16 Rocks as a Resource

READING

HUMANS DEPEND ON Earth for many different natural resources. Many of the natural resources people rely on form as a result of geological processes that change Earth's surface. Some of these geological processes happen quickly, but many happen over geological time. This makes their supply limited. The geological processes that form some natural resources occur only at certain locations or for a limited amount of time. This makes their supply unevenly distributed across Earth's surface. Both the uneven distribution of natural resources as well as the long periods of time required for their formation are challenges people face when finding and using Earth's natural resources.

GUIDING QUESTION

How do geological processes affect where we find rock and mineral resources?

The Chino Copper Mine in New Mexico, USA, is one location where copper is taken out of the earth.

MATERIALS

For each student

- 1 Student Sheet 16.1, "Directed Reading Table: Rocks as a Resource"
- 1 Student Sheet 1.1, "Considering Where to Store Nuclear Waste"

PROCEDURE

1. You and your partner will read about three different resources that form through geological processes.
2. Read the article with your partner. As you read, record the information about each resource on Student Sheet 16.1, "Rocks as a Resource."

READING

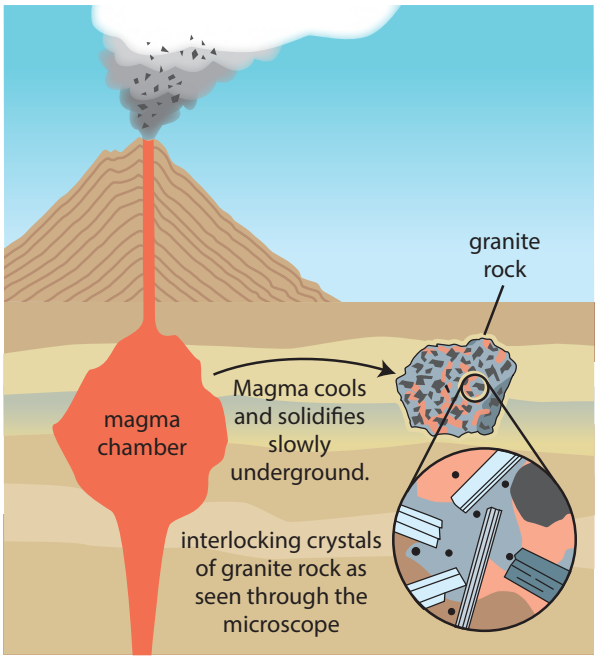
Granite: An Igneous Rock

Granite is a common igneous rock on Earth. The Appalachian Mountains and the Sierra Nevada are made mostly of granite. Mount Rushmore is made of granite as well. Granite is commonly used in counter tops, floor tiles, bridges, and statues.

You know that igneous rock forms both above and below Earth's surface. When a volcano erupts, lava cools and solidifies quickly on the surface to form igneous rock, such as basalt and pumice. Igneous rock also forms when magma cools and solidifies deep

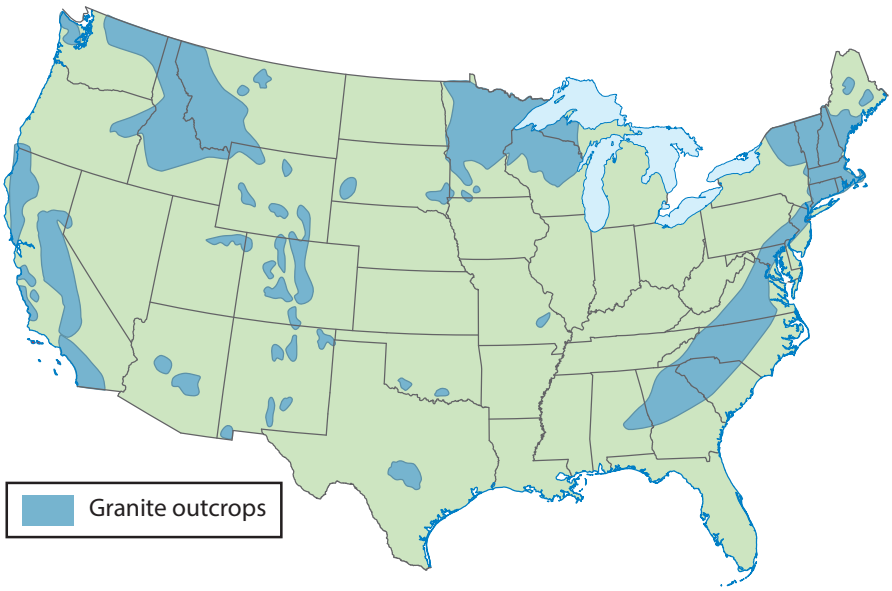
Half Dome in Yosemite National Park is made of granite.

below Earth's surface. This is how granite forms. It can take millions of years for magma to cool and solidify deep underground to form granite. This geological process happens deep below Earth's surface inside the magma chamber of a volcano.



