UNIT

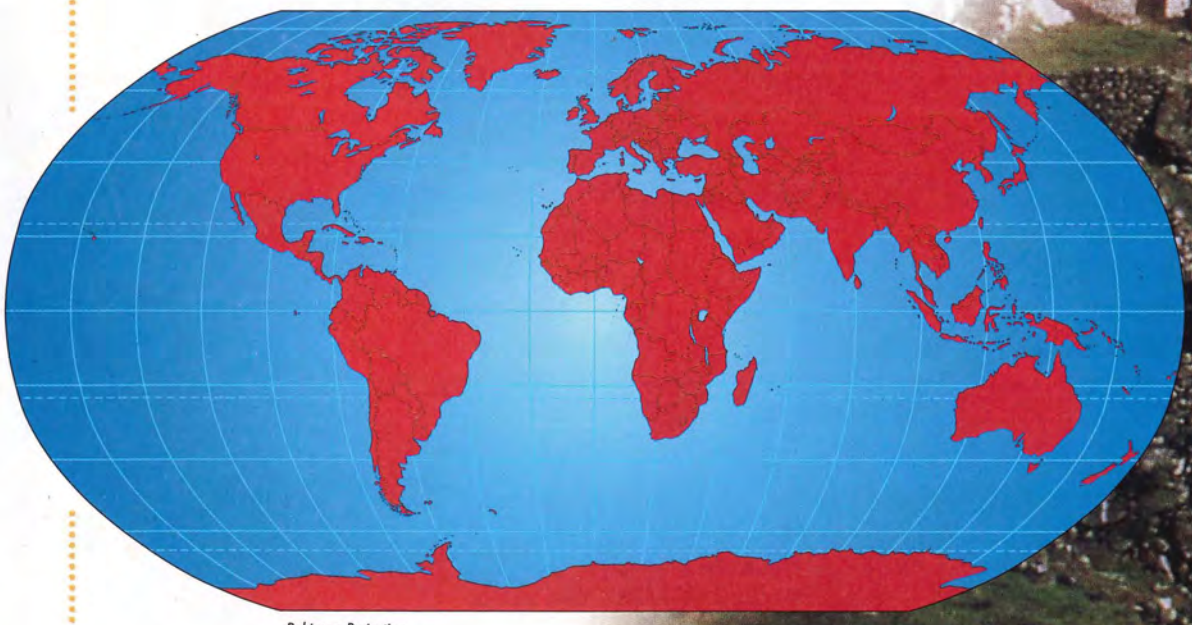
one

Physical and Human Geography

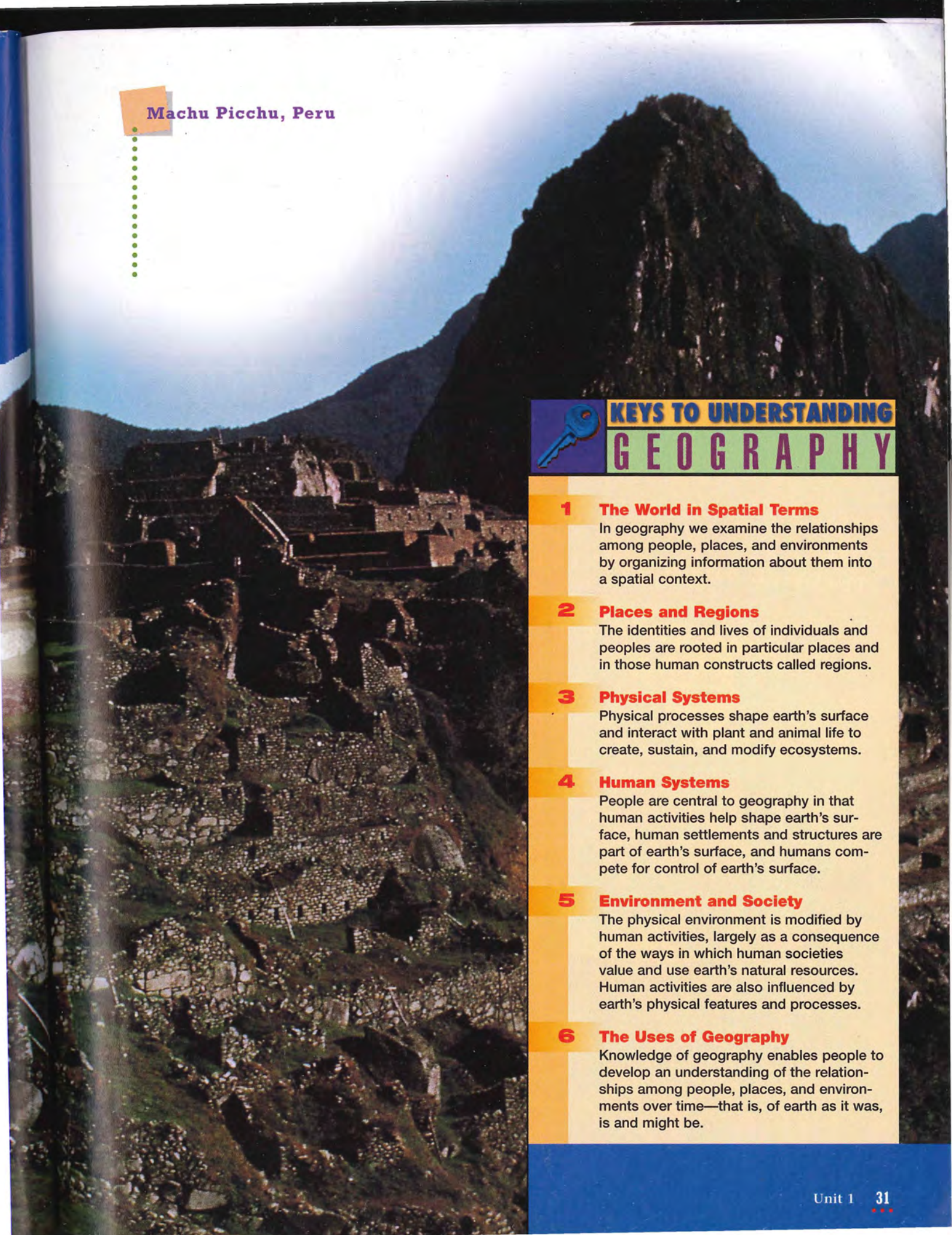
CHAPTERS

A Global Perspective

Geography allows people to find answers to questions about the world. Through the study of geography, you will explore and discover the processes that shape the earth, the relationships between people and environments, and the links between people and places. Geography will help you to build a global perspective and to understand the connections between global and local events.



Robinson Projection



Machu Picchu, Peru

KEYS TO UNDERSTANDING GEOGRAPHY

1 The World in Spatial Terms
In geography we examine the relationships among people, places, and environments by organizing information about them into a spatial context.

2 Places and Regions
The identities and lives of individuals and peoples are rooted in particular places and in those human constructs called regions.

3 Physical Systems
Physical processes shape earth's surface and interact with plant and animal life to create, sustain, and modify ecosystems.

4 Human Systems
People are central to geography in that human activities help shape earth's surface, human settlements and structures are part of earth's surface, and humans compete for control of earth's surface.

5 Environment and Society
The physical environment is modified by human activities, largely as a consequence of the ways in which human societies value and use earth's natural resources. Human activities are also influenced by earth's physical features and processes.

6 The Uses of Geography
Knowledge of geography enables people to develop an understanding of the relationships among people, places, and environments over time—that is, of earth as it was, is and might be.

CHAPTER 1

Exploring Geography

SECTIONS

The World: CONTINENTS, OCEANS, AND SEAS

Robinson Projection

learning LOCATIONS

Mapping the World

Create a map like the one above, lightly shading each continent a different color. Then add labels for the continents, oceans, and seas that are shown on this map.

1 The Five Themes of Geography

Section Preview

Main Ideas

- **Places may be described as having absolute and relative locations, and physical and human characteristics.**
- **Interactions between people and their environments have both positive and negative consequences.**

Vocabulary

geography, absolute location, Equator, hemisphere, latitude, longitude, Prime Meridian, relative location, formal region, functional region

Hang gliding provides a unique look at the earth for both man and beast.

What is your world? Is it the small area where you spend most of your time—your home, school, favorite hangout, stores, and the routes that connect them?

Or is it those locations you have visited, read about, or seen on television?

Or is it the entire earth—the small blue planet that provides a life-sustaining balance of resources for a wide range of living species?

Through the study of geography you will learn to see your world from many different perspectives. Whether you are looking at global patterns or the finer details of neighborhood patterns, you will develop valuable insights about the earth, its people, and the many different kinds of relationships between them.

The Study of Geography

We know about the world around us because people are—and always have been—curious about their surroundings. In a sense, people have always wanted to be geographers.

What is geography? *Geography* comes from a Greek word meaning "writing about," or "describing," the earth. **Geography** is the study of where people, places, and things are located and of the ways in which things relate to each other. Geography provides a way to discover and organize information regarding many aspects of the world. It explores the earth's surface and the various processes that shape it. Geography also examines the people of the world, their distinct cultures and economies, and the complex relationships that develop between people and their environments.

Does the world seem bigger than it did in ancient times because our understanding of it has greatly increased? Or does it seem smaller because it is no longer so mysterious and unknown? As we learn, our perspective changes, and so does the focus of geography. Now that we have explored almost all of the earth's land areas, geographers are paying more attention to the complex relationships and interactions between humans and natural forces around the globe.

Satellite images show the whole world looking like a small and fragile crystal ball, and in many ways, the earth is fragile. Rapidly

◀ **Signpost in Canada's Yukon Territory** *(photo left)*

A WORLD OF extremes

Mariana Trench

Extremely Deep
The Mariana Trench's Challenger Deep, the deepest spot in the world, drops 35,802 ft (10,912 m) below the ocean surface.

Under Pressure
The pressure in Challenger Deep is over 8 tons per square inch—equal to an average-sized woman holding up 48 jumbo jets.

Deep-sea Creatures
Sea slugs, tube worms, and shrimp were all captured on film by a Japanese robot that journeyed down to this most inhospitable place on earth.

