

## 6.2 Read

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# ***How Do Scientists Describe the Interactions Between Moving Plates?***

You just observed in the animations that different types of plate interactions result in different types of geologic activity. In this section, you will learn more about the ways plates interact. This will help you better explain the geologic activity in your region. After learning how scientists describe plate interactions, you will read to find out more detail about one of the ways plates interact. You will then report what you have learned to the class.



## How Scientists Describe Plate Interactions

**convergent boundary:** a plate boundary where two plates are moving toward each other.

**converge:** to move together, toward each other.

**subduction zone:** an area where the edge of one plate moves under another plate at a convergent boundary.

**buckling zone:** an area where plates push against each other making large folds in the rock.

**divergent boundary:** a boundary where two plates are moving away from each other.

**diverge:** to move away from each other.

**rift zone:** a valley that is caused as two continental plates diverge.

**transform boundary:** a boundary where two plates are moving sideways along each other's edge.

Scientists use specific terms when talking about plate movements and interactions. Understanding the meaning of these terms can help you learn about what scientists think happen at places where Earth's plates meet.

In some places where Earth's plates meet, they are moving toward each other. When plates are moving toward each other, scientists call the place where they meet a **convergent boundary**. To **converge** means two things have moved toward each other. As you saw in the animations, in some areas where plates converge, the edge of one plate moves under another one. Scientists call an area where one plate moves under another a **subduction zone**. In other areas where plates converge, they push against each other. If there is enough force pushing the plates together, the edge of one or both plates will crumple, forming large folds in the rock. An area where plates push against each other making large folds in the rock is called a **buckling zone**.

Scientists refer to a boundary where two plates are moving away from each other as a **divergent boundary**. To **diverge** means to move away from each other. When there is a divergent boundary between two plates of continental crust, a valley can begin to form in the gap that grows between the plates. As this valley grows wider, it takes on a characteristic form. Often there are faults along the valley, and rivers can flow into the valley, filling it with water. This sort of valley that is caused as two continental plates diverge is called a **rift zone**.

Plates can also slide sideways past another plate. Or, two plates may slide in opposite directions past each other. A boundary where two plates are moving sideways along each other's edge is called a **transform boundary**. The movement between plates is sideways at a transform boundary. Since the plates do not move toward each other or away from each other at a transform boundary, no crust is created or destroyed. However, a transform boundary can still cause many changes to Earth's crust. Most transform boundaries occur between two plates under an ocean, but a few occur on land, between plates of continental crust.

## Procedure

On the following pages are four descriptions of the different way plates interact at their edges. You will read the description of the plate interaction you simulated with your flip book. Then you will share what you have learned with the class. Through sharing, everyone in the class will have the opportunity to learn about all of the different types of boundaries and interactions.

Work with your partner to read and understand the description of the plate interaction you are assigned. While you are reading, think about the following questions, and record answers to them in the appropriate column of a *Plate Interactions: Boundaries and Zones* page.

- How are the plates moving in this kind of zone?
- What earthquake and volcano patterns are associated with this type of plate interaction?
- What Earth structures and topography result from this type of plate interaction?
- Which regions do you think have this type of plate interactions?
- How can you make the simulation in your flip book more accurate?

When you finish reading the description and answering the questions, re-label your flip book, if needed, to make it more accurate.

Plate Interactions: Boundaries and Zones				
				6.2.1
Name: _____		Date: _____		
Fill in the table below with information from your reading about boundaries and zones.				
	Convergent Boundary: Subduction Zone	Convergent Boundary: Buckling Zone	Divergent Boundary: Rift Zone	Transform Boundary
How the plates move				
Typical earthquake and volcano patterns				
Resulting topography				
Regions with plate boundary zones that match these plate movements				

