Glencoe Science

Chapter Resources

Plate Tectonics

Includes:

Reproducible Student Pages

ASSESSMENT

- ✔ Chapter Tests
- ✔ Chapter Review

HANDS-ON ACTIVITIES

- ✔ Lab Worksheets for each Student Edition Activity
- ✔ Laboratory Activities
- ✔ Foldables–Reading and Study Skills activity sheet

MEETING INDIVIDUAL NEEDS

- ✔ Directed Reading for Content Mastery
- ✔ Directed Reading for Content Mastery in Spanish
- ✔ Reinforcement
- ✔ Enrichment
- ✔ Note-taking Worksheets

TRANSPARENCY ACTIVITIES

- ✔ Section Focus Transparency Activities
- ✔ Teaching Transparency Activity
- ✔ Assessment Transparency Activity

Teacher Support and Planning

- ✔ Content Outline for Teaching
- ✔ Spanish Resources
- ✔ Teacher Guide and Answers

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Table of Contents

To the Teacher iv

Reproducible Student Pages

■ Hands-On Activities

MiniLAB: Try at Home *Interpreting Fossil Data* 3
MiniLAB: *Modeling Convection Currents*. 4
Lab: *Seafloor Spreading Rates* 5
Lab: Use the Internet *Predicting Tectonic Activity* 7
Laboratory Activity 1: *Paleogeographic Mapping*. 9
Laboratory Activity 2: *How do continental plates move?* 13
Foldables: Reading and Study Skills 17

■ Meeting Individual Needs

Extension and Intervention

Directed Reading for Content Mastery 19
Directed Reading for Content Mastery in Spanish 23
Reinforcement 27
Enrichment 30
Note-taking Worksheet 33

■ Assessment

Chapter Review 37
Chapter Test 39

■ Transparency Activities

Section Focus Transparency Activities. 44
Teaching Transparency Activity. 47
Assessment Transparency Activity. 49

Teacher Support and Planning

Content Outline for Teaching T2
Spanish Resources T5
Teacher Guide and Answers T9

ASSESSMENT ADVANTAGE

Additional Assessment Resources available with Glencoe Science:

- Exam*View*® Pro Testmaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at **msscience.com**
- Interactive Chalkboard
- The Glencoe Science Web site at: **msscience.com**
- An interactive version of this textbook along with assessment resources are available online at: **mhln.com**

To the Teacher

This chapter-based booklet contains all of the resource materials to help you teach this chapter more effectively. Within you will find:

Reproducible pages for
- Student Assessment
- Hands-on Activities
- Meeting Individual Needs (Extension and Intervention)
- Transparency Activities

A teacher support and planning section including
- Content Outline of the chapter
- Spanish Resources
- Answers and teacher notes for the worksheets

Hands-On Activities

MiniLAB and Lab Worksheets: Each of these worksheets is an expanded version of each lab and MiniLAB found in the Student Edition. The materials lists, procedures, and questions are repeated so that students do not need their texts open during the lab. Write-on rules are included for any questions. Tables/charts/graphs are often included for students to record their observations. Additional lab preparation information is provided in the *Teacher Guide and Answers* section.

Laboratory Activities: These activities do not require elaborate supplies or extensive pre-lab preparations. These student-oriented labs are designed to explore science through a stimulating yet simple and relaxed approach to each topic. Helpful comments, suggestions, and answers to all questions are provided in the *Teacher Guide and Answers* section.

Foldables: At the beginning of each chapter there is a *Foldables: Reading & Study Skills* activity written by renowned educator, Dinah Zike, that provides students with a tool that they can make themselves to organize some of the information in the chapter. Students may make an organizational study fold, a cause and effect study fold, or a compare and contrast study fold, to name a few. The accompanying *Foldables* worksheet found in this resource booklet provides an additional resource to help students demonstrate their grasp of the concepts. The worksheet may contain titles, subtitles, text, or graphics students need to complete the study fold.

Meeting Individual Needs (Extension and Intervention)

Directed Reading for Content Mastery: These worksheets are designed to provide students with learning difficulties with an aid to learning and understanding the vocabulary and major concepts of each chapter. The *Content Mastery* worksheets contain a variety of formats to engage students as they master the basics of the chapter. Answers are provided in the *Teacher Guide and Answers* section.

Directed Reading for Content Mastery (in Spanish): A Spanish version of the *Directed Reading for Content Mastery* is provided for those Spanish-speaking students who are learning English.

Reinforcement: These worksheets provide an additional resource for reviewing the concepts of the chapter. There is one worksheet for each section, or lesson, of the chapter. The *Reinforcement* worksheets are designed to focus primarily on science content and less on vocabulary, although knowledge of the section vocabulary supports understanding of the content. The worksheets are designed for the full range of students; however, they will be more challenging for your lower-ability students. Answers are provided in the *Teacher Guide and Answers* section.

Enrichment: These worksheets are directed toward above-average students and allow them to explore further the information and concepts introduced in the section. A variety of formats are used for these worksheets: readings to analyze; problems to solve; diagrams to examine and analyze; or a simple activity or lab which students can complete in the classroom or at home. Answers are provided in the *Teacher Guide and Answers* section.

Note-taking Worksheet: The *Note-taking Worksheet* mirrors the content contained in the teacher version—*Content Outline for Teaching*. They can be used to allow students to take notes during class, as an additional review of the material in the chapter, or as study notes for students who have been absent.

Assessment

Chapter Review: These worksheets prepare students for the chapter test. The *Chapter Review* worksheets cover all major vocabulary, concepts, and objectives of the chapter. The first part is a vocabulary review and the second part is a concept review. Answers and objective correlations are provided in the *Teacher Guide and Answers* section.

Chapter Test: The *Chapter Test* requires students to use process skills and understand content. Although all questions involve memory to some degree, you will find that your students will need to discover relationships among facts and concepts in some questions, and to use higher levels of critical thinking to apply concepts in other questions. Each chapter test normally consists of four parts: Testing Concepts measures recall and recognition of vocabulary and facts in the chapter; Understanding Concepts requires interpreting information and more comprehension than recognition and recall—students will interpret basic information and demonstrate their ability to determine relationships among facts, generalizations, definitions, and skills; Applying Concepts calls for the highest level of comprehension and inference; Writing Skills requires students to define or describe concepts in multiple sentence answers. Answers and objective correlations are provided in the *Teacher Guide and Answers* section.

Transparency Activities

Section Focus Transparencies: These transparencies are designed to generate interest and focus students' attention on the topics presented in the sections and/or to assess prior knowledge. There is a transparency for each section, or lesson, in the Student Edition. The reproducible student masters are located in the *Transparency Activities* section. The teacher material, located in the *Teacher Guide and Answers* section, includes Transparency Teaching Tips, a Content Background section, and Answers for each transparency.

Teaching Transparencies: These transparencies relate to major concepts that will benefit from an extra visual learning aid. Most of these transparencies contain diagrams/photos from the Student Edition. There is one *Teaching Transparency* for each chapter. The *Teaching Transparency Activity* includes a black-and-white reproducible master of the transparency accompanied by a student worksheet that reviews the concept shown in the transparency. These masters are found in the *Transparency Activities* section. The teacher material includes Transparency Teaching Tips, a Reteaching Suggestion, Extensions, and Answers to Student Worksheet. This teacher material is located in the *Teacher Guide and Answers* section.

Assessment Transparencies: An *Assessment Transparency* extends the chapter content and gives students the opportunity to practice interpreting and analyzing data presented in charts, graphs, and tables. Test-taking tips that help prepare students for success on standardized tests and answers to questions on the transparencies are provided in the *Teacher Guide and Answers* section.

Teacher Support and Planning

Content Outline for Teaching: These pages provide a synopsis of the chapter by section, including suggested discussion questions. Also included are the terms that fill in the blanks in the students' *Note-taking Worksheets*.

Spanish Resources: A Spanish version of the following chapter features are included in this section: objectives, vocabulary words and definitions, a chapter purpose, the chapter Activities, and content overviews for each section of the chapter.

Reproducible Student Pages

Reproducible Student Pages

■ Hands-On Activities

MiniLAB: Try at Home *Interpreting Fossil Data* 3
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Lab: *Seafloor Spreading Rates* 5
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Laboratory Activity 2: *How do continental plates move?* 13
Foldables: Reading and Study Skills. 17

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Directed Reading for Content Mastery 19
Directed Reading for Content Mastery in Spanish 23
Reinforcement 27
Enrichment. 30
Note-taking Worksheet 33

■ Assessment

Chapter Review 37
Chapter Test 39

■ Transparency Activities

Section Focus Transparency Activities. 44
Teaching Transparency Activity 47
Assessment Transparency Activity 49

Hands-On Activities

TRY AT HOME Mini LAB

Interpreting Fossil Data

Procedure

1. Build a three-layer landmass using **clay** or **modeling dough**.
2. Mold the clay into mountain ranges.
3. Place similar "**fossils**" into the clay at various locations around the landmass.
4. Form five continents from the one landmass. Also, form two smaller landmasses out of different clay with different mountain ranges and fossils.
5. Place the five continents and two smaller landmasses around the room.
6. Have someone who did not make or place the landmasses make a model that shows how they once were positioned.
7. Return the clay to its container so it can be used again.

Analysis

What clues were useful in reconstructing the original landmass?

Mini LAB Modeling Convection Currents

Procedure

1. Pour **water** into a **clear, colorless casserole dish** until it is 5 cm from the top.
2. Center the dish on a **hot plate** and heat it. **WARNING:** *Wear **thermal mitts** to protect your hands.*
3. Add a few drops of **food coloring** to the water above the center of the hot plate.
4. Looking from the side of the dish, observe what happens in the water.
5. In the space below, illustrate your observations.

Analysis

1. Determine whether any currents form in the water.

____

2. Infer what causes the currents to form.

____

____

Seafloor Spreading Rates

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. Where can you find the data about each peak that you need for this lab?

____

2. What formula do you use to calculate the rate of movement in this lab?

____

How did scientists use their knowledge of seafloor spreading and magnetic field reversals to reconstruct Pangaea? Try this lab to see how you can determine where a continent may have been located in the past.

Real-World Question

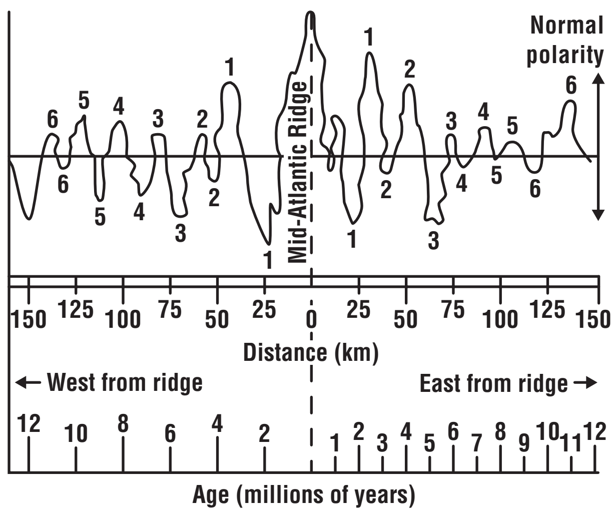
Can you use clues, such as magnetic field reversals on Earth, to help reconstruct Pangaea?

Materials

metric ruler pencil

Goals

- **Interpret** data about magnetic field reversals. Use these magnetic clues to reconstruct Pangaea.



Procedure

1. Study the magnetic field graph below. You will be working only with normal polarity readings, which are the peaks above the baseline in the top half of the graph.
2. Place the long edge of a ruler vertically on the graph. Slide the ruler so that it lines up with the center of peak 1 west of the Mid-Atlantic Ridge.
3. **Determine** and record the distance and age that line up with the center of peak 1 west. Repeat this process for peak 1 east of the ridge.
4. **Calculate** the average distance and age for this pair of peaks.
5. Repeat steps 2 through 4 for each remaining pair of normal-polarity peaks.
6. **Calculate** the rate of movement in cm per year for the six pairs of peaks. Use the formula rate = distance/time. Convert kilometers to centimeters. For example, to calculate a rate using normal-polarity peak 5, west of the ridge:

$$\text{rate} = \frac{125 \text{ km}}{10 \text{ million years}} = \frac{12.5 \text{ km}}{\text{million years}}$$

$$= \frac{1{,}250{,}000 \text{ cm}}{1{,}000{,}000 \text{ years}} = 1.25 \text{ cm/year}$$

LAB (continued)

Data and Observations

Peaks	Peak 1	Peak 2	Peak 3	Peak 4	Peak 5	Peak 6
Distance west normal polarity (km)						
Distance east normal polarity (km)						
Average distance (km)						
Average age from scale (millions of years)						
Rate of movement (cm/year)						

Conclude and Apply

1. **Compare** the age of igneous rock found near the mid-ocean ridge with that of igneous rock found farther away from the ridge.

____

____

2. If the distance from a point on the coast of Africa to the Mid-Atlantic Ridge is approximately 2,400 km, calculate how long ago that point in Africa was at or near the Mid-Atlantic Ridge.

____

____

____

____

3. How could you use this method to reconstruct Pangaea?

____

____

____

Use the Internet

Predicting Tectonic Activity

The movement of plates on Earth causes forces that build up energy in rocks. The release of this energy can produce vibrations in Earth that you know as earthquakes. Earthquakes occur every day. Many of them are too small to be felt by humans, but each event tells scientists something more about the planet. Active volcanoes can do the same, and volcanoes often form at plate boundaries.

Think about where earthquakes and volcanoes have occurred in the past. Make a hypothesis about whether the locations of earthquake epicenters and active volcanoes can be used to predict tectonically active areas.

Real-World Question

Can you predict tectonically active areas by plotting locations of earthquake epicenters and volcanic eruptions?

Goals

- **Research** the locations of earthquakes and volcanic eruptions around the world.
- **Plot** earthquake epicenters and the locations of volcanic eruptions obtained from **msscience.com** site.
- **Predict** locations that are tectonically active based on a plot of the locations of earthquake epicenters and active volcanoes.

Data Sources

Visit **msscience.com/internet_lab** for more information about earthquake and volcano sites and data from other students.

Make a Plan

1. Study the data table shown below. Use it to record your data.
2. Collect data for earthquake epicenters and volcanic eruptions for at least the past two weeks. Your data should include the longitude and latitude for each location. For help, refer to the data sources given above.

Locations of Epicenters and Eruptions

Earthquake Epicenter/Volcanic Eruption	Longitude	Latitude

LAB (continued)

Follow Your Plan

1. Make sure your teacher approves your plan before you start.
2. **Plot** the locations of earthquake epicenters and volcanic eruptions on a map of the world. Use an overlay of tissue paper or plastic.
3. After you have collected the necessary data, predict where the tectonically active areas on Earth are.
4. **Compare** and **contrast** the areas that you predicted to be tectonically active with the plate boundary map shown in **Figure 9** in your textbook.

