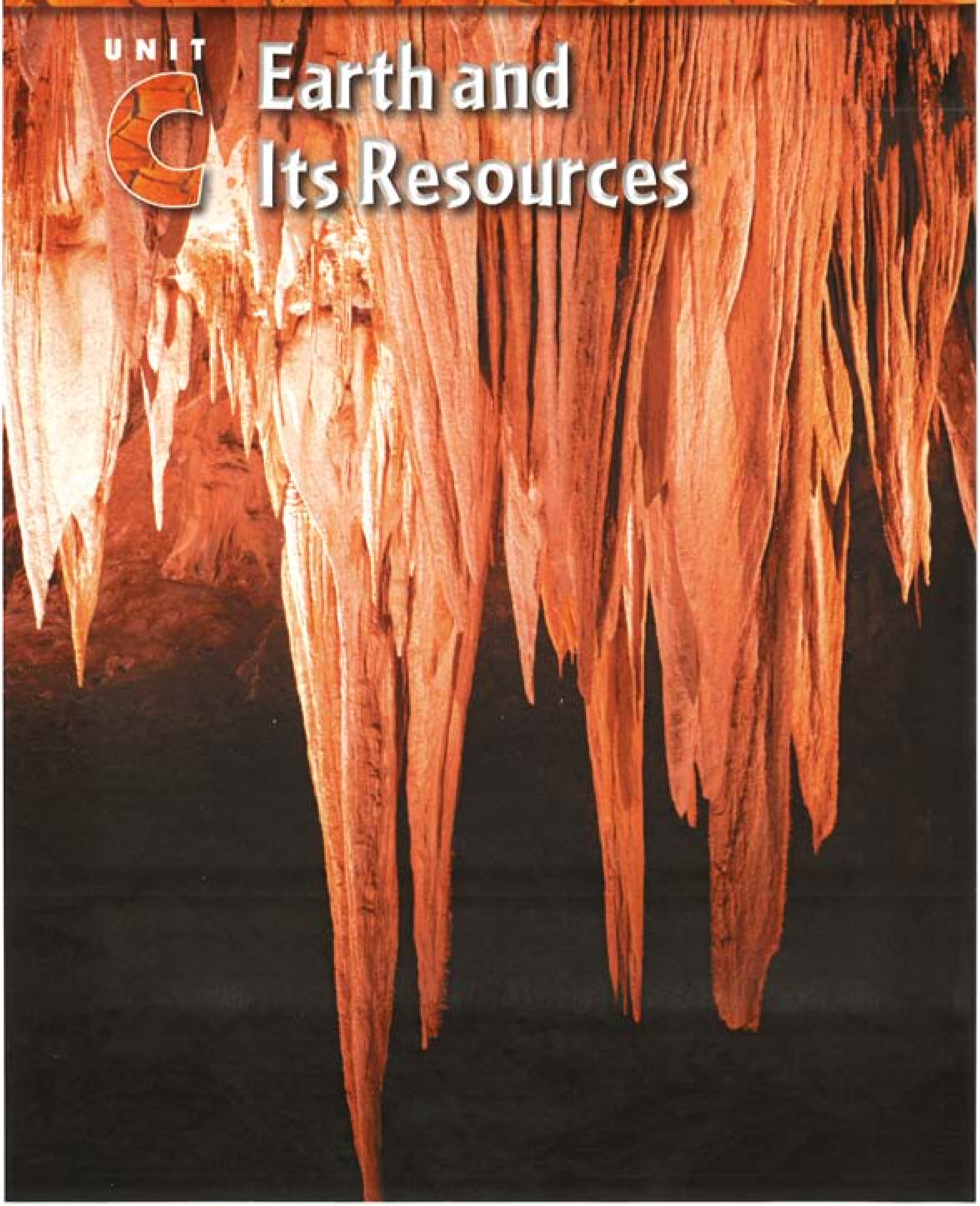
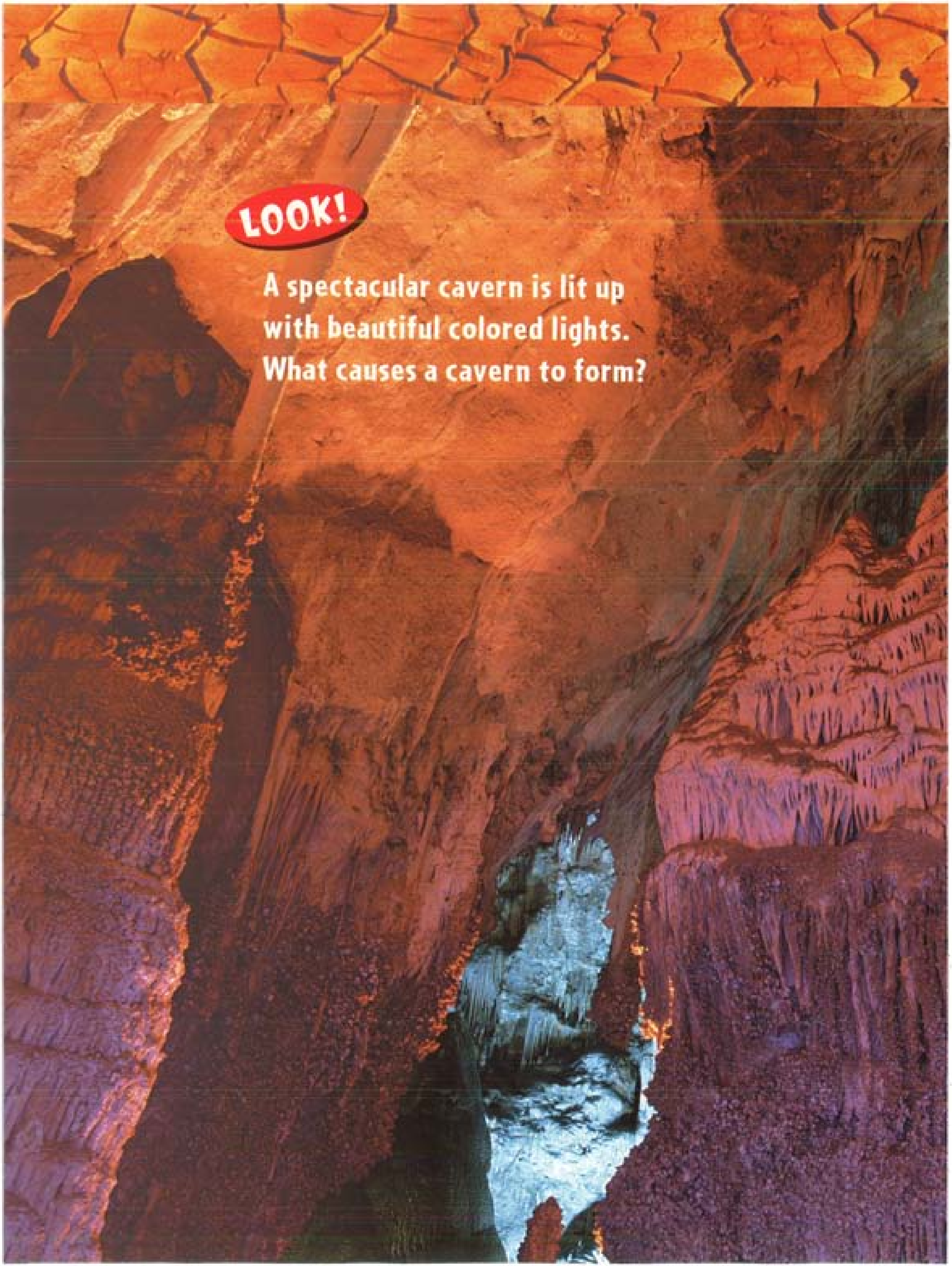
UNIT C

Earth and Its Resources

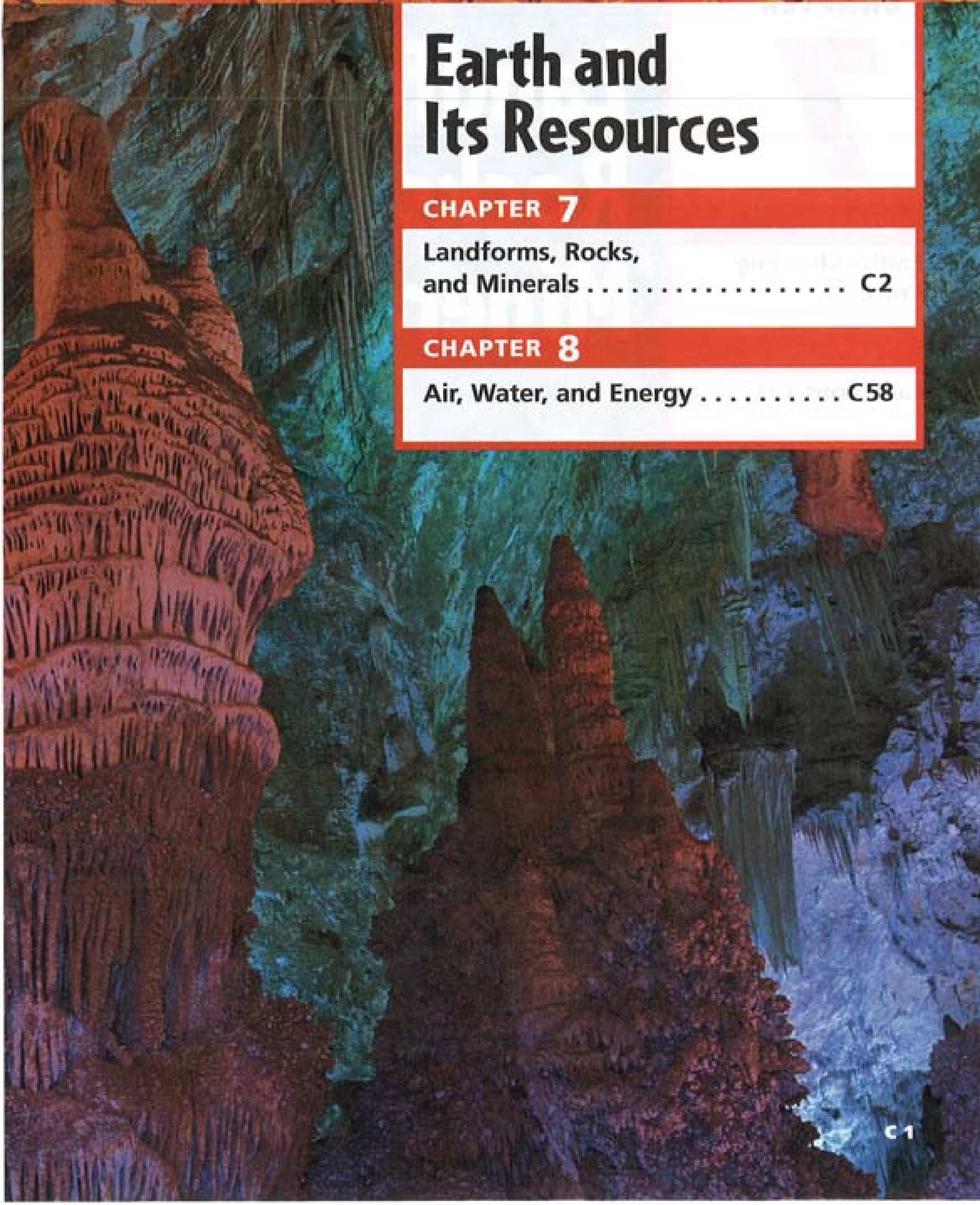


LOOK!

A spectacular cavern is lit up with beautiful colored lights. What causes a cavern to form?



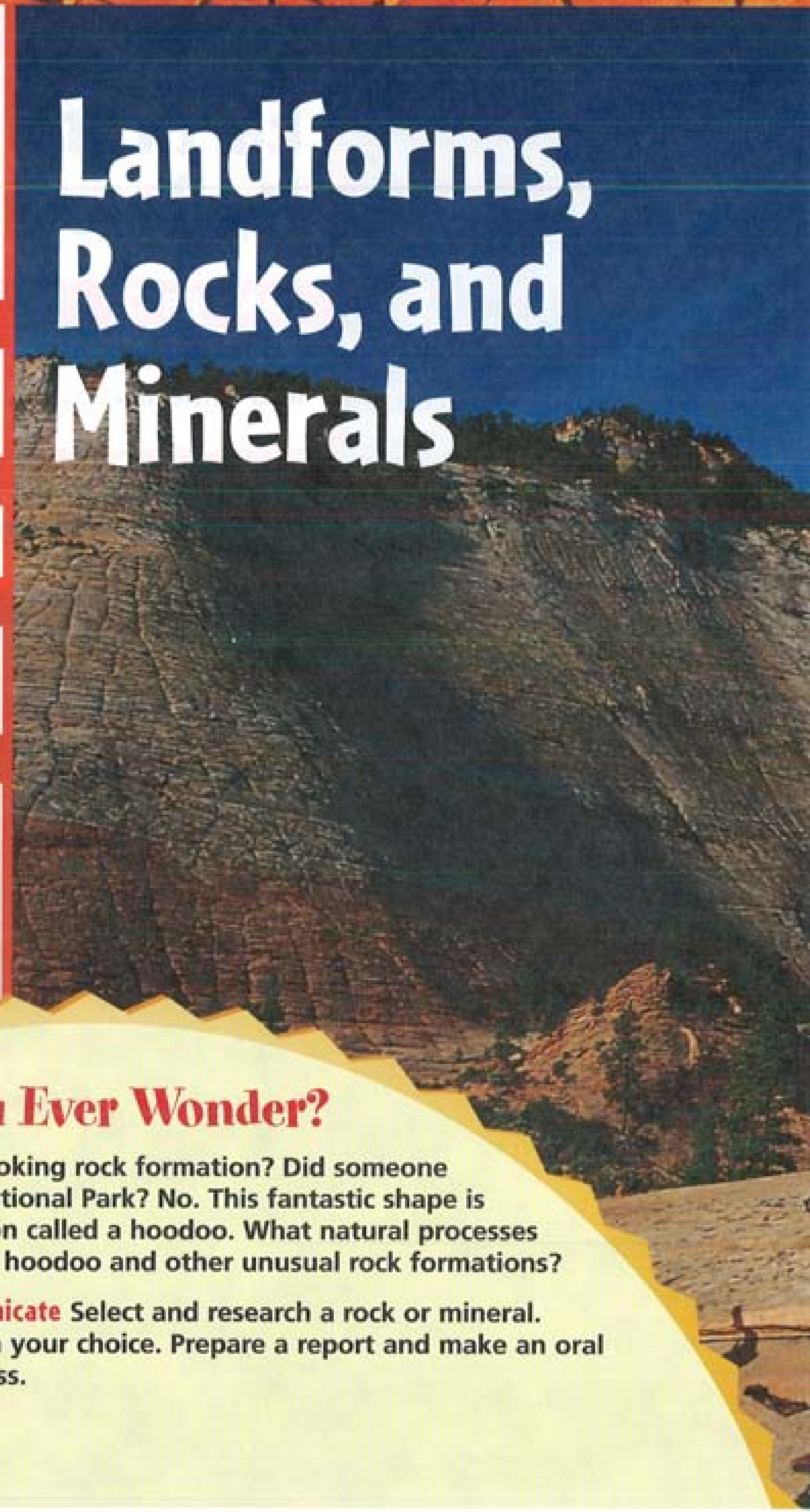
Earth and Its Resources



CHAPTER

7

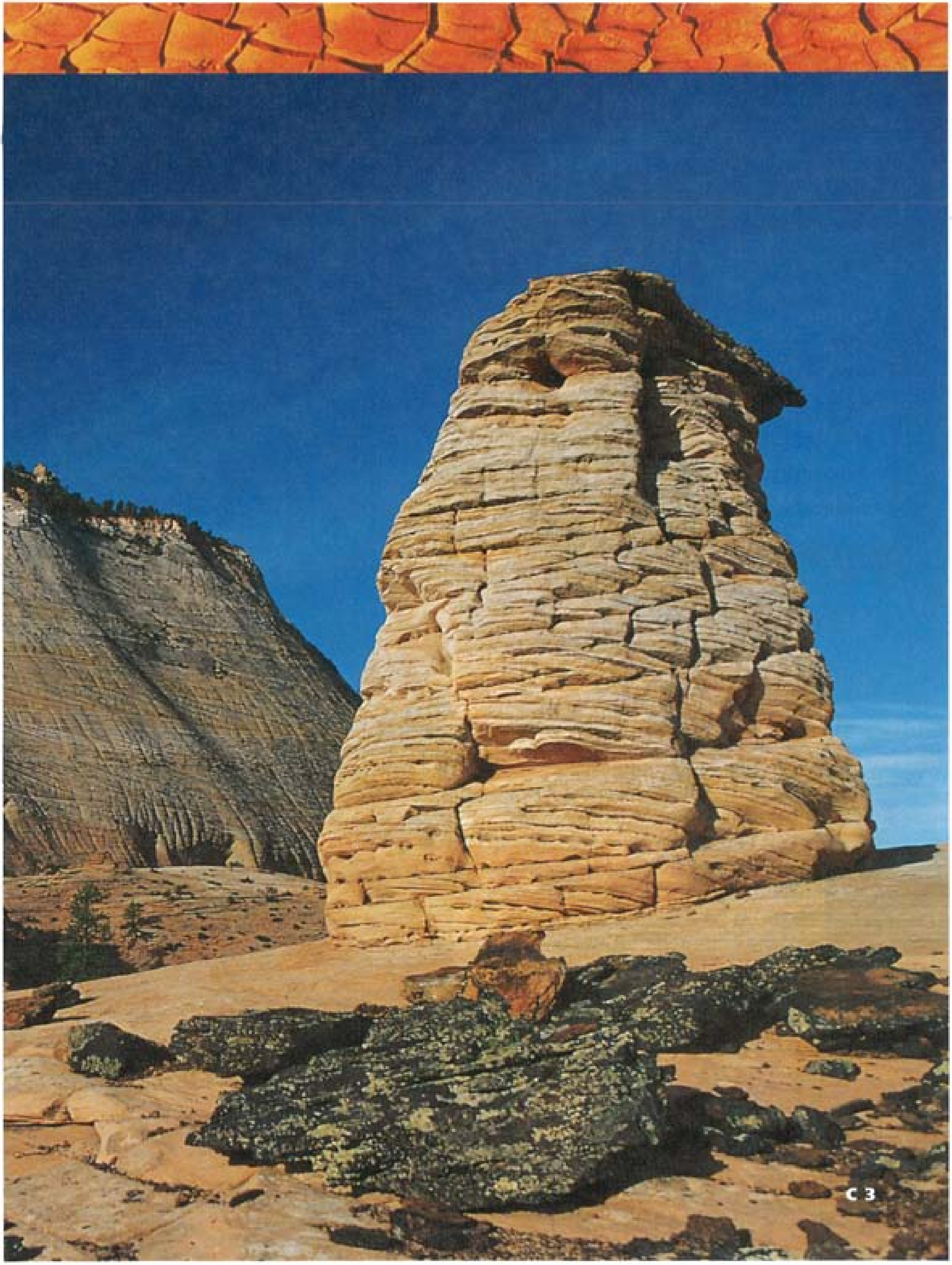
Landforms, Rocks, and Minerals



Did You Ever Wonder?

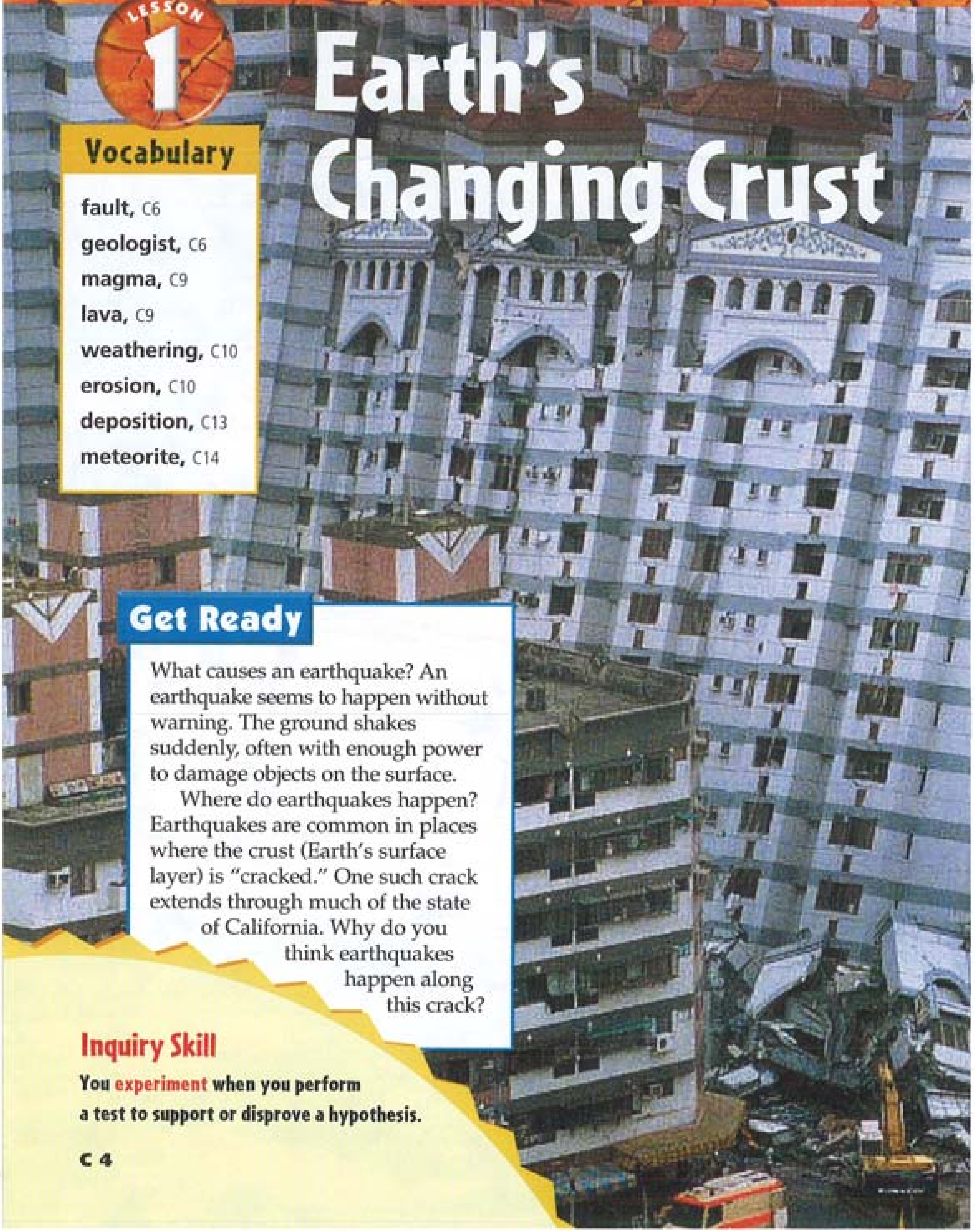
What is this strange-looking rock formation? Did someone build it here in Zion National Park? No. This fantastic shape is a natural rock formation called a hoodoo. What natural processes could have produced a hoodoo and other unusual rock formations?

INQUIRY SKILL Communicate Select and research a rock or mineral. Become an "expert" on your choice. Prepare a report and make an oral presentation to the class.



LESSON 1

Earth's Changing Crust



Vocabulary

fault, C6
geologist, C6
magma, C9
lava, C9
weathering, C10
erosion, C10
deposition, C13
meteorite, C14

Get Ready

What causes an earthquake? An earthquake seems to happen without warning. The ground shakes suddenly, often with enough power to damage objects on the surface.

Where do earthquakes happen? Earthquakes are common in places where the crust (Earth's surface layer) is "cracked." One such crack extends through much of the state of California. Why do you think earthquakes happen along this crack?

Inquiry Skill

You experiment when you perform a test to support or disprove a hypothesis.

Explore Activity

What Makes the Crust Move?

Procedure: Design Your Own

1. **Make a Model** Work with a partner to model layers of rock. You may use books, clay, or other materials to represent rock layers. Build your model on wax paper. Include a "crack" down through the layers. Stack cubes on the top of the model to represent buildings and other surface features.
2. **Experiment** Find as many ways of moving the model as you can to show how the crust may move during an earthquake. What happens to the surface features as you move the model each way? Draw and describe each.
3. **Experiment** How can you show movement without causing any visible effect on the surface features?

Drawing Conclusions

1. How many different ways could you move your model? How were they different?
2. **Communicate** How did each way you moved the model affect the surface features? How did each way change the positions of the layers? Explain.
3. **Communicate** How did you move the model without moving the surface features? Did the model change in any way? Explain.
4. FURTHER INQUIRY **Experiment** How can you use your model to show how a mountain might rise up high above sea level? Explain and demonstrate.

Materials

- 4–6 matching books (optional)
- layers of clay or modeling compound (optional)
- plastic knife
- cubes
- wax paper

Read to Learn

Main Idea **Forces on and under Earth shape its surface.**

What Makes the Crust Move?

Earth's crust is constantly moving, if not in one place then in another. Sometimes it moves quickly enough to be seen and felt. People who have been through an earthquake tell of seeing the ground heave up and down like an ocean wave.

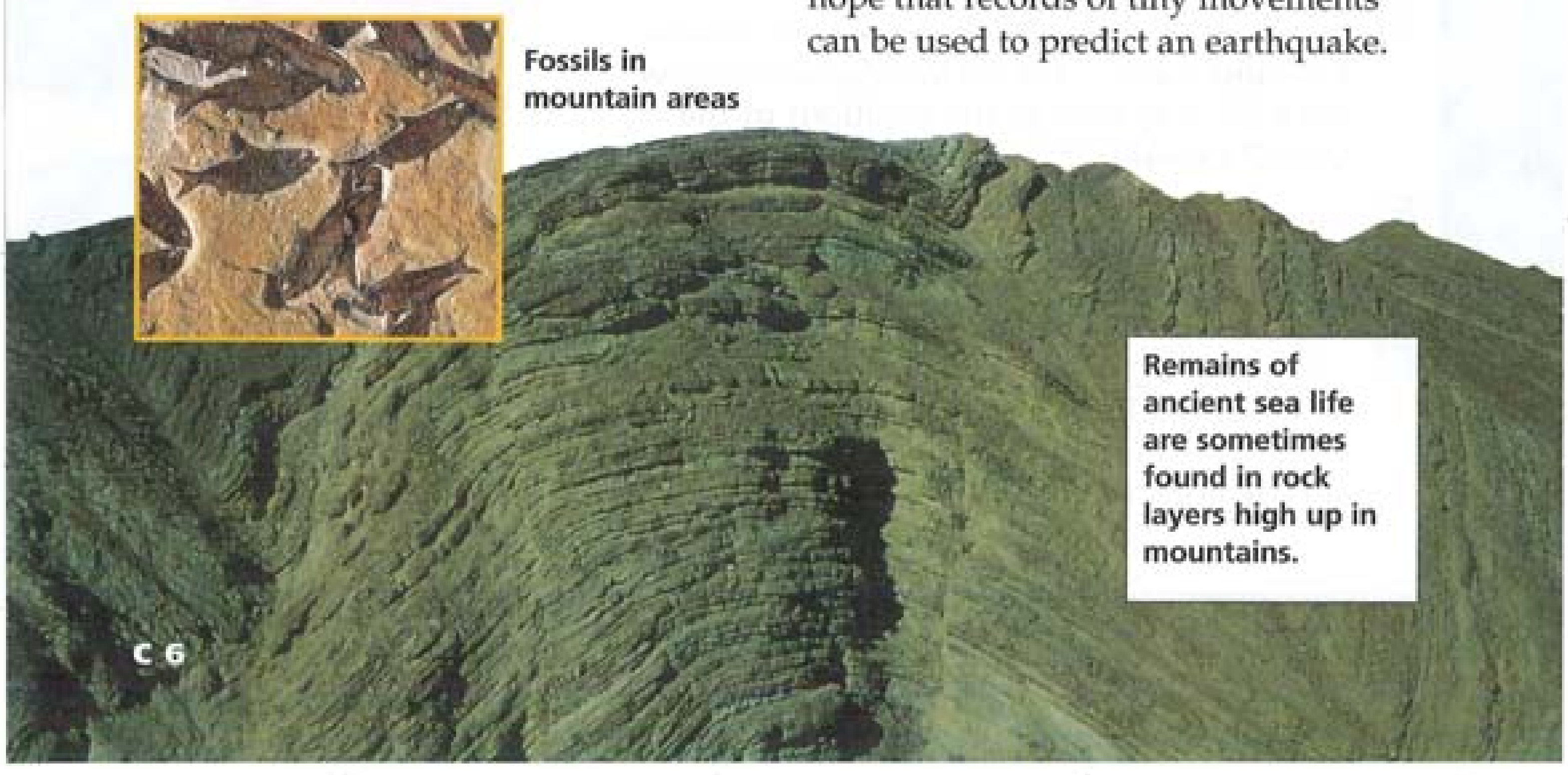
Earthquakes are related to cracks in the crust called **faults**. These faults may have formed from earlier earthquakes. Sometimes they form while the earthquake happens. During an earthquake the crust on either side, or on both sides, of a fault is in motion.

During an earthquake vibrations travel through the crust. The farther away people are from the earthquake, the harder it is for them to feel the vibrations. However, delicate devices called *seismographs* (SIGHZ·muh·grafs) can record this motion at locations all around the crust.

Most of the time, however, the crust moves very slowly. Rocks can move slowly on either side of a fault over centuries. People realize there is movement only when something visibly changes position. Not all motion happens along faults, either. Often, layers of the crust bend, as shown in the picture below. Bending, like motion along a fault, may happen gradually over time.

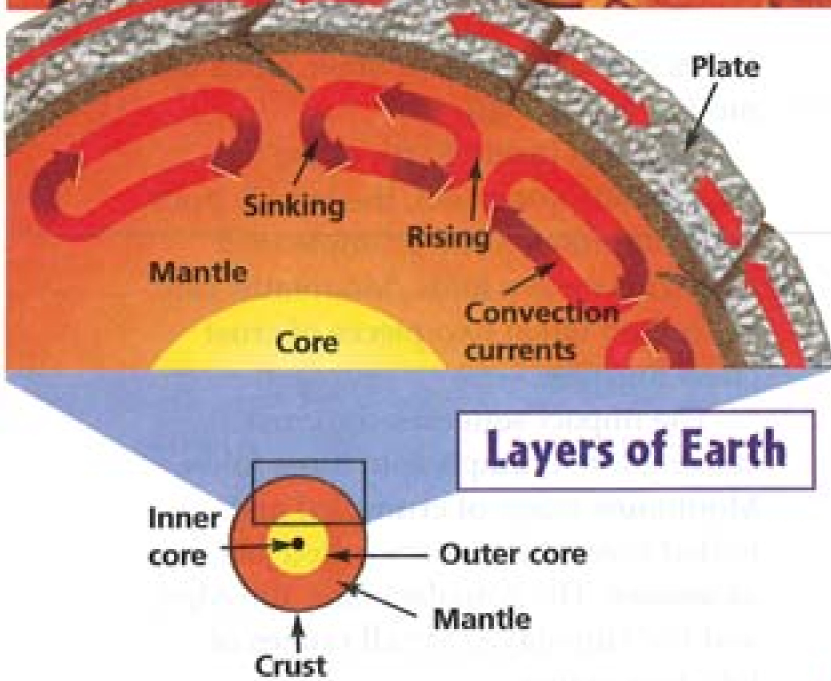
To measure crust movement, *surveyors* (suhr·VAY·uhrz) measure *elevation*—how high a place is above sea level. They leave plaques called *bench marks* that tell the exact location and elevation of a place. When some bench marks are remeasured, they are found to have risen or sunk.

Geologists (jee·AHL·uh·jists), scientists who study Earth, place sensitive devices all along faults, such as the San Andreas Fault in California. They hope that records of tiny movements can be used to predict an earthquake.



Fossils in mountain areas

Remains of ancient sea life are sometimes found in rock layers high up in mountains.



Layers of Earth

Plate Tectonics

The crust is Earth's hard surface. Compared with the distance to Earth's center, it is very thin. It is only about one-thousandth of Earth's thickness.

Under the crust is the mantle, Earth's thickest layer. The rock material here is solid. However, it can flow like a liquid—as putty can "flow" when you squeeze it between your hands. Below the mantle is Earth's core. It is in two parts, a liquid outer core and a solid inner core.

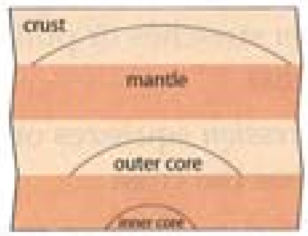
The rock material in the mantle is in motion, something like heated water in a pot. It rises and pushes against the bottom of the crust. This movement causes the thin, brittle crust at the surface to break into pieces, or *plates*. The plates themselves can move along Earth's surface. Earthquakes and the slow motions of the crust all result from moving plates.

How are earthquakes related to faults and plates in the crust?

QUICK LAB

Model of Earth

FOLDABLES Make a Four-Tab Book. (See p. R 44.) Label the tabs as shown.



BE CAREFUL! Students who are allergic to peanuts should not do this activity.

1. **Infer** You will use four materials to make a model of Earth on wax paper. Each material is one of Earth's layers. Read step 2. Decide which material represents which layer. Decide how thick each layer needs to be.
2. **Make a Model** Wash your hands. Cover a hazelnut with a layer of peanut butter. Put the covered nut in a plastic bag of mashed banana so that banana covers it completely. Roll the result into graham cracker crumbs on wax paper.
3. **Draw Conclusions** How does each material represent a different layer? Make your book and use it to record your response.
4. How thick did you decide to make each layer? Explain your reasoning.

What Forces Act on the Crust?

As the plates of the crust move, they can collide. They can pull away from each other. They can also slide past each other. These movements cause three kinds of forces to act on the crust.

- *Tension* stretches or pulls apart the crust.
- *Compression* squeezes or pushes together the crust.
- *Shear* twists, tears, or pushes one part of the crust past another.

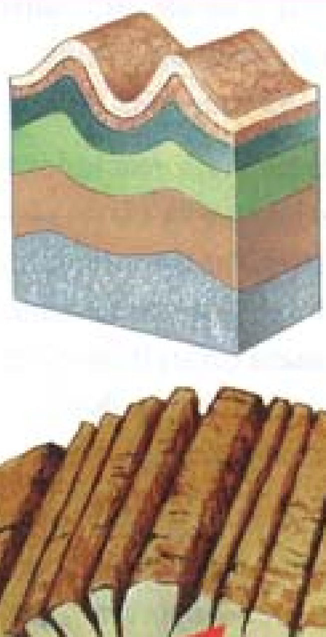
Each of these forces can cause a fault to form in the crust. Each can cause movement along a fault. These forces can also result in other kinds of motion in the crust.

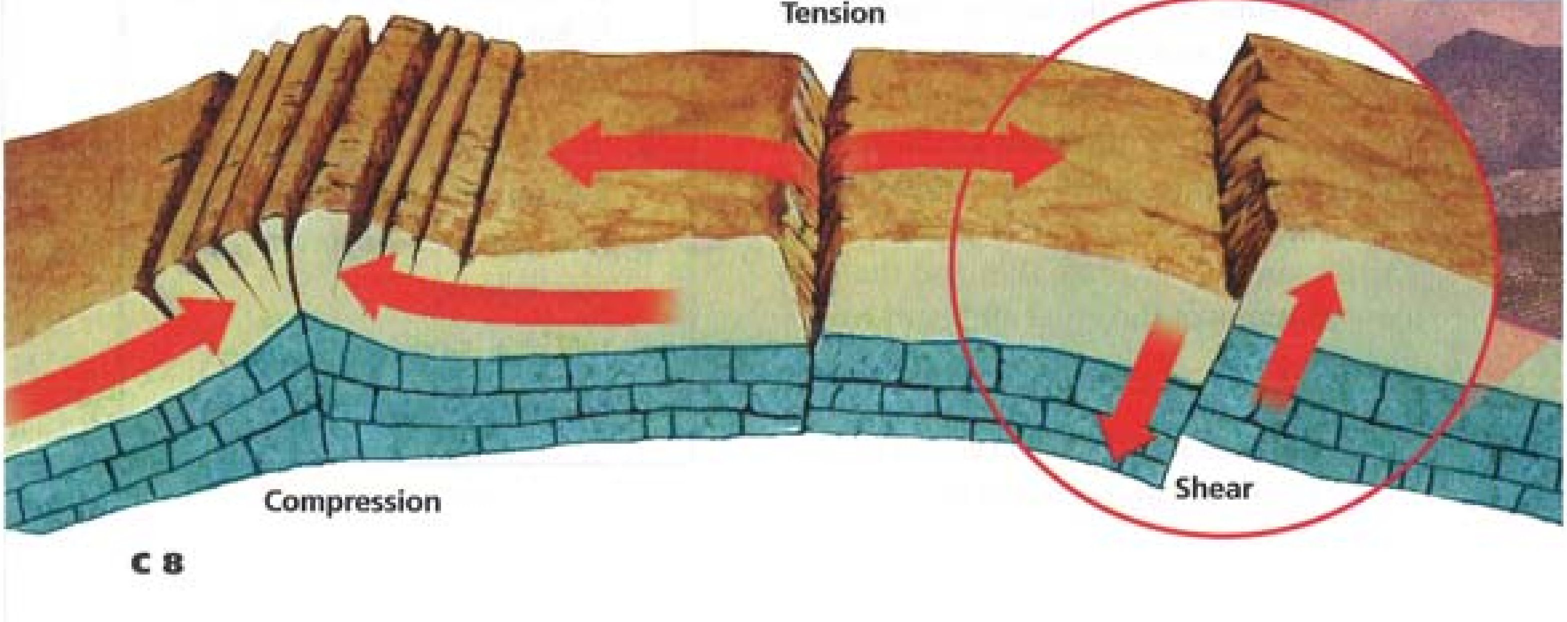
As forces inside Earth cause the crust to move upward, the land is built up. Compression can crumple rock layers into wavy folds. Mountains can be formed when two pieces of crust crash together.

The impact squeezes the crust, causing it to crumple into huge folds. Mountains made of crumpled and folded layers of rock are called *fold mountains*. The Appalachians, the Alps, and the Himalayas are all ranges of fold mountains.

Tension and shear can also build up the crust. Mountains can be formed as the crust is pulled apart. How?

Forces in the Crust





Hot molten rock deep below Earth's surface, called **magma**, rises upward. If magma reaches the surface, it may flow out as **lava**.

Lava flows out or is hurled out when a volcano erupts. A volcano is building a new island off the coast of Iceland. Its lava is gushing up through a crack between two pieces of crust that are being pulled apart.

Tension and shear also cause great blocks of crust to break apart cleanly and move along faults. Blocks of crust moving along a fault can form *fault-block mountains*. A vast region of fault-block mountains known as the Basin and Range Province blankets several western states (see map).

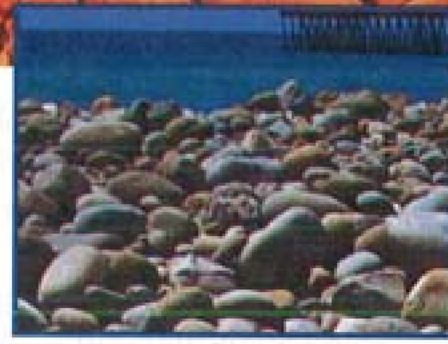
Surtsey, an island near Iceland, is forming from an undersea volcano.

What are three forces that act on Earth's crust?

Fault-block mountains

Basin and Range Province

What Other Forces Shape Earth's Surface?



Rounded pebbles worn down by moving water.

While movements of the crust are building up Earth's surface, other forces are at work breaking it down. These processes are known as **weathering** (WETH·uhr·ing) and **erosion** (i·ROH·zhuhn). Weathering is the breaking down of the materials of Earth's crust into smaller pieces. Erosion is the picking up and carrying away of the pieces. Weathering and erosion have been going on for billions of years. They both happen in many ways.

Physical Weathering

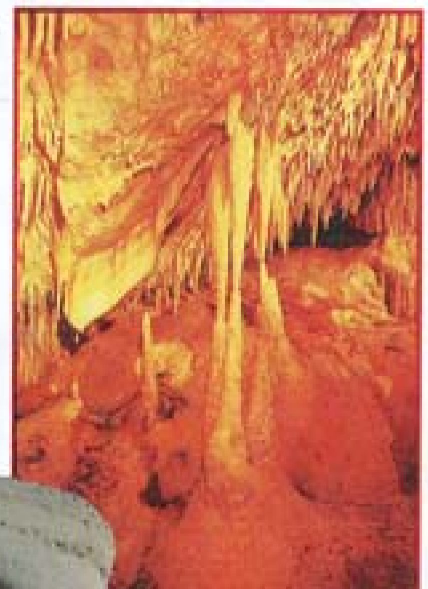
Weathering happens when the crust is exposed to water, air, and changes in temperature. How do these break down rocks?

Water can break down the crust in many ways. Water can dissolve some minerals right out of the crust. Moving water can make pieces of rock bang into each other. Small chips can break off the surface of the rock. This causes the rock to get smaller and rounder. The churning waters of a stream can wear down big pieces of rock into small rounded pebbles.

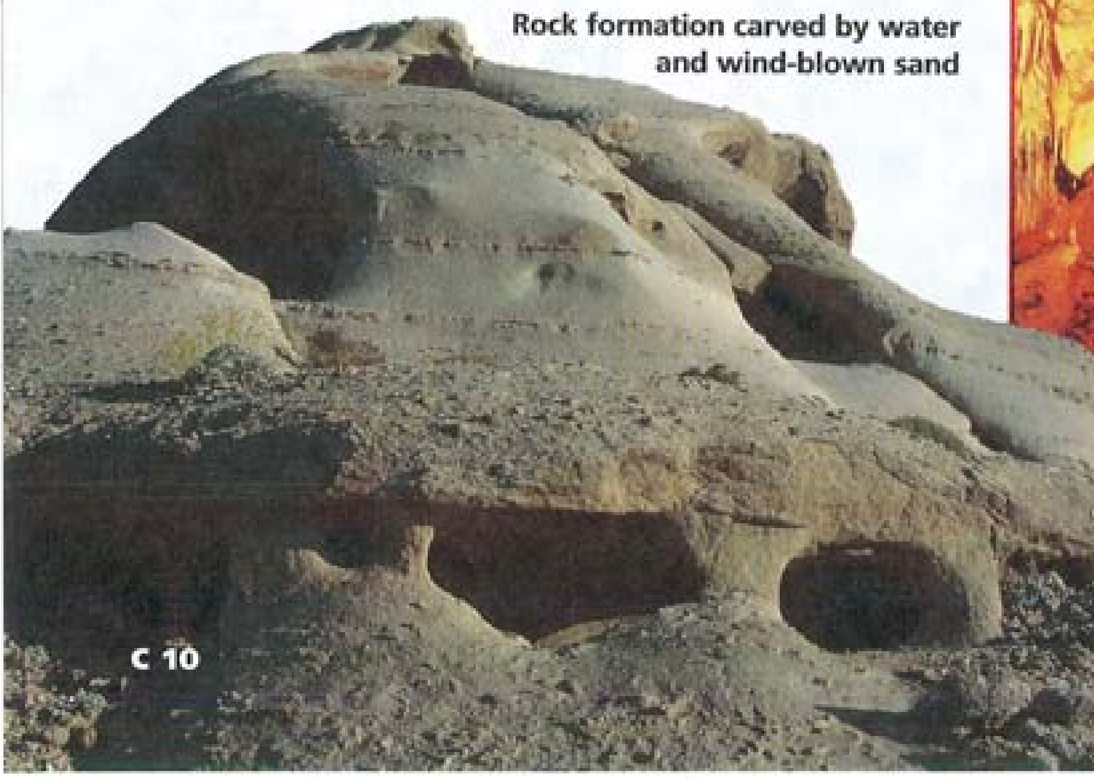
Wind is moving air. The wind blows sand and other broken bits of rock over Earth's surface. These particles also wear away rock.

