4H • ENV • 101

Geology Project
Book 2: Intermediate

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

OSU EXTENSION
4-H YOUTH DEVELOPMENT

Oklahoma Energy Resources Board

OERB

Geology Project
Book 2—Intermediate

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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Book 2
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Unit 1
Where to Find Rocks, Minerals and Fossils

Introduction

Do you ever wonder why the landscape around where you live is flat or hilly? Did you ever ask the question, “Where can I find a piece of granite or limestone in Oklahoma?” or “Why are the creeks in Cherokee County very clear, but the creeks in Payne County are not?” 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 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 Will I Learn?

In Unit 1, we take a trip around Oklahoma and learn where to find specific kinds of rocks, minerals and fossils. We learn that fossil types are linked to specific types and ages of rocks.

Activities

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

1. Collect rocks, mineral and fossils and identify them. A collection of 30 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 in the resources section of your book.

3. Plan a trip to visit sites where distinct fossils, minerals or rocks can be found. Examples are brachiopods or crinoids in Osage or Pawnee Counties, gypsum in Major County, granite or gabbro in Comanche County, selenite crystals in Alfalfa County or coal in LeFlore County.

The Types of Rocks Where You Live

Before we look at the types of rocks around us, let's ask ourselves this question, "What exactly is a rock?"

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, inorganic, solid substances with a specific chemical or molecular formula. The best way to learn about 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, or changed to stone. Sediments are materials such as sand, clay, gravel and sea shells. Sediments are also precipitates such as lime, gypsum or salt.

Sandstone is a sedimentary rock that is composed of grains of sand that are cemented by minerals such as quartz or calcite.

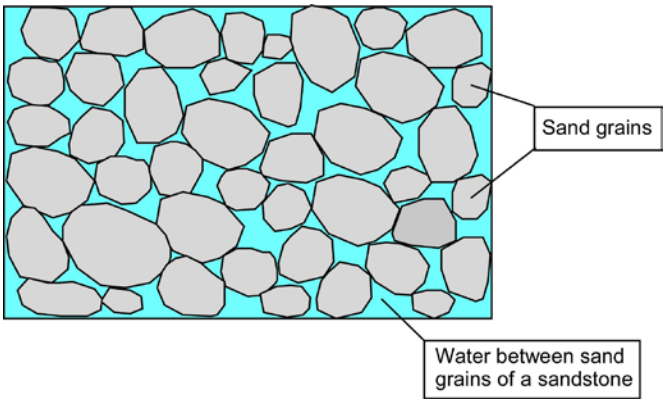
Sediment type: original material	**Rock** that forms by lithification	**Features:** how it looks
Mud	Shale	Usually soft, breaks into very thin **sheets** or **crumbles**. Often forms mud when wet. Surface feels **smooth.**
Silt	Siltstone	Breaks into thin, **hard layers**. Surface feels **gritty** like 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.

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)



Outcrop of the red-colored Rush Springs Sandstone east of Anadarko, Caddo County.

A sample of the Garber Sandstone from along I-35 north of Edmond, Oklahoma County. This sandstone forms the Central Oklahoma Aquifer, which is also called the Garber-Wellington Aquifer.

Pebble conglomerate with sandstone from Boley, Okfuskee County. This rock, which is called the Boley Conglomerate, is a member of the Vamoosa Formation, an important aquifer in east-central Oklahoma.

Limestone is another common sedimentary rock. Most limestone contains fossil grains that are crystals of a mineral called calcite. Fossils provide evidence to interpret how the sediments were deposited.

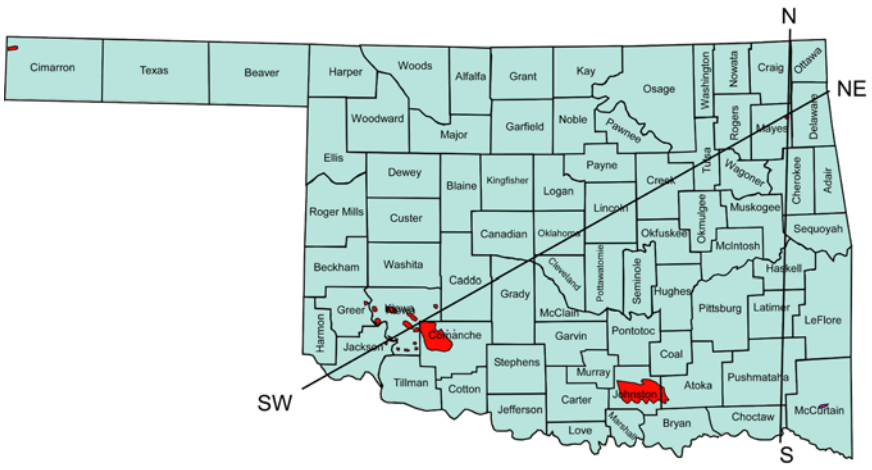
Limestone sample from Pawnee County, Oklahoma that contains fragments of crinoids and other marine fossils.