Analyze Your Data

1. What areas on Earth do you predict to be the locations of tectonic activity?

2. How close did your prediction come to the actual location of tectonically active areas?

Conclude and Apply

1. How could you make your predictions closer to the locations of actual tectonic activity?

2. Would data from a longer period of time help? Explain.

3. What types of plate boundaries were close to your locations of earthquake epicenters? Volcanic eruptions?

4. **Explain** which types of plate boundaries produce volcanic eruptions. Be specific.

Communicating Your Data

Find this lab using the link below. Post your data in the table provided. **Compare** your data with those of other students. Combine your data with those of other students, and **plot** these combined data on map to **recognize** the relationship between plate coundaries, volcanic eruptions, and earthquake epicenters.

Science Online **msscience.com/internet_lab**

LAB 1 Laboratory Activity

Paleogeographic Mapping

Paleo- means old as in paleontology, the study of old life (fossils). *Geo-* means Earth, as in geology, the study of Earth. *Graphic* refers to a drawing or painting. Therefore, paleogeographic could be translated as "Old Earth Picture." Scientists often use fossil evidence to help them develop a picture of how Earth was long ago. By examining and dating rock formations and fossils of various plants and animals, scientists are able to formulate hypotheses about what Earth's surface might have looked like during a particular period in history. For example, similar rock formations and certain types of plant and animal fossils of a particular age could indicate whether two, now separate, land areas might have been connected during that period. Further analysis of the samples and data could also provide clues to the climate of that area or whether it was dry land or covered by an ocean. To classify events in the geologic past, scientists have divided the millions of years of Earth's history into segments, called *eras.* In this activity, you will examine evidence from the fossil record relative to a current map of an imaginary continent and develop a map of what the continent and the surrounding area might have looked like during the Mesozoic Era (248 million to 65 million years ago).

Strategy

You will determine how fossil evidence can be used to infer information about a continent during the geologic past.

You will interpret fossil evidence to draw a map showing how a continent appeared during the Mesozoic Era.

Materials

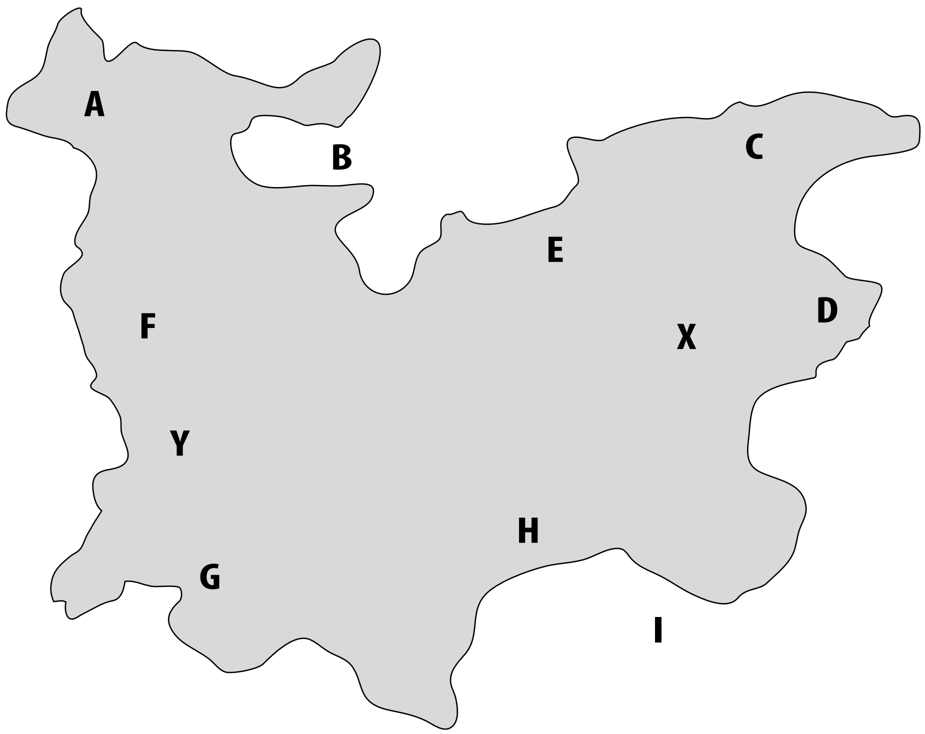
colored pencils or markers

Procedure

1. Figure 1 shows a map of a present-day imaginary continent. Locations *A* through *I* are places where fossils have been found in rocks dating to the Mesozoic Era. Study the map and look at the fossils key below the map.
2. From the locations of the different fossils, infer where the land areas were at the time the fossil organisms lived. Keep in mind that the way the modern continent looks may have no relationship to where the land/ocean boundaries were during the Mesozoic Era.
3. Use one color of pencil or marker to color in the land areas on the map in Figure 1. Fill in the block labeled Land with the same color. Use a different color of pencil or marker to color in the ocean areas on the map in Figure 1. Fill in the block labeled Ocean with this color.
4. In the space provided under Data and Observations, draw a map showing land and water areas during the Mesozoic Era. Use the color boundaries you added to Figure 1 as your guideline. Based on these boundaries, add all of the symbols from the map key in Figure 1 to your map.
5. Color all the areas around and between the labeled areas on your map as either land or ocean. Fill in the blocks labeled Land and Ocean with the colors you used.

Laboratory Activity 1 (continued)

Figure 1



❒ **Land** ❒ **Ocean**

Fossils found in Mesozoic rocks

A (shark teeth)
B (petrified wood)
C (sea stars)
D (leaf and fern imprints)
E (seashell fragments)
F (teeth/bones of small mammals)
G (dinosaur bones)
H (corals)
I (dinosaur footprints)
X, Y (Areas to be identified after completing your map)

Laboratory Activity 1 (continued)

Data and Observations

Mesozoic Map

❒ Land ❒ Ocean

Questions and Conclusions

1. According to your map, was location Y land or water during the Mesozoic Era? Explain how you decided.

2. According to your map, was location X land or water during the Mesozoic Era? Explain how you decided.

3. Compare your map with those of other students. Why do you think that not everyone agreed on whether location X was land or water? How could you find out which interpretation was correct?

Laboratory Activity 1 (continued)

4. Corals grow only in warm, shallow oceans near the coastlines of continents that are relatively near the equator. Would knowing this fact make you revise your map? Why or why not?

____

____

____

5. Suppose the modern continent shown in Figure 1 was located in an area that is extremely cold. Using the evidence you have, plus the information in Question 4, what could you infer about the continent?

____

____

____

Strategy Check

_______ Can you determine how fossil evidence can be used to infer information about a continent during the geologic past?

_______ Can you interpret fossil evidence to draw a map showing how a continent appeared during the Mesozoic Era?

Name Date Class

LAB 2 Laboratory Activity

How do continental plates move?

One of the models that helps explain how tectonic plates move is the convection model. In this hypothesis, the molten magma of the mantle boils like water in a pot. The pattern of the moving water forms a circular wave or current as hot water rises to the top and cooler surface water is forced to the side of the pot and back down to be heated again. Inside the Earth it is believed there are many convection cells, or regions in the mantle, that boil like this. The different cells have their own currents and constantly move independently of one another. The crust of the Earth has a much lighter mass and density than the magma. As a result, the plates of crust are moved by convection currents and broken up on the boiling surface of the mantle.

Strategy

You will model convection currents and the movement of tectonic plates.
You will predict what will happen to tectonic plates at the margins of convection cells.

Materials

hot plate
scissors
tongs
water
medium to large–mouthed pot
sheets of plastic foam wrap for padding packages (not made from corn or organic materials)

Procedure

1. The hot plates should be turned on high. Carefully fill the pot 2/3 full of water and place it on the hot plate. It will take a while for the water to boil.
2. Obtain a piece of flat plastic foam wrap. Use scissors to cut several shapes that represent tectonic plates. If you are working in a group you may mark your tectonic plates with a pencil or pen if you wish so that you can recognize it when the water boils.
3. Carefully place your pieces of foam on the surface of the water. If the water has any steam or tiny bubbles at the bottom of the pan, ask your teacher to place the foam in the pot for you.
4. As the water heats, watch the action of the bubbles as they rise from the bottom of the pot. Observe everything you can about what happens to them when they rise under a piece of foam. Record your observation in the table provided.
5. Once the water begins to boil, watch your pieces of foam. How do they move? In what direction do they go? Do they stay in one place in the pot or do they move ? Do they crash into other pieces of foam? Record the answers to these observations in the data table. Be sure to observe the boiling pot for a while. It may first seem there is no pattern to the action in the pot, but careful observation will reveal certain movements in the boiling water.

Figure 1

Laboratory Activity 2 (continued)

6. When the experiment is over, your teacher will turn off the hot plates and remove the foam with tongs for cooling. DO NOT remove the pieces yourself. They will cool quickly. When they are cooled, find your pieces and return to your lab station or seat.

7. In your data table write down any observed changes in your foam. Does it still have water in it? Have any of the corners been melted or damaged? Write down any other observations in your table.

Data and Observations

Action of bubbles	1.
Movement of foam pieces in boiling water	2.
Condition of foam after experiment	3.

Questions and Conclusions

1. How did you describe what happened to the bubbles as they gathered under the foam? What happened at the sides of the foam?

Laboratory Activity 2 (continued)

2. What type of natural feature is similar to the action of the bubbles? Explain your answer.

3. Describe the movement of the plastic pieces when the water started to boil. Could you see a pattern?

4. How does this experiment model the moving tectonic plates?

5. How is this experiment different from the real world in terms of tectonic plates? (Hint: What were your foam pieces like after the experiment?)

6. Predict what would happen if the convection currents of the molten magma changed direction or stopped altogether?

Strategy Check

_______ Can you model convection currents and the movement of tectonic plates?

_______ Can you predict what will happen to tectonic plates at the margins of convection cells?

FOLDABLES Reading & Study Skills

Plate Tectonics

Directions: *Use this page to label your Foldable at the beginning of the chapter.*

Know

Like to know

Learned

Meeting Individual Needs

Name Date Class

Directed Reading for Content Mastery

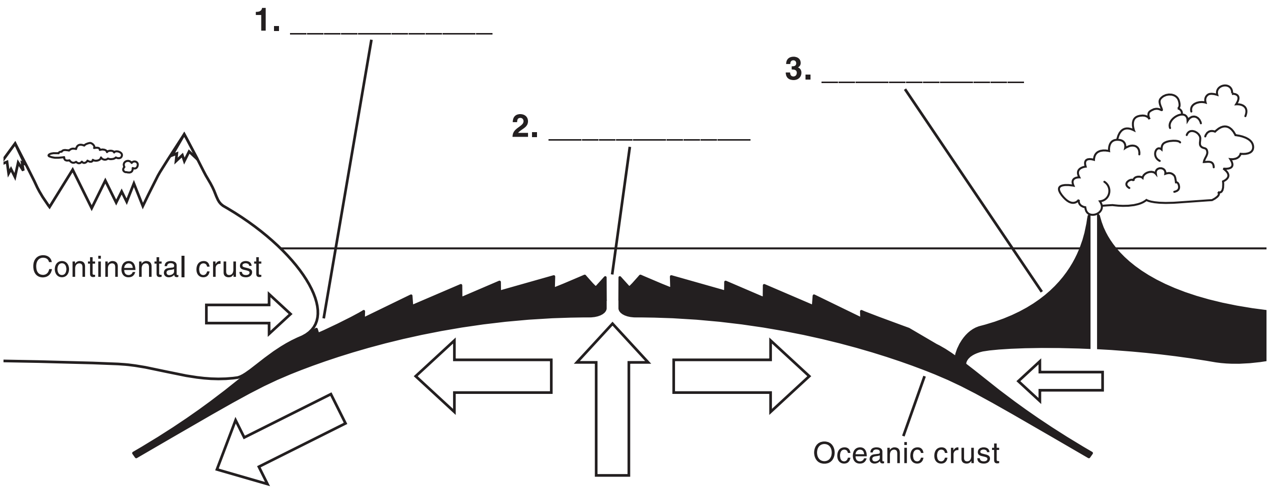
Overview
Plate Tectonics

Directions: *Study the following diagram. Then label each part with the letter of the correct description below.*

A. A mid-ocean ridge forms whenever diverging plates continue to separate, creating a new ocean basin. As the rising magma cools, it forms new ocean crust.

B. When an oceanic plate converges with a less dense continental plate, the denser oceanic plate sinks under the continental plate.

C. When two oceanic plates converge, the denser plate is forced beneath the other plate and volcanic islands form above the sinking plate.



Directions: *Circle the words in parentheses that best complete the sentences below.*

4. (Fossils, Human bones), rocks, and climate provided Wegener with support for his continental drift theory.

5. The fact that the (youngest, oldest) rocks are located at the mid-ocean ridges is evidence for seafloor spreading.

6. The transfer of (solar, heat) energy inside Earth moves plates.

Meeting Individual Needs

Directed Reading for Content Mastery

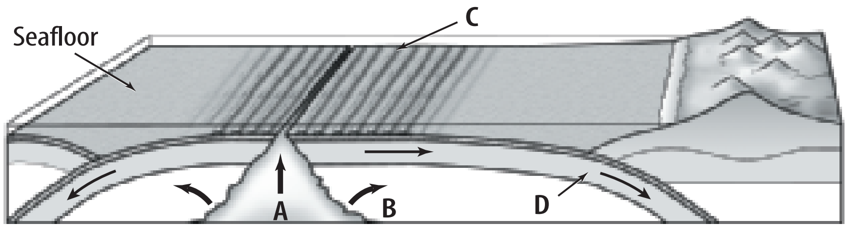
Section 1 ▪ Continental Drift
Section 2 ▪ Seafloor Spreading

Directions: *Complete the paragraph by filling in the blanks using the words below.*

Pangaea	**Arctic**	**rock**
continents	**Africa**	**seafloor spreading**

Alfred Wegener was one of the first people to suggest that all of the **1.** ____________________ were joined together in the past. He called the one large continent **2.** ____________________. Evidence exists to support his hypothesis. For example, similar fossils have been found in South America and **3.** ____________________. Also, fossils of warm weather plants have been found in the **4.** ____________________. Similar **5.** ____________________ structures exist in the Appalachian Mountains and in Greenland and western Europe. But until clues on the ocean floor led to Harry Hess's theory of **6.** ____________________, scientists could not think of how the continents might move.

