7TH GRADE · UNDERSTAND

Puzzle Pieces on the Move: Plates, Boundaries, and the Clues They Leave Behind

01 A hot spot stays fixed while the plate above slowly moves, creating a chain of volcanic islands over time.

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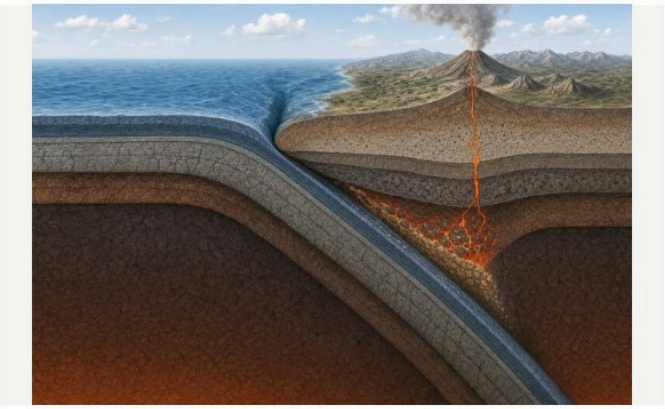
01 A hot spot stays fixed while the plate above slowly moves, creating a chain of volcanic islands over time.

Earth's Crust Isn't One Piece—It's a Cracked Shell

Imagine Earth's rigid outer layer, called the **lithosphere**, is a cracked eggshell resting on thick, slowly swirling syrup. That cracked shell is broken into giant slabs called **tectonic plates**, and they're constantly on the move—just really, really slowly. Here's the one-sentence connection you need from your last lesson: heat from deep inside Earth drives **mantle convection**, and that slow churning motion helps push and pull the plates above it around like items on a conveyor belt. With that link in mind, let's focus on what happens *because* the plates move.



02 At this boundary, one plate sinks beneath another, a process called subduction that can trigger earthquakes and volcanoes.

What Happens Where Plates Meet?

The edges where two plates touch are called **plate boundaries**, and this is where Earth gets dramatic. There are three basic types of action happening at boundaries:

- **Plates crashing together** can push up mountain ranges or cause one plate to sink beneath another in a process called **subduction**, which triggers earthquakes and volcanoes.
- **Plates pulling apart** allow magma to rise and harden into new ocean floor at a **mid-ocean ridge**, slowly widening ocean basins.
- **Plates sliding past each other** grind along cracks called **faults**, releasing energy as earthquakes.

Not all volcanic activity happens at boundaries, though. Sometimes a **hot spot**—a relatively fixed source of rising hot mantle material—burns straight through the middle of a plate, poking a hole no matter where the plate happens to be sitting above it. In rare cases, huge pools of magma collect beneath the surface and build up so much pressure that they erupt explosively, forming a **supervolcano** capable of reshaping the landscape for miles around.

03 Fresh volcanic rock like this forms near active hot spots such as the one beneath Hawaii's Big Island.

The Hawaiian Hot Spot: A Trail of Evidence

The Hawaiian Islands sit above one of Earth's most famous hot spots. Kīlauea, on the Big Island, is currently active because it sits near the rising heat. But here's the cool part: as the Pacific Plate slides over this steady hot spot, it drags old volcanoes away and leaves fresh ones behind,

forming a long trail of underwater volcanic mountains called the Hawaiian–Emperor **seamount** chain.

According to data from the USGS Hawaiian Volcano Observatory, volcanic rock farther from Kīlauea is older, while rock closer to Kīlauea is younger and still active. This age-distance pattern is direct evidence of plate motion! If a volcanic island sits 500 kilometers from Kīlauea and its rock is 5 million years old, you can estimate the plate's speed by dividing distance by age: 500 divided by 5 equals 100 kilometers per million years—roughly 10 centimeters per year. That number tells scientists how fast the Pacific Plate has been crawling along—proof that motion, even at a snail's pace, adds up dramatically over millions of years.

