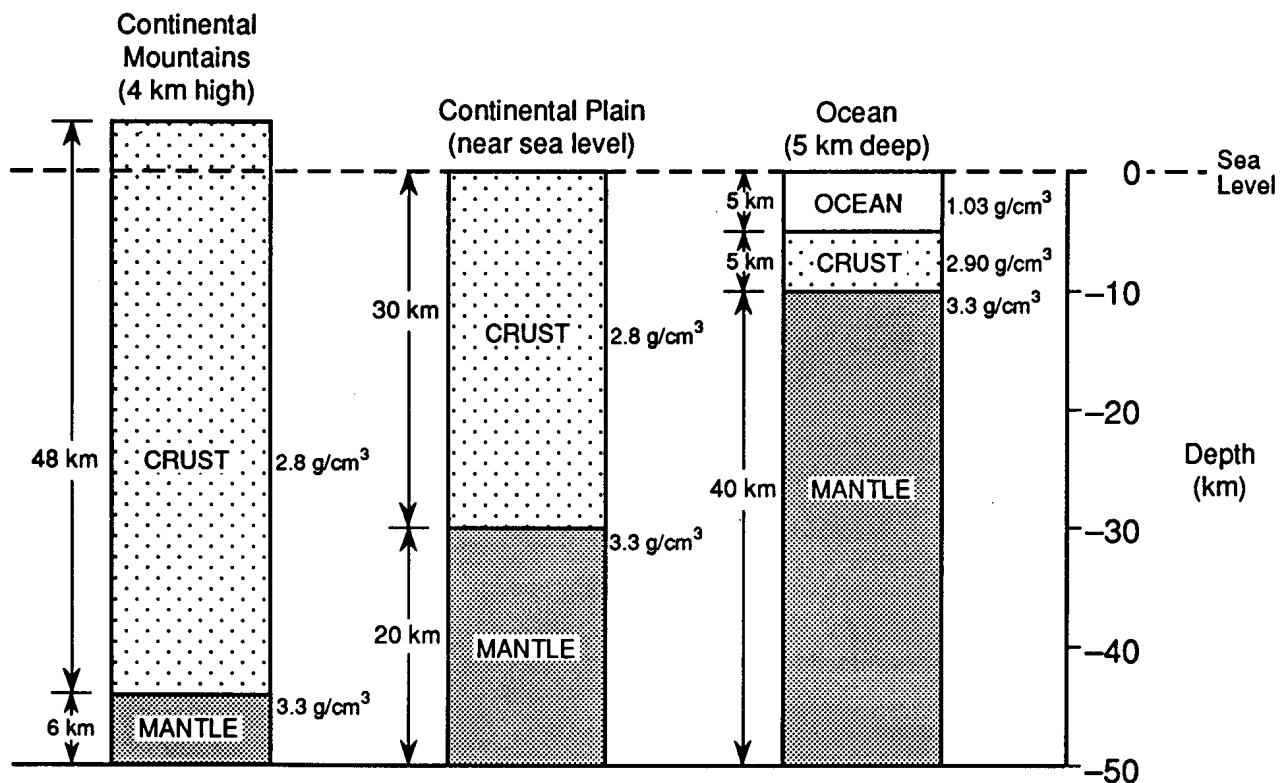


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Topic 12: Dynamic Earth Pracatice

- Earth's outer core is best inferred to be
 - liquid, with an average density of approximately 4 g/cm^3
 - liquid, with an average density of approximately 11 g/cm^3**
 - solid, with an average density of approximately 4 g/cm^3
 - solid, with an average density of approximately 11 g/cm^3
- Base your answer to the following question on the diagram below which represents three cross sections of the Earth at different locations to a depth of 50 kilometers below sea level. The measurements given with each cross section indicate the thickness and the density of the layers.

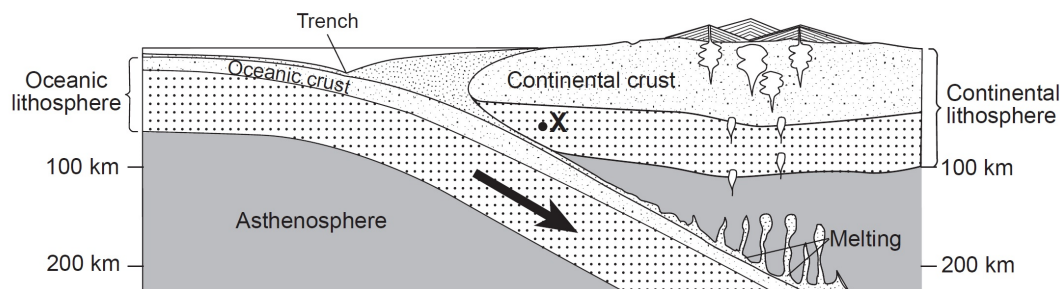


The division of the Earth's interior into crust and mantle, as shown in the diagram, is based primarily on the study of

- radioactive dating
 - seismic waves**
 - volcanic eruptions
 - gravity measurements
- Beneath which surface location is Earth's crust the thinnest?
 - East Pacific Ridge**
 - the center of South America
 - Old Forge, New York
 - San Andreas Fault
 - Where is the thickest part of the Earth's crust?
 - at the edge of continental shelves
 - at mid-ocean ridges
 - under continental mountain ranges**
 - under volcanic islands

Topic 12: Dynamic Earth Pracatice

5. Base your answer to the following question on the cross section below, which shows the boundary between two lithospheric plates. Point *X* is a location in the continental lithosphere. The depth below Earth's surface is labeled in kilometers.



