable. No flames of any kind, including matches and lighters, should be used on or near tanks.

For more information on staying safe around crude oil and natural gas locations and well sites, please log onto www.oerb.com.

Abandoned Mining Sites

Just like oilfield sites, abandoned mines are also very dangerous. These mines are often times not filled in, and you could easily fall inside and become trapped or hurt. It is very important to not play around these areas. They make look like very neat areas to play or explore but can be very dangerous. In addition, the air inside an abandoned mine can also be harmful. Trapped air or air that is contaminated with harmful gases can be deadly. Also, beware of drinking the water around abandoned mining sites. There can be leftover mineral deposits or other items in the water that could be harmful to you if swallowed. Even though the stream is flowing, doesn't mean it is always safe to drink. Bring along some cold water or other beverage to drink during your adventures.

SAFETY TIPS

Caution: Collecting minerals in abandoned mining districts requires care. **Stay away from dangerous ponds, shafts or steep slopes**. Most mineral specimens can be found near the piles of large boulders. If you are going to be collecting in an area that might have falling rocks, you might want to avoid the area or wear a bike helmet. Never collect in an area where there are large falling rocks or boulders.

Do not trespass on posted lands. Always seek landowner permission before you collect on private property, even if it is not posted. By asking the landowner's permission you are not only letting them know that you will be there, but they can also let you know of objects or areas that you will need to stay away from. In addition, **it is illegal to collect rocks, minerals, and fossils, on certain State and Federal lands.** Always check with a ranger first.

Eye protection: Hammering on rocks can often cause rock or steel fragments to break off and fly through the air. Remember, most mineral specimens can be found on smaller rocks and hammering or digging is not required. **If you must hammer, wear eye protection.**

Traffic: Many collecting sites are on the right of way of busy highways. Try to park off of the roadway and watch for vehicles.

Snakes, scorpions, paper wasps, black-widow spiders, brown recluse (Fiddleback) spiders and poison ivy: Snakes, scorpions, wasps, spiders and poison ivy are common occupants of rocky areas. Wear long sleeves, long pants and never place your hands or feet where you cannot see.

Let an adult know where you are going. Remember to let your parents know where you are going (if they are not going along), even if it is just within your neighborhood or on your own property, make sure that your parents know where you are and how long you plan to be gone. Also, use the buddy system. Collecting as a group or team is more fun, and it also provides someone to go back and let your family or an adult know if you get hurt.

Unit 3
Drinking Water Doesn't Come from a Faucet?

Introduction

Every time you get a glass of water from the faucet, take a bath or shower, brush your teeth or put on a set of clean clothes and sit down to a meal at home you probably don't think about the fact that all of these things used water and it starts out long before it comes out of your faucet. Some people get water from a well in their backyard, from the city in which they live or from a rural water district. However, the source of your water begins long before your faucet is turned on.

What Will I Learn?

In Unit 3, we examine the major groundwater aquifers in Oklahoma, how aquifers work and their importance to our state. We will learn how to locate water wells where you live and how to test water for hardness.

Activities

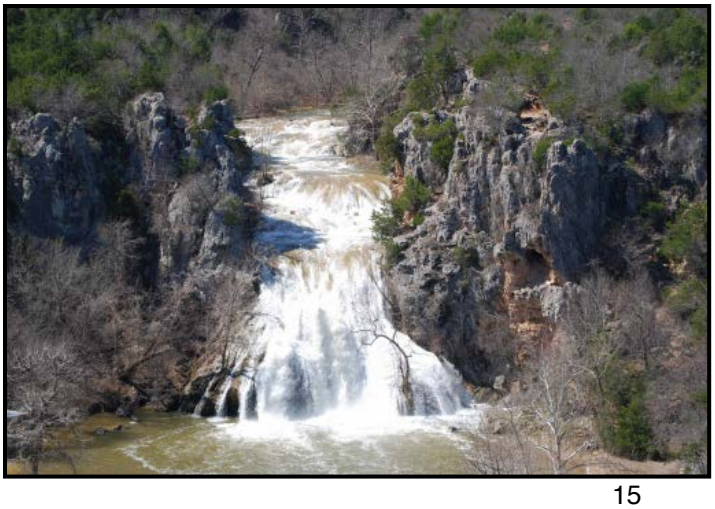
The following activities are examples of things we can do as 4-H members and volunteers to learn about water resources and hydrogeology of Oklahoma:

1. Make a poster showing the parts of an aquifer. This poster may be used as an educational fair exhibit.

2. Draw a diagram of a private or municipal water well that shows the well depth and water level

3. Use the website of the Oklahoma Water Resources Board to download a picture showing the location of known water wells in the area where you live.

4. Use a test kit to test the water in your house, well or stream for hardness.



Turner Falls near Davis, Murray County. Honey Creek is fed by springs. The water contains dissolved minerals that precipitate to form the ledge that creates Turner Falls.

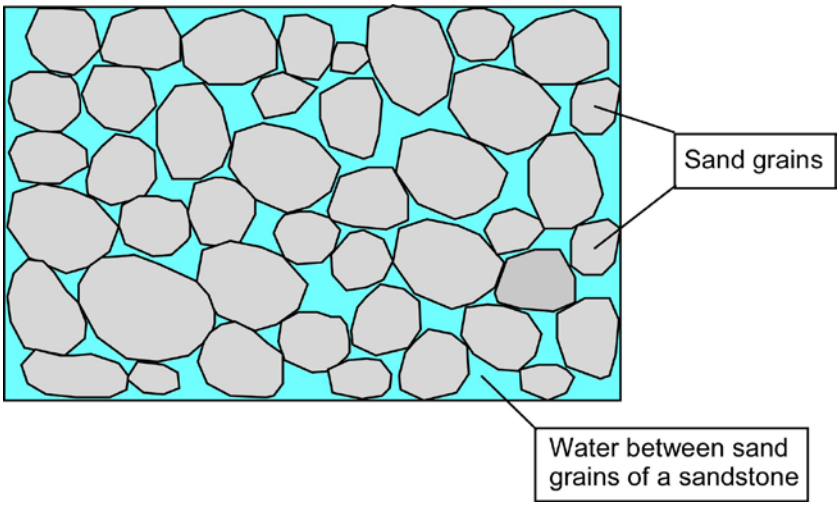
Oklahoma Water

Rainwater that falls on the land either soaks into the soil and rock or runs off. The water that enters the soil or rock is called groundwater. Groundwater is stored in openings or voids in the rock or soil. This water is later recovered by wells or flows from springs to help maintain the flow in streams. The soil or rock that stores groundwater is called an aquifer. The major groundwater aquifers in Oklahoma are layers of sand and gravel along streams, limestone, sandstone and gypsum. Groundwater in these aquifers provides 80% of the water used for irrigation and approximately 20% of the water used by cities and towns. Groundwater is the major source of water for the rural residents of Oklahoma.

