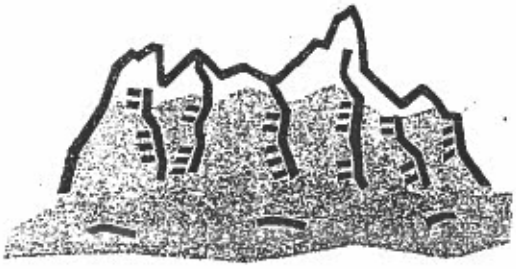
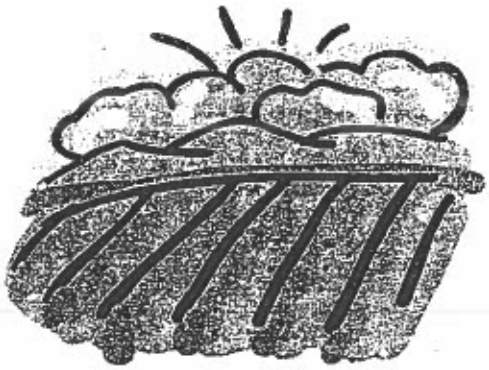
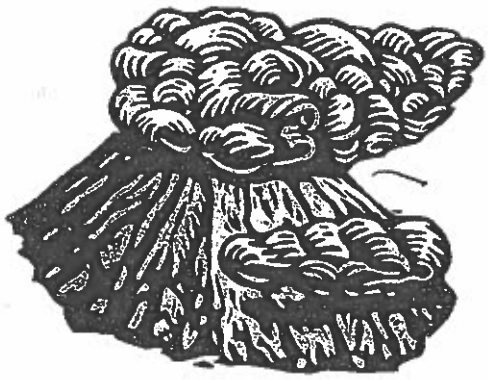


Rocks, Minerals & Erosion

Landforms

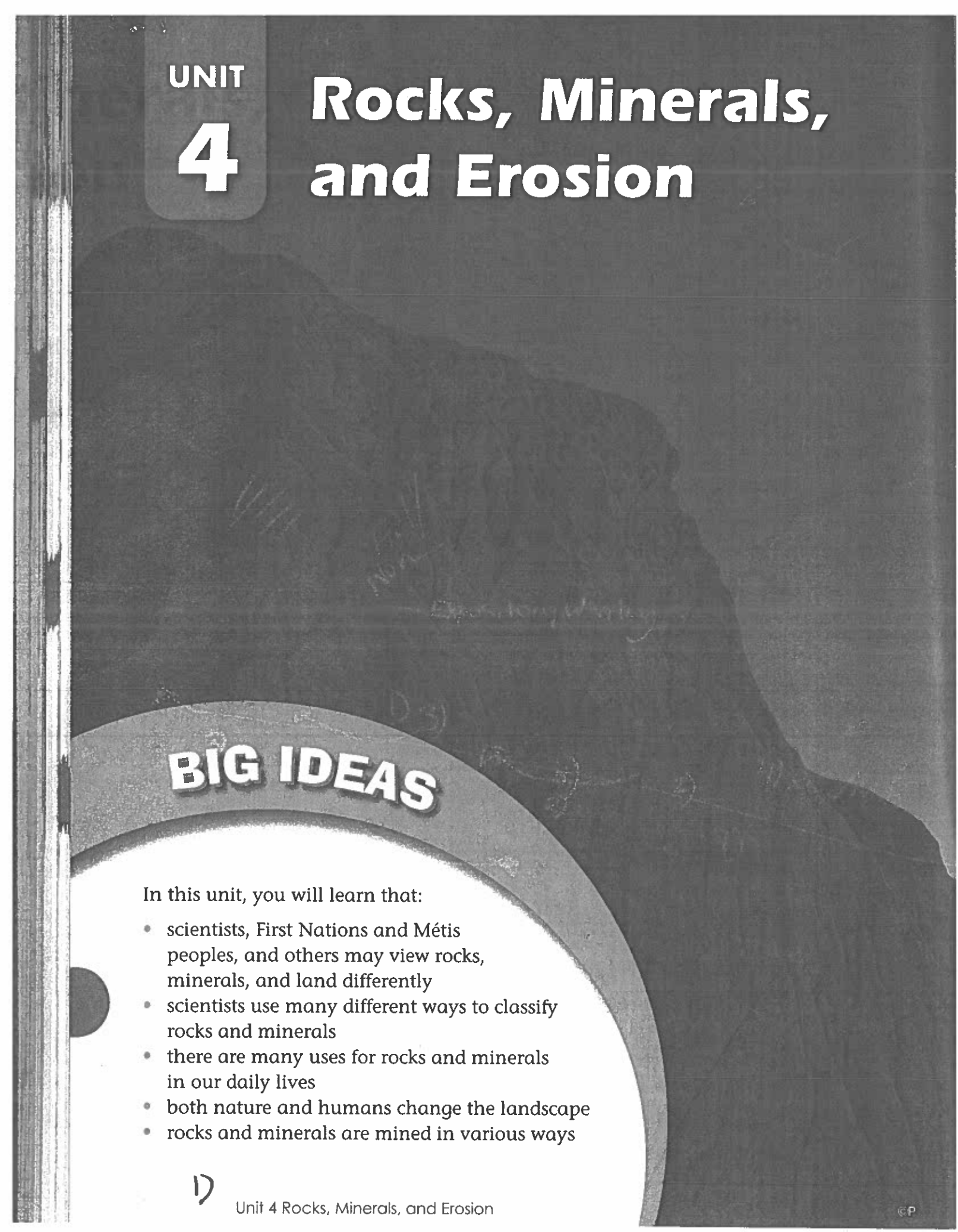


Earth Sciences



UNIT 4

Rocks, Minerals, and Erosion



BIG IDEAS

In this unit, you will learn that:

- scientists, First Nations and Métis peoples, and others may view rocks, minerals, and land differently
- scientists use many different ways to classify rocks and minerals
- there are many uses for rocks and minerals in our daily lives
- both nature and humans change the landscape
- rocks and minerals are mined in various ways

Saskatchewan has many interesting rock formations. Some of them are considered sacred. People have also used rocks to make interesting and sometimes sacred creations. Inuksuit and Medicine Wheels are rock formations made by humans. Saskatchewan also has many mineral resources. These resources are an important part of the province's economy. In this unit, you will learn how scientists view and describe rocks and minerals. You will also learn how First Nations and Métis people view nature.

First Nations and Métis people have a history and a knowing that connects them with all of creation. Many believe that rocks and minerals are alive because Spirit (a life force or energy) flows through everything in nature. Many First Nations and Métis peoples recognize Earth as their Mother. **Mother Earth** supports life and must be valued.

Looking Forward

1. Create a mind map with "rocks and minerals" in the centre. Add everything you know about rocks and minerals to the mind map. Later in this unit, you will return to your mind map and add what you have learned.

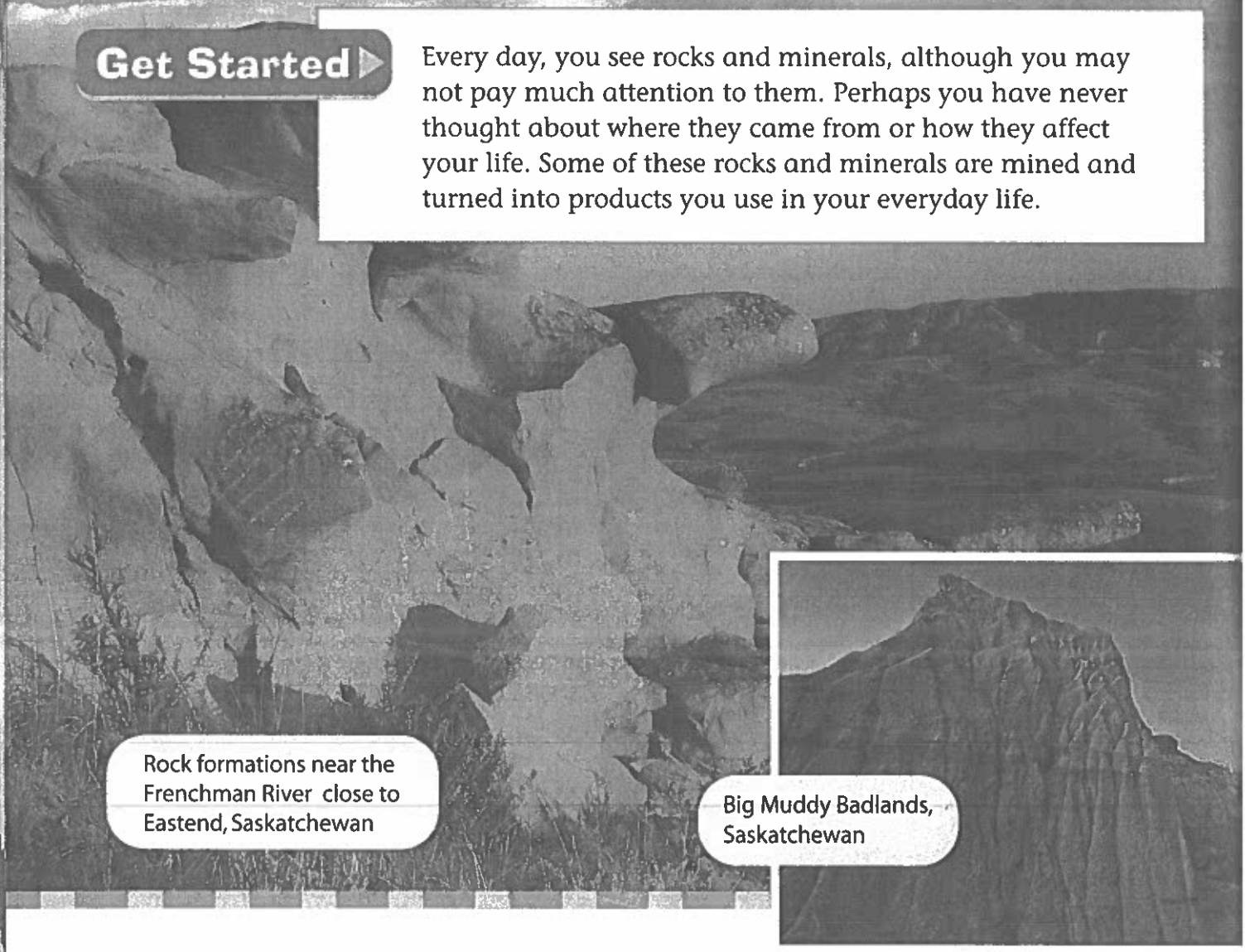
Design Project

You will complete a Design Project at the end of this unit. You will design and build a model for protecting cabins along a lakeshore from being damaged by the lake water. The *Build On What You Know* activities in this unit will help you create your model.

Amazing Rocks and Minerals

Get Started

Every day, you see rocks and minerals, although you may not pay much attention to them. Perhaps you have never thought about where they came from or how they affect your life. Some of these rocks and minerals are mined and turned into products you use in your everyday life.



Rock formations near the Frenchman River close to Eastend, Saskatchewan

Big Muddy Badlands, Saskatchewan

Work On It

1. Look at the four photos of Canadian rock formations above. In a small group, decide which two rock formations you would most like to visit. What do you find interesting about these two rock formations?
2. Do you think nature made these rock formations, or were they created by people? Give reasons.
3. With your group, make a list of places where you have seen rock formations in your community or while travelling. Why do these rock formations stand out in your mind? Include a brief description of what makes each rock formation special, and any other information that you know about it.

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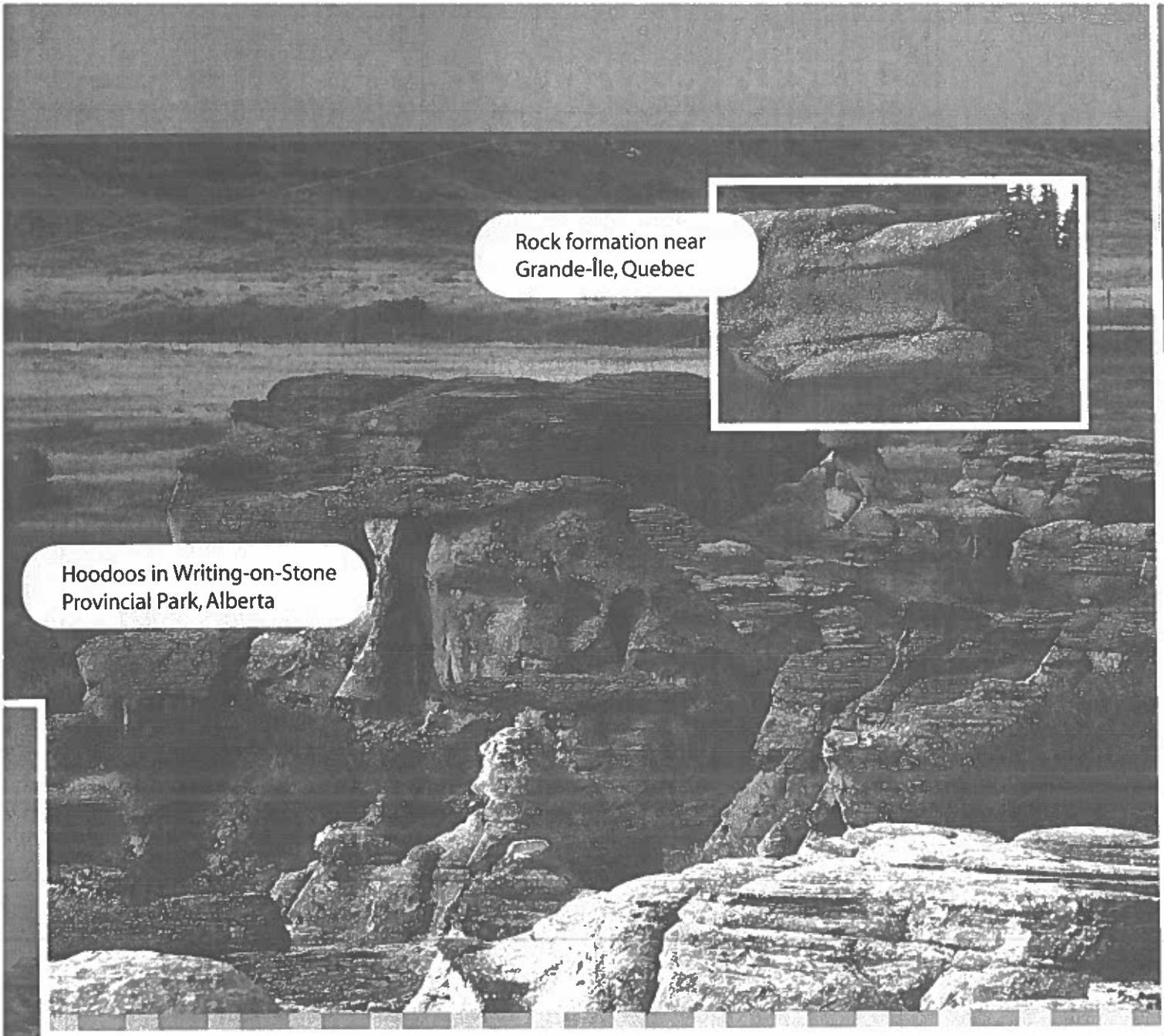


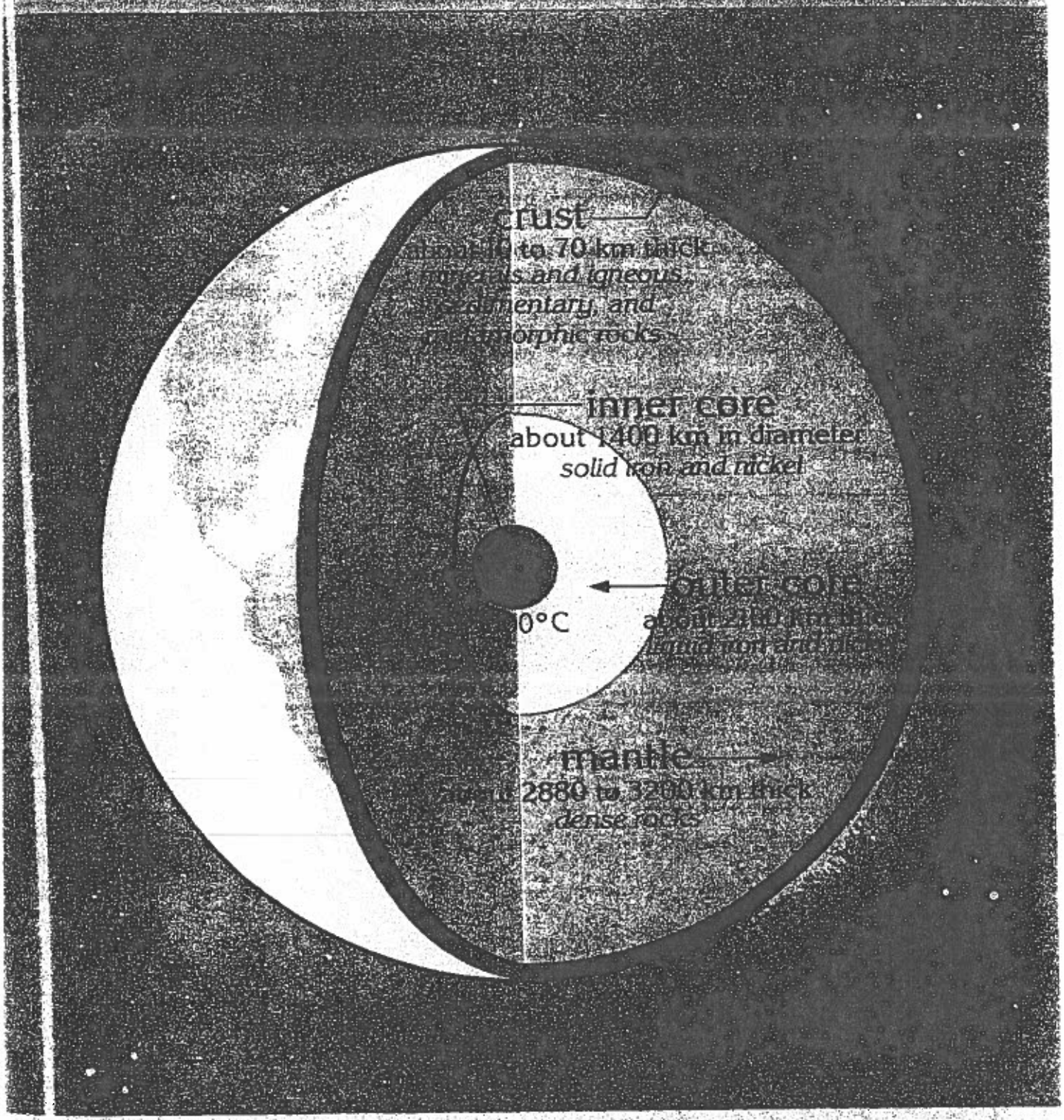
Rock formation near Grande-Île, Quebec

Hoodoos in Writing-on-Stone Provincial Park, Alberta

Communicate

1. Look in magazines or on the Internet for photos of interesting rock formations. Use the photos you find to create a poster or a computer presentation. Include the location of each rock formation and some facts about it. If any of the rock formations have special meaning for First Nations or Métis people, include this information as well. Give your poster or presentation the title "Landscapes and Rocks I Like."
2. What questions about rocks would you like to have answered in this unit? Write your questions on the back of your poster, or include them at the end of your computer presentation.

The Earth's Interior



1. Which layer of the earth's interior is the thickest?
2. Which layer is a molten liquid?

STUDY QUESTION: How is information about the earth's interior obtained?

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THE EARTH - FROM CORE TO CRUST

The Earth is made up of three layers called:

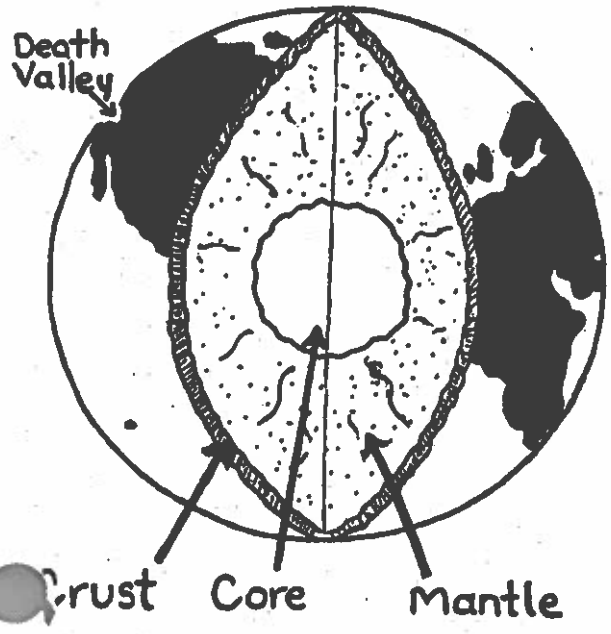
1) **core**
2) **crust**
3) **mantle.**

The core is the center part of the earth and is solid. It is made of nickel and iron.

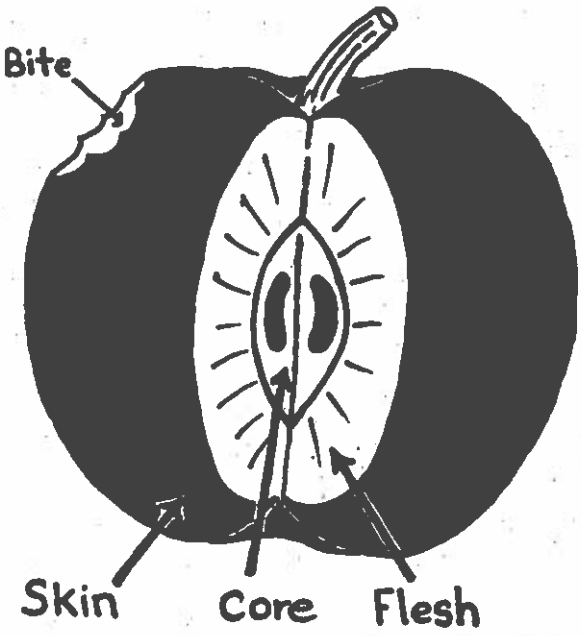
The mantle surrounds the core and is made up of melted rock called magma. The magma is hot and is able to flow like hot plastic.

The crust is a thin, cold layer of hard rock that floats on the mantle. It is the part we live on.

Earth



Apple



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The Earth's Interior

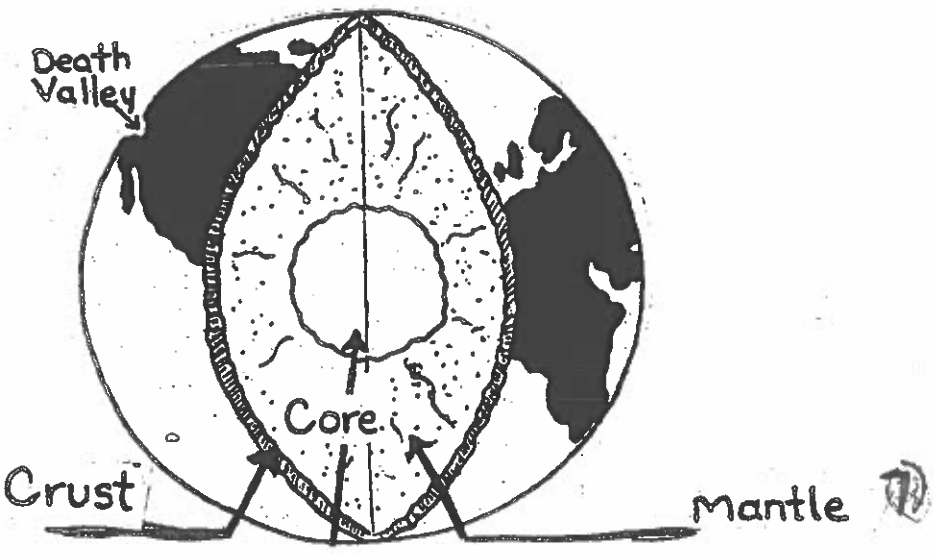
The earth's interior is made up of three main layers -crust, mantle, and core. Man's knowledge of the mantle and core is based on a theory, or ideas that cannot be proven.

The **crust**, about 10-70 km thick, is the outer layer. Soil, water, coal, petroleum, gas, rocks, and minerals are found in the crust. Granite rock makes up a large part of the crust. The **mantle**, about 2880 to 3200 km thick, is the middle layer. This layer is a dense rock layer of mostly olivine and basalt rock. Upper portions of the mantle are like liquid, allowing for the movement of large crustal plates. The movement of these plates causes earthquakes, tsunamis, volcanic eruptions, and other disturbances.

Beneath the mantle is the inner layer called the core. The **core**, the center of the earth, is about 3500 km thick. Geologists believe the core is made up of a mixture of dense molten nickel (90%) and molten iron (10%). Traveling to the center of the earth, there is a steady increase in temperature. At 30 km the temperature is about 500 C; at 100 km it is 1100 C. Geologists estimate the temperature of the mantle to be about 2000 C. The core might be as high as 5000 C. It is believed that the extreme heat is present because the materials within the earth's interior are highly compressed (squished).

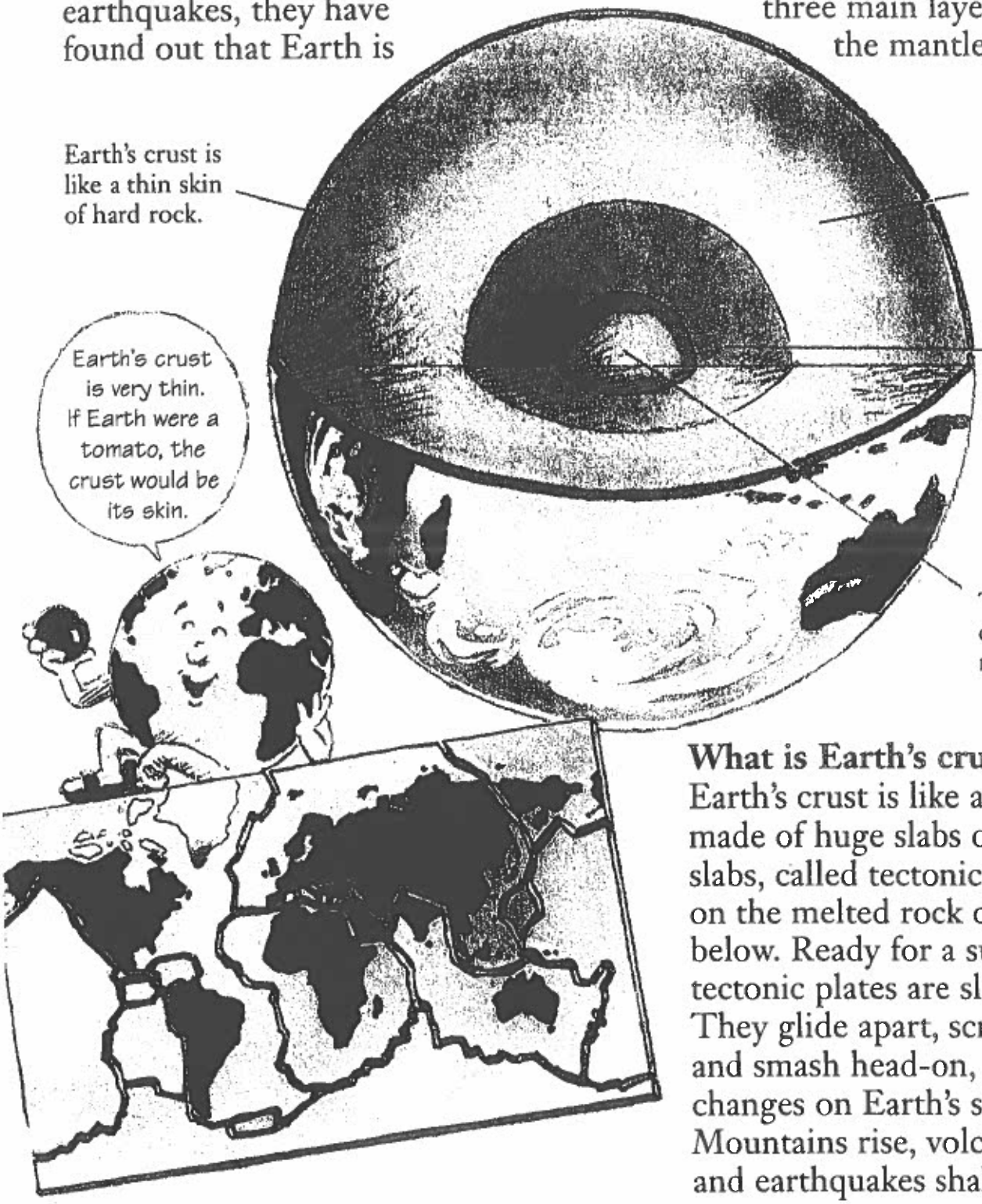
When underground water becomes superheated and flows to the surface, hot springs and\or geyser are formed. Upon reaching the surface, water in hot springs may be pleasantly warm or at boiling temperatures. Surface waters usually have a high mineral content of chlorides, sulfates, and carbonates. When water evaporates, minerals are deposited around the mouth of the hot springs, forming brightly coloured mineral deposits and rock layers. The vent of a hot spring is rather straight, enabling the water to reach the surface quickly; the vent of a geyser is narrow, curved, and twisted. Water is easily trapped, superheated, and is under great pressure when it reaches the surface.

Earth



What is inside Earth?

Since Jules Verne's time, scientists have learned a lot about the inside of our planet. By studying earthquakes, they have found out that Earth is filled with rock and metal, which become hotter and hotter towards Earth's centre. Scientists have also discovered that Earth's interior has three main layers: the crust, the mantle and the core.