If the temperature drops low enough, water can freeze. When water freezes it expands, or takes up more space. Water freezing in cracks in rocks expands against the rock. The force of the expanding water is so great that it can split the rock apart.

Limestone cavern



Rock formation carved by water and wind-blown sand

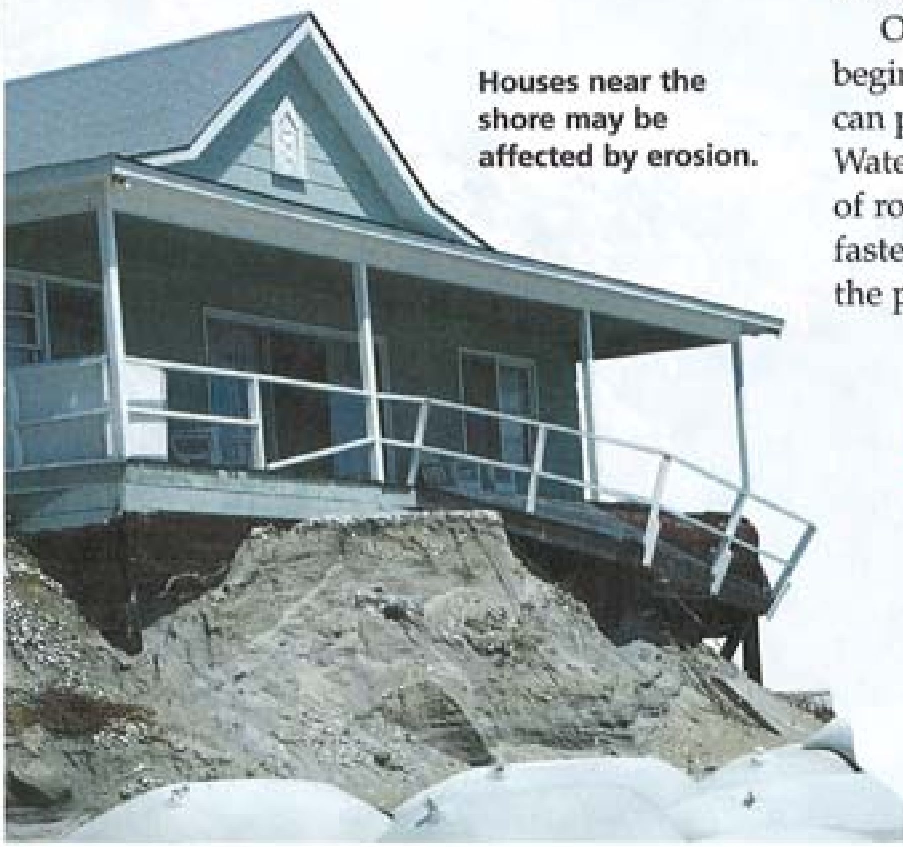


The action of plant roots also causes rocks to weather and erode.

Changes in temperature also cause rock to expand and contract. A rock may be made of a number of different materials. Sometimes one part of a rock expands or contracts more than another part. This difference can cause one part of the rock to push or pull against another part of the rock. Some geologists think that this eventually can cause the rock to break.

Chemical Weathering

Air contains gases that react chemically to form new substances. Oxygen in air reacts with iron to form rust. Carbon dioxide and sulfur dioxide in air react with rain to form acids. These acids eat away at limestone rocks. A limestone cavern was once solid rock. Acid rainwater seeping through the rock dissolved part of it. It "ate away" a huge hole—the cavern.



Houses near the shore may be affected by erosion.

Erosion

Erosion is the carrying away of pieces of weathered rock by gravity, water, wind, and ice. Piece by piece erosion can carry away a boulder, a hill, or even a whole mountain range!

The greatest agent of erosion is water. From the moment a drop of water falling from the sky first hits the ground, it erodes the land.

It may not seem like much, but think of how many raindrops fall in a rainstorm. Altogether they can move a lot of soil.

Once water reaches the ground, it begins to flow downhill. Moving water can push and carry things along with it. Water running downhill picks up pieces of rock and carries them downhill. The faster the water is moving, the bigger the pieces of rock it can move.

How do weathering and erosion work together to shape Earth's surface?

How Can Wind and Ice Erode Rock?

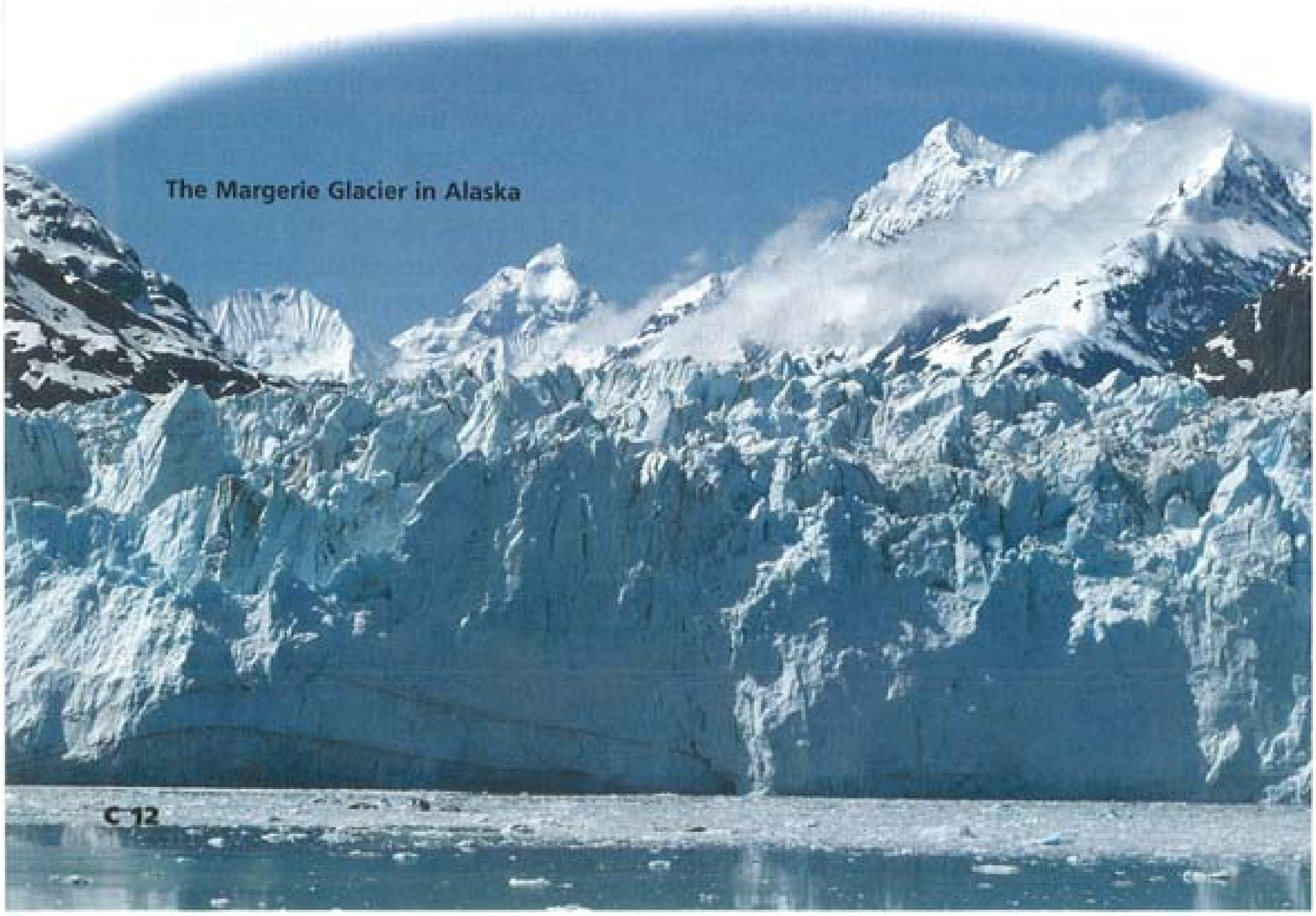
Wind is moving air. Wind can push things along with it, just like moving water. Wind does not exert as hard a push as water moving at the same speed, however. Therefore, wind mostly erodes pieces of rock that are the size of sand particles or smaller.

Ice also causes a lot of erosion. The Margerie Glacier in Alaska is a moving river of ice. It may not move as quickly as water, but don't underestimate its power. When the ice of a glacier freezes onto rock and then the glacier moves downhill, the rock is torn right out of the ground. This glacier can carry chunks of rock bigger than your house with ease.

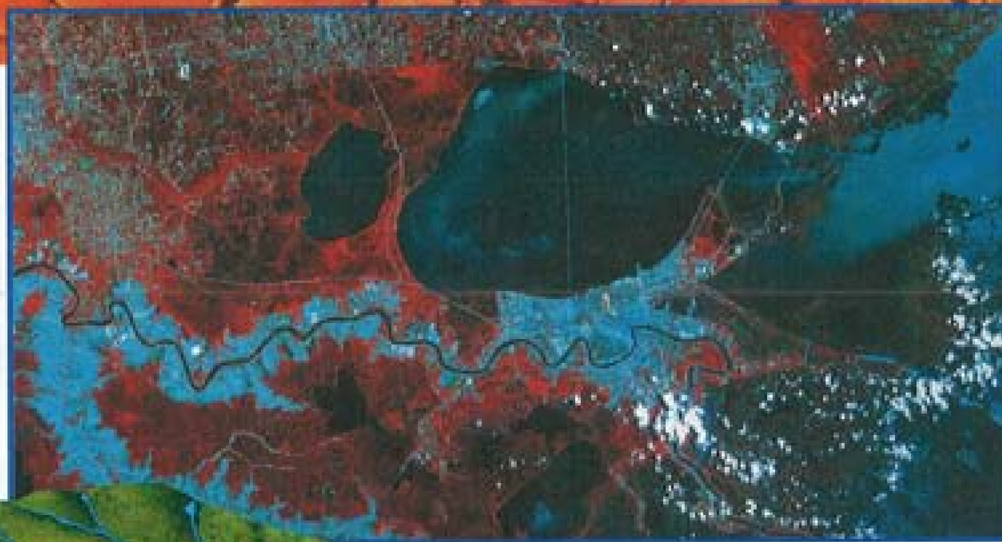
Glaciers also wear away the land as they flow over it. Place an ice cube in some sand for a minute or two. Then look at the bottom of the ice cube. What has become frozen into the bottom of the ice cube? Now rub the bottom of the ice cube on a bar of soap. What happens to the surface of the bar of soap?

Rocks of all sizes become frozen into the bottom of a glacier. As the glacier moves, the rock beneath it is scratched and worn down.

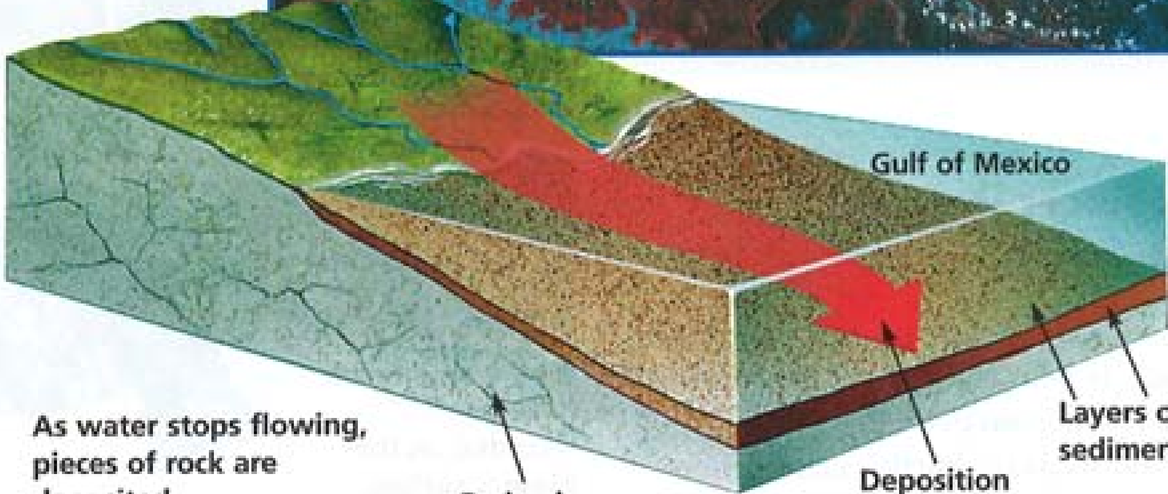
How do wind and ice cause erosion?



The Margerie Glacier in Alaska



This satellite image of the Mississippi River near New Orleans shows the deposition of sediment carried by the river.



As water stops flowing, pieces of rock are deposited.

Where Do Eroded Rocks Go?

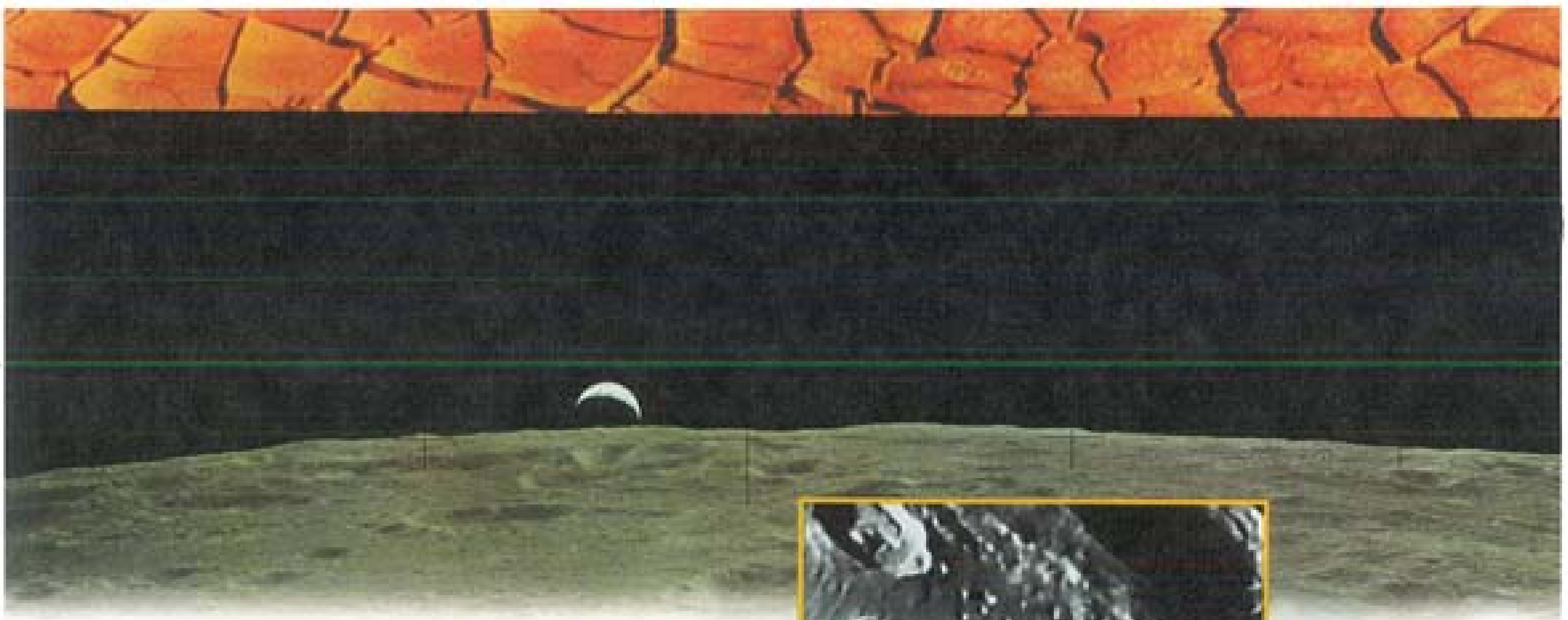
What happens to pieces of rock that are carried along by wind, moving ice, or moving water? A fast wind eventually slows down. A glacier stops moving and eventually melts at its front end and sides. All streams eventually slow down and end when they flow into a large body of water, such as a lake or ocean.

When water stops moving, it also stops carrying along bits and pieces of rock. The pieces of rock are dropped to the bottom of the stream, lake, or ocean. The dropping off of bits of eroded rock is called **deposition** (dep·uh·ZISH·uhn).

Deposition also takes place when glaciers melt and winds stop blowing. Layer by layer, pile after pile, bits and pieces of rock deposited by water, wind, and ice build up Earth's surface.

Very slowly deposition may fill up depressions, or basins, in Earth's surface. It can build up land along shorelines and at the end of rivers. Deposition does not seem as dramatic as colliding continents. However, the slow, steady work of deposition is one of the greatest constructive actions on Earth.

READING **Sequence of Events**
What happens to rocks after they break down?



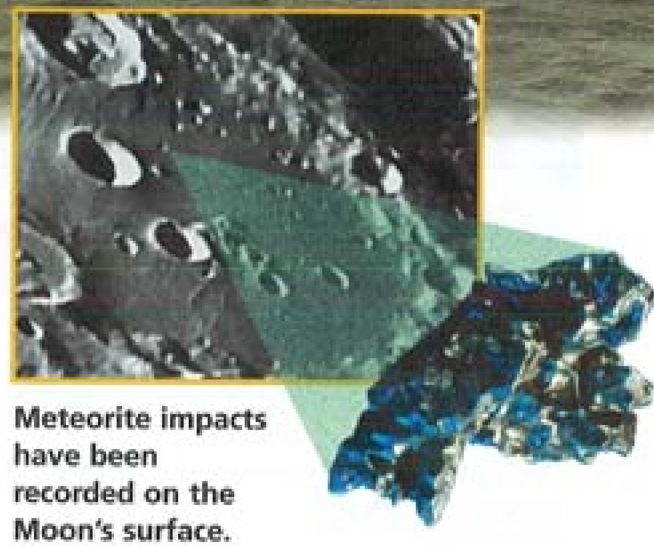
What Forces Shape the Moon's Surface?

Earth's Moon, our nearest neighbor in space, is a far different place from Earth. There is no evidence of earthquake faults as on Earth's crust. There are no erupting volcanoes. In fact, there is no evidence of any of the kinds of motion that Earth's crust has.

Without air and water, there can be very little weathering or erosion. The Moon has almost no air or water. There are no streams, no glaciers, and no wind. The only weathering and erosion is due to the impact of rocks from space hitting the Moon's surface.

These rocks from space that strike a surface are called **meteorites**. Some craters formed by the impact of meteorites are big enough to be seen from Earth. Others are so tiny the entire crater is on a single mineral crystal.

Can meteorites also strike Earth's surface and produce craters? Yes. However, Earth's atmosphere protects its surface from many such impacts.



Meteorite impacts have been recorded on the Moon's surface.

Rocks from space "burn up" as they pass through Earth's atmosphere. The Moon has little atmosphere. How does that fact affect the Moon's surface?

Meteorite impacts shatter rocks on the Moon and also create a lot of heat. The heat melts the rock. Pieces of rock may melt together, and droplets and globs of molten rock can splatter outward. Over time continual meteorite impacts break down the rock. The end result is a mixture of shattered pieces of rock, rock droplets, and melted-together bits of rock.

How do meteorites shape the Moon's surface?

Lesson Review

Why It Matters

Natural forces change Earth and the other planets in our solar system. Evidence of surface changes and erosion has been found on other worlds. There are perhaps thousands of volcanoes on Venus. The largest volcano in the solar system is Mars's Olympus Mons. It is 24 km (15 mi) high and 550 km (344 mi) across.

Some of Jupiter's moons also show evidence of constructive and destructive forces. Io has erupting volcanoes. The moons Ganymede, Callisto, and Europa have water and ice. The presence of water, organic compounds, and internal heat mean life may be possible on Europa.

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on plate tectonics.

Think and Write

1. What are some types of evidence that show Earth's crust has moved?
2. What are three types of forces acting on Earth's crust?
3. How are earthquakes measured?
4. What is the difference between weathering and erosion?
5. **Critical Thinking** How do fault-block mountains compare with fold mountains?

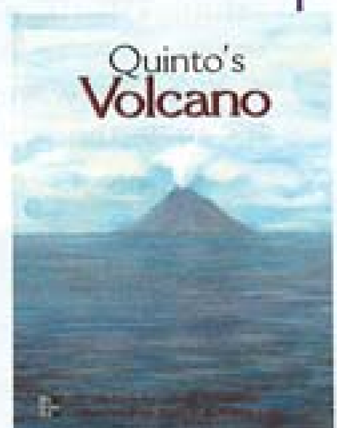
L·I·N·K·S

WRITING LINK

Explanatory Writing How can people prepare for an earthquake or another force that can suddenly change Earth's crust? Make a poster that shows people how to prepare for an earthquake or a similar disaster. Give step-by-step instructions. Include illustrations that show the steps.

LITERATURE LINK

Read *Quinto's Volcano* to learn about a boy who overcomes his fear of the sea and saves his village. Try the activities at the end of the book.



MATH LINK

Calculate percentages. Scientists estimate they can detect about 500,000 earthquakes worldwide each year. Of these, 100,000 can be felt, and 100 cause damage. What percent can be felt? What percent cause damage?

TECHNOLOGY LINK

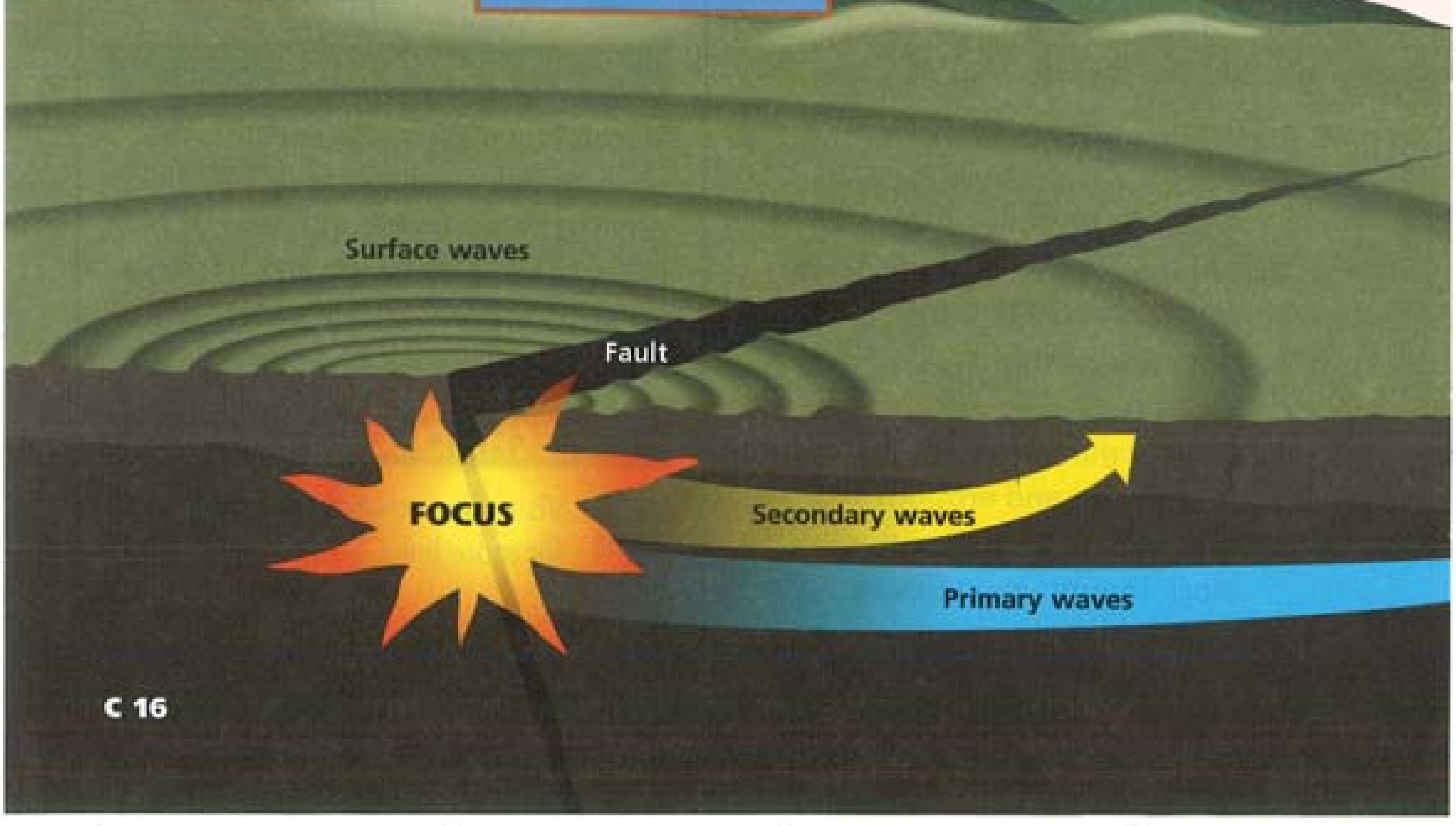
LOG ON Visit **www.science.mmhschool.com** for more links.

The Sounds of Earthquakes

The ground begins vibrating wildly. Rising from Earth are seismic (SIGHZ-mik) waves—they're like huge sound waves. It's an earthquake!

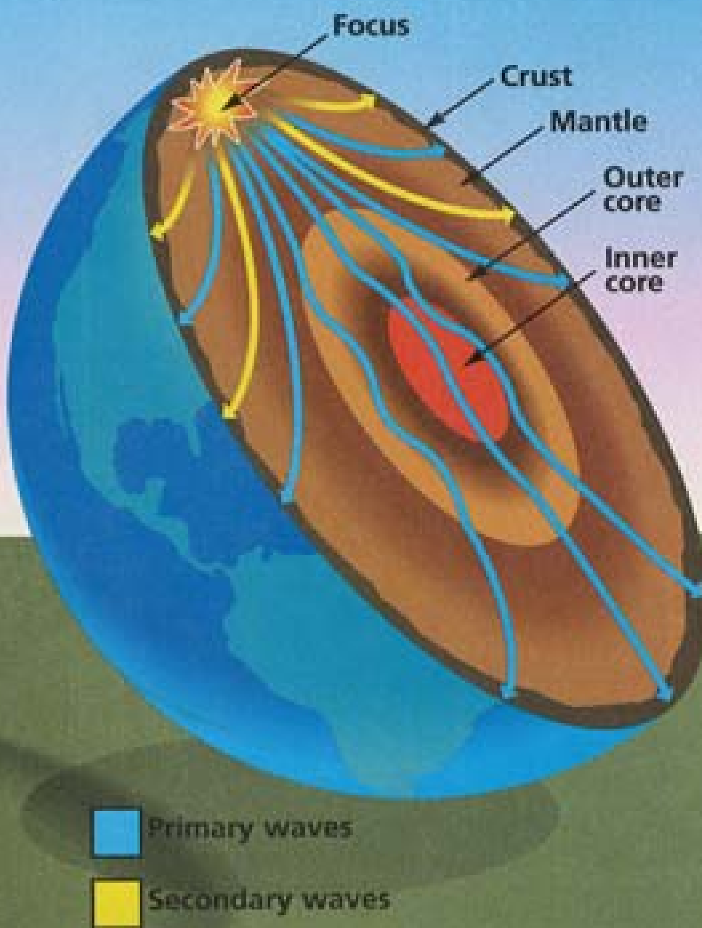
This simple seismograph has a pen held delicately against a rolling drum with graph paper on it. The pen records the seismic waves.

As soon as an earthquake begins, seismic waves travel out in all directions from the focus—where the quake began. They also travel inside Earth. Scientists used seismic waves to piece together a model of the inside of Earth.



Seismic waves get weaker the farther they get from the focus. Even so they can still be detected by very sensitive devices called seismographs (SIGHZ·muh·grafs).

The fastest, or primary, waves are recorded soon after an earthquake occurs. Slower, secondary waves come later. Surface waves, the slowest, come even later.



Scientists found that seismic waves change speeds at certain depths below Earth's surface. They speed up when they reach about 30–60 kilometers (19–37 miles) below the surface. Why? This depth, called the Moho (after its discoverer), is a boundary between two of Earth's layers—the outer layer, or thin crust, and the next layer, or thick mantle.

The primary waves slow down when they reach Earth's outer core, a layer of thick liquid. Secondary waves completely stop there. The primary waves speed up again as they reach Earth's solid, inner core.

What Did I Learn?

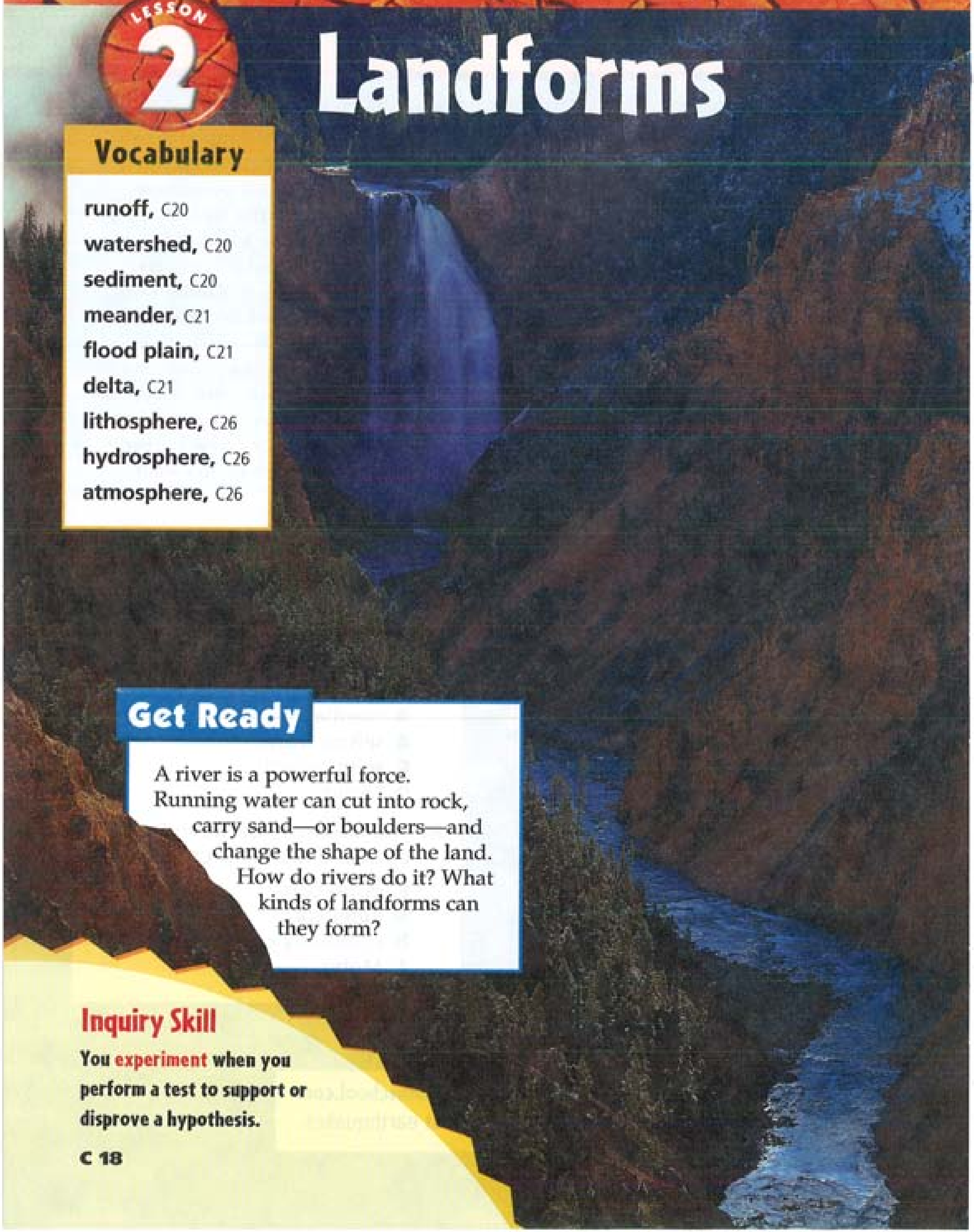
1. An instrument that detects earthquakes is a
   - **A** mantle.
   - **B** seismic wave.
   - **C** seismograph.
   - **D** Moho.

2. The boundary between Earth's crust and mantle is called the
   - **F** outer core.
   - **G** inner core.
   - **H** secondary core.
   - **J** Moho.

LOG ON Visit **www.science.mmhschool.com** to learn more about earthquakes.

LESSON 2

Landforms



Vocabulary

- **runoff,** C20
- **watershed,** C20
- **sediment,** C20
- **meander,** C21
- **flood plain,** C21
- **delta,** C21
- **lithosphere,** C26
- **hydrosphere,** C26
- **atmosphere,** C26

Get Ready

A river is a powerful force. Running water can cut into rock, carry sand—or boulders—and change the shape of the land. How do rivers do it? What kinds of landforms can they form?

Inquiry Skill

You experiment when you perform a test to support or disprove a hypothesis.

Explore Activity

How Does Steepness of Slope Affect Stream Erosion?

Materials

- long cake pan
- mixture of sand, coarse gravel, pebbles
- sprinkle bottle
- water
- books or wood blocks

Procedure: Design Your Own

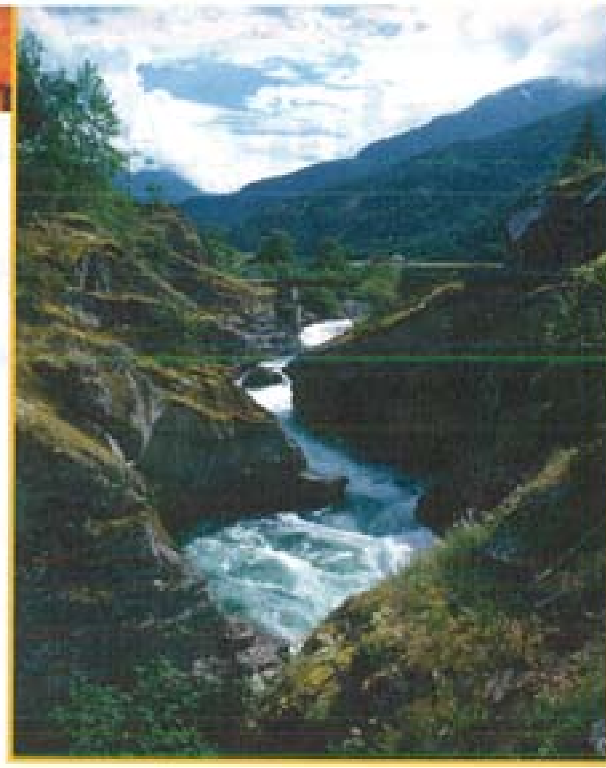
1. **Hypothesize** Water flowing in rivers and streams can pick up and carry sediments like silt, sand, and gravel. How does steepness of slope affect how fast a stream flows? How does this affect the size and amount of material rivers can carry? Write a possible explanation, or hypothesis, to answer this question.
2. **Make a Model** Make a model to test your hypothesis. What materials will you need? What will you do? Which factors will you control? What factor will you manipulate?
3. **Experiment** Set up your model and carry out your experiment. Make a chart to organize your data.

Drawing Conclusions

1. **Interpret Data** Do the data you collected support your hypothesis? Explain. Compare your data with others.
2. **Communicate** Write a short newspaper article explaining how steepness of slope affects stream erosion.
3. FURTHER INQUIRY **Experiment** How does the volume of water affect stream erosion? Propose a hypothesis and experiment to test it.

Read to Learn

Main Idea **Running water is a major factor in changing the surface of Earth.**



Water flows down a straight path on a steep slope much faster than it flows down a winding, gentle slope. You may want to keep this in mind the next time you visit a water park!

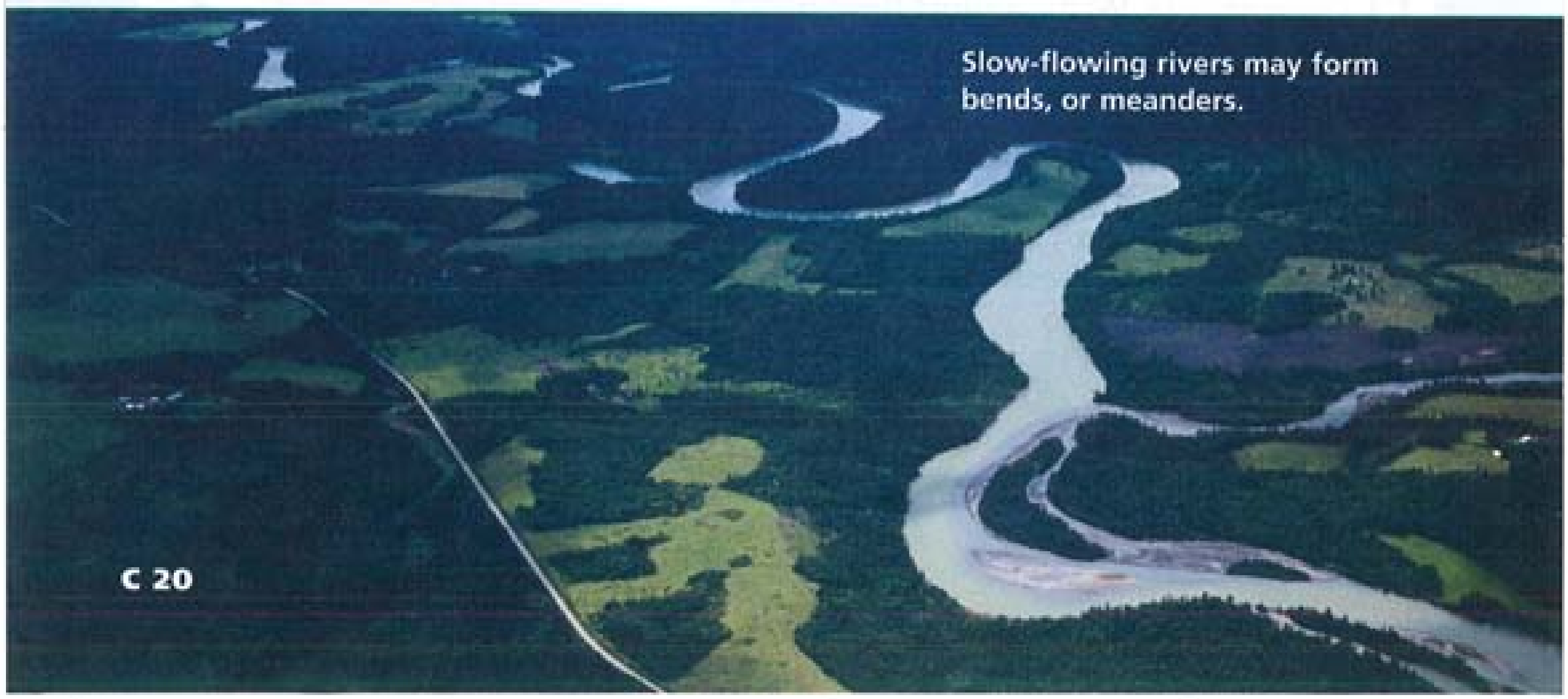
How Do Rivers Change the Land?

Earth's surface has been constantly changing. Some changes occur in minutes. Other changes are very slow. Some changes happen over millions of years. One of the most important causes of change on Earth is running water.

Rivers begin high in the mountains or hills as small *tributaries,* or "feeder streams." Tributaries are fed by **runoff** —water that runs off Earth's solid surface. The areas from which the water is drained are called **watersheds**. Tributaries keep merging until they form larger streams or rivers.

The force of gravity keeps water flowing downhill. Where slopes are steep, the water in streams and rivers flows very fast. Rivers flowing along gentle slopes move more slowly. The moving water carries **sediment** (pieces of material) with it. The amount of sediment a stream or river can carry depends on how much water there is and how fast it is flowing. Larger, faster-flowing streams can carry much larger loads of sediment.

Sediments can range in size from small boulders to gravel, sand, silt, and



Slow-flowing rivers may form bends, or meanders.

Deltas often change shape as channels become clogged with sediments and water is diverted to new outlets.

dissolved materials. The force of running water with its load of sediment can erode the stream bed.

As a stream moves down the slope and into gentler, flatter land, it begins to slow down. When the stream or river slows down, sediments are dropped or deposited on the river floor. Where river valleys are nearly flat and sediments are thick, rivers form bends. These bends or S-shapes are called **meanders**. Here the river erodes material on the outer side of the meanders and deposits material on the inner side. This process makes the river valley wider. As the landscape continues to flatten, **flood plains** may form along the banks of a river. Some of the world's most important agricultural areas are found in flood plains. A river might overflow its banks following a heavy rain. As the water covers the surrounding land, it releases sediments. Over time, these sediments build up, creating fertile farmlands.

All rivers eventually end as they empty into a lake or ocean. The place where a river empties into the ocean is called the *mouth* of the river. The water slows down so much at its mouth, that it unloads most of its sediment there. This sediment forms a fan-shaped deposit called a **delta**. Deltas are very important agricultural areas. That is because they are a source of fertile soil.

Why are river deltas important?

