Chapter 4
Plate Tectonics

Includes:

**LEVELED ASSESSMENT**
- Chapter Review
- Chapter Tests
  - Test A (Below Level) BL
  - Test B (On Level) OL
  - Test C (Advanced Learner) AL

**LABS**
*For leveled labs, use the CD-ROM.*
- Lab worksheets from Student Edition Labs
  - MiniLab
  - Lab: Version A (Below Level) BL
  - Lab: Version B (On Level) OL
  - (Advanced Learner) AL

**UNIVERSAL ACCESS/LEVELED RESOURCES**
- Target Your Reading
- Chapter Content Mastery English (Below Level) BL
- Chapter Content Mastery Spanish (Below Level) BL
- Reinforcement (On Level) OL
- Enrichment (Advanced Learner) AL

**READING SUPPORT**
- Content Vocabulary
- Chapter Outline

**TEACHER SUPPORT AND PLANNING**
- Chapter Outline for Teaching
- Teacher Guide and Answers
Photo Credits
Cover: Alamy Images
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### Additional Assessment Resources available with Glencoe Science:

- ExamView® Assessment Suite
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at [science.glencoe.com](http://science.glencoe.com)
- Interactive Classroom
- The Glencoe Science Web site at [science.glencoe.com](http://science.glencoe.com)
- An interactive version of this textbook along with assessment resources are available online at [mhln.com](http://mhln.com).
Student Lab/Activity Safety Form

Student Name: ________________________________

Date: ________________________________

Lab/Activity Title: ________________________________

In order to show your teacher that you understand the safety concerns of this lab/activity, the following questions must be answered after the teacher explains the information to you. You must have your teacher initial this form before you can proceed with the activity/lab.

1. How would you describe what you will be doing during this lab/activity?

2. What are the safety concerns associated with this lab/activity (as explained by your teacher)?
   - ____________________________________________________________________
   - ____________________________________________________________________
   - ____________________________________________________________________
   - ____________________________________________________________________
   - ____________________________________________________________________

3. What additional safety concerns or questions do you have?

Imagine one huge landmass. This ancient supercontinent began to break apart about 200 million years ago. These pieces very slowly drifted to their present-day locations. Can you model the past, present, and future locations of Earth’s continents?

**Procedure**

1. Complete a lab safety form.
2. Obtain a map of Pangaea, a map of the present-day continents, glue, and scissors.
3. Cut out the present-day continents.
4. Place the pieces in the appropriate locations on the map of Pangaea.
5. Take the pieces and move them to their present-day locations. Refer to a map of the world for help. Think about how far and in what direction each continent has moved.
6. Place the continents where you think they might be millions of years from now.
7. Glue the continents in their future locations.

**Analysis**

1. **Determine** which continents moved the farthest from the time of Pangaea to the present.

2. **Explain** whether you think there could be another supercontinent in the near future.
MiniLab

What force controls the movement of plates?

Ridge push, slab pull, and convection currents all forces that, scientists hypothesize, move Earth’s lithospheric plates. Complete this lab to determine how these forces work.

Procedure

1. Read and complete a lab safety form.
2. Obtain a large roll of tape.
3. Make a plate by sticking several layers of tape together. Keep the sticky side down for all layers. The plate should be long enough to wrap halfway around the roll of tape.
4. Stick the tectonic plate to your clothes to get lint on it and reduce its stickiness. Then stick it lightly to the roll of tape.
5. Experiment with ridge push by pushing against one end of the plate.
6. Experiment with slab pull by pulling on the other end of the plate.
7. Get together with two other lab groups. Fasten your plate lightly to two other plates by sticking them together with a tiny strip of tape.
8. Imitate convection currents by turning the rolls of tape underneath the plates.

Analysis

1. How much does ridge push cause the plate to move? How does ridge push affect the shape of the plate?

2. How much does the slab pull cause the plate to move? How does slab pull affect the shape of the plate?
Problem The movement of lithospheric plates causes forces that build up energy in rocks. Some of this energy is released as earthquakes. Earthquakes occur every day. Many are too small to be felt by humans, but each event tells scientists something more about Earth. Can you infer plate tectonic activity by plotting locations of recent earthquakes on a world map?

