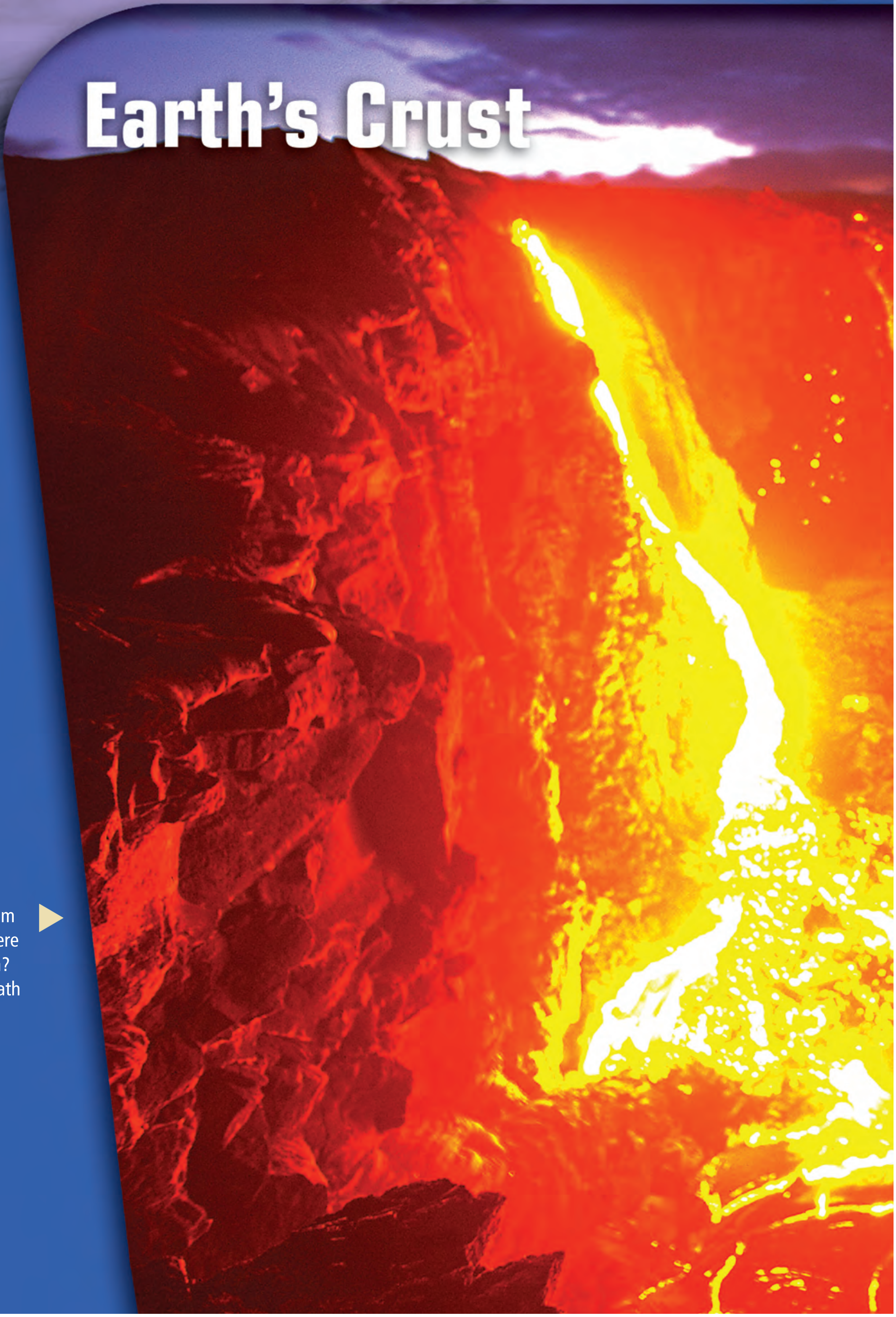
UNIT

4 Earth's Crust



White-hot lava pours from an erupting volcano. Where does the heat come from? What is happening beneath Earth's surface?

Key Ideas

10 **Earth's crust is made up of rocks and minerals.**

11 **Earth's crust is constantly changing.**

12 **Soil is the living component of Earth's crust.**

Getting Started

Gilbert Hay's sculpture "Dance of Joy" is made from rock found near Nain, Labrador.

Why is the island of Newfoundland called "The Rock?" Finding the answer is as easy as looking beneath your feet. The province of Newfoundland and Labrador is built on rock, covered in places by a thin layer of soil. That rock includes some of the oldest and most beautiful minerals on Earth.

The rock that makes up Newfoundland and Labrador is put to many uses both in our province and around the world. For example, the anorthosite quarry shown in the photograph above is the source of stone that decorates buildings in Italy and art that is shown throughout North America.

The Ten Mile Bay quarry is situated near Nain in Labrador and is operated by the Labrador Inuit Association. The anorthosite rock in the quarry formed about 1.3 billion years ago, deep in Earth's crust. Anorthosite is used as a decorative covering for buildings, called dimension stone. The Ten Mile Bay quarry at Nain produces about 1000 m^3 of dimension stone each year. Much of the anorthosite quarried at Ten Mile Bay and Igiak Bay is sold to markets in Europe. Anorthosite is also used for other decorative purposes, such has counter tops, table tops, monuments, and furniture.

Gilbert Hay is a senior Inuit carver who creates sculptures in anorthosite. He gathers his stone from the edges of the Ten Mile Bay quarry. Gilbert practises a traditional lifestyle. The images he sculpts are inspired by his love of the land and the sea and pride in his Inuit heritage.

internet connect

Find out more about Gilbert Hay and other artists who work with rocks and minerals. Start your search at **www.discoveringscience.ca.**

What Makes a Rock a Rock?

Find Out ACTIVITY

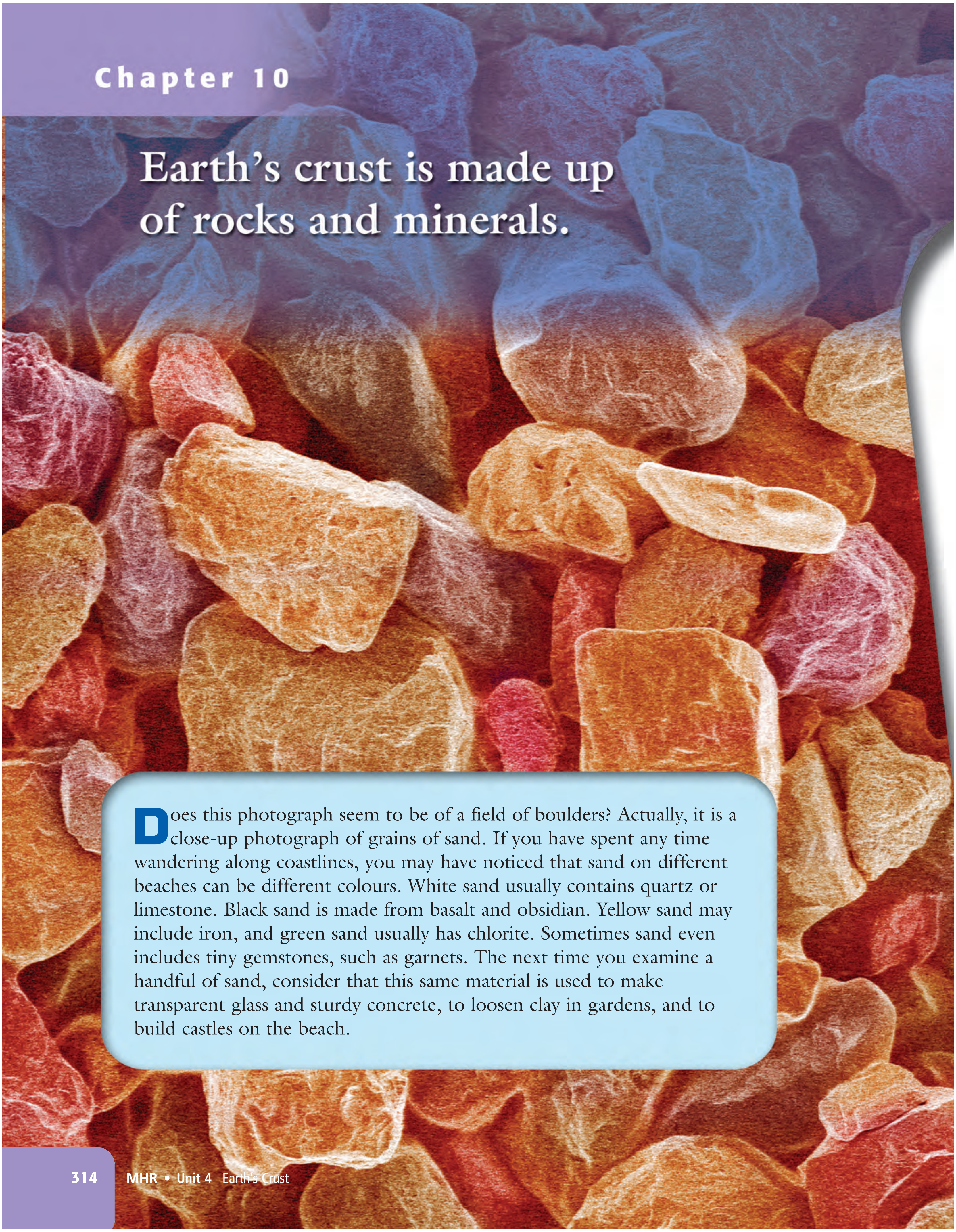
It is perfectly easy to describe a rock. Or is it? In this activity, you will examine some common objects and determine which ones are rocks and which ones are not.

Materials

- selection of materials provided by your teacher

What to Do

1. Your teacher will give you a variety of materials to examine. Some materials are rocks; others are not.
2. With a partner, examine the materials. Make a list of characteristics that you could use to group or classify these materials.
3. Classify all the materials into two groups using your list of characteristics. Compare your classifications with those of other students.
4. Discuss with your partner what makes a rock a rock. Record your ideas.



Chapter 10

Earth's crust is made up of rocks and minerals.

Does this photograph seem to be of a field of boulders? Actually, it is a close-up photograph of grains of sand. If you have spent any time wandering along coastlines, you may have noticed that sand on different beaches can be different colours. White sand usually contains quartz or limestone. Black sand is made from basalt and obsidian. Yellow sand may include iron, and green sand usually has chlorite. Sometimes sand even includes tiny gemstones, such as garnets. The next time you examine a handful of sand, consider that this same material is used to make transparent glass and sturdy concrete, to loosen clay in gardens, and to build castles on the beach.

What You Will Learn

In this chapter, you will
- **classify** minerals based on their physical properties
- **classify** rocks based on their characteristics and how they formed
- **identify** relationships between rocks in the rock cycle
- **explain** how society's needs lead to new uses of rocks and minerals
- **research** the uses of rocks and minerals in Newfoundland and Labrador

Why It Is Important

Rocks and minerals have been used by humans for many thousands of years for everything from tools and building materials to paints and jewellery. Almost every product we use either comes from a mineral or has minerals involved in its manufacture.

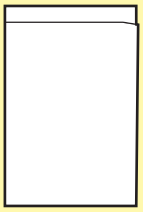
Skills You Will Use

In this chapter you will
- **select** methods and tools for collecting and organizing data to identify minerals
- **use** a classification key to identify common minerals
- **observe** differences in the properties of rocks and minerals

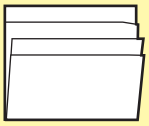
FOLDABLES™ Reading & Study Skills

Make the following Foldable to take notes on what you will learn in Chapter 10.

