

7 The Formation of the Ocean

BIG IDEAS

- Through the movement of crustal plates, Earth and its ocean have changed over time.
- The Theory of Plate Tectonics explains how geologic features on Earth's surface and seafloor were created and how they have changed.
- This theory illustrates the Nature of Science, in which hypotheses are formed, data are collected, and ideas are re-examined over time as new evidence becomes available.

Engage

In this Lesson you will learn about plate tectonics and how features of the seafloor were formed. Use the chart below to record what you already know about these topics. After you complete the Lesson, use the chart to record new information you learned.

Before reading and trying the activities in your textbook, think about the Questions below. Record what you know about each topic in the What I Know column of the chart.

Question	What I Know	What I Learned
Have the continents always had their current shape and configuration?		
How do the continents move?		
How are features of the seafloor, such as trenches, ridges, and abyssal plains formed?		
What are scientific theories?		

Explore

Build Background

The activity on Pages 122–123 of your textbook asks you to explore ways in which the ocean and land have changed over time. Scientists explain these changes with the Theory of Plate Tectonics. It is likely that you have learned something about Earth changes in previous science classes. Recall that Earth's crust, the outermost layer of Earth, is made up of huge rocky plates. These plates "float" atop Earth's mantle, an inner layer of Earth made up in part of molten (melted) rock. The plates can bump, slide past, or pull away from one another in many ways. When they do, the shape of Earth's land can change.

Read the paragraphs below to review vocabulary terms that describe crustal movement. Then, do the activities that follow to help build your background knowledge of this subject.

"The junction of two tectonic plates is known as a plate boundary. Where two plates slide horizontally past each other, the junction is known as a *transform plate boundary*. Movement of the plates causes huge stresses that break portions of the rock and produce earthquakes. Places where these breaks occur are called faults. A well-known example of a transform plate boundary is the San Andreas Fault in California.

Where tectonic plates are moving apart, they form a *divergent plate boundary*. At these boundaries, magma (molten rock) rises from deep within Earth and erupts to form new crust on the lithosphere. Most divergent plate boundaries are underwater (Iceland is an exception), and form submarine mountain ranges called "oceanic spreading centers" or "mid-ocean ridges."

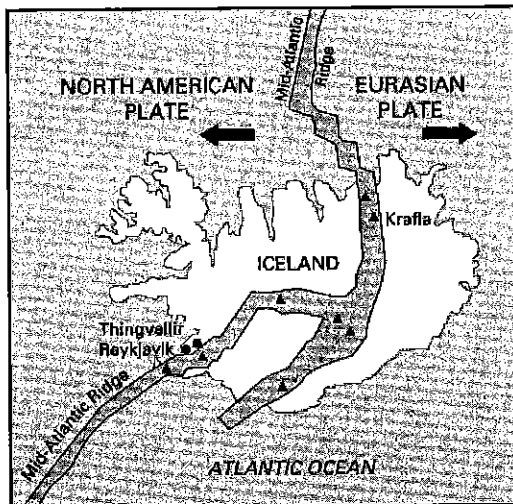
If two tectonic plates collide more or less head-on, they produce a *convergent plate boundary*. Usually, one of the converging plates moves beneath the other in a process called *subduction*. Subduction produces deep trenches, and earthquakes are common. As the sinking plate moves deeper into the mantle, increasing pressure and heat release fluids from the rock causing the overlying mantle to partially melt. The new magma rises and may erupt violently to form volcanoes that often form arcs of islands along the convergent boundary. These island arcs are always landward of the neighboring trenches. This process can be visualized as a huge conveyor belt on which new crust is formed at the oceanic spreading ridges and older crust is recycled to the lower mantle at the convergent plate boundaries. The Ring of Fire marks the location of a series of convergent plate boundaries that surrounds the Pacific Ocean basin."

