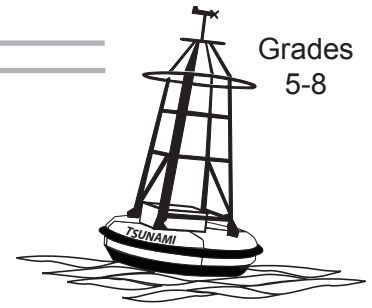


Convection and Plate Motion

Grades
5-8



Overview:

In this activity, students model spreading and subduction of plates in addition to geomagnetic reversals. Then they apply this knowledge by interpreting a figure depicting of the age of the Pacific Plate.

Targeted Alaska Grade Level Expectations:

Science

- [5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [7] SD2.2 The student demonstrates an understanding of the forces that shape Earth by describing how the movement of the tectonic plates results in both slow changes (e.g., formation of mountains, ocean floors, and basins) and short-term events (e.g., volcanic eruptions, seismic waves, and earthquakes) on the surface.
- [8] SD2.2 The student demonstrates an understanding of the forces that shape Earth by using models to show the relationships between convection currents within the mantle and the large-scale movement of the surface.

Objectives:

The student will:

- simulate ocean floor spreading and subduction;
- distinguish newer rock from older rock by its proximity to a spreading center; and
- apply understanding of the model to explain a figure depicting the age of the Pacific Plate.

Materials:

- Register tape
- Markers
- Tables (three per group)
- Digital timer
- STUDENT WORKSHEET: "Convection and Plate Motion"
- VISUAL AID: "Convection and Plates"

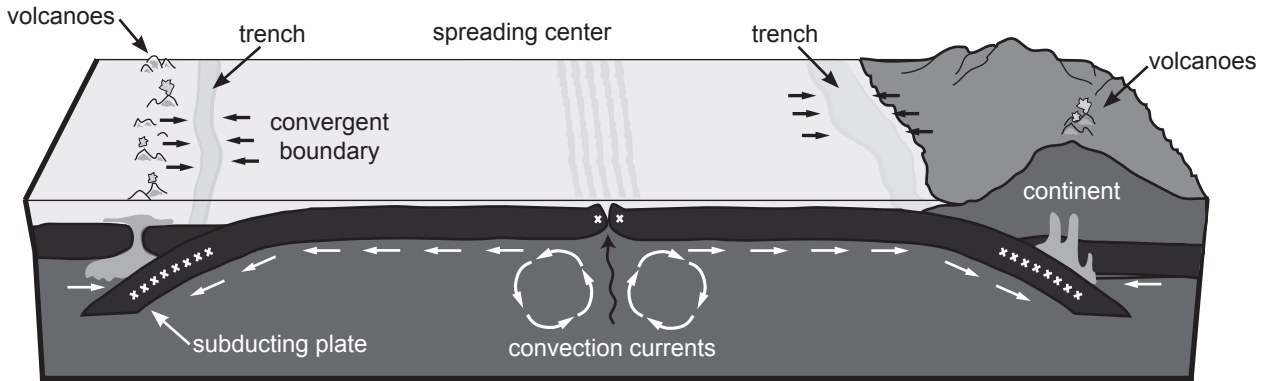
Science Basics:

Earth's crust and the top of Earth's mantle form a solid layer called the lithosphere. Under this layer lies a soft, jelly-like layer called the asthenosphere. The lithosphere floats and moves around on top of the mushy asthenosphere.

Convection currents within Earth contribute to large-scale movement of the surface. Convection currents push against sections of the lithosphere called "plates," causing them to move. This motion causes earthquakes and formation of volcanoes at, or near, plate boundaries and hot spots.