(Not drawn to scale)

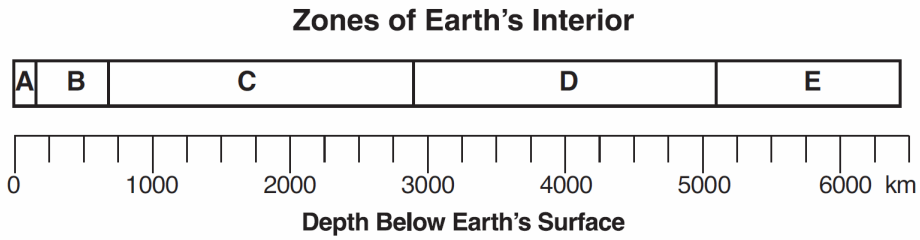
Compared to the continental crust, the oceanic crust is

- A) less dense and thinner
B) less dense and thicker
C) **more dense and thinner**
D) more dense and thicker
-
6. Compared to the continental crust of central North America, the oceanic crust of the Mid-Atlantic Ridge is

- A) **younger**
B) thicker
C) less dense
D) more felsic
7. Which statement about the Earth's mantle is correct?
- A) The density of the mantle is greatest 300 km below the Earth's surface.
B) The highest temperatures within the Earth occur in the mantle.
C) The greatest pressures within the Earth exist in the mantle.
D) **The temperature of the mantle 300 km below the Earth's surface is very near its melting point.**

Topic 12: Dynamic Earth Pracatice

8. Base your answer to the following question on the diagram below, which represents zones of Earth's interior, identified by letters *A* through *E*. The scale shows depths below Earth's surface, measured in kilometers.



Which zone is characterized by partially melted rock and large-scale convection currents?

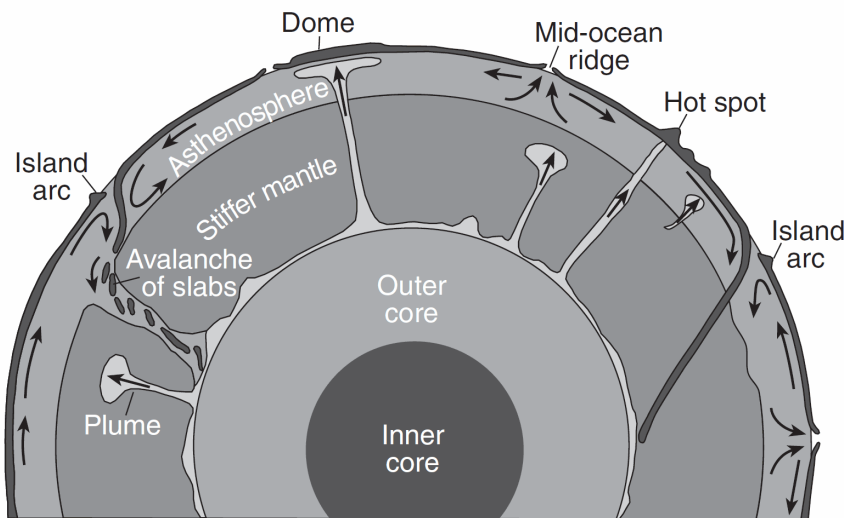
- A) zone *A* **B) zone *B*** C) zone *C* D) zone *E*

Topic 12: Dynamic Earth Pracatice

Base your answers to questions 9 and 10 on the passage and cross section below and on your knowledge of Earth science. The cross section represents one theory of the movement of rock materials in Earth's dynamic interior. Some mantle plumes that are slowly rising from the boundary between Earth's outer core and stiffer mantle are indicated.

Hot Spots and Mantle Plumes

Research of mantle hot spots indicates that mantle plumes form in a variety of sizes and shapes. These mantle plumes range in diameter from several hundred kilometers to 1000 kilometers. Some plumes rise as blobs rather than in a continuous streak; however, most plumes are long, slender columns of hot rock slowly rising in Earth's stiffer mantle. One theory is that most plumes form at the boundary between the outer core and the stiffer mantle. They may reach Earth's surface in the center of plates or at plate boundaries, producing volcanoes or large domes.