Because granite forms very slowly, the crystals that make it up form in an interlocking arrangement, as shown in the diagram on the right. The interlocking crystals make granite hard and stable, which means it resists being broken down into sediments. The interlocking crystals make it difficult for groundwater to flow through the rock because there are few open spaces for water to flow and collect between the interlocked crystals.

Places with granite outcrops, where large sections of granite are found on Earth's surface, typically have more granite beneath them. Because of the hardness and stability of the rock, some scientists have argued that granite outcrops make an ideal location for storing nuclear waste deep underground.



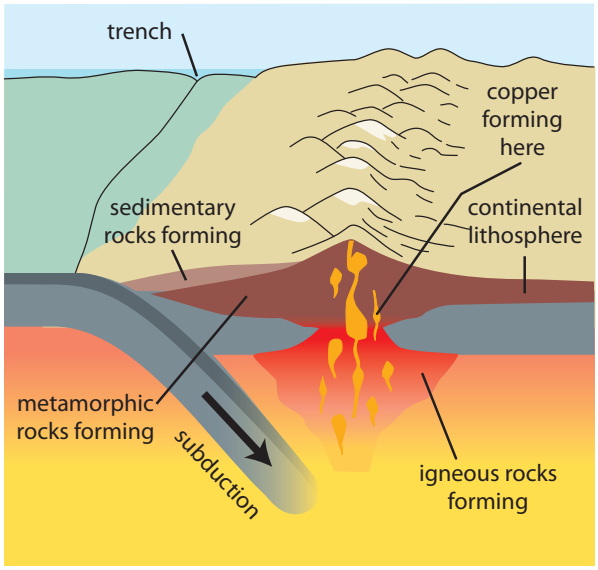
Copper: Subduction

Copper is a valuable natural resource used by humans for over 10,000 years. Today, it is commonly used in homes for electrical wiring and in pipes for plumbing.

A copper sample

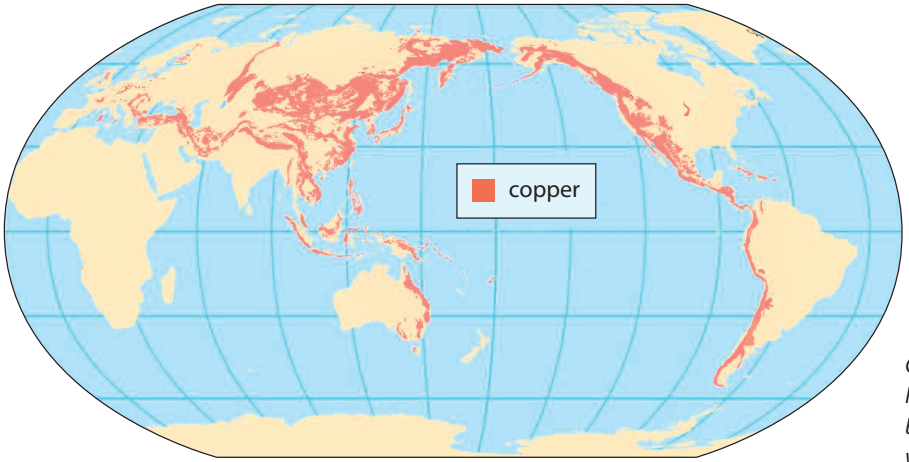
You know that at convergent plate boundaries, one plate will subduct another plate. When this happens at locations where an oceanic plate goes under another plate, it drags water down along with it as it sinks into the mantle. This water is heated by thermal energy from the mantle and seeps into the cracks in the plate above. The super-heated water melts the surrounding rock. While the rock is melting, chemicals in the rock, including copper, dissolve in the water to form a solution.

As the magma and copper solution move toward the surface, away from the source of thermal energy, it cools, and the magma solidifies into crystals. The copper solution becomes more and more concentrated as the magma cools and solidifies. Eventually, the copper solution is squeezed into the cracks between the crystals in the rock. The copper solution also cools and solidifies.