04 Matching coastlines and rock layers on separated continents are evidence they were once joined together.

Rocks, Fossils, Seafloors, and Puzzle-Piece Continents

Plate motion doesn't just build islands—it rearranges entire continents over time. Scientists find matching fossils of the same ancient land-dwelling creatures on continents now separated by oceans, like South America and Africa. They also find matching rock layers and mountain ranges that line up when the continents are pushed back together, like puzzle pieces. Scientists also map the age of the ocean floor: the youngest seafloor sits right next to mid-ocean ridges, while older seafloor lies farther away on both sides. This pattern shows that new crust forms at ridges and moves outward as plates separate. Geologists also rely on the **law of superposition**, which explains that in undisturbed rock layers, the oldest layers sit at the bottom and younger layers stack on top—helping scientists place all this evidence in order over time.

Small Motions, Huge Results

A few centimeters a year sounds tiny, barely more than a fingernail's growth. But multiply that by millions of years, and you get ocean basins that widen, mountain ranges that rise, and continents that wander halfway around the globe. Fossils, rock patterns, continental shapes,

and seafloor age data all tell the same story: Earth's surface is not fixed—it's a slow, ongoing puzzle shuffle powered by heat from below.

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01 Lesson Objective

In this lesson, you will explain how tectonic plates move and interact at different types of boundaries, including how these movements cause earthquakes, volcanoes, mountains, and ocean basins. You will also interpret evidence like fossils, rock patterns, and seafloor ages to understand how scientists know continents have shifted over millions of years.

Standard: NGSS MS-ESS2-3; NGSS MS-ESS2-2; TEKS 7.10B; TEKS 7.10A

Bloom's Level: Understand

Bloom's Goal: Explain the causes and effects of plate motion using evidence from fossils, rocks, seafloor patterns, and hot spot trails.

Explanation: This objective asks students to demonstrate understanding by summarizing and explaining relationships between plate motion and geologic evidence rather than simply recalling facts.

Standard

NGSS MS-ESS2-3 (primary) — Analyze and interpret data on fossils, rocks, continental shapes, and seafloor structures as evidence of past plate motions.; NGSS MS-ESS2-2 (supporting) — Explain from evidence how geoscience processes change Earth's surface across different scales.; TEKS 7.10B (primary) — Describe how plate tectonics causes ocean-basin formation, earthquakes, mountain building, volcanic eruptions, supervolcanoes, and hot spots.; TEKS 7.10A (supporting) — Describe evidence that Earth

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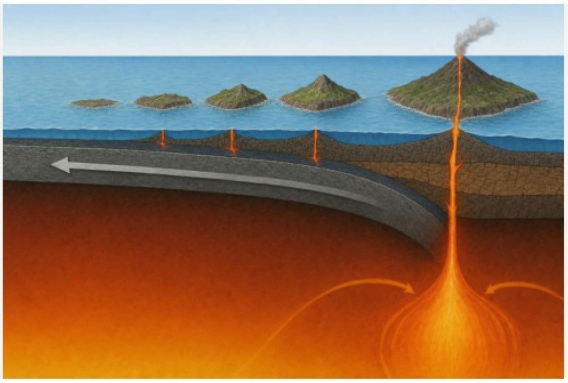
02 Vocabulary



01 A hot spot stays fixed while the plate above slowly moves, creating a chain of volcanic islands over time.

> Define the terms in your own words.

faults *Explain in your own words:*

hot spot *Explain in your own words:*

law of superposition *Explain in your own words:*

lithosphere *Explain in your own words:*

mantle convection *Explain in your own words:*

mid-ocean ridge *Explain in your own words:*

plate boundaries *Explain in your own words:*

subduction *Explain in your own words:*

supervolcano *Explain in your own words:*

tectonic plates *Explain in your own words:*

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03 Multiple Choice

Choose the best answer for each question based on what you learned about plate tectonics, plate boundaries, and the evidence scientists use to study plate motion.