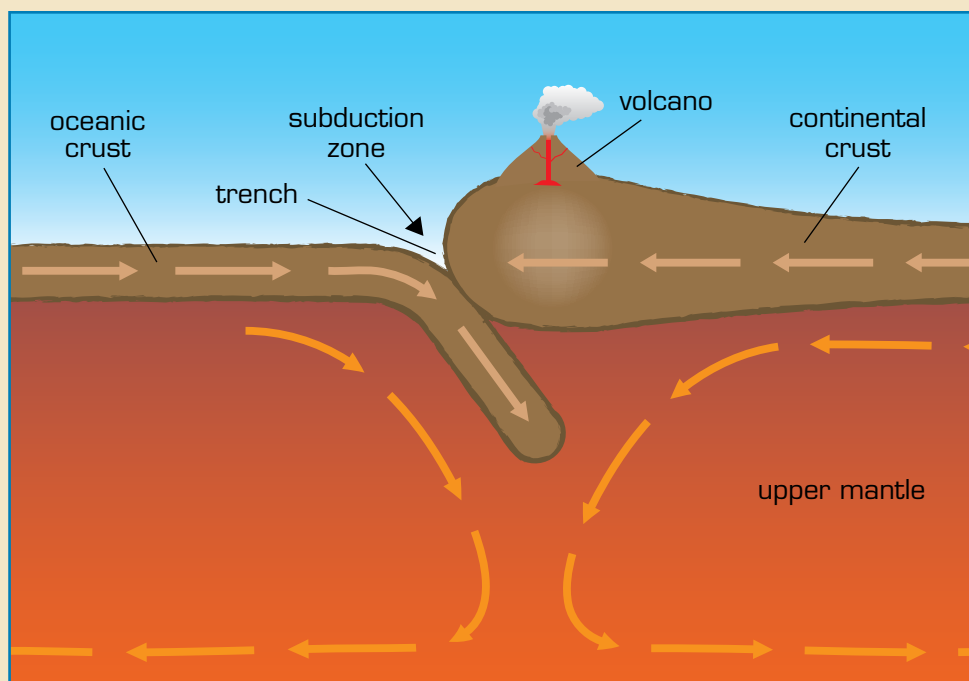
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**trench:** an Earth structure formed at a convergent boundary when an oceanic plate moves under another plate, with long, steep sides and a deep depression.

### Subduction Zones

Remember that a convergent boundary is one in which two plates are moving toward each other. What happens when plates converge depends on the type of crust that the plate edges are made of. A plate interaction in which two plates converge can involve two oceanic plates, or one continental and one oceanic plate. The interactions that occur between different kinds of plates result in different geologic activity and the formation of different Earth structures.

Oceanic crust is more dense than continental crust. When oceanic crust and continental crust converge, the more-dense oceanic crust moves under the continental crust. This causes a subduction zone. A subduction zone can also occur between two oceanic plates. Along the subduction zone, a new structure is formed. The sides of the structure tend to be very steep, with a deep depression that runs along the length of the boundary between the plates. An Earth structure that is formed when an oceanic plate moves under another plate is called a **trench**. Trenches have been found that are very deep. The deepest has been measure to be 10,911 m deep (35,797 ft).



The arrows show the movement of material in the mantle pulls the plates in a subduction zone together.

Thinking about what happens to the sinking plate can help explain the geologic activity that happens in subduction zones. As the edge of the sinking plate moves down toward the mantle, it becomes hotter and hotter. Eventually it is destroyed as the edges of the plate melt from the high temperatures in the mantle and form magma. This creates pockets of magma beneath the upper plate. This magma rises because it is hotter and, therefore, less dense than the surrounding mantle material. As the magma makes its way back toward the crust, it melts its way through rocks of the crust. This melted crust mixes with the rising magma, changing its composition. If it makes its way to the surface, it breaks through as a volcanic eruption, forming a volcanic mountain or island.

Since oceanic crust is denser than continental crust, oceanic crust always sinks when continental crust and oceanic crust collide. If the two converging plates are both oceanic, then the older, denser ocean plate will be the one to sink. Oceanic crust includes rocks and sediments that contain large numbers of water molecules. This means that huge amounts of water are carried deep within Earth. As it moves towards the mantle, the water turns to steam. This sets up conditions for very explosive volcanic eruptions.

There can be earthquakes in subduction zones also. Friction between the top of the sinking plate and bottom of the floating plate can cause earthquakes as far as 700 km (435 mi) below the surface of Earth. These earthquakes, which may create new cracks in the crust, can also contribute to volcanic activity.



*Mount St. Helens is located in a subduction zone. The denser Juan de Fuca oceanic plate is pushed beneath the North American plate made up of rocks with lower densities. As you can see, the eruption of Mount St. Helens in 1980 was very explosive. Volcanoes along subduction zones eject slow-moving lava and various sizes of volcanic particles.*

**Subduction Zones**

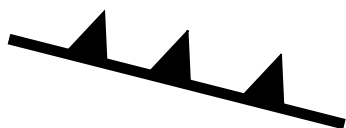
**To illustrate a subduction zone:**

Use your two hands to represent two plates next to each other, sliding the edge of one hand under the other. This is subduction. The edge on the top hand gets pushed up as the bottom hand pushes under.