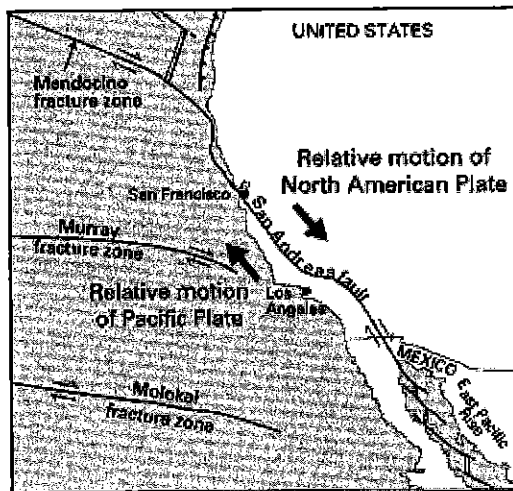
Credit: NOAA

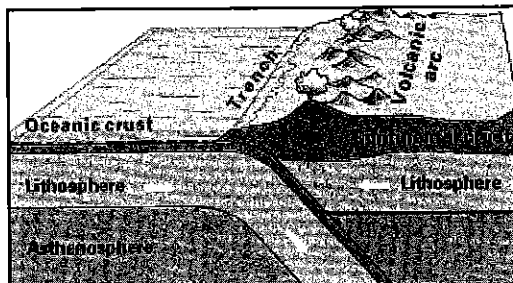
Draw a line to match each type of plate boundary with its definition.

Divergent boundaries	Where crust is destroyed as one plate dives under another
Convergent boundaries	Where crust is neither produced nor destroyed as the plates slide horizontally past each other
Transform boundaries	Where new crust is generated as the plates pull away from each other and magma rises from within Earth

Below are several diagrams of plate boundaries. Label each one as a divergent, a convergent, or a transform boundary.







Credit: USGS

Explain**Vocabulary Review**

Use Pages 124–129 of your textbook to complete the vocabulary activities below. For Questions 1–7, match each term with the correct definition.

- | | |
|------------------------------------|--|
| 1. _____ Convergent plate boundary | a. The study of heavenly bodies and their influence on human activities |
| 2. _____ Plate | b. A high-energy wave caused by earthquakes, landslides, volcanic eruptions, and other natural occurrences |
| 3. _____ Theory | c. A fracture between plates that slide past each other |
| 4. _____ Convection | d. A region where two plates collide and one goes under the other forming a trench |
| 5. _____ Transform fault | e. The culmination of many scientific ideas on a particular topic |
| 6. _____ Astrology | f. A large piece of the Earth's crust |
| 7. _____ Tsunami | g. A heat distribution process in which heat is circulated through a liquid or a gas |

Draw a line to match each ocean feature to its correct description and location.

Mid-Atlantic Ridge

A deep canyon which runs the length of the Mid-Ocean Ridge

Great Global Rift

An area of the Pacific where large numbers of earthquakes and volcanic eruptions occur

Ring of Fire

A continuous mountain-like structure that runs through the Atlantic Ocean to the southwest coast of Africa

Reading Strategy: SEQUENCE of EVENTS

In the Explain section of your textbook you are reading about the sequence of events that led to Wegener's initial Theory of Continental Drift and its ultimate revisions and acceptance by the scientific community. Remember, a sequence of events describes the order in which something happened. Identifying sequences as you read can help you better understand events and processes that happen over time.

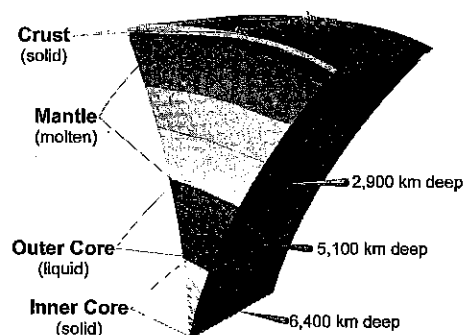
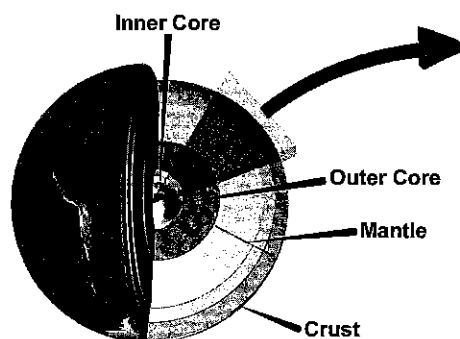
The statements below describe events you read about in your textbook. Write a number on the line next to each statement to arrange the events in the correct order and review what you learned.

