

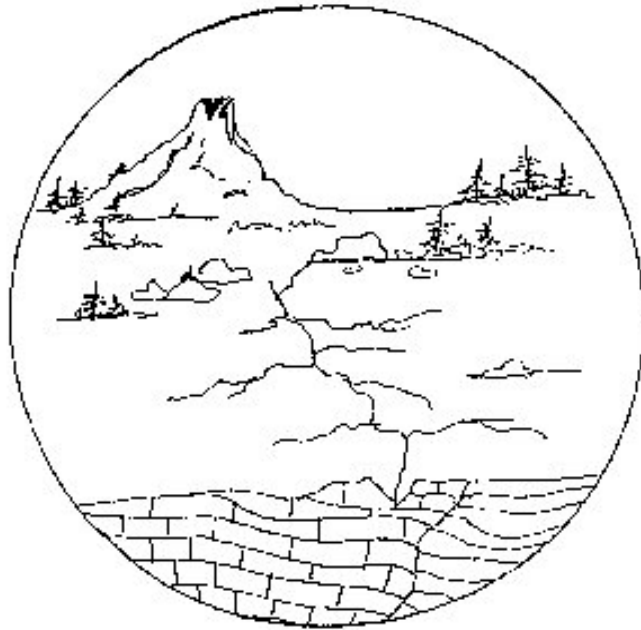


Plate Tectonic Cycle

Earth's Moving Force



FOURTH GRADE PLATE TECTONICS



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE OVERVIEW OF FOURTH GRADE

VOLCANOES

WEEK 1.

PRE: *Comparing different structures of volcanoes.*

LAB: *Modeling three types of volcanoes.*

POST: *Illustrating a volcanic eruption.*

EARTHQUAKES

WEEK 2.

PRE: *Comparing the Richter and Mercalli scales of earthquake measurement.*

LAB: *Testing how different shapes react during an earthquake.*

POST: *Describing a seismogram.*

PLATE TECTONICS

WEEK 3.

PRE: *Distinguishing the different layers of the Earth.*

LAB: *Observing the effects caused by plate movements.*

POST: *Exploring the reason for earthquakes and volcanoes.*

HAZARDS

WEEK 4.

PRE: *Exploring about structural damage caused during an earthquake.*

LAB: *Comparing structural damage caused by earthquakes.*

POST: *Contrasting the Richter and Mercalli scales.*

PLATE TECTONIC CYCLE - PLATE TECTONICS (4)

PRE LAB

Students calculate the thickness of the Earth's internal layers.

OBJECTIVES:

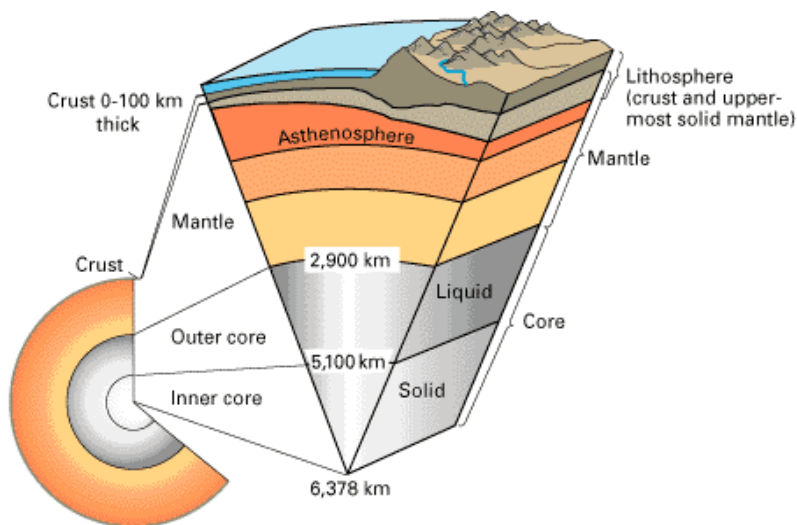
1. Exploring the meaning of Plate Tectonics.
2. Distinguishing the different layers of the Earth.