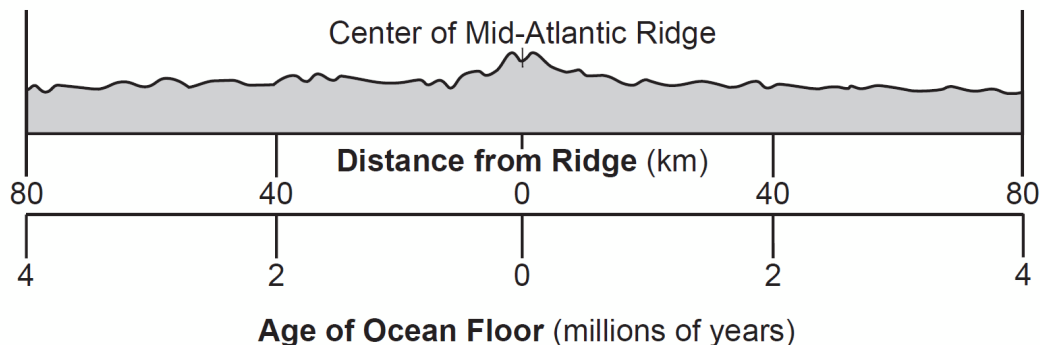


(Not drawn to scale)

9. The basaltic rock that forms volcanic mountains where mantle plumes reach Earth's surface is usually composed of
- A) fine-grained, dark-colored felsic minerals
 - B) fine-grained, dark-colored mafic minerals**
 - C) coarse-grained, light-colored felsic minerals
 - D) coarse-grained, light-colored mafic minerals
10. Compared to the surrounding material, mantle plumes rise toward Earth's surface from the core-mantle boundary because they are
- A) cooler and less dense
 - B) cooler and more dense
 - C) hotter and less dense**
 - D) hotter and more dense

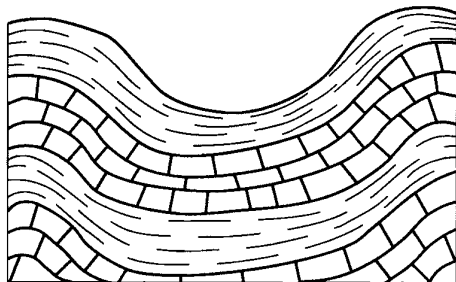
Topic 12: Dynamic Earth Pracatice

11. Base your answer to the following question on the cross section below and on your knowledge of Earth science. The cross section represents the distance and age of ocean-floor bedrock found on both sides of the Mid-Atlantic Ridge.



According to the cross section, every 1 million years, the ocean floor bedrock moves approximately

- A) 20 km toward the Mid-Atlantic Ridge
B) **20 km away from the Mid-Atlantic Ridge**
C) 40 km toward the Mid-Atlantic Ridge
D) 40 km away from the Mid-Atlantic Ridge
12. The cross section below shows a portion of Earth's crust.



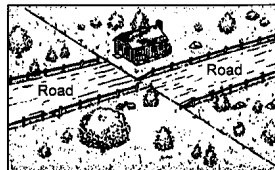
Which observation provides the most direct evidence that crustal plate collision has occurred near this region?

- A) alternating layers of shale and limestone bedrock
B) absence of an igneous intrusive rock
C) different thicknesses of the sedimentary layers
D) **folding of the sedimentary layers**

13. Fossils of marine plants and animals are found in the bedrock of mountains many thousands of feet above sea level. The most likely reason for this observation is that

- A) the mountains were part of a mid-ocean ridge
B) the ocean level has dropped several thousand feet
C) **forces within the Earth caused uplift**
D) transported materials were deposited at high elevations

14. The diagram below shows land features that have been disrupted by an earthquake.

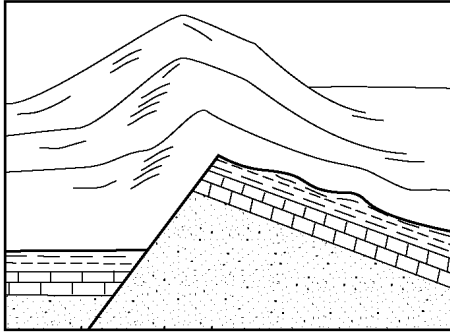


Which type of crustal movement most likely caused the displacement of features in this area?

- A) vertical lifting of surface rock
B) folding of surface rock
C) down-warping of the crust
D) **movement along a transform fault**

Topic 12: Dynamic Earth Pracatice

15. The diagram below shows the bedrock structure beneath a series of hills.



Which process was primarily responsible for forming the hills?

- A) folding **B) faulting**
 C) deposition D) vulcanism
16. Base your answer to the following question on the data table below, which gives information collected at seismic stations *W*, *X*, *Y*, and *Z* for the same earthquake. Some of the data have been omitted.

Data Table

Seismic Station	P-Wave Arrival Time (h:min:s)	S-Wave Arrival Time (h:min:s)	Difference in Arrival Times (h:min:s)	Distance to Epicenter (km)
W	10:50:00	no S-waves arrived		
X	10:42:00	10:46:40		
Y	10:39:20		00:02:40	
Z	10:45:40			6200

