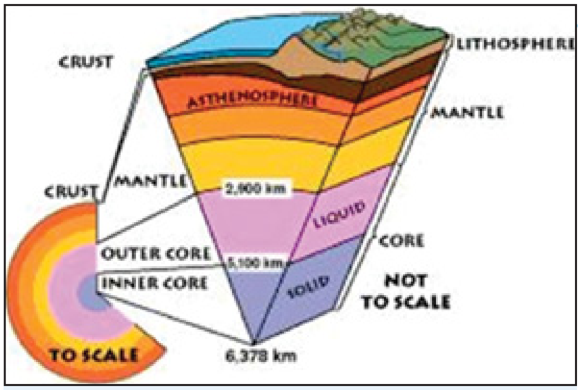
reflect

Has anyone ever told you to sit still? You may do as you're told, but in truth, you can never really sit still. You have probably already learned that Earth is constantly moving through space, but did you know that the ground beneath your feet is constantly moving, too? Why don't you feel this constant movement?



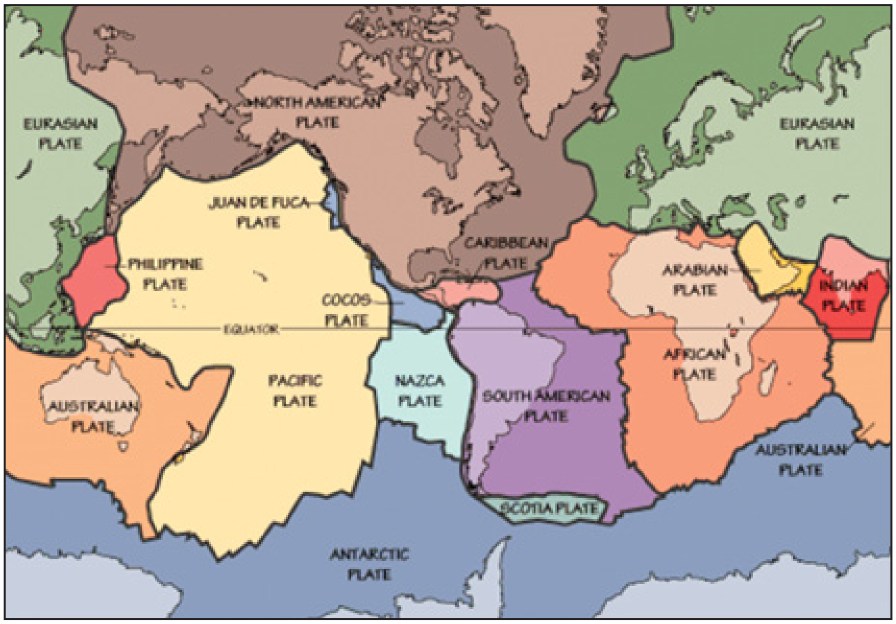
Earth's lithosphere consists of the crust (light brown) and upper mantle (dark brown).

Earth's surface is divided into plates.
Our planet is made up of several layers. The top layer is the *crust*, and the center layer is the *core*. Between the crust and core is a thick layer of partly **molten** rock called the mantle.

molten: melted; liquefied

Earth's crust and the uppermost part of the mantle together make up a layer of solid rock called the *lithosphere*. The lithosphere is the cool, rigid, outermost layer of Earth. It is broken into large, thick pieces called *tectonic plates*. These tectonic plates contain different kinds of crust. Crust beneath the oceans (*oceanic crust*) is denser than crust beneath the continents (*continental crust*).

Scientists have given names to Earth's tectonic plates. This map shows the major tectonic plates at present. Many of these plates are named for the continents or oceans they support.