What is Earth's crust like?

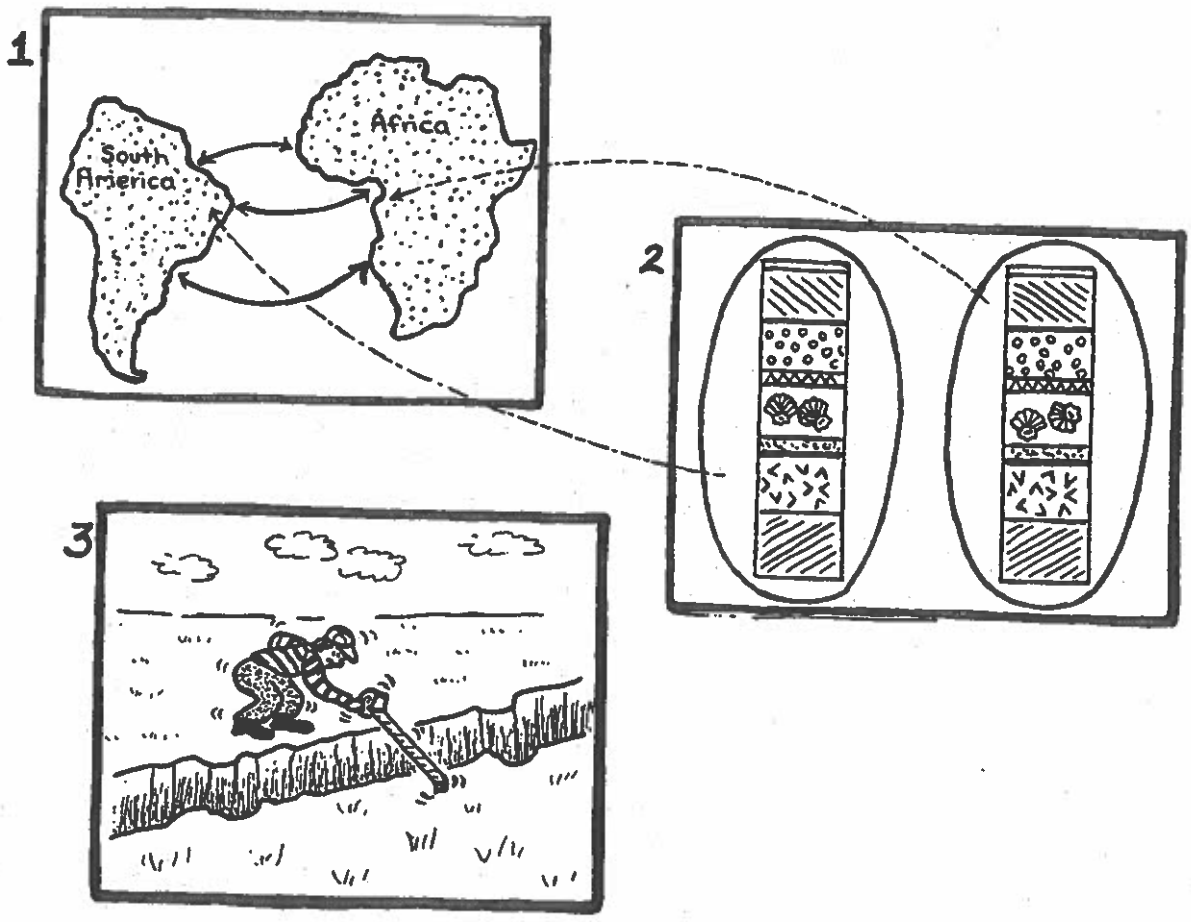
Earth's crust is like a jigsaw puzzle made of huge slabs of rock. These slabs, called tectonic plates, float on the melted rock of the mantle below. Ready for a surprise? The tectonic plates are slowly moving. They glide apart, scrape together and smash head-on, causing big changes on Earth's surface. Mountains rise, volcanoes erupt and earthquakes shake the ground.

PLATE TECTONICS

Millions of years ago all of the continents were joined together in one supercontinent called Pangea. The continents have split apart and are moving very slowly. (3-5 cm each year)

The plates sort of "float" on the squishy mantle. Three reasons we know the plates are moving are:

1) **jigsaw-puzzle effect**
2) **fossils and rocks are the same on both sides of the ocean**
3) **measuring.**



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Lesson 1

Discovering the World of Rocks and Minerals

Goal To study a variety of rocks

Get Started

To learn about rocks and minerals, you need a collection of samples. Your teacher may have a collection ready for you to use, or your class may go on a field trip to find samples. Saskatchewan has a large variety of rocks. The rocks you find may depend on whether you live in northern Saskatchewan or southern Saskatchewan. Throughout this study, try to find out which rocks are more likely to be seen in northern Saskatchewan and which are more likely to be seen in southern Saskatchewan.

Look closely at rocks to see how they differ.

Work On It

For this activity, you will go on a walk in search of interesting rocks. The right tools can help you with your search.

What You Need

- bag, box, or pail for carrying samples
- cloth, newspaper, or paper towels for wrapping samples
- safety goggles
- chisel
- rock hammer
- pencil crayons or markers
- magnifying glass
- egg carton
- camera or video (optional)

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What You Will Do

1. With your group, collect at least six samples of different types of rocks. Wrap the samples when you collect them, so they are not damaged as you carry them. When you wrap each sample, include a note about its location. You may go to a place where you are allowed to chip samples from large rocks. If so, be sure to wear safety goggles when chipping.
2. On your walk, you may see large rocks or interesting rock formations. Photograph or sketch the rock formations to keep a record of your observations. Use a magnifying glass to take a close look at rocks that are too large to collect. Make notes about what you see.
3. Place the rocks you collected into an egg carton. Assign a number to each rock, and write the number on the section of the egg carton where the rock is placed. Write the same number on the note about its location.
4. Place any photos or drawings of large rocks or rock formations in a place where they can be viewed later.
5. For the next few weeks, be on the lookout for different types of rocks. Keep adding to the class collection.

SAFETY CAUTION!

Always wear safety goggles when you chip a rock.

There are rules to follow when collecting rocks:

- Always ask permission before entering private land.
- Disturb the environment as little as possible.
- Keep away from wildlife.
- Be respectful of nature.
- Keep a record of where you found the rocks you collect. Return them at the end of your study.

Communicate

1. How do the rocks that you collected compare with the rocks that your classmates collected?
2. In books or on the Internet, find photos of rocks from other places. How are these rocks the same as the rocks you collected? How are they different from the rocks you collected?
3. What do you find interesting about rocks?

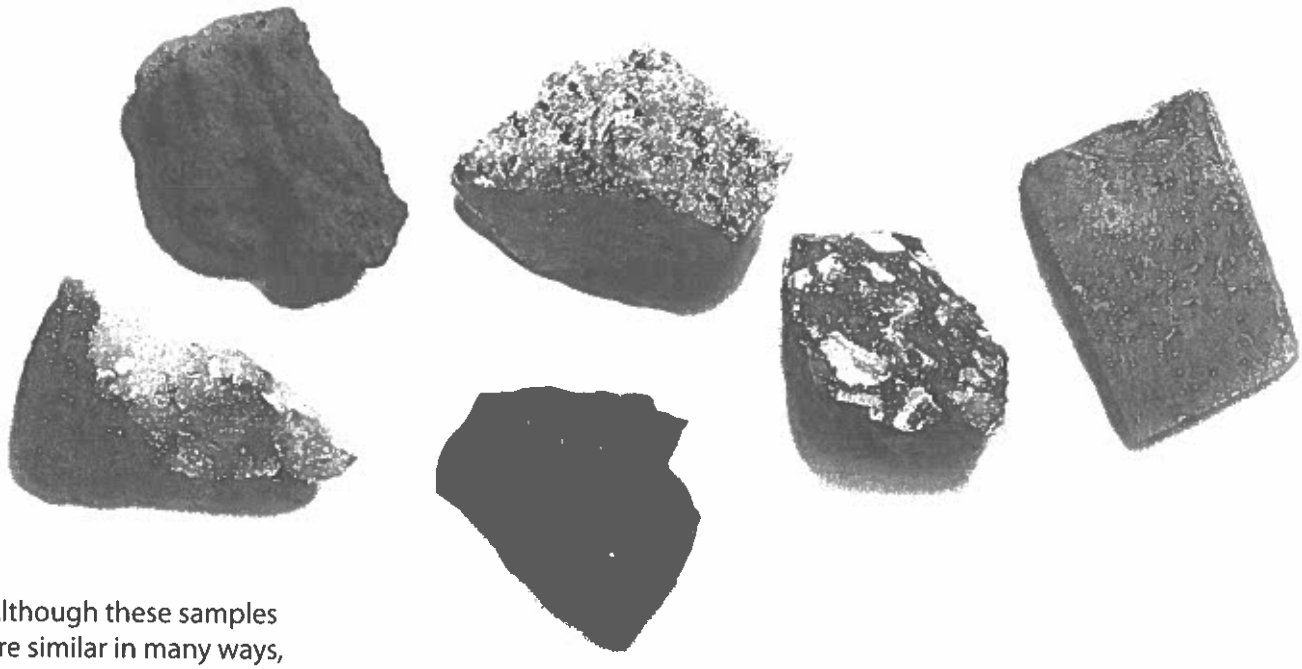
Lesson 2

Grouping Rocks and Minerals

Goal To learn about the properties of rocks and minerals

Get Started

You can tell a lot about a rock by looking at it carefully. What makes one rock different from another?



▲ Although these samples are similar in many ways, they are not exactly alike.

When you look at your rocks, there are some properties you will notice right away. A **property** is a quality that helps us identify an object. Rocks and minerals have different properties.

Properties of Rocks	Properties of Minerals
the size and shape of particles in the rock	hardness (ability to resist scratching)
the colour(s) of particles in the rock	the same throughout
whether crystals are visible	**transparency** (whether light passes through a mineral)
whether there are layers in the rock	**lustre** (whether a mineral is shiny or dull)
whether the rock breaks apart easily	**cleavage** (whether it splits apart cleanly)

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Name _____

MATTER AND PHYSICAL PROPERTIES

A **solid** is a form of matter which keeps a definite shape. The molecules in a solid are always moving, just as they are in liquids and gases. The molecules in a solid are closer together and move more slowly. Most solids have molecules arranged in patterns like crystals. That is why solids are rigid and keep their shapes. Solids can change shape by having a force act on them such as hammering, sawing, and drilling.

Solids can be described and identified by their **physical properties**: color, texture, hardness, odor, and luster (how they reflect light).

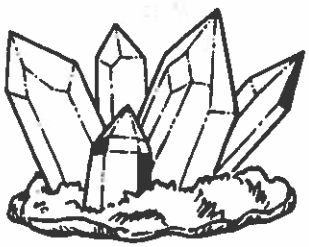
Describe a piece of classroom chalk by its physical properties.

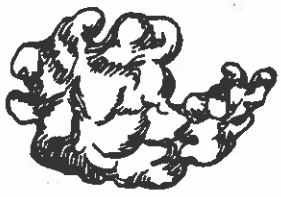
Determine those physical properties by using your senses.

solid	color	texture	hardness	odor	luster
chalk					

Choose two other solids and describe them this way.

Some physical properties of solids can be determined by using special tools and laboratory tests. A magnet can be used to find out if metals are magnetic. The melting point of a substance is a physical property. Many substances have very high melting points, which help to identify them. Substances must be heated in a laboratory to reach high temperatures. Each kind of substance has a definite specific gravity, a number which compares the weight of its volume with an equal volume of water. A solid which cannot be identified by its physical properties can be identified by its chemical properties. Chemical properties can be determined by testing in a chemistry laboratory.





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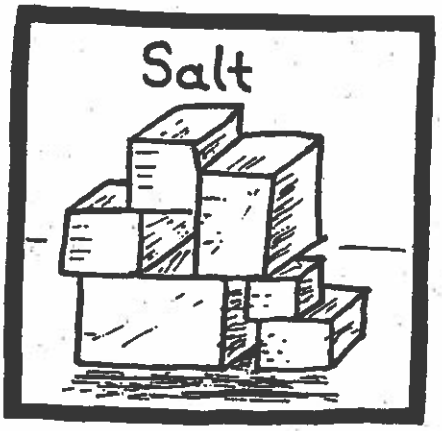
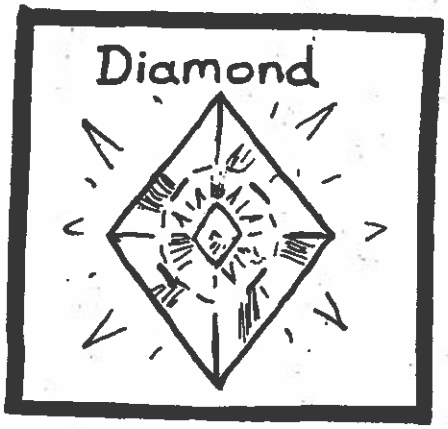
MINERALS

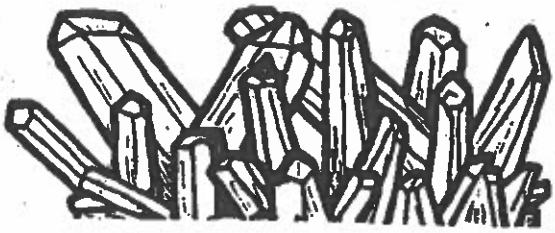
Minerals are substances that:

1) occur naturally (not man-made)
2) form crystals (shapes with flat sides)

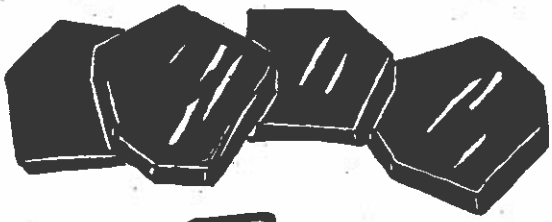




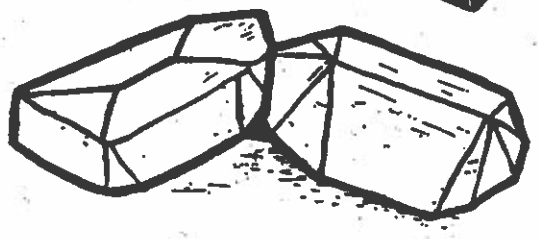
There are hundreds of minerals but some of the more well-known ones include: quartz, mica, feldspar, diamond and salt.



quartz
- **white in colour**
- **long crystals**
- **very hard to scratch**
- **often crystals are too small to see**



mica
- **black**
- **flat, flaky crystals**
- **soft**



feldspar
- **pinkish colour**
- **will scratch with steel**

salt
- **white**
- **cube-shaped crystals**
- **will scratch with steel**

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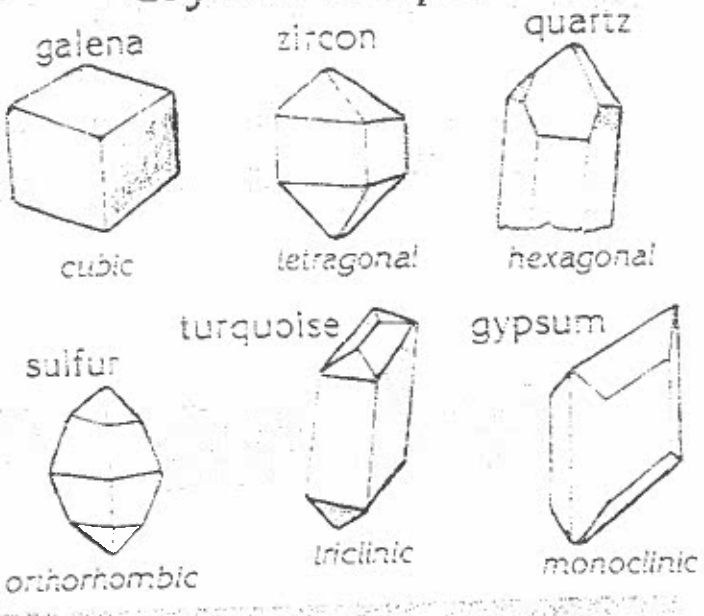
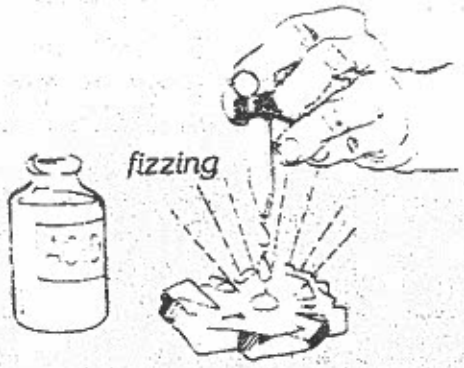
Minerals and Their Identification

Minerals are natural substances that have definite crystal structure and chemical composition.

Crystal Shape



Acid Test



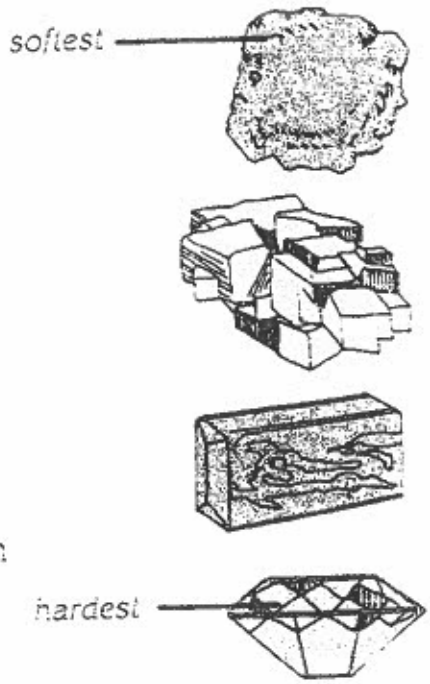
carbonate minerals
calcite
dolomite

Streak Test

Streak Color	*Mineral*
lead gray	galena
green	olivine
yellow-brown	limonite
red-brown	hematite
black-green	pyrite
scarlet	cinnabar
light blue	azurite

Hardness Test

1. talc
2. gypsum
3. calcite
4. fluorite
5. apatite
6. feldspar
7. quartz
8. topaz
9. corundum
10. diamond



1. What two means could be used to identify the mineral quartz?
2. Iron pyrite is known as "fool's gold." What test can be used to identify it?

STUDY QUESTION: What other tests are used to identify minerals?

Minerals and Their Identification

Minerals are naturally occurring substances found on the earth's surface that have definite crystal structure and chemical composition. Geologists use a variety of tests to identify minerals.

The earth's crust is composed of naturally occurring elements. The most abundant elements are oxygen (46.7%), silicon (27.7%), aluminum (8.1%), iron (5.0%), calcium (3.6%), sodium (2.8%), potassium (2.6%), and magnesium (2.0%). These elements make up 99% of the earth's crust. Some of the elements are found as free atoms or molecules. However, most of the elements are found in naturally occurring combinations called **minerals**.

Minerals have definite **physical and chemical properties**. The rocks which make up the earth's crust are made up of minerals. Many rocks contain several kinds of minerals. Certain minerals are commonly found to be the building blocks of rocks.

Six of the most common minerals on earth are ***feldspar, quartz, mica, hornblende, calcite,*** and ***olivine***. The identification of minerals can accurately be determined in the laboratory by chemical analysis. However, in the field it is often necessary for geologists to make identifications. They do this by observing the physical characteristics and by performing simple chemical and physical tests.

Acid test : Diluted acid will cause carbonate minerals to effervesce (to become covered with a crust of saline particles left by a chemical change).

Crystal shape: In most minerals there are distinctive crystals. Crystals are an indication of the inside arrangements of the atoms. Some minerals do not have atoms arranged in crystals and are called ***amorphous.***

Streak test: Certain minerals leave a characteristic coloured streak when rubbed across a piece of unglazed tile or porcelain.

Hardness test: Minerals vary in their hardness, that is, in their ability to scatch another substance or to be scratched. The geologist Mohs devised a scale of hardness using ten common minerals. Minerals can be tested for hardness by comparing their ability to scratch or be scratched by the reference minerals on the scale.

Work On It

In this activity, you will create rock groups. These are not the rock groups that you hear on the radio. They are groups of rocks that have something in common.

What You Need

- your rock collection
- magnifying glass
- measuring tape
- water

What You Will Do

1. With your group, take a close look at the rocks in your rock collection.
2. Decide on a way to group the rocks, such as by colour. Arrange the rocks into groups based on that property. Every rock must belong to a group. None can be left out.
3. Now record your groups. You can use tables, graphs, Venn diagrams, mind maps, or a combination of pictures and words. An example is shown here.

Solid Colour	Speckled	Striped
rock 2	rock 1	rock 3
rock 4	rock 5	rock 6
	rock 7	rock 8

4. Think of another way to group the rocks. Use a second sheet of paper to record these groups. See how many different ways you can group the rocks in your rock collection.

Communicate

1. Prepare to share your classification sheets with the class. Work as a group to make sure that your ideas are clear and your records are complete. Then present your ways of grouping the rocks to the class.
2. How did the ways you grouped your rocks compare with the ways your classmates used? Explain any differences in the ways that rocks were grouped.
3. Think about how other students recorded their groups. Which way of presenting the groupings worked the best? Explain your answer.

Lesson 3

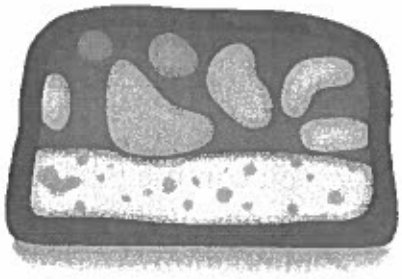
Rock or Mineral? What Geologists Say

Goal To identify rocks and minerals

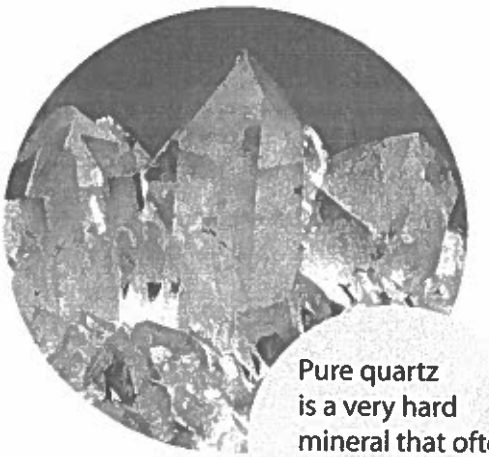
Get Started

Geologists are scientists who study rocks. To a geologist, a rock and a mineral are two different things that occur in nature. Imagine two chocolate bars. One is pure chocolate, and the other has caramel and nuts in it. The pure chocolate bar is like a mineral. In science, a **mineral** is a solid that is made of the same substance throughout. The chocolate bar that contains nuts and caramel is like a rock. A **rock** is a solid that is made of two or more minerals.

▲ Like a mineral, this chocolate bar is made of one substance throughout.



▲ Like a rock, this chocolate bar is made of several substances mixed together.

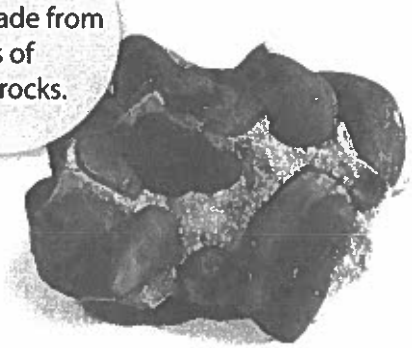


Pure quartz is a very hard mineral that often forms six-sided crystals.

A mineral will form a crystal under the right conditions. Mineral **crystals** have straight edges and flat surfaces. Minerals have certain qualities, such as colour, hardness, and crystal shape.

The Inside Story

Geologists learn more about mineral and rock samples by looking inside them. Minerals look the same on the inside as they do on the outside. This is because they are made of only one substance. However, one part of a rock may look quite different from another part of the same rock. Rocks contain flecks and grains of different sizes and colours. If you look inside the samples you collected, you will be able to tell whether they are rocks or minerals.



Some rocks are made from pieces of other rocks.

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Work On It

In this activity, you will look inside two samples provided by your teacher. Then you will decide whether each one is a rock or a mineral.

What You Need

- safety goggles
- samples
- cloth or towel
- rock hammer
- chisel
- camera (optional)

What You Will Do

1. Before you begin, put on the safety goggles.

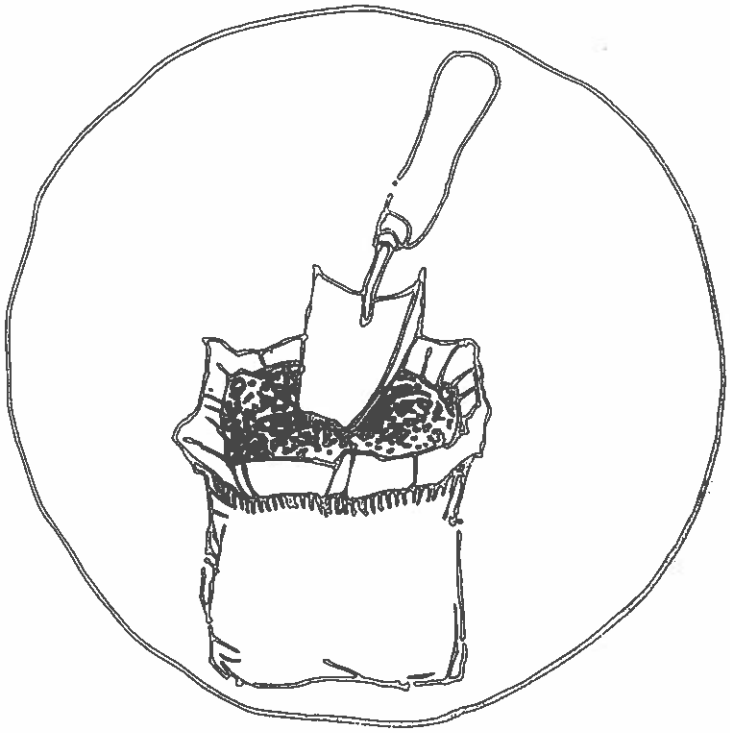
SAFETY CAUTION!

Remember to wear safety goggles when you chip a rock or a mineral.

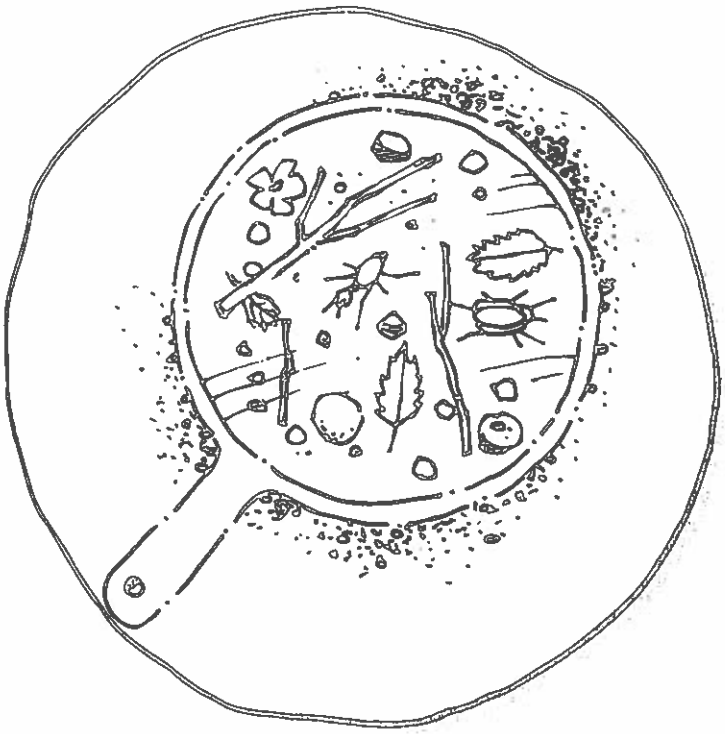
2. Draw a picture or take a photo of the sample that you are going to break.
3. Cover the sample with a cloth. This will stop the pieces from scattering when you break the sample.
4. Use the hammer or chisel to break open the sample.
5. Look at the inside of the sample. Is the sample a rock or a mineral? Write a few sentences on a piece of paper to explain why you think it is a rock or a mineral. Put the piece of paper with your explanation beside your broken sample.
6. Walk around the room, and look at other groups' broken samples. Read their explanations.

Communicate

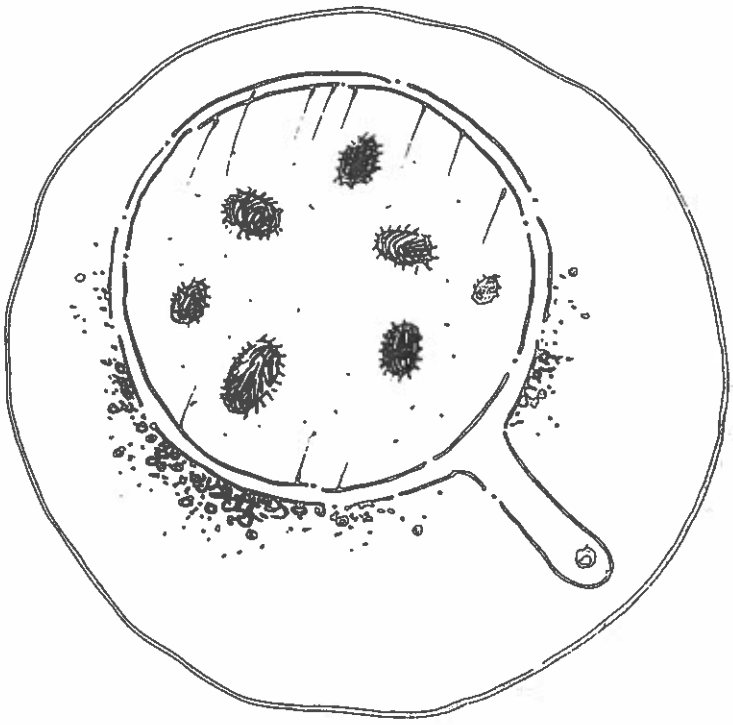
1. What do you need to know before you can be sure that a sample is a rock or a mineral?
2. Do you think that the other groups correctly identified their samples as rocks or minerals? Which groups did you not agree with? What are your reasons?
3. Revisit your rock collection. Are all of your samples rocks, or are some of them minerals? Make an argument either way, and be ready to present it to the class.
4. After listening to the presentations of other students, think about the properties of the rocks and minerals. Write down one or two properties shared by all of the rocks that were found in a similar location.



