Ms. Hanrahan's Days 11-20 Science NTI Assignments, 8 Gold

We will be learning about plate tectonics. Plate tectonics includes topics such as Pangea, convergent, divergent, and transform plate boundaries, continental drift, and seafloor spreading. You will see that the fossils we just learned about are a key piece of evidence supporting the theory of continental drift. You learned about plate tectonics in 6th grade, but we review it in 8th grade before you go to high school.

Days 11 and 12

1. Read "Section 3 Plate Tectonics"
2. Answer questions 1-3 in the "section 3 review"
3. Complete the "plate tectonics section 3 theory of plate tectonics" practice (actual document pages 76-78)

Day 13

1. Complete "Going Deep with Plate Tectonics" passage and questions

Day 14

1. Complete "Plate Boundary Homework"

Day 15 and 16

1. Read "Section 1 Continental Drift"
2. Answer questions 1-4 in the "section 1 review"
3. Complete the "plate tectonics section 1 continental drift" practice (actual document 70-72)

Day 17

1. Complete "Continental Drift CER"
2. Complete "Pangea Exists" newspaper article

Day 18 and 19

1. Read "Section 2 Seafloor Spreading"
2. Answer questions 1-5 in the "section 2 review"
3. Complete the "plate tectonics section 2 seafloor spreading" practice (actual document 73-75)

Day 20

1. Complete "Chapter 7 Review" questions 7-14
2. Complete "Chapter 7 Standardized Test Practice" questions 1-7 and 13-15

Additional Video Resources you can use to help you learn:

1. Go to YouTube: search "Plate tectonics" and watch the first video. It is published by BrainPop and is a little over 7 minutes long. We would have watched this in class at the beginning of the

unit. It is an overview of plate tectonics, continental drift, and seafloor spreading. https://www.youtube.com/watch?v=RA2-Vc4PIOY

2. Go to YouTube: search "a giant crack appeared in Kenya, seemingly overnight". It is published by CBS News and is a little over 4.5 minutes long. We would have watched this in class in order for you to see how the movement of the Earth's plates are currently impacting human life. https://www.youtube.com/watch?v=RG-wx-KYnTk
3. Go to YouTube: search "Undersea Volcano Eruptions Caught on Video". It is published by Discovery and is a little less than 2 minutes long. We would have watched this in class so that you could see an underwater volcano erupting along a convergent plate boundary where two ocean plates come together. https://www.youtube.com/watch?v=hmMlspNoZMs
4. Follow this link to watch a clip about the 2011 earthquake that rattled Japan. We would have watched this in class when we discussed earthquakes happening along transform plate boundaries. https://video.nationalgeographic.com/video/news/00000144-0a26-d3cb-a96c-7b2f4fde0000
5. Go to YouTube: search "magnetic mineral alignment.wmv" It is published by terencedoran and is a little less than 2 minutes long. We would have watched it in class while talking about how scientists look at how minerals are laid on the seafloor in order to track a switch of the magnetic north and south poles during seafloor spreading. https://www.youtube.com/watch?v=WhiF6IqGACo
6. Go to YouTube: search "What happens when Earth's Magnetic Poles Reverse?." It is published by Seeker and is a little over 3 minutes long. We would have watched this video while discussing how Earth's magnetic north and south poles switch. This is evidence for seafloor spreading. This video discusses how our lives might be different when the magnetic poles switch. https://www.youtube.com/watch?v=Ou1BiorYRNU
7. Go to YouTube: search "Sea Floor Spreading & Plate Tectonic Evidence." It is published by Alexandria Cellucci and is a little over 2 minutes long. We would have watched this video to review evidence of seafloor spreading. https://www.youtube.com/watch?v=ZzvDlP6xd9o

Questions, Comments, or Concerns?

1. Call the middle school 859-234-7123
2. Email me at emma.hanrahan@harrison.kyschools.us
3. Message me on the Remind App. Remind info: text @7g6c8k to 81010
4. I am going to be utilizing the website/app Zoom. This program allows students/parents to video chat with me. This can be used on either computers, tablets, or smart phones. I will do my best to be on Zoom between 10:45-11:30 and 2:30-3:00 daily. All you have to do is click on this link/ type this link into a search bar if you are going to be using a computer https://zoom.us/j/5825812645. You will want to run the extension. If you are using a tablet or smart phone, download the Zoom app, click join a meeting, enter this code 5825812645, and then click join. Please do not hesitate to join if you have a question, need an explanation, or simply want to chat.

If you would like to turn in assignments early, please feel free to scan and email them to me or take a picture of completed assignments and send them to me on Remind or email. DO NOT throw away written assignments if you chose to submit via email or Remind.

section 3

Theory of Plate Tectonics

as you read

What You'll Learn

- **Compare and contrast** different types of plate boundaries.
- **Explain** how heat inside Earth causes plate tectonics.
- **Recognize** features caused by plate tectonics.

Why It's Important

Plate tectonics explains how many of Earth's features form.

Review Vocabulary

converge: to come together
diverge: to move apart
transform: to convert or change

New Vocabulary

- plate tectonics
- plate
- lithosphere
- asthenosphere
- convection current

Plate Tectonics

The idea of seafloor spreading showed that more than just continents were moving, as Wegener had thought. It was now clear to scientists that sections of the seafloor and continents move in relation to one another.

Plate Movements In the 1960s, scientists developed a new theory that combined continental drift and seafloor spreading. According to the theory of **plate tectonics**, Earth's crust and part of the upper mantle are broken into sections. These sections, called **plates**, move on a plasticlike layer of the mantle. The plates can be thought of as rafts that float and move on the layer.

Composition of Earth's Plates Plates are made of the crust and a part of the upper mantle, as shown in **Figure 8**. These two parts combined are the **lithosphere** (LIH thuh sfihr). This rigid layer is about 100 km thick and generally is less dense than material underneath. The plasticlike layer below the lithosphere is called the **asthenosphere** (as THE nuh sfihr). The rigid plates of the lithosphere float and move around on the asthenosphere.

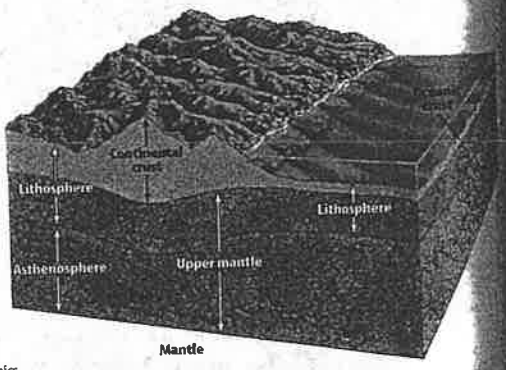


Figure 8 Plates of the lithosphere are composed of oceanic crust, continental crust, and rigid upper mantle.

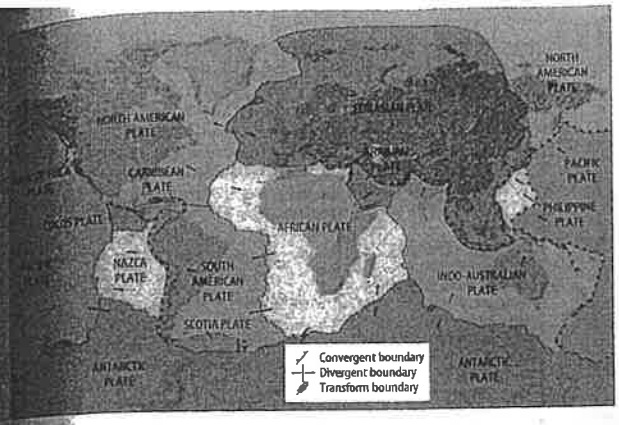


Plate Boundaries

When plates move, they can interact in several ways. They can move toward each other and converge, or collide. They also can pull apart or slide alongside one another. When the plates interact, the result of their movement is seen at the plate boundaries, as in **Figure 9**.

Reading Check *What are the general ways that plates interact?*

Movement along any plate boundary means that changes must happen at other boundaries. What is happening to the Atlantic Ocean floor between the North American and African Plates? Compare this with what is happening along the western margin of South America.

Plates Moving Apart The boundary between two plates that are moving apart is called a divergent boundary. You learned about divergent boundaries when you read about seafloor spreading. In the Atlantic Ocean, the North American Plate is moving away from the Eurasian and the African Plates, as shown in **Figure 9**. That divergent boundary is called the Mid-Atlantic Ridge. The Great Rift Valley in eastern Africa might become a divergent plate boundary. There, a valley has formed where a continental plate is being pulled apart. **Figure 10** shows a side view of what a rift valley might look like and illustrates how the hot material rises up where plates separate.

Figure 9 This diagram shows the major plates of the lithosphere, their direction of movement, and the type of boundary between them. **Analyze and Conclude** *Based on what is shown in this figure, what is happening where the Nazca Plate meets the Pacific Plate?*

Science Online

Topic: Earthquakes and Volcanoes

Visit blue.msscience.com for Web links to recent news or magazine articles about earthquakes and volcanic activity related to plate tectonics.

Activity Prepare a group demonstration about recent volcanic and earthquake events. Divide tasks among group members. Find and copy maps, diagrams, photographs, and charts to highlight your presentation. Emphasize the locations of events and the relationship to plate tectonics.

Plates Moving Together If new crust is being added at one location, why doesn't Earth's surface keep expanding? 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 where two plates move together at a convergent boundary.