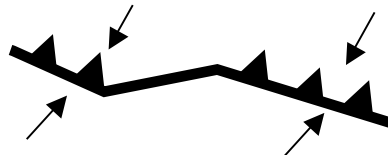


**Label subduction zones:**

Mark each subduction zone with this symbol:

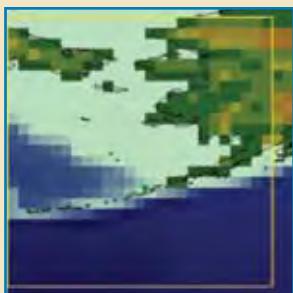


Draw arrows to show that the two plates are moving together:



**What Does the Geologic Activity at a Subduction Zone Look Like?**

- Earthquakes happen in a narrow band.
- Volcanoes happen in a narrow line right next to the line of earthquakes.
- Earthquakes generally happen deep below the surface as one plate sinks beneath the other.
- A deep trench is next to a line of steep volcanic mountains.



## Buckling Zones

Remember that a convergent boundary is one in which two plates are moving toward each other. What happens when plates converge depends on the type of crust that the plate edges are made of. A convergent plate interaction can involve two oceanic plates or one continental and one oceanic plate. The interactions that occur between different kinds of plates result in different geologic activity and the formation of different Earth structures. Buckling zones are regions along convergent plate boundaries where two continental plates of equal density converge. As the two plates slowly collide, the enormous force causes rocks at the edges of the plates to buckle. The edges of these plates thicken and push upward, forming large, folded mountain ranges. Some of the largest and highest mountain ranges in the world were created in this way. Some mountain ranges, such as the Himalayas, are still being pushed up today as the plates involved continue to collide.

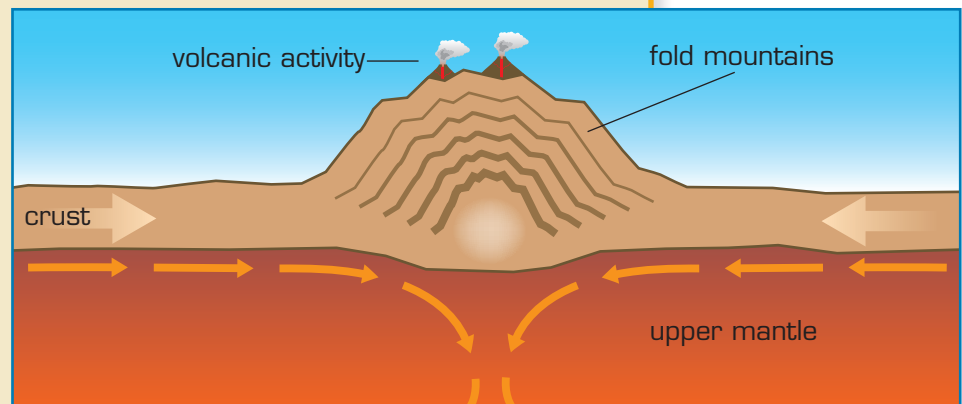
To visualize what happens in a buckling zone, think about what might happen if you pushed two graham crackers together. Graham crackers are thick and crumbly, similar to continental crust. Two graham crackers also have the same density. When you push the two crackers into each other,

the edges crumble and create smaller bits. Imagine those small bits as giant rocks that push up, forming a mountain range.

When two plates push against each other with enough force to fold the rocks at the edges, they create a lot of heat. The heat causes some of the continental crust on the edges to melt. The crust that melts mixes with mantle material beneath the plates to create magma. This melting could cause volcanoes, but usually the crust is so thick at a buckling zone that the magma remains underground. When volcanic eruptions occur in buckling zones, they usually eject hot rock, ash, and slow-moving lava.