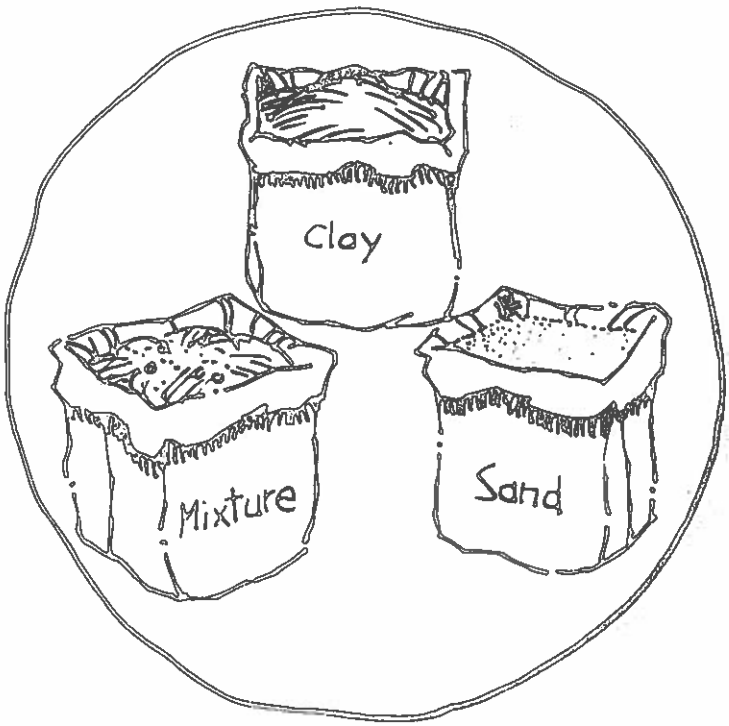
Soil covers much of the land on Earth.



Soil is made up of broken rock, dead plants, and dead animals.



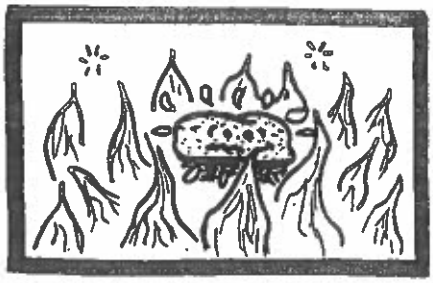
Oxygen and water are in soil. So are tiny living plants called bacteria.



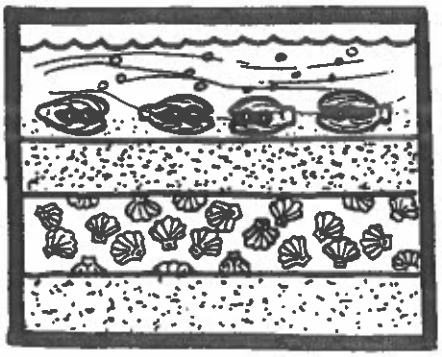
Different kinds of soils are found in different places. They can be different colors. Soil can be sand, clay, or a mixture.

There are three main types of rocks:

1) Igneous (fire rocks)
   - formed from hot magma from inside the earth.
   - the magma cools to form rock
   - volcanoes produce igneous rocks which is where the word "fire rocks" comes from.
   - granite, volcanic glass, basalt



2) Sedimentary (layered rocks)
   - rocks that are made up of particles that form layers
   - sand from a beach can harden to form a rock called sandstone
   - mud in a stream can harden to form mudstone
   - the shells of little animals that live in the ocean pile up to form layers of rock and are called limestone
   - chalk is a special kind of limestone made up of millions of tiny seashells too small to see.



3) Metamorphic (changed rocks)
   - rocks that are changed by heat and pressure (squeezing)
   - when limestone is heated and squeezed it becomes marble.
   - when mudstone is squeezed it becomes slate used in old-style chalkboards.
   - these rocks sometimes have some layering in them similar to sedimentary rocks.

Lesson 4

How Do Rocks Form?

Goal To learn about three main types of rocks and how they form

Get Started

▲ Lava is magma that has flowed to the surface but not yet hardened into rock.

When geologists study rocks and minerals, they are studying the history of Earth. They learn about what caused the rocks to form and how Earth is changing. Geologists also learn where mineral deposits are located. Mining and oil and gas companies want to know this information. Geologists are important to these industries in Saskatchewan.

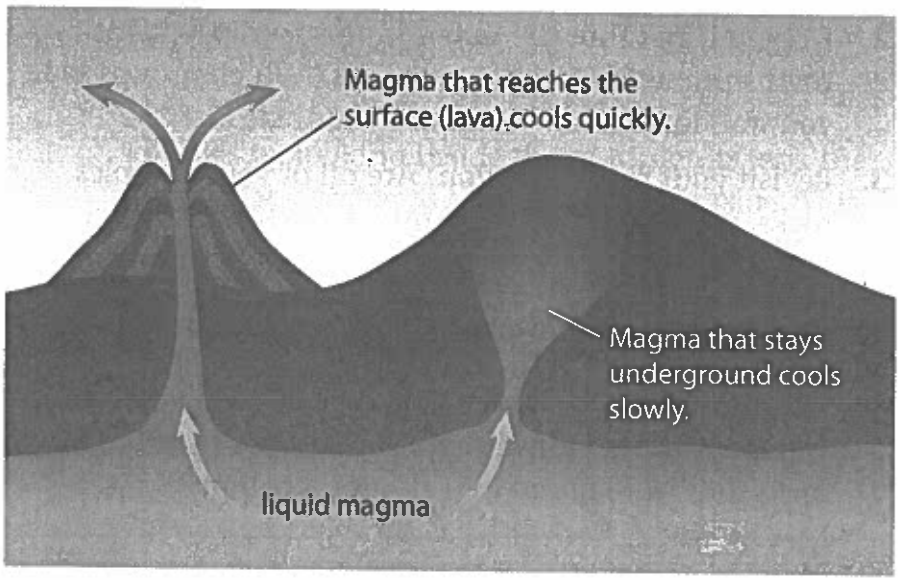
Scientists have identified many different minerals. However, they believe that there are only three types of rocks. Each type of rock is formed in a different way.

Igneous Rock

Deep below Earth's surface, the temperature is so high that the rock is liquid. **Igneous rock** forms when this liquid rock, or **magma**, hardens as it rises near to or through Earth's crust. Igneous rock covers the ocean floor, so two-thirds of Earth's surface is igneous rock! In fact, all types of rocks on Earth began as igneous rock.

Some igneous rock contains air bubbles. The air bubbles make this rock quite light. Other igneous rock has no air bubbles and is heavy. Granite and basalt are examples of igneous rock. Igneous rock is found close to the surface only in northern Saskatchewan.

▲ Granite



▶ How igneous rock forms

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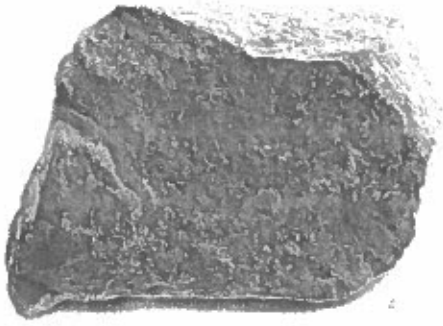
Sedimentary Rock

Rocks at or near Earth's surface are broken into smaller pieces by water, wind, and ice. Soil and shell pieces are also moved along with rock pieces. The pieces (called **sediment**) often settle in layers, such as in desert dunes and on the bottoms of rivers, lakes, and oceans. Over millions of years, the layers are squeezed together. The weight and pressure of the layers above cause the sediment to become cemented together to form new rock. This is how igneous, metamorphic, and older sedimentary rocks are recycled to become new **sedimentary rocks**. You can usually see grains of the sediment in sedimentary rocks, such as sandstone and conglomerate. Sedimentary rocks are found close to the surface in northwestern, east central, and southernmost Saskatchewan.



▲ Limestone sometimes forms from pieces of shells and other fossils.

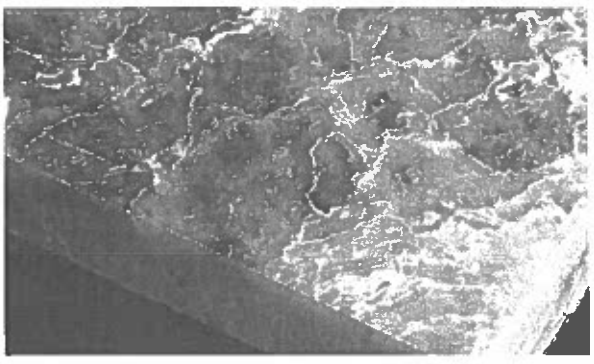
▲ Sandstone

Metamorphic Rock

Over time, as igneous and sedimentary rocks become deeply buried under Earth's crust, intense heat and pressure can cause these rocks to change form. For example, minerals may be flattened, producing banding in the rock. New minerals may also form. This type of rock is called **metamorphic rock**. Igneous, sedimentary, and metamorphic rocks may also sink below Earth's crust, where they may melt and become magma again.

Marble, gneiss, and slate are examples of metamorphic rock. Metamorphic rock is found close to the surface, only in the northern part of Saskatchewan.

The word "metamorphic" comes from the Greek words *meta* (meaning "change") and *morph* (meaning "form"). Combined, they mean "change of form."



▲ Marble

▲ Gneiss

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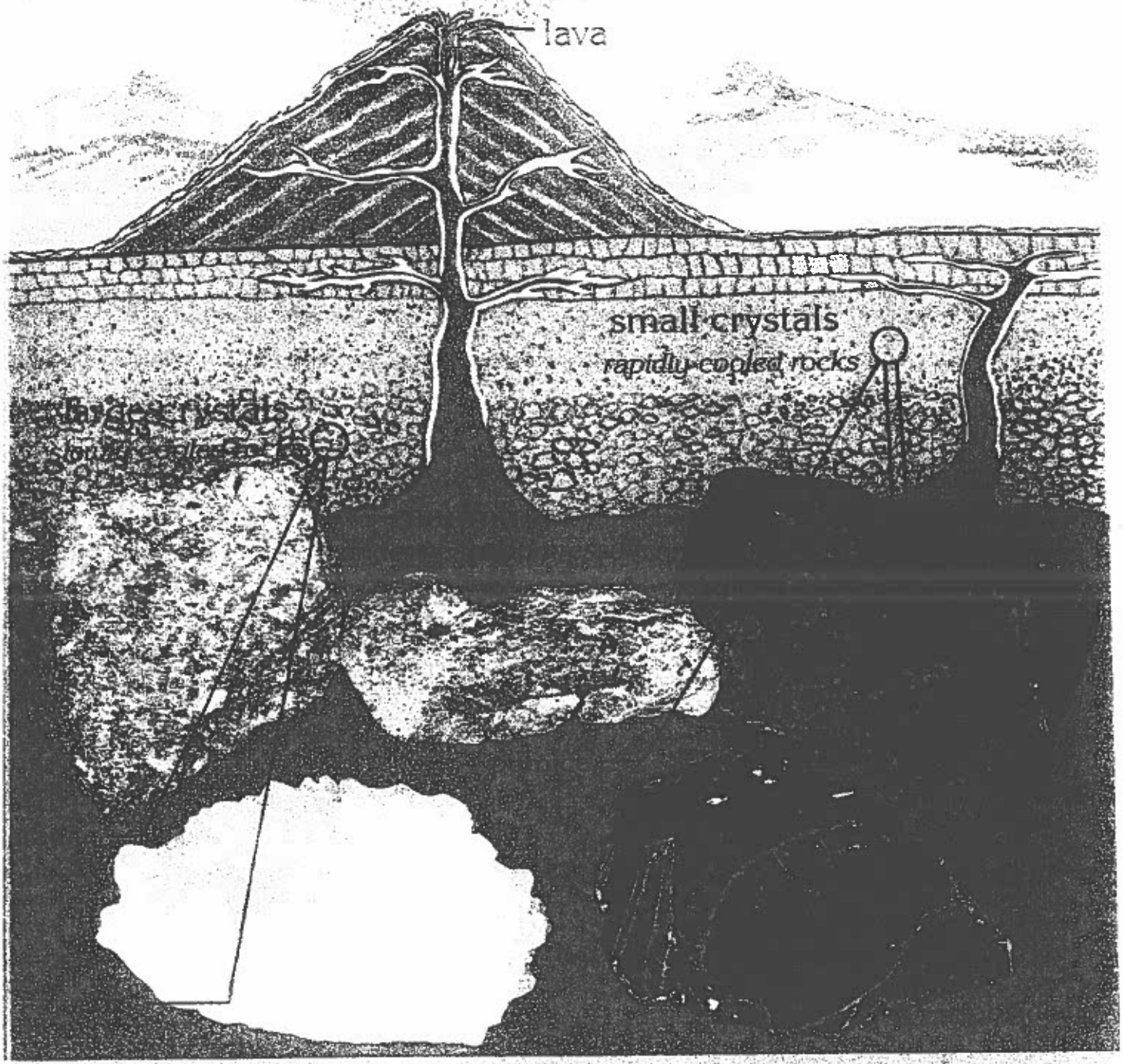
Formation of Igneous Rocks

Igneous rocks are formed when molten rock material called magma cools and solidifies.



1. Describe the importance of magma and lava in forming igneous rocks.
2. Identify the rocks formed with large crystals and those formed with small crystals.

STUDY QUESTION: Find out about intrusive and extrusive igneous rocks.

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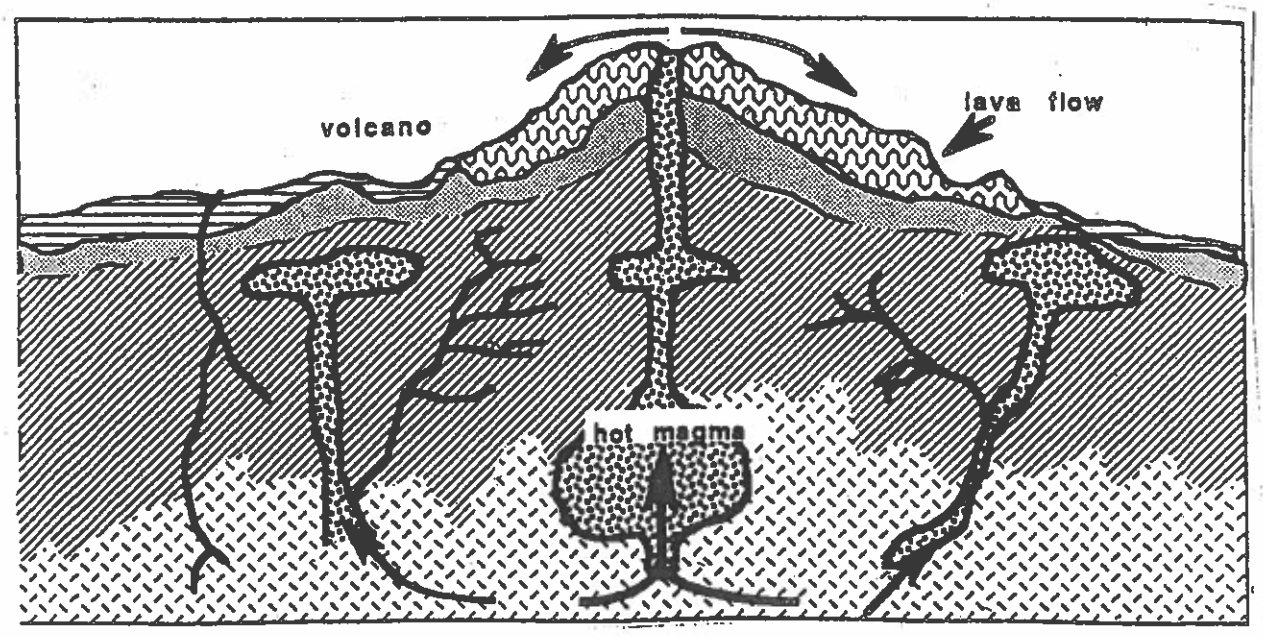
Formation of Igneous Rocks

Igneous rocks are formed from hot, molten material called magma. Igneous rocks are divided into two groups, based on where the rocks form, extrusive rocks (volcanic rock) are formed at the outer portion of the earth's surface or intrusive rocks (plutonic rock) are formed underneath the earth's surface.

Igneous rocks are formed from molten material deep below the earth's crust. This molten material is called ***magma.*** Magma may force its way toward the surface of the earth through cracks in the rock strata. ***Lava***, liquid magma that reaches the earth's surface, flows from volcanoes, cools rapidly(fast), and forms rocks with small, fine-grained crystals or glassy appearance. Some examples of glassy rock with small crystals are ***basalt, pumice,*** and ***obsidian***. This is called ***extrusive igneous rocks*** or ***volcanic rock***, because this rock forms when the lava cools quickly at or above the earth's surface.

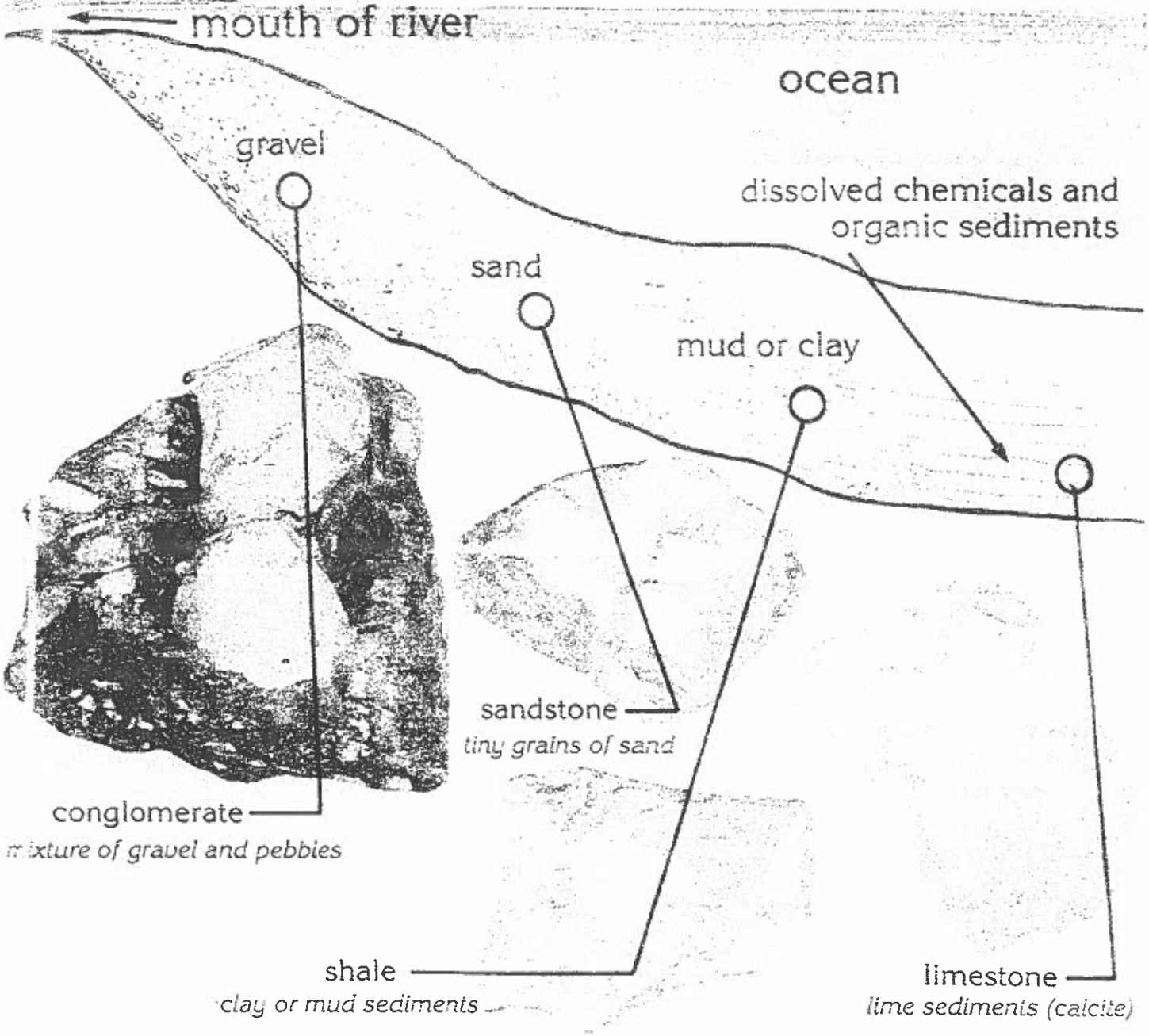
Magma that is blocked from reaching the earth's surface by rock layers above it cools slowly below the land surface. Igneous rocks that form below the earth's surface are called ***intrusive igneous*** rocks or ***plutonic rock***. Because this takes place in an underground chamber it takes a long time for the particles to cool down, therefore tocks formed under these conditions have large crystals and are coarse-grained in appearance. Some examples of this kind of rock are ***granites***, the most common of igneous rocks: ***gabbro, quartz***, and ***diabase***.

IGNEOUS ROCKS



Formation of Sedimentary Rocks

Most *sedimentary rocks* are formed from layers of sediments that have been compressed under water for long periods of time.



1. Tell why large-sized sediments are located closer to the mouth of a river than small-sized sediments.
2. Identify the various kinds of sediments that make the sedimentary rocks shown above.

STUDY QUESTION: Find out how petroleum and natural gas deposits are formed within layers of sedimentary rock.

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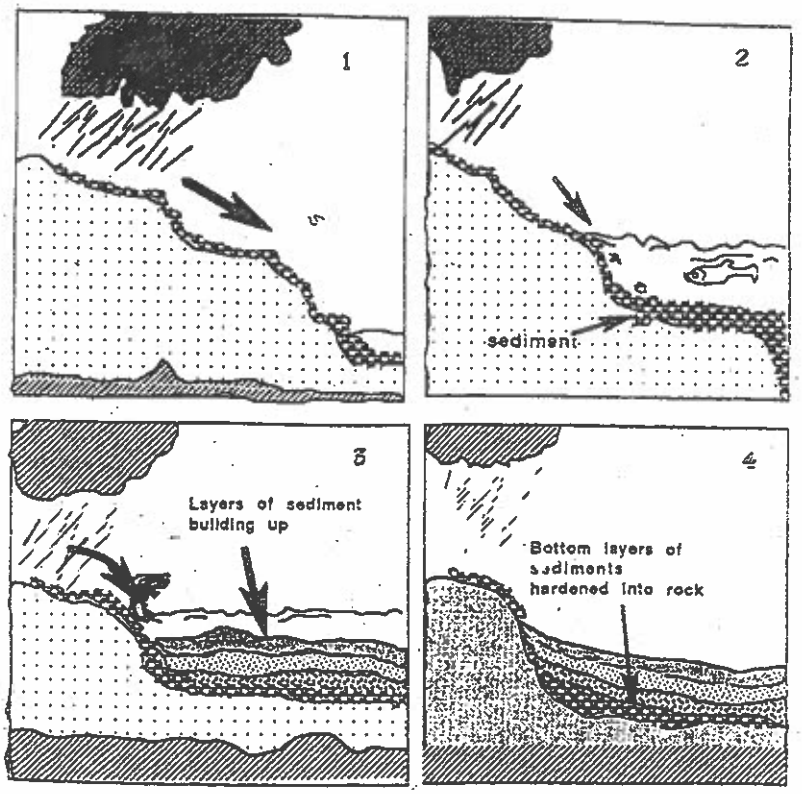
Formation of Sedimentary Rocks

Nearly all sedimentary rocks, formed in layers or beds, are formed from layers of sediments that have been compressed under water for long periods of time. Sedimentary rocks make up 75% of the rocks that are at the earth's surface.

When streams carrying sediments empty into larger bodies of water, the loss in velocity(moving quickly and with stregnth) causes the larger and heavier particles to be deposited first. Smaller and lighter particles are carried away and settle farther from the mouth of the stream.

The weight of the water plus the weight of the top layers press the sediment of the bottom layers tightly together. Chemiclas found in the water are deposited between the particles of sediment, fill the tiny spaces, and cement and form the sediment into rock layers. Common examples of sedimentary rocks are ***conglomerates:*** formed by a compressed mixture of gravel usually deposited where rivers empty into larger bodies of water and ***sandstone*** is formed by compressed sand grains, ***shale*** is formed by compressed layers of clay, mud, and\or silt.

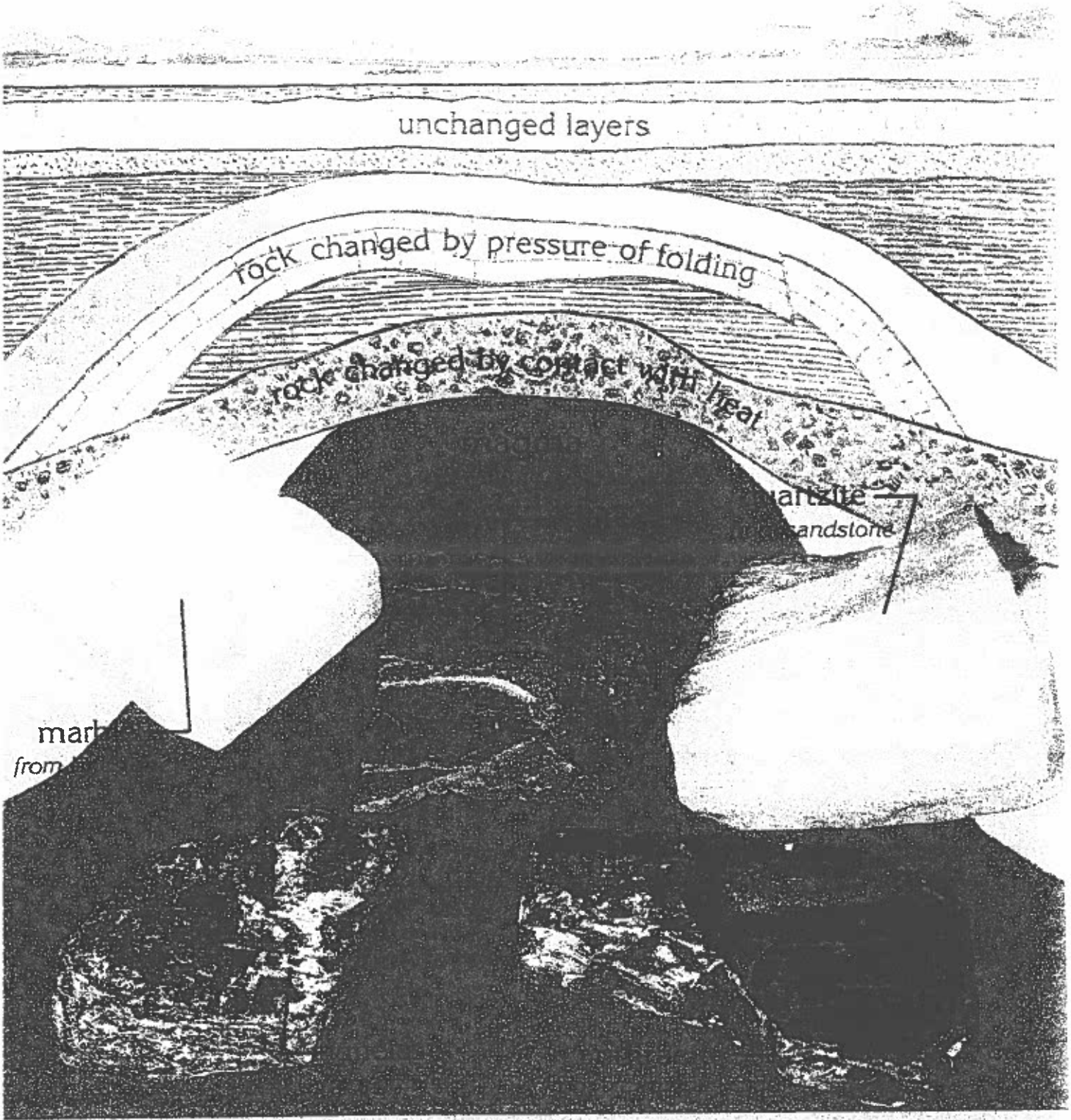
Some kinds of sedimentary rocks are fromed by sediments which include the remains of tiny plants and animals and dissolved chemicals, such as ***salt*** and ***calcium carbonates*** found in ocean water. Some examples are, ***limestone,*** a very useful sedimentary rock, and ***gypsum***. Both are formed from the remains of corals, plants, shells, and dissolved chemicals.



SEDIMENTARY ROCKS

Formation of Metamorphic Rocks

Metamorphic rocks are formed at depths under the earth's surface in regions of great heat and pressure.



1. What two factors cause change in rocks?
2. What is one cause for pressure under the earth's surface?

STUDY QUESTION: Describe the rock cycle.