Researchers explored the trench in a special submarine

growing populations, greater demands on resources, and elevated levels of pollution threaten global environments. By studying how people and natural phenomena interact at specific places and by examining movement between places, geographers can better understand the ways in which each of us operates as part of a greater whole.

Geography's Five Themes

The study of geography is fueled by human curiosity. Why are places on the earth so amazingly different from each other? Five important questions can help organize information about places:

- What is the location of a place?
- What is the character of a place?
- How do people interact with the natural environment of a place?
- How do people, goods, and ideas move between places?
- How are places similar to and different from other places?

Each of these questions is related to one of five themes that geographers use to organize their study of the world. The five themes are location, place, human-environment interaction, movement, and regions. Each theme offers a way of looking at the world and its people. The themes are not mutually exclusive. To thoroughly understand a place or problem, you need to know how the different themes relate to each other.

For example, the tiny principality of Monaco occupies steep hillsides on three sides of a beautiful natural harbor of the Mediterranean Sea. This breathtaking site is a popular destination for thousands of tourists who flock yearly to the Côte d'Azur region of southern France. However, continued movements of people into the area are causing steadily increasing pressures on the region's fragile environment.

In using the five themes to study places, geographers learn from advances and discoveries made in other natural and social sciences, such as biology and history. According to geographer B. L. Turner II:

Geographers focus on anything and everything but relate their investigations to place and space. A linkage to other disciplines is basic to addressing and answering the why of where.

Location

Geographers studying a place usually begin by finding its location. A place's location can be described in either absolute or relative terms.

Absolute Location Where is a place? One way to answer this question is by describing its **absolute location**—its position on the globe.

The most common way to find a place's absolute location is by using the imaginary lines marking positions on the surface of the earth. The **Equator** is one such line. It circles the globe halfway between the North and South poles. The Equator divides the world into two halves, or **hemispheres**. All land and water between the Equator and the North Pole is located in the Northern Hemisphere. Likewise, everything that lies between the Equator and the South Pole is located in the Southern Hemisphere.

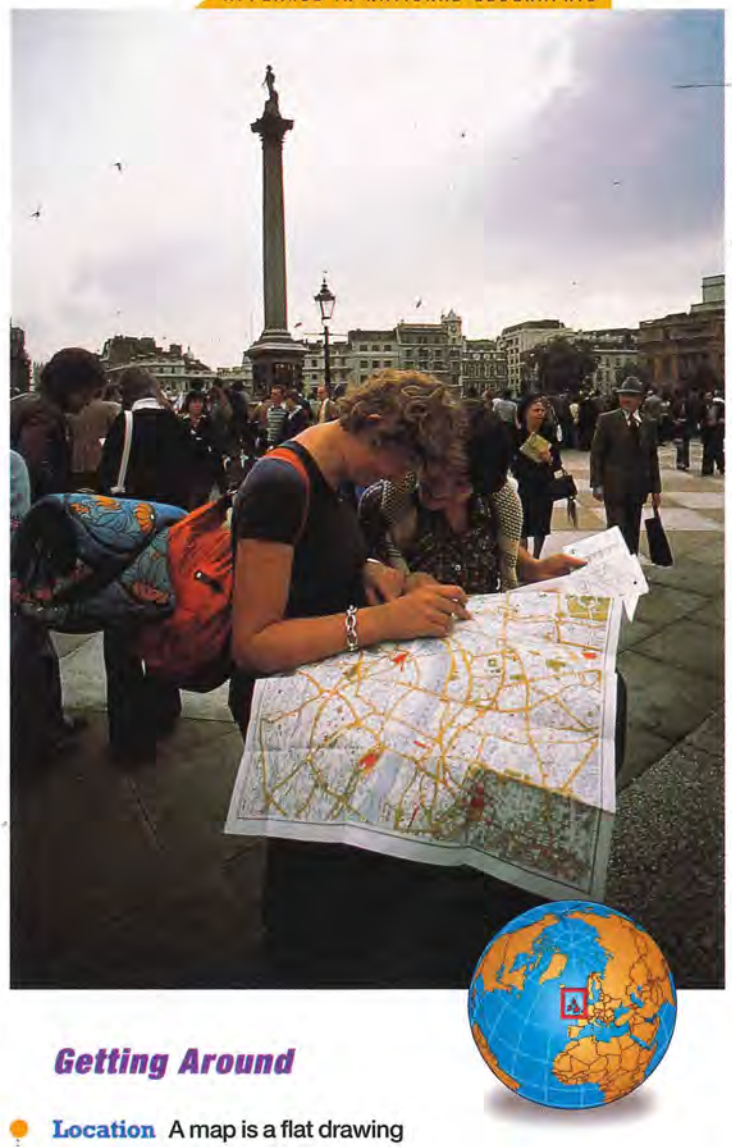
Imaginary lines that run parallel to the Equator are called lines of **latitude**, or parallels. They measure distances north or south of the Equator. The Equator is designated 0°, while the poles are 90° north (N) and 90° south (S).

Because the earth is tilted about 23½° as it revolves around the sun, the Tropic of Cancer at 23½°N and the Tropic of Capricorn at 23½°S mark the boundaries of the places on the earth that receive the most direct sunlight and the greatest heat energy from the sun. Find the Equator and the tropics in the diagram on page 5.

Another set of imaginary lines are lines of **longitude**, or meridians, which run north and south between the two poles. The **Prime Meridian**, at 0°, runs through the Royal Observatory in Greenwich, England. Other meridians are measured in degrees from 0 to 180 east (E) or west (W) from Greenwich. Unlike lines of latitude, meridians are not parallel to each other. As you can see on the diagram on page 5, the distance between meridians is greatest at the Equator but decreases as you approach the poles.

Using the grid formed by lines of latitude and longitude, you can name the precise or absolute location of any place on earth. Mogadishu, Somalia, is located at 2°N latitude and 45°E longitude. Atlanta, Georgia, is at 34°N and 84°W. See page 237 to read more about this grid system.

APPEARED IN *NATIONAL GEOGRAPHIC*



Getting Around

Location A map is a flat drawing representing all or part of the earth's surface. The tourists shown here are using a city map to find their way around Trafalgar Square in London, England. ***What is the difference between absolute and relative location?***

Critical Thinking ***Will these tourists be using absolute or relative location to find their way around London?***

Relative Location The second way to find where a place is located is by describing its **relative location**—where it is located in relation to other places. Atlanta, Georgia, for example, can be described as being southwest of Columbia, South Carolina.

GEO facts

The average American will use 7.5 million gallons of water during his or her lifetime.

Each place has only one absolute location and that location never changes. In contrast, each place has many relative locations and these can change over time. For example, while Atlanta once was many days' travel away from Los Angeles, now—thanks to the airplane—it is only a few hours away.

Place

Every place on the earth has features that distinguish it from other places. One challenge of geography is to understand how places are similar to and distinct from one another.

Physical Characteristics Places have unique physical characteristics, including landforms, vegetation, and climate. These physical characteristics vary around the world. Land may be mountainous, flat, or anywhere in between. Vegetation ranges from leafy tropical rain forests to the sparse, moss-covered tundra. Climate includes not only normal weather patterns but more dramatic occurrences like hurricanes, blizzards, droughts, and floods.

Human Characteristics Places can also be described in terms of their human characteristics. How many people live, work, and visit a place? What are their languages, customs, and beliefs? How does their economy work? How are they governed? In answering questions such as these, geographers study all aspects of human activity, such as urban growth, farming techniques, architectural styles, and politics.

Each place on the earth has a unique combination of physical and human characteristics. Returning travelers do not describe the longitude and latitude of a vacation spot. Instead they tell of the interesting people, sites, and customs that made their visit memorable. But they may also report having spoken the same language, used the same credit cards, and watched the same television shows as at home. This mix of unique and common features is what geographers mean when they talk about place.

A Modern Mosaic

Human-Environment Interaction Color-enhanced satellite imagery demonstrates the land-use patterns along the Canada–United States border. The dark-tinted land indicates Canadian grazing land, while the light-colored land indicates United States wheat fields. The red areas are land left in its natural state. ***To what degree have humans altered the landscape?***

City at Night

Movement This time-lapsed photograph shows movement of traffic in and out of Atlanta. The yellow streaks were made by car headlights, and the red streaks by car taillights. ***What role has transportation played in Atlanta's development?***

Human-Environment Interaction

The third geographic theme involves how people use their environment. Have they changed it? What are the consequences of those changes? How have people responded to changes in their environment?

Human beings have made enormous changes in their environment. Some changes are intentional and others are accidental; some changes are favorable and others are destructive. The American Southwest is one example. Before the era of swimming pools, air-conditioning, massive irrigation, and automobiles, this hot, dry region had few residents. Today it is one of the fastest-growing regions in the country. People from all over the country have flocked to this area, looking for a comfortable place to retire. New buildings and roads have altered the region's natural environment. The rapid growth in the region's population is straining the already limited supplies of water. This change may cause problems in the future.

Movement

Places do not exist in isolation. Because places have different characteristics, it follows that people, goods, and ideas will move between them. The fourth geographic theme explores the impact geography has on this movement.

Atlanta's history illustrates the importance of movement. The city was established in 1837 at the terminus, or end, of a section of railroad and was even named Terminus at first. During the Civil War, Atlanta served as a major Confederate supply center because of its rail connections. Rebuilt after the Civil War, Atlanta remained an important transportation hub in the Southeast.

Modern Atlanta still depends on movement. The city's transportation links have attracted not only manufacturers, but also companies that handle distribution tasks such as warehousing and trucking. These new jobs, in turn, have helped the city grow. In addition, Atlanta's Hartsfield International Airport is one of the nation's largest and busiest.

Regions

The last of the five geographic themes deals with regions. A region is a group of places with at least one common characteristic. Geographers divide the world into many diverse regions.

Formal regions are areas in which a certain characteristic is found throughout the area. For example, states, countries, and cities are all political regions. Within these formal regions,

APPEARED IN *NATIONAL GEOGRAPHIC*

South Pacific

Regions The village of Luatuanuu is located in Western Samoa. This area is known for its scenic beauty. ***What regional characteristics can you determine from this photograph?***

all people are subject to the same laws and are ruled by the same government. Formal regions can also be defined using other characteristics. The steppe region in Northern Eurasia consists of temperate grasslands with rich soils. The Corn Belt is the part of the United States where corn is grown in abundance. Chinatown is a part of San Francisco, California, containing many Chinese-American people, restaurants, and stores.

