Plate Tectonics: Evidence of Plate Movement

A Carolina Essentials™ Activity

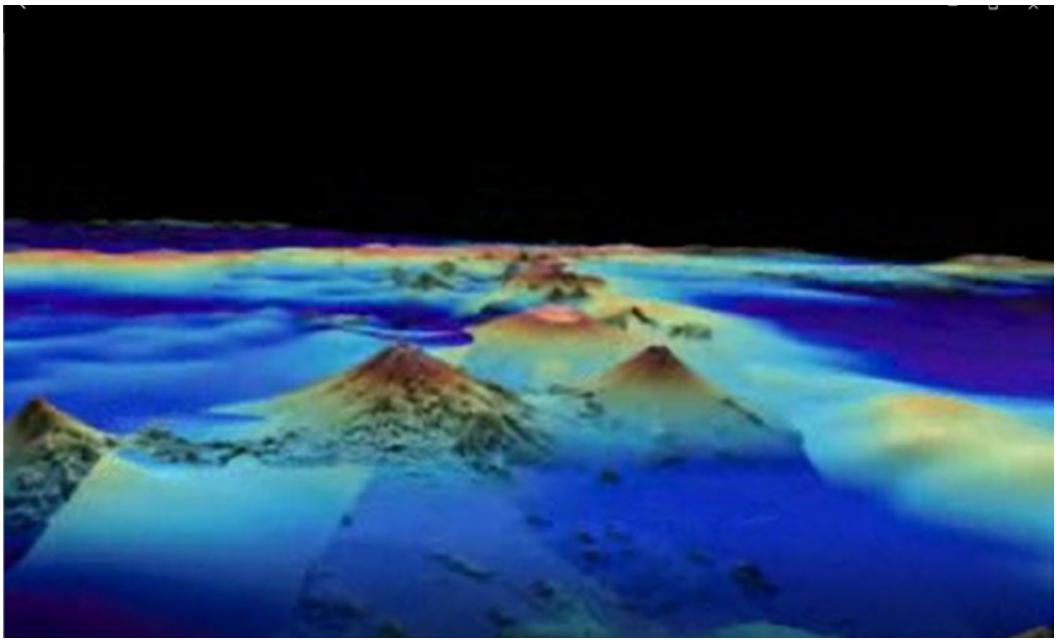
Overview

This activity is a quick, simple way to introduce tectonic plate movements and plate boundaries using maps of the ocean floor. Students examine the north-central part of the Pacific plate and identify volcanoes, lava fields, and ocean trenches. Their observations are used as evidence to make a claim about plate movement and constructive and destructive forces at work on the Pacific plate. Students should have a working knowledge of the types of plate boundaries, subduction zones, and rift zones.

Earth and Space Science
Grades: 9–12

Phenomenon

Watch the virtual fly-through. What looks familiar? Where do you think this is?



Virtual fly-through of the Mariana Arc

Essential Question

How do surface features provide evidence of tectonic plate movement?

Activity Objectives

1. Use information from ocean floor maps to determine past tectonic plate movement.
2. Use information from ocean floor maps to determine the type of tectonic plate boundary.

TIME REQUIREMENTS

PREP	ACTIVITY
15 min	20-30 min

Teacher Prep: 15 min to download virtual fly-through of the Mariana Arc

Extra time may be needed if laminating maps

Student Activity: 20-30 min

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS (PER GROUP)

4 Pacific Ocean maps (see the student worksheet)

Colored pens, pencils, or overhead markers

HELPFUL LINKS

Plate Tectonics Activity

Volcano in the Classroom

Tectonic Sandbox

Carolina® Convection Fluid, 1 L

NOAA Ocean Explorer: Submarine Ring of Fire 2006: Mariana Arc

NOAA Office of Ocean Exploration and Research: Canyon and Seamount Habitats

REFERENCE KITS

Plate Tectonics and Island Formation

Continued on the next page.

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Next Generation Science Standards* (NGSS)

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**ESS1.C: The History of Planet Earth** • Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. **PS1.C: Nuclear Processes** • Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.	**Patterns** • Empirical evidence is needed to identify patterns.

Teacher Preparation and Disposal

Copy or upload the student activity sheets. The 4 maps need to be copied in color and may be laminated and used repeatedly to reduce paper use. If using laminated maps, make sure students use washable markers to complete the activity.

Download the Mariana Arc phenomenon video prior to class. If you are assigning this activity as a homework or online assignment, share the URL of the video with students. Disposal is not required.

