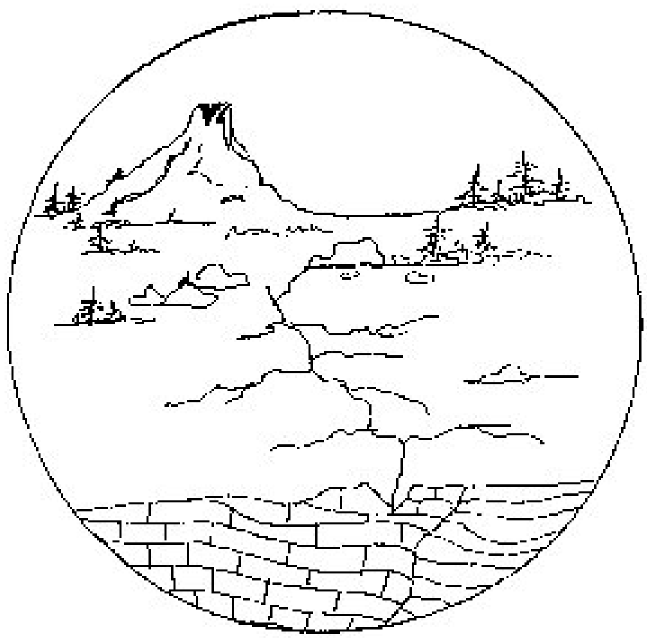
Plate Tectonic Cycle

Earth's Moving Force

SECOND GRADE

PLATE TECTONICS



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE
OVERVIEW OF SECOND GRADE

VOLCANOES

WEEK 1.
PRE: *Investigating the parts of a volcano.*
LAB: *Comparing the parts of a volcano to different types of models.*
POST: *Discovering that volcanoes occur around the world.*

EARTHQUAKES

WEEK 2.
PRE: *Discovering earthquake faults.*
LAB: *Tracing a fault map of the San Francisco Bay Area.*
POST: *Exploring how deep you can drill into the Earth.*

PLATE TECTONICS

WEEK 3.
PRE: *Exploring how the Earth's outermost portion moves.*
LAB: *Exploring the results of movement on the Earth's crust.*
POST: *Exploring how plates have moved through time.*

HAZARDS

WEEK 4.
PRE: *Discovering how to think during an earthquake.*
LAB: *Assessing what a mayor should do during strong, moderate, and weak earthquakes.*
POST: *Analyzing earthquake safety at home.*

PLATE TECTONIC CYCLE - PLATE TECTONICS (2)

PRE LAB

Students experiment with convection.

OBJECTIVES:

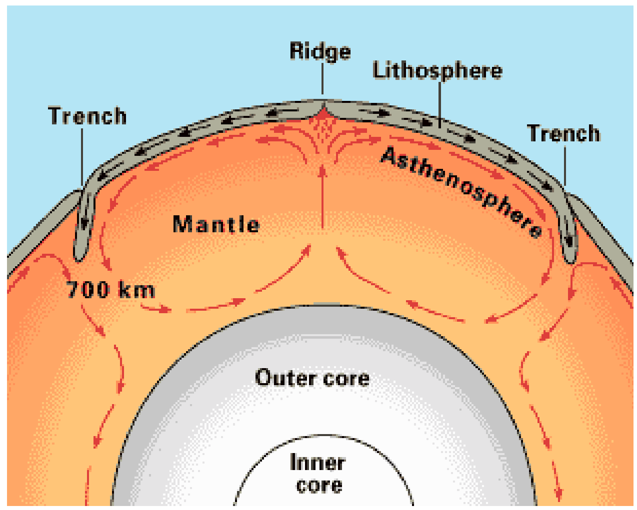
1. Exploring why the Earth's outermost portion moves.
2. Introducing the concept of convection currents.