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



_______ **7.** Molten rock flows onto the seafloor and hardens as it cools.

_______ **8.** Hot, molten rock is forced upward toward the seafloor at a mid-ocean ridge.

_______ **9.** New seafloor moves away from the ridge, cools, becomes denser, and sinks.

_______ **10.** Molten rock pushes sideways in both directions as it rises, moving the mantle with it.

Name ______ Date ______ Class ______

Directed Reading for Content Mastery

Section 3 ▪ Theory of Plate Tectonics

Directions: *In the blank at the left, write the letter of the term that best completes the sentence.*

______ **1.** Earth's crust and upper mantle are broken into sections called ______
a. lava. **b.** plates.

______ **2.** The collision of one continental plate with another may produce ______
a. oceans. **b.** mountains.

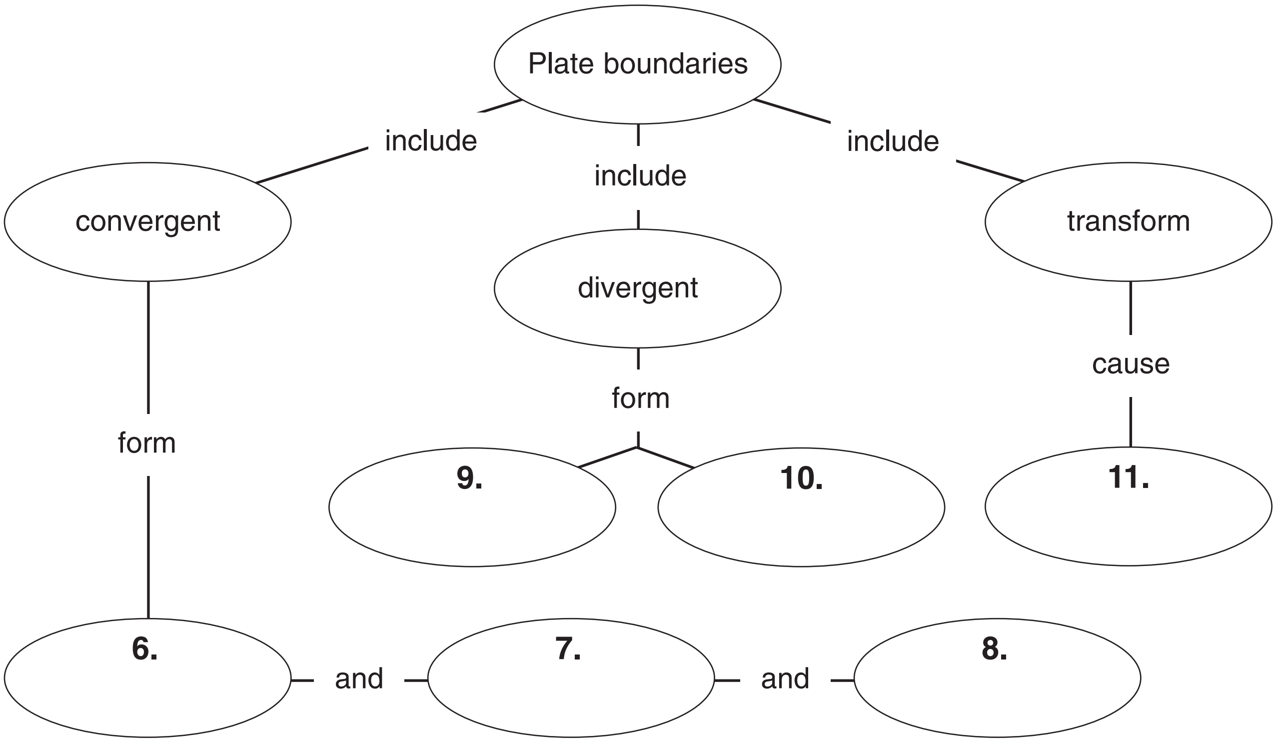
______ **3.** New ocean crust is formed at a ______
a. rift valley. **b.** mid-ocean ridge.

______ **4.** A rift valley can form where two continental plates are ______
a. moving apart. **b.** colliding.

______ **5.** Where Earth's plates move, they may slide alongside one another, pull apart, or ______
a. collide. **b.** divide.

Directions: *Complete the concept map using the terms in the list below.*

mid-ocean ridges	**volcanic islands**	**major earthquakes**
rift valleys	**deep-sea trenches**	**volcanic mountains**



Meeting Individual Needs

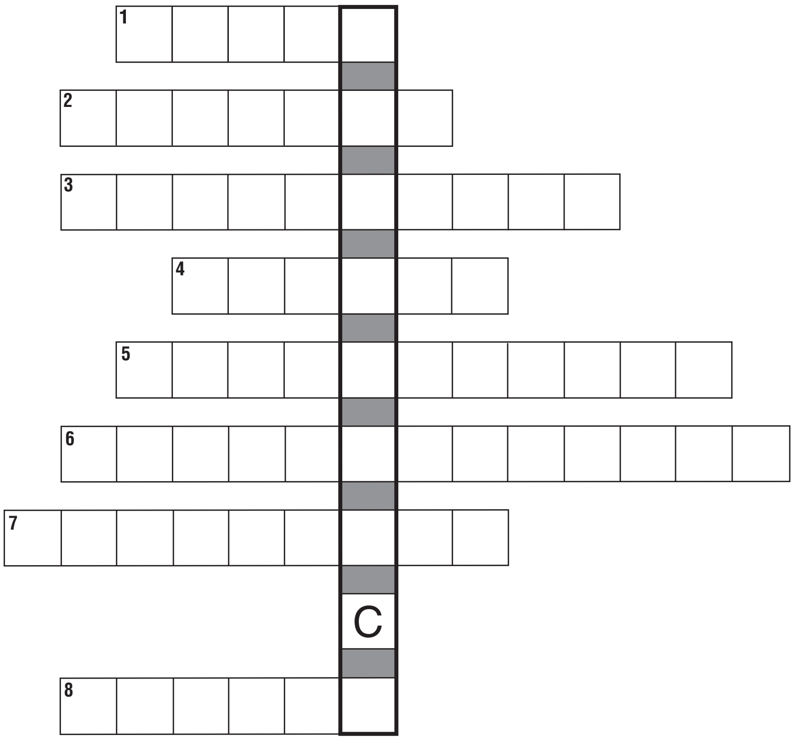
Name Date Class

Directed Reading for Content Mastery

Key Terms
Plate Tectonics

Directions: *Use the following terms to complete the puzzle below. The letters in the darker, vertical box complete question 9.*

Pangaea	**mantle**	**spreading**	**lithosphere**
convection	**plates**	**drift**	**asthenosphere**



1. The hypothesis that continents move slowly is called continental ______.

2. All continents once might have been connected in a large landmass called ______.

3. The cycle of heating, rising, cooling, and sinking is a ______ current.

4. Just below Earth's crust is the ______.

5. The crust and part of the upper mantle are known as the ______.

6. Continental plates move on the plasticlike layer of Earth's surface called the ______.

7. Hot magma forced upward at mid-ocean ridges produces seafloor ______.

8. Sections of Earth's crust and part of the upper mantle are called ______.

9. The theory that Earth's crust and upper mantle are in sections that move is called plate ____________________.

Meeting Individual Needs

Lectura dirigida para Dominio del contenido

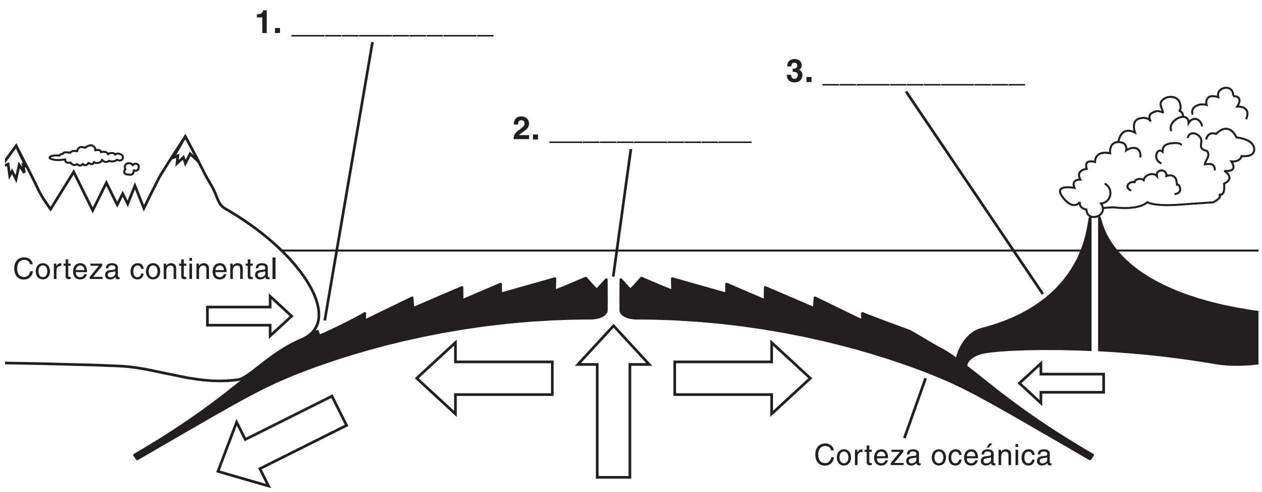
Sinopsis Tectónica de las placas

Instrucciones: *Estudia el siguiente diagrama. Luego rotula cada parte con la letra de la descripción correcta.*

A. Una dorsal mediooceánica se forma cuando las placas divergentes continúan separándose, creando una cuenca oceánica. A medida que se eleva y se enfría, el magma forma nueva corteza oceánica.

B. Cuando una placa oceánica converge con una placa continental menos densa, la placa oceánica más densa se hunde debajo de la placa continental.

C. Cuando dos placas oceánicas convergen, la placa más densa es forzada a moverse debajo de la otra placa y se forman islas volcánicas sobre la placa que se está hundiendo.



Instrucciones: *Haz un círculo alrededor de las palabras que mejor completan las siguientes oraciones.*

4. Las principales pruebas que Wegener usó para apoyar su teoría de la deriva continental fueron (las rocas, los lenguajes), (los huesos humanos, los fósiles) y (el clima, antiguos cuentos populares).

5. El hecho de que las rocas (más recientes, más antiguas) están ubicadas en las dorsales mediooceánicas es una prueba de la expansión del suelo marino.

6. La transferencia de energía (solar, térmica) dentro de la Tierra mueve las placas.

Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

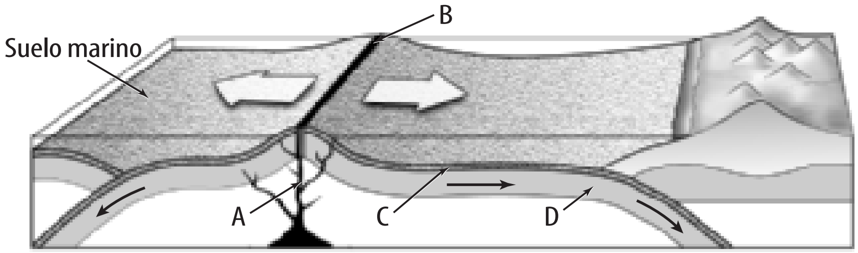
Sección 1 ▪ Deriva continental
Sección 2 ▪ Expansión del suelo marino

Instrucciones: *Completa el párrafo llenado los espacios en blanco con las siguientes palabras:*

Pangaea	**el Ártico**	**roca**
continentes	**África**	**expansión del suelo marino**

Alfred Wegener fue una de las primeras personas que sugirió que todos los **1.** ____________________ estuvieron unidos en el pasado. Él llamó a este gran continente único **2.** ____________________. Existen pruebas que apoyan su hipótesis. Por ejemplo, se han encontrado fósiles similares en Sudamérica y en **3.** ____________________. Además, se han encontrado fósiles de climas cálidos en **4.** ____________________. Existen estructuras de **5.** ____________________ que son similares en las montañas Apalaches y en Groenlandia y el oeste de Europa. Pero no fue sino hasta que pistas encontradas en el suelo marino llevaron a la teoría de Harry Hess de la **6.** ____________________, que los científicos pudieron pensar sobre cómo podrían moverse los continentes.

Instrucciones: *Estudia el siguiente diagrama del suelo marino. Aparea luego las letras con las afirmaciones de abajo.*



_______ **7.** La roca fundida fluye sobre el suelo marino y se endurece al enfriarse.

_______ **8.** La roca caliente y fundida es forzada hacia arriba hacia el suelo marino en las dorsales mediooceánicas.

_______ **9.** El nuevo suelo marino se aleja de la dorsal, se enfría, se hace más denso y se hunde.

_______ **10.** La roca fundida fluye hacia los lados en ambas direcciones, dividiendo la corteza.

Lectura dirigida para Dominio del contenido

Sección 3 ▪ Teoría de la tectónica de placas

Instrucciones: *Escribe en el espacio a la izquierda, la letra del término que completa mejor cada oración.*

_______ **1.** La corteza y el manto superior de la Tierra están quebrados en secciones llamadas _______

a. lava. **b.** placas.

_______ **2.** La colisión de una placa continental con otra puede producir _______

a. océanos. **b.** montañas.

_______ **3.** Se forma corteza oceánica nueva en un(a) _______

a. valle de dislocación. **b.** dorsal mediooceánica.

_______ **4.** Un valle de dislocación se puede formar cuando dos placas continentales están _______

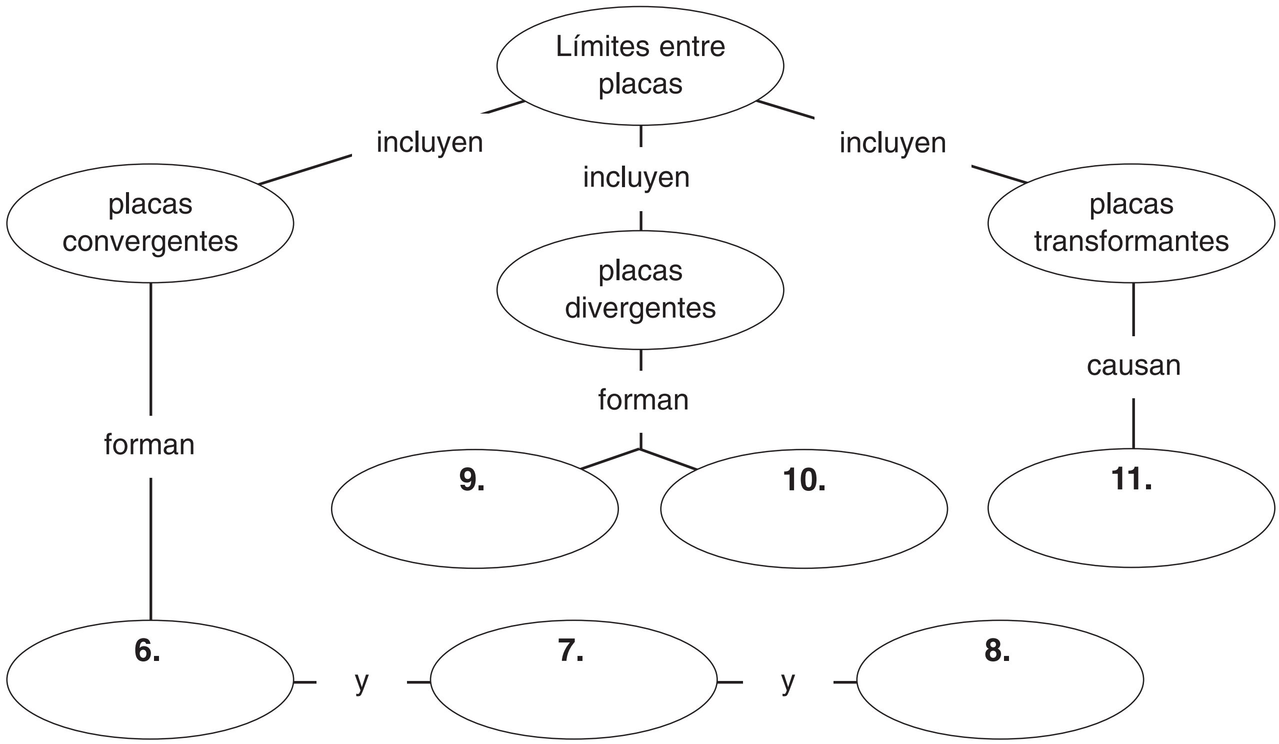
a. separándose. **b.** chocando.

