The Formation of Fossil Fuels

Reflect

If you have ever walked along the bottom of a cliff, you may have noticed that the rocks form layers. Different layers may have different colors or textures. They may be made of bits of other rocks.

Rocks form layers like these over millions of years. As the layers build up, the **pressure** on the bottom layers increases. The pressure on the rocks causes their temperatures to increase as well. Sometimes, rock layers form over the remains of plants and animals. Scientists call these remains *organic matter*. High pressures and temperatures can change organic matter into three very important kinds of things: coal, oil, and natural gas.

pressure: the action of force by one object against another object

Coal, oil, and natural gas are also called fossil fuels. Why do you think this is so?

What are fossil fuels?

Fossils are the remains of creatures that lived long ago. So, fossils include organic matter buried beneath layers of rocks. A *fuel* is a source of energy. Without fossil fuels, most people could not drive their cars. They could not turn on their lights or heat their homes. This is because most of the energy needed to do these things comes from fossil fuels.

The energy in fossil fuels originally came from the Sun. Plants use the energy in sunlight to make their own food. The energy in plants passes to the animals that eat the plants. (You can learn about these processes in the lesson **Food Webs**.) Some energy remains in plants and animals that die and become fossil fuels. Burning the fossil fuels releases the energy for humans to use.

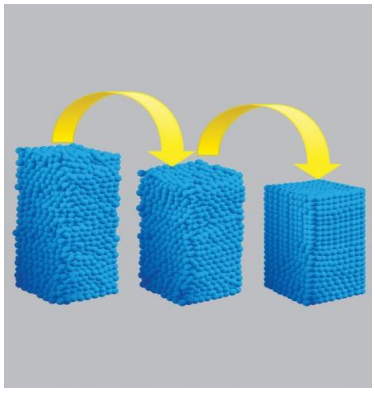
Look Out!

When you think of fossils, you might think of dinosaurs, wooly mammoths, or other large creatures that lived long ago. However, most of the fossils that become fossil fuels are the remains of much smaller plants and animals.

Reflect

What is sedimentary rock?

To understand how fossil fuels form, it is important to learn more about rocks. Most of the rocks that form layers at Earth's surface are sedimentary rocks. A *sedimentary* rock is made of bits of other rocks. Processes such as **weathering** break down rocks at Earth's surface. These bits of broken rock are called *sediments*.



Compaction happens when sediments are packed tightly together. Cementation binds the sediments together to form a rock.

weathering: the breakdown of rock into smaller particles from the effects of wind, water, and ice

Sediments form layers at the bottoms of valleys and seas. New layers increase the pressure on older layers. This pressure compacts the sediments. (During *compaction*, bits of rock are pressed tightly together.) Over time, water flows through the compacted sediments. Most of the water on Earth contains dissolved minerals. Some of these minerals stick to the sediments. Eventually, enough minerals stick to form a kind of cement. The cement holds together all the bits of rock to form new rock.

Not all sedimentary rocks form in this way. In other lessons, you will learn more about the different ways that sedimentary rocks form.

How is sedimentary rock involved in the formation of fossil fuels? How long does this process take?

The effects of pressure and temperature can change organic matter into fossil fuels. This does not happen quickly. The transformation takes millions of years.

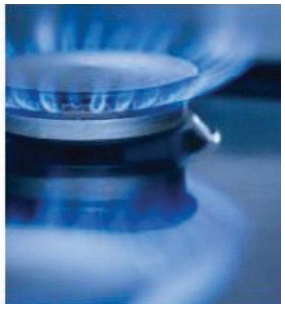
Coal forms from dead plants that sink to the bottoms of swamps. The organic matter is buried under sediments and slowly transformed into peat. If the peat is buried under more sediment, it can become coal.

Dead plants buried at the bottoms of swamps can form peat. Over millions of years, the peat can become coal.

Reflect

There are several kinds of coal. Coal that has experienced greater pressure contains more energy.

Some people consider coal to be a type of sedimentary rock. The other kinds of fossil fuels, *oil* and *natural gas*, are not rocks. They formed from microscopic animals that lived in ancient seas. When these tiny creatures died, they were buried beneath layers of sediments. The sediments became sedimentary rocks. Over millions of years, pressure from the rocks changed some of the organic matter into oil. (Another word for this kind of oil is *petroleum*.) Given enough pressure, organic matter can also become natural gas.



What Do You Think?

Heat and pressure are the two main forces that transform organic matter into fossil fuels. Can you think of other examples of heat or pressure changing one type of thing into something else? For example, what happens to dough when it is placed in a hot oven?

Career corner: What is petroleum engineering?
If you wanted to drill underground and find oil, what would you look for? Oil is not found in underground lakes filled with black liquid. Instead, the rocks in an oil reservoir have tiny holes called *pores*. Pressure from the layers of rock above the reservoir squeezes drops of oil into the pores. Petroleum engineers look for ways to remove oil from underground rocks. They test the ground to determine the best places to drill. They build pumps to force the oil to the surface. However, these methods remove only a quarter of the oil in any reservoir. How can people get the remaining oil? That's a problem petroleum engineers are still working on.