VOCABULARY:

convection
core
crust
mantle

MATERIALS:

pan (optional)
water
hot plate
ladder



This picture shows convection of the whole mantle. It make actually happen on a smaller scale

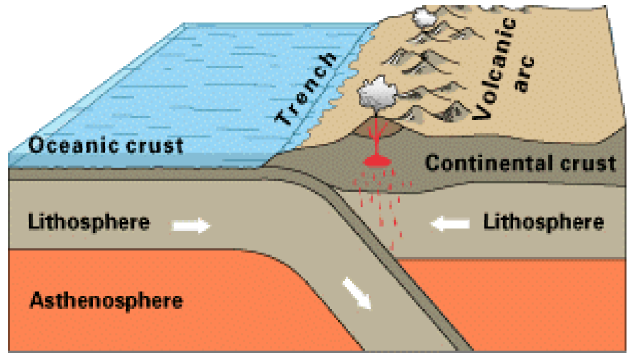
BACKGROUND:

Understanding the movement and behavior of the Earth's outermost layers has been a painstakingly long scientific process. The theory of plate tectonics is our current “best explanation” and working model for answering these questions. Plate tectonic theory has developed slowly and progressively since it was developed in the 1960s. It is a theory that truly has the entire world as its experiment.

According to the theory of plate tectonics, the Earth's crust and upper mantle are broken into moving plates of "lithosphere." The lithospheric plates are solid rock. There are several very large plates, each consisting of both oceanic and continental portions. There are a dozen or more smaller plates. The plates average about 80 kilometers (50 miles) in thickness.

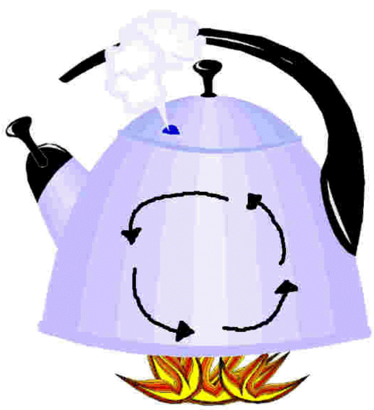
All of the plates are moving. They are slow, moving at speeds of centimeters to tens of centimeters per year. They slide along on top of an underlying mantle layer called the asthenosphere, which contains a little magma (molten rock). Many types of evidence indicate that the plates move.

Many lines of evidence indicate that the plates are moving. What is less clear, however, is why the plates move. There are two main scientific ideas for explaining plate movement: gravity and convection currents. All objects on and in the Earth are pulled towards its center by the force of gravity. This may affect the plates at converging plate boundaries in areas called subduction zones, where one plate sinks into the mantle. Some evidence suggests that gravity pulls the sinking plate down. The rest of the plate is dragged along behind it. This is physically similar to slowly pushing a piece of paper off a table; it eventually bends, and slides off, pulling the rest of the paper behind it. The other reason for plate motion relates to convection currents within the upper part of the mantle.



Gravity at this subduction zone pulls the plate down.

Convection is the heat-driven circulation of a fluid. In the mantle, heat from deeper in the Earth causes the overlying mantle to circulate. The mantle can circulate because it contains a little magma (molten rock); it behaves like a very hot mush. Mantle convection currents move very, very, slowly. It is possible that as the mantle convects, it drags the overlying plates along with it. It is likely that both convection and gravity contribute to the movement of the plates.

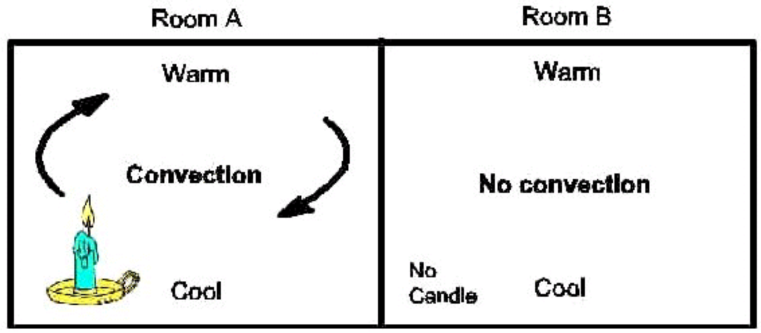


This unit introduces the importance of convection currents into the overall concept of plate tectonics. Convection currents are common in everyday life. Water that is put over a hot stove heats by convection. The water closest to the heat source becomes less dense and rises. The water that is cooler and on top will sink to the bottom. This sinking of the denser fluid and rising of the less dense fluid causes movement in a circular motion as shown in the diagram below; this is convection.

PROCEDURE:

1. Explain the physical basis of convection currents to the students. Explain that it may be a force responsible for moving the plates.