Form a Hypothesis Think about how earthquakes define the boundaries of lithospheric plates. There are some places that have many earthquakes, and other places that have almost none. Make a hypothesis about whether the locations of earthquakes can be used to infer plate tectonic activity.

Materials
metric ruler  world map
pencil  computer with Internet access

Procedure

Directions: Check the boxes below as you complete each step of the procedure.

☐ 1. Study the data table on the next page, or make one like the table shown.
☐ 2. Visit ca6.msscience.com to collect and record data for earthquake locations from the last two weeks.
☐ Use the Internet to locate recent locations. Try these sites: www.neic.cr.usgs.gov/neis/current/world.html; www.quake.wr.usgs.gov/recent/index.html
☐ 3. Plot the locations on a copy of a map of the world like the one below. This map should include lines of latitude and longitude to guide your plotting.
Lab: Version A CONTINUED

Data and Observations

<table>
<thead>
<tr>
<th>Locations of Earthquakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Description</td>
</tr>
<tr>
<td>_______________________</td>
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</table>

Analyze and Conclude

1. **Infer** where plate tectonic activity occurs on Earth today.

2. **Compare** and **contrast** the active plate tectonic areas and the plate boundary map shown in your textbook.
Lab: Version A CONTINUED

3. **Identify** lithospheric plates that are represented by the earthquake locations you plotted.

4. **Explain** how data from a longer period of time might help you better identify plate tectonic activity.

**Communicate**
Select one of the earthquakes you plotted. Research the details of the event, including the geography of the area near the earthquake, and whether the lives of humans or other organisms were impacted by the event.
Problem The movement of lithospheric plates causes forces that build up energy in rocks. Some of this energy is released as earthquakes. Earthquakes occur every day. Many are too small to be felt by humans, but each event tells scientists something more about Earth. Can you infer plate tectonic activity by plotting locations of recent earthquakes on a world map?

Form a Hypothesis Think about how earthquakes define the boundaries of lithospheric plates. There are some places that have many earthquakes, and other places that have almost none. Make a hypothesis about whether the locations of earthquakes can be used to infer plate tectonic activity.

Materials
metric ruler
pencil
world map
computer with Internet access

Procedure

Directions: Check the boxes below as you complete each step of the procedure.

☐ 1. Study the data table provided below, or make one like the table shown.
☐ 2. Visit ca6.msscience.com to collect and record data for earthquake locations from at least the last two weeks.
☐ 3. Plot the locations on a copy of a map of the world. This map should include lines of latitude and longitude to guide your plotting.

Data and Observations

<table>
<thead>
<tr>
<th>Locations of Earthquakes</th>
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</thead>
<tbody>
<tr>
<td>Location Description</td>
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</table>
Lab: Version B CONTINUED

Analyze and Conclude
1. Infer where plate tectonic activity on Earth today.

2. Compare and contrast the active plate tectonic areas and the plate boundary map shown in your textbook.

3. Identify lithospheric plates that are represented by the earthquake locations you plotted.

4. Explain how data from a longer period of time might help you better identify plate tectonic activity.

Going Further

Challenge
5. Predict if there is a relationship between the location of earthquakes and the location of volcanoes.
Lab: Version B CONTINUED

6. Conclude  Use your world map from the questions above. Use a different color to locate rings of volcanoes. If there is a relationship between the location of earthquakes and the location of volcanoes.

7. Look at your map. Are these areas located in densely populated areas? Speculate as to how this information might help city planners.

Extension
Create an outline map of California by tracing a map on tracing paper. Draw and label the plate boundaries using colored pencils. Draw and label major faults using another colored pencil. (A fault is a crack in the Earth’s crust that is the result of differential motion within the crust. Faults are the location of many earthquakes.) Below the outline note any relationships you find between the faults and the plates.

Communicate
Select one of the earthquakes you plotted. Research the details of the event, including the geography of the area near the earthquake, and whether the lives of humans or other organisms were impacted by the event.
Target Your Reading

Plate Tectonics

Use this to focus on the main ideas as you read the chapter.
1. Before you read the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   • Write an A if you agree with the statement.
   • Write a D if you disagree with the statement.

