

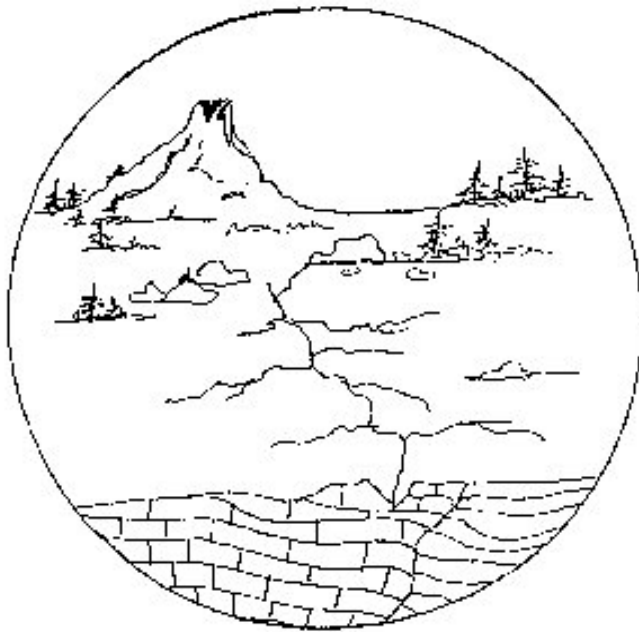


Plate Tectonic Cycle

Earth's Moving Force

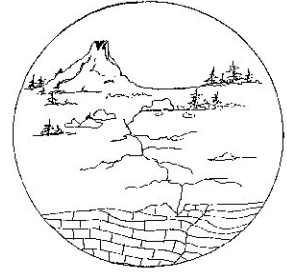


THIRD GRADE PLATE TECTONICS



1 WEEK
LESSON PLANS AND
ACTIVITIES

PLATE TECTONIC CYCLE OVERVIEW OF THIRD GRADE



VOLCANOES

WEEK 1.

PRE: *Explaining why there are many types of volcanic rocks.*

LAB: *Comparing rocks from different volcanoes.*

POST: *Learning that volcanoes produce different types of rocks.*

EARTHQUAKES

WEEK 2.

PRE: *Discovering that earthquakes produce energy.*

LAB: *Observing different energy experiments.*

POST: *Learning that pressure inside the Earth causes earthquakes.*

PLATE TECTONICS

WEEK 3.

PRE: *Dividing the earth into layers.*

LAB: *Discovering how the earth's crust creates plates.*

POST: *Explaining how plates have moved through time.*

HAZARDS

WEEK 4.

PRE: *Discussing different volcanic hazards.*

LAB: *Exploring different types of volcanoes during an eruption.*

POST: *Learning about historical eruptions.*

PLATE TECTONIC CYCLE - PLATE TECTONICS (3)

PRE LAB

Students learn about stresses in the Earth.

OBJECTIVES:

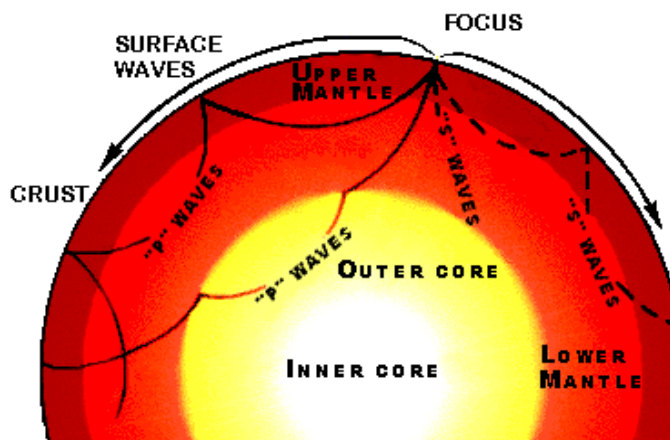
1. Discovering that there are many types of stress.
2. Exploring stress on the outside portion of the Earth.

VOCABULARY:

converging
crust
diverging
inner core
mantle
outer core
stress
transform

MATERIALS:

blocks of wood (optional)



BACKGROUND:

