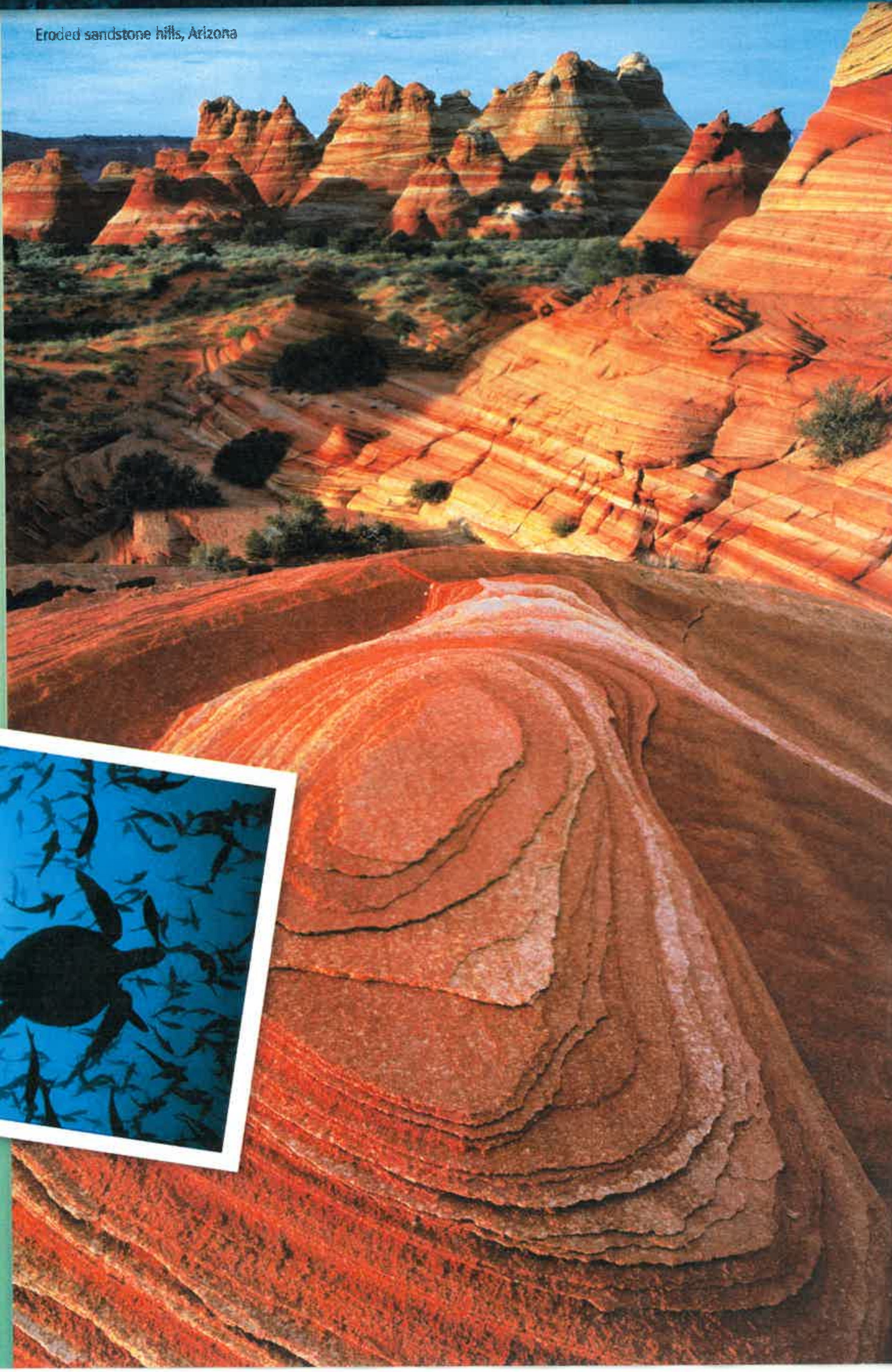
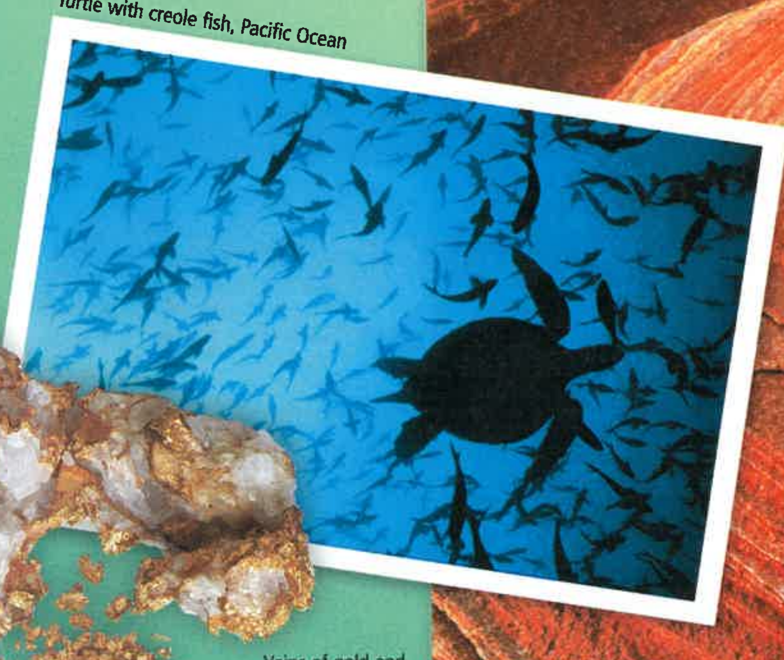
CHAPTER 4

Landforms, Water, and Natural Resources

Earth has many different types of landforms. They are shaped by forces deep within the planet and by conditions on Earth's surface. In this chapter, you will learn about Earth's landforms, water features, and natural resources.



Eroded sandstone hills, Arizona



Turtle with creole fish, Pacific Ocean

Veins of gold and gold flakes

Section 1

Landforms

HOLT Geography's Impact Video Series
Watch the video to understand the impact of water on Earth.

READ TO DISCOVER

1. What physical processes inside Earth build up the land?
2. What physical processes on Earth's surface wear down the land?
3. How do these physical processes interact to create landforms?

Reading Strategy

READING ORGANIZER Before you read, create a chart with columns titled Term, Definition, and Example. Write each of the terms above in the left column. As you read write the definition and give an example of each term in the other two columns.

DEFINE

core
mantle
magma
plate tectonics
continental drift
rift valleys
abyssal plains
continental shelves
trench
folds
faults
weathering
sediment
erosion
glaciers
plateau
alluvial fan
delta

Forces below Earth's Surface

Geology—the study of Earth's physical structures and the processes that have created them—is important to geographers. We live and build on hills, mountains, valleys, and other landforms. They can make travel easy or difficult. Landforms can also give us clues to what Earth was like in the past. Forces below Earth's surface are a key to the shaping of landforms.

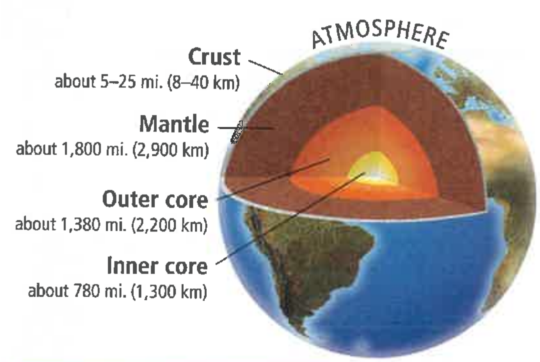
Scientists have identified four important zones in Earth's interior, as you can see in the diagram. The planet's center is like a nuclear furnace, where decaying radioactive elements generate heat. At Earth's center, or **core**, both temperatures and pressures are very high. The core is divided into inner and outer layers. The inner core is solid. The outer core is mostly dense liquid metal, mainly iron and nickel. Beyond the core is the **mantle**—the zone that has most of Earth's mass. The uppermost layer is the crust. Although it is up to about 25 miles (40 km) thick, the crust is comparatively thin. Huge currents carry heat from the core through the mantle to the crust. Liquid rock within Earth is called **magma**. When this liquid rock spills out onto the surface it is called lava. Magma erupts from vents called volcanoes.

Internal Forces The theory of **plate tectonics** explains how forces within the planet create landforms. This theory views Earth's crust as divided into more than a dozen rigid, slow-moving plates. The plates can be compared to the cracked shell of a hard-boiled egg. Some plates are as large as a quarter of the planet, but others are only a few hundred miles across. The plates slowly move across the upper mantle, usually less than an inch per year. This process is called **continental drift**. Along the plate boundaries, the crust is subject to stresses that lead to melting, bending, and breaking. In the middle of

internet connect

GO TO: go.hrw.com
KEYWORD: SW3 CH4
FOR: Web sites about landforms, water, and natural resources

The Interior of Earth

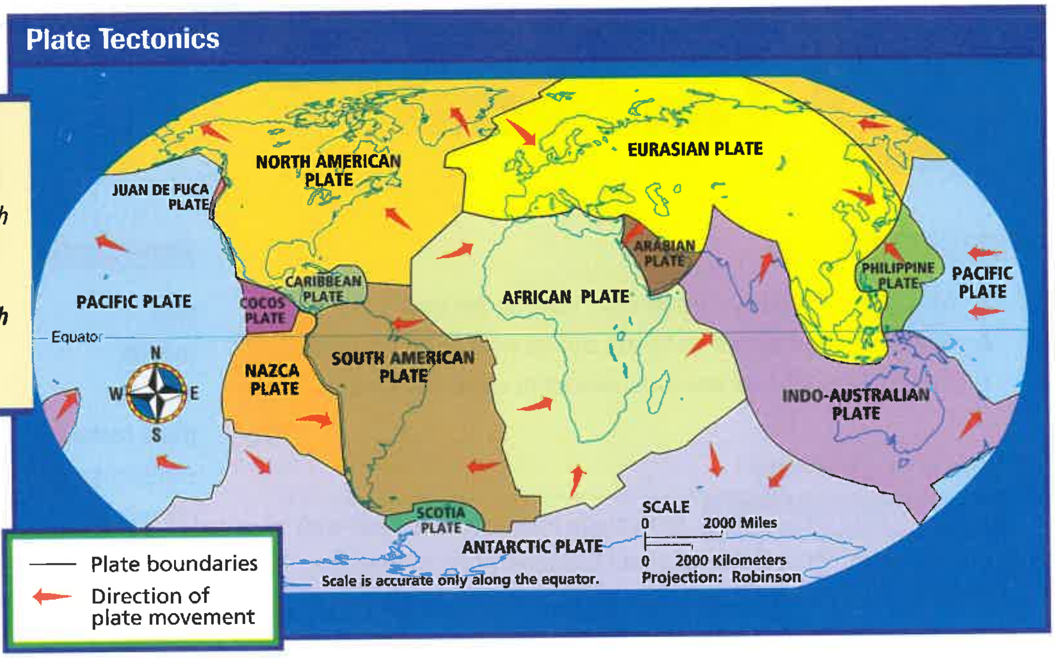


INTERPRETING THE DIAGRAM *Temperatures within Earth increase with depth. In the inner core, temperatures may reach as high as 12,000°F (7,000°C).* ***How far below the surface is Earth's inner core?***

INTERPRETING THE MAP

This map shows Earth's tectonic plates and the directions in which they are moving. ***Which plates appear to be the largest? Which are the smallest? Which plates meet in the center of the Atlantic Ocean?***