In contrast, most cities pump water from lakes. This water, which is called surface water, is closely tied to the groundwater because springs and seeps create flow in streams and rivers that fill the lakes.

Groundwater

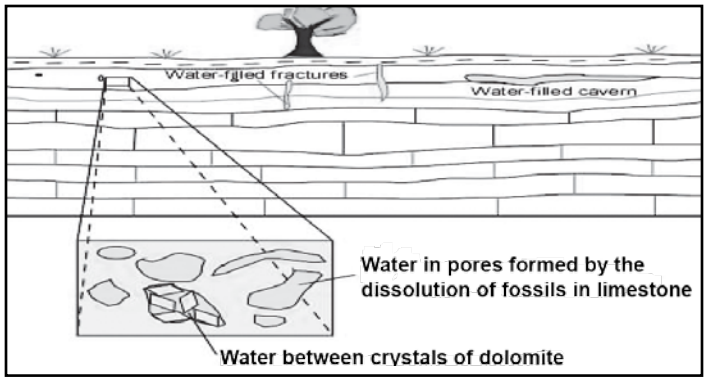
Oklahoma has major groundwater aquifers. Most groundwater is used to irrigate crops or for drinking water for humans and animals. An example is the Ogallala Aquifer in the Oklahoma Panhandle. Water pumped from the Ogallala allows Oklahoma to produce crops in an area that is normally too dry for farming. What is groundwater? Groundwater is the water in aquifers beneath the surface of the earth. Aquifers are sediments like sand and gravel. The water in these aquifers exists between the grains. Similarly, water is found between the grains of sand in the rock, sandstone. Sediment aquifers are commonly the sand and gravel deposits along rivers or streams. Some sand deposits are formed by the wind. These are typically found along the north sides of rivers. The wind picks up the sand along the river and blows it into sand dunes. Since the prevailing wind direction in Oklahoma is from the southwest, these deposits form on the north banks of the rivers. In some parts of the state, groundwater is pumped from beds of limestone and dolomite, which are rocks. Small holes in rocks may become enlarged to become passageways called caverns. Groundwater dissolves rocks and the mineral constituents enter the water. As a result, groundwater contains mineral constituents like calcium, magnesium, chloride, sulfate, bicarbonate, and carbonate.



Hardness

Hardness is a measure of the amount of calcium and magnesium dissolved in groundwater. Since minerals containing calcium and magnesium are found in limestone and dolomite, water pumped from limestone aquifers is often “harder” than water pumped from sandstone aquifers. Water pumped from gypsum aquifers is typically very hard.

Evidence for hard water includes layers of calcium carbonate (lime) in coffee and tea pots and lime buildup around faucets and in pumps.



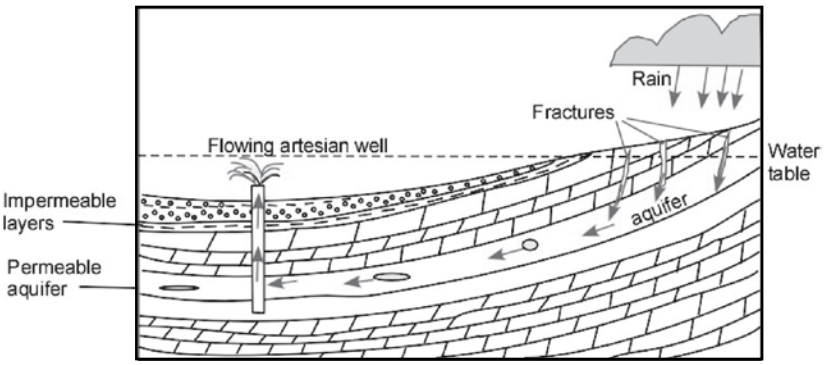
Alluvium and Terrace Aquifers

Sand and gravel deposits along the major streams in Oklahoma are important sources of water for irrigation, community and household use. The towns of Enid and Perkins use these types of aquifers for their water sources.

Thousands of Oklahomans use groundwater from aquifers that are not listed above. However, the amount of water from these aquifers is very limited and the wells typically are only used to supply household needs.

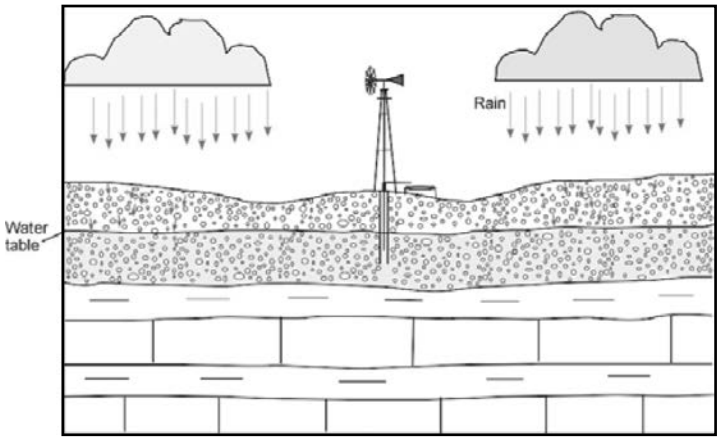
Types of Aquifers and Water Wells

Aquifers receive water called recharge by precipitation that falls on the aquifer where it outcrops. The water soaks into (infiltrates) the aquifer and moves into the space between the grains or other crevices or cavities. If the water cannot escape from the aquifer because it is overlain by an impermeable bed, it is called a confined aquifer. If water enters the aquifer (recharges) at higher elevation than the position of a well, the well will flow water to the surface. A water well that flows water to the surface is called a flowing artesian well. A famous flowing artesian well is Vendome Well in Sulphur.



Artesian well flowing from a confined aquifer. This example is modeled after Vendome Well in Sulphur, Murray County, Oklahoma.

Western Oklahoma is dotted with windmills that pump water to the surface from shallow aquifers that are not confined by an impermeable bed. These are called unconfined aquifers. The gravel and sand deposits along the major rivers that cross the state are examples of unconfined aquifers. These aquifers are important sources of irrigation and municipal water supplies.

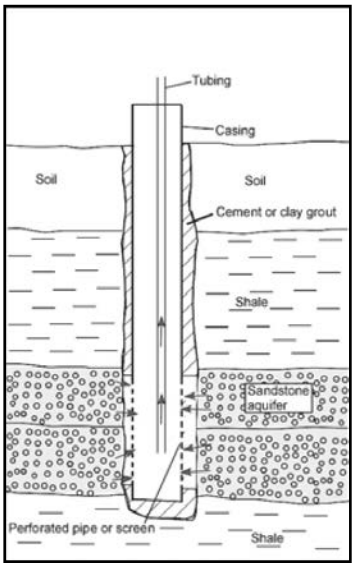


Unconfined sand and gravel aquifer that is being pumped using a windmill. Notice that rainfall that falls on this aquifer seeps directly into the aquifer.