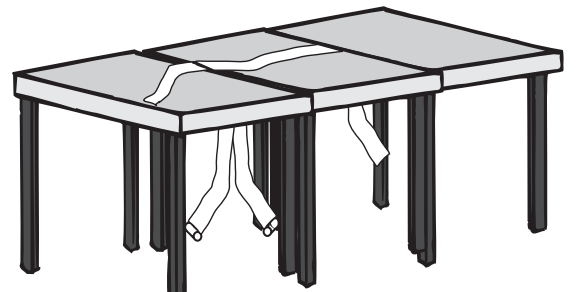
In the Pacific Ocean, the Juan de Fuca Ridge off the coast of Washington state and British Columbia pushes rock onto the Pacific Plate to the west and the Juan de Fuca Plate to the east. The Juan de Fuca Ridge is the closest spreading center to Alaska. This spreading center contributes to westward plate movement. In the Gulf of Alaska, the Pacific Plate moves north and west to subduct below the North American Plate. The main subduction zone in Alaska is the Aleutian Megathrust.

Earth's magnetic field is preserved in the alignment of magnetic particles within rocks. These particles align to Earth's magnetic field when the rocks are formed. Earth's magnetic field reverses polarity at irregular intervals but on average every 500,000 years. Therefore, measuring the magnetic polarity of the rocks and comparing those measurements establishes the relative ages of rocks on the ocean floor. The magnetic polarity of rocks near ocean floor spreading centers indicates younger paleomagnetic birth dates than does the magnetic polarity of rocks far from ocean floor spreading centers.



Activity Procedure:

1. Explain students will model ocean floor spreading and subduction by pulling strips of paper at timed intervals between three tables. The sections of register tape will represent lithospheric plates and the table will represent the asthenosphere.
2. Divide students into groups of four and ask each group to push three tables or desks together. Give each group a package of markers and two strips of register tape (one at least 6 feet long and the other at least 10 feet long).
3. Push one end of each strip of paper up between two tables. Pull the longer strip so that the tip begins to "subduct" in between the middle and third table. Explain the four jobs associated with the model. Assign the following positions in each group:



Crust Movers—Two students are needed to represent the force of Earth. Each student will slowly pull one strip of paper out from between the tables until the teacher tells them to stop. The student pulling the subducting strip may need to be situated below the table. It is important that both students pull their paper at the same rate so that approximately the same amount of paper is coming out on both sides of the spreading center.

Grapher—One student will use markers to color the strips of paper as the Crust Movers are pulling. Each time the teacher tells students to stop pulling, the Grapher should change marker colors. Explain the use of magnetic reversals and how they help establish the age of rock.

Recorder—One student will be the Recorder. Each time the teacher stops the Crust Movers and calls out the time, the Recorder will write the time on both strips of paper at the point where the papers are coming out from between the tables.

4. Ask students to arrange themselves around their tables. The Crust Movers should sit opposite each other and the Recorder and Grapher should sit where they can easily reach the point where the two strips of paper come up between the tables.
5. Set a digital timer for 2 minutes. Start the timer and ask Crust Movers to begin pulling slowly. After 10 seconds, say, "Stop" and report the time (1:50). Stop the timer. Allow Recorders to write the time and

Graphers to finish coloring. Repeat the process, allowing 5-15 second intervals. After two minutes, groups will have long strips of multicolored paper pulled up from between the tables. Do not let students pull the paper out from between the tables completely.

- Display VISUAL AID: "Convection and Plates." Guide the class in examining the visual aid and comparing components displayed in the model. The crack between the tables represents an ocean floor spreading center, and the colored strips on the paper represent different ages of rock. The point where the register tape goes below the table represents subduction. Ask students which rock is the youngest (*rock closest to the spreading center*). Ask which rock is the oldest (*rock farthest from the spreading center*). Explain although students completed the demonstration in just a few minutes, it would take the ocean floor many years to move such a great distance. Along the Aleutian Megathrust, the Pacific Plate moves North and West at a rate of 6.4 to 7.6 centimeters (2.5-to-3 inches) per year.
- Identify components not modeled (convection currents, volcanoes, and earthquakes).