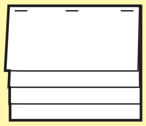
STEP 1 **Stack** two sheets of 8.5″ × 11″ paper so that the back sheet is 2 to 3 cm higher than the front sheet. (**Hint:** From the tip of your index finger to your first knuckle is about 2.5 cm.)



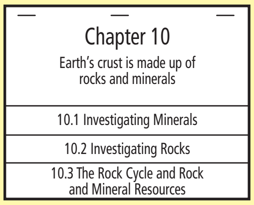
STEP 2 **Bring** the bottom of both sheets upward and **align** the edges so that all of the layers or tabs are the same distance apart. **Fold** the paper and **crease** well.



STEP 3 **Staple** the papers along the fold.



STEP 4 **Label** the Foldable as shown.



Organize As you read the chapter, take notes and define terms under each tab.

10.1 Investigating Minerals

A mineral is a pure, naturally occurring, inorganic, solid substance. There are thousands of types of minerals, and many look alike. Colour alone is not a reliable way to tell them apart. You can identify a mineral by examining its other properties, such as streak, hardness, lustre, cleavage, and fracture.

Key Terms

cleavage
fracture
hardness
lustre
mineral
streak

Imagine a day at the beach. You have a few buckets, a shovel, and several tonnes of building material: sand! If you look closely at the sand, what will you see? Sometimes there are crushed shells and seaweed mixed in with the particles of sand. If you remove those from the sand, you will see that the sand is made up of many tiny coloured grains. Those coloured grains are mineral crystals. A **mineral** is a pure, naturally occurring, inorganic (non-living), solid substance.

You have probably seen and used many metals that come from minerals, such as silver, aluminum, and tin. You may enjoy ground up halite (table salt) on your food. Perhaps you have used ground up talc in talcum powder. Your bones and teeth are strong thanks to the mineral calcium. Copper and iron help keep your blood healthy. Do you think you could identify these minerals if you saw them?

Did You Know?

If you pass a magnet through sand, it may attract tiny, black particles called micrometeorites, which have fallen to Earth from space.

10-1A Sand Detective

Find Out ACTIVITY

In this activity, you will take a close-up look at the minerals in sand. Most of the grains in sand are quartz, one of the most common minerals on Earth. Quartz can be white, pink, brown, or other colours. Thin black flaky grains in the sand are probably mica. Some white or grey particles may be feldspar.

Polished agates. Agates are a type of quartz.

Materials

- sand
- white cardboard (for dark sand) or dark cardboard (for light sand)
- hand lens
- tweezers

What to Do

1. Remove any pieces of shell or seaweed from the sand.
2. Observe the sand through the hand lens. Record your observations.
3. Use the tweezers to separate the sand crystals into piles based on their colour.
4. Observe the grains in each pile. How are the grains different from and similar to other grains of the same colour?
5. Within each colour pile, separate the sand according to the shape of the grains.

What Did You Find Out?

1. Describe the mineral grains that you found.
2. Which minerals do you think you found in your sand?
3. How could you find out for sure which minerals they are?

Properties of Minerals

The minerals in sand are just a few of the more than 4000 minerals that are found on Earth. Most minerals are very rare, but about 150 minerals are common, and many of those minerals are found in Newfoundland and Labrador.

Many minerals look alike, but you can examine their properties to get clues about which mineral is which. Some properties of minerals include lustre, colour, streak, hardness, cleavage, and fracture.

Lustre

One clue to the identity of a mineral is how shiny it is. The shininess, or **lustre,** of a mineral depends on how light is reflected from its surface. If a mineral shines like a polished metal surface, it has a metallic lustre. If a mineral reflects light like a piece of glass, it has a glassy lustre. If the mineral does not reflect light well, it has a dull lustre. Table 10.1 shows examples of three kinds of lustre.

Table 10.1 Classification of Lustre

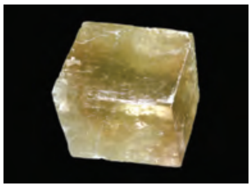
Kind of Lustre	Appearance	Example
Dull	Does not reflect light	 Chalk
Glassy	Has a surface reflection like a piece of glass	 Calcite
Metallic	Looks like metal	 Pyrite

Figure 10.1 All of these gems are formed from corundum. Corundum is white when it is pure, but when it contains iron it is blue. When corundum contains chromium, it is red.

Colour

Colour may seem like an easy way to identify minerals, but colour alone is not reliable. The valuable mineral gold has a golden colour, but so does the much less valuable mineral pyrite. Quartz, calcite, and corundum can all be white. One type of mineral may have different colours (Figure 10.1).

Streak

A more reliable way to identify a mineral is to rub it across a piece of unglazed porcelain tile (Figure 10.2). The mark it makes is called a **streak,** which is the powdered form of the mineral. You can tell gold from pyrite using a streak test. Gold makes a yellow streak. Pyrite makes a greenish-black or brown-black streak.

Figure 10.2 The mineral hematite can be dark red, grey, or silvery in colour. Its streak, however, is always dark red-brown.

Did You Know?

Graphite is a soft mineral that is used in pencils. The pencil marks you make on a piece of paper are actually graphite streaks.

Hardness

Another important clue to the identity of a mineral is its hardness. **Hardness** is a measure of how difficult it is to scratch a mineral. How can you use hardness to identify minerals? German scientist Friedrich Mohs asked himself this question in 1812. He tested many minerals and developed a scale of 10 minerals that he ranked with a hardness value of 1 to 10 (as shown in Table 10.2). The higher the number on the Mohs Hardness Scale, the harder the mineral.

Table 10.2 Mohs Hardness Scale

Mineral	Mineral Hardness	Hardness of Common Objects
Talc	1 softest	Soft pencil point (1.5)
Gypsum	2	Fingernail (2.5)
Calcite	3	Copper penny (3.5)
Fluorite	4	Iron nail (4.5)
Apatite	5	Glass (5.5)
Feldspar	6	Steel file (6.5)
Quartz	7	Streak plate (7)
Topaz	8	Sandpaper (7.5)
Corundum	9	Emery paper (9.0)
Diamond	10 hardest	

Suppose that you have an unknown mineral that you think is either calcite or quartz. Notice that calcite is 3 on the scale and quartz is 7. You could try to scratch your mineral with an iron nail, which has a hardness value of 4.5. If the iron does not scratch your mineral, then you know it must have a hardness greater than 4.5, and so your mineral is not calcite.

Cleavage and Fracture

You can get important clues to a mineral's identity by breaking it apart. Sometimes a mineral has **cleavage,** which means it splits along smooth, flat surfaces called planes. Mica (shown in Figure 10.3) is an example of a mineral with cleavage. Separating the layers of mica is a bit like separating the pages in a book. Not all minerals have cleavage.

Minerals may have **fracture,** which means they break with rough or jagged edges. Quartz (shown in Figure 10.4) is an example of a mineral that fractures when it is broken apart. In order to examine cleavage and fracture, you need to look at a freshly broken surface of a mineral.

Figure 10.3 Mica is a mineral with a single cleavage that allows it to be pulled apart into sheets.

Figure 10.4 Quartz is a mineral that has fracture. Notice the jagged edges on the bottom and the crystals on top.

Word Connect

The word "crystal" comes from *krustallos*, a Greek word that means "ice crystal." Many mineral crystals look like coloured ice.

Other Properties of Minerals

Most minerals form crystals. Sometimes you can see the crystal structure in a mineral (Figure 10.4). However, in many minerals the crystals are too small to be seen.

Some other properties of minerals include heft (how heavy it feels), odour, magnetism (Figure 10.5), and whether the surface feels powdery, soapy, or greasy.

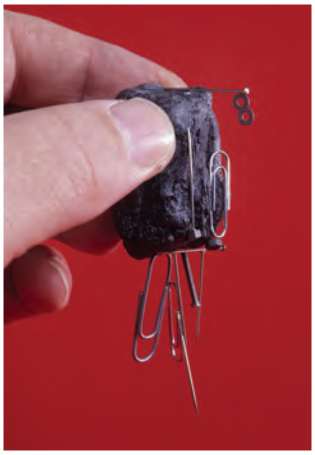
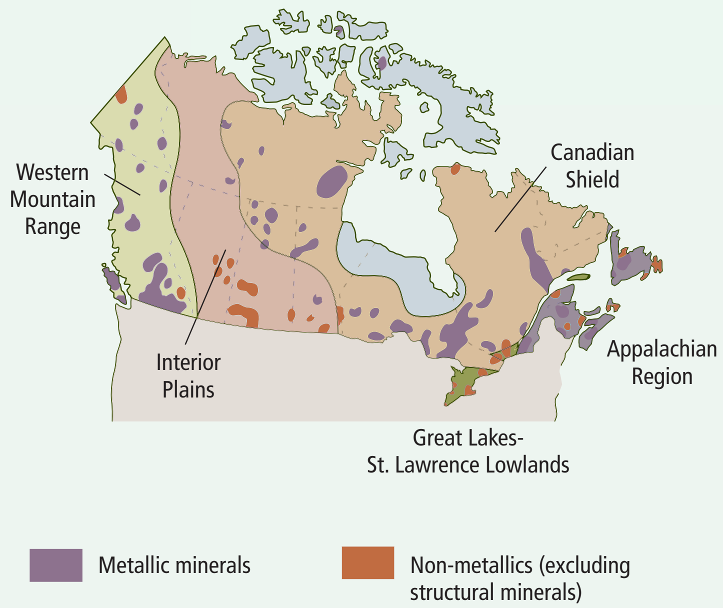


Figure 10.5 Some minerals, such as magnetite, are magnetic.

10-1B Mapping Minerals and Their Uses

Think About It

Minerals are found across Canada and are used in many different ways. Some minerals are used in building homes and offices. Some minerals are used to make jewellery and other works of art. Other minerals are used for fertilizers or in industries. In this activity, you will discover where minerals are found in Canada and some of the ways they are used.



What to Do

1. Your teacher will give you a map of where minerals are found across Canada. In a group, research and list all the minerals found in Canada.
2. Choose one mineral. Research what it is used for. You can begin your research at **www.discoveringscience.ca.**
3. Share the information you learned. Prepare a booklet or poster about your mineral, or create a commercial or advertisement for it. Be sure to include a picture of your mineral.

Reading Check

1. What are three types of lustre?
2. What is the name of the scale used for measuring the hardness of a mineral?
3. What is the property of a mineral that splits along smooth, flat surfaces?
4. What is the property of a mineral that breaks along jagged edges?

Explore More

Transparency is another property of minerals. If you can see through the mineral clearly, it is transparent. If some light can pass through it, it is translucent. If you cannot see through the mineral, it is opaque. Find out more about properties of minerals. Begin your search at **www.discoveringscience.ca.**

10-1C A Mineralogist's Mystery

Core Lab

Skill Check

- Observing
- Classifying
- Interpreting data
- Evaluating information

Imagine that you are a mineralogist, a person who studies minerals. You have just received a package of minerals from your company's field team in northern Labrador. The attached note reads: "New mine discovered. Enclosed are samples of minerals found there. Please identify." In this activity, you will investigate how the properties of minerals can help you solve the mystery of the unknown minerals.

Safety

- Be careful when handling materials with sharp points or edges.

Materials

- numbered mineral samples
- streak plate
- copper penny
- iron nail
- glass plate or jar
- steel file
- sandpaper
- emery cloth
- hand lens
- optional: magnet
- Tables 10.1 and 10.2 from pages 318 and 319

Science Skills

For help in making observations, turn to Science Skill 5.

Question

How can you identify different minerals?