- _____ Wegener examines research in the fields of geology and paleontology to search for further proof that the continents may have been attached once.
- 1 Wegener studies a map of the world, looking closely at the coastlines on both sides of the Atlantic Ocean. He notices that they could fit together like the pieces of a puzzle.
- _____ The Theory of Continental Drift is refined to include evidence that Earth's crust is made up of plates. These plates make up both Earth's continents and the seafloor.
- _____ Wegener publishes his book about the Theory of Continental Drift. He cites evidence such as the existence of similar fossil species on varying continents, the matching shapes of coastlines, and the positions of mountain ranges on each continent.
- _____ As new evidence is discovered about seafloor features, Wegener's Theory of Continental Drift is strengthened. However, his ideas that land and ocean are different layers of Earth and that land floats on water are shown to be incorrect.
- _____ Wegener finds research from paleontologists that provides evidence of a former land bridge between Brazil and Africa.
- _____ Wegener's theory sparks debate within the scientific community, and scientists look for new evidence to support or disprove his theory.
- _____ At a meeting in Germany, Wegener addresses his fellow scientists and presents his ideas about the Earth's crustal features.
- _____ By the late 1960s and early 1970s the evidence supporting Continental Drift was overwhelming, and the theory was accepted by most scientists.
- _____ Today the theory is known as the Theory of Plate Tectonics.

Visual Literacy: Reading Diagrams

A variety of diagrams are shown throughout this Lesson to help you understand and visualize key concepts. Remember, diagrams, maps, and graphs are often used in science as tools for communicating information. The diagram of Earth on Page 126 of your textbook is a cross-section diagram. A cross-section diagram shows what you would see if you could slice through an object with a knife. Such diagrams are often used to show what's "buried" beneath an object's surface. Page 126 also shows a cutaway diagram. Cutaway diagrams are another type of diagram that helps you see the inside of something.

Look at the diagrams below and answer the Questions that follow to practice reading information from diagrams.



1. What are Earth's four layers? _____

2. What is Earth's thickest layer? _____

3. What is Earth's thinnest layer? _____

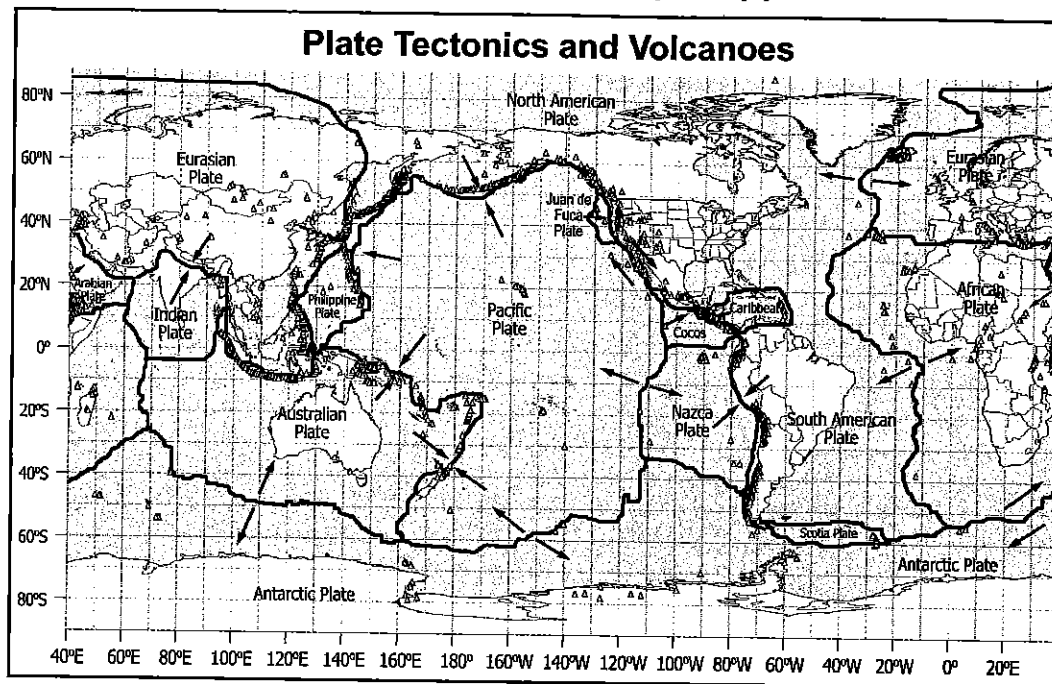
4. How do Earth's outer and inner core differ? _____