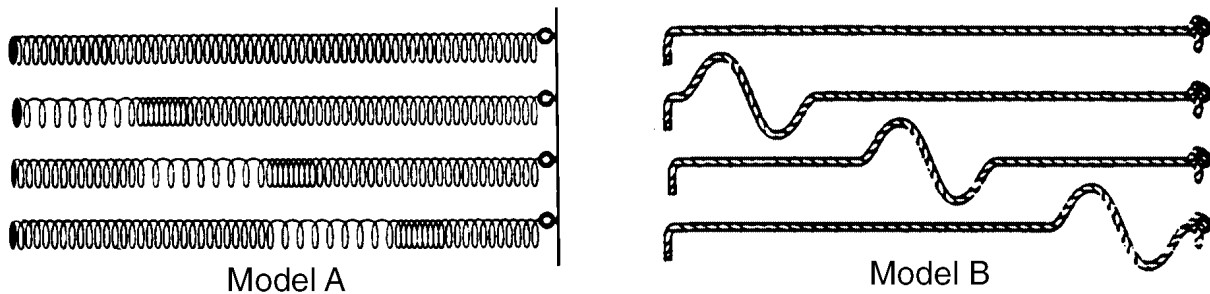
What is the most probable reason for the absence of *S*-waves at station *W*?

- A) *S*-waves were not generated at the epicenter.
B) *S*-waves cannot travel through liquids.
 C) Station *W* was located on solid bedrock.
 D) Station *W* was located on an island.

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Topic 12: Dynamic Earth Pracatice

17. Base your answer to the following question on the diagram below, which shows models of two types of earthquake waves.

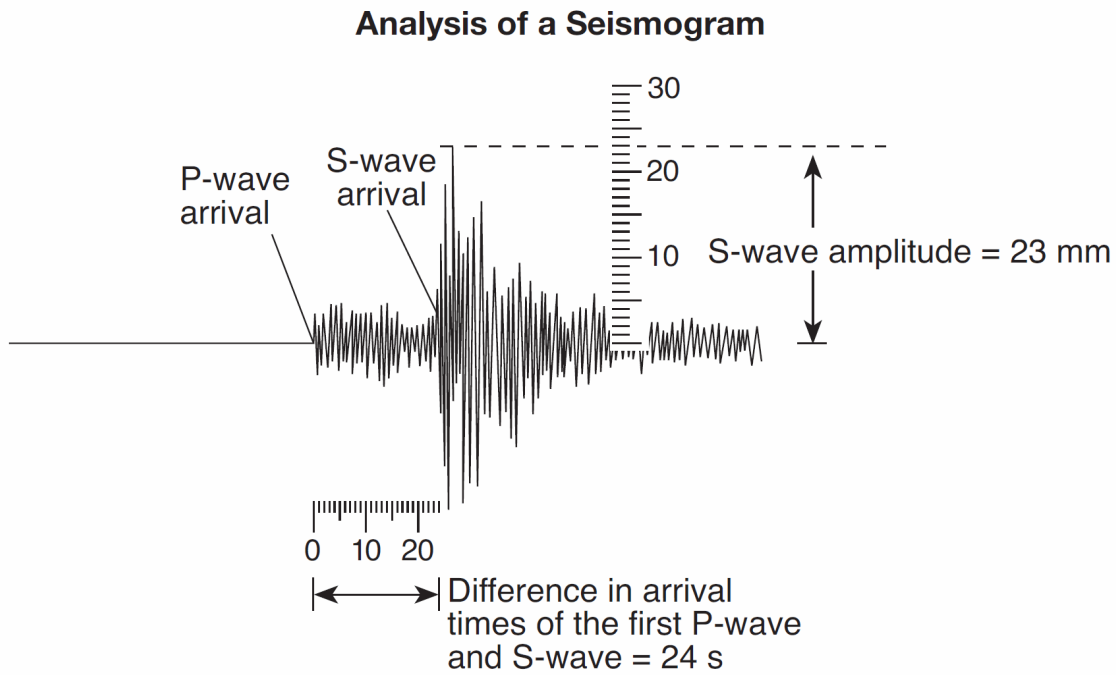


Model *A* best represents the motion of earthquake waves called

- A) *P*-waves (compressional waves) that travel faster than *S*-waves (shear waves) shown in model *B*
- B) *P*-waves (compressional waves) that travel slower than *S*-waves (shear waves) shown in model *B*
- C) *S*-waves (shear waves) that travel faster than *P*-waves (compressional waves) shown in model *B*
- D) *S*-waves (shear waves) that travel slower than *P*-waves (compressional waves) shown in model *B*
-
18. How long after receiving the first *P*-wave from an earthquake centered 4000 kilometers away does a seismic station receive its first *S*-wave from the same earthquake?
- A) 1 minute
- B) 5 minutes 35 seconds**
- C) 7 minutes
- D) 12 minutes 40 seconds
19. What is the approximate *P*-wave travel time from an earthquake if the *P*-wave arrives at the seismic station 8 minutes before the *S*-wave?
- A) 4 minutes 20 seconds
- B) 6 minutes 30 seconds
- C) 10 minutes 0 seconds**
- D) 11 minutes 20 seconds