VOCABULARY:

converging
crust
diverging
inner core
mantle
outer core
plate tectonics
transform

MATERIALS:

worksheet
metric rulers



BACKGROUND:

Geologists have distinguished three main internal subdivisions of the Earth, based on the behavior of seismic waves and laboratory experiments. These divisions are based on the composition of each layer. The outermost layer is the crust. The Earth has two types of crust. Continental crust underlies much of the Earth's land surface and is what we live on. The ocean floors are underlain by oceanic crust. These materials are composed of different kinds of minerals. The continental crust is like the igneous rock granite, and the oceanic crust is like basalt, another igneous rock.

Underlying the crust is the second layer, the mantle. It comprises the largest portion of the Earth. Like the crust, it is also composed of silicate minerals. The innermost portion of the Earth is the core. It is composed of metallic elements, primarily iron and nickel. The core is subdivided into two parts. The outer core is liquid metal, while the inner core is solid.

The plates are composed of the crust and the uppermost part of the mantle. These two layers are often called the lithosphere because they are both composed of solid rock. The underlying, partially molten part of the mantle, on which the plates slide, is called the asthenosphere. In contrast to the crust-mantle-core division, which was based on

composition, the lithosphere and asthenosphere are separated based on strength. The lithosphere is strong, rigid rock, while the asthenosphere is a weaker, very viscous fluid.

Students have learned that the locations of earthquakes and volcanoes provide clues (or data) that help understand plate tectonics. The causes of these movements are complicated, but at this level students should begin to recognize that some of the stresses come from within the Earth. In particular, one reason for the movement of the plates may be convection currents within the upper part of the mantle. 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 upper mantle can circulate because it contains a little magma (molten rock) and 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 possible that as the mantle convects, it drags the overlying plates along with it. Where convection currents come together, a converging plate boundary is present. Where they move apart, a diverging plate boundary forms.

PROCEDURE:

1. Show students how geologists divide the interior of the Earth. Make sure you go over the vocabulary and contrast lithosphere and asthenosphere with the crust, mantle and core. Draw a picture on the board of the different divisions.

2. On the worksheet, have the students label and color in each layer of the Earth. Next, instruct students to measure the thickness of each of the unit in millimeters and record their answers. Finally, have them calculate the approximate thickness of each layer.

ANSWERS (Please note that these figures are simplified. The amount calculated by scientists is written in parenthesis.) 1. crust: 1mm/82 km (71 km); 2. mantle: 37mm/3034 km (2900 km); 3. outer core: 26mm/2132 km (2300 km); 4. inner core: 14mm/1148 km (1200 km).

PLATE TECTONIC CYCLE - PLATE TECTONICS (4) - PRE LAB

LABEL: CRUST, MANTLE, OUTER CORE, INNER CORE

What is the thickness of the:

CRUST	_____mm X 82 km = _____km
MANTLE	_____mm X 82 km = _____km
OUTER CORE	_____mm X 82 km = _____km
INNER CORE	_____mm X 82 km = _____km