When an oceanic plate converges with a less dense continental plate, the denser oceanic plate sinks under the continental plate. The area where an oceanic plate subducts, or goes down into the mantle is called a subduction zone. Some volcanoes form above subduction zones. **Figure 10** shows how this type of convergent boundary creates a deep-sea trench where one plate bends and sinks beneath the other. High temperatures cause rock to melt around the subducting slab as it goes under the other plate. The newly formed magma is forced upward along these plate boundaries, forming volcanoes. The Andes mountain range of South America contains many volcanoes. They were formed at the convergent boundary of the Nazca and South American Plates.

Applying Science

How well do the continents fit together?

Recall the Launch Lab you performed at the beginning of this chapter. While you were trying to fit pieces of a cut-up photograph together, what clues did you use?

Identifying the Problem

Take a copy of a map of the world and cut out each continent. Lay them on a tabletop and try to fit them together, using techniques you used in the Launch Lab. You will find that the pieces of your Earth puzzle—the continents—do not fit together well. Yet, several of the areas on some continents fit together extremely well.

Take out another world map—one that shows the continental shelves as well as the continents. Copy it and cut out the continents, this time including the continental shelves.

Solving the Problem

1. Does including the continental shelves solve the problem of fitting the continents together?
2. Why should continental shelves be included with maps of the continents?

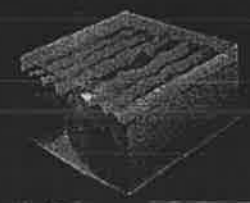
NATIONAL GEOGRAPHIC VISUALIZING PLATE BOUNDARIES

Figure 10

...y diverging at some boundaries and converging at others, Earth's plates are continually—but gradually—reshaping the landscape around ...he Mid-Atlantic Ridge, for example, was formed ...the North and South American Plates pulled ...from the Eurasian and African Plates (see globe). ...features that occur along plate boundaries—...eys, volcanoes, and mountain ranges—are ...on the right and below.

A RIFT VALLEY When continental plates pull apart, they can form rift valleys. The African continent is separating now along the East African Rift Valley.

SUBDUCTION Where oceanic and continental plates collide, the oceanic plate plunges beneath the less dense continental plate. As the plate descends, molten rock (yellow) forms and rises toward the surface, creating volcanoes.



... A mid-ocean ridge, like ... Atlantic Ridge, forms where oceanic ...ntinue to separate. As rising magma ...cools, it forms new oceanic crust.

CONTINENTAL COLLISION Where two continental plates collide, they push up the crust to form mountain ranges such as the Himalaya.

Where Plates Collide A subduction zone also can form where two oceanic plates converge. In this case, the colder, older, denser oceanic plate bends and sinks down into the mantle. The Mariana Islands in the western Pacific are a chain of volcanic islands formed where two oceanic plates collide.

Usually, no subduction occurs when two continental plates collide, as shown in **Figure 10.** Because both of these plates are less dense than the material in the asthenosphere, the two plates collide and crumple up, forming mountain ranges. Earthquakes are common at these convergent boundaries. However, volcanoes do not form because there is no, or little, subduction. The Himalaya in Asia are forming where the Indo-Australian Plate collides with the Eurasian Plate.

Where Plates Slide Past Each Other The third type of plate boundary is called a transform boundary. Transform boundaries occur where two plates slide past one another. They move in opposite directions or in the same direction at different rates. When one plate slips past another suddenly, earthquakes occur. The Pacific Plate is sliding past the North American Plate, forming the famous San Andreas Fault in California, as seen in **Figure 11.** The San Andreas Fault is part of a transform plate boundary. It has been the site of many earthquakes.

Figure 11 The San Andreas Fault in California occurs along the transform plate boundary where the Pacific Plate is sliding past the North American Plate.

Overall, the two plates are moving in roughly the same direction. **Explain** *Why, then, do the red arrows show movement in opposite directions?*

This photograph shows an aerial view of the San Andreas Fault.

Causes of Plate Tectonics

Many new discoveries have been made about Earth's crust since Wegener's day, but one question still remains. What causes the plates to move? Scientists now think they have a good idea. They think that plates move by the same basic process that occurs when you heat soup.

Convection Inside Earth Soup that is cooking in a pan on the stove contains currents caused by an unequal distribution of heat in the pan. Hot, less dense soup is forced upward by the surrounding cooler, denser soup. As the hot soup reaches the surface, it cools and sinks back down into the pan. This entire cycle of heating, rising, cooling, and sinking is called a **convection current.** A version of this same process, occurring in the mantle, is thought to be the force behind plate tectonics. Scientists suggest that differences in density cause hot, plasticlike rock to be forced upward toward the surface.

Moving Mantle Material Wegener wasn't able to come up with an explanation for why plates move. Today, researchers who study the movement of heat in Earth's interior have proposed several possible explanations. All of the hypotheses use convection in one way or another. It is, therefore, the transfer of heat inside Earth that provides the energy to move plates and causes many of Earth's surface features. One hypothesis is shown in **Figure 12.** It relates plate motion directly to the movement of convection currents. According to this hypothesis, convection currents cause the movements of plates.

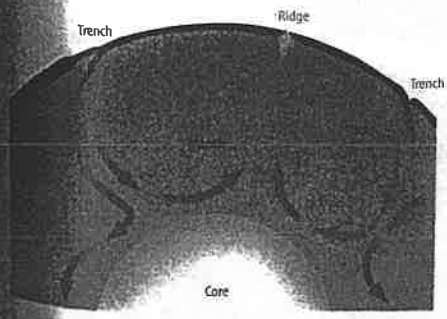


Figure 12 In one hypothesis, convection currents occur throughout the mantle. Such convection currents (see arrows) are the driving force of plate tectonics.

Mini LAB

Modeling Convection Currents

Procedure

1. Pour water into a clear, colorless casserole dish until it is 5 cm from the t
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 o the dish, observe what happens in the water.
5. Illustrate your observati in your Science Journal

Analysis

1. Determine whether any currents form in the wa
2. Infer what causes the cu rents to form.

Features Caused by Plate Tectonics

Earth is a dynamic planet with a hot interior. This heat leads to convection, which powers the movement of plates. As the plates move, they interact. The interaction of plates produces forces that build mountains, create ocean basins, and cause volcanoes. When rocks in Earth's crust break and move, energy is released in the form of seismic waves. Humans feel this release as earthquakes. You can see some of the effects of plate tectonics in mountainous regions, where volcanoes erupt, or where landscapes have changed from past earthquake or volcanic activity.

Reading Check *What happens when seismic energy is released as rocks in Earth's crust break and move?*

Normal Faults and Rift Valleys Tension forces, which are forces that pull apart, can stretch Earth's crust. This causes large blocks of crust to break and tilt or slide down the broken surfaces of crust. When rocks break and move along surfaces, a fault forms. Faults interrupt rock layers by moving them out of place. Entire mountain ranges can form in the process, called fault-block mountains, as shown in **Figure 13.** Generally, the faults that form from pull-apart forces are normal faults—faults in which the rock layers above the fault move down when compared with rock layers below the fault.

Rift valleys and mid ocean ridges can form where Earth's crust separates. Examples of rift valleys are the Great Rift Valley in Africa, and the valleys that occur in the middle of mid-ocean ridges. Examples of mid-ocean ridges include the Mid-Atlantic Ridge and the East Pacific Rise.

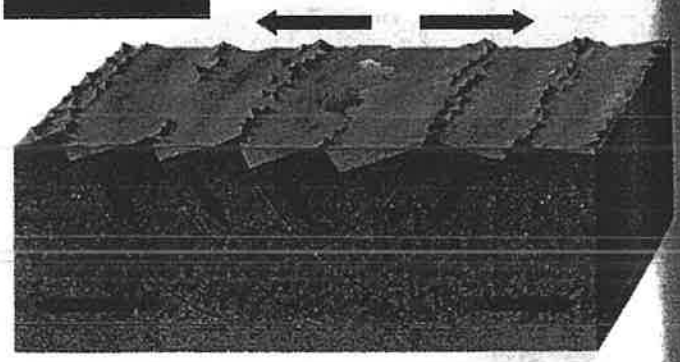
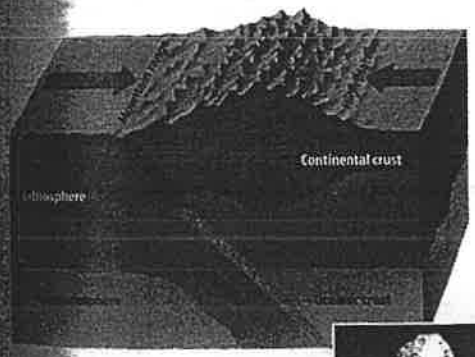


Figure 13 Fault-block mountains can form when Earth's crust is stretched by tectonic forces. The arrows indicate the directions of moving blocks.
Name *the type of force that occurs when Earth's crust is pulled in opposite directions.*

Mountains and Volcanoes Compression forces squeeze objects together. Where plates come together, compression forces produce several effects. As continental plates collide, the forces that are generated cause massive folding and faulting of rock layers into mountain ranges such as the Himalaya, shown in **Figure 14,** or the Appalachian Mountains. The type of faulting produced is generally reverse faulting. Along a reverse fault, the rock layers above the fault surface move up relative to the rock layers below the fault.