Unconfined aquifers are highly susceptible to contamination from pollutants such as fertilizer, animal waste, pesticides and other chemicals.

Wells are designed to bring water from the aquifer to the surface. A typical well contains casing, which is cemented or grouted with clay to prevent surface water from contaminating the well.

Most wells do not flow water to the surface and must be pumped. There are several types of pumps and all require tubing to bring the water to the surface. In shallow domestic wells, the casing and tubing may be a type of plastic. In deeper wells, the casing and tubing are normally steel. In both cases, the casing contains holes called perforations or slots called screens that allow the water to flow from the aquifer into the casing.



Generalized diagram of a well that produces water from a sandstone aquifer.

Surface Water and Municipalities

As mentioned earlier, some municipalities and cities use water that comes from the surface. This could be from rivers, lakes or streams. This water is then pumped to a processing plant where the water goes through several processes to make it safe and clean to drink. This water is then stored in large towers until it is ready to use. Other chemicals may be added to the water like fluoride, which helps to strengthen teeth. Another common chemical additive is chlorine, which keeps the water from growing bacteria until it is ready to use. Obviously, the amount of chlorine is not as strong as the amount you would add to a swimming pool. It is just enough to be safe to drink.

Pollution Concerns

Because rural water or water from water wells that are not operated by a municipality are not filtered or processed, pollution is a big concern. Also, if a municipality does not process its waste water before it enters back into the water system or into a body of water, it can cause major pollution problems.

A common concern is non-point source pollution. This pollution comes from sources that cannot be pointed out easily. This could be as simple as someone changing the oil in their car and not disposing of it properly and pouring it onto the ground. Other common sources are lawn fertilizers, pesticides, animal waste runoff and other chemicals that are not applied according to their directions or are not disposed of in the proper manner. These chemicals and products then leach (or are absorbed) into the soil and eventually, if it rains enough or the amount of the product is large enough, they end up in the aquifers or surface water from which drinking water comes. Special state agencies have been set up to help provide guidelines and regulation over this type of pollution,, such as; The Oklahoma Water Resources Board (OWRB), the Oklahoma Department of Environmental Quality (ODEQ) and the Oklahoma Department of Agriculture Food and Forestry (ODOAFF).

References

Geological Survey Educational Publication No. 1, p. 8.

Unit 4
Where's the Energy?

Introduction

Each day we wake up and brush our teeth, take a hot shower, put on clothes and then head into the kitchen maybe to pop something in the microwave or toaster for breakfast. While doing all of these tasks, we probably give little thought to the electricity that allowed for all of these things to happen. Energy can come from many forms. The world is full of movement. Birds fly in the air, trees move in the wind, and ships sail on the sea. People, animals and machinery move around, but not without a source of energy. Living things and machines need energy or fuel to work. For example, the energy that turns the blade of a windmill comes from the wind. The sun provides the energy needed to produce the food you eat. Food provides the energy your muscles need to ride your bike. The energy to make a car, plane or motorboat move comes from the gasoline inside the engine.

Where Does Energy/Fuel Come From?

All energy originates from the sun. Without the sun, there would be no life on earth. The energy from the sun is transformed into many other types of energy that we use every day. Important forms of energy are oil, natural gas, coal (also known as fossil fuels), hydro, solar and wind. The energy needed to provide you with electricity to perform all of your morning tasks comes from a variety of sources. We will explore these sources during this unit.

What Will I Learn?

In Unit 4, you will learn about the basics of where energy comes from, how it was formed and how it is used. This will provide you with a basic knowledge of the energy process. As you graduate on to Geology books 2 and 3 you will discover more about energy and the newer, innovative ways that we are able to find and produce more energy for use in our homes, vehicles, and workplaces.

Activities (*all activities requiring instructions are found in the activities section)

1. Learn about crude oil migration through an easy experiment.*

2. Learn how crude oil and natural gas are removed from different depths of the ground by conducting an experiment utilizing a simple soda can and drinking straws, as well as an experiment using a BB and a dropper.*

3. Learn how to make your own "muddy microbes" using basic products.*

4. Draw a poster showing a drilling rig exploring for crude oil and natural gas, or a pumping unit pulling crude oil or natural gas out of the ground.

5. List items or consumer products made from petroleum.

6. Check newspaper for crude oil and natural gas activity in your area.

7. Notice if you see any houses in your area with solar panels on the roof. If you know the owner, ask about their reasons for using solar power.

8. Visit one of the many lakes with dams on it that produce electricity or check out the Grand River Dam Authority's Web Site at www.grda.com.

Crude Oil

Where does it come from?

Millions of years ago, the seas were filled with billions of tiny plants and animals. As these plants and animals died, their remains sank to the ocean floor and were buried in layers of sand and sediment, much like the sediment you see in a pond or a lake. As more and more time passed, heat and pressure worked on the buried remains until they became fossil fuels. These fossil fuels were then trapped in underground rock formations. If rock is porous (containing holes or void spaces), it can accumulate crude oil, natural gas and coal.

For more than 150 years, man has been exploring for and extracting fossil fuels. Today, when we use the estimated 6,000 products made from fossil fuels, we are releasing the energy that first came to earth from the sun millions of years ago.

How do we get it out of the ground?

Edwin L. Drake was the first person to drill specifically for oil. In 1859, near Titusville, Pennsylvania, Drake struck crude oil. Drake's discovery led to the finding of oilfields all over the country, especially in Oklahoma and Texas.

Today prospecting for crude oil and natural gas is highly skilled detective work, as scientists use computers, satellites, sound waves and high-tech equipment to search both underground and under the ocean floor. Long before drilling can begin, geologists and geophysicists (scientists who explore for oil and natural gas) gather clues to locate possible sites for drilling. These clues come in many forms, from maps to locate fossils to studying sound waves from deep beneath the surface. The scientists make their best predictions, locate the spot and then the exploration begins.

Careful consideration is given to the animals, people and plants that are living in the area in which the possible drill site is located. From time to time, companies will move their drilling location to avoid negative environmental impacts. These companies and their employees live in the same area as you do and drink the same water, breathe the same air, etc. They are just as concerned with keeping the environment in good shape as you are.

A drilling rig is then set up on the location, which usually has had extensive dirt work done to build up a strong foundation for the rig to rest on while the drilling occurs. The drilling team uses pipe, special mud, water, brine and many other products to try to reach the crude in the ground. During this time there is a lot of activity around the clock at the drilling site. Roughnecks and derrick hands, as well as a variety of other service employees, work to try to reach the crude oil in the shortest amount of time possible by using different drilling methods. After the well "comes in," they sometimes put a pumping unit or pump jack on it. A pumping unit is a piece

of equipment with weights that move in a circle as the pump goes up and down in a rhythmic motion. The pumping unit pumps the oil out of the rock formation below the surface of the earth.