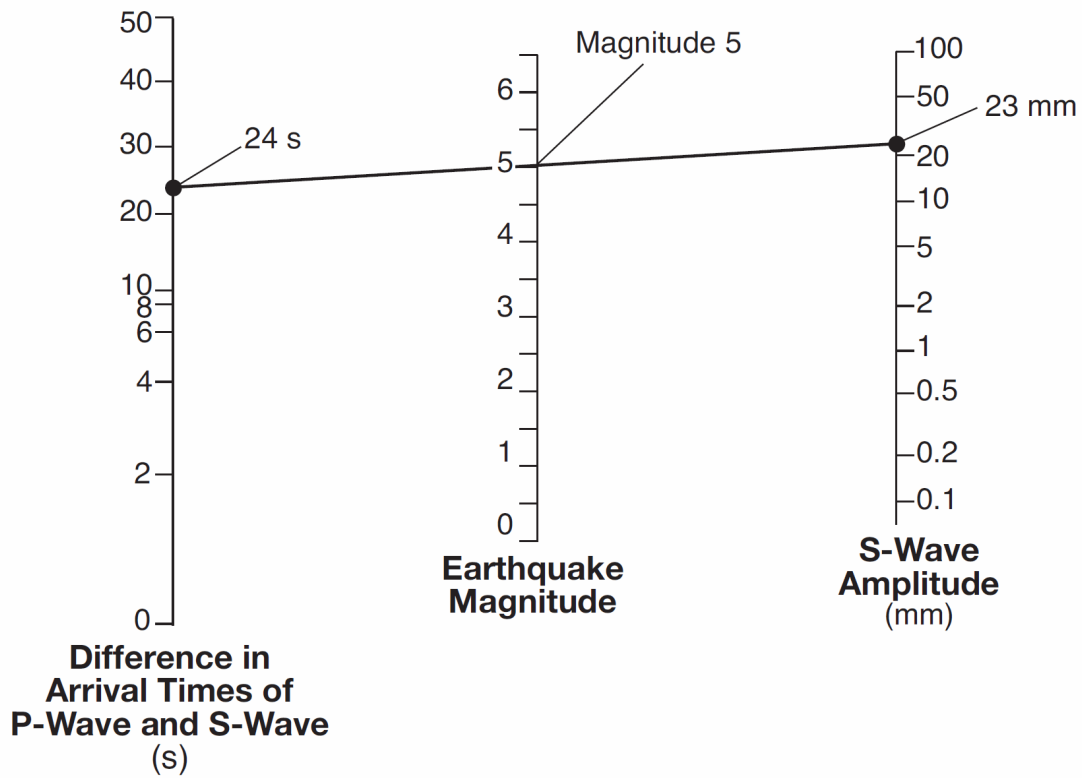
Topic 12: Dynamic Earth Pracatice

20. The diagram below represents the analysis of a seismogram used to calculate an earthquake's magnitude on the Richter Scale. This seismogram shows the difference in arrival times, in seconds, of the first P-wave and S-wave and the amplitude of the S-wave in millimeters.



The diagram below represents how the earthquake's magnitude is determined by drawing a line connecting the difference in arrival times of the P-wave and the S-wave, and the S-wave amplitude.