Functional regions consist of one central place and the surrounding places affected by it. As is true of formal regions, functional regions can be defined using several different criteria. The Amazon drainage basin in South America is the region drained by the Amazon River. The Denver, Colorado, metropolitan region consists of the city of Denver plus its surrounding suburbs.

Because various criteria can be used to define regions, the same place may be found in several different regions. From a physical perspective, Mexico is part of the North American continental region. Culturally, Mexico is linked to the Spanish-speaking nations of Central and South America.

Section 1 Review

Vocabulary and Main Ideas

1. **Define: a. geography b. absolute location c. Equator d. hemisphere e. latitude f. longitude g. Prime Meridian h. relative location i. formal region j. functional region**
2. **Describe the physical and human characteristics of the place where you live.**
3. **Give one example of the effect of movement on the history of your community.**
4. **Critical Thinking: *Making Comparisons* How does the study of a place's human characteristics differ from the study of its physical characteristics?**

learning LOCATIONS

5. **Which continent is located closest to the South Pole?**
6. **Which ocean is located closest to the North Pole?**

Focus on Skills

- [x] Social Studies
- [ ] Map and Globe
- [ ] Critical Thinking and Problem Solving

Demonstrating Visual Literacy

The Rock of Gibraltar climbs 1,400 feet into the air to guard the narrow passage between the Atlantic Ocean and the Mediterranean Sea. Use the five geographic themes to analyze the map and photo below.

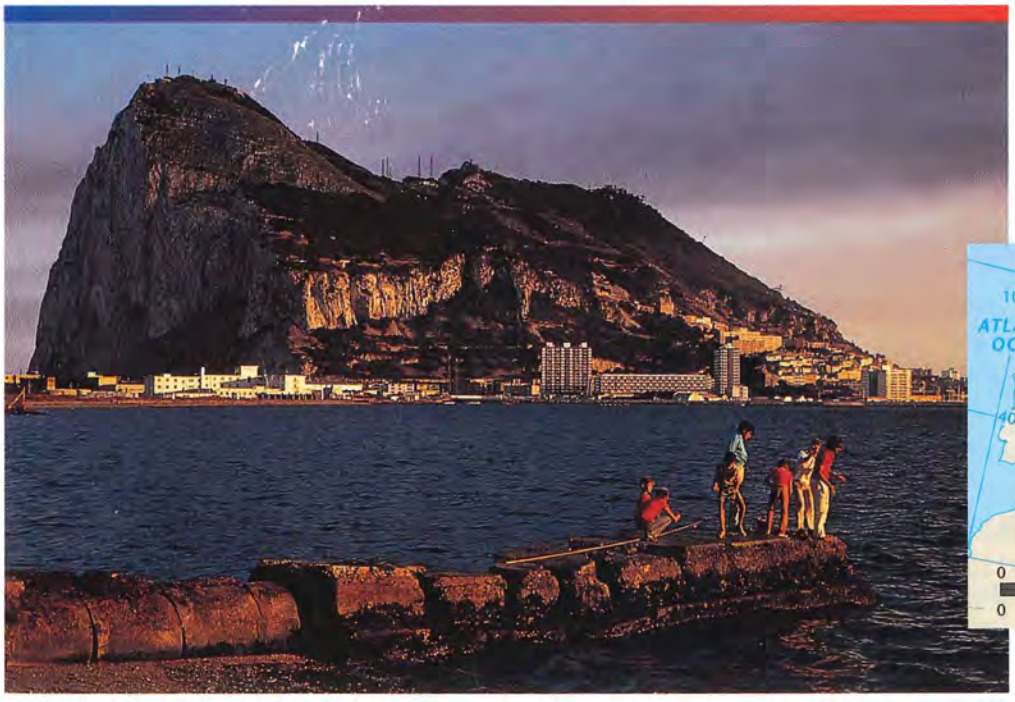
1. Identify the location of Gibraltar. An English colony since 1713, Gibraltar sits at the entrance to the Mediterranean Sea. Look on the map to find the location of Gibraltar. Then answer the following questions: (a) What is the absolute location of Gibraltar? (b) Describe Gibraltar's relative location.

2. Describe the characteristics that make the Strait of Gibraltar a unique place. Every place on earth has both physical and human characteristics that make it unique. Answer the following questions: (a) What physical feature distinguishes Gibraltar? (b) If you were standing on the Rock of Gibraltar, what two continents would you be able to see?

3. Consider the impact people have had on Gibraltar. Gibraltar has been settled since Neolithic times. It has been influenced by many cultures and races, including Phoenicians, Romans, Carthaginians, Moors, Spanish, and British. Why do you think so many different people have contributed to Gibraltar's culture?

4. Analyze how movement through the Strait of Gibraltar impacts the surrounding area. Seeking to control passage into the Mediterranean Sea, the Spanish developed Gibraltar as an important military and naval base. It was seized by the British in 1713 and remains under British control, despite several Spanish attempts to regain possession of the territory. (a) Why would a country want to control Gibraltar? (b) What water bodies can be accessed by the Strait of Gibraltar?

5. Determine the common characteristics that identify the region in which Gibraltar is located. A region is defined by a group of places that share some common characteristics. In what regions would you place Gibraltar?



Rock of Gibraltar

2 Changes Within the Earth

Section Preview

Main Ideas

- **Earth is a changing planet, affected by geologic processes.**
- **Forces inside the earth create and change landforms on the surface.**
- **The theory of plate tectonics suggests answers to many questions about the earth's landforms.**

Vocabulary

geology, core, mantle, crust, continent, relief, lava, fold, fault, plate tectonics, continental drift theory, Ring of Fire

APPEARED IN *NATIONAL GEOGRAPHIC*

Volcanic eruptions betray the dynamic forces at work within the earth.

One of geographers' biggest tasks is to understand the earth's constant changes. Earth is not a quiet planet. Earthquakes topple buildings and open up great cracks in the ground. Volcanoes erupt with red-hot lava and dangerous gases. While these are some of the more spectacular ways in which the earth is changing, they are not the only ways. Many processes—some dramatic like these, others less noticeable—are always at work shaping the earth on which we live.

The Earth's Structure

Geology—the study of the earth's physical structure and history—is a relatively new science. It deals, however, with very ancient history—that of the earth itself. This history, scientists now think, goes back about 4.6 billion years. Since it began, the earth has been changing. Geologists try to learn what those changes were, to understand why they occurred, and to predict any future changes.

Inside the Earth Scientists have developed an idea of what the interior of the earth is like. The diagram on page 41 shows the earth's layers as geologists envision them.

The **core**, or center, of the earth consists of very hot metal, mainly iron mixed with some nickel. The inner core is thought to be dense and solid, while the metal of the outer core is molten, or liquid. Around the core is the **mantle**, a thick layer of rock. Scientists speculate that the mantle is about 1,800 miles (2,896 km) thick. Mantle rock is mostly solid, but some upper layers may be pliable. The mantle also contains pockets of magma, or melted rock.

The earth's **crust**, the rocky surface layer, is surprisingly thin, like frosting on a cake. The thinner parts of the crust, which are only about 5 miles (8 km) thick, are below the oceans. The crust beneath the continents is thicker and very uneven, averaging about 22 miles (35 km) in thickness. Natural forces interact with and affect the earth's crust, creating the landforms, or natural features, found on the surface of the earth.

Land and Water Photographs of the earth taken from space show clearly that it is truly a "watery planet." More than 70 percent

of the earth's surface is covered by water, mainly the salt water of oceans and seas. The large landmasses in the oceans are the **continents**. Although some of these landforms are not completely separated by ocean waters, geographers define seven separate continents. Asia is the largest, Australia the smallest. All the continents have a variety of landforms, although those in Antarctica are hidden by ice.

Landforms are commonly classified according to differences in **relief**—the difference in elevation between the highest and lowest points. Another important characteristic is whether they rise gradually or steeply.

The major types of landforms are mountains, hills, plateaus, and plains. Mountains have high relief, rising at least 2,000 feet (610 m) above the surrounding terrain. Hills are lower, rounded, and generally less steep than mountains. The elevation of the surrounding land determines whether a landform is called a mountain or a hill. What is referred to as a mountain in the British Isles might be called a hill in western North America. It all depends on the relative height of other nearby landforms. A plateau is also a raised area, but its surface is generally level. Many plateaus, however, have deep gulleys or canyons, making the surface seem rough rather than flat. At least one side of a plateau rises steeply above the surrounding land.

Plains are landforms, too. A plain is a flat or gently rolling area where there are few changes in elevation. Many plains are along coasts.

Other landforms include valleys, canyons, and basins. Various geographical features of landscapes include rivers, peninsulas, and islands. Many of the earth's landforms are shown on the diagram on page 42.

Internal Forces

When a geologist or geographer looks at a piece of land they often ask, "What forces shaped the mountains, plains, and other landforms that are here?" Landforms are shaped first by internal forces that originate in the earth's interior. One of these forces is volcanism, which involves the movement of magma inside the earth. Other major internal forces consist of movements that fold, lift, bend, or break the rock of the earth's crust.

The Earth's Layers

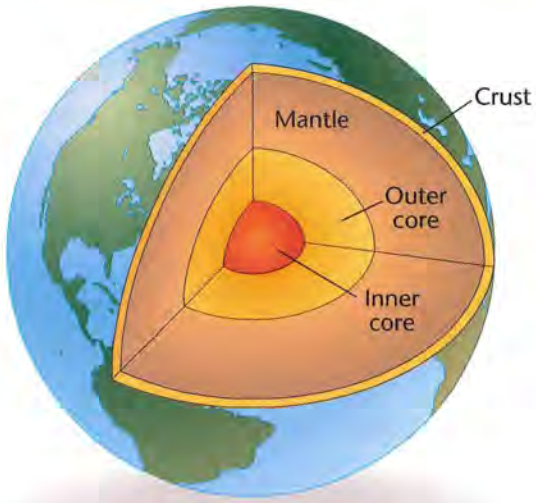


DIAGRAM STUDY

This diagram shows what geologists believe is the internal structure of the earth. Recent discoveries suggest that the inner core may be spinning at a different rate from the rest of the earth. ***What is the outermost layer called?***

Volcanoes The ancient Romans believed that a god named Vulcan worked with hot iron and gold at his forge beneath the earth. In his honor, a fiery island off the coast of Italy was named Vulcano, and all mountains formed by molten rock were called volcanoes.