This crude oil is then transferred to a storage tank or tank battery (a series of tanks). The crude oil is then held there until a tanker truck comes by to remove the stored oil and transport it to a refinery. Crude oil can also be transported by pipeline and by ship to refineries or factories to be processed.

How is it processed?

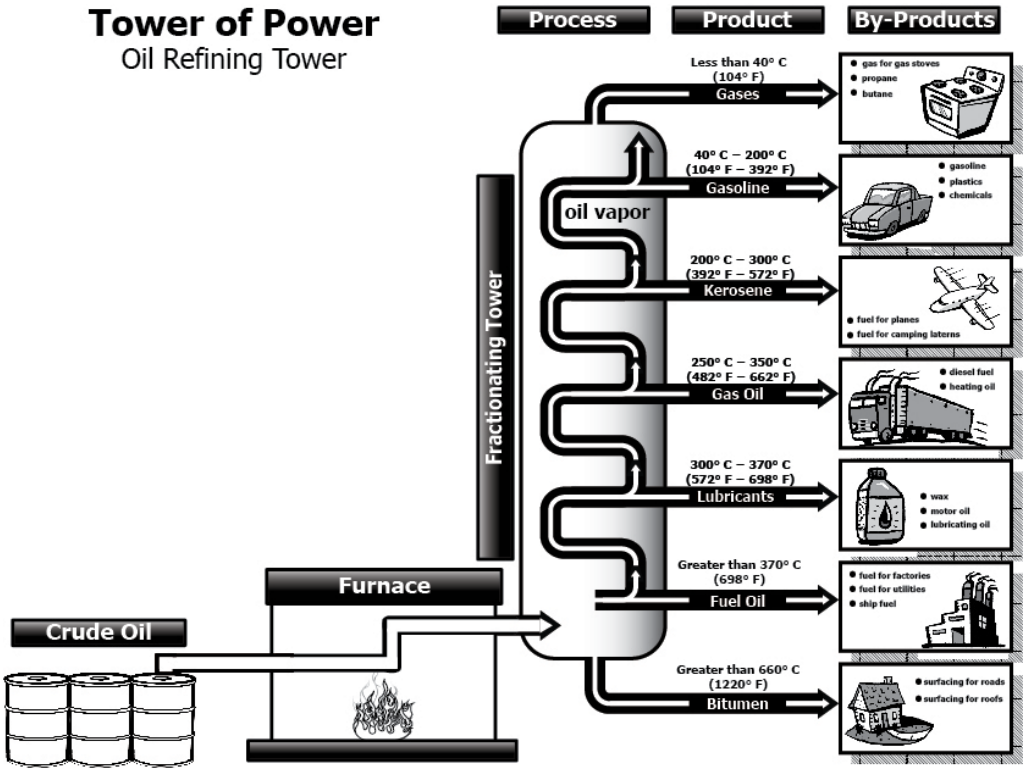
Crude oil is processed in a refinery. A refinery is a place where the product (oil) is heated to different temperatures (cooked) to create different by-products.Crude oil and other products are blended together to form gasoline, diesel, heating oil and other petroleum products. In fact, everyone uses or comes in contact with at least one petroleum-based product a day.

By processing fossil fuels at power stations, stored energy can be converted to electricity. The carpet on your floor and the paint on your walls probably have oil in them. You brush your teeth with a plastic toothbrush, which is made of petroleum (oil is the key ingredient in plastic). It is estimated that we have found more than 500,000 uses for crude oil.

What products come from crude oil?

Crude oil is heated to different temperatures. During this heating process, different products are made using the crude oil at different temperatures.

The “Tower of Power” shows the process and temperatures that crude oil is heated to so that it can be made into a variety of products.



Natural Gas

What is Natural Gas?

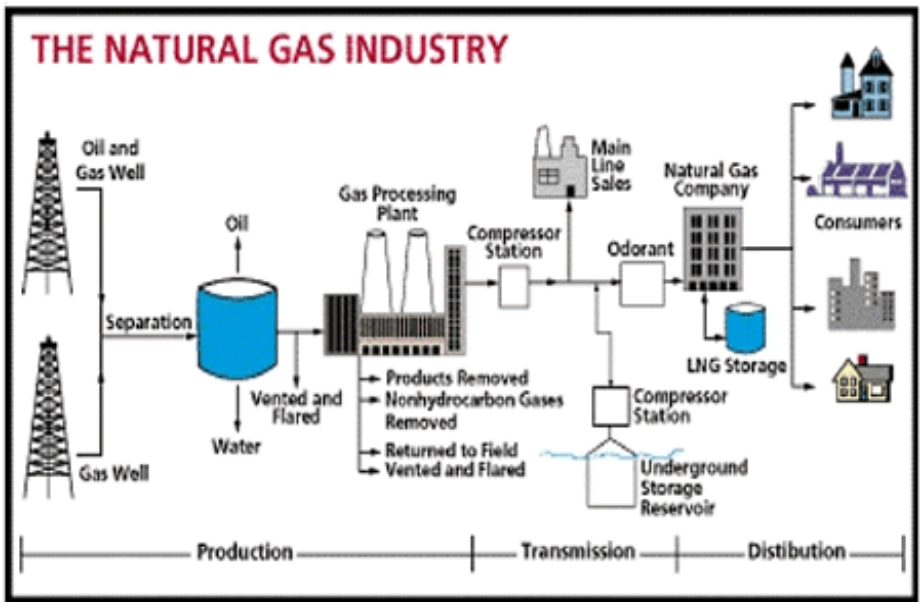
It is a naturally occurring gas that was formed in the same way that crude oil was formed. To remember this process, please refer to page 23.

Where does it come from?

Natural gas is found below the earth's surface in rocks, much like crude oil.

How do we get it out of the ground?

Natural gas is a gas that is produced at the same time as crude oil and in the same manner. It is the vapor that is collected from the same well that produces oil. When the crude oil is lifted from beneath the earth, the natural gas is as well. The natural gas is separated from the crude oil using special equipment known as a separator and sometimes a dehydrator. This natural gas is then shipped to a processing plant using pipelines. The diagram on the next page from the US Department of Energy shows the process that natural gas goes through to become a usable product in our homes, etc.



How is it processed?

Natural Gas is processed in a gas plant where they utilize different types of machinery to process the gas into a usable form. This natural gas can then be used in a variety of ways.

How is natural gas used?

Natural Gas can be used to heat homes, cook and for electricity production. Natural gas also fuels factories that make everything from cars to cereal.

Coal

Coal was very heavily mined in areas across the US. It was used mainly for transportation. Prior to the discovery of crude oil, coal was used as fuel for trains and steamboats. In the eastern side of Oklahoma, coal was commonly mined along with other minerals.