Topic 12: Dynamic Earth Pracatice

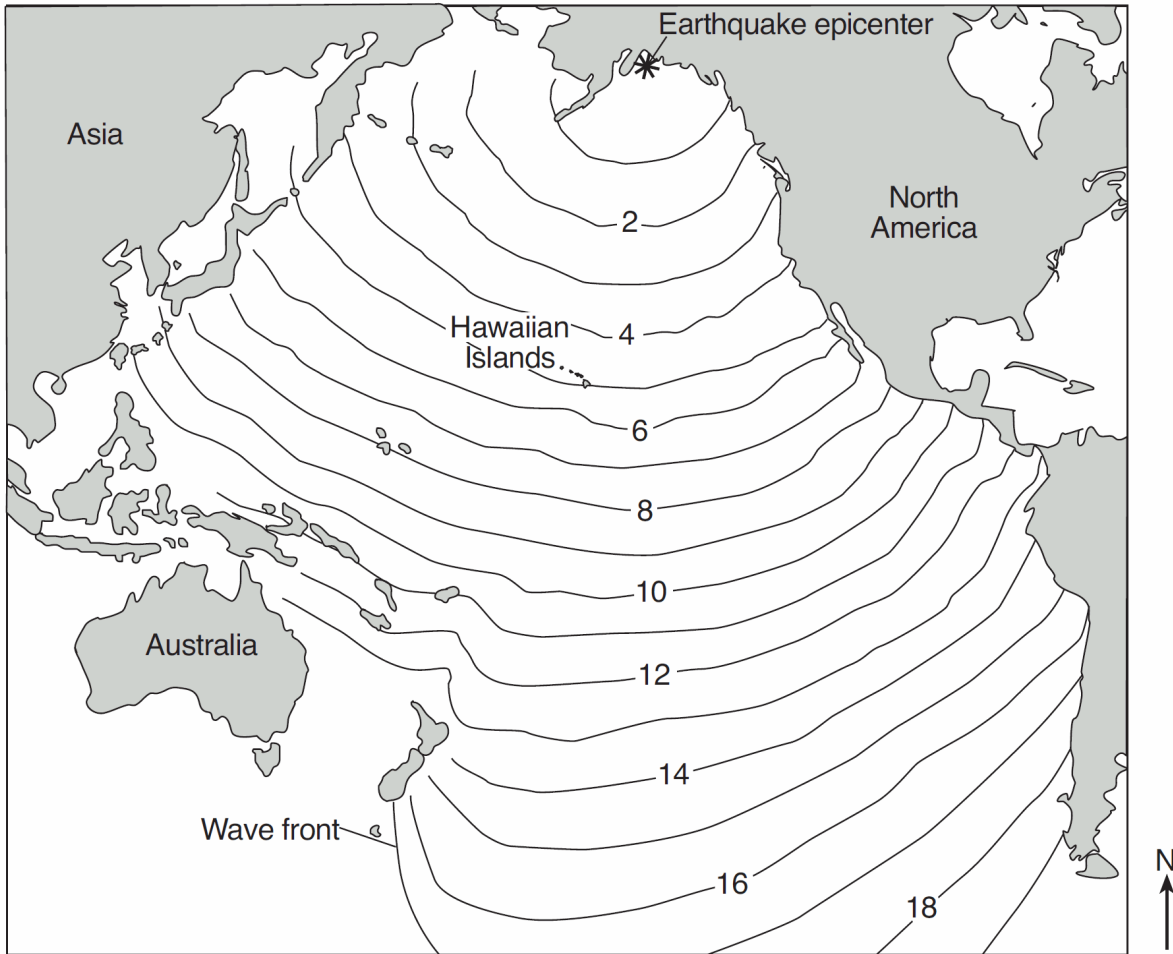


What is the magnitude of a recorded earthquake if the difference in arrival times of the first P-wave and S-wave is 2 seconds and the S-wave amplitude is 20 millimeters?

- A) 3.8 B) 2.0 C) **3.0** D) 4.8

Topic 12: Dynamic Earth Pracatice

21. The map below shows changes in the position of the tsunami wave front produced by the 1964 Alaskan earthquake. The numbers indicate the time, in hours, for the wave front to reach the positions indicated by the isolines.

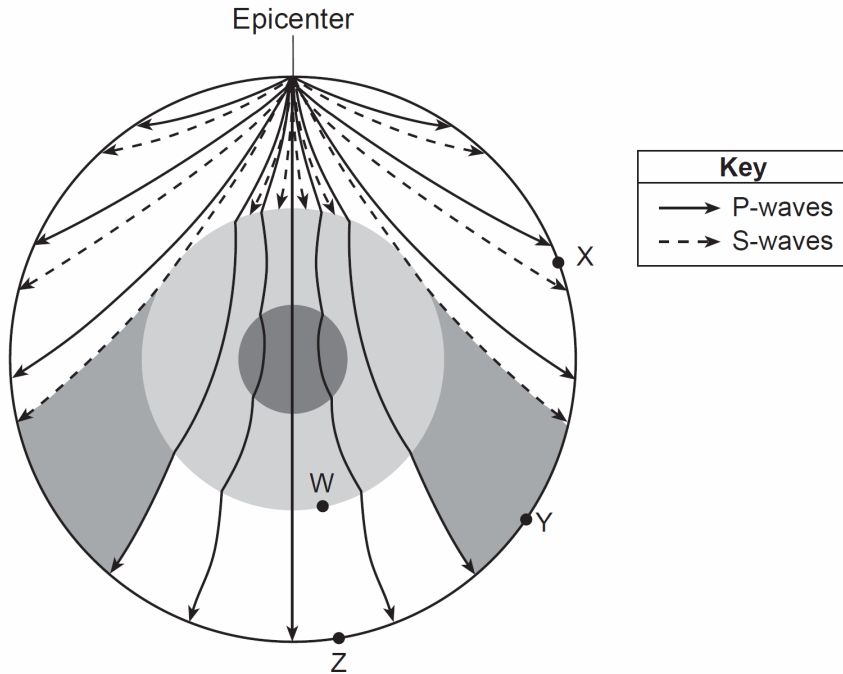


If the wave front reached the Hawaiian Islands at 10:30 p.m., at approximately what time did the earthquake occur?

- A) 1:30 p.m. **B) 5:30 p.m.** C) 3:30 p.m. D) 4:30 p.m.

Topic 12: Dynamic Earth Pracatice

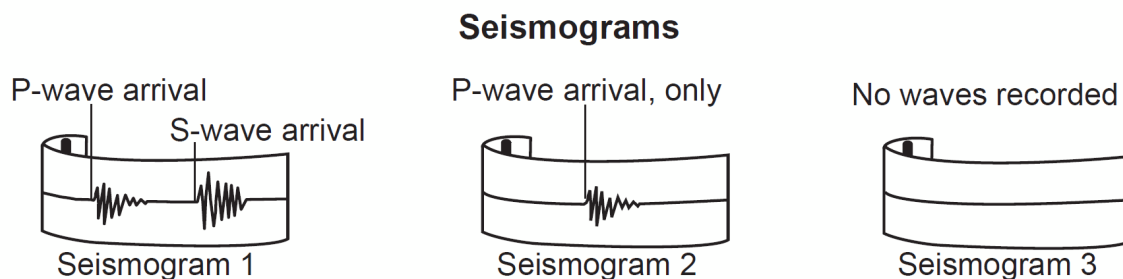
Base your answers to questions **22** and **23** on the cross section of Earth below and on your knowledge of Earth science. The cross section represents the pattern of seismic wave movement away from an earthquake. Point *W* represents a location at the boundary between two layers of Earth's interior. Points *X*, *Y*, and *Z* represent seismic stations on Earth's surface.