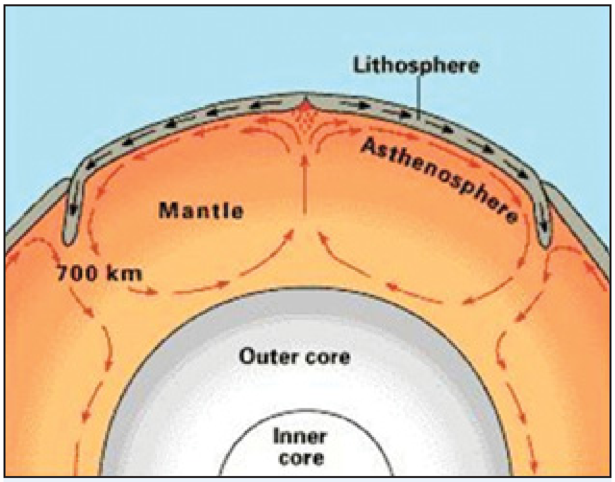


Earth's major tectonic plates include the African plate, Antarctic plate, Eurasian plate, Indo-Australian plate, North American plate, South American plate, and Pacific plate.

TECTONIC PLATES

Convection currents move tectonic plates.
Just below the lithosphere is a shallow layer of mantle called the *asthenosphere*. The molten rock in the asthenosphere slowly flows due to a process called convection. Tectonic plates "float" on top of the asthenosphere as it flows. The tectonic plates of the lithosphere are less dense than the material of the asthenosphere, so they float on top of it.

Convection is the process by which hot material rises and cooler material sinks. Beneath Earth's surface, temperature increases with depth. Deep within Earth, the soft material of the asthenosphere heats up and rises toward the crust. As the material gets close to the crust, it cools down. As it cools, it sinks back toward the core. Eventually, the sinking material heats up and rises again. This produces circular movements called *convection currents*.



Red arrows in this diagram represent convection currents. These currents move tectonic plates floating upon the asthenosphere.

As you see in this diagram, some convection currents in the asthenosphere flow in a clockwise direction. Other convection currents flow in a counterclockwise direction. As the asthenosphere flows, tectonic plates move with it in different directions. Scientists describe this process through the *theory of plate tectonics*.

look out!

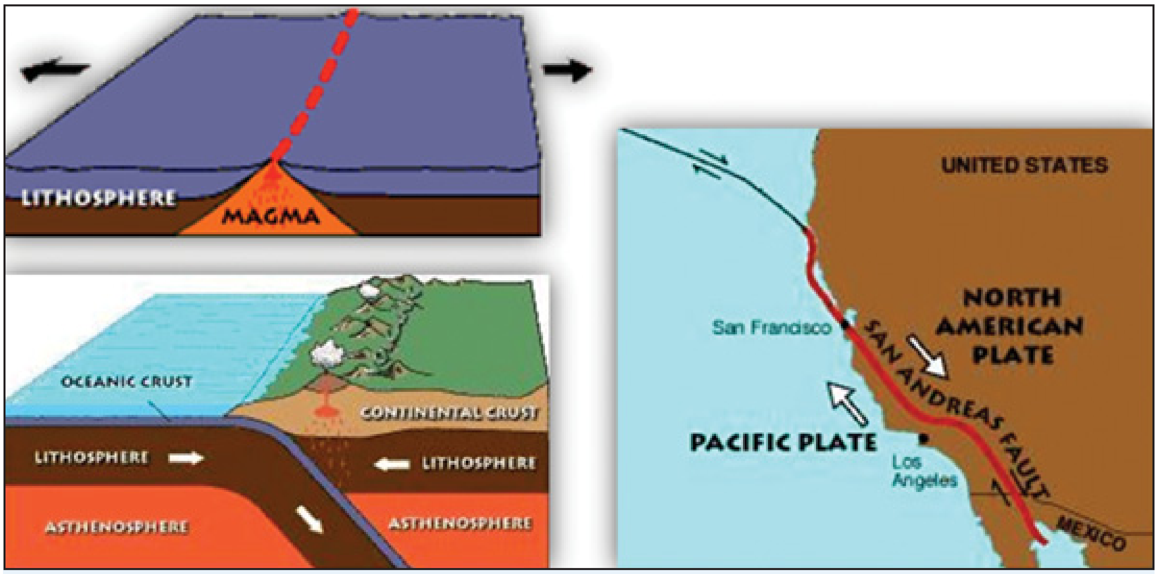
Tectonic plates float on top of the asthenosphere as it flows. However, the asthenosphere is *not* in the liquid state of matter. The asthenosphere is solid, but it has plasticity. *Plasticity* is the condition of a solid that allows it to flow like dough or putty.