Reading Check *What features occur where plates converge?*

As you learned earlier, when two oceanic plates converge, the denser plate is forced beneath the other plate. Curved chains of volcanic islands called island arcs form above the sinking plate. If an oceanic plate converges with a continental plate, the denser oceanic plate slides under the continental plate. Folding and faulting at the continental plate margin can thicken the continental crust to produce mountain ranges. Volcanoes also typically are formed at this type of convergent boundary.



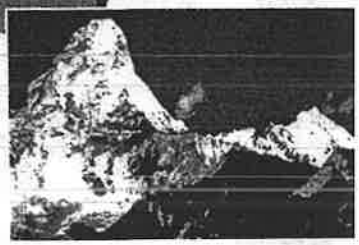


Figure 14 The Himalaya still are forming today as the Indo-Australian Plate collides with the Eurasian Plate.

INTEGRATE Career

Volcanologist This person's job is to study volcanoes in order to predict eruptions. Early warning of volcanic eruptions gives nearby residents time to evacuate. Volcanologists also educate the public about the hazards of volcanic eruptions and tell people who live near volcanoes what they can do to be safe in the event of an eruption. Volcanologists travel all over the world to study new volcanic sites.

Figure 15 Most of the movement along a strike-slip fault is parallel to Earth's surface. When movement occurs, human-built structures along a strike-slip fault are offset, as shown here in this road.

Strike-Slip Faults At transform boundaries, two plates slide past one another without converging or diverging. The plates stick and then slide, mostly in a horizontal direction, along large strike-slip faults. In a strike-slip fault, rocks on opposite sides of the fault move in opposite directions, or in the same direction at different rates. This type of fault movement is shown in **Figure 15.** One such example is the San Andreas Fault. When plates move suddenly, vibrations are generated inside Earth that are felt as an earthquake.

Earthquakes, volcanoes, and mountain ranges are evidence of plate motion. Plate tectonics explains how activity inside Earth can affect Earth's crust differently in different locations. You've seen how plates have moved since Pangaea separated. Is it possible to measure how far plates move each year?

Testing for Plate Tectonics

Until recently, the only tests scientists could use to check for plate movement were indirect. They could study the magnetic characteristics of rocks on the seafloor. They could study volcanoes and earthquakes. These methods supported the theory that the plates have moved and still are moving. However, they did not provide proof—only support—of the idea.

New methods had to be discovered to be able to measure the small amounts of movement of Earth's plates. One method, shown in **Figure 16,** uses lasers and a satellite. Now scientists can measure exact movements of Earth's plates of as little as 1 cm per year.

INTEGRATE Physics

Direction of Forces In which directions do forces act at convergent, divergent, and transform boundaries? Demonstrate these forces using wooden blocks or your hands.

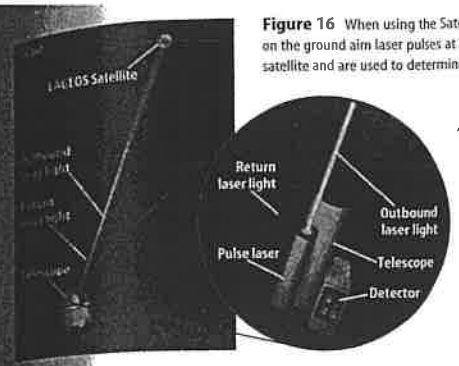


Figure 16 When using the Satellite Laser Ranging System, scientist on the ground aim laser pulses at a satellite. The pulses reflect off the satellite and are used to determine a precise location on the ground.

Current Data Satellite La Ranging System data show th Hawaii is moving toward Jap at a rate of about 8.3 cm p year. Maryland is moving aw from England at a rate of 1.7 per year. Using such metho scientists have observed th the plates move at rates rang from about 1 cm to 12 cm p year.

section 3 review

Summary

Plate Tectonics

- The theory of plate tectonics states that sections of the seafloor and continents move as plates on a plasticlike layer of the mantle.

Plate Boundaries

- The boundary between two plates moving apart is called a divergent boundary.
- Plates move together at a convergent boundary.
- Transform boundaries occur where two plates slide past one another.

Causes of Plate Tectonics

- Convection currents are thought to cause the movement of Earth's plates.

Features Caused by Plate Tectonics

- Tension forces cause normal faults, rift valleys, and mid-ocean ridges at divergent boundaries.
- At convergent boundaries, compression forces cause folding, reverse faults, and mountains.
- At transform boundaries, two plates slide past one another along strike-slip faults.

Self Check

1. **Describe** what occurs at plate boundaries that are associated with seafloor spreading.
2. **Describe** three types of plate boundaries where volcanic eruptions can occur.
3. **Explain** how convection currents are related to plate tectonics.
4. **Think Critically** Using Figure 9 and a world map, determine what natural disasters might occur in Iceland. Also determine what disasters might occur in Tibet. Explain why some Icelandic disasters are not expected to occur in Tibet.

Applying Skills

5. **Predict** Plate tectonic activity causes many events that can be dangerous to humans. One of these events is a seismic sea wave, or tsunami. Learn how scientists predict the arrival time of a tsunami in a coastal area.
6. **Use a Word Processor** Write three separate descriptions of the three basic types of plate boundaries—divergent boundaries, convergent boundaries, and transform boundaries. Then draw a sketch of an example of each boundary next to your description.

Online blue.msscience.com/self_check_quiz

Name _____ Date _____

Plate Tectonics

Section 3 Theory of Plate Tectonics

Scan *the headings and illustrations in Section 3. List four features caused by plate tectonics.*

1. _____ 3. _____

2. _____ 4. _____

Review Vocabulary

Define *the review terms to show their scientific meanings.*

converge _____

diverge _____

transform _____

New Vocabulary

Use your book to define the following terms.

plate _____

plate tectonics _____

lithosphere _____

asthenosphere _____

convection current _____

Academic Vocabulary

Use a dictionary to define rigid.

rigid _____

Name _____ Date _____

Section 3 Theory of Plate Tectonics (continued)

Main Idea **Details**

Plate Tectonics

I found this information on page _____.

Complete *the following outline on the theory of* plate tectonics.

I. A new theory

A. In the 1960s, a new theory called _____ was developed.

B. Earth's _____ and part of the _____ are broken into sections called _____, that move slowly.

II. Details about the theory

A. The layer of Earth that is broken into sections is called the _____.

B. The _____ is the plasticlike layer below the _____.

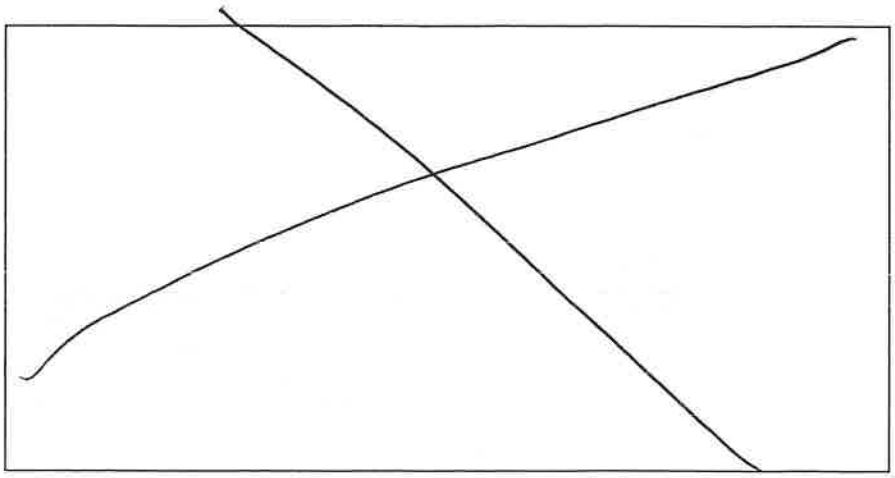
C. The rigid plates move over the _____.

Plate Boundaries

I found this information on page _____.

Compare and contrast *the different* plate *boundaries by defining them side by side. Draw the plates of the world. Identify plate motion by using arrows.*

Divergent	Convergent	Transform



Name _____ **Date** _____

Section 3 Theory of Plate Tectonics (continued)

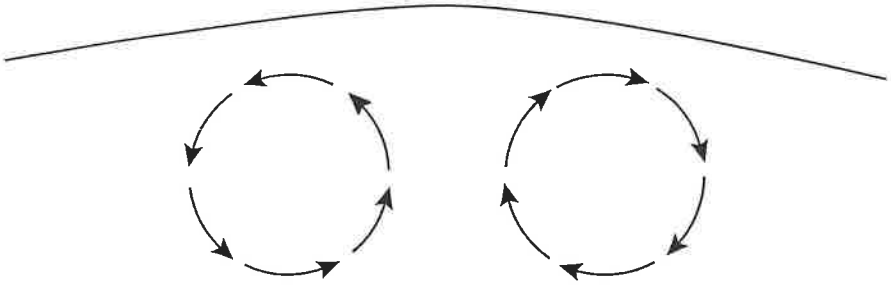
Main Idea

Details

Causes of Plate Tectonics

I found this information on page _____.

Label *the* convection currents *depicted below with heating, rising, cooling, and sinking.*



Features Caused by Plate Tectonics

I found this information on page _____.

Organize *information to describe features caused by plate tectonics. Fill in the chart below.*

Feature	Description
Rift valley	
Folded and faulted mountains	
Strike-slip faults	

Testing for Plate Tectonics

I found this information on page _____.