TOTAL THICKNESS OF THE EARTH = _____km

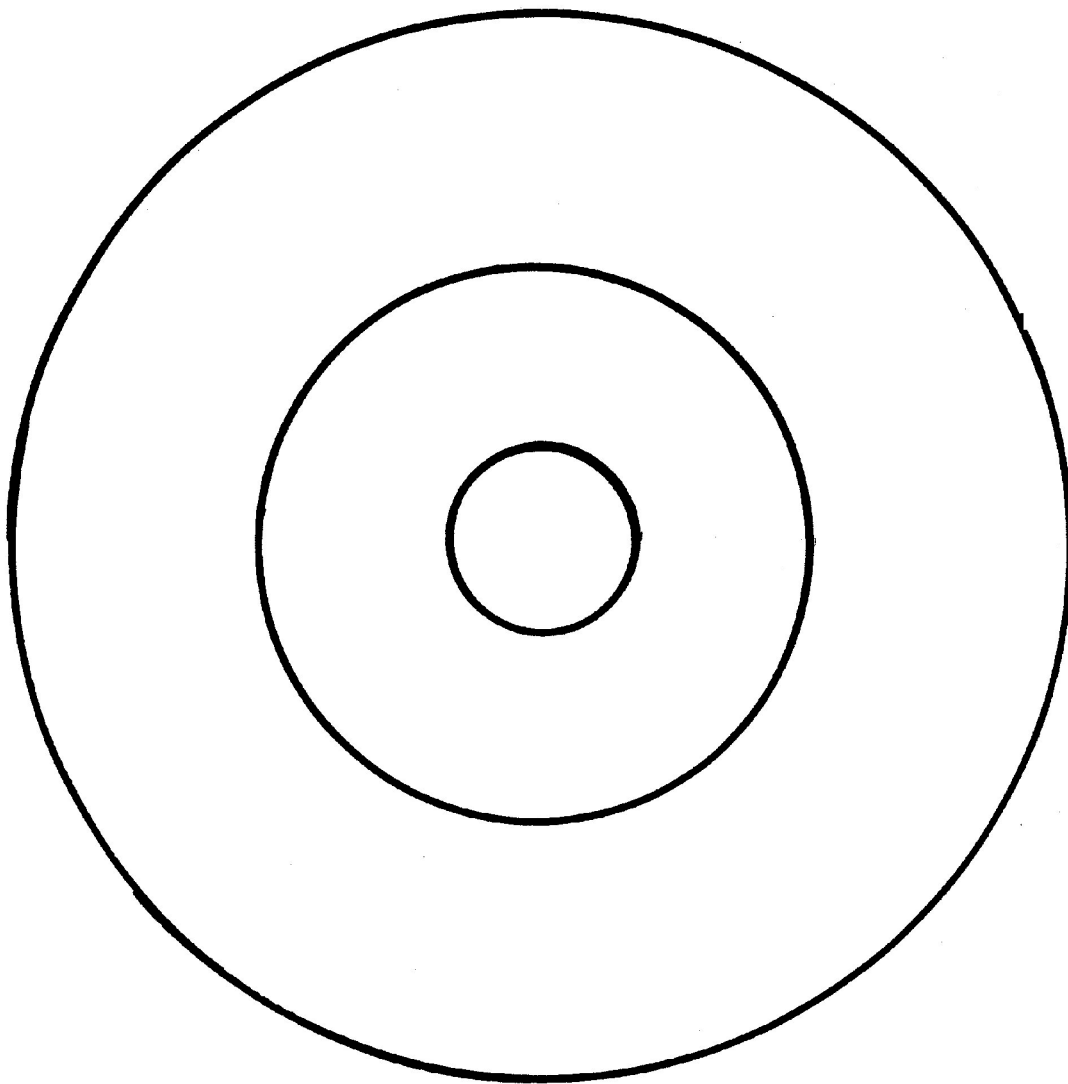


PLATE TECTONIC CYCLE - PLATE TECTONICS (4)

LAB

Students explore plate boundary motions and predict geologic events.

OBJECTIVES:

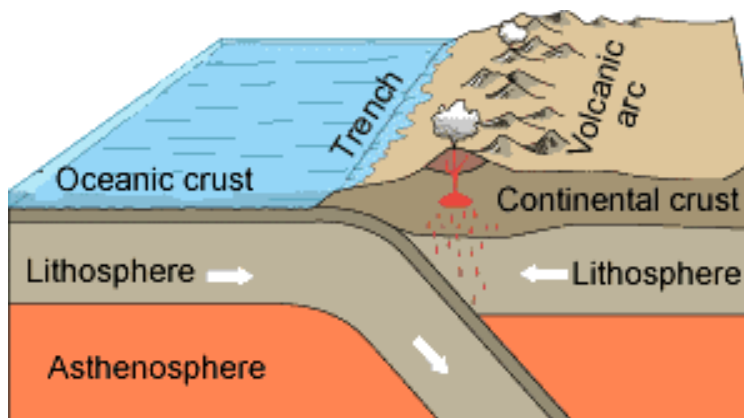
1. Exploring plate movements.
2. Observing the effects caused by plate movements.