_______ **5.** En los sitios en donde las placas de la Tierra se mueven, éstas pueden deslizarse una al lado de la otra, separarse o _______

a. chocar. **b.** dividirse.

Instrucciones: *Completa el mapa conceptual con los siguientes términos.*

dorsales mediooceánicas **islas volcánicas** **terremotos fuertes**
valles de dislocación **fosas oceánicas** **montañas volcánicas**



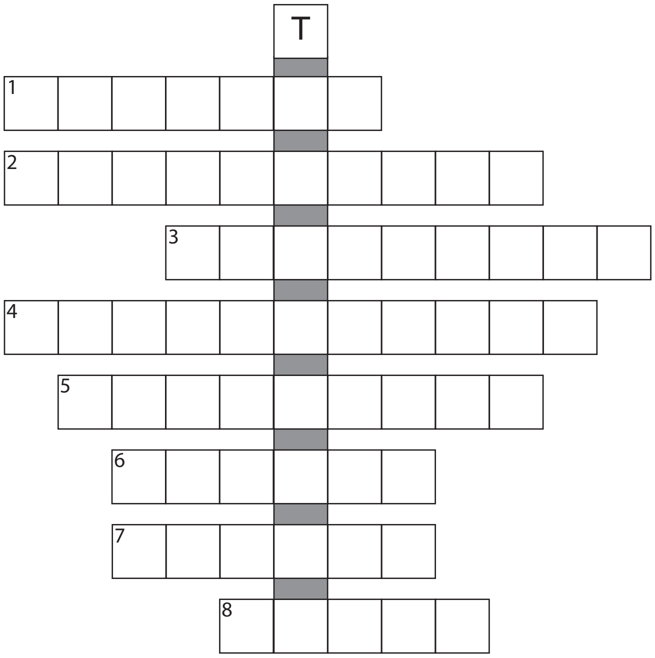
Satisface las necesidades individuales

Lectura dirigida para Dominio del contenido

Términos claves
Tectónica de las placas

Instrucciones: *Usa los siguientes términos para completar el crucigrama. Las letras en la caja vertical oscura contestan la pregunta 9.*

Pangaea	**manto**	**expansión**	**litosfera**
convección	**placas**	**deriva**	**astenosfera**



1. Todos los continentes estuvieron conectados una vez formando una gran masa de tierra llamada ______.
2. Ciclo de calentamiento, elevación, enfriamiento y hundimiento se llama corriente de ______.
3. La corteza y la parte superior del manto se conocen como ______.
4. Las placas continentales se mueven sobre una capa viscosa bajo la superficie de Tierra llamada ______.
5. El magma caliente que sube en las dorsales mediooceánicas produce ______ del suelo marino.
6. La hipótesis de que los continentes se mueven lentamente se llama ______ continental.
7. Las secciones de la corteza y el manto superior de la Tierra se llaman ______.
8. Justo debajo de la corteza terrestre está ubicada la ______.
9. La teoría de que la corteza y el manto superior de la Tierra están divididos en secciones que se mueven se llama ____________________ de placas.

Name Date Class

SECTION 1 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	Column II
_______ **1.** reptile fossil found in South America and Africa	**a.** Pangaea
_______ **2.** fossil plant found in Africa, Australia, India, South America, and Antarctica	**b.** Appalachians
_______ **3.** clues that support continental drift	**c.** continental drift
_______ **4.** mountains similar to those in Greenland and western Europe	**d.** glacial deposits
_______ **5.** Wegener's name for one large landmass	**e.** *Glossopteris*
_______ **6.** slow movement of continents	**f.** *Mesosaurus*
_______ **7.** evidence that Africa was once cold	**g.** fossil, climate, and rock

Meeting Individual Needs

Directions: *Answer the following questions 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? What do scientists now think might be a possible cause of continental drift?

____

____

____

____

____

SECTION 2 Reinforcement

Seafloor Spreading

Directions: *Find the mistakes in the statements below. Rewrite each statement correctly on the lines provided.*

1. During the 1940s and 1950s, scientists began using radar on moving ships to map large areas of the ocean floor in detail.

2. The youngest rocks are found far from the mid-ocean ridges.

3. The scientist Henry Hess invented echo-sounding devices for mapping the ocean floor.

4. As the seafloor spreads apart, hot saltwater moves upward and flows from the cracks.

5. As the new seafloor moves away from the ridge and becomes hotter, it moves upward and forms still higher ridges.

6. The research ship *Glomar Challenger* was equipped with a drilling rig that records magnetic data.

7. Rocks on the seafloor are much older than many continental rocks.

8. When plates collide, the denser plate will ride over the less-dense plate.

9. Earth's magnetic field has always run from the north pole to the south pole.

10. The magnetic alignment in rocks on the ocean floor always runs from the north pole to the south pole.

SECTION 3 Reinforcement

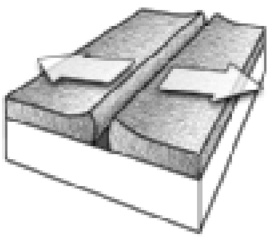
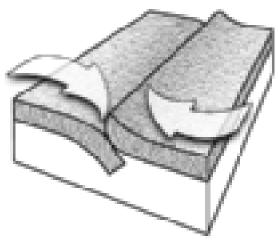
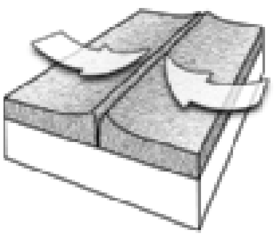
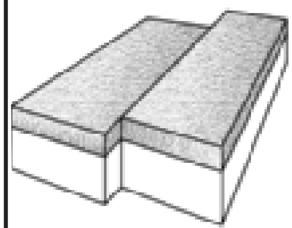
Theory of Plate Tectonics

Directions: *Use the following words to fill in the blanks below.*

asthenosphere **lithosphere** **plate tectonics**
convection **plates**

1. The theory of ____________________ states that Earth's crust and upper mantle are broken into sections.
2. These sections, called ____________________, are composed of the crust and a part of the upper mantle.
3. The crust and upper mantle together are called the ____________________.
4. Beneath this layer is the plasticlike ____________________.
5. Scientists suggest that differences in density cause hot, plasticlike rock to be forced upward toward the surface, cool, and sink. This cycle is called a ____________________ current.

Directions: *Four diagrams are shown in the table below. Label and describe each diagram in the space provided in order to complete the table.*

Diagram	Type of boundary and motion at boundary	Diagram	Type of boundary and motion at boundary
6. 		8. 	
7. 		9. 	

Name Date Class

Section 1 Enrichment — Studying Seafloor Spreading on Land

You know from your textbook 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

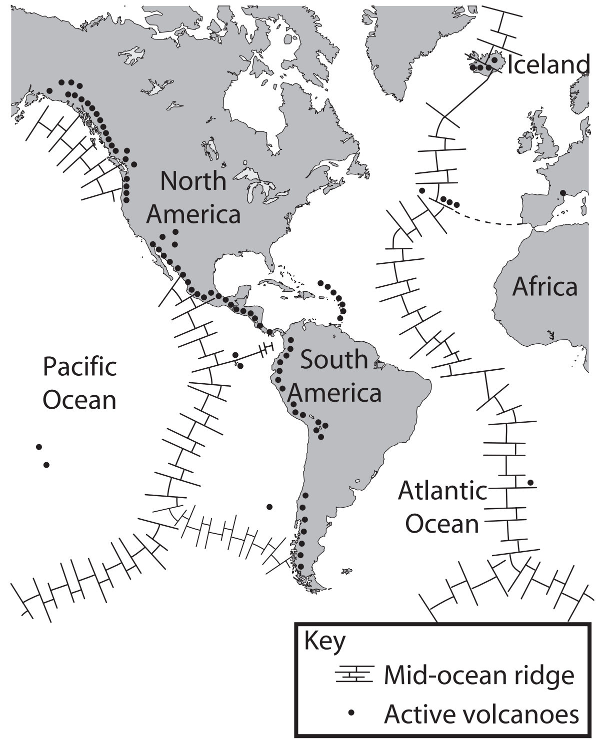
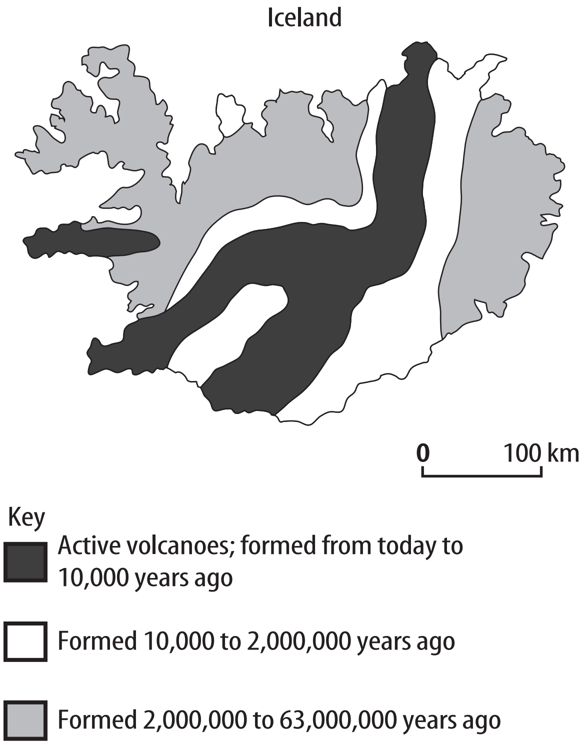


Figure 2



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

____

____

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

____

____

____

3. Why do you think geologists might find Iceland a useful place to conduct research on seafloor spreading?

____

____

SECTION 2 Enrichment

Axial Volcano—Evidence for Seafloor Spreading

What happens when a volcano erupts under water? Ocean scientists got the opportunity to find out in January 1988 when Axial erupted. Axial is an underwater volcano, or seamount, located about 480 km west of Oregon's coast. It looms the largest of all the underwater structures on the Juan de Fuca ridge.

Quakes Along the Seafloor

Underwater listening instruments called hydrophones, which are used by the Navy to hear submarines, first picked up rumblings from Axial on January 25. Scientists recorded nearly 7,000 earthquakes during the first four days alone. Scientists hypothesized that these quakes resulted from hot magma moving and cracking rock, uncapping the top of Axial. The earthquakes followed a line in the seafloor where the Juan de Fuca oceanic plate is moving eastward, away from the Pacific oceanic plate. East of the shoreline, the Juan de Fuca plate is being pushed under the North American continental plate.

Creating New Seafloor

The scientists discovered that when Axial erupted, boiling-hot water shot up out of the volcano, followed by a great amount of superhot lava. Much of this lava filled part of the gap between the Pacific Ocean plate and the Juan de Fuca plate, creating new seafloor. Having lost so much magma, Axial caved in somewhat—by about 3.2 m in the center.

Megaplumes

Around the same time, another group of scientists was on a 52 m research ship, the *Wecoma,* on the ocean's surface about a mile above. They fought stormy conditions to gather data such as water temperature, water current flow, and samples of chemicals from the eruption. In 1986 scientists had learned that underwater volcanoes can cause underwater "hurricanes," called megaplumes, which shoot hot water loaded with minerals and lifeforms some 305 m up from the bottom. Only seven megaplumes in the world had been observed previously.

Hydrothermal Vents

At Axial's summit sits a rectangular caldera (roughly 20 km^2 in area) between two rift zones. In the dark caldera, hydrothermal vents furnish heat and "food" such as hydrogen sulfide—poisonous to most creatures—to communities of bacteria and tube worms comfortable in temperatures hotter than the boiling point of water.

Axial provides scientists with a model for the rest of Earth's 64,000 km or so of mid-ocean ridges. Various groups of scientists are conducting long-term studies of Axial and other areas along the Juan de Fuca ridge, focusing on various aspects of seafloor exploration.

1. Describe how seafloor spreading occurs along the Juan de Fuca ridge.

____

____

2. Using a physical map of Oregon, identify the geographical feature where the Juan de Fuca plate is pushing under the North American plate. ______________________

3. Do you think that the rocks near Axial are younger or older than the rocks in Oregon? Explain.

____

____

Meeting Individual Needs

SECTION 3 Enrichment

Predicting Plate Movement

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.