Volcanoes form when magma—molten rock inside the earth—breaks through the earth's crust. On the surface the molten rock, or **lava**, may flow evenly, producing a plateau-like shield volcano. Ash and cinders erupting from a break in the ground may produce small cinder cones. Alternating sequences of explosive eruptions and smooth lava flows create distinctive cone-shaped mountains. One example of this type of volcano is Japan's Mount Fuji.

Changes in the Earth's Crust The movements that bend and break the earth's crust are varied and complex. When rock layers bend

and buckle the result is a **fold.** Other stresses on rocks cause **faults,** or breaks in the earth's crust. Sometimes the rock on either side of a fault slips or moves suddenly. Rock on one side of a fault may move sideways, up, or down in relation to the rock on the other side of the fault. Slow movements along a fault will produce subtle, almost unnoticeable changes. A large, sudden movement along a fault can send out shock waves through the earth, causing an earthquake. Whether rock layers fault or fold is determined by the hardness of the rock and the strength of the movement.

Geologic History

Most changes in the earth's surface take place so slowly that they are not immediately noticeable to the human eye. Geologists have reconstructed much of the earth's history from the record they read in the rocks. For many years scientists assumed that the basic arrangement of oceans and continents was stable and permanent. Today, however, most accept the idea that the earth's landmasses have broken apart, rejoined, and moved to other parts of the globe. This concept forms part of the plate tectonic theory, which suggests answers to many puzzling questions about the earth's landforms.

Plate Tectonics According to the theory of **plate tectonics**, the earth's outer shell is not one solid piece of rock. Instead, the lithosphere—the earth's crust and the brittle, upper layer of the mantle—is broken into a number of moving plates. The plates vary in size and thickness. The North American Plate stretches from the mid-Atlantic Ocean to the northern tip of Japan. The Cocos Plate covers a small area in the Pacific Ocean just west of Central America. These plates are not anchored in place, but slide over a hot and pliable layer of the mantle.

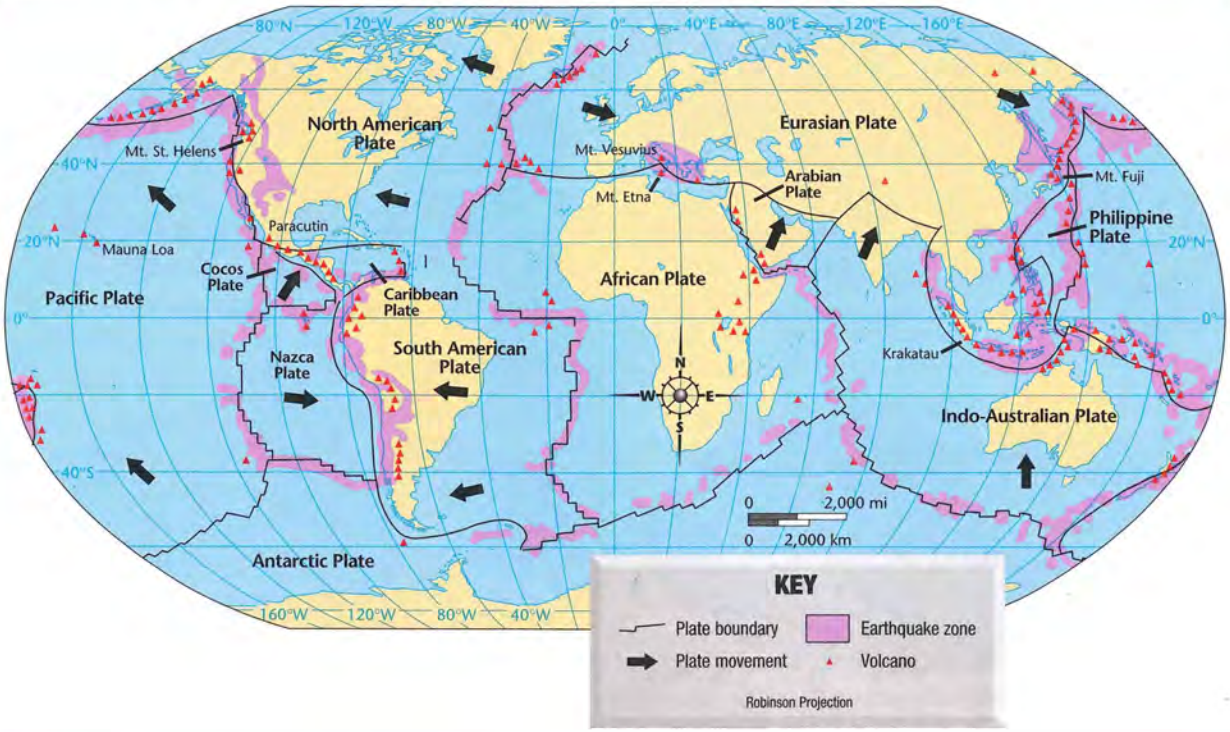
The earth's oceans and continents ride atop the plates as they move in different directions. The map on page 43 shows the boundaries of

Landforms and Water Bodies

DIAGRAM STUDY

- The diagram shows many of the earth's most common landforms. Examine the landforms and their labels. ***How does a plateau differ from a plain?***
- ***What is a delta?*** **Use the glossary beginning on page 721 to check your answer.**

Tectonic Plate Boundaries



APPLYING THE GEOGRAPHIC THEMES

- **Place** The world's continents and oceans ride atop moving tectonic plates. ***In which direction are the Nazca and South American plates moving?***
- **Critical Thinking** ***What are some results of the movement of these plates?***

the different plates. It also shows the direction in which the plates are moving. The Pacific Plate and the Nazca Plate, for example, are moving apart. The Nazca Plate and the South American Plate, however, are moving toward each other. It is along the boundaries where plates meet that most earthquakes, volcanoes, and other geologic events occur.

The plate tectonic theory began to be widely accepted in the 1960s. It was based on earlier ideas and research, however, and encompasses two other theories: continental drift and seafloor spreading.

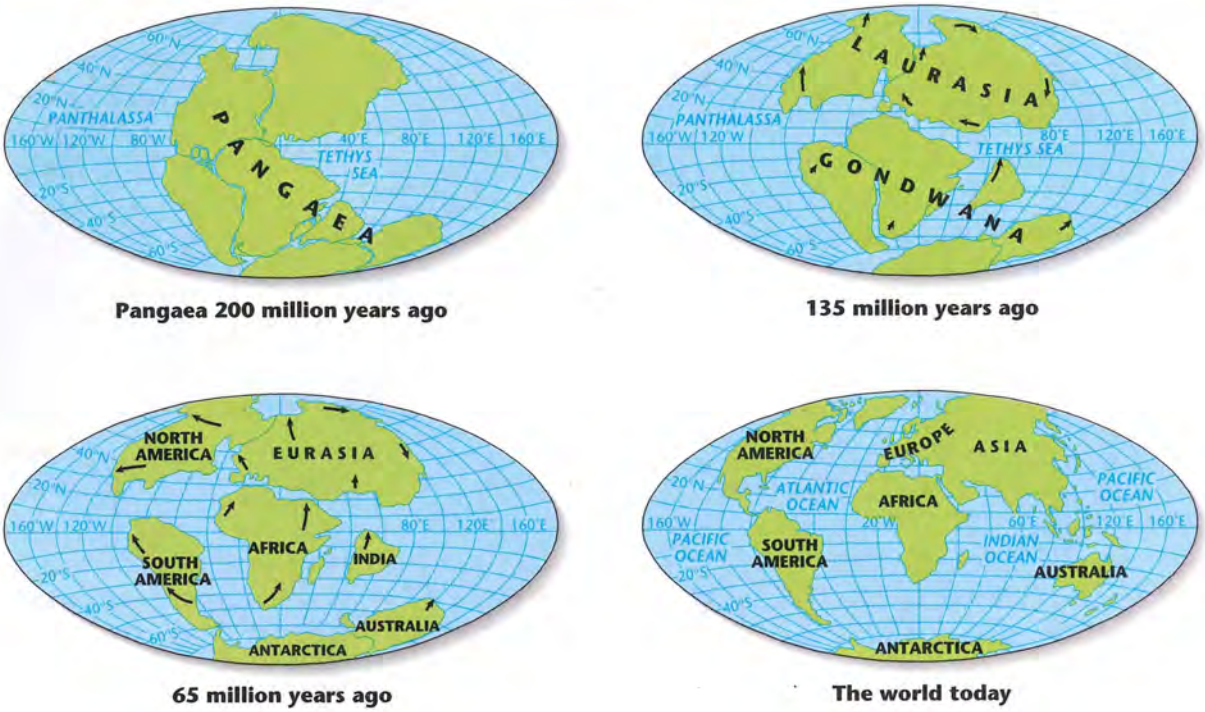
Continental Drift As early as the 1600s, people looking at maps noticed that several continents seemed to fit together like jigsaw puzzle pieces. Could they once have been joined as one gigantic landmass?

In the early 1900s a German explorer and scientist named Alfred Wegener suggested the **continental drift theory**. Wegener proposed that there was once a single "supercontinent." He called it Pangaea (pan JEE uh), from the Greek words *pan,* meaning "all," and *gaia,* personifying the earth. Wegener theorized that about 180 million years ago, Pangaea began to break up into separate continents.

To support his theory, Wegener found evidence that showed that fossils—the preserved remains of ancient animals and plants—from South America, Africa, India, and Australia were almost identical. The rocks containing the fossils were also much alike. Still, many scientists remained unconvinced by these arguments.