Plate Tectonics



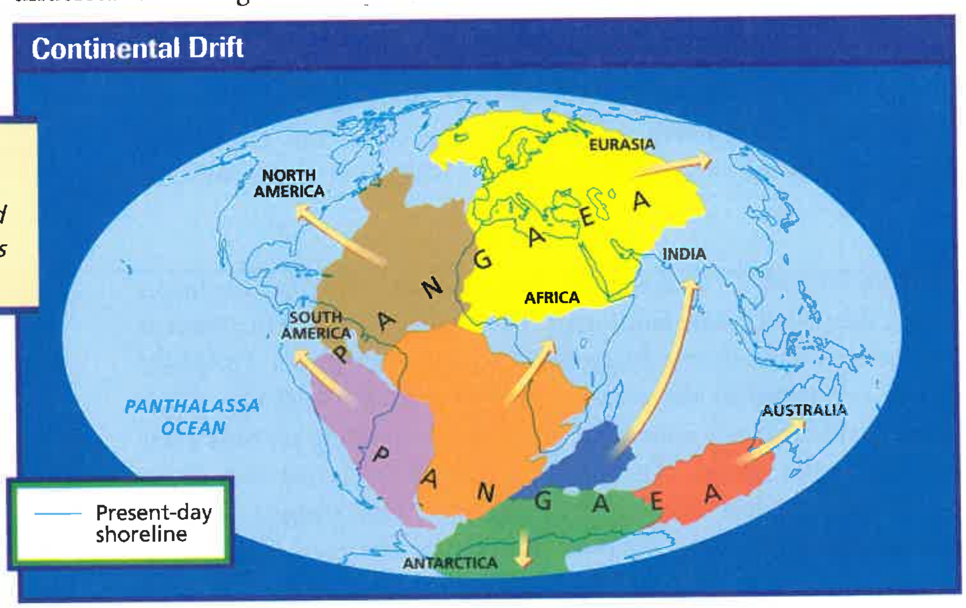
plates, however, little tectonic activity takes place. Continental areas in the middle of plates are steadily eroded. Ocean floor areas in the middle of plates are steadily buried with sediment.

Volcanoes often form long rows and signal that a plate boundary is nearby. Earthquakes—sudden shakings of Earth's crust—take place when tectonic forces cause masses of rock inside the crust to break. Earthquakes are also common near plate boundaries.

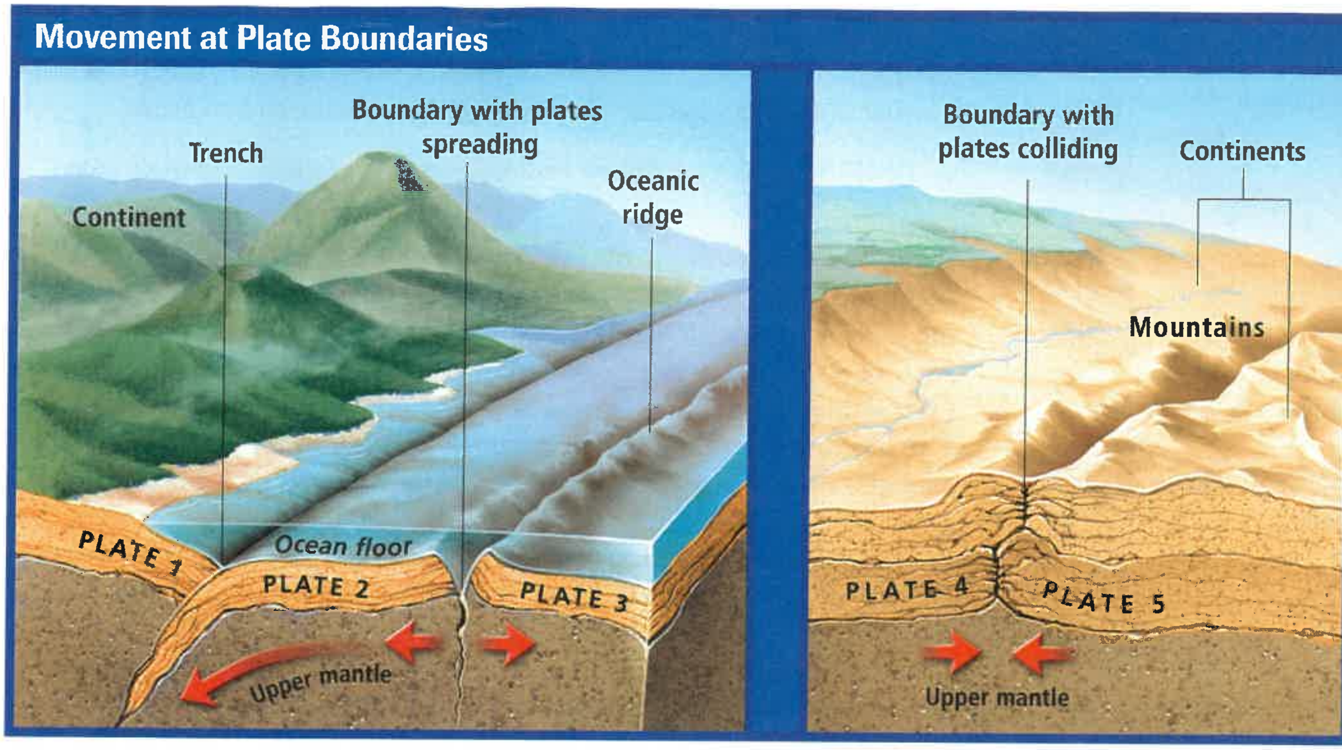
Scientists use the theory of plate tectonics to explain the long history of Earth's surface. They believe that about 200 million years ago all the modern continents were part of one supercontinent called Pangaea (pan-JEE-uh). Pangaea then broke into two smaller supercontinents called Gondwana and Laurasia. These two, in turn, broke into the modern continents during the last 100 million years. The theory of plate tectonics helps explain the "fit" between the coastlines of Africa and South America. Rock formations that match up across the boundaries provide more evidence. The theory also helps geographers understand the origins of mountains and the landforms of the ocean floors.

Pangaea, a supercontinent about 200 million years ago, was surrounded by Earth's single ocean, Panthalassa. New oceanic crust formed as Pangaea broke apart and continental plates drifted away from each other.

Continental Drift



Movement at Plate Boundaries



Left: Where Plate 2 pushes under Plate 1, a deep trench forms. Where Plate 2 and Plate 3 move apart, lava creates an oceanic ridge. Right: Where Plate 4 and Plate 5 collide, the crust is pushed up, forming a mountain range.

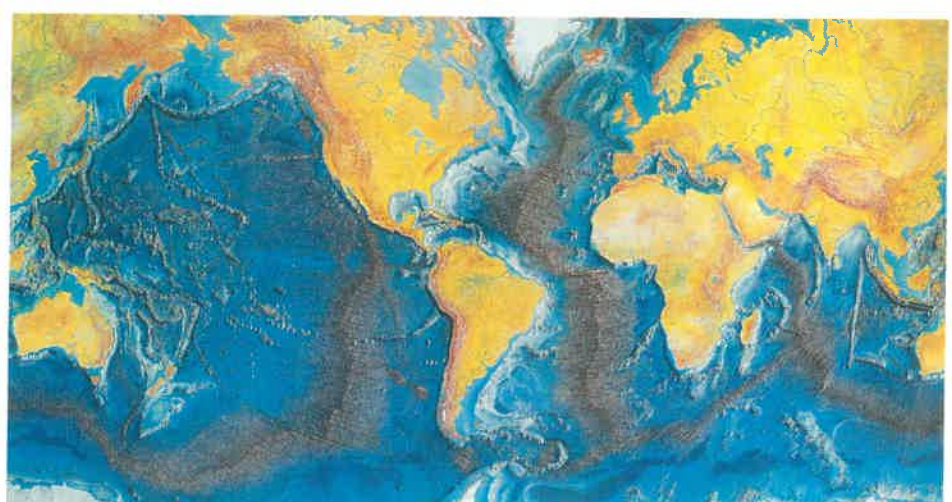
Plate Movement Three types of movements at plate boundaries are possible. First, the plates can move apart, or spread. Second, the plates can collide. Third, the plates can move laterally, slipping past each other. The movement of plates creates distinctive landforms.

Long ago in Earth's history the crust sorted itself into two layers of different kinds of rocks. The lower layer, made of heavier rock, is found on the ocean floors. Lying on top is a patchy layer of lighter rock. This layer makes up the continents. Nearly all spreading plate boundaries are found on the ocean floors. As fresh lava wells upward, this new crust pushes the plates apart. The rising heat also lifts the crust upward, building a chain of young volcanic mountains, called an oceanic ridge. Earth's oceanic ridges connect in a nearly continuous submarine mountain chain. This chain is nearly 40,000 miles (60,000 km) long and contains some of the world's highest peaks. The part of this chain that runs through the Atlantic Ocean is called the Mid-Atlantic Ridge. However, except for on a few islands, such as Iceland, these mountains are hidden beneath the waves.

A few spreading plate boundaries lie under continents. In these places, the crust stretches until it breaks, forming **rift valleys**. The biggest rift valleys are in eastern Africa.

Away from the oceanic ridges, rocks of the ocean floors gradually sink because they have no supporting heat below them. Here we find **abyssal plains**, the world's flattest and smoothest regions. In these areas a thick layer of mud, clay, and other materials has buried all features.

This map shows some of the landforms on the oceans' floors. Note how the Mid-Atlantic Ridge runs the length of the ocean and continues into the Indian Ocean.

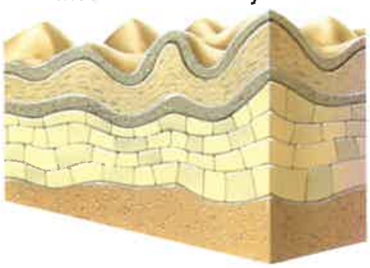


World Ocean Floor, Bruce C. Heezen and Marie Tharp, 1977, © MarieTharp, 1 Washington Avenue, South Nyack, NY 109601

Folds and Faults

Mountains formed by faults

Mountains formed by folds



Top: Fault-block mountains form where parts of Earth's crust are pushed up along a fracture line, or fault. Bottom: Many large mountain ranges are created by folding, which occurs when two plates collide and their edges wrinkle.

The continental surface extends under the shallow ocean water around the continents. These areas are called **continental shelves.** At the edges of the continental shelves, the seafloor drops steeply down to the abyssal plains.

✓ **READING CHECK:** ***Physical Systems*** What physical process forms oceanic ridges?

When Plates Collide Colliding plate boundaries are found both on ocean floors and along continental edges. When two plates on the ocean floor collide, one slides underneath the other. This plate boundary is called a subduction zone, and the deep valley marking the plate collision is called a **trench.** The plate sliding downward generates heat as it grinds against the plate above it. This heat may produce a row of volcanoes. Some of these volcanoes rise high enough to become island chains. This process created places like the Tonga Trench and the nearby Tonga Islands in the western Pacific.

Sometimes one of the colliding plates is carrying a continent. In this case the heavier oceanic plate dives under the lighter continental plate. The squeezing of the continental plate causes volcanoes, **folds**, and **faults.** Folds are places where rocks have been compressed into bends. Faults are places where rock masses have broken apart and moved away from each other. (See the diagrams.)

It is also possible for two continental plates to collide. The result is a great long-lasting episode of mountain building with awesome folding, faulting, and volcanism. The Himalayas of Asia formed along such a plate boundary. There, scientists believe, a small continent marked by the triangle of modern India began crashing into Asia millions of years ago. The Himalayas, the mountains formed by this collision, are still growing. In fact, plate collisions have built most of the world's mountains.