*The movement of material in the mantle pulls the plates in a buckling zone together. Because these two plates are of equal density, the two plates push together to form large mountain ranges such as the Himalayas.*

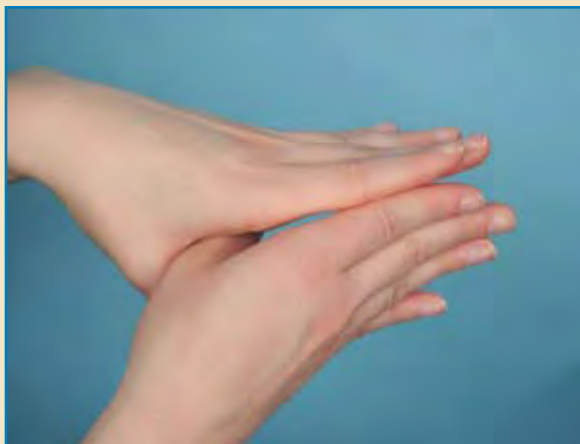


*The Appalachian Mountains, extending from Maine to Georgia, are among the oldest mountains on Earth. Their formation began over a billion years ago through a series of collisions between plates of continental crust. As the continents collided, their edges buckled to form the majestic Appalachian range.*

**Buckling Zones**

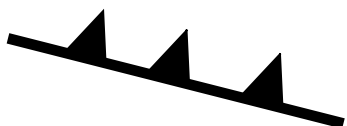
**To illustrate a buckling zone:**

Use your two hands to represent two plates next to each other. Push your two hands against each other, with the touching edges rising up together like a mountain. This is buckling.

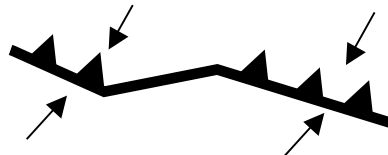


**Label buckling zones:**

Mark each buckling zone with this symbol:

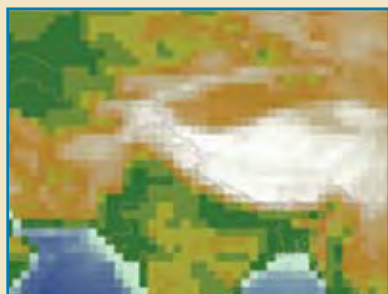


Draw arrows to show that the two plates are moving together:



**What Does the Geologic Activity at a Buckling Zone Look Like?**

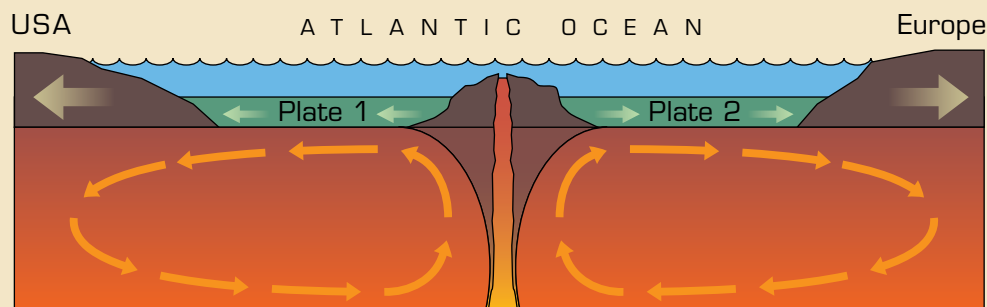
- Earthquakes happen in a scattered pattern.
- Volcanoes are few and scattered.
- Earthquakes generally happen near the surface.
- A large, folded mountain range sits on continental crust.





## Divergent Boundaries and Rift Zones

A divergent boundary is a region where two plates are spreading away from each other. Diverging plates move away from each other very slowly as a result of the movement of mantle material underneath. As plates move apart, magma rises from the mantle. It pushes up the crust at the edges of the plates, eventually breaking through the plate boundary and creating new crust at the point where the plates pulled apart. The Mid-Atlantic Ridge is an underwater mountain range created at this type of plate boundary.