Tectonic plates interact at plate boundaries.
Tectonic plates are constantly moving. At different times, some plates move faster than others. However, even the fastest plates move only a few centimeters every year. *Tectonic plate boundaries* are places where the edges of two or more plates interact with each other. Because Earth's plates are all moving at different rates and in different directions, there are different kinds of *tectonic plate boundaries*.

- **Convergent Plate Boundaries:** At convergent plate boundaries, tectonic plates move *toward* each other.
- **Divergent Plate Boundaries:** At divergent plate boundaries, tectonic plates *move away* from each other.
- **Transform Plate Boundaries:** At transform plate boundaries, tectonic plates slide

horizontally past each other in opposite directions.

Below, you can see a diagram of each type of plate boundary. Remember, tectonic plates are made up of Earth's lithosphere, which floats atop the asthenosphere. Some



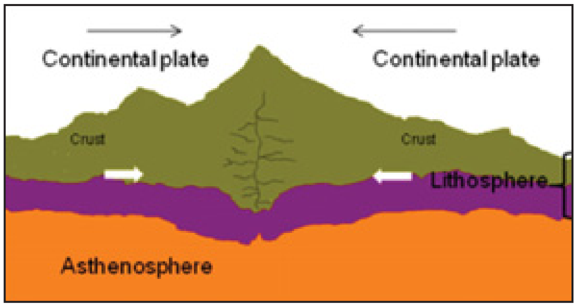
The upper-left diagram shows a divergent boundary. As two tectonic plates move away from each other, molten rock (*magma*) flows between them. The lower-left diagram shows a convergent boundary. As two tectonic plates move toward each other, one plate is forced beneath the other plate. The right diagram shows a transform boundary. The North American Plate is moving slowly southeast, while the Pacific Plate is moving slowly northwest.

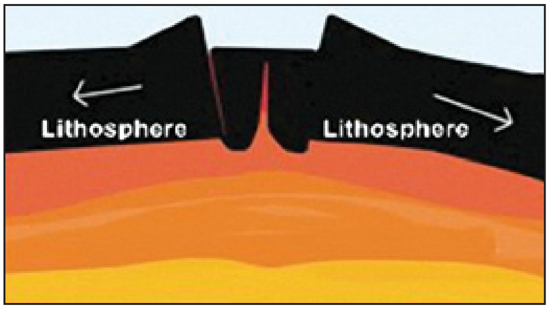
tectonic plates are mainly beneath oceans, while other tectonic plates are mainly beneath continents.

TECTONIC PLATES

what do you think?

These two diagrams show different plate boundaries. Which type of plate boundary does each diagram show? What do you think might be the result of each plate boundary movement?