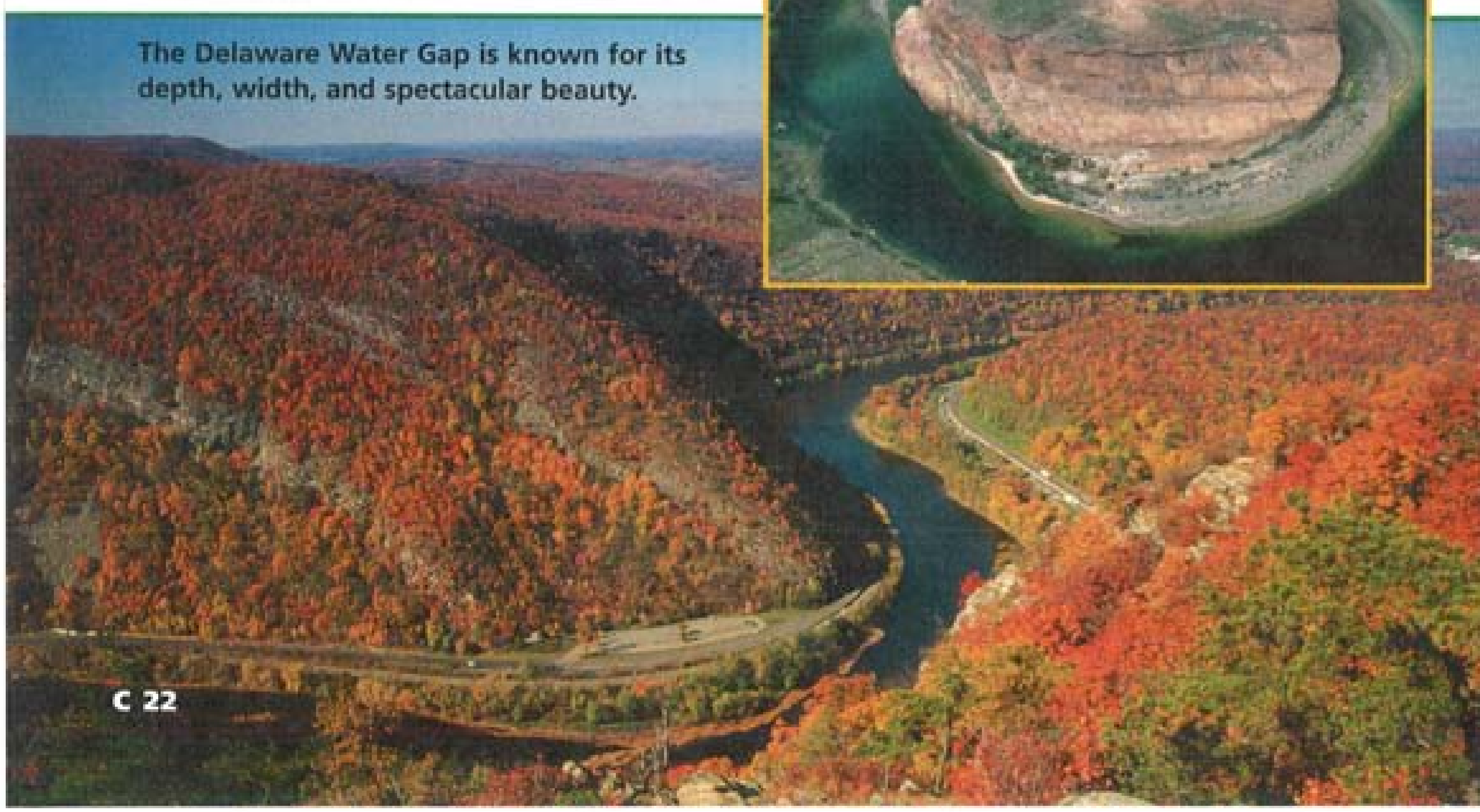
How Do Water Gaps, Canyons, and Valleys Form?

River valleys form from small channels that are deepened and widened by erosion. Small gullies become deeper and wider as their walls are eroded and the sediments are carried away. Where downward cutting is greater than valley widening, narrow V-shaped valleys form. Deep V-shaped valleys are often called canyons. Usually more than one process is involved in the formation of canyons and other landforms. For example, the Grand Canyon would not exist if the surrounding plateaus had not been pushed upward as the Colorado River cut deeper and deeper.

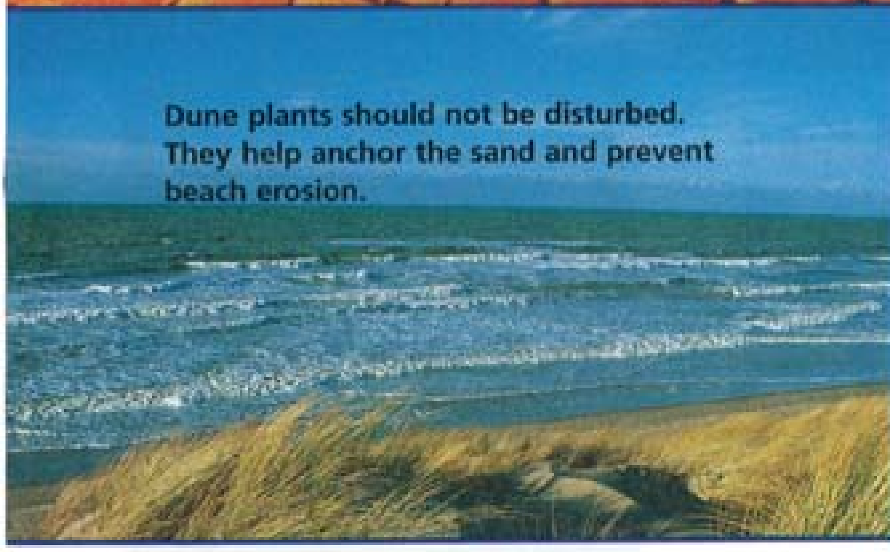
Water gaps are rare. The Delaware Water Gap began forming millions of years ago. It was formed by the river flowing over a sediment-covered plain. As geologic forces pushed the land upward, the river began cutting deeper into the plain. In time, the river encountered a more resistant rock formation below. Instead of changing course, the river slowly cut its way across and down into the resistant rock. Over time, this formed a narrow steep-walled canyon called a water gap. Eventually, much of the surrounding area eroded away. What is left today is a long ridge with the river still flowing through the gap.

How are valleys and canyons related?

The Grand Canyon formed over millions of years.



The Delaware Water Gap is known for its depth, width, and spectacular beauty.



Dune plants should not be disturbed. They help anchor the sand and prevent beach erosion.

How Do Beaches, Dunes, and Landslides Form?

Gravity, wind, waves, and glaciers can also reshape the land.

Waves can erode land along coast lines or deposit sand and sediment, forming beaches. Sediment can also be picked up at one point on the shoreline and deposited at another. Sometimes beaches can change shape overnight.

Along the shoreline, windblown sand creates dunes. Wind picks up the sand particles and carries them until some obstacle, such as a rock or bush, slows the wind speed. When it slows down it begins to deposit sediment. As more sand is deposited, the sand dunes grow. Sand dunes help protect shorelines from further erosion. Dunes are formed in a similar manner in some desert areas.

Gravity can pull rocks and soil down slopes. A landslide is an example of a rapid movement of materials down a slope. Rapid landslides can be set off by earthquakes or volcanic activity. They can also occur when heavy rains *saturate* (soak) and loosen the soil.

QUICK LAB

Erosion Challenge

FOLDABLES Make a Two-Column Chart. (See p. R 44.) Label as shown.

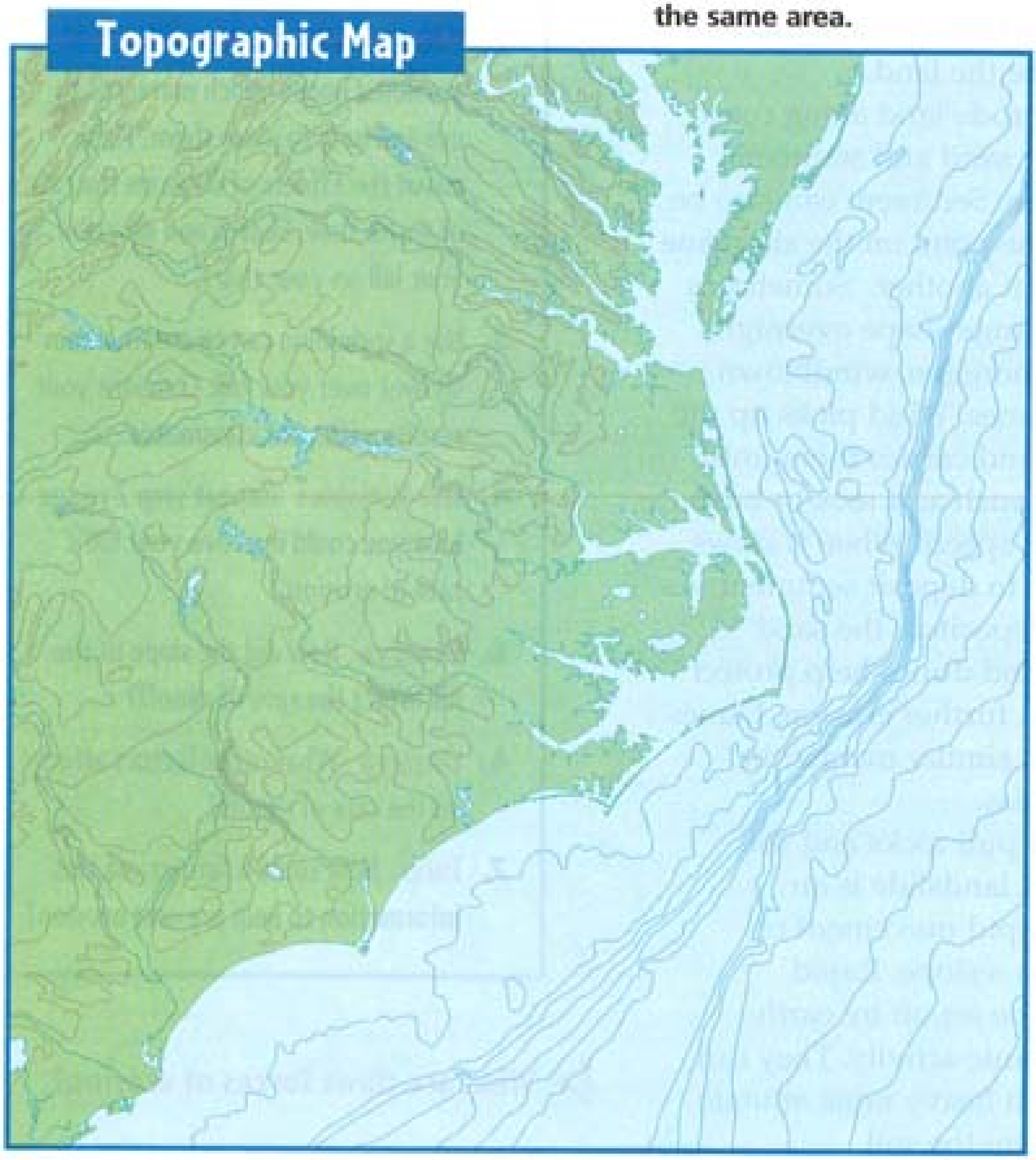
1. Cover your workspace with newspaper. Gather materials from your teacher (soil, sand, gravel, plastic plants) and a foil pan to build in.
2. Design a "hill" that is resistant to erosion. Choose which materials to use and how to place them. Think about the effects of slope on the rate of water flow. Sketch and describe your hill on your chart.
3. Use a sprinkling can to create a rain shower over your hill. Compare your results with your classmates'.
4. **Use Variables** Repeat step 2 to see how you could improve your hill's rate of erosion.
5. **Observe** How did the slope of the hill affect the rate of runoff?
6. **Observe** What other factors affected the rate of runoff?
7. **Infer** How could a farmer use this information to help prevent erosion?

What are three forces of erosion?

How Do You Read Topographic Maps?

Topographic maps use contour lines to show the shape of Earth's surface. A contour line is an imaginary line drawn on a map. It connects points of equal height above or below sea level. Sea level is the mean level of the surface of the sea between high and low tides and is considered as 0 elevation.

The satellite photo above shows part of the eastern coastline of the United States. The contour map below shows the elevations in the same area.

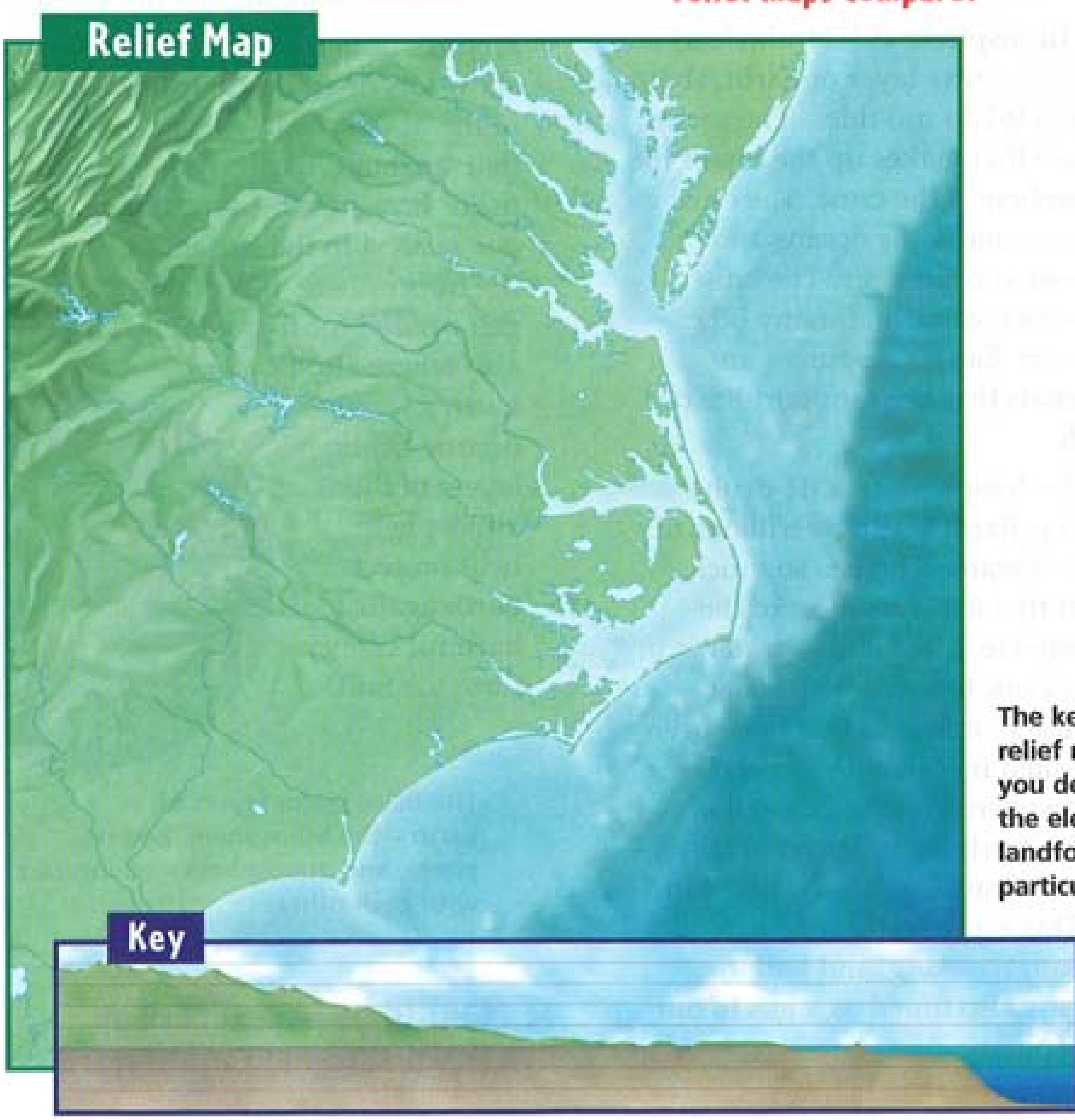


The spacing of contour lines indicates how steep a slope is. Contour lines that are farther apart indicate a gentler slope. Contour lines that are closer together indicate a steeper slope.

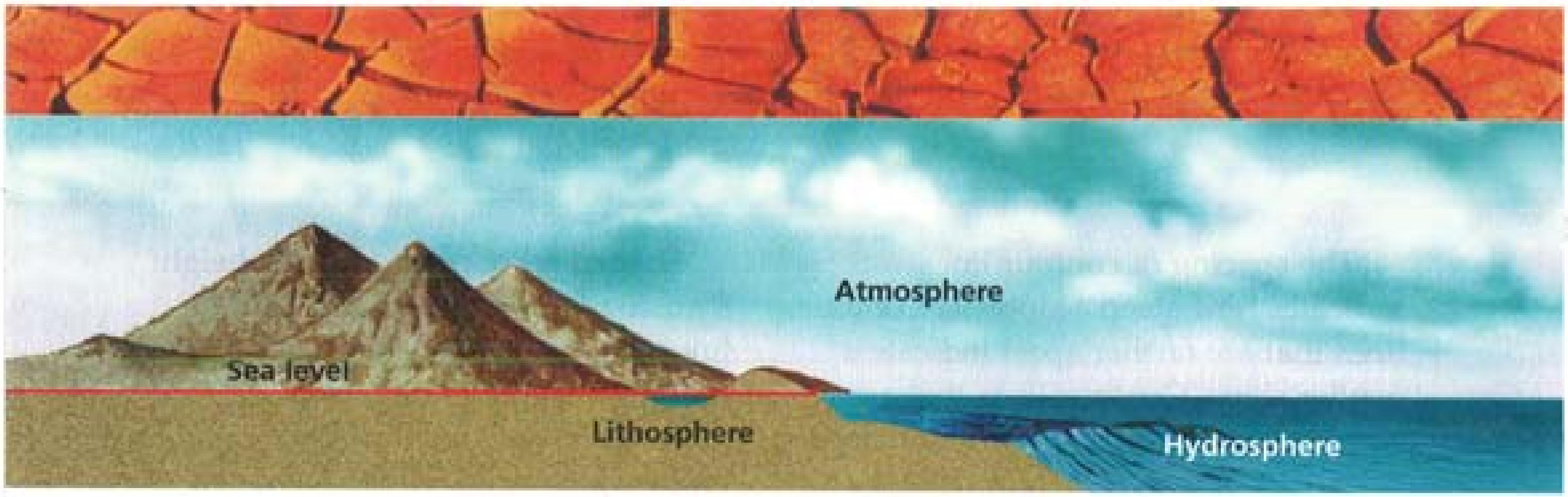
Bodies of water, such as oceans, rivers, and lakes, are also indicated on topographic maps. Symbols are used to locate forests, roads, railroad tracks, and buildings.

Shaded relief maps indicate height by using shading instead of contour lines. The shading makes it easier to recognize sloping hills, steep mountains, and deep valleys. Some topographic maps combine shaded relief maps with contour lines to give an even clearer idea of the geology of an area.

How do topographic maps and relief maps compare?



The key for a relief map helps you determine the elevation of landforms in a particular area.



What Are Earth's Major Layers?

Earth has a solid surface layer, mostly covered by a layer of water, and surrounded by layers of gases.

- The **lithosphere** (LITH-uh-sfeer) is the hard, outer layer of Earth, about 100 km (62.14 mi) thick. The rocky surface that makes up the top of the lithosphere is the crust. The crust is thinnest under the oceans and thickest at continents. The crust includes the soil and many other *resources*. Earth's resources are materials that help support life on Earth.
- The **hydrosphere** (HIGH-druh-sfeer) is Earth's water—trillions of liters of water. There is so much water that it covers most of the lithosphere. Most of this water is in the oceans. Ocean water is salty because of minerals that have been deposited in it over the ages. The hydrosphere also includes all of Earth's fresh water found in lakes, rivers, streams, groundwater, and ice. This is the water we use for drinking, cooking, and bathing. Water is also found as a gas in our atmosphere.

  The hydrosphere acts as a big heat absorber. Water changes temperature slowly compared to land. The oceans keep temperatures on Earth from changing too drastically.
- Pictures of Earth taken from space show lots of white clouds swirling in the **atmosphere**—layers of gases that surround Earth. There are four major layers of the atmosphere. The one nearest to the surface of Earth is the troposphere. It contains the oxygen needed for living things. It is also where almost all of Earth's weather occurs. Other layers of the atmosphere help protect Earth against harmful energy from the Sun.

The three major layers of Earth – the lithosphere, hydrosphere, and atmosphere – all interact with each other.

READING Sequence of Events
What is the order of Earth's layers?

Lesson Review

L·I·N·K·S

Why It Matters

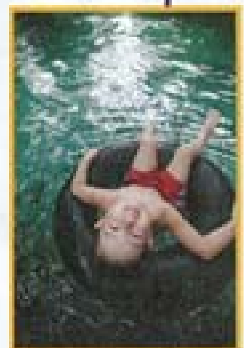
Since Earth first formed it has changed, renewed, and recycled itself through natural processes. Perhaps the most powerful force of erosion is running water. Running water and the sediments it carries are vital to the environment and to the quality of our lives. The constant cycling of water and sediments provides fresh water and fertile soils. Before we remove vegetation, build dams, or re-channel streams and rivers, we must consider the short-term benefits against the long-term effects on Earth.

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on the effects of altering river systems.

Think and Write

1. Why do gentle, sloping, wide rivers have more meanders than steep, fast-flowing rivers?
2. How does the slope of a hill affect the runoff of surface water?
3. What processes are involved in the formation of a delta?
4. How do topographic maps differ from relief maps?
5. **Critical Thinking** Why are farms often found near rivers?

WRITING LINK



Persuasive Writing State officials want to build a dam in the river near your town. Research the advantages and disadvantages of building a dam. Take a position on the issue. Write a persuasive speech to present your point of view. Save your strongest argument for last.

MATH LINK

Make a bar graph. Find the elevations of three mountains from around the world. Make a bar graph showing the differences in elevation.

SOCIAL STUDIES LINK

Research ancient and modern civilizations. Learn more about how floodplains affected the establishment and growth of ancient civilizations. How did the annual flooding of the Nile affect the growth of civilization? How does the growth of this ancient civilization compare with the development of towns and cities along other major rivers?

TECHNOLOGY LINK

LOG ON Visit **www.science.mmhschool.com** for more links.

Science, Technology,

Waves of Erosion

Have you ever stood by the ocean and felt a wave pull the sand from under your feet? Waves constantly carry sand away from a beach, bit by bit.

People who live by beaches can watch their "front yards" slowly disappear. Many beach homes are built on stilts. That puts the buildings above water during high tides and storms. However, if the sand supporting the stilts washes away, the houses fall!

If there are cliffs on a shoreline, the pounding waves can wear away the lowest parts. Eventually the cliffs collapse and fall into the water. Then waves slowly break the rocks into smaller pieces. In time the cliffs will become sand.

Stormy winter weather increases erosion. Fierce winds push the waves, giving them the strength to pick up and carry small stones. The stones pound cliffs along with the waves and help to break the rocks. The stronger wind also pushes waves farther inland.

Some towns truck in sand to replace what's lost. Other towns build breakwaters close to shore. The stone and concrete breakwaters reduce the force of the waves before they reach shore. An island or a sandbar close to shore serves as a natural breakwater.

Nearly all sand and rock removed by wave erosion is deposited elsewhere. Only a small percentage is carried out to sea.

Waves can wear away the sand that supports a beachfront home.

and Society

People sometimes build sea walls to try to protect the beaches from pounding waves.

What Did I Learn?

1. Beach homes may be protected from high tides by
   - **A** sea walls.
   - **B** stilts.
   - **C** breakwaters.
   - **D** all of the above
2. The main idea of this story is that
   - **F** people should not live near the beach.
   - **G** beaches are affected by erosion.
   - **H** towns should build sea walls to protect beaches.
   - **J** all of the above

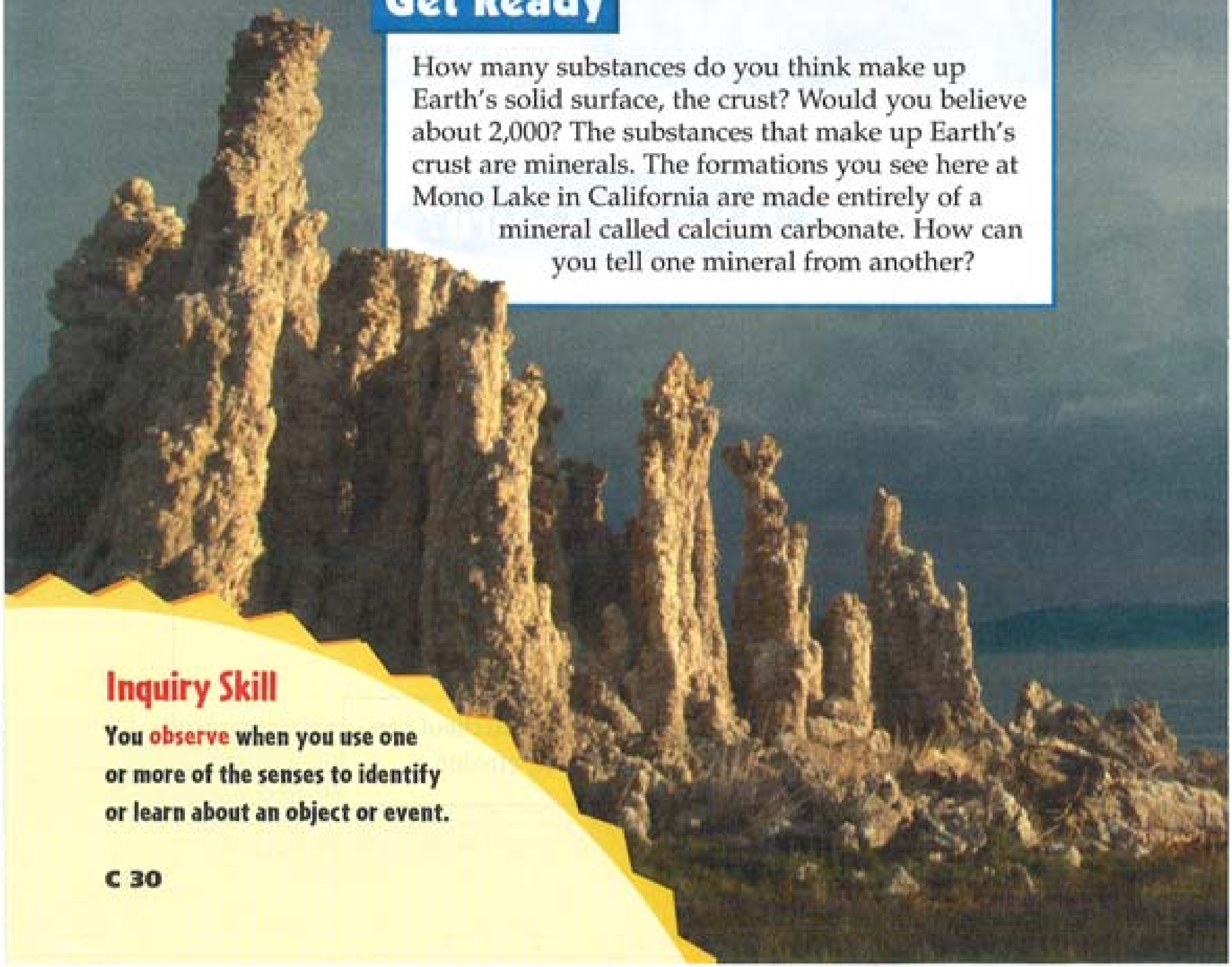
LOG ON Visit **www.science.mmhschool.com** to learn more about erosion.

LESSON 3

Minerals of Earth's Crust

Vocabulary

mineral, C32
luster, C33
streak, C34
hardness, C34
cleavage, C34
ore, C38
gem, C38



Get Ready

How many substances do you think make up Earth's solid surface, the crust? Would you believe about 2,000? The substances that make up Earth's crust are minerals. The formations you see here at Mono Lake in California are made entirely of a mineral called calcium carbonate. How can you tell one mineral from another?

Inquiry Skill

You observe when you use one or more of the senses to identify or learn about an object or event.

Explore Activity

How Can You Identify a Mineral?

Materials

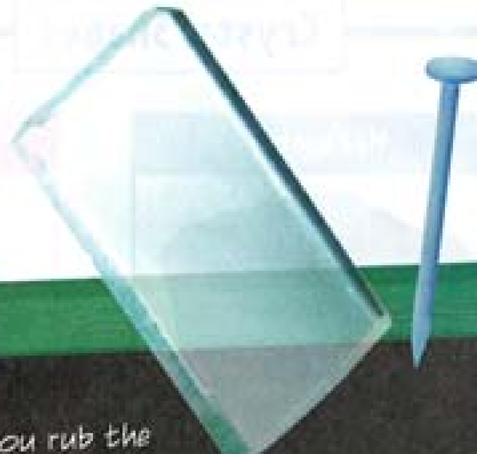
- mineral samples
- clear tape
- red marker
- copper penny or wire
- porcelain tile
- hand lens
- nail

Procedure

1. **Communicate** Use tape and a marker to label each sample with a number. Make a table with the column headings shown. Fill in numbers under "Mineral" to match your samples.
2. **Observe** Use the table shown as a guide to collect data on each sample. Fill in the data in your table. Turn to the table on page C35 for more ideas to fill in "Other."

Drawing Conclusions

1. Use your data and the table below to identify your samples. Were you sure of all your samples? Explain.
2. Which observations were most helpful? Explain.
3. FURTHER INQUIRY **Experiment** How could you make a better Scratch (Hardness) test?



Color = color of surface

Porcelain Plate Test = the color you see when you rub the sample gently on porcelain

Shiny Like a Metal = reflects light like a metal, such as aluminum foil or metal coins

Scratch (Hardness): Does it scratch copper? A piece of glass?

Other: Is it very dense? (Is a small piece heavy?) Has it got flat surfaces?

	Mineral	Color	Shiny Like a Metal (Yes/No)	Porcelain Plate Test	Scratch (Hardness)	Other
1.						

Read to Learn

Main Idea **Earth's crust contains many types of minerals with important uses.**

How Can You Identify a Mineral?

What do diamond rings, talcum powder, and aluminum foil have in common? They are made from **minerals**. So are copper wire, teeth fillings, china dishes, and table salt.

With so many differences in minerals, what can they have in common? Minerals are solid materials of Earth's crust. Like all matter they are made of elements. Some minerals, like gold, silver, copper, and carbon, are made of one element. Most minerals are chemical compounds, that is, two or more elements joined together.

Whether it is an element or a compound, each mineral has a definite chemical composition. Scientists can classify minerals by identifying the elements or compounds they are made of.

As minerals form, their atoms and molecules fall into fixed patterns. These patterns cause minerals to form geometric shapes, called *crystals*. Different patterns form different crystal shapes. You can see the six main crystal shapes on these pages.

No two minerals are exactly alike. Each mineral has a different composition. Each has its own set of properties

Crystal Shapes

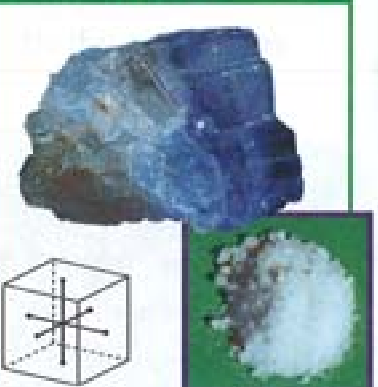
Hexagonal

The "lead" in a lead pencil is not the metal element lead at all. It is the mineral graphite (GRAF·ight), which is a form of the element carbon.

Tetragonal

The mineral chalcopyrite (kal·kuh·PIGH·right) is a compound made of the elements copper, iron, and sulfur. It is where much of our copper comes from. Copper is used for wire, coins, pots, and pans.

Cubic



Rock salt, which is used to melt ice, is the mineral halite (HAL·ight). It is a compound made of the elements sodium and chlorine.

that you can use to tell them apart. Crystal shape is one property. However, telling the exact chemical composition of most minerals or their crystal shape isn't easy. This requires special instruments.

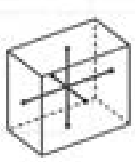
Here are some simpler properties to use.

- The color of the outer surface of the mineral is the first thing you see. However, if a mineral is exposed to weather, it can become discolored. Therefore, you should always observe color on a fresh surface. Color alone cannot be used to identify most minerals. Why not? Some minerals come in a variety of colors, and some colors are common to many minerals.
- **Luster** is the way light bounces off a mineral. Minerals with a metallic luster are shiny, like metals. Graphite has a metallic luster.

Minerals with a nonmetallic luster may look shiny or dull. Nonmetallic luster can be described as glassy, waxy, pearly, earthy, oily, or silky. Talc has a nonmetallic luster often described as oily.

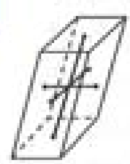
What are the characteristics of a mineral?

Orthorhombic



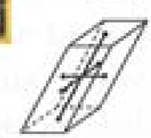
Topaz is a mineral used in many kinds of jewelry. It comes in many colors—pink, pale blue, and even yellow or white.

Monoclinic



Talc is the mineral used in talcum powder. Talc comes in white and greenish colors.

Triclinic



The mineral kaolinite (KAY·uh·luh·night) is used in china plates and ceramic objects. It comes in many colors—red, white, reddish brown, and even black.

Hematite has a blackish color but a reddish streak.

Galena has three cleavage planes. It breaks into cubes.

Mica has one cleavage plane. It breaks into sheets.

How Else Can You Identify Minerals?

Here are three other ways to identify a mineral.

- **Streak** is the color of the powder left when a mineral is rubbed against a hard, rough surface. Rub it against a porcelain streak plate. The streak is always the same for a given mineral, even if the mineral varies in color.

  The streak may not be the color of the outer surface of the mineral. Fool's gold, pyrite, is brassy yellow, but it has a greenish black streak. Gold has a yellow streak. You would need a streak plate to identify real gold.
- **Hardness** is a measure of how well a mineral resists scratching. Soft minerals are easily scratched. Mohs' scale of hardness is a numbered list of minerals. Talc, number 1, is the softest mineral. It can be scratched with your fingernail. Any item on the list, including the tools, can scratch something above it. You can use the tools to help find the hardness.
- The way a mineral breaks is also helpful. Some minerals have **cleavage**. This property is the tendency of a mineral to break along flat surfaces. Cleavage is described by the number of directions, or planes, along which the mineral breaks.

READING Tables

Which mineral does a fingernail scratch? Which does a glass plate scratch?

Mohs' Scale of Hardness

Hardness	Sample Mineral	Tool
1 2	Talc Gypsum	
		Fingernail
3	Calcite	
		Copper penny/wire
4	Fluorite	
		Iron nail
5	Apatite	
		Glass plate
6	Feldspar	
		Steel file
7	Quartz	
		Streak plate
8 9 10	Topaz Corundum Diamond	

A form of calcite shows double image because it refracts light twice as you look through it.

READING Tables

How is hornblende different from quartz? From feldspar? From mica?

Properties of Minerals

Mineral	Color(s)	Luster (Shiny as Metals)	Porcelain Plate Test (Streak)	Cleavage (Number)	Hardness (Tools Scratched By)	Density (Compared with Water)
Gypsum	colorless, gray, white, brown	no	white	varies	2 (all six tools)	2.3
Quartz	colorless, various colors	no	none	no	7 (streak plate)	2.6
Pyrite	brassy, yellow	yes	greenish black	no	6 (steel file, streak plate)	5.0
Calcite	colorless, white, pale blue	no	colorless, white	yes—3	3 (all but fingernail)	2.7
Galena	steel gray	yes	gray to black	yes—3 (cubes)	2.5 (all but fingernail)	7.5
Feldspar	gray, green, yellow, white	no	colorless	yes—2	6 (steel file, streak plate)	2.5
Mica	colorless, silvery, black	no	white	yes—1 (thin sheets)	2–3 (all but fingernail)	3.0
Hornblende	green to black	no	gray to white	yes—2	5–6 (steel file, streak plate)	3.4
Bauxite	gray, red, brown, white	no	gray	no	1–3 (all but fingernail)	2.0 – 2.5
Hematite	black, gray, red-brown	yes	red or red-brown	no	1–6 (all)	5.3

Many minerals do not break smoothly. They are said to have *fracture*. Quartz, for example, shows jagged edges when it breaks.

Some minerals have special properties that help you identify them. Magnetite, for example, is attracted by a magnet. Some minerals are more *dense* than others. That means they have a lot of mass packed into a given volume. *High density* makes a sample feel quite heavy. Gold, silver, and galena are examples of dense minerals.

How do tests for streak, hardness, and cleavage help you tell minerals apart?

How Do Minerals Form?

Where do you find minerals? The answer is simple–in the ground. Minerals make up the rocks of the crust. If you examine rocks with a hand lens, you can often find some of the most common rock-forming minerals in the rock.

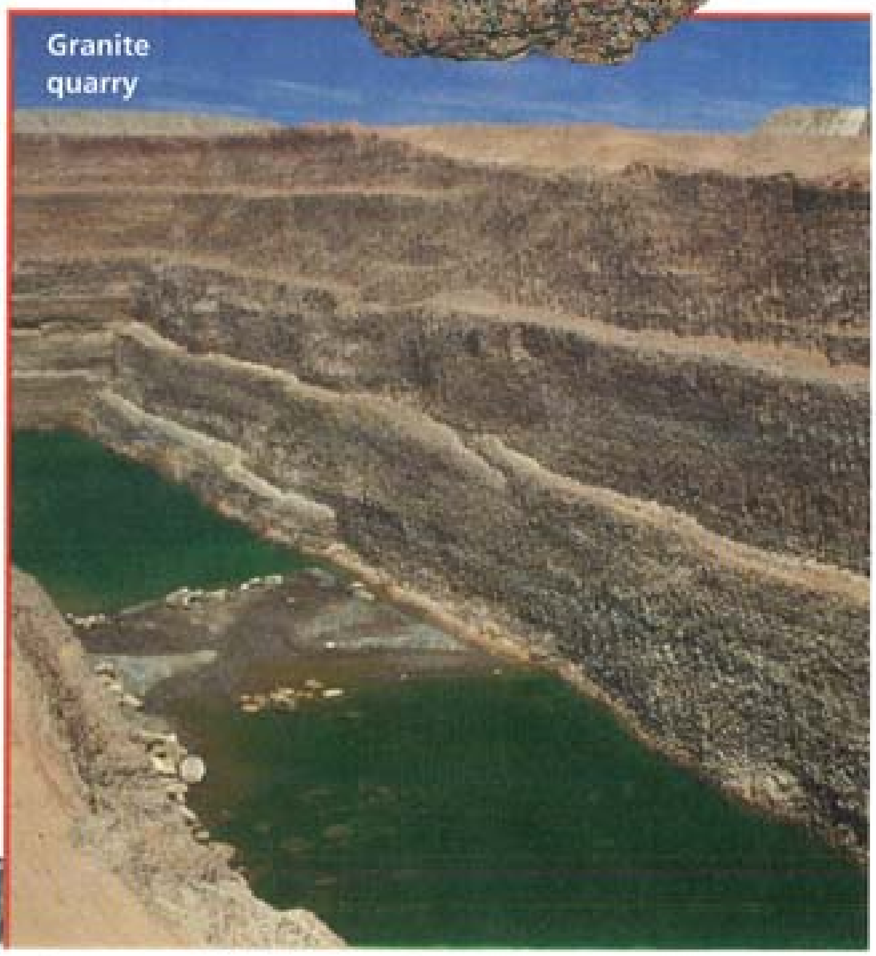
How do minerals form? Many form when hot liquid rock, or magma, cools and hardens into a solid. Magma is very hot, and its molecules move very fast. When magma cools, its molecules slow down and get closer together. Then they connect into a pattern, forming crystals. The longer it takes magma to cool, the more time the crystals have to grow, and the larger they get.

Some of the rarest minerals form deep within Earth. The temperatures are high at great depths. The weight of rocks overhead presses down on rocks below, like a huge pressure cooker. The heat and pressure produce minerals such as diamonds. Movements of Earth's crust then bring the minerals near the surface, where they can be mined.

Diamond

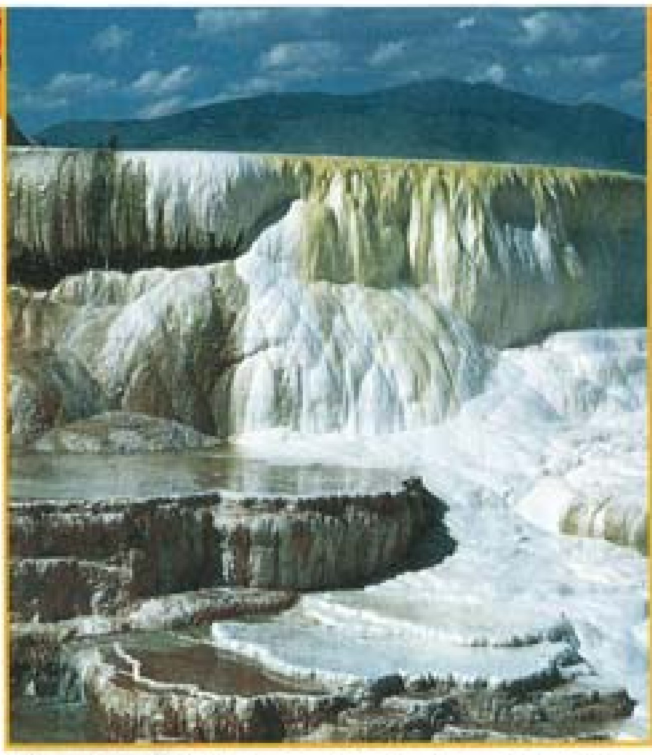
Crystals can form from the cooling of hot water. Water heated by magma inside the Earth is rich in dissolved minerals. Hot water can hold more dissolved minerals than cold water. As the water cools, it is able to hold less of the dissolved minerals. The minerals that can no longer stay dissolved form crystals. The huge quartz crystal shown below formed in this way.

The specks you see in this rock include minerals such as quartz, feldspar, hornblende, and mica.



Granite quarry

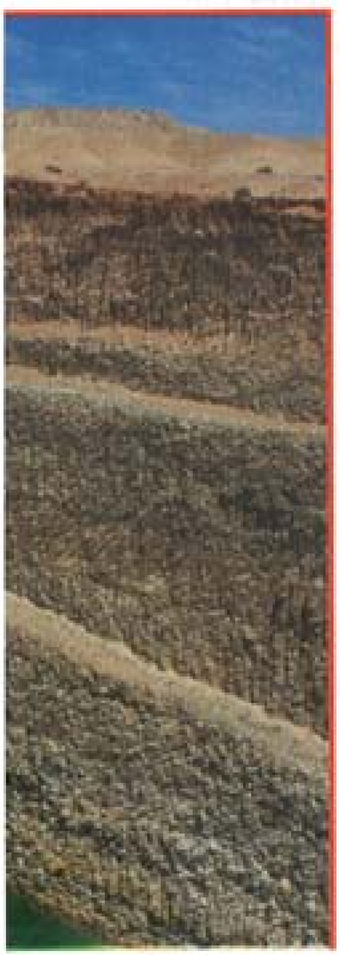
Quartz crystal



The piles of brightly colored minerals in this hot spring form when the heated water cools as it is exposed to the air.