Summarize *how the Satellite Laser Ranging System measures plate movement.*

_____

_____

_____

_____

_____

NAME _____

Going DEEP with PLATE TECTONICS

Study Guide and Practice

How do mountains form? Why do earthquakes happen? What is a volcano and why does it erupt? Throughout recorded human history, there were always questions like these trying to understand how or why these events happened. Questions such as these led to plenty of research from hundreds of scientists over the past century to find the answers. These answers were found! From the collected facts and evidence, there was a theory to explain it all... The *Theory of Plate Tectonics*!

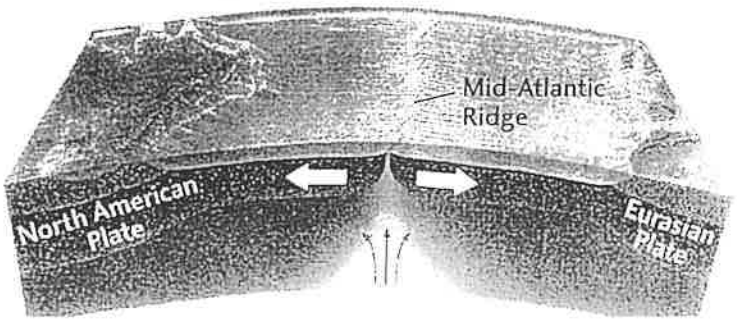
We live on a restless Earth, in which 7 major and 8 minor tectonic plates move about on top of the asthenosphere. Whether they are colliding, dividing, or sliding, these plates are always in motion. Where these plates meet, called 'plate boundaries', is where most of the earthquakes and volcanoes on Earth happen.

The Theory of Plate Tectonics underlines that the Earth forms new crust at the mid-ocean ridges. This crust begins to move outward to either side of the ridge. As it moves, it is forced below another plate where it is melted back into magma. Far into the geological future, this recycled crust emerges again at a mid-ocean ridge.

What causes the plates to move about? It's very simple really! It's called *CONVECTION CURRENTS*! Think of how boiling water in a pot moves... the hotter water rises up. Then, as the water moves to the pot's edge, it is forced back down to be heated back up again. Inside the Earth, instead of convecting water, it is convecting magma.

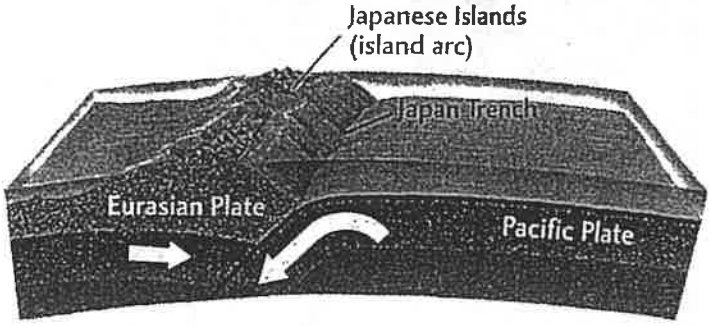
There are THREE types of plate boundaries: *DIVERGENT*, *CONVERGENT*, and *TRANSFORM*! Each of these give rise to new landforms and can cause many natural disasters.

Divergent Plate Boundaries are where plates are moving away from each other. This movement is found along mid-ocean ridges where new crust material is being formed.

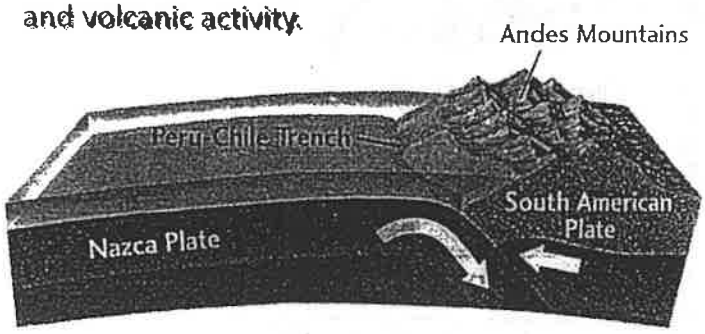


Convergent Plate Boundaries are where one plate subducts under crust that is less dense to be recycled back into the asthenosphere. There are three type of convergent plate boundaries:

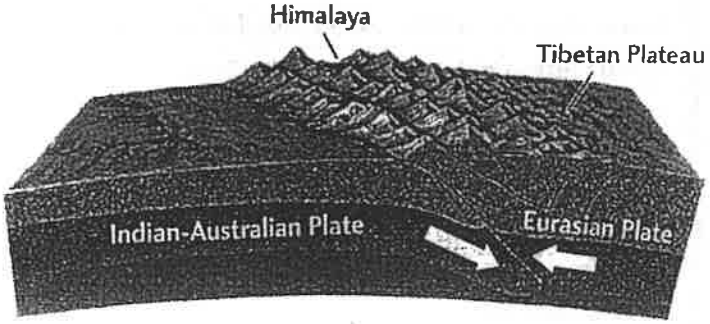
- ***Ocean to Ocean*: when the crust of two oceanic plates meet, usually forming island arcs.**



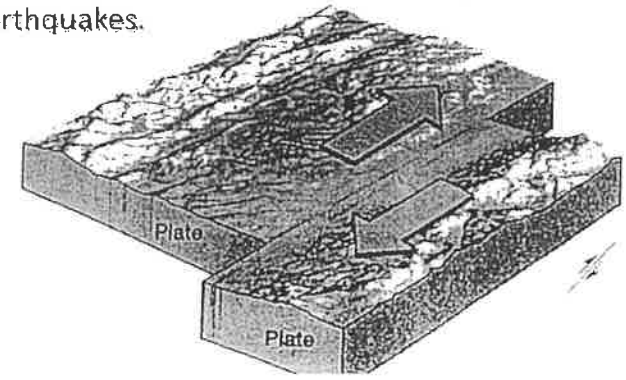
- ***Ocean to Continental*: when ocean crust subducts under continental crust forming mountain chains and volcanic activity.**



- ***Continental to Continental*: when two continental plates meet and buckle up forming large mountains.**



Transform Plate Boundaries are when plates move side by side with each other resulting in frequent earthquakes.



TECTONIC PLATE PRACTICE

Directions:

- Using the map to the right, determine what type of plate boundary exists between each of the two plates and record in the table provided.
- Record the stress type that occurs at the plate boundaries. Use the choices below for stress type

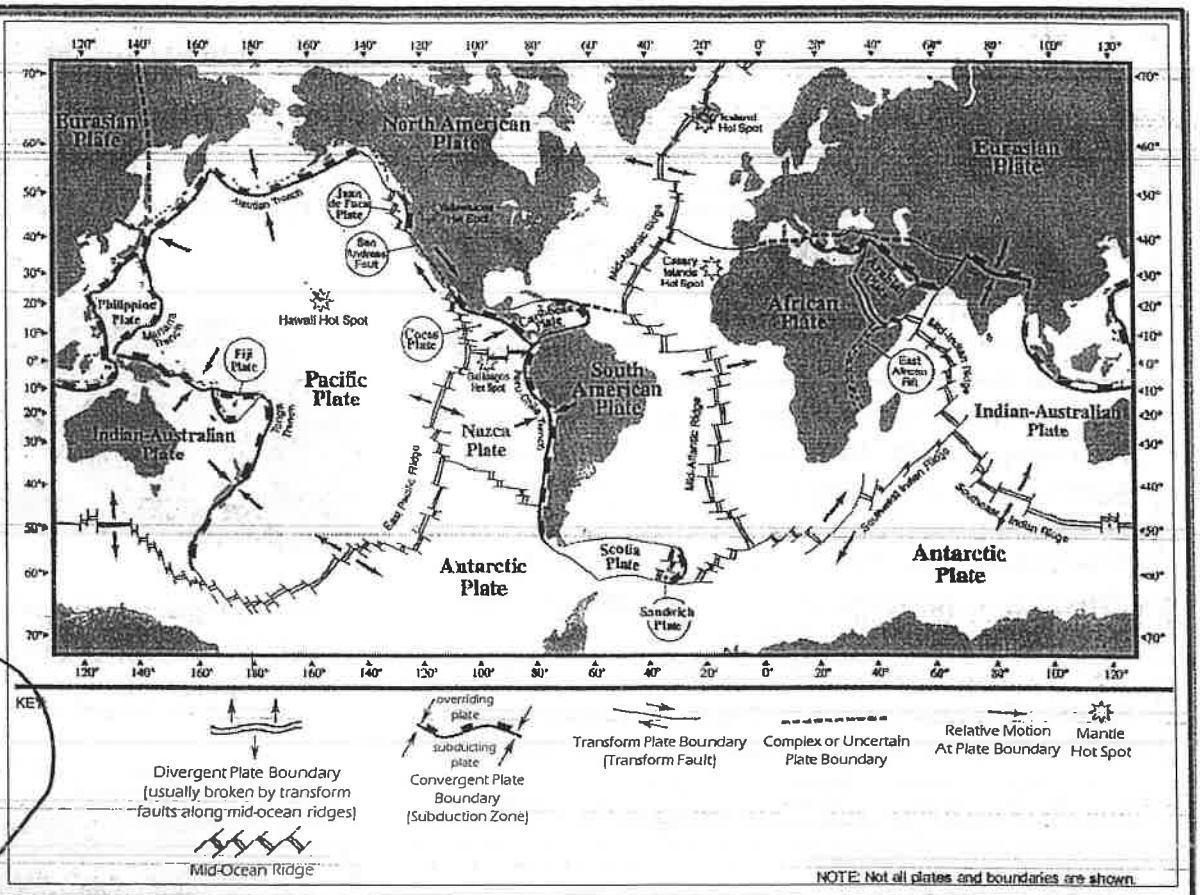


Plate Boundary	Boundary Type	Stress Type
Indian-Australian Plate and Eurasian Plate	Convergent	Compression
Antarctic Plate and Pacific Plate		
Caribbean Plate and South American Plate		
Pacific Plate and Juan de Fuca Plate		
North American Plate and Pacific Plate @ San Andreas Fault		
Nazca Plate and South American Plate		
Arabian Plate and Eurasian Plate		
Scotia Plate and Antarctic Plate		
North American Plate and Eurasian Plate		
Philippine Plate and Pacific Plate		