Coal is mined from seams or pockets underneath the ground. These mines vary in depth and length. Coal production in Oklahoma has slowly gone away, however, the exploration of coalbed methane gas is increasing. This gas is collected from the same coal shales and seams from which coal used to be mined. This gas is then converted into usable energy, much like natural gas.

Alternative Fuels

What are alternative fuels?

Alternative fuels are fuels that are not fossil fuels, but fuels that utilize different types of weather or atmospheric conditions. Water, sun, steam and wind provide energy from nature.

Where do alternative fuels come from?

Alternative fuels utilize the weather and atmospheric conditions to produce energy for us to use everyday. Most commonly, it is energy that comes from the sun, water or wind.

Hydro Energy

Hydro energy is energy that is produced using water. To produce this type of energy, a dam is made to catch the water flowing down a major tributary or lake. The collected water turns turbines within the dam, producing energy that is converted into electricity. A very large hydro energy system in Oklahoma is the Grand River Dam Authority (GRDA).

Solar Energy

Another form of alternative fuel is solar energy. Many of you have probably seen a house that uses solar energy panels to make energy to heat and cool the home. In some states where there is a lot of sun, like Nevada, they have solar farms. These farms utilize empty land to put up huge panels. The sun's energy is stored in these panels and is then processed to form electricity for complete neighborhoods and areas.

Wind Energy

An example of a traditional windmill used to pump water.

This is one of the many wind turbines in western Oklahoma that is being used for electricity generation.

In addition to solar energy, we also use wind energy. If you have lived in Oklahoma very long, you know that a day without wind is abnormal, and it blows from every direction. People have been utilizing wind energy since the first windmill was developed. These windmills were used to pump water out of the ground. It is still very common to see windmills today. However, recently in Oklahoma we have begun to "harness" the wind's power by putting up large wind turbines in places where the wind is consistently strong and consistently present. These wind farms are made up of turbines that are placed in different directions. A noticeable wind farm is located to the west of Geary on I-40. The energy created from the turbines turning is then turned into electricity for us to use.
Although an electricity company will utilize large wind farms to produce electricity for their customers, many people, especially farmers and ranchers, utilize windmills for electricity as well. Some people have much smaller wind turbines that they use for electricity for their house and household uses. Some people use windmills to produce electricity to pump water for their livestock. Windmills are especially important in areas of western Oklahoma where farms and ranches are very large. There are often no electricity poles and no large ponds for livestock. Farmers and ranchers use windmills to generate electricity and pump water out of the ground into water or stock tanks.

Back in pioneer times, especially in Oklahoma, windmills were the main source of energy and were used for electricity as well as for pumping water.

Ethanol Blends

The last form of alternative energy we are going to look at are some of the alternative fuels that have recently been developed. Depending on where you live in the US different environmental regulations control what type of fuel you put in your car. Because of concern for the environment and the growing population, scientists have researched and developed additional fuels, including ethanol and ethanol/gasoline blended fuel.

Ethanol contains grain alcohol as well as other products. It is a clear, colorless liquid. Blends of at least 85% ethanol and 15% gasoline are considered alternative fuels. In some areas, ethanol is blended with gasoline to form a fuel grade that is 10% ethanol, 90% gasoline.

Scientists and researchers continue to look at other uses for ethanol and for other types of alternative fuels for the environment.

Unit 5
What's Underneath My Feet?

Introduction

Do you ever wonder why the landscape around where you live is flat or hilly? Did you ever ask the question, "Why is the soil in my yard a certain color?" These are all questions that relate to the types of rocks in our backyard. The types of rocks, along with the climate and erosion, have shaped the Oklahoma topography or landscape. This unit of the Oklahoma 4-H Geology program is designed to help us understand how the landscape across our state formed as a result of geological processes.

What Will I Learn?

In Unit 5, we take a trip around Oklahoma and learn the different landscapes that are found here. For example, we will learn where to go to see clear streams and lakes, the areas of the state producing wheat, or ancient mountains that have been worn down by millions of years of erosion.

Activities

The following activities are examples of things you can do as 4-H members and volunteers to learn about the geology of our great state:

1. Visit a state park in your area and make a note of the landscape features such as hills, streams or rocks that make the park special.

2. Prepare a photography exhibit of a state park or scenic region. Enter the exhibit in the fair.

3. Use the Oklahoma Department of Agriculture website or other resources to determine the types of crops grown where you live. Compare these crops to the geology and/or soil type.

4. Make a poster showing the different types of soils where you live.

5. Make a forestry, crops or grass exhibit for the county fair.

6. Enter a set of landscape pictures into the photography contest at the county fair.

Oklahoma's Landscape and Soils

Oklahoma's scenic beauty and agricultural resources are closely linked to geology. Rock type and climate play major roles in determining the types of soils, and as a result, the crops that grow in an area.

For instance, Grant and Kay Counties are known for wheat production. Le Flore and McCurtain Counties are known for timber production. The Oklahoma Panhandle is noted for its many irrigated crops, including corn, milo, wheat and cotton.

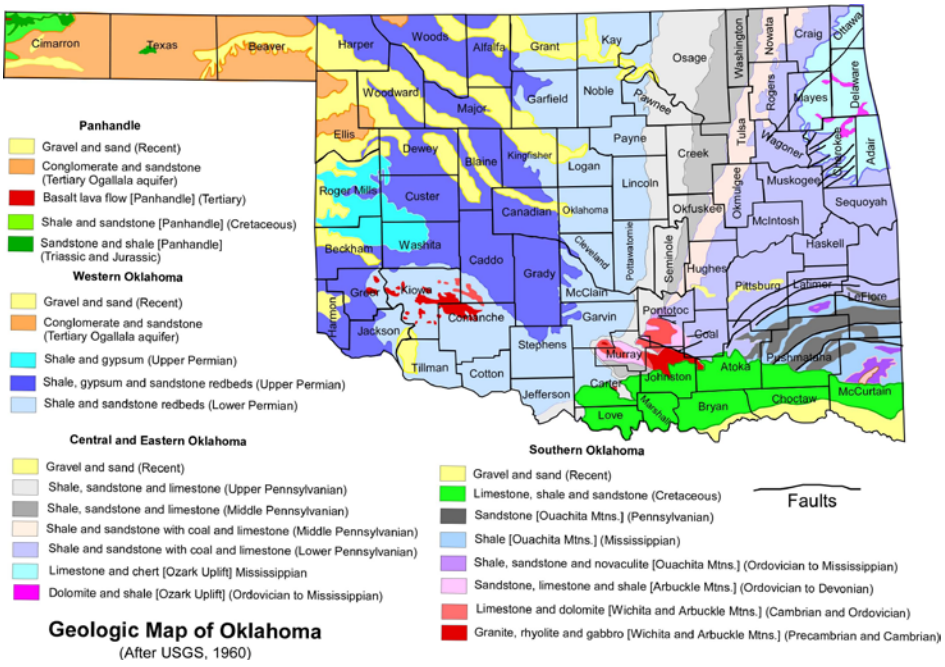
Eastern Oklahoma tends to be hilly in some areas, whereas much of northwestern Oklahoma and the Panhandle are very flat. The landscape of Oklahoma formed as a result of uplift and erosion.