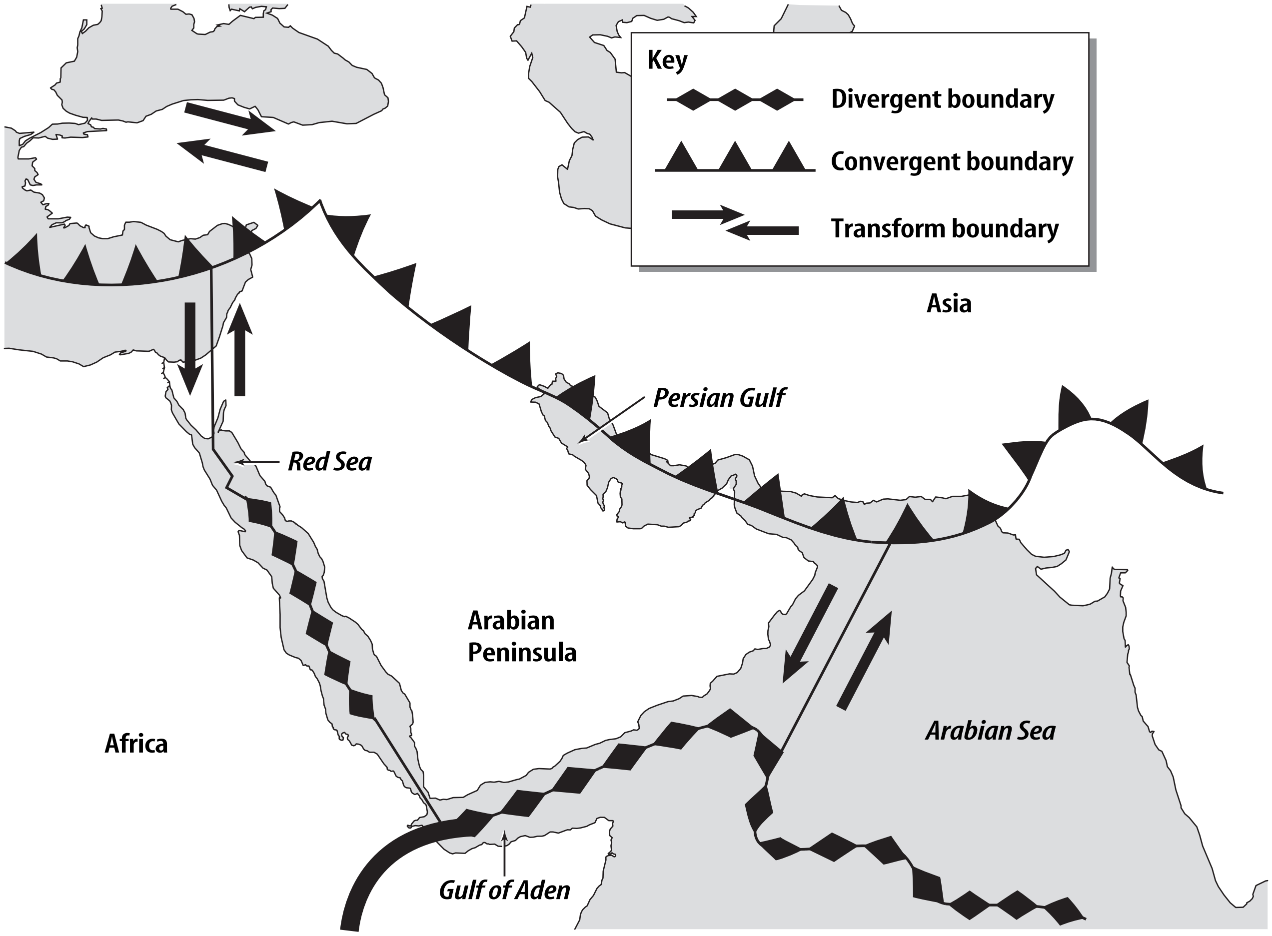
1. Cut the map along the boundaries. Move the pieces to show how the plates will move in the next million years, according to the types of boundaries. Tape the pieces in place.
2. In which place(s) did you have to crumple your paper to account for the various plate movements?

____

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

____

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



Note-taking Worksheet

Plate Tectonics

Section 1 Continental Drift

A. The **continental drift** hypothesis—continents have moved slowly to their current locations.

1. All continents were once connected as one large landmass now called ________________.

2. The land mass broke apart, and the ___________________ drifted to their present positions.

3. Evidence for continental drift

a. ____________________ fit of the continents

b. Similar ________________ have been found on different continents.

c. Remains of warm-weather plants in _______________ areas and glacial deposits in __________________areas suggest that continents have moved.

d. Similar _____________ structures are found on different continents.

B. At first, continental drift was not accepted because no one could explain ____________ or _____________continents had moved.

Section 2 Seafloor Spreading

A. Using ______________ waves, scientists discovered a system of underwater mountain ranges called the mid-ocean ridges in many oceans.

B. In the 1960s, Harry Hess suggested the theory of ___________________________ to explain the ridges.

1. Hot, less dense material below Earth's ______________ rises upward to the surface at the mid-ocean ridges.

2. Then, it flows sideways, carrying the _________________ away from the ridge.

3. As the seafloor spreads apart, ______________ moves up and flows from the cracks, cools, and forms new seafloor.

C. Evidence for seafloor spreading

1. _________________ rocks are located at mid-ocean ridges.

2. Reversals of Earth's ________________ field are recorded by rocks in strips parallel to ridges.

Note-taking Worksheet (continued)

Section 3 Theory of Plate Tectonics

A. Plate movements

1. Earth's ______ and upper mantle are broken into sections.

2. The sections, called ______, move on a plasticlike layer of the mantle.

3. The plates and upper mantle form the ______.

4. The plasticlike layer below the lithosphere is called the ______.

B. Plate boundaries

1. Plates moving ______—divergent boundaries

2. Plates moving ______—convergent boundaries

a. Denser plates sink under less ______ plates.

b. Newly formed hot ______ forced upward forms volcanic mountains.

3. Plates collide

a. Plates crumple up to form ______ ranges.

b. ______ are common.

4. Plates slide past—called ______ boundaries; sudden movement can cause earthquakes

C. Convection inside Earth—the cycle of heating, rising, cooling, and sinking of material inside Earth is thought to be the ______ behind plate tectonics.

D. Features caused by plate tectonics

1. Faults and ______ valleys

2. Mountains and ______

3. Strike-slip faults—cause of ______

E. Testing for plate tectonics—scientists can measure ______ as little as 1 cm per year.

Assessment

Assessment

Name Date Class

Chapter Review

Plate Tectonics

Part A. Vocabulary Review

Directions: *Write the term that matches each description below in the spaces provided. Then unscramble the letters in the boxes to reveal the mystery phrase.*

1. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ [ ] ___
2. ___ ___ ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ [ ] ___ ___ ___ ___
3. [ ] ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
4. [ ] ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
5. ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
6. ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___
7. [ ] ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
8. ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___ ___
9. ___ ___ ___ ___ ___ ___ [ ]
10. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___
11. ___ ___ ___ ___ ___ ___ [ ] ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
12. ___ ___ ___ ___ [ ] ___
13. ___ [ ] ___ ___ ___ ___
14. ___ ___ ___ [ ] ___
15. ___ ___ ___ ___ ___ ___ - ___ ___ [ ] ___ ___ ___ ___ ___ ___

1. plasticlike layer of Earth's surface below the lithosphere
2. cycle of heating, rising, cooling, and sinking
3. theory that states that Earth's crust and upper mantle are broken into sections, which move around on a special layer of the mantle
4. area where an oceanic plate goes down into the mantle
5. plate boundary that occurs when two plates slide past one another
6. place where two plates move together
7. rigid layer of Earth's surface made up of the crust and a part of the upper mantle
8. sensing device that detects magnetic fields, helping to confirm seafloor spreading
9. one large landmass hypothesized to have broken apart about 200 million years ago into continents
10. hypothesis that the continents have moved slowly to their current locations
11. boundary between two plates that are moving apart
12. sections of Earth's crust and upper mantle
13. largest layer of Earth's surface, composed mostly of silicon, oxygen, magnesium, and iron
14. outermost layer of Earth's surface
15. where rocks on opposite sides of a fault move in opposite directions or in the same direction at different rates
16. Mystery phrase:

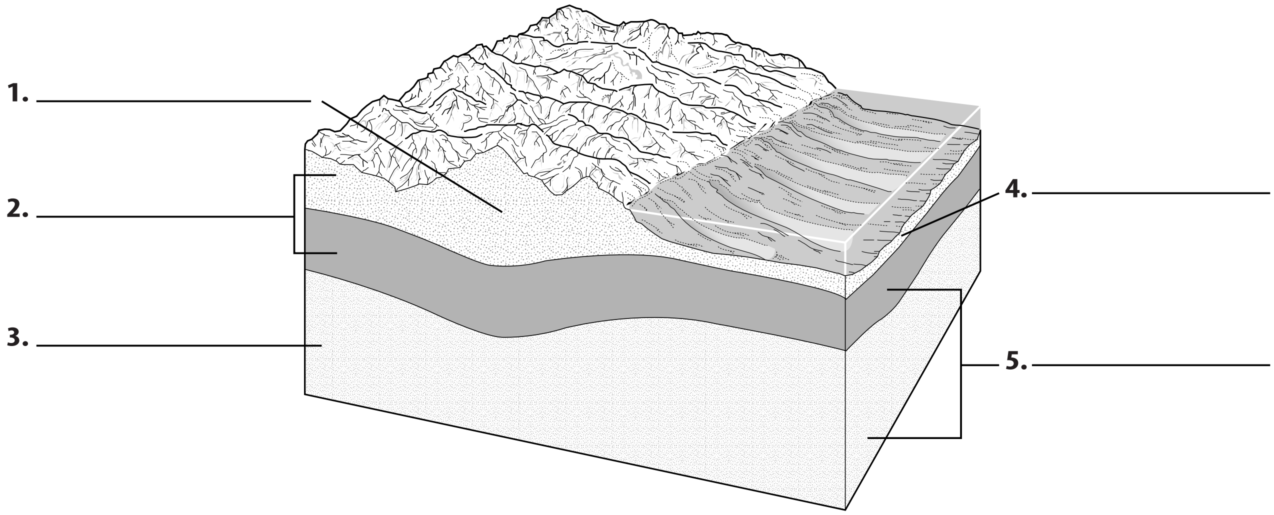
____

Assessment

Chapter Review (continued)

Part B. Concept Review

Directions: *Study the following diagram. Then label the parts of Earth's surface.*



Directions: *Answer the following questions using complete sentences.*

6. Compare and contrast divergent, convergent, and transform plate boundaries.

7. Describe how convection currents might be the cause of plate tectonics.

8. Why are new ideas often rejected, and what is needed before new ideas should be accepted?

Assessment

Chapter Test

Plate Tectonics

I. Testing Concepts

Directions: *For each of the following, write the letter of the term or phrase that best completes the sentence.*

_______ **1.** The seafloor spreading theory was proposed by _______
a. Alfred Wegener. **c.** Abraham Ortelius.
b. Harry Hess. **d.** Carl Sagan.

_______ **2.** As Earth's plates move apart at some boundaries, they collide at others, forming _______
a. mountains and volcanoes. **c.** strike-slip faults.
b. ocean basins. **d.** both a and b.

_______ **3.** The youngest rocks in the ocean floor are located at the mid-ocean _______
a. volcanoes. **b.** basins. **c.** trenches. **d.** ridges.

_______ **4.** The results of plate movement can be seen at _______
a. rift valleys. **c.** plate centers.
b. plate boundaries. **d.** both a and b.

_______ **5.** The _______ are forming where the Indo-Australian plate collides into the Eurasian plate.
a. Andes mountain range **c.** Himalayas
b. Rocky Mountains **d.** Appalachian Mountains

_______ **6.** The presence of the same _______ on several continents supports the idea of continental drift.
a. fossils **b.** rocks **c.** neither a nor b **d.** both a and b

_______ **7.** Continental drift occurs because of _______
a. seafloor spreading. **c.** magnetic reversal.
b. Pangaea. **d.** earthquakes.

_______ **8.** The cycle of heating, rising, cooling, and sinking is called a _______
a. subduction zone. **c.** convection current.
b. convergent boundary. **d.** conduction current.

_______ **9.** Oceanic plates are pushed down into the upper mantle in _______
a. convection currents. **c.** strike-slip faults.
b. subduction zones. **d.** divergent boundaries.

_______ **10.** The hypothesis that continents have moved slowly to their current locations is called _______
a. continental drift. **c.** magnetism.
b. continental slope. **d.** convection.

_______ **11.** Plates move apart at _______ boundaries.
a. convergent **b.** transform **c.** divergent **d.** magnetic

_______ **12.** Ocean floor rocks are _______ continental rocks.
a. more eroded than **c.** younger than
b. older than **d.** the same age as

Chapter Test (continued)

_______ **13.** The alignment of iron-bearing minerals in rocks when they formed reflects the fact that Earth's _______ has reversed itself several times in its past.
a. magnetic field **b.** core **c.** asthenosphere **d.** gravity

_______ **14.** The lack of an explanation for continental drift prevented many scientists from believing a single supercontinent called _______ once existed.
a. *Glomar* **b.** *Glossopteris* **c.** *Pangaea* **d.** *Mesosaurus*

_______ **15.** Scientists aboard the *Glomar Challenger* added to the evidence for the theory of seafloor spreading by providing _______
a. high altitude photos of existing continents.
b. samples of plant life from different locations.
c. samples of rock from different locations.
d. direct measurements of the movement of continents.

_______ **16.** Where plates slide past one another, _______ occur.
a. volcanoes **b.** earthquakes **c.** island arcs **d.** ocean trenches

_______ **17.** The places between plates moving together are called _______
a. divergent boundaries. **c.** strike-slip faults.
b. convergent boundaries. **d.** lithospheres.

_______ **18.** Seafloor spreading occurs because _______
a. new material is being added to the asthenosphere.
b. earthquakes break apart the ocean floor.
c. sediments accumulate on the ocean floor.
d. hot, less-dense material below Earth's crust is forced upward toward the surface.

_______ **19.** Studying the ocean floor, scientists found rocks showing magnetic _______
a. weakening. **b.** reversal. **c.** bonds. **d.** poles.

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

20. The theory that describes Earth's crust and upper mantle as being broken into sections is called ______________________.

21. The theory of ______________________ was shown to be correct by age evidence and magnetic clues.

22. ______________________, occurring in the mantle, are thought to be the force behind plate tectonics.

23. Earth's plasticlike layer is the ______________________.

24. Earth's ______________________ move around on a special layer of the mantle.

25. The main lines of evidence for ______________________ are fossil, rock, and climate clues, and the theory of seafloor spreading.

26. The rigid part of the plates of the ______________________ are made of oceanic crust or continental crust and upper mantle.

27. The name ______________________ means "all land."

Assessment

Chapter Test (continued)

II. Understanding Concepts

Directions: *Answer the following questions on the lines provided.*

1. What is the difference between a convergent and a divergent plate boundary?

2. What happens to warmer material in a convection current?

3. What observation led Alfred Wegener to develop the hypothesis of continental drift?

4. Which part of Earth's structure is about 100 km thick?

5. How were the Andes mountain range, the Himalayas, and the islands of Japan formed alike?

6. How were the Andes mountain range, the Himalayas, and the islands of Japan formed differently?

Skill: Recognizing Cause and Effect

7. What causes new material to form at a mid-ocean ridge on the ocean floor?

Chapter Test (continued)

III. Applying Concepts

Directions: *Answer the following questions on the lines provided.*

1. Why are there few volcanoes in the Himalayas?

2. Glacial deposits often form at a high latitude near the poles. Explain why glacial deposits have been found in Africa.

3. Why would the fossil of an ocean fish found on two different continents **NOT** be good evidence of continental drift?

IV. Writing Skills

Directions: *Answer the following questions using complete sentences.*

1. Explain how research from the G*lomar Challenger* helped scientists support the theory of seafloor spreading.

2. Since new crust is constantly being added, why does Earth's surface not keep expanding?

Transparency Activities

SECTION 1 Section Focus Transparency Activity

A Cold Dig

If you were interested in the fossils of an animal that liked warm weather, would you think of digging in Antarctica? Archaeologists have found many interesting fossils there, including parts of a hadrosaur, a dinosaur previously found only in the Americas.