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Formation of Metamorphic Rocks

Metamorphic rocks are formed from igneous, sedimentary, and other metamorphic rocks. These rocks are changed by heat, pressure, and chemical action.

Within the earth's crust, rocks are subjected to pressure and heat. The weight of overlying rock strata may produce great pressures on the rocks below them. It has been estimated that rocks lying several miles under the earth's surface may have pressures of four to twelve tons per square centimeter exerted upon them. This great pressure causes a physical readjustment or alignment of the mineral particles. Pressure on rocks may also be caused by the folding of strata, as in the mountain-building process. As one goes deeper and deeper into the earth's crust, there is a corresponding increase in temperature.

Temperatures around ***magma*** (liquid rock) intrusions are very high and may cause changes within the surrounding rock. Often very hot gases and liquids associated with magma also cause a change in adjacent (lying near or close by) rocks. New elements may be added or elements may be removed. These changes can cause an alteration in the chemical composition of the rock. Metamorphic rocks are characterized by change in their texture due to recrystallization and\or their change in chemical composition.

Metamorphism can occur among igneous, sedimentary, and other metamorphic rocks. Often the original characterisics are profoundly changed. Metamorphic rocks may be more crystalline, more massive (dense), or have minerals arranged in parallel layers.

Marble: Limestone changes into marble. Various impurities in the limestone give marble its characteristic colour. Marble, because of its compactness, is an excellent building stone and is used for statues.

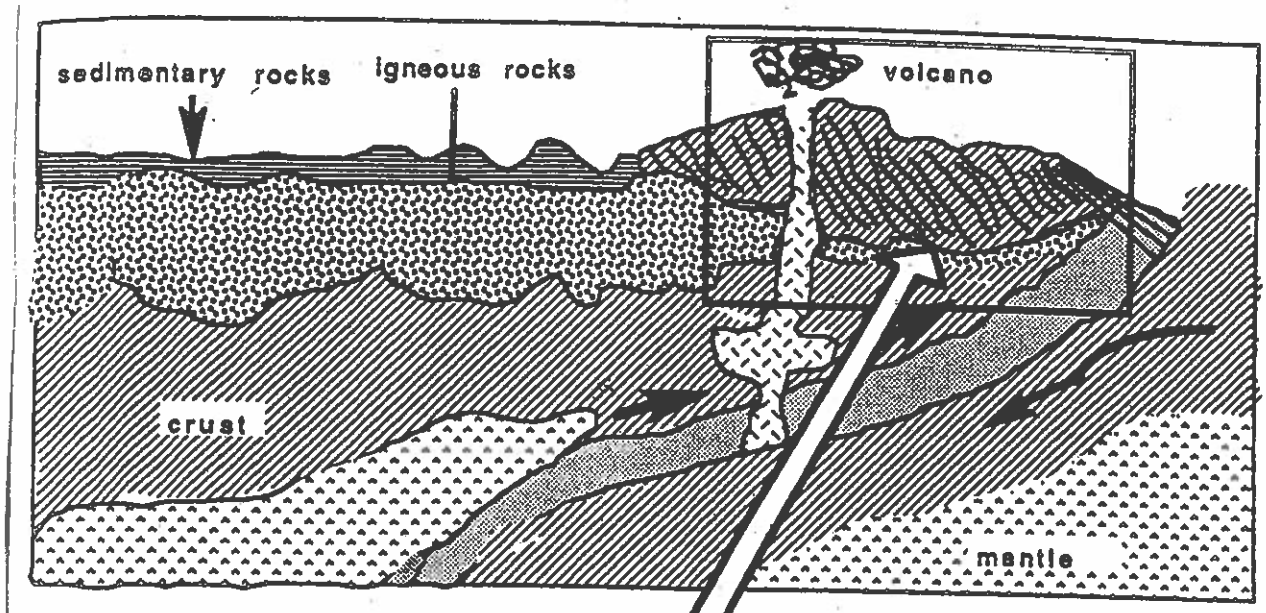
Quarzite: This rock comes from sandstone. Sandstone is composed of sand particles cemented together by various other materials. When, crushed, sandstone breaks around the individual particles. Quartzite, has particles cemented by a silica material and when crushed, the rock breaks through the particles.

Slate: Sediments such as silt formt he sedimentary rock, shale. When shale goes through metamorphism it changes to slate. Slate is impervious(not capable of letting things pass through)to water, resistant to weathering, and easily splits into thin sections. These qualities have been used for roofing material. Volcanic ash may metamorphose into slate.

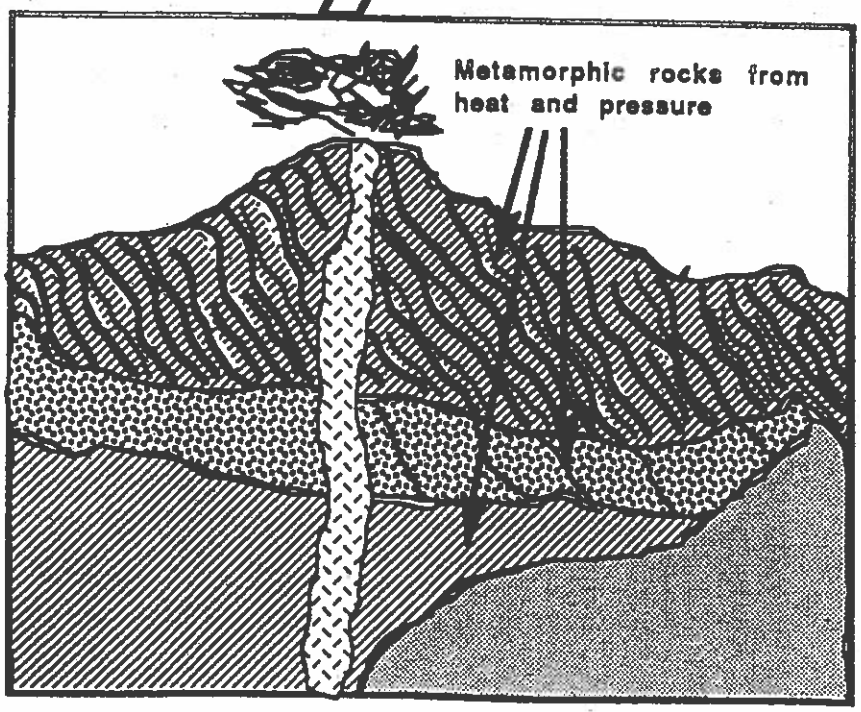
Gneiss: The various igneous granites may become changed into the rock called gneiss. It usually has a coarsely banded appearance with dark and

Gneiss: The various igneous granites may become changed into the rock called gneiss. It usually has a coarsely banded appearance with dark and light bands. The dark bands may be the minerals *biotite* and *hornblende* and the light bands, minerals *quartz* and *feldspar.*

Anthracite Coal: Bituminous coal becomes hard coal, anthracite. This rock is harder and has a greater carbon content than soft coal. Anthracite coal is found in areas of mountain building activity. Further metamorphose may change it into granite.



METAMORPHIC ROCKS



Recycling Rocks *(cont.)*

The Rock Cycle

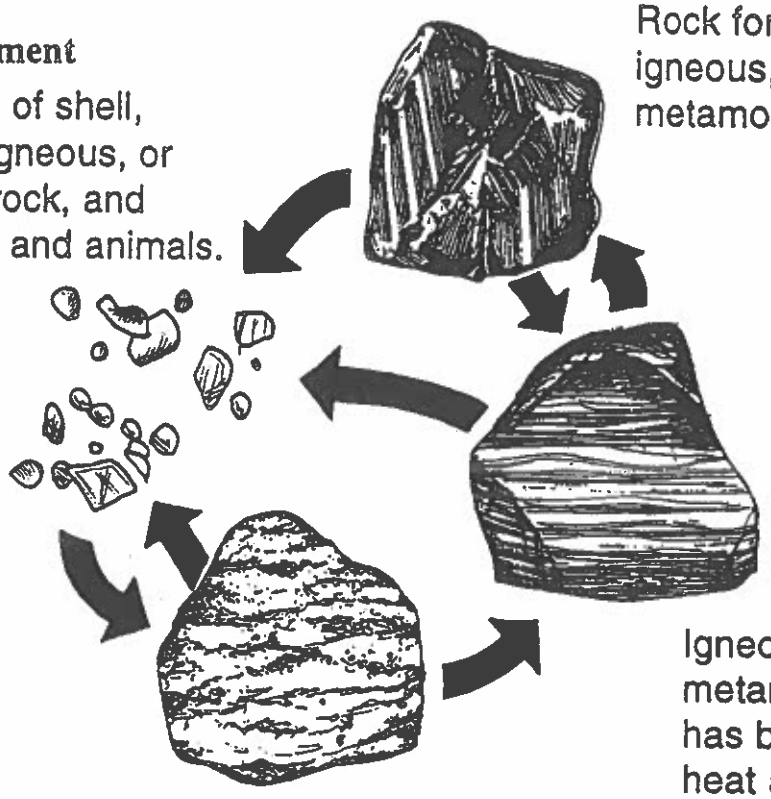
Examples of the Three Types of Rocks

Igneous

Rock formed from melted igneous, sedimentary, or metamorphic rock.

Sediment

Broken pieces of shell, sedimentary, igneous, or metamorphic rock, and parts of plants and animals.



Metamorphic

Igneous, sedimentary, or metamorphic rock which has been changed by heat and pressure.

Sedimentary

Rock made from compressed pieces of sediment.

Examples of the Three Types of Rocks

Igneous—obsidian, pumice, and granite

Metamorphic—marble (from limestone) and slate (from shale)

Sedimentary—sandstone, limestone, and shale

Note: Quartz is found in all three of these types of rocks.

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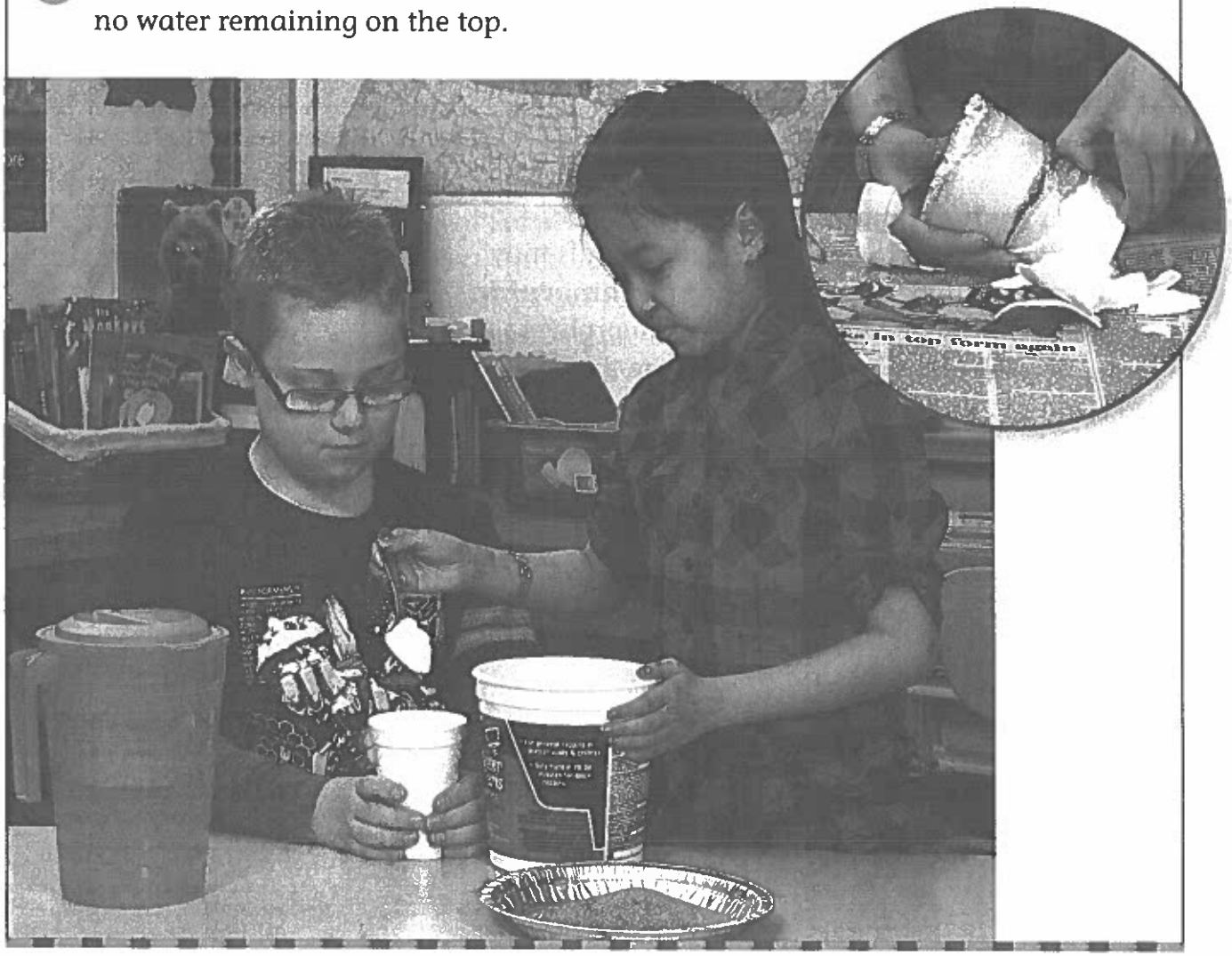
Work On It

You have learned that sedimentary rock can be made from layers of tiny pieces of rocks and minerals. In this activity, you will make a model of a sedimentary rock.

What You Need

- paper cup
- water
- sand
- tablespoon
- plaster of Paris

1. Half fill the paper cup with water.
2. Add five or six tablespoons of plaster of Paris to the water. Do not stir. Allow time for the plaster of Paris to settle.
3. Add four or five tablespoons of sand to the water. Allow time for the sand to settle.
4. Repeat steps 2 and 3 until there is no water remaining on the top.
5. Allow the mixture to sit for a few days, until all the water has evaporated. Make sure that the mixture is placed where it can dry without being disturbed.
6. Slowly and carefully, peel away the paper cup to reveal your model of a sedimentary rock.



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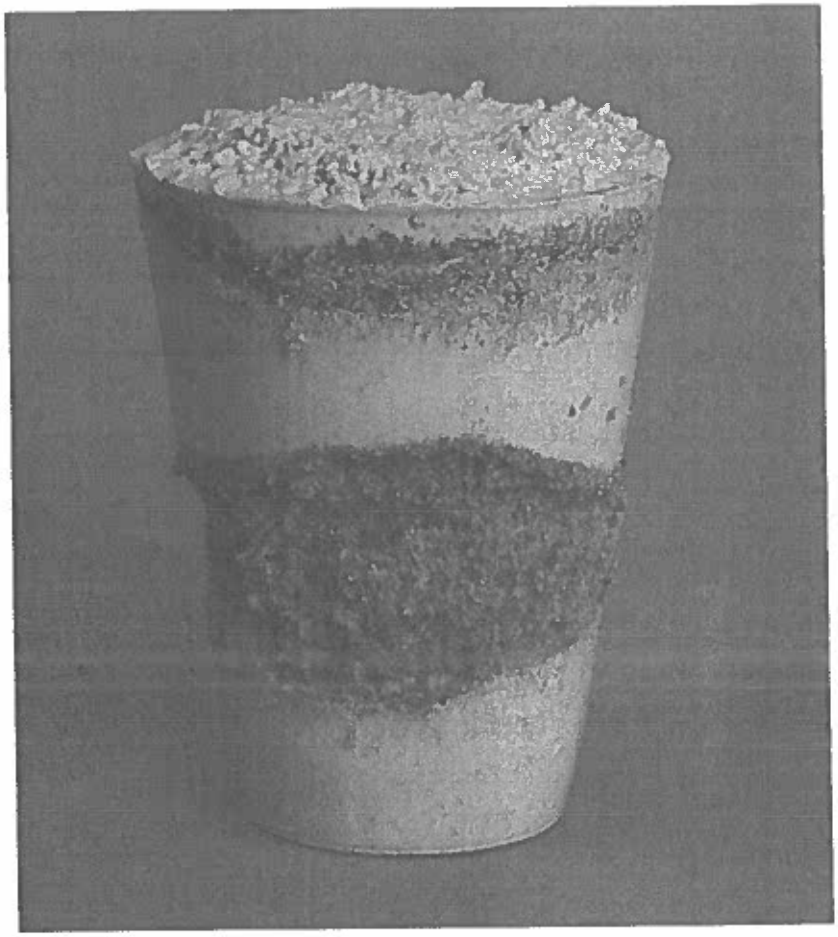
Communicate

1. How does the hardened object that you removed from the paper cup in step 6 resemble a sedimentary rock?



2. From your rock collection, identify the rocks that you think are igneous, sedimentary, and metamorphic. Have your partner do the same. Do you both agree? Think about the processes that form the three types of rocks. How does this knowledge help you group the rocks?
3. Research what granite is used for and what marble is used for. Make a list of ways that these rocks are used. Include images, if possible.
4. Create a flow chart or a series of drawings that shows how sedimentary rock is formed.

The Woods Cree peoples of northern Saskatchewan once called themselves *Asiniskaw Ithinіniwak*, which means "people of the country with abundant rock."

Lesson 5

Why Test Rocks and Minerals?

Goal To identify rocks and minerals by testing them

Get Started

So far, you have used your senses to find out about rocks and minerals. You have looked at their colour and grain size and felt how rough or smooth they are. Geologists do this, and more, when they study rocks. They use many different tools and techniques. They conduct tests and observe their results. The more they learn, the more they understand about the history of Earth. What they learn also helps them figure out how we can use rocks and minerals in our daily life.

Work On It

You will work with your group to carry out tests that will help you compare and **classify**, or group, rocks and minerals. For each test, you must record the tools you use, the steps you take, and what you observe. Remember that it is important to clean up your tools and other materials at the end of each test.

SAFETY CAUTION!

Be very careful when handling sharp tools.

Hardness Test

When you touch different minerals, they may feel as if they are all the same hardness. However, they are not. In 1812, Friedrich Mohs developed a scale of hardness. The **Mohs scale** is still used today.

Mohs tested 10 minerals and arranged them in order of hardness. A mineral on the Mohs scale can be scratched by any mineral above it. It can scratch only those below it. Talc is at the bottom of the scale (1), so it can be scratched by many other minerals. Diamond is at the top of the scale (10), so it can scratch all other minerals.

The Mohs Scale

Hardness	Mineral	Everyday Materials
10	diamond	
9	corundum	
8	topaz	
7	quartz	concrete nail (7.5)
6	feldspar	steel file (6.5)
5	apatite	glass (5.5 to 6.5)
4	fluorite	common nail (5.2)
3	calcite	penny (3)
2	gypsum	fingernail (2.5)
1	talc	

What You Need

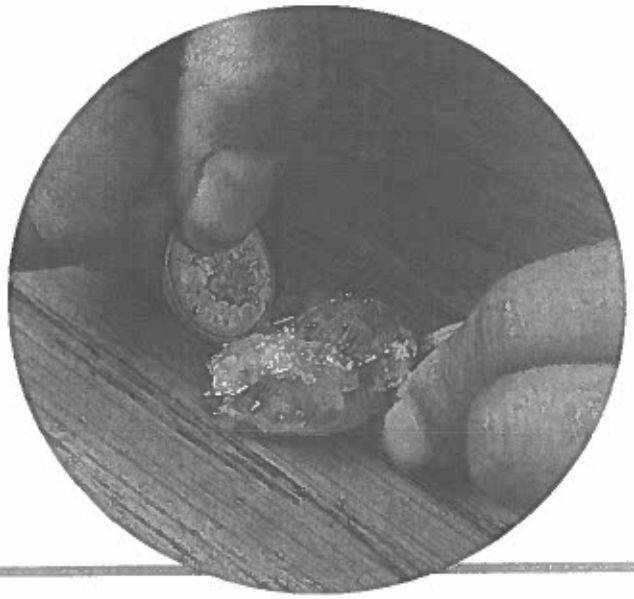
- mineral samples provided by your teacher
- some items from the third column of the Mohs scale

What You Will Do

1. Before you begin to test for hardness, create a table like the one below in your notebook. You will use your table to record your observations.

Test	Sample 1	Sample 2	Sample 3
fingernail test			
penny test			
glass test			
file test			

2. Test each sample, using all of the test materials. Fill in your table with either "scratched" or "did not scratch," depending on your observations.



3. Now use your observations, along with the Mohs scale, to give each sample a hardness number. Add the hardness numbers beside the sample numbers at the top of your table.
4. Make a display that shows your samples in order, from softest to hardest.

Limestone Test

You have read about sedimentary rock and how it is formed. You even made a model of a sedimentary rock. Limestone is a common sedimentary rock. There is a mineral in limestone called calcite. It fizzes when it comes in contact with vinegar. This fact will help you figure out if any of your samples are limestone.

What You Need

- rock samples
- magnifying glass
- medicine dropper
- vinegar

What You Will Do

1. Begin by looking at your rock samples. Separate the samples that you think are sedimentary. Now look for rock samples with tiny particles. You will need a magnifying glass to see the particles in limestone. In fact, the particles in limestone are so tiny that you may not even be able to see them.

Continued →

2. Now look at these samples more carefully. Do you see any pieces of shells or other fossils? Which rocks do you think are limestone?
3. Use a medicine dropper to dribble a little vinegar on your rock samples. Watch to see what happens. Do you see tiny bubbles? Can you hear fizzing? Bubbling and fizzing are signs that the rock is limestone.
4. Record which of your rock samples are limestone.
5. Look at the rocks that are limestone. How are they similar?

Magnetism Test

Geologists often want to know whether there is any metal in a rock. Minerals may contain these metals, and the minerals are magnetic. Magnetic minerals are attracted to magnets. **Attracted** means that the magnet is drawn toward the magnetic minerals in the rock. In this activity, you will find out if any of your rock samples contain magnetic minerals that are attracted to a magnet.

What You Need

- rock samples
- magnet
- string

What You Will Do

1. Sort your rock samples into two groups: those that you think may contain magnetic minerals and be attracted to a magnet and those you think will not be attracted. How did you decide?
2. Tie the magnet to a string so that you can hang it above the sample you are testing.

3. Place one of the samples on the table. Hold the string so that the magnet is beside the sample. It should be close to the sample but not touching it. Is the magnet attracted to the sample? How does the magnet move? Remember to test all sides of the sample. The minerals that attract the magnet may be located in only part of the sample.
4. Record which of your rock samples are attracted to the magnet and which are not.

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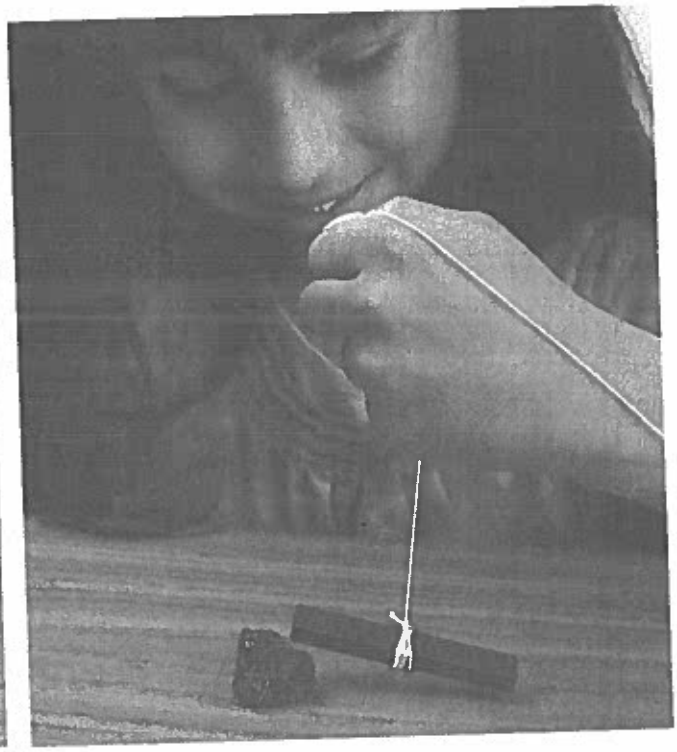
Communicate

1. Prepare one table that combines the results of your limestone test and your magnetism test. Your table should show whether or not each sample is limestone and whether or not it is attracted to a magnet.
2. State a reason that geologists might look for rocks containing magnetic minerals.
3. Do you think that the softness or hardness of a mineral determines its use? Give an example to explain your reason for thinking this.
4. Look at the two photos below. Which rock likely contains a magnetic mineral? Explain your choice.

Some rocks and minerals act like magnets themselves. A magnetic mineral called lodestone was used by early explorers to make compasses. Can you think of other uses for rocks and minerals that are magnetic?



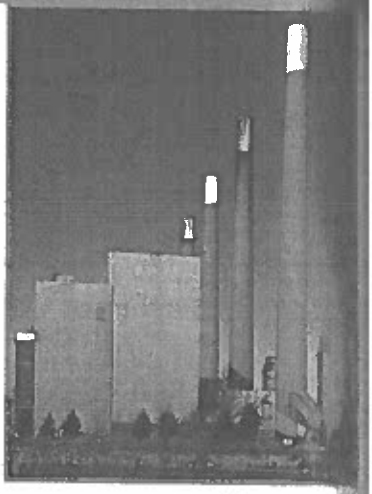
Build On What You Know

For your Design Project, you will come up with ideas to stop the possible flooding of cabins on a Saskatchewan lake. Which properties would you look for in the rocks used for building barriers? Will you have to think about the minerals in the rocks used for building barriers?

©P

How have rocks and minerals contributed to the province of Saskatchewan?

Ask...



A Miner

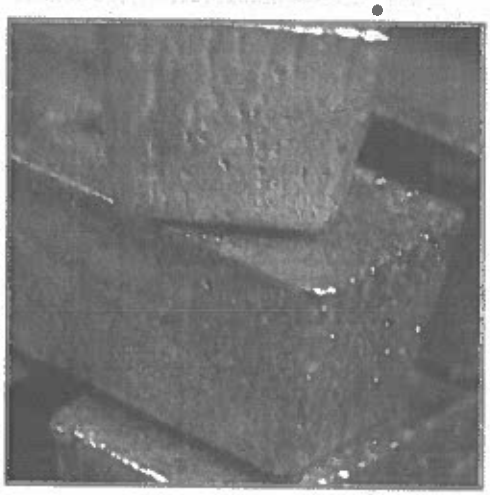
My name is Trevor Lees. I am a miner at the McArthur River mine in northern Saskatchewan. My job at the mine takes me underground. I mine rocks that contain the mineral uranium. Uranium is used to create power in power plants. I have also worked in mines that produce diamonds and potash.

Mines provide jobs for many people in Saskatchewan. Mining is hard work, and it can be dangerous. However, it is rewarding. For some mining jobs, you need a university degree. For other positions, workers are trained on the job.

A Geologist

My name is Mary Anderson. I am a mine geologist for Golden Band Resources Inc. I work at my company's gold mine near La Ronge in northern Saskatchewan. I visit the underground mine every day and give the miners direction. Veins of gold rarely run in a straight line, so I figure out which way the miners should turn to follow the gold.

People benefit from the mines in Saskatchewan. The company I work for buys some of its supplies from the local community. Many Canadians work at the gold mine. They live in the community when the workday is over, and the money they spend helps the community. The provincial government is also paid some money from the sale of the minerals that are mined. This money benefits all of the people in the province.



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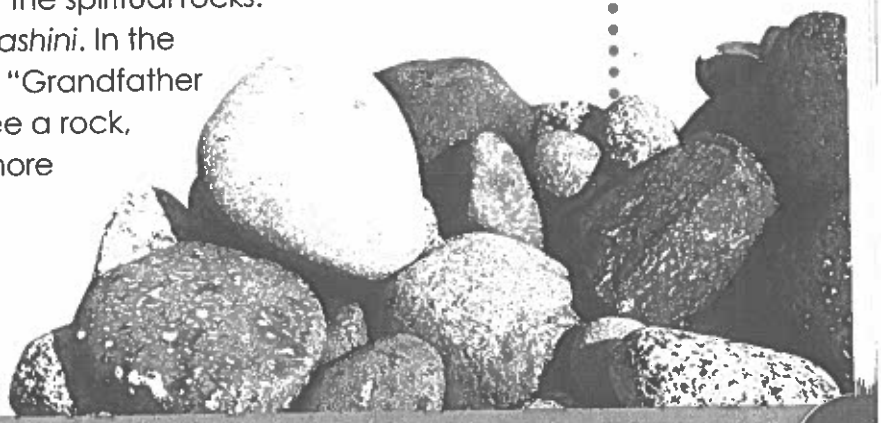
A Traditional Knowledge Keeper

My name is Glen Myo, and I am a Cree Traditional Knowledge Keeper from the Moosomin First Nation. In the beginning of time, Creator made rocks. Creator made rocks for two reasons. The first reason was so the rocks would listen to our prayers and then pass those prayers on to Creator. The rocks help us say our prayers the way our hearts mean to say them, because we have a hard time saying them with our voices.

Creator also made rocks to be used in the sweat lodge. In the sweat lodge, we pray to Creator while we splash water on the rocks. The steam created in the sweat lodge cleanses our mind, body, spirit, and heart. When collecting rocks to be used in the sweat lodge, we offer tobacco to the spiritual rocks. Rocks are called *ksina byo ashini*. In the Cree language, this means "Grandfather Rock." The next time you see a rock, remember that it is much more than just a simple rock.



Research

Research other jobs or careers related to rocks and minerals. Find out what people who have these jobs or careers need to know about rocks and minerals to do their work.

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How have rocks and minerals contributed to the province of Saskatchewan?