You may wish to demonstrate convection to the class with a glass pan, water, and a hot plate. Another way to demonstrate this is to get a ladder and have the students take turns "feeling" the temperature of the air near the floor of the room, then near the ceiling. It is warmer near the ceiling because warm, buoyant air rises, just like warm buoyant rock rises inside the Earth.



2. Draw the diagram on the board. Ask the students in which room the air will circulate by convection currents. Emphasize that in room A, the difference in temperature caused by the candle will help circulate the air by convection. Ask the students in which directions they air will circulate. Warm air will rise, cool down and move to the left. When the air cools it will then descend.

3. Remind the students that a similar process goes on in the Earth's mantle. Emphasize that convection currents, in a room and in the Earth's mantle, are not just arrows, but are large three dimensional movements.

PLATE TECTONIC CYCLE - PLATE TECTONICS (2)

LAB

Students reconstruct the super continent Pangaea.

OBJECTIVES:

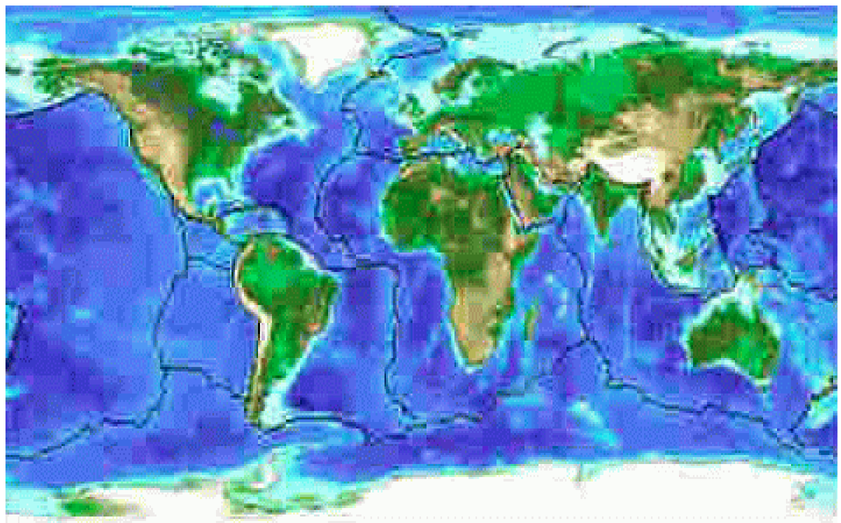
1. Exploring the results of movement on the Earth's crust.
2. Discovering that the physical fit of continents is one piece of evidence.

VOCABULARY:

continents
plate tectonics
stress

MATERIALS:

worksheet
crayons
scissors
world map for reference

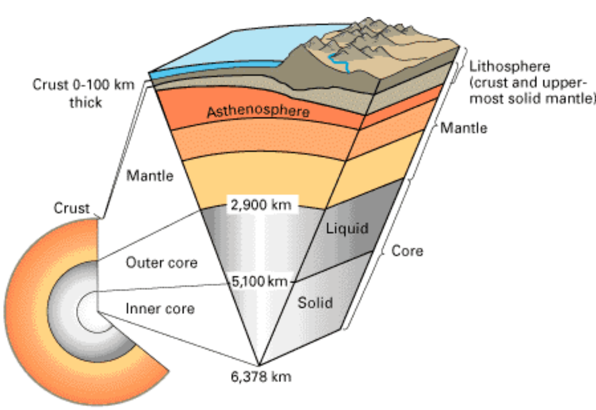


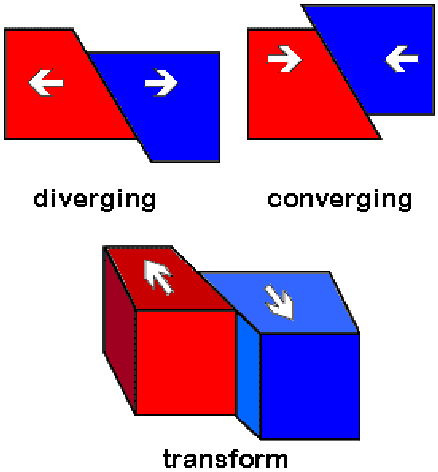
A map of the plates

BACKGROUND:

According to the theory of plate tectonics, the Earth's crust and upper mantle are broken into moving plates of "lithosphere." The Earth has two types of crust. Continental crust underlies much of the Earth's land surface. The ocean floors are underlain by oceanic crust. These material have different compositions; the continental crust is like the igneous rock granite, and the oceanic crust is like basalt, another igneous rock.

