LessON 3 A Moving Crust

Lesson at a Glance

Students are introduced to plate tectonics in this lesson. In Lesson 2, they discovered that the ocean bottom is not flat when they viewed bathymetric maps showing representations of different ocean geologic features, and the geographic location of some of the most prominent underwater features. In this lesson, they learn how some of the features of the ocean bottom are formed. Students watch a demonstration, and conduct a simple experiment of their own to learn more about seamounts, ridges, trenches, and submarine canyons. They will also play a concentration game to reinforce the concepts of slow and fast processes that shape and reshape the surface of the Earth.

Lesson Duration

Two 45-minute periods

Essential Question(s)

How do fast and slow processes shape and reshape the geologic features of the ocean floor?

How are earthquakes and volcanoes related to ocean geology?

Key Concepts

- The Earth's crust is made of approximately a dozen large tectonic plates and numerous smaller plates.
- Tectonic plates move slowly on top of hot flowing magma.
- In other locations where these plates move away from each other (divergent), hot molten magma rises, forming ridges.
- In instances where plates meet (convergent), many things may happen: deep trenches form, volcanic activity, earthquakes, and some of the world's largest mountain peaks, longest mountain chains, and deepest rift valleys are formed.

Related HCPSIII Benchmark(s):

Science: SC 4.8.1 Describe how slow processes sometimes shape and reshape the surface of the Earth.

Science: SC 4.8.2 Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.

Instructional Objectives

- I can describe how slow and fast processes in the Earth's crust shape and reshape the surfaces of the Earth.
- I can explain how earthquakes and volcanoes relate to ocean geology.
- I can use symbols to label underwater geographic features on my world map.

Assessment Tools

Benchmark Rubric:

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes

Assessment/Evidence Pieces

- **Student Worksheet:** *A Moving Crust*

Materials Needed

Teacher	Class	Group	Student

- Overhead projector - Cutout of tectonic plates - Scissors - 1 set of tangrams or use pattern provided - 1 can of shaving cream (no gel) - Safety goggles	None	- Transparency cutouts of Earth's plates (triangles to represent plates) - Shaving cream (1 can per four students) - Sponges and paper towels for cleaning - Drawing paper, drawing supplies - World map, safety goggles, large plastic plates or trays, waxed paper or Saran Wrap to protect desk surfaces - One set of A Moving Crust Concentration Game	- Student Worksheet: Student Vocabulary - Student Worksheet: A Moving Crust - Student Worksheet: Moving Crust Crossword Puzzle (Enrichment Activity) - Student Worksheets: Divergent and Convergent Plates Enrichment Activity

Instructional Resources

PowerPoint Presentation: *Plate Tectonics*
PowerPoint Presentation: *Geologic History of a Volcano in the Pacific*
PowerPoint Presentation: *Plate Boundaries Around the World*
Teacher Reading: *The Earth's Plates* – 2 copies- one copy on paper and one copy on a transparency for overhead demonstration. Or cut triangles from the transparency for the demonstration. Student Reading: *Plate Tectonics*
Student Worksheet: *Student Vocabulary*
Student Worksheet*: A Moving Crust Pre-Assessment*
Student Worksheet*: A Moving Crust Post-Assessment*
Student Worksheet: *A Moving Crust Concentration Game*
Student Worksheet: *Moving Crust Crossword Puzzle*
Teacher Answer Key: *Moving Crust Crossword Puzzle*
Student Worksheet: *Divergent and Convergent Plates Activity Seafloor Spreading-Divergent Plates*
Teacher Answer Key: *Divergent and Convergent Plates Activity Seafloor Spreading-Divergent Plates*
Student Worksheet: *Divergent and Convergent Plates Activity Subduction-Convergent Plates* Teacher Answer Key: *Divergent and Convergent Plates Activity Subduction-Convergent Plates* Supplemental Resource: *Ocean Geography and Geology Interactive Game*