Procedure

1. Prepare a table of observations like one below. Give your table a title.

Mineral Number	Colour	Lustre	Streak	Hardness	Other Properties	Mineral Name

2. (a) Record the number of the first mineral sample in the first column of the table.
   (b) Observe the colour of the first mineral sample. Record your observations in the column under "Colour."
   (c) Observe the lustre of the mineral. Refer to Table 10.1. Record your observations.
   (d) Scrape the mineral once across the streak plate. Brush off the excess powder. Record the colour of the streak. If the mineral is too hard to leave a streak, write "none" in the column under "Streak."
   (e) Scratch the sample with your fingernail. If your fingernail does not leave a scratch, use a copper penny to scratch the sample. If the penny does not leave a scratch, use the iron nail, followed by the glass plate, followed by the steel nail, followed by the sand paper, followed by the emery cloth until something leaves a scratch. Refer to Table 10.2. Record the hardness from 1 to 10.
   (f) Record any other properties you can observe such as cleavage, fracture, crystals, smell, magnetism, heft, feel, and transparency under "Other Properties."
3. Repeat all of step 2 for the remaining mineral samples.

4. Try to identify each mineral by using the Mineral Identification Guide. Record the name of each sample.
5. Wash your hands thoroughly after completing the investigation. Clean up and put away the equipment you have used.

Mineral Identification Guide

Mineral	Colour	Lustre	Streak	Hardness	Other Properties
Feldspar	orange, pink, or white	glassy	white	6	2 cleavage planes
Hematite	brick red or grey	dull	brick red	5	heft
Magnetite	black	metallic	black	6	magnetic
Pyrite	gold	metallic	green/black	6.5	cubic crystals
Quartz	white	glassy	white	7	transparency
Gypsum	white	dull	white	2	powdery feel
Sphalerite	dark brown	glassy	pale brown	4	rotten egg odour
Fluorite	colourless or blue/green	glassy	white	4	heft
Galena	lead grey	metallic	lead gray	2.5	cubic crystals
Mica	black	glassy	white	2.5	1 cleavage plane
Sulphur	yellow	dull	white	2	rotten egg odour
Calcite	colourless	glassy	white	3	double refraction
Coal	black	dull/glassy	black	1	fracture
Pyrophyllite	yellow	dull	white	2	soapy feel
Talc	brown	dull	white	1	soapy feel

Analyze

1. Before testing, which minerals looked the same?
2. (a) Which mineral was the softest?
   (b) Which mineral was the hardest?
3. (a) Which minerals were the same colour as their streak or powder?
   (b) Which minerals had streaks with colours that surprised you?
4. What other features or properties helped you identify the samples?

Conclude and Apply

1. (a) Were you able to identify all the mineral samples?
   (b) If not, what other tests could you use to identify them?
2. (a) Which property was the most useful for identifying a mineral? Explain.
   (b) Which properties were not very useful for identifying a mineral? Explain.
3. If your mineral was harder than your streak plate you would be unable to observe the colour of its streak. What would be another way to determine the streak of the mineral?

Wild, Weird, Wonderful

www Science

Labradorite

Sometimes the beauty of a mineral is hidden beneath its surface. For example, suppose someone gave you a mineral with the following properties:

Colour: dark grey

Streak: white

Lustre: dull

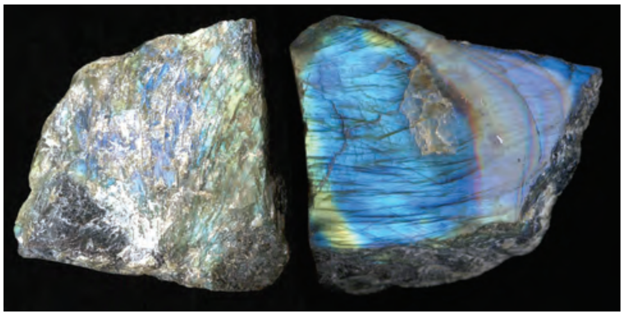
Hardness: 6–6.5

Cleavage: yes

You might at first think this is a dull, dark-looking mineral with no special quality. But as you turn the piece around in the sunlight you may suddenly notice a flash of blue light. Move the mineral again, and green light plays across its surface. You might see flashes of violet light and then yellow light.

What you are holding in your hand is a piece of labradorite, the provincial mineral of Newfoundland and Labrador. This mineral is found in only a few places in the world, most notably in our province.

The play of colours on the surface of labradorite has fascinated people for a long time.



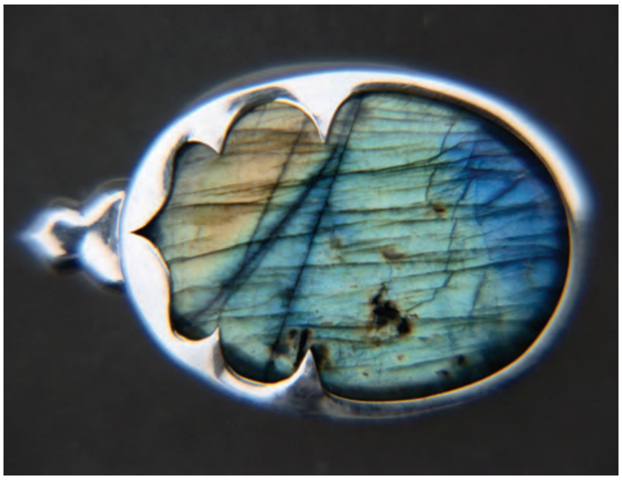
Specimens of labradorite are usually polished or sliced to display the colours.

As early as 1770, this mineral was collected by missionaries and early visitors to the area. It was taken to Europe where it was called *firestone*. In Europe, labradorite was prized for its beauty and thought to have special powers to cure disease.

The shimmering light of labradorite does not come from its surface colour. The colours in labradorite are due to the internal refraction of light in the mineral. When a ray of light enters the cleavage layers, it is bent back and forth between the layers. The colours depend on the thickness and angle of the layers. If the layers are too thick or too thin, you will not see the colours.

The play of light across its cleavage plane is called *labradorescence*. The colours mainly range from blues and violets through greens, but sometimes yellows, oranges, and even reds can be seen.

Samples of labradorite are on display in many countries, bringing a bit of the "light" of our province to the world.



High quality specimens of laboradorite are used in jewellery.

Check Your Understanding

Checking Concepts

1. What is a mineral?
2. (a) What are three types of lustre?
   (b) Give an example of a mineral for each type of lustre.
3. Why is streak a useful way to identify a mineral?
4. (a) What is the softest mineral on the Mohs Hardness Scale?
   (b) What is the hardest mineral on the Mohs Hardness Scale?
5. How would you use the Mohs Hardness Scale to help identify a mineral?
6. What is the difference between cleavage and fracture?

Understanding Key Ideas

7. Why is colour alone not a reliable clue for identifying minerals?
8. Glass is made from the mineral quartz, so it is very hard to scratch. Would you recommend cutting glass with a metal blade? Explain. (Hint: You may want to check Table 10.2.)
9. Suppose you were given several minerals that look similar. Write a note to another student describing several tests that may help to tell them apart.
10. You can use a sentence to help you remember the order of minerals in the Mohs Hardness Scale. For example, you could write "The good cop from Avondale fought quickly to catch Dave." The beginning letters in that sentence are "t, g, c, f, a, f, q, t, c, d." Those letters start the names of the minerals: talc, gypsum, calcite, fluorite, apatite, feldspar, quartz, topaz, corundum, diamond. Write your own sentence to help you remember the names and order of the minerals in the Mohs Hardness Scale.

Pause and Reflect

Can ice be classified as a mineral? Explain the reasons for your answer.

10.2 Investigating Rocks

Rocks can be grouped into three families, depending on how they formed. One family of rocks is igneous rocks, which are formed when magma or lava cools. The crystal size in igneous rocks depends on whether the rocks formed quickly or slowly. Another family of rocks is sedimentary rocks, which are formed by the processes of compaction and cementation into visible layers called beds. A third family, called metamorphic rocks, are formed when heat, pressure, and hot fluids are applied to igneous, sedimentary, or other metamorphic rocks.

Key Terms

beds
cementation
compaction
extrusive rock
igneous
intrusive rock
lava
magma
metamorphic
parent rock
rock
sedimentary

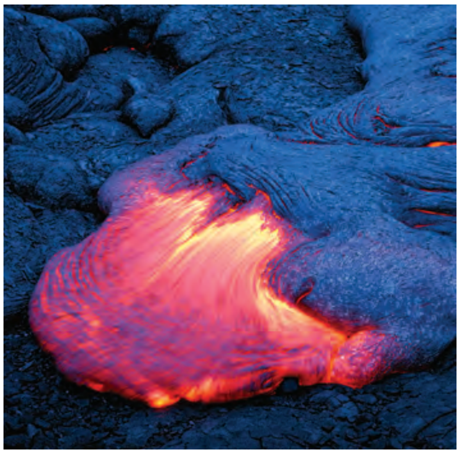


Figure 10.6 These streams of red-hot lava will cool to form rocks.

Figure 10.7 Pillow lava at Snook's Arm on the north central coast of Newfoundland is an example of rock formed from lava.

A **rock** is a mixture of two or more minerals. Where do you think rocks come from? The red-hot lava shown in Figure 10.6 is melted rock that comes from below Earth's surface. At the surface it cools and hardens into solid rock (Figure 10.7). Did all rocks form this way? Can you tell how a rock formed by comparing it with other rocks?

Rock Families

Rocks can form deep inside Earth, on Earth's crust, or in the waters found on Earth's surface. Some of the processes that make rocks happen quickly. Other processes take millions of years.

Scientists have grouped rocks into three major families, or types, based on how they form. The three families are igneous, sedimentary, and metamorphic rocks. Each type of rock can usually be identified by its appearance and by the arrangement of mineral grains within it.

10-2A Write about Rocks

Find Out ACTIVITY

In this activity, you will examine the properties of rocks and look for clues about how they formed.

Safety

- Be careful using the knife.

Materials

- rock samples
- clear adhesive tape
- marker
- hand lens
- plastic knife or other scraping tool
- index cards
- sand in plastic cup (optional)

What to Do

1. Tag each rock sample with an ID number using the tape and marker.
2. Look carefully at each sample. Use a hand lens to observe details.
3. How rough is the surface of each sample? Try scratching each rock gently with a plastic knife.
4. What properties can you use to tell your rocks apart? Colour? Size of pieces that make up the rock? Other properties?
5. Make a data table to record the properties of your samples.
6. Write a description of each sample on a card. Do not include the ID number. Ask a partner to match the cards and the samples. The better your partner does, the better your descriptions are.
7. Together with your partner, record three questions that you could investigate about how different types of rocks are formed.

What Did You Find Out?

1. Do you think all rocks have a similar history? Explain your answer based on your observations.
2. How could you turn a cup of sand into a rock? Share your ideas with others and your teacher before trying it.

Did You Know?

Pumice is a volcanic rock with a very interesting property—it floats! Pumice forms when gases cause the lava to foam up. The rock hardens quickly before the bubbles in the foam disappear. Pumice is very porous and lightweight. It is the only rock that floats.

Igneous Rock

Igneous rock results from the cooling of molten (melted) rock material. As this material cools, crystals are formed. The crystals are different sizes depending on whether the rock cools quickly or slowly. The longer the molten material takes to cool, the larger and more organized the crystals will be. The shorter the cooling time, the smaller the crystals will be.

Magma is molten material found below Earth's surface, where temperatures and pressures are high. Any rock heated at these great depths can melt into magma. Under high pressure, the magma can push away or dissolve the surrounding rock, making room for itself. Sometimes fingers of hot magma push up to the surface through cracks in Earth's crust (Figure 10.8).