Plates Moving Laterally When plates move laterally past each other, long fractures develop along the edges of both plates. The pressures along these boundaries are seldom uniform. While a little squeezing produces low mountains, a little spreading generates broad valleys. Earthquakes can be frequent in

Left: The San Andreas Fault cuts through the Carrizo Plain in California. Right: This freeway in Oakland, California, collapsed during a 1989 earthquake.

these areas. Again, most of these plate boundaries lie under the oceans. However, the San Andreas Fault in California is a famous example on land. Here a sliver of continental crust on the Pacific plate's edge is moving northwestward along the edge of North America. Meanwhile, the North American plate is being pushed westward by the oceanic ridge in the Atlantic Ocean. As this plate boundary occasionally skids along, earthquakes occur from Los Angeles to north of San Francisco.

✓ **READING CHECK:** *Physical Systems* What physical processes created the Himalayas and the San Andreas Fault in California?

Forces on Earth's Surface

While tectonic forces are building up Earth's surface, other forces are wearing it down and making it more level. It is the interaction of these two kinds of forces that shapes the landforms we see.

Weathering and Erosion Rocks break and decay over time in a process called **weathering**. Weathering is usually slow and difficult to detect. However, even the hardest rocks will eventually wear down. Chemical processes cause some weathering. Substances in air and water react with the rock, creating new chemical compounds and slowly dissolving the rock. Weathering is also caused by physical processes that break rocks into smaller pieces. In desert areas, daytime heating and nighttime cooling can cause rocks to crack. In high mountains, repeated freezing and thawing of water inside a cracked rock can cause it to break even more. The roots of trees can pry rocks apart. Weathering breaks rock into smaller particles of gravel, sand, and mud called **sediment**.

Along with weathering, the other process changing landforms on Earth's surface is **erosion**. Erosion is the movement of surface material from one location to another. Water, wind, and ice cause erosion.

Water, Waves, and Wind Water is the most important force of erosion. Rainfall can cause rapid erosion where few plants protect the ground. Water erosion can begin as tiny channels on hillsides. If erosion is severe, a channel may grow into a gully. Running water can even carve deep canyons, such as the Grand Canyon. Rivers usually carry water and sediment from mountains in the center of continents all the way to the ocean. Wave action is another powerful force of erosion. During a storm, waves can tear away tons of beach sand in a few hours. Waves can also change shorelines slowly over many years.

Wind is another force that causes erosion. Plants protect most land surfaces from wind action. However, in dry lands, on beaches, and in places where people or animals have destroyed the vegetation, wind can cause significant erosion. Wind works in two ways. One is abrasion—that is, it blasts particles of sand against rock. The other way is by blowing sand and dust from one place to the next. Hills of wind-deposited sand are called dunes. Sand dunes are common on beaches and in deserts. Wind also lifts dust high into the atmosphere and transports it great distances. For example, dust from the Sahara in Africa is carried across the Atlantic Ocean to the Caribbean islands!

✓ **READING CHECK:** *Physical Systems* How do wind and water shape the land?

INTERPRETING THE VISUAL RECORD

Erosion wears away Earth's surface at an island beach off the Florida coast (top) and at Theodore Roosevelt National Park, North Dakota (bottom). ***What physical processes are causing erosion in these places?***

INTERPRETING THE VISUAL RECORD

Weathering is slowly wearing down this mountainside. Rock that has been shattered by frost and falls from a mountain forms what is called a talus slope. Gravity slowly pulls the rock down in a process called talus creep. ***In what other ways does gravity affect erosion?***

The Power of Ice Thick masses of ice—called **glaciers**—also erode rock and move sediment. Glacier ice builds up when winter snows do not melt during the following summer. Glaciers may be great ice sheets covering whole regions. Today ice sheets more than two miles (three kilometers) thick cover most of Antarctica and Greenland. As these giant domes of ice sag with the pull of gravity, the edges of the ice sheets are pushed outward.

Glaciers are also found in the valleys of high mountains. These mountain glaciers flow slowly downhill, often sliding on a thin layer of liquid water at their bases. Glaciers can level anything in their paths. They can move rocks as big as houses over long distances. They can grind rocks into sediment as fine as flour. During the ice ages, glaciers reached to what are now St. Louis in North America and Moscow in Russia.

Glaciers can be found in high mountains all around the world, even on high mountains near the equator. Flowing downhill like slow rivers of ice, mountain glaciers carve great U-shaped valleys and sharp mountain peaks. The carving action of glaciers created many of the spectacular valleys we see around the world today. Yosemite Valley in California is a good example.

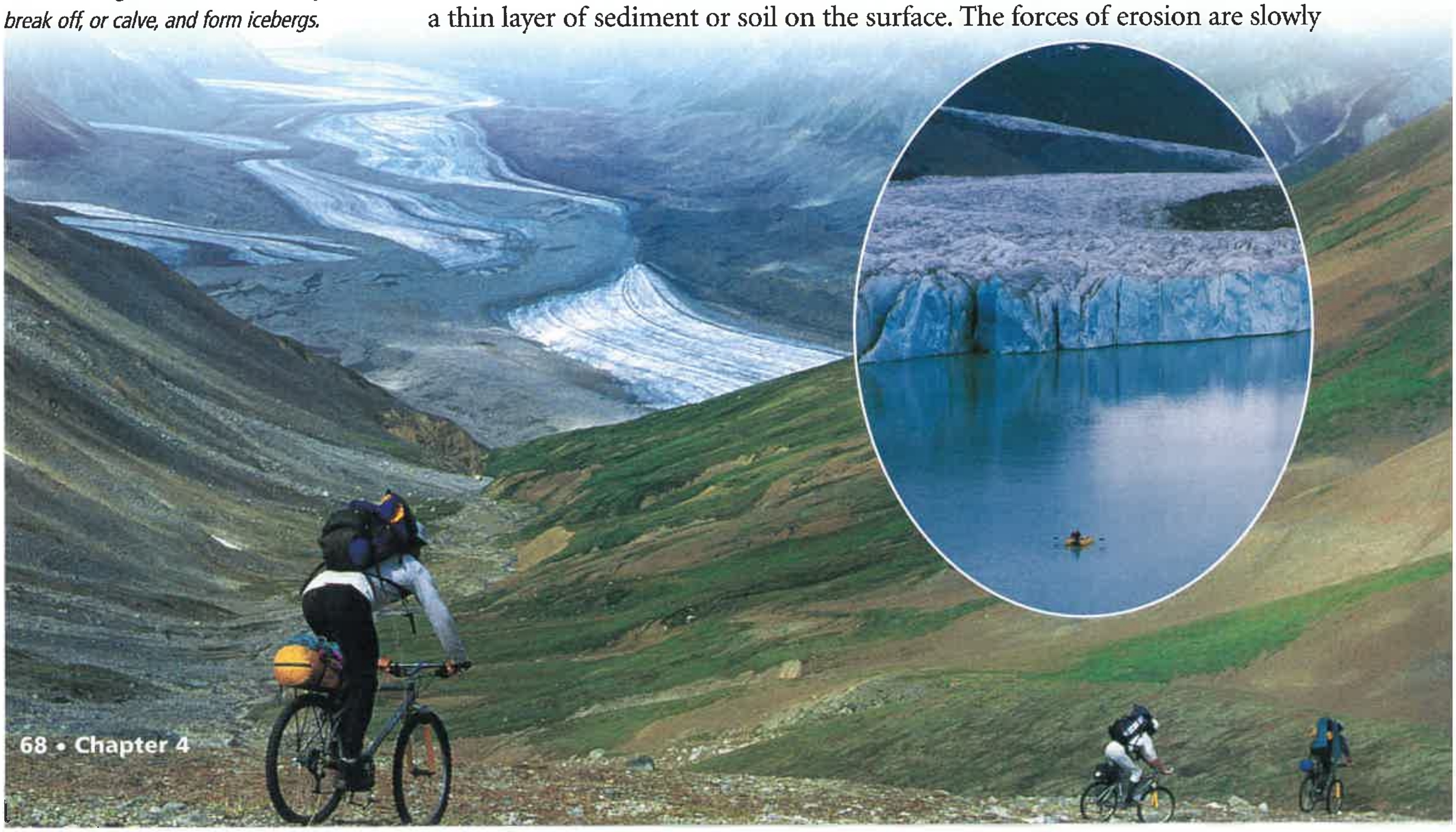
✓ **READING CHECK:** ***Physical Systems*** What role do gravity and ice sheets play in shaping the land?

Shapes on the Land

One way to better understand landforms is to divide them into three groups. One group is built by tectonic processes. These landforms, such as mountains and some valleys, are created by volcanoes, folding, and faulting. Erosion and the depositing of sediment may be changing these landforms, rounding and smoothing their edges. Yet the basic landform is the result of tectonic processes.

A second type of landform is created by erosion. It is made of rock and has a thin layer of sediment or soil on the surface. The forces of erosion are slowly

Cyclists in Alaska descend to Black Rapids Glacier. In 1936 this glacier surged forward at the rate of 10 feet (3 m) per hour. It has slowed since then. The inset photo shows the face of a glacier. Here chunks may break off, or calve, and form icebergs.



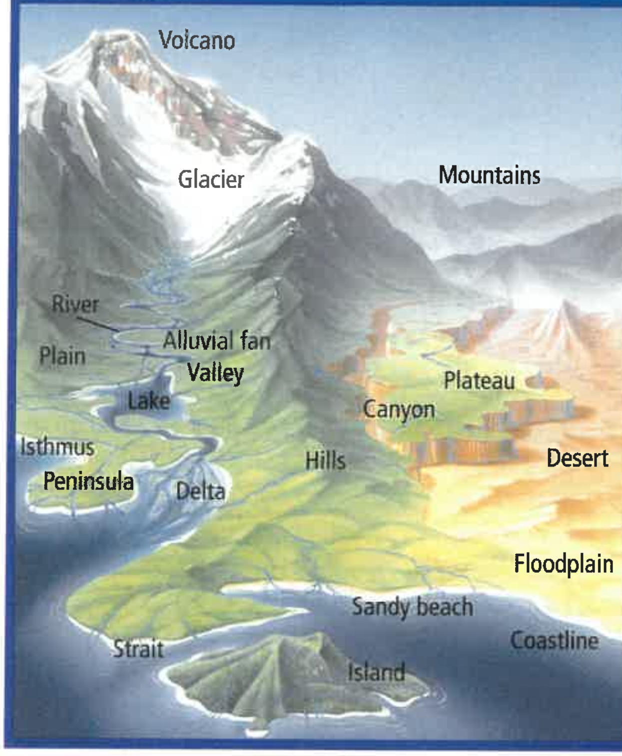
lowering its surface. These landforms often reflect the hardness of the underlying rock. Harder rocks resist erosion and over time will stand above the surrounding land. One example of this landform is a **plateau**. A plateau is an elevated flatland that rises sharply above nearby land on at least one side. A plain—a nearly flat area—is often the final stage of a landscape wearing smooth.

A third kind of landform is formed by sediment deposited by ice, water, or wind. A sand dune in a desert is an example of this kind of landform. Another example is a floodplain. A floodplain is a landform of level ground built by sediment deposited by a river or stream.

The terrain in most regions is a jigsaw puzzle of many landforms. For example, a mountain range is formed by tectonic activity. Erosion may then form deep valleys between the mountains. The sediment eroded from the mountains may then be deposited at the mountains' bases. The result of this process can be an **alluvial fan**. This is a fan-shaped deposit of mud and gravel often found along the bases of mountains. Still later a stream may erode the sediments in the alluvial fan, carrying them all the way to a river mouth. There the sediment may move out into the ocean and sink, or the sediment may accumulate, building a **delta**. Eventually this sediment from the distant mountains could travel still farther. It might finally be deposited in an oceanic trench.