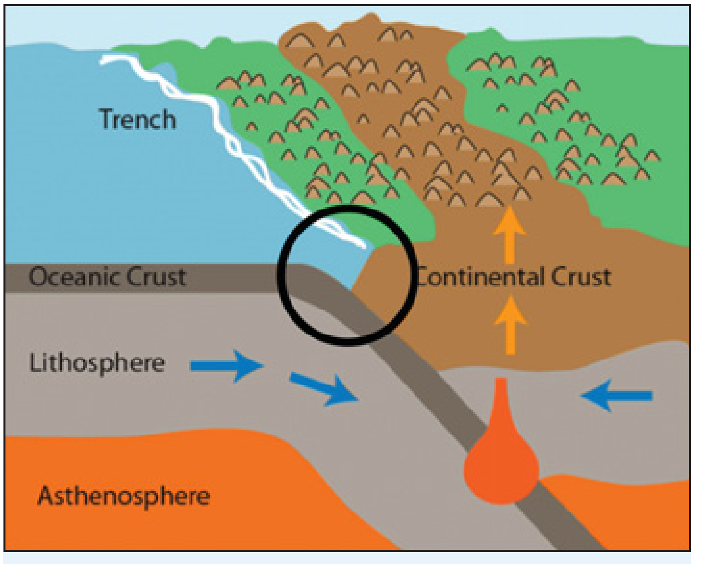




Recycling Earth's Crust

Earth's crust is constantly being recycled. In other words, old crust is forced far beneath Earth's surface, where it melts. At the same time, molten rock at Earth's surface cools and forms new crust. Older crust is melted at special convergent boundaries called *subduction zone*s.

A subduction zone happens where oceanic crust meets continental crust. A subduction zone also happens where oceanic crust on two different plates collides. When the two plates come together, the denser of the two plates is pushed underneath the less dense plate. Oceanic crust is denser than continental crust. Therefore, at a subduction zone between continental crust and oceanic crust, the oceanic crust is always pushed underneath the continental crust. At a subduction zone where two plates of oceanic crust meet, whichever plate is denser is pushed beneath the other plate. Eventually, the bottom plate is pushed far enough into Earth's mantle that it begins to melt. It becomes molten rock that can be recycled back into the mantle.



The circled part of this diagram shows a subduction zone. The denser oceanic crust is pushed beneath the less dense continental crust. A deep valley called a *trench* forms along the subduction zone.

New crust is made at special divergent boundaries called *seafloor spreading centers*. Seafloor spreading occurs at *mid-ocean ridges*. A mid-ocean ridge is made up of two long mountain chains separated by a deep valley in the middle. Two oceanic plates move away from each other on either side of this valley, pulling the ridge apart. As the two plates move away from each other, magma rises up from the mantle in between. When the magma rises up into the valley, it cools and solidifies into new rock. This creates new oceanic crust. The formation of this new crust helps to push the two plates farther apart.

Locating Tectonic Plate Boundaries

When two continental plates come together at convergent boundaries, they push against each other. This can force the crust at the edges of these continental plates upward over time. This pressure can create long mountain chains. Scientists can look for these landforms to help locate the boundaries between tectonic plates. The types of features that scientists find at tectonic plate boundaries can also tell them if the boundary is convergent, divergent, or transform. For example, mid-ocean ridges are found at divergent boundaries.

In addition to landforms and other features, scientists can study geologic events to help locate tectonic plate boundaries. Earthquakes are particularly useful in this way. When tectonic plates push against each other at convergent boundaries or slide against each other at transform boundaries, pressure builds. Eventually, enough pressure builds up and the plates suddenly slip. This sudden release of pressure causes an earthquake.

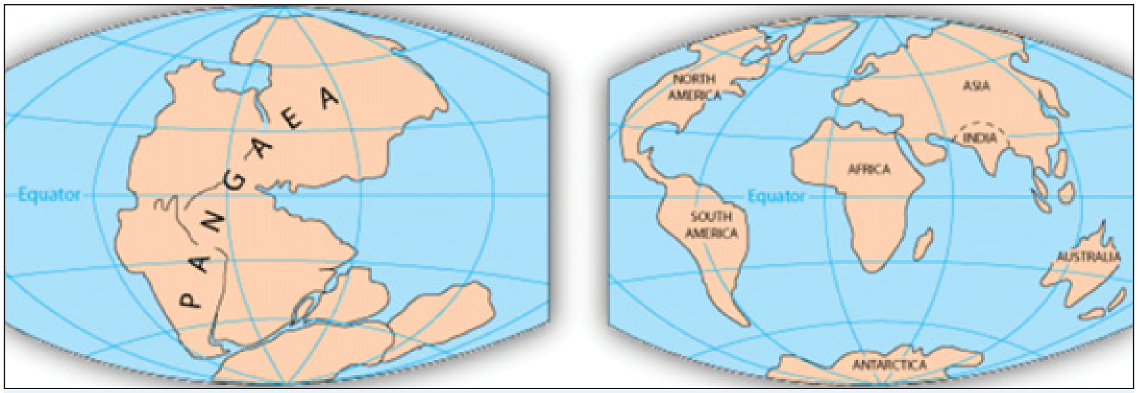
The release of pressure during an earthquake can also allow magma to come up from the mantle. This sometimes results in a volcanic eruption. Volcanoes are also common around subduction zones where converging plates are melting into magma. Volcanoes are another feature scientists can use to help locate and classify tectonic plate boundaries.