2. After you read the chapter, look back to this page to see if you’ve changed your mind about any of the statements.
   • If any of your answers changed, explain why.
   • Change any false statements into true statements.
   • Use your revised statements as a study guide.

<table>
<thead>
<tr>
<th>Before You Read A or D</th>
<th>Statement</th>
<th>After You Read A or D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Most oceanic crust is made of granite.</td>
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<tr>
<td>2. The density of rock increases as its temperature increases.</td>
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<tr>
<td>3. Earth’s lithosphere is broken into 100 large pieces called plates.</td>
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<tr>
<td>4. A slab is less dense than continental crust.</td>
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<tr>
<td>5. Fossils of sharks provide evidence for Pangaea.</td>
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<td>6. Harry Hess proposed the continental drift hypothesis in the mid-1950s.</td>
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<tr>
<td>7. Earthquakes and volcanic eruptions occur at boundaries of lithospheric plates.</td>
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<tr>
<td>8. Heat is currently escaping from the interior of Earth.</td>
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<tr>
<td>9. Seafloor spreading provided part of an explanation of how continents could move on Earth’s surface.</td>
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<td></td>
</tr>
<tr>
<td>10. The theory of plate tectonics is well established, so scientists no longer study it.</td>
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</tr>
</tbody>
</table>
Alfred Wegener was one of the first people to suggest that all the (1) __________________________ were once joined together. He called this ancient supercontinent (2) __________________________.

Wegener’s hypothesis, (3) __________________________, is the idea that the continents move slowly across Earth’s surface. Evidence exists to support his hypothesis. For example, similar fossils have been found in South America and (4) __________________________. Also, fossils of warm-weather plants have been found in the (5) __________________________. Similar (6) __________________________ structures exist in the Appalachian Mountains and in Greenland and western Europe.

Directions: Match the letter of the type of evidence with its example below.

A. rock types  B. fossil evidence  C. fit of the continents  D. ancient climate evidence

7. Preserved remains of the large-seed fern *Glossopteris* were found on five continents.
8. Distinctive groups of ancient rocks were found on continents opposite each other across the Atlantic Ocean.
9. Preserved remains of tropical reefs were found on the Arctic island of Spitsbergen.
10. The shape of the northwest African coastline appears to interlock with the space between the North and South American continents.
**Seafloor Spreading**

**Directions:** Circle the word in parentheses that correctly completes each sentence below.

1. The fact that the seafloor is (youngest/oldest) at the mid-ocean ridge is evidence for seafloor spreading.

2. Temperatures on the seafloor (increase/decrease) as the distance from the mid-ocean ridge increases.

3. During World War II, a new method using (sonar/magnetic) technology was used to map the topography of the seafloor.

4. Seafloor spreading is the process by which new seafloor is continuously made at the (mid-ocean ridges/oceanic crust).

5. Continents and the seafloor move a few (centimeters/meters) per year.

6. Scientists use magnetic stripes on the seafloor to calculate the (velocity/depth) of seafloor movement.

7. Harry Hess’s seafloor spreading hypothesis helped (prove/disprove) Alfred Wegener’s hypothesis about continental drift.

**Directions:** Study the following diagram of the seafloor. Then match the letters to the statements below.

8. Molten rock flows onto the seafloor and hardens as it cools.

9. Hot, molten rock is forced upward toward the seafloor at a mid-ocean ridge.

10. New seafloor moves away from the ridge, cools, becomes denser, and sinks.

11. Molten rock pushes sideways in both directions as it rises, moving the mantle with it.
Break or bend    Earthquakes    Horizontally    Igneous
Oceanic lithosphere    Plate tectonics    Satellites

1. The thickness of __________________________ increases as it ages and cools.

2. The theory of __________________________ explains how lithospheric plates move and cause major geologic features and events on Earth’s surface.

3. Plate tectonics explains how the plates that make up Earth’s surface move __________________________.

4. Oceanic crust is made mostly of __________________________ rock.

5. When forces act on rocks in the lithosphere, they might __________________________.

6. When a plate sinks back down into the mantle, it can cause __________________________.

7. The Global Positioning System is a network of __________________________ used to determine locations on Earth.

Directions: Circle the word in parentheses that correctly completes each sentence.