Soil composition helps us to determine a lot of things. For example in central Oklahoma we have a lot of red clay. Brick is commonly made from this clay and that is why we have so much red brick in our state. In other states and other areas of Oklahoma, the brick color is determined by the soil that they use to make the brick.

Soil composition is also important when building a house or landscaping. If you have red clay it would not be very good for growing beautiful plants and flowers because it is very compact and doesn't allow the plant's roots to spread.Therefore, a lot of times topsoil is brought in for flowerbeds and lawns. The important thing to remember is that some clay will expand and could possibly crack a concrete pad or foundation.

Sand is just the opposite of clay. It is not the best choice for building a house on, but it is a better choice for growing crops, grasses and for landscape bedding than clay.

By participating in contests like land judging you will be better able to determine what types of soil are best for what you would like to do.



Geologic Map of Oklahoma
(After USGS, 1960)

Scenic Regions of Oklahoma

The Oklahoma landscape is divided into approximately nine general scenic regions. These are the Ozark Uplift, Ouachita Mountains, San Bois Mountains, Cross Timbers, Arbuckle Mountains, Wichita Mountains, Central Plains, Coastal Plains and the Western High Plains. Notice how these areas are closely related to color patterns on the Geologic Map of Oklahoma. Many counties contain one or more of these regions. Other counties are totally within one region.

Ozark Uplift

The Ozark Uplift is the area of timbered hills and clear streams in Ottawa, Delaware, Mayes, Cherokee and Adair counties. The area is known for its scenic streams, lakes and recreational activities.

Ouachita Mountains

The Ouachita Mountains in Le Flore, McCurtain, Pushmataha, Latimer, Pittsburg and Atoka counties are steep timbered hills. These hills are formed of faulted and folded layers of sedimentary rock deformed by mountain building processes.

San Bois Mountains

The San Bois Mountains are an area of high hills in northern Le Flore, Latimer and Pittsburgh counties, as well as Sequoyah, Haskell, McIntosh and parts of Muskogee counties.

Cross Timbers

The Cross Timbers region is the area of wooded hills and open prairie extending across parts of Osage, Pawnee, Payne, Lincoln, Logan, Oklahoma, Cleveland, McClain, Garvin, Pottawatomie, Seminole, Hughes, Okfuskee, Okmulgee, Creek, Tulsa, Rogers, Craig, Nowata and Washington counties. The area contains gentle hills and valleys formed by the differential erosion of the softer and harder rock layers. For example, sandstone outcrops tend to be covered by oak trees, whereas prairie (now pasture or farmland) tends to dominate the shale outcrops.

Arbuckle Mountains

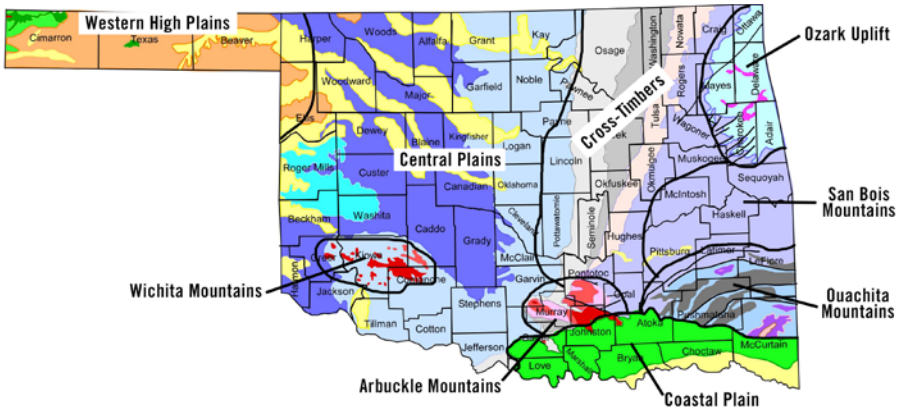
The Arbuckle Mountains are an area of uplifted, folded and faulted sedimentary rocks in Pontotoc, Coal, Murray, Johnston and Carter counties. Igneous rocks outcrop in the Arbuckle Mountains in Murray and Johnston counties.

Wichita Mountains

The Wichita Mountains are igneous rocks faulted to the surface during what is called the Pennsylvanian Period. The Wichita Mountains are centered in Comanche County, but igneous rock outcrops extend across Kiowa into Greer County. The Wichita Mountains contain granite, rhyolite and gabbro igneous rock types, as well as sedimentary rocks such as conglomerates formed by alluvial fans that developed on the flanks of the mountains when they were much taller.

Central Plains

The Central Plains region of Oklahoma is the broad expanse of prairie that once extended across much of west-central Oklahoma. Much of the Central Plains region is now farmland that is the major wheat producing area of the state. The Central Plains area is mostly shale with lesser amounts of sandstone, limestone and gypsum. Where gypsum or sandstone is at the surface, the topography becomes hilly and is cut by canyons. Kay, Noble, Grant, Garfield, Kingfisher, Logan, Oklahoma, Cleveland, Stephens Jefferson, Cotton, Tillman, Jackson, Harmon, Blaine, Canadian, Alfalfa, Major, Dewey, Custer, Roger Mills, Ellis, Woodward, Woods, Beckham, Washita, Caddo and Grady counties are all in this area.



Scenic Regions of Oklahoma Superimposed on the Geological Map

Coastal Plain

The Coastal Plain region is the relatively flat-lying area along the Red River in southern Oklahoma. The Coastal Plain lies to the south of the Arbuckle and Ouachita Mountains and includes parts of Carter, Love, Marshall, Bryan, Johnston, Atoka, Choctaw, Pushmataha and McCurtain counties.

Western High Plains

The Western High Plains are located primarily in the Panhandle. This mostly flat-lying area is noted for its ranching and irrigated cropland. In the western end of the Panhandle in the vicinity of the Black Mesa, the terrain becomes too rough to support farming. Cimarron, Texas, Beaver and parts of Harper and Ellis counties are in the High Plains.

State Parks of Oklahoma

Oklahoma has approximately 40 state parks widely distributed across the state. The website of Oklahoma Parks, Resorts & Golf gives the locations of all parks. Many of these parks have great scenic beauty. Some have educational exhibits explaining how geology affected the landscape around the park.