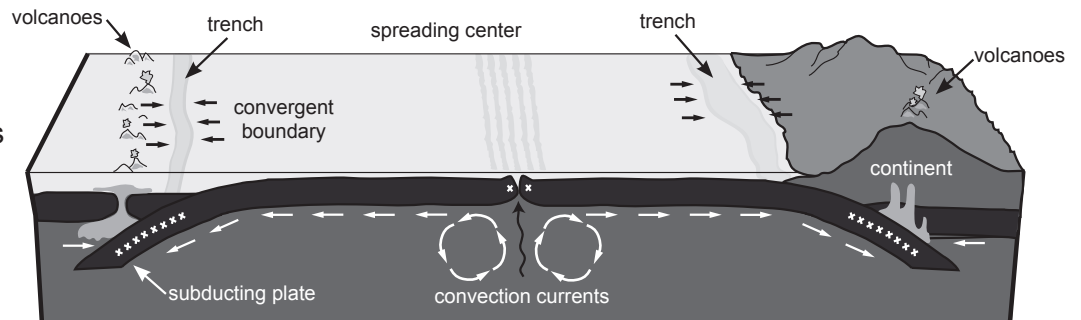
Critical Thinking: Wait Time Method. To give students time to think about their answers, explain you will be asking a question but will not call on them for answers immediately. The wait time can be about 15 seconds or longer. When the time is up ask for a show of hands or select a student to answer. Look at the two ocean crusts that converge. The ocean crust with the spreading center subducts below the ocean crust with the volcanoes. Why might ocean crust with the spreading center subduct below the ocean crust with volcanoes on it? (*At the plate boundary, the older rock is on the plate showing the spreading center. It is cooler and denser than the rock on the other plate. Therefore it subducts below the lighter, less dense rock.*)

- Distribute and ask students to complete the Student Worksheet: "Convection and Plate Motion."

Answers:

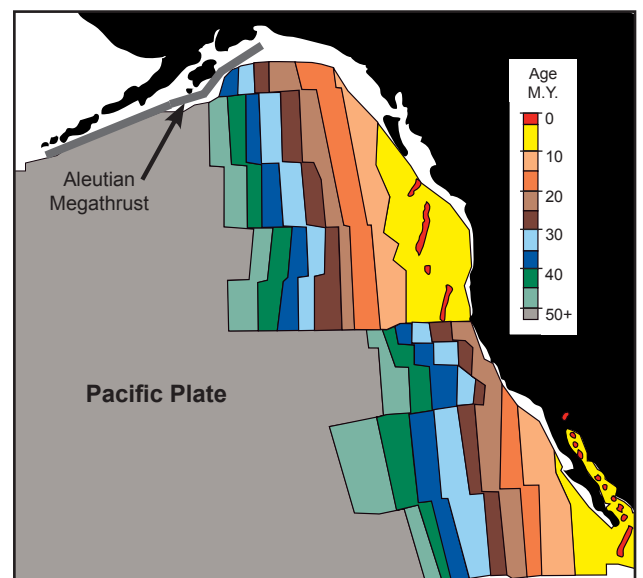
Part 1:

- See figure.
- See figure. Locations where earthquakes are most likely to occur are indicated by an x.



Part 2:

- See figure. Spreading centers are red.
- The spreading center is identified by the age of the rock. The rock at the spreading center is the newest of all the rock.
- A) No
- B) All areas of the plate do not move at the same rate. The evidence shows in the geomagnetic reversals that do not line up.
- About 20-50+ million years old.



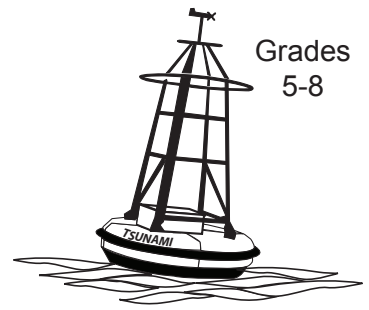
Lesson Information Sources:

- Dutch, S. (1997.) The north Pacific and the west coast of North America. Retrieved July 22, 2008 from <http://www.uwgb.edu/DutchS/plate tec/kula.htm>
- Haeussler, P. J., & Plafker, G. (1995). *Earthquakes in Alaska*. [Reston, VA]: United States Geological Survey.
- McLellend, C. & Metzger, E. (n.d.) Seafloor Spreading Made Easy. Retrieved July 22, 2008 from <http://www.geosociety.org/educate/LessonPlans/SeaFloorSpreading.pdf>
- Table Tectonics. (2007). University of Alaska Fairbanks Geophysical Institute. Retrieved July 22, 2008, from Ola Ka Honua: Volcanoes Alive. <http://www.volcanoesalive.com/>

