



<b>Title:</b> Digging Into Energy from Arkansas Rocks--A Unit for Discovery	
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<b>Course:</b> Science <b>Grade Level:</b> 3	<b>Duration:</b> 5 to 7 – 45 minute class periods
<p><b>Objective:</b> The student will be able to differentiate between the three categories of rocks and discuss the energy found in a specific type of sedimentary rock called shale. In addition they will learn the types of drilling methods employed to extract the energy resources from this type of rock. They will learn more about oil and natural gas production from experts who visit the class or from online experts who answer student’s questions.</p>	
<p><b>Summary of Lesson:</b> This unit consists of a five part scaffold to teach students the three categories of rocks and then requires students to take a closer look at one of those categories – sedimentary rocks—by making their own model of a sedimentary rock. Once the models are made the teacher will then introduce a common sedimentary rock called shale and explain its link to oil and natural gas production in Arkansas. Students will interview experts about the impact of oil and natural gas production on the state and will learn more about careers in this industry.</p>	
<b>Standards: CCSS, Arkansas State Frameworks, Next Generation Science Standards, Other</b>	
<b>Code:</b>	<b>Standard:</b>
CCSS.ELA – Literacy.RF.3.	Read grade level text with purpose and understanding
CCSS.ELA – Literacy.W.3.2	Write Informative/explanatory texts to examine a topic and convey ideas and information clearly.
CCSS.ELA – Literacy.W.3.7	Conduct short research projects that build knowledge about a topic.
CCSS.ELA – Literacy.SL.3.3	Ask and answer questions about information from a speaker offering appropriate elaboration and detail.
ESS.8.3.3 – Science	Identify the three categories of rocks: metamorphic, igneous, and sedimentary
ESS.8.2.4 – Science	Identify common uses of rocks and minerals
<p><b>Teacher Excellence and Support System:</b> Domain 3 – Focus on 3a Communicating with Students, 3b Using Questioning and Discussion</p>	



Techniques, 3c Engaging Students in Learning

**Instructional Strategies and Practices:**

The lessons related to this topic focus mainly on STEM (Science, Technology, Engineering, and Mathematics)

**Bloom's Level:** (*Highest Level Only*)

Creating – design, create, invent

**Materials and Resources:**

Materials

Day 1

- Copies of Student Handout: *Lesson 1: Categories of Rocks* (See Student Handout section)
- Rock samples—sedimentary, metamorphic, igneous—enough for several students to use at once

Day 2

- Copies of Student Handout: *Lesson 2: Teach About Rocks*
- Texts, magazines or handouts with information about types of rocks
- Construction paper for each group
- Glue or tape for all students
- Markers / crayons / scissors/writing utensils for all students

Day 3

- Copies of Student Handout: *Lesson 3: Sedimentary Rocks*
- Sedimentary rock containing a fossil
- Disposable plastic gloves
- Paper towels
- Sedimentary Sandwich ingredients
  - Loaf of white bread
  - Loaf of brown bread
  - Graham cracker crumbs
  - Red jam
  - Purple jam
  - Raisins
  - Crunchy peanut butter
  - Animal shaped crackers or candy (optional)
- Plastic knives, forks and spoons—one per student
- Paper plates—one per student

Day 4

- Copies of Student Handout: *Lesson 4: Drilling for Oil and Natural Gas*
- Straws of various sizes ( regular, coffee, bendable) for all students (These might be



donated from local fast food restaurants)

- String for all students
- Popsicle sticks for all students
- Toothpicks for all students
- Classroom scale (must be able to weigh less than an ounce)
- Small paper cups for all students
- Cream -filled cupcakes, one for each student (Check with a local grocer to see if these can be donated). The cupcakes must all be the same.
- Chart for recording results of engineering design in *Lesson 4: Drilling for Oil and Natural Gas*

#### Day 5

- Copies of Student Handout *Lesson 5: Ask and Expert*

#### Resources

Computers and/or iPads with internet access

<http://www.geology.ar.gov/home/index.htm> Arkansas Geological Survey has some great resources.

[www.energy4me.org](http://www.energy4me.org) – A site with **free classroom materials** to teach about energy resources and request a classroom speaker. Features information about careers in energy; includes pre-made teacher ready lesson plans and free downloadable/printable lesson materials

[www.energyfromshale.org/hydraulic-fracturing](http://www.energyfromshale.org/hydraulic-fracturing) - This site has information about shale and every step in retrieving the natural gas stored in the shale.