These crystals then slowly settle to the bottom of the water.

Minerals can also form from evaporation. Ocean water contains many dissolved substances. As the ocean water evaporates, the substances that were dissolved form crystals. Common table salt is mined in areas that were once covered with salt water. The salt is a mineral, halite. It was left behind when an ancient sea evaporated.



READING **Sequence of Events**
In what ways do minerals form?

QUICK LAB

Growing Crystals

FOLDABLES Make a Six-Row Table. (See p. R 44.) Label the rows as shown.

Date:	Observation:
Date:	Observation:
Date:	Observation:
Date:	Observation:
Date:	Observation:
Date:	Observation:

Your teacher will put a cup of hot water onto a counter for you.

BE CAREFUL! Wear goggles. Use a kitchen mitt if you need to hold or move the cup. Don't touch the hot water.

1. Use a plastic spoon to gradually add small amounts of salt to the water. Stir. Keep adding and stirring until no more will dissolve.
2. Tie one end of a 15-cm piece of string to a crystal of rock salt. Tie the other end to a pencil. Lay the pencil across the cup so that the crystal hangs in the hot salt water without touching the sides or bottom.
3. **Observe** Observe the setup for several days. Record what you see.
4. Did any crystals grow? If so, did they have many shapes or just one? Explain your answer. If not, how would you change what you did if you tried again?

What Are Minerals Used For?

Can you find minerals being used at home or school? Minerals are used to make many products, from steel to electric light bulbs.

Some of the most useful minerals are called **ores** (AWRZ). An ore is a mineral that contains a useful substance. Ores contain enough useful substances to make them valuable to mine.

For example, iron comes from the mineral hematite (HEE·muh·tight). Iron is used to make nails, buildings, and even ships. Aluminum comes from the mineral bauxite. It is used for food-wrap foil, soft-drink cans, and pie tins, just to name a few uses.

The iron and aluminum that come from these two ores are *metals*. Metals have many useful properties. Metals conduct electricity and can be stretched into wires. The metal copper, for example, comes from a mineral ore. It is used to make electrical wires.

Aluminum is lightweight and strong. It shares these properties with another metal that comes from an ore, magnesium. These metals are ideal for use in building jets and spacecraft.

If you look in a jewelry store window, you'll probably see some minerals called **gems**. Gems are minerals that are valued for being rare and beautiful. You may have seen diamond rings. Rubies and sapphires are two other gemstones.

Gemstones mark special occasions—such as weddings and birthdays. What is your birthstone? Birthstones are gemstones.

Gypsum is used in drywall, or wall-board, for construction of buildings.

What are two types of useful minerals?

Lesson Review

Why It Matters

Minerals are *nonrenewable resources*. They take so long to form that they cannot be replaced in your lifetime.

Because minerals are nonrenewable, they must be *conserved*. To *conserve* means to "use wisely or avoid waste." One way people can conserve minerals is by recycling them—finding ways to treat them or use them again. Researchers also develop substitutes to use in place of natural minerals. Many diamonds used in industry for cutting stone, for example, are not natural diamonds.

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on minerals.

Think and Write

1. Which properties are most useful to identify a mineral? Explain your answer.
2. What if you had two white samples of talc and gypsum? How could you tell them apart in one step?
3. How does time affect crystals?
4. How useful are metallic ores? Give some ways you use them.
5. **Critical Thinking** How could you avoid the mistake that miners made, thinking fool's gold was real? What observations help you tell them apart?

L·I·N·K·S

SOCIAL STUDIES LINK

Research minerals. Learn about ways to conserve and recycle minerals. Use the Internet or an encyclopedia.

WRITING LINK

Expository Writing Research the mineral resources in your state. How can these resources be conserved or recycled? Record your findings in a research report.

MATH LINK

Think about shapes. You have learned about the three-dimensional shapes of minerals. How many other regular 3-D shapes do you know? Make a poster illustrating different 3-D shapes.

TECHNOLOGY LINK

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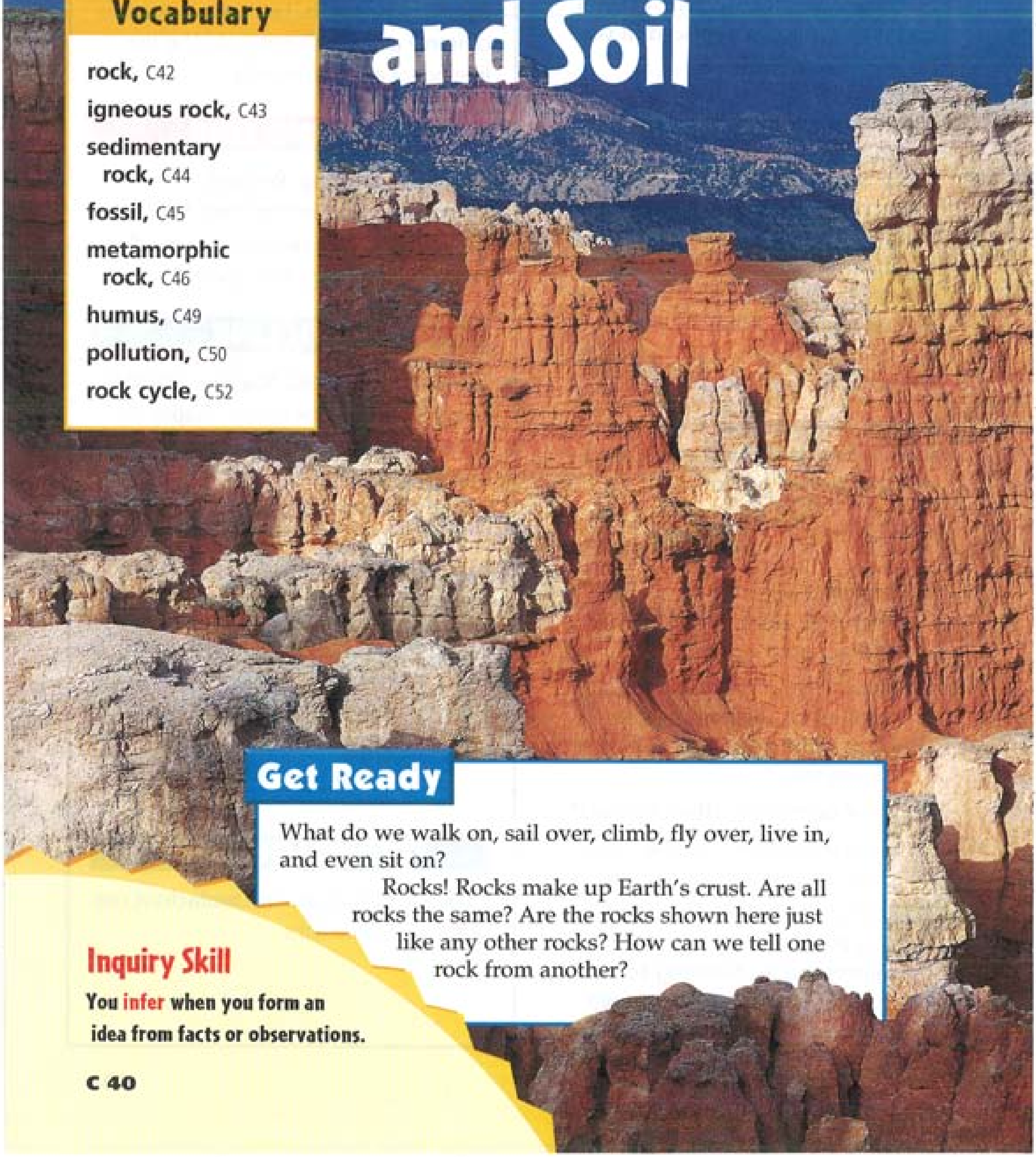
LESSON 4

Earth's Rocks and Soil



Vocabulary

rock, C42
igneous rock, C43
sedimentary rock, C44
fossil, C45
metamorphic rock, C46
humus, C49
pollution, C50
rock cycle, C52

Get Ready

What do we walk on, sail over, climb, fly over, live in, and even sit on?

Rocks! Rocks make up Earth's crust. Are all rocks the same? Are the rocks shown here just like any other rocks? How can we tell one rock from another?

Inquiry Skill

You infer when you form an idea from facts or observations.

Explore Activity

How Are Rocks Alike and Different?

Materials

- samples of rocks
- clear tape
- red marker
- hand lens
- copper wire
- streak plate
- balance
- metric ruler
- calculator

Procedure: Design Your Own

1. Use the tape to number each sample in a group of rocks.
2. **Classify** Find a way to sort the group into smaller groups. Determine what properties you will use. Group the rocks that share one or more properties. Your fingernail, the copper wire, and the edge of a streak plate are tools you might use. Scratch gently. Record your results.
3. **Use Numbers** You might estimate the density of each sample. Use a balance to find the mass. Use a metric ruler to estimate the length, width, and height.
   Length × width × height = volume
   Density = mass ÷ volume

Drawing Conclusions

1. How were you able to make smaller groups? Give supporting details from the notes you recorded.
2. Could you find more than one way to sort the rocks into groups? Give examples of how rocks from two different smaller groups may have a property in common.
3. **Communicate** Share your results with others. Compare your systems for sorting the rocks.
4. **FURTHER INQUIRY** **Infer** How might a sample be useful based on the properties that you observed?

Read to Learn

Main Idea **Rocks can be classified according to their composition and properties.**

How Are Rocks Alike and Different?

Rocks are mineral treasure chests. A **rock** is any naturally formed solid in the crust made up of one or more kinds of minerals. You can often see mineral crystals in a rock. Sometimes the crystals are too small to see easily.

Look with a hand lens at a piece of granite. You can often find crystals of quartz (whitish), feldspar (pink), mica (black), and even hornblende (black).

Each mineral in a rock has its own streak, hardness, or crystal shape. A rock with several minerals may have a mixture of properties. For example, it may have both hard and soft minerals. It may make both light and dark streaks.

The most exact way to identify a rock is to name the minerals it contains. However, color, density, and the way the rock's surface feels, or its *texture*, are also identifying features. The texture comes from the size, shape, and arrangement of the mineral crystals or grains in a rock. Are the grains large (coarse) or small (fine)? Do they interlock, or can you see each clearly? Are they soft edged or jagged?

A rock's color, density, and texture result from how the rock was formed. Rocks are grouped into three types according to how they were formed.

What are the characteristics of rocks?

Igneous Rocks

Extrusive—Cooled Above Ground

Rhyolite (RIGH·uh·light) has a fine texture and is light colored.

Obsidian (uhb·SID·ee·uhn) has no mineral grains and is dark colored.

Basalt (buh·SAWLT) has a fine texture and is dark colored.

What Are Igneous Rocks?

All the rocks on these two pages were at one time deep below Earth's surface. There it is hot enough for some rocks to be melted, or molten. Molten rock material deep below the surface is called magma.

Magma is less dense than the material surrounding it, so it rises toward the surface. Before magma reaches the surface, however, it may cool and harden into solid rock. Rocks that form when melted rock material cools and hardens are called **igneous rocks**.

Often magma makes it to the surface before hardening. Magma reaching the surface is called *lava*. Exposed to the air above ground, lava, too, hardens and cools, forming igneous rocks.

Below ground magma cools slowly. Crystals take a long time to grow. They grow to large (coarse) sizes.

Above ground cooling is much quicker. Crystals are smaller. Lava may cool so quickly that no crystals have a chance to form. What results is obsidian, a solid piece of volcanic glass.

The granite and gabbro shown on this page formed below ground. They both have large mineral crystals. However, granite contains lighter-colored minerals than gabbro.

All the rocks on page C42 formed above ground. They have small crystals or no crystals at all. How do they differ in color?

The texture and color make a difference in how an igneous rock is used. If you were making a monument, which of these rocks might you choose?

How are igneous rocks formed?

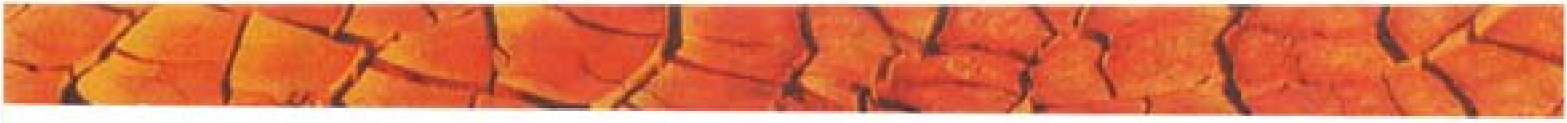
READING Charts

How could you classify the rocks shown on these two pages? Show your results by making a table with two or three columns and rows. Use the properties as headings, and fill in the table with rock names.

Intrusive—Cooled Below Ground

Granite has a coarse texture. The crystals are large enough to be seen. It is a light-colored rock.

Gabbro (GAB·roh) has a coarse texture, but it is dark colored.



What Are Sedimentary Rocks?

How do the rocks here compare with igneous rocks? These rocks are **sedimentary rocks**. Sedimentary rocks are made of small bits of matter joined together. These bits of matter, or sediments, may be bits of weathered rocks. They may be shells or other remains of living things. Long ago water, wind, and ice picked up sediment and carried it. Eventually they dropped the sediment in places where it collected into layers.

Most common sedimentary rocks are formed when sediment is compacted or cemented together. The weight of layer upon layer of sediment on top of each other compacts or squeezes sediment together.

Coarser sediments are cemented by bits of minerals that "glue" the sediments together. Water that contains dissolved minerals seeps between the coarse pieces of sediment. The water evaporates, and mineral crystals form. These crystals hold together the coarse sediment, turning it into a solid rock.

You can see the pieces of sediment that make up these rocks. These rocks are named by the kind of sediment they contain.

Some sedimentary rocks are made of crystals of minerals that were once dissolved in water. The crystals were left behind when the water evaporated. Halite, the rock salt that is used to melt snow and ice, is formed this way.

One type of limestone consists mostly of a mineral called calcite that was once dissolved in ocean water. As the water evaporated in certain areas, the calcite was left behind as solid limestone.

Some sedimentary rocks are made of substances that were once part of, or made by, living things. Cemented-together shells form *coquina* (koh·KEE·nuh). Coral skeletons form coral limestone.

How are sedimentary rocks formed?

Sediment (Small to Large)		Rock
Clay		Shale
Silt		Siltstone
Sand		Sandstone
Gravel		Conglomerate

Coquina

How Are Sedimentary Rocks Useful?

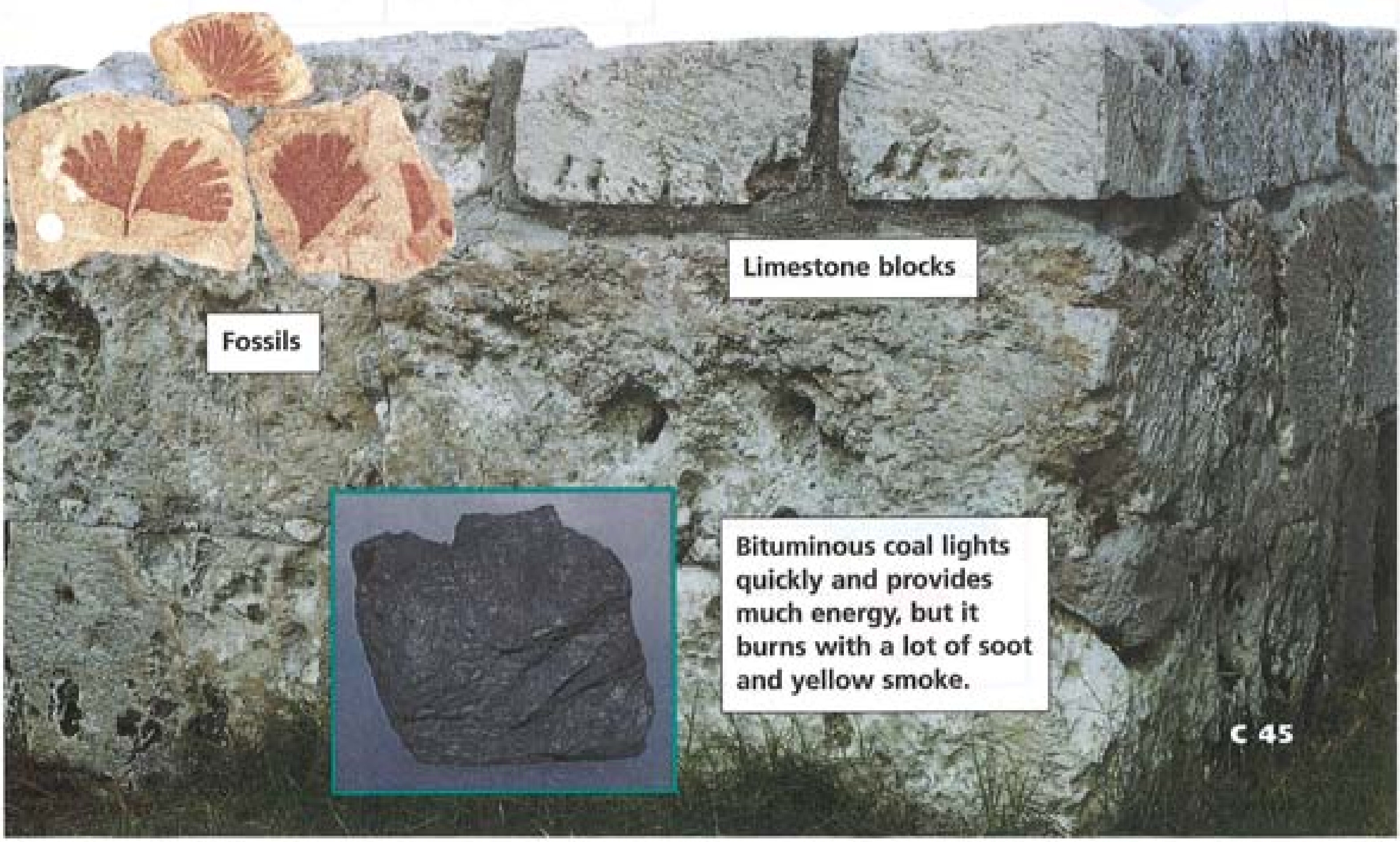
They may be just clumps of bits and pieces, but sedimentary rocks are very useful. Sandstone, for example, is used for buildings and trim. Limestone is used for buildings, trim, monuments, and even park benches. Limestone is often ground up to make cement and then used to make concrete.

Sedimentary rocks are very useful in helping to piece together Earth's history. They often contain clues, called **fossils**, to life long ago. Fossils are the remains or imprints of living things of the past.

The remains of dead organisms were often covered with mud, sand, or other sediment. Sometimes a living thing left an imprint, such as a footprint, in soft mud. Over centuries of time, the sediment and the remains or imprint hardened into rock. Almost all fossils are found in sedimentary rocks. Why do you think fossils could not be found in an igneous rock?

Bituminous (bigh·TEW·muh·nuhs) coal, or soft coal, is a sedimentary rock. Earth's supplies of coal were formed millions of years ago from dead plants buried in ancient swamps and forests. Coal today is a source of energy, the energy that comes from those ancient forms of life.

What are some ways sedimentary rocks are used?



What Are Metamorphic Rocks?

Deep below Earth's surface, rocks can undergo great change. They are heated by the high temperatures at great depths. They are under pressure from the rocks lying above.

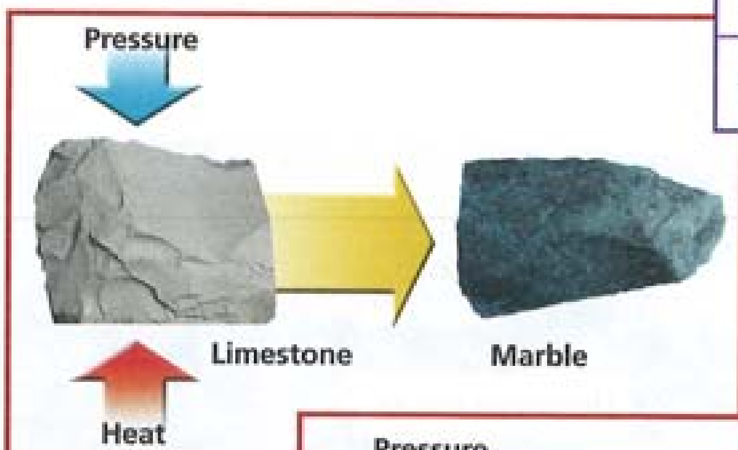
Great heat and pressure can change one rock into another rock. A rock formed under heat and pressure from another kind of rock is called a **metamorphic** (met·uh·MAWR·fik) **rock**. In the process the original rock does not melt under heat and pressure. If it did, it would become an igneous rock. Instead the original rock remains solid, but

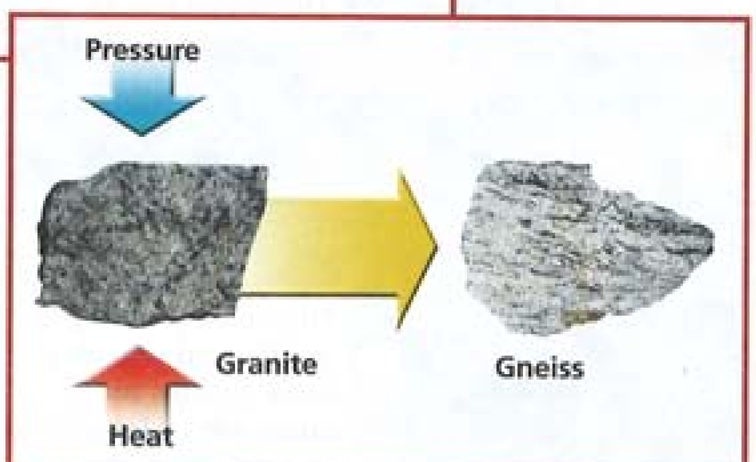
- the mineral grains in the original rock may flatten and line up
- the minerals may change their identity; substances in a mineral may be exchanged with substances in surrounding minerals
- the minerals in the original rock may separate into layers of different densities

In each case the result is a rock different from the original.

Original Rock	Metamorphic Rock
Granite (igneous rock)	gneiss (NIGHS)
Shale (sedimentary rock)	slate
Sandstone (sedimentary rock)	quartzite
Limestone (sedimentary rock)	marble
Slate (metamorphic rock)	schist

How are metamorphic rocks made from other rocks?





How Are Metamorphic Rocks Used?

Metamorphic rocks are "rock makeovers." In their remade form, these rocks have new properties that are very useful.

Slate, for example, breaks into thin sheets. The minerals in slate are so tightly packed together that water cannot seep through this rock. This makes slate useful as roofing shingles as well as stepping stones and outdoor floors.

Marble is often shiny. It often contains minerals that give it brilliant colors, from greenish to red. It is easy to carve. It is often a first choice for making statues, floors, countertops, and monuments.

One kind of coal is a metamorphic rock. It is called anthracite, or hard coal. Anthracite is formed from soft coal.

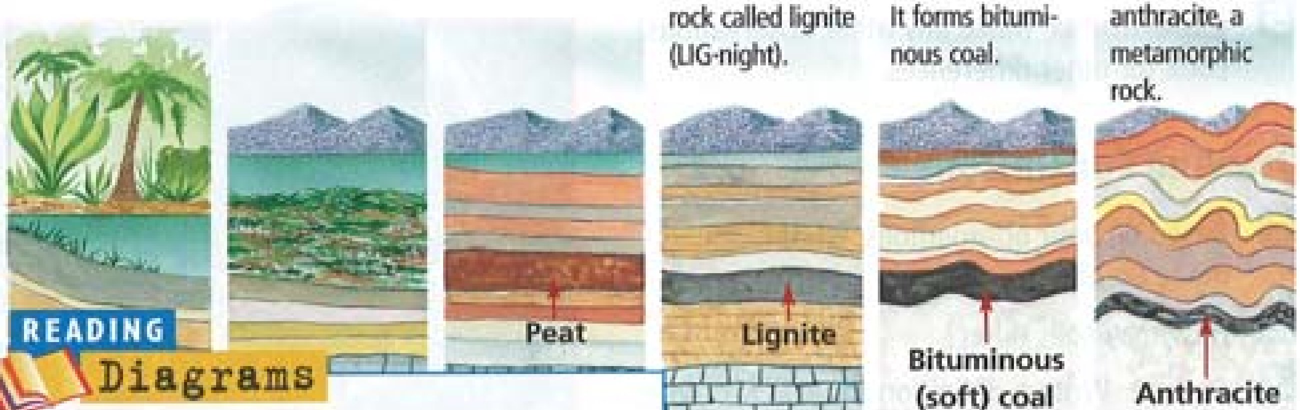
Where might you find metamorphic rocks used in your community?

Anthracite, hard coal, burns cleaner and longer than soft coal, but does not provide as much energy.

The Story of Coal

Millions of Years Ago

300	280	220	150	10	Present
A forest swamp	Plants die and sink to the bottom.	A thick layer of peat, partly decayed plants, builds up.	The swamp dries up. Buried under layers of sediment, the peat changes to a sedimentary rock called lignite (LIG-night).	Buried by more and more layers of sediment, the lignite becomes more compacted. It forms bituminous coal.	Buried even deeper, bituminous coal is changed by great heat and pressure. It forms anthracite, a metamorphic rock.



READING Diagrams

1. How is the position of the fuel layer changing from picture to picture?
2. How does this position affect what happens to the layer?

SKILL **Define Based on Observations**

Defining Soil

Earth's crust is made up of rocks and minerals. However, to get to the rocks, you usually have to dig through layers of soil.

Soil looks different at different places. It has different properties. Soil can be sandy. It can be moist.

Just what is soil? Make some observations. Write a definition that fits your observations.

Materials

- moist soil sample in plastic bag
- sand sample in plastic bag
- hand lens
- 2 cups
- 2 plastic spoons

Procedure

1. **Observe** Use a hand lens to examine a sample of moist soil. What materials can you find? How do their sizes compare? Write a description.
2. Some soils are more like sand. How does a sample of sand compare with your moist soil sample?
3. **Use Variables** Which sample absorbs water more quickly? Fill a cup halfway with sand and another with moist soil. Pour a spoonful of water in each at the same time.
4. **Experiment** Which absorbs more water? Make a prediction. Find a way to test your prediction.
5. **Experiment** Make any other observations. Look for other differences.

Drawing Conclusions

1. Based on your observations, what is soil made up of?
2. How may soils differ?
3. **Define** Write a definition for *soil*. Take into account all your observations.

Where Does Soil Come From?

Under a hand lens, you can see that any soil shows that it is a mixture of many things. The main ingredient in soil is weathered rock. Soil may also contain water, air, bacteria, and **humus**. Humus is decayed plant or animal material.

Where does soil come from? A layer of solid rock weathers into chunks. The chunks weather into smaller pieces. Living things die and decay and form humus.

Gradually layers of soil, or soil horizons, develop. If you dig down through soil, you can see many layers and the solid rock, bedrock, beneath it. How do the horizons differ?

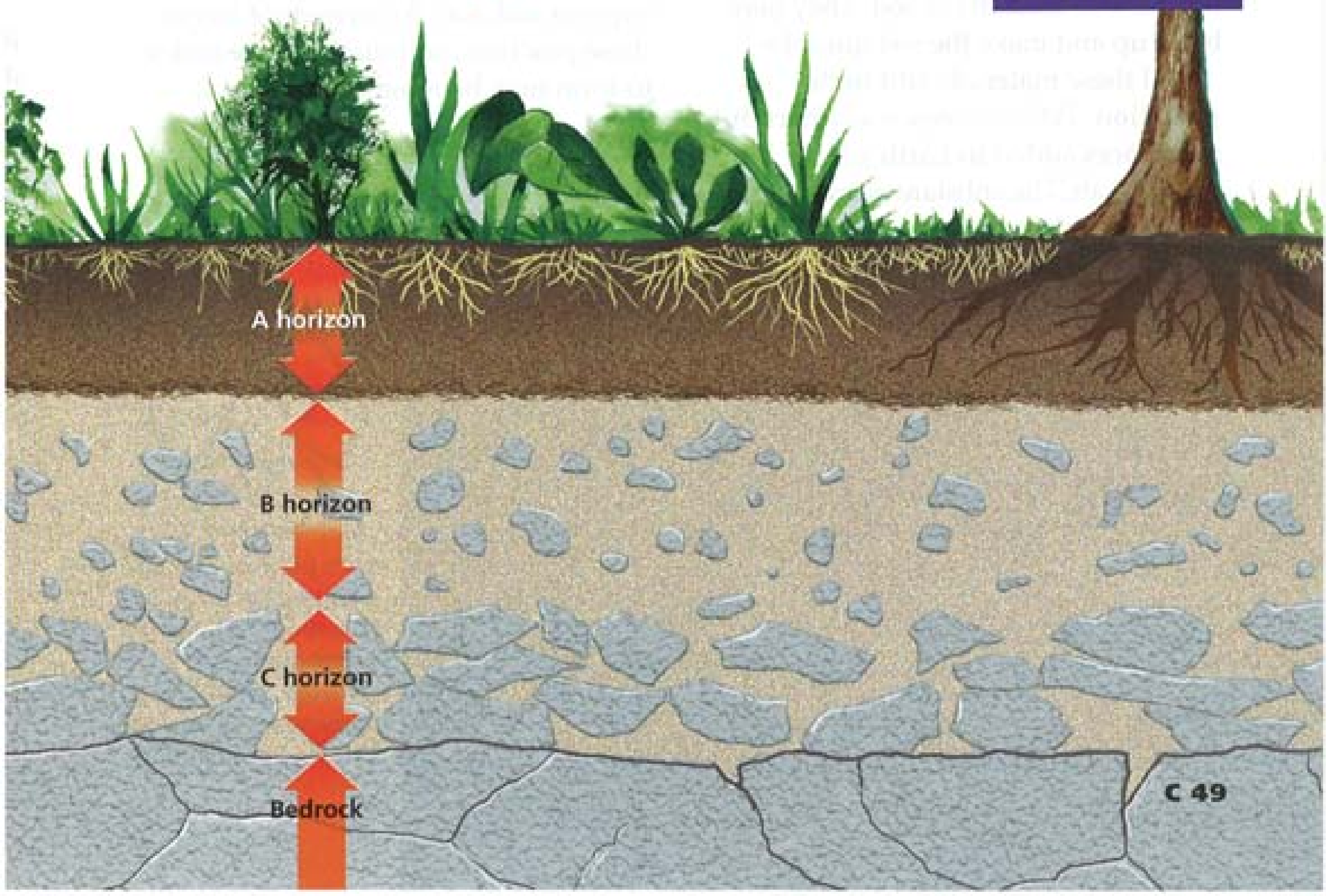
Soils differ in different locations. In polar deserts there is no A horizon at the top. However, grassland and forest soils can have very thick A horizons. Why do you think this is so? Some soils are very sandy. Why? How would they differ from soils in many farms?

Sometimes the materials in soil match the bedrock below it. Sometimes they do not match. Can you explain why?

Soil is Earth's greatest treasure. Most plants need soil to grow. Therefore, almost all living things depend on soil for food—and survival. One of the most important uses of soil is farming. All of the food you eat depends on soil.

What is soil made up of?

Soil Horizons



How Can People Ruin Soil?

People depend on soil. Would you believe people ruin and waste soil? That might include you! It may be people in general or industries—such as factories or farms.

People often get rid of garbage and hazardous wastes by burying them in soil. Hazardous wastes are wastes that may be poisonous or cause diseases, such as cancer.

Spraying chemicals on soil to kill unwanted animals and plants also affects the soil. These chemicals become a part of the soil.

Tossing materials such as foam cups and plastic wrappers onto the ground, instead of using trash baskets, harms the soil. They do not decay. They remain as wastes in the soil. They may build up and make the soil unusable.

All these materials add up to **pollution**. *Pollution* means any harmful substances added to Earth's land, water, or air. The substances are called *pollutants*. When people cause pollution, we say they *pollute* soil, water, or air.

Not only do people pollute soil, but they often waste it, too. For example, soil needs plants. When plants die and decay, they add valuable substances back into the soil. When a crop is harvested, the plants are removed. They do not decay and return nutrients back into the soil. Growing the same crop year after year uses up the nutrients in soil. Plants don't grow well in nutrient-poor soil.

Plant roots hold soil particles together. They protect soil from being blown away by wind or washed away by water. If plants are removed or if weak, sickly plants are growing in an area, the soil is exposed to erosion by wind and rain.

Letting cattle graze in the same area for a long time also exposes soil. Cutting down forests for lumber exposes soil, too. As a result of any of these practices, soil that took centuries to form may be removed in weeks.

How do people pollute and waste the soil?

Each piece of garbage was thrown away by somebody. It takes people to make garbage. What are some ways to prevent this kind of pollution?

By building terraces people in Bali have been able to farm steep hillsides.

Contour means "shape." How does contour plowing prevent water from running downhill?

How Can People Protect the Soil?

People need to take care of soil. We have to protect it from being polluted and wasted. Farmers take care of soil by

- *adding fertilizers and humus.* After growing crops, farmers add these materials to replace minerals removed by crops.
- *using crop rotation.* Each year farmers grow different crops. In this way the soil does not use up the same kinds of minerals year after year. Crops from one year may help replace minerals in the soil that are used up another year.
- *strip farming.* Many crops have stems spaced far apart. Rainwater can run off between the stems and wash soil away. In strip farming strips of tightly growing grasses are grown between more widely spaced crops. The grasses trap runoff and the soil it carries. The next year the position of the strips is switched.
- *contour plowing.* Farmers plow furrows across a slope rather than up and down a slope. Each furrow traps rainwater and keeps it from eroding the soil.
- *terracing.* A hillside is shaped into a series of steps. Runoff water and eroded soil get trapped on the steps. Planting rows of trees to block the wind prevents soil from being blown away.

What can you do to prevent soil from being polluted or wasted? Think about what you toss away as garbage. Is there any way to throw it away to make sure it does not simply end up in the soil? Is there any way to keep from throwing as much garbage away each day as you might?

What are two ways people can protect the soil?

What Is the Rock Cycle?

Where do rocks and soil come from? Igneous rocks come from magma or lava. Where did the magma and lava come from?

Sedimentary rock is made of broken-up pieces of rock. However, where did the pieces of rock come from?

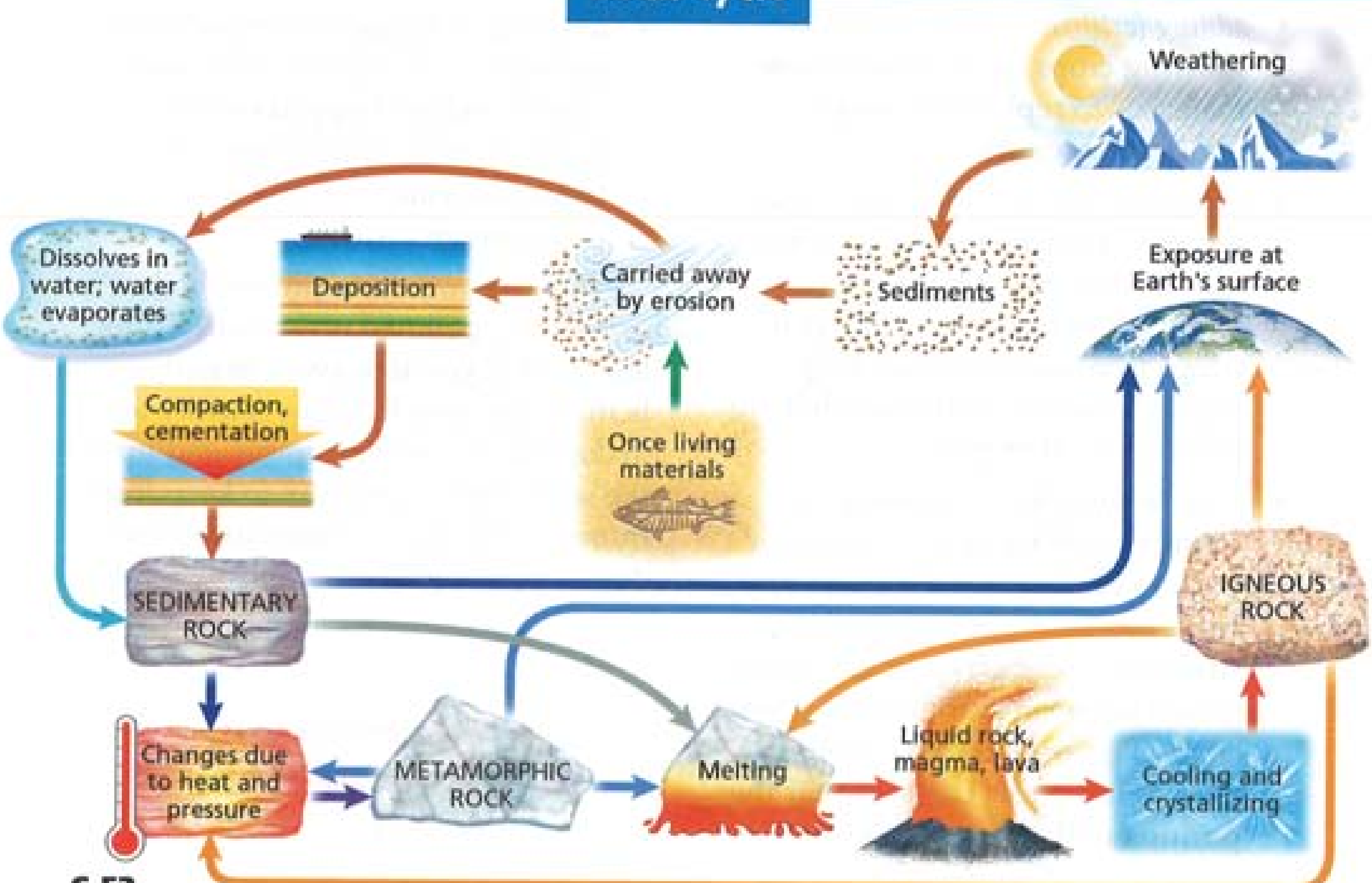
All rocks come from other rocks. Rocks are constantly changing from one rock into another. They change in a never-ending series of processes called the **rock cycle**. Part of this cycle is the weathering of rocks into bits and pieces—some of which may eventually become soil.

Rocks are constantly forming—one changing into another. However, any rock takes a really long time to form. When we dig up a deposit of sandstone or use up the coal in an area, it cannot be replaced. Rocks are a nonrenewable resource.

People get into the rock-making process, too. Concrete, porcelain, and brick are all artificial rocks.

READING **Sequence of Events**
What is the path of a rock through the rock cycle?

Rock Cycle



Lesson Review

Why It Matters

It is important to be able to tell one type of rock from another. Just think of all the ways you use rocks. What would life be like without them? There would be no mountains to climb, no beaches to walk on. There would be no soil—so that means no food, or forests, or fields. There would be no metals, because metals come from mineral ores that are found in rocks. There would be no bricks, no concrete, no buildings, no . . .

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on rocks.

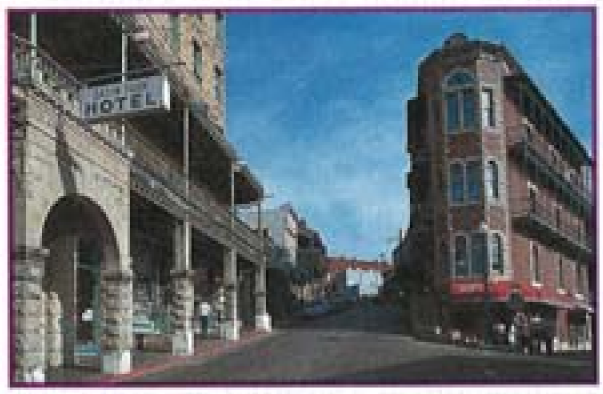
Think and Write

1. How are soils alike? How are they different?
2. How can you tell igneous rocks apart?
3. You pick up a rock. How can you tell if it is a sedimentary rock?
4. **Define** How can you tell rocks apart? Why are they identified in a different way from minerals?
5. **Critical Thinking** How can an igneous rock become a metamorphic rock? Think of three different ways.

L·I·N·K·S

WRITING LINK

Writing a Story What would life be like without soil? Write a science-fiction story. Tell how people might live without food or fields, without metals or buildings. Describe the setting of your story in detail. Develop characters and a plot. Include a problem that is solved at the end.



MATH LINK

Do metric conversions. A kilogram is 2.2 pounds. What is the mass in kilograms of a 13.2 pound rock?

ART LINK

Make a diagram. Where do igneous rocks come from? Draw a picture to show how igneous rocks form.

TECHNOLOGY LINK

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RECORD IN THE ROCKS

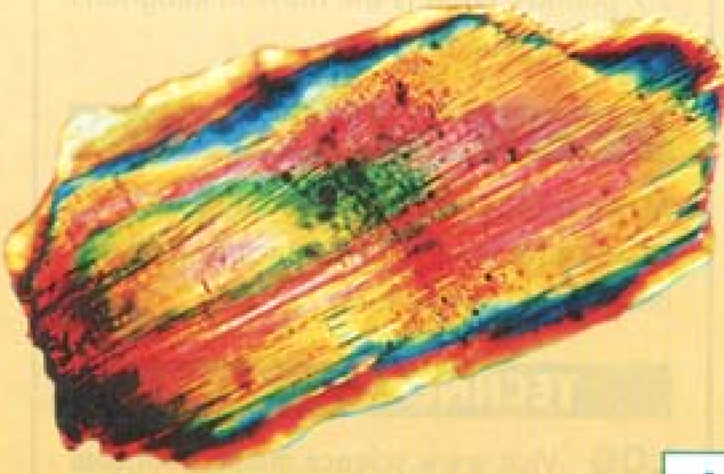
How did the age of ancient glass found in Mexico help scientists solve the mystery of what killed off the dinosaurs?

Fossils show that dinosaurs and most reptiles, plants, and fish vanished about 65 million years ago. Scientists suspected that a huge asteroid, a rock from space, was to blame. They needed proof.

They studied rocks around a huge crater called Chicxulub (cheek-SHEW-lewb) in the Yucatan Peninsula of Mexico. Some chemical elements in rocks work like a clock. They decay (give off radiation) at a steady rate, and in the process turn into other elements. The clock starts ticking when the rock forms.

By measuring what is left of these elements in rocks at Chicxulub today, scientists backtracked to the crater's age—65 million years old. Glass beads found nearby could only have been formed by extreme temperatures and pressures like those never seen on Earth. The glass had to be the leftovers of melted rocks from a huge collision. Geologists dated the glass using the same methods they used to date the other rocks.

The ages matched. An asteroid must have hit 65 million years ago. The impact blasted a crater 110 miles wide and launched an enormous cloud of hot vapor and dust into the air. Eventually, the cloud circled the world and wiped out most of Earth's plants and animals.



