



**Fossil Fuels and
the Carbon Cycle**

**The Science of Global
Atmospheric Change:
Activity 4**

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Fossil Fuels and the Carbon Cycle

The objectives of this activity are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. "Fossil Fuels and the Carbon Cycle" uses guided inquiry to provide introductory instruction related to Earth's energy and resources. In this activity, students will use a classroom model to learn how geologists locate fossil fuels. They will make predictions and observations, identify patterns, do mapping, and draw conclusions.

Concepts

- Fossil fuels are found within the Earth's crust.
- The presence of certain layers of soil and/or rock helps to predict the presence of oil.
- Our supply of fossil fuels cannot be replenished.

Student Worksheets

Student pages in the teacher's guide are provided in English and in Spanish.

Reference

Moreno N., and B. Tharp. (2011). *The Science of Global Atmospheric Change Teacher's Guide*. Third edition. Baylor College of Medicine. ISBN: 978-1-888997-76-7. Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

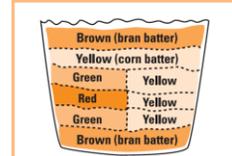
Image of coal seam in a cliff that is approximately 335 million years old © David Shand, Used with permission.
https://www.flickr.com/photos/14508691@N08/with/5187817955/#photo_5187817955

Key Words

lessons, carbon cycle, fossil fuels, global change, atmosphere, energy, coal, oil, rock, sediments, natural gas, drilling, carbon dioxide, CO₂, petroleum, crude oil, Earth, sulfur, nitrogen, diesel oil, gasoline, heating oil, methane, CH₄, gas, gases, bituminous, anthracite,

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Materials



The colored layers in the muffin represent the following.

- RED = Oil
- GREEN = Predicting layer for oil
- YELLOW = Soil or rock layer
- BROWN = Soil or rock layer



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Materials

Students may work individually or in groups.

Teacher Materials

- 24 aluminum baking cups and a cookie sheet (or 24 paper liners and a muffin pan)
- 2 envelopes of bran muffin mix (plus ingredients)
- 2 envelopes of corn muffin mix (plus ingredients)
- Green and red food coloring
- Copy of “GeoMuffin Baking Instructions” page

Materials per Student

- Prepared GeoMuffin (see Setup)
- Cotton swab
- Crayons or colored markers
- Plastic serrated knife
- Section of plastic straw, about 8 cm (3 in.) in length
- Toothpick
- Copy of “GeoMuffin Observations” page

Optional

As an alternative to baking, have students make layered GeoMuffins from clay or

modeling dough.

Setup

You will need to bake 24 GeoMuffins (see recipe, teacher's guide) in advance, using two envelopes of prepared bran muffin mix and two envelopes of prepared corn muffin mix, plus ingredients listed

on the packages. Other flavors may be substituted as long as they are different colors and contain no fruit or nuts. (The colored layers in the GeoMuffins represent the following: red = oil; green = predicting layer for oil; yellow = soil or rock layer; brown = soil or rock layer.) See the teacher's guide for full details.

Note. Cake mixes usually are less satisfactory because the baked texture is too soft.

Cut straws into 3-in. lengths for students to use.

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Image Reference

1. Illustration by M.S. Young © Baylor College of Medicine.
2. Photo by Christopher Burnett © Baylor College of Medicine.

Key Words

materials list, materials needed,

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Science Safety Considerations

- Follow all instructions.
- Begin investigation only when instructed.
- Be careful with the plastic knife.
- Do not eat your GeoMuffin.
- Report accidents.
- Wash hands thoroughly after the investigation.



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Science Safety Considerations

Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Safety first!

- Always follow school district and school science laboratory safety guidelines.
- Have a clear understanding of the investigation in advance.
- Practice any investigation with which you are not familiar before conducting it with the class.
- Make sure appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.

Safety note: Caution students to use care when handling the plastic knife, and to not eat the muffin.

References

1. Dean R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. National Science Teachers Association.
2. Moreno N., and B. Tharp. (2011). *The Science of Global Atmospheric Change Teacher's Guide*. Third edition. Baylor College of Medicine. ISBN: 978-1-888997-76-7.

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Key Words

science, classroom, safety, lab, laboratory, rules, safety signs,

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What Is in Earth's Crust?

- What do you think the people in the picture are doing?
- Who do you think they are?
- Have you ever wondered what geologists do?
- What are geologists looking for when they drill into the Earth?



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What Is in Earth's Crust?

Begin a discussion by asking students if they have ever wondered what Earth's crust is made of, or what it contains. Then ask, *What do you think the people in this picture are doing? Who do you think they are?* Tell students that the people in this picture are a type of scientist, called geologists. Then ask, *Have you ever wondered what geologists do?* Tell students that geologists drill into Earth's crust and collect samples, which they use to determine if fossil fuels might be found nearby.

Help students to recognize that fossil fuels are important resources that we use to make gasoline, plastic, fertilizer, and medicines. Tell students that they will learn how geologists locate fossil fuels by using a straw to extract core samples from a model that has different layers.