Lesson 6

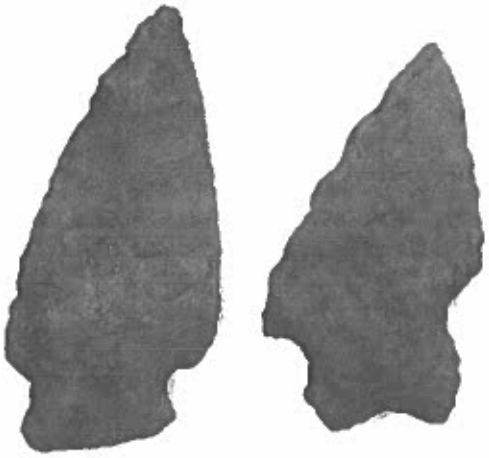
How Are Rocks and Minerals Important in Your Life?

Goal To connect rocks and minerals to your life

Get Started

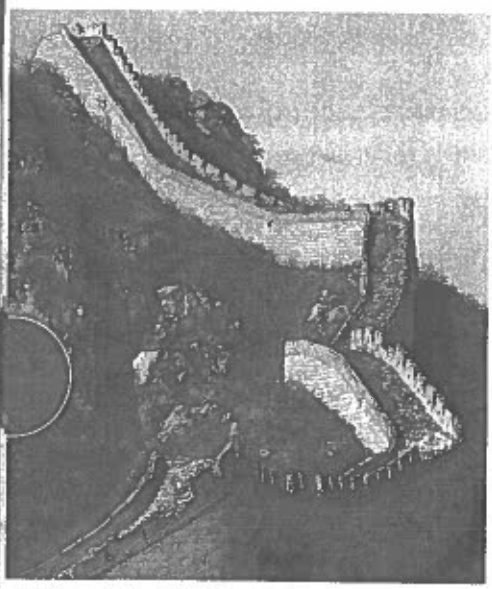
You have observed and tested rocks and minerals to learn about their properties. You now know that all rocks are not the same. In fact, they vary a lot. How we use certain rocks and minerals depends on their properties. For example, would a rock made of soft minerals, such as talc and gypsum, be a good building material? Think about why granite would be better. Look at the photos of the pot and the knives. Think about why First Nations peoples would make knives from different materials than those they would use for pots.

▲ This 500-year-old cooking pot was found in Anglin Lake near Prince Albert National Park.



◀ These quartzite knives from central Saskatchewan were used by First Nations people in the past for daily tasks such as cutting meat.

Since the beginning of time, people have used rocks and minerals in many different ways. Think of how you use rocks and minerals in your daily life. For instance, computers contain gold, silver, and other minerals. As you read the rest of this lesson and look at the photos, make a list of other photos that could be added to each section.



▲ The Great Wall of China

Rocks for Building

For centuries, rocks have been used for building. Pyramids, temples, castles, and the Great Wall of China were built from rocks a very long time ago. Yet these structures still stand today. This shows us that some rocks are strong enough to last through the ages. Today, we continue to use rocks for building.

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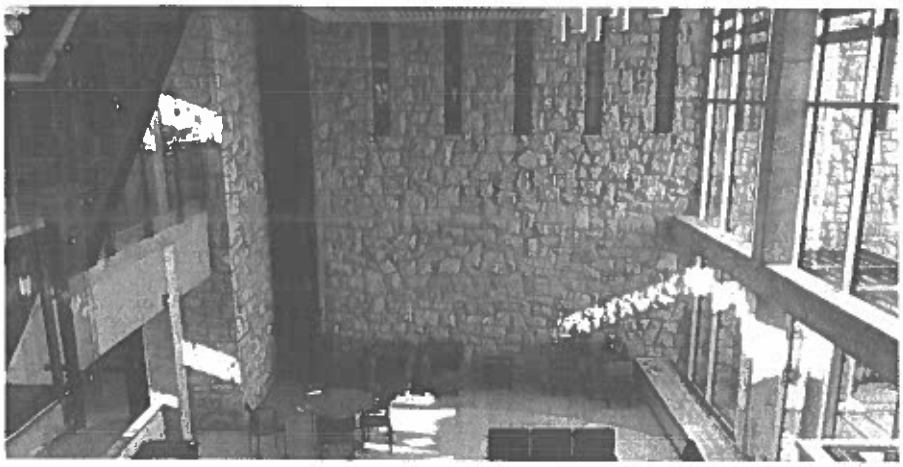


◀ Rock was used in the construction of some buildings at the University of Saskatchewan.

Concrete is a very common building material in Canada. We use it in the foundations of our homes and the roads we drive on. A chemist at the University of Saskatchewan (Dr. Thorbergur Thorvaldson) developed a type of cement that made concrete buildings last longer.

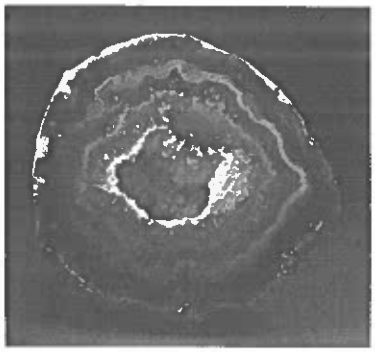
Minerals for Decoration

Gemstones are rare and beautiful minerals that have been cut and polished. Gemstones such as emeralds, diamonds, rubies, sapphires, and opals have been used for centuries to create expensive pieces of jewellery. Gemstones are found only in certain places in the world. The rarer a gemstone is, the more valuable it is.

Sometimes, beautiful mineral crystals are hidden inside a different type of rock. The crystals are discovered only when the rock is broken open. A rock with crystals inside is called a geode.

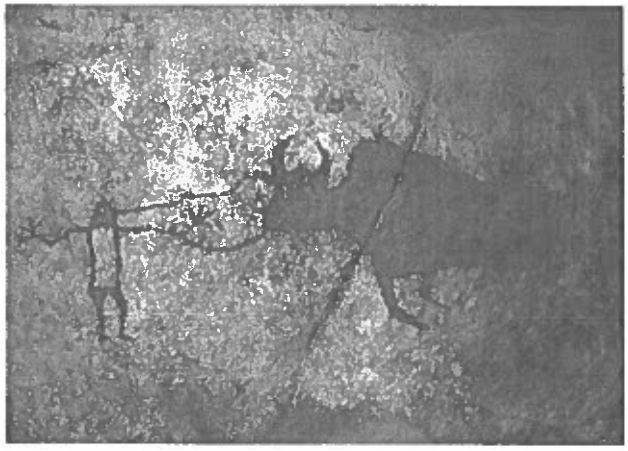
For thousands of years, many cultures have used jade, turquoise, and lapis lazuli as decoration. People used these and other minerals and stones with intense colours in jewellery, pottery, and other objects. In the past, people traded gemstones with groups from other locations. They also melted copper to make jewellery.

Some rocks and minerals that contain iron oxide have been used traditionally as colour pigments in the artwork of First Nations peoples. Ochre is a common name for some of these iron oxide substances. Ochre can be yellow, green, or purple.



▲ People display open geodes as decorations in their homes.

◀ Blue lapis lazuli was used to outline the eyes on this gold mask of Tutankhamun.



▶ Rock drawings at Wanuskewin Heritage Park

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Rocks and Minerals as Tools

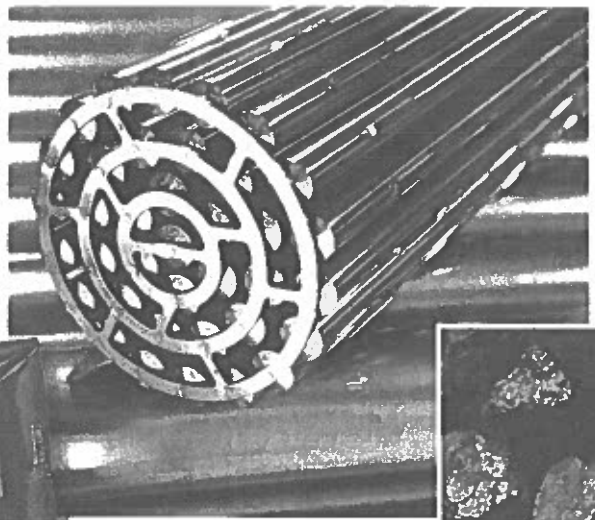
Throughout the world, archeologists have found many weapons and tools made from rocks, which were used by people in the past. Some rocks, such as obsidian, were crafted into arrowheads and other weapons. Other rocks were used as tools for grinding grain or tending crops. Rocks that were used for these purposes needed to be strong and long-lasting. Flint is another rock that was important to many different peoples through time. It was used to make tools and weapons and to create a spark for lighting a fire.

Today, we use diamond in drill bits because diamond is very hard. We use graphite in pencils because it is soft and will leave a mark on paper.

▲ This leaf-shaped spear point was used to hunt large animals on the plains of North America about 10 000 years ago.

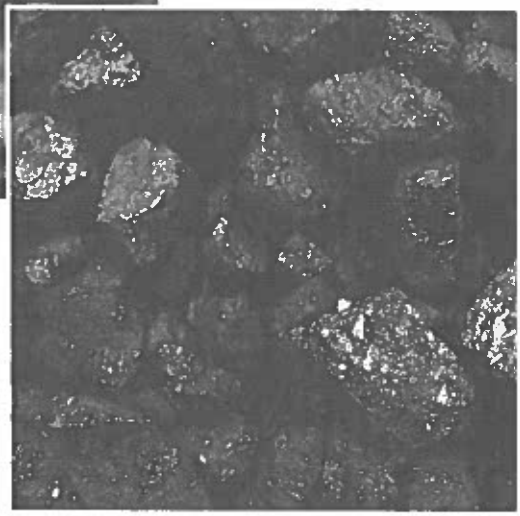
Rocks and Minerals From Saskatchewan

Saskatchewan has many valuable rocks and minerals that are turned into different products. Rocks, minerals, and their products, such as those shown below, are used locally or sold to other countries around the world.



◀ Uranium inserted into these rods is used in some power stations to produce electricity.

◀ More than 90% of the world's potash is used in fertilizers.



▲ Coal is also used to produce electricity.

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Work On It

In this activity, you will discuss your list of photo ideas and organize them into a table.

What You Will Do

1. Discuss the lists you made while you were reading about the uses of rocks and minerals.
2. Create a four-column table with the headings "Building," "Decoration," "Tools," and "Saskatchewan." Place each item in your list in one of the four columns. Some items may fit in more than one column.
3. Choose one item from your table, and state which rock or mineral is used for it. Then explain the properties of the rock or mineral that make it suitable for this use.
4. Suggest materials other than rocks and minerals that could be used for building, for decoration, or for making tools.

Communicate

1. Choose one of the following ideas to show what you have learned about rocks and minerals:

a) Be a landscape designer. Plan an interesting decoration for a garden using rocks and minerals. Which kinds of rocks and minerals will you choose? Give reasons for your choices. Draw a picture of your decoration.

b) Be a geologist. Look around your classroom for things made using rocks and minerals, such as computers, chalk, and phones. Be a geologist at home, as well. Record all the things made from rocks or minerals that you can find in your home. Create a poster or computer presentation to display what you found.

c) Which rock or mineral do you think it would be difficult to live without? Prepare a short speech to convince others that you have made a good choice.

Lesson 7

What Are Fossils?

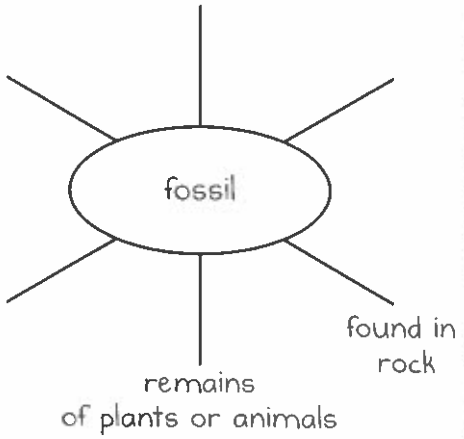
Goal To learn about types of fossils

Get Started

Rocks give us clues to what Earth was like in the past. One way we can learn about the past is by studying fossils. You may have seen fossils in museums. You may have even found fossils in the rocks you have been examining in this unit. Most people think that fossils are hard to find because there are not many of them. In fact, there are billions of them. You can find fossils almost anywhere in the world if you know what to look for and where to look. Think about how igneous, sedimentary, and metamorphic rocks are formed. Which type of rock do you think is the most likely to contain fossils?

Work On It

1. Work with a partner to write your own definition of "fossil." You can include drawings with your definition, if you wish. As you read this lesson, you may want to add to your definition.
2. Place a blank piece of paper on the desk in front of you and your partner. Write the word "fossil" in the centre of the paper, and circle it. As you read this lesson, add information to create a mind map about fossils.



What Is a Scientific Idea of a Fossil?

In your definition of "fossil," did you mention the remains of dinosaurs? For scientists, fossils are much more than the remains of dinosaurs. Fossils can be the shells, bones, or teeth of animals. They can be the leaves, pollen, or woody stems of plants. Fossils can even be the bones or teeth of ancient people. In other words, a **fossil** is the remains, imprint, or trace of a plant or animal that lived long ago.

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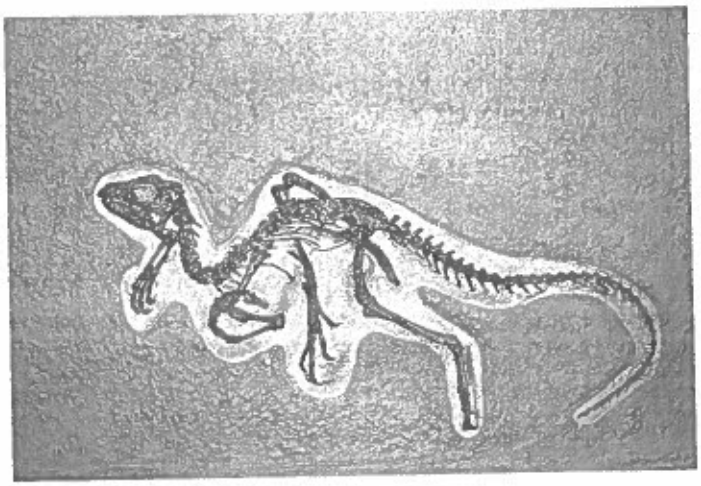
How Fossils Form

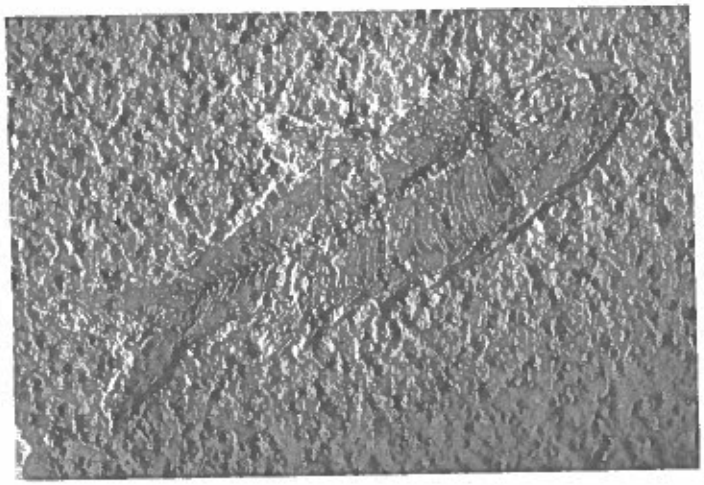
Fossils are found in sedimentary rock, such as limestone, sandstone, or shale. You have learned that sedimentary rock is formed when bits of soil, rocks, minerals, and shells settle in layers on land or on the bottoms of rivers, lakes, and oceans. After a very long time, these layers squeeze together and harden into rock. The remains of plants and animals are sometimes buried in this sediment. The skin and flesh of animals rot away. However, the hard parts, such as the bones and teeth, may remain and form fossils.

According to Elder Betty McKenna, the Anishinabe have a different explanation of how fossils formed. They tell of a good brother and a bad brother who lived long ago, when there were huge animals and insects on Earth. The bad brother made these huge animals and insects poisonous. The good brother tried to make them smaller so they would be less dangerous. He also tried to take away their poison. The brothers fought. As they fought, they crashed into each other. The huge crash caused an explosion that sent dust into the sky. The dust covered the Sun. The big animals dropped where they were standing and were covered with soil. They died under the soil, and their bones stayed there until people dug them up.

▲ Fossilized fern



▲ Fossilized dinosaur



▲ Fossilized fish

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Common Fossil Types

Type of Fossil	Definition	Example
trace fossil	an impression of a footprint or burrow found in a rock. These impressions are not actual remains of an animal or a plant, but they still teach us a lot about ancient life.	
mould fossil	an empty space in a rock, where a whole plant or animal has decayed	
cast fossil	minerals and sediment that have seeped through a rock and hardened to form the shape of the fossil mould	
petrified fossil	bone or shell material is replaced by minerals	

Learning From Fossils

Scientists who study fossils are called **paleontologists**. Often, paleontologists find fossils that are only pieces of plants and animals. They may not find all the pieces. Their job is like putting together a jigsaw puzzle with missing pieces, and there is no picture of how the completed puzzle should look!

Paleontologists take special care when bringing fossils back to a laboratory, where they test, measure, and study them to figure out their age. Their observations can sometimes tell scientists what might have happened on Earth during the time that the fossilized plant or animal lived.

▲ Paleontologists at work

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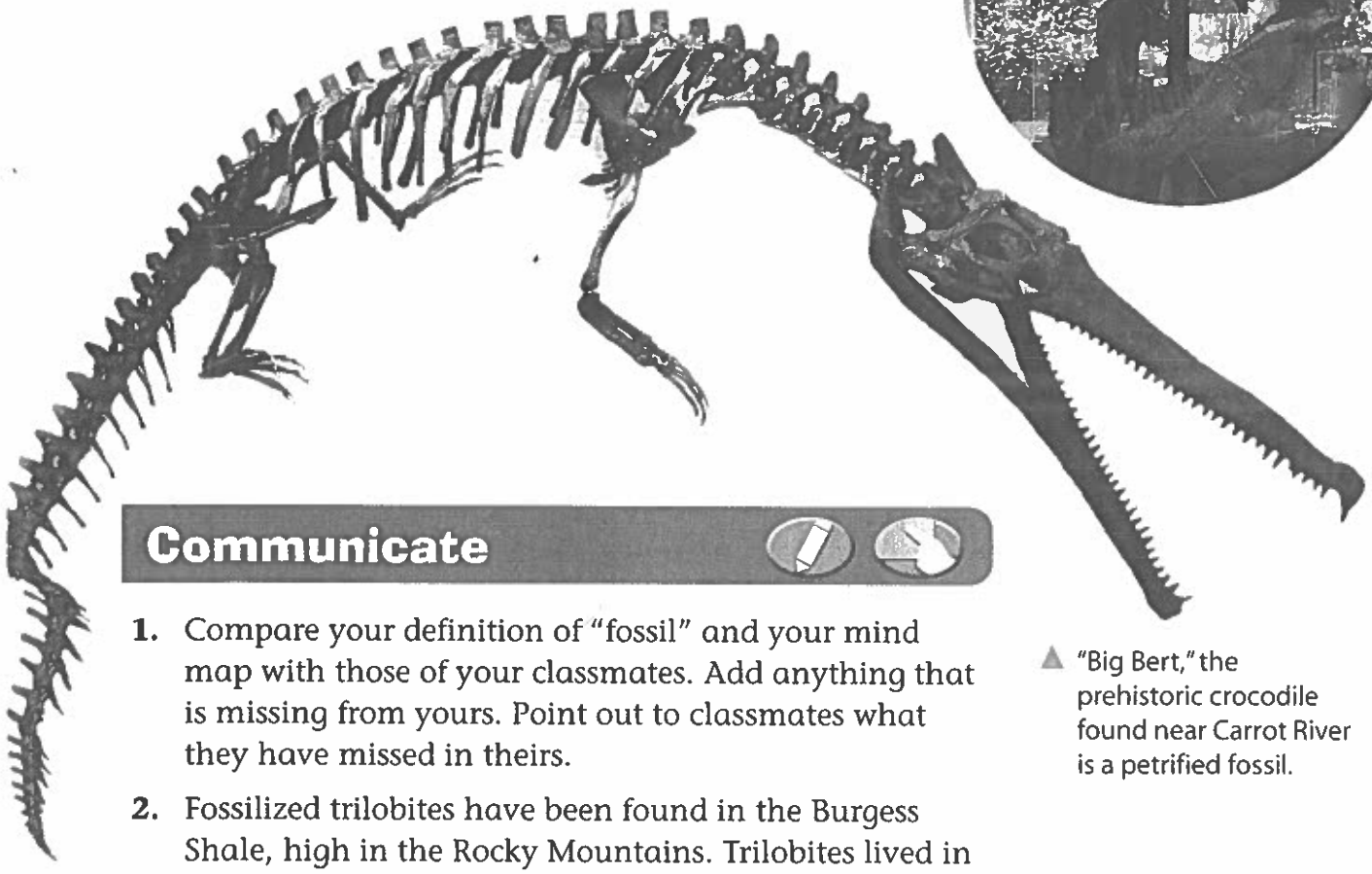
Fossils in Saskatchewan

Fossils have been found throughout Saskatchewan. Eastend, in southern Saskatchewan, is well known for fossil discoveries, such as *Tyrannosaurus rex* bones. The fossilized remains of a large prehistoric crocodile, *Terminonarus robustus*, were found along the banks of the Carrot River in northern Saskatchewan. Stories of ancient crocodiles living in the area are part of the First Nations and Métis oral tradition. Elders and Knowledge Keepers know the history of the land and relate stories of the different animals that lived in the province in the past.

▼ This *T. rex* skull was created based on bones discovered near Eastend, Saskatchewan.



▲ "Big Bert," the prehistoric crocodile found near Carrot River is a petrified fossil.

Communicate

1. Compare your definition of "fossil" and your mind map with those of your classmates. Add anything that is missing from yours. Point out to classmates what they have missed in theirs.
2. Fossilized trilobites have been found in the Burgess Shale, high in the Rocky Mountains. Trilobites lived in ancient seas. Why would sea creatures be found near the tops of mountains? Research how trilobite fossils helped paleontologists learn about the history of the area and the formation of mountains.
3. Pretend that you are a paleontologist in the past, present, or future. What types of animal or plant fossils would you expect to find in Saskatchewan? To help you figure this out, research what Saskatchewan was like thousands of years ago. How was the climate different then? What types of animals roamed the province?

WHAT ARE FOSSILS?

A fossil is a rock containing the preserved remains of once living animals or plants. A **fossil is, to a scientist, any trace, impression or remains of plant or animal life of long ago that has been preserved by burial in the earth or under the sea for anywhere from thousands of years to hundreds of millions of years.** The imprint of a shell, the skeleton of a bird, the scales of a fish, the outline of a leaf, the bones or footprint of a dinosaur or the petrified limb of a tree all can be considered fossils. Fossils have been found from every era and period. Since fossils form most readily in sediments, laid down on the floor of the sea, more than 90% of all known fossils are marine animals.

The remains of plants are common but they are very difficult to identify because they generally consist of a single leaf or other fragments. Insect fossils are fragile and very rare. The average collector seldom finds vertebrate fossils.

Most of the fossils known today are of plants and animals that are now extinct. A few however have modern descendants that have kept many of the features of their prehistoric ancestors. They are often called "living fossils" because they are living things that have come down to the present time without changing too much from their age-old ancestors, known to us by means of their fossil prints in rock.

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Lesson

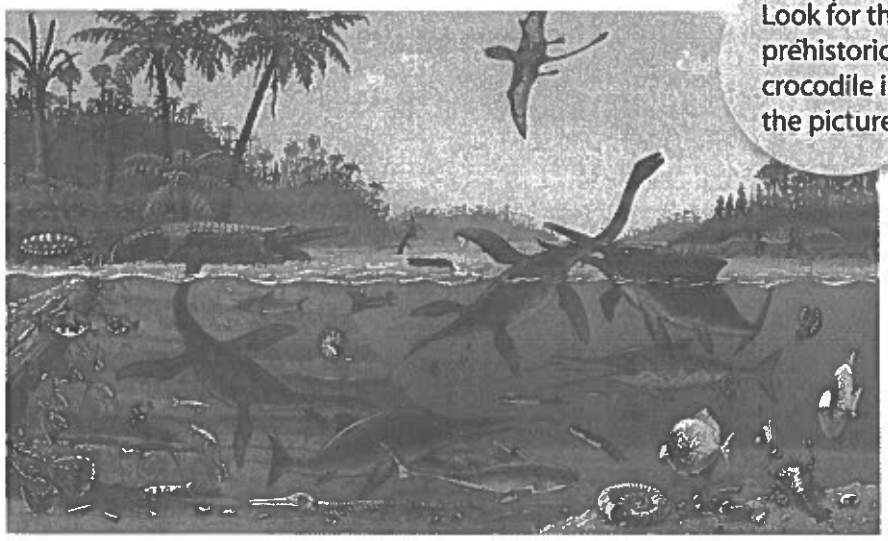
8 Making Fossils

Goal To create models of fossils

Get Started

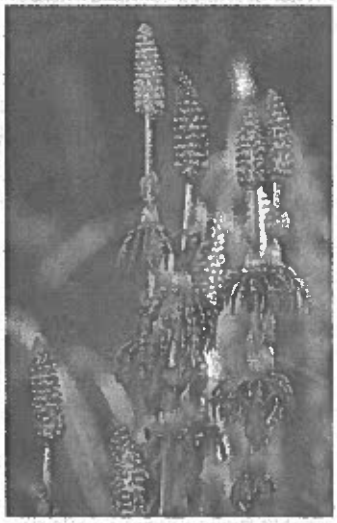
Fossils help us picture what Earth was like thousands or even millions of years ago. If you compare fossils of ancient animals and plants with the animals and plants of today, you can see how they have changed. You will also see how some have stayed the same.

Paleontologists have found fossils of dinosaurs, which are extinct. That is, they no longer exist. Scientists have also found fossils of turtles, crocodiles, horseshoe crabs, and cockroaches, which have changed very little since the age of the dinosaurs.



Look for the prehistoric crocodile in the picture.

About 300 million years ago, a common plant was a tree 20 m tall with a trunk 30 cm wide. Scientists who have studied fossils of this tree have called it a giant horsetail. It looks like a huge version of the horsetails found in Saskatchewan today.



Work On It

In this activity, you will create your own mould fossil and cast fossil.

What You Need

- small object, such as a seashell, a twig, or a leaf
- petroleum jelly
- plaster of Paris
- water
- spoon for mixing
- small plastic container

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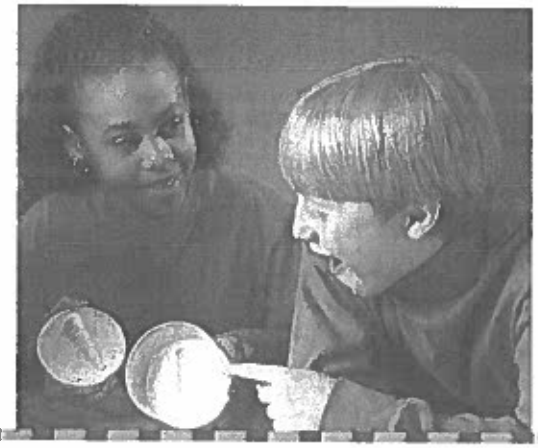
What You Will Do

1. As a group, select a small natural object. You will use plaster of Paris to create a mould fossil and a cast fossil of this object. Coat the object with a thin layer of petroleum jelly. The jelly will keep the plaster of Paris from sticking to the object.
2. Mix a small amount of plaster of Paris with water. The plaster should be thick and creamy, like yogurt. Pour it into the plastic container to fill it three-quarters full. Let the plaster sit until it is still soft but no longer liquid. The plaster is like the sediment that living things fell into when they died.
3. Press the small object into the plaster of Paris. The object should not sink into the plaster.
4. Place the container where it will not be disturbed. Let the plaster of Paris dry overnight. The plaster will form an imprint as it hardens.
5. When the plaster is dry, remove the object. The hole in the dry plaster is your mould. Now you will make a cast of the mould. First, spread a thin layer of petroleum jelly on the mould. Then, mix more plaster of Paris with water and pour it over the mould. Let the plaster dry overnight. The plaster represents the minerals and sediment that filled the mould. These minerals and sediment hardened to form a cast of the mould created by the plant or animal that died.
6. When the second batch of plaster is dry, carefully lift it off the mould. You have created a cast fossil.



Communicate

1. Display the fossils you made. Do not include the object you used to make them. Visit the displays of other groups. Look closely at their fossils. Then write a description of the object used to make them.
2. How can fossils teach scientists about different landforms and about Earth's history?
3. What does making a mould and cast fossil tell you about how rocks and minerals change over time?

With the help of an adult, make models of other types of fossils. Look for recipes and directions online. Type "how to make your own fossils" into your Web browser.

©P

Lesson 9

What Shapes Landscapes and Landforms?

Goal To create a model of a Saskatchewan landform or landscape

Get Started

Saskatchewan has many areas of land that are unique. These areas of land, called **landscapes**, have been formed over thousands of years. Large masses of ice, called **glaciers**, and the water left behind when they melted have created many of the landscapes you see in Saskatchewan today. Rivers, rain, and wind have also helped shape our landscape. Within the landscapes are different landforms. A **landform** is a naturally formed feature, such as a valley, plain, or hill.

Some landscapes and landforms in Saskatchewan are important to many First Nations and Métis peoples. They may be important for several reasons. If the people have lived in a certain landscape for hundreds or thousands of years, the landscape becomes part of who they are. Some landforms may be sites of important ceremonies or other cultural activities.