Looking to the Future: Supercontinents

The crust beneath Earth's continents is less dense than the crust beneath the ocean. As a result, at subduction zones continental crust is not usually forced deep enough into the mantle to be melted. Instead, the continents move or drift across Earth's surface over time. The continents have not always been in their current locations. If you look closely at a world map, you may start to notice that some of the continents seem like they could fit together like puzzle pieces. That is because at one point, they did! During several periods in Earth's history, some of the continents were so close together they formed larger *supercontinents*. 250 million years ago, *all* of the continents were connected together in one giant supercontinent called *Pangaea*. (Pangaea means "All Earth.")

The continents are still moving today, which means they will not always be in their current locations. Maybe someday—millions of years in the future—they will come together to form another supercontinent!

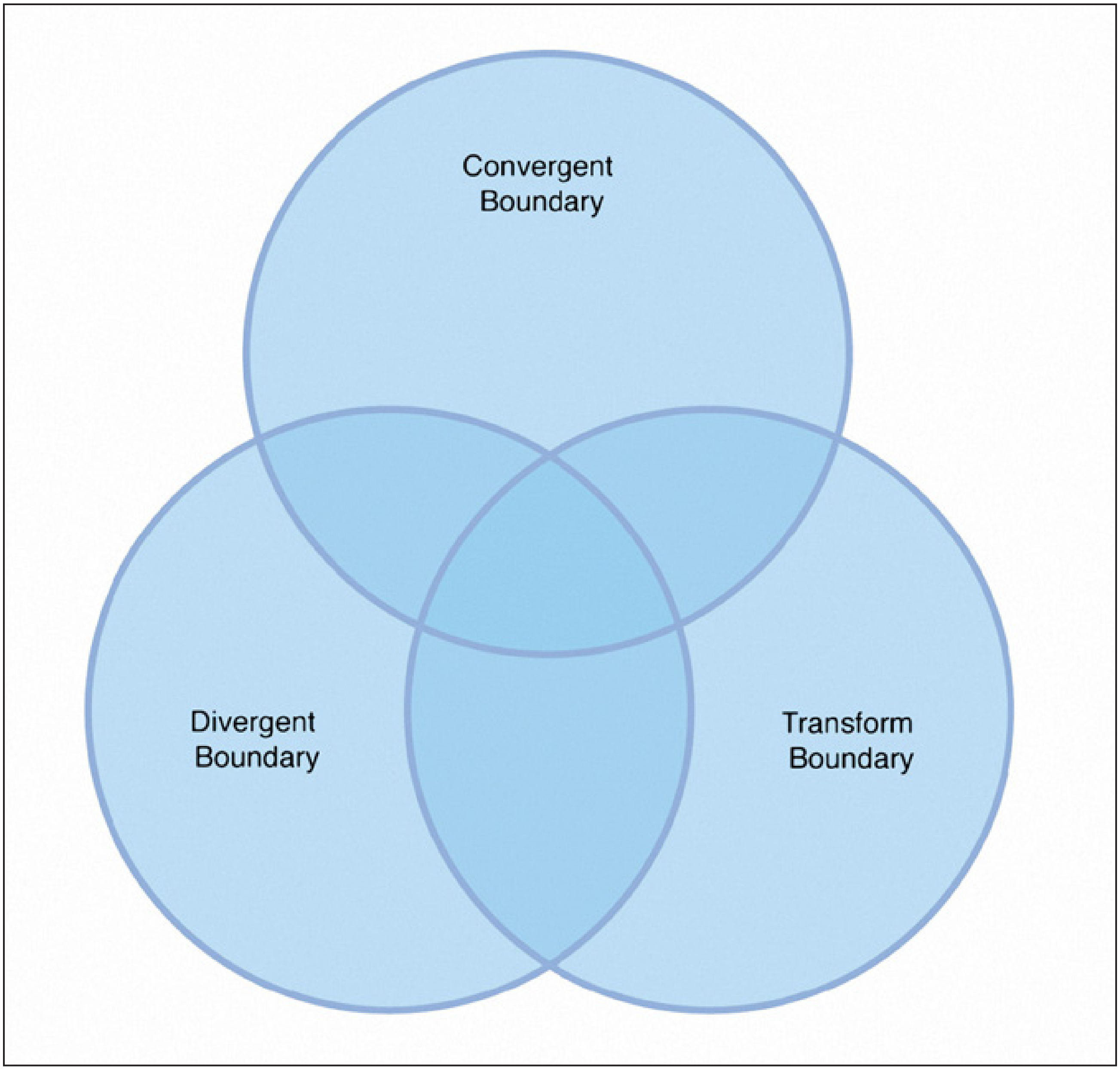
TECTONIC PLATES



About 250 million years ago, all the continents on Earth formed one supercontinent called Pangaea. Can you locate the present-day continents in Pangaea?

What do you know?
Tectonic plates interact at convergent, divergent, and transform boundaries. Read the characteristics of plate boundaries in the box below. Write each characteristic in the correct section of the Venn diagram on the next page. Some characteristics describe more than one type of plate boundary.

Characteristics of Tectonic Plate Boundaries	
• Can create a mountain chain	• Can cause seafloor spreading
• Can create new crust	• Can create a mid-ocean ridge
• Can melt old crust	• Earthquakes often happen here
• Can create a subduction zone	• Plates coming together
• Plates moving apart	• Plates sliding past each other


Convergent
Boundary
Divergent
Boundary
Transform
Boundary

TECTONIC PLATES

connecting with your child

Searching for Tectonic Plate Boundaries