Copper is formed at subduction zones.

Over geological time, these copper-containing rocks are found at the surface. They are called *metal ores* when the amount of metal in the rock is considered valuable for human use. Metal ores can also contain other valuable metals, such as gold and molybdenum. At mines, people take metal ores out of the earth and process them for use.



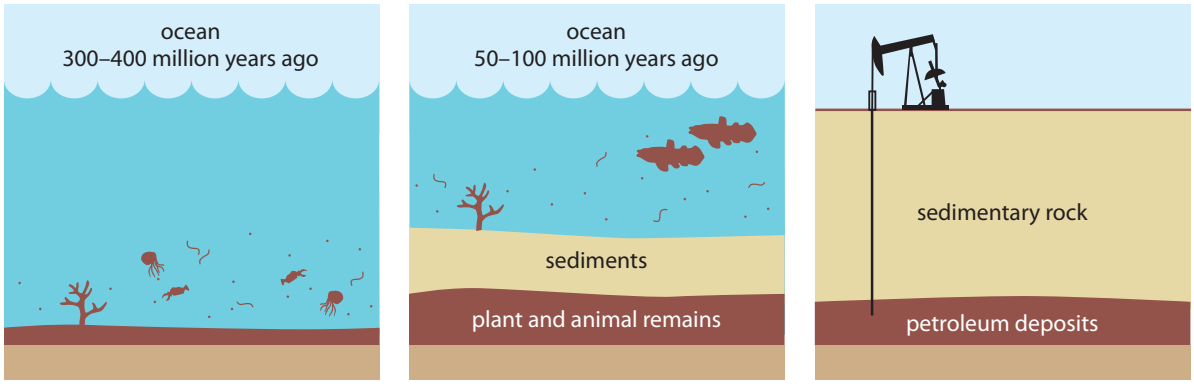
Copper deposits (highlighted in red) formed by subduction are found worldwide.

Petroleum: A Sedimentary Process

Petroleum is a natural resource that you probably use every day. Petroleum products are used as gasoline, jet fuel, and heating oil, and as raw materials to make asphalt and plastics. It is also widely used to generate electricity.

The petroleum we use now took hundreds of millions of years to form through the geological processes that form sedimentary rock. You learned in the previous activities that sedimentary rock forms from sediments. Over time, layers of sediment pile up and are buried deep underground, where they are pressed and glued together to form sedimentary rock.

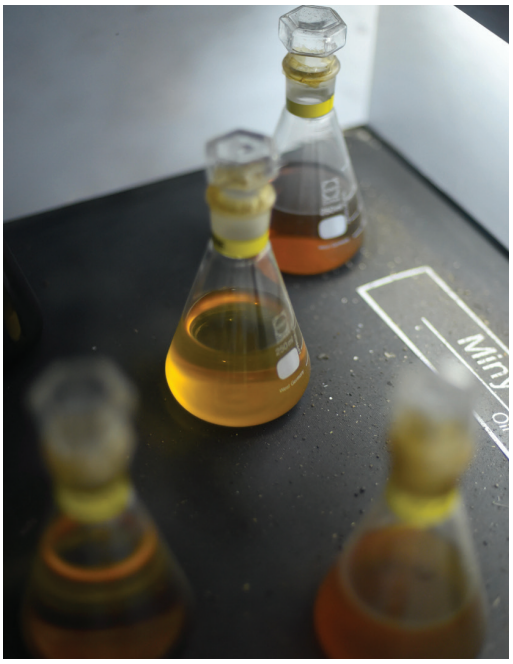
In ocean basins where there is a lot of sediment being deposited, the remains of many microorganisms are deposited with the sediments. The microorganisms, like plankton, were living in the ocean



Fossil fuels, such as petroleum, formed from the remains of ancient organisms over millions of years.