03 Fresh volcanic rock like this forms near active hot spots such as the one beneath Hawaii's Big Island.

1. What is the lithosphere best described as?

- **A.** A liquid layer of magma beneath the crust
- **B.** Earth's rigid outer layer broken into tectonic plates
- **C.** The molten core at the center of Earth
- **D.** A single unbroken layer covering all of Earth

2. What process drives the slow movement of tectonic plates?

- **A.** Mantle convection caused by heat from inside Earth
- **B.** Wind patterns pushing the continents
- **C.** Ocean tides pulling the plates apart
- **D.** Gravity from the moon shifting the crust

3. At a mid-ocean ridge, what typically happens?

A. Two plates slide past each other, causing earthquakes

B. One plate sinks beneath another, forming volcanoes

C. Plates pull apart and magma rises to form new ocean floor

D. A hot spot burns through the middle of a plate

4. Subduction occurs when...

A. plates pull apart and new crust forms

B. one plate sinks beneath another at a boundary

C. plates slide past each other along a fault

D. a hot spot melts through a plate's interior

5. How is a hot spot different from activity at a typical plate boundary?

A. A hot spot only occurs where plates pull apart

B. A hot spot is a fixed source of rising heat that can occur in the middle of a plate, not just at its edges

C. A hot spot always causes plates to slide past each other

D. A hot spot only forms deep ocean trenches

6. What does the age pattern of the Hawaiian–Emperor seamount chain provide evidence for?

A. That the Pacific Plate is not moving at all

B. That volcanoes form only at mid-ocean ridges

C. That the plate has moved over a steady hot spot, creating older volcanoes farther away and younger ones near the active volcano

D. That all volcanoes in the chain formed at the same time

7. A volcanic island is 400 kilometers from Kīlauea, and its rock is 4 million years old. Based on the method described in the article, about how fast has the Pacific Plate been moving?

- **A.** 10 kilometers per million years
- **B.** 100 kilometers per million years
- **C.** 400 kilometers per million years
- **D.** 4 kilometers per million years

8. Matching fossils of the same ancient land creatures found on South America and Africa are used as evidence that these continents...

- **A.** have always been separated by a wide ocean
- **B.** were once connected and have since moved apart
- **C.** were never part of the same landmass
- **D.** formed at the same mid-ocean ridge recently

9. According to seafloor age data, where is the youngest ocean crust usually found?

- **A.** Far away from mid-ocean ridges
- **B.** At the deepest ocean trenches only
- **C.** Right next to mid-ocean ridges
- **D.** Only near hot spots like Hawaii

10. The law of superposition helps geologists understand rock layers by explaining that...

A. younger layers are always found at the bottom

B. all rock layers form at exactly the same time

C. in undisturbed layers, the oldest rock is at the bottom and younger rock is on top

D. rock layers cannot be used to determine age

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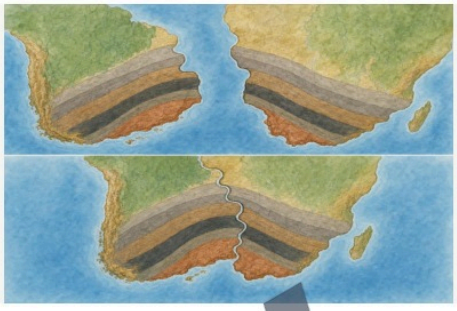
04 True / False

Read each statement carefully. Decide whether it is True (T) or False (F) based on what you learned about plate tectonics, plate boundaries, and the evidence scientists use to study plate motion.



04 Matching coastlines and rock layers on separated continents are evidence they were once joined together.

1. Earth's lithosphere is broken into large sections called tectonic plates.

○ True ○ False

2. Mantle convection is the slow churning motion caused by heat that helps move tectonic plates.

○ True ○ False

3. At a mid-ocean ridge, plates crash together and one plate sinks beneath the other.

○ True ○ False

4. Subduction happens when plates pull apart and new crust forms.

○ True ○ False

5. Earthquakes can occur when plates slide past each other along faults.

○ True ○ False

6. A hot spot can cause volcanic activity in the middle of a plate, not just at plate boundaries.

○ True ○ False

7. The Hawaiian Islands show that volcanic rock farther from Kīlauea is generally younger than rock closer to it.

○ True ○ False

8. Matching fossils and rock layers found on continents separated by oceans provide evidence that continents were once connected.