The "lines" in this quartz grain show that part of the crystal structure was "shifted" by the intense impact of the meteorite. "Shocked quartz" like this is not formed naturally on Earth.

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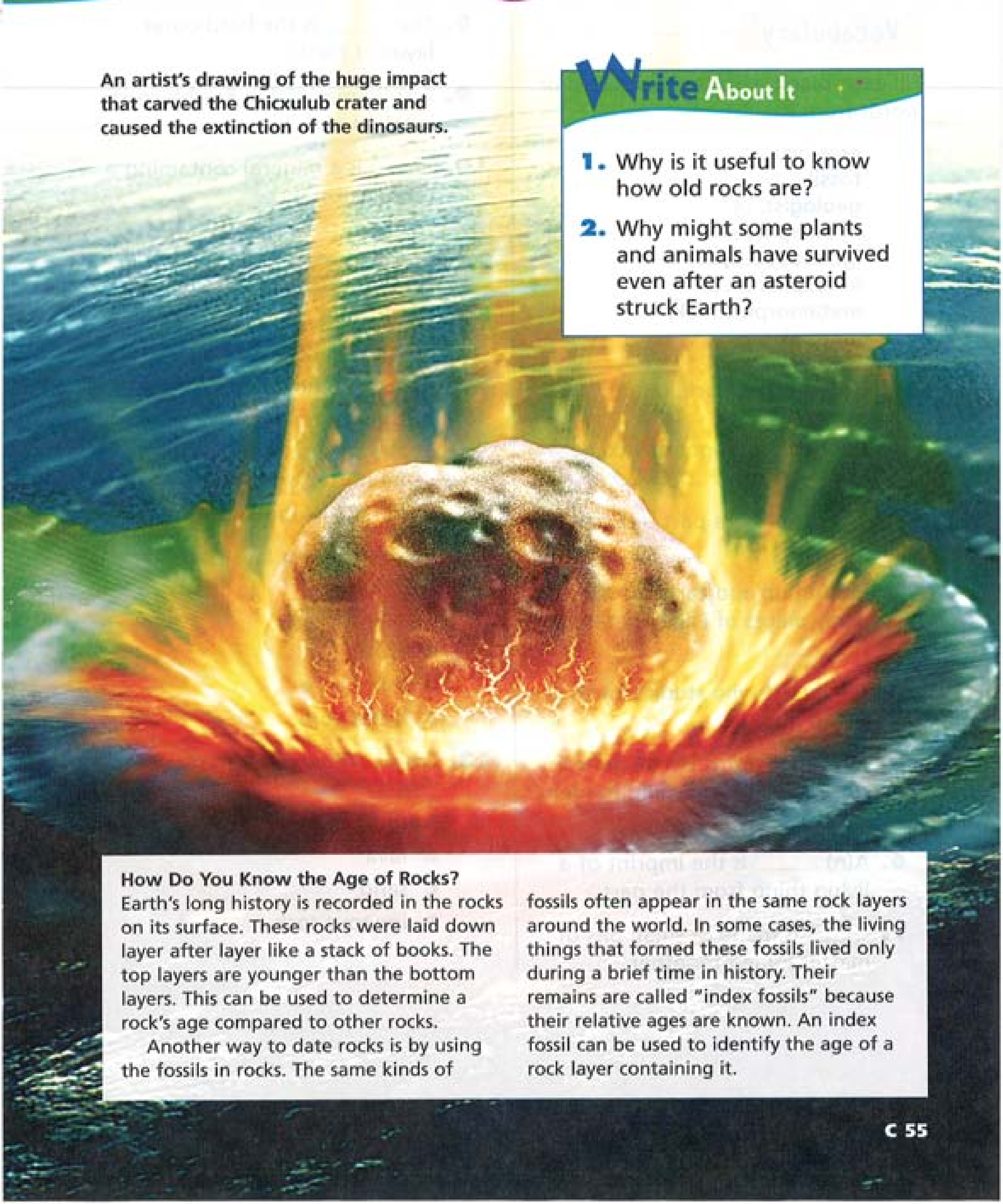

An artist's drawing of the huge impact that carved the Chicxulub crater and caused the extinction of the dinosaurs.

Write About It

1. Why is it useful to know how old rocks are?
2. Why might some plants and animals have survived even after an asteroid struck Earth?

How Do You Know the Age of Rocks?
Earth's long history is recorded in the rocks on its surface. These rocks were laid down layer after layer like a stack of books. The top layers are younger than the bottom layers. This can be used to determine a rock's age compared to other rocks.

Another way to date rocks is by using the fossils in rocks. The same kinds of fossils often appear in the same rock layers around the world. In some cases, the living things that formed these fossils lived only during a brief time in history. Their remains are called "index fossils" because their relative ages are known. An index fossil can be used to identify the age of a rock layer containing it.

Chapter 7 Review

Vocabulary

Fill each blank with the best word or words from the list.

erosion, C10
fossil, C45
geologist, C6
hydrosphere, C26
igneous rock, C43
lithosphere, C26
metamorphic rock, C46
mineral, C32
ore, C38
sedimentary rock, C44

1. Rock that changes due to heat and pressure is _____.
2. The oceans are part of Earth's _____.
3. Picking up and carrying away pieces of Earth material is _____.
4. A scientist who studies Earth is called a(n) _____.
5. Rock that forms when melted rock material cools and hardens is _____.
6. A(n) _____ is the imprint of a living thing from the past.
7. _____ is made of small bits of matter joined together.
8. The _____ is the hard outer layer of Earth.
9. A solid material in Earth's crust is called a(n) _____.
10. _____ is a mineral containing a useful substance.

Test Prep

11. The Moon is unlivable compared with Earth because _____.
    - **A** there is no air to breathe
    - **B** there is no water to drink
    - **C** the surface temperature can be hotter than boiling water
    - **D** all of the above
12. Earth's thickest layer is called the _____.
    - **F** mantle
    - **G** crust
    - **H** inner core
    - **J** outer core
13. Fossils are most often found in _____.
    - **A** sedimentary rock
    - **B** lava
    - **C** sand
    - **D** igneous rock

14. Igneous rock is formed from ______.

- **F** crystals left behind when water evaporated
- **G** meteorites that fell to Earth
- **H** melted rock material that cooled and hardened
- **J** layers of sediment that were squeezed together

15. The main ingredient in soil is ______.

- **A** bacteria
- **B** weathered rock
- **C** decayed animal material
- **D** decayed plant material

Concepts and Skills

16. INQUIRY SKILL **Define** You find a rock that is made up of different-colored layers. It seems to be made of different-sized grains. Some of it looks as though it is made of tiny seashells glued together. What type of rock is it?

17. **Critical Thinking** Describe two tests you can use to determine what minerals a rock is made of.

18. **Reading in Science** Explain the sequence of events that turns peat into anthracite coal.

19. **Scientific Methods** Explain what tests you would do to tell real gold from fool's gold. What would you do to tell quartz from diamond?

20. **Decision Making** What would you need to consider before building a dam on a river. Explain.

Did You Ever Wonder?

INQUIRY SKILL **Infer** Between 1969-1972, American astronauts brought back from the Moon 382 kilograms (842 pounds) of rocks and dust. The samples are kept in special cabinets filled with nitrogen gas. Why are the Moon samples protected this way?

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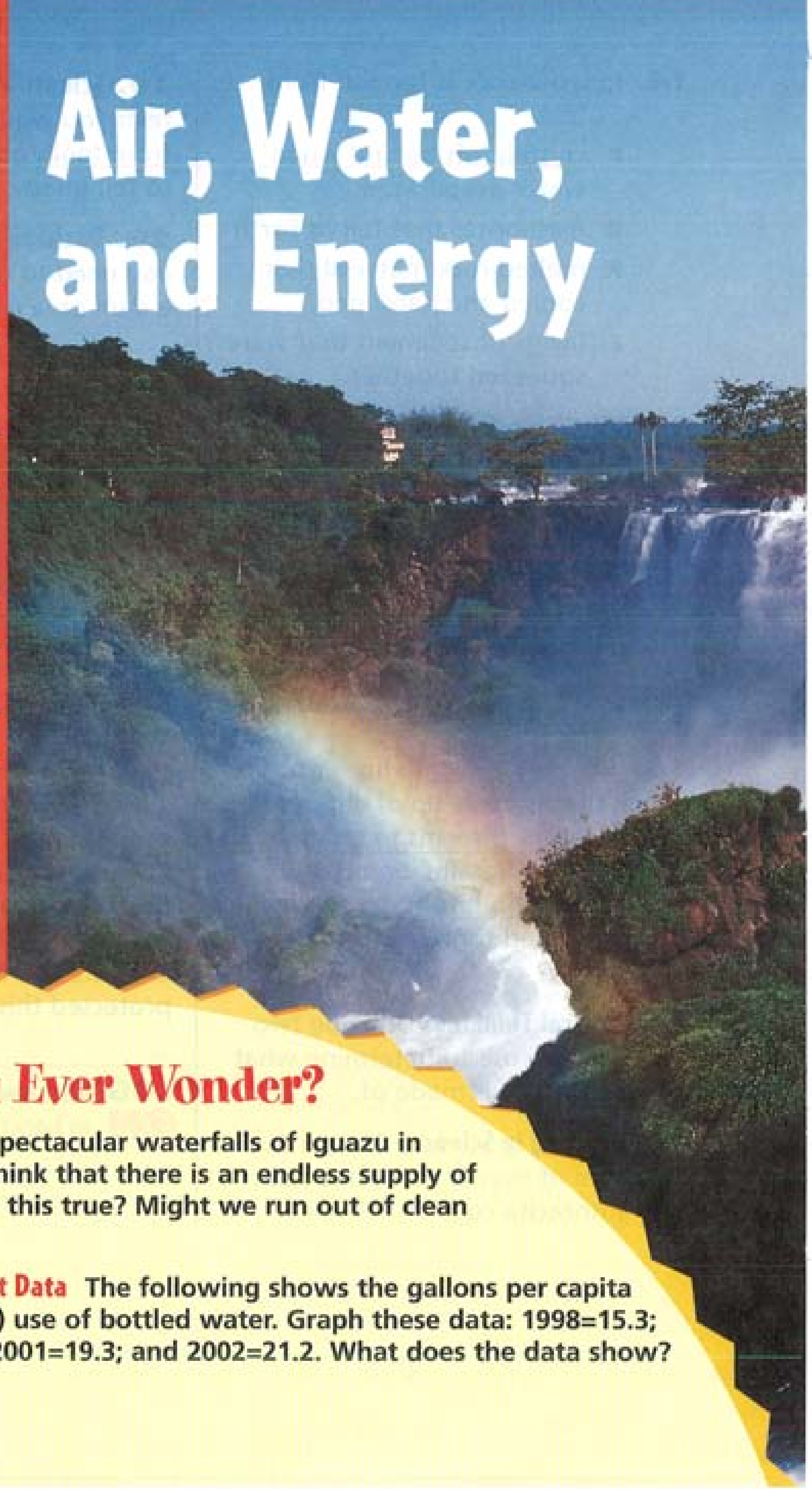
CHAPTER 8

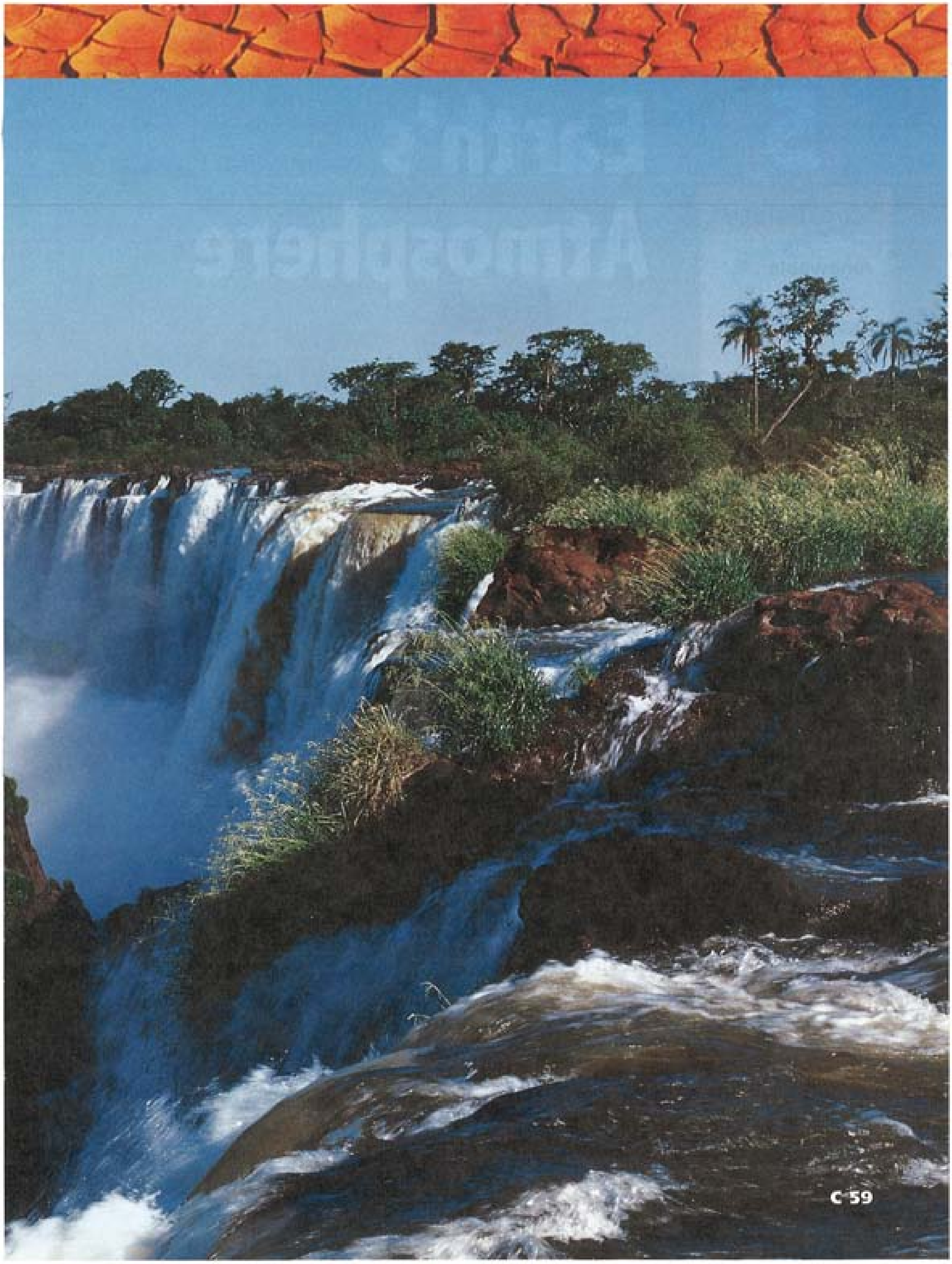
Air, Water, and Energy



Did You Ever Wonder?

When you look at the spectacular waterfalls of Iguazu in Argentina, you might think that there is an endless supply of fresh water on Earth. Is this true? Might we run out of clean drinking water?

INQUIRY SKILL Interpret Data **The following shows the gallons per capita (each individual person) use of bottled water. Graph these data: 1998=15.3; 1999=16.8; 2000=17.8; 2001=19.3; and 2002=21.2. What does the data show?**

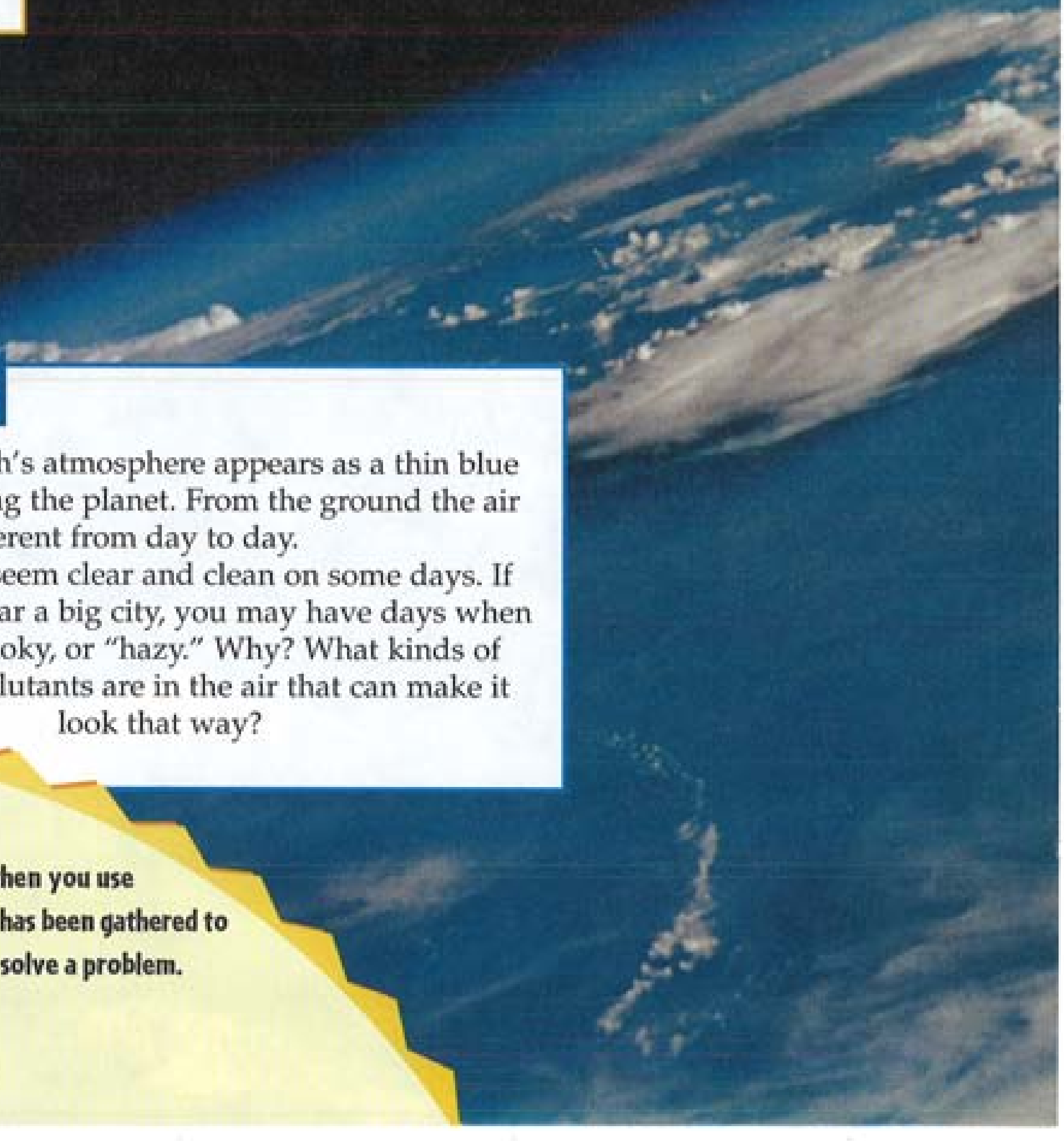


LESSON 5

Earth's Atmosphere

Vocabulary

- **renewable resource,** C62
- **ozone layer,** C63
- **fossil fuel,** C64
- **nonrenewable resource,** C64
- **smog,** C64
- **acid rain,** C65



Get Ready

From space Earth's atmosphere appears as a thin blue layer surrounding the planet. From the ground the air may appear different from day to day.

The air may seem clear and clean on some days. If you live in or near a big city, you may have days when the air seems smoky, or "hazy." Why? What kinds of pollutants are in the air that can make it look that way?

Inquiry Skill

You interpret data when you use the information that has been gathered to answer questions or solve a problem.

Explore Activity

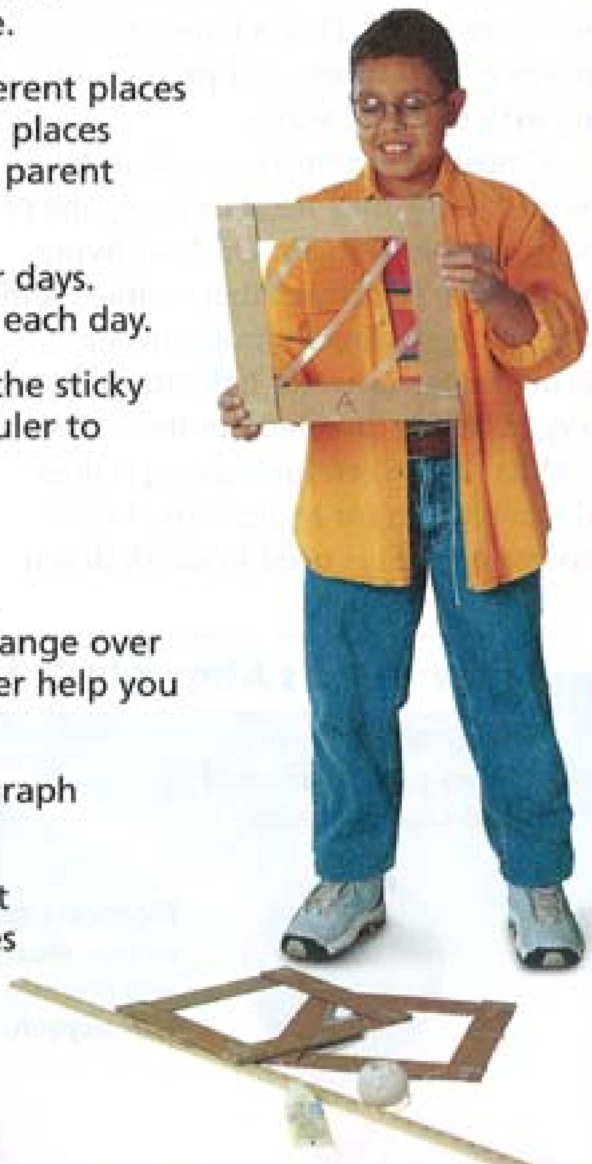
What Makes Air Dirty?

Procedure

1. Make square "frames" by taping together the corners of four cardboard strips. Make three frames, and label them A, B, and C. Tie a 30-cm string to a corner of each frame.
2. Stretch and attach three strips of tape across each frame, with all sticky sides facing the same way. Use a plastic knife to spread a thin coat of petroleum jelly across each sticky side.
3. **Use Variables** Hang the frames in different places to try to collect pollutants. Decide on places indoors or outdoors. Be sure to tell a parent or teacher the places you choose.
4. **Observe** Observe each frame over four days. Record the weather and air condition each day.
5. **Measure** Collect the frames. Observe the sticky sides with a hand lens and a metric ruler to compare particles.

Materials

- 12 cardboard strips
- petroleum jelly
- plastic knife
- transparent tape
- string
- hand lens
- metric ruler
- marker



Drawing Conclusions

1. **Interpret Data** How did the frames change over time? How did the hand lens and ruler help you describe any pollution?
2. **Communicate** Present your data in a graph to show differences in amounts.
3. FURTHER INQUIRY **Use Variables** What kinds of pollutants would your frames not collect? How might you design a collector for them? How might you extend this activity over different periods of time?

Read to Learn

Main Idea **Earth's atmosphere supports life on Earth.**

Why Do Living Things Need the Atmosphere?

Why couldn't humans live on a planet that does not have an atmosphere like that on Earth? Every minute of every day, you need air.

Air is a mixture of nitrogen, oxygen, and a few traces of other gases, including water vapor. This mixture is a vital resource. It supports and protects life on Earth in many ways.

Almost all organisms need air to live. Actually, they need oxygen, one of the gases that is in air. On land living things have structures that enable them to get oxygen directly from the air. Living things in water habitats take in oxygen that is dissolved in the water.

What is oxygen for? Living things take in oxygen for respiration. In this process oxygen is used to break down food so that energy can be gotten from it. As a result of this process, living things give off wastes, including the gas carbon dioxide.

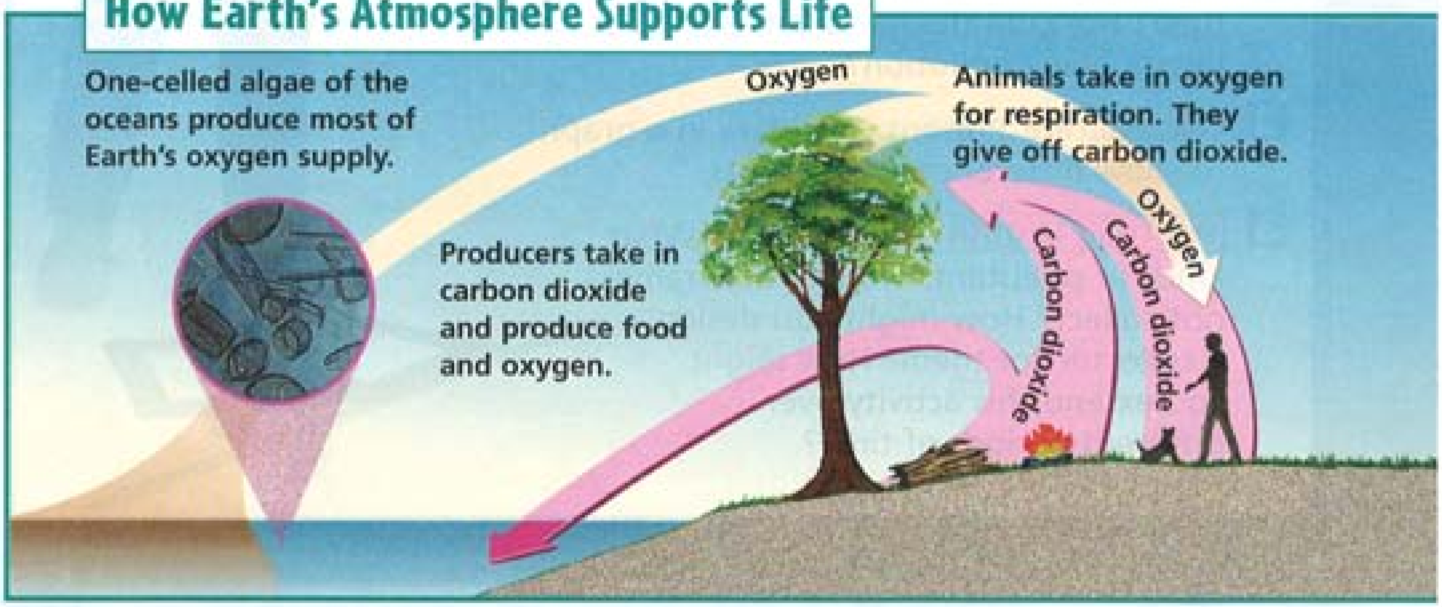
Why doesn't the atmosphere fill up with carbon dioxide? Plants and other producers, living things that have the green substance chlorophyll, take in carbon dioxide. They use it for making food. In the presence of light, these organisms carry on the process called photosynthesis. In this process they make food and give off oxygen.

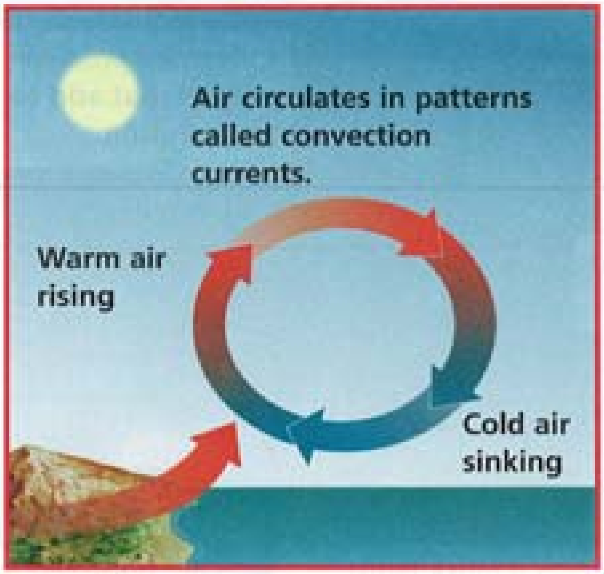
Producers range in size from green plants to one-celled algae. They replace oxygen in the atmosphere. This makes oxygen a naturally **renewable resource**. A renewable resource is one that can be replaced. It can be replaced in a short enough period of time, such as a human lifetime, to support life on Earth.

Protection

The atmosphere also acts as a protective shield. It shields Earth's surface from harmful energy that comes from

How Earth's Atmosphere Supports Life





the Sun. The atmosphere helps screen out harmful ultraviolet rays (UV rays) from the Sun. About 30 km (18.6 mi) above your head is a layer of gas called ozone (OH·zohn). This **ozone layer** screens out from 95 to 99 percent of the Sun's UV rays.

The atmosphere also shields Earth from rocks from space. The "shooting stars" you see on a clear night are not stars. They are rocks from space that burn up due to friction with the air as they speed through the atmosphere.

The atmosphere also protects life from extremes of temperature. Clouds block sunlight during the day. At night they keep much of the heat from escaping into space, so that the planet does not "cool off." Whenever one part of the atmosphere gets hotter than another, the air moves, or circulates, and spreads the heat around.

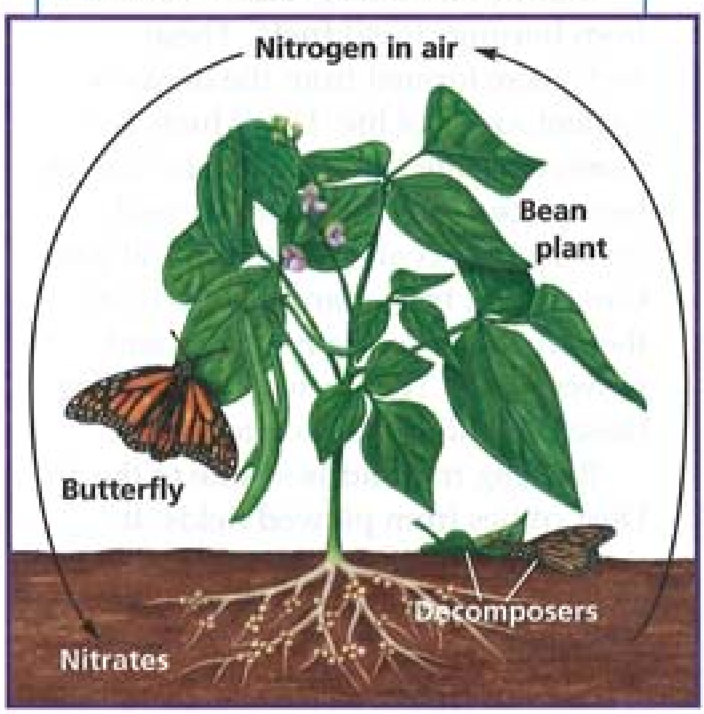
Most of the air, about 78 percent, is nitrogen. Nitrogen is an important ingredient in food, namely proteins. How does it get into proteins? Nitrogen is taken from the air by certain kinds of bacteria. These bacteria change the nitrogen into a form that stays in the soil.

Plants use this nitrogen in the soil to make proteins. As living things eat the plants, nitrogen is passed along. It is returned to the soil when living things die.

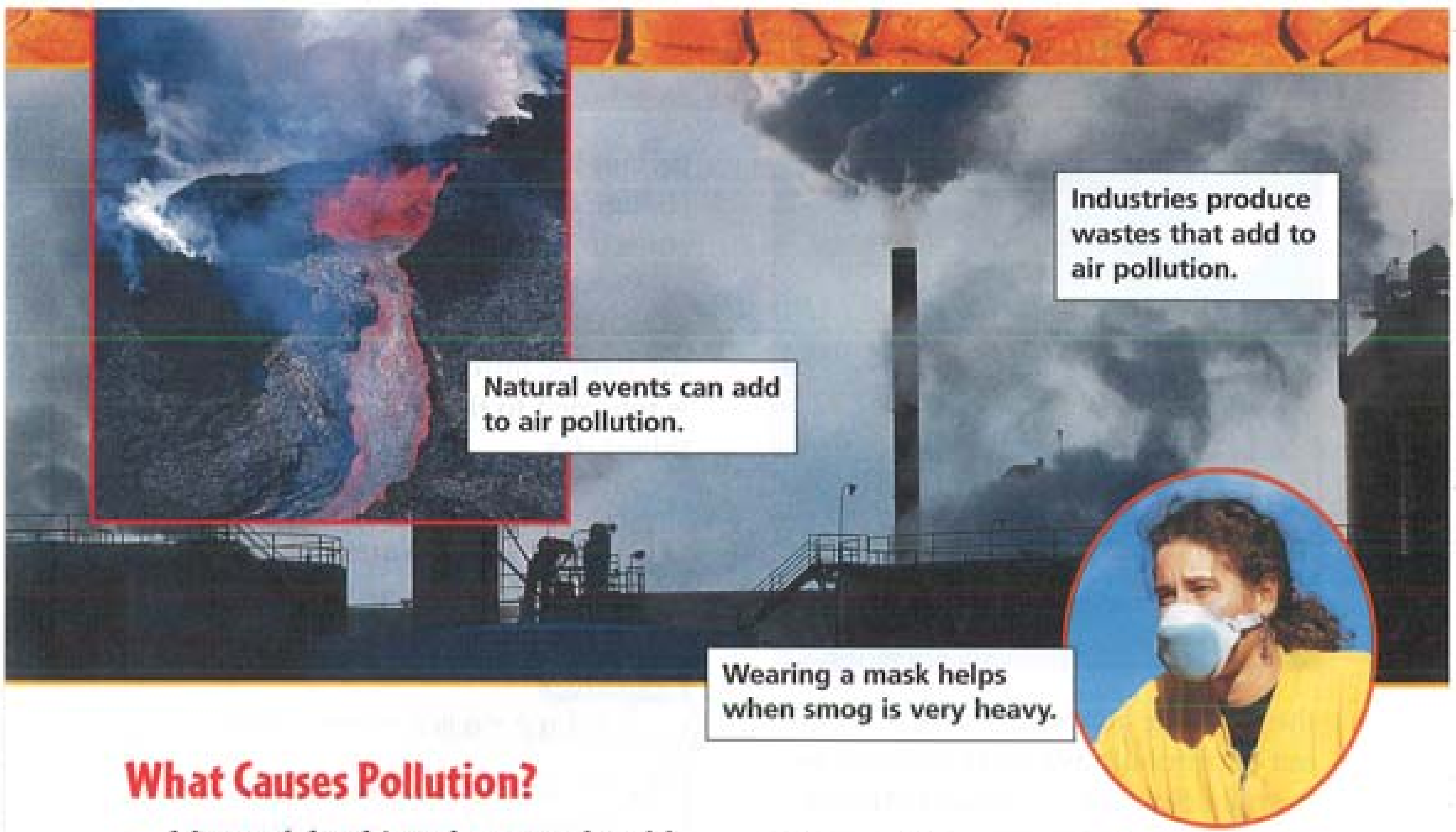
What does the atmosphere provide for living things?

READING Diagrams

1. Do you see any cycles in this diagram? Cycles are continuous processes, where one thing happens after another over and over in the same order.
2. Explain any cycles you see.



Nitrogen goes from air to plants to all living things. When living things die, nitrogen is returned to the soil.



Natural events can add to air pollution.

Industries produce wastes that add to air pollution.

Wearing a mask helps when smog is very heavy.

What Causes Pollution?

Many of the things humans do add pollution to the air. There are harmful solids, gases, and liquids in the air. Where do they come from?

Many pollutants get into the air from burning **fossil fuels**. These fuels were formed from the decay of ancient forms of life. Fossil fuels are **nonrenewable resources**. They cannot be replaced in your lifetime. Fossil fuels include coal, oil, and natural gas. Cars, buses, trucks, and planes burn these fuels, as do many homes and power plants. The wastes from burning these fuels add pollution to the air.

Burning trash adds smoke to the air. Dust comes from plowed fields. It comes from construction sites and from mines. Factories add chemical wastes to the air.

Other events also add to air pollution. Volcanoes erupt and shoot gases and particles into the air. Forest fires and grass fires can spread smoke over great distances.

All these pollutants can build up into thick clouds called **smog**. Smog is a mixture of smoke and fog. It forms when smoke and fumes collect in moist, calm air. Smog irritates the eyes, nose, and throat. People with breathing problems have died from heavy smog.

Smog hangs like a brown cloud over many cities. Why do you think it is most common in big coastal cities like Los Angeles?

Sometimes ozone can form in smog. High up in the atmosphere, remember, ozone protects Earth from UV radiation. However, at ground level this gas can make people sick.

What are five sources of air pollution?

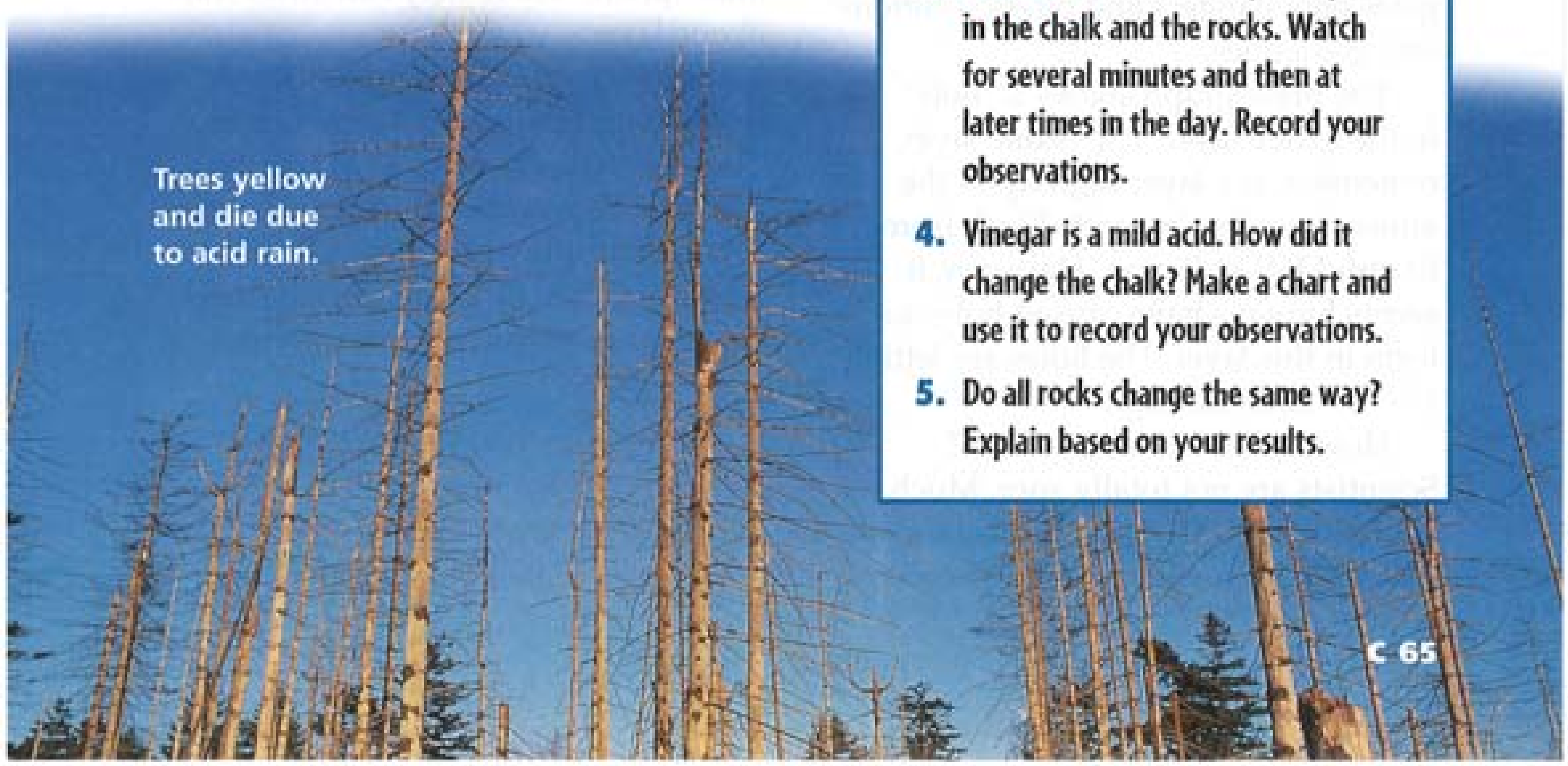
What Is Acid Rain?

What can destroy forests, kill animals and plants in lakes, and even eat away at buildings? Part of the answer comes from power plants that burn coal to produce energy. Another part comes from motor vehicles that burn gasoline.

Wastes that come from burning these fossil fuels travel into the air. In the air the wastes mix with moisture. They can form chemicals called acids in the moisture. The moisture with acids can eventually fall to Earth's surface as **acid rain**. This term includes all forms of precipitation—rain, snow, hail, and sleet.

Acid rain can harm soil and water supplies. Some trees sicken and die if there is too much acid in the soil. Fish die when water in lakes contains too much acid. The acid weathers away statues and buildings. It can cause metal surfaces on cars to crumble.

READING **Draw Conclusions**
Why is acid rain harmful?



Trees yellow and die due to acid rain.

QUICK LAB

Acids

FOLDABLES Make a Four-Column Chart. (See p. R 44.) Label as shown.

Your teacher will give you a stick of chalk and some rock samples.

Sample	Observation
Chalk	
Rocks That Change	
Rocks That Do Not Change	

BE CAREFUL! Wear goggles.

1. **Use Variables** Break a stick of chalk into smaller pieces. Place some small pieces in a plastic cup. Place each rock sample in its own cup. Slowly pour vinegar into each cup to cover each object.
2. Cover each cup using plastic wrap and a rubber band to help keep the vinegar from evaporating.
3. **Observe** Watch for any changes in the chalk and the rocks. Watch for several minutes and then at later times in the day. Record your observations.
4. Vinegar is a mild acid. How did it change the chalk? Make a chart and use it to record your observations.
5. Do all rocks change the same way? Explain based on your results.

How Can We Clean Up the Air?