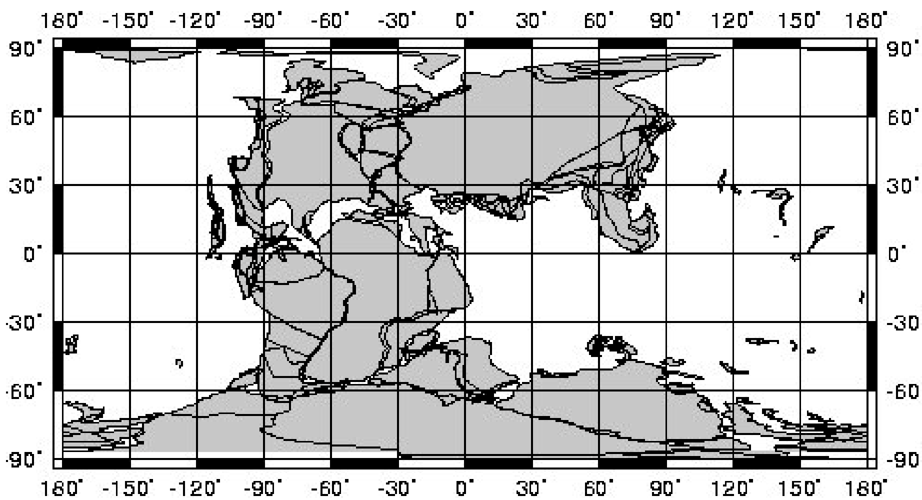
Students and many adults often equate the geographic continents, i.e., land, with the plates. This is incorrect. The Earth's various units of continental crust are actually embedded into plates. You may wish to explain this to your students by saying that the continental crust "ride on the back" of a plate. Moreover, continental and oceanic crust are often part of the same plate. For example, the North American plate has continental crust (essentially the land area of North America) at its core and is surrounded on most sides by oceanic crust.





As they move, plates interact at their edges or boundaries. There are three basic directions or types of boundary interactions. In some places, two plates move apart from each other; this is called a diverging plate boundary. Elsewhere two plate move together, which is called a converging plate boundary. Finally plates can also slide past each other horizontally. This is called a transform plate boundary. Volcanoes and earthquakes help define the boundaries between the plates. Volcanoes form mostly at converging and diverging plate boundaries, where much magma is generated. Earthquakes occur at all three types of boundaries. Because the plates are rigid, they tend to stick together, even though they are constantly moving. This builds up stress in the rocks at the plate boundary. When the strength of the rocks is exceeded, they move rapidly, "catching up" with the rest of the plates. We feel this release of energy as an earthquake.

One of the first observations used to suggest that the outer portion of the Earth is mobile is the fit of the continents, particularly the west coast of Africa against the east coast of South America. This observation predates plate tectonics. It was first noticed in the 18th century, and most recently proposed by a German scientist, Alfred Wegener in 1912. Wegener called his theory "continental drift", referring to the apparent movement of continents alone. However, "continental drift" is a only historical term. We now know it is not the continents that move, but the plates, in which the continents are embedded. South America and Africa were once together, but were split apart by the formation of a diverging plate boundary. This is also confirmed by matches between the rocks and fossils of the two continents. The two continents are still moving away from each other today.



A map of Pangaea shortly after it began to split, 160 million years ago.

This exercise looks at the continents of North America, South America, Africa, Antarctic, and Australia, and how they have moved over the last 200 million years. At that time, these five continents were all part of a single large super continent, called Pangaea. Starting about 180 million years ago, Pangaea began to break up; new diverging plate boundaries formed within it. This eventually created the continents we see today. In this exercise, the students will reconstruct Pangaea. They will use the fit of the continental crust to put Pangaea back together.

PROCEDURE:

1. Remind the students of the information they learned in the Pre Lab. Explain again that the plates are moving, due to convection and gravity. Explain that this movement causes stress within the plates, which generates earthquakes and volcanoes. You may want to show students a map of the plates.

2. Review the composition of the plates with the class. Make sure the students understand that the continents make up the non-oceanic part of the crust. Discuss with them that the edges of the continents look as if they may have fit together at one time.

