LESSON 5:
TECTONIC BOUNDARIES

GRADE LEVEL 6-8

VOLCANOES EDUCATOR GUIDE

An SK Films Release

DIGITAL CROSSING FILMS

Volcanoes Educator Guide

LESSON 5:
TECTONIC BOUNDARIES

GRADE LEVEL 6-8
(1) 15 MINUTE PREP LESSON
(2) 45 MINUTE OR (1) 90 MINUTE LESSON(S)

LESSON OVERVIEW:

In this series of lessons, students conduct an investigation into plate tectonics and landforms. Students begin by learning about the formation of Earth's interior layers. Students test the boundary to simulate the three types of plate interactions. Afterwards, students conclude what kind of land formations occur at each. Finally, students examine a global map of plate boundaries and make predictions on what kinds of landforms are found at each.

SCIENCE STANDARDS:

- MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

SCIENCE AND ENGINEERING PRACTICES:

- MS-ETS1-4. Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

FROM THE FILM:

The film ***Volcanoes*** speaks about the different kinds of plate boundaries that are capable of building a volcano. Tectonic plate boundaries, however, are capable of shaping our earth in many other ways. In this lesson, students will investigate plate dynamics.

MATERIALS:

- Sandwich bags
- Sand
- Pebbles or fish tank rocks
- Styrofoam, crumbled into small pieces
- Crayons or colored pencils
- Play dough

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TEACHER PREP:

DAY 1:

Prepare Theia and Earth bags. Using a sharpie, label 8 (or however many lab groups you have) sandwich bags "Earth" and 8 labeled "Theia". Fill Earth with 250 ml of sand and 250 ml of pebbles or fish gravel. Fill Theia with 250ml of crumbled Styrofoam.

DAY 2:

Prepare a lab kit for each group. Each kit should have a container of play dough and cup of gravel. To allow for easier clean up, it is recommended you have students perform the experiment in a shallow bin rather than directly on the tables.

TO DO:

BEFORE VIEWING THE FILM:

1. Ask students: *"Do you know how a volcano is made?"* Allow students to offer their ideas, recording them on the left hand side of a T Chart. Inform students that soon, they will view the film ***Volcanoes***. ***Volcanoes*** follows the lives of photographers and scientists as they get up close and personal with some of the most dangerous natural features on Earth. During the film, they will discuss multiple ways that volcanoes are formed. Ask them to pay special attention and be prepared to explain the different ways that volcanoes are made when they return to the class.

DAY 1:

1. As a warm up, have students share their memories from the film. *How are volcanoes made?* Record their new ideas on the right hand side of the t-chart, noting how their ideas have evolved.

2. Note that they mentioned tectonic plates in their responses. Most volcanoes on earth form from tectonic plate interactions. Tectonic plates, however, form much more than just volcanoes. Over the next couple days, you are going to explore other ways that tectonic plates influence the shape of earth.

3. To begin, revisit the formation of Earth. When Earth was not yet a full planet, it was orbiting the Sun with another planetesimal in its path, Theia. Eventually, Theia collided with Earth. Parts of the two planets fused together and their elements were mixed.

4. Give students the bags labeled Theia and Earth. Tell students to simulate the collision of Theia and Earth by pouring each of these bags into a beaker or cup. Remember, the energy of the collision was so strong that the Earth's outer layers were liquefied into molten rock. This allowed the minerals that were part of Theia and Earth to mix. We will simulate this by stirring the beaker. Prompt students to stir the beaker three times.

Iceland sits on the mid-Atlantic ridge and is a hotspot for volcanic and geologic activity.

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DAY 1 CONTINUED:

5. Remind students that the planets were made of different minerals. Like they have learned before, all minerals have different properties. One of those important properties is density. Density is the amount of mass something has per its volume e.g. a ball bearing. Very dense objects are relatively heavy, even when they are small. Less dense objects are light, even when they are large e.g. a beach ball.

6. Remind the students that the debris in their beakers have different densities just like the minerals that make up the early Earth. Eventually, these densities will influence the anatomy of the Planet. To model this, have students either stir or shake the beaker for one minute. At the end, all of the denser material should have moved towards the bottom of the beaker and the less dense material will rise to the top. Have students note this layering effect in their beakers. This layering effect also happened to Earth. Show students an image of the four layers of the Earth on the board. Describe the properties of each layer and have students color in and label their own diagram in the "Anatomy of Earth" activity page(s).

- Inner core: The inner core is the hottest part of the planet at temperatures between 9,000 and 13,000 degrees Fahrenheit. The layer is mostly iron and the most dense layer.
- Outer core: Composed mostly of iron and nickel in liquid form, this layer is between 7,000 and 9,000 degrees.
- Mantle: The mantle is hot (between 900 and 7,000 degrees Fahrenheit) and moves as a semi-solid rock. The rocks flows in a liquid-like motion around the globe.
- Crust: The outermost layer of earth is solid, cool, and thin. The crust is made up of three different rock types and divided into separate pieces called tectonic plates. There are two types of crust: continental crust (less dense, carries land) oceanic crust (thinner but more dense, carries ocean).

DAY 2:

1. As a warm up, review the layers of the Earth with students.

2. Remind students that the crust of the earth is cool and hard while the mantle beneath it is hot, liquid, and flowing. This dynamic creates a unique feature of Earth: tectonic plates. The crust is not one continuous solid piece but is broken up into many smaller pieces, or tectonic plates. These plates are floating on top of the magma mantle. Just like rafts in a river, they flow in the direction of the magma beneath them. Because of this, plates can crash into each or slip past each other as they flow along the mantle.

