GOVERNOR'S OFFICE OF ENERGY DEVELOPMENT

*Advancing Utah's Energy Future*

# Candy Bar Core Drilling

***Grade/Subject: 8th Science***

**Strand/Standard Standard 8.4.1 Construct a scientific explanation** based on evidence that shows that the uneven distribution of Earth's mineral, energy, and groundwater resources is caused by geological processes. Examples of uneven distribution of resources could include Utah's unique geologic history that led to the formation and irregular distribution of natural resources like copper, gold, natural gas, oil shale, silver, and uranium. (ESS3.A)

**Lesson Performance Expectations:**

- Students will learn how sedimentary layers are formed by building their own rock. They will learn how scientists test what is underground by using core samples to determine whether or not the area is good for their particular needs, whether it be drilling for energy sources, mining for minerals necessary to our everyday lives, or building homes or other structures.
- Students will explore the process by "drilling" into candy bars and characterizing the "sample.".
- Students will answer questions about their observations and discuss the importance of core drilling and what minerals are found and mined in Utah.
- Students will then construct a scientific explanation for why resources such as oil are not found everywhere in the state.

**Materials:**

- A tall, thin acrylic container for creating a sedimentary rock OR a small container such as a test tube or clear plastic cup for each student.
- A variety of materials that can be used to represent rock layers, enough for each student to create their own "rock" and enough to fill the flat container used for the core drilling game. Some suggestions:
    - Flour or sugar (sugar can be colored with liquid food coloring)
    - Brown sugar
    - Colored sand
    - Potting soil
    - Sprinkles
    - Glitter
- Plastic spoons for scooping the rock material

**Candy Bar Cores**

- Mini candy bars that look similar from the outside such as Snickers, Milky Way, and 3 Musketeers - one for each student
- Plastic gloves for unwrapping the candy
- A ziplock bag for storing the unwrapped candy
- Small paper plates for each student

- Plastic knives, one for each student or group
- Clear plastic straws cut into 3" lengths, two per student

**Core Drilling Game**

- A flat container (a metal 9x13 pan works)
- Flour, sugar, or other materials used for the Build-a-Rock activity
- Thin clear straws, three per group
- Metric rulers, one per group
- Posters of Utah's Geologic History (http://www.mapstore.utah.gov/pi054.html - One per student group)

**Time:**
Two to four 45 minute class periods, depending on which activities are done

**Teacher Background Information:**

- **How are sedimentary rocks formed?** Information on the formation of sedimentary rocks and types of sedimentary rocks can be found **here.**

- **What is core drilling?** Mineral exploration is the process of drilling small-diameter holes in the ground using reverse circulation to bring the cuttings (core samples) to the surface for analysis.. Taking **core samples** (core drilling) is an excellent and cost effective way to discover what is beneath the earth's surface without impacting the surrounding area.

- **Geologists** and engineers analyze the geological data found using these types of drilling methods. They use the analysis to make predictions about the earth's layers and the presence of certain **minerals** and fossil fuels that we use on a daily basis: everything from medicine and fuel, to computers and cell phones. The findings determine whether or not the land is rich in mineral deposits, thereby allowing companies to strategically mine for them.

- **Why is core drilling done?** There are many reasons why scientists want to know what is beneath the earth's surface. Engineers must check the composition of the earth so they can design properly supported structures. Companies also want to identify and/or quantify a resource before they spend time and money drilling or mining for it. Natural resources inside Earth known as **fossil fuels** are used as energy sources, which are converted into electricity, gasoline, and heat. Utah has many fossil fuels available to create these types of energy: coal, petroleum, natural gas, and several others. Currently, drilling occurs in counties such as Uintah, Duchesne, Summit, Carbon, Emery, Grand, Wayne, Garfield, San Juan, and Kane. Carbon, Uintah, and Emery Counties have many wells and mining sites. Kennecott copper mine, located 28 miles southwest of Salt Lake City, is the largest mine in Utah and has been in production since 1906. Kennecott and other sites provide jobs and economic benefits to the counties in which they're located.

**Student Background Knowledge:**

- Students need to know that there are 3 types of rocks. Igneous rocks are rocks that formed from the cooling of molten rock inside the earth or on the surface. Metamorphic rocks are formed when rocks are altered through exposure to heat and pressure or by chemical means. Sedimentary rocks are formed from sediments, or small pieces of rock. More information can be found here.
- Students need to know what a mineral is. A mineral is a naturally occurring, inorganic, pure substance with a crystalline structure. More information can be found here.
- Students need to know what a natural resource is. A natural resource is a material or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain.

**Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students**

**to experience the phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.**

1. **Phenomenon: The Daisy Bradford No. 3**

Read to the students the story of the discovery of oil in East Texas. As they hear the story, ask them to record three observations about it on their student sheet.

"Columbus Marion Joiner was a lawyer and legislator in Tennessee. In 1907 he lost much of his money and property in the financial crash and left for Texas to seek new fortune. He became a wildcatter. A wildcatter is someone who blindly drills wells in hope of striking oil. In the 1920s he obtained leases to drill on Daisy Bradford's farm. Others had told Joiner that the Bradford land had been rejected for oil. Wells drilled just to the east were dry. Wells drilled to the northeast were dry. Wells drilled to the southeast were also dry. Joiner drilled a well on the farm, the Daisy Bradford No.1. It had to be abandoned when broken equipment blocked the hole. He dug the Daisy Bradford No. 2. It made it twice as deep as the No.1 but was also abandoned because of broken equipment. Joiner was running out of money but he decided to drill a third well, at times burning old tires to get enough steam to keep powering the drill. Finally, in September of 1930 slurry of mud, oil, and natural gas came pouring out of the well, followed by a gusher of oil 2 weeks later. Word immediately spread and a black gold rush started as people began buying leases around the Bradford farm. Wells dug to the west and north of the Daisy Bradford No. 3 were successful including one that produced 22,000 barrels of oil a day!"
Source: https://aoghs.org/petroleum-pioneers/east-texas-oilfield/

Ask the students to explain what occurred in the phenomenon story. Record three questions they have about it.

Choose from the following activities to help students explore how sedimentary rocks are formed, how we learn about the rocks that are buried below the ground, and why oil isn't found everywhere.

2. **How are layered rocks in the earth's crust formed?**

Put together a slideshow of pictures that could have come from four or five different events. Include one to five photos of each event. The photos from each event should be grouped together but none should be labeled. Tell the students to imagine that they found a box in their grandparents' house while exploring one day. When they opened the box they found a stack of photos. Tell them you are going to show them the photos they found in the order they were removed from the box. They will need to record all the different events they see in the photos. Discuss the results. How many events did they identify? Why did different students come up with a different number of events? Which event do they think happened first? What assumptions did they make? If they don't think of it, ask if the order the photos were placed in the box might be related to the age of the photos.

Show the students a photo of a cliff face or road cut that has many rock layers. Ask the students how this photo could be related to the photo box activity. Discuss how each rock layer is like a photo that tells what the earth was like at that point in time.

**Build-a-Rock**

Students will build their own layered rock. You can do this as a class with a single tall thin tank or individually in test tubes or clear plastic cups. Provide the students with a variety of materials with different properties, such as flour or sugar (can be colored by mixing drops of liquid food coloring into the sugar), small gravel, brown sugar, sand, potting soil, sprinkles, glitter, etc. Tell the students how many layers their rock should have. Allow each student to decide what rock layers they will include and what substance they will use to represent each rock. They will build their rock inside

their container, draw the layers of their rock, record what rock type it represents, and then tell what the earth was like when that rock layer was formed using the key.

3. **Core Samples - What are they?**

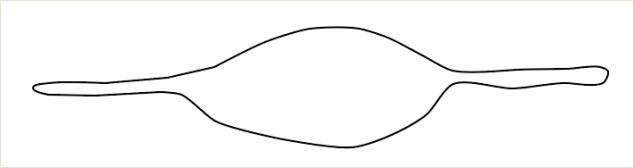
Before class use plastic gloves to unwrap enough mini candy bars so that each student in the class will have one. Use candy bars such as Snickers, 3 Musketeers, or Milky Way that look similar from the outside. Store them in a ziplock bag. Inform the students that they will each be provided with a different candy bar. Their task is to discover what kind of candy bar they have without biting, cutting, or tasting it. Ask the class to brainstorm ways this could be done. Show the students the clear plastic straws. Ask if there is a way to use the straw to discover what candy bar they have. The straw can be used to "drill" into the candy bar. Pass out the candy bar drilling student sheet and the straws and let the students take a sample of their candy bar. (You may want to have them take two samples from different locations on the candy bar and compare them.) They will draw the layers inside the straw, record the number, thickness and description of each layer, and decide what kind of candy bar they have. You may have them trade cores with others on their table and compare it to their own.