Student Procedure

1. Look at map 1, covering the north-central portion of the Pacific Ocean.
   a. At the bottom right edge, locate the Hawaiian Islands.
   b. Using a colored pen or pencil, trace the island and seamount features that begin with Hawaii and end at the Aleutian Trench. Seamounts appear light blue.
   c. Label the compass direction for each line segment drawn.
2. Look at map 2, the Hawaiian Ridge topography.
   a. Place a mark on what appear to be or have been volcanoes.
   b. Draw a boundary around the location of the volcanoes.
3. Look at maps 3 and 4, the North American and Pacific Plates Boundary. The color coding indicates the darker the shade of blue, the greater the depth of water. Browns and greens indicate features above sea level.
   a. Label the deepest areas and shallowest areas on map 3.
   b. Circle the features above sea level that are adjacent to the trenches.

Teacher Preparation and Tips

A color key is not provided on the maps. Review with students that the brown and green features are above sea level and that darker shades of blue indicate deeper features.

Point out the location of the Hawaiian Islands for students having trouble.

Make sure students are using the writing tools you selected.

Review question: what is the difference between a volcanic mountain, a volcanic island, and a seamount? Volcanic mountains form on land. Volcanic islands reach a height above sea level, so they are islands. Seamounts are volcanos that never obtain a height greater than sea level.

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Analysis and Discussion

Map 1

1. The north-central Pacific hot spot has not changed location. In what direction(s) has the Pacific plate moved through history? State the evidence to support your claim.

   The Pacific plate is currently moving northwest and prior to that it was moving north (N) to north-northwest (NNW). The evidence is the chain of volcanic islands and seamounts on the Pacific Ocean floor form a feature with a distinct bend indicating a change in the direction of the Pacific plate. Check student work to look for lines tracing the islands and seamounts.

2. In what direction is the Pacific plate moving now? State the evidence to support your claim.

   The Hawaiian Islands are the most recent features formed over the hot spot and they form a feature aligned in the northwesterly direction.

3. Given that darker blue is deeper and lighter blue is shallower, what happens to the depth of seamounts as you travel north from the Hawaiian Islands?

   The Hawaiian Islands are above sea level as they are color coded green. As you travel across the Hawaiian Ridge the seamounts are colored a very light blue, indicating that they are below the surface but not at a great depth. As you approach the Aleutian Trench, the color darkens slightly, but it is still light enough to indicate the seamounts are substantial features on the ocean floor.

4. Where along the seamount feature are the mounts the oldest? Where are they the youngest? State the evidence to support your claim.

   The mounts are oldest closer to the Aleutian Trench and youngest at the Hawaiian Islands. The Hawaiian Islands are above sea level, and volcanic activity is adding land mass to the island of Hawaii.

   Note: If you have had discussions about weathering and erosion, you may expect students to attribute a lower elevation to weathering of the seamounts.

Map 2

1. What evidence did you use to locate past and current volcanoes?

   Student answers will vary, but a circular mountain is usually what students select.

2. How does the boundary you drew compare to the Hawaiian Ridge?

   The boundary and the Hawaiian Ridge should have a similar shape. The ridge will probably be larger.

3. Based on the evidence, where is the location of the hot spot?

   There is no sizable ridge south of the island of Hawaii, so the hot spot must be located beneath Hawaii.

Maps 3 and 4

1. What is the spatial relationship between the location of deep areas and surface features?

   There are island chains just to the north of the trenches (deep areas).

2. What type of plate boundary does this topography suggest? State the evidence for your claim.

   The deep trench and island formation indicate a subduction zone and convergent plate boundary. As the Pacific plate slides beneath the North American plate, old rock is destroyed. As the Pacific plate is subducted, rock is melted. It reaches the surface again during a volcanic eruption, forming islands and mountain chains.

3. Does the topography on maps 3 and 4 support or refute your claim for the direction of plate movement from map 1? Explain your reasoning.

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Since the deepest trench is to the north and west of the seamount chain, it supports the claim for movement in the north-northwest (NNW) direction.

Use the surface feature evidence you gathered in this activity to propose an explanation for tectonic plate movement. Explain the constructive and destructive forces occurring at hot spots and tectonic plate boundaries.

Student answers may vary. Key points are below.

Constructive forces:

- *Hot spots construct land formations through the addition of lava, not a plate boundary; new rock formed.*
- *Volcanic activity as the result of subduction is also a land forming process; new rock formed.*

Destructive forces:

- *Subduction at a convergent plate boundary is destructive. Old rock/seafloor is dragged under a continental plate where it melts.*
- *Weathering breaks rock down physically and/or chemically and happens on land or under the ocean.*

TEACHER NOTES