The location, shape, and size of landforms have influenced human settlement and transportation throughout history. For example, people tend to settle in flat areas where they can farm. People use rivers for water supplies and transportation. Many railroads and highways have been built along river valleys as well. People have also changed Earth's surface to suit their needs. Large machines can smooth ground for home construction, and explosives clear the way for roads. Governments build dams across rivers, turning valleys into lakes.

Landforms



INTERPRETING THE VISUAL RECORD

Many of the landforms shown here can be found together in various regions of Earth. ***Which landforms can you identify where you live?***

✓ **READING CHECK:** ***Physical Systems*** What are two kinds of landforms created by deposits of sediment?

Section 1 Review

Homework Practice Online
go.hrw.com
Keyword: SW3 HP4

Define

core, mantle, magma, plate tectonics, continental drift, rift valleys, abyssal plains, continental shelves, trench, folds, faults, weathering, sediment, erosion, glaciers, plateau, alluvial fan, delta

Reading for the Main Idea

1. ***Physical Systems*** What are some processes that shape landforms?
2. ***Physical Systems*** What are the three kinds of landforms?

Critical Thinking

3. **Analyzing Information** How might a plateau show the effects of both tectonic process and erosion?
4. **Drawing Inferences and Conclusions** Why do you think farming and raising livestock may lead to rapid erosion?

Organizing What You Know

5. Copy the table below. Use it to list the three types of tectonic plate boundaries, the landforms that result from each type, and an example of each type.

Type of plate boundary	Resulting landforms	Example

Section 2

The Hydrosphere

READ TO DISCOVER

1. In what forms and where do we find water on Earth?
2. What are the causes and effects of floods?

DEFINE

desalinization
hydrologic cycle
headwaters
tributary
watershed
drainage basin
estuaries
wetlands
groundwater
water table

Reading Strategy

READING ORGANIZER Draw a line down the center of a sheet of paper to create two columns. Title one column What I Know. Title the other column What I Learned. Before you read, write down what you know about the hydrosphere in the first column. As you read the section, write down the information you learn in the other column. Include key terms and their definitions.

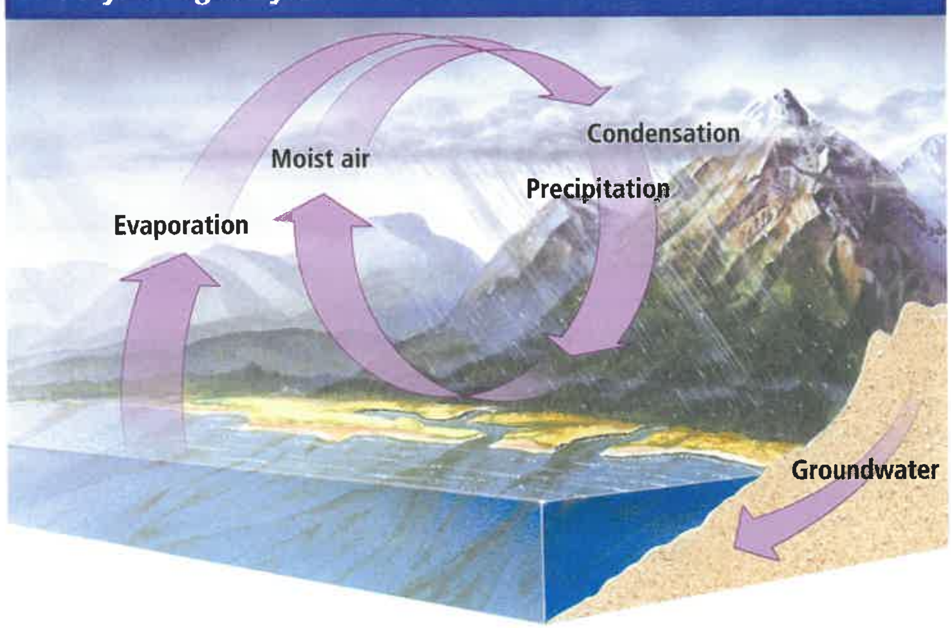
Water on Earth

Necessary for life, water is abundant on Earth. Yet 97 percent of the world's water is in oceans and is too salty for most uses. The salt in ocean water can be removed through **desalinization.** For example, some countries in the very dry region of Southwest Asia use this process to get freshwater. However, it is expensive because of the large amount of energy needed.

Less than 3 percent of the world's water is fresh. Most of this water is frozen in the ice caps of Antarctica and Greenland. The remainder is less than 1 percent of the world's water. This water is found in clouds, lakes, and rivers and in the ground. It is only this tiny proportion of the world's water that is available for human use.

The Hydrologic Cycle The amount of water on Earth stays much the same over time. However, its physical state is always changing, from gas (water vapor)

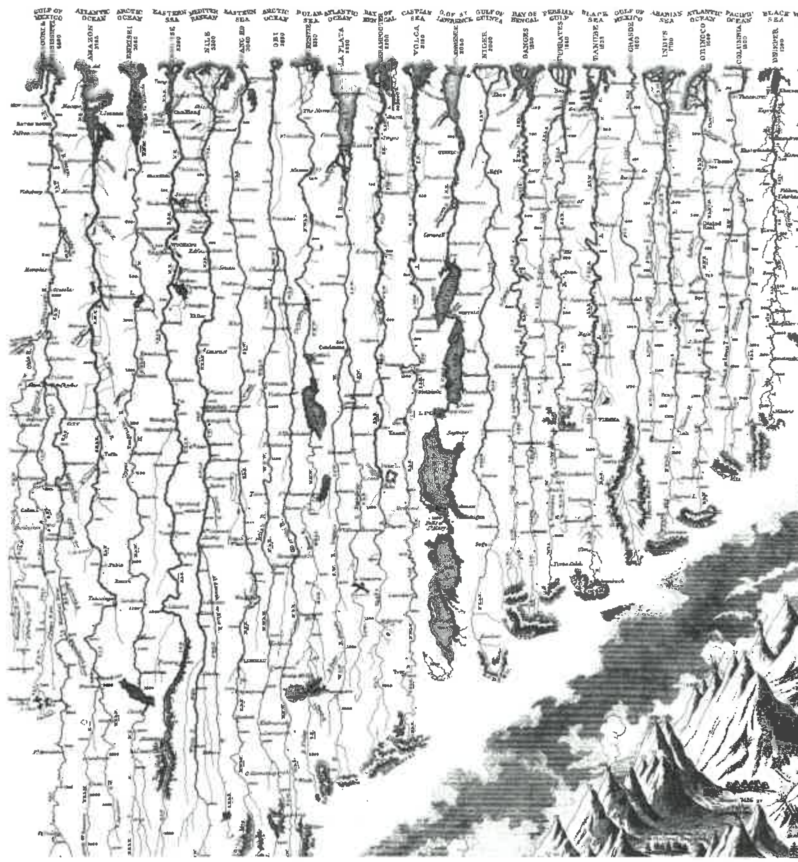
The Hydrologic Cycle



The circulation of water from one part of the hydrosphere to another is driven by solar energy. Following evaporation, water eventually returns to the surface in various forms of precipitation.

to liquid to solid (ice). The movement of water through the hydrosphere is called the **hydrologic cycle**. Solar energy, winds, and gravity drive this cycle. When heated by solar energy, water may change to vapor. This process is called evaporation. Most water in the atmosphere has evaporated from the ocean. As water vapor rises with the air, it cools and forms tiny liquid droplets in a process called condensation. Joining to form clouds, these droplets may grow to become raindrops heavy enough to fall to Earth. Water falling to the surface, either as rain, snow, or hail, is called precipitation. If it falls on land, water may be stored. It can build up in plants, in a river or stream, in a lake, or below the ground. Surface water either flows to the sea in a river or evaporates again and returns to the atmosphere.

✓ **READING CHECK:** ***Physical Systems***
What forces drive the hydrologic cycle?



INTERPRETING THE VISUAL RECORD *This diagram showing the headwaters, tributaries, lakes, and deltas of major rivers was published in 1864. The rivers appear side by side.* ***Use a map of North America to identify the lake and river system in the diagram's center. This river is the heart of what functional region?***

Surface Water As precipitation falls on continents and islands, it flows down hills and mountains toward the lowlands and coasts. The first and smallest streams from this runoff are called **headwaters**. As these headwaters join, they form larger streams, and farther downstream they eventually form rivers. Any smaller stream or river that flows into a larger stream or river is called a **tributary**. In the central United States the Arkansas, Missouri, and Ohio Rivers are all major tributaries of the Mississippi River. The whole region drained by a river and its tributaries is called a **watershed** or **drainage basin**. Thus, the Mississippi River watershed has hundreds of tributaries and a watershed of more than 1.2 million square miles.

On continents, surface water may collect in lakes. Many lakes, including the Great Lakes along the U.S.-Canada border, were carved by glaciers during the ice ages. Other lakes, like the Dead Sea in Israel and Jordan, lie in valleys created by continental rifts. Some lakes lie in volcanic craters, like Crater Lake in Oregon. Lakes provide water supplies, fish, and recreation opportunities. Because water heats and cools more slowly than land, large lakes can also reduce the severity of the climates on their shores. This moderating effect allows palm trees to grow on the shore of Lake Geneva in Switzerland. In fact, this effect is common on almost any lakeshore.

Some lakes are not connected to an ocean. These lakes, like the Great Salt Lake in Utah, may collect minerals from runoff. As water continually flows in and evaporates, more and more minerals build up in the lake water. Thus, the lake becomes more and more salty.

Surface water is also found in **estuaries**. An estuary forms where a river meets an inlet, or small arm, of the sea. In this semi-enclosed body of coastal

Our Amazing Planet

The Everglades is still one of the world's great wetlands, although it is now about one half of its original size. The marshland once covered almost 9 million acres (3.6 million hectares).

water, seawater and freshwater mix. Chesapeake Bay on the Atlantic coast of the United States is a good example. Many estuaries provide good harbors, and most of the largest port cities in the United States lie on estuaries. Examples include New York, New Orleans, and Seattle. Estuaries are rich in shellfish and fish, so they must be carefully protected from pollution. Their usefulness as harbors often conflicts with their importance as shelters for animals.

Surface water is also found in **wetlands**. A wetland is any landscape that is covered with water for at least part of the year. They include bogs, coastal marshes, river bottomlands, and wooded swamps. The Everglades in Florida and the Okavango inland delta in southern Africa are two of the world's most famous wetlands. Wetlands support large populations of fish, shellfish, birds, and native plants. Many migrating birds depend on wetlands for food, water, and rest during their long journeys. Unfortunately, people have drained, paved, or filled many wetlands and used the land for farms, houses, and industrial sites. More than half the original wetlands in the United States have been destroyed. Preserving the remaining wetlands has become an important environmental issue.