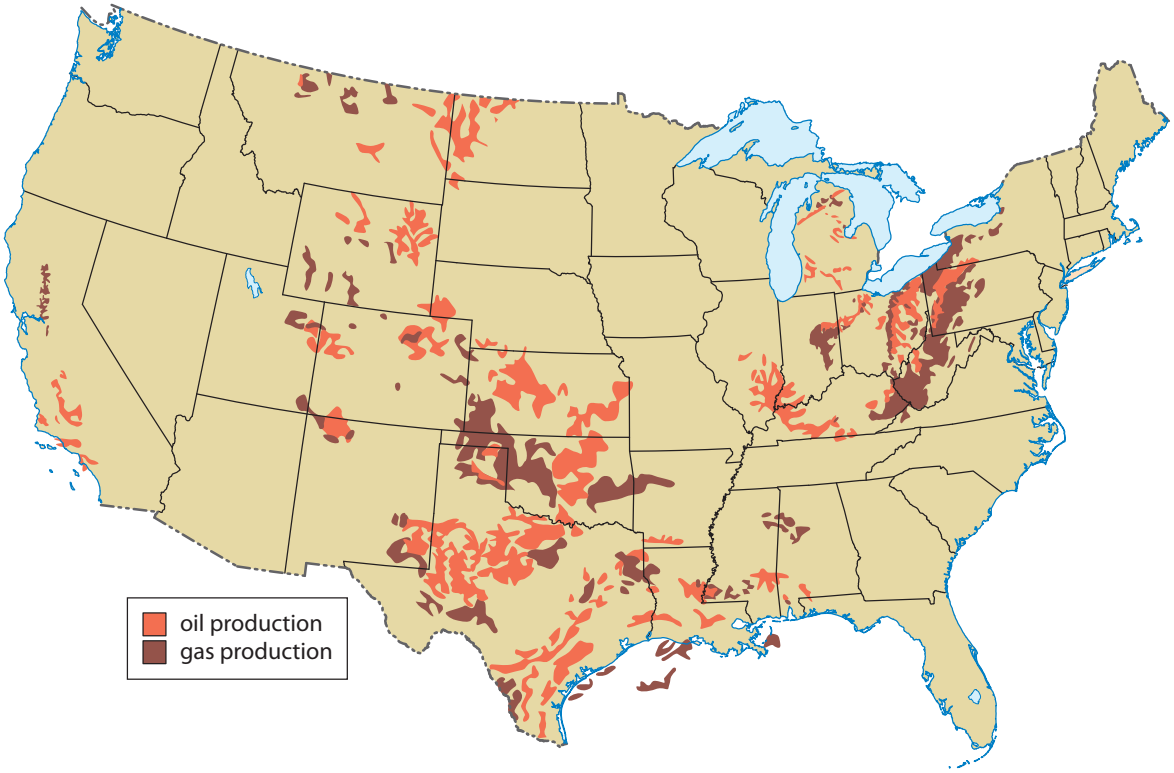
and fall to the bottom when they die. Over time, the organisms' remains are buried to a significant depth under Earth's surface where pressure is higher and temperatures are warmer (66°–177°C). When the remains are under these conditions for millions to tens of millions of years, they eventually form petroleum.

Because petroleum is made of the remains of organisms, it is called a *fossil fuel*. After petroleum is taken out of the earth, it is sent to refineries where it is prepared for different uses.



Samples of petroleum on display at a museum.

Oil and Natural Gas Production in the Contiguous United States



A map of locations where oil and natural gas production happens in the United States. (USGS. Derived from Mast, et al. 1998)

ANALYSIS

1. **Nonrenewable resources** are those that cannot be replaced faster than they are used up by human populations. Do you think the resources you read about in this activity are nonrenewable? Explain why.
2. Why aren't granite, copper, or petroleum found everywhere on Earth's surface?
3. One consideration in deciding where to store nuclear waste is the presence of valuable natural resources in a proposed location. Add the consideration "Location of Natural Resources" in a new row on Student Sheet 1.1, "Considering Where to Store Nuclear Waste." In the second column, write your recommended action to take in regard to this consideration. Explain why you recommend taking this action when deciding where to store nuclear waste.
4. Your friend tells you that we don't need to consider the location of valuable natural resources when choosing a site to store nuclear waste. After all, Earth is always changing, and the processes that create these resources are still occurring. Explain how you would respond to your friend using an example from the reading.

   In your explanation, be sure to

   - indicate whether you are writing about copper, granite, or petroleum. Describe what the natural resource is used for.
   - explain the geological processes that form your natural resource and the rate at which these changes occur.
   - describe where the natural resource is found and what that says about the geological processes that happened in that area.

EXTENSION

What kinds of natural resources, formed through geological processes, exist around your home? Conduct research to find out which resources are being taken out of the earth around you, and what geological processes created those natural resources.