*The movement of material in the mantle causes diverging plates to move apart.*

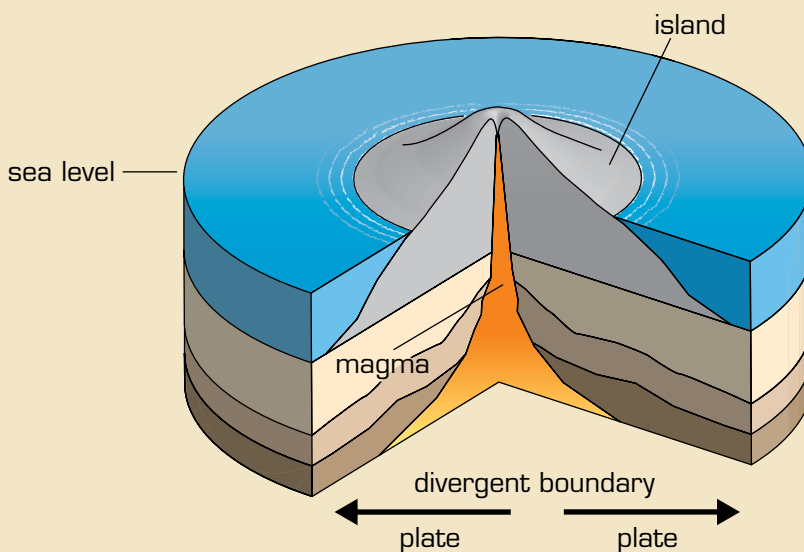
At divergent boundaries, convection currents in the mantle are constantly pulling the two plates away from each other. This means that mantle material coming to the surface does not have much time to build up and harden before the mantle pulls the plates apart again. When the plates pull apart, the mantle material that was just laid down is pulled along with one or both of the plates. When mantle material rises out of a divergent boundary as plates are continuing to move apart, volcanic mountains are built.

Divergent boundaries are found in oceanic crust and continental crust. When oceanic plates move apart from one another, the magma that quietly bubbles out is generally runny and dense. New crust is added each time magma erupts, creating a ridge of underwater mountains. Most of these eruptions, which happen on the ocean floor, go undetected. But they can be quite spectacular. After an underwater eruption, the thin magma cools quickly and forms layers of new crust on the sea floor.

**rifting:** surface cracking that occurs at a divergent boundary beneath continental crust.

**rift valley:** a valley formed when the thin crust between spreading plates sinks.

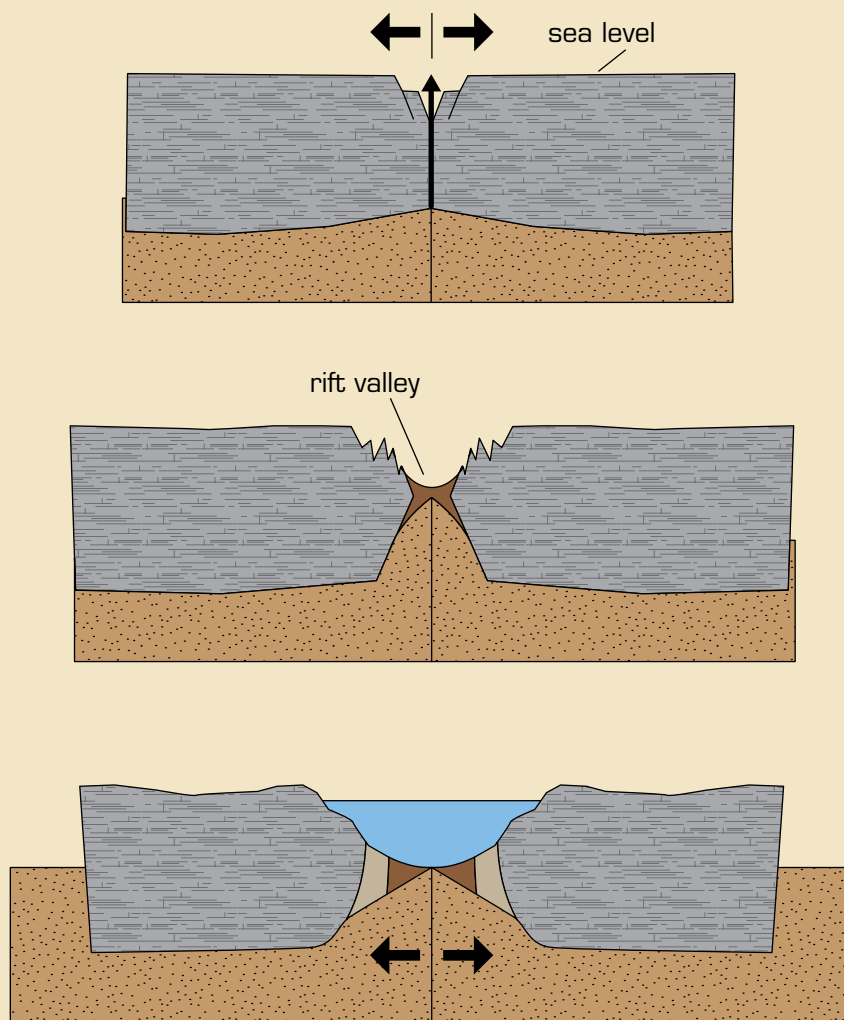
The Great Rift Valley, located in Kenya, Africa, is a large rift in Earth's crust that literally tears Kenya down the length of the country for thousands of kilometers.