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Image Reference

Photo of a geologist examining a freshly recovered drill-core courtesy of Geoz,

released into the public domain.

http://commons.wikimedia.org/wiki/File:Exploration_geologist.jpg

Key Words

lessons, carbon cycle, fossil fuels, global change, atmosphere, energy, coal, oil, rock, sediments, natural gas, drilling, carbon dioxide, CO₂, petroleum, crude oil, Earth, sulfur, nitrogen, diesel oil, gasoline, heating oil, methane, CH₄, gas, gases, bituminous, anthracite, combustion,

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Let's Get Started

1. Complete steps 1 and 2 on the "GeoMuffin Observations" worksheet.
2. Mark "North" on your muffin with a toothpick.
3. Take your first core sample to the right of the North marker.
4. Draw and color the layers of your sample on the worksheet.
5. Take 5 more core samples and draw each one.
6. Cut the muffin in half and draw what you see.
7. Compare your drawings.



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Let's Get Started

In this activity, students will learn about the layers of Earth's crust by exploring a representative model. Each student will "drill" into his or her GeoMuffin and take core samples to identify what fossil fuels might be present. Students will learn that different fossil fuels are formed in different layers of Earth's crust.

Lead a class discussion of how fossil fuels were formed under the ground, how they are mined and how they are used. Then, show the GeoMuffins to the class. Point out that all of the muffins look the same on the surface. Tell students that the muffins have layers similar to those visible in a cross-section of Earth's crust. Explain that each student will explore a muffin to discover whether or not it holds petroleum deposits, and where those deposits might be located.

Give a GeoMuffin and a copy of the student page to each student or team of students. Ask, *What do you think the inside of the muffin looks like?* (The colored layers in the GeoMuffins represent the following: red = oil; green = predicting layer for oil; yellow = soil or rock layer; brown = soil or rock layer.)

Instruct students to draw their predictions on their student sheets without touching or removing the baking cup. Students also should predict whether or not they will find oil.

Have students insert a toothpick near the edge of their muffins to represent "North." Based on what they can observe on the top surface of the muffin, have students select and mark six places on the muffin to "drill." Demonstrate how to take a core sample by gently twisting a section of plastic drinking straw into a muffin and then pulling it back out.

Use a cotton swab to dislodge to the core by inserting it into the top of the straw and pushing the core out the bottom. Encourage students to take at least six samples, recording each sample's location on their worksheets, and then drawing and coloring the samples in order.

When students have finished sampling, recording and coloring, they should evaluate their information, looking for a pattern. Based on their cores, students should draw an estimated side view of their GeoMuffins, showing all the layers. Next, have students cut through the center of their muffins and compare the actual appearance of the muffins to their predictions.

Ask, *Did the core samples provide helpful information? Why or why not? Did you find anything to predict the presence of oil?* Mention that geologists frequently look for certain patterns of the layers in cores. Certain patterns can predict or suggest the presence of oil.

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Key Words

lesson, Earth, energy, rock layers, oil, natural gas, fossil fuels, drilling, core samples,

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Let's Talk About It

- What did the inside of the muffin look like?
- Did the core samples help you predict the presence of oil?
- What layer represented oil?
- What color layer predicted that oil was nearby?
- Does burning oil produce CO₂?
- Can we run out of oil on Earth?



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Let's Talk About It

This activity provides instruction regarding the composition of Earth's crust, and leads students to discover that Earth's crust consists of layers of soil and rock that contain fossil fuels.

When conducting the class discussion, expect a variety of answers and observations, and pose questions that encourage students to think. Ask, *How did your muffin resemble Earth's crust?* Remind students that their muffins had layers, as one would find in a cross section of Earth's crust. Ask, *Did all of the muffins look the same on the outside? What about on the inside?* Explain that although the muffins (like Earth's crust) generally looked the same on the outside, they were different on the inside.

Next, discuss the fossil fuels found in Earth's crust and the ways in which they are formed, mined and used. Remind students that geologists go into Earth to sample the soil for fossil fuels. Note that students conducted similar "sampling" in their activity using the GeoMuffin. Ask, *Did the core samples help you to predict the presence of "oil" in your GeoMuffin? What color layer represented oil? What color layer predicted that oil was nearby?*

Have students think about petroleum as a resource. Ask, *What happens when we burn products made from oil? Does burning oil produce carbon dioxide? Do you think we could run out of oil? Are there other energy sources we can use instead of oil?* Help students understand that oil and coal are resources that cannot be replaced once they have been "used up." Initiate a discussion about where oil and other fossil fuels come from. Use the "Carbon Dioxide and the Carbon Cycle" page as an overhead to help students understand how photosynthesis by ancient plants and similar organisms produced the carbon now found in fossil fuels.

Challenge students to figure out what happens to the carbon in fossil fuels when those fuels are burned (carbon returns to the atmosphere as carbon dioxide). Ask, *How might carbon dioxide production affect life on Earth?*

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Image Reference

Photo of GeoMuffin core samples by M.S. Young © Baylor College of Medicine.