Oil drops gather in pores in rocks.

Try Now

Take some time to explore how oil droplets gather in the pores of rocks.

1. To complete this activity, you will need the following materials:
   - An eyedropper
   - Mineral oil or baby oil
   - A paper plate
   - A magnifying glass (optional)
   - Three different sedimentary rocks. One rock should have extremely small pores. Another rock should have pores that are easily visible. Limestone, sandstone, and shale are recommended.
2. Spend a few minutes observing each rock. Use a magnifying glass if you have one. Based on your observations, predict which rock will absorb the most oil and which rock will absorb the least oil. Explain your reasons for each prediction.
3. Place the rocks on the paper plate. Leave plenty of space between the rocks. Use the eyedropper to place three drops of oil on each rock. (For each rock, place all three drops in the same location.)
4. Observe whether the oil sinks into each rock or slides off the rock's surface. (This could take a while. You might want to check on the rocks every 10 or 15 minutes.) Compare your observations to your predictions.

What Do You Think?

Everyday life: What is gasoline?

Petroleum is a mix of chemicals. By breaking apart these chemicals, people can turn petroleum into a wide range of products. (This process is called *refining*. Before it has been refined, petroleum is sometimes called crude oil.) One such product is gasoline. When gasoline is burned, it expands very quickly. This expansion releases lots of energy in the form of explosions. A gasoline engine allows people to create and control these explosions. The energy can then be used to propel a car forward. Americans use hundreds of millions of gallons of gasoline each day. Nearly one-fifth of all the energy used in the United States comes from gasoline.

What Do You Think?

Looking to the future: Can we run out of fossil fuels?
It is very important for people to use less coal, oil, and natural gas. Removing fossil fuels from the ground pollutes the environment. So does burning them. But, there is an even simpler reason for people to find other sources of energy. Fossil fuels are *nonrenewable resources*. This means that we use them much more quickly than nature makes them.

Remember: coal, oil, and natural gas take millions of years to form. Yet Americans use billions of barrels of oil each year. Even if people could remove every drop of oil from the ground, eventually all the oil would be gone. You can learn about possible solutions to this problem in the **Alternative Energy** lesson.

Fossil fuels include coal, oil, and natural gas. Read the characteristics in the box below. Decide whether each characteristic describes coal, oil, or natural gas. Then write each characteristic in the correct section of the chart on the next page. Some characteristics may belong in more than one category.

Characteristics of Fossil Fuels	
• forms from organic matter buried beneath sediments • changed by high pressures and temperatures • exists mostly as a solid • exists mostly as a liquid • exists mostly as a gas	• forms mostly from plant matter • forms mostly from microscopic animals • releases energy when burned • pollutes the environment when burned • nonrenewable resource

What Do You Think?

Characteristics of Fossil Fuels

Oil	Coal	Natural Gas

Connecting With Your Child

Fossil Fuels at Home

Work with your child to determine how much your family depends on fossil fuels. A typical household will likely consider four main categories of usage:

- **Transportation:** Do you use vehicles powered by gasoline, diesel, or other fossil fuels?
- **Electricity:** Do you use electricity generated by burning coal, oil, or natural gas?
- **Heating:** Do you heat your home using appliances that burn coal, oil, or natural gas? (Some heating appliances are powered by electricity.)
- **Products:** Do you use products that are made from petroleum? Examples include polyester clothing; ballpoint pens and printer cartridges; lipstick; and sporting equipment such as footballs, soccer balls, and tennis racquets.

Instruct the members of your family to keep track of their activities for one week. Record how long you spend doing each activity that depends on fossil fuels, and try to measure how much fossil fuel is necessary for each activity. For example:

- How many gallons of gasoline are necessary to drive somewhere?
- How many cubic feet of natural gas are necessary to heat your home? (Your utility bill will likely have this information.)
- How many kilowatt-hours of electricity are necessary to run your television for 30 minutes? (The amount of fuel used to generate one kilowatt-hour of electricity equals the heat rate of the generator divided by the heat content of the fuel. You may not be able to obtain this information; regardless, the more electricity you use, the more fossil fuel is burned.)

When you have tracked your activities for one week, discuss your data as a family. Consider how you could reduce your dependency on fossil fuels. For example:

- Can you combine errands so that you make fewer trips in a car?
- Can you take public transportation instead of a car?
- Can you turn off the lights or electronic equipment when you are not using them?
- Rather than turn up the heat, can you stay warm by wearing extra layers of clothing?

Try to determine how much fossil fuel your family would save by changing your behavior in these ways. Make an effort to follow some of these strategies, and encourage your child to follow your example.