Word Connect

The word "igneous" comes from the Latin word *ignis*, meaning fire, which also gives us the word "ignite."

Intrusive rock

Geologists classify igneous rock based on whether it was formed above or below Earth's surface. Magma can cool and harden below the surface. The resulting rock is called **intrusive rock.** Granite is an example of igneous rock that forms very deep and very slowly in Earth's crust (Figure 10.9).

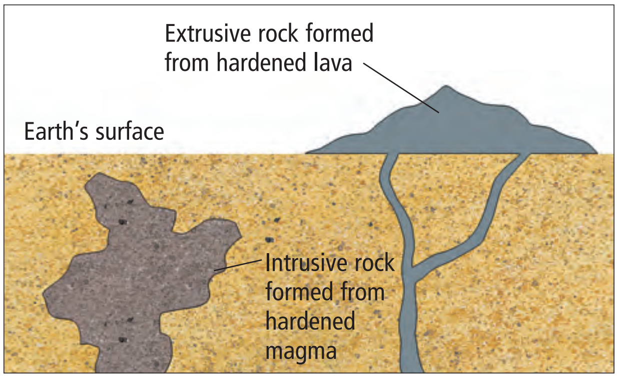


Figure 10.8 Igneous rocks are divided into two groups, depending on where the rocks cooled.

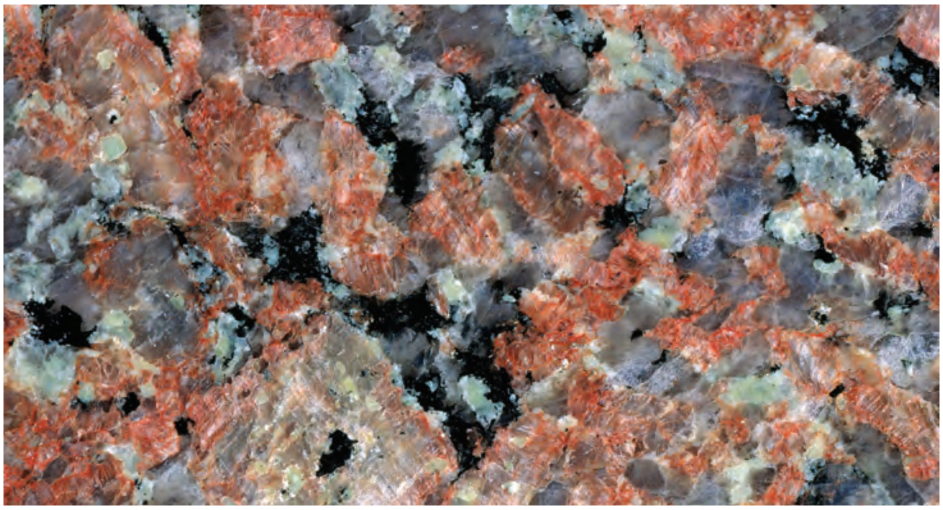


Figure 10.9 Granite is one of the most common igneous rocks found in Earth's crust.

Extrusive rock

Lava is molten material that breaks through Earth's surface in the form of a volcanic eruption. Rock that forms when lava cools on Earth's surface is called **extrusive rock**. Basalt is an example of igneous rock that forms relatively quickly at Earth's surface (Figure 10.10A). Obsidian forms when lava cools so quickly that no crystals can develop (Figure 10.10B).

A

B

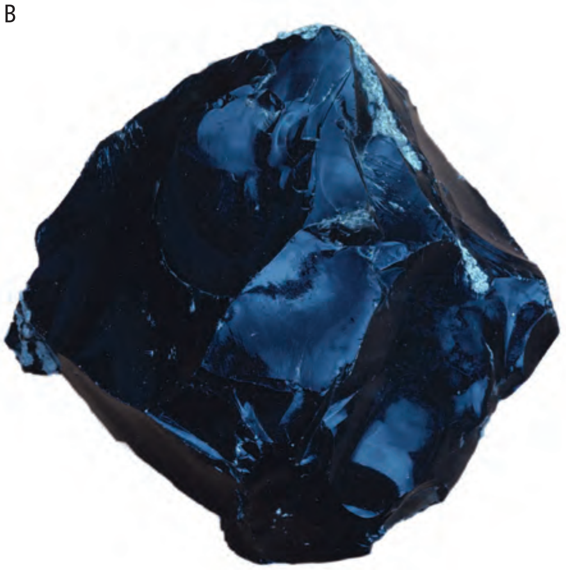


Figure 10.10 The time it takes for lava to cool determines the size of crystals in the rock, or whether crystals will form at all. For example, basalt has small crystals (A). The grains in obsidian are so fine that it looks like smooth, black glass (B). How does their size compare with the size of the crystals in granite?

Reading Check

1. Where is intrusive rock formed?
2. Where is extrusive rock formed?
3. What is the difference between magma and lava?
4. What are three examples of igneous rock?

Suggested Activity

Conduct an Investigation 10-2B on page 334

Sedimentary Rock

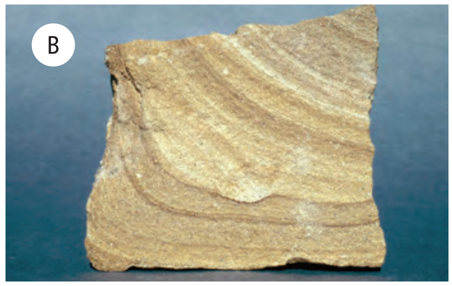
Sediment is loose particles, such as bits of rocks and minerals and decaying plants and animals. What happens to sediment? Water, wind, ice, and gravity can move sediment from place to place until it finally settles. Sediment slowly settles on top of other sediment, forming visible layers (Figure 10.11). Each layer is squeezed together by the weight above it. The process of squeezing together layers of sediment is called **compaction.**

Figure 10.11 You can see layered sedimentary rock at the end of Lighthouse Road on the east end of Bell Island.

In some rocks, minerals dissolve as water soaks into the rock. The dissolved minerals form natural cement that sticks the larger pieces of sediment together. The process in which pieces of sediment are held together by another material is called **cementation.**

Sedimentary rocks form from the compaction and cementation of sediments into visible layers called **beds.** Sedimentary rocks are often made in oceans and lakes where the larger, heavier sediments settle first. The appearance of sedimentary rock can reveal what type of sediment formed it. Sedimentary rocks are classified according to the size of their grains (Figure 10.12).

A. Shale has the smallest particles and is formed from fine grains of clay or mud.



B. Sandstone has medium-size particles that you could roll between your fingers. It is harder than shale and is usually made from quartz.

C. Conglomerate has large particles such as rounded pebbles and small stones. The particles are cemented together.

D. Limestone has particles made up of the remains of shells and skeletons from organisms that were once alive.

Figure 10.12 Four examples of sedimentary rocks

Did You Know?

Limestone can include fossils, which are the remains of plants and animals. Ocean animals, such as mussels and snails, make their shells mainly from the mineral calcite. When the animals die, their shells accumulate on the ocean floor, where most sedimentary rock is formed.

Reading Check

1. What are three examples of sediments?
2. What are the two main processes that form sedimentary rocks?
3. What do we call layers of sedimentary rocks?
4. What is an example of sedimentary rock that has
   (a) small particles?
   (b) medium particles?
   (c) large particles?
   (d) plant and animal particles?

Suggested Activity

Find Out Activity 10-2C on page 336

Metamorphic Rock

The third family of rock is called metamorphic (meaning "changed form") rock. A **metamorphic rock** is made when heat, pressure, or hot fluids change one type of rock into another type of rock. Metamorphic rock can be made from igneous and sedimentary rock and from other metamorphic rock. The formation of metamorphic rock is a long, slow process.

For example, granite is an igneous rock found deep below Earth's surface. In Figure 10.13, you can see what can happen to the mineral grains of granite as the pressure of heavy, overlying rock squeezes them closer together. The result is the metamorphic rock gneiss (pronounced "nice").

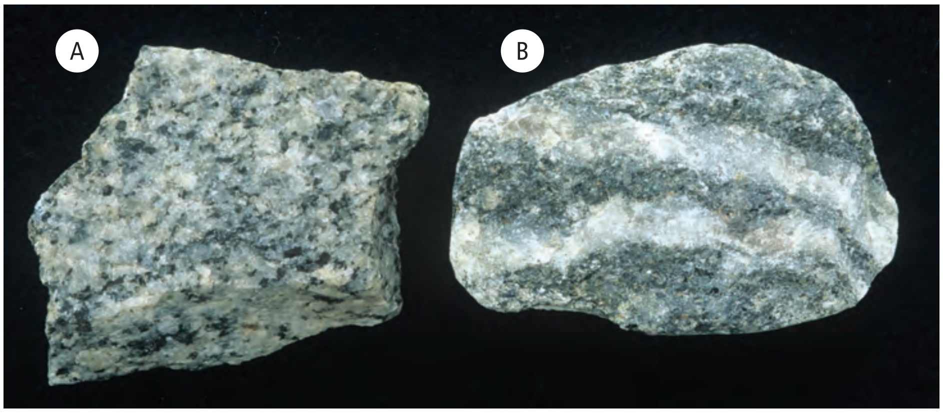


Figure 10.13 The change from igneous rock (A) to metamorphic rock (B) is a long, slow process caused by heat and pressure over time.

Metamorphic rocks form below the surface of Earth where heat and pressure are very high. Hot fluids can flow into igneous, sedimentary, or other metamorphic rock and change the rock both physically and chemically. The type of rock that has been changed into metamorphic rock is called the **parent rock.** For example, shale, a parent rock, can change into slate (see Figure 10.14).

Figure 10.14 Slate (shown) can be formed when pressure is applied to shale.

A metamorphic rock can change so completely that it no longer looks like the parent rock (Figure 10.15). Think of changes that happen when cookie dough is baked or snow is packed together. Metamorphism may change the colour, lustre, hardness, and the way in which a mineral breaks.