Sometimes the underwater mountains that are formed at divergent boundaries surface above the water and become islands. The island of Surtsey in the North Atlantic Ocean was formed by this process.

When a divergent boundary occurs beneath continental crust, **rifting**, or surface cracking, occurs. Rifting begins as hotter than normal magma causes thick continental crust to bulge. As the crust continues to bulge, it is stretched thin and cracks occur. To understand this better, think of a cake baking in the oven. As it rises, it stretches the outer crust until cracks form in the top of the cake.

In Earth's crust, the diverging plates are pulled apart by convection in the mantle, eventually causing a tear. Faults form on either side of the tear and the thin crust between the spreading plates sinks to form a valley between two mountain ranges. These are called **rift valleys**. Over millions of years, as the two plates continue to diverge, a rift valley can sink so low that it is below sea level. As sea water moves in, new oceans are formed.



*Plate movement at a rift zone.*

Rift zones are often very active geologically. Rising magma sometimes works its way through the widening cracks, resulting in volcanic activity. Even if it does not break through to the surface, the pressure it creates beneath the crust can cause more bulging and cracking to occur. Earthquakes occur along the faults that form. Rift zones explain earthquake activity that occurs far from plate boundaries. One of the largest earthquakes in the United States began in New Madrid, Missouri in 1811. This area, far from a plate boundary, is the site of a failed rift zone that almost split North America into two pieces millions of years ago. Although the rift failed, it left a 240 km [150 mi] fault system that remains as a weak spot in Earth's crust.

### Divergent Boundaries

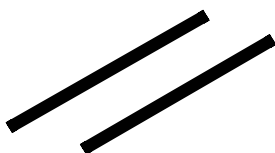
#### To illustrate a divergent boundary:

Use your two hands to represent two plates next to each other. Have a partner push his or her hands up, in between your hands, representing the rising magma as the plates move apart.

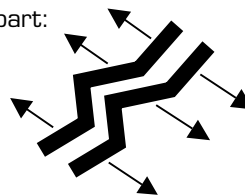


#### Label divergent boundaries:

Mark each rift zone with this symbol:

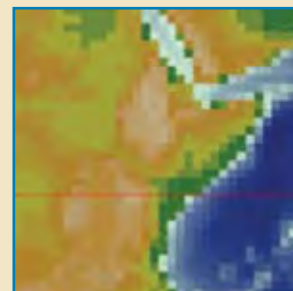
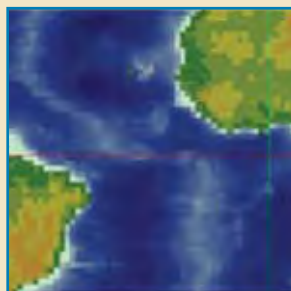
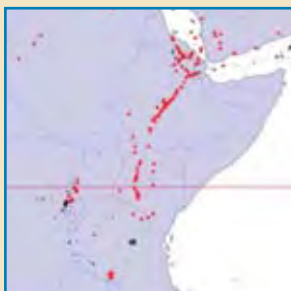


Draw arrows to show that the two plates are moving apart:



#### What Does the Geologic Activity at a Divergent Boundary Look Like?

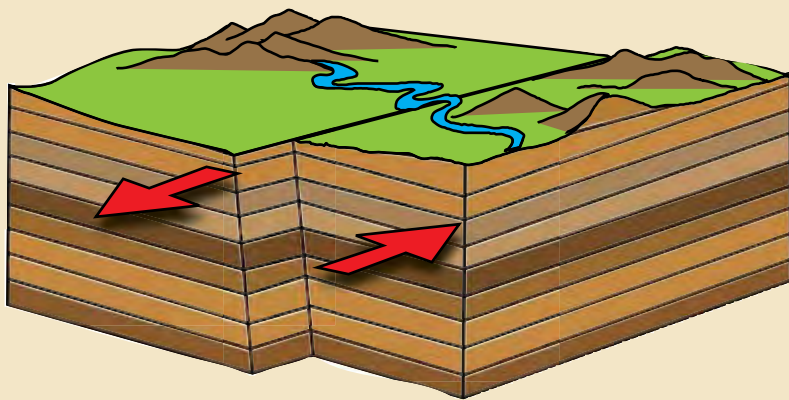
- Earthquakes are shallow and small. The data pattern forms a narrow band or line of earthquakes.
- If volcanoes are under water, there are a few scattered volcanoes near the line of earthquakes. If volcanoes are on land, they appear as a narrow band.
- There is a narrow ridge of volcanic mountains or a narrow ridge of mountains with a valley in between.