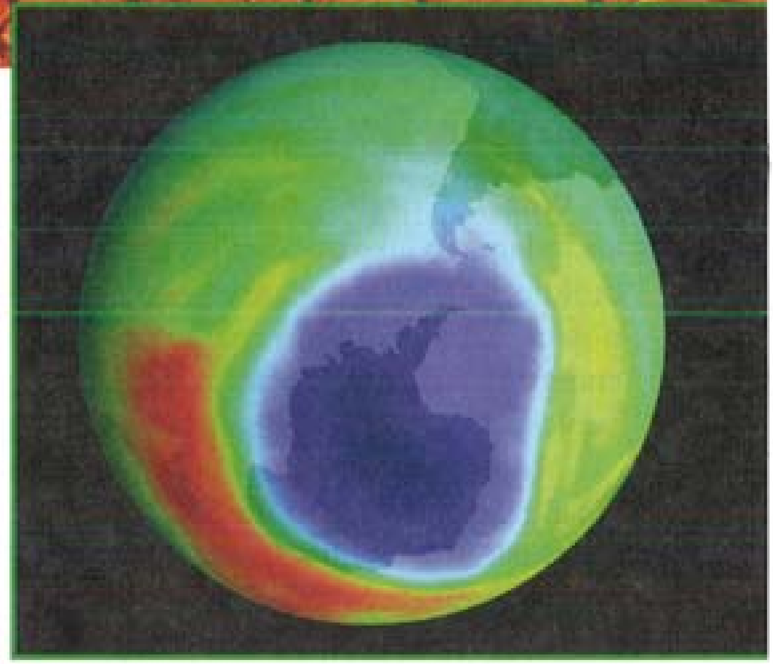
Cleaning up the air is a job that all nations must work on. That is why the Congress of the United States passed laws to protect the air. It passed the Clean Air Act in 1967 and added more parts in 1970, 1977, and 1990.

As a result of these laws, cars now release lowered amounts of harmful wastes. "Clean coal" methods were introduced to lower the amount of harmful wastes that result in acid rain. Power plants that burn coal can wash coal before burning it, to remove sulfur. Sulfur can result in acid rain when the coal burns.

In 1970 the first Earth Day was celebrated. People were becoming very concerned about the health of planet Earth. That year the Environmental Protection Agency (EPA) was formed. The EPA is part of the United States government. It has the job of checking that laws are being followed. It investigates new dangers and offers solutions and guidelines.

The photograph shows a "hole" in the ozone layer. The ozone layer, remember, is a layer high up in the atmosphere that protects Earth from harmful UV radiation. However, it seems humans have caused holes to form in this layer. The holes are letting UV radiation through.

How did the holes get there? Scientists are not totally sure. Much evidence points to certain substances that have been widely used. These substances are called CFCs, which is short for chlorofluorocarbons (klawr·oh·floor·oh·KAHR·buhnz). They are gases used in such things as refrigerators, freezers, and air conditioners. CFCs were also used in many aerosol spray cans. Spray paints, hair sprays, and even shaving foams released CFCs. When the CFCs leak out from these products, they rise into the atmosphere. There they can affect the ozone layer.



Satellite image shows a "hole" in Earth's ozone layer

In 1990 a group of representatives from around the world met in London. They signed an agreement to ban the use of CFCs worldwide in just ten years.

Aerosol spray cans now use substitutes for CFCs. Just read the label on a spray can, and you can see for yourself.

What are some ways we can reduce air pollution?

Lesson Review

Why It Matters

Air pollution harms trees, lakes, and buildings. It can also affect you directly. Air pollution can make people sick. It can make your eyes and nose feel like they are burning. It can make your throat feel itchy and irritated.

Laws help to protect the air. However, it takes people to save the air. The Clean Air Act can work only if people work together. For example, using less electricity can save fuel. Finding ways to cut down on using cars saves fuel, too. Cutting down on burning fuel lowers air pollution.

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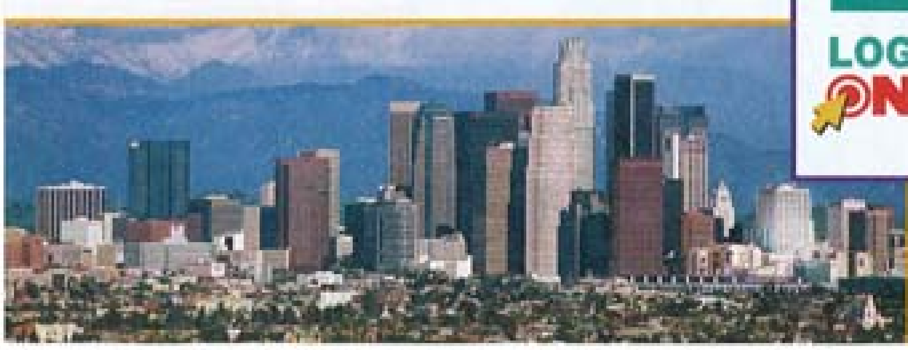
Think and Write

1. Why is air important to living things?
2. How does the atmosphere protect Earth?
3. How do people pollute the air?
4. What causes acid rain? How does acid rain affect land and water?
5. **Critical Thinking** How can using less electricity cut down on the use of fossil fuels?



L·I·N·K·S

LITERATURE LINK

Read *The Greenhouse Effect and Earth* to learn about how Earth's gases affect its temperatures. Try the activities at the end of the book.

MATH LINK

Plot data. Air samples are graded by how many parts per million (ppm) of various pollutants they contain. Watch the news and note the air quality each night for a week. Show the range of air quality and the average air quality in your community by plotting the data on a number line.

WRITING LINK

Explanatory Writing How can you cut down on using electricity and fuel? Think about all the things that you and your family can do. Make a list. Use your list to write an essay about how you can save energy.

SOCIAL STUDIES LINK

Conduct research. Research the Clean Air Act using the Internet or an encyclopedia.

TECHNOLOGY LINK

LOG ON Visit **www.science.mmhschool.com** for more links.

Clean Watersheds, Clean Water

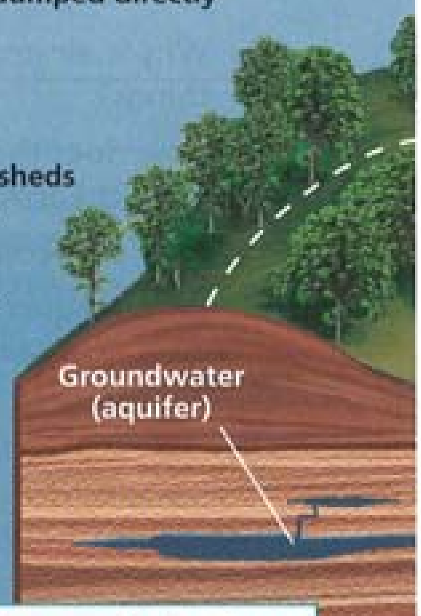
Keeping our water clean is a big job—from making sure our drinking water is safe, to protecting the fish and other animals that live in lakes and rivers. How do we do this? One way is to monitor our watersheds.

What's a watershed? It's an area of land that drains into a single stream or river. The boundary of each watershed is formed by a ridge or a mountain. When rain or snow falls on a mountain, it trickles down the mountainside into streams. Streams flow downhill and merge into a river.

The United States has 18 major watersheds. The Mississippi River Watershed extends across one-third of the United States. Each watershed includes the land the water runs through and everything on the land—from towns to farms and factories.

Since rain falls everywhere and must drain somewhere, the community each of us lives in is part of a watershed. Everyone who lives in a particular watershed shares the water that drains through it. So our activities play a big role in the quality of water downstream from us. What watershed do you live in? How can you help keep your water supply clean?

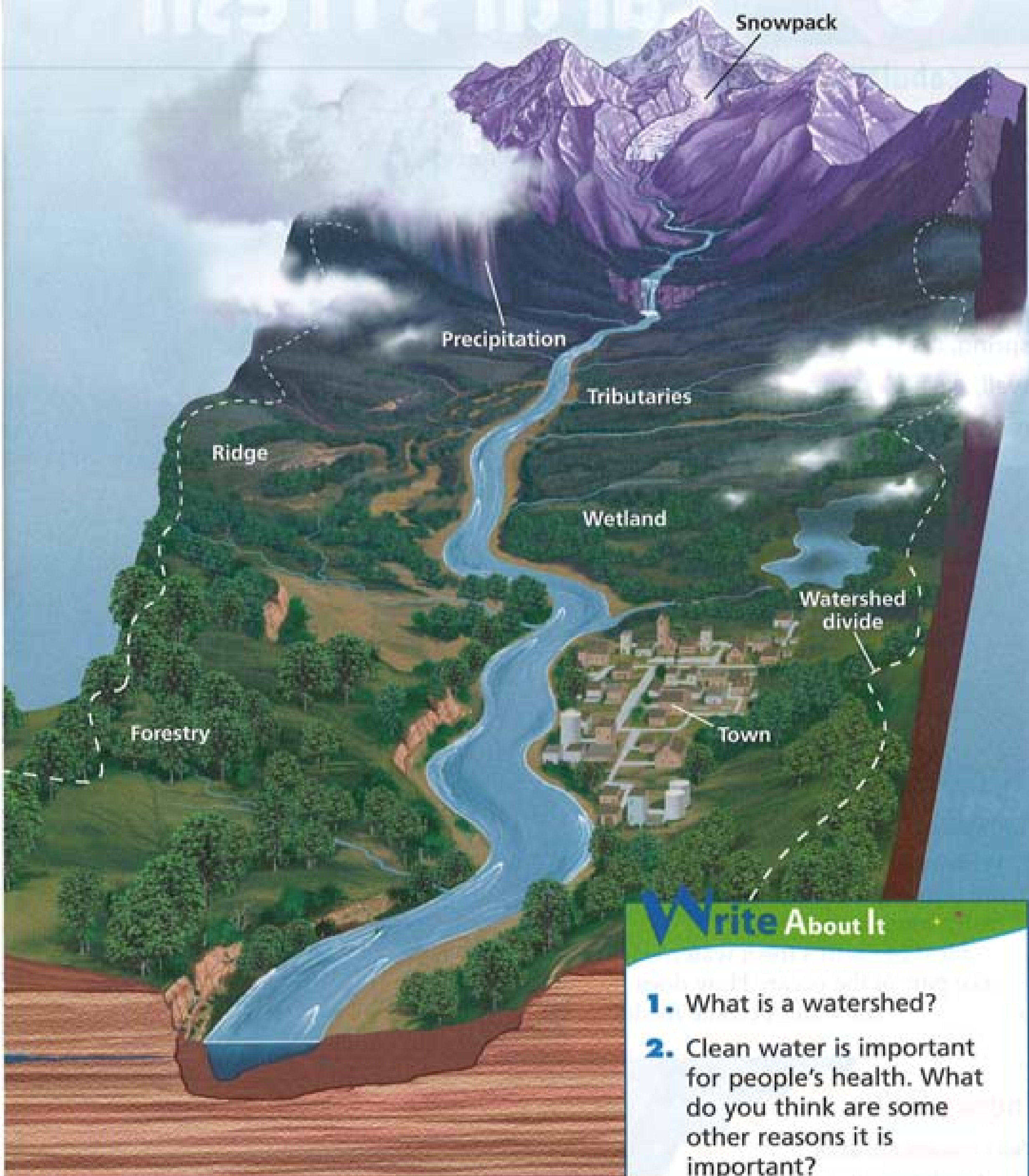
Before the Clean Water Act was passed in 1972, waste could be dumped directly into rivers!



The boundaries of watersheds are often determined by geographical features, such as mountain ridges.

LOG ON Visit **www.science.mmhschool.com** to learn more about watersheds.

Sally Ride Science

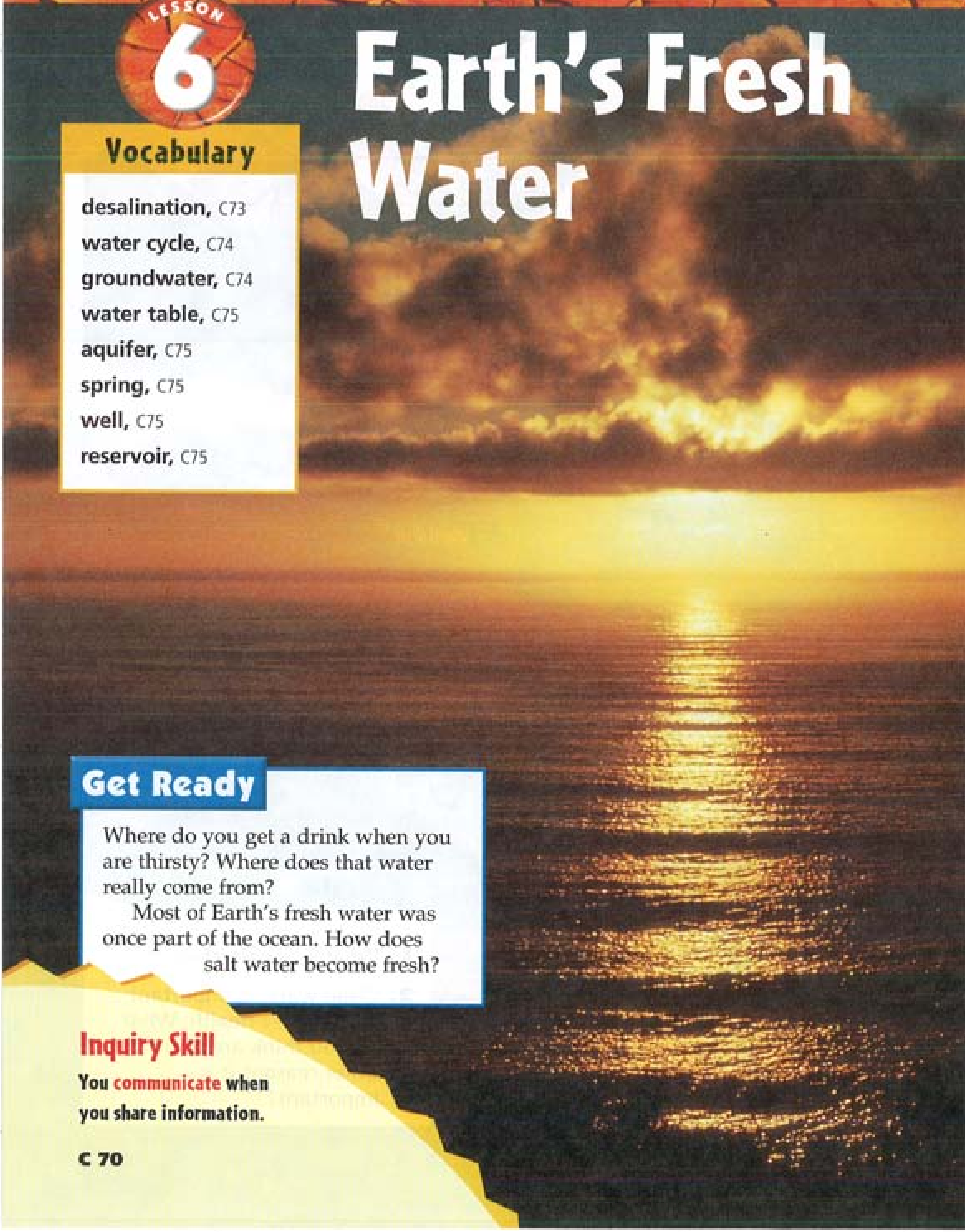


Write About It

1. What is a watershed?
2. Clean water is important for people's health. What do you think are some other reasons it is important?

LESSON 6

Earth's Fresh Water



Vocabulary

desalination, C73
water cycle, C74
groundwater, C74
water table, C75
aquifer, C75
spring, C75
well, C75
reservoir, C75

Get Ready

Where do you get a drink when you are thirsty? Where does that water really come from?

Most of Earth's fresh water was once part of the ocean. How does salt water become fresh?

Inquiry Skill

You communicate when you share information.

Explore Activity

Investigate How to Make Salt Water Usable

Materials

- tea bag
- deep pan
- plastic cup
- saucer (or petri dish)
- large, clear bowl or container
- water

Procedure

1. **Make a Model** Keep a tea bag in a cup of water until the water is orange.
2. **Make a Model** Place a pan where there is strong light (sunlight, if possible). Pour some tea water into the saucer. Put the saucer in the pan. Cover the saucer with a large bowl.
3. **Observe** Look at the bowl and pan several times during the day and the next day. Note any water you see on the bowl or in the pan. Record your observations.

Drawing Conclusions

1. How was the water that collected in the bowl or pan different from the tea water?
2. **Infer** What do you think caused the water to collect in the bowl and pan?
3. How does this model represent what might happen to salt water, the water of Earth's oceans?
4. **Use Variables** How long did it take for water to collect in the bowl and pan? How might this process be speeded up?
5. **FURTHER INQUIRY** **Communicate** Suppose you added salt to the water instead of using a tea bag. How could you tell if the salt had been removed? Try it. Might this model work as a way to get fresh water from ocean water? Explain.

Read to Learn

Main Idea **Fresh water is constantly renewed by the water cycle.**

How Do We Use Earth's Oceans?

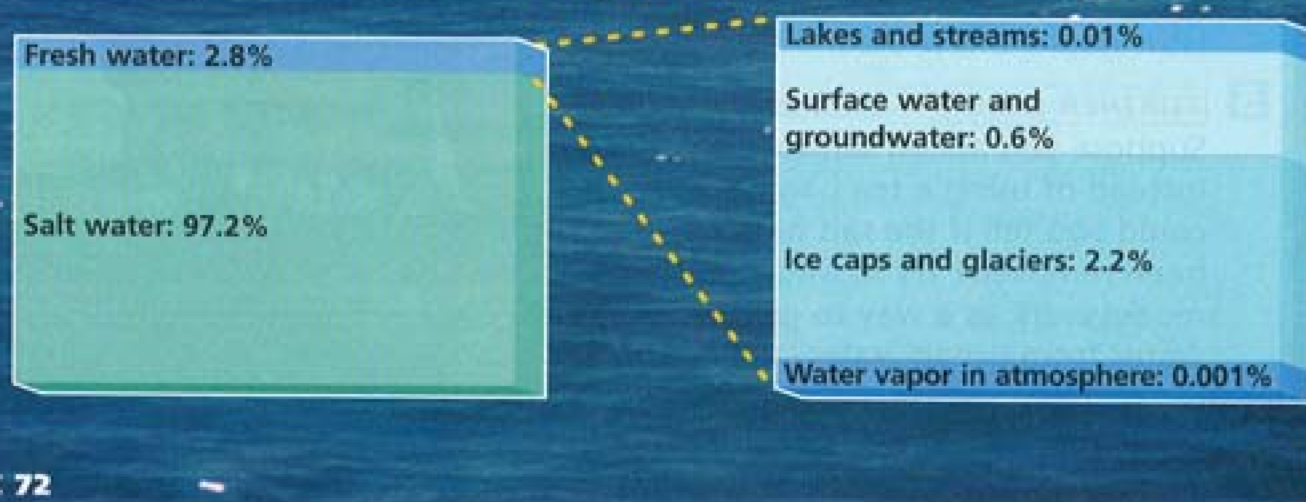
If all the water in Earth's hydrosphere was represented by 100 cents, not even 3 cents would represent fresh water. Over 97 cents would be salt water. Salt water is water in the oceans as well as saltwater lakes and inland seas.

Much of the salt in salt water is halite, common rock salt. Salt water has seven times more salt than a person can stand. A person cannot survive drinking it. However, Earth's oceans and inland seas are still useful for the resources they contain.

- **Seafood** What kinds of seafood do you eat? Why are these foods healthful? The oceans support many forms of life. The water has dissolved gases, oxygen, and carbon dioxide, as well as minerals. Plants and other producers of the sea are able to get sunlight so that they can make food. They become food for other forms of sea life, which become food for us.
- **Minerals** Almost everything dissolves in water, at least a little. A pail of seawater contains almost every known element. It contains more minerals than just rock salt.

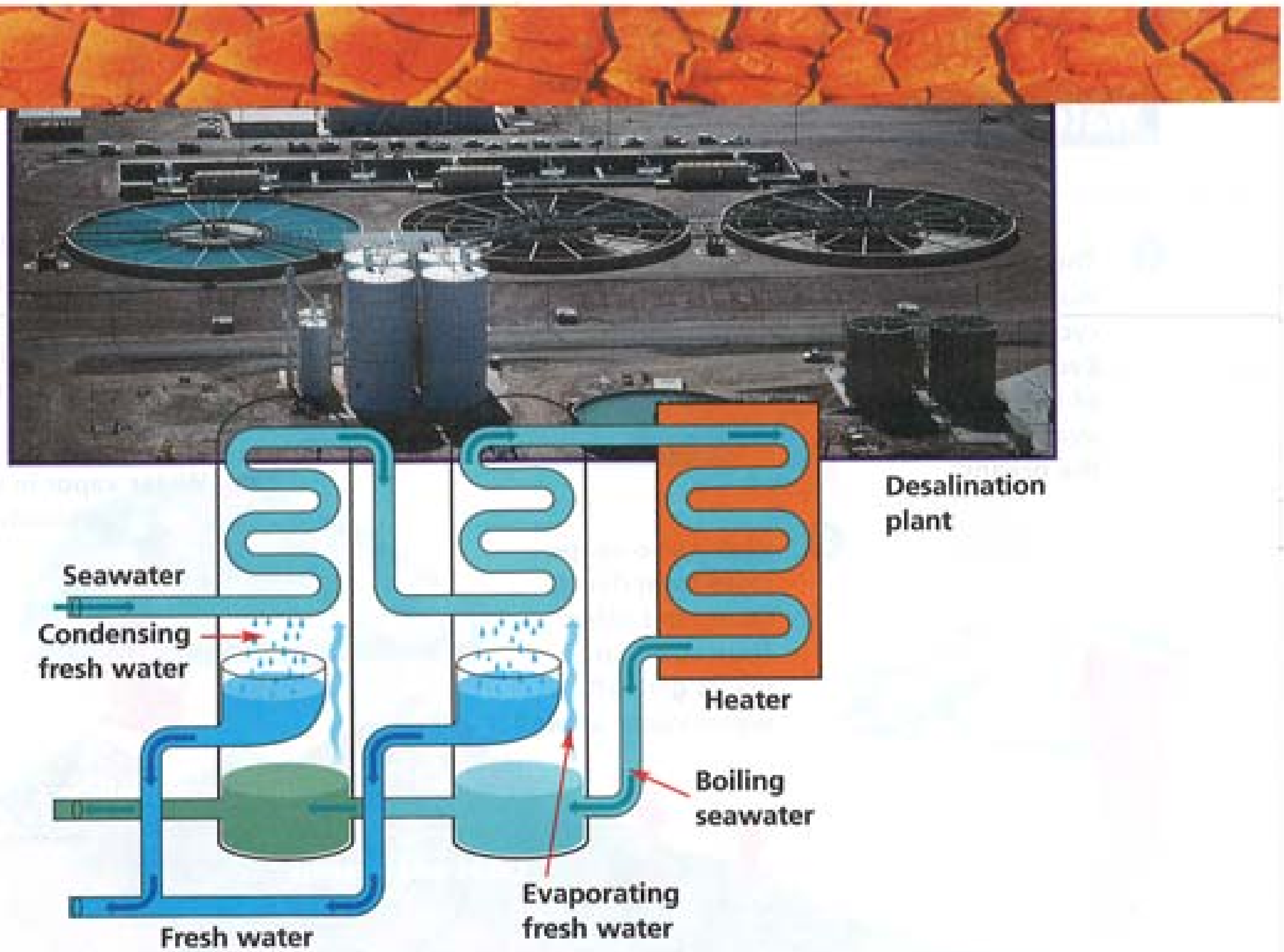
Hot water bubbling out of underwater volcanoes is especially mineral rich. It leaves rich deposits of minerals on the sea floor. Nodules, or lumps, of minerals can be picked up from the sea floor. They contain manganese and iron. Metals such as tin and gold are also found on the sea floor.

Earth's Water Supply



READING Graphs

1. Order the items in the bar graph from greatest to least.
2. Where is most of Earth's fresh water found?



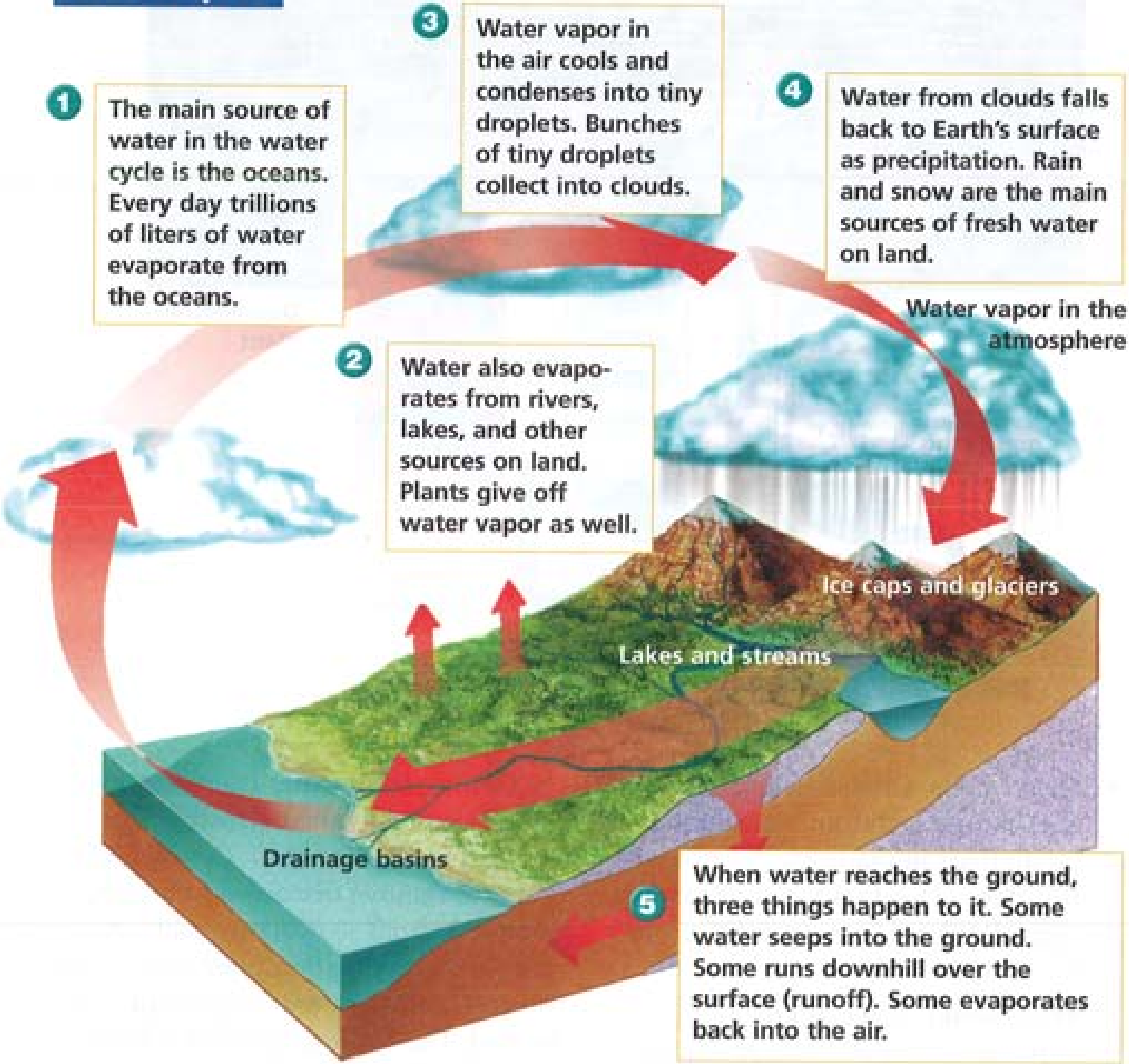
- **Fossil fuels** Offshore rigs pump oil and natural gas from beneath the ocean floor in many places around the globe. This fuel is worth more than all other resources taken from the oceans.
- **Fresh water** You can't drink seawater or use it to water plants. You need fresh water. Your fresh water comes mostly from freshwater lakes and rivers.

Some areas have very little fresh water available. The islands of Malta, for example, are surrounded by the Mediterranean Sea. However, they have no permanent lakes or rivers. Over two-thirds of the water used by people who live there comes from seawater.

Getting fresh water from seawater takes a process called **desalination** (dee·sal·uh·NAY·shuhn). Desalination helps to remove dissolved salts and materials from seawater to make it usable. A desalination plant aids in this process. Seawater entering the plant is heated. The boiling seawater is then pushed into another chamber. As water evaporates, it leaves the dissolved materials behind. The liquid water that collects at the end of the process is free of dissolved materials.

READING **Draw Conclusions**
Why are oceans a valuable resource?

Water Cycle



Where Is Fresh Water From?

Only a tiny fraction of Earth's water is usable fresh water. People use so much fresh water each day, you might wonder why it doesn't run out. Fresh water doesn't run out because it is constantly renewed by the **water cycle**.

In the water cycle, water is on the move—as a liquid that changes to a gas (water vapor) and back to liquid. When water evaporates, remember, it leaves behind the material it contained. The water vapor is not salt water.

When water falls back to Earth, where does it go? Some water seeps into the ground. It becomes **groundwater**. Groundwater seeps into the spaces between bits of rock and soil. It seeps downward until it is blocked by a kind of rock that is so tightly packed that it has few spaces.

Then the water starts to back up and fill the spaces in the soil and rocks above. The top of the water-filled spaces is called the **water table**. If the water table reaches above the surface, a pond, a lake, or a stream forms.

Ponds and lakes are still bodies of water. They form where water fills up low-lying places. Streams, however, flow downhill. As they flow, they join with other streams, becoming a river. Eventually rivers reach the oceans or other large bodies of water.

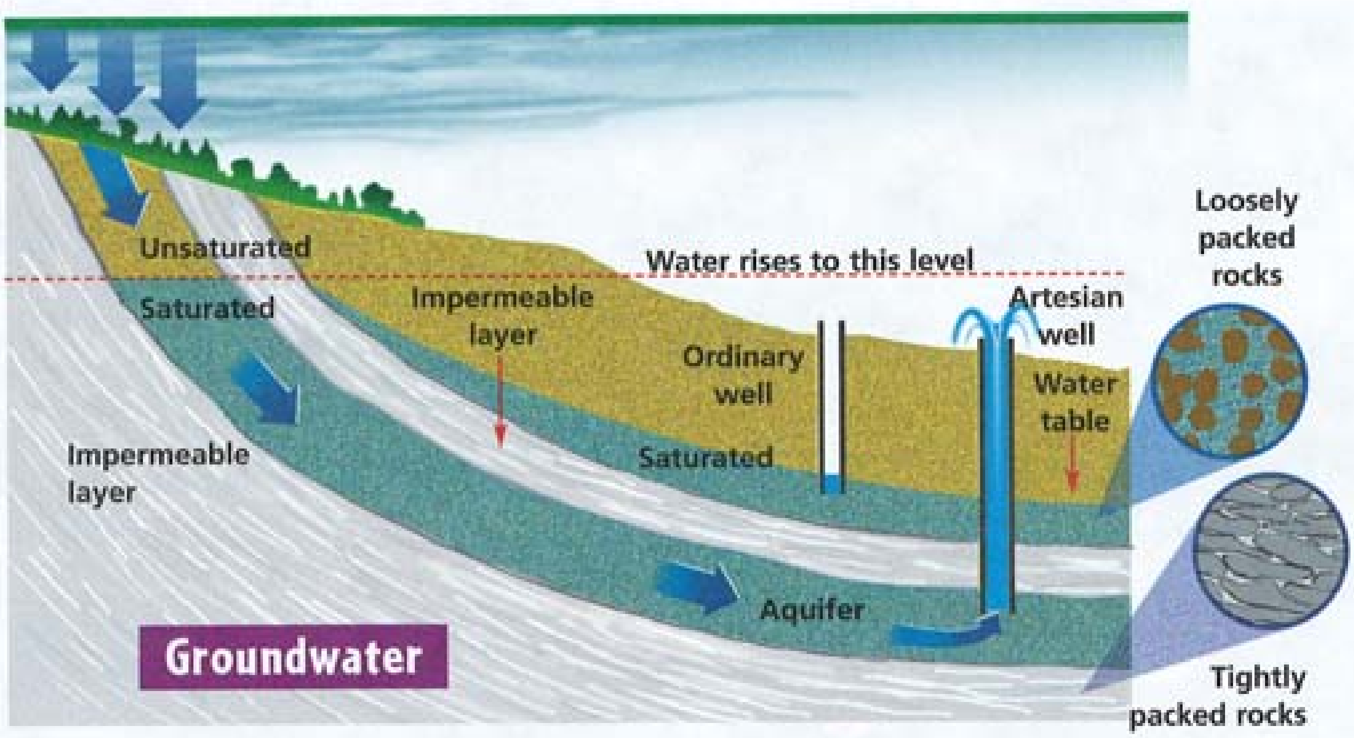
An underground layer of rock or soil that is filled with water is called an **aquifer** (AK·wuh·fuhr). Water can move through an aquifer for great distances.

Some groundwater seeps out of the ground in a **spring**. Springs occur where the water table meets the surface. They feed water into streams and lakes long after it stops raining.

Long ago people learned to tap into groundwater by digging **wells**. Wells are holes dug below the water table. The water seeps into the hole. In some wells people get the water out of the hole with pumps. Wells can also be dug deep into aquifers that are sandwiched between tightly packed layers of rock. Water spouts up in these wells because it is being squeezed by the rock layers.

Most supplies of fresh water for large towns and cities come from **reservoirs** (REZ·uhr·vwahrz). Reservoirs are storage areas for freshwater supplies. They may be human-made or natural lakes or ponds. Pipelines transport the water from reservoirs.

Why is groundwater an important part of the water cycle?



How Can Fresh Water Be Polluted?

Oceans are polluted by people dumping wastes and spilling chemicals. Fresh water can be polluted, too, in many ways.

- **Precipitation** Rain or snow may pick up pollutants from the air. Some chemicals in the air make the rain turn into an acid. Acid rain harms living things and property.
- **Runoff water** Fresh water also gets polluted as it runs off over the land. Water that runs over dumped garbage can end up in streams and lakes. In some cases garbage is dumped into rivers.
- **Groundwater** As water soaks down through the soil, it can pick up chemicals, such as pesticides.
- **Industry** Water used by industry gets polluted as it is used. For example, water that is used to help produce paper is filled with fibers and chemicals.
- **Household waste** You pollute water, too. Every time you flush the toilet, take a bath, brush your teeth, or wash dishes or clothes, water is polluted with wastes. Where do you think this water ends up?

Because of local pollution, many families use water-treatment devices in their faucets. Some families have to use bottled water for cooking and drinking.

What are four sources of water pollution?

Inquiry Skill BUILDER

SKILL **Form a Hypothesis**

How Do Wastes from Land Get into Lakes and Rivers?

In seeking an answer to a question, the first thing you might do is find out as much as possible. You make observations. You might look up information.

Next, you would think of an explanation for these observations. That explanation is a hypothesis. It may be stated as an "If . . . then" sentence. "If water runs over land where garbage is dumped, then . . ." Sometimes you can test a hypothesis by making and observing a model.

Materials

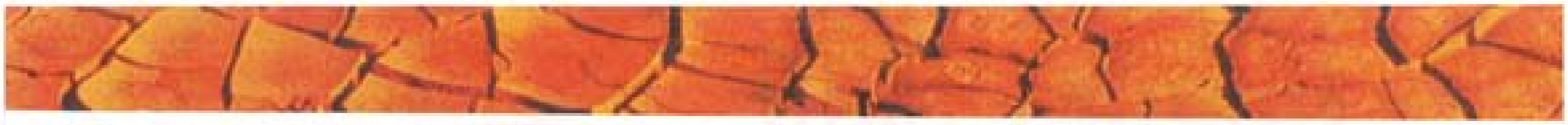
- soil
- food color
- foam bits
- 2 aluminum pans
- water
- 2 textbooks

Procedure

1. **Hypothesize** Write a hypothesis to answer the question above.
2. **Make a Model** Pack moist soil to fill one-half (one side) of one aluminum pan. As you pack the soil, add 10–20 drops of food color to the soil just below the surface. Sprinkle crumbled bits of foam over the top.
3. **Experiment** Use two books to tilt the pan with the soil side up. Place the lower edge of the soil-filled pan in the other pan. Pour water over the uppermost edge of the pan. Describe what happens. Let your model stand for some time, and observe it again.

Drawing Conclusions

1. How does this model represent wastes on land?
2. Based on the model, how do wastes from land get into water? Does the model support your hypothesis? Explain.
3. **Hypothesize** How can some wastes be removed from water? Form a hypothesis, and test your ideas.



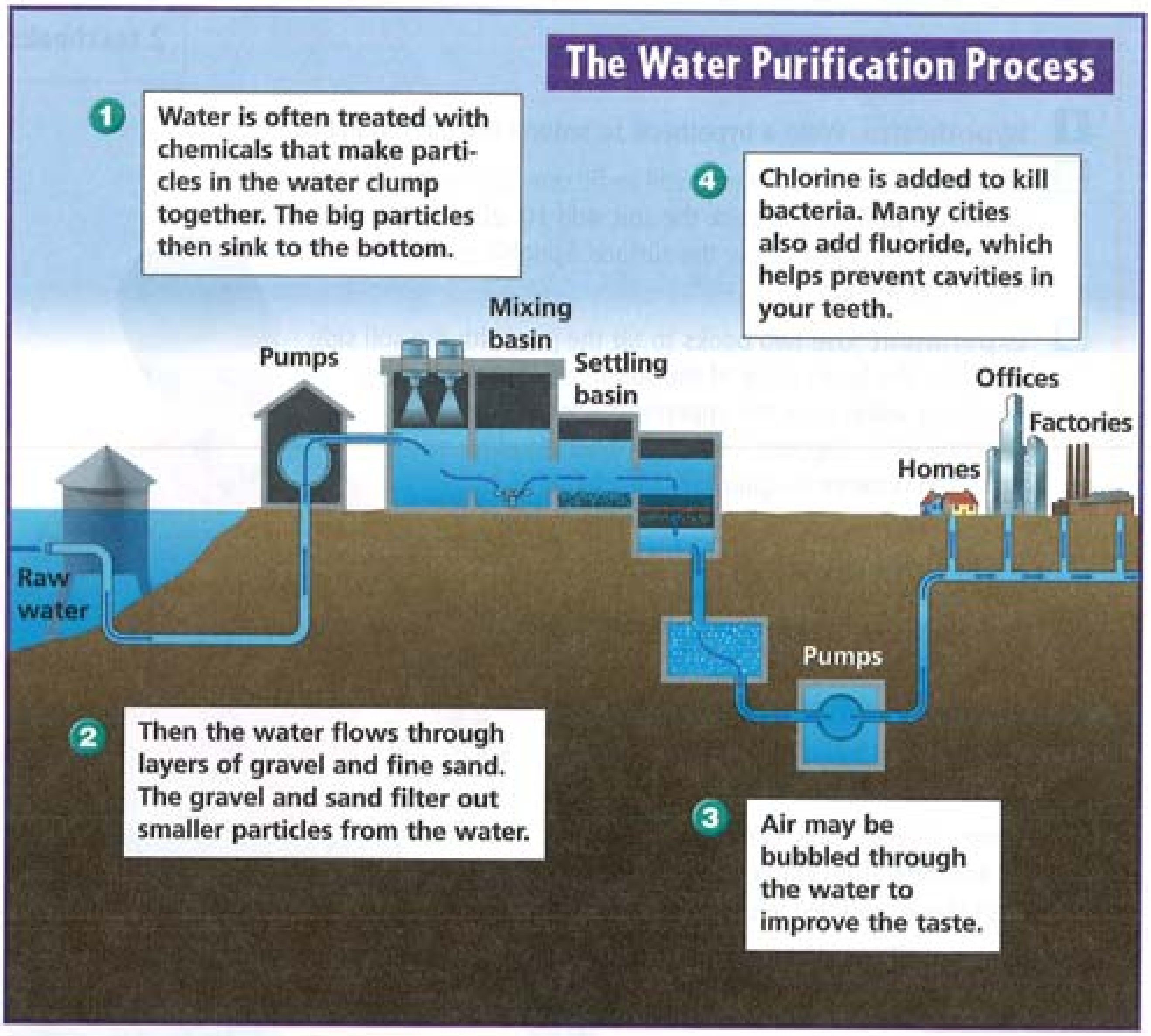
How Can We Purify Water?

Can polluted water be cleaned up? Yes, it can be—in many ways. For example, the water cycle helps clean water. Remember that when water evaporates, it leaves behind materials it contained. The water vapor and eventually the rain that forms no longer contain those materials.

When water seeps into the ground, the ground acts as a fine screen, or filter. Most dirt particles in water are trapped, or filtered out, as water seeps down through the ground. As a result, a well that is dug down deep in the ground collects water that has been filtered.

Freshwater supplies for large areas can be cleaned on a large scale. Follow the steps in the process.

What are three ways that water is purified?



Lesson Review

Why It Matters

The United States Congress has passed laws such as the Safe Drinking Water Act and the Clean Water Act. These laws set standards for water purity.

Laws are important. However, it takes people—like you—to help save water and keep it clean.

People waste fresh water more than they realize. Often water can become safely reused. At times when the rainfall is low, water supplies may become very low. Saving and recycling water should be part of your daily routine.

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Think and Write

1. How do you depend on the oceans, even if you don't live near one?
2. How can freshwater supplies be cleaned up?
3. How do wastes get into ocean water? Fresh water?
4. **Hypothesize** How does the Sun help provide you with freshwater supplies?
5. **Critical Thinking** How can you tell the amount of water wasted in a day by a leaky faucet? Find a way to tell without wasting any.

L•I•N•K•S

WRITING LINK

Persuasive Writing Sometimes without even knowing it, people waste fresh water. Write an editorial for your school newspaper. Try to convince your readers that saving and recycling water should be something they do every day.

MATH LINK

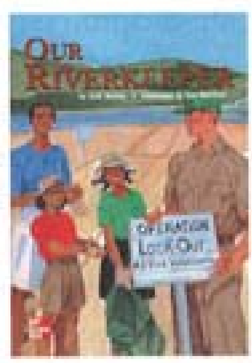
Make a graph. Graph how much water is used in different tasks.

Daily Uses of Water

Activity	Amount Used
Flushing a toilet	16–24 liters
Washing dishes	32–80 liters
Taking a shower	80–120 liters
Taking a bath	120–160 liters

LITERATURE LINK

Read *Our Riverkeeper* to learn about cleaning up polluted waters. Try the activities at the end of the book.



TECHNOLOGY LINK

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What's the Point?

When you think of pollution, you probably picture big factories pouring solid and liquid waste into rivers and dirty smoke into the air. This nasty stuff is called "point source pollution," because its source can be easily pinpointed. But every day you contribute to what's called "nonpoint source pollution," whose sources are less direct and more difficult to pinpoint. This pollution also finds its way into the air you breathe and the water you drink.

Every day, exhaust from millions of cars enters the air. Rain washes garbage, waste, and chemicals into nearby rivers, lakes, and wetlands. Fertilizer is washed off farms. Motor oil and garbage are washed down city streets. That weed killer you use in your garden runs off the lawn. City sewer systems collect some of this. Even then, leaks and overflows can add raw sewage to the water we use.

Nonpoint source pollution doesn't affect only people; it also affects wildlife. After your garden chemicals kill weeds, they may go on to contaminate water used by other plants and animals. Drastic changes in natural habitats have put over 1,000 plants and animals on the Endangered Species List.