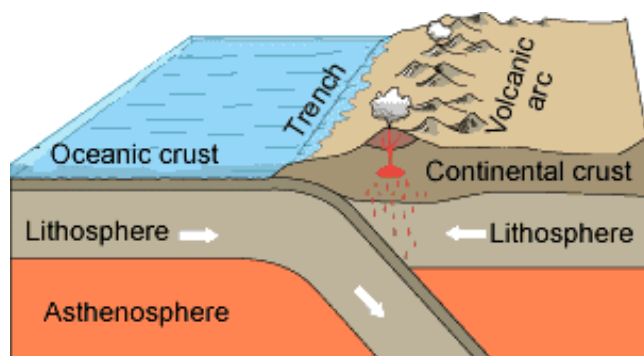
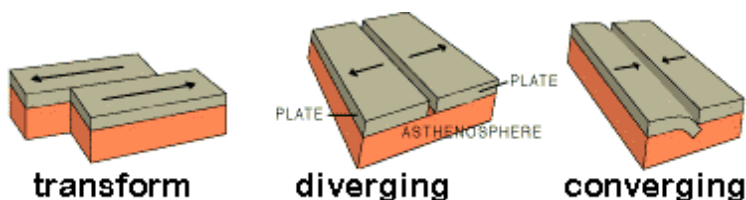
According to the theory of plate tectonics, the Earth's crust and upper mantle are broken into moving plates. The lithospheric plates are solid rock. There are several very large plates, each consisting of both oceanic and continental portions. There are a dozen or more smaller plates. The plates average 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 is composed of a rock that is fluid-like.

Geologists have distinguished three main internal subdivisions of the Earth, based on the behavior of seismic waves and laboratory experiments. The outermost layer is the crust. 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.

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. 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.

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



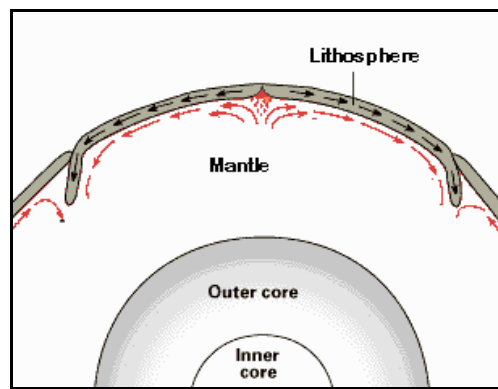
Gravity drags the plate on the left into the Earth

Earth are pulled towards its center by the force of gravity. This may effect the plates at converging plate boundaries in areas called subduction zones, where one plate sinks into the mantle. This is shown in the left picture below. 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. Convection is the heat-driven circulation of a fluid. The inside of the Earth is much hotter than its surface. Heat thus moves from the interior towards the surface. 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 is a very hot, thick (viscous) fluid. Mantle convection currents move very, very, slowly. 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. An example is shown above. This picture portrays convection of the entire mantle, but it some scientists think that is more likely that just the upper part of the mantle convects. Convection and gravity contribute to the movement of the plates.

PROCEDURE:

1. This unit reinforces the concept that the movements within the Earth cause stress in the plates. Most of the stress is caused by movement



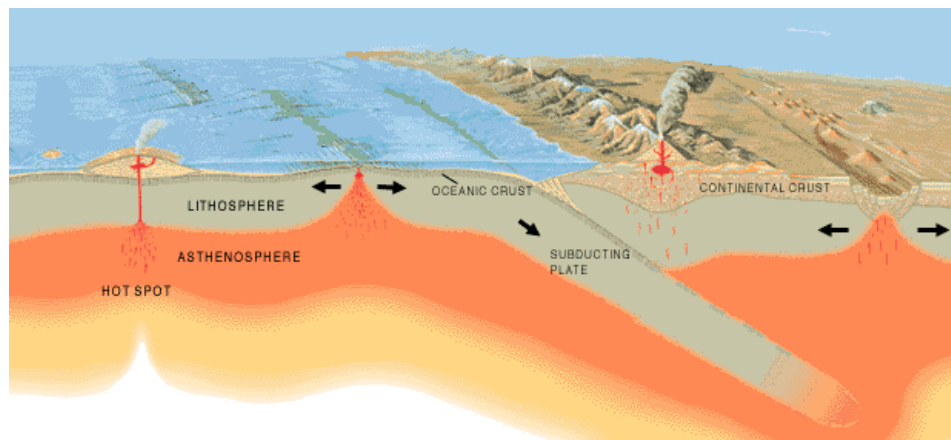
with the Earth and gravity. A portion is also due to external forces such as the Earth's rotation.

2. Draw the diagram on the board. Discuss the crust, mantle, outer core, and inner core. These terms are discussed in the Earthquakes portion of the Plate Tectonic Cycle.

3. Prepare the students to think about what lies inside of the Earth. Have them guess how we know what is inside of the Earth. Many of the students will think we can drill deep into the Earth, but we can not. We cannot even drill through the crust. Refresh their memories on seismic waves from the previous unit on Earthquakes. Scientists use variations in the speed and behavior of seismic waves to distinguish the different parts of the Earth's interior.

4. Explain the meaning of converging, diverging, and transform plate motion to the class.

5. Draw the diagram below. Ask the students where the stress is. In the diverging picture it is near the pull-apart area; in the converging picture it is where the plates bump; and in the transform motion picture it is where the plates are slipping past each other.