Questions:

1. Where does the most earthquakes and volcanoes occur on the Earth's surface?

2. Explain why 'recycling' is used to describe the process of the tectonic plates.

3. How could the movement of tectonic plates create another supercontinent like Pangaea?

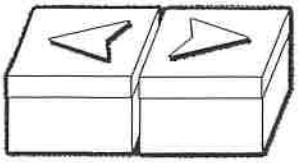
4. The core of the Earth provides the heat that creates the convection currents of the mantle and drives the tectonic plates. Describe what would happen as the Earth's core cools down over billions of years?

5. What are the different ways in which the tectonic plates interact with each other as they move around?

Plate Boundary Homework

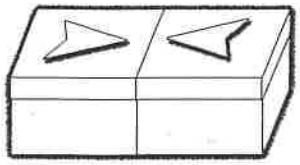
Name _____

A



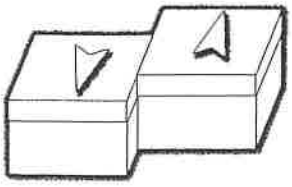
1. What is the name of this type of boundary in Figure A?
   _____
2. What type of features are found at this boundary?
   - In the ocean _____
   - On the continent _____
3. How are these plates moving? _____
4. Is this an example of a subduction zone? Yes or No

B



5. What is the name of this type of boundary in Figure B?
   _____
6. What type of features are found at this boundary?
   - Continental/Continental _____
   - Continental/Oceanic _____
   - Oceanic/Oceanic _____
7. How are these plates moving? _____
8. Put a check by the ones that are subduction zones.

C



9. What is the name of this type of boundary in figure C?
   _____
10. What type of features are found at this boundary?
    _____
11. How are these plates moving? _____
12. Is this an example of a subduction zone? Yes or No

Bonus: Name a place on Earth where you would find these boundaries:

A _____

B _____

C _____

Section 1

Continental Drift

As You Read

What You'll Learn

- **Describe** the hypothesis of continental drift.
- **Identify** evidence supporting continental drift.

Why It's Important

The hypothesis of continental drift led to plate tectonics—a theory that explains many processes in Earth.

Review Vocabulary

continent: one of the six or seven great divisions of land on the globe

New Vocabulary

- continental drift
- Pangaea

Evidence for Continental Drift

If you look at a map of Earth's surface, you can see that the edges of some continents look as though they could fit together like a puzzle. Other people also have noticed this fact. For example, Dutch mapmaker Abraham Ortelius noted the fit between the coastlines of South America and Africa more than 400 years ago.

Pangaea German meteorologist Alfred Wegener (VEG nur) thought that the fit of the continents wasn't just a coincidence. He suggested that all the continents were joined together at some time in the past. In a 1912 lecture, he proposed the hypothesis of continental drift. According to the hypothesis of **continental drift,** continents have moved slowly to their current locations. Wegener suggested that all continents once were connected as one large landmass, shown in **Figure 1,** that broke apart about 200 million years ago. He called this large landmass **Pangaea** (pan JEE uh), which means "all land."

Reading Check *Who proposed continental drift?*

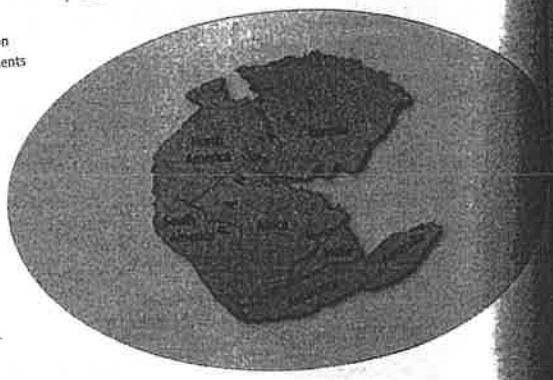


Figure 1 This illustration represents how the continents once were joined to form Pangaea. This fitting together of continents according to shape is not the only evidence supporting the past existence of Pangaea.

A Controversial Idea Wegener's ideas about continental drift were controversial. It wasn't until long after Wegener's death in 1930 that his basic hypothesis was accepted. The evidence Wegener presented hadn't been enough to convince many people during his lifetime. He was unable to explain exactly how the continents drifted apart. He proposed that the continents plowed through the ocean floor, driven by the spin of Earth. Physicists and geologists of the time strongly disagreed with Wegener's explanation. They pointed out that continental drift would not be necessary to explain many of Wegener's observations. Other important observations that came later eventually supported Wegener's earlier evidence.

Fossil Clues Besides the puzzlelike fit of the continents, fossils provided support for continental drift. Fossils of the reptile *Mesosaurus* have been found in South America and Africa, as shown in **Figure 2.** This swimming reptile lived in freshwater and on land. How could fossils of *Mesosaurus* be found on land areas separated by a large ocean of salt water? It probably couldn't swim between the continents. Wegener hypothesized that this reptile lived on both continents when they were joined.

Reading Check *How do* Mesosaurus *fossils support the past existence of Pangaea?*

Science Online

Topic: Continental Drift
Visit blue.msscience.com for Web links to information about the continental drift hypothesis.

Activity Research and write a brief report about the initial reactions, from the public and scientific communities, toward Wegener's continental drift hypothesis.

Figure 2 Fossil remains of plants and animals that lived in Pangaea have been found on more than one continent.
Evaluate *How do the locations of* Glossopteris, Mesosaurus, Kannemeyerid, Labyrinthodont, *and other fossils support Wegener's hypothesis of continental drift?*

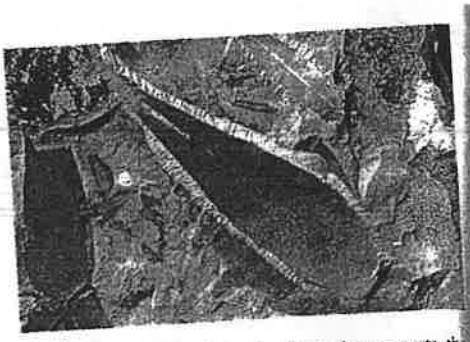


Figure 3 This fossil plant, *Glossopteris*, grew in a temperate climate.

A Widespread Plant Another fossil that supports the hypothesis of continental drift is *Glossopteris* (glahs AHP tur us). **Figure 3** shows this fossil plant, which has been found in Africa, Australia, India, South America, and Antarctica. The presence of *Glossopteris* in so many areas also supported Wegener's idea that all of these regions once were connected and had similar climates.

Climate Clues Wegener used continental drift to explain evidence of changing climates. For example, fossils of warm-weather plants were found on the island of Spitsbergen in the Arctic Ocean. To explain this, Wegener hypothesized that Spitsbergen drifted from tropical regions to the arctic. Wegener also used continental drift to explain evidence of glaciers found in temperate and tropical areas. Glacial deposits and rock surfaces scoured and polished by glaciers are found in South America, Africa, India, and Australia. This shows that parts of these continents were covered with glaciers in the past. How could you explain why glacial deposits are found in areas where no glaciers exist today? Wegener thought that these continents were connected and partly covered with ice near Earth's south pole long ago.

Rock Clues If the continents were connected at one time, the rocks that make up the continents should be the same in location where they were joined. Similar rock structures are found on different continents. Parts of the Appalachian Mountains of eastern United States are similar to those found in Greenland and western Europe. If you were to study rocks from eastern South America and western Africa, you would find other rock structures that also are similar. Rock clues like these support the idea that continents were connected in the past.

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?

Try at Home

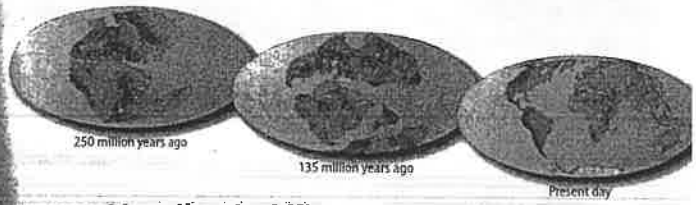


Figure 4 These computer models show the probable course the continents have taken. On the far left is their position 250 million years ago. In the middle is their position 135 million years ago. At right is their current position.

How could continents drift?