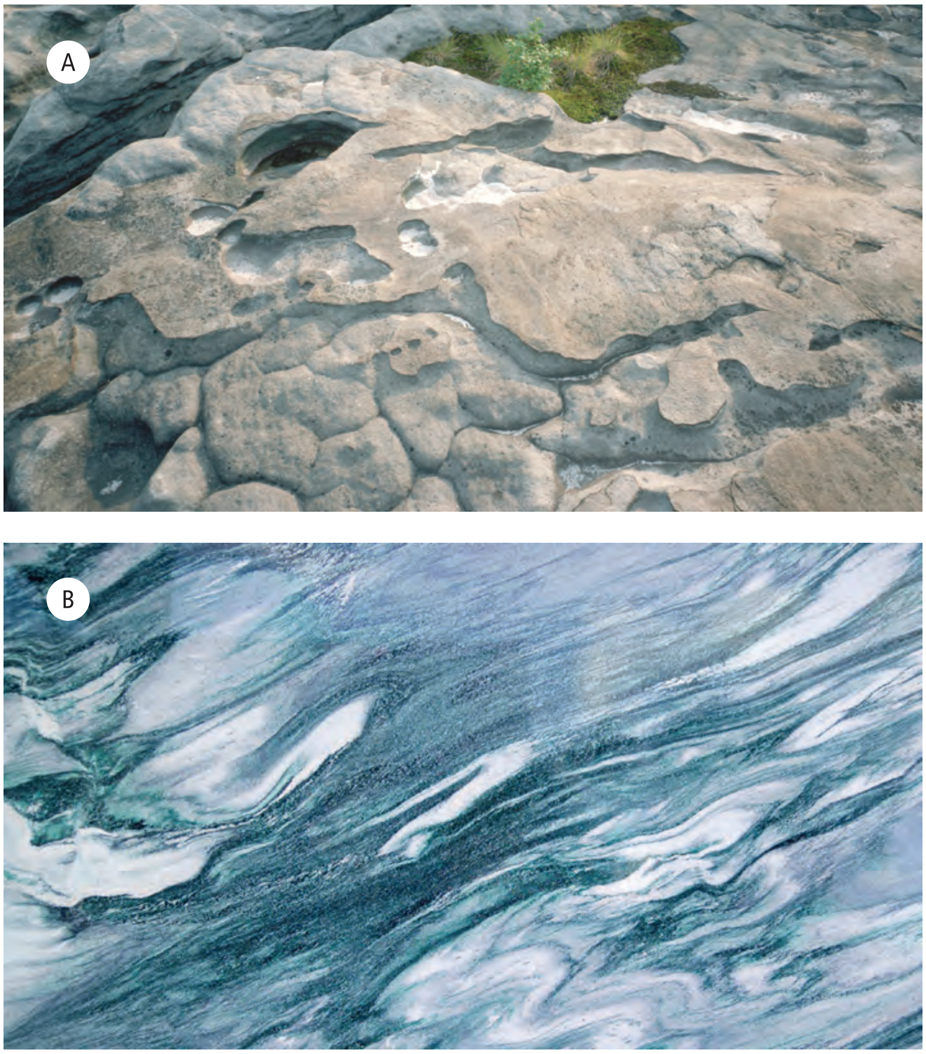


Figure 10.15 Heat and pressure can turn the parent rock limestone (A) into marble (B).

Reading Check

1. What types of rock can become metamorphic rock?
2. What are three conditions that can form metamorphic rock?
3. What is a parent rock?
4. What are three examples of metamorphic rocks and their parent rocks?

Explore More

Much of the central and eastern part of Canada consists of the Canadian Shield, a huge area of ancient igneous and metamorphic rock. Find out more about the rocks of the Canadian Shield. Start your research at **www.discoveringscience.ca**.

Suggested Activity

Find Out Activity 10-2D on page 337

10-2B Cool Crystals, Hot Gems!

Skill Check
- Observing
- Classifying
- Controlling variables
- Evaluating information

Safety

- Heat is used in this activity. Handle heated items carefully.
- Do not eat anything in the science classroom.
- Be careful pouring hot liquids.
- Wash your hands after each day's activity.

Materials

- measuring cup or graduated cylinder
- tap water
- small pot
- heat source
- measuring spoons
- 90 mL Epsom salts
- stirring rod or stirring spoon
- two small beakers
- two bowls
- hot water
- ice (crushed or broken)
- labels
- hand lens

Could you turn small crystals into larger, dazzling gemstones? Yes, if you could re-create the formation of igneous rocks and, at the same time, control the conditions for crystal growth. In this activity, you will use a liquid solution to represent the melted rock. The crystal size and different rates of cooling represent igneous rock formation.

Question

How does the rate of cooling affect crystal size?

Step 3

Step 4

Procedure

Day 1

1. Make sure that all containers and spoons are very clean.
2. Measure 100 mL of tap water using the measuring cup or graduated cylinder. Put the water in the pot.
3. Add 90 mL of Epsom salts to the water in the pot. Stir over low heat. DO NOT boil.
4. When most of the Epsom salts are dissolved (not all crystals may dissolve), remove the pot from the heat. Carefully pour off equal amounts of the solution into each beaker (about 50 mL in each). Make sure that none of the undissolved crystals get into the beakers.
5. Place one beaker in a bowl of ice and the other in a bowl of hot water. Label each beaker. Wash your hands.
6. Leave the beakers for 24 h to allow crystals to form.

Inquiry Focus

Day 2

Step 7

7. Tilt each beaker slightly, and, using a hand lens, examine the crystals. Make a drawing of what you see.
8. Clean up and put away your equipment. Wash your hands thoroughly after completing this investigation.

Analyze

1. In which beaker did the larger crystals form?
2. Did you observe in which beaker the crystals took longer to form? If so, which one?
3. For a fair comparison of crystal size based on rate of cooling, all of the other conditions had to be the same, or controlled. List all of the conditions, or variables, that were controlled for each beaker in this investigation.
4. What was the manipulated variable (the feature you changed)?
5. What was the responding variable (the feature that changed as a result of the experiment)?

Conclude and Apply

1. How did the rate of cooling affect the size of the crystals?
2. Which sample of crystals could represent extrusive rock? Why?
3. What is more likely to happen to crystal size in intrusive rock?
4. Where might larger crystals be found, on the surface of Earth or deep in the ground?

10-2C Settling Sediments

Find Out ACTIVITY

Sediments of different rocks can get churned up and mixed together in a rushing river or in larger lakes and oceans by the action of waves. How does the sediment settle into organized layers of rock? In this activity, you can observe the process of how sediments settle.

Safety

- Avoid inhaling dust from the clay and gravel.
- Be careful using the glass jar.
- Wipe up any spills immediately.

Materials

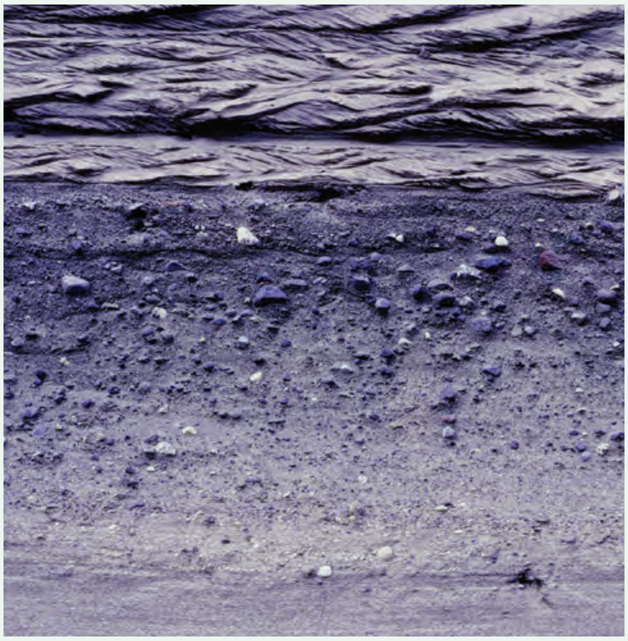
- dampened clay powder
- sand
- fine gravel
- coarse gravel
- clear glass jar or soft drink bottle (2 L or larger) with a screw-cap lid
- water

What to Do

1. Half fill the container with water.
2. Place 100 mL of each type of sediment into the container. Top up the container with water.
3. Cap the container tightly, and shake it until all the sediments are moving about. Make a prediction about how the sediments will settle.
4. Set the container down, and observe the sediments settling. Record your observations.
5. Let the container sit undisturbed for 30 min to 1 h. Then, record your observations. Include a drawing of what you observe. Label the layers in your drawing.

What Did You Find Out?

1. Which sediments started to settle immediately?
2. Which sediments took the longest to settle out of the water?
3. (a) Does the water look the same as when you first poured it into the jar?
   (b) Why or why not?
4. What properties do the bottom sediments have that caused them to settle first?



Sometimes sediments settle with the finer grains deeper than the coarser grains. This photograph shows a bed of sediments washed out from a glacier in British Columbia.

10-2D Sort It Out

Find Out ACTIVITY

How do the crystals or minerals form in a rock? Why do some rocks have layers? Why do some rocks have rounded particles and other rocks have angular particles? These and other questions can give you clues to the history of rocks. In this activity, you will classify rocks based on their characteristics and on how they were formed.

Materials

- a set of rocks, including rocks from your geographic area
- rocks you have found and brought to class
- hand lens or binocular microscope

What to Do

1. Compare the rocks you brought in with the samples provided. How are they similar? How are they different?
2. Use a magnifying glass to examine the minerals that make up these rocks.
3. Create your own classification system based on your observations. These points may help you get started:
   - Sedimentary rocks are often made up of small or large rounded particles that are compacted or cemented together.
   - Igneous rocks often have small or large angular crystals of minerals visible and the minerals appear to be interlocking.
   - Metamorphic rocks are created under a great deal of heat and pressure, causing them to have thin, flattened particles and layers that are easily visible.
4. Try to classify each of the rocks into one of the three groups. Do not be discouraged if some rocks are difficult to classify. The system you develop is more important than how accurately you sort the rocks.

What Did You Find Out?

1. Which characteristics did you use to classify igneous rocks?
2. Which characteristics did you use to classify sedimentary rocks?
3. Which characteristics did you use to classify metamorphic rocks?
4. Were there any rocks you were unable to classify? If so, describe their characteristics.

Science Skills

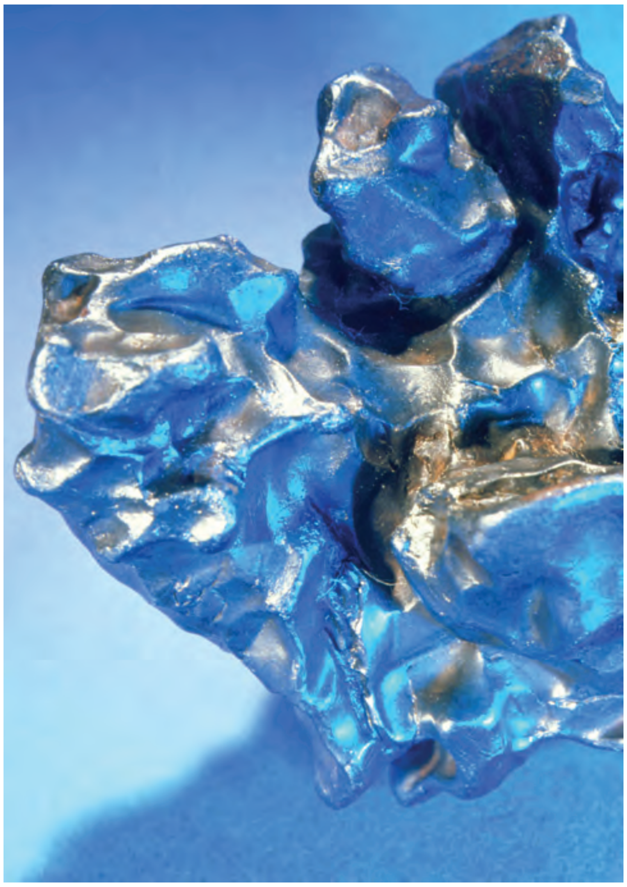
For help in making observations, turn to Science Skill 5.

Wild, Weird, Wonderful

www Science

Space Rocks on Earth

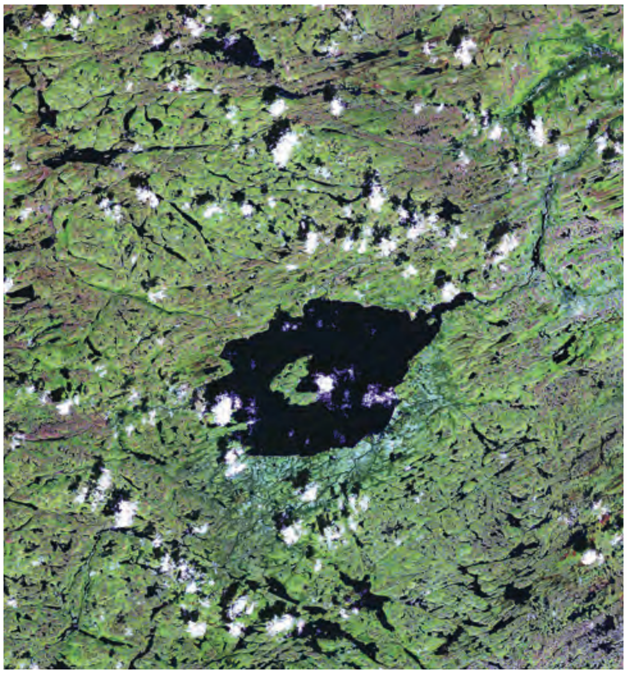
When you are outside walking about or digging in the ground, take a good look at the rocks you find. One of them might be from outer space.