VOCABULARY:

converging plates
diverging plates
transform movement

MATERIALS:

sand
clay
wax paper
box



A converging plate boundary - the plate on the left subducts under the right hand plate.

BACKGROUND:

Using a variety of instruments, geologists have measured the directions and rates of plate movement at the surface of the Earth. They have found that plates move in three basic ways. In some places, two plates move apart from each other; this is called a diverging plate boundary. Elsewhere two plates move together; this is a converging plate boundary. Finally plates can also slide past each other horizontally. This is called a transform plate boundary.

All of the plates move slowly. Their speeds vary from a few millimeters per year to a maximum of 15 centimeters per year. On average, the plates move about as fast as human fingernails grow.

Volcanoes and earthquakes help define the boundaries between the plates. Earthquakes occur at all three types of boundaries. Because the plates are rigid, they tend to stick together, even though they are constantly moving. When the strength of the rocks at the plate boundary is exceeded, they move rapidly, "catching up" with the rest of the plates. We feel this release of energy as an earthquake. At diverging plate boundaries, earthquakes occur as the plates pull away from each other. Volcanoes form between the plates, as magma rises upward from the underlying mantle. Two situations are possible at converging plate boundaries. First, only earthquakes occur when two plates collide (obduct), building a mountain range. Second, both volcanoes and earthquakes form where one plate sinks under the other, instead of colliding. This process

is called subduction. Transform plate boundaries commonly have only earthquakes.

PROCEDURE:

1. Review the interior structure of the Earth with the class. Make sure that they also understand that the plates are composed of the crust and uppermost mantle - the lithosphere. In Exercise I below, the students will draw the basic internal structure of the Earth.

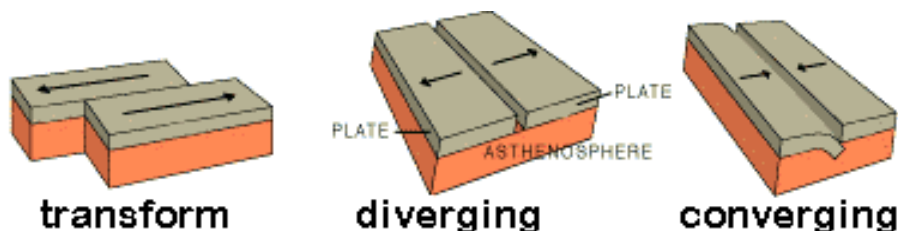
2. In Exercise II, the students will simulate plate motions at each type of plate boundary. Have the students imagine that they are “Mother or Father Earth,” who are feeling the pain of the moving Earth. As they move the sand or clay, have them try to capture the slowness of movements in the real Earth. We use clay and sand to represent the many types of rocks that make up the plates, as well as the Earth's surface. Here are some guidelines for Exercise II:

A. The slower the students do this exercise the better their results will be. They will form parallel “mountains” by compressing and sliding the sand or clay. At transform boundaries, mostly earthquakes are produced; any mountains will be very small.

B. Diverging plate motion is difficult to show. Make sure that you use a tub of sand that is large enough for the students to be able to move their hands in it. If done slowly, the students will realize that you cannot pull the earth apart without the “tear” replacing itself with “lava,” here represented by sand. Diverging plate boundaries thus produce both earthquakes and volcanoes.

C. Converging plates will produce mountain chains. In this case, you will get earthquakes.

3. Conclude with the class that plate motions are associated with earthquakes and volcanoes. Explain that scientists (geologists) use plate tectonics to explain the movement of the Earth's crust. Illustrate the three different crust movements on the chalkboard and a wall map to point out some of the boundaries.