Seafloor Spreading The other theory supporting plate tectonics emerged from study

Pangaea and the Drifting Continents



Mollweide Projection

APPLYING THE GEOGRAPHIC THEMES

Place Scientists theorize that the earth once supported a single "supercontinent," which they have named Pangaea. ***Between which years did South America break away from Africa? What two giant landmasses do scientists believe existed 135 million years ago?***

of the ocean floor. Using sonar, scientists began to map the floor of the Atlantic Ocean. Sonar exploration revealed that the ocean floor was not flat. The landforms under water closely resembled continental landforms, including rugged mountains, deep canyons, and wide plains. Scientists were surprised to find that rocks taken from the ocean floor were much younger than those found on the continents. The youngest rocks of all were those nearest the underwater ridge system—a series of underwater mountains that extend around the world, stretching more than 40,000 miles (64,000 km).

The explanation first suggested in the 1960s is the theory of seafloor spreading. According to this theory, molten rock from the mantle rises under the underwater ridge and breaks through a split at the top of the ridge. The split is called a rift valley. The rock then spreads out in both directions from the ridge as if it were on two huge conveyor belts. As the seafloor moves away from the ridge, it carries older rocks away. Seafloor spreading, along with the older theory of continental drift, became part of the theory of plate tectonics.

Plate Movement One reason that people in the 1920s doubted the continental drift theory was the question of just *how* the continents moved. What force is powerful enough to send gigantic plates sliding around the earth?

Today, most scientists believe this force is a process called convection. Convection is a circular movement caused when a material is heated, expands and rises, then cools and falls. This process is thought to be occurring in the mantle rock beneath the plates. The heat energy that

drives convection probably comes from the slow decay of materials under the earth's crust.

When Plates Meet As mentioned earlier, the places where plates meet are some of the most restless parts of the earth. Plates can pull away from each other, crash head-on, or slide past each other.

When plates pull away from one another—a process known as spreading—they form a diverging plate boundary, or spreading zone. Such areas are likely to have a rift valley, earthquakes, and volcanic action.

What happens when plates crash into each other depends on the types of plates involved. Because continental crust is lighter than oceanic crust, continental plates "float" higher. Therefore, when an oceanic plate meets a continental plate, it slides under the lighter plate and down into the mantle. The oceanic rock then melts deep in the earth. This process is known as subduction. Molten material produced in a subduction zone can rise to the earth's surface and cause volcanic mountain building and earthquakes on the continental plate. The Andes Mountains, for example, formed over the course of millions of years as the Nazca Plate slid under the South American Plate.

When two plates of the same type meet, the result is a process called converging. When both are oceanic plates, one slides under the other. Often an island group forms at this boundary. When both are continental plates, the plates push against each other, creating mountain ranges. Earth's highest mountain range, the Himalayas, was formed millions of years ago when the Indo-Australian Plate crashed into the Eurasian Plate. Even today, the Indo-Australian Plate continues to push against the Eurasian Plate at a rate of about 2 inches (5 cm) a year.

GLOBAL Issues

Population

Human population is growing fastest along the "Ring of Fire," where most of the world's roughly 600 active volcanoes and many earthquake zones are found.

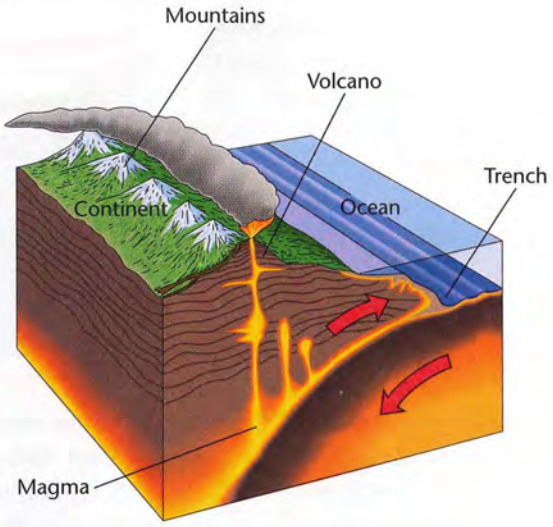
Finally, instead of pulling away from each other or colliding with each other, plates sometimes slip or grind past each other along faults. This process is known as faulting. The San Andreas Fault in California is a well-known example of faulting.

Explaining Volcanoes Plate tectonic theory attempts to explain many of the processes affecting the earth, such as volcanic eruptions. Most eruptions occur along plate boundaries. The **Ring of Fire** is a circle of volcanoes surrounding the Pacific Ocean. The ring includes the Cascades in North America, the islands of Japan and Indonesia, and the Andes in South America. Locate the "Ring of Fire" on the map on page 43.

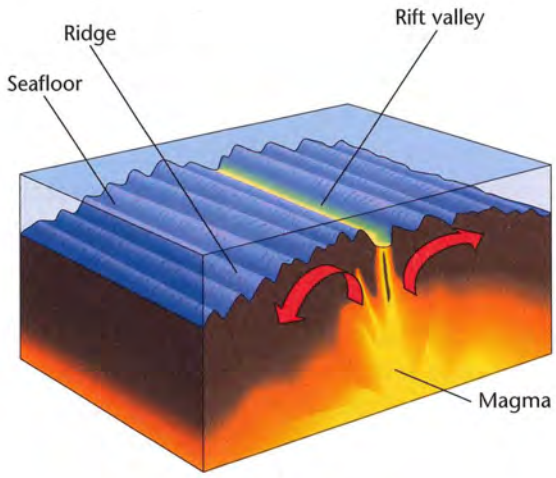
Where the Fault Lies

Regions California's San Andreas Fault lies on the boundary between two tectonic plates, the North American Plate and the Pacific Plate (see the map on page 43). The two plates are sliding past each other at a rate of 2 to 2¼ inches (5 to 6 centimeters) each year. The fault, which is over 750 miles (1,210 km) long, frequently plagues California with earthquakes. ***How does faulting differ from subduction?***

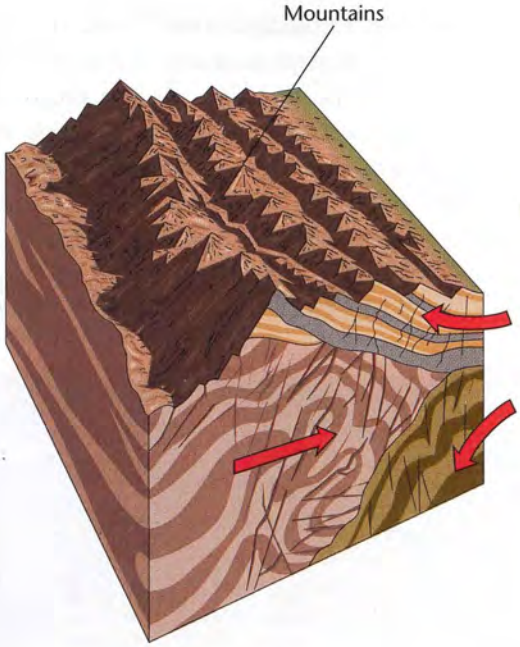
Major Types of Plate Movement



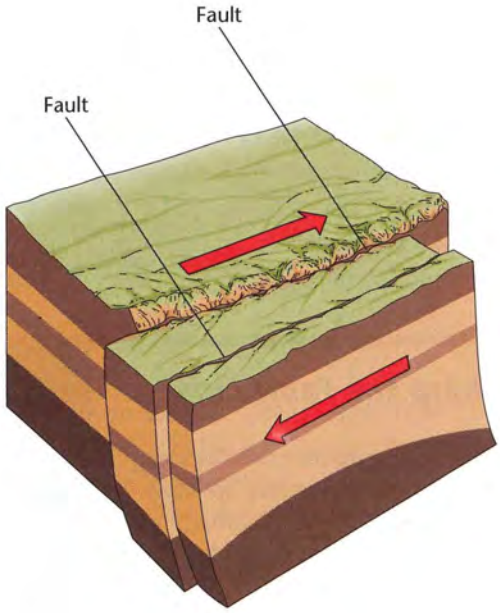
Subduction



Spreading



Converging



Faulting

DIAGRAM STUDY

In a subduction zone, one plate slides or dives under another. In a spreading zone, two plates move apart from each other, creating a rift, or crack, in the earth's crust. In a converging zone, two plates collide and push slowly against each other. At a fault, plates grind or slide past each other, rather than collide. ***Which type of plate boundary occurs when an oceanic plate meets a continental plate?***

Letting Off Steam

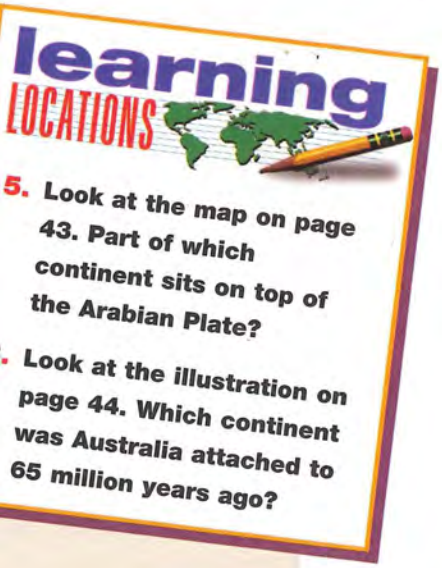
Place Hot rocks heat springs deep within the earth. Pressure from steam created at the lower depths forces the remaining water upward. Such violent eruptions of water and steam are called geysers. Old Faithful, in Yellowstone National Park, erupts once every 73 minutes. ***How are geysers similar to volcanoes?***

Plate tectonic theory also attempts to explain how volcanic island arcs, or chains of islands, are formed far away from plate boundaries. "Hot spots" are hot regions deep within the earth's mantle that produce plumes of magma that rise toward the earth's surface. As the molten rock rises from a hot spot, the magma may heat underground water and produce hot springs or geysers such as the ones found in Iceland or in Yellowstone National Park in the United States. However, if molten rock flows out of a crack in the earth's surface, it may produce a volcanic island chain as the plate drifts over a stationary hot spot. The easterly island of Hawaii is part of an island arc that formed in the center of a plate. Hawaii, which is currently over a hot spot, is constantly erupting. Other islands to the west have remained dormant since the moving Pacific Plate removed them from the hot spot.