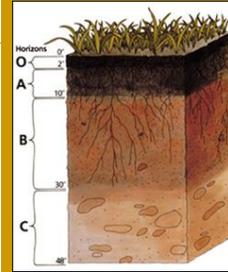
Key Words

lessons, Earth, layers, oil, natural gas, fossil fuels, drilling, core samples, CO₂, carbon dioxide, rock layers, Earth,

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The Science of Earth's Crust

- Fossil fuels are found within Earth's crust.
 - Petroleum
 - Natural gas
 - Coal
 - Other
- The presence of certain layers of soil and rock helps predict the presence of oil.
- The supply of fossil fuels cannot be replenished.



Layers of soil and rock in Earth's crust.



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The Science of Earth's Crust

Earth's crust is made of layers of rock and soil that contain fossil fuels. In this activity, students learned the following.

- **Fossil fuels are found within the Earth's crust.** Fossil fuels are remnants of ancient plants and other living things that were buried under intense heat and pressure over millions of years. Fossil fuels are very efficient sources of energy. Use of these fuels also is responsible for much of the world's air and water pollution, and has increased the levels of heat-trapping gases, such as carbon dioxide and methane, in the atmosphere.
- **The presence of certain layers of soil and rock helps to predict the presence of oil.** Geologists often drill deep into the Earth to look for fossil fuels. They remove narrow cores of rock and sediment and examine them for clues about the possible presence of oil and other fuels.
- **Earth's supply of fossil fuels cannot be replenished.** The energy in fossil fuels originally came from the sun. It was trapped by plants and organisms during photosynthesis, which is responsible for the carbon now found in fossil fuels.

Reference

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Image Reference

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http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr7/tr/?cid=nrcs142p2_047970

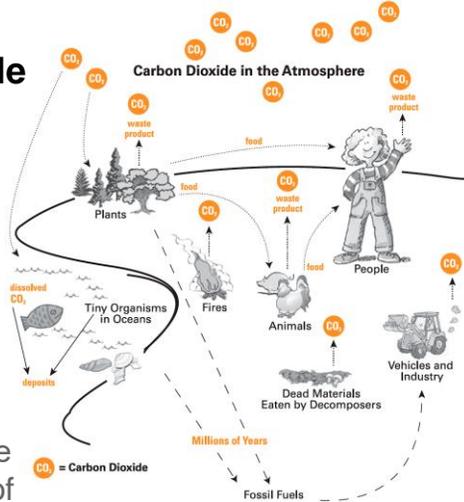
Key Words

lessons, Earth, layers, oil, natural gas, fossil fuels, drilling, core samples, CO₂, carbon dioxide, rock layers, Earth, sediment,

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Carbon Dioxide and the Carbon Cycle

- In the U.S., more than 75% of the energy used in homes and businesses, and for transportation comes from coal, oil or natural gas.
- These fuels are known as “fossil” fuels because they are the remnants of ancient plants and other living things buried under intense heat and pressure over millions of years.



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Carbon Dioxide and the Carbon Cycle

Carbon is the basic building block for many molecules in living organisms. Producers take carbon from carbon dioxide gas (CO_2) and create substances such as glucose (a kind of sugar) through photosynthesis. All other living things rely on producers for food. When food is broken down or digested, carbon is converted back into CO_2 , which is released into the atmosphere. Other processes, such as burning and decomposition, also release CO_2 back into the atmosphere. In the oceans, some carbon is incorporated into the shells of organisms and becomes deposited in sediments.

Challenge students to figure out what happens to the carbon in fossil fuels when the fuels are burned (carbon returns to the atmosphere as carbon dioxide).

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Image Reference

Composite illustration by M.S. Young © Baylor College of Medicine.

Key Words

lessons, Earth, air, atmosphere, carbon, carbon cycle, carbon dioxide, CO₂,

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Extensions

- Try to restore the “landscape” on the top of your muffin.
- Do research to find out answers to these questions.
 - How many different uses of fossil fuels are there?
 - What will happen when we use up Earth’s supply of fossil fuel?
 - How much fossil fuel remains?
 - What can we do to use these resources wisely?
- Investigate other types of Earth cycles.



Offshore oil well



Petrochemical refinery



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Extensions

•Instead of having students cut their muffins in half after making their predictions, challenge students to restore the “landscape” on the top of their muffins before proceeding with the rest of the activity.

•Ask students, *What cycles besides the carbon cycle are important in ecosystems?* Encourage students to learn about those other cycles by using resources in the library or on the Internet. For example, nitrogen is another atmospheric gas that cycles through non-living and living parts of ecosystems in many different forms.

•Have students conduct research on the Internet about fossil fuels (uses, conservation efforts and ideas, etc.)

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Image References

- 1.Photo of offshore platform located in the Gulf of Mexico © Chad Teer. CC-BY-SA 2.0. http://commons.wikimedia.org/wiki/File:Gulf_Offshore_Platform.jpg
- 2.Photo a petrochemical refinery in Grangemouth, Scotland, UK, courtesy of John. Wikimedia Commons CC-BY-SA 3.0.

<http://commons.wikimedia.org/wiki/File:Grangemouth04nov06.jpg>

Key Words

lessons, Earth, layers, oil, natural gas, fossil fuels, drilling, core samples, CO₂, carbon dioxide, rock layers, Earth, petroleum, refinery, offshore well, petrochemical,

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