Provide each student with a picture of rock layers in Utah and ask them to compare their candy bar sample to what is in the picture. What are the similarities and differences? Provide the students with a knife to cut the candy bar in two and compare the inside with their core samples. Allow the students to eat their candy bar.

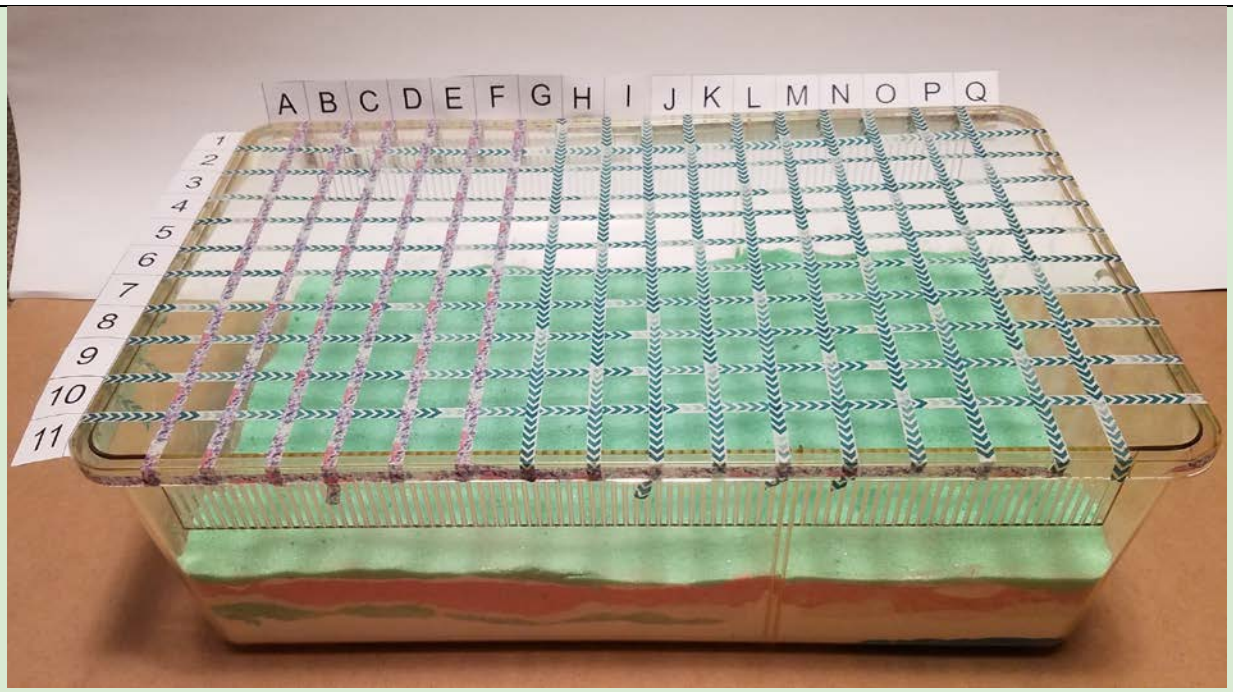
Tell the students to suppose that there is a place where geologists want to know what is below the surface of the earth. What are some ways they could find out? Discuss what a core sample is. Show a picture of one if possible. Geologists can drill down into the earth and pull out a cylindrical slice of rock. Why might geologists want to do this?

4. **Wildcat Core Drilling Game**

Before class, prepare several distinct "rock layers" in a flat container using flour, sand, sugar or any of the materials the students used to build their rocks in the Build-a-Rock activity. Make the layers uneven; some should spread across the whole pan but others could be localized. If you are using sand or sugar it is best to put a layer of a finer powder such as flour in the base of the pan. This will help hold the other layers in the straw when they take their core samples. In a few places in the tray, hide lenses of brown sugar between some of your layers. The lenses should be much thicker in the middle like in the drawing below.



None of the brown sugar layers should be visible from the outside of the container. Make a grid across the top of the pan using thin Washi craft tape and then assign each row and column a number or letter like a Battleship board.