Section 2 Review

Vocabulary and Main Ideas

1. **Define: a. geology b. core c. mantle d. crust e. continent f. relief g. lava h. fold i. fault j. plate tectonics k. continental drift theory l. Ring of Fire**
2. **What are the two internal processes that create landforms?**
3. **How can the plate tectonic theory help explain the formation of the Andes and Himalayan mountains?**
4. **Critical Thinking: *Making Comparisons* Use the map on pages 28 and 29 to identify three types of landforms that are found on the ocean floor.**



5. **Look at the map on page 43. Part of which continent sits on top of the Arabian Plate?**
6. **Look at the illustration on page 44. Which continent was Australia attached to 65 million years ago?**

3 Changes on the Earth's Surface

Section Preview

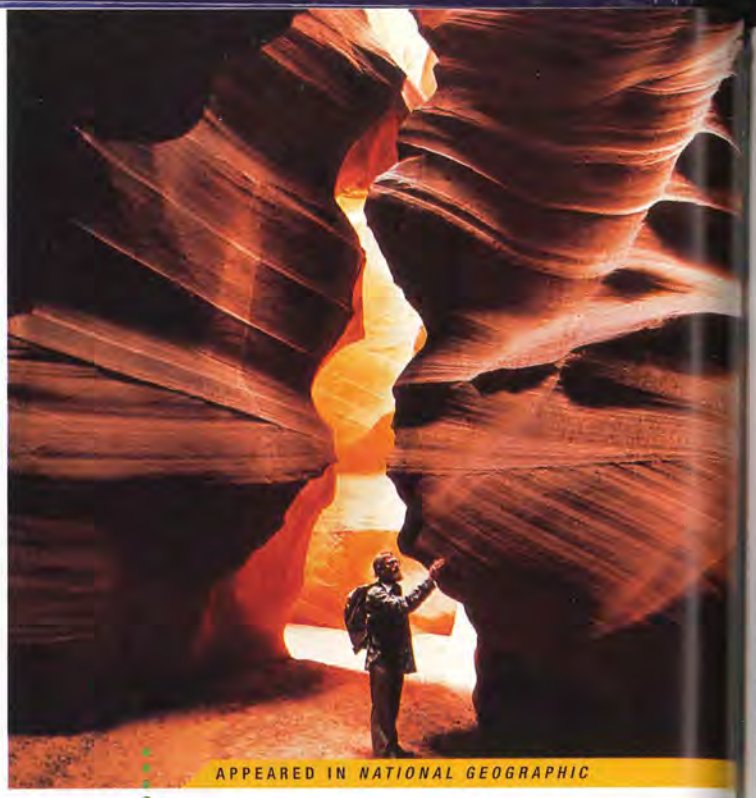
Main Ideas

Mechanical and chemical weathering are forces that change landforms.

Erosion is another external process that alters the surface of the earth.

Vocabulary

weathering, mechanical weathering, chemical weathering, acid rain, erosion, sediment, loess, glacier, moraine



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Portions of the earth have been sculpted into magnificent shapes by weathering and erosion.

Mixed in the soil of the Hawaiian Islands is a crumbly, gray clay that is older than the islands themselves. For years scientists wondered how this soil had formed. Now they think that the clay comes from a desert in far-off China. Blown across thousands of miles of ocean by the wind, it was deposited on the islands by centuries of rainstorms. This process is still going on today. World Watch Institute president Lester Brown explains:

> *So much soil from the Asian mainland blows over the Pacific Ocean that scientists taking air samples at the Mauna Loa observatory in Hawaii can now tell when spring plowing starts in North China.*

Wind is only one of several external agents that change the earth's surface. These forces, which can act over thousands or even millions of years, are usually grouped into two broad categories: weathering and erosion.

Weathering

Weathering is the breakdown of rock at or near the earth's surface into smaller and smaller pieces. Over millions of years, weathering can reduce a mountain to gravel. There are two kinds of weathering: mechanical and chemical.

Mechanical Weathering The process of **mechanical weathering** occurs when rock is actually broken or weakened physically. Mechanical weathering breaks large masses of rock into even smaller pieces, producing boulders, stones, pebbles, sand, silt, and dust. The most common type of mechanical weathering takes place when water freezes to ice in a crack in the rock. Because water expands when it freezes, the ice widens the crack and eventually splits the rock. This process is known as frost wedging.

Frost wedging is most likely to occur in areas where the freezing is both frequent and intense. Over time it can even cause huge parts of a mountainside to break and fall away. This form of

weathering can easily be observed above the tree line in mountainous areas.

Another kind of mechanical weathering occurs when seeds take root in cracks in rocks. In the same way as sidewalks crack when tree roots grow beneath them, a rock will split as plants or trees grow within a fracture.

Chemical Weathering While mechanical weathering can destroy rock, it changes only the physical structure, not the original crystals or minerals that make up the rock. It leaves the chemical structure unchanged. One important effect of mechanical weathering is to expose bedrock to the forces of **chemical weathering**. The process of chemical weathering alters a rock's chemical makeup by changing the minerals that form the rock or combining them with new chemical elements. Unlike mechanical weathering, chemical weathering can change one kind of rock into a completely different kind.

The most important factors in chemical weathering are water and carbon dioxide. Carbon dioxide from the air or soil combines with water to make a weak solution of carbonic acid. When the acidic water seeps into cracks in certain types of rock, such as limestone, it can dissolve the rock. Many caves were formed in this way.

Moisture is an important element in chemical weathering. In dry regions where water is scarce, there is little chemical weathering. But in a damp or wet area, chemical weathering occurs quickly and is widespread. Chemical weathering is also more likely to occur under high temperature conditions than in cooler regions.

Another type of chemical weathering is **acid rain**. Chemicals in the polluted air combine with water vapor and fall back to earth as acid rain. Acid rain not only destroys forests and pollutes water, but also eats away the surfaces of stone buildings and natural rock formations. Industrial pollution, acid-producing agents from the ocean, and volcanic activity are among the known causes of acid rain. For more information about the effects of acid rain, see the Geographer's Lab on pages 382 and 383.

Rock Unsolid

Human-Environment Interaction
Chemical weathering has contributed to the bedraggled look of this stone traveler. ***What impact has human activity had on acid rain?***

Observing Weathering The effects of weathering can be seen on almost any old stone structure. Weathering blurs the lettering on old tombstones, softens the sharp features on carved stone statues, and breaks down the mortar that holds together stone or brick walls.

Weathering changes natural landforms, too. Over millions of years, mountains can be worn from jagged peaks to rounded hills. In an area where temperature changes cause frost wedging, the south side of a mountain in the Northern Hemisphere is likely to be more rugged than the north slope. Because the south side receives more sunlight, water in the cracks of rocks thaws and freezes more often than on the cold north

Rising Waters

Regions Water can make dramatic changes to the earth's surface. Some changes, such as the creation of canyons, are made slowly over time. Other changes are more immediately felt. Water overflowing the Mississippi River can flood homes and farms located on the flood plain. ***What do river waters carry?***

side. As a result, rocks on the southern slope are more likely to split and fall away, making the mountainside uneven.

Erosion

Erosion is the movement of weathered materials such as gravel, soil, and sand. The three most common causes of erosion are water, wind, and glaciers.

Erosion is an important part of the cycle that has made and kept the earth a place where living things can survive. Without this process, the earth's surface would be barren rock, with no soil where plants can grow. Erosion is actually a significant agent in mechanical weathering. The erosive forces that caused the "weathering away" that created Niagara Falls and the Grand Canyon, for example, are all part of mechanical weathering.

Water The largest canyons and the deepest valleys on the earth were created in part by moving water. Moving water—rain, rivers, streams, and oceans—is the greatest cause of erosion. Over time, water can cut into even the hardest rock and wear it away.

It is not water alone that carves out valleys and canyons. Water moving swiftly down a streambed carries **sediment**—small particles of soil, sand, and gravel. Like sandpaper, the sediment helps grind away the surface of rocks along the stream's path.

The rocks and soil carried away by water are eventually deposited somewhere else. When the stream or river slows down, sediment settles out of the water and lands on the banks or streambed, creating new kinds of landforms. A broad flood plain, or alluvial plain, may form on either side of the river, or a delta may form. A delta is a flat, low-lying plain that is sometimes formed at the mouth of a river—the place where the river enters a lake, a larger river, or an ocean.

The Mississippi River, for example, carries an estimated 500 million tons (454 million metric tons) of sediment a year. The river deposits some of this rich sand, silt, gravel, and clay along its flood plain, which is as much as 80 miles (129 km) wide in some places. The rest of the sediment builds up in the delta where the river empties into the Gulf of Mexico.

Rivers and streams play the largest role in water erosion. But crashing ocean surf or the gentler waves along a lakeshore can also erode beach cliffs, carve steep bluffs, and pile up sand dunes. As bluffs are undercut by the force of water, rocks tumble down cliffs into the

water. Continuing erosion wears rocks into sandy beaches, then carries the sand farther down the shoreline.

Ocean waves may move sand away from the shore. For example, the barrier islands off the coast of North Carolina, known as the Outer Banks, have been slowly eroding away due to wave action. The Cape Hatteras Lighthouse built in 1870 on the Outer Banks once stood over 3,000 feet (1,000 m) from the ocean. Now the ocean laps at the shore less than 200 feet (60 m) from the base of the lighthouse.

Wind Wind is a second major cause of erosion, especially in areas with little water and few plants to hold the soil in place. In the 1930s wind erosion devastated the Great Plains in the central United States. As the population grew farmers plowed under more farmland. More land was stripped of its plant life and was exposed to the wind. The upper layers of soil that are usually rich in minerals and nutrients were dry from a long drought. As a result, the wind that swept across the Great Plains picked up and carried away the soil in great dust storms. As their farms' fertile soil blew away, several states became part of what was called a "dust bowl." Writer George Greenfield described it in this way:

> ***In this country there is now no life for miles upon miles; no human beings, no birds, no animals. Only a dull brown land with cracks showing. Hills furrowed with eroded gullies—you have seen pictures like that in ruins of lost civilizations.***

On the other hand, the windblown deposits of mineral-rich dust and silt called **loess** (luss) have benefited farmers in China, the American Midwest, and other parts of the world. Loess is valued in part because it is extremely porous. This allows it to absorb and hold on to great amounts of water. Because its particles are so fine, loess may be blown thousands of miles.