3. Teach students that there are three major types of plate interactions. Divergent plates separate away from each other. To help students remember this, have them practice a hand signal. They should hold their hands together (touching palm to palm), then when you say divergent, they separate them apart. Convergent plates move towards each other. Practice a hand signal for this by having students hold their hands apart. When you say convergent, they bring their hands together in a loud clap. Transverse plates slide past each other. Practice a hand signal by having students hold their arms in front of them, palms touching. When you say transverse, they should slide one palm forward and move one palm back towards themselves.

4. Play a quick game of "Simon Says" to help students internalize the vocabulary.

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DAY 2 CONTINUED:

5. These three types of plate boundaries can shape the crust of earth. In order to investigate how, students will conduct a short lab simulation. In the lab, students should flatten out play dough into two four-inch squares. The play dough squares will simulate the tectonic plates. Have students place the plates side by side. On top of the plates, students should pour a cup of gravel. The gravel represents the looser crust found on top of the plates. Students should simulate the three kinds of plate boundaries by pulling them apart, pushing them together, then sliding them past each other. After each boundary simulation, students should record what they observed happened to the looser gravel crust. They should analyze the results and predict what kind of landform this would be on earth. Afterwards, they should place the boundaries side by side again and recover them evenly with gravel. They can then try simulation of the next plate boundary type.

6. Afterwards, review with students what they observed and make explicit connections between boundary types and landforms.

7. Finally, have students look at an image of the tectonic plates on Earth and their movement. Have students use the information to predict what kind of landforms will be located at each area. Afterwards, they can use a computing device to research if their predictions were correct and learn the proper names of the landforms in that area.

Folded limestone on Crete, Greece, which is located above a subduction zone between the African, Aegean and Eurasian plates.

Anatomy of Earth

Directions:

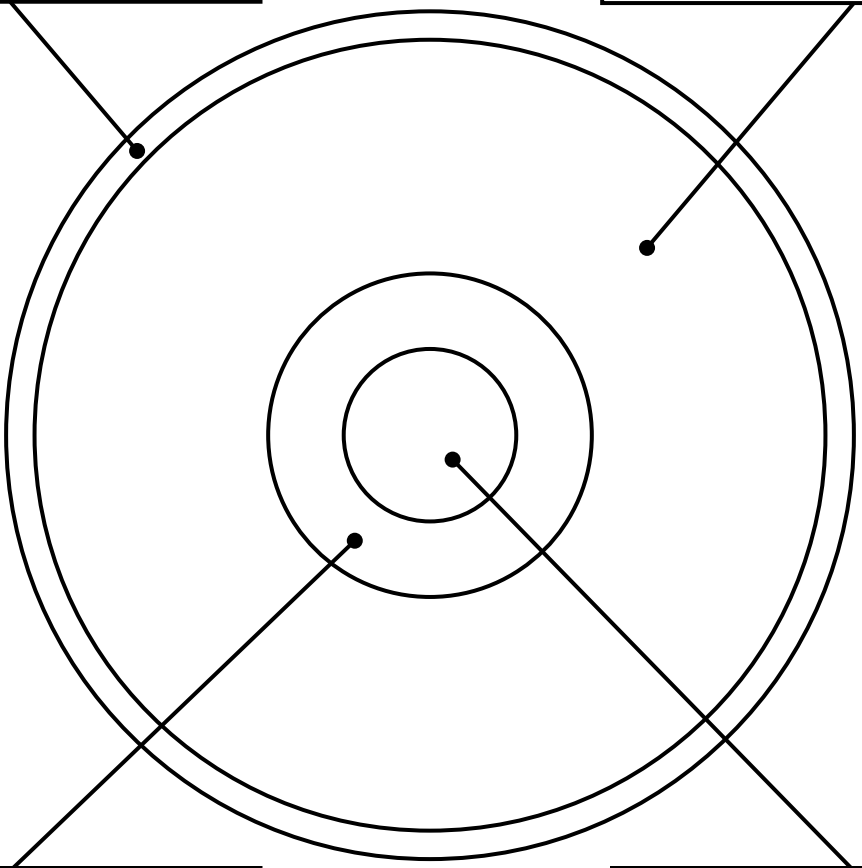
Color the layered diagram of the Earth below. Label each layer with the correct name and describe its properties.

Layer:

Properties:

Layer:

Properties:



Layer:

Properties:

Layer:

Properties:

Plate Boundary Lab

Directions:

1. Make two tectonic plates: Using your hands, shape play dough into two flat squares that are approximately 4 inches on each side.

2. Place the plates side by side. Cover the plates with a cup of gravel. This will represent the looser rock material of the upper crust.

3. For the divergent boundary, move the plates apart from each other.

4. Record your observations by drawing what you see in the chart.

5. What is this landform on Earth? List your ideas.

6. Reset the plate boundary by scooping all of the gravel back into the cup. Place the two plates back to side by side again. Repeat steps 2-5 for transverse and convergent plate boundaries.

Plate Boundary Type	Observations	What landform could this be?
Divergent:		
Transverse:		
Convergent:		

Predicting Landforms

Directions:

1. Below is an image of Earth. The lines on the image show the boundaries of tectonic plates. The arrows show the movement of the plates. For each area noted, identify the plate boundary type and predict the landform you would find there.

2. Afterwards, use the internet or research device to check your predictions. What is the proper name of the landforms actually found in that region?