In 1987, Congress amended the Clean Water Act to reduce nonpoint source pollution. These laws control the disposal of pollutants into the water. They also set standards for how clean different bodies of water should be. The standards depend on how the water is used. Do we swim in it? eat fish from it? Or do we drink it?

Most important, the Clean Water Act gives us the power to decide how clean the water should be. You can help make laws to keep local rivers and lakes clean. It's your water—do everything you can to protect it.

Down the drain! Urban runoff, which includes chemicals, oils, and heavy metals like lead, mercury, and zinc, drains into local water supplies.

LOG ON Visit **www.science.mmhschool.com** to learn more about pollution.

1. If you use chemicals like paints and weed killers, be sure to dispose of them properly.
2. Deforestation and agriculture let soil and natural organisms wash into local waterways and also increase flooding. These changes can hurt the local habitat.
3. Car exhaust contains nitrogen oxides that combine with water in the atmosphere to form acid rain.
4. Boats release pollutants.

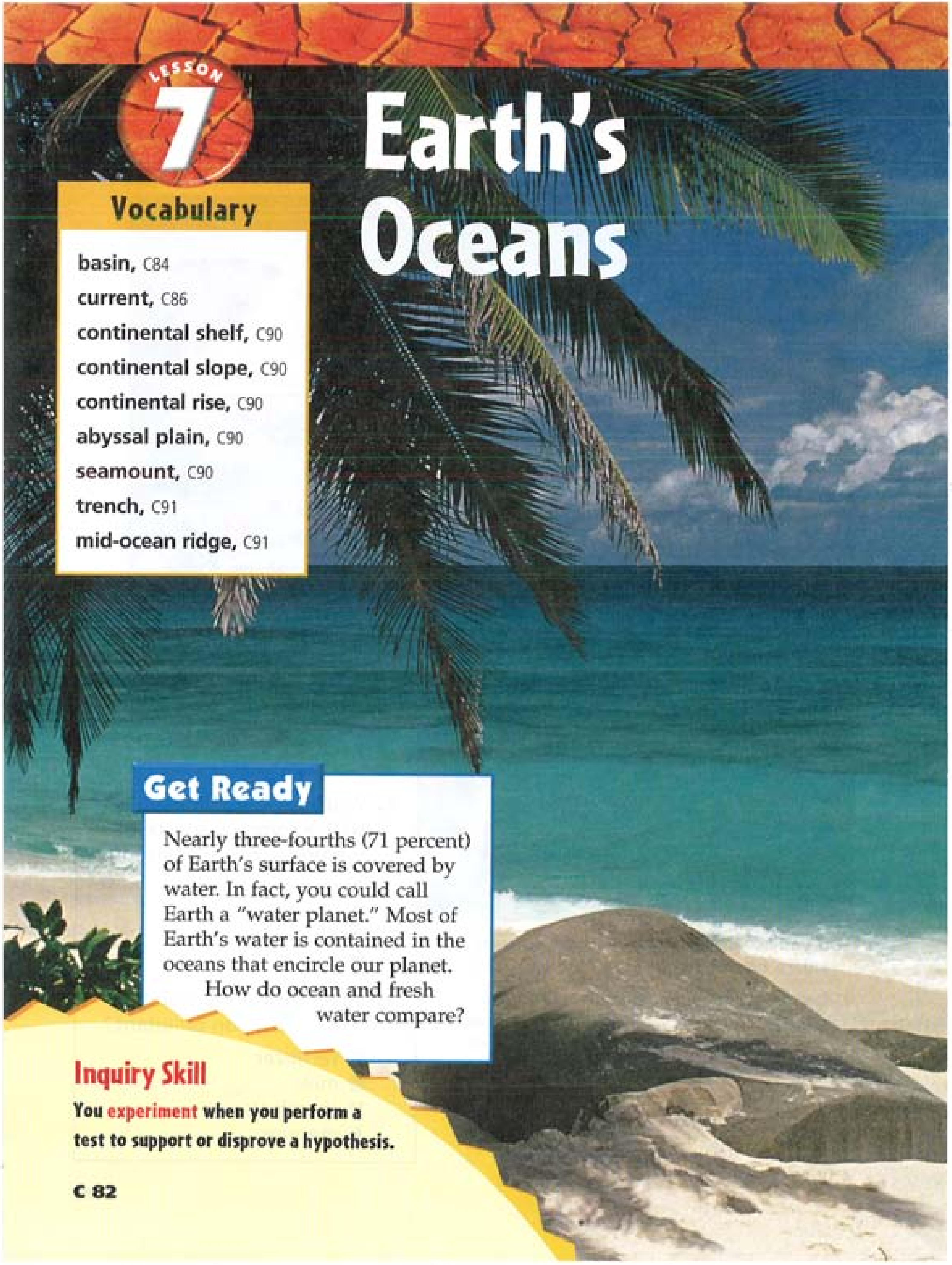
What Did I Learn?

1. Which of the following is NOT a common source of nonpoint source pollution?

A mines
B farms
C cars
D books

2. Which of the following is NOT a common pollutant?

F fertilizer
G milk
H chemicals
J manure



LESSON 7

Earth's Oceans

Vocabulary

basin, C84
current, C86
continental shelf, C90
continental slope, C90
continental rise, C90
abyssal plain, C90
seamount, C90
trench, C91
mid-ocean ridge, C91

Get Ready

Nearly three-fourths (71 percent) of Earth's surface is covered by water. In fact, you could call Earth a "water planet." Most of Earth's water is contained in the oceans that encircle our planet.

How do ocean and fresh water compare?

Inquiry Skill

You experiment when you perform a test to support or disprove a hypothesis.

Explore Activity

How Do Ocean and Fresh Water Compare?

Materials

- 3 small plastic cups
- "ocean water"
- "fresh water"
- clear-plastic straw
- waterproof marking pen
- wax paper
- ruler

Procedure

1. Spread wax paper on your desk before you begin to work.
2. **Predict** What happens when you mix fresh and ocean water?
3. **Experiment** From the bottom of the straw, make a mark every 4 cm. Gently place the bottom of the straw 4 cm under the surface of the "ocean water." Seal the top of the straw with your finger. With your finger still sealing the straw, lift it out of the water. Keeping your finger on top of the straw, place the bottom of the straw 8 cm down in the "fresh water." Lift your finger off the straw, and then put it back again and lift the straw out of the water.
4. **Observe** What happened? Record the results. Now try it again, starting with "fresh water" first. Observe and record what happens.

Drawing Conclusions

1. **Communicate** Which liquid combinations mixed in the straw and which made layers?
2. FURTHER INQUIRY **Experiment** Make a third liquid by mixing equal parts of ocean water and fresh water. How will the mixture compare to fresh and ocean water? Make your prediction, then test it.

Read to Learn

Main Idea **Ninety-seven percent of Earth's water comes from oceans. Oceans are an important natural resource.**

What Are Oceans, Seas, and Basins?

Most of Earth's water is contained in large bodies of salt water called oceans. Examples include the Atlantic and Pacific Oceans.

If all the water evaporated from the oceans, a layer of salt about 60 m (200 ft) thick would be left on the ocean floor. Not all of this salt is table salt. There are many other forms of salt, too. Where does all this salt come from?

One source is the rocks on Earth's surface. Rocks break down through weathering. Their minerals flow into streams. Eventually, the minerals end up in the ocean—more than 2,500 million tons each year.

The other source is from deep inside Earth. When volcanoes erupt, they let out water vapor and other gases. The water vapor is the major source of Earth's water. The other gases include some of the salts that are found in the ocean.

Why doesn't the ocean get saltier and saltier? Because the salts are removed as fast as they are added. Plants and animals use them as they build shells and skeletons. Other minerals fall out of the water to become part of the ocean floor.

Although you may have heard the ocean called the "sea," a sea is actually a body of water much smaller than an ocean. Some seas are part of an ocean. The North Sea, for example, is connected to the Atlantic Ocean and the Arctic Ocean, just north of Europe.

The ocean floor, or **basin**, is as varied as Earth's continents. It contains mountains, valleys, and plains.

Resources from the Ocean

As you saw in Lesson 6, the oceans are rich in natural resources. Seawater is an important source of minerals. To obtain these minerals, people use the heat of the Sun to evaporate water. The minerals left behind are then harvested.

Some resources, such as oil, natural gas, and coal, lie beneath the ocean floor. Drilling rigs, such as the one shown, are used to extract oil and natural gas from beneath the sea.

The ocean's living creatures are also a valuable resource. People use fish, crabs, and squid for food. They eat

From space it is easy to see that 71 percent of Earth's surface is covered by water. Oceans contain valuable resources such as fish and oil.

some kinds of seaweed. A product made from seaweed, *carrageenan,* is used as an ingredient in everything from toothpaste to ice cream.

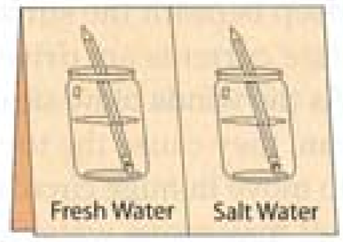
Other resources are too difficult for us to take from the ocean at this time. For example, certain parts of the ocean floor are covered with lumps called nodules. These nodules contain manganese, iron, and other useful minerals. Gold is an example of a mineral that is dissolved in ocean water. However, we do not yet know how to mine these minerals economically.

What are oceans like?

QUICK LAB

Salt Water, Fresh Water

FOLDABLES Make a Two-Tab Book. (See p. R 41.) Label the tabs as shown.



1. Fill a jar with fresh water to about 1 cm from the top. Carefully push a thumbtack into the center of the eraser of a pencil.
2. **Observe** Place the pencil, eraser side down, in the water. Let go. Record what happens.
3. **Measure** Mark the pencil to show where the water line is. Measure and record the length of the pencil above the water mark.
4. Fill the jar with salt water. Repeat steps 2–3. Record your results. Compare with your results for fresh water.
5. **Predict** What do you think will happen if you add a tablespoon of salt to your salt water? Test your prediction.

What Causes Ocean Currents?

Ocean waters are constantly pushed around the planet by currents. A **current** is a stream of water that flows through the ocean like a river. Some currents are on the surface. Others move deep beneath the surface.

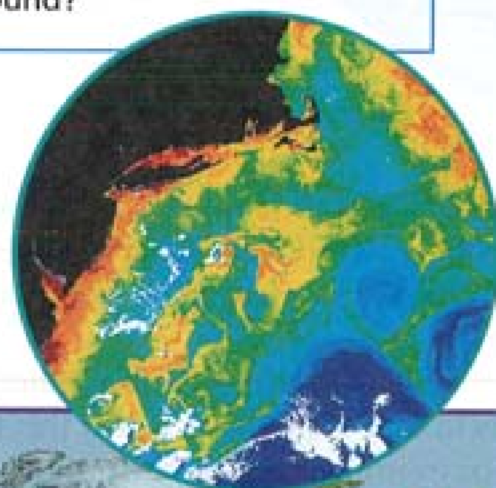
Surface currents are driven by the wind. As the winds blow steadily across the ocean, they cause the top layer of water to move in huge circular patterns. A current may move water hundreds of kilometers through the ocean.

Earth's rotation also affects surface currents. As Earth rotates, it pulls great masses of water on the surface along with it. This causes currents to bend to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The currents start flowing in huge circles.

Surface currents move at a speed of about 220 km (137 mi) a day. Some of these currents are huge. A surface current may move water hundreds of kilometers through the ocean and may carry more water than the Amazon River.

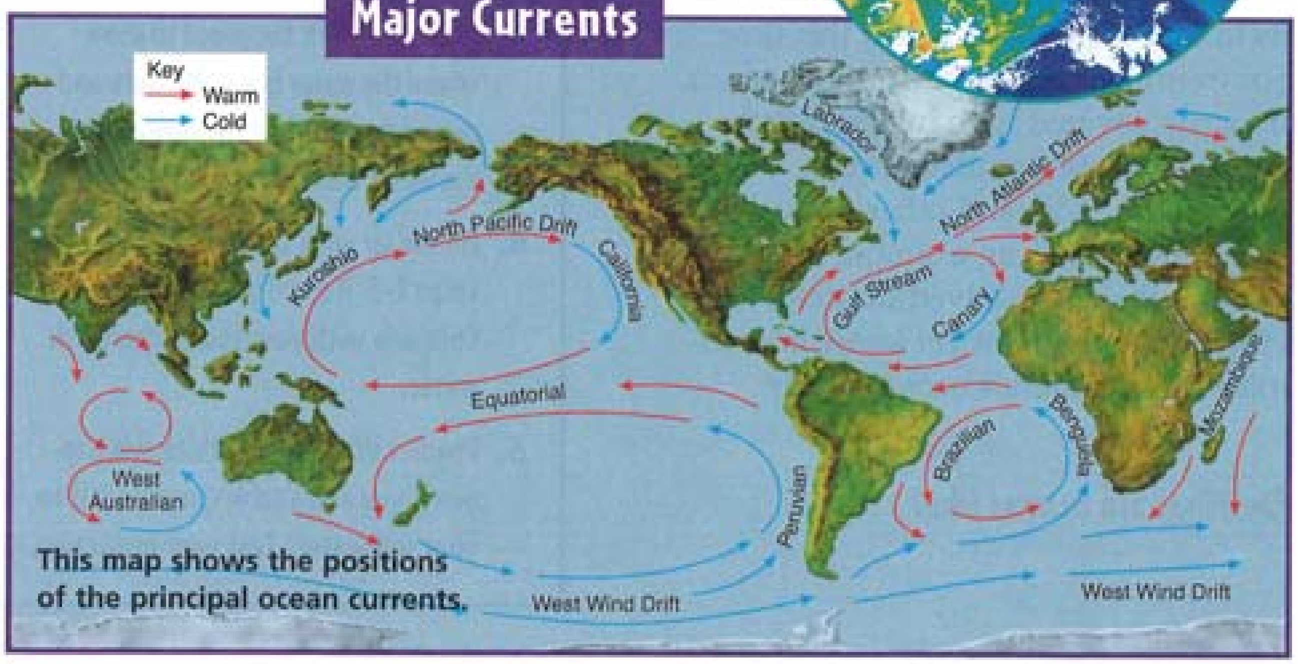
READING Maps

What if you enclosed a message in a bottle and dropped it in the ocean off the California coast? Where might the bottle be found?

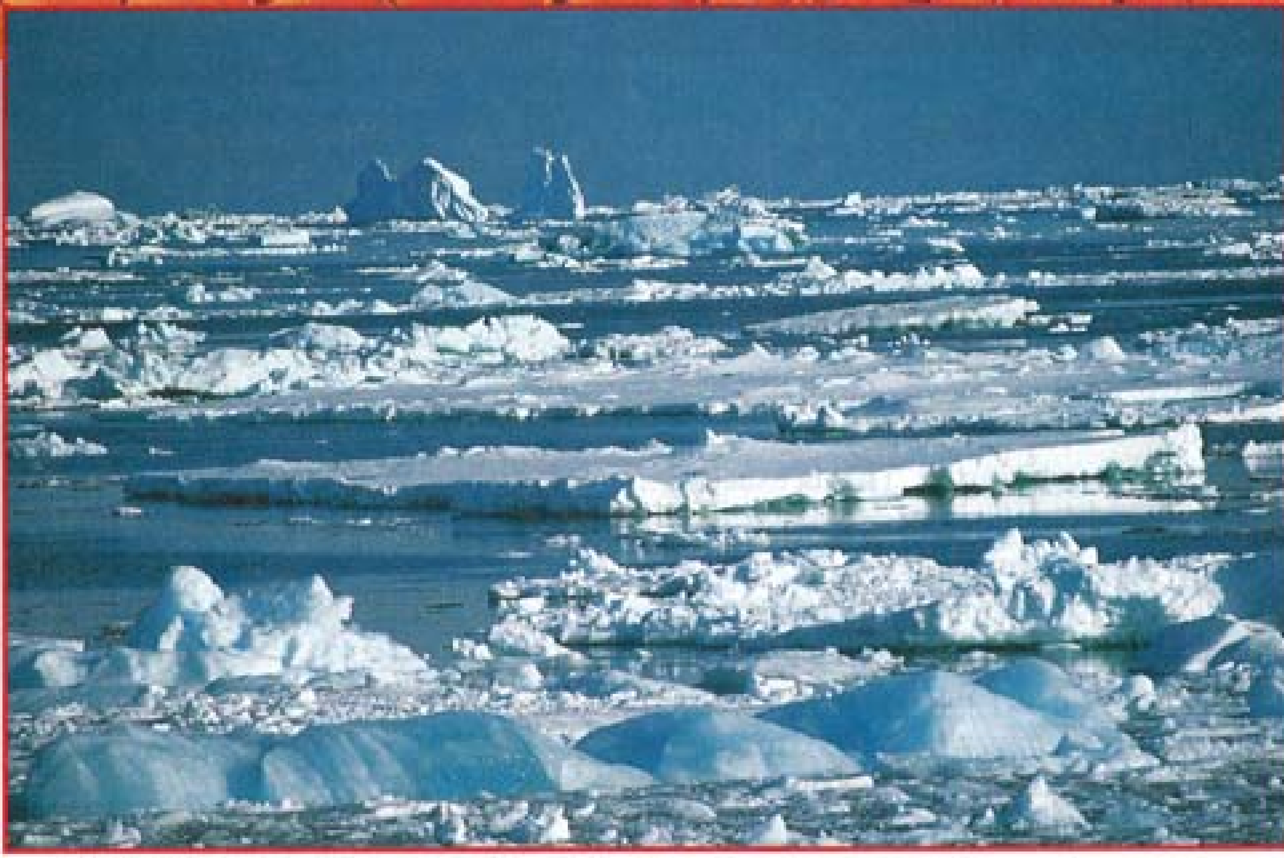


The Gulf Stream is a surface current that begins near the equator and flows north past the United States, bringing warm waters to the eastern coast. What causes surface currents like the Gulf Stream?

Major Currents



This map shows the positions of the principal ocean currents.



As ocean water freezes, the salts do not become part of the ice. The remaining water becomes saltier, causing it to become more dense. It begins to flow to the bottom of the ocean.

As ocean currents flow along the edges of continents, they affect the land's climate. The California current carries cold water along the West Coast of our country, helping it to stay cool there. On the East Coast, the Gulf Stream keeps the climate warm.

Deep-water currents move far beneath the ocean. They are set in motion by differences in the temperature and saltiness of water.

Near Earth's poles, water at the surface of the ocean loses heat to the atmosphere. It may also become saltier as water is removed by evaporation or freezing. This colder, saltier water is *denser* than the water below it. It slowly sinks toward the ocean bottom. The less dense water below flows in to replace it closer to the surface.

In this way, a deep-water current is set up. The water in a deep-water current moves much slower than the water in a surface current—just a few meters a day.

Dense water forms mainly in Antarctica and in the North Atlantic Ocean. From there the water sinks and spreads slowly outward toward the equator. The water may not resurface for another 500 years.

What are three ways an ocean current may form?

How Does the Water in a Wave Move?

Have you ever watched a toy boat bobbing on the surface of a lake or ocean? As the waves go by, the boat moves up, around, down, and then back. It returns to almost the same position where it started. This is exactly what happens to the water particles in waves—they move in circles.

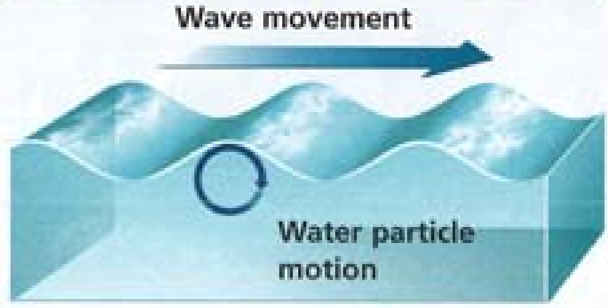
All waves carry energy from place to place. In the ocean the winds blow across the surface, passing energy to the water. The energy of a wave moves forward across the water, but not the water particles themselves. As a wave passes through the ocean, each water particle moves in a circle, returning to almost its original position.

As the winds blow across the ocean, they also drag the water forward slightly, causing the surface currents you read about on page C86. However, most of the energy passes through the water as waves, as shown in the illustration above.

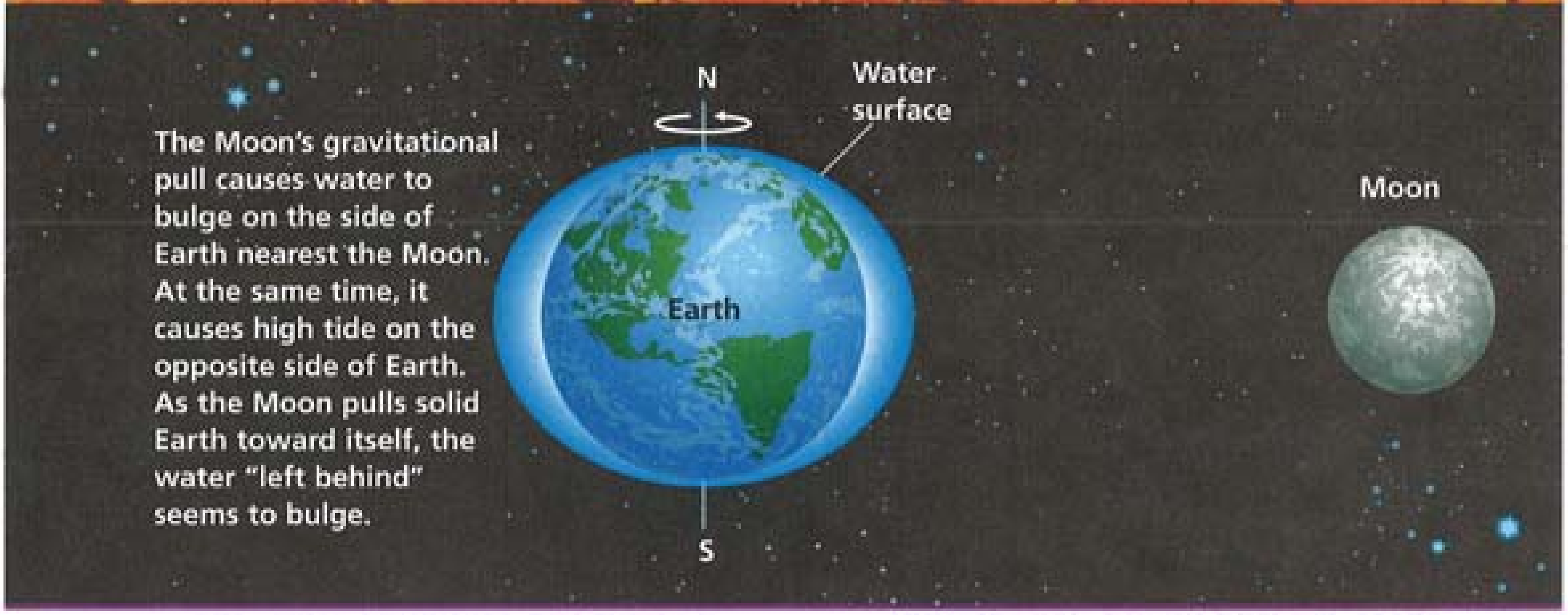
When a wave approaches the shore, it begins to slow down. At the same time, it gets higher. The tall wave reaches a point where it collapses, or breaks, against the shore.

The force of breaking waves can be very powerful. Each wave may hurl thousands of tons of water against the shore, breaking rocks apart and smoothing the fragments into pebbles and sand.

How Water Moves in a Wave



What is the motion of water particles as a wave passes through water?

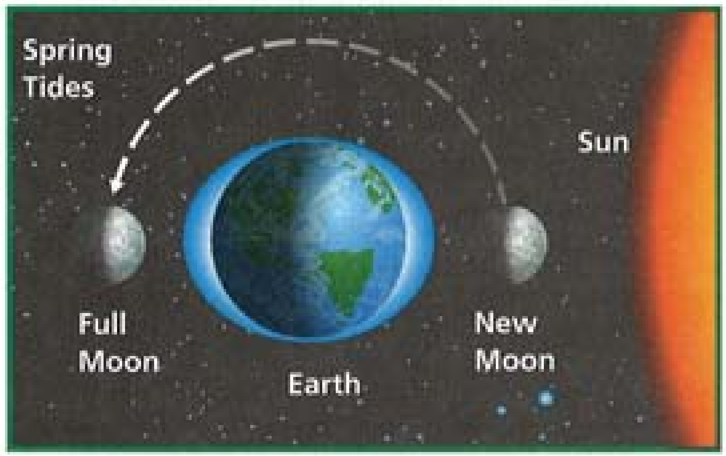


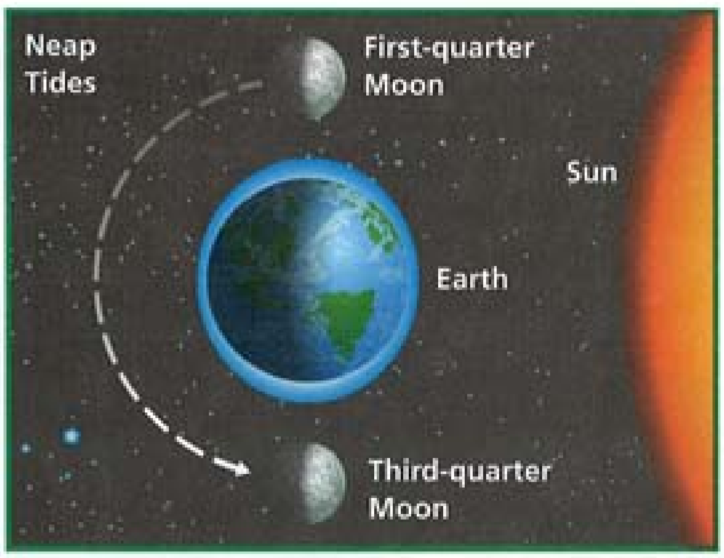
What Causes the Tides?

People living along the coasts are familiar with the rise and fall of the ocean's surface, called the *tide*. Tides result from the pull of the Moon's and the Sun's gravity on Earth. Although the Moon is much smaller than the Sun, it is also much closer to Earth. It is the Moon that has the greatest effect on the tides.

The Sun also influences the tides. However, it is so far away that it has less than half the pull of the Moon. About twice a month, near the times of new and full Moons, the Sun and the Moon line up. Their combined pull causes the highest high tides and lowest low tides, called *spring tides*.

The tides with the smallest range, called *neap tides*, occur between spring tides. During a neap tide, the Moon and the Sun are at right angles to Earth, and their pulls partly cancel each other.





READING **Drawing Conclusions**

What are tides the result of?

What Is the Ocean Floor Like?

If you could ride in a submarine from the shore of the Atlantic Ocean out to its deepest part, you would see a varied landscape of mountains, valleys, and plains. As you left the shore, your trip would start above the **continental shelf**, the underwater edge of a continent. It extends from the shore to a depth of about 200 m (600 ft) and has a gentle slope.

About 80 km (50 mi) out from the shore, the land would slope steeply down. You would now be above the **continental slope**. The continental slope leads from the continental shelf toward the sea floor. It is steeper, deeper, and narrower than the shelf.

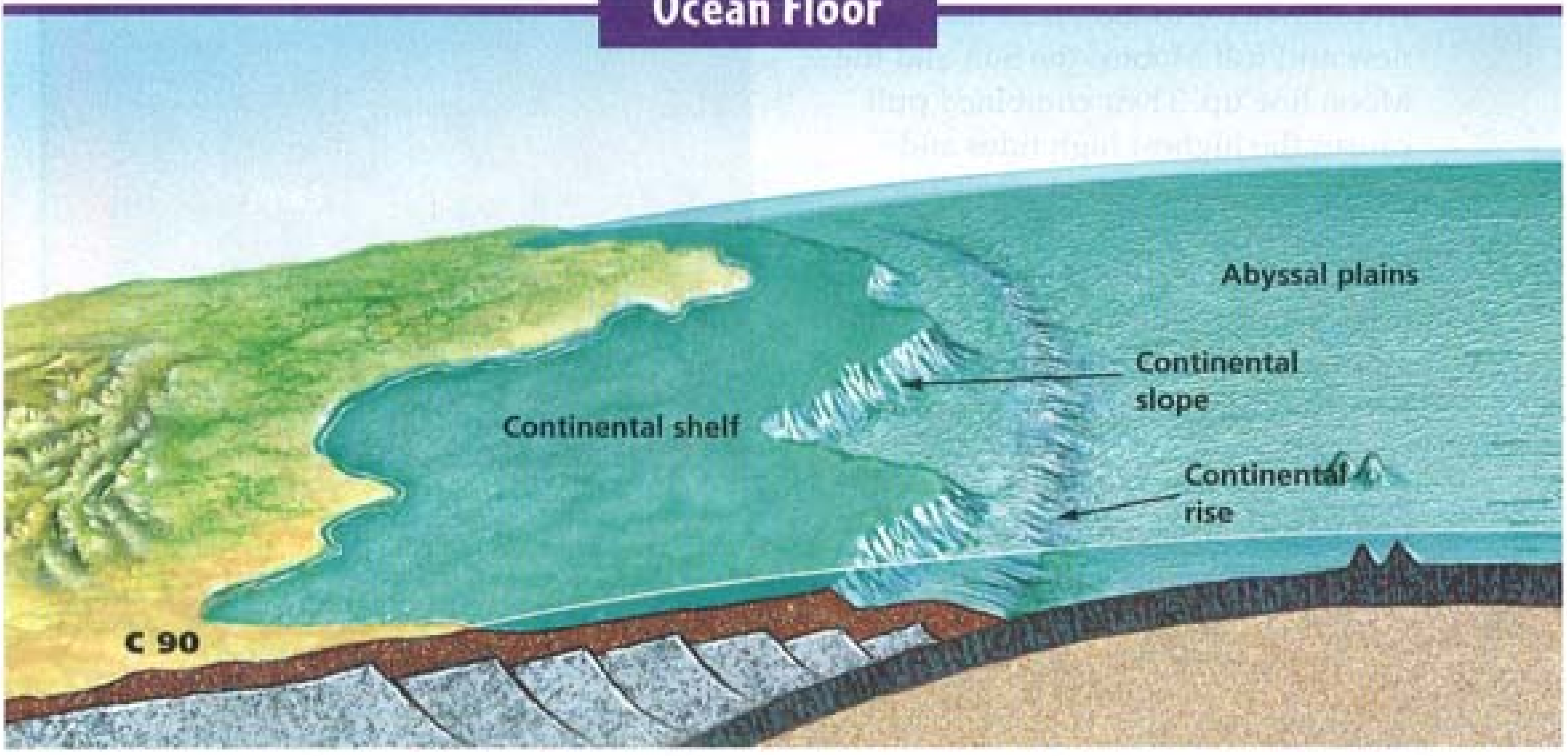
After traveling another 20 km (12.4 mi) out into the ocean, you would find yourself above the **continental rise**. The continental rise is a buildup of sediment on the sea floor at the bottom of the continental slope. It is a zone of sand and mud that stretches from the slope down to the deep-sea floor.

At the end of the continental rise, you would reach one of the flattest places on Earth—the **abyssal** (uh·BIS·uhl) **plain**. Most of the hills and valleys at the bottom of the ocean were buried under a layer of sand and mud long ago. This created the level abyssal plains. These vast, flat lands cover almost half of the deep ocean floor.

As your trip continued across the abyssal plain, you might come to a huge underwater mountain called a **seamount**. The peak of a seamount rises thousands of meters above the ocean floor. A seamount is a volcano. It is formed in the same way as a volcano on land—hot molten rock from inside Earth rises to the surface and cools to a solid.

A seamount may never cross the surface of the ocean. However, if it

Ocean Floor



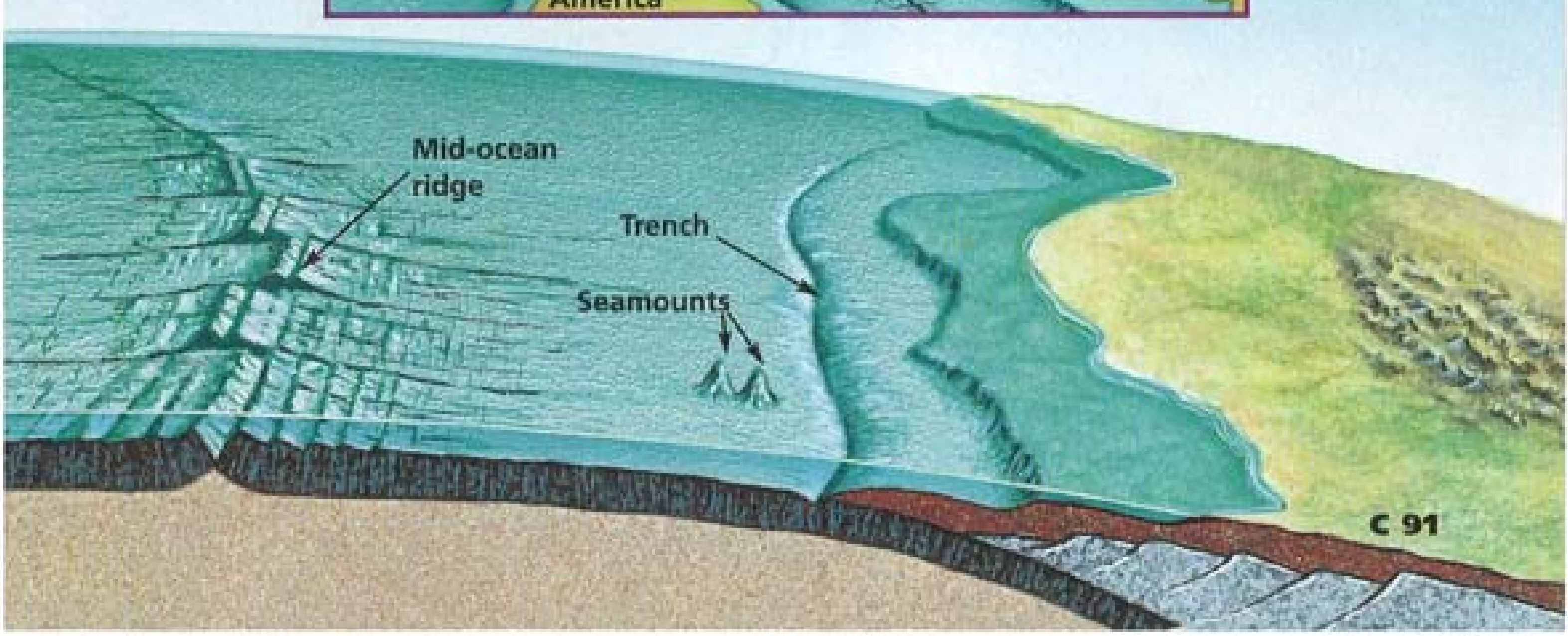
grows large enough, it may emerge as an island. The Hawaiian Islands are an example of a chain of seamounts.

As your travels continued, your submarine might come to a long, narrow V-shaped valley known as a **trench**. Deep-sea trenches are the deepest points on Earth. They plunge as far down as 8,000–10,000 m (5–6 mi) below sea level. One is more than 11,000 m (7 mi) deep. If you could put the tallest mountain on Earth—Mount Everest—in the trench, its tip would still be about 2,000 m (1.25 mi) below the ocean surface.

The trenches are too deep beneath the ocean to ever see the sunlight. They are pitch black and freezing cold. Your submarine couldn't dive to the bottom of a trench—the pressure of the water above is so great that it would crush a normal submarine.

As you reached the middle of the Atlantic Ocean, you would see a mountain range rising above the ocean floor. This is known as the mid-Atlantic ridge. It is part of the chain of mountains, called **mid-ocean ridges**, that winds its way through all the world's major oceans. The mid-Atlantic ridge runs the entire length of the Atlantic Ocean. Like seamounts, these mountain ranges were formed by molten rock that cooled and hardened.

What are some of the features of the ocean floor?



How Do We Explore the Oceans?

Today ocean scientists explore the oceans using a variety of techniques. One of the first breakthroughs in technology came in the 1920s, when sonar equipment was invented. Sonar helps scientists map the ocean floor. Sonar instruments give out sound waves that hit the ocean floor and send back echoes. The echoes are recorded. Their pattern is traced on paper to make a "sound map" of features like underwater mountains and trenches.

The ability of people to move about underwater was aided by the invention in the 1940s of scuba (*s*elf-*c*ontained *u*nderwater *b*reathing *a*pparatus). Scuba was invented by Jacques Cousteau and Emile Gagnan. For the first time, divers had their own air supply.

A diver wearing scuba gear can explore the ocean to about 50 m. After that, the water pressure is too great for the human body to handle safely.

Starting in the 1960s, scientists began using deep-diving research vessels called *submersibles* to explore the ocean. They can go much deeper than a diver can go. Using submersibles like *Alvin*, scientists have found a new world deep beneath the sea. They have studied new

The *Titanic*

animals like tube worms. Submersibles also helped locate and explore the ocean liner *Titanic*. The ship lies on the Atlantic floor almost 4,000 m (2.5 mi) below the surface.

Satellites are yet another way to study the ocean. Satellites can measure surface temperature, wave height and direction, sea level, currents, sea ice, and levels of marine plant life. This information can be used in different ways. For example, patterns in ocean temperatures and currents can be used to predict the weather. Satellites can also monitor ocean pollution.

Deep-sea drilling is also used to study the ocean. Research vessels collect samples from beneath the sea floor. The sediment gathered allows scientists to understand how the oceans have changed over time.

Sea-Floor Vents

In 1977 scientists in a submersible traveled deep below the ocean to one of the mid-ocean ridges. They were there to study hot springs called *sea-floor vents*. These vents are formed when seawater trickles down into the hot, newly formed oceanic crust. The water becomes saturated with minerals. Eventually, it boils out of a vent in the crust.

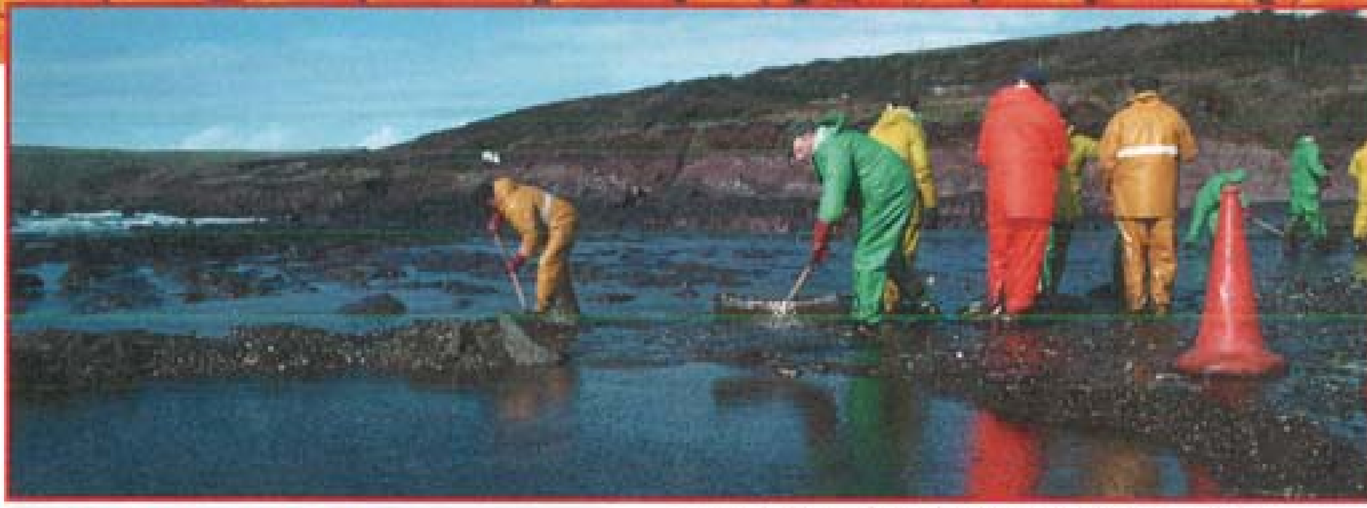
To the scientists' amazement, large wormlike animals were waving in the water near some of the vents. They named the animals *tube worms*. Tube worms get nourishment from bacteria living inside them. The bacteria, in turn, use the hydrogen sulfide and oxygen taken in by the worms to create nutrients through a process called *chemosynthesis* (kee·moh·SIN·thuh·sis).

Tube worms are found deep beneath the ocean near vents in the ocean floor. How can tube worms get nutrients in these deep, dark waters?

Recall that photosynthesis is the food-making process in green plants that uses sunlight. Never before had scientists seen a food chain that did not rely on photosynthesis for energy and food. Instead, the bacteria–tube worm food chain gets its food and energy from the mineral-rich waters and the heat energy from the hot vents.

Since that first discovery, more than 400 species new to science have been found living in and around sea-floor vents.

What are some of the ways that today's scientists explore the oceans?



People can help clean up polluted waters.

How Do People Affect the Oceans?

The oceans have a tremendous ability to absorb human waste. Unfortunately, at some point the pollution becomes too much for the water to handle. Marine pollution has become a serious problem for the world's oceans.

Each year sewage, waste from factories, and fertilizers and other farm wastes are dumped into rivers that flow into the sea or into the ocean itself. Ships may spill oil or dump sewage overboard. Offshore drilling for oil and natural gas also harms the environment.

Ocean pollution can harm or kill marine animals and plants. It is also dangerous to people who eat seafood from the polluted waters.

Overfishing is another threat to marine animals. People around the world depend on fish and marine animals, such as crabs and lobsters, for food. According to the United Nations Food and Agriculture Organization, 70 percent of the fish species caught to be sold are being overfished. If this continues, entire species may die out.

What are some of the ways that people affect the ocean environment?

A factory fishing boat is a huge boat where thousands of fish at a time can be caught, cleaned, and quick frozen. How might such a boat contribute to overfishing?

Lesson Review

Why It Matters

Oceans provide many valuable resources. Most of the world's nations are now aware of the need to protect their coasts and water from pollution. They have begun to enforce laws to keep sewage, chemicals, and other waste out of the water.

Many countries limit the number of fish that can be caught in their waters. Many governments have also set aside protected areas in their waters where marine animals can live undisturbed.

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on the oceans.

Think and Write

1. What resources are found in oceans?
2. Where do the oceans' salts come from?
3. How does the water in waves move? In currents?
4. What does the ocean floor look like?
5. **Critical Thinking** In the Indian Ocean, there are seasonal wind shifts known as the summer and winter monsoons. What do you think happens to the surface currents when the winds change direction? Explain.

L·I·N·K·S

MATH LINK

Compare ocean depths. The deepest region in the Atlantic Ocean is the Puerto Rico Trench. It is over 8,600 m deep. The deepest region in the Pacific Ocean is the Mariana Trench. It is more than 11,000 m deep. About how much deeper is the Mariana Trench than the Puerto Rico Trench?