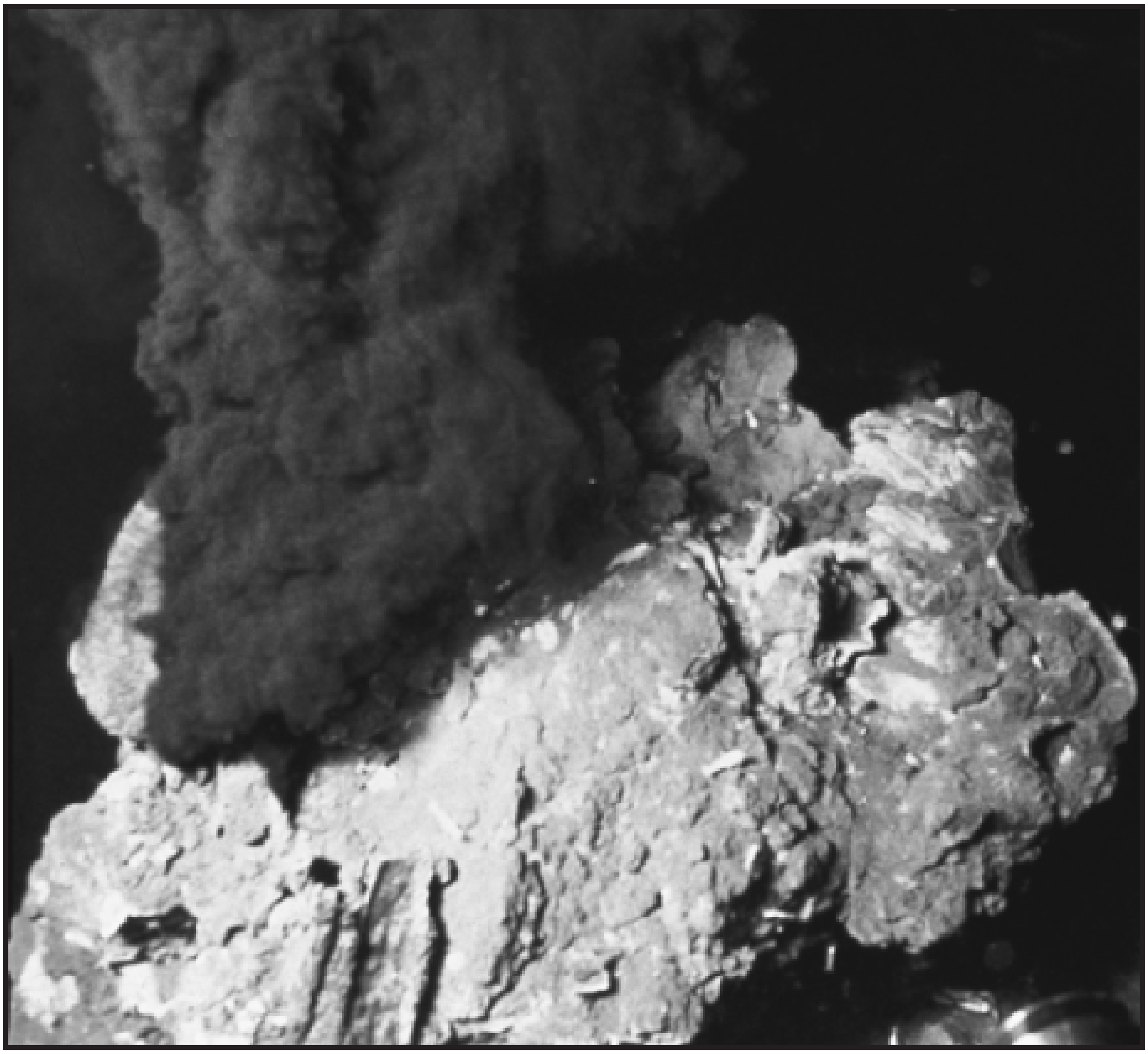
1. Antarctica has a very inhospitable climate. Why might fossils of warm-weather animals be found there?

2. What are some reasons that the climate of Antarctica might change in the future?

SECTION 2 Section Focus Transparency Activity

The Main Event

Until recently, the bottom of the sea was impossible to see. New technology has improved the view, and today we have a better idea of what is going on there. This photo shows one feature of the ocean floor—a deep-sea vent.



1. What is occurring in the photograph?
2. What features on land are similar to this deep-sea vent?
3. Judging from the photo, what do you think conditions around this vent are like?

SECTION 3 Section Focus Transparency Activity

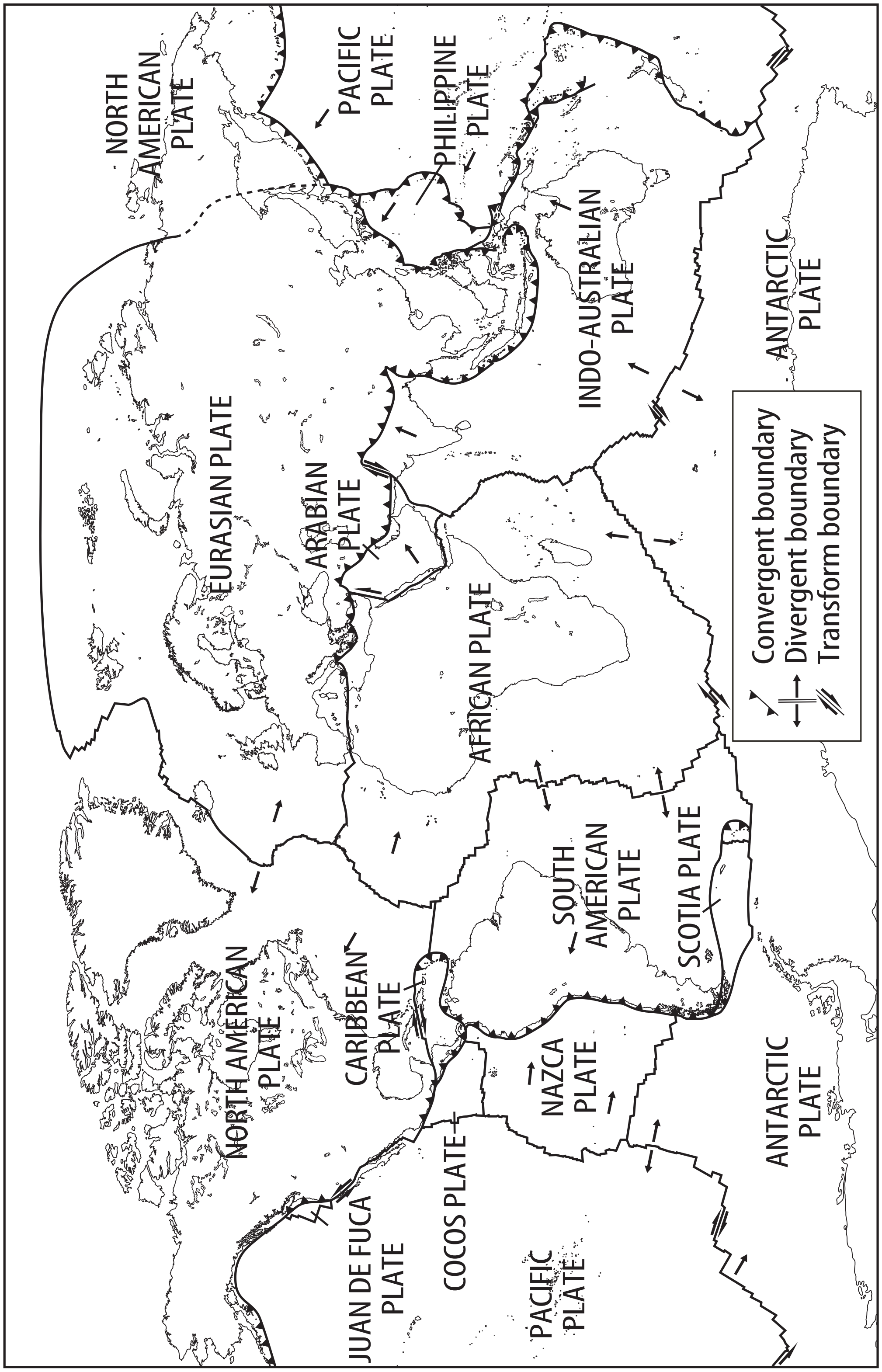
Valley of Ten Thousand Smokes

One of the most massive volcanic eruptions ever investigated occurred in a valley in southern Alaska in 1912. The eruption covered over forty square miles with ash as deep as 210 meters and left thousands of vents (called fumaroles) in the valley spewing steam and gas.

1. **How did this valley get its name, the Valley of Ten Thousand Smokes?**
2. **Why don't you see any smoke in the photograph?**
3. **Name some other places where there are volcanoes.**

SECTION 3 Teaching Transparency Activity

Plates of the Lithosphere



Teaching Transparency Activity (continued)

1. What makes up the lithosphere?

2. What is a convergent boundary?

3. What type of boundary is on the western coast of South America?

4. Which plate is covering most of two continents? What two continents?

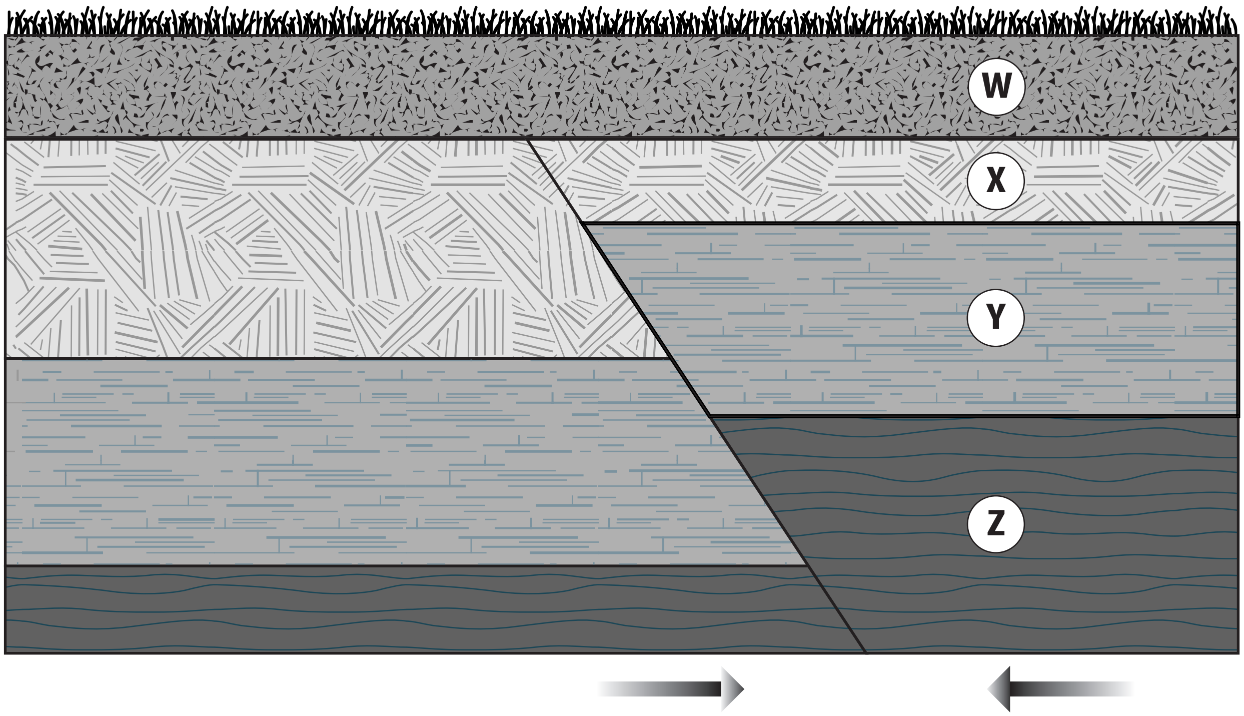
5. What kind of boundary forms the Mid-Atlantic Ridge?

6. What two plates form the boundary on the western coast of Canada?

Assessment Transparency Activity

Plate Tectonics

Directions: *Carefully review the diagram and answer the following questions.*



1. Which is the oldest rock layer in the picture?

A W
B X
C Y
D Z

2. The arrows indicate the directions the two plates are moving. What is this type of boundary called?

F convergent boundary
G divergent boundary
H transform boundary
J moving boundary

3. Which of the following is the danger most likely posed by the rock formation shown in the diagram?

A flooding
B earthquake
C tornado
D forest fire

Teacher Support and Planning

Teacher Support and Planning

Content Outline for Teaching T2
Spanish Resources T5
Teacher Guide and Answers. T9

Content Outline for Teaching

Plate Tectonics

Section 1 Continental Drift

Underlined words and phrases are to be filled in by students on the Note-taking Worksheet.

A. The **continental drift** hypothesis—continents have moved slowly to their current locations

1. All continents were once connected as one large landmass now called **Pangaea**.
2. The land mass broke apart, and the continents drifted to their present positions.
3. Evidence for continental drift
   a. Puzzle-like fit of the continents
   b. Similar fossils have been found on different continents.
   c. Remains of warm-weather plants in Arctic areas and glacial deposits in tropical areas suggest that continents have moved.
   d. Similar rock structures are found on different continents.

B. At first, continental drift was not accepted because no one could explain how or why continents had moved.

DISCUSSION QUESTION:
Why is the fact that similar fossils have been found on different continents considered evidence for continental drift? *If fossils of similar plants and animals are found on widely separated continents, it is more likely that the continents had once been joined than that the plants and animals migrated.*

Section 2 Seafloor Spreading

A. Using sound waves, scientists discovered a system of underwater mountain ranges called the mid-ocean ridges in many oceans.

B. In the 1960s, Harry Hess suggested the theory of **seafloor spreading** to explain the ridges.

1. Hot, less dense material below Earth's crust rises upward to the surface at the mid-ocean ridges.
2. Then, it flows sideways, carrying the seafloor away from the ridge.
3. As the seafloor spreads apart, magma moves up and flows from the cracks, cools, and forms new seafloor.

C. Evidence for seafloor spreading

1. Youngest rocks are located at mid-ocean ridges.
2. Reversals of Earth's magnetic field are recorded by rocks in strips parallel to ridges.

DISCUSSION QUESTION:
How could seafloor spreading be related to continental drift? *If the seafloor is constantly spreading apart and moving, it will affect and move the continents as well.*

Section 3 Theory of Plate Tectonics

A. Plate movements

1. Earth's crust and upper mantle are broken into sections.
2. The sections, called plates, move on a plasticlike layer of the mantle.
3. The plates and upper mantle form the lithosphere.
4. The plasticlike layer below the lithosphere is called the asthenosphere.