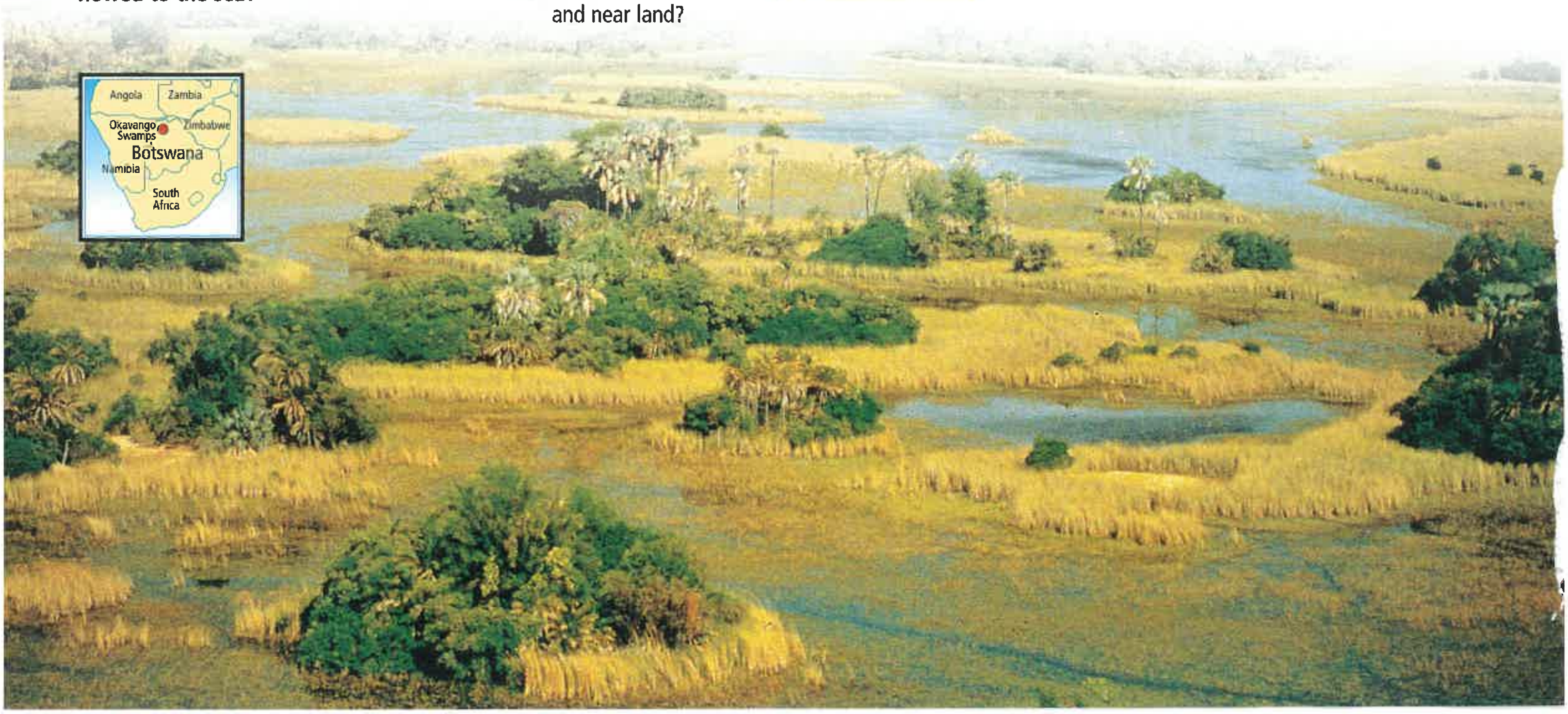
Groundwater Water found below ground is called **groundwater**. When rainwater sinks into the ground, it is first stored in the soil. Plant roots reach down through the soil to take up this water. Water in the soil slowly moves downslope and deeper underground. The cracks and spaces in the rock immediately below the soil contain both air and water. However, farther down all the spaces inside the rock are filled with water. The level at which all the spaces are filled with water is called the **water table**. The level of the water table rises and falls with rainy and dry seasons.

In some areas, groundwater is being used up as the water is pumped out for both farms and cities. As a result, water tables may drop. In addition, the ground may settle or slump where it is no longer supported by water below. This process can damage buildings, roads, sewer lines, and other structures. In some places, big cracks open in Earth's surface. For example, these cracks have caused considerable damage in southern Arizona.

✓ **READING CHECK:** ***Physical Systems*** What are some common sources of water on and near land?

INTERPRETING THE VISUAL RECORD

The Okavango River empties into an area that receives little rainfall, forming a large swamp in what is otherwise a desert. The swamp is rich in vegetation, including reeds and water lilies. Examples of the animals that live there are storks, cranes, ducks, hippopotamuses, crocodiles, and lions. ***What kinds of plants and animals might live there if the Okavango River flowed to the sea?***



INTERPRETING THE VISUAL RECORD

Floods can devastate human settlements, but they can also make human settlement possible. This satellite photo of the Nile River delta in northern Egypt shows how the river turns the desert into fertile farmland. For thousands of years, the Nile flooded along its length every year, bringing rich mud to the Egyptian fields. A dam now controls the Nile's waters. ***How do you think the Nile's flooding has affected the size of Egypt's population?***

Floods

Floods occur when rivers carry more water than the stream channels can hold. They usually result from heavy rains or sudden snow melts. Floods erode land and destroy vegetation. They can also drown people and livestock. People who do not drown may die from starvation after the flood has destroyed their crops. Others may die from diseases caused by polluted drinking water. Flooding is natural, but human activity can make floods worse. For example, people increase surface runoff when they clear vegetation from land and cover the ground with pavement and buildings. Flooding increases if rainwater cannot sink quickly into the soil.

The damage flooding causes is often increased because, for many reasons, people choose to live next to rivers. Floodplains are fertile farmland. Cities and industries are typically located along rivers because of the easy water transport, waterpower, and abundant water supply. For thousands of years, governments have been trying to control floods with dams and artificial channels. These measures work to some degree, but flood disasters still occur.

✓ **READING CHECK:** ***Environment and Society*** How do floods affect the environment and people?

Section 2 Review

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Keyword: SW3 HP4

Define desalinization, hydrologic cycle, headwaters, tributary, watershed, drainage basin, estuaries, wetlands, groundwater, water table

Reading for the Main Idea

1. ***Physical Systems*** How much of the water on Earth is liquid freshwater?
2. ***Physical Systems*** How and why do humans destroy wetlands?

Critical Thinking

3. **Evaluating** What might be some advantages and disadvantages of policies that limit economic development and water use in and around estuaries and wetlands?
4. **Drawing Inferences and Conclusions** How does the presence of buildings and roads make flooding worse?

Organizing What You Know

5. Create and label a pie graph showing the distribution of water on Earth.

Section 3

Natural Resources

READ TO DISCOVER

1. Why are soil and forests important resources?
2. What are the concerns about water quality and air quality?
3. What are some of the ways minerals are used?
4. What are the main energy resources, and how are they used?

Reading Strategy

DEVELOPING VOCABULARY Before you read, write the key terms on a sheet of paper. Leave space between each one. As you read the section, write down the meaning of each term. Then describe how the term relates to the natural resources.

DEFINE

humus
leaching
contour plowing
soil exhaustion
crop rotation
irrigation
soil salinization
deforestation
reforestation
acid rain
aqueducts
aquifers
fossil water
ore
fossil fuels
petrochemicals
hydroelectric power
geothermal energy

Soil and Forests

Landforms and water are among Earth's most visible features. They are also essential natural resources. A resource is any physical material that makes up part of Earth and that people need and value. Some of Earth's natural resources are renewable, while others are nonrenewable. Renewable resources, such as soil and forests, are those that natural processes continuously replace. Nonrenewable resources are those that cannot be replaced naturally after they have been used.

Soil Building Soil is natural material that includes both rocky sediments and organic matter. The sediments can come from the rocks below the ground surface. They may also be transported to the site by streams and the wind. The organic material can be decayed plant and animal matter. Soil differs from place to place, and there are hundreds of soil types.

Thick soil makes the state of Mississippi a fertile farming area. The layer of soil in the picture was probably picked up elsewhere by the wind and deposited there.

Near the surface, bacteria, insects, and worms break down the plant and animal material into a mixture called **humus**. These creatures—along with larger animals like rodents—open up spaces in the soil. The spaces allow air and water into the soil. Weathered rock material, organic matter, gases, and water must all be present in the soil to support plant life.

One important factor in the composition of soil is the rock the soil particles come from—the parent rock. Minerals in the soil vary depending on the type of parent rock. For example, eroded sandstone produces a different type of soil than does eroded granite or limestone. Climate is another major factor in soil variation. Moisture, sunlight, temperature, wind, and plants and animals in the soil all influence rock weathering. Soils vary between landforms as well. For example, sloping ground, like the side of a ridge, tends to erode steadily. As a result, the soil there is usually shallow. In contrast, sediments generally build up on valley floors, creating deep soils.

Soil develops very slowly, taking a few or even hundreds of years. It forms distinct layers, called soil horizons. (See the diagram.) Most soils have three layers, called the A, B, and C horizons. The upper layer, the A horizon, is also called the topsoil. This horizon is rich in humus and has active populations of plants and small animals. This horizon also has the most plant roots. The B horizon, sometimes called the subsoil, is the middle layer. This horizon is mostly minerals, but the roots of large plants penetrate to these depths. The C horizon is composed of weathered rock fragments of the soil's parent material. The depths of all these horizons can vary greatly from place to place. Taken together, the soil horizons at any place are called the soil profile.

Particularly important to soil profile development is the amount of rainwater moving through it. **Leaching** eventually moves the nutrients out of the reach of plants' roots. Leaching is the downward movement of minerals and humus in soils. Areas with abundant rain often have deep soils where many minerals have been leached downward. The result can be soil with low fertility even though the area's vegetation may be a rain forest. On the other hand, soils in dry areas are often shallow and leaching is limited. Soils here may contain abundant supplies of the minerals needed by plants.

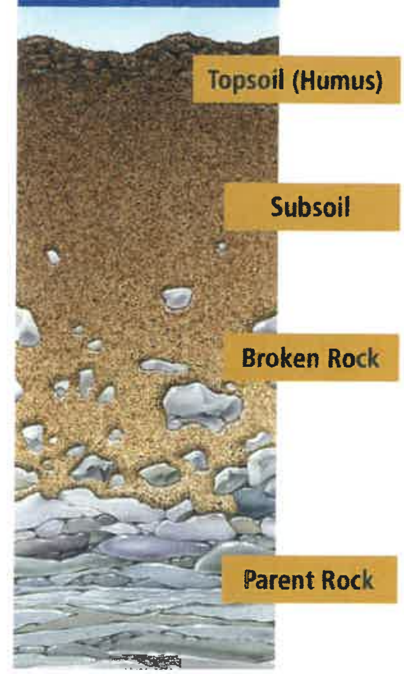
Around the world, soil profiles vary according to climate and major vegetation types. The soils beneath semiarid grasslands in central Kansas are much the same as soils beneath semiarid grasslands in Ukraine. Similarly, the soils in the rainy tropics of South America resemble the soils in the rainy tropics of Africa. However, soil profiles also vary based on local environmental conditions. For example, soils next to swamps have abundant moisture and humus, no matter what the climate is like.

✓ **READING CHECK:** ***Physical Systems*** Why do some dry areas have very fertile soil?

Sustaining Soil Resources Producing the world's food depends on soil. For this reason, preserving soil resources is important to all of us.

Soil erosion is a natural process. However, farming usually leads to increased erosion, removing soil faster than new soil can be formed. Maintaining the A horizon is particularly important because this is where most plant nutrients are found. Farmers can control erosion by plowing less and by using **contour plowing**. Contour plowing works across the hill, rather than up and down the hill. This slows the movement of water down the slope, reducing erosion.