A meteorite is irregular in shape.

Meteorites are pieces of rock that reach Earth's surface without getting burnt up in the atmosphere. Every year, Earth is showered by meteorite material falling from space, ranging from tiny particles of dust to larger pieces of rock. Billions of tiny meteorites have fallen to Earth. Larger meteorites have also fallen, including some that weigh several tonnes.

A meteorite may be made of iron and have a crust and smooth pits. The crust may be dull black or brown, very soft, and may have partly flaked off. The smooth pits may look a bit like thumbprints. Meteorites often are strongly magnetic and may contain nickel. They are often more dense than Earth rocks and tend to feel heavy for their size.



Mistastin Lake in Labrador is formed in a meteor crater. The meteor fell to Earth about 36 million years ago.

You can find a meteorite almost anywhere. It may be near the surface or buried underground, depending on how long ago it fell to Earth and how much of an impact it created.

By examining a meteorite, you can learn not only how it formed but also more about how Earth formed. Evidence indicates that Earth, the Moon, and meteorites all formed at about the same time from the same material that formed all the planets of our solar system.

Check Your Understanding

Checking Concepts

1. Define rock.
2. (a) Define igneous rock.
   (b) Describe how igneous rock forms.
3. What is the difference between magma and lava?
4. (a) What is the difference between intrusive and extrusive rocks?
   (b) What is an example of each type?
5. Define sedimentary rock.
6. (a) What are four examples of sedimentary rock?
   (b) What type of particle does each example have?
7. Define metamorphic rock.
8. How are metamorphic rocks formed?
9. (a) List two examples of metamorphic rocks.
   (b) What is the parent rock of each of the examples?

Understanding Key Ideas

10. Explain how the crystal size in igneous rocks can help you predict how it was formed.
11. (a) Describe compaction and cementation.
    (b) Make a drawing of each process.
12. Suppose you were asked to identify whether a rock specimen was igneous, sedimentary, or metamorphic. What steps would you use to identify it?
13. (a) What family of rocks do you think is shown below?
    (b) How did you make your decision?

Pause and Reflect

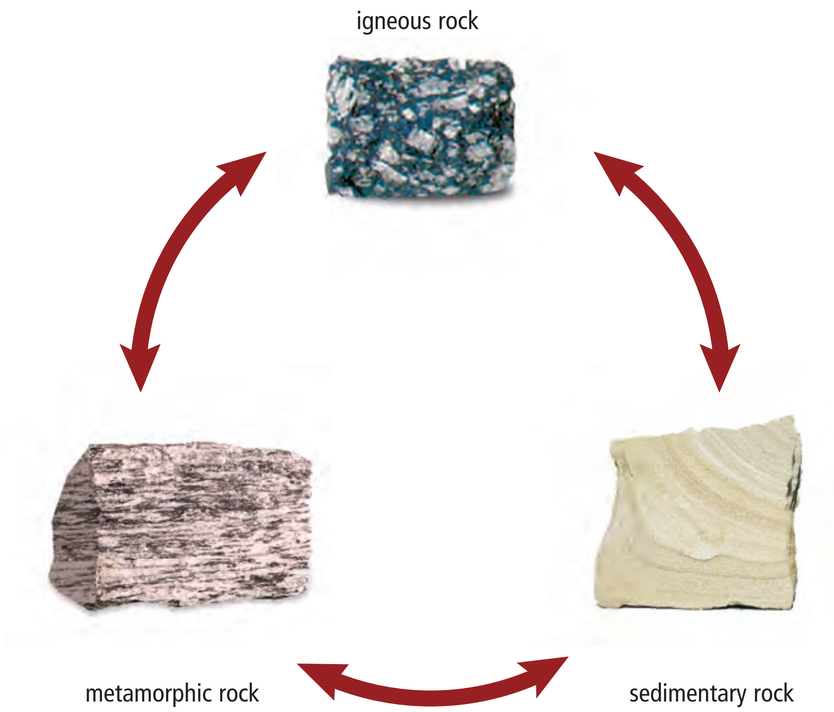
What questions could you ask in order to investigate differences in rocks? Make a list of at least five questions.

10.3 The Rock Cycle and Rock and Mineral Resources

In the rock cycle, different conditions produce different types of rocks. Rocks are constantly changing as they are heated up, cooled down, worn away, and placed under pressure. The processes that change rocks do not occur in a set order. Each process may take thousands or millions of years. Rock and mineral resources have been used by humans throughout history. We continue to find more uses for them that improve our lives.

Key Terms

resource
rock cycle



Rocks are always changing. All rocks can be broken down to form smaller rock fragments called sediments. Sediments can be compacted and cemented to form sedimentary rock. How else can rocks change?

Rocks can be broken apart, chemically altered, dissolved, and even carried away by water or ice. Although human activity is responsible for some of the breakdown process, most of it occurs naturally. Once a rock has reached a new location, the rock can undergo even more drastic changes and become part of an entirely different family of rocks. Sedimentary and igneous rocks can become metamorphic rocks. As metamorphic rocks sink back into the depths of Earth's crust, the heat and pressure can turn them back into magma.

Rocks continue to change in ongoing processes called the **rock cycle.** The rock cycle, like any natural cycle, represents a process of change where the same materials are cycled throughout. The materials found in rocks undergo constant change to produce new types of rocks under different conditions. The changes that take place in the rock cycle never destroy or create matter. The matter is just recycled in other forms.

Did You Know?

All the rocks around you, including the rocks used to build homes and schools, are part of the rock cycle.

10-3A Recycling the Rocks

Think About It

Rocks are always changing in the rock cycle. For example, to form igneous rock from sedimentary rock, the sedimentary rock has to be changed to metamorphic rock first. Then, the metamorphic rock is melted to form magma, which is then cooled to form igneous rock. In this activity, you will create a flow chart to show what happens in the rock cycle.

Materials

- index cards or other pieces of paper
- coloured pencils or felt pens
- poster paper
- glue
- optional: yarn, string, and other materials

What to Do

1. Make a card for each of igneous, sedimentary, and metamorphic. On each card, draw or glue a picture of that type of rock. Arrange your cards on a piece of poster paper with plenty of space between them. Do not glue them yet.
2. Think about the processes involved as each type of rock becomes another type of rock. Make a list of the processes, such as heat, pressure, compaction, and so on.
3. Decide how to show the effect each process has on each type of rock. You may wish to use yarn and labels or use colours to show the processes that change rocks from one type into another.
4. Experiment with placing your labels and rocks in different places on the poster paper. Keep moving them around until you are satisfied that you have a way to show how all the processes act on all the rocks. Then, glue them into place.
5. Add any additional colours, labels, or details that will help make your poster clear and easy to understand.
6. Share your poster with your classmates and observe the details on their posters. There are many ways to represent the rock cycle!

Science Skills

For help in organizing information, turn to Science Skill 9.

Processes in the Rock Cycle

The rock cycle consists of the processes in which rocks are continually changed over long periods of time. Examine the models of the rock cycle in Figures 10.17A and 10.17B. Notice that all three families of rocks are shown, along with the processes that make them. Weathering and erosion are processes that break rock down and carry it away. You will learn more about weathering and erosion in Chapter 12.

The processes in the rock cycle do not occur in a set order. Each of these processes can take thousands or even millions of years.

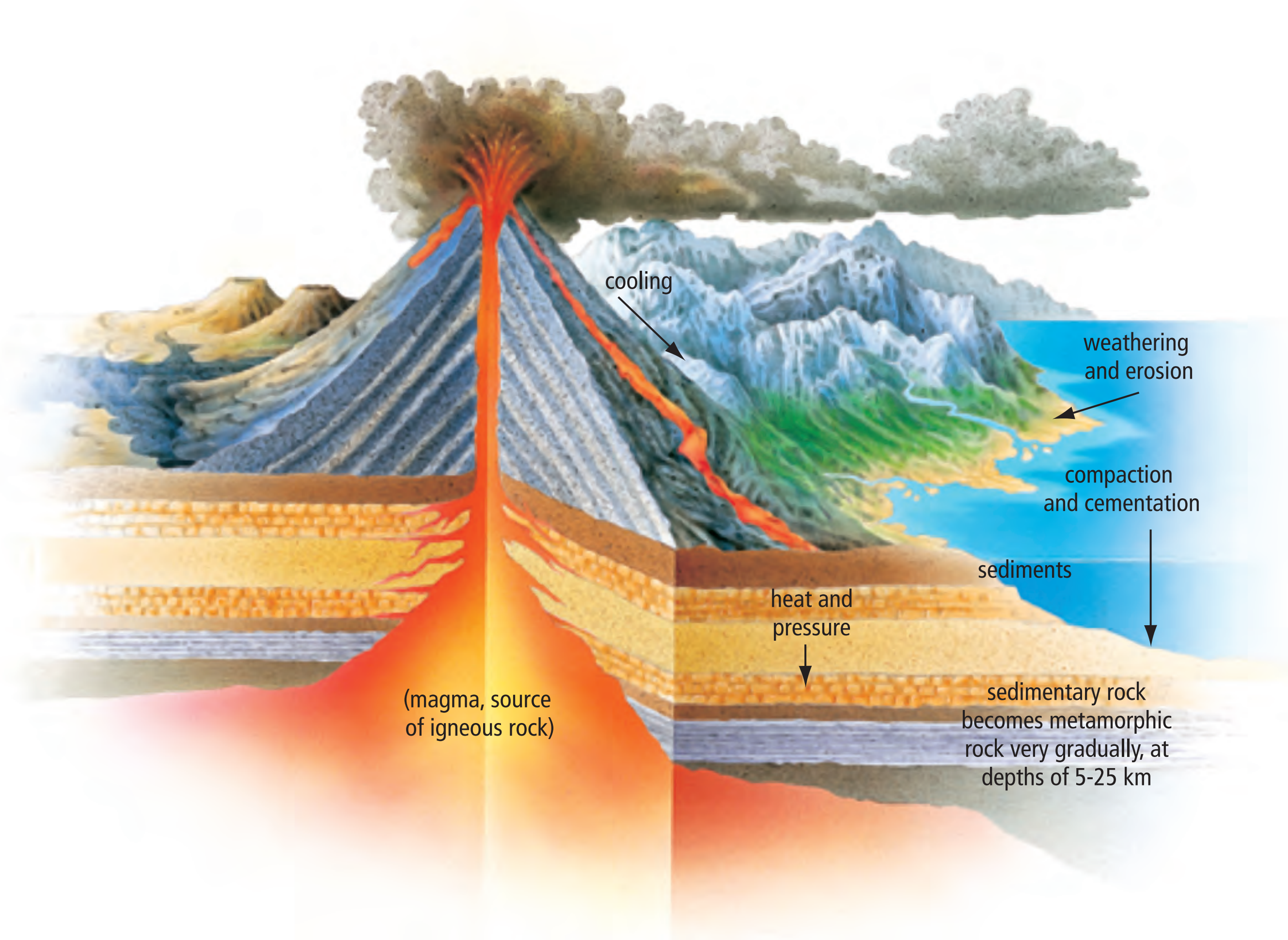


Figure 10.17A This model shows part of the rock cycle. Notice that the diagram is not drawn to scale. Hot molten magma and lava metamorphoses surrounding rocks due to their tremendous heat. Rocks can change from one type into another type.