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Student Worksheet (Part 1)

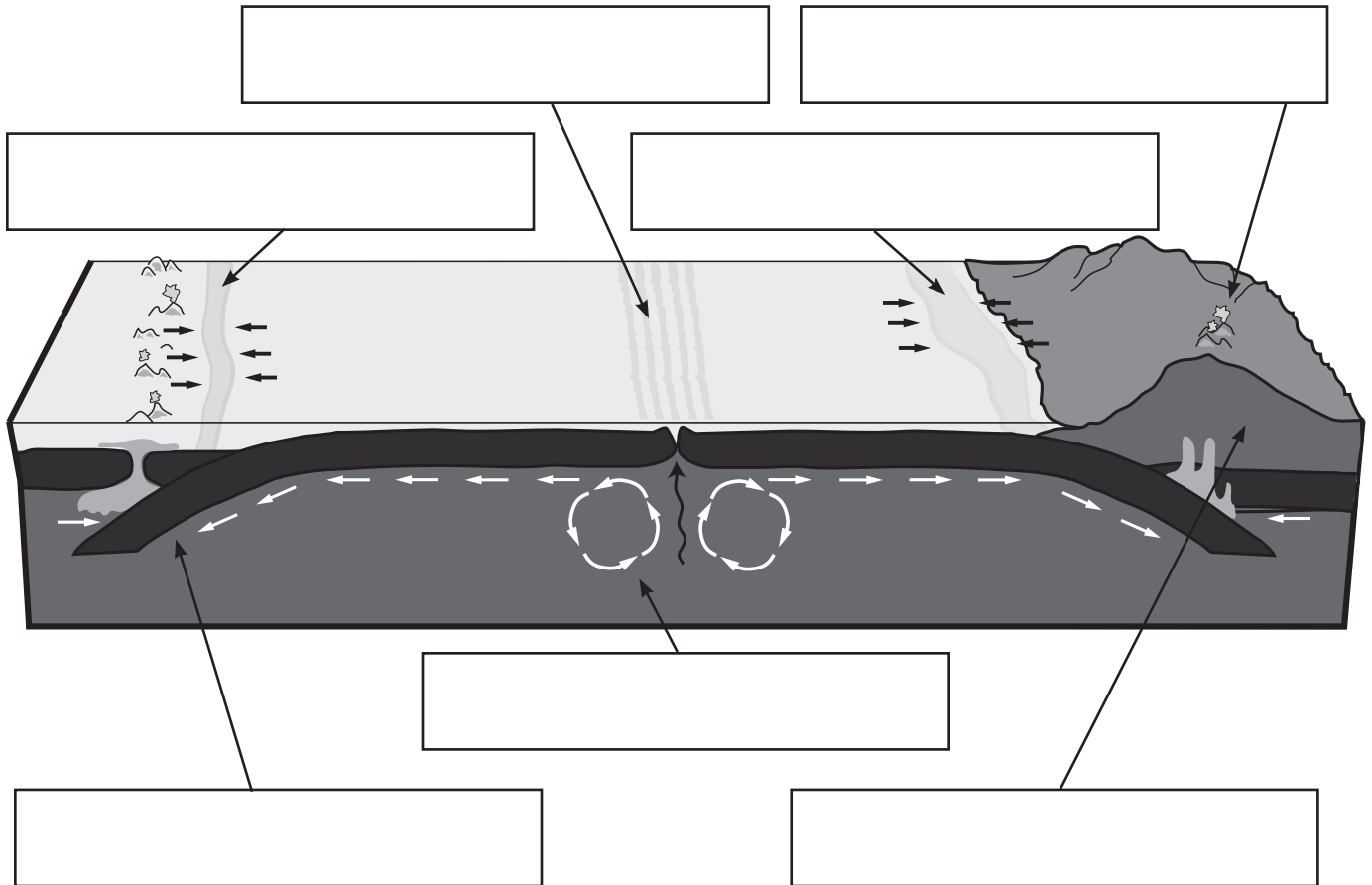
Convection and Plate Motion



Word Bank

- | | |
|------------------------|---------------------|
| a. convection currents | e. subducting plate |
| b. convergent boundary | f. trench |
| c. continent | g. volcano |
| d. spreading center | |

1. Label the diagram below with words from the word bank.
2. Place "X"s on areas of the diagram below where earthquakes are most likely to occur.