▶ Buffalo jump at Wanuskewin Heritage Park

Wanuskewin Heritage Park, located outside Saskatoon, is one example of an important landscape. Archeologists have evidence that early Plains people lived there for thousands of years. The area is very close to the South Saskatchewan River. The valley along the river provided shelter and water for those who lived there. The area has a buffalo jump that was used for hunting.

©P

Work On It

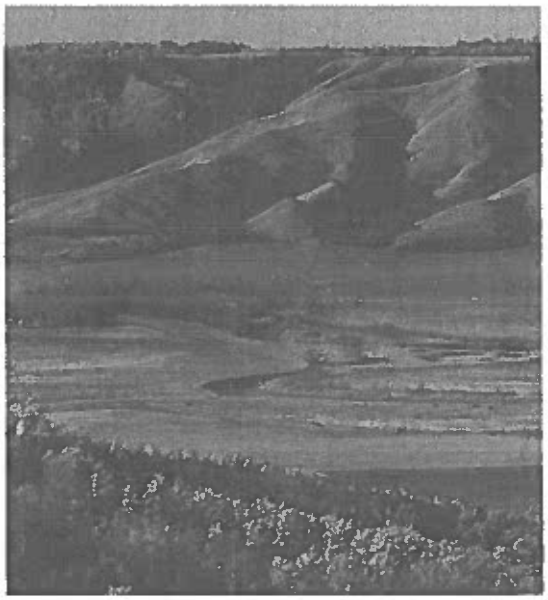
In this activity, you will create a model of a Saskatchewan landscape or landform.

What You Will Do

1. Choose any Saskatchewan landscape or landform. An example is shown here.
2. Create a model of the landscape or landform you chose. You can use modelling clay to shape a landform on the cardboard, or you can make a diorama in the shoebox, using any of the materials listed.
3. Label your model.
4. Draw an outline map of Saskatchewan. Put a dot where your landscape or landform is located in the province.
5. Over the next few weeks, look in newspapers or on the Internet for stories about how the weather has changed the land and people's lives. Bring the articles to class. Be prepared to share and discuss them with your classmates.

What You Need

- photos of Saskatchewan landscapes or landforms
- modelling clay
- cardboard, at least 30 cm by 30 cm
- craft sticks
- shoebox
- pencil crayons or markers
- scissors



Qu'Appelle Valley

Communicate

1. Explain your reasons for choosing the landscape or landform that you modelled.
2. List three or four questions you have about this landscape.
3. Research the answers to your questions.
4. What do you think caused Saskatchewan to have such a variety of landscapes and landforms?

Lesson

10 Weathering and Erosion

Goal To discover how weathering and erosion affect the environment

Get Started

Imagine that there is a large, interesting rock in front of your school. Every day, when you walk by it, it always seems to look the same. However, if you could time travel 1000 years into the future, you might notice a few small changes in the rock. Rocks are always changing. The changes are usually so slow that you do not notice them.

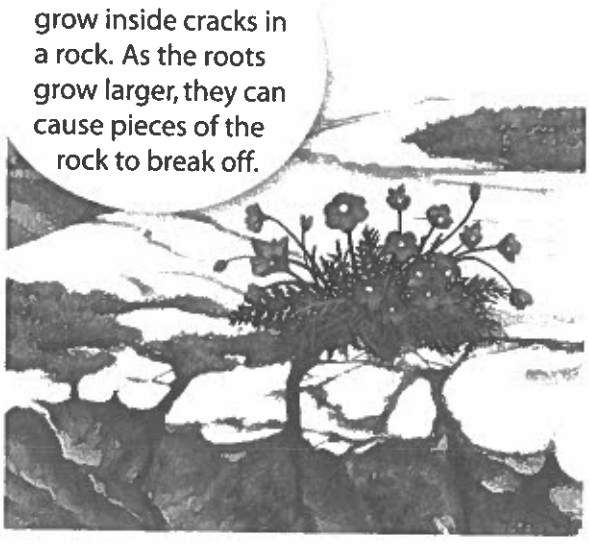
Most of the changes in rocks and minerals are caused by weathering and erosion. These are two terms that geologists use. Many First Nations and Métis peoples believe that wind and water made the land the way it is, when Creator shaped Mother Earth.

▲ Water seeps into cracks in a rock and then freezes. The ice expands, and the cracks become larger. Over time, pieces of the rock break off.

Weathering is a long and very slow process. It breaks rocks and minerals into small pieces.

There are many different ways weathering can happen. Water, wind, temperature change, and plant life can all contribute to weathering. For example, over time, wind blowing sand or dust against a rock or a building will wear it down.

Another cause of weathering is acid rain. Chemicals from car exhaust and factories become air pollution. When rain falls through the air pollution, the chemicals mix with the water and form acid rain. Acid rain can weather rocks, statues, and buildings.



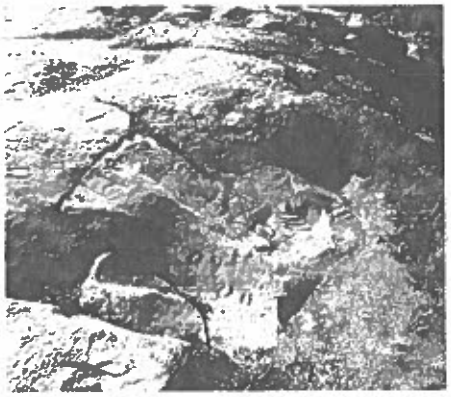
Plant roots often grow inside cracks in a rock. As the roots grow larger, they can cause pieces of the rock to break off.

An example of weathering can be seen in the ancient rock carvings that are found in the sandstone cliffs around St. Victor, Saskatchewan. Some or all of the carvings are believed to have been made, at different times, by ancient peoples. The carvings are wearing away.

©P

A sizable chunk of the carved rock appears ready to break off. This weathering is happening because of the wind, water, and temperature changes that occur in Saskatchewan. Water gets into the cracks in rocks. When it freezes, it breaks the rock apart. The wind and rain help to polish the rock, giving it a smooth surface.

Erosion occurs when bits of rocks and minerals are carried away by water, wind, gravity, or glaciers. Eventually, all these bits of rocks and minerals settle into layers and form new sedimentary rock. Tiny pieces of rock can also mix with rotting plant and animal matter to form soil over hundreds of years.



▲ Rock carvings near St. Victor include images of animals, birds, and humans.

Work On It

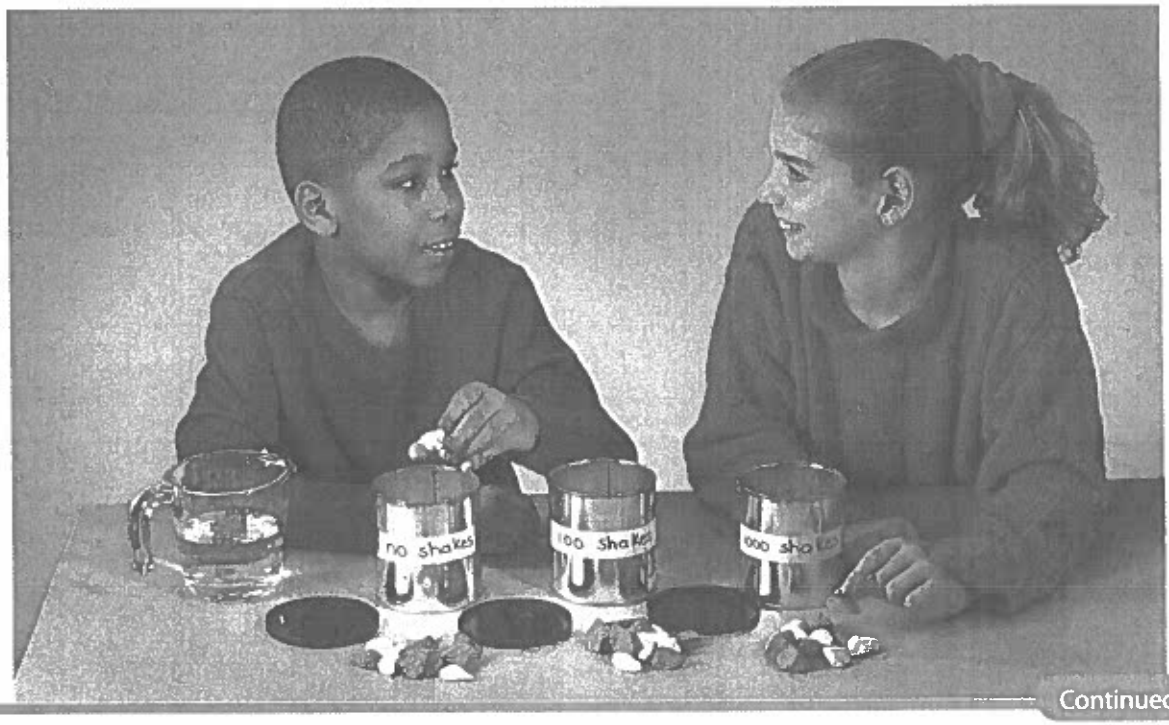
In this activity, you will learn about the process of weathering.

What You Will Do

1. Label one can "no shakes," label another can "100 shakes," and label a third can "1000 shakes." Do the same for the plastic containers.
2. Half fill each can with water.
3. In each can, put two jagged rocks and two soft rocks.

What You Need

- 3 cans with lids
- water
- felt marker
- at least 6 jagged rocks
- at least 6 soft rocks (or pieces of brick)
- sieve
- 3 empty plastic containers

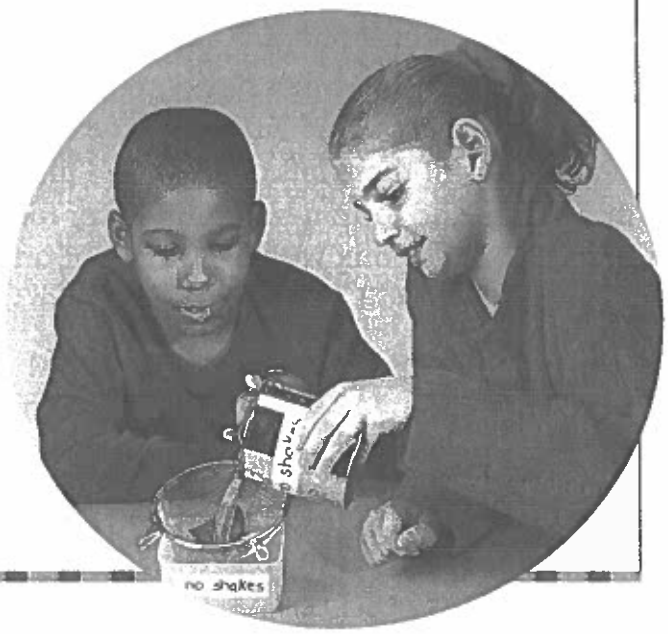


Continued →

4. Do not shake the can labelled "no shakes." Shake the can labelled "100 shakes" 100 times very hard. Take turns shaking the can, so that no one gets tired. Then, shake the third can 1000 times very hard, again taking turns.

5. Open the cans, and remove the rocks. Keep the rocks from the three cans in separate piles. Pour the water from each can through the sieve, into the plastic container with the matching label. Put whatever remains in the sieve back into the labelled can.

6. Draw pictures and write a description of the rocks, the water, and what remains in each can.



Communicate

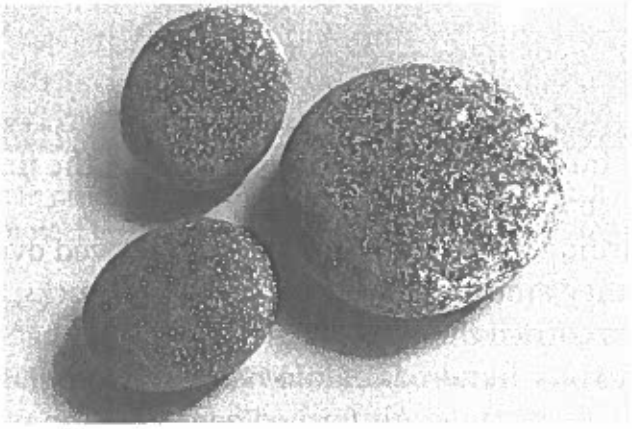
▲ Sandbars in the South Saskatchewan River

1. How can natural elements, such as wind and water, create or change a sandy beach, sandbars in a river, or a rounded rock formation?
2. Look at the photo below of the giant sand dunes in the Great Sand Hills north of Maple Creek. How do you think they formed?

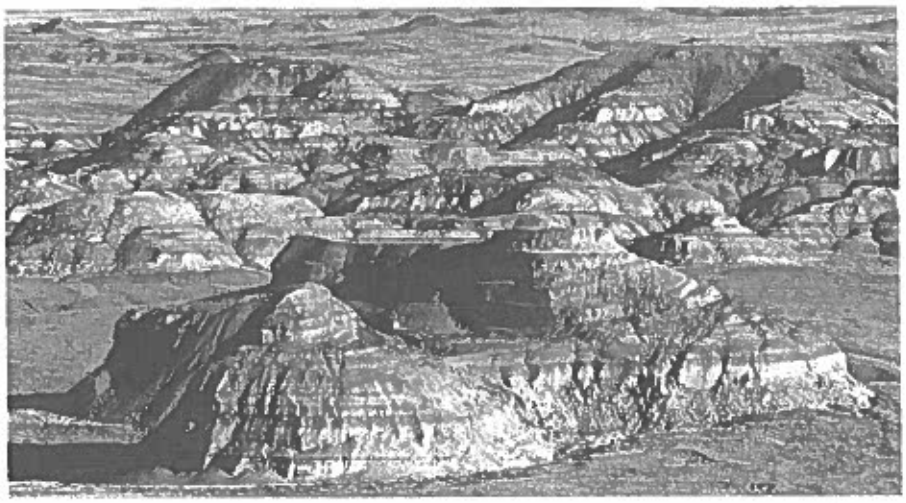
©P

3. Explain how blowing wind, running water, and growing plants cause rocks to form soil over time. You may draw diagrams to help you explain your answer.

4. Look at the photo below. Predict where you think these rocks were found. Explain your thinking.



5. Look at the photo below of a landform in Killdeer Badlands in Grasslands National Park, Saskatchewan. Consider whether this landform has weathered over time. How do you think it has changed or will change? Research to find out whether your idea is correct.

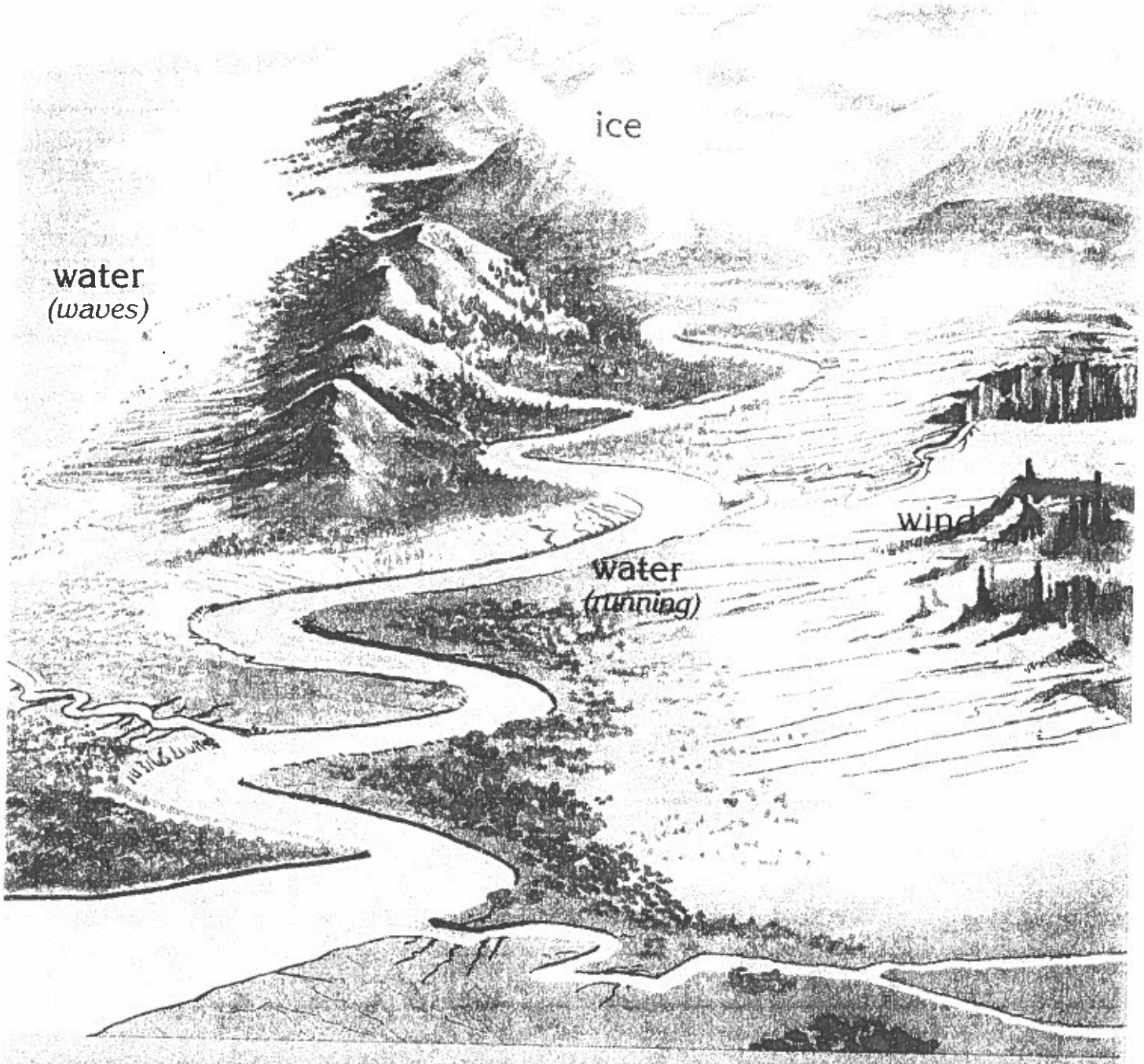


Build On What You Know

Erosion can occur as a result of extreme weather, such as flooding or mudslides. Research some examples of erosion caused by extreme weather. How did people try to prevent future erosion? Review your research when you work on your Design Project.

Erosion

Erosion is the continuous wearing away of land by wind, water, and ice.



1. What are the major agents of erosion?
2. Where are glaciers mostly likely to be found?

STUDY QUESTION: Find out why gravity can be considered an agent of erosion.

Erosion

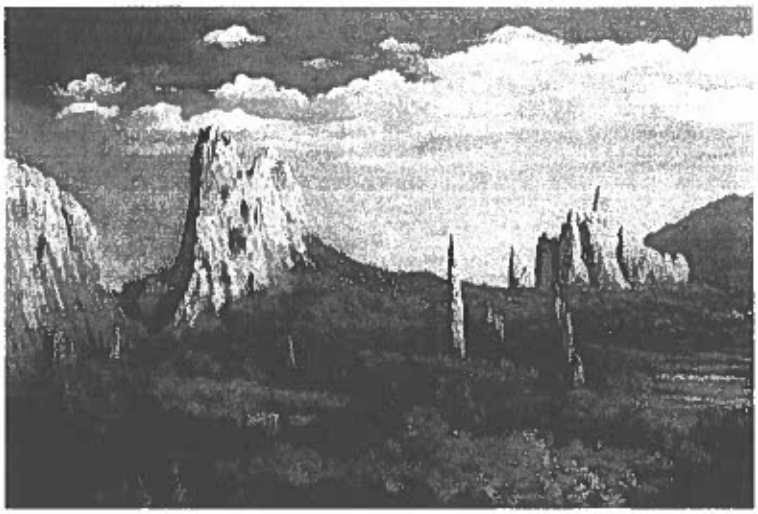
Erosion is the wearing away and carrying away of earth's soils. The major agents of erosion are ice, water, and wind.

Erosion is the wearing away of the land or carrying away particles of soil from the results of weathering. Erosion is carried on by waves, ocean currents, winds, streams, rivers, glaciers, and underground water. The force behind every kind of erosion-whether by water, ice, or wind is affected by the force we call gravity or ***gravitational force***. The earth exerts gravitational force on every object, tending to pull the object closer to its center.

Gravity pulls on a boulder, rolling downhill and eroding themselves and other objects in their path. Falling rain and water flowing downhill can cause erosion of mountains and deposit sand, soil, and debris into streams. Glaciers slowly slide down a valley under the influence of gravity. Wind moves fine particles by picking them up one place and dropping them somewhere else. It is a never ending cycle.

Running water is said to be the greatest of all erosive actions. As running water moves over the hardest of rocks, it can in time wear them away. It also carries with it materials resulting from weathering and deposits them into ponds, lakes, rivers, and oceans. This compiling of sediment is called ***deposition.***

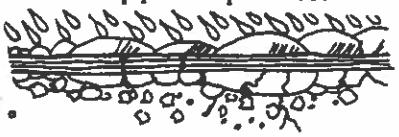
The continuous beating of ocean waves on land, the washing up of soil and rocks, and the action of tides all help wear away seashores. ***Wind*** carries away tiny particles of soil. Dust storms are the result of erosive power of wind. Wind can also pile up sand into ***dunes***. As windblown sand strikes solid rock, the abrasive action slowly wears the rock away. Such action produces rock formation like those seen in the Garden of the Gods, Colorado.



Garden of the Gods, Colorado

As masses of ice and snow move over the land, they wear away and carry rocks, soil, and other materials with them. These materials are deposited along the side or at the end of the glacier. U-shaped valleys are examples of what the erosive action of moving ice can do.

Soil, composed of weathered rock and humus, is the material on the earth's crust that supports plants.

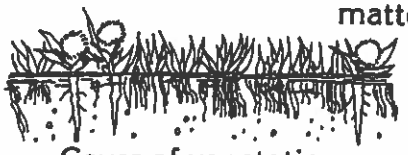


Rain, ice, thawing, and freezing break down rocks and some mineral particles.

Simple plants and animals begin to live on weathered rock.

Lichens produce acid; organisms die and deposit organic matter (humus).

Top layer of soil is formed and is able to support plant roots.



Cover of vegetation is formed; soil contains minerals.

Soil conservation is essential for man's survival today and in the future.

Ways to Conserve Soil

Contour plowing

Cultivated rows run sideways, rather than up and down, on hillsides. This slows down the water as it flows down hillsides.

Terracing

Step-like ridges are built, arranged sideways on a hill. This holds and slows down water and soil being carried away.

Strip cropping

Different crops are grown on the same piece of land. A large area of corn grows next to a large area of ground cover (alfalfa). The next year the crops grown in these areas are reversed. The ground cover crop catches and holds any soil washed away from the other crop.

Shelter belt

Rows of trees are planted close together to help force wind movement upward, away from the ground.

Erosion and Deposition

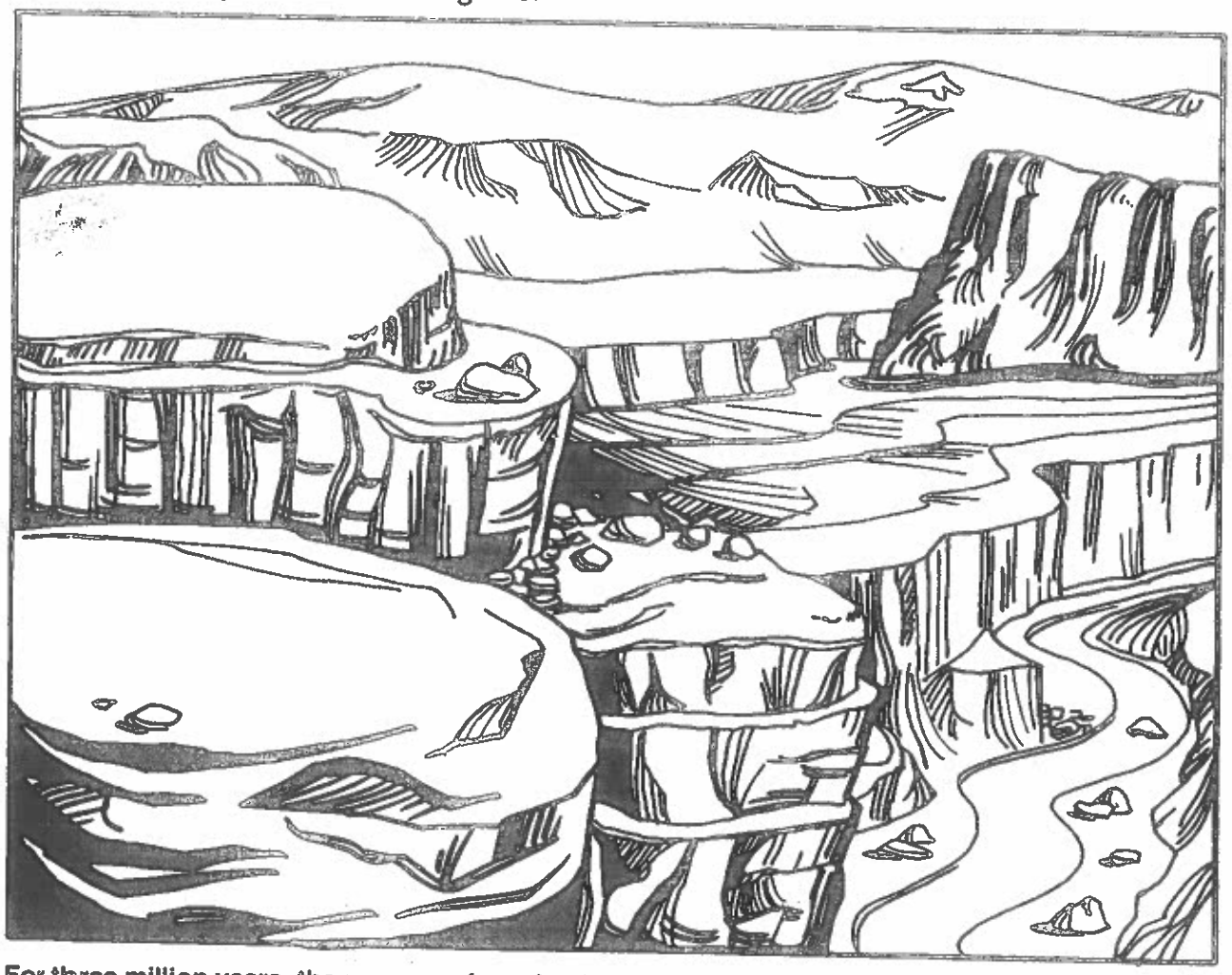
Weathering is the process that breaks down rock into smaller pieces. There are several different ways in which this can occur. Once the weathering process has occurred, other processes take over.

Erosion is the process of carrying away weathered material. The agents of erosion include moving water, ice, waves, and wind. *Deposition* is the process of laying the weathered material down in a new location.

Most of the time, erosion is a gradual process. It may take millions of years for the agents of erosion to make noticeable differences in the Earth's surface. The Grand Canyon in Arizona is the result of close to three million years of erosion.

Erosion, however, can also act very rapidly. An unusually rainy period can cause rivers to overflow their banks and flood the areas surrounding them. The erosion caused by the rapid rivers and their flooding action can have very quick, devastating results for the Earth's surface and especially for its inhabitants.

In the next few pages, we will look at moving water, ice, waves, and wind as the agents of erosion. We will see how each agent works. We will also investigate the effects of deposition by each of these agents.



For three million years, the process of erosion has been creating the Grand Canyon.

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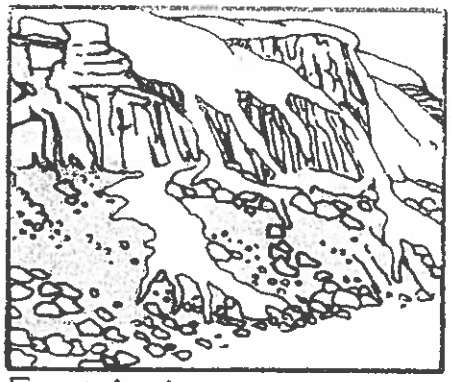
Weathering

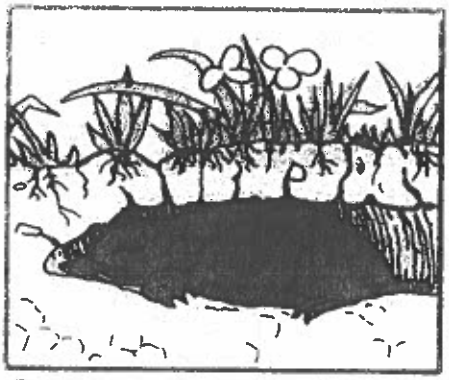
Weathering is the process of breaking rocks into smaller pieces by the action of ice, water, temperature changes, and chemical means.

Mechanical or Physical Weathering

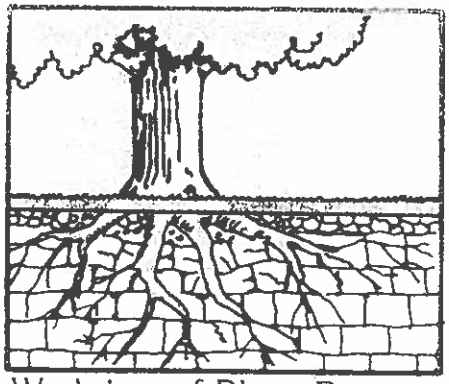
Mechanical or physical weathering breaks up rock into smaller fragments without any chemical changes in the rock itself.