Ozark Uplift
A - Bernice
B - Cherokee Landing
C - Cherokee
D - Disney/Little Blue
E - Honey Creek
F - Natural Falls
G - Snowdale
H - Spavinaw
I - Tenkiller
J - Twin Bridges
K - Western Hills/Sequoyah

Central Plains
L - Alabaster Caverns
M - Boiling Springs
N - Fort Cobb
O - Foss Lake
P - Gloss Mountains/Glass Mountains
Q - Great Salt Plains
R - Little Sahara
S - Red Rock Canyon
T - Roman Nose

Western High Plains
U - Black Mesa

Coastal Plain
V - Hugo Lake
W - Lake Texoma
X - Raymond Gary

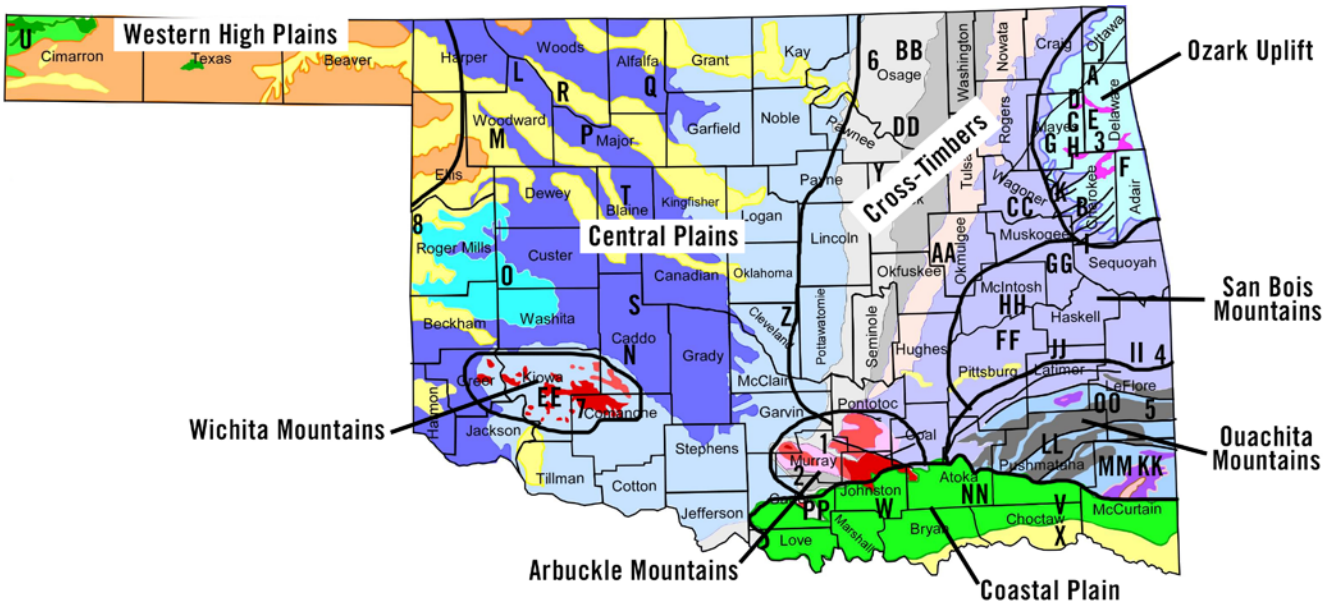
Cross Timbers
Y - Keystone
Z - Lake Thunderbird
AA - Okmulgee
BB - Osage Hills
CC - Sequoyah Bay
DD - Walnut Creek

Wichita Mountains
EE - Great Plains

San Bois Mountains
FF – Arrowhead
GG - Greenleaf
HH - Lake Eufaula
II - Lake Wister
JJ - Robbers Cave

Ouachita Mountains
KK - Beavers Bend
LL - Clayton Lake
MM - Hochatown
NN - McGee Creek
OO - Talimena

Arbuckle Mountains
PP - Lake Murray



Other Parks and Preserves

Arbuckle Mountains
1 - Chickasaw National Recreation Area (National Park Service)
2 - Turner Falls (City of Davis)

Ozark Uplift
3 - Lake Eucha (City of Tulsa)

Ouachita Mountains
4 - Cedar Lake (National Forest Service)
5 - Ouachita National Forest (National Forest Service)

Cross Timbers
6 - Tall Grass Prairie Preserve

Wichita Mountains
7 - Wichita Mountains National Wildlife Refuge

Central Plains
8 - Black Kettle National Grassland

Description of Some Parks with Specific Geological Features

Ozark Uplift

Western Hills/Sequoyah State Park
This park offers an interpretive fossil trail and an opportunity to see outcrops of Mississippian- and Pennsylvanian-age rocks. The fossil “Archimedes” is common here.

Lake Eucha
Prominent bluffs that bound this scenic lake are Mississippian-age limestone beds. Within the park, Ordovician-age dolomite outcrops along the lake shore.

Ouachita Mountains

Beavers Bend State Park
The high hills and steep-walled valleys in this park are the result of erosion of highly folded and steeply dipping layers of sedimentary rocks. Beavers Bend State park also is the home of ancient volcanic ash and pumice deposits called “tuff.”

Talimena State Park
Talimena State Park is the western trailhead for the Ouachita Trail on Winding Stair Mountain. Winding Stair Mountain formed as a result of faulting and folding of sedimentary rock layers during collision of the North American and African/South American tectonic plates. Prominent sandstone ledges on Winding Stair Mountain are lower Pennsylvanian age.

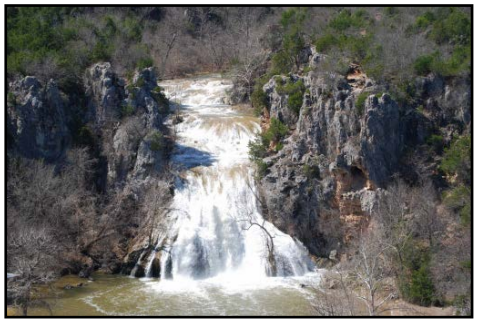
San Bois Mountains

Lake Wister State Park
The ridges and valleys in this park formed as the result of the differential weathering of layers of tilted sandstone and shale. These rocks are Pennsylvanian in age and contain coal beds.

Robbers Cave State Park
The sandstone beds forming the ledges or “cave” at Robbers Cave State Park are Pennsylvanian age. The sandstone and shale in the park formed from sediments deposited in an ancient delta.

Arbuckle Mountains

Turner Falls Park
Turner Falls Park is owned and operated by the City of Davis. Turner Falls is formed where Honey Creek flows over a large travertine deposit. Travertine is a variety of limestone formed by freshwater rich in the mineral calcium carbonate. The highly mineralized water is formed when limestone and dolomite are dissolved in the Timbered Hills region southwest of the park. The limestone and dolomite are Cambrian and Ordovician-age. As these rocks dissolve, caverns are formed. Many springs with highly mineralized water feed Honey Creek above Turner Falls.


Turner Falls near Davis, Murray County.