Limestone ledges in the Arbuckle Group along I-35, Arbuckle Mountains, Murray County.

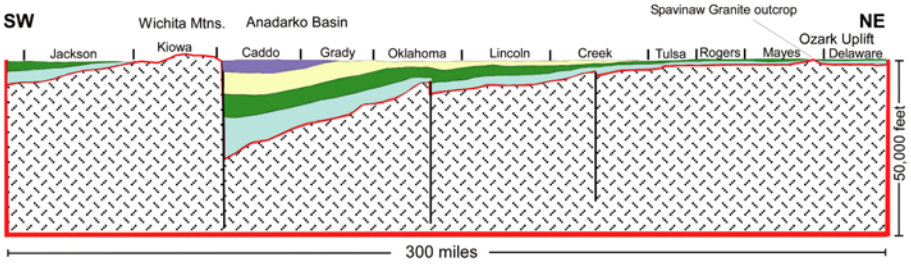
Shale is lithified clay and silt. Thin layers of silt cause shale to split into very thin sheets.

(Left) Outcrop of Chattanooga Shale (called Woodford in central and western Oklahoma) along Spavinaw Creek, Delaware County. The gray-colored ledge above the black shale is called the Compton Limestone Member of the St. Joe Group.

(Left) A sample of Woodford Shale from near Springer, Carter County, Oklahoma.



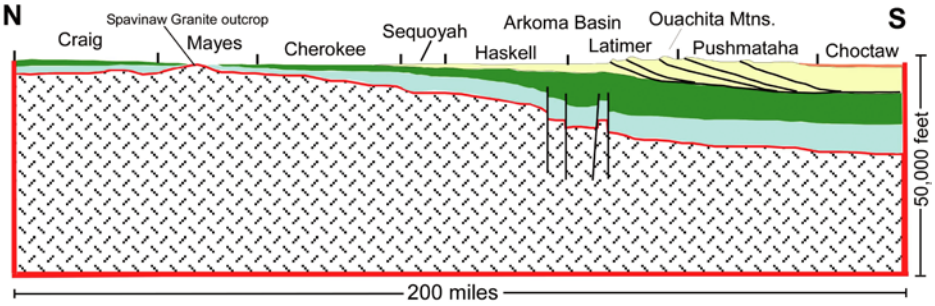
Outcrops of sedimentary rocks in Oklahoma



Sedimentary rocks

Igneous and metamorphic rocks

Fault



Sedimentary rocks

Igneous and metamorphic rocks

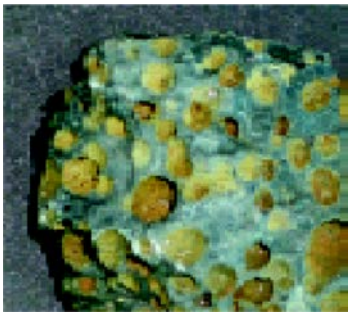
Fault

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.

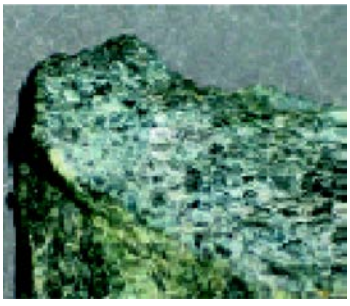
Granite is a type of igneous rock that is common to certain parts of Oklahoma. It often contains crystals of three minerals: quartz (grey), feldspar (pink) and mica (black) as in the sample on the next page.

Granite sample from the Wichita Mountains, Commanche County, Oklahoma.



Basalt lava sample from near Black Mesa, Cimarron County, Oklahoma.

Rhyolite lava from near Medicine Park, Comanche County, Oklahoma.



Gabbro sample from near Medicine Park, Comanche County, Oklahoma.

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 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 re-crystallize into the metamorphic rock marble. When marble forms, the fossils in the original limestone are re-crystallized and no longer seen.