Soil Horizons



INTERPRETING THE DIAGRAM *The three layers of soil are the topsoil, subsoil, and broken rock.* ***What physical processes may have broken the rock beneath the subsoil?***

INTERPRETING THE VISUAL RECORD

Farmers are trying to preserve the soil of this field in southeastern Washington State by using contour plowing. ***What role might the angle of a field's slope play in contour plowing?***

Crops draw certain nutrients out of the soil. If the same crop is planted year after year, a field may suffer nutrient loss. In extreme cases this loss can lead to **soil exhaustion**. This is a condition in which the soil becomes nearly useless for farming. The usual way to build up soil nutrients is with fertilizer. Some fertilizers are natural organic materials like manure and decayed plants. Chemical fertilizers are also used. Yields can also be maintained by **crop rotation**, or planting different crops in alternating years. Crop rotation gives a field time to replace naturally the nutrients used by each different crop.

People often look to the world's drylands to expand farming. Many dry regions can support farming if water is artificially supplied to the land—a process called **irrigation**. However, irrigation can lead to **soil salinization**, or salt buildup in the soil. Salt is destructive to nearly all crops. Small amounts of salt are often present in irrigation water. Evaporation of the water concentrates the salt on the surface of the soil. Irrigation can also cause salt to rise into the topsoil from the parent materials below. Soil salinization is a serious problem in many dry areas of the world, including the southwestern United States.

READING CHECK: ***Environment and Society*** How do farmers adapt to the need to avoid soil exhaustion?

Our Amazing Planet

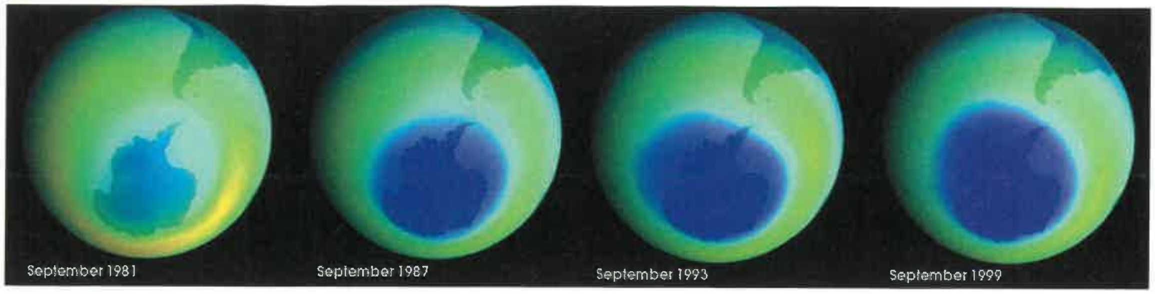
Redwoods, the world's largest trees, were among Earth's first trees. They probably date from more than 100 million years ago. Once plentiful across North America, redwoods are now limited to California and Oregon in a narrow area near the Pacific Ocean.

Forests Forests protect soil from erosion, provide habitats for many different species, and yield useful products. In addition to wood, we get food, medicines, oils, and rubber from forests.

Deforestation is the destruction or loss of forests. The tropical rain forests of Africa, Asia, and Latin America are being cleared at a rapid rate today. Logging for wood, clearing for farmland and ranch land, and cutting wood for fuel are the main causes of deforestation. Deforestation is also a problem in North America.

Many countries are taking steps to protect their forests. For example, cutting trees has been outlawed in some areas. Many countries require that new trees be planted after an area has been cut. This replanting process is called **reforestation**. In many cases the young trees can be harvested after a few decades. Still, these new forests cannot fully replace the ecological diversity of the original old-growth forests.

READING CHECK: ***Environment and Society*** What policies and regulations have countries taken to prevent deforestation?



These satellite images show how the Southern Hemisphere's ozone layer has been damaged. The purple area is a hole in the ozone. During September 2000 the hole extended for the first time over a populated area—the city of Punta Arenas, Chile. People there were briefly exposed to high levels of ultraviolet radiation.

Air and Water

All living things on Earth depend on clean air and water. Fortunately, they are renewable resources. However, as the population grows and industry expands, our air and water supplies are at risk.

Air Humans, animals, and plants need the gases in air to survive. Pollution threatens our air supply. Automobiles and factories release smoke and fumes into the atmosphere. These chemicals build up in the air, particularly in large cities. The chemicals can interact with sunlight and create a mixture called smog. Some cities, such as Los Angeles and Mexico City, have terrible smog. At high enough levels, air pollution is dangerous to human health.

Some chemicals in air pollution form a mild acid when they combine with water vapor in the atmosphere. The acid can be similar in strength to vinegar. When it falls, this **acid rain** can damage trees and kill fish in lakes.

The effects of smog and acid rain are generally short-term. Air pollution also has the potential to cause long-term change in Earth's atmosphere. Certain kinds of pollution can damage a part of the atmosphere called the ozone layer. The ozone layer is important because it absorbs harmful ultraviolet radiation

Connecting to TECHNOLOGY

Irrigation

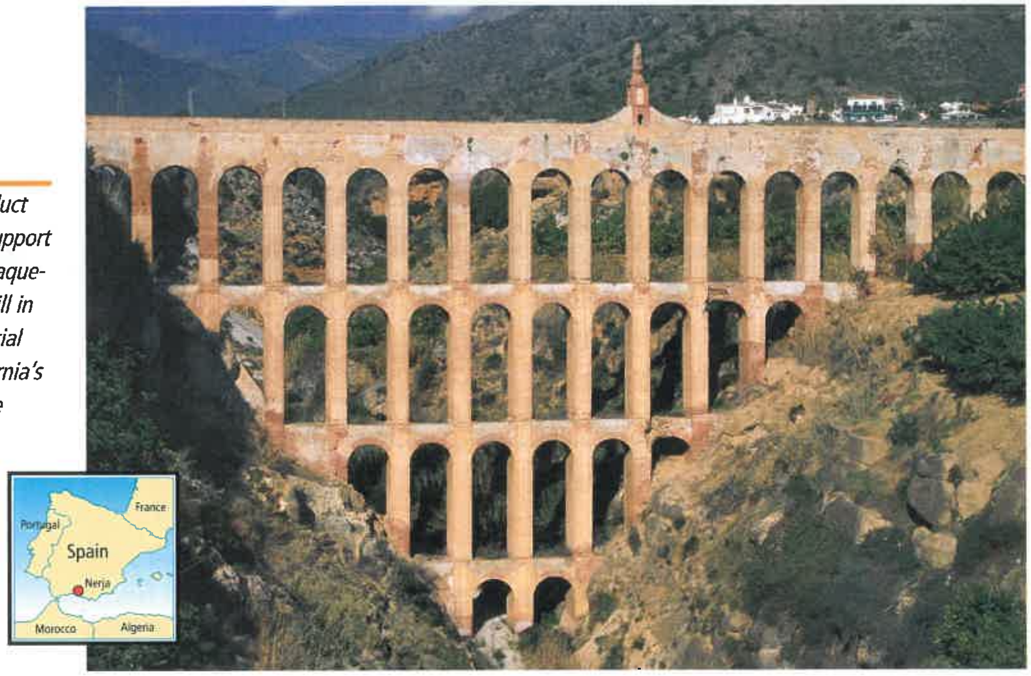
Irrigation water is delivered to farmland by many different methods. The oldest ways involve directing water into a field, usually from a small canal. This process can be as simple as flooding, in which water covers the entire surface of the field. Water can also be run into furrows—shallow trenches plowed between rows of crops. In either case, ditches are usually dug at the lower edge of the field. They allow the excess water to drain off the field. Proper drainage is very important for preventing soil salinization. If water is allowed to remain on a field and evaporate, salts are likely to concentrate in the soil.

More modern irrigation techniques use water more efficiently. Sprinkler irrigation is widely used in the United States. This method allows water flow to be controlled, from a mist to a heavy soaking. Sprinkler systems often use an automated device to travel over a field. The center-pivot system uses a long arm with sprinklers mounted on it. Anchored in the center of the field, the arm sweeps in a circle.

Drip irrigation, the most efficient method, applies water directly to the base of the plant with special "leaky" hoses. Drip irrigation is relatively expensive to set up and maintain. As a result, farmers generally use it only where water is very scarce. However, it is also used where a crop may be valuable enough to offset the high cost.

Analyzing Information How have different kinds of modern irrigation systems aided agriculture?

Sprinklers irrigate hay fields in Idaho.



The ancient Romans built this aqueduct in southern Spain. Rows of arches support the water channel at the top of the aqueduct. Some Roman aqueducts are still in use. Modern aqueducts are also crucial links in water supply systems. California's aqueduct system is the largest in the world.

from the Sun, protecting living things. As pollution damages the ozone layer, more solar radiation may cause an increase in skin cancer. You read about another long-term result of air pollution in the previous chapter. Some polluting gases may contribute to global warming.

Water In many parts of the world, maintaining a dependable supply of clean water is a major challenge. Cities and farms in dry regions often require water to be stored or transferred from other areas. For centuries, people have built complex systems of dams, canals, reservoirs, and **aqueducts**—artificial channels for transporting water.

In many dry areas, groundwater is the only dependable source of water. Thousands of years ago people learned to reach groundwater by digging wells. Today wells are drilled into the ground, and pumps bring the water to the surface. Wells are drilled to the depth of rock layers where groundwater is plentiful. These layers are called **aquifers**. Groundwater must be protected from pollution. This pollution is hard to remove.

Most groundwater is fed by rain. Because it can be preserved and managed like surface water, groundwater is usually a renewable resource. However, some groundwater, particularly in desert areas, was deposited long ago when the climate was wetter. This **fossil water** is not being replenished by rain. Today fossil water is being pumped to farmlands in many desert areas. These wells will run dry someday.

READING CHECK: *Environment and Society* How is pollution caused by humans affecting Earth's air and water?

Our Amazing Planet

Mining is dangerous! The deepest shafts of one South African gold mine reach 13,000 feet (3,962 m) below the surface. Temperatures in the mine would reach 140°F (60°C) if huge refrigeration units did not pump cool air from the surface.

Mineral Resources

Minerals are solid substances that come out of the ground. Examples include metals, rocks, and salt. Some minerals, such as the quartz in sand, are quite common. Others are hard to find—gold, for example. Over the centuries, people have developed countless uses for minerals.

Uses of Minerals Minerals are used in many processes and products, including construction, jewelry, and manufacturing. Rock, such as limestone, can be cut into blocks for building. Metals, from aluminum to zinc, are shaped into a vast range of products. Our daily lives are filled with metal objects, from airplanes to soft drink cans. Other important materials are made up of many different minerals. For example, sand that contains the mineral quartz is a key ingredient in glass.

Workers extract minerals from holes in the ground called mines. Some mines, like the gold mines in South Africa, tunnel deep underground. Other mines are open pits, some of which are miles across. Long ramps allow giant trucks to move in and out of the pit. The trucks move the **ore**—the mineral-bearing rock—to a processing plant where the valued mineral is removed.

Some minerals are truly rare. For example, gemstone-quality diamonds are minerals found in just a few countries. In addition, the deposits that contain diamonds are often only a few hundred yards across.

A mine employee shows the reddish ore of the largest iron mine in the world. This open-pit mine produces some 45 million tons of iron annually, along with gold and other metals. It is located deep in the forest of northern Brazil.

Mineral Recycling Today many products are made from recycled minerals. The advantages of recycling are obvious. For one thing, the more we recycle, the slower we will use up nonrenewable resources. For another, mines often cut great scars into the landscape. Processing plants belch dust and smoke and consume large amounts of energy. In contrast, using mineral products again can save money and spares damage to the environment. Recycling also saves space in landfills.

Recycling is not new. Precious metals like gold and silver have been reused over and over again through the centuries. However, increasing environmental awareness has encouraged more reuse of mineral products. Today aluminum, copper, and steel are often recycled.