6. You may want to use blocks of wood to demonstrate the different motions of the plates.

PLATE TECTONIC CYCLE - PLATE TECTONICS (3)

LAB

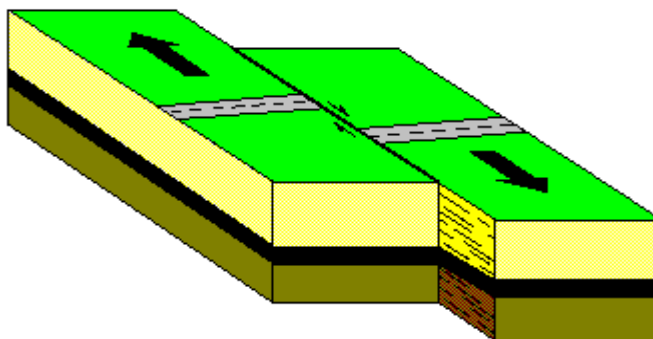
Students learn about stress in the Earth's crust.

OBJECTIVES:

1. Discussing that the Earth's surface is constantly under stress.
2. Discovering that there are many ways substances react to stress.

VOCABULARY:

converging
diverging
fault
plates
stress
transform



MATERIALS:

worksheet
glue ball
clay

BACKGROUND:

Stress is an important geologic concept to understand. It is important to distinguish the geologic meaning of this word from its other meanings, such as anxiety and tension. In geology, a stress is a force that is applied to a geological material, whether it is a tiny mineral crystal or a gigantic plate.

Stresses that build from plate motion eventually causes earthquakes. When the earthquake occurs, some of the stress is relieved. If the stress accumulates a rupture or fault will occur. As the plates continue to move, stress builds up in the rocks again. More earthquakes will take place, but the ruptures this time will tend to happen along the fault. It is an existing zone of weakness in the rocks.

There are three basic ways stress is applied to rocks within the lithosphere. First, rocks can converge or be compressed. Second, rocks can be pulled apart, or diverging. This is the opposite of converging. Finally, rocks can be slip slide pass each other. Squeezing is most common at converging plate boundaries, pulling apart at diverging plate boundaries, and shearing at transform plate boundaries.

PROCEDURE:

1. Define “plate” to the class. Explain that plates are large areas of the Earth's outer portion (crust and upper mantle) that move together.

2. Explain the concept of stress in rocks to the class. Define the three basic types of stress to the students. You can demonstrate these with the wooden blocks from the Pre Lab, or use a sheet of paper. Converging a piece of paper from both sides crumbles the paper toward the center. Pulling on opposite sides of it is extension. Holding opposite sides and moving one hand up and the other down is shear.

Explain that once a fault exists, it is a weak point in the crust. It is likely to become the location of future crustal breakage.

3. Here are answers and information for the lab exercise:

EXERCISE I. Have the students follow the directions on the lab sheet. The glue ball represents a portion of the Earth. The glue ball is made of a polymer used to insulate telecommunication cables. This material “has memory”. In other words, it will return to its original shape after a stress is applied to it. Emphasize to the students that the stresses applied to the glue balls will cause the “fault” to reappear.

EXERCISE II. This exercise illustrates that under similar stresses, different substances respond differently. For example, ask the students if the rocks they observed in previous class would react differently if subjected to similar stresses. The answer is no, with respect to the stress a human can put on a rock, but yes in terms of geologic stresses.

EXERCISE III. It is important for the students to start hearing the vocabulary words associated with stress and plate boundaries. Stress is very important to understand but hard to explain. Letting them experience stress by playing with the clay will help them to understand the concept.

This illustrates the 3 major types of stress effecting the plates by using hand motion and clay.

A. Simulates “plates” moving past each other at a transform plate boundary such as the San Andreas Fault.

B. Simulates “plates” diverging from each other, such as the Mid Atlantic Ridge.

C. Simulates “plates” converging toward each other such as the Himalaya Mountains, where the Indian and Asian plates collide.

PLATE TECTONIC CYCLE - PLATE TECTONICS (3) LAB

PROBLEM: How does the earth "relieve" itself of stress?


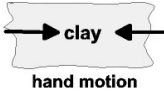
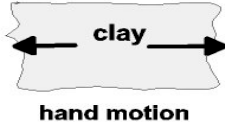
PREDICTION: _____

EXERCISE I. Glue Ball. (1) Each Glue Ball represents a portion of the Earth. (2) Stick Glue Balls together and mix well. (3) Predict what will happen if the "Glue Ball Earth" is "stressed." _____

EXERCISE II. Find out how much stress the following items can withstand. Put each one between the palms of your hands. See if you can create enough pressure to break them!