Outcrops of metamorphic rocks in Oklahoma

Vocabulary Words

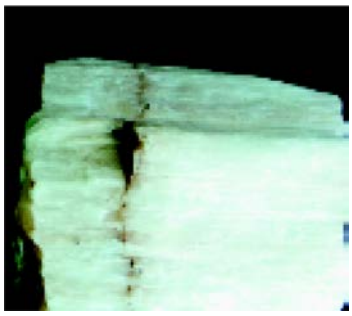
Igneous - Formed by the solidifcation (becoming solid) of magma. (Examples: Granite, quartz, feldsbar and mica)

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

Minerals of Oklahoma

Certain minerals are common in Oklahoma and can be collected with ease. The most commonly recognized mineral from Oklahoma is likely to be selenite, a variety of hydrated calcium sulfate. Selenite crystal collecting at the Great Salt Plains in Alfalfa County is a very popular activity.

Selenite crystals from the Great Salt Plains, near Jet, Alfalfa County.



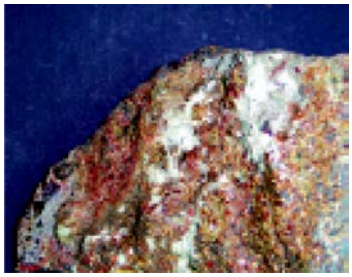
Satin spar variety of hydrated calcium sulfate from near Orienta, Major County.

Quartz crystals can be found in areas of the Ouachita Mountains. The crystals can be clear to white (milky quartz).

The abandoned Tri-State Mining District in Ottawa County is a source of several minerals. The more common minerals found on the mine dumps are chert, calcite, dolomite, sphalerite and galena. Chalcopyrite and marcasite are also present, but more difficult to find.

Chert (white and gray) that contains the mineral galena (blue-gray). The smaller sample contains sphalerite (dark red) and galena (blue-gray). Found near Picher, Ottawa County.

White dolomite crystals on side of chert fragment (larger piece). Dolomite crystals are partially coated by chalcopyrite. The smaller crystal is calcite. Both samples are from the Tri- State Mining District, Picher, Ottawa County.



Red and yellow sphalerite with white chert, Picher, Ottawa County.

Finding Fossils 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. Look in the shale beds beneath thin ledges of limestone.

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 fossils in the northeastern, central and southern 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.

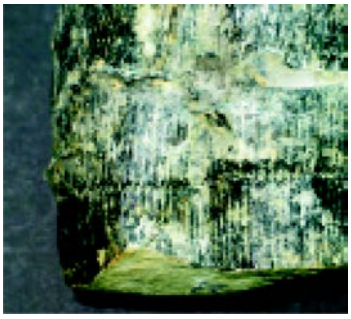
Pennsylvanian Fossils from Central Oklahoma

Fossils: Bryozoans from Pennsylvanian rocks in Pawnee and Tulsa Counties.

Solitary "horn" corals from Pawnee, Osage 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 south of Heavener in LeFlore County.

Fossil stems of Lepidodendron from near Stigler in Haskell County.

Additional Resources

Johnson, K. S., 1972, Guidebook for geologic field trips in Oklahoma, Book II: Northwest Oklahoma: Oklahoma Geological Survey Educational Publication No. 3, 24 p.

Naff, J. D., 1981, Guidebook for geologic field trips in north-central Oklahoma: Oklahoma Geological Survey Educational Publication No. 4, 42 p.

Neman, R. L., D. Schulte and D. Johnston, 2002, Guidebook for geological field trips in south-central Oklahoma: Arbuckle Geosciences, Ada, Oklahoma, 140 p.

Suneson, N. H., 1996, Guide to resources for Earth Science information in Oklahoma: Oklahoma Geological Survey Educational Publication No. 5, 76 p.

Unit 2
Where Does your Water Come From?

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 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 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 Will I Learn?

In Unit 2, we examine the major groundwater aquifers in Oklahoma, how aquifers work and their importance to our state. We learn how to locate water wells where you live and how to test water for mineral content.

Activities

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

1. 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.

2. Contact your county extension office to see about participating in the Environmental Impact program and volunteering to test water.

3. Use a test kit to test the water in your house, well or stream for mineral content.

Where Does Your Water Come From?

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, some 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 dissolves rocks and the mineral constituents enter the water. As a result, groundwater contains mineral constituents like calcium, magnesium, chloride, sulfate, bicarbonate and carbonate.

If you live in certain areas of Oklahoma, it is likely you drink water pumped from an aquifer. The major aquifers in Oklahoma are discussed below. Major aquifers produce or yield volumes of water that are sufficient for irrigation or city water supplies. The map on the below shows the locations of major groundwater aquifers in Oklahoma.