8. (Convection/Conduction) in the mantle is hypothesized by some scientists to drive plate movement.

9. Ridge push and (subduction/slab pull) are two forces that are also important in controlling how plates move.

10. Rocks are always moving through the (tectonic plates/rock cycle).

11. (Sedimentary rock/Magma) will rise to become igneous rock at the mid-ocean ridge.

12. A plate will slowly move away from the ridge and (break/cool), carrying the igneous rock with it.
Alfred Wegener fue una de las primeras personas en sugerir que todos los

(1) _______________________ en algún tiempo estaban unidas. Él nombró este supercontinente

(2) _______________________ . La hipótesis de Wegener, (3) ________________________, es la
idea de que los continentes se mueven muy despacio sobre la superficie de la Tierra. Hay pruebas
que apoyan su hipótesis como por ejemplo, fósiles similares que se han encontrado en Suramérica
y en (4) _______________________. También, fósiles de plantas de clima caliente se han
encontrado en el (5) _______________________. Estructuras de

(6) ________________________ rocas similares existen en las montañas de Apalachina y en
Groenlandia y en el oeste de Europa.

**Instrucciones:** Coincide la letra del tipo de pruebas con su ejemplo.

A. clases de rocas          C. encajamiento de los continentes
B. pruebas de fósiles       D. pruebas del clima antiguo

_______ 7. Los restos preservados del helecho de semillas grandes Glossopteris se encontraron
en cinco continentes.

_______ 8. Distintos grupos de rocas antigua se encontraron en continentes en ambos lados del
oceán Atlántico.

_______ 9. Los restos preservados de arrecifes tropicales se encontraron en la isla ártica de
Spitsbergen.

_______ 10. La forma de la costa africana noroeste parece interconectar con el espacio entre los
continentes de Norteamérica y Suramérica.
Dominio del contenido

La extensión del piso del mar

Instrucciones: Circula la palabra entre paréntesis que correctamente completa cada oración.

1. El hecho de que el piso del mar es (más joven/más viejo) en la cresta en medio del océano es prueba de la extensión del piso del mar.

2. Las temperaturas en el piso del mar (aumentan/disminuyen) cuando la distancia de la cresta en medio del océano aumenta.

3. Durante la segunda guerra mundial, un método nuevo que involucraba tecnología (sonar/magnética) se usó para trazar un mapa de la topografía del piso del mar.

4. La extensión del piso del mar es un proceso por el cual piso del mar nuevo se hace continuamente en (las crestas del océano/el estrato del océano).

5. Los continentes y el piso del mar se mueven unos cuantos (centímetros/metros) por año.

6. Los científicos usan rayas magnéticas en el piso del mar para calcular la (velocidad/profundidad) del movimiento del piso del mar.

7. La hipótesis de Harry Hess acerca de la extensión del piso del mar ayudó a Alfred Wegener a (probar/refutar) su hipótesis acerca del movimiento continental.

Instrucciones: Estudia el siguiente diagrama del piso del mar. Entonces coincide las letras con las oraciones.

8. La roca fundida fluye al piso del mar y endurece mientras se enfría.

9. Roca fundida y caliente es empujada hacia arriba hacia el piso del mar en una cresta en medio del océano.

10. El piso nuevo del mar se mueve de la cresta, se enfría, se hace más denso y se hunde.

11. La roca fundida empuja en ambas direcciones laterales mientras sube, moviendo el manto con ella.
La teoría del movimiento tectónico de placas

Instrucciones: Usa los siguientes términos para completar las oraciones que siguen.

horizontalmente  ígneas  litosfera oceánico  movimiento tectónico de placas
romper o doblar  satélites  terremotos

1. La espesor del (de la) __________________________ aumenta mientras envejece y se enfría.

2. La teoría de __________________________ explica cómo las placas litosferas se mueven y causan mayores rasgos geológicos en la superficie de la Tierra.

3. El movimiento tectónico de placas explica cómo las placas que forman la superficie de la Tierra se mueven __________________________.