Tell the students that they are prospectors looking for oil below the ground. They will be “wildcatting” or taking cores to look for oil without having any proof that there is oil below the surface. Tell the students that the oil is represented by brown sugar. Divide the students into teams and provide each team with three clear straws that they will use to take cores within the “rock”. Their goal is to find the thickest oil bearing rock. One at a time the teams will send one student up to take a core. They will need to record what area in the pan they took the core from and they are not allowed to drill a grid that another team has already drilled. They will take their core sample back to their group where they will analyze it by recording the layers, including any oil bearing layers (the brown sugar). Record how many millimeters of oil bearing rock they found. After each team has had one turn you may want to suggest that sometimes layers are thinner on the edges of a deposit. Finding a thin layer may lead you to a thicker layer. After each team has taken three turns, have each team add up their total thicknesses of oil bearing rock. The team with the most millimeters of oil bearing rock is the winner.


Class discussion: How did the game compare to real-life examples? What resources are mined in Utah? Which are found using core samples?

5. **Why is oil found in some places in Utah but not others?**

Draw or print a blank outline map or physical map of Utah. Post it on the wall where the students can reach it. Provide each student with photos that show Utah through time. An example is Utah: A Geologic History From Paleozoic to Present available from the Utah Geological Survey bookstore. Ask the students to look at the pictures to decide where they think oil is found in Utah today. Once they have decided they will mark their choice on the Utah map. Show the students a map of the oil fields in Utah. Were their predictions correct? Discuss why oil is found in these locations but not others.

**Assessment of Student Learning.**

How do geologists find oil deposits beneath the ground? (*seismic survey, core drilling)*

Has oil been discovered in Utah? *Yes* Where are deposits located in Utah? *Oil located on the Colorado Plateau and Uinta Basin of eastern Utah.*

Explain what causes natural resources to not be found evenly across the state. Cite evidence from specific resources to back up your claim. *The resource must first be formed in a location by a specific geologic process and then, over time, be found close enough to the surface to extract.*

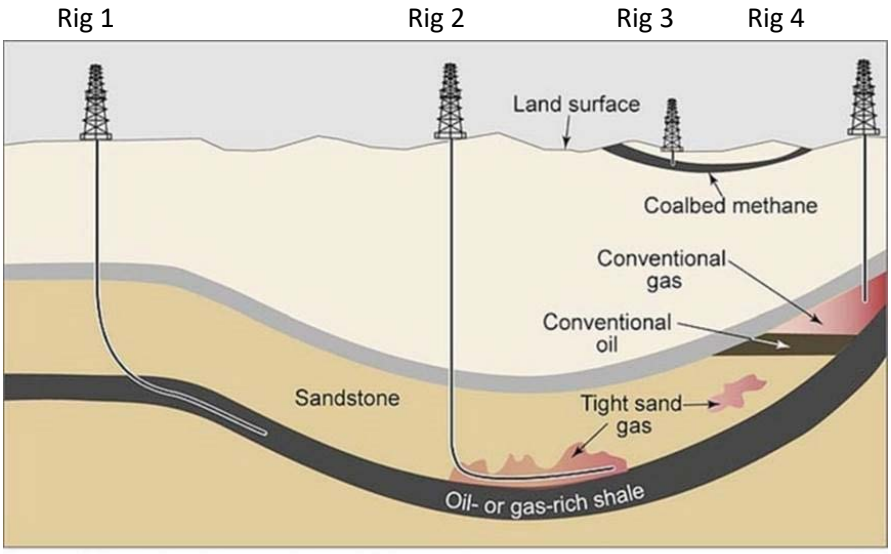
**Standardized Test Preparation:**

**Candy Bar Core Drilling**

1. What information does a core sample provide to geologists? Choose all that apply.
    a. What types of rock are located in the depth sampled.*

b. Where to take the next core sample.
c. If oil was formed in the area.
d. If oil is located in the depth sampled.*

Cross Section of Shale Bed




Sources: U.S. Energy Information Administration and U.S. Geological Survey.

2. Which cross section represents a core sample taken near Rig 2?

A. *  B.  C.  D. 

3. What evidence shows that the sedimentary layers have been altered?
a. There are three types of rock.
b. The rock layers have been deformed.*
c. The oil is found in the sandstone layer.
d. The layers have the oldest rock on the bottom.

4. Why are natural resources, like oil, only found in some places? Choose all that apply.

a. People have not looked everywhere to find them.
b. Resources only form under certain conditions.*
c. Rock layers containing resources must be near the surface.*
d. Resources have been used up in many locations.