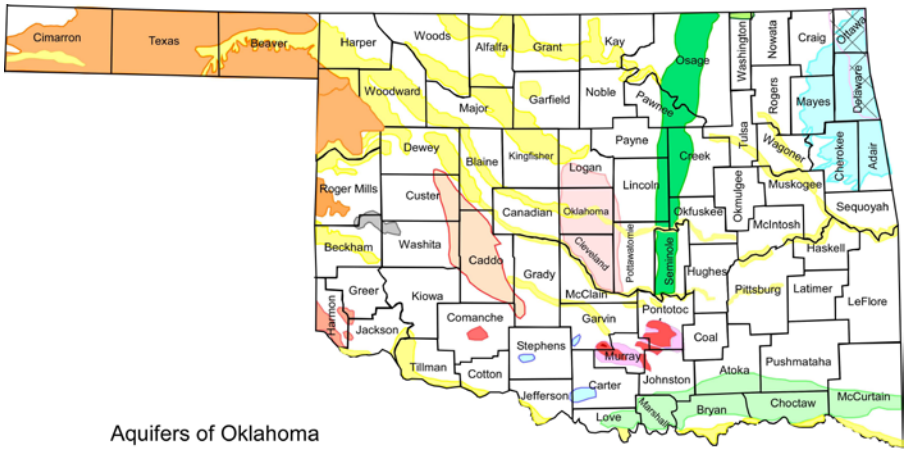
Areas that are not covered by these aquifers have shale, sandstone and limestone aquifers that yield small volumes of water that are often sufficient for home use.

Panhandle

Residents of Cimarron, Texas and Beaver Counties pump their water from the Ogallala aquifer. This large aquifer is about 10,000 years old. The Ogallala aquifer is the source of water that used to irrigate the cropland in the Oklahoma Panhandle.

Ozark Region in Northeastern Oklahoma

Portions of Ottawa and Delaware Counties have two aquifers beneath them. One aquifer is called the Boone aquifer. It is a cherty limestone with water in fractures (cracks) and caves. The other aquifer is deeper. This aquifer is mostly dolomite with sandstone beds. It is commonly called the Roubidoux (Ru-bi-du) aquifer. The towns of Miami, Picher, Quapaw and Fairland pump their water from the Roubidoux aquifer. Many rural residents in the Ozark Region drink water pumped from these aquifers or that flows from springs in the Boone aquifer. The Boone aquifer extends into Mayes, Craig, Cherokee and Adair counties.



Central Oklahoma

The Garber-Wellington aquifer is a large sandstone aquifer that covers much of central Oklahoma. It is a major source of water in Lincoln, Logan, Pottawatomie, Oklahoma and Cleveland counties. Many towns including Oklahoma City, Mustang, Edmond, Midwest City and Nichols Hills pump drinking water from the Garber-Wellington aquifer.

Another large aquifer is the Vamoosa Sandstone. It extends from eastern Osage County southward through parts of Pawnee, Creek, Lincoln, Okfuskee and Seminole counties.

Southern Oklahoma (Arbuckle Mountains)

Parts of Pontotoc, Murray, Carter and Johnston Counties have limestone and dolomite underneath them that make up the Arbuckle aquifer, which is an important source of water for towns such as Sulphur and Ada. Sulphur's water supply is flowing artesian wells. Ada's water supply is Byrd's Mill Spring, which flows from the Arbuckle aquifer. Streams such as Pennington Creek, Honey Creek and Blue River are primarily fed from springs that discharge from the Arbuckle aquifer. Parts of Coal, Pontotoc, Murray and Johnston counties have sandstone aquifers in rocks known as the Simpson Group. The town of Mill Creek pumps its water from this aquifer.

Southern Oklahoma (Coastal Plain)

Significant parts of Bryan, Marshall, Love, Choctaw, Atoka, McCurtain and Pushmataha counties contain a sandstone aquifer called the Trinity Sandstone.

Southwestern Oklahoma (Arbuckle and Simpson)

Parts of Comanche County is above the Arbuckle and Simpson aquifers, which outcrop on the flanks of the Wichita Mountains.

Southwestern Oklahoma (Rush Springs Aquifer)

The Rush Springs Sandstone is an important aquifer in Caddo, Custer, Dewey, Grady and Washita counties.

Southwestern Oklahoma (Gypsum aquifers)

The Blaine Gypsum is an aquifer in parts of Harmon, Jackson and Greer counties. The water in Blaine is used mainly for irrigation. The Wichita Formation aquifers are important aquifers in parts of Stephens, Carter, Garvin and Jefferson counties.

Western Oklahoma

The Elk City Sandstone is an important aquifer around the community of Elk City in Beckham county. The aquifer extends to the east into Washita county. The Ogallala aquifer extends into Ellis, Woodward and Roger Mills counties.

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.