Frost Action
repealed freezing and melting of water in pores of rock



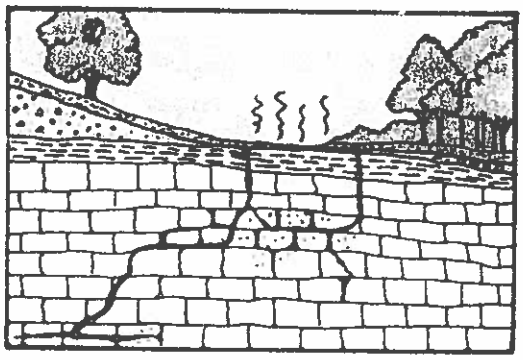
Burrowing Animals
expose areas for weathering



Wedging of Plant Roots
Pressure from rootlets causes rock breakdown.

Chemical Weathering

Chemical weathering acts on the small fragments and rearranges the elements into new minerals which are more easily carried away.



Carbon dioxide (CO_2) in air dissolves in water and forms carbonic acid.

Lichens grow on rocks and then give off an acid.

Oxidation

magnetite *(black color)* + oxygen (O) *from air* = hematite *(red color)* + water (H_2O) = limonite *(yellow-brown color)*

1. Describe the process of mechanical or physical weathering.
2. Compare the process of chemical weathering to mechanical weathering.

STUDY QUESTION: Find out why chemical weathering takes place more rapidly in warm regions than in cold regions.

Weathering

Weathering is the process of breaking rocks into smaller pieces by the action of ice, water, temperature changes, and chemical means. There are two kinds of weathering: mechanical and chemical.

The breaking down of rocks, ***weathering***, has been and is taking place on the earth constantly. There are two kinds of weathering- mechanical\ physical and chemical. Rocks at down below the earth's surface change very little with time. As soon as this rock is exposed at the earth's surface, a variety of agents work relentlessly at breaking down of these surfaces.

Mechanical weathering: breaks up rock into smaller fragments without any chemical changes in the rock itself. This occurs in a number of ways.

a) ***frost action:*** water seeps into cracks and pores in a rock and freezes, expands, exerts pressure within the crack or pore and causes pieces of rock to break off.

b) ***wedging plant roots***: the roots of shrubs and trees work their way into small cracks in a rock causing the rock to split and crumble.

c) ***burrowing animals:*** animals such as gophers and prairie dogs expose rock surfaces by their constant digging. The exposed surfaces are now subject to the weathering processes.

Chemical weathering: acts on the small fragments and rearranges the elements into new minerals which are more easily carried away. A chemical change takes place in the rock. Areas where water is present or the air is ***humid*** are subject to chemical weathering.

a) ***carbonic acid:*** when carbon dioxide(CO_2) from the air dissolves in water, a weak acid, carbonic acid is formed. This acid attacks rocks such as limestone.

b) ***lichen growth:*** lichen are tiny plants that grow on rocks and produce an acid that attacks the rock and helps break it into smaller pieces. Lichens use minerals from the rock to live, grow, and produce the rock breaking acid.

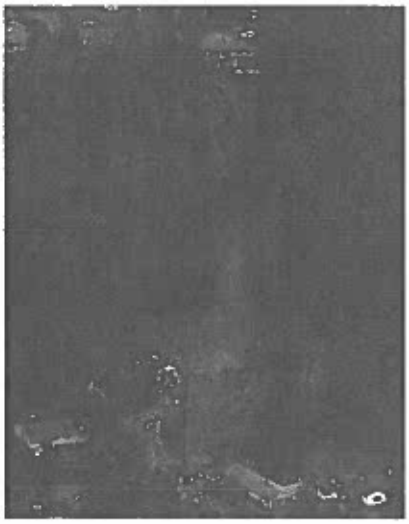
c) ***oxidation:*** oxygen in the air combines directly with many minerals in rocks, forming new materials or rocks that can change into another material or rock type which crumbles more easily than the original rock.

Lesson
11 What Changes the Landscape?

Goal To explore the changing landscape

Get Started

▲ There are still glaciers in many parts of the world, including Canada. Perhaps you have seen Victoria Glacier when visiting Lake Louise, in the Canadian Rockies.



▲ Heavy rains in 2005 caused this mudslide, which destroyed two homes in North Vancouver, BC.

Look out a window, and imagine what the landscape might have been like 20 000 years ago. Did you imagine a huge ice sheet? Most of Canada was buried under two kilometres of ice 20 000 years ago. It was the time of The Great Ice Age.

During this time, as huge glaciers moved over the land, they eroded clay, sand, gravel, and rocks. The glaciers carried these materials within and beneath the ice, often for hundreds of kilometres. As the glaciers melted, these materials formed gently rolling plains and hills. The melting ice also released a huge amount of water. Giant rivers carved deep valleys, such as the Qu'Appelle and Frenchman Valleys. Many large glacial lakes formed where melt water was trapped in low areas in front of the ice. As the lakes dried up, they revealed areas of very flat land. The materials that were deposited in glacial lakes and formed the gently rolling plains became the rich soil that is now prairie farmland.

What Causes Fast Change?

You have learned how weathering and erosion can slowly change a landscape. Some things can quickly change a landscape. Extreme weather, such as floods, tornadoes, hurricanes, and heavy rainstorms, can cause huge changes to a landscape in a short time.

People can also change a landscape. Sometimes, logging companies, mining companies, and farmers remove all the trees in an area. The roots of plants hold the soil in place. Without these roots, the soil can more easily be blown away by wind or washed away by rain or rivers.

Controlling Erosion

However, erosion and weathering can be reduced and controlled. In Saskatchewan and around the world, methods have been used to protect against weathering and erosion.

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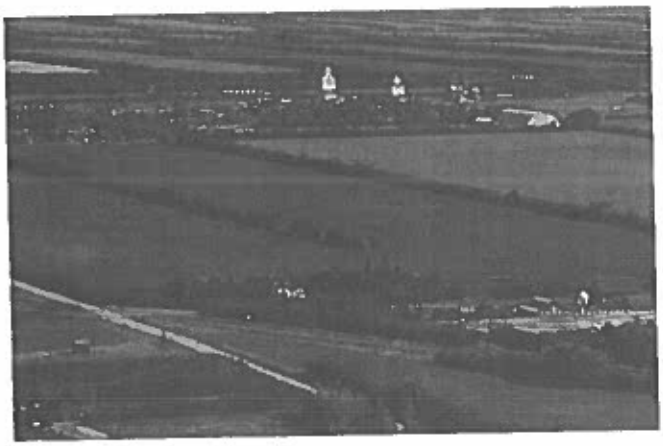
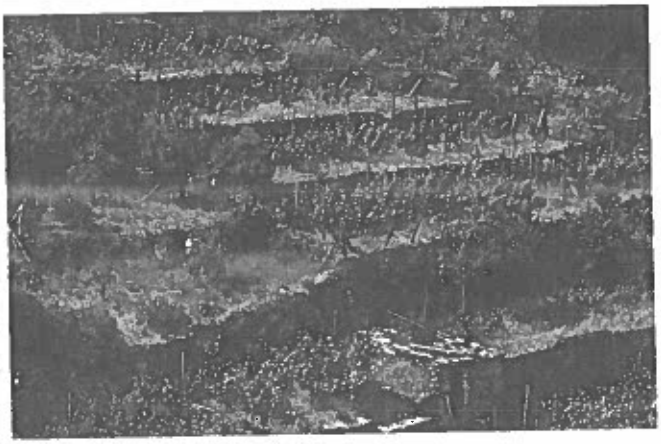


▲ Windbreaks planted along the edge of fields are used to protect the soil from blowing wind.



▲ In Italy, a series of steps, or terraces, are used to slow the flow of water down sloping land.

Work On It

In this activity, you will look at methods used to reduce erosion.

1. Look at the following photos with a partner. Write down how you think erosion is being reduced in each photo.

2. Research other methods that are used around the world to prevent erosion.

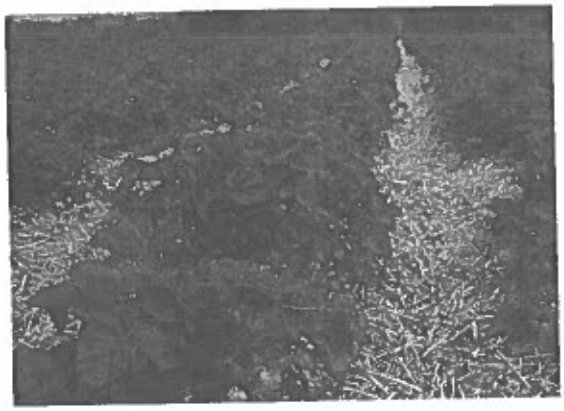


Photo #1

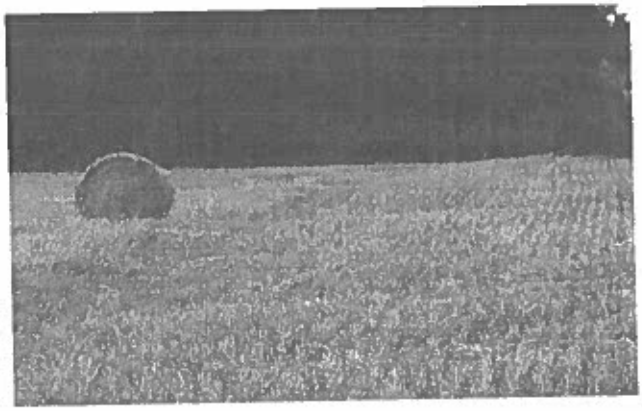


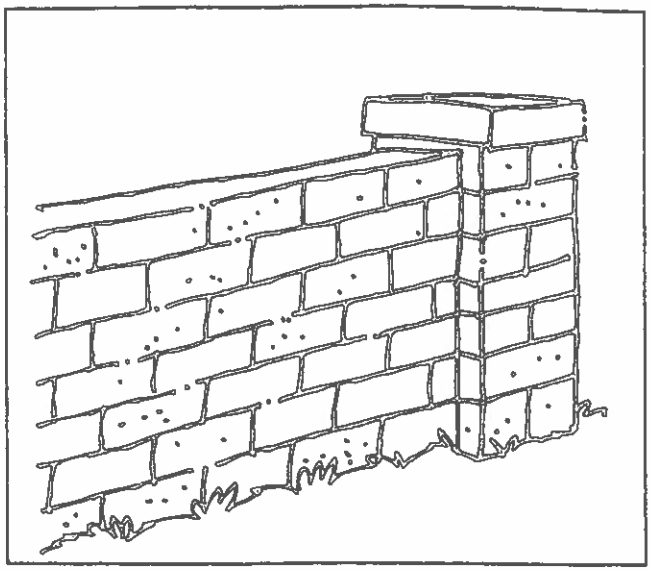
Photo #2

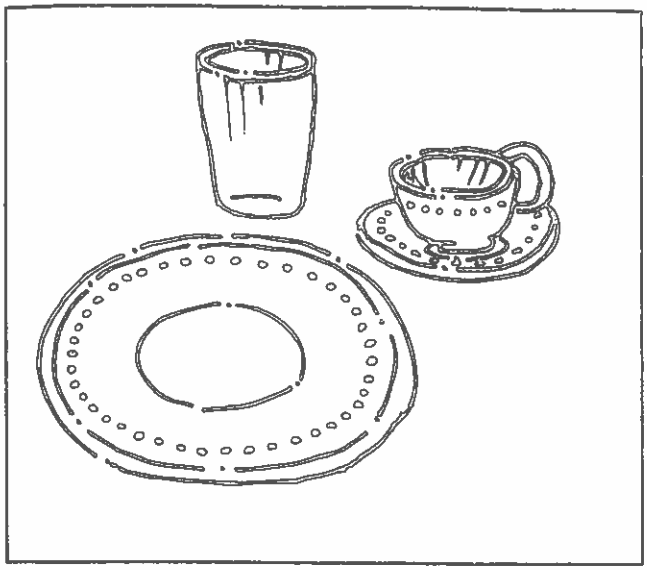
Communicate

1. List some of the methods that are used in other countries to stop erosion. What makes each method suitable for its location?
2. Name two methods that would not be suitable to use in Saskatchewan. Explain your choices.

The Earth Gives Us What We Need

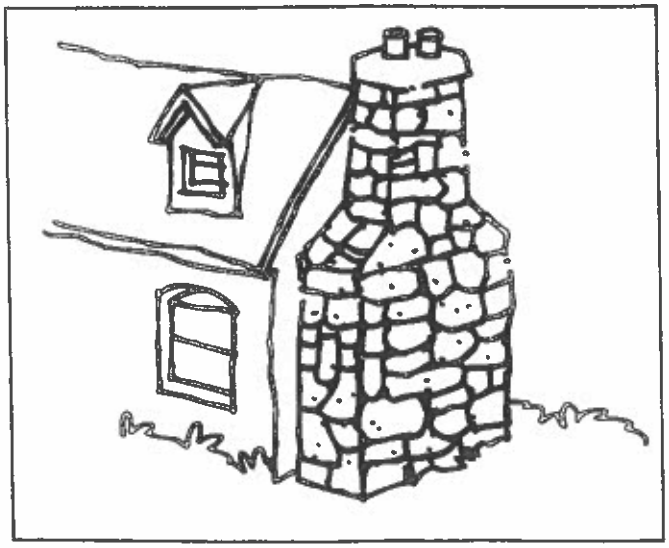
People have learned how to use the natural resources that are found in the Earth's crust. Let's learn about some of the resources we use.

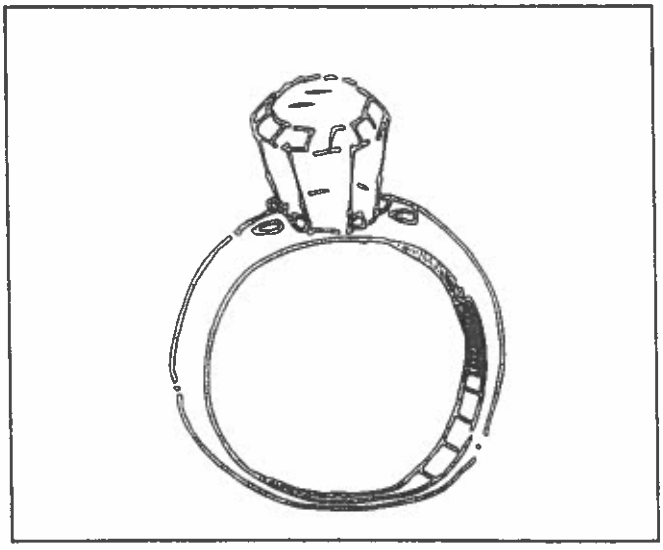




Rocks

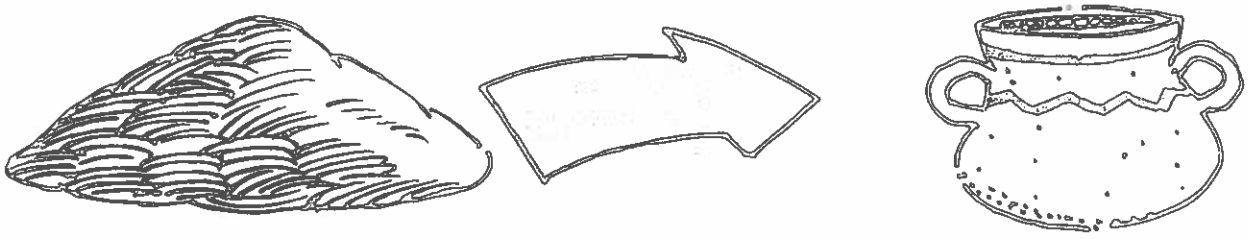
We use rocks for many things. Fences, chimneys, and walls are built of cut stones. Statues and monuments are made of polished stones like marble. A hard rock called granite is use to build roads. Precious stones like diamonds are made into jewelry.



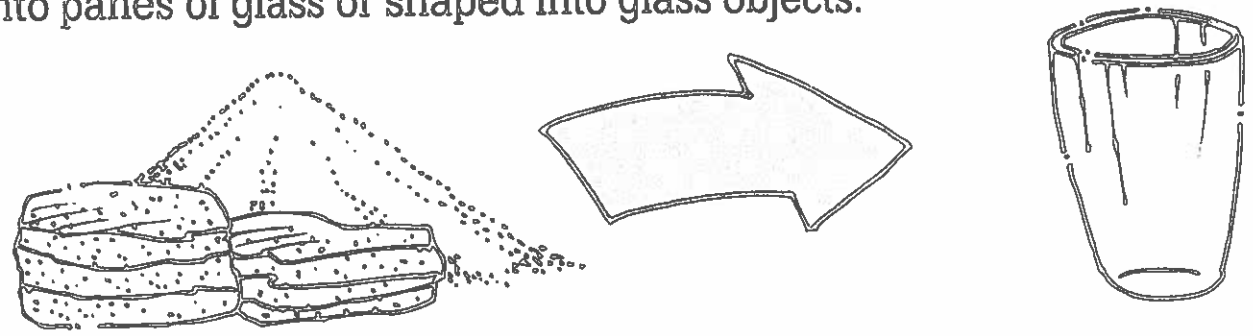


Some Rocks are Changed

Clay is soft and can be easily shaped into pots, dishes, or other forms. When the clay is baked in a special oven, it becomes very hard.

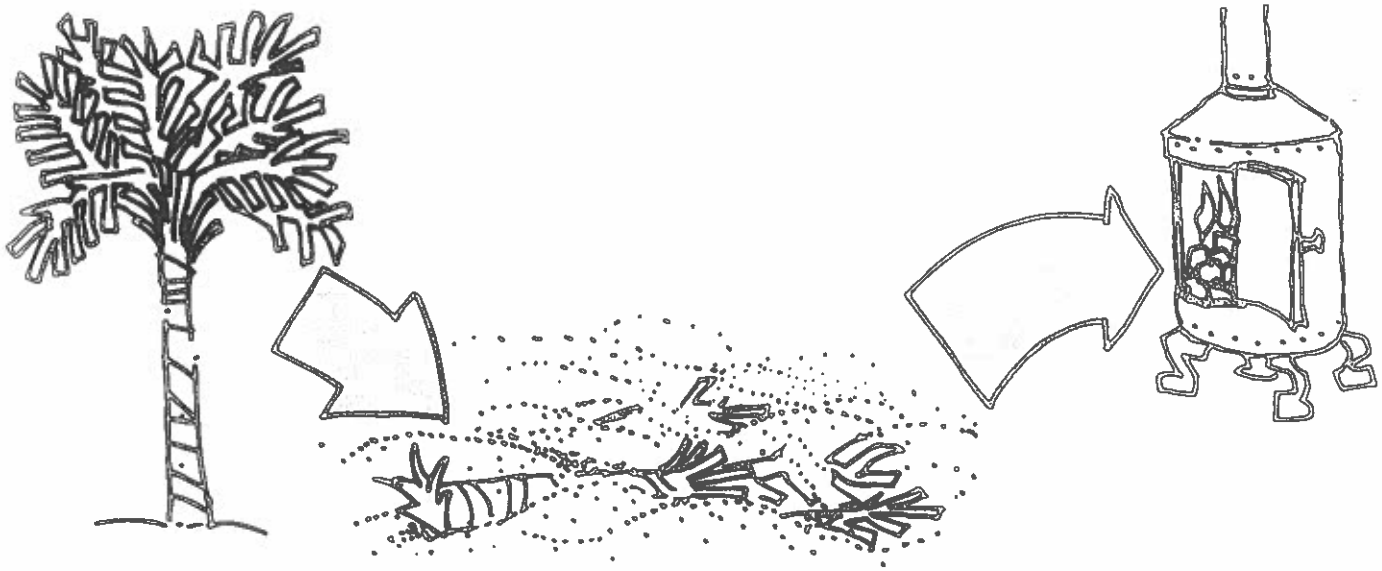


Did you know that glass is made from rocks? Sand and limestone are melted together. While the glass is still hot and soft, it can be stretched into panes of glass or shaped into glass objects.



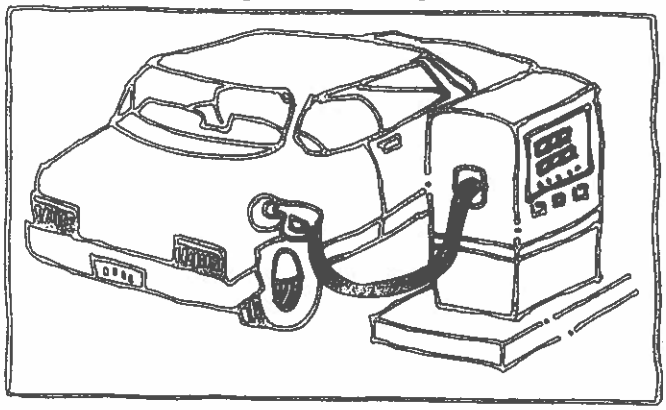
Coal

One of the most useful rocks is coal. People in many parts of the world burn coal for fuel. Coal was made from trees and plants that died millions of years ago. They were covered in mud and sand. As time passed, they were slowly turned into rocks called coal.

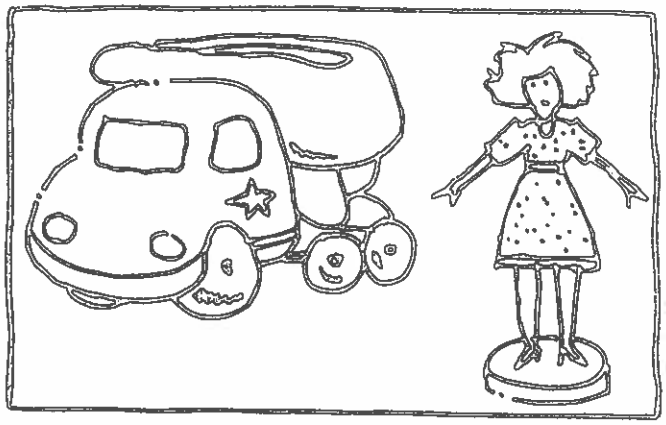


Petroleum

Petroleum is a dark, oily liquid found in the Earth. It was made from living things that died and were buried in mud and sand. After millions of years they turned into drops of oil.



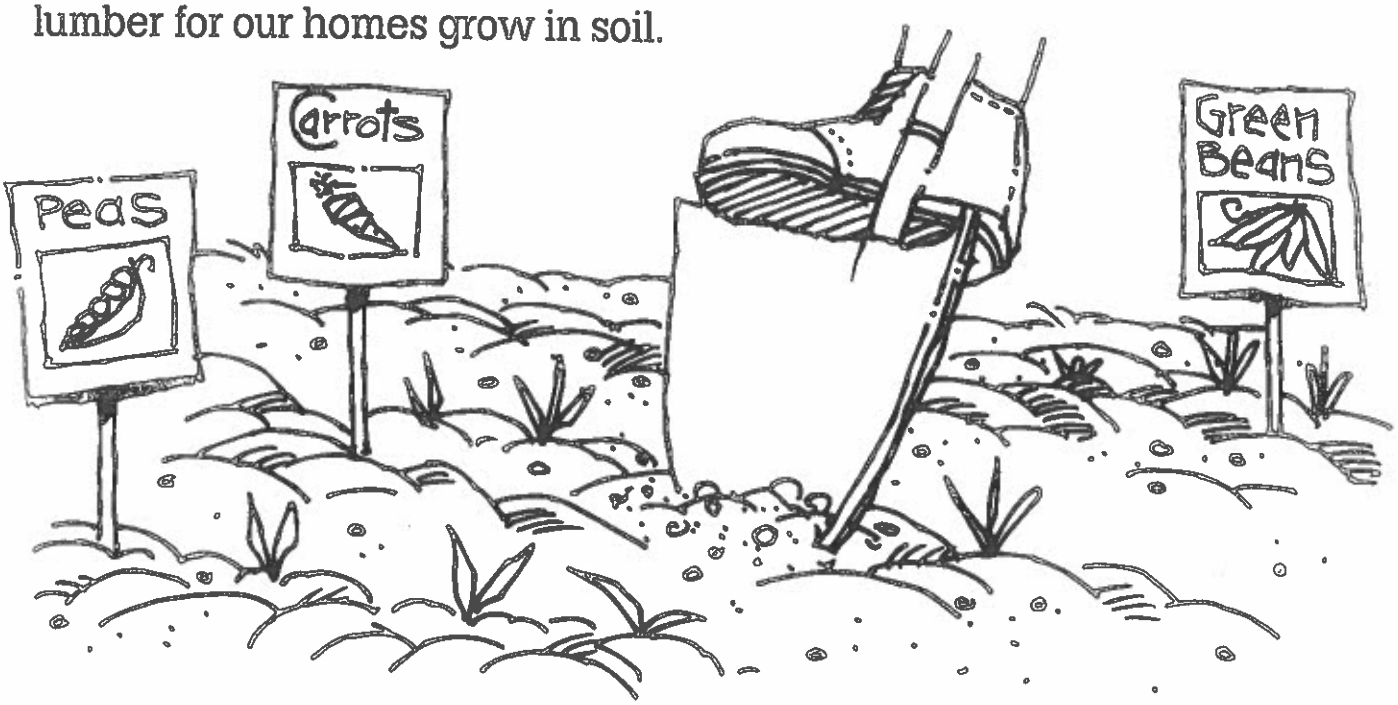
Many products we use are petroleum. Gasoline and oil for cars and other machines come from petroleum.



Petroleum is even used to make plastic. The plastic is turned into all kinds of things we use every day.

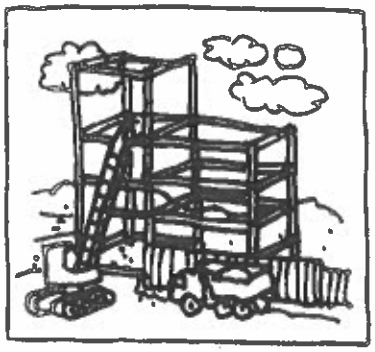
Soil

Soil is one of the Earth's most important resources. Much of the food we eat comes from plants that grow in the soil. Trees cut to make lumber for our homes grow in soil.



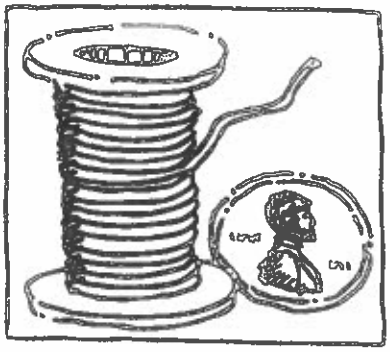
Metals

Many metals are found in rocks. Sometimes a metal is used by itself. Sometimes several metals are mixed together before being used.



Steel is made from the metal iron. The steel is used in buildings and in all kind of machines.

Aluminum is light and strong. It is used in building large machines like airplanes. It is used to make small things like soda cans.



Copper is used to make wire used in electrical equipment. It is easy to stretch without breaking, and it doesn't rust.

Do You Remember?

Name one thing that is made from each natural resource.

1. clay _____
2. rock _____
3. metal _____
4. petroleum _____
5. sand and limestone _____

Precious Metals Primer

Aluminum is the third most common element in the Earth's crust, and it is the most common metal. Aluminum is most easily removed from rock called *bauxite*. Aluminum from bauxite ore is strong and lightweight. It is used for building, automobiles, airplanes, foil, pots and pans, and has many other uses.

Copper is used mainly for making water pipes and wire. It is also used to make cooking pots because it is a good conductor of heat. Copper, when mixed with zinc, makes an alloy called *brass*. Copper ores are brilliant in color. Azurite is blue, malachite is green, and chalcopyrite is gold.

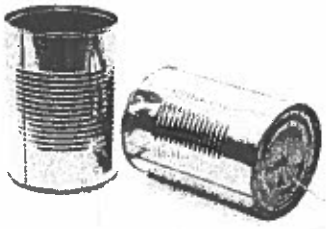
Iron is a very important precious metal. It is strong and hard but it melts easily so it can be poured into molds and flattened into sheets. When combined with carbon and other elements, iron forms alloys such as wrought iron, cast iron, and steel, which is the most-used metal in the world. The main iron ore is called *hematite*.

Lead is made from a shiny black mineral known as *galena* that is often found in limestone and silver. Lead is used in materials to protect people against x-rays and radioactivity. Lead is also used in making batteries. Lead is a very heavy metal.

Mercury is the only metal that is in a liquid form even when it is not hot. It comes from a red ore called *cinnabar* and is found only in a few places in the world, including Italy, Spain, and the western part of the United States. Mercury is used in thermometers and barometers and as an ingredient in paint and some medicines.

Nickel is a strong metal that can stand up to hard wear and high temperatures. Its main use is to add strength to steel. The main nickel ores are *pyrrhotite* and *pentlandite*. Nickel is also mixed with copper to make coins. The U.S. nickel has three times more copper than nickel!

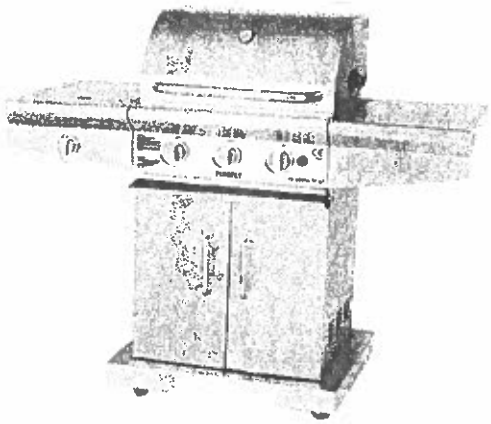
Tin is used mostly in making products such as tin cans. It comes from a hard and heavy ore called *cassiterite*. Tin is mixed with copper to make bronze and is mixed with lead to make pewter.



Zinc is used to make brass and to give metals a protective coating. It comes from an ore called *sphalerite*. The rock is generally black but can also be green, yellow, or red, which makes it difficult to identify.