Sandstorms, or windblown sand, are major causes of erosion, especially near deserts. Just as sandblasting cleans stone buildings, windblown sand carves or smoothes the surfaces of both rock formations and objects made by humans.

Sand and dust carried by the wind are eventually deposited when the wind dies down. The cumulative effects of windblown sand can be seen both in the desert and along ocean shores in the form of sand dunes, loose windblown sand heaped into a mound or a low hill. Winds may move shifting dunes so far that they bury any vegetation or human

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Winds of Change

Human-Environment Interaction Strong winds have caused sands to drift like snow, nearly burying this Texas farm. ***How has human activity contributed to erosion?***

Regions In the 1930s, the Great Plains suffered severe effects of drought and erosion. Much of its rich top soil was lost to scouring winds. ***What was this area called?***

Ice Sculpture

Regions Columbia Glacier in the Canadian Rocky Mountains is an example of an alpine glacier. Alpine glaciers form on mountainsides and move downhill by the force of gravity. ***How do glaciers alter the landscape?***

Critical Thinking ***Explain why you think Columbia Glacier will bring great or small changes to the landscape.***

settlements in their path. Grasses that take root in ocean dunes help prevent further wind erosion. Human development along the shoreline has contributed to beach erosion. When natural vegetation barriers are removed for construction, wind erosion occurs at a faster pace.

Glaciers Another major agent of erosion is **glaciers**—huge, slow-moving sheets of ice. They form over many years as layers of unmelted snow are pressed together, thaw slightly, and then turn to ice. As glaciers move, they carry dirt, rocks, and boulders. The terrain is worn away by the rock debris dragged along with the moving ice.

When the earth was cooler than it is today, much of the planet's water became locked up in immense glaciers that covered up to a third of the earth's surface. Over thousands of years the glaciers melted back, then grew again when the earth became colder. Long periods of these colder temperatures are known as Ice Ages. Geologists believe that there have been at least four Ice Ages in the past 600 million years, the last of which peaked about 18,000 years ago.

If you live in the northern part of the United States you might see the effects of Ice Age glaciers. Like giant bulldozers, glaciers scooped out the basins of the Great Lakes, as well as thousands of smaller lakes elsewhere in the United States and Canada. When glaciers melted and receded in some places, they left behind ridgelike piles of rocks and debris called **moraines** (muh RAYNS). In some places, moraines acted like dams, blocking valleys and creating areas where water collected into lakes. In other cases glacial debris formed long ridges of land. Long Island in New York is one such example of a moraine.

The glaciers of the Ice Ages were mainly continental glaciers, or ice sheets. Today such broad, flat glaciers exist in only a few places in the world. They cover about 80 percent of Greenland and most of the continent of Antarctica. The Greenland glacier is estimated to be 9,900 feet (3,018 m) thick. The front of the glacier usually moves forward a few feet each winter and then recedes during the summer. Great chunks of continental glaciers frequently break off from the edges of the ice sheets to produce floating icebergs.

Valley or alpine glaciers, on the other hand, are found throughout the world in high mountain valleys where the climate is not warm enough for the ice to melt. In North America,

valley glaciers snake through the Rocky and Cascade mountains, the Sierra Nevada, and the Alaskan ranges.

Although glaciers are sometimes described as "rivers of ice," they do not move and flow quickly like water. Glaciers slide forward because of their great weight. The entire mass does not move at once; rather it oozes outward down-valley from the top of an alpine glacier. Large valley glaciers in Europe may move nearly 600 feet (183 m) in a year. Glacial landscapes are distinctly different from landscapes formed by water. While rivers cut sharp-sided, V-shaped valleys, glaciers carve out valleys that are rounded and U-shaped. The amount of erosion that occurs when a glacier passes by depends partly on the size and speed of the glacier and partly on the terrain and texture of bedrock being covered. On flat land, glacial erosion is relatively minor. In mountainous areas the erosion can be significant.

Section 3 Review

Vocabulary and Main Ideas

1. **Define: a. weathering b. mechanical weathering c. chemical weathering d. acid rain e. erosion f. sediment g. loess h. glacier i. moraine**
2. **What are the two most important forces in chemical weathering?**
3. **What are the three most common causes of erosion?**
4. **Critical Thinking: *Making Comparisons* Which process—weathering or erosion—is easier to see actually taking place? Explain your answer.**

learning LOCATIONS

5. **On which continent is the Great Plains, site of the "dust bowl" of the 1930s, located?**
6. **What continent is mostly covered by glaciers?**

CHAPTER 1

Review and Activities

Summarizing Main Ideas

Section 1 The Five Themes of Geography

- The theme of location describes where a place is in absolute or relative terms.
- The theme of place describes the features that make a place unique.
- The theme of human-environment interaction describes the ways in which people and their environment have affected one another.
- The theme of movement describes how people, goods, and ideas move between places.
- The theme of regions classifies places according to characteristics that they share.

Section 2 Changes Within the Earth

- The earth consists of a hot metal core surrounded by a thick mantle and topped off by a relatively thin rock crust.
- The theory of plate tectonics states that the top layers of the earth are broken into a number of huge, moving plates.
- The movement of plates explains the formation of separate continents and the creation of volcanoes.

Section 3 Changes on the Earth's Surface

- Mechanical weathering breaks large rocks into smaller ones.
- Chemical weathering, caused mainly by water and carbon dioxide, turns rock into other substances.
- Erosion—caused by water, wind, and glaciers—moves materials such as soil and sand across the earth's surface.

Reviewing Vocabulary

Use each of the following terms in a sentence that shows its meaning.

1. **geography**
2. **absolute location**
3. **Equator**
4. **hemisphere**
5. **latitude**
6. **longitude**
7. **relative location**
8. **formal region**
9. **functional region**
10. **continent**
11. **weathering**
12. **erosion**

Applying the Geographic Themes

1. **Location** How does the theory of plate tectonics explain the location of certain mountain ranges?
2. **Place** How do wind and water alter places on the earth's surface?
3. **Human-Environment Interaction** In what ways do the houses that people build reflect the environment in which they live?
4. **Movement** What factors might cause people to want to move to a new place? What factors might force people to move?
5. **Regions** Do all the places in any given region look alike? Explain.

Critical Thinking and Applying Skills

1. **Drawing Conclusions** Explain how erosion can have both negative and positive effects and provide at least one example of each.
2. **Expressing Problems Clearly** Living near the boundaries of moving plates can be dangerous. Explain why this statement is true.
3. **Demonstrating Visual Literacy** Look again at the photograph of Atlanta on page 37. Identify how each of the five geographic themes are represented in the picture.

Journal Activity

Writing Across Cultures

1. Using each of the five geographic themes, describe a favorite place from your childhood. Your description should also explain why that place is important to you.

2. Though acid rain is caused by industrial pollution, winds can carry acid rain thousands of miles away from the sources of that pollution. Explain how this makes the problem of acid rain more difficult to confront. Describe the problem from two points of view: a country that produces a great deal of pollution, and a country that produces little pollution but suffers from acid rain anyway.

INTERNET link

Visit the Learning Web at the U.S. Geological Survey to learn more about the world we live in:

- http://www.usgs.gov/education/living

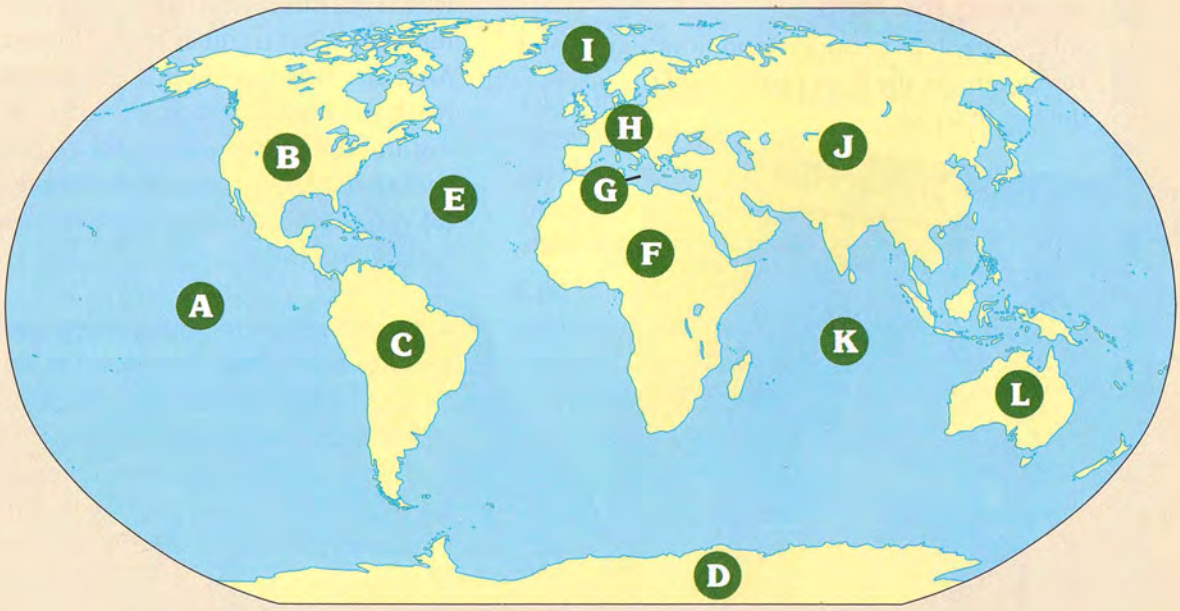
Choose a topic which interests you and explore it. When you are done, write a paragraph stating what you learned.

learning LOCATIONS

Continents, Oceans, and Seas

Number from 1 to 12 on a piece of paper. Next to each number, write the letter of the place on the map that corresponds to the places listed below.