B. Plate boundaries

1. Plates moving apart—divergent boundaries
2. Plates moving together—convergent boundaries
   - **a.** Denser plates sink under less dense plates.
   - **b.** Newly formed hot magma forced upward forms volcanic mountains.
3. Plates collide
   - **a.** Plates crumple up to form mountain ranges.
   - **b.** Earthquakes are common.
4. Plates slide past—called transform boundaries; sudden movement can cause earthquakes.

C. Convection inside Earth—the cycle of heating, rising, cooling, and sinking of material inside Earth is thought to be the force behind plate tectonics.

D. Features caused by plate tectonics

1. Faults and rift valleys
2. Mountains and volcanoes
3. Strike-slip faults—cause of earthquakes

E. Testing for plate tectonics—scientists can measure movements as little as 1 cm per year.

DISCUSSION QUESTION:

What will happen if a continental plate collides with an oceanic plate? A continental plate with a continental plate? Why? *The denser plate will always subduct, or bend under, the less dense plate. Oceanic plates are denser than continental plates, so the oceanic plate will sink under it. When two continental plates collide, neither will subduct because they are both less dense than the asthenosphere beneath them. Instead, they will crumple up and form mountain ranges.*

Spanish Resources

Tectónica de las placas

SECCIÓN 1 Deriva continental

Lo que aprenderás

- A describir la hipótesis de la deriva continental.
- A identificar la prueba que apoya la deriva continental.

Vocabulario

continental drift / deriva continental: hipótesis de Wegener que afirmaba que todos los continentes estuvieron unidos en algún momento formando una sola masa continental, la cual se separó hace unos 200 millones de años, haciendo que los continentes derivaran lentamente a sus posiciones actuales.

Pangaea / Pangaea: masa de tierra extensa y antigua que una vez estuvo formada por todos los continentes.

Por qué es importante

La hipótesis de la deriva continental condujo a la tectónica de placas, la cual es una teoría que explica muchos procesos dentro de la Tierra.

SECCIÓN 2 Expansión del suelo marino

Lo que aprenderás

- A explicar la expansión del suelo marino.
- A reconocer la forma en que las pistas sobre la edad y la prueba del magnetismo apoyan la expansión del suelo marino.

Vocabulario

seafloor spreading / expansión del suelo marino: teoría de Hess que afirma que el nuevo suelo marino se forma cuando el magma es forzado a subir a la superficie en una dorsal mediooceánica.

Por qué es importante

La expansión del suelo marino ayuda a explicar por qué se separaron los continentes.

LABORATORIO Tasas de expansión del suelo marino

¿De qué forma usaron los científicos su conocimiento sobre la expansión del suelo marino y las inversiones del campo magnético para reconstruir Pangaea? Haz esta laboratorio para ver si puedes determinar dónde pudo estar situado un continente en el pasado.

Preguntas del mundo real

¿Puedes usar claves tales como las inversiones del campo magnético de la Tierra, para ayudarte a reconstruir Pangaea?

Materiales

regla métrica
lápiz
libro de texto

Metas

- **Interpretar** datos sobre las inversiones del campo magnético. Usa las claves del magnetismo para reconstruir Pangaea.

Procedimiento

1. Estudia la gráfica del campo magnético que aparece arriba. Sólo trabajarás con las polaridades normales, las cuales son los picos sobre la línea base en la mitad superior de la gráfica.
2. Coloca el borde largo de la regla en forma vertical sobre la gráfica. Desliza la regla hasta que esté alineada con el centro del pico 1 al oeste de la dorsal mediooceánica.
3. **Determina** y anota la distancia y la edad que corresponden al centro del pico 1 hacia el oeste. Repite este proceso con el pico 1 al este de la cordillera.
4. **Calcula** la edad promedio y la distancia entre este par de picos.
5. Repite los pasos del 2 al 4 para los restantes pares de picos con polaridad normal.
6. **Calcula** la tasa de movimiento en cm por año para seis pares de picos. Usa la fórmula tasa = distancia/tiempo. Convierte kilómetros a centímetros. Por ejemplo, para calcu-

lar la tasa usando la polaridad normal del pico 5, al oeste de la cordillera:

7. $$\text{tasa} = \frac{125 \text{ km}}{10 \text{ millones de años}} = \frac{12.5 \text{ km}}{\text{millones de años}} = \frac{1{,}250{,}000 \text{ cm}}{1{,}000{,}000 \text{ años}} = 1.25 \text{ cm/año}$$

Concluye y aplica

1. **Compara** la edad de las rocas ígneas que se encuentran cerca de la dorsal mediooceánica, con las rocas ígneas que se encuentran más lejos de la dorsal.
2. Si la distancia desde un punto de la costa de África a la dorsal mediooceánica es aproximadamente 2,400 km, calcula hace cuánto tiempo estuvo ese punto sobre o cerca de la dorsal mediooceánica.
3. ¿De qué forma podrías usar este método para reconstruir Pangaea?

SECCIÓN 3 Teoría de la tectónica de placas

Lo que aprenderás

- A comparar y contrastar los diferentes tipos de límites entre placas.
- A explicar la forma en que el calor dentro de la Tierra causa la tectónica de placas.
- A reconocer relieves causados por la tectónica de placas.

Vocabulario

plate tectonics / tectónica de placas: teoría que afirma que la corteza y el manto superior terrestres se separan en placas que flotan y se mueven sobre una capa viscosa del manto.

plate / placa: región extensa del manto superior rígido y de la corteza oceánica o continental de la Tierra que se mueve sobre la astenosfera.

lithosphere / litosfera: capa rígida de la Tierra de unos 100 km de grosor formada por la corteza y parte del manto superior.

asthenosphere / astenosfera: capa viscosa de la Tierra donde las placas litosféricas flotan y se mueven.

convection current / corriente de convección: corriente en el manto terrestre que transfiere energía en el interior de la Tierra y que provee la potencia de la tectónica de placas.

Por qué es importante

La tectónica de placas explica cómo se forman muchos de los relieves terrestres.

LABORATORIO *Usa Internet* Predice la actividad tectónica

El movimiento de las placas terrestres genera fuerzas que causan la acumulación de energía en las rocas. La liberación de esta energía puede producir vibraciones en la Tierra, las cuales conoces como terremotos. Ocurren temblores todos los días. Muchos de ellos son tan leves que no se sienten, pero cada evento le dice algo nuevo a los científicos acerca del planeta. Los volcanes activos pueden hacer lo mismo y con frecuencia se forman en los límites de las placas.

Preguntas del mundo real

Si conoces la localización de los epicentros de los terremotos y las erupciones volcánicas, ¿podrás predecir dónde se encuentran las áreas tectónicamente activas?

Formula una hipótesis

Piensa en los sitios en donde han ocurrido terremotos y volcanes en el pasado. Formula una hipótesis sobre la posibilidad de predecir la localización de las áreas tectónicamente activas, basándote en la posición de los epicentros de los terremotos y la actividad volcánica.

Metas

- **Investigar** la posición de los terremotos y las erupciones volcánicas en varias partes del mundo.

- **Marcar** en un mapa las posiciones de los epicentros de los terremotos y de las erupciones volcánicas, las cuales obtuviste del sitio Web de msscience.com.
- **Predecir** la localización de áreas tectónicamente activas basándote en tu diagrama de las posiciones de los epicentros de los terremotos y de los volcanes activos.

Diseña un plan

1. En tu Diario de ciencias, haz una tabla para datos como la que se muestra.
2. Recoge datos sobre los epicentros de los terremotos y las erupciones volcánicas durante por lo menos las dos últimas semanas. Tus datos deben incluir la longitud y la latitud de cada localidad. Para obtener ayuda, consulta las fuentes de datos que se presentan en la página opuesta.

Localización de epicentros y erupciones		
Epicentro del terremoto/ erupción volcánica	**Longitud**	**Latitud**

Sigue tu plan

1. Antes de comenzar, asegúrate de que tu maestro(a) apruebe tu plan.
2. Marca la localización de los epicentros de los terremotos y de las erupciones volcánicas en un mapamundi. Usa una cubierta de papel de calcar o de plástico.
3. Después de recoger los datos que necesitas, predice dónde están las áreas tectónicamente activas de la Tierra.
4. Compara y contrasta las áreas que tú predijiste como tectónicamente activas con el mapa de los límites de placas que se muestra en la Figura 9.

Analiza tus datos

1. ¿Cuáles áreas de la Tierra predices tú como tectónicamente activas?
2. ¿Cuánto se aproximó tu predicción a la localización real de las áreas tectónicamente activas?

Concluye y aplica

1. ¿Qué podrías hacer para lograr que tus predicciones estén más cerca de las posiciones reales de áreas de actividad tectónica?
2. ¿Crees que ayudaría obtener datos de un período de tiempo más largo? Explica.
3. ¿Qué tipos de límites de placas están cerca de tus posiciones de epicentros de terremotos? ¿De erupciones volcánicas?
4. Explica cuáles tipos de límites de placas producen erupciones volcánicas. Sé específico.

Guía de estudio

Repasa las ideas principales

Sección 1 Deriva continental

1. Alfred Wegener sugirió que los continentes estuvieron unidos una vez, formando una gran masa que llamó Pangaea. Wegener propuso que los continentes se han movido lentamente durante millones de años, hasta sus posiciones actuales.
2. El encaje de los continentes como si fueran un rompecabezas, los fósiles, los indicios climáticos y las estructuras similares de las rocas, apoyan las ideas de Wegener sobre la deriva continental. Sin embargo, Wegener no pudo explicar un proceso que causara el movimiento de las masas de tierra. *¿De qué forma apoyan los fósiles la hipótesis de la deriva continental?*

Sección 2 Expansión del suelo marino

1. El trazado de mapas detallados del suelo marino en los años 50, mostró la existencia de montañas y valles submarinos.
2. En la década de 1960, Harry Hess sugirió la expansión del suelo marino como explicación para la formación de las dorsales

mediooceánicas. *¿De qué forma conservan las rocas la prueba magnética cuando se forman en la dorsal mediooceánica?*

3. La teoría de la expansión del suelo marino tiene apoyo en la prueba del magnetismo de las rocas y en las edades de las rocas del suelo marino.

Sección 3 Teoría de la tectónica de placas

1. En la década de 1960, los científicos combinaron las ideas de la deriva continental con las ideas de la expansión del suelo marino para desarrollar la teoría de la tectónica de placas. La teoría dice que la superficie terrestre está dividida en secciones llamadas placas, las cuales se mueven sobre la astenosfera.
2. Las corrientes en el manto de la Tierra, llamadas corrientes de convección, transfieren el calor en el interior de la Tierra. Las placas se mueven como resultado de esta transferencia de calor.
3. La Tierra es un planeta dinámico. Cuando las placas se mueven, interaccionan, lo que produce muchos de los relieves de la superficie terrestre. *¿De qué manera forman montañas las placas convergentes?*

Hands-On Activities

MiniLAB: Try at Home (page 3)

Possible answers: I looked for clues in the pattern of fossils and "mountain ranges."

MiniLAB (page 4)

1. Some students will observe currents; others won't.
2. The transfer of thermal energy from the burner to the dish warms the water near the bottom of the dish. The cooler, denser water at the top of the dish sinks displacing the warmer, less dense water, which then moves toward the top of the dish. As the warmer water cools, it becomes denser and sinks to start the cycle again.

Lab (page 5)

Lab Preview

1. the magnetic field graph in the Data and Observation section
2. rate = distance/time

Conclude and Apply

1. The nearer rock is to the ridge, the younger it is.
2. About 192 million years ago, assuming a relatively constant rate of spreading
3. Students could determine when points on both coasts were at the ridge. This would mark when at least part of Pangaea was intact.

Lab: Use the Internet (page 7)

Analyze Your Data

1. Predictions will likely match the locations of plate boundaries.
2. Answers will depend on data collected. Most occur along plate boundaries. Hot spot eruptions may not coincide with plate boundaries.

Conclude and Apply

1. by collecting more data points
2. Yes; it would provide more data, which would help to more closely pinpoint these areas.
3. Earthquakes: near any type with many near convergent and transform boundaries; volcanoes: near divergent boundaries and subduction zones
4. Convergent ocean-ocean and ocean-continental boundaries where one plate is subducted under the other produce magma that rises and forms volcanoes. Volcanoes also form along divergent boundaries where magma rises through cracks in the crust, either at mid-ocean ridges or on land in rift valleys.

Laboratory Activity 1 (page 9)

Lab Note: It is unlikely that any two maps will be exactly the same. Map should be fairly split on the interpretation of location X as land or water.

Questions and Conclusions

1. Most students will indicate that it was land because it is located between places where fossils of small mammals and dinosaurs were found.
2. Answers will vary, because it is located between areas where fossils of land organisms and ocean organisms were found.
3. Because it is located between areas where fossils of land organisms and ocean organisms were found, some students will make it land while others will make it ocean. You could only know for sure if you found Mesozoic fossils at that location.
4. Answers will vary, depending on where students drew the shoreline of the land near location H.
5. The continent must have moved. During the Mesozoic it must have been located near the equator for corals to have grown in the oceans.

Laboratory Activity 2 (page 13)

Data and Observations

Students' data will vary. When observing the bubbles at the beginning of the experiments, students should notice that the bubbles tend to collect under the pieces of foam and coalesce. Bubbles will grow larger and larger until they slip to the sides of the foam and escape. Where two pieces of foam are touching, the bubbles will escape fairly vigorously. Eventually they will almost explode or pop. This action should lead students to consider the pressure and activity of magma and volcanoes at continental plate margins. When students observe the movement of their foam pieces during a full boil, they should see that the pieces are circulated from the center of the pot up to the top and out to the sides of the pot. There they will either get stuck or recirculate. Either way it is important that students draw inferences about the behavior and motion of crustal plates from the activity of their foam continents.

At the end of the experiment most students will not see much change in their foam continents. They should conclude that unlike real plates, the foam ones did not melt or break apart.

Teacher Guide & Answers (continued)

Questions and Conclusions

1. The bubbles were stuck under the foam. They grew together and formed one large bubble. Then the large bubbles floated to the sides of the foam where they burst up between two pieces of foam.
2. The action of the bubbles is similar to that of a volcano. The bubbles were like magma that increases in pressure at weak points along plate boundaries. It escapes like the bubbles in an explosion.
3. At first it seemed as though the foam went all over the place. After a while, the pattern was noticeable: the foam went down at the sides of the pot and up in the middle of the boiling water.
4. The tectonic plates move along the hot liquid mantle just like the foam. When they cannot move any farther they get stuck, like the Indian plate, or go under, like the Pacific plate.
5. This experiment is different because the foam never changed shape or cracked. In the real world, the plates change according to the kinds of forces acting on them. As a result, the plates of crust are moved by convection currents and broken up on the boiling surface of the mantle.
6. If the convection currents in the mantle changed direction or stopped, the tectonic plates would also stop. Everything would stay right where it is. Volcanoes and earthquakes might stop.