Although Wegener provided evidence to support his hypothesis of continental drift, he couldn't explain how, when, or why these changes, shown in **Figure 4**, took place. The idea suggested that lower-density, continental material somehow had to plow through higher-density, ocean-floor material. The force behind this plowing was thought to be the spin of Earth on its axis—a notion that was quickly rejected by physicists. Because other scientists could not provide explanations either, Wegener's idea of continental drift was initially rejected. The idea was so radically different at that time that most people closed their minds to it.

Rock, fossil, and climate clues were the main types of evidence for continental drift. After Wegener's death, more clues were found, largely because of advances in technology, and new ideas that related to continental drift were developed. You'll learn about a new idea, seafloor spreading, in the next section.

section 1 review

Summary

Evidence for Continental Drift

- Alfred Wegener proposed in his hypothesis of continental drift that all continents were once connected as one large landmass called Pangaea.
- Evidence of continental drift came from fossils, signs of climate change, and rock structures from different continents.

How could continents drift?

- During his lifetime, Wegener was unable to explain how, when, or why the continents moved.
- Since his death, advances in technology allowed new ideas to be developed to help explain his hypothesis.

Self Check

1. **Explain** how Wegener used climate clues to support his hypothesis of continental drift.
2. **Describe** how rock clues were used to support the hypothesis of continental drift.
3. **Summarize** the ways that fossils helped support the hypothesis of continental drift.
4. **Think Critically** Why would you expect to see similar rocks and rock structures on two landmasses that were connected at one time.

Applying Skills

5. **Compare and contrast** the locations of fossils of the temperate plant *Glossopteris*, as shown in **Figure 2**, with the climate that exists at each location today.

blue_msscience.com/self_check_quiz

Name _____ **Date** _____

Plate Tectonics

Section 1 Continental Drift

Skim *through Section 1 of your book. Write three questions that come to mind from reading the headings and examining the illustrations.*

1. _____

2. _____

3. _____

Review Vocabulary

Define continent *to show its scientific meaning.*

continent _____

New Vocabulary

Use your book to define the following terms. Then write an original sentence using each term.

continental drift _____

Pangaea _____

Academic Vocabulary

Use a dictionary to define controversy.

controversy _____

Name _____ Date _____

Section 1 Continental Drift (continued)

Main Idea — **Details**

Evidence for Continental Drift

I found this information on page _____.

Summarize Alfred Wegener's hypothesis *about Earth's continents.*

_____

_____

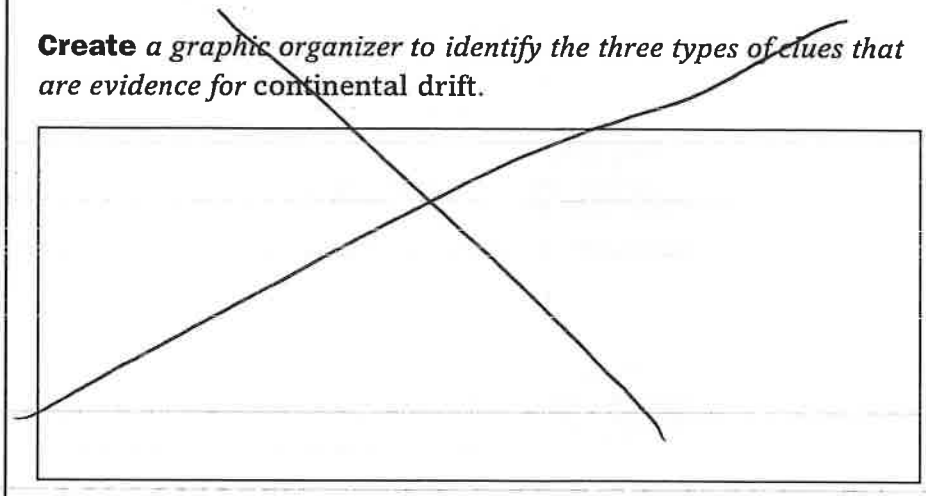
_____

_____

_____

I found this information on page _____.

Create *a graphic organizer to identify the three types of clues that are evidence for* continental drift.



I found this information on page _____.

Analyze *the clue in the left column below. Then describe how Alfred Wegener would have explained it in the right column.*

Clue	Wegener's Response
Fossils of Mesosaurus found in South America and Africa	
Fossil plant found in five continents, including Antarctica	
Fossils of warm weather plants found on Arctic island	
Glacial deposits found in Africa, India, and Australia	

Name _____ **Date** _____

Section 1 Continental Drift (continued)

Main Idea — **Details**

I found this information on page _____.

Model *what the continents may have looked like 250 million years ago.*

How could continents drift?

I found this information on page _____.

Summarize *Wegener's explanations of how and why continental drift occurs.*

Wegener's explanation for continental drift

How: _____

_____

Why: _____

_____

EVALUATE IT

Do you think it was reasonable for scientists initially to reject the hypothesis of continental drift? Explain your response.

_____

_____

_____

_____

_____

Imagine you are Alfred Wegener in 1915. Write your argument to support Continental Drift

Continental drift is the theory that the continents were once together in a large land mass that broke up and split apart.

Evidence

Example! fossils

Notes/Examples to help you!

Reasoning

Example: fossils of the same organism have been found on different continents.

You can talk about glacier, rock, plant, or climate evidence in your chart!

Reasoning

Evidence

Imagine you are Alfred Wegener in 1915. Write your argument to support Continental Drift

"All the News That's Fit to Print"

The New York Times

Late Edition
New York: **Today**, cloudy. High 66. **Tonight**, slighly more humid. Low 55. **Tomorrow**, sun then clouds

VOL, CL . . No. 51,874 *NEW YORK, TUESDAY, OCTOBER 6, 2015* *75 CENTS*

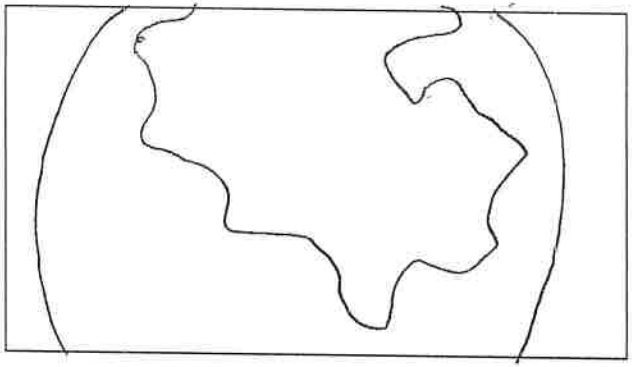
PANGAEA EXISTS

PUZZLE PIECED TOGETHER BY SCIENTIST

By

All of the continents were once together in a single landmass called Pangea. Pangea was in occurence about 200 million years ago. Since then, the landmass has broken apart into their current positions today. This is a process I call continental drift.

There has been many fossils of the same species found in continents that aren't even close to eachother. Fossils of the Mesosaurus have been found in both South America and Africa. These continents are really far apart.



Plants also help support the idea of continental drift. Plants of the same species have been found in different countries such as: Africa, Australia, India, America and Antarctica. It means that all of those continents were once together and had similar climates for the plant.

Another piece of evidence that supports continental drift is rock. Many mountain ranges have been found to connect to other mountains on different continents. The Appalachin mountains in America seem to connect with the mountains found in Western Europe. Before continental drift, Pangea did exist

Chan

"All the News That's Fit to Print"

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VOL, CL . . No. 51,874 *NEW YORK, TUESDAY, OCTOBER 6, 2015* *75 CENTS*

PANGAEA EXISTS

PUZZLE PIECED TOGETHER BY SCIENTIST

By _____

Chan

You only have to ~~[redacted]~~ fill the first 2 columns

section 2

Seafloor Spreading

as you read

What You'll Learn

- Explain seafloor spreading.
- Recognize how age and magnetic clues support seafloor spreading.

Why It's Important

Seafloor spreading helps explain how continents moved apart.

Review Vocabulary

seafloor: portion of Earth's crust that lies beneath ocean waters

New Vocabulary

- seafloor spreading

Mapping the Ocean Floor

If you were to lower a rope from a boat until it reached the seafloor, you could record the depth of the ocean at that particular point. In how many different locations would you have to do this to create an accurate map of the seafloor? This is exactly how it was done until World War I, when the use of sound waves was introduced by German scientists to detect submarines. During the 1940s and 1950s, scientists began using sound waves on moving ships to map large areas of the ocean floor in detail. Sound waves echo off the ocean bottom—the longer the sound waves take to return to the ship, the deeper the water is.

Using sound waves, researchers discovered an underwater system of ridges, or mountains, and valleys like those found on the continents. In some of these underwater ridges are rather long rift valleys where volcanic eruptions and earthquakes occur from time to time. Some of these volcanoes actually are visible above the ocean surface. In the Atlantic, the Pacific, and in other oceans around the world, a system of ridges, called the mid-ocean ridges, is present. These underwater mountain ranges, shown in **Figure 5,** stretch along the center of much of Earth's ocean floor. This discovery raised the curiosity of many scientists. What formed these mid-ocean ridges?

Reading Check *How were mid-ocean ridges discovered?*

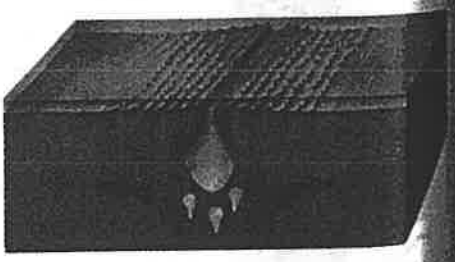


Figure 5 As the seafloor spreads apart at a mid-ocean ridge, new seafloor is created. The older seafloor moves away from the ridge in opposite directions.