References

Marcher, M. V., 1972, Major sources of water in Oklahoma (Map): Oklahoma Geological Survey Educational Publication No. 1, p. 8.

Unit 3
What's Porosity and Permeability Got To Do With It?

Introduction

The porosity and permeability of a rock determines a lot of things about the ability of the rock to hold or not hold water, crude oil or natural gas in the pockets or holes.

What is Porosity and Permeability?

Porosity refers to the percentage of holes (pores) in the rock. Permeability is the ability of fluids to travel through porous rocks.

What Will I Learn?

You will learn what rocks are more porous and how oil migrates through different layers.

Activities

1. Test different types of rocks - (sandstone, granite, limestone and shale) by adding drops of water to see how much each rock will absorb to compare the porosity of the rocks.

2. Make a migration model using a plastic cup or a baby food jar and other supplies listed in the activities portion of the book to see how oil migrates through different rock layers depending on the porosity.

How does porosity and permeability effect water, oil and natural gas?

If a well is to be successfully produced, the reservoir rock must have porosity, permeability and enough pressure to move the oil and natural gas to the well bore. Reservoir pressure can be created by injecting natural gas or water into the formation.

Because oil, natural gas and water are under extreme pressure below the surface, these fluids typically flow up a well without assistance (much like a soft drink that has been shaken and then opened). This is called primary recovery; When the initial pressure is depleted, only a portion of the oil and natural gas has been produced. This does not, however, mean the end of the well's life.

Artificial lifting systems, or pumping units, are used to help pull the oil out of the reservoir rock and pump it up the well. Secondary recovery can also be done, which will be discussed in book 3.

During a waterflood, water is injected into the productive zone of some of the wells within a field to push the oil and natural gas up the other producing wells within the same field. Natural gas is lighter than the oil and can float on top of the oil as a gas cap. Sometimes natural gas in re-injected into the producing formation to push the oil to other wells that have been perforated in the oil zone. This is called a secondary gas drive. But again, we will learn more about secondary recovery in the next book.

Unit 4
Not Your Granpappy's Oil Patch!

Introduction

Just like the automobile and modes of transportation have changed with new technologies and designs so has drilling for crude oil and natural gas. In addition to changing the look and mechanisms of a drilling rig, chemicals and other products have been introduced to help increase production of crude oil and natural gas.

What Will I Learn?

In Unit 4, you will learn about different drilling techniques and strategies as well as various products that are introduced during the drilling phase that help increase production. After a period of time, some wells begin to drop in production amounts. At this point, some well operators will go back in the original drill site or one nearby and redrill or re-complete the well. It is usually done in a slightly different way than before, mostly because of new technologies. This process of re-completion hopefully, will produce more crude oil and natural gas. This is just one of the ways that crude oil and natural gas operators are able to produce more domestic crude oil and natural gas and increase the amount of crude oil and natural gas that can be recovered out of the earth.

Activities

1. Make a display showing the different types of drilling practices (directional, horizontal, vertical) in Oklahoma.

2. Look in the newspaper (*Daily Oklahoman* or *Tulsa World*) under the business section in oil and natural gas and see what depths the wells in your area are drilled. Also, chart for 1, 3 or 6 months the daily price of a barrel of oil sweet (low sulfur content) and sour (high sulfur content) and the price of natural gas per mcf (thousand cubic feet).

3. Note how much crude oil and natural gas is produced in your county or surrounding areas.

4. If you have drilling occurring on land your family owns, chronicle the drilling process.

Vocabulary Words

Kickpoint - Spot where vertical drilling ceases and hortizontal or directional drilling begins.

Hortizontal and/or Directional Drilling – Drilling in both an up and down and sideways direction to find oil and natural gas pockets.

Percussion Drilling – Utilizes a heavy metal drill bit and was basically hoisted up and down, which created a hole in the earth's surface that later became the drill hole.

Rotary Drilling – Utilizes a drill bit that rotates into the earth's surface to create a drill hole.

Vertical Drilling

Vertical drilling was the first method of drilling in the United States. This original drilling practice was done with a cable tool rig. This type of drilling is also called percussion drilling. Because the first wells drilled in Oklahoma and in other areas of the United States were shallow wells, this type of rig was a great fit. Although the products used to construct this type of rig have changed over the years, the concept is still the same. Cable tool drilling utilizes a heavy metal bit. It is raised and lowered to make a hole in the earth's surface until crude oil or natural gas is found, (each time going deeper and deeper). Original cable tool rigs were quite crude consisting of wood, and the force used to "drill" the hole was manpower. Eventually steam engines were introduced and steel instead of wood. This led to a faster and consistent way to drill using cable tool rigs. Although this method is not as commonly used today (new technology has made way to much faster drilling rigs for deeper wells) cable tool rigs can still be found.