4. El estrato oceánico está hecho principalmente de rocas __________________________.

5. Cuando las fuerzas actúan en las rocas en la litosfera, quizás éstas se podrían __________________________.

6. Cuando una placa se hunde abajo en el manto, puede causar __________________________.

7. El sistema de posición global es una red de __________________________ que se usa para determinar emplazamientos en la Tierra.

Instrucciones: Circula la palabra entre paréntesis que correctamente completa la oración.

8. Algunos científicos han hecho la hipótesis de que la (convección/conducción) en el manto conduce el movimiento de las placas.

9. El empuje de la cresta y el (la) (subducción/tirón de losa) son dos fuerzas que son muy importantes para controlar el movimiento de las placas.

10. Las rocas sedimentarias siempre están moviéndose por medio de los (las) (placas tectónicas/ciclo de rocas).

11. (Las rocas sedimentarias/La magma) subirán(n) para hacerse roca ígnea en la cresta en medio del océano.

12. Una placa se moverá lentamente de la cresta y se (quebrará/enfriará), cargando la roca ígnea con ella.
### Reinforcement: Continental Drift

**Directions:** Match the descriptions in Column I with the terms in Column II. Write the letter of the correct term in the blank at the left.

**Column I**
- 1. mountain range similar to the mountains in Greenland, Great Britain and Scandinavia
- 2. fossil plant found in Africa, Australia, India, South America, and Antarctica
- 3. clues that support continental drift
- 4. the oldest rocks on the African and South American continents
- 5. Wegener’s name for one large landmass
- 6. slow movement of continents
- 7. island now located above the Arctic Circle showing evidence of a tropical climate

**Column II**
- A. Precambrian rocks
- B. continental drift
- C. geometric fit, fossils, climate, and rock types
- D. Spitsbergen
- E. *Glossopteris*
- F. Appalachian Mountains
- G. Pangaea

**Directions:** Answer each question on the lines provided.

8. How did the discovery of *Glossopteris* support Wegener’s continental drift hypothesis?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

9. Why was Wegener’s hypothesis of continental drift not widely accepted at the time it was proposed?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
Seafloor Spreading

Directions: Circle the word in parentheses that correctly completes each sentence.

1. During the 1940s and 1950s, scientists began using (the global positioning system/sonar) on moving ships to map large areas of the ocean floor in detail.

2. There is more heat escaping Earth at the (mid-ocean ridges/ocean trenches) than at other locations in the oceans.

3. The scientist Henry Hess proposed a hypothesis known as (magnetic polarity/seafloor spreading).

4. Addition of new seafloor makes the ocean (hotter/wider). As a result the continents drift (apart/together) as the ocean grows.

5. Seafloor spreading seemed to explain (mid-ocean ridges/continental drift).

6. The Earth’s magnetic field has not always had the same (strength/orientation).

7. The term (normal/north) describes the orientation of the magnetic field the way it is today. When it points in the opposite direction it is called (south/reversed).

8. (Sedimentary/Igneous) rocks can record reversals in Earth’s magnetic field.

Directions: Answer each question and respond to each statement on the lines provided.

9. Explain how the reversal of Earth’s magnetic poles can be used to produce a “calendar” for part of Earth’s history.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

10. How did seafloor drilling help scientists find evidence to support the seafloor-spreading hypothesis?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
**Reinforcement:** Theory of Plate Tectonics

**Directions:** Complete the following sentences using the terms below.

boundaries  Global Positioning System  lithospheric plates  mid-ocean ridges
ocean trenches  oceanic  plate tectonics  rock cycle
satellite laser ranging  slab pull  volcanic eruptions

1. The theory of ___________________________ explains how lithospheric plates move and cause major changes to Earth’s surface.
2. The large brittle pieces of Earth’s outer shell are called ___________________________.
3. ___________________________ show where some of Earth’s plate boundaries are located.
4. Earthquakes and ___________________________ occur where the edges of plates run into, move apart, or scrape past each other as they move.
5. The two types of lithosphere are ___________________________ and continental.
6. Because the ___________________________ can be used to accurately measure distances, it can also be used to measure the movement of Earth’s plates.
7. ___________________________ uses pulses of light to measure distances.
8. Pieces of the plates meet at wide regions called ___________________________.
9. Some earthquakes and volcanoes occur at these regions, located at long, deep parts of the seafloor called ___________________________.
10. Plate movement causes rocks to be recycled through the ___________________________.