<http://www.youtube.com/watch?v=eOuPsJwYu9I>(**Geology Kitchen Series**) describes how sedimentary rocks are made

<http://www.youtube.com/watch?v=NygdD8uATng> describes how sedimentary rocks are made

<http://www.videojug.com/film/geology-sedimentary-rocks> describes how sedimentary rocks are made

<http://www.pages.drexel.edu/~ks73/Ediblerocks.htm> -- Pages 1-3 describe how to make an edible model of an igneous rock, pages 4-9 give instructions for making an edible model of a sedimentary rock like shale, and pages 10-13 make a metamorphic rock)

[www.chevron.com/deliveringenergy/naturalgas/shalegas/howweoperate/](http://www.chevron.com/deliveringenergy/naturalgas/shalegas/howweoperate/) -- Video of shale drilling

[www.neok12.com/Natural-Resources.htm](http://www.neok12.com/Natural-Resources.htm) -- Video of oil drilling (scroll down to watch videos; click on Offshore Drilling (2:50), and then watch Extreme Oil Drilling (3:00))

#### **EXTENSION: Game for oil drilling**

<http://www.earthscienceworld.org/games/VirtualOilWell/content/page1.htm>

#### **Formative Assessment:**

The lessons have activities, assignments or questions that can be used for exit slips or assessments. Use a question from the lesson as review to start the new lesson the following day – it's an entrance slip instead of an exit slip



### **Teaching Notes:**

All background knowledge and lesson specific notes are provided in this unit. Each lesson builds on previous lessons thereby providing all necessary information as students move through the unit.

#### Background:

Rocks come in all kinds of colors, shapes and sizes, but geologists can organize them into three basic categories—sedimentary, igneous and metamorphic. They classify them based on how they were formed.

**Igneous rocks** are formed from melted rock that has cooled and hardened. When rocks are buried deep within the Earth, they melt because of the high pressure and temperature; the molten rock (called lava or magma) can then flow upward or can be blown out from a volcano onto the Earth's surface. There are two basic types of igneous rocks. There are the rocks that make it to the surface (extrusive) and the ones that are stuck in the crust just below the surface (intrusive). Geologists describe different igneous rocks according to their texture and composition

**Sedimentary rocks** are formed at the surface of the Earth from particles of sand, shells, pebbles, and other fragments of material. The particles are pieces of a different, pre-existing rock that have been weathered and transported by wind, water, ice, or gravity and accumulate in layers. Over long periods of time, the layers are compressed and harden into rock. This process can take place in water or on land. Generally, sedimentary rock is fairly soft and may break apart or crumble easily. You can often see sand, pebbles, or stones in the rock. It is usually the only type that contains fossils. Chemical sedimentary rocks form from minerals that have been dissolved in water and settle out, forming a solid rock. Geologists describe sedimentary rocks according to the size and shape of the particles in them or their mineral composition (in the case of chemical sedimentary rocks).

Some sedimentary rocks contain fossils. Fossils are the remains or imprints of once living organisms. These remains often get trapped in sediment and as layers of sediment form atop one another a fossil is embedded in the rock. Look at the sample sedimentary rocks at your table that contain fossils. Discuss within your group how you think those fossils were formed.

Shale is the most abundant type of sedimentary rock and is found worldwide. In Arkansas, we have two areas of shale where natural gas is found - the Arkoma Basin in western Arkansas and eastern Oklahoma and in The Fayetteville Shale which covers ten counties from western to eastern Arkansas. Millions of dollars of natural gas is produced in Arkansas every day. In fact, Arkansas now ranks as the 8th leading natural gas producing state in the US.

**Metamorphic rocks** get their name from "meta" (change) and "morph" (form). These rocks are made up of igneous and sedimentary rocks of all ages which have been exposed to intense pressure and heat, usually under the surface of the earth. The rocks that result from these processes often have ribbon-like layers and may have shiny crystals, formed by minerals slowly



growing on their surface over time,. Even though heat is involved, they didn't start off as molten rock. However, you can often find metamorphic rock near volcanoes and sources of super-hot rock. Geologists classify metamorphic rocks according to how much they have been changed from the original, or parent, rock.

The rocks of Earth's crust are constantly being recycled and changed into new forms through geologic processes. This continual transformation of rocks from one type to another is called the rock cycle. Through processes such as weathering, heating, melting, cooling, and compaction, any one rock type can be changed into a different rock type as its chemical composition and physical characteristics change.

In Arkansas, we drill for oil and natural gas and have for many decades. Shale in southern Arkansas is rich in oil, some of which they have been able to extract through vertical drilling – that is drilling one straight, vertical hole and pulling from the shale at the point where the hole was drilled. Vertical drilling is also used to extract natural gas in Arkansas' Arkoma Basin, which is located in northwestern Arkansas in Crawford and Sebastian Counties.