To help your child learn more about tectonic plate boundaries, try examining a world map together. Tectonic plate boundaries are classified as convergent, divergent, and transform. Each type of boundary is defined by the relative motion of tectonic plates.

Convergent plate boundaries are boundaries where tectonic plates come together. When two continental plates come together, mountain chains will often form on the land along these boundaries. Where continental and oceanic plates come together, there will often be volcanoes caused by the melting of subducting plates.

Divergent plate boundaries are boundaries where tectonic plates move away from one another. At divergent boundaries, new crust is made on the seafloor, creating mid-ocean ridges. Mid-ocean ridges are composed of underwater mountain chains that are separated by a central rift valley along the seafloor. The most famous of these is the Mid-Atlantic Ridge.

Transform plate boundaries are boundaries where tectonic plates slide horizontally against each other in opposite directions. Pressure builds along these boundaries due to the friction between the plates. When this pressure is released, it can cause major earthquakes. The San Andreas fault in California is a transform boundary.

Examine a world map with your child. Take a close look at any landforms your child notices. Discuss any observations your child makes about the landforms, paying particular attention to mountain chains. Although it may not be possible to locate actual plate boundaries on a typical map, have your child explain where they think some boundaries are likely located. In addition, look at the shapes of the continents. Ask your child to examine the ways the continents may once have fit together like a puzzle and to explain where the continents may have been connected to form supercontinents.

Here are some questions to discuss with your child:

- What geologic features do you see on this map (e.g., mountain chains, volcanoes)?
- Where do you think there might be a plate boundary? How do geologic features support this?
- What kind of plate boundary do you think it is?
- Do you see any places where the continents may have fit together?