Meeting Individual Needs

Directed Reading for Content Mastery (page 19)

Overview (page 19)

1. b
2. a
3. c
4. Fossils
5. youngest
6. heat

Sections 1 and 2 (page 20)

1. continents
2. Pangaea
3. Africa
4. Arctic
5. rock
6. seafloor spreading
7. c
8. b
9. d
10. a

Section 3 (page 21)

1. b
2. b
3. b
4. a
5. a

(6–8 can be in any order)

6. volcanic islands
7. deep-sea trenches
8. volcanic mountains

(9–10 can be in any order)

9. mid-ocean ridges
10. rift valleys
11. major earthquakes

Key Terms (page 22)

1. drift
2. Pangaea
3. convection
4. mantle
5. lithosphere
6. asthenosphere
7. spreading
8. plates
9. tectonics

Lectura dirigida para Dominio del contenido (pág. 23)

Sinopsis (pág. 23)

1. b
2. a
3. c
4. rocas, fósiles, clima
5. más recientes
6. térmica

Secciones 1 y 2 (pág. 24)

1. continentes
2. Pangaea
3. África
4. Ártico
5. roca
6. expansión del suelo marino
7. c
8. b
9. d
10. a

Sección 3 (pág. 25)

1. b
2. b
3. b
4. a
5. a

6–8 pueden estar en cualquier orden

6. islas volcánicas
7. fosas oceánicas
8. montañas volcánicas

9–10 pueden estar en cualquier orden

9. dorsales medioceánicas
10. valles de dislocación
11. terremotos fuertes

Términos claves (pág. 26)

1. deriva
2. Pangaea
3. convección

4. manto
5. litosfera
6. astenosfera
7. expansión
8. coloides
9. placas
10. tectónica

Reinforcement (page 27)

Section 1 (page 27)

1. f
2. e
3. g
4. b
5. a
6. c
7. d
8. The fossil plant *Glossopteris* has been found on five continents. Its presence in so many diverse climate areas support Wegener's hypothesis that these areas were once connected and had similar climates.
9. Although Wegener explained his hypothesis and its supporting evidence, he could not explain how, when, or why continental drift had occurred. Without these explanations, most people could not accept such a different idea. Today scientists believe seafloor spreading may explain how the continents would move.

Section 2 (page 28)

1. During the 1940s and 1950s, scientists began using sound waves on moving ships to map large areas of the ocean floor.
2. The youngest rocks are found at the mid-ocean ridges.
3. Henry Hess proposed a theory known as seafloor spreading to explain what formed ocean ridges.
4. As the seafloor spreads, hot magma moves upward and flows from the cracks.
5. As the new seafloor moves away from the ridge, it cools, contracts, and begins to sink, helping to form the ridge.
6. The research ship *Glomar Challenger* was equipped with a drilling rig that allowed scientists to drill into the seafloor to obtain rock samples.
7. Rocks on the seafloor are much younger than many continental rocks.
8. When plates collide, the denser plate will subduct.
9. Earth's magnetic field has reversed itself many times in the past.
10. The magnetic alignment in the rocks reverses back and forth over time in stripes parallel to the mid-ocean ridges.

Section 3 (page 29)

1. plate tectonics
2. plates
3. lithosphere
4. asthenosphere
5. convection
6. divergent boundary; plates move apart
7. convergent boundary; an ocean plate sinks under a continental plate, or one plate sinks under another ocean plate at a subduction zone.
8. convergent boundary; two continental plates collide and crumple up, forming mountain ranges
9. transform boundary; occurs when two plates slide past one another in opposite directions or in the same direction at different speeds

Enrichment (page 30)

Section 1 (page 30)

1. Iceland
2. The oldest volcanoes are found at the outer ends of the island. They are separated by bands of more recent volcanoes. The most recent volcanoes are found at the center of the island.
3. The results of seafloor spreading can be observed on dry land in Iceland, without the need for deep-sea measuring instruments.

Section 2 (page 31)

1. As the Juan de Fuca plate moves eastward away from the Pacific plate, hot magma pushes up from below the seafloor, forming volcanoes such as Axial. As erupting lava fills in the growing gap between the two plates, new seafloor is formed.
2. the Cascade mountain range
3. The rocks near Axial are young because they are formed in an area where new seafloor is forming, at a mid-ocean ridge. The rocks in Oregon are much older because they are located far from the center of seafloor spreading.

Section 3 (page 32)

1. See students' maps.
2. at the convergent boundaries
3. Students' results will vary somewhat. Differences may result from how far the students move the pieces along the boundaries.
4. Answers will vary.

Note-taking Worksheet (page 33)

Refer to Teacher Outline, student answers are underlined.

Assessment

Chapter Review (page 37)

Part A. Vocabulary Review

1. asthenosphere (6/3)
2. convection current (6/3)
3. plate tectonics (5/3)

Teacher Guide & Answers (continued)

4. subduction zone (5/3)
5. transform boundary (5/3)
6. convergent boundary (5/3)
7. lithosphere (6/3)
8. magnetometer (4/2)
9. Pangaea (1/1)
10. continental drift (1/1)
11. divergent boundary (5/3)
12. plates (5/3)
13. mantle (6/3)
14. crust (6/3)
15. strike-slip fault (7/3)
16. seafloor spreading (3/2)

Part B. Concept Review

1. crust (6/3)
2. lithosphere (6/3)
3. asthenosphere (6/3)
4. oceanic crust (6/3)
5. upper mantle (6/3)
6. All are boundaries of tectonic plates, but they behave in different ways. At divergent boundaries, plates move away from each other. Convergent boundaries occur when two plates move together. Then one of three things will happen: one plate may sink under the other; one plate may bend and slide under the other; or both may crumple. A transform boundary occurs when two plates slide past one another. (5/3)
7. Scientists hypothesize that the cycle of heating, rising, cooling, and sinking of the hot, plasticlike rock in the asthenosphere provides the energy to move plates in the lithosphere. (6/3)
8. Some new ideas are so different from people's thinking that people cannot accept them. New ideas should be backed by some evidence before they are accepted. (1/1)

Chapter Test (page 39)

I. Testing Concepts

1. b (3/2)
2. d (7/3)
3. d (4/2)
4. d (7/3)
5. c (7/3)
6. d (2/1)
7. a (3/2)
8. c (6/3)
9. b (5/3)
10. a (1/1)
11. c (5/3)
12. c (4/2)
13. a (4/2)
14. c (2/1)
15. c (4/2)
16. b (7/3)
17. b (5/3)
18. d (3/2)
19. b (4/2)
20. plate tectonics (6/3)
21. seafloor spreading (4/2)
22. Convection currents (6/3)
23. asthenosphere (6/3)
24. plates (5/3)
25. continental drift (2/1)
26. lithosphere (5/3)
27. Pangaea (1/1)

II. Understanding Concepts

1. Convergent plates move together. Divergent plates move apart. (5/3)
2. Warmer material rises. (6/3)
3. The edges of some continents looked as though they would fit together like a puzzle. (1/1)
4. lithosphere (5/3)
5. All were formed at convergent boundaries. (7/3)
6. The Andes were formed at the convergent boundary of an oceanic plate and a continental plate. The islands of Japan were formed where two oceanic plates collided. The Himalayas formed where two continental plates collided. (7/3)
7. Hot, less-dense material below Earth's crust is forced upward at the mid-ocean ridges. Then it turns and flows sideways, carrying the seafloor away from the ridge in both directions. (3/2)

III. Applying Concepts

1. The plates that collide to form the Himalayas crumple, but no subductions take place. Volcanoes occur above subduction zones. (5/3)
2. When the continents were connected, they were covered with ice near Earth's south pole. (2/1)
3. It's possible for ocean fish to swim all over the world, so they could have reached all continents. (2/1)

IV. Writing Skills

1. The *Glomar Challenger* had a drilling rig that allowed scientists to obtain rock samples from the seafloor. They discovered that the youngest rocks are located at the mid-ocean ridges. The rocks became increasingly older in samples obtained farther from the ridges, adding to the evidence for seafloor spreading. (4/2)
2. As new crust is added in one place, it disappears below the surface in another. The disappearance of crust can occur when seafloor cools, becomes denser, and sinks. This occurs when two plates meet at a convergent boundary. (5/3)

Transparency Activities

Section Focus Transparency 1 (page 44)

A Cold Dig

Transparency Teaching Tips

- You may use this transparency to introduce continental drift. Point out that temperatures in Antarctica range from 0°C (32°F) to around –90°C (–130°F), and the continent is buried under several thousand feet of ice. Ask the students to hypothesize how fossils of leafy plants and various warm-climate animals came to be found in Antarctica.
- Explain that 400 million years ago all of Earth's continents, including Antarctica, were joined together. Use a map to illustrate how the continents fit together.
- Ask the students to explain the process by which the continents became separated (continental drift/plate tectonics).
- Explain that when the continents were joined, Antarctica experienced warm weather and great numbers of flora and fauna. Slowly pushed apart by convection currents (heating, rising, cooling, sinking of magma within Earth), the plates traveled to their present positions.

Content Background

- The continents began drifting apart around 200 million years ago. Antarctica moved toward its current position about 70 million years ago.
- Alfred Wegener first proposed the theory of continental drift in 1912. He named the one continent Pangaea, which is Greek for "all of Earth".
- The hadrosaur, or the crested duckbilled dinosaur, was most common in North America, Europe, and Asia, between 65 and 100 million years ago.

Answers to Student Worksheet

1. Antarctica was once warm and had many kinds of plants and animals. Even though its climate changed, the fossils of these warm-weather living things remain.
2. The continents continue to move. Events could also cause worldwide temperatures to rise, and that would impact Antarctica.

Section Focus Transparency 2 (page 45)

The Main Event

Transparency Teaching Tips

- This is an introduction to plate tectonics and the forces it releases. If possible, draw the major fault lines (see book for guide) on a large map. Point out that most of them occur in the oceans called seafloor spreading.
- Ask the students to consider these faults lines and their relationship to what is shown on the overhead.

Content Background

- The feature shown on the transparency is a type of hydrothermal vent called a black smoker. This particular vent is the *Saracen's Head* vent, and the image was made by the ALVIN deep-sea vehicle during exploration of the Broken Spur Vent Field, which is located in the Mid-Atlantic Ridge. While the water at this depth (3,100 m) is usually very cold, temperatures at the vent are around 360°C. The black smoke is composed of minerals, often sulfur compounds, from Earth's interior.
- The surface of Earth is comprised of approximately 30 rigid plates. These plates are moving slowly, relative to each other. Each plate includes the crust and the outermost mantle. When these tectonic plates move, they carry the continents and ocean floors with them. It is at the plate boundaries where the action occurs. When the plates are moving apart in an underwater area, the ocean floor spreads, and magma wells to the surface to fill the gap. This creates underwater mountain ranges called ocean ridges. When plates move apart on land, they cause rifts.
- When continental plates converge, one crust is thrust downward and the other upward. This process can create mountains and generate earthquakes and volcanoes.
- When the plates move horizontally relative to each other, it is called a transform fault (such as the San Andreas fault in California).
- The ocean floor consists of a dense rock called basalt. The continents are underlined with granite, a rock less dense than basalt, which explains why they are elevated relative to the ocean floor.

Answers to Student Worksheet

1. Black smoke is escaping from a deep-sea vent. Students may realize the smoke is composed of minerals escaping from Earth's interior.
2. Answers include fumaroles, geysers, and volcanoes. These are various forms of geothermal activity.
3. Answers will vary. Students may note that it is very dark (the light is artificial light from the exploring vehicle) and probably very hot right at the vent.

Section Focus Transparency 3 (page 46)

Valley of Ten Thousand Smokes

Transparency Teaching Tips

- The concept presented here is plate tectonics. Explain that the surface of Earth is comprised of 30 plates, each moving independently. One hypothesis conjectures that convection currents within Earth are behind the movement of Earth's plates
- Using two flexible sponges, demonstrate how the plates move apart, slide past one another, and compress together.

Teacher Guide & Answers (continued)

- The transparency shows the aftermath of the 1912 eruption of the Mount Katmai and Novarupta volcanoes. One of the largest eruptions in history, the blast blew almost 30 cubic kilometers of volcanic matter into the air, causing a high altitude haze and reducing summer temperature in surrounding areas by ten percent. Four years later, thousands of fumaroles were still jetting streams of gas in excess of 600°C (1,100°F). The eruption and ash cover destroyed all vestiges of life in the area.

Content Background

- The Novarupta eruption was the largest this century, extruding 15 cubic kilometers of magma, 30 times the amount extruded by the eruption of Mount St. Helens in 1980. The Novarupta and Katmai volcanoes lie near the intersection of two tectonic plates.
- Because of their isolated locations, the eruptions of Katmai and Novarupta caused no human casualties.

Answers to Student Worksheet

1. It got its name from the thousands of vents spewing steam and gas.
2. The energy that caused the eruption eventually dissipated, and the vents stopped smoking.
3. Answers will vary. Students may name specific volcanoes, like Mount St. Helens, Mount Pinatubo (the Phillipines), and Mauna Kea (Hawaii), or general areas, like the Mid-Atlantic Ridge and the Pacific's Ring of Fire.

Teaching Transparency (Page 47)

Plates of the Lithosphere

Section 3

Transparency Teaching Tips

- Using the map on the transparency, have students locate the Andes, Himalayas, and the island of Japan.
- Use the transparency to locate the three types of plate boundaries indicated in the map's key.

Reteaching Suggestion

- Have the students use their text to briefly review each type of plate boundary shown on the transparency.

Extensions

Activity: Let students work with partners to compare and contrast the three types of plate boundaries.

Challenge: In cooperative learning groups, have the students make the three types of plate boundaries with modeling clay. Have each group explain their model to the class.

Answers to Student Worksheet

1. crust and part of the upper mantle
2. two plates coming together or moving toward each other
3. convergent boundary
4. Eurasian Plate; Europe and Asia
5. divergent
6. the Juan De Fuca Plate and the North American Plate

Assessment Transparency (Page 49)

Plate Tectonics

Section 3

Answers

1. **D.** Students need to use the information in the cross-sectional drawing to identify the best answer choice. Level Z is the deepest rock layer, so it must be the oldest.
2. **F.** Students need to use the information given by the arrows to identify the best answer choice. The boundaries formed by colliding plates are called convergent boundaries.
3. **B.** Students must recognize that the movement of a fault line is a direct cause of an earthquake.
   Choice A: No, flooding could be secondary effect caused by an earthquake, but it is not caused directly by a fault.
   Choice B: Yes, earthquakes are caused by moving plates.
   Choice C: No, tornadoes are caused by weather systems, not fault lines.
   Choice D: No, forest fires could be a secondary effect caused by an earthquake, but they are not caused directly by a fault.

Test-Taking Tip

Remind students to watch for qualifiers such as *most likely, most common, least likely,* or *least common.* Such questions are not looking for absolute answers.