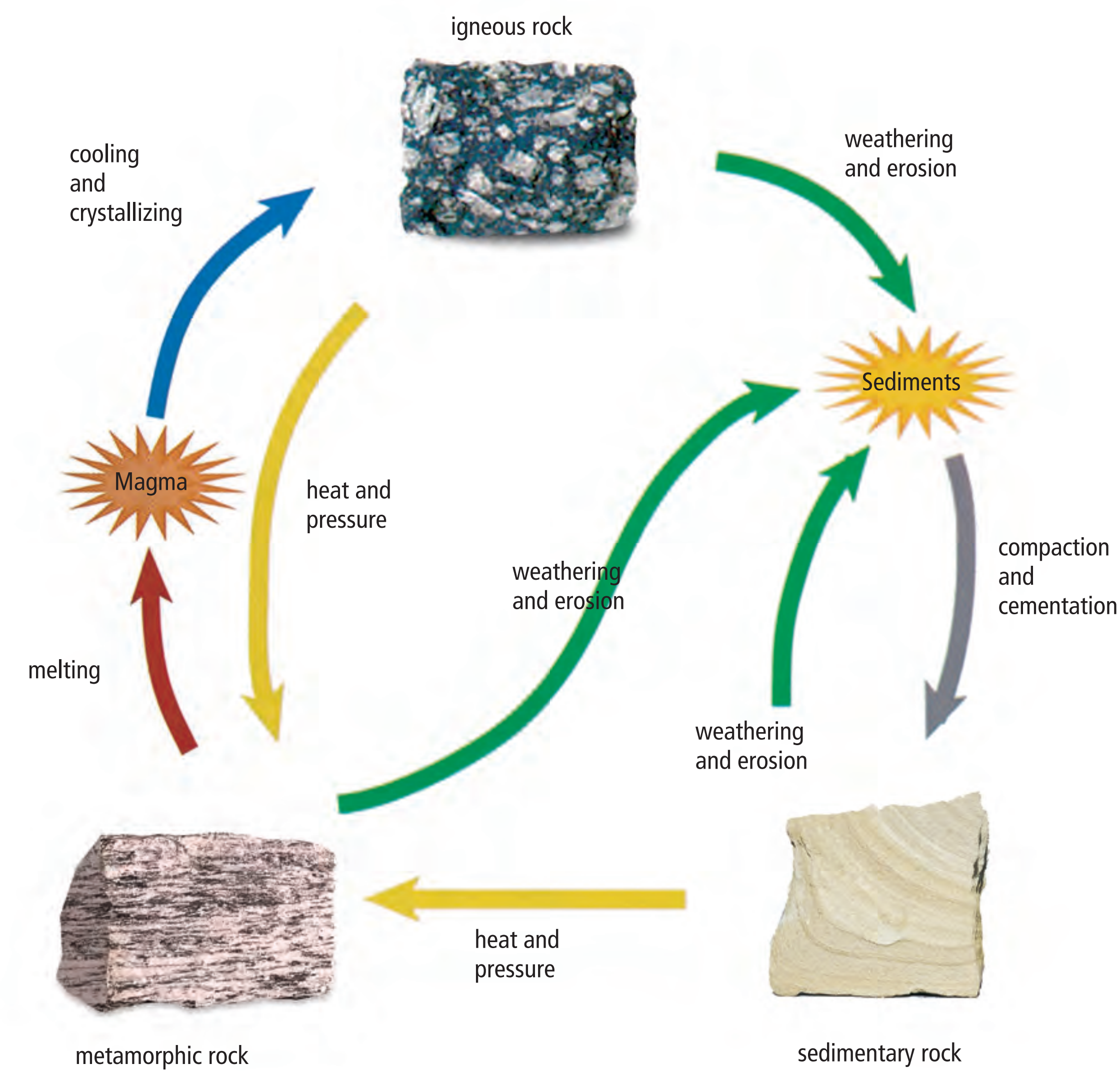


Figure 10.17B This model is one way to represent the rock cycle. Follow each of the arrows through the rock cycle.

Reading Check

1. What is the rock cycle?
2. How do igneous and metamorphic rocks become sedimentary rocks?
3. How do igneous and sedimentary rocks become metamorphic rocks?
4. How do metamorphic rocks become igneous rocks?

Suggested Activity

Conduct an Investigation 10-3C on page 348

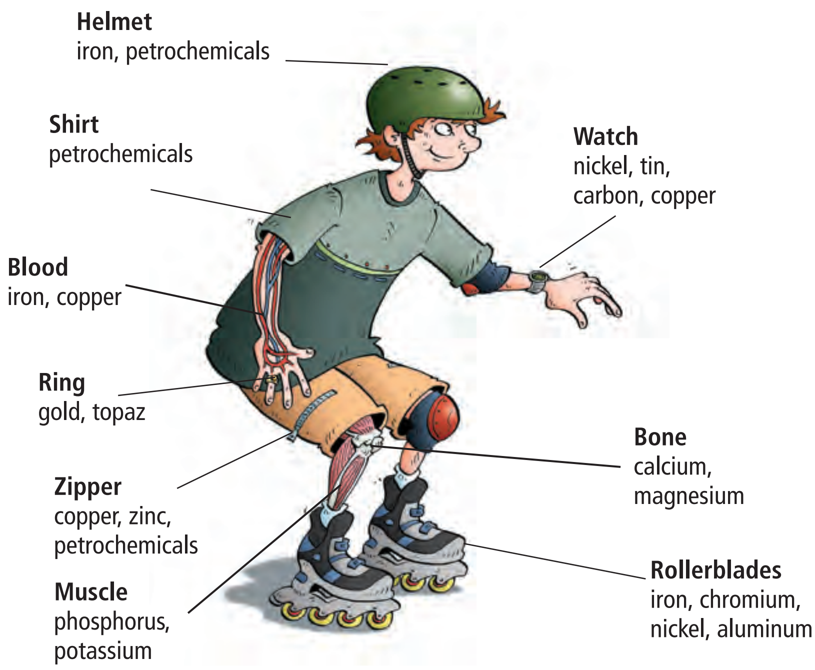


Figure 10.18 Which parts of your clothes and your body come from rocks and minerals?

Rock and Mineral Uses

In what ways do you use rocks and minerals? The answer might surprise you. Many of the things you wear come from rocks and minerals. The same is true of the bikes, cars, buses, and other vehicles you use for transportation. Even your bones, your blood, and other parts of your body contain substances that come from rocks and minerals! Look at Figure 10.18 to discover just a few of the many ways in which rocks and minerals are a part of your life.

People have used rocks and minerals since the beginning of our existence. Some of the first shelters our ancestors used for protection from weather and wild animals were made from rocks. Today, most homes around the world include rocks or rock materials such as soil in their structure. The foundation on which your home and school were built may be made from concrete, which comes from limestone. The bricks used to make buildings and the cement used to pave sidewalks that lead to those buildings are also made from rocks.

internet connect

Learn about the history of limestone production in our province in Chapter IV of Once Upon a Mine, the Story of Pre-Confederation Mines on the island of Newfoundland. Visit **www.discoveringscience.ca.**

Rock and mineral resources

A rock or mineral **resource** is a rock or mineral that can be mined and used for a specific purpose. For example, petroleum, metals, and gems are all resources.

- *Petroleum* and coal are examples of mineral resources that are made from the remains of once-living plants and small plant-like and animal-like organisms that lived in the ancient ocean. Petroleum (crude oil) is used to make fuels, plastics, and many other useful products.

- *Metals* are among the most useful products that come from rock and minerals resources. Commonly used metals include gold, silver, copper, iron, zinc, aluminum, and nickel. We use metals to make cars, applicances, computers, and tools.
- *Gems* are highly prized minerals because they are rare and beautiful. Gems are brighter and more colourful than common samples of the same mineral (Figure 10.20). Diamond, a very valuable gem, also has practical uses. Because diamonds are the hardest of all minerals, they are used on drill bits and other instruments to cut through hard substances, such as steel and rock. Scientists apply tiny rows of diamonds on the edges of surgical scalpels, razor blades, dental drills, and computer parts.

Figure 10.20 Unpolished amethyst (A). Polished amethyst (B). Many gems are cut and polished for use in jewellery

Putting Rocks and Minerals to Work

Much of the exploration of Earth's crust is done for economic reasons. Geologists search for minerals, ores, and rocks that can be mined and used. As technologies improve and are refined, we are able to use rocks and minerals for more and more purposes.

For example, iron is one of the most common and most used elements on Earth. Yet for thousands of years, meteorites were the only source of useable iron because people did not yet know how to extract iron from iron ore. Once humans discovered a process for extracting iron, they could make many more tools and structures. Over the past thousand years, the extraction process has been refined, resulting in a better and more useful quality of iron.

We are still discovering new ways to use rocks and minerals to improve our lives. Some common uses of rocks and minerals are listed in Table 10.3 on the next page.

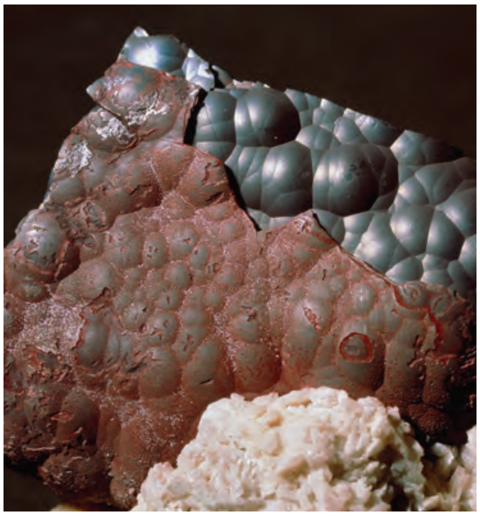


Figure 10.20 Hematite is mined as the main ore of iron.

Connection

Section 9.2 has information about gold ore.

Table 10.3 Some Rock and Mineral Resources of Newfoundland and Labrador

Rock or Mineral Resource	Examples of Uses
Barite	drilling muds, paints, chemicals, television screens
Calcite	limestone, crystals
Coal	fuel
Copper	electrical wires, water pipes
Fluorite	fluoride for toothpaste, chemicals
Galena	lead
Gold	coins, jewellery, electrical components, medical uses
Granite	building stone, monuments
Gypsum	chalk, plaster, fertilizer, paint filler, cement
Halite	table salt, fertilizer, soap, food preservative
Hematite	iron and steel, jewellery
Iron	steel, appliances, motor vehicle parts, machinery, transportation, buildings, pots and pans
Limestone	cement, building stone, construction
Marble	building stone, monuments
Mica	insulation, spark plugs
Nickel	stainless steel, batteries, coins, electronics, building and construction, transportation
Pumice	skin cleanser
Pyrophyllite	insecticides, glazing ceramic tiles, crafts
Quartz	glass, silicon chips, jewellery, radio transistors, crystals for computers and watches, lenses for glasses, binoculars, and telescopes
Slate	floors, roofing, blackboards
Sphalerite	zinc, cadmium
Sulphur	fertilizer, chemicals, industrial uses
Sylvite	potassium for fertilizer
Talc	talcum powder, paint, crayons, paper, rubber, table tops, sinks

Explore More

Find out which metals are used in Canadian coins. You can start your research at **www.discoveringscience.ca.**

Reading Check

1. What is a resource?
2. Name two examples of rock or mineral resources.
3. What are gems?

10-3B Research the Resource

Think About It

The properties of the rocks and minerals make them useful in many ways. For example, granite is very hard and stable and is used in the construction industry. Pumice, a very abrasive rock, is used in skin cleansers.