ANSWERS:

A. Transform: clay: cracks in clay, sand: valleys and hill; model of San Francisco area, San Andreas Fault

B. Diverging: forms mountains, volcanoes; example Iceland

C. Converging: clay forms mountains and valleys that are parallel; sand forms same structural form; example: parts of California's Coast Ranges
Conclusion: (1) B; (2) A, B, C; (3) B

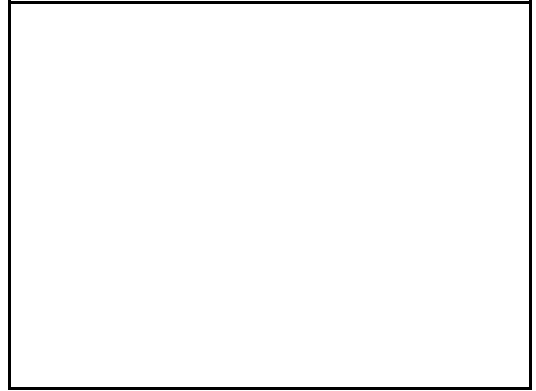
PLATE TECTONIC CYCLE - PLATE TECTONICS (4) LAB

PROBLEM: When the crust of the Earth moves what does it create?

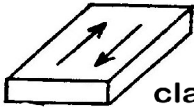
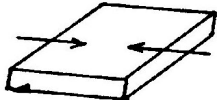
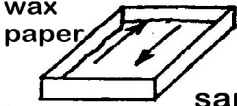
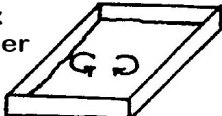
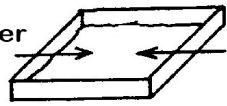
PREDICTION: _____

EXERCISE I. Draw the inside of the Earth.
Label the crust, mantle, inner core, outer core.

EXERCISE II. Using either a piece of clay or wax paper and sand, try to recreate the three types of pressure that occur in the plates. Try to imagine if earthquakes or volcanoes would occur in each. Do the experiment **slowly**. Describe what happens in the space



MATERIALS: box, slab of clay, sand, wax paper

A	B	C
 clay	do not use clay	 clay
 wax paper sand	 wax paper sand	 wax paper sand
TRANSFORM	DIVERGING	CONVERGING

CONCLUSION:

Which situations create volcanoes? _____

Which situations create earthquakes? _____

Which situation creates both earthquakes and volcanoes? _____

PLATE TECTONIC CYCLE - PLATE TECTONICS (4)

POST LAB

Students explore geologic events at converging plate boundaries.

OBJECTIVES:

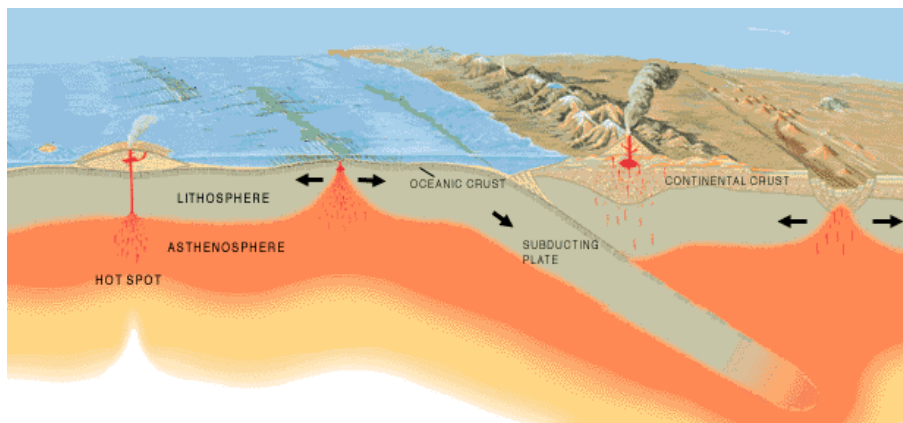
1. Exploring the reasons for earthquakes and volcanoes.
2. Discovering how converging plates can create volcanoes.