✓ **READING CHECK:** ***Environment and Society*** Why is recycling resources important?

Energy Resources

Some of the most important nonrenewable resources are sources of energy. These energy resources have become increasingly useful and valuable as people develop new technologies that need them for power. Energy resources include coal, natural gas, and petroleum. These substances are called **fossil fuels** because they were formed from the remains of ancient plants and animals. Coal comes from ancient swamps and bogs. Petroleum and natural gas are the remains of tiny plants and animals that lived in seas and lakes. Over millions of years, heat and pressure converted the dead plants and animals into oil and gas.

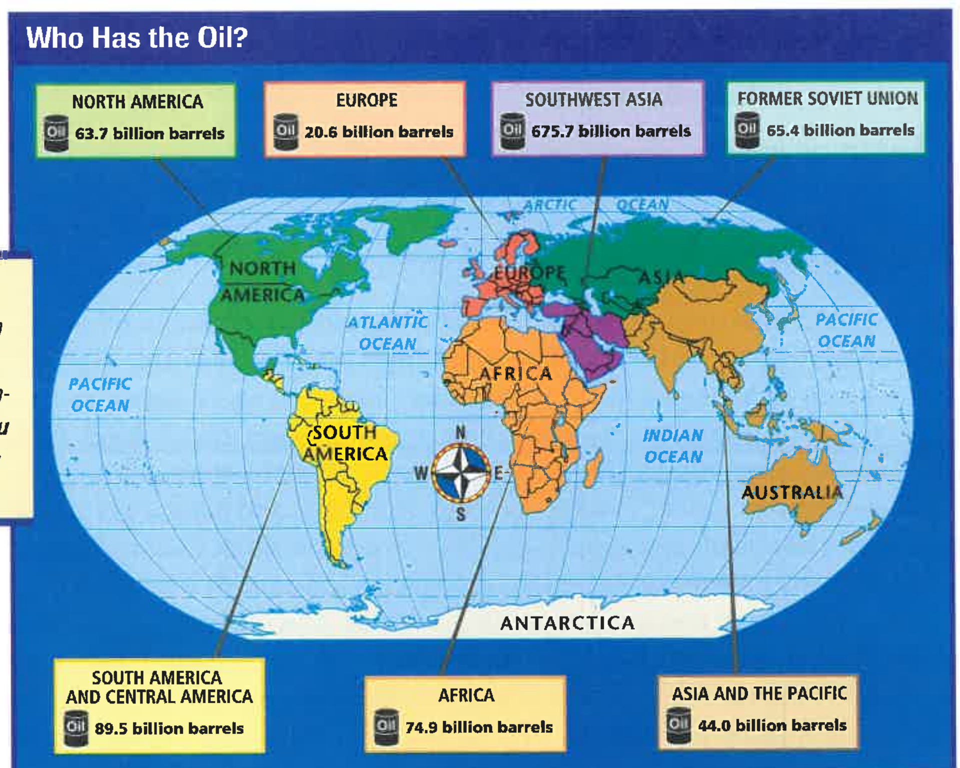
Another energy resource is uranium, a metallic element. Uranium is radioactive and provides the energy for nuclear power plants. Nuclear power does not pollute the air, but it creates waste material that remains dangerous for thousands of years. The problem of disposing of nuclear waste has limited the use of nuclear power.

Fossil Fuels Coal was the first fossil fuel to be used as a major energy source. It is a solid and is often found near the land surface. People have long used coal for heat. Coal also powered early steam engines and steel mills. Coal remains an important fuel for electric power generation. However, it has environmental disadvantages. Often it contains minerals that do not burn. This waste material either goes into the air as pollution or must be disposed of in landfills. Burning coal that contains sulfur is one of the causes of acid rain. However, coal has the advantage of being plentiful. At current rates of consumption, the world has enough coal for centuries to come.

Petroleum and natural gas come from wells drilled into deep sedimentary deposits. About 150 years ago, people began to use petroleum as fuel for lamps. The invention of the automobile later greatly expanded the market and need for petroleum, also called oil, as a fuel source. Today oil is made into gasoline, diesel and heating fuel, asphalt, and many other products. As oil has become more useful, it has become more valuable. Today its production and processing is a major industry. However, supplies are limited. Reducing the need for oil is important for our future.

Natural gas is usually odorless, but it is given an artificial smell so that leaks can be detected. Natural gas is particularly important for home and industrial heating. Both natural gas and oil are also used to generate electricity. They usually burn more cleanly than coal. Natural gas is growing in importance as a fuel. It is abundant, and supplies will certainly be available for decades to come. On the other hand, natural gas prices have been rising.

Fossil fuels are also important sources of chemicals. Coal has long been important in making dyes. Oil is the source of many important products called **petrochemicals**. Petrochemicals include the raw materials for many explosives, food additives, medicines, pesticides, and plastics. Having dependable sources of fossil fuels is a key factor for a country's economic success. Unfortunately, as



INTERPRETING THE MAP *About two thirds of all known oil deposits are located in Southwest Asia. New deposits are still being found, but Southwest Asia will probably continue to hold the largest share.* ***How do you think the location of oil deposits affects global trade routes?***

fossil fuels are burned, they release carbon dioxide. Carbon dioxide is one of the gases, called greenhouse gases, that keep extra heat in the atmosphere.

✓ **READING CHECK:** *Environment and Society* How are fossil fuels used?

FOCUS ON SCIENCE, TECHNOLOGY, AND SOCIETY

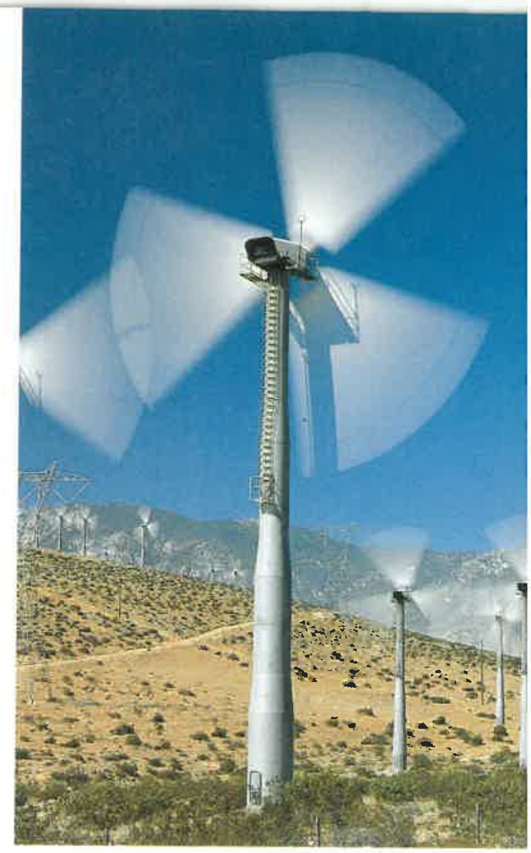
Renewable Energy Resources Renewable energy sources include waterpower, wind power, heat from Earth's interior, and solar energy. **Hydroelectric power**—electricity produced by moving water—is the most widely used type. Dams hold water back and force it to flow through narrow openings. As the water is pulled through these openings by gravity, it turns generators to produce electricity. Dams produce about 10 percent of the electricity used in the United States.

Wind has been used to propel ships for thousands of years. Windmills were also invented centuries ago. They were used to pump water out of wells or grind grain. Modern versions of windmills, called wind turbines, create electricity. Although wind contains great power, it may take thousands of wind turbines to equal the electricity of a conventional power plant. This fact limits the use of wind power.

The heat of Earth's interior, called **geothermal energy**, can also be used to generate electricity. Geothermal power plants, which capture this energy, are built in places with volcanoes or hot springs.

The energy of the Sun—solar energy—can also be used to create power. Special solar panels can absorb solar energy and convert it to electricity. Also, the Sun's rays can be concentrated and used to heat water or homes. Although solar energy has great promise, the technology needed to harness it is costly and complex. Breakthroughs in the future may make solar energy a major power source.

✓ **READING CHECK:** *Environment and Society* What has been the effect of new technologies and new perceptions of fossil fuel resources?



INTERPRETING THE VISUAL RECORD *Some renewable energy sources can also be called flow resources. These resources must be used when and where they occur. They include running water, sunlight, and wind. For example, wind power can only be effective in places that have strong steady winds. Wind turbines, like these in southern California, harness wind to produce energy.* ***How might stricter regulations on the use of fossil fuels affect the use of flow resources?***

Section 3 Review

go.hrw.com Homework Practice Online
Keyword: SW3 HP4

Define humus, leaching, contour plowing, soil exhaustion, crop rotation, irrigation, soil salinization, deforestation, reforestation, acid rain, aqueducts, aquifers, fossil water, ore, fossil fuels, petrochemicals, hydroelectric power, geothermal energy

Reading for the Main Idea

1. *Physical Systems* From which soil horizons do plants draw nutrients?
2. *Physical Systems* What are the two causes of soil salinization?

Critical Thinking

3. **Drawing Inferences and Conclusions** Are old-growth forests a renewable or nonrenewable resource? Why?
4. **Analyzing Information** How have changing perceptions of oil's usefulness made it more valuable over time?

Organizing What You Know

5. Copy the table below. Use it to list two short-term and two long-term threats to the atmosphere.

Short-term threats	Long-term threats

Geography for Life

World Ecosystems and Biomes

Plant and animal communities that cover large land areas are called biomes. Areas that share the same biome have similar ecosystems. These ecosystems display complex relationships among the area's climates, vegetation, soil, and geology. Some biomes even have the same names as some climate regions.

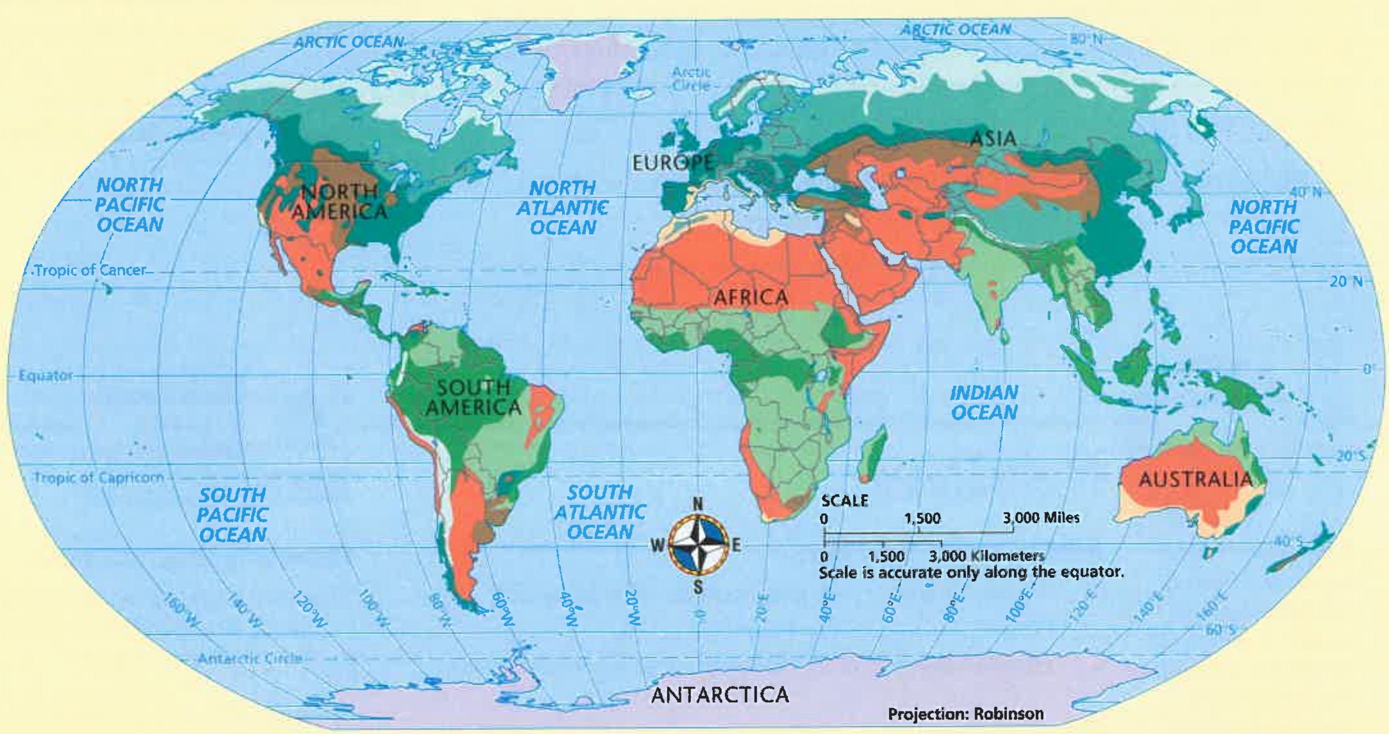
Different biomes also can be found in the oceans. In contrast to land biomes, marine biomes depend mainly on the depth at which the plants and animals live. For now, however, we will limit our discussion to biomes on land.