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The word *tectonics* comes from the same Greek base word as “architect.” Both words refer to building. An architect designs structures. Tectonics is a process by which Earth’s structures are built and changed.

**Directions:** Cut and move the map pieces below and answer the questions that follow.

1. Photocopy this page, and cut the map along the boundaries. Move the pieces to show how the plates will move in the next million years, according to the types of boundaries. Tape the pieces in place.

2. **Inspect** In which place(s) did you have to crumple your paper to account for the various plate movements?

3. **Compare** your new map with those of your classmates. Discuss similarities and account for any differences.

4. **Apply** Research another area in the world where plates meet. Share your findings with the class.

---

**Key**

- Divergent boundary
- Convergent boundary
- Transform boundary
You now know how seafloor spreading changes the ocean floor. You know that magma rises at the mid-ocean ridge and flows away from the ridge. In general, this activity is hidden beneath the ocean’s water. But there is a place where seafloor spreading can be seen on land.

Figure 1

Figure 2

Iceland

Key
- Mid-ocean ridge
- Active volcanoes

Key
- Active volcanoes; formed from today to 10,000 years ago
- Formed 10,000 to 2,000,000 years ago
- Formed 2,000,000 to 63,000,000 years ago

Directions: Answer the questions on the lines provided.

1. **Determine** What is the name of the landmass through which the mid-ocean ridge in the Atlantic Ocean passes?

2. **Analyze** How do the land structures of Iceland help confirm seafloor spreading?

3. **Conclude** Why do you think geologists might find Iceland a useful place to conduct research on seafloor spreading?
Enrichment The Cornell Andes Project

Since the mid-1970s, scientists from Cornell University in Ithaca, New York have been studying the orogenesis of the Andes Mountains. Orogenesis is the process of mountain formation caused by the folding of rock layers. The Andes are a folded mountain system located along the west coast of South America. They formed more than 200 million years ago when the South American continental plate collided with the Nazca oceanic plate. The Nazca plate made its way under the South American plate, causing the land above it to be uplifted and then squeezed.

Purpose of the Project

Why did scientists launch the Cornell Andes Project more than two decades ago? They say the Andes are a “mega-scale, modern laboratory of tectonic processes.” Even though scientists generally know how the Andes formed, they are trying to understand the geology of the mountain system. They are doing this, in part, to help them predict and prepare for earthquakes.

The scientists know that 20 million years ago, the effects of subduction spread to a larger area. Subduction occurs when one oceanic or continental plate passes under another. At one point, the crust folded and quickly formed mountains, creating a 12,000-m drop at the western edge of the Andes.

Then volcanoes erupted. Today, the subduction continues. This same area not only contains active volcanoes, but is also likely to have earthquakes.

Work on the Project

To help them understand more about the region’s geology, scientists have worked with NASA to analyze data obtained through the Shuttle Radar Topography Mission of the space shuttle Endeavour. This high-resolution radar took images of areas of the Andes that hadn’t been mapped before. These areas have never been surveyed from ground level because they are too remote. Cloud cover prevents them from being photographed from the air. The radar gave scientists 3-D images of the mountains and sent back information about the surface characteristics.

To help them in their work, scientists have also been using satellite imagery, digital topography, and geographic information systems (GIS) technology. As part of the larger project, they have investigated changes in ground and glacial surfaces, studied tectonics history and plate evolution, and researched the relationship of climate to surface processes and mountain building.

Directions: Respond to each statement or question on the lines provided.

1. **Indicate** what occurred to form the Andes Mountains more than 200 million years ago.

2. **Conclude** why Cornell scientists called the Andes a “mega-scale, modern laboratory of tectonic processes.” Use a separate sheet of paper for your answer.