Seafloor Moves In the early 1960s, Princeton University scientist Harry Hess suggested an explanation. His now-famous theory is known as **seafloor spreading.** Hess proposed that hot, less dense material below Earth's crust moves toward the surface at the mid-ocean ridges. There, it flows sideways, carrying the seafloor away from the ridge in both directions, as seen in Figure 5.

As the seafloor spreads apart, magma is forced upward and flows from the cracks. It becomes solid as it cools and forms new seafloor. As new seafloor moves away from the mid-ocean ridge, it cools, contracts, and becomes denser. This denser, colder seafloor sinks, helping to form the ocean floor. The theory of seafloor spreading was later supported by the following observations.

Reading Check *How does new seafloor form at mid-ocean ridges?*

Evidence for Spreading

In 1968, scientists aboard the research ship *Glomar Challenger* began gathering information about the rocks on the seafloor. *Glomar Challenger* was equipped with a drilling rig that allowed scientists to drill into the seafloor to obtain rock samples. Scientists found that the youngest rocks are located at the mid-ocean ridges. The ages of the rocks become increasingly older in samples obtained farther from the ridges, adding to the evidence for seafloor spreading.

Using submersibles along mid-ocean ridges, new seafloor features and life-forms also were discovered there, as shown in Figure 6. As molten material is forced upward along the ridges, it brings heat and chemicals that support exotic life-forms in the deep ocean water. Among these are giant clams, mussels, and tube worms.

Figure 6 Many new discoveries have been made on the seafloor. These giant tube worms inhabit areas near hot water vents along mid-ocean ridges.

INTEGRATE Chemistry

Curie Point Find out what the Curie point is and describe in your Science Journal what happens to iron-bearing minerals when they are heated to the Curie point. Explain how this is important to studies of seafloor spreading.

Magnetic Clues Earth's magnetic field has a north and a south pole. Magnetic lines of directions, of force leave Earth near the south pole and enter Earth near the north pole. During a magnetic reversal, the lines of magnetic force run the opposite way. Scientists have determined that Earth's magnetic field has reversed itself many times in the past. These reversals occur over intervals of thousands or even millions of years. The reversals are recorded in the rocks forming along mid-ocean ridges.

Normal magnetic polarity
Reverse magnetic polarity

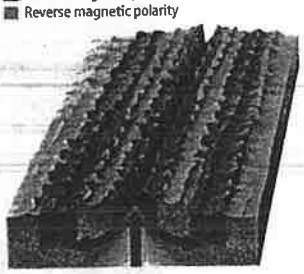


Figure 7 Changes in Earth's magnetic field are preserved in rock that forms on both sides of mid-ocean ridges.
Explain *why this is considered to be evidence of seafloor spreading.*

Magnetic Time Scale Iron-bearing minerals such as magnetite, that are found in the rocks of the seafloor can record Earth's magnetic field direction when they form. Whenever Earth's magnetic field reverses, newly forming iron minerals will record the magnetic reversal.

Using a sensing device called a magnetometer (mag nuh TAH muh tur) to detect magnetic fields, scientists found that rocks on the ocean floor show many periods of magnetic reversal. The magnetic alignment in the rocks reverses back and forth over time in strips parallel to the mid-ocean ridges, as shown in **Figure 7.** A strong magnetic reading is recorded when the polarity of a rock is the same as the polarity of Earth's magnetic field today. Because of this, normal polarities in rocks show up as large peaks. This discovery provided strong support that seafloor spreading was indeed occurring. The magnetic reversals showed that new rock was being formed at the mid-ocean ridges. This helped explain how the crust could move—something that the continental drift hypothesis could not do.

section 2 review

Summary

Mapping the Ocean Floor

- Mid-ocean ridges, along the center of the ocean floor, have been found by using sound waves, the same method once used to detect submarines during World War I.
- Harry Hess suggested, in his seafloor spreading hypothesis, that the seafloor moves.

Evidence for Spreading

- Scientists aboard *Glomar Challenger* provided evidence of spreading by discovering that the youngest rocks are located at ridges and become increasingly older farther from the ridges.
- Magnetic alignment of rocks, in alternating strips that run parallel to ridges, indicates reversals in Earth's magnetic field and provides further evidence of seafloor spreading.

Self Check

1. **Summarize** What properties of iron-bearing minerals on the seafloor support the theory of seafloor spreading?
2. **Explain** how the ages of the rocks on the ocean floor support the theory of seafloor spreading.
3. **Summarize** How did Harry Hess's hypothesis explain seafloor movement?
4. **Explain** why some partly molten material rises toward Earth's surface.
5. **Think Critically** The ideas of Hess, Wegener, and others emphasize that Earth is a dynamic planet. How is seafloor spreading different from continental drift?

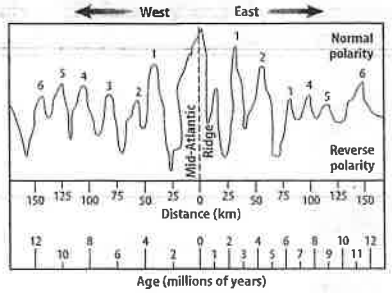
Applying Skills

6. **Solve One-Step Equations** North America is moving about 1.25 cm per year away from a ridge in the middle of the Atlantic Ocean. Using this rate, how much farther apart will North America and the ridge be in 200 million years?

LAB

Seafloor Spreading Rates

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?

Goals

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

Materials

metric ruler
pencil

Procedure

1. Study the magnetic field graph above. 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 the remaining pairs 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:

$$\text{rate} = \frac{125\text{ km}}{10\text{ million years}} = \frac{12.5\text{ km}}{\text{million years}} = \frac{1{,}250{,}000\text{ cm}}{1{,}000{,}000\text{ years}} = 1.25\text{ cm/year}$$

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?

Name _____ **Date** _____

Plate Tectonics

Section 2 Seafloor Spreading

Predict *three things that might be discussed in Section 2 after reading its headings.*

1. _____
2. _____
3. _____

Review Vocabulary

Define seafloor. *Then use the word in a sentence.*

seafloor

_____

_____

_____

_____

New Vocabulary

Use your book to define seafloor spreading. *Then use the term in a sentence.*

seafloor spreading

_____

_____

_____

_____

Academic Vocabulary

Use a dictionary to define interval. *Then use the word in a sentence about magnetic clues to seafloor spreading.*

interval

_____

_____

_____

_____

Name _____ Date _____

Section 2 Seafloor Spreading (continued)

Main Idea — **Details**

Mapping the Ocean Floor

I found this information on page _____.

Summarize *how sound waves are used to map the seafloor.*

_____

_____

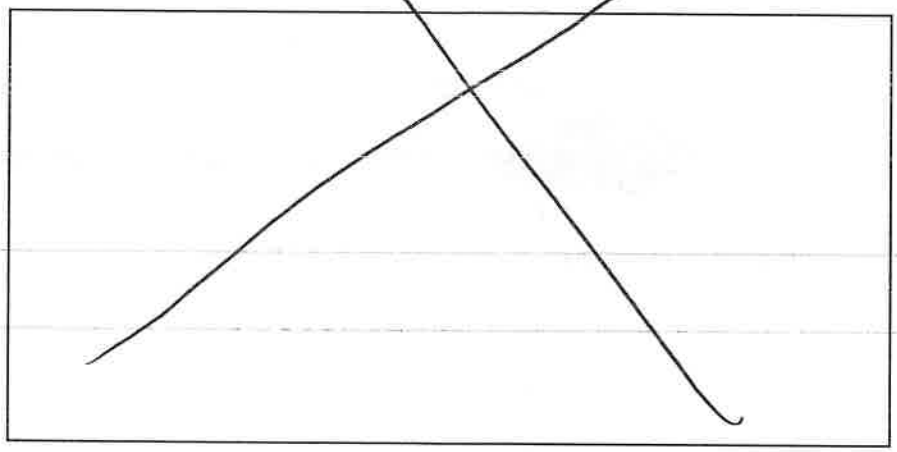
_____

_____

_____

I found this information on page _____.

Model *the process of* seafloor spreading *by drawing a cross section of a mid-ocean ridge and the magma below it. Use arrows to indicate the directions of motion.*



Sequence *steps describing seafloor spreading.*

Hot, less dense material below Earth's crust rises toward the surface at a mid-ocean ridge.

↓

The less dense material flows _____

_____.

↓

As the seafloor spreads apart, magma is _____

_____.

Name _____ **Date** _____

Section 2 Seafloor Spreading (continued)

Main Idea

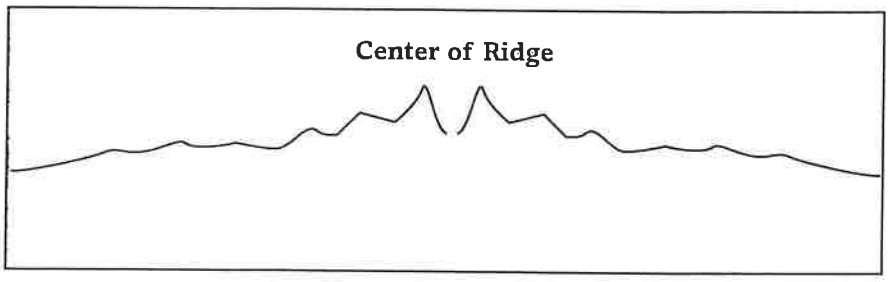
Evidence for Spreading

I found this information on page _____.