5. How does this diagram help you understand Earth? _____

Visual Literacy: Reading Maps

Practicing map reading skills can help you interpret and understand better not only maps, but the concepts and ideas they are trying to communicate. Below is a map that shows Earth's major plates and plate boundaries. This map represents what is currently believed about our planet's crust. Scientific evidence for the locations of plate boundaries includes earthquake, volcano, and seafloor spreading data.

Use the map, what you have learned in this Lesson and your knowledge of geography to answer the Questions below. If necessary, use a globe or world map to help you.



1. How many plates are named on the map? _____
2. Find the United States. On what plate is the country located? _____
3. Which parts of the ocean does the Australian Plate span? _____
4. In what ocean is the Juan de Fuca Plate located? _____
5. Which continents look like they might fit together well? _____

Elaborate

Organize Your Thoughts

In the Elaborate section of your textbook, you and your research team are given the task of reviewing a topic related to the ocean and the Theory of Plate Tectonics. Your team must first read an assigned reading selection and record information that provides oceanic evidence for plate tectonics. You then present your findings to the class.

Use the Questions and table below to organize your thoughts and arrange your information as you work on this assignment.

Research Question	Answer
In your own words, what is the Theory of Plate Tectonics?	
How do scientists decide to research specific topics and investigate specific locations related to plate tectonics?	
What are some places mentioned in the selection you read?	
What geological features are mentioned and how were they formed?	
How do these features relate to plate tectonics and what evidence do they provide for the theory?	
What oceanic processes are described in your selection?	
Why are scientists researching this area?	
What important terms are mentioned in what you read?	
What important events happen in your passage that are related to plate tectonics?	

Evaluate

Lesson Summary

- The Earth's surface consists of many crustal plates, both continental and oceanic, that rest upon the Earth's mantle.
- These plates can be involved in diverging, converging, or transforming boundaries.
- Alfred Wegener's Theory of Continental Drift attempted to explain how similar fossils might have appeared on continents that were located across vast oceans. Wegener believed that the continents had the ability to move together and apart, along the ocean's surface, over time.
- Wegener's theory was renamed the Theory of Plate Tectonics and refined in the 1960s and 1970s.
- The Theory of Plate Tectonics explains how the plates that make up the Earth's surface move when earthquakes, volcanoes, etc. occur and create or destroy land and seafloor features.
- By studying these theories, we can understand how the Earth's ocean and land features were formed and have changed greatly throughout Earth's existence, including how the ocean basins were formed and how the continents have moved.
- Both of these theories illustrate the Nature of Science, in which ideas are tested, data are collected, and information is always being re-examined.

Lesson Review

Answer the Questions below to review the key concepts of the Lesson. Then, return to Page 55 of this workbook and record information you gained from this Lesson in the What I Learned column of the chart.

1. Using the chart you completed for the Explore activity of your textbook, what are several ways Earth's surface and ocean features have changed over time? _____

Name _____

Class _____

Date _____

2. Why did the existence of similar fossils on various continents encourage the theory of crustal movement? _____

3. Compare and contrast the Mid-Atlantic Ridge and the Great Global Rift. _____

4. What did most scientists believe about Earth and its features in Wegener's time? _____

5. How did arguments and debate among scientists help further Wegener's beliefs? _____

6. List at least three pieces of oceanic evidence that support the Theory of Plate Tectonics.