The second type of vertical drilling rig is a rotary drilling rig. This type of rig is commonly used in Oklahoma as well as many other states today. Although its purpose is the same as a cable tool rig, it is set up differently. It uses a variety of types of large rotating drilling bits that replicate an electric screwdriver, but on a much larger scale. These bits rotate and bite into the earth's surface crushing and breaking up the rock and minerals until it hits crude oil or natural gas. Some of these drilling bits are even made out of diamonds, because of hardness of diamond. Researchers and developers are constantly striving to find new materials to make better, longer lasting bits for drillers to use.

A good example of cable tool and rotary drilling rigs can be found at the Oklahoma State Capital in Oklahoma City. The rigs commonly used in Oklahoma are on display across from the Oklahoma Capital building near the Oklahoma History Museum. The Oklahoma History Museum or the Seminole Oil Museum in Seminole, Ok., are also great places to visit to learn about Oklahoma's early crude oil and natural gas history.

Horizontal and Directional Drilling

In an attempt to remove or recover more crude oil and natural gas from the earth, researchers developed new technologies and a new type of drilling, one that still amazes many. Horizontal and directional drilling have the same basic concept of rotary drilling rigs, but they also have large differences.

A vertical drill is simply that, vertical (up and down), but a horizontal or a directional drill is up and down and sideways. This type of drilling has been useful in areas where large deposits of crude oil or natural gas have been determined, but because of the topography of the land or various pre-existing structures on the land that cannot be moved, the well cannot be drilled from directly above the deposit. Basically, the well is drilled vertical to a certain pre-determined depth, depending on the location of the deposit(s), and this is determined to be its kickpoint. A kickpoint is the spot where vertical drilling ceases and horizontal or directional drilling begins. The drilling bit is then angled sideways or angled at some form of degrees to create a bend and a horizontally drilled seam. This technology can also be used to maximize and speed up crude oil and natural gas recovery.

This type of drilling is particularly helpful in the recovery of coalbed methane gas (CBM). This gas, although very volatile in a coal mining operation, is a good alternative or non-traditional fuel source that is located in eastern Oklahoma. This gas is found in seams or pockets with shale usually present above and below. By using directional drilling you do not get as many fines, which are dusty pieces of shale and you are better able to drill straight into the pockets where the CBM gas is present. On these types of drills, multiple kickpoints may be drilled at varying depths and lengths. This allows for continued recovery of natural gas as one seam is completely recovered.

Although horizontal and directional drilling is much more expensive in price, it provides opportunities for drillers to work around different formations that cannot be moved or for more than one kickpoint to be drilled, which sometimes yields to greater production than if it had been drilled vertically.

After a well is drilled, casing (pipe) is inserted into the hole to keep the well bore (hole) from collapsing and to keep outside materials from entering into the hole. This casing protrudes above the ground and becomes the wellhead of the well. From here, the crude oil and natural gas are removed. Crude oil is put into storage tanks until picked up, and the natural gas is sent down a pipeline to a processing plant.

As time progresses, these technologies will be replaced by newer, better technologies and drilling practices that yield larger amounts of crude oil and natural gas from the earth.

Hydraulic Fracturing and Drilling Fluids

In addition to newer drilling strategies, other methods have been introduced to help yield a more productive well. One of these methods is hydraulic fracturing. After a well is drilled into the crude oil or natural gas reservoir area, often the drilling company will try to maximize productivity by pumping various fluids like water, CO2, and specialized foam and water down the well-bore (hole where the well was drilled) at very high pressures for hours at a time. After some time, the rock will then fracture due to the pressure caused by the fluids, and this allows the crude oil and natural gas to move more freely from trapped areas leading to greater production amounts. The fractures are then filled with a highly permeable proppant. The most common proppant is called frac sand. Most of the fluids that were injected in, then flow back out of the hole and are removed.

Another type of fluid that is commonly used is drilling fluid or drilling mud. This fluid or mud contains a mixture of man-made and naturally occurring fluids and solids. This mixture is used during the drilling process and helps to cool the bit, keep the bore hole from collapsing, and from filling with unwanted rock and soil fines. Also, mud helps to lift drill cuttings to the surface.

Unit 5
How the Past Influences the Future: Environment

Introduction

During the crude oil and natural gas boom, cities literally sprung up over night amongst the drilling rigs that covered as far as the eye could see in areas like Seminole, Ada and even Oklahoma City. Early drilling practices were crude and primitive to say the least. As these wells dried up or no longer produced large quantities of crude oil or natural gas, they were abandoned.