3. **Analyze** What might scientists look for when studying the images and maps provided by the space shuttle Endeavour’s Shuttle Radar Topography Mission? Use a separate sheet of paper for your answer.
1. The hypothesis that continents move slowly across Earth’s surface is called continental               
   ________________.
2. The ancient supercontinent thought to have broken apart millions of years ago is called               
   ____________________.
3. The long, deep, canyon-like parts of the seafloor are called ocean ____________________.
4. The heating, rising, cooling, and sinking of plates is caused by mantle ____________________
   currents.
5. The large brittle pieces of Earth’s outer shell are called ____________________ plates.
6. Earthquakes and volcanoes occur in wide regions where plates join, called plate               
   ____________________.
Content Vocabulary CONTINUED

7. Hot magma forced upward at cracks in the oceanic crust produces seafloor ________________.

8. Underwater mountain ranges form ____________________________ ridges.

9. The theory of plate ____________________________ explains how lithospheric plates move and cause major geologic features and events on Earth’s surface.

Directions: Match each term with its definition by writing the correct letter on the blank.

10. technology used to map the seafloor using sound waves
    - A. Global Positioning System (GPS)

11. network of satellites used to measure plate movement
    - B. magnetometer

12. when the force of gravity moves a plate downward and away from a ridge
    - C. ridge push

13. sensing device that detects the magnetic field in rocks
    - D. Satellite Laser Ranging (SLR)

14. gravity acting on a dense, cool, slab as it sinks deep into the mantle
    - E. slab

15. plate that bends and breaks as it sinks back into the mantle
    - F. slab pull

16. satellite system using pulses of light to measure distances
    - G. sonar

17. In the space below, draw a diagram showing how seafloor spreading occurs at the mid-ocean ridges. Indicate the movement of magma using arrows.
Part A. Vocabulary Review

Directions: Write the correct term from the word bank next to its definition.

1. theory that Earth’s crust and upper mantle are in sections that move
2. network of satellites used to determine locations on Earth and to measure plate movement
3. large, brittle piece of Earth’s outer shell
4. underwater mountain range where new seafloor is formed
5. large landmass hypothesized to have broken apart a few hundred million years ago
6. hypothesis that continents move slowly across Earth’s surface
7. long, deep, canyon-like part of the seafloor where seafloor sinks down into mantle
8. plate that bends and breaks as it sinks back into the mantle
9. process by which new seafloor is made at a mid-ocean ridge

Directions: Label each cause of plate movement with its correct name by writing the matching letter in the blank.

A. convection  B. ridge push  C. slab pull

10. force that moves a cool, dense, plate deep into the mantle
11. force that moves a plate downward and away from a ridge
12. provides matter and energy for plate motion
Chapter Review CONTINUED

Part B. Concept Review

Directions: Arrange the steps by which new oceanic lithosphere is made in the correct order from 1 to 4 by writing the number on the line.

1. magma flows out as lava through cracks in the surface along the ridge
2. seafloor moves sideways, away from the center of the mid-ocean ridge
3. basaltic lava cools and forms new seafloor
4. convection current brings hot material in the mantle up toward the surface

Directions: Answer each question or respond to each statement using complete sentences.

5. Apply How have technologies such as sonar and the Global Positioning System been used to provide evidence supporting the theory of plate tectonics?

6. Indicate how convection currents might drive movement of Earth’s plates.

7. Conclude How is the rock cycle related to the movement of Earth’s plates?
Lesson 1: Continental Drift

A. Drifting Continents

1. People looking at early maps noticed that the edges of the American continents looked as if they might fit like puzzle pieces into ____________________________ and ______________________.

2. In the early 1900s, Alfred Wegener proposed the ______________________ hypothesis, which states that the continents move slowly across Earth’s surface.

3. He thought that ______________________ years ago, all of the continents formed one huge landmass he called ______________________.

4. The landmass eventually started to ______________________, and slowly the continents drifted to their present locations.

B. Evidence for Continental Drift

1. Geographic Fit of the Continents
   a. If the ______________________ were removed, the continents would fit back together.
   b. Some ______________________ and ______________________ that are now far apart were previously close together.

2. Fossil Evidence
   a. Wegener studied the fossils of ______________________, a seed fern found on ______________________ continents.
   b. He didn’t believe the heavy seeds could have ______________________ or ______________________ so far across the oceans.

