

Hard Core Rock

Next Generation Science Standards:

- 4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth’s features.
- 5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Hawai’i Content and Performance Standards III:

- SC.4.8.1 Describe how slow processes sometimes shape and reshape the surface of the Earth.
- SC.4.8.2 Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.
- SC.5.2.1 Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

Duration: 45 minutes

Objectives: At the end of this lesson, the students will be able to:

- Describe the theory of geological processes that created the Hawaiian archipelago while demonstrating an understanding of terms and concepts associated with hotspot theory and plate tectonics.

Description:

Students are introduced to the study of geology. They will learn about what is hidden beneath the surface of the Earth and how the geology of the Earth gives shape to the landscape. They will learn about the theory of plate tectonics and how the movement of these plates affects the world around us.

Background:

Geology is the study of the Earth, its formation, composition and transformations. The Earth is composed of a series of layers: crust (plates), upper mantle, lower mantle, outer core, and inner core. The crust and the top of the mantle form a rigid layer called the lithosphere, which is broken into a number of pieces called plates. Beneath the lithosphere the mantle rock is hot and under pressure, making it soft and pliable. As the soft mantle circulates, the overlying plates are moved.

About 95% of Earth’s volcanoes and earthquakes occur at plate edges, known as plate boundaries. As an example, Mt. St. Helens in Washington is located in the Pacific “Ring of Fire”

and is created by a convergent boundary. At convergent boundaries, where plates collide, dense oceanic plates sink under continental plates and melting results. At transform boundaries, the plates slide by each other causing earthquakes. At divergent boundaries, where plates move apart, magma fills the cracks making both plates grow. Hawai'i is located in the middle of the Pacific Plate which is moving northwest at a rate of about 4 inches per year.

Vocabulary:

Convergent boundary: Boundary where plates are colliding into each other.

Core: The center of the Earth, about 2,200 miles thick; made up of an inner and outer core.

Crust: The outer layer of the Earth, about 2-25 miles thick; crust is thicker under the continents and thinner under the oceans.

Divergent boundary: Boundary where plates are moving apart from each other.

Magma: Molten rock containing dissolved gases beneath the Earth's surface.

Mantle: Layer of molten rock between the crust and the Earth's core, about 1,800 miles thick.

Molten: Liquefied by heat, usually referring to lava or magma.

Tectonic plates: Theory of the Earth's crust being broken into a series of plates in motion.

Transform boundary: Boundary where plates are sliding by each other.

Viscous: Thick, gel like, sticky, not fluid.

Materials Needed:

Layers of the Earth Worksheet (included)

Plate Tectonics Worksheet (included)

Plate Tectonics Teacher Answer Key (included)

Coloring supplies

Bag of Peanut M&M's (optional)

Procedure:

Step 1: Introduction to Geology

Scientists believe that the Earth is approximately 4.6 billion years old. Geology is the study of the Earth, its formation, composition and transformations. There are five main layers of the Earth – the crust, upper mantle, lower mantle, outer core, and inner core.

Begin by describing that the Earth is like a peanut M & M.

- The candy shell = crust
- The chocolate part = upper & lower mantle
- The peanut = inner & outer core

Earth's rocky outer shell, or crust, is not as solid as you might think. It is actually made of many huge pieces of rock known as tectonic plates. These plates are slowly moving and shifting. The plates ride on currents of molten rock in the upper mantle which is very hot and under tremendous pressure. The mantle is thought to be a soft, yet solid material kind of like butter that has been left out on the table. The outer core, which begins more than 1,800 miles beneath the

surface, is hot molten liquid, while the inner core is most likely solid due to the extreme high pressure in the center of the Earth.

Step 2: Layers of the Earth Worksheet

Hand out the Layers of the Earth Worksheet. Have students list the 5 main layers of the Earth and color them as listed on the worksheet.

Step 3: Pass out Plate Tectonics Worksheet

There are 8 major tectonic plates that make up the Earth's crust. Explain that each plate is named according to its geographic location. Instruct students to label the plates using the list provided at the top of the worksheet.

Step 4: Review Worksheet and point out other features on the map.