After time, environmental issues started to appear. In an effort to reclaim the environment in these areas, environmental regulations were passed requiring producers to return the land to its natural state prior to drilling. In addition, Oklahoma producers of crude oil and natural gas also joined these efforts by creating the Oklahoma Energy Resources Board (OERB). The OERB (uses funds voluntarily contributed by the industry to clean up abandoned oilfield sites.

Like the crude oil and natural gas industry, mining sprung up overnight in various areas across the state for minerals and coal ore. Currently mining in Oklahoma is for aggregate materials. Underground mines or strip mines were constructed. Most mining in the state of Oklahoma for mineral and ore stopped around the late 1930's.

The tri-state drilling district in northeastern Oklahoma is probably one of the biggest examples of the environmental effects of mining. Other areas that were mined were in southeastern Oklahoma and in areas like Pawnee, Noble and Payne counties. Some mining occurred in the area of Creta, in Jackson County. After the mines were abandoned there wasn't a program in place to help fill in these mines or to help with their environmental effects.

What Will I Learn?

In Unit 5, you will learn about the regulations and processes that crude oil and natural gas producers and the OERB go to in ensuring that the land is kept in a state that is environmentally pleasing place for all of us to live.

In addition, you will learn a little bit about the environmental concerns of mining and the lingering environmental concerns caused by mining.

Activities

1. Complete the “Hungry Microbes” experiment, which is located in the activities portion of your project book.

2. Go to www.oerb.com and review the environmental restoration section.

3. Contact OERB for an advanced project to see if there is a site near you that is being restored. If so, document the transformation, etc. Enter this display (with attached summary of the events and processes) in the fair.

4. Research the mining industry and the Tar Creek area in NE Oklahoma. Develop a poster project or a report about the dangers of lead in this area. If you live in this area, you might want to help test water for lead.

Oklahoma Energy Resources Board (OERB)

What is the history and function of the OERB?

In 1993, leaders representing Oklahoma’s oil producers and royalty owners, working with the Oklahoma State Legislature, formed the Oklahoma Energy Resources Board. Oklahoma’s natural gas producers joined soon after. The OERB’s mission is to bring the vitality, contributions and environmental responsibility of Oklahoma’s oil and natural gas industry to light through positive action and education.

By 1995 OERB had hit the ground running. It had cleaned up its first abandoned oilfield site and ran its first commercial during the Super Bowl. In addition, it also started its first educational series “Fossils to Fuel” designed to educate elementary students.

In 2013, OERB is offering eight curricula for K-12 grade students in 95% of Oklahoma school districts, and cleaned up their 13,000th abandoned oilfield site.

How does a site become eligible for remediation or clean up?

A landowner who has identified an abandoned oilfield site contacts the OERB office in Okalahoma City and gives them necessary information about the site. This includes the legal description as well as an acknowledgement that the landowner does in fact want the site restored (cleaned up).

Another way sites are found is through the Oklahoma Corporation Commission field inspectors. These inspectors find and determine sites within their area that need to be restored.

After sites are turned in by OCC inspectors or landowners, they are prioritized according to the severity of the site. Also, if a wellbore has not been plugged, it cannot become eligible until plugging has occurred. Every effort is made to determine if a current crude oil and natural gas operating company is responsible for this cleanup. If it is in fact abandoned, then it is put on a list to be restored.

To see a list of sites that have been restored or to find out more about the functions of OERB, please visit OERB’s web site at www.oerb.com.

Current Environmental Efforts by Producers of Crude Oil and Natural Gas

There are a variety of state and federal regulatory agencies that monitor the activities of crude oil and natural gas operators in the state of Oklahoma. Some of the more actively involved agencies are the Oklahoma Department of Environmental Quality (monitors air and some water), Oklahoma Water Resources Board (monitors water), Oklahoma Corporation Commission (monitors or regulates most crude oil and natural gas activities, including permits, spacing, etc.), Environmental Protection Agency (monitors or assigns monitoring of air, water and soil), National Spill Response Center (agency to report spills to), US Fish and Wildlife Service (animals and other living creatures are not damaged or harmed) and many others.

These groups ensure that the environment is taken into consideration before, during and after production.

Each of these agencies has the right to impose rules and regulations on the industry after they have been properly filed and commented on by industry officials as well as others. Some of these include the reduction of non-point source pollution through a variety of measures including silk screens, hay bales and other vegetative covers that are placed along and around the drilling or well site. Also, dikes are created of soil and other materials that prevent crude oil or salt water from being washed across the land in case of a spill.

What Happens After Production Ceases to Exist?