What's in a Biome?

A single biome can exist in places scattered around the world. Different species that live in areas with the same biome may have much in common. We can use rain forests as one case. The plants and animals in Africa's rain forests are different species than those of Brazil's rain forests. Monkeys of the Western Hemisphere, for example, are different from African monkeys. However, the two groups' appearance and behaviors are often similar because they have adapted to similar environments. Monkeys of both hemispheres spend much of their time in trees, because they find their main foods in trees.

These similarities are what make biomes such a useful way to classify large parts of the world. Geographers can make generalizations about factors like a biome's structure and seasonal growth patterns. Geographers can also generalize about ways people use the biome's plants and animals. In turn, this information can help people manage and conserve these environments.

World's Biomes



Distribution of Biomes

Latitude and the world climate zones have influenced the distribution of biomes. However, a biome results from the interaction of many factors. A sharp variation in one factor can result in a biome existing where you might not expect it. Perhaps the most dramatic examples are caused by variations in elevation. For example, the plants and animals that make up the tundra biome live in northern Alaska near the Arctic Circle. Similar life-forms can be found near the top of Kilimanjaro, a mountain on the equator in eastern Africa.

Variation in soil and geology can also determine a given place's biome type. The process of desertification provides a clear example. If animals overgraze a grassland area, wind or water can erode the topsoil. Without topsoil to support plant growth, the area can become a desert. This process can take place in a dramatically short time. On the other hand, fertile volcanic soil can support denser and more varied vegetation than thin nutrient-poor soil. Different types of fertile soil also support different plants. For example, an isolated pocket of sandy acidic soil supports a small forest of tall pines in Bastrop County, Texas. Surrounding the so-called Lost Pines are oak and pecan trees growing in different soils. Thus, two places with the same climate but different soils have different biomes.

Applying What You Know

1. **Drawing Inferences and Conclusions** Compare the map of world biomes to the map of world climate regions in Chapter 3. What connections do you see between the two distribution patterns?
2. **Analyzing Information** Describe the climate, soils, vegetation, and representative animals of the biome in which you live. What geological features do you think have influenced plant and animal life in your region? How?

Biome Legend

Biome	Climate	Soil	Vegetation	Typical Animals
Tropical rain forest	warm and rainy year-round	thin; poor in nutrients as a result of leaching	most diverse of all biomes; huge variety of trees, vines, and other plants	monkeys, lemurs, parrots, snakes, tree frogs, bats, pigs, small antelopes, tigers, jaguars, and leopards
Savanna	warm year-round; distinct rainy and dry seasons	generally poor in nutrients	tall grasses, some trees, and thorny shrubs	gazelles, rhinoceroses, giraffes, lions, hyenas, ostriches, crocodiles, and elephants
Semiarid and desert	dry; sunny and hot in tropical regions; wide temperature variations in middle latitudes	poor in organic matter but may have plentiful minerals	moisture-retaining plants such as cacti; shrubs and thorny trees	kangaroo rats, lizards, scorpions, snakes, birds, bats, and toads
Grassland	low rainfall; warm summers; cold winters	most fertile soils of all biomes	grasses; trees near water sources	lions; large grazing animals, including buffaloes, kangaroos and antelopes
Temperate forest	plentiful rainfall; warm summers; cold winters	very fertile; rich in organic nutrients	deciduous and evergreen trees; shrubs; herbs	deer, bears, badgers, squirrels, wolves, wild cats, red foxes, owls and many other birds
Mediterranean scrub forest	hot dry summers; cool wet winters	rocky; nutrient-poor soils	evergreen shrubs; scrubby trees; herbs	ground squirrels, deer, elk, mountain lions, coyotes, and wolves
Boreal forest	short warm summers; long cold winters	acidic soil	mosses, lichens, and coniferous trees	birds, rabbits, moose, elk, wolves, lynxes, and bears
Tundra	short cool summers; long cold winters	permafrost	mosses, lichens, sedges, and dwarf trees	rabbits, lemmings, reindeer, caribou, musk oxen, wolves, foxes, birds, and polar bears
Barren	cold year-round	thin; poor soils	few mosses and lichens in coastal areas	animals that depend on the sea including penguins, other birds, and seals

CHAPTER 4 Review

HOLT
Geography's Impact Video Series
Review the video to answer the closing question:
What are some reasons for water shortages, and what can be done to solve this problem?

Building Vocabulary

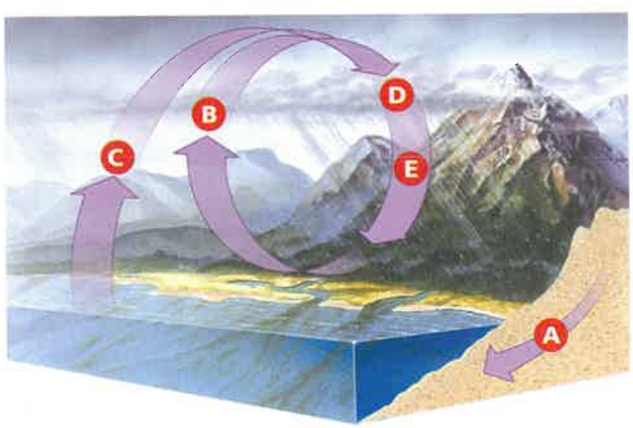
On a separate sheet of paper, explain the following terms by using them correctly in sentences.

magma	wetlands
continental drift	groundwater
abyssal plains	humus
sediment	crop rotation
plateau	irrigation
delta	fossil water
headwaters	fossil fuels
watershed	

Locating Key Places

On a separate sheet of paper, match the letters on the diagram of the hydrologic cycle with their correct labels.

evaporation	precipitation
condensation	groundwater
moist air	



Understanding the Main Ideas

Section 1

1. *Physical Systems* What are the three types of movements possible at plate boundaries?
2. *Physical Systems* What are the two physical processes that wear down landforms on Earth's surface?

Section 2

3. *Physical Systems* What process makes some inland lakes salty?

Section 3

4. *Environment and Society* What are two short-term effects of air pollution?
5. *Environment and Society* What is a major drawback of using coal as an energy source?

Thinking Critically

1. **Analyzing Information** Which would have a smoother shape, a young mountain chain or an old mountain chain? Why?
2. **Drawing Inferences and Conclusions** In an area where a rain forest has been cleared, why would you expect the soil to become exhausted quickly?
3. **Identifying Cause and Effect** What new technologies made fossil fuels more valuable over time? What effect have development and use of these resources had on the physical environment?

Using the Geographer's Tools

1. **Creating Maps** Review the maps of the United States in the atlas at the front of this textbook. Then sketch a map of the United States and shade the region drained by the Mississippi River system. In what ways do you think this and other river systems constitute a region?
2. **Analyzing Information** Sketch the soil horizons diagram. Label the A, B, and C horizons. Add arrows and symbols to the diagram to show the leaching process.
3. **Preparing Charts** Study the Plate Tectonics map. Create a chart listing each plate and the direction or directions of its movement, if any.

Writing about Geography

Keep a journal listing all the natural resources you use during a single day. Then create a journal from the point of view of a person living 50, 100, or 200 years in the past. Remember that technology changes the way people use resources. When you are finished with your two journals, proofread them to make sure you have used standard grammar, spelling, sentence structure, and punctuation.

SKILL BUILDING

Geography for Life

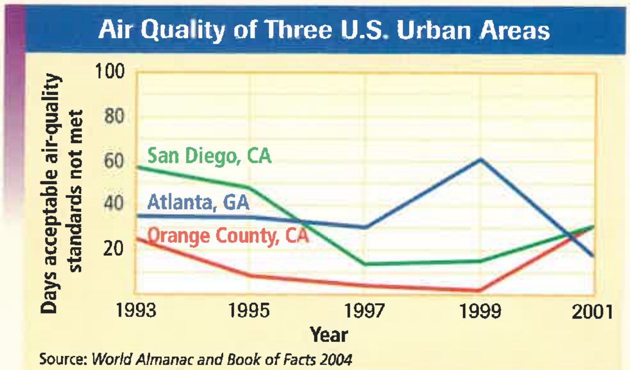
Preparing Diagrams and Models

Physical Systems Use construction paper or modeling clay to create posters or three-dimensional models of the different types of plate boundaries. Show landforms that may result, such as mountain ranges.

Building Social Studies Skills

Interpreting Graphs

Study the line graph below. Then use the information from the line graph to help you answer the questions that follow. Mark your answers on a separate sheet of paper.



1. How many days did Atlanta fail to meet acceptable air-quality standards in 1997?
   - **a.** 31
   - **b.** 61
   - **c.** 14
   - **d.** 3
2. Describe the overall pattern of air quality in Orange County and San Diego between 1993 and 2001. Then contrast those patterns with that of Atlanta during the same period.

Building Vocabulary

Answer the following questions on a separate sheet of paper.

3. *Magma* specifically means
   - **a.** layer of Earth's interior between the crust and core.
   - **b.** liquid rock.
   - **c.** rock that contains minerals.
   - **d.** Earth's solid center.
4. Many earthquakes have been caused by movement along the San Andreas Fault. In which sentence does *fault* have the same meaning as it does in the sentence above?
   - **a.** It is partly the fault of the geologist that the exploration company has gone bankrupt.
   - **b.** The fault in this circuit is preventing the light from coming on.
   - **c.** The area of deforestation is a fault in an otherwise beautiful landscape.
   - **d.** When layers of rock break and move, a fault results.

Alternative Assessment

PORTFOLIO ACTIVITY

Learning about Your Local Geography

Group Project: Field Work

As a group, learn about recycling in your community. If possible, tour your local recycling facility. Find out what materials are recycled and how they are gathered, transported, and processed. Interview workers at the recycling center or public officials to learn the costs and benefits of recycling to your community's economy and natural environment.

internet connect

Internet Activity: go.hrw.com
KEYWORD: SW3 GT4

Choose a topic about landforms, water, and natural resources to:

- create a newspaper on the causes and effects of earthquakes.
- understand the formation and uses of fossil fuels.
- analyze the different stages of the hydrologic cycle.