22. Which statement best explains why *no* S-waves were received directly from this earthquake at some seismic stations?
- A) **An interior Earth layer absorbs S-waves.**
 - B) Earth's mantle reflects S-waves.
 - C) S-waves travel slower than P-waves.
 - D) S-waves travel only on Earth's surface.

Topic 12: Dynamic Earth Pracatice

23. The diagram below represents the seismograms of this earthquake recorded at seismic stations *X*, *Y*, and *Z*.



Which table best matches each seismic station with its likely seismogram?

A)

Seismic Station	Seismogram
X	1
Y	2
Z	3

B)

Seismic Station	Seismogram
X	3
Y	2
Z	1

C)

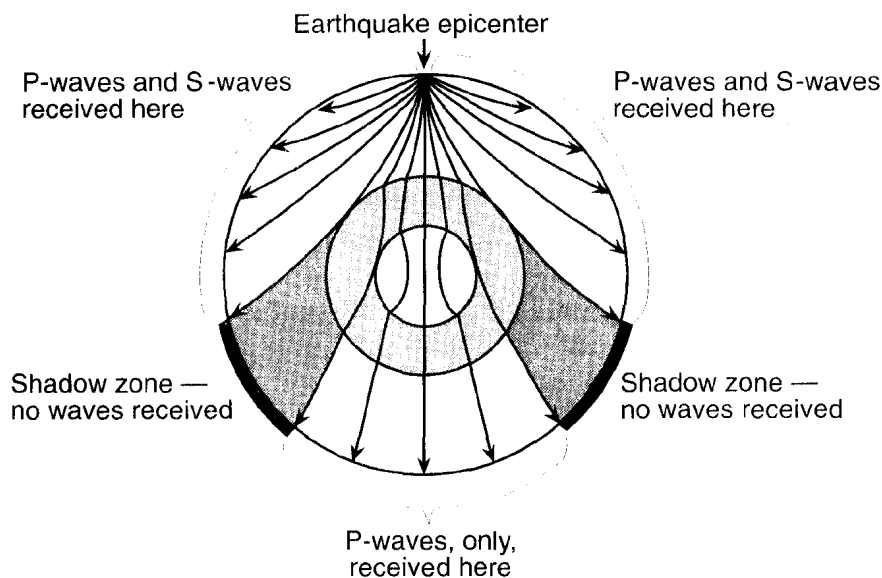
Seismic Station	Seismogram
X	2
Y	3
Z	1

D)

Seismic Station	Seismogram
X	1
Y	3
Z	2

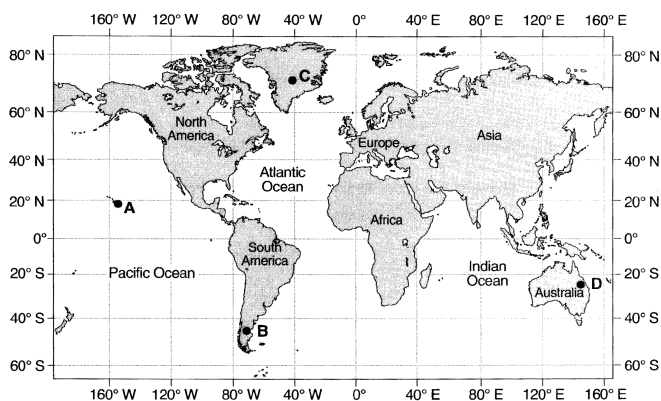
Topic 12: Dynamic Earth Pracatice

24. Base your answer to the following question on the cross section below, which shows the paths of seismic waves traveling from an earthquake epicenter through the different layers of Earth's interior.



The distance from Albany, New York, to the epicenter of this earthquake is 5600 km. Approximately how much longer did it take for the *S*-wave to arrive at Albany than the *P*-wave?

- A) 4 minutes and 20 seconds
 B) **7 minutes and 10 seconds**
 C) 9 minutes and 0 seconds
 D) 16 minutes and 10 seconds
25. A seismograph station recorded the arrival of the first *P*-wave at 7:32 p.m. from an earthquake that occurred 4000 kilometers away. What time was it at the station when the earthquake occurred?
- A) 7:20 p.m.
 B) **7:25 p.m.**
 C) 7:32 p.m.
 D) 7:39 p.m.
26. On the map below, points *A* through *D* represent locations on Earth's surface.



Which location is positioned over a mantle hot spot?