3. Have the students label, color, cut out, and fit the continents together. The lines and numbers make this puzzle a little easier. You may want your students to work in pairs. Matching up the continents is not as easy as it looks.

4. Once the students have placed the continents together have them move the pieces apart very slowly. They are to move the pieces until they reach their present positions.

5. Ask students if they think this movement could have happened. Let them come up with stories about why it took place. Remind them of convection and the moving of the plates. This is a difficult concept to get across to the students.

PLATE TECTONIC CYCLE - PLATE TECTONICS (2)

LAB

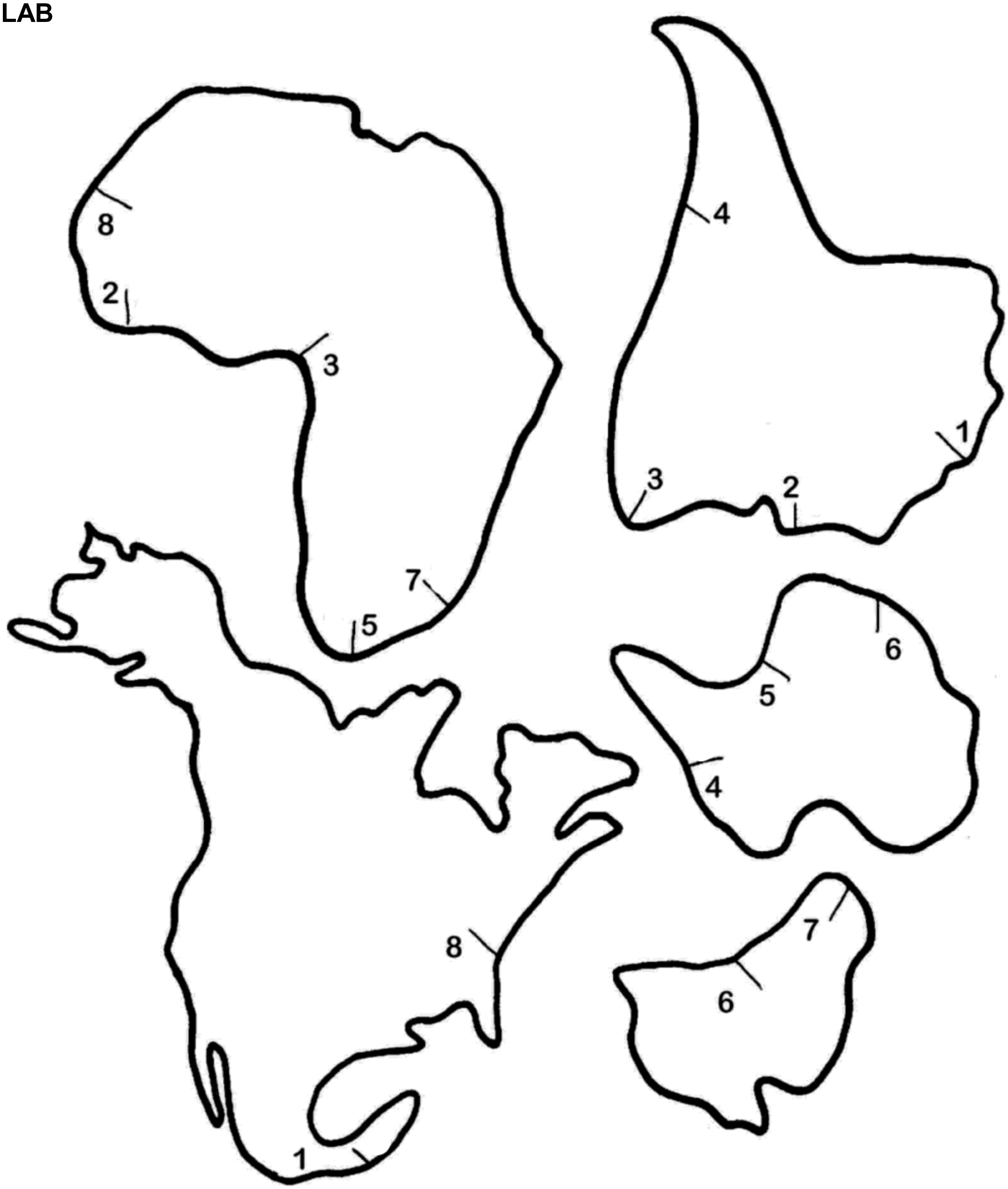


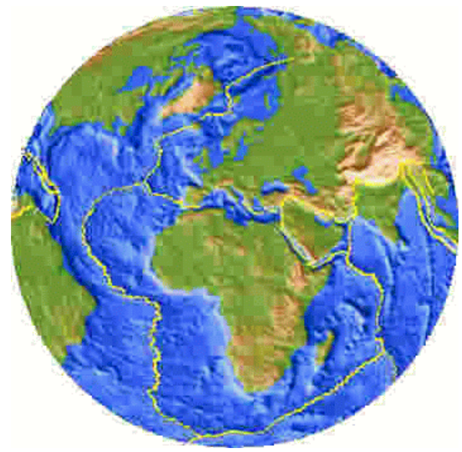
PLATE TECTONIC CYCLE - PLATE TECTONICS (2)

Students locate plate boundaries using earthquakes and volcanoes.

POST LAB

OBJECTIVES:

1. Exploring how the plates have moved through time.
2. Comparing volcanoes and earthquakes to the boundaries of plates.



VOCABULARY:

continents
earthquakes
time
volcanoes

MATERIALS:

worksheet

BACKGROUND:

Plate boundaries are marked by numerous volcanoes and earthquakes. The pattern of occurrence of these events is one of the key pieces of evidence for plate tectonics.

In this exercise, the students will examine the pattern of earthquakes and volcanoes at occur in the Atlantic Ocean. Most of these occur at the diverging plate boundary that runs north-south through the ocean. The remainder are at two east-west running transform and converging plate boundaries that goes through the Mediterranean Sea to the east and the Caribbean Sea to the west.

The diverging plate boundary occurs at an underwater mountain range called the Mid-Atlantic Ridge. The center of this mountain range is a low lying area or rift, called the Atlantic Rift Zone. This is the actual plate boundary, and is where most of the earthquakes and volcanoes take place. The shape of this plate boundary mimics the shapes of the continents on either side of it, especially Africa and South America, because these areas of crust were together before the diverging plate boundary formed.