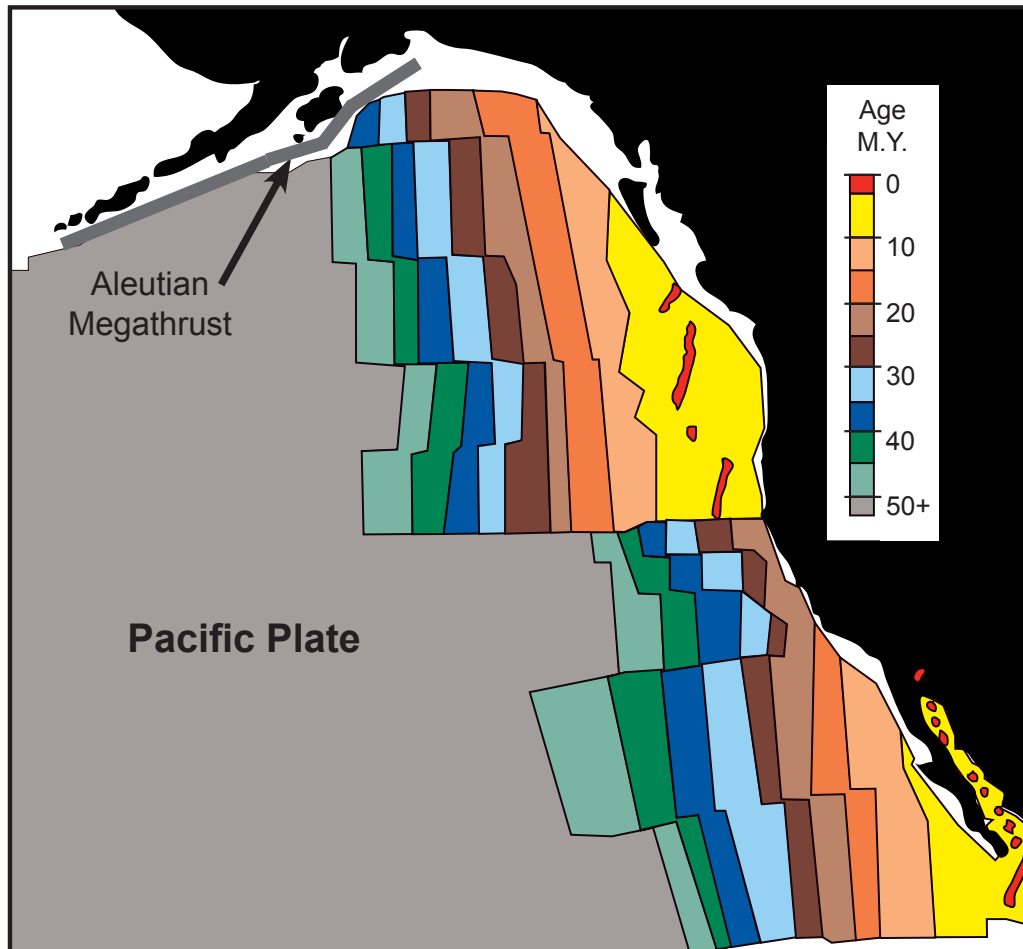


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Student Worksheet (Part 2)

Convection and Plate Motion

3. Circle the spreading center on the diagram.



4. Explain how the location of the spreading center can be determined.

5. A) Do all parts of the plate move at the same rate? _____
B) Explain how you know.

6. Locate the Aleutian Megathrust on the diagram of the Pacific Plate. What is the approximate age range of the plate subducting along the megathrust? _____