○ True ○ False

9. According to the law of superposition, the youngest rock layers are usually found at the bottom of undisturbed rock formations.

○ True ○ False

10. The youngest seafloor is typically found far away from mid-ocean ridges, while the oldest seafloor is found right next to them.

○ True ○ False

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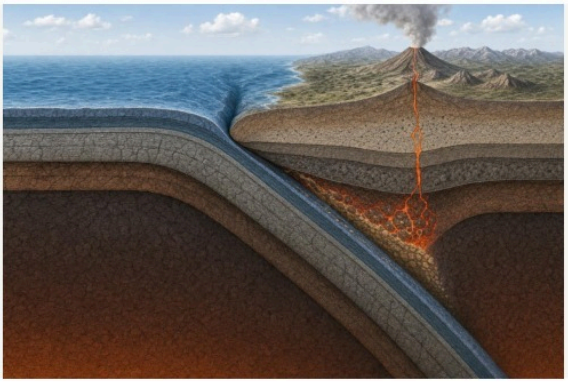
05 Short Answer



02 At this boundary, one plate sinks beneath another, a process called subduction that can trigger earthquakes and volcanoes.

> Answer each question in 1-2 complete sentences using evidence and ideas from the lesson article.

1. Describe two different things that can happen when tectonic plates meet at a boundary.

2. Explain how the pattern of older versus younger volcanic rock in the Hawaiian island chain provides evidence that the Pacific Plate is moving.

3. Explain how matching fossils, rock layers, and seafloor age patterns on different continents support the idea that Earth's plates have moved over time.

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06 Case Study

Read the scenario carefully, then answer the three questions using evidence from the article about plate tectonics.

01 A hot spot stays fixed while the plate above slowly moves, creating a chain of volcanic islands over time.

Scenario: A team of student scientists is studying the Hawaiian–Emperor seamount chain, a long trail of underwater volcanic mountains stretching across the Pacific Ocean. They know Kīlauea, on the Big Island, is currently active because it sits directly above a hot spot. Using rock samples collected by the USGS Hawaiian Volcano Observatory, the team finds that a volcanic island located 400 kilometers from Kīlauea has rock dated at 4 million years old. Meanwhile, an island only 100 kilometers away has rock that is just 1 million years old. The students notice that the farther an island is from Kīlauea, the older its volcanic rock tends to be. They also recall that the hot spot itself stays in roughly the same place beneath the moving Pacific Plate. Their teacher asks them to explain what this age-distance pattern reveals about the plate's movement and to connect it to the deeper forces driving that motion.

1. Why does the volcanic rock get older as you move farther away from Kīlauea along the seamount chain?

2. Using the data given (400 kilometers and 4 million years), calculate the speed of the Pacific Plate in kilometers per million years, and explain what this calculation shows about plate motion.

3. What deep-Earth process ultimately powers the movement of the Pacific Plate over the fixed hot spot?

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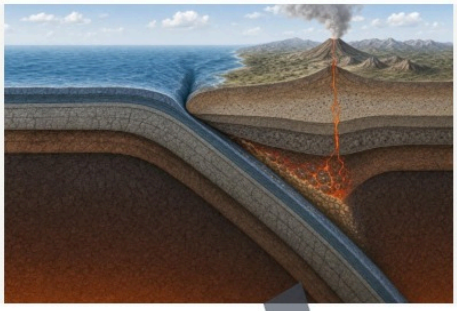
07 Discussion Questions

Discuss each question with your group and be ready to share your reasoning with evidence from the article.



02 At this boundary, one plate sinks beneath another, a process called subduction that can trigger earthquakes and volcanoes.

1. Why do scientists describe Earth's lithosphere as a 'cracked eggshell' rather than one solid piece, and how does this idea help explain earthquakes and volcanoes?