Student Vocabulary Words

abyss: the bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters).
abyssal plain: the nearly flat portion of deep-ocean floor. About 75 percent of the deep ocean is abyssal plain.
basalt: a type of tough volcanic rock that makes up most of the ocean's basins, mid-ocean ridges, and plates.
convergent plate movement: when two plates collide (at a convergent plate boundary), some crust is destroyed in the impact, and the plates become smaller. The results differ, depending upon what types of plates are involved. **divergent plate movement**: seafloor spreading is the movement of two oceanic plates away from each other (at a divergent plate boundary), which results in the formation of new oceanic crust (from magma that comes from within the Earth's mantle) along a mid-ocean ridge.
magma: molten, mobile, rock material, deep under the Earth's crust.

mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 kilometers).
mantle: the zone within the Earth, from below the crust to the core, made up of semi-molten rock upon which the Earth's tectonic plates float.
plates: huge, mobile rock slabs of varying sizes and thickness that form the Earth's crust. **rift**: an opening or fissure. In geology, a large rift is caused mainly by lateral movement. **seamount:** an isolated volcanic peak that rises at least 3,280 feet (1,000 meters) from the seafloor. **tectonics**: a study of the building and changing of the Earth's crust.

Lesson Plan

Lesson Preparation

- Review the Science Background provided in the Unit's Overview and the Teacher Reading. • Prepare copies of the Student Worksheets.
- Copy the vocabulary onto chart paper. Include a picture/diagram, where appropriate, next to the vocabulary word. You may choose to photocopy the Student Vocabulary included in this lesson.
- Have a copy of Teacher Reading: *The Earth's Plates* and scissors to cut them. Make sure that you have an overhead projector handy and enough shaving cream (not the gel kind) for each group of students. (Approximately one can for every four students.)
- Cut triangles from transparencies to represent the Earth's plates for the groups.
- Prepare cards for *A Moving Crust Concentration Game*. Reprint, laminate and cut game cards, one set for each group of 4 to 5 students.
- Preview PowerPoints *Plate Tectonics, Geologic History of a Volcano in the Pacific* and *Plate Boundaries Around the World*. Make arrangements to project them.
- **Preview the interactive piece** *Ocean Geography and Geology* **to be completed at the of Step V.**

I. *Introducing the Lesson*

Begin the lesson by distributing a copy of the Student Worksheet for lesson 3, A *Moving Crust*, and asking the students to write, or draw, how they think the underwater mountain ranges were formed. As they finish writing their predictions, distribute the student vocabulary terms, or have students write them down.

II. *Teacher Demonstration with Overhead Projector*

A. Explain to students that the Earth is not one solid ball. The Earth is comprised of plates of rock of various sizes that make up the Earth's crust. Show PowerPoint *"Plate Boundaries Around the World."* Leave the PowerPoint up on the screen as a point of reference as you continue this portion of the lesson. The *Mid-Ocean Ridge* they marked on their world map in the previous lesson marks one of these plate boundaries. The *plates* float above hot liquid magma, whose heat makes them come together (convergent), move apart (divergent), and slide past each other (transformed). Sometimes, the plates come together until one plate sinks under the other to be recycled in the magma; both deep ocean trenches and high mountains are formed in the process.

B. Explain to the students that the movement of the plates are considered slow processes overall. However, an earthquake or volcanic eruption is considered a fast process when it happens.

C. Show the PowerPoint *Plate Tectonics* to the students. Hand out copies of the *Divergent and Convergent Plates Activity* sheets to each student. Have them fill in the sheets as they view the PowerPoint.

D. Hold up a transparency copy (preferably color) of Teacher Resource: *The Earth's Plates.*

E. Cut the plates apart and lay them on the overhead.

F. Discuss ocean spreading and *divergent plates* – move the North American and Eurasian divergent plate away from each other. Explain that, when this happens, magma rises up, forming new ocean floor and mid-ocean ridges**.** G. Next, slide the Pacific Plate and the North American plate laterally (transformed boundaries). This represents the San Andreas Fault, a geological fault line that moves in a northwest–southeast direction through the state of California.

H. To represent a convergent plate, show the Pacific Plate moving under the Philippine Sea Plate. This convergence will cause deep trenches, such as the Mariana Trench.

III. *Student Activity-Tectonic Plates and Shaving Cream*

(Comment to teacher: This could be done as a teacher demo instead of student activity.)