I found this information on page _____.

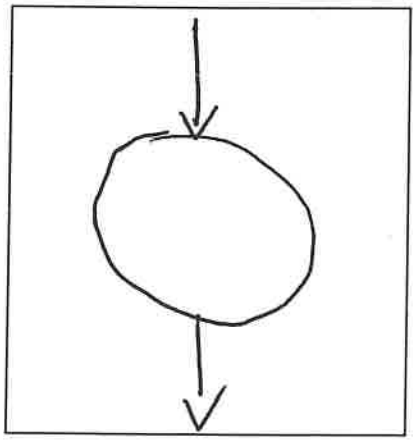
Details

Label *the diagram below to identify evidence for seafloor spreading. Add arrows to show the direction of spreading, and indicate where older rock and newer rock occur.*



Model *the polarity of Earth's magnetic field today.*

- Draw a sphere to represent Earth.
- Label the north pole and south pole.
- Draw arrows indicating the direction in which magnetic lines of force enter and leave Earth.



Summarize *how reversals in the direction of Earth's magnetic field have provided evidence of seafloor spreading.*

At times, the _____ that pass through Earth have _____. _____ of Earth's magnetic field are recorded in _____ that forms along _____. Scientists can detect _____ that are _____ to mid-ocean ridges. This occurs on _____.

Using Vocabulary

asthenosphere p. 190 — Pangaea p. 182
continental drift p. 182 — plate p. 190
convection current p. 195 — plate tectonics p. 190
lithosphere p. 190 — seafloor spreading p. 187

Each phrase below describes a vocabulary term from the list. Write the term that matches the phrase describing it.

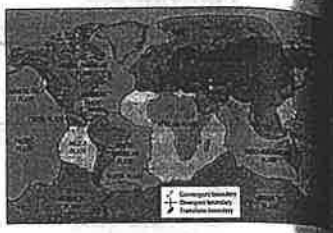
1. plasticlike layer below the lithosphere
2. idea that continents move slowly across Earth's surface
3. large, ancient landmass that consisted of all the continents on Earth
4. composed of oceanic or continental crust and upper mantle
5. explains locations of mountains, trenches, and volcanoes
6. theory proposed by Harry Hess that includes processes along mid-ocean ridges

Checking Concepts

Choose the word or phrase that best answers the question.

7. Which layer of Earth contains the asthenosphere?
   A) crust C) outer core
   B) mantle D) inner core
8. What type of plate boundary is the San Andreas Fault part of?
   A) divergent C) convergent
   B) subduction D) transform
9. What hypothesis states that continents slowly moved to their present positions on Earth?
   A) subduction C) continental drift
   B) erosion D) seafloor spreading

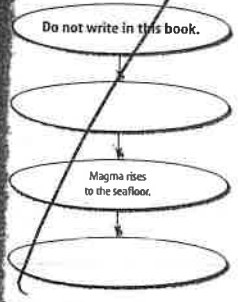
Use the illustration below to answer question 10.



10. Which plate is subducting beneath the South American Plate?
    A) Nazca C) North American
    B) African D) Indo-Australian
11. Which of the following features are evidence that many continents were at one time near Earth's south pole?
    A) glacial deposits C) volcanoes
    B) earthquakes D) mid-ocean ridges
12. What evidence in rocks supports the theory of seafloor spreading?
    A) plate movement
    B) magnetic reversals
    C) subduction
    D) convergence
13. Which type of plate boundary is the Mid-Atlantic Ridge a part of?
    A) convergent C) transform
    B) divergent D) subduction
14. What theory states that plates move around on the asthenosphere?
    A) continental drift
    B) seafloor spreading
    C) subduction
    D) plate tectonics

Thinking Critically

- Why do many earthquakes but few volcanic eruptions occur in the Himalaya?
- Glacial deposits often form at high latitudes near the poles. Explain why glacial deposits have been found in Africa.
- Explain how magnetism is used to support the theory of seafloor spreading.
- Explain why volcanoes do not form along the San Andreas Fault.
- Explain why the fossil of an ocean fish found on two different continents would not be good evidence of continental drift.
- **Form Hypotheses** Mount St. Helens in the Cascade Range is a volcano. Use **Figure 9** in the U.S. map to hypothesize how it might have formed.
- **Concept Map** Make an events-chain concept map that describes seafloor spreading along a divergent plate boundary. Choose from the following phrases: *magma cools to form new seafloor, convection currents circulate hot material along divergent boundary,* and *older seafloor is forced apart.*



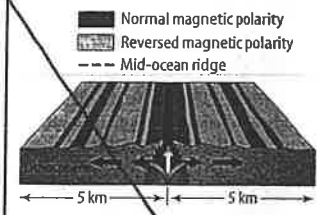
Performance Activities

22. **Observe and Infer** In the MiniLab called "Modeling Convection Currents," you observed convection currents produced in water as it was heated. Repeat the experiment, placing sequins, pieces of wood, or pieces of rubber bands into the water. How do their movements support your observations and inferences from the MiniLab?

Applying Math

23. **A Growing Rift** Movement along the African Rift Valley is about 2.1 cm per year. If plates continue to move apart at this rate, how much larger will the rift be (in meters) in 1,000 years? In 15,500 years?

Use the illustration below to answer questions 24 and 25.



24. **New Seafloor** 10 km of new seafloor has been created in 50,000 years, with 5 km on each side of a mid-ocean ridge. What is the rate of movement, in km per year, of each plate? In cm per year?
25. **Use a Ratio** If 10 km of seafloor were created in 50,000 years, how many kilometers of seafloor were created in 10,000 years? How many years will it take to create a total of 30 km of seafloor?

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the illustration below to answer question 1.

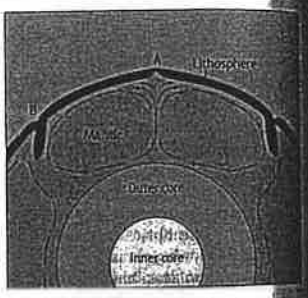
1. What is the name of the ancient supercontinent shown above?
   - A. Pangaea
   - B. Gondwanaland
   - C. Laurasia
   - D. North America
2. Who developed the continental drift hypothesis?
   - A. Harry Hess
   - B. J. Tuzo Wilson
   - C. Alfred Wegener
   - D. W. Jason Morgan
3. Which term refers to sections of Earth's crust and part of the upper mantle?
   - A. asthenosphere
   - B. plate
   - C. lithosphere
   - D. core
4. About how fast do plates move?
   - A. a few millimeters each year
   - B. a few centimeters each year
   - C. a few meters each year
   - D. a few kilometers each year

Test-Taking Tip

Marking Answers Be sure to ask if it is okay to mark in the test booklet when taking the test, but make sure you mark all answers on your answer sheet.

5. Where do Earth's plates slide past each other?
   - A. convergent boundaries
   - B. divergent boundaries
   - C. transform boundaries
   - D. subduction zones

Study the diagram below before answering questions 6 and 7.



6. Suppose that the arrows in the diagram represent patterns of convection in Earth's mantle. Which type of plate boundary is most likely to occur along the region labeled "A"?
   - A. transform
   - B. reverse
   - C. convergent
   - D. divergent
7. Which statement is true of the region marked "B" on the diagram?
   - A. Plates move past each other sideways.
   - B. Plates move apart and volcanoes form.
   - C. Plates move toward each other and volcanoes form.
   - D. Plates are not moving.

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

What is an ocean trench? Where do they form?

How do island arcs form?

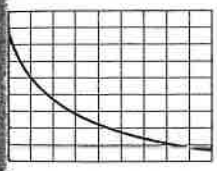
Why do earthquakes occur along the San Andreas Fault?

Describe a mid-ocean ridge.

Why do plates sometimes sink into the mantle?

Use the graph below to answer questions 13–15.

Relationship Between Depth and Age of Seafloor



Use the graph to estimate the average depth below the ocean of ocean crust that just formed.

Estimate the average depth of ocean crust that is 60 million years old.

Describe how the depth of ocean crust is related to the age of ocean crust.

On average, about how fast do plates move?

What layer in Earth's mantle do plates move over?

Describe how scientists make maps of the ocean floor.

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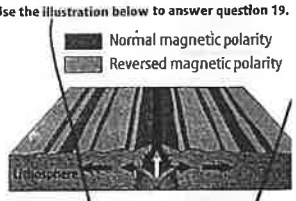
Part 3 Open Ended

Record your answers on a sheet of paper.

Use the illustration below to answer question 19.



19. Examine the diagram above. Explain how the magnetic stripes form in rock that makes up the ocean crust.
20. What causes convection in Earth's mantle?
21. Explain the theory of plate tectonics.
22. What happened to the continents that made up Pangaea after it started to break up?
23. How does Earth's lithosphere differ from Earth's asthenosphere?
24. What types of life have been discovered near mid-ocean ridges?
25. What are the three types of motion that occur at plate boundaries? Describe each motion.
26. What forms when continents collide? Describe the process.
27. What occurs at the center of a mid-ocean ridge? What might you find there?
28. What evidence do we have that supports the hypothesis of continental drift?
29. Who proposed the first theories about plate tectonics? Explain why other scientists questioned these theories.