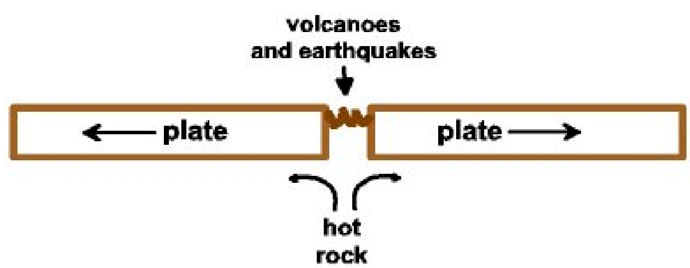
PROCEDURE:

The point of the exercise is for students to see that earthquakes and volcanoes mark the plate boundaries, and that the shapes of the diverging boundaries match the edges of the areas from which they formed.

1. Tell the students that earthquakes and volcanoes occur within the dotted areas on the worksheet. Make sure that they notice that the continents are not near these boundaries in most places, especially North America, South America, and Africa.

Tell the students to trace the boundaries of the moving plates by connecting the dots. Ask them if they recognize any connections or patterns between the fit of the continents and the position of the earthquakes and volcanoes. Hopefully they can see that the pattern of earthquakes and volcanoes mimics the edges of the continents. especially between South America and Africa. Tell them that this pattern marks the diverging plate boundary from which these continents, as well as Europe and North America, have split.

2. Explain to the students that in the Atlantic Ocean this zone of volcanoes and earthquakes is similar to the fit of the continents. Tell them it is called the Atlantic Rift Zone. You may wish to show them maps of the ocean floor and plate boundary.



3. Draw the diagram. Ask your students to explain what they think will happen if the mantle convection currents pull in opposite directions. Explain that the hot rock will come up and form volcanoes. Ask them where in the Atlantic Ocean area the volcanoes are located. The volcanoes are under the ocean, on the sea floor. Iceland is an exception: here the volcanoes are on land. You may wish to show them the presentation image of the Atlantic Ocean region below. It shows the Mid Atlantic Ridge clearly.

PLATE TECTONIC CYCLE - PLATE TECTONICS (2)

POST LAB