VOCABULARY:

converging
diverging
subduction
transform

MATERIALS:

worksheet



BACKGROUND:

Most earthquakes and volcanoes occur because of the movement of the plates, especially as plates interact at their edges or boundaries. At diverging plate boundaries, earthquakes occur as the plates pull away from each other. Volcanoes also form as magma rises upward from the underlying mantle along the gap between the two plates. We almost never see these volcanoes, because most of them are located on the sea floor.

At converging plate boundaries, two situations are possible. First, both volcanoes and earthquakes form where one plate sinks under the other. This process, called subduction, takes place because one plate is denser than the other. The denser plate, which invariably has oceanic crust on its top, does the sinking. Second, only earthquakes occur when two plates collide (obduct), building a mountain range. The density of continental crust is too low for it to subduct, like wood floating on water. Instead, the two plates have a head on collision - building a mountain range. The Himalaya Mountains in Asia formed this way, from a collision between the Indian and Asian Plates. At transform plate boundaries, the two plates slide by each other. This generates little volcanic activity (there is no "gap" between the plates) or mountain building. Earthquakes, however, are common.

Much magma is generated at a converging plate boundary where subduction is occurring. The sinking plate melts as it descends into the asthenosphere; this generates magma, which rises through the other plate to form volcanoes. As it rises, more melting takes place in the rocks it travels through, generating yet more magma.

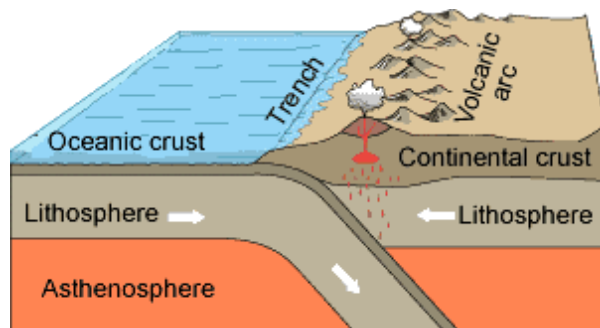
The volcanoes that form in areas of subduction form linear volcanic ranges. The

Cascade Range in the Pacific Northwest of the United States is a good example. The volcanoes Mt. Lassen, Mt. Shasta, Mt. St. Helens, Mt Hood, and many others are all part of this chain. They have formed, and continue to erupt, as a small plate subducts underneath the North American Plate.

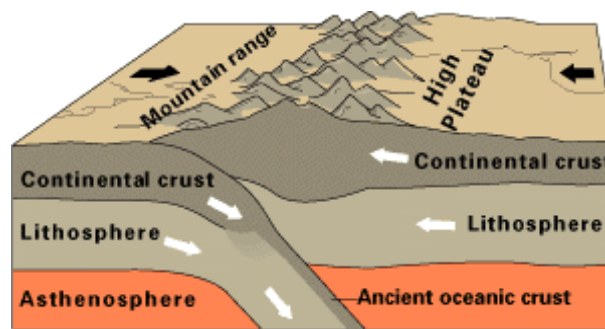
PROCEDURE:

1. Review the three types of plate boundary motions with the class. Emphasize that a plate has different pressures on it in different places. These may create a volcano, an earthquake, or both. You can make the analogy that people burp because they have pressures inside them... well, the Earth has pressure inside too! The Earth spells relief ... EARTHQUAKE or VOLCANO!

2. Introduce the students to the concepts of subduction and collision (obduction). Draw the pictures on your board. You may wish to explain these motions in terms of “stronger” and “weaker” plates. The “weaker” plate is the one that is subducted. If both plates are the same strength, a collision is more likely. Note that the word “obduction” is somewhat out-of-date among geologists; they use collision instead. However, we have found that students really like the word “obduction,” so you may want to introduce both terms.



A converging plate boundary where subduction occurs.