- Go over the plate names. (Teacher answer key is included.)
 - Point out that that each plate has arrows, indicating the direction the plate is slowly moving.
 - Review North, South, East, and West and ask questions about the direction of different plates.
 - The Pacific plate is moving northwest.
- What do the dots indicate? = Volcanoes.
 - Where are the majority of volcanoes located?
 - Notice the concentration of volcanoes along the plate boundaries.
 - Have students speculate as to why.
 - About 95% of Earth's volcanoes and earthquakes occur at plate edges, known as plate boundaries.
 - Explain the great amount of force involved when giant plates collide into each other. What geologic features might this cause and why? = Trenches, volcanoes, and mountains.
- Which is the largest tectonic plate? = Pacific Plate.
- Ask the students to locate Hawai'i. Is Hawai'i near a plate boundary? = No.

Step 5: Color boundary types

Look at the different marks on the plate boundaries.

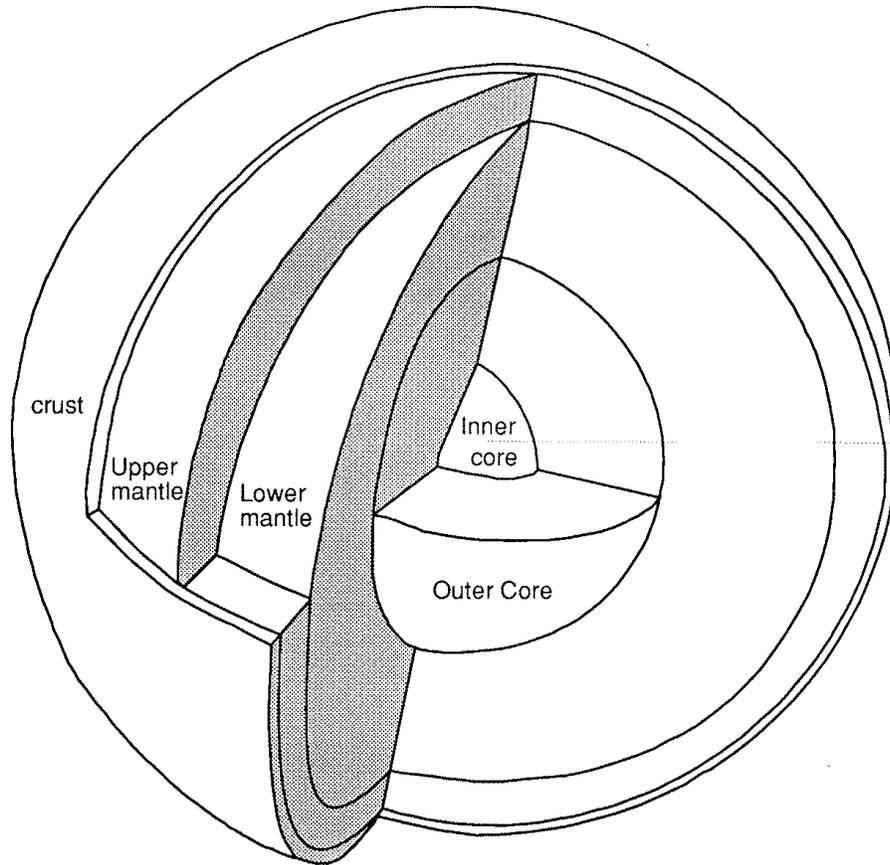
- Point out that there are 3 different types of plate boundaries.
- Have the students color them as follows:
 - Divergent: Plates spreading apart = Color these blue
 - Transform: Sliding side to side = Color these yellow
 - Convergent: Meeting/crashing into each other = Color these red

References:

Adapted from Mattox, S. (1994). *A teacher's guide to the geology of Hawaii Volcanoes National Park*. (Figure 1.1). Honolulu, HI: Hawai'i Natural History Association.

Adapted from 'Ōhi'a Project. (1989). The puzzling earth. *An environmental education guidebook for Hawai'i*. (pp. 5.4-5.10). Honolulu, HI: Bernice Pauahi Bishop Museum and Moanalua Gardens Foundation.

Layers of the Earth Worksheet



List the layers of the Earth from the outermost to the innermost layer and color:

1. _____ = color blue
2. _____ = color red
3. _____ = color orange
4. _____ = color yellow
5. _____ = color black

Adapted from Mattox (1994) figure 1.1

Plate Tectonics Teacher Answer Key