A. Have students split into pairs and clear their desk surface.

B. Distribute two triangles from the transparency cut outs set to each group.

C. Circulate around room, squirting ¼ can shaving cream onto each group's desk; explain that below the Earth's crust is magma, or molten lava. The shaving cream represents the magma.

D. Have students lay their two triangles from the transparency cut outs on top of the shaving cream so that they form a square.

E. Ask students to, very *slowly*, push down and gently pull the two triangles apart to represent divergent plates. •
What did you see happening as the plates moved apart? *(shaving cream filled up in between, making a ridge.)*

F. Next, have students scrape their shaving cream into a clean pile to work with again. Place the transparency cut out triangles back on top to form a square. This time, have students push one of the triangles down and under the other.

- What did you see happening when your plates converged, or slid underneath one another? *(A small ridge and trench formed.)*

G. Engage students in a short debate to discuss whether these are fast or slow processes. *(It is relative)* H. Using a sponge, paper towels, and clean water, have students wash their desks clean. Shaving cream is a good cleaning agent.

IV. *Volcanoes PowerPoint and Student Activity-Modeling Origins of Seamounts using Shaving Cream*

A. Explain to students that the Hawaiian Archipelago was formed by a hot spot. Most hot spots are located along divergent plate boundaries with a few at the mid ocean ridge and some away from plate boundaries. The most notable hot spot is found beneath the Big Island. As the plates move away from the hot spot, new islands are formed. The farther away from the hot spot, the older the island. Coral reefs form around these islands as they settle and erode and become seamounts.

B. Show students the *Geologic History of a Volcano in the Pacific* PowerPoint. Have students take notes. C. Teacher Demonstration: Origins of Seamounts

D. Make, or purchase, a framed window screen and one can of shaving cream

1. Review the concept of plate tectonics. Make sure that students understand the different volcanic activities: slow, oozing lava at seafloor spreading ridges, and active volcanoes (seamounts) at hot spots or subduction zones.

2. Demonstrate how volcanic eruptions at a hot spot produced the Hawaiian Islands archipelago. Procedures:

a. Invite two students to come up front and hold the screen, which represents the *plate*.

b. Holding the shaving cream can under the screen, gently squirt a small amount of foam out as the students move the screen very slowly over the shaving cream can.

c. As the screen moves over the can, small mounds (seamounts) will form on top of the screen. Make 4–6 mounds to show how a chain of seamounts is formed.

d. Discuss with students whether volcanic activity is a fast or slow process.

V. *A Moving Crust Concentration Game*

A. The concentration game reinforces students understanding of slow and fast processes that sometimes shape and reshape the surface of the Earth. Students will match the information on a card with its example. B. Students could create more information cards and examples to add to the collection of game cards. Keep in mind that a process that is considered as a fast process, may take thousands of years. The seamount, *Lōʻihi***,** will take thousands of years before it surfaces as an island, however, eruptions at its surface underwater are constantly reshaping the surface of the Earth. Therefore, volcanoes and hot spots are fast processes.

C. If time permits have students work in pairs on the computer using the *Ocean Geography and Geology*

Interactive Game to reinforce learning.

VI. *Pre/Post Assessment*

A. As a Post Assessment, have students draw pictures to match the definition of divergent and convergent plates on page 2 of their worksheet, *A Moving Crust*. Also, have the students write a brief description on the lines at the bottom of their pictures. (LA.3.1.3)

B. As students complete their drawings, they may work on coloring and labeling their world map in their portfolio from previous lessons.