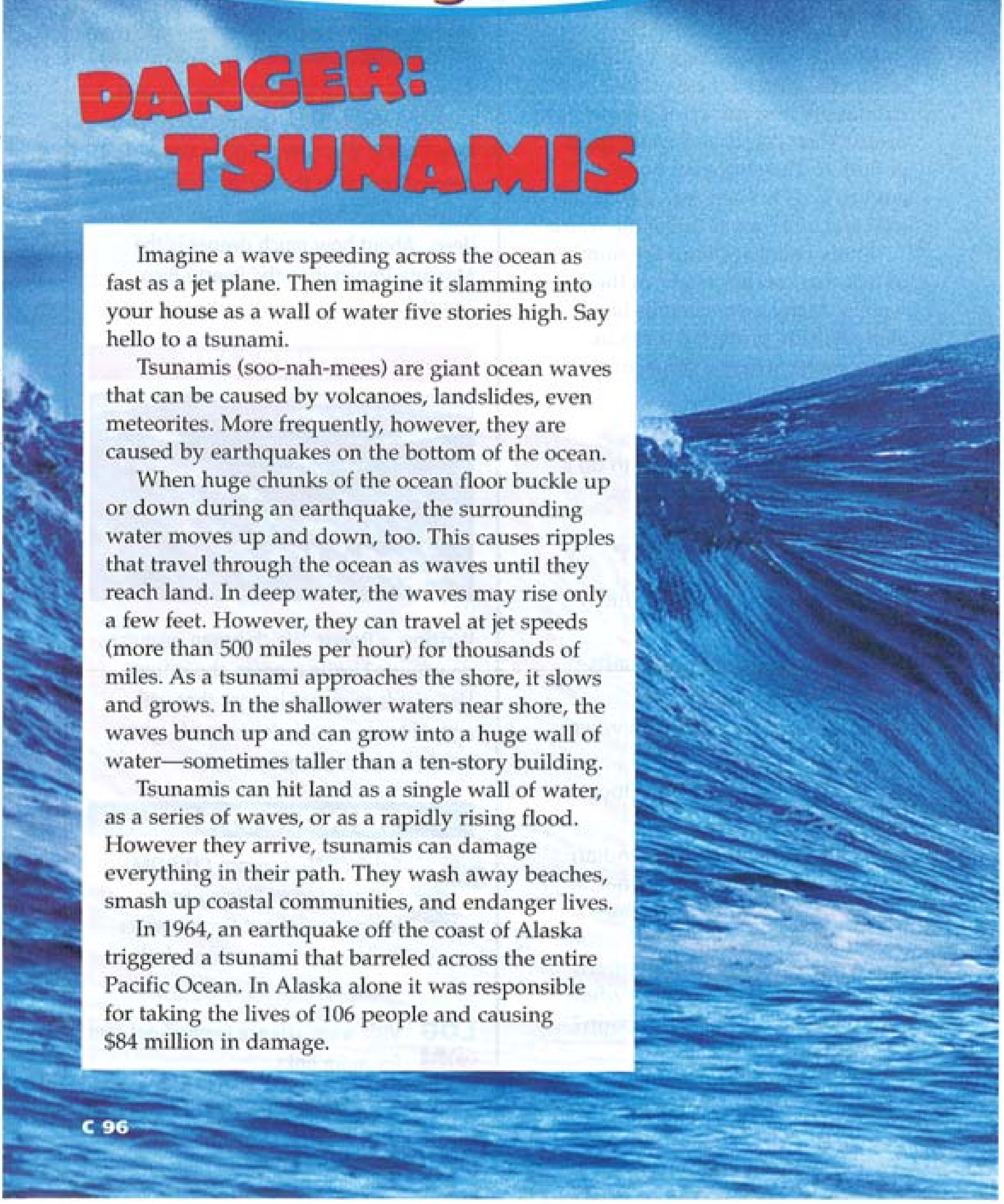
WRITING LINK

Writing a Poem Which ocean resources do you use? Write a poem about them. Use words to create images that will appeal to your reader's sense of sight, touch, taste, hearing, or smell.

TECHNOLOGY LINK

Science Newsroom CD-ROM Choose *Sea to Shining Sea* to learn more about Earth's water and how it moves through the water cycle.

LOG ON Visit **www.science.mmhschool.com** for more links.



DANGER: TSUNAMIS

Imagine a wave speeding across the ocean as fast as a jet plane. Then imagine it slamming into your house as a wall of water five stories high. Say hello to a tsunami.

Tsunamis (soo-nah-mees) are giant ocean waves that can be caused by volcanoes, landslides, even meteorites. More frequently, however, they are caused by earthquakes on the bottom of the ocean.

When huge chunks of the ocean floor buckle up or down during an earthquake, the surrounding water moves up and down, too. This causes ripples that travel through the ocean as waves until they reach land. In deep water, the waves may rise only a few feet. However, they can travel at jet speeds (more than 500 miles per hour) for thousands of miles. As a tsunami approaches the shore, it slows and grows. In the shallower waters near shore, the waves bunch up and can grow into a huge wall of water—sometimes taller than a ten-story building.

Tsunamis can hit land as a single wall of water, as a series of waves, or as a rapidly rising flood. However they arrive, tsunamis can damage everything in their path. They wash away beaches, smash up coastal communities, and endanger lives.

In 1964, an earthquake off the coast of Alaska triggered a tsunami that barreled across the entire Pacific Ocean. In Alaska alone it was responsible for taking the lives of 106 people and causing $84 million in damage.

The seaport town of Seward, Alaska, received heavy damage from a 1964 tsunami. It prompted the formation of the Alaska Tsunami Warning Center. The Center quickly alerts towns of any threats of tsunamis.

Write About It

1. How do tsunamis in the deep ocean differ from those approaching shore?
2. How can damage from tsunamis be reduced?

LOG ON Visit **www.science.mmhschool.com** to learn more about tsunamis.

LESSON 8

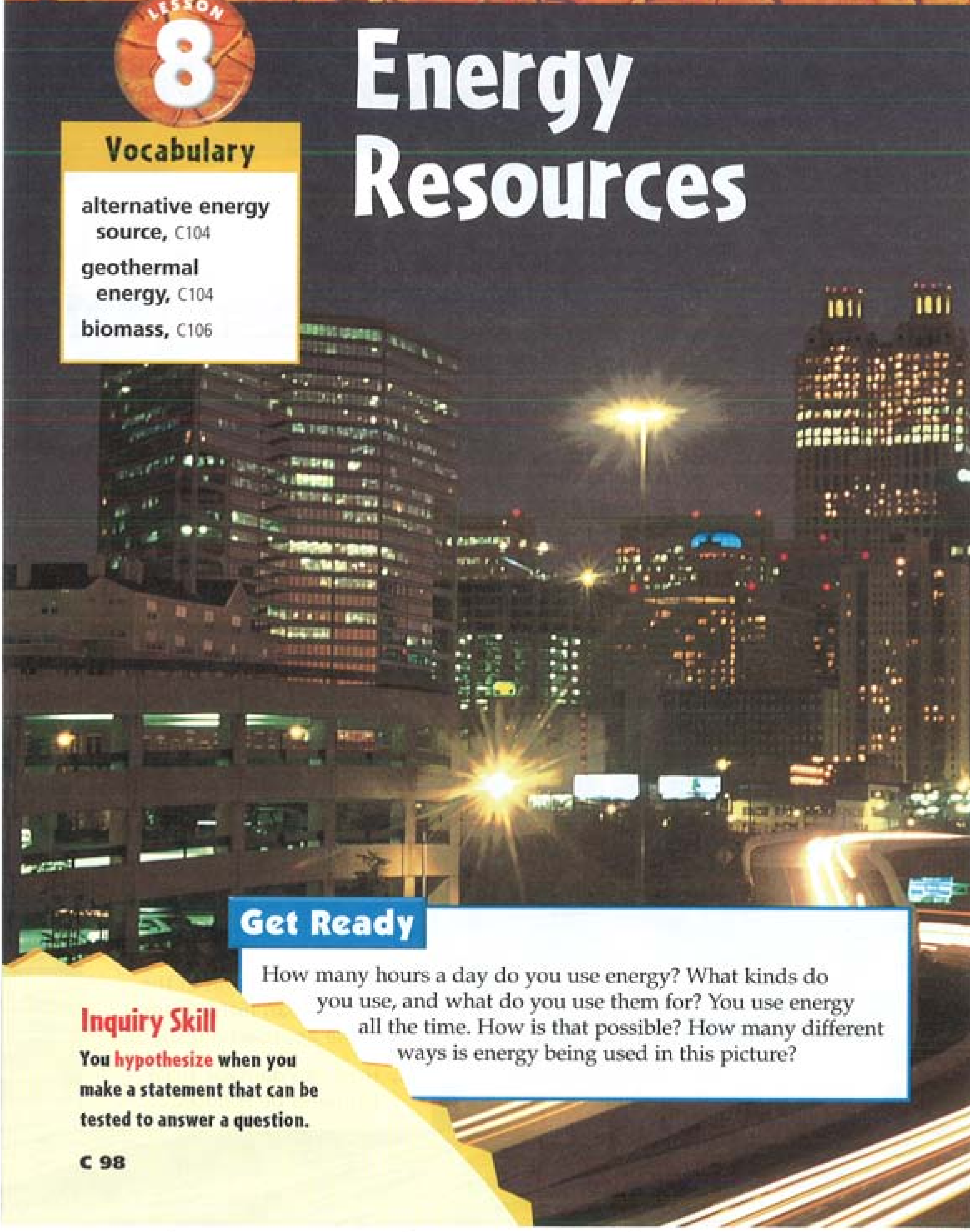
Energy Resources

Vocabulary

alternative energy source, C104

geothermal energy, C104

biomass, C106



Get Ready

How many hours a day do you use energy? What kinds do you use, and what do you use them for? You use energy all the time. How is that possible? How many different ways is energy being used in this picture?

Inquiry Skill

You hypothesize when you make a statement that can be tested to answer a question.

Explore Activity

How Do People Use Energy?

Procedure

1 **Communicate** Make a list of all the different ways you use energy.

2 Make a table listing all the kinds of energy you use in a day, how you use that energy, and how many hours you use each kind.

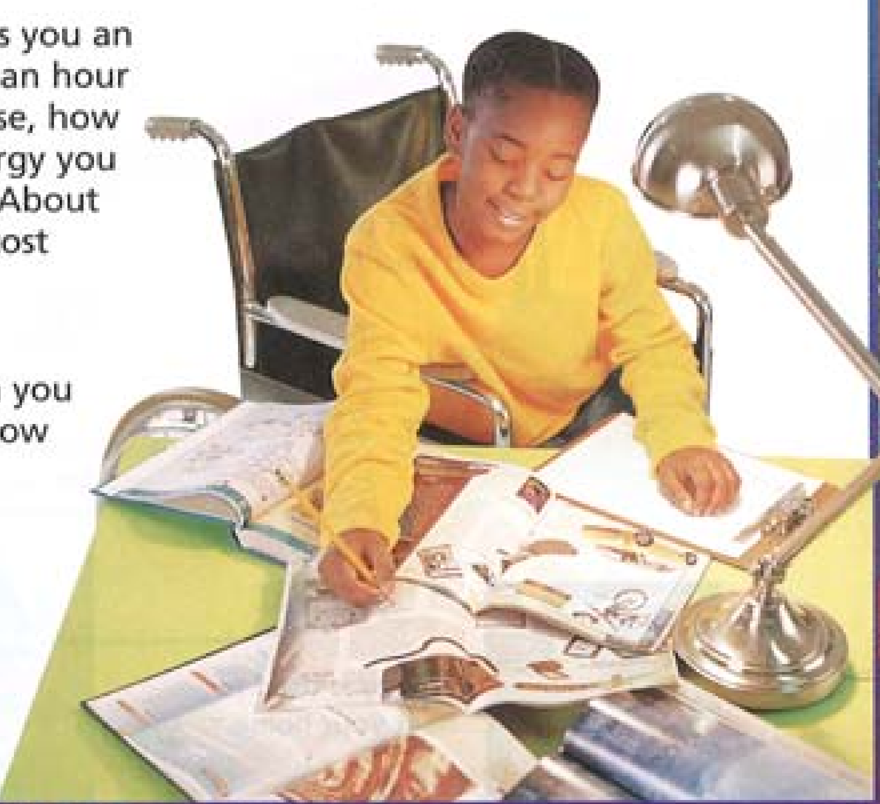
Drawing Conclusions

1 How many different ways do you use electricity each day? How many hours a day do you use electricity? What other sources of energy do you use? How many hours a day do you use each?

2 **Infer** Make a log to keep track of your energy use at home and at school. How can you use that information to help you make a plan to save energy?

3 **Use Numbers** If it costs you an average of ten cents an hour for the energy you use, how much would the energy you use cost each week? About how much would it cost each month?

4 FURTHER INQUIRY
Hypothesize How can you use less electricity? How much money do you think you could save on energy use in a month? Design and carry out a test of your hypothesis.



Read to Learn

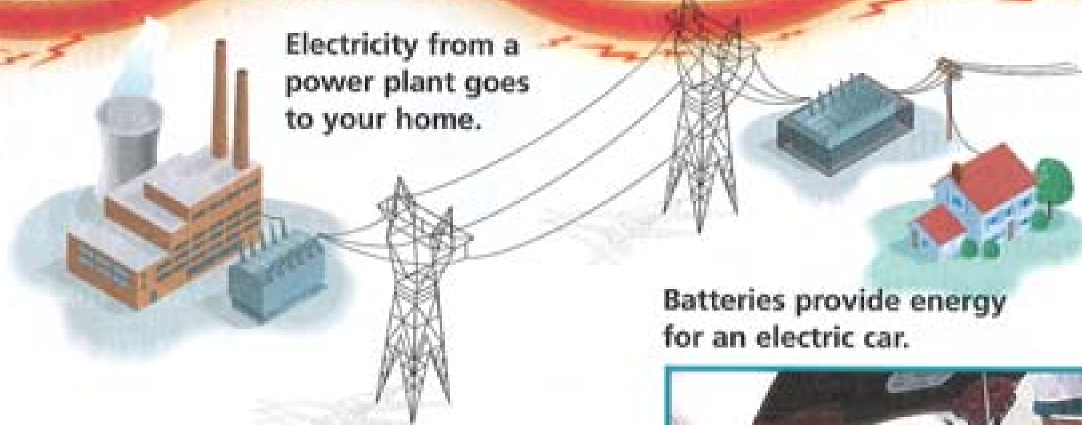
Main Idea **Some energy sources will last forever, while others will run out eventually.**

How Are Fossil Fuels Turned into Energy?

You use a number of different energy sources each day. Where does the energy you use come from? Try tracing it back to its source. Many homes, schools, and businesses get heat by burning oil or natural gas. Some older buildings still burn coal for heat. Some homes burn wood for heat.

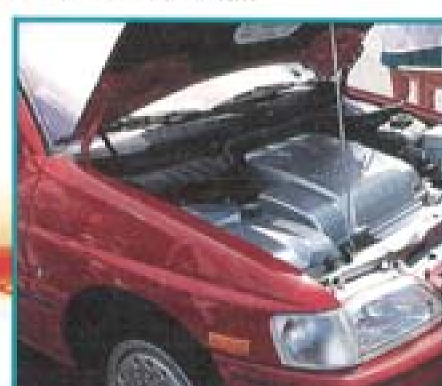
The heat in many other homes and businesses comes from electricity. So does the energy to run many common devices, such as lights, computers, radios, TVs, and washers. Some small devices, such as flashlights and portable CD players, get their electricity from batteries. Most of the other devices use electricity from a wall outlet. That electricity comes from a power plant. Electricity from that plant reaches your home through wires. However, the power plant makes electricity by using energy from burning fuels such as coal, oil, and natural gas.

It takes a lot of energy to move a car, bus, or train. Public and private transportation is one of the greatest uses of energy in today's world. Most vehicles get their energy from burning fuels, such as gasoline or diesel oil. Others run on electricity, propane, or liquefied natural gas.

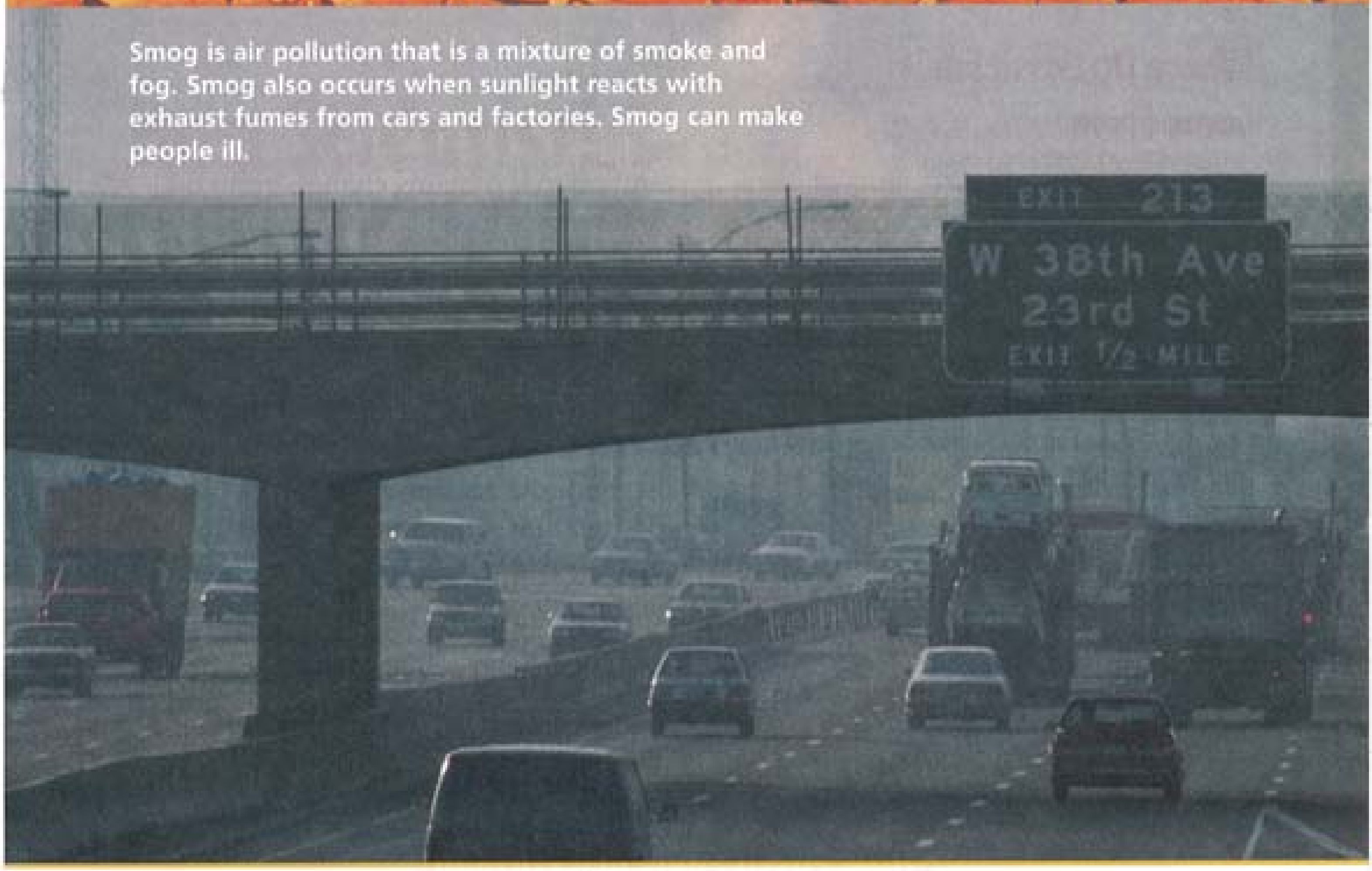


Electricity from a power plant goes to your home.

Batteries provide energy for an electric car.



Energy is used to heat your home.



Smog is air pollution that is a mixture of smoke and fog. Smog also occurs when sunlight reacts with exhaust fumes from cars and factories. Smog can make people ill.

As you can see, most of the energy you use can be traced back to fossil fuels—coal, oil, or natural gas. The energy in fossil fuels, in turn, can be traced back to the Sun.

Heat from burning fossil fuels can be used directly to heat homes, schools, businesses, and factories.

The heat can also be used to generate electricity. The heat is used to boil water and turn it into steam. The steam is trapped, and pressure builds up. Then the steam is released. The steam is directed at a big, pinwheel-like turbine. When the steam hits the turbine, it causes it to spin. The spinning turbine turns a generator to make electricity.

All fuels have advantages and disadvantages. The advantage of using fossil fuels is that they contain a lot of energy. However, fossil fuels take millions of years to form. Once used they cannot be replaced fast enough for future use. Therefore, they are nonrenewable.

Burning a fossil fuel also gives off smoke, gases, and other by-products. These pollute the environment. That is why the search is on for other, cleaner fuels.

What are some energy sources that come from fossil fuels?

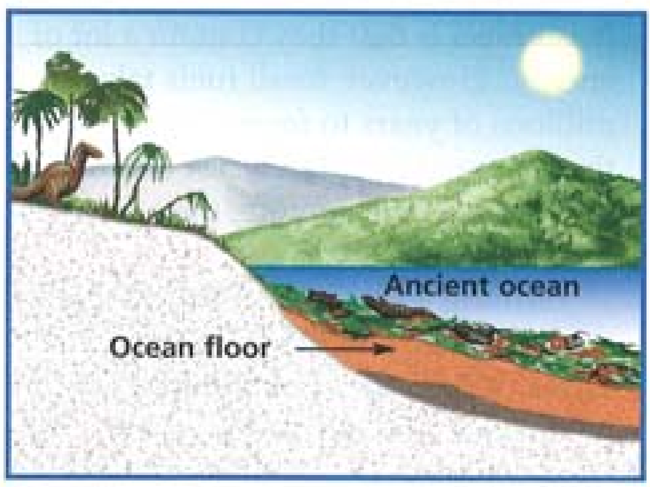
Where Do Fossil Fuels Come From?

Fossil fuels are the remains of once-living things. Coal formed from the remains of dead plants buried in ancient swamps and forests. Natural gas and oil formed from the remains of tiny ocean plants and animals. These sea creatures died and fell to the bottom of the ocean. There their bodies were buried by layers of sand and mud. As more and more layers covered these remains, pressure on them built up. Eventually, the layers of sediments turned into sedimentary rock. Over millions of years, the plant and animal remains changed into oil and natural gas. Plants and animals get their energy from the Sun. Therefore, the source of energy in fossil fuels can be traced back to the Sun.

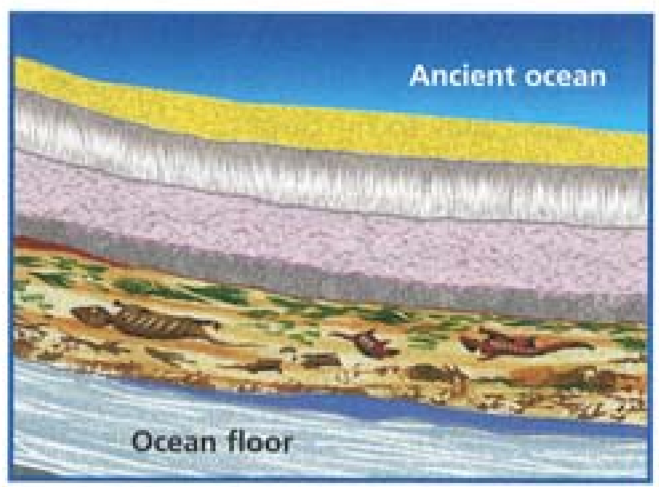
Our supplies of fossil fuels are limited, and fossil fuels are not a renewable energy source.

With the growth of industry, the demand for and use of energy also grows. The United States is the world's largest consumer of energy. The energy we use makes our lives easier.

How Fossil Fuels Are Formed



1 Dead plants and animals fall to the ocean floor.



2 Dead plants and animals are covered with layers of sand and mud.

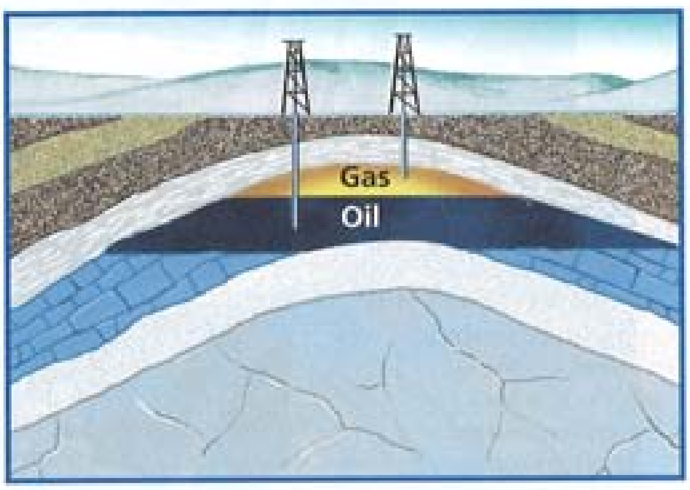
However, energy use pollutes the environment. It also speeds up the rate at which Earth's energy resources are used up.

If we continue to use fossil fuels at our present rate, we will run out of them. There are two possible solutions to this problem. One is to conserve our energy resources so that they will last longer. Another is to search for other sources of energy.

How do fossil fuels form?

READING Diagrams

What were oil and natural gas made from?



3 Over millions of years, pressure and heat help to turn the dead plant and animal remains into oil and natural gas.

QUICK LAB

Fuel Supply

FOLDABLES Make a Half-Book. (See p. R 41.) Label the book as shown.

This table shows how fast we are using up oil and natural gas.

World Supply of Oil and Natural Gas (as of January 1, 1996)	
Oil	1,007 billion barrels (1,007,000,000,000)
Natural gas	4,900 trillion cubic feet
World Use of Oil and Natural Gas for 1995	
Oil	about 70 million barrels a day (70,000,000)
Natural gas	about 78 trillion cubic feet

1. **Observe** Examine the data in the table.
2. **Communicate** Make a Half-Book. On the front draw a graph showing how long the fossil fuels we know about will last, based on the data in the table.
3. **Infer** Inside your book, explain how long it will be until we run out of each type of fossil fuel. Assume that the rate of use remains the same.

What Other Sources of Energy Are There?

Sources of energy other than the burning of fossil fuels are called **alternative energy sources**. Here are some alternative energy sources.

Water

Any whitewater rafter can tell you that running water has a lot of energy. That energy can be harnessed to do work using waterwheels. Running or falling water turns the wheel. The turning wheel spins an axle, which is attached to various machines to do work.

In a mill the axle turns a big stone that grinds up grain. In a sawmill it spins a blade to cut wood. In a *hydroelectric* (high·droh·i·LEK·trik) *plant*, running or falling water spins a generator to make electricity.

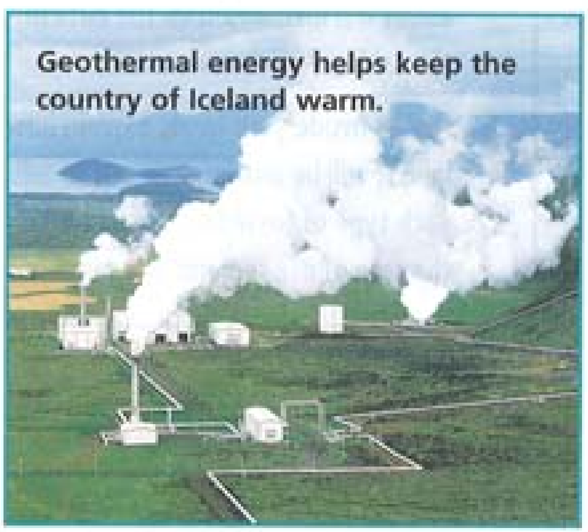
Wind

Wind, or moving air, can also spin a wheel. Windmills generate electricity in the same way waterwheels do.

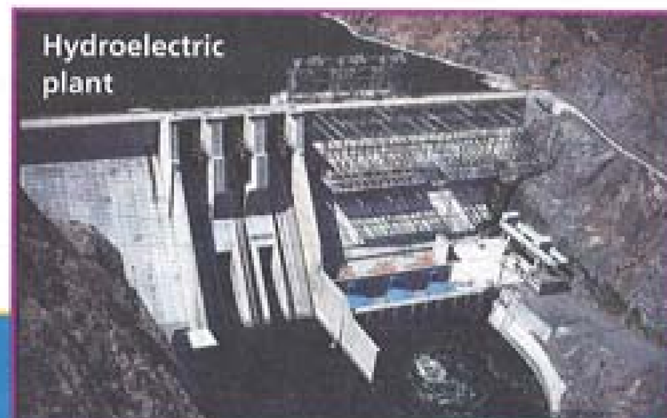
Internal Heat

The Earth's interior is very hot. The most common evidence of that heat is simply hot water or steam coming out of the ground. The water is heated below the surface in places where magma collects. Earth's internal heat is called **geothermal** (jee·oh·THUR·muhl) **energy**. Geothermal energy can be used to heat homes and produce electricity.

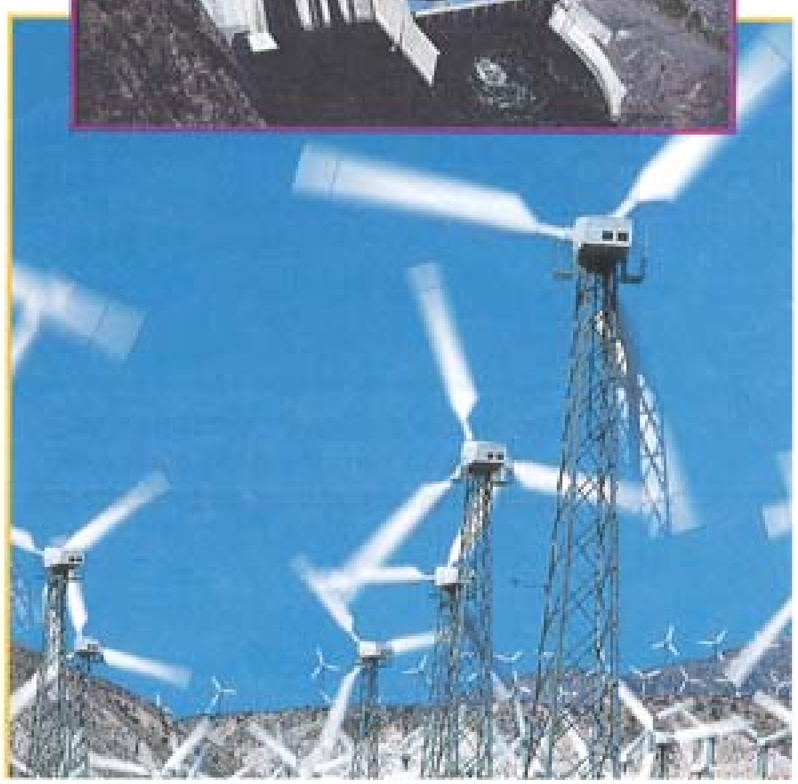
- Homes in Boise, Idaho, have been heated by hot springs since the 1890s.
- At The Geysers in California, steam drives turbines that generate electricity. The steam comes from underground water heated by geothermal energy.



Geothermal energy helps keep the country of Iceland warm.



Hydroelectric plant



Solar houses use solar cells for electric energy and solar collectors for heat.

The Sun

Every day the Sun bathes Earth in energy. We usually think of that solar energy simply as sunlight. Plants harness the Sun's energy through photosynthesis to make chemical compounds rich in energy. When you burn wood, you are releasing energy that a tree absorbed from the Sun.

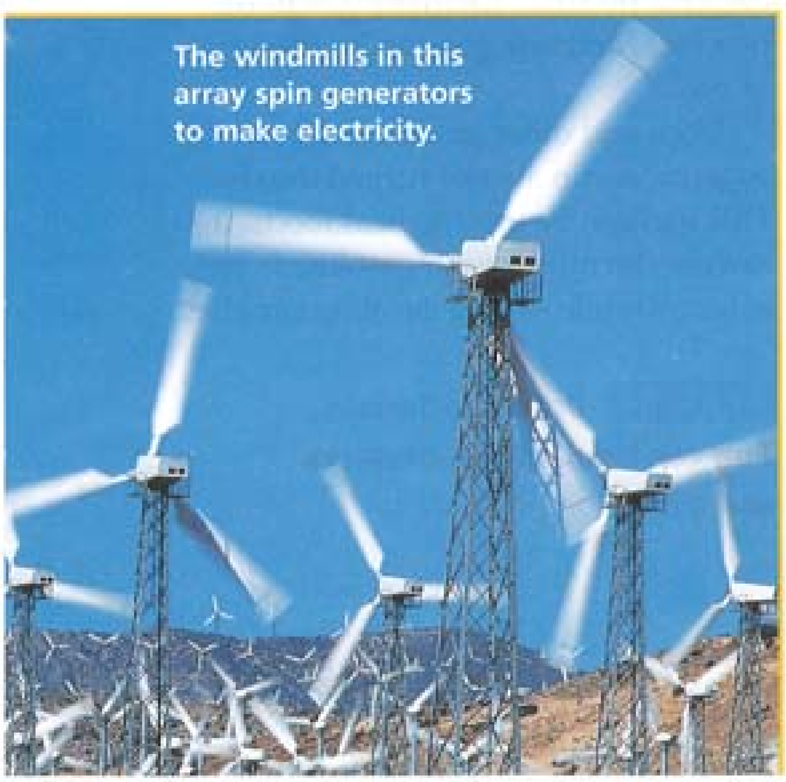
Sunlight also gives water the energy to evaporate and rise into the atmosphere. In this way the energy of running water can also be traced back to sunlight.

Today people are using new ways to harness the power of sunlight. One way is to trap or concentrate sunlight with the use of solar panels, or collectors. The trapped sunlight can be used to heat water or entire homes. Another way to use it is with solar cells. Solar cells are devices that convert sunlight into electric energy.

Tides

Every day the tide causes the water level to rise and drop along the world's coastlines. Now imagine a big tank built just below the high-water level. The tide rises, and water fills the tank. When the tide drops, the water flows out of the tank. Add a waterwheel so the water flowing out of the tank spins the wheel. Now you have a spinning axle that can be used to do work. That's the idea behind tidal power plants.

What are five alternative energy sources?



The windmills in this array spin generators to make electricity.

Tidal power plant in Holland

Cars can be powered by a special mixture that combines alcohol from biomass with gasoline.

How Can We Conserve Energy?

Unfortunately, alternative energy sources are not fully replacing fossil fuels. Therefore, we need to conserve these nonrenewable resources.

What does it mean to conserve our resources? It means we don't waste what we have and we use as little of what we have as possible. Take a typical house as an example. Better insulation of homes has cut United States' consumption of fuel oil almost in half. Newly designed bodies and engines have doubled the gasoline mileage of most cars. If we could cut our present consumption in half, our oil reserves would last twice as long! How can we do that?

One way is to use alternative energy sources, such as water, wind, and solar energy. Every watt of electricity we get from a solar cell is one less watt we have to get by burning oil or coal.

You have learned that fossil fuels are the stored energy that came from once-living plants and animals. Fossil fuels are nonrenewable. However, plant matter and animal wastes or other remains—called **biomass**—can be used as a renewable energy source. Plant material and animal wastes that might wind up as garbage can be processed to form fuel. This is done in waste-treatment plants. The treated wastes can then be burned. Special devices called scrubbers help prevent pollutants from entering the air when these wastes are burned. Solid wastes can also be digested by bacteria. The bacteria produce methane gas in the process. Methane gas can be used as fuel.

Corn and other grains, and even sugarcane, can also be turned into fuel. This fuel can be used to heat foods. It can also be mixed with gasoline to help run cars while saving gasoline supplies.

READING **Draw Conclusions**
How can biomass help conserve energy?

Lesson Review

L·I·N·K·S

Why It Matters

You probably look forward to driving a car someday. Think about this: Cars run on gasoline, and gasoline comes from oil. Remember the graph you did comparing known oil reserves with our current rate of use? If we don't conserve, will there be enough gas for your children's cars? Will there be enough gas for their children?

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on energy sources.

Think and Write

1. How do you use energy each day?
2. Why are coal, oil, and natural gas called "fossil" fuels?
3. How does burning fossil fuels pollute the environment?
4. List five ways people can help to conserve fossil fuels. Which of these suggestions do you think would conserve the most fuel? Which of these suggestions do you think more people would try?
5. **Critical Thinking** What alternatives do we have to using fossil fuels for energy? What are some of the advantages and disadvantages to using these energy sources?

WRITING LINK

Writing That Compares Compare two types of alternative energy sources, such as wind power and solar energy. Write about their similarities and differences. Then draw a conclusion about which of these energy sources might be used someday to replace fossil fuels.

MATH LINK

Calculate percents. A barrel of crude oil contains 42 gallons. When refined, it produces 21 gallons of gasoline, 9 gallons of fuel oils, 5 gallons of jet fuel, 4 gallons of lubricants, and 3 gallons of asphalt. Convert these numbers to percents and make a circle graph with your results.

TECHNOLOGY LINK

Science Newsroom CD-ROM Choose *Fuel Rush In* to learn how fossil fuels are formed and used.

LOG ON Visit **www.science.mmhschool.com** for more links.

Chapter 8 Review

Vocabulary

Fill each blank with the best word or words from the list.

acid rain, C65
biomass, C106
continental shelf, C90
continental slope, C90
fossil fuel, C64
geothermal energy, C104
ozone layer, C63
reservoir, C75
smog, C64
water table, C75

1. The _____ screens out much of the Sun's UV rays.

2. The top of the water-filled spaces in the ground is the _____.

3. Dangerous air pollution is called _____.

4. A(n) _____ is a storage area for fresh water.

5. A type of precipitation caused by air pollution is _____.

The **6.** _____ of the ocean floor is steeper and deeper than the **7.** _____.

8. _____ and **9.** _____ are alternative energy sources to **10.** _____.

Test Prep

11. Most of Earth's oxygen supply is produced by _____.

- **A** bacteria in the soil
- **B** one-celled algae of the ocean
- **C** green plants
- **D** the ozone layer

12. All of the following are examples of nonrenewable resources EXCEPT _____.

- **F** oil
- **G** coal
- **H** oxygen
- **J** natural gas

13. Geothermal energy comes from _____.

- **A** the Sun
- **B** falling water
- **C** fossil fuels
- **D** Earth's internal heat

14. Fossil fuels are stored energy that came from _____.

- **F** sedimentary rocks
- **G** wind and water
- **H** once-living plants and animals
- **J** waste-treatment plants

15. An underground layer of rock or soil that is filled with water is ______.

A a reservoir

B an aquifer

C a lake

D groundwater

Concepts and Skills

16. INQUIRY SKILL **Hypothesize** Does rain remove pollutant particles from the air? Form a hypothesis. What could you do to test your hypothesis?

17. **Reading in Science** All electricity is made by burning fossil fuels. Is this true or false? Explain your answer.

18. **Scientific Methods** How can salt water be turned into drinkable water?

19. **Critical Thinking** Does filtering water remove all impurities? Explain your answer. How would you prove your answer?

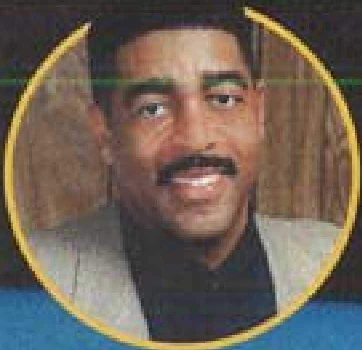
20. **Making Decisions** Solar energy is considered "too expensive" to use in the Northeast. However, sunlight is a renewable resource. Is it better to use solar energy or depend on fossil fuels? What are the benefits and disadvantages of each?

Did You Ever Wonder?

INQUIRY SKILL **Form a Hypothesis** Icebergs are fresh water. Can icebergs be a source of water for areas of the Earth lacking fresh water?

LOG ON Visit **www.science.mmhschool.com** to boost your test scores.

Meet a Scientist



Evan B. Forde

Oceanographer

Oceans cover two-thirds of Earth's surface. In this underwater environment, new species wait to be discovered. Amazing rock formations, resources, and unusual-looking creatures are waiting to be studied.

Oceanographers use ideas from geology, chemistry, biology, geography, and physics to study the oceans.

Evan B. Forde is an oceanographer. He works at the National Oceanic and Atmospheric Administration (NOAA) in Florida. About 25 years ago, Forde came up with some original ideas about the formation and structure of the underwater canyons off the Northeast coast of the United States. Some of the canyons are much larger than the Grand Canyon.

To study them, Forde traveled in *Alvin*—a tiny vehicle that carries scientists deep beneath the sea. Oceanographers on *Alvin* have gone to depths of more than two miles! Thanks to *Alvin* and to other deep-diving submarines, Forde was able to explore underwater canyons and landscapes beneath the Atlantic Ocean. It was a sight that few people have ever seen!

These days Forde is using satellite sensors to study ocean conditions that lead to hurricanes. This information will help scientists predict more accurately when a hurricane will form. Evan B. Forde knows his oceans!

Write About It

1. How did *Alvin* help Forde study underwater canyons?
2. Why do some people say the oceans are one of Earth's last frontiers?

TOP 5

Deep Oceans and Seas

The oceans are very deep. The deepest known spot is about 29 times as deep as the Empire State Building is tall!

Ocean or Sea	Greatest Depth (in feet)
1. Pacific Ocean	35,840
2. Indian Ocean	23,376
3. Atlantic Ocean	28,374
4. Caribbean Sea	22,788
5. South China Sea	16,456

LOG ON Visit **www.science.mmhschool.com** to learn more about the work of oceanographers.

Name That MINERAL

Your goal is to test properties of minerals to determine their identity.

What to Do

1. Make a table with the column headings shown below.
2. Do the following tests to determine properties. Record data in your table for each sample.

   Color(s): What color is its surface?

   Luster: How shiny is the sample?

   Porcelain plate test: What color is the powder when the mineral streaks?

   Cleavage: How many directions does it break into?

   Hardness: How well does the mineral resist scratching?

   Density: How heavy does the sample feel compared with a sample of water with the same volume?

Analyze Your Results

Complete the table. Use the results of your tests and the chart Properties of Minerals (page C35) to name each mineral.

SPOT the SOURCE

Your goal is to make a brochure to educate people about air pollution.

What to Do

1. Look at pictures in a newspaper or magazine. Which of the pictures show things that cause air pollution?
2. Create a brochure about air pollution. Your brochure should do three things:
   a. explain what air pollution is
   b. name the sources of air pollution in the pictures
   c. describe how those sources pollute

Analyze Your Results

1. Name one way that people use energy that causes air pollution.
2. How are air pollution and water pollution alike?