1. Africa
2. Antarctica
3. Asia
4. Australia
5. Europe
6. Mediterranean Sea
7. North America
8. South America
9. Arctic Ocean
10. Atlantic Ocean
11. Indian Ocean
12. Pacific Ocean



Map Skills for Life

Skill: Reading a Building Floor Plan
Setting: Touring the U.S. Capitol

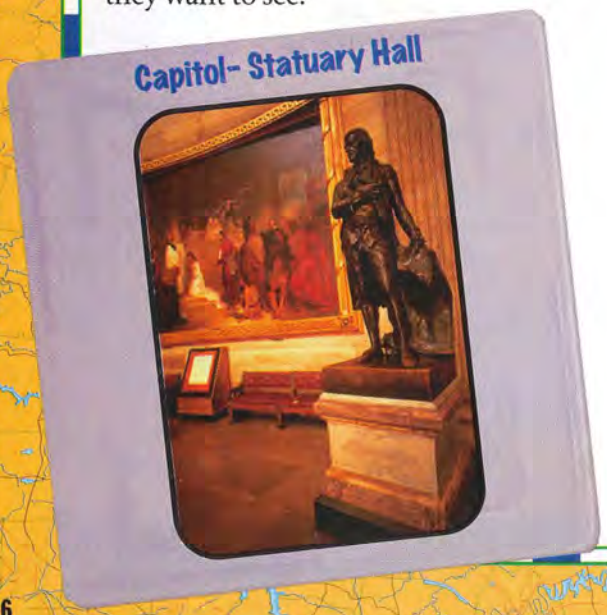
Marcus and Teresa, along with their classmates, are on the annual school trip to Washington, D.C. As they tour the capital of the United States, they plan to visit the White House and the Lincoln Memorial. They also want to visit the Capitol building, where the Senate and the House of Representatives meet.

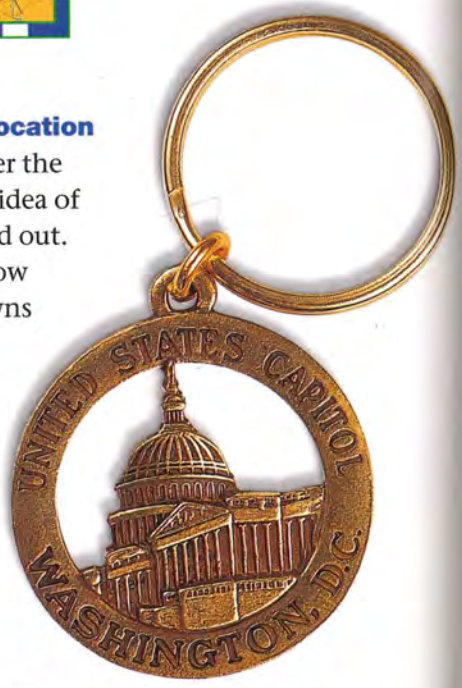
Since Congress is in session, this is a good time to visit the Capitol. Teresa and Marcus want to see the following places:

- ★ the House Chamber, where the House of Representatives meets.
- ★ the Senate Chamber, where the U.S. Senate meets.
- ★ Statuary Hall, with its many marble statues of distinguished Americans.

Reading the Map

Follow the steps to understand how Marcus and Teresa can use the floor plan to find the places they want to see.



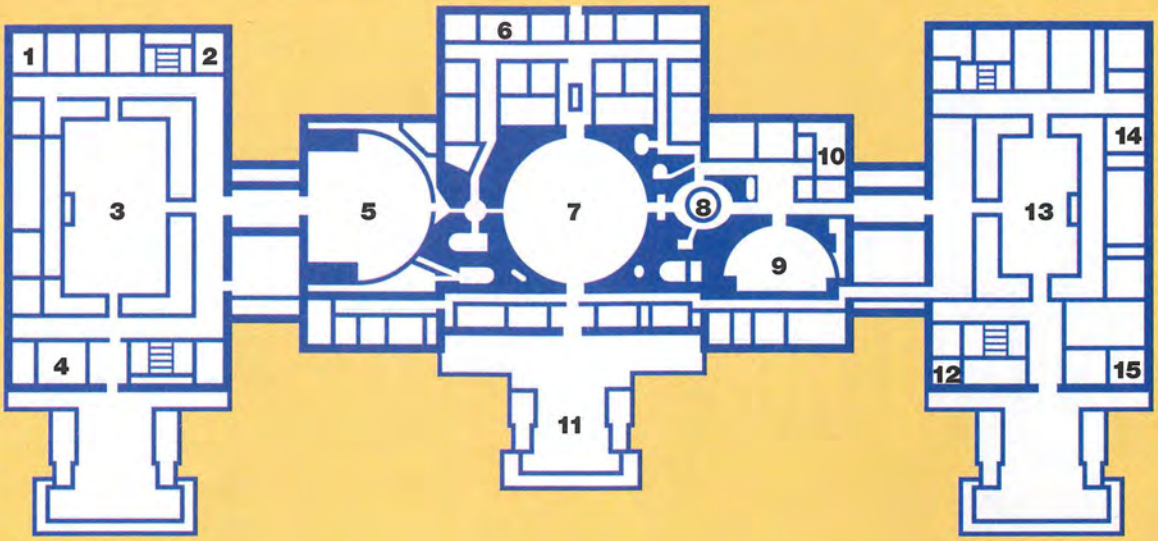


1. Find the starting location on the map. Look over the map and get a general idea of how the building is laid out. From pictures, you know that a huge dome crowns the center of the Capitol. This dome is above the Rotunda. **(a)** What is the general plan of the Capitol? **(b)** What are in the two wings of the building? **(c)** If Teresa and Marcus enter the Capitol through the East Front, what will be in front of them?

2. Use the map and key to locate the sights they want to see. Like many visitors' guides, this map includes a key to major features, which are numbered in the key and on the map. **(a)** What number is the House Chamber? After entering the Capitol, Marcus and Teresa reach the Rotunda, facing the back of the building and the private offices. **(b)** Which way should they turn to reach the House Chamber? **(c)** Which of the other sights will they pass through on the way?

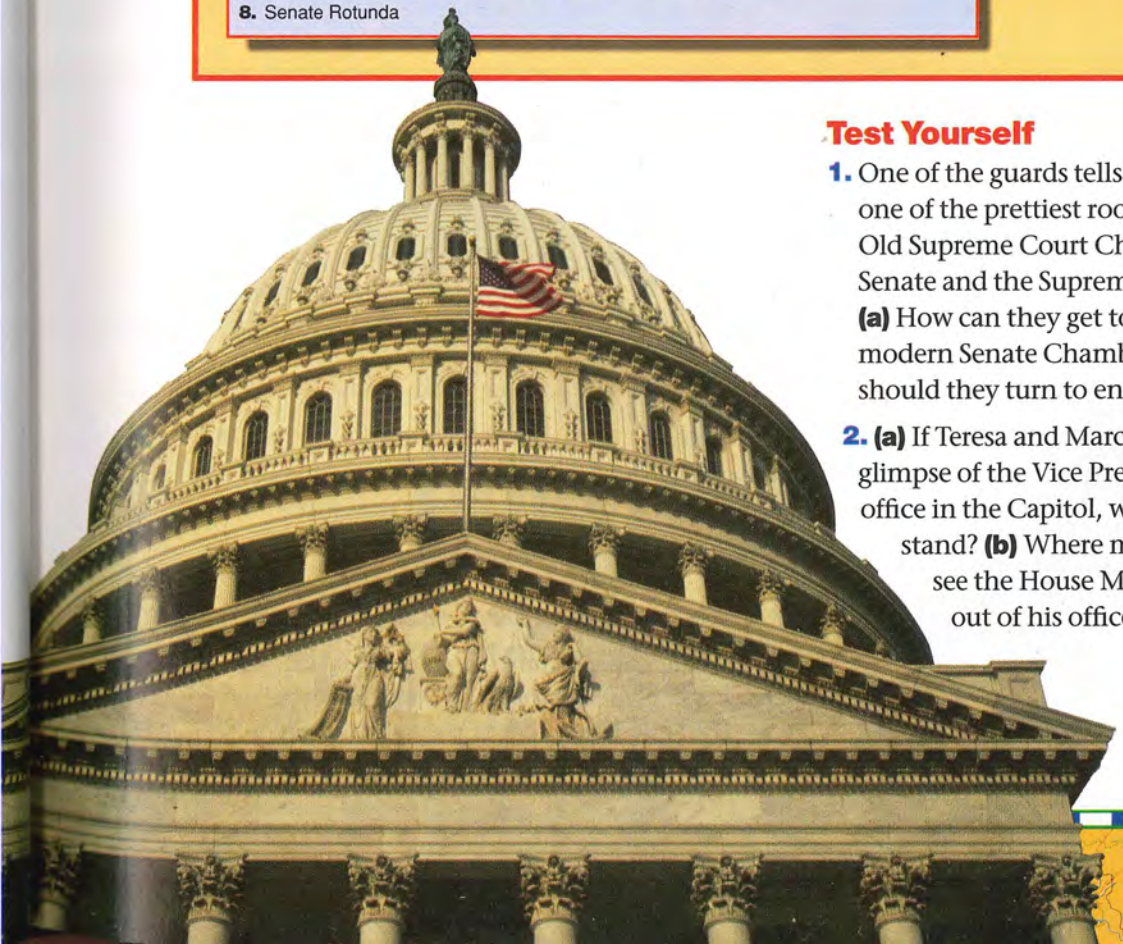
3. Use the map to plan a route that will include the sights they want to see. **(a)** If the Senate session is about to start, and Teresa and Marcus want to hurry directly to the Senate Chamber, where should they enter the building? **(b)** What sights would they see in walking from the Senate Chamber to the House Chamber?

U.S. Capitol Floor Plan



Capitol of the United States

1. Committee on Appropriations
2. House Minority Whip's office
3. House Chamber
4. Speaker's offices
5. Statuary Hall
6. House Minority Leader's office
7. Rotunda
8. Senate Rotunda
9. Old Supreme Court Chamber
10. Senate Majority Leader's office
11. East Front (site of presidential inaugurations)
12. Senate Majority Leader's office
13. Senate Chamber
14. President's Room
15. Vice President's Room



Test Yourself

1. One of the guards tells Marcus and Teresa that one of the prettiest rooms in the Capitol is the Old Supreme Court Chamber, where both the Senate and the Supreme Court used to meet. **(a)** How can they get to that room from the modern Senate Chamber? **(b)** Which way should they turn to enter the room?

2. **(a)** If Teresa and Marcus hope to catch a glimpse of the Vice President going into his office in the Capitol, where should they stand? **(b)** Where might they be likely to see the House Minority Leader coming out of his office?