A newer, more technologically advanced method is called horizontal drilling. This method drills a vertical hole, then has a special drill bit that is able to do a ninety degree turn and then drill further in a horizontal line. After this path is drilled, a process called hydraulic fracturing takes place. In this process, the drill bit is removed and another tool places small charges at certain segments in the path. These charges are then set off and create cracks in the surrounding shale. A plug is placed after each charge to hold the natural gas in until all fracturing has concluded. At that point, the plugs are all removed and fracturing fluid is forced at a very high rate of speed into the path. Fracturing fluid is composed of 99.5% water and sand and .5% chemicals. The chemicals, most of which are used in our homes to clean and on our bodies to clean and lubricate our skin, help in the fracturing process to clean out the drilling path and grease the path for the sand that will stay inside of the cracks in the shale to hold it open so it can release its gas into the pipeline.

Advances in horizontal fracturing over the past ten years have created what is called the “Shale Revolution” in the United States and beyond. We are now able to drill and extract both oil and natural gas from places that were thought unrecoverable previously. Therefore we are now producing more oil and natural gas in the United States than ever before in history. Horizontal drilling is preferred when possible because it creates fewer holes and disturbances to the land and a much larger volume of oil and gas can be extracted from the shale through this process. An easy metaphor would be in trying to extract icing from the middle layer of a cake. If you take a straw and poke a hole down to the icing layer, you can get some of the icing. But if you take a bendable straw and poke it down to that layer, then turn it horizontally, you can pull a great deal more icing out – a much “sweeter” way of attaining your goal!



## **Student Activity:**

### **Day 1: Categories of Rocks**

1. Before class begins, place several sets of rock samples around the room. Each set should have an example of sedimentary, metamorphic and igneous rocks.
2. Distribute Student Handout: *Lesson 1: Categories of Rocks* (See Student Handout section.) and go over the instructions with students. Show students the sets of rock samples and explain the rules for use.
3. Allow time for students to research the categories of rocks and complete question 1 on the handout.
4. As students finish the first question, have them choose a partner and complete question 2 on their handout.
5. When the pair completes question 2, they may move to a set of rocks and complete question 3.
6. Collect handouts to be used for background on Day 2.

### **Day 2: Teach About Rocks**

1. Distribute Student Handouts *Lesson 2: Teach About Rocks*
2. Organize students into groups of five. Have the groups select one type of rock to research. Using the information gained from *Lesson 1: Categories of Rocks* and other classroom resources, have students design a brochure about the rock type. The brochure must include a drawing of the rock and must include the following information:
  - what it is made of
  - where it is found ( any in Arkansas)
  - what it is used for
  - how it is formed.
3. Using the computer, their textbook, an iPad or other classroom resources, each student should write about one of the four topics listed in their handout. One member of the group will make a drawing of the rock.
4. Explain that each group will use their information to teach the class about their rock and will display their brochure on the class learning wall.
5. Use a rubric to assess the students as they make their presentations. Good examples can be found in the following web sites:
  - <http://www.ncsu.edu/midlink/rub.pres.html>
  - [http://www.readwritethink.org/files/resources/lesson\\_images/lesson416/OralRubric.pdf](http://www.readwritethink.org/files/resources/lesson_images/lesson416/OralRubric.pdf)
  - <http://ed.fnal.gov/lincon/w01/projects/library/rubrics/presrubric.htm>

### **Day 3: Sedimentary Rocks**

1. Before class begins, assemble all materials for preparing the model of the sedimentary rock: These are listed in the materials list at the beginning of the unit, in the students' handout, *Lesson 3 Sedimentary Rocks*, or on the following web site:



<http://www.pages.drexel.edu/~ks73/Ediblerocks.htm> (pages 4-9.)

2. Label each ingredient with what it represents.

WHITE SAND                      White Bread

The river washes small pieces off the surrounding rocks. These pieces of sand are carried along by the water and left on the bottom of the river.

MUD AND ROCKS                      Peanut Butter

A flood washes mud and rocks into the river.

CLAY                      Brown Bread

The river is dammed so that the water barely moves. The water no longer has the power to carry the rocks and dirt so these all fall to the bottom of the river making a layer of clay.

PLANT PARTS                      Red Jam

As the plants along the river's edge die, their remains fall into the river and settle at the bottom.

ANIMAL BONES                      Purple Jam

There are many kinds of creatures living in and around the river. When they die, their bones fall to the bottom of the river.

DUST                      Graham Cracker Crumbs

There is a drought so the area is dusty and dry. Strong winds pick up bits of dust from nearby mountainside. These fall in the river.

ROCKS                      Raisins

A part of the riverbank falls into the river, dumping lots of rocks on the bottom of the river.

(Optional:

FOSSILS                      Animal shaped cracker or candy

A large animal died and fell to the bottom of the river. Conditions were such that the carcass was immediately covered with clay and the animal was preserved as a fossil.)

3. Since students will be allowed to eat the sandwich, be sure to provide sanitary conditions for preparing their "experiment."

4. To prepare students for today's lesson, show a video from the internet or from classroom materials that explains how sedimentary rocks are formed. The Geology Kitchen video shown in the list below is excellent.