Chickasaw National Recreation Area
The Chickasaw National Recreation Area is home to numerous springs and Vendome artesian well. The rocks in the recreation area include Pennsylvanian-age conglomerates containing rounded cobbles made up of the limestone and dolomite that outcrop in the Arbuckle Mountains to the south. This layer of cobbles formed in streams that carried them from the mountains to their present location. These deposits indicate the Arbuckle Mountains were much higher during Pennsylvanian time. The water flowing from Vendome well is highly mineralized and contains a strong odor of hydrogen sulfide. The well is one of the more popular tourist attractions in the area.

Central Plains

Alabaster Caverns
Alabaster Caverns formed by the dissolution of gypsum beds. The cave is the largest gypsum cave in the world open to the public (Suneson, 1996). Alabaster Caverns is known for its multiple colored examples of alabaster, a fine crystalline form of gypsum.

Great Salt Plains
The Great Salt Plains is world renown for its “hourglass” selenite crystals. Selenite is a form of hydrous calcium sulfate, or gypsum. The “hourglass” is formed by brown sand, silt or clay particles that become incorporated in the crystals as they grow. Crystal digging at the park is a fun, recreational activity permitted between April 1 and October 15.

Little Sahara
Little Sahara State Park is a sand dune field. The sand originated along the Cimarron River. Prevailing southwesterly winds transported the sand from the river valley to its present position.

Roman Nose
The rocks in Roman Nose State Park are Permian redbeds. The unusual rock formations were formed by erosion. Cliffs and steep slopes are gypsum and dolomite. Some of the more unusual rock formations are capped gypsum and dolomite that are resistant to erosion. Roman Nose State Park is noted for its springs, which flow from gypsum beds (Suneson, 1996).

Red Rock Canyon
Red Rock Canyon State Park is named for the Permian red-colored sandstones that outcrop there. The red color is from hematite, or iron oxide, that was deposited with the sand.

Western High Plains

Black Mesa
Black Mesa State Park is unique among the other parks. It contains outcrops of rocks different from those in the rest of Oklahoma. The Jurassic-age Morrison Formation, which contains dinosaur fossils, outcrops there. Black Mesa is capped by a relatively young basaltic lava flow that originated nearby in Colorado. Black Mesa is the highest point in Oklahoma at more than 4,970 feet above sea level.

Soils and Geology

The type of soil in a region is closely related to the geologic history or the area. For instance, the clay soils of north-central and northwestern Oklahoma form from weathered Permian age shales. However, very sandy soils are located along the major rivers that cross this area. These soils formed on sand dunes or sand deposits along these rivers. The sand dunes formed from sand blown from the river bottoms by the southwesterly prevailing winds. Other examples are from the mountainous regions of the Ozark, Ouachita and Arbuckle Mountains. Soils in these regions can be very rocky, shallow and unsuitable for cropland. As a result, these areas are predominantly forest or grassland.

Soil Surveys

Soil surveys are available for each county in Oklahoma. They may be found at local Natural Resources Conservation Service Offices, which are present in all counties. Most soil surveys contain a simplified geologic map for the county. These maps, when used in conjunction with the soils maps, show the link between geology and soil type.

Resources

The Oklahoma Geological Survey publishes geologic information on Oklahoma. Publications that deal directly with Oklahoma State Parks are listed below.

Guidebook 15, Guidebook to Alabaster Cavern and Woodward County, Oklahoma, by A. J. Myers and others

Guidebook 11, Guide to Beavers Bend State Park, by W. D. Pitt and others

Guidebook 28, Geology of Wister State Park Area, Le Flore County, Oklahoma, by L. A Hemish

Guidebook 22, Guide to Robbers Cave State Park, by A. J. Myers and others

Guidebook 9, Guide to Roman Nose State Park, Blaine County, Oklahoma, by R. O.Fay

References

Suneson, N. H., 1996, A guide to resources for earth science information in Oklahoma: Oklahoma Geological Survey Educational Publication No. 5, 76 p.

USGS, 1960, Geologic Map of the United States of America, United States Geological Survey, Reston, Virginia.

Unit 6
What Does a Geologist or a Geoscientist Look Like?

Introduction

So what does a person who is interested in geology do once they are all grown up? The geoscience career field is filled with opportunities, and in a place like Oklahoma, the opportunities are limitless. You probably know at least one person who works in the crude oil and natural gas industry. There are a variety of careers to choose from. These range from actual people who work in the field to individuals who spend most of their time in an office setting. All of these people are essential to the industry, even though their education and job responsibilities are very different. We will start out looking at the careers that help to discover, lease and guide a company to finding crude oil and natural gas and making it into a usable product. We will also look at other careers that utilize principles of geology.

What Will I Learn?

In Unit 6, you will learn about some of the many careers that utilize the principles of geology. These will provide you with a basic knowledge to decide if any of these career paths are right for you. As you graduate on to Geology books 2 and 3 you will discover more of the responsibilities, subjects and working conditions of these careers.

Activities

1. Find someone in your community or neighboring community who holds one of these jobs. Ask them about what they do in their every day work. Take pictures of them doing their job and develop a poster project and possible paper regarding their job responsibilities and how their career utilizes geology principles.

2. Go to your county courthouse and look up the deed on your house or residence through the county clerk's office. Ask your family how they came to own their particular property, including who they purchased it from, etc. If you do not own your own property, look up the property of a close relative or friend. Write a summary of your trip and note it through pictures and develop a poster regarding this experience.

3. While working in this unit, make note of all of the drilling rigs and oilfield equipment that you see. Also, observe other types of working teams like land surveyors, seismic crews, etc. Determine how active your community is in relation to these career fields.

Geoscientist

A geoscientist has many different names and specialties. Although all geoscientists gather information and evaluate research about the earth's surface and interior, they are very specialized. Some study the chemical properties of the earth and water, while others will study the surface and interior of the earth. Others will look at seismic data and others will study volcanic activity.

Geologist

Traditionally, a geologist studies rocks, minerals and fossils and looks at the history of the earth. By looking at the characteristics of specific earthen materials and fault lines in an area, they are better able to determine if the area is a good place to drill. Geologists also look at seismic graphs to determine if an area is more likely to have crude oil and natural gas present and if so where and to what depths to drill.

A geologist usually spends a good portion of his/her time both in the office and on possible drill locations. This person has a degree in geology, most likely focused on crude oil and natural gas.

Engineer

An engineer is a person who enjoys math and science. Engineers help design, construct and oversee projects involving construction, problem solving or research and development. Engineers can be involved in geoscience by drilling, mapping and studying the area around a drilling area. They could also work to develop new products, tools or drilling strategies.

Landman

A landman is not necessarily a job just for guys, there are also many girls who work in this career field. A landman is an individual who can either work on his/her own or be employed by a company who secures crude oil and natural gas leases, checks legal titles and works on any problems with a title before drilling can occur.

A landman generally spends a large amount of time in county courthouses and other places of record determining who owns the property in the area in which he/she would like to drill or obtain minerals. Minerals include crude oil and natural gas.