Because crude oil and natural gas are not renewable, after a period of time the deposits in various areas are depleted and production no longer exists. At this point, producers are asked to return the area to its natural state prior to drilling. Also, any wellbores are capped or plugged.

The steps that have been taken by producers in the last 50 years have dramatically changed the opportunity for environmental pollution to occur. We must always remember that crude oil and natural gas producers and employees drink the same water and breathe the same air that we do. Keeping the environment clean is a priority for this industry.

Mining in Oklahoma

Just as the old western movies depicted the gold rush, mining was just as exciting in Oklahoma. In various areas of the state mining was the main source of income and development of cities by growing mine camps. Mining was either underground and used donkeys to bring up the mined materials or strip mined. Strip mining uses equipment that basically removes the product being mined in sections or layers. Concerns with underground mines were commonly the quality of the air and the risk of death due to mine collapses.

Over time the products that were being mined disappeared or were never found at all in some mines. When these mines were abandoned, there wasn't any regulation in place to fill in the mine or make sure that the water and soil around the mine were not harmful to the environment or people that lived nearby. Unlike the crude oil and natural gas industry and the OERB, the mining industry doesn't have an organization in place to voluntarily clean up or restore these sites to their previous state prior to mining.

However, in areas where the contamination of soil and water is great, state and federal agencies have stepped in to help in the clean-up. Probably one of the best examples of this is the Tar Creek project near Picher, Oklahoma. This area has high levels of lead, where it had previously been mined and is still present in the soil and water in the area. It is very toxic or harmful to young children and pregnant mothers.

As the years go by this site will be restored if possible or the individuals living in this area that are at risk will be moved to an area that is not contaminated with the lead.

Unit 6
Filling Someone Else's Shoes

Introduction

In book 1, you learned a little about the areas in which you could work in Geology or the sciences. In this book, the focus will be on the number of jobs in Oklahoma and what these jobs consist of, pay, etc.

What Will I Learn?

You will learn more about specific areas of the industry and determine if any of these areas are of significant interest to you, possibly even a future career goal. In book 3, you will learn more about these careers and even how to apply to schools within Oklahoma to obtain training.

Activities

1. Find out if anyone in your family has ever been involved in oil or natural gas production or drilling. If they have, or still are, interview them and ask about what their job consisted of on a daily basis.

2. Learn a little about different opportunities that are available in the field on OERB.com/careers. Notice how some aren't actually production or drilling, but truck driving, construction, etc.

3. Participate in the job readiness contest.

Exploring Employment Opportunities

In book 1, you found out a little bit about what a geoscientist, landman, engineer and a geologist do. However, these are pretty broad categories of jobs. In addition to these job areas, there are many more opportunities for employment. Everyone has different advice for how to determine your career goals. Some people say you should do something that makes you happy or you would enjoy doing for free, but you have to make money so that you can pay for the things that come with being a grown up. It is also wise to choose a career path that has a steady employment rate.

In 2009, 1 and 6 jobs were directly and indirectly provide by Oklahoma's oil and natural gas industry. That is 344,503 individual jobs! The average salary was $113,000 per year compared to the average salary for Oklahoma of $37,000 per year.

Other job sectors that closely resemble crude oil and natural gas or mining in respect to outside work, manual labor, skill set, etc. are construction, agriculture and food processing and forestry and lumber. The jobs paid on average anywhere from $28,000 to $48,000 per year. This is still more than $65,000.00 less than the average wage of crude oil and natural gas jobs in Oklahoma.

As Oklahoma's energy industry continues to grow, oil and natural gas producers are aggressively seeking qualified professionals. From accountants to engineers to floorhands, the industry is looking for people with all types of skills.

It is never too late to start thinking about your future career and what steps you need to take in order to start preparing. There are many classes you could be taking now that will put you a step ahead of the rest and help you gain insight on what you want to do once finished with high school.

The oil and natural gas industry welcomes young Oklahomans. The future is bright and there are many jobs available for innovative thinkers and hard workers. Many scholarships are offered through various oil and natural gas companies along with internships and other opportunities to prepare you for your future. For a list of colleges in Oklahoma offering petroleum related degrees, visit oerb.com/careers.

Job Shadowing and Exploration

It is never too early to explore a job opportunity. Think of some people you know in your community that work in the energy industry. Ask if you can visit them at work and see what they do. If that isn't a possibility, see if you can interview them or talk with them about what they do on a daily basis. Ask what subjects were the most helpful to them in school that they use daily in their job. If you know several people that do different things, don't be afraid to talk to more than one. It doesn't hurt to look at more than one option within the energy career cluster.