3. Rock Types and Mountain Ranges
   a. Particular groups of ______________________ on the continents matched.
   b. ______________________ match across the continental boundaries.
   c. The ______________________ in eastern North America are similar to the mountains in Greenland, Great Britain, and Scandinavia.
4. Ancient Climate Evidence
   a. When sedimentary rocks form, they preserve ______________ about the climate in which they form.
   b. Wegener found rocks formed during the time of Pangaea showing that the ______________ island of Spitsbergen had a ______________ climate.
   c. Ancient rocks made by ______________ were found across Africa, India, and Australia.
   d. The climates of Pangaea were ______________ the climates on Earth today.

C. A Hypothesis Rejected
   1. Wegener proposed that the ______________ drifted by plowing through the seafloor.
   2. He thought the same ______________ that produced tides had caused the continents to slowly drift over millions of years.
   3. Most other scientists did not accept Wegener’s hypothesis because they could not think of any ______________ strong enough to make continents drift.

Lesson 2: Seafloor Spreading

A. Investigating the Seafloor
   1. ______________ was developed for mapping the seafloor using ______________ waves.
   2. ______________ in the middle of the seafloor are called mid-ocean ridges.
   3. The closer you move toward a mid-ocean ridge, the ______________ the seafloor gets.

B. The Seafloor Moves
   1. Harry Hess, an American geologist, suggested a new hypothesis describing how ______________ were formed.
   2. Seafloor spreading is the process by which new ______________ is made at the mid-ocean ridges.
Chapter Outline CONTINUED

a. Convection brings hot material up from the ________________ toward the surface.

b. ________________ flows out as lava through cracks along the ridge.

c. Lava ________________ and forms new seafloor.

d. The seafloor moves away from the center of the ________________.

3. The age of the seafloor ________________ with distance from the mid-ocean ridge.

4. Continents drift ________________ as the ocean grows.

C. Evidence for Spreading

1. ________________ rock records magnetic polarity ________________ that occur about every 10,000 years.
   a. Scientists can measure the magnetic field with an instrument called a ________________.
   b. By measuring the distance of a stripe of rock from the mid-ocean ridge and determining its age, scientists calculated the ________________ of seafloor movement.

4. The seafloor and attached continents move only ________________ per year.

5. The boat named the Glomar Challenger ________________ and collected samples from the seafloor beginning in 1968.

6. Scientists found that the ________________ rocks were in the center of the mid-ocean ridge.

Lesson 3: Theory of Plate Tectonics

A. Earth’s Plates

1. Earth’s lithosphere is broken into about a dozen large, brittle pieces called ________________.

2. The theory of ________________ explains how plates ________________ and cause major geologic features and events on Earth’s surface.

3. The locations of ________________ and ________________ indicate the plate boundaries where the lithospheric plates meet.
   a. The edges of plates run into, move apart, or ________________ past each other.
Chapter Outline CONTINUED

b. Plates also meet at long, deep parts of the seafloor called _________________.

B. Types of Lithosphere

1. Oceanic lithosphere is much _________________ than continental lithosphere.
   a. _________________ crust is made up mainly of the dense igneous rocks of basalt and gabbro.
   b. The oceanic lithosphere is _________________ at the mid-ocean ridge and gets _________________ as you move farther from the ridge.

2. _________________ lithosphere is not as _________________ as oceanic crust.

C. Plate Movement

1. Convection currents, which transfer _________________ energy from inside Earth’s mantle to the surface, are thought to drive plate movement.
   a. Heat _________________ the density of rock.
   b. _________________ force pushes the heated rock upward.
   c. A dense rock plate that sinks back into the mantle is called a _________________.
   d. Hot rock material is brought near the surface and _________________.
   e. Rock then cools at the surface, making new _________________ at the ridge.
   f. New rock starts to move away from the _________________.

2. Ridge Push and Slab Pull
   a. The force of gravity moves the plate downward and away from the ridge during _________________.
   b. As oceanic crust cools and becomes denser, it is forced into the mantle because of the force of _________________.

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D. Measuring Plate Movement

1. The Global Positioning System (GPS) is a network of ________________ used to determine locations on Earth and measure the ________________ and ________________ of plates.

2. Satellite laser ranging (SLR) uses pulses of ________________ to measure plate movement.