Gold is the most workable of all the precious metals. It can be hammered into very thin sheets called *gold leaf*, stretched to make thin wire for chains, and molded into almost any shape. It is used to make coins and jewelry. Gold is usually found in veins (or cracks) of quartz and does not have to be processed as many other metals do.

Platinum doesn't tarnish like silver but it doesn't have the gleam and shine of gold either. It is more valuable than gold in some ways because it is in great demand in the oil refining industry and in making low-pollution car exhaust systems. It is also used for jewelry. In the days of Czar Nicholas I, three-ruble Russian coins were made of platinum.

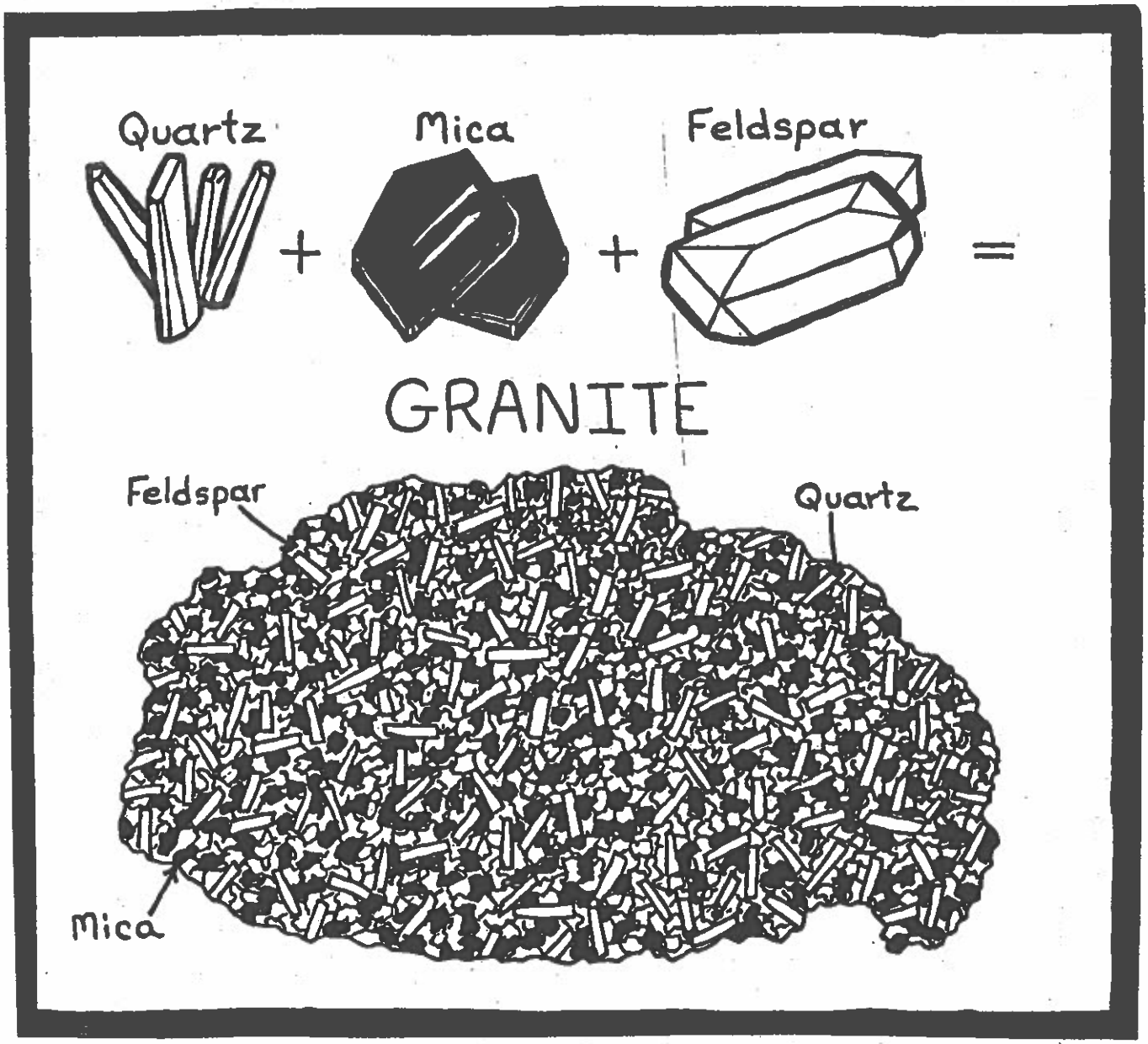


Silver is a less precious metal than gold because its surface reacts with air and causes the metal to tarnish or darken. It has to be polished occasionally to remove the tarnish and bring back its natural shine. Silver is used for fine tableware, jewelry, and coins. More than one-third of all silver mined in the United States is used for making and developing photographic film. Silver is found as a native metal or in ore known as *argentite*.

ROCKS

Rocks contain two or more minerals mixed together. One very common kind of rock is called granite, which is made up of quartz, mica and feldspar.

quartz + mica + feldspar = granite



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Lesson

12 Saskatchewan's Resources

Goal To learn about resource industries in Saskatchewan

Get Started

Saskatchewan is a province that is rich in mineral and oil and gas resources. Mines are located throughout the province. Saskatchewan mines produce potash, uranium, coal, gold, and salt, as well as other mineral resources.

▶ Although diamond deposits have been found in Saskatchewan, they have not yet been mined.

Canada produces more potash than any other country. Potash is used mainly for fertilizer. Canada is also one of the leading producers of uranium in the world. Uranium is used to create electricity. It is also used for medical purposes. About 90% of Canada's potash and all of Canada's uranium is mined in Saskatchewan. As well, Saskatchewan has large deposits of oil and natural gas. Oil and gas are pumped out of the ground and transported to a gas processing plant or a refinery. There, they are changed into products that we use to heat homes, power vehicles, and make plastics.

Jobs in the Mining and Oil and Gas Industries

Mining and petroleum provide jobs for thousands of people in Saskatchewan. Geoscientists and engineers help find and produce mineral and oil and gas resources. Electricians, mechanics, and welders keep the machines working at a mine site or refinery. Other people have jobs that support mining and oil and gas production. For example, truckers haul coal from mine sites, and pilots fly workers to mine sites.

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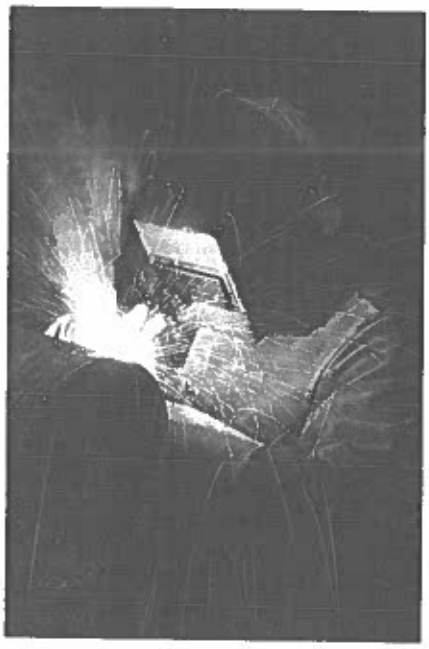
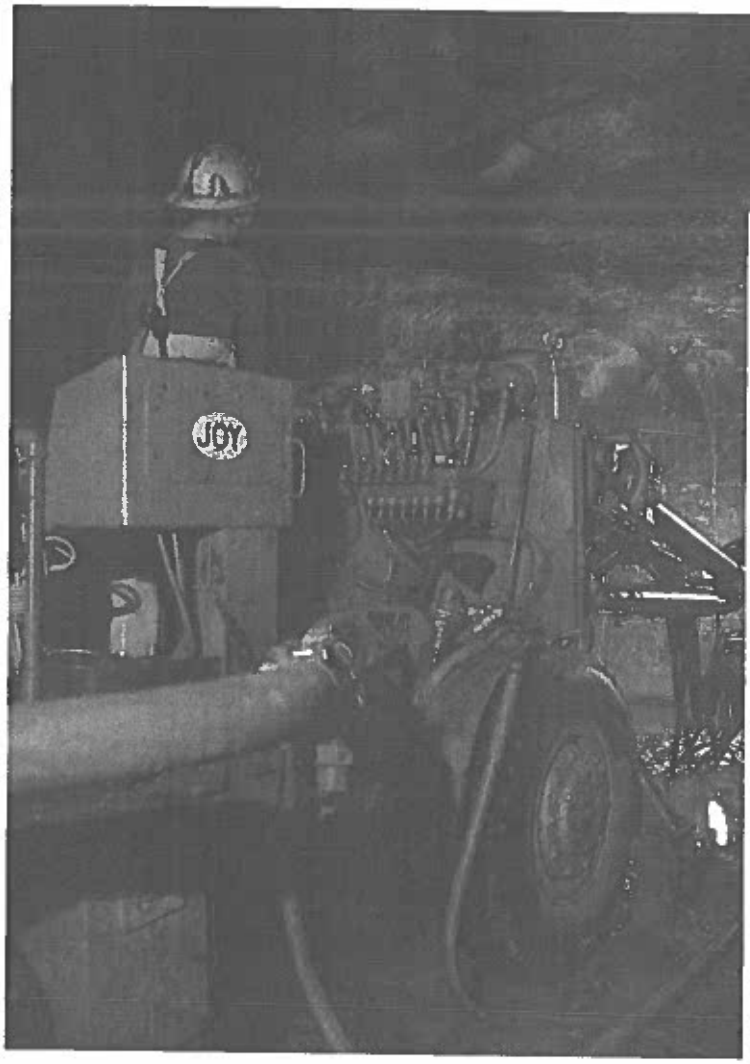
How Our Resources Benefit Saskatchewan

Workers in our resource industries build skills that they can also use in other jobs. Our government receives a share of the money earned by mining and oil and gas companies from the sale of Saskatchewan resources. These companies and their workers also pay taxes. This money is used for health care, education, and roads that benefit the people of Saskatchewan.

As the world's population grows, more of the resources that are produced in Saskatchewan will be needed. Other provinces and territories within Canada will buy our resources. Other countries will too. The demand for our resources currently supports about 30 000 jobs related to mining, and another 30 000 jobs related to the oil and gas industry.



▲ A welder fixes metal equipment by joining breaks and cracks.



▲ A miner works underground operating the mining equipment.

▲ Geologists work outside, in mines, and in offices.

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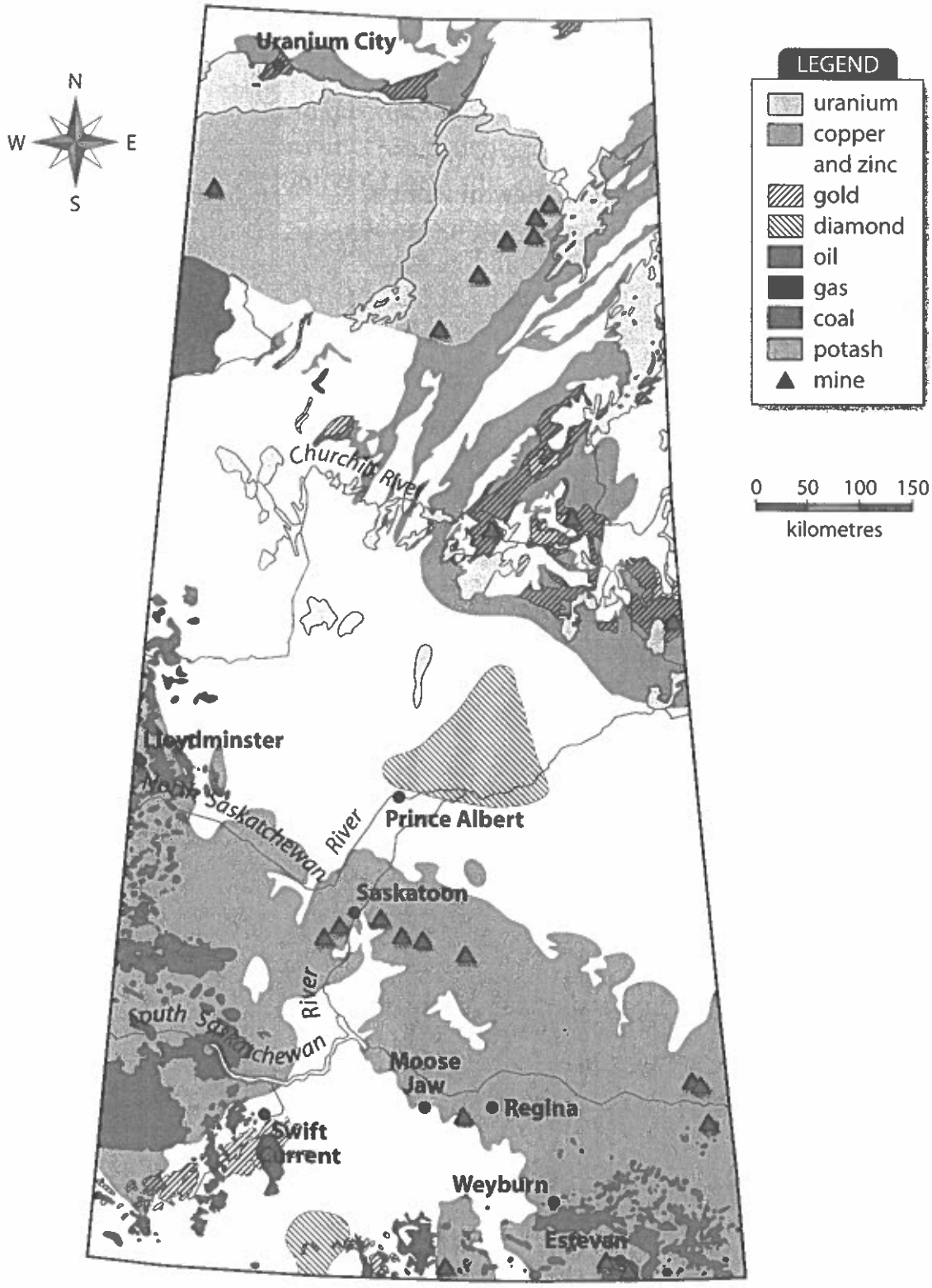
Work On It

In this activity, you will locate mineral deposits and mines in Saskatchewan.



Mineral Resource Map of Saskatchewan, 2010 Edition, Saskatchewan Ministry of Energy and Resources

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1. Look at the legend on the map.
2. In which part of the province (north, south, east, or west) are potash deposits located? Write the answer in your notebook.
3. In which part of the province are uranium deposits located?
4. In which part of the province are gas reserves located?
5. In which part of the province are coal fields located?
6. Create a two-column table in your notebook like the one shown here. In the first column, list the minerals that are mined in Saskatchewan.
7. Count the number of locations where each mineral is mined. Record the numbers in the second column of your table.
8. In your table, circle the minerals that are closest to your home.

Mineral	Number of Locations

Communicate

1. What impact, if any, do mines have on your community?
2. Some mineral resources, such as potash, are mined in many locations in Saskatchewan. What does this tell you about rocks and minerals?
3. Look back at your table of minerals that are mined in Saskatchewan. What are some benefits of removing minerals and turning them into products that are sold?

Lesson
13 How Are Mining and the Environment Connected?

Goal To understand the pros and cons of mining

Get Started

▲ This machine is drilling potash far underground.

▲ An Elder shares local knowledge so the land will not be harmed .

Mining affects the environment because the land is disturbed at mine sites. Early mines did not have the same rules as mining companies follow today. Sometimes the environment was damaged. Now, mining companies must follow rules that are created by governments to protect the environment. Mining companies must return the land to the way it was before the rocks or minerals were mined. Millions of dollars are being spent to clean up the old mine sites, retuning the land to the way it was before.

Mining: First Nations and Métis Point of View

Many First Nations and Métis peoples know that all parts of nature are alive and connected to each other and to Mother Earth. First Nations and Métis people are related to their land through Spirit, so they show gratitude for their land by not damaging it. They receive "gifts," such as plants and animals, from the land. In return, they offer something, such as tobacco, to the land. This offering shows that they are grateful for what Mother Earth has given them.

Many First Nations and Métis people worry that their traditional lands might be damaged or polluted by mines. Their land is sacred and must be protected from harm. Some First Nations communities allow mining on their Reserve Lands. However, they have made agreements with the mining companies to have the land that was mined put back to the way it was before the mining began.

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How Mines Work

Mines affect the environment in different ways because minerals are mined in different ways. The way that a mineral is mined depends on how deep below the surface the mineral is.

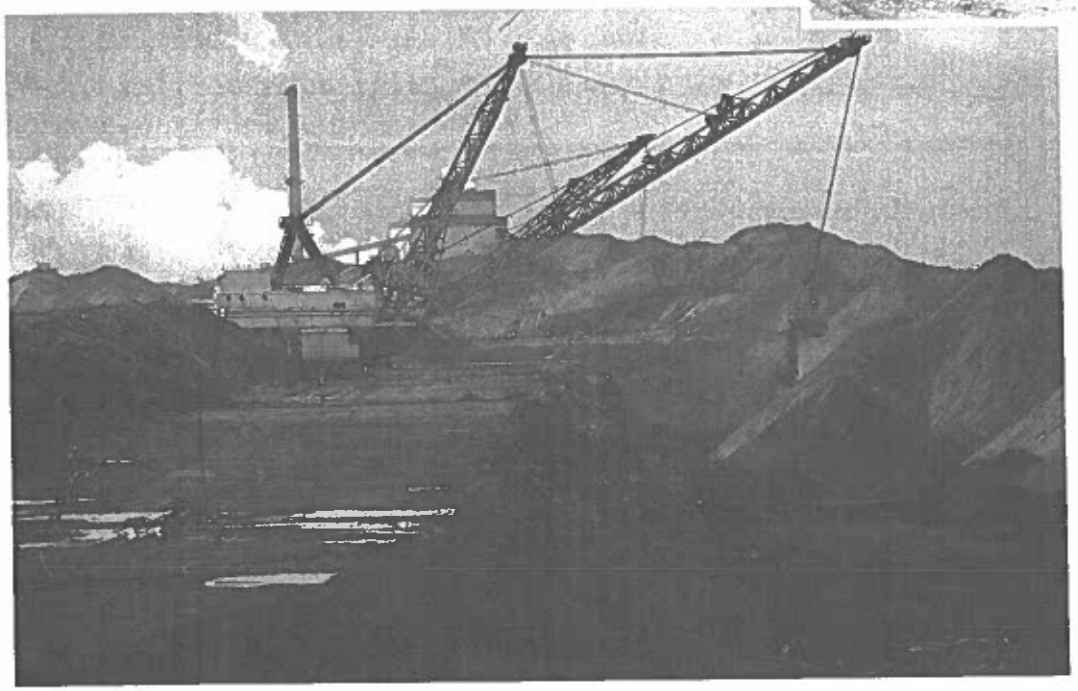
Above-Ground Mines

Some minerals are mined from the surface. The mining companies use heavy machinery to dig up the ground. The minerals that are wanted are kept. The leftover soil and rocks are piled. When the company has finished mining an area, the piled soil and rocks are returned to the ground.

Coal is often surface mined. In Saskatchewan, coal is used in power plants near Estevan and Coronach to produce electricity. After the coal has been taken from an area, the mining company replaces the top layer of soil that was removed. Trees and other plants are planted so that animals will return to the area, and farmers can again plant crops. This process is meant to turn the land back to the way it was before the mining occurred.

Rock and gravel are also surface mined. They are removed from a quarry, leaving a large pit. After a quarry is no longer useful, the steep walls are sloped to allow topsoil and plants to be added.

▼ Most of the gravel dug from quarries in Saskatchewan is used for building and repairing roads in the province.



◀ Large machines with cables drag a bucket to scrape off a layer of coal.

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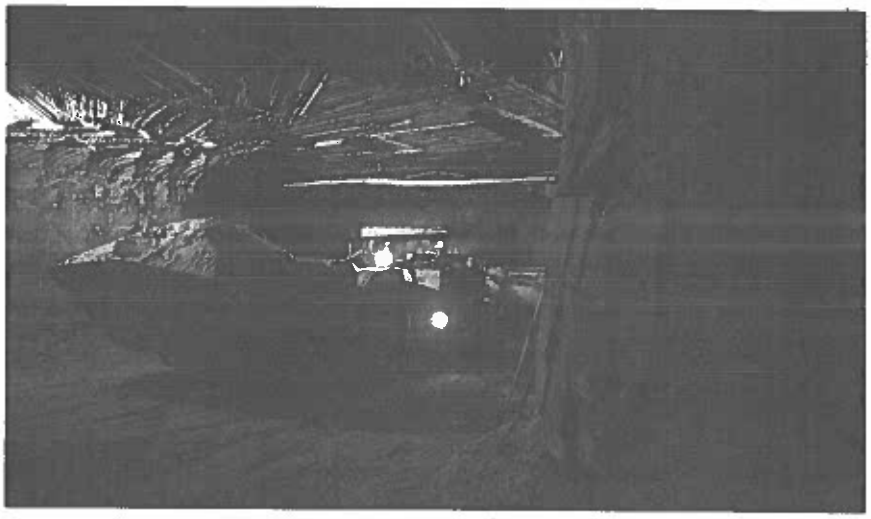
Underground Mines

Some valuable minerals are found deep underground. Mining companies dig shafts and tunnels to reach them.

Potash, gold, coal, and uranium can be mined using underground methods. After the rock is removed from the ground, the minerals are separated from the waste rock. The valuable minerals are removed and processed, while the waste rock is stored in piles above ground. It is sometimes placed back in the mine when the mine is shut down.

Underground mines affect the environment much like above-ground mines. When building a mine, the ground is dug up. Trees and other plants are removed. Now, government rules protect the environment. After the mine is shut down, the land must be returned to the way it was before mining began.



▶ This mine loader is low to the ground to fit inside the mine.

Work On It

Imagine that a mining company wants to develop a mine five kilometres from the community where you live. You hear your parents discussing the mine. They do not agree about whether the mine will be good or bad for your community. At a town meeting, they will be voting on whether or not to allow the mining company to build a mine near your community.

Conservation officers work to protect natural areas.

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What You Will Do

1. Think about what you have learned about mines. In your notebook, list the following people: mining company owner, scientist, conservation officer, townsperson. Then, beside each of the people in your list, write whether you think he or she would be for or against the mine. Give a reason for each viewpoint.
2. Years ago, the Canadian government and First Nations people agreed that they would decide together how resources would be shared. How might First Nations people, their Elders, and their communities react to the construction of a mine?

Communicate

1. As you have learned, mines change the environment while they are operating. Suggest one way that a mining site could be reclaimed. Think about the environment and nearby communities.
2. Copy the table below into your notebook. Research the rocks and minerals listed in the first column. Find out which products are made from these rocks and minerals. Then find out how these products can be reused or recycled. Fill in your table with the information you find.

Rock or Mineral	Consumer Products	Ways to Reuse or Recycle
granite		
copper		
gold		

3. Think about ways that your family uses products made from resources that are mined. How might you and your family reduce your use of these resources? Write down two of your ideas.

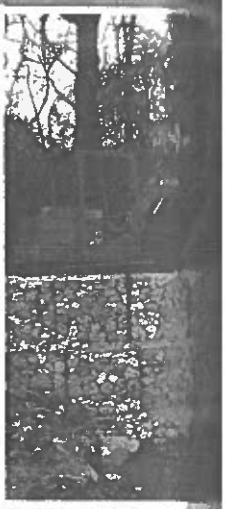
Design Project

Protecting the Environmen

Get Started

Many people own cabins along the shores of a Saskatchewan lake where the water rose two metres one spring. Two factors caused the water level to rise: heavy rains and runoff from nearby fields. Much of the beach has disappeared, and the water has nowhere to go. Many of the cabin owners are worried about flooding. They have brought in rocks and gravel to stop erosion beneath their cabins. As well, construction companies have been hired to help reroute the water that is draining off the fields.

Look at the three photos to the right, showing some of the methods that people have used to stop erosion. Which methods do you think might be useful for the people on the lake?



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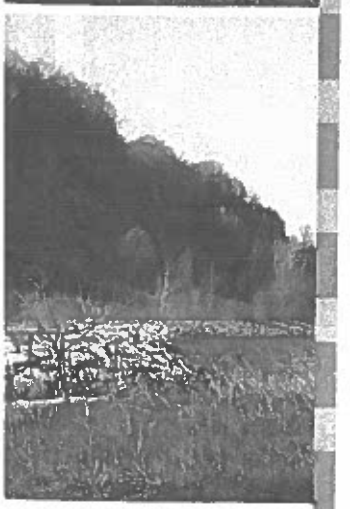

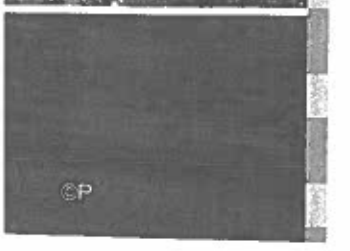

Work On It

Preventing erosion and weathering of the shoreline is a design challenge that the owners have been working on to protect their cabins.

1. With your group, design a plan to help save the cabins. In your plan, you can include any ideas about preventing erosion and weathering from this unit. You can also research other solutions. Here are a few ideas to consider:
   - Build a retaining wall.
   - Plant shrubs on the hillside.
   - Change the slope of the hillside.
   - Plan a way to reroute the water.

   Remember to consider the building materials that you will be working with: soil, rocks, sand, water, and plant material.
2. Create a model of the shoreline to test your plan. Include the design changes that will help protect the cabins.
3. Test your plan, using your model.

Communicate

1. Present to the class your plan for saving the cabins. Be ready to answer your classmates' questions.
2. What was the most challenging part of this task?
3. How did your solution compare with your classmates' solutions?
4. In which other places have you seen evidence that people are working to change the rate of erosion?

Assessment Checklist

Check to make sure that you

- ☑ designed a plan to prevent damage to the cabins and shoreline
- ☑ created a model, as described in step 2
- ☑ tested your design
- ☑ reflected on your design

Show What You Know

1. How do scientists define "rock" and "mineral"?
2. Compare how a geologist might view rocks with how a First Nations Elder would view rocks.
3. Use the Mohs scale below to explain how the test for hardness works. Give an example of a soft mineral and a hard mineral.

The Mohs Scale

Hardness	Mineral	Everyday Materials
10	diamond	
9	corundum	
8	topaz	
7	quartz	concrete nail (7.5)
6	feldspar	steel file (6.5)
5	apatite	glass (5.5 to 6.5)
4	fluorite	common nail (5.2)
3	calcite	penny (3)
2	gypsum	fingernail (2.5)
1	talc	

4. Gold is used in jewellery and in computers. Research other uses for this mineral.
5. Explain how scientists believe that fossils formed. You can use pictures in your explanation.
6. In what type of rock are most fossils found? Why does this make sense?
7. How are rocks and soil connected?
8. At school, you use graphite in the pencils you write with. At home, you may season your food with salt. List three other rocks or minerals that are part of your everyday life, and explain what they are used for.

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A B C D E

9. Look at the rock and mineral samples above. With a partner, decide which samples are rocks and which are minerals. Make a two-column table in your notebook. List the letters of the rocks in one column and the letters of the minerals in the other column.

10. Describe an example of erosion and an example of weathering.

11. Erosion is a problem that can affect shorelines and farmland. Describe one method of stopping erosion.

12. Use a Venn diagram to compare and contrast underground mining and above-ground mining.

13. Suppose that a mining company has approached your community about setting up a mine nearby. If you had the choice, would you allow the mine? What factors would you think about when making your decision?

Looking Back

14. You learned many new things about rocks and minerals. What was the most interesting thing you learned in this unit? Give reasons for your choice.

15. If you were to redo your Design Project, what would you do differently?

Glossary

boulder—a large stone moved by nature from its original bed.

calcite—a mineral which is in limestone, marble, and chalk.

crust—the rocky, uppermost layer of the Earth.

eruption—the bursting forth of lava from a volcano.

extrusive rock—rock formed from lava after it has reached the surface of the Earth.

facet—any of the many polished sides of a cut gemstone.

feldspar—a mineral found in igneous rocks.

gem—a precious, rare, and perfect stone, especially when set as an ornament.

granite—an abundant, strong, durable igneous rock useful in the construction of buildings and monuments.

hardness—the measurement of how easily a mineral is scratched.

igneous rock—rock formed from magma as it cools and hardens.

intrusive rock—rock formed when magma works its way between rocks and hardens beneath the surface of the Earth.

jewel—a precious stone or gem, especially one set in precious metal.

lava—melted rock that pours out onto the surface of the Earth from a volcano.

limestone—a type of sedimentary rock made from seashells and tiny sea animals which makes an excellent building material because it can be carved easily.

magma—melted rock beneath the Earth's surface.

metamorphic rock—rock created when igneous or sedimentary rock is changed by heat and pressure.

minerals—natural substances that make up rocks and have a chemical composition and a crystalline structure.

pebble—a small, rounded fragment of rock.

pumice—an igneous rock formed from cooled lava that is light and contains air bubbles.

quartz—a common, very hard mineral found in all three major types of rocks.

rock—a natural solid material that makes up the Earth's crust, usually consisting of a mixture of minerals.

sand—a hard, granular rock material that is smaller than gravel and larger than silt.

sedimentary rock—rock formed from many layers of sand, mud, rock fragments and plant and animal remains that have undergone pressure from above.

stalactite—a limestone formation found in some caves that hangs down from the ceiling and is formed when ground water, rich in carbon dioxide, dissolves the mineral calcite from limestone directly above.

stalagmite—a limestone formation found in some caves that rises up from the floor and is formed when water, dripping on the floor, carries with it deposits of calcite.

stone—a small piece of rock.

strata—layers of rock.

volcano—an opening in the Earth's crust through which lava, dust, and hot gases are spewed out.