<http://www.youtube.com/watch?v=eOuPsJwYu9I> (Geology Kitchen Series)

<http://www.youtube.com/watch?v=NygdD8uATng>

<http://www.videojug.com/film/geology-sedimentary-rocks>

5. Distribute the Student Handout: *Lesson 3: Sedimentary Rocks* and an example of a sedimentary rock containing a fossil for each table group. Go over the background information with the students. Have students underline important facts. Students will refer to the rock sample as they review the background information.



6. Explain that the students will make a model of a sedimentary rock with the ingredients around the room, and then write a story about how their “rock” was formed according to how they layered their ingredients.

### **Helpful Hints**

- Check for food allergies. You can substitute cream cheese with fruit bits for the peanut butter if you have students with peanut allergies.
- To make your own graham cracker crumbs put whole graham crackers in a sealed bag and roll with a rolling pin or hit with a hammer.
- To simulate a fossil, gummy bears, gummy worms, chocolate teddy grahams or other soft animal shaped foods can be added to the sandwich. If a fossil is included, add the following ingredient(s) and description to the materials list:

#### **FOSSILS**

#### **Animal shaped candy or cracker**

A large animal died and fell to the bottom of the river. Conditions were such that the carcass was immediately covered with clay and the animal was preserved as a fossil.

- Stress that students use disposable gloves and practice sanitary handling so they may eat the sandwich when finished.
- Move around the room and ask questions about what is happening in each addition of ingredients to their sandwich. Check for understanding of the process
- Ask for volunteers to read the story of their “rock.”
- Question students about what they did and how it relates to the actual formation of sedimentary rocks.
- Collect stories to check students grasp of sedimentary rock formation.

### **Day 4: Drilling for Oil and Natural Gas**

1. Before class begins arrange the materials for the “drilling activity” on a classroom table. (See Student Handout for a list of materials) Cover the materials so that students do not see the “tools” and the “land mass” (cupcakes)
2. Prepare a certificate or some other award for the winner(s) of the engineering challenge. These can be displayed on the learning wall.
3. Go over the background information about oil and natural gas production included in the *Teaching Notes* section at the beginning of the unit.
4. Distribute Student Handout: *Lesson 4: Drilling for Oil and Natural Gas* and have students read the introduction and questions.
5. Show selected or all videos depending on how much time you have planned for the activity. (You MUST show at least one that has both oil and gas drilling or one of each process.)
6. Allow time for students to work in pairs to answer the questions on the handout.
7. Read the Activity section of the student handout with the students and answer any questions they have about how to precede with the drilling model.





8. Reveal the materials they can use and ask one person from each table to get a cream filled cupcake for each person at their table. (See materials list)
9. Give students time to plan and carry out their engineering design for “drilling” for “sweet energy” (cream filling in cupcake).
10. After all results are recorded on the class chart, determine the winning design(s) and award certificates to the winning team(s).
11. Allow students to enjoy their land mass and sweet energy sample.
12. For students who finish early or to extend the lesson, allow students to play the virtual oil well game: <http://www.earthscienceworld.org/games/VirtualOilWell/content/page1.htm>

### **Day 5**

1. Invite an expert or panel of experts who are knowledgeable about oil and natural gas resources in Arkansas to come to your class to speak. Multiple speakers can be found through the Arkansas Energy Rocks website ([www.arkansasenergyrocks.com](http://www.arkansasenergyrocks.com)), the Arkansas Oil & Gas Commission (<http://www.aogc.state.ar.us>) the Arkansas Geological Survey (<http://www.geology.ar.gov/home/index.htm>), the Arkansas Department of Environmental Quality (<http://www.aedq.state.ar.us>) or the state organization representing the oil and natural gas industry (AIPRO [www.aipro.org](http://www.aipro.org)).
2. Another option is to ask your students if they have a parent or grandparent working in the oil and natural gas industry in Arkansas who would be willing to speak to your class. If you cannot find a speaker to come to your class there are many videos on the internet to introduce the lesson and facilitate a discussion with the students. Also, you could email questions to USGS and other organizations that have experts who answer online requests for information. The websites below can guide you in your delivery of this fifth lesson.

Ask a geologist

<http://walrus.wr.usgs.gov/ask-a-geologist/>

Electrical Universe – General

<http://centerpoint.electricuniverse.com/>

National Energy Education Development Project: NEED

<http://www.need.org>

3. Have your students prepare questions for the speakers about the topics covered in the unit and others they would like answered. Also, this would be a great opportunity to have your students teach the speaker something new they learned from this unit using the brochure they created or the design plan they invented for drilling.
4. Students will take notes on the speaker(s) and write a report to summarize what they learned.
5. Ask volunteers to share one interesting thing they learned from the speaker.
6. Collect the reports and post them on the learning wall.

**See Student Handouts**