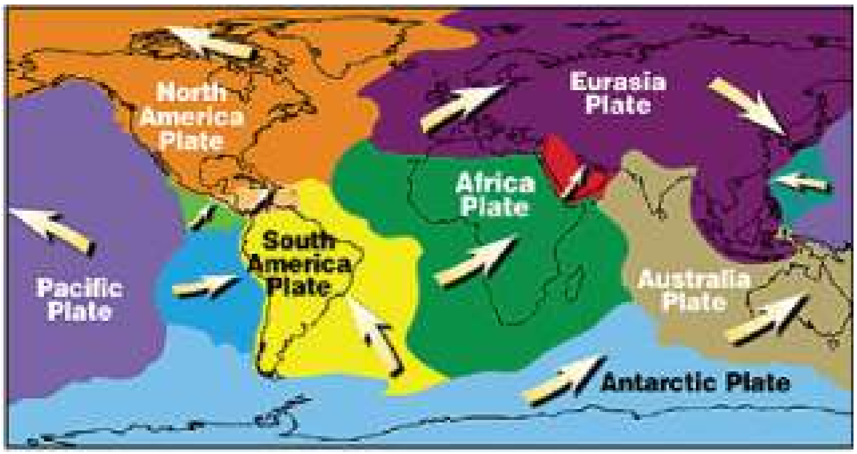
Extended Activities

Students review terms and definitions by completing the crossword puzzle in class or as homework. **5**

Lesson 3 Student Reading

Plate Tectonics

The term **plate tectonics** refers to how the Earth's surface is made up of plates. In geology, a **plate** is a large slab of rock, while **tectonics** is a word of Greek origin meaning *to* **build.** According to this theory, the Earth's crust is made up of plates on which the continents and ocean rests. These plates are continually shifting because the surface beneath them — the hot, soft mantle — is moving slowly like a conveyor belt, driven by heat and other forces at work in the Earth's core. The plates are moving approximately 1 centimeter (0.5 inches) to 15 centimeters (6 inches) per year in different directions. This map shows the major tectonic plates that make up the Earth's crust and the directions in which they are moving.



Map adapted from NOAA **Vents, Volcanoes, and Earthquakes**

The Earth's tectonic plates can move apart, collide, or slide past each other. The Mid-Ocean Ridge system — the Earth's underwater mountain range — arises where the plates are moving apart. As the plates move apart, the seafloor cracks. Cold seawater seeps down into these cracks, becomes super-heated by magma, and then bursts back out into the ocean, forming hydrothermal vents. As the plates move farther apart, magma from the Earth's mantle fills the gap, sometime leading to the eruption of undersea volcanoes. This process, called **seafloor spreading**, is how new seafloor is formed.

Conversely, when tectonic plates meet at a **convergent boundary**, the force causes Earthquakes, mountains to rise, and deep trenches to form. When the edge of one plate is forced under another — a process called **subduction** — the crust of the sinking plate is destroyed as it remelts in the hot mantle. When the edges of one plate slides past another plate – along a **transform boundary** – crust is neither created nor destroyed. The current continental and oceanic plates include: the Eurasian Plate, Australian-Indian Plate, Philippine Plate, Pacific Plate, Juan de Fuca Plate, Nazca Plate, Cocos Plate, North American Plate, Caribbean Plate, South American Plate, African Plate, Arabian Plate, the Antarctic Plate, and the Scotia Plate. These plates consist of smaller sub-plates.

LessON 3 student Vocabulary

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LessON 3 A Moving Crust

Pre-Assessment

Name:______________________________ **Date:** _____________

Question:

What might be some ways tectonic plates move? What do you think happens when tectonic plates

move?

I think that this is what happens when tectonic plates move…

11

12

18

17

s are gradually moving apart anic ridge – mountain range where Earth's located under the oceans an ic crust – thin parts of the Earth's crust ocean's crust – large bodies of water sitting atop the cru

Volcanoes – places in the Earth's surface

8.

Volcanoes - places in the Earth's surface

7.

Upper mantle – the top part of the ma ntle

7.

Upper mantle – the top part of the mantle another plate

another plate part o

6. Subduction zone – the place where one under the ocean

under the ocean

5. Ocean

the oceanic crust

4. Ocean – large bodies of water sitting on

4. Ocean – large bodies of water sitting on crust

crust that moves from the asthenosphere to the

that moves from the asthenosphere to the

3. Magma – molten rock in the Ea

ntle

2. Lower mantle – the deepest parts of the

2. Lower mantle – the deepest parts of the Earth's crust not located under the ocean

Earth's crust not located under the ocean 1. Continental crust – thick layers of the

1. Continental crust – thick layers of the dis

gram of the convergent plates.

diagram of the convergent plates. Read the definitions and use them to label the

Read the definitions and use them to label the Subduction – Convergent Plates

Subduction