### What Is a Transform Boundary?

A transform boundary is an area of Earth's crust where two plates move in opposite directions, sliding past each other. Transform boundaries can occur at both convergent and divergent boundaries. When plates slide past each other at a diverging boundary, an offset occurs, so the diverging boundary no longer lines up in a straight line. Less commonly, transform boundaries occur at converging boundaries.

The San Andreas Fault Line in California is a good example of a transform boundary. It is a place where the plates are sliding past each other. The Great San Francisco Earthquake of 1906 happened, in part, because two plates were sliding past each other.

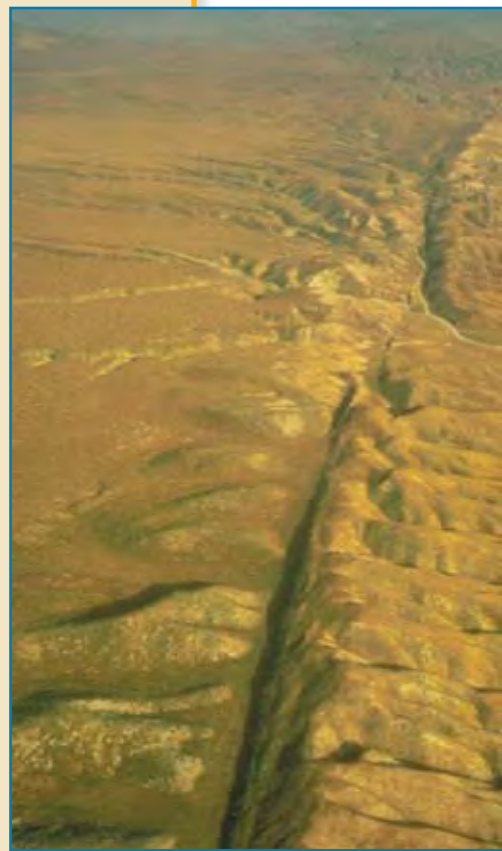


*Two plates in a transform zone slide past each other. This movement can displace creek beds and roads and create bends and folds in the crust.*



*As two plates slip past each other, the results can sometimes be very dramatic and visible.*

*The San Andreas Fault in California is well known as a location where two plates are sliding past each other.*



**Transform Boundaries**

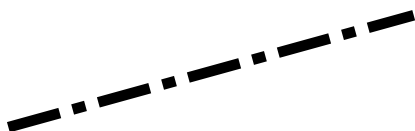
**To illustrate a transform boundary:**

Use your two hands to represent two plates next to each other. Keeping the edges of your hands touching, move both hands, sliding one past the other.

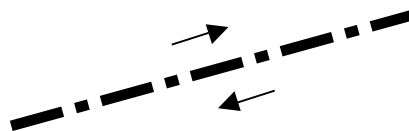


**Label transform boundaries:**

Mark each transform zone with this symbol:



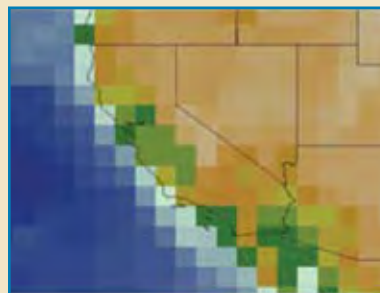
Draw arrows to show that the two plates are sliding past each other:



**What Does the Geologic Activity at a Transform Boundary Look Like?**

Transform boundaries are difficult to identify from earthquake and volcano data. You can identify all other plate boundary predictions and then try to predict which remaining boundaries must be transform boundaries.

- Lots of earthquakes.
- Volcanoes occur in a variety of patterns.



## Conference

After you have read your article, get together with the same small group you worked with on the flip book. Review and revise your flip book, making sure it reflects what you read in the section about the plate boundary. Share the notes on your *Plate Interactions* pages. If you disagree with others, review the article and see if that helps you come to an agreement. If you cannot agree, make a note of it so you can investigate it further.