Many rock and mineral resources are found in Newfoundland and Labrador. In this activity, you will discover how the rock and mineral resources that are near your community are mined and used.

Materials

- map of Newfoundland and Labrador mines
- red and black pens
- research materials

What to Do

1. Your teacher will give you a map of Newfoundland and Labrador that has symbols for the locations of mines. Mark the community where you live on the map.
2. Divide the names of mines among your group members. Each person should have at least three mines.
3. Research each mine of your assigned mines to find out what rock and/or mineral resource is mined there. Record the rock and/or mineral resource, and give one use for it.
4. Record the names of your mines on your map in black pen. Record the names of the rock and/or mineral resources and their uses on your map in red pen.
5. Share the information you collected with your group. Add the names of the other mines, as well as the rock and/or mineral resources and their uses, to your map.
6. Choose one of the mines to research further. Find out how the resource is mined and what effects the mining processes have on the surrounding environment.

What Did You Find Out?

1. (a) Which mine is closest to where you live?
   (b) What resource is mined there?
   (c) What is one use for the resource?
2. (a) What are five common mineral resources that are found in Newfoundland and Labrador?
   (b) Give one use for each resource.
3. What effects does mining have on the surrounding environment?

Open pit mine near Labrador City

10-3C Rolling Out the Rock Cycle

Skill Check

- Observing
- Classifying
- Modelling
- Explaining systems

Safety

- Use care when handling the hot water and when working around the heat source.
- Carefully unplug the hot plate at the end of the investigation. Let it cool completely before you put it away.

Materials

- different colours of wax crayons
- coin
- aluminum foil
- rolling pin or heavy weight
- hot mitts
- tongs
- water
- hot plate or electric kettle
- plastic spoon
- small aluminum dish
- beaker or small glass bowl

Rocks can be broken down into sediments when they are exposed to rain, wind, and ice. The sediments can then be compacted or cemented to form new sedimentary rocks. If the new sedimentary rocks are buried deep underground, they can be changed into metamorphic rocks by the processes of heat and pressure. Metamorphic rocks can melt and become igneous rocks. In this activity, you will model the rock cycle and the processes that form and change rocks.

Question

Which of the processes of the rock cycle can you model?

Step 7

Step 15

Procedure

Part 1

1. Choose three different colours of crayons. Remove the paper coverings from the crayons.
2. Use the edge of a coin to scrape off small bits ("sediments") of each crayon into a pile on a piece of aluminum foil.
3. Place some of the coloured sediments in a neat pile in the centre of a 10 cm by 10 cm piece of aluminum foil. Fold the piece of foil over the sediments to enclose them completely.
4. Roll the rolling pin (or heavy weight) to apply mild pressure to the foil package. Roll the rolling pin back and forth several times.
5. Open the foil, and observe the sediments. Record your observations. Save the sediments and foil for use in Part 2.

Part 2

6. Fold the foil securely around the sediments once again.
7. Put on your safety glasses, apron, and hot mitts. Your teacher will supply you with a source of boiling water. Use the tongs to place the foil package in the boiling water. CAUTION: Be very careful near the boiling water. It is very hot and can severely burn your skin.
8. Carefully remove the foil package with the tongs after 20 s.
9. Immediately use the rolling pin to apply a lot of pressure to the package.
10. Open the foil, and observe your "rock." Record your observations.

Part 3

11. Create more sediments by scraping the crayons with the coin.
12. Warm up a hot plate. Be sure to wear your safety glasses and hot mitts. CAUTION: Be very careful when using the hot plate.
13. Collect a spoonful of sediments. Put your sediments in a small aluminum dish. Place the dish on the hot plate.
14. Heat the sediments just until they melt. Do not overheat them.
15. Hold the aluminum dish with the tongs. Pour your heated sediments into a beaker or small glass bowl of cold water. Leave the sediments in the water for 1 min.
16. Use the plastic spoon to remove your newly formed "rock." Observe your rock, and record your observations.
17. Clean up and put away the equipment you have used.

Analyze

1. (a) What processes of the rock cycle were you modelling in Part 1 of the investigation?
   (b) How do you know?
2. (a) What processes of the rock cycle were you modelling in Part 2 of the investigation?
   (b) How do you know?
3. (a) What processes of the rock cycle were you modelling in Part 3 of the investigation?
   (b) How do you know?

Conclude and Apply

1. (a) What processes in the rock cycle were you not able to model in this investigation?
   (b) Why were you not able to model these processes?
2. How might you change this investigation so that you could model all the processes in the rock cycle?

Science Watch

Holding History Together

What holds a building together for thousands of years? If you are looking at an impressive building such as the Colosseum of Ancient Rome, then the answer is "Roman cement."

Cement is used to bond or glue rocks and bricks together in building construction. Modern cement is a mixture of mineral resources, mostly limestone and sand or clay. The ingredients are burnt together in a kiln, which changes the chemicals in the mixture. The mixture is then finely ground and mixed with sand to use as an ingredient of concrete and mortar. When water is added, the mixture hardens, just as natural cement hardens when sedimentary rock is formed.

Cement has a long history. In early civilizations of the Middle East, people made walls for their homes from moulded clay. They discovered that if they coated the clay with a moist coating of thin, white, burnt limestone, the walls would be protected from crumbling.

This Roman wall is several thousand years old. The wall is made from limestone and red Roman tiles, held together by a coarse cement mortar.

The ancient Romans knew that burnt limestone could be mixed with river sand to make cement. The cement was useful, although it could not be used to make structures that were built in water. Then, the Romans discovered a secret ingredient.

The Colosseum was built almost 2000 years ago. It has been damaged in earthquakes, but the cement is still holding strong.

An ancient architect named Vitruvius described a powder that came from natural sources and produced astonishing results. He wrote that when the powder was mixed with lime and rubble, it could be used to strengthen buildings and to make piers under water.

What was the mystery powder? The powder was ash from a nearby volcano. The ash had already been heated by the volcano, so the chemicals in it had been changed. It was ready to be mixed with the limestone.

Roman cement was a mixture made from equal portions of lime (calcium oxide) and volcanic ash or crushed tiles, mixed with a little water. Many buildings, like the famous Colosseum in Rome, were made from huge rocks glued together thousands of years ago with long-lasting Roman cement.

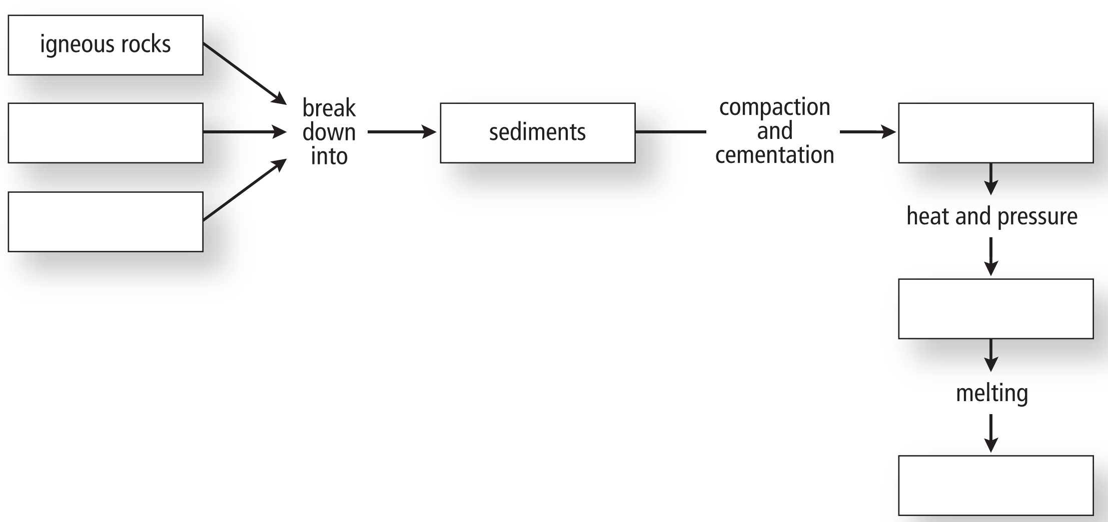
Questions

1. What is cement?
2. Why do the ingredients need to be heated to make modern cement?
3. Why did the ancient Romans not have to heat their cement ingredients?

Check Your Understanding

Checking Concepts

1. Sketch and label a diagram of the rock cycle.
2. How are igneous and sedimentary rocks related?
3. How are sedimentary and metamorphic rocks related?
4. How are metamorphic and igneous rocks related?
5. (a) What are three minerals or mineral resources you have used today?
   (b) How did you use them?
6. (a) Name two mineral resources found in Newfoundland and Labrador.
   (b) How are they used?
7. This flow chart shows part of the rock cycle. Copy and complete the chart in your notebook.



Understanding Key Ideas

8. How is the rock cycle similar to the recycling of matter?
9. How do society's needs lead to developments in technologies designed to use rocks? Explain your ideas using an example.

Pause and Reflect

How has your life been improved by the rock and mineral resources found in Newfoundland and Labrador?

Chapter 10

Chapter Review

Prepare Your Own Summary

In this chapter, you investigated minerals, rocks, the rock cycle, and the uses of rocks and minerals. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 9 for help with using graphic organizers.) Use the following headings to organize your notes:

1. Properties of Minerals
2. Three Families of Rocks
3. The Rock Cycle
4. The Uses of Rocks and Minerals

Checking Concepts

1. Define the following:
   (a) rocks
   (b) minerals
2. (a) List the properties used to identify minerals.
   (b) Explain how to use each property.
3. What is the difference between cleavage and fracture?
4. Explain why a diamond does not leave a streak on a streak plate.
5. What hardness does a mineral have if it can be scratched by glass but it can scratch an iron nail?
6. What is the difference between magma and lava?
7. What are two differences between intrusive and extrusive rocks?
8. Where do sediments come from?
9. What are three examples of sedimentary rocks?
10. Draw a flow chart of the rock cycle.

Understanding Key Ideas

11. Use the rock cycle to explain why pieces of granite (igneous) and slate (metamorphic) can be found in the same piece of conglomerate (sedimentary).
12. (a) Which family does the rock below belong to?
    (b) How did you decide?

13. Copy and complete the following table in your notebook.

	What It Is Formed From	Where It Is Formed	Distinguishing Features	Examples
Igneous rock				
Sedimentary rock				
Metamorphic rock				

14. Draw sketches to show how baking cookies in the oven represents what happens to mineral crystals in sedimentary and igneous rocks when they are subjected to great heat.
15. Create a diagram to show how metamorphic rock is formed from its parent rock (e.g., limestone to marble, shale to slate, and granite to gneiss). Label the changes that the rock undergoes.
16. Diamonds are the hardest natural substance known. You can, however, easily break a diamond into several pieces if you hit the diamond with a small hammer. What does this indicate?
17. (a) Why do you think some igneous rocks have bubbles or pores?
    (b) Do you think such rocks are likely to be intrusive or extrusive?
    (c) Explain why.
18. Why are metamorphic rocks created deep in Earth's crust, not on the surface?
19. Suppose you had a piece of paper, a piece of steel, and a glass bottle. Explain how you could use these materials to distinguish between calcite and quartz.

Pause and Reflect

How is the formation of ice in a glacier or snowbank similar to the formation of sedimentary rock beds? Use a sketch in your answer.