	DO YOU THINK YOU CAN BREAK IT?	WHAT HAPPENS
1. Peanut		
2. Clay		
3. Marbles		
4. Styrofoam		

EXERCISE III. You have a slab of clay. "Stress" your clay in the following ways.

DRAW CLAY AFTER EARTHQUAKE		
A.		
B.		
C.		

CONCLUSION: What happens when the Earth is under stress? _____

PLATE TECTONIC CYCLE - PLATE TECTONICS (3)

POST LAB

Students create a story about the Earth's interior

OBJECTIVES:

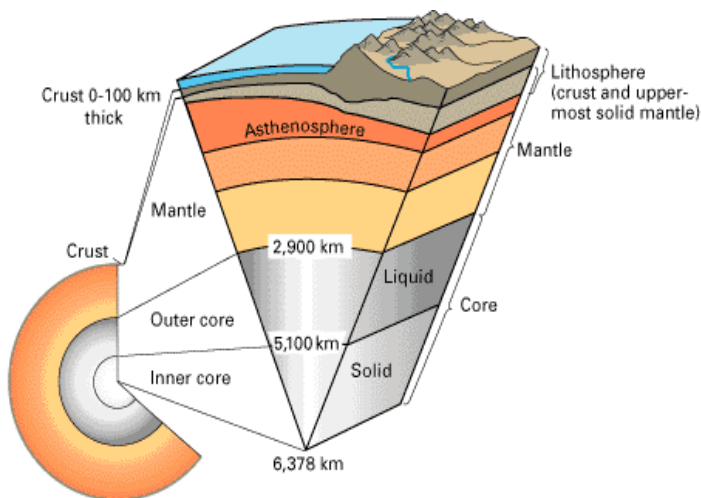
1. Creating a myth about stress inside the Earth.
2. Understanding that the plates have moved through time and are still moving.

VOCABULARY:

earthquake
plate tectonics
plates
stress
volcano

MATERIALS:

worksheet



BACKGROUND:

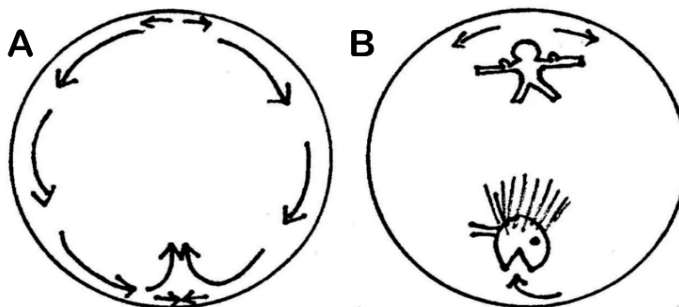
The interior structure of the Earth

Before the advent of modern science, people created stories to explain the world around them. These myths and legends often used supernatural explanations to explain natural phenomena. The eruption of a volcano might reflect the anger of a particular deity, or a hunger monster.

The concept of stress is very difficult for students to understand. In this exercise the students will use their imaginations to explain the origin of stress in the Earth without using science. In this imaginary version of plate tectonics, "Pressuretron" pushes the surface of the Earth apart, while "Consumatron" eats or gets the surface of the Earth to collide.

PROCEDURE:

1. Introduce the exercise to the students. Tell them that they are going to create a myth to explain stress. Introduce the characters of Pressuretron and Consumatron. Draw diagram A, on the board (B is an example of a final drawing). Have the students creatively develop their own



versions of Pressuretron and Consumatron. Do not offer too many suggestions or constraints.

2. Explain to the class that when Pressuretron pushes upward from the inside of the Earth, he causes the crust to move apart (diverging plate boundaries) above him. This causes volcanoes to form. Consumatron eats the crust (convergent plate boundaries) that Pressuretron pushes toward him/her/it. This causes earthquakes to occur.

3. Have the students draw the following on the diagram:

- a. Draw Pressuretron and Consumatron inside of the earth
- b. Draw a circle where the crust moves apart (diverges)
- c. Draw a triangle where the crust is eaten (converges)

4. When completed, the students' pictures should show cartoon characters creating forces inside of the Earth that control what happens on the outside. This will help them grasp the idea that real internal Earth processes, such as convection are responsible for much of what happens on the surface. You may wish to remind the class that in some locations, subsurface forces cause the crust to diverge (be "pulled apart). In other locations these forces cause crustal convergence (consumption of the plate's boundary), or a sideways moving shearing motion (transform plate boundary).

PLATE TECTONIC CYCLE - PLATE TECTONICS (3)

POST LAB

DRAW PRESSURETRON AND CONSUMATRON. SHOW HOW THEY CAUSE MOVEMENT IN THE EARTH'S CRUST