**Extension of lesson and Career Connections:**

1. Boart Longyear and Major Drilling are two companies that perform drilling operations in Utah. Research some jobs that would be required to work on a project that uses core drilling (**Geologist, Geotechnical engineer, core drill operator, mining engineer**, etc.); interview someone who works there via video chat. This could also be an individual student or group assignment; in that case, ask the students to share their findings with the class.
2. Utah has led Forbes Magazine's list of Best States for Business every year since 2010 with one exception, coming in after Virginia in 2013 (Source: *Forbes Magazine*). In addition, Fraser Institute's 2015 Survey of Mining Companies ranks Utah in the top 10 globally as the most attractive place to mine (Source: Fraser Institute). What are some reasons that Utah is such a good place for a company to do business? How does this relate to the mining and energy industries, workforce development, and Utah's economy?
3. After playing the core sample game, ask the students to pool their data of the locations of the oil bearing rock and create a map of their "oil field". You may also have the students draw a simple stratigraphic column based on their drill core and correlate the columns from different areas of the tray.

# Candy Bar Core Drilling

Name: _____

**Phenomenon: The Daisy Bradford No. 3**

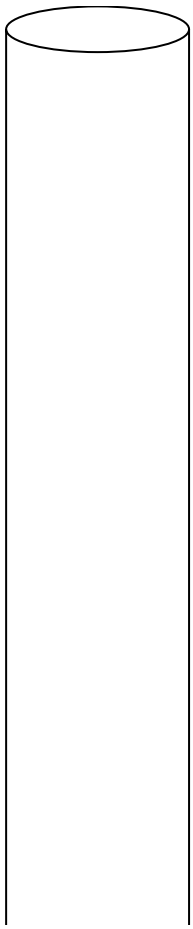
| | |
|---|---|
| After experiencing the phenomenon, record three observations about what occurred. | |
| | |
| | |
| Draw or explain what you think is causing this phenomenon. | |
| Ask three questions about what is causing the phenomenon. | |
| | |
| | |

**Photo Box**

| | |
|---|---|
| As you watch the slideshow, list all of the events that you think are being shown by the photos in the order in which they occurred. | |
| Most Recent Event<br><br><br><br><br><br>Oldest Event | |
| What assumptions did you make? | |

| |
|---|
| Explain how this relates to rock layers. |
| |

**Build-a-Rock**

| Draw your rock here. | What substance did you use for this rock layer? | What rock type does it represent? | Why did you choose this substance to represent this rock? | Draw a picture of what the land would have looked like while this rock was being created. |
|---|---|---|---|---|
|  | | | | |
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|---|---|---|---|---|
| | | | | |

**Candy bar Drilling**

| Carefully drill into your candy bar using the straw. Draw the layers in the straw in the space below. | | | |
|---|---|---|---|
| Draw the layers of your sample. | Thickness | Texture | Other Observations: what is it made of? |
| | | | |
| | | | |
| | | | |
| | | | |

| | |
|---|---|
| Which layers of your candy bar were made first? | |
| What kind of candy bar do you think you have? | |
| What is your evidence that it is this candy bar? | |
| How does your candy bar sample compare to the rocks in the picture you have been given? | |

**Wildcat Oil Drilling - Game Card** **Group Number: _____**

| Core # | Name of your well: | |
|---|---|---|
| Draw the layers in this core. | Describe the layers you see. | Total millimeters of oil bearing rock. |
| | | |

| Core # | Name of your well: | |
|---|---|---|
| Draw the layers in this core. | Describe the layers you see. | Total millimeters of oil bearing rock. |
| | | |

| Core # | Name of your well: | |
|---|---|---|
| Draw the layers in this core. | Describe the layers you see. | Total millimeters of oil bearing rock. |
| | | |

# Additional Materials

**Build-a-Rock Key**

| Type of rock | Material used to represent this rock. | Environment where this rock is deposited. |
|---|---|---|
| Sandstone | | Beaches |
| Limestone | | Deep oceans |
| Mudstone | | Tidal Flat |
| Shale | | Continental shelf |
| Coal | | Ancient swamps |
| Coquina or fossiliferous limestone | | Beaches or coral reefs |
| Cross-bedded sandstone | | Ancient sand dunes |
| Conglomerate | | Base of mountain ranges |
| Salt | | Evaporated water such as restricted lakes, bays or lagoons |
| Freshwater limestone | | Lakes |
| Freshwater shale | | Lakes |