Together, prepare a poster summarizing what you learned about your type of plate interaction. Your poster should include your type of plate boundary or zone, the data patterns associated with it, a description of how plates move in these regions, the resulting changes in the topography, and the Earth structures your class has been investigating that you think resulted from each type of interaction. Make sure your poster has all the information your classmates need to understand your kind of boundary or zone and its interactions. Make the poster neat and organized enough so your classmates will be able to find information they need.

Decide how you are going to make your presentation.

Everybody in the group should have a chance to be part of the presentation. You may use a drawing describing your boundary type or zone, your poster, and your flip books in your presentation. Use these visuals to help you clearly present the way the plates are moving, the earthquake and volcano patterns those kinds of movements create, and the kinds of landforms that are created by your type of plate interaction. Two people should use their hands to model the plate boundary or zone that is being presented. At the end of your presentation, be prepared to share your ideas about the regions with geologic activity that matches your type of zone.





## Communicate

### Investigation Expo

When it is your turn to share with the class what you have read, begin by naming the type of boundary or zone you have read about. Then use the drawing describing your zone, your poster, and your flip books to teach the class about your boundary or zone type.

Plate Interactions: Boundaries and Zones <span style="float: right;">6.2.1</span>				
Name: _____ Date: _____				
Fill in the table below with information from your reading about boundaries and zones.				
	Convergent Boundary: Subduction Zone	Convergent Boundary: Buckling Zone	Divergent Boundary: Rift Zone	Transform Boundary
How the plates move				
Typical earthquake and volcano patterns				
Resulting topography				
Regions with plate boundary zones that match these plate movements				

© It's About Time

As you listen to others, record what you are learning about each plate boundary in your *Plate Interactions: Boundaries and Zones* page. If you do not understand something that is presented, ask clarification questions. You may find that you disagree about the examples of each boundary or zone type. Save discussion of these disagreements for after everybody has presented.

After all the groups have presented, spend some time as a class discussing which Earth structures you think developed

from which kinds of plate interactions. Be sure to provide evidence when you present your ideas. Your class will probably have disagreements. And for some of the regions, you may think that none of the plate interactions match. You may want to add questions to the *Project Board*.



## Reflect

Working with your partner, answer these questions. Some are about your region and Earth structure.

- Use the chart you made to answer the following questions:
  - At which types of boundaries or in which types of zones is material being added to the crust?
  - At which types of boundaries or in which types of zones is crust being destroyed?
  - What causes one plate to slip beneath another plate?
  - Most earthquakes happen near the surface in thin crust. At which types of boundaries or in which types of zones do earthquakes happen deep below the surface? Why?
- You now know the patterns of geologic activity that are usually associated with each type of plate interaction and boundary zone. Which pattern matches the pattern of earthquakes and volcanoes you observed in your region? What does that tell you about the type of boundary and zone in your region?
- Now that you know what kind of boundary and zone you have in your region, you might want to revise your prediction about how the plates are moving. How do you think the plates are moving in your region? Add your ideas to the *What do we think we know?* column of your *Region Project Board*.

## What's the Point?

Convergent boundaries occur where two plates are moving toward each other. If the two plates have different densities, the plate with greater density will slip beneath the plate with lower density. The denser plate then sinks into the mantle, and its edges melt and combine with mantle material to make magma. This magma then works its way toward the crust, resulting in volcanic activity. Regions where this is happening are called subduction zones. The interaction of plates in a subduction zone also causes earthquakes deep within the Earth.



If the plates at a convergent boundary are of equal density, then the results are different. The edges of the plates crumble and push upward, forming mountain ranges. This kind of region is called a buckling zone.

Diverging boundaries occur where two plates are moving away from each other. When thinner, oceanic plates move away from each other, magma quietly reaches the surface in the gap created by the separation of the two plates, and new crust is formed. This creates a ridge of mountains. As new crust is added at the divergent boundary, older crust moves away from the plate boundary.

Transform boundaries occur where two plates are sliding past each other. This action produces a great deal of stress as the rugged edges of the plates grind past each other. The stress is released as earthquakes.

As you begin to apply this information to your region, you will see how the plate movements and type of crust involved determine the geologic activity in the area.



*The stress caused by plates moving past one another at transform boundaries cause earthquakes that can lead to extensive property damage.*