2. How do the three types of plate boundaries (colliding, pulling apart, and sliding past) each produce different kinds of landforms or events?

3. How does the age pattern of the Hawaiian–Emperor seamount chain serve as evidence that the Pacific Plate is moving, even though the hot spot itself stays in roughly the same place?

4. What are some different types of evidence (fossils, rocks, seafloor age, continental shapes) that scientists use to show continents have moved over time, and why is it convincing when multiple types of evidence agree?

5. Why can a motion as slow as a few centimeters per year eventually cause dramatic changes like new ocean basins or towering mountain ranges?

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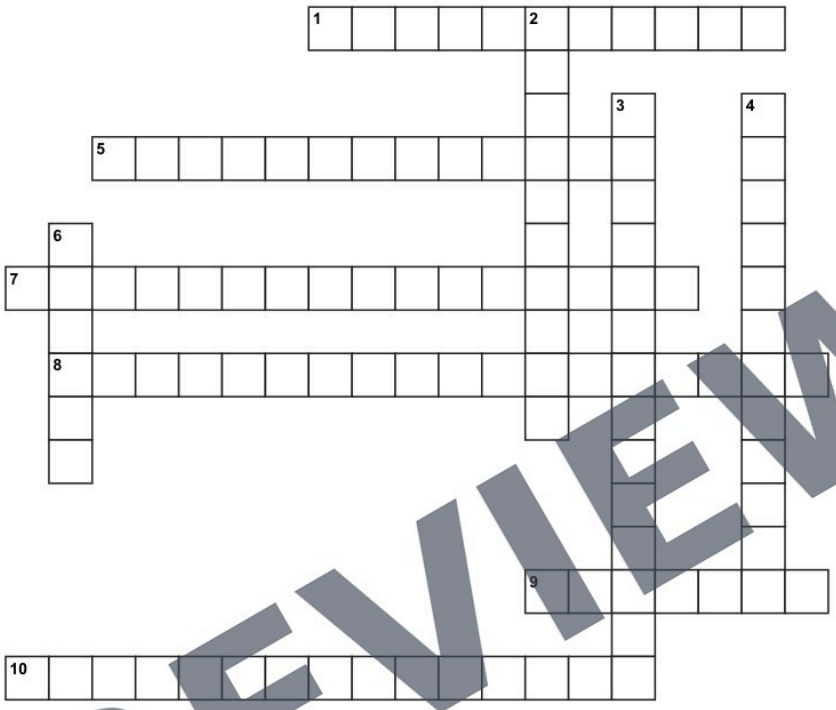
Crossword



ACROSS

1. Earth's rigid outer layer that is broken into giant slabs called tectonic plates.
2. An underwater location where plates pull apart and magma rises to form new ocean floor.
3. The slow churning motion caused by heat inside Earth that helps push and pull tectonic plates.
4. The principle that in undisturbed rock layers, the oldest layers are at the bottom and younger layers are…
5. A relatively fixed source of rising hot mantle material that can burn through the middle of a plate to…
6. The edges where two tectonic plates meet and interact, causing earthquakes, volcanoes, or mountain building.

DOWN

1. The process where one tectonic plate sinks beneath another, often triggering earthquakes and volcanoes.
2. Giant slabs of Earth's lithosphere that slowly move over the mantle below.
3. A volcano formed when huge pools of magma build up so much pressure that they erupt explosively and reshape…
4. Cracks in Earth's crust where plates slide past each other, releasing energy as earthquakes.

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Word Search

U S S U S P E A D T L M T N N S A A
M A T U O L O O C S D C P T E H S U
L A W O F S U P E R P O S I T I O N
T P N L I T H O S P H E R E A P B P
P O O T O U M C A U P A G D T S U A
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N M I S U P E R V O L C A N O R R E
F E S T N N C E I Y T C F L N N O O
A T U I N A S C I H S E C O C T P S

FIND THESE WORDS

law of superposition
mantle convection
plate boundaries
tectonic plates
mid-ocean ridge
supervolcano
lithosphere
subduction
hot spot
faults