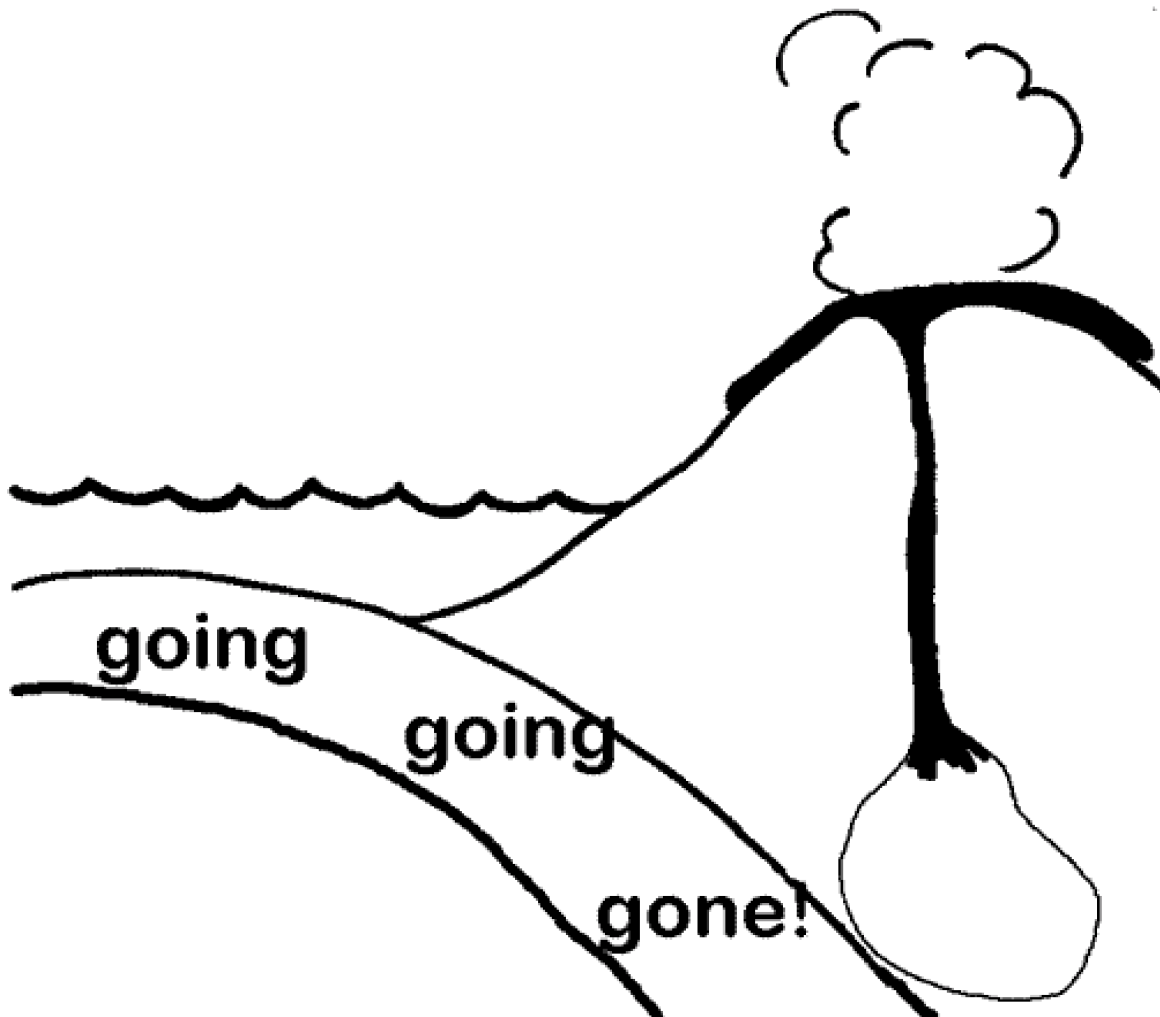


A converging plate boundary showing collision (obduction) and mountain range formation.

3. Have the students complete the worksheet.

PLATE TECTONIC CYCLE - PLATE TECTONICS (4) POST LAB

WHERE CAN YOU LOCATE MELTED ROCK?



LABEL THIS AREA AS "MELT" ON YOUR DIAGRAM.

LABEL THE AREA WHERE EARTHQUAKES
CAN OCCUR WITH AN "X."

HOW CAN A VOLCANO BE CREATED?