- A) A B) B C) C D) D

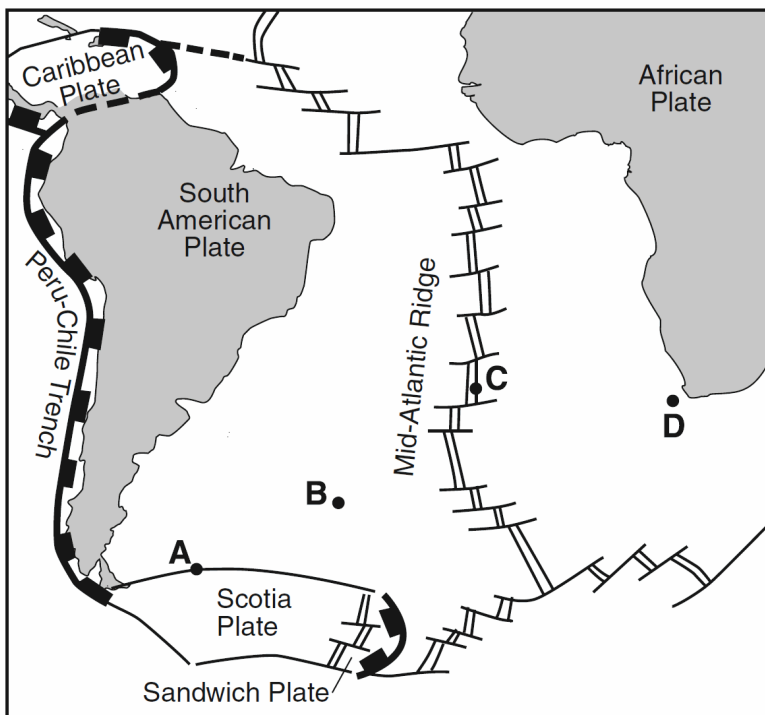
Topic 12: Dynamic Earth Pracatice

27. Base your answer to the following question on the passage below.

Crustal Activity at Mid-Ocean Ridges

Mid-ocean ridges are found at one type of tectonic plate boundary. These ridges consist of extensive underwater mountain ranges split by rift valleys. The rift valleys mark places where two crustal plates are pulling apart, widening the ocean basins, and allowing magma from the asthenosphere to move upward. In some cases, mid-ocean ridges have migrated toward nearby mantle hot spots. This explains why mid-ocean ridges and mantle hot spots are found together at several locations.

The map below shows a part of Earth's surface. Points *A* through *D* are locations on the ocean floor.

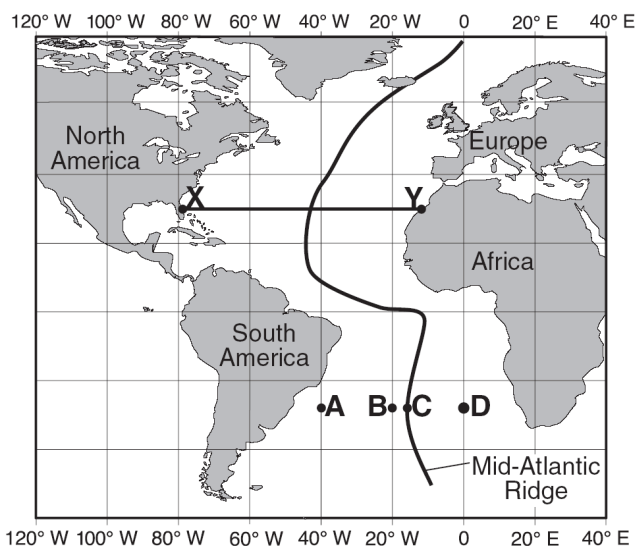


At which location is the temperature of the ocean floor bedrock most likely highest?

- A) *A* B) *B* C) *C* D) *D*

Topic 12: Dynamic Earth Pracatice

28. Base your answer to the following question on the map of the Mid-Atlantic Ridge shown below. Points *A* through *D* are locations on the ocean floor. Line *XY* connects locations in North America and Africa.



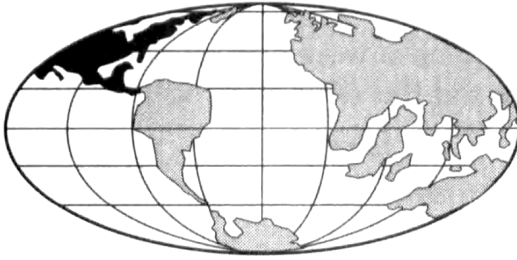
In which cross section do the arrows best show the convection occurring within the asthenosphere beneath line *XY*?

- A) Cross-section A shows the Mid-Atlantic Ridge between points X and Y. The Atlantic Ocean is above the asthenosphere. Arrows in the asthenosphere indicate a clockwise convection cell: material rises in the center (under the ridge) and moves back down towards the sides (under North America and Europe).
- B) Cross-section B shows the Mid-Atlantic Ridge between points X and Y. The Atlantic Ocean is above the asthenosphere. Arrows in the asthenosphere indicate a clockwise convection cell: material rises in the center (under the ridge) and moves back down towards the sides (under North America and Europe).
- C) Cross-section C shows the Mid-Atlantic Ridge between points X and Y. The Atlantic Ocean is above the asthenosphere. Arrows in the asthenosphere indicate vertical convection: material rises in the center (under the ridge) and moves back down towards the sides (under North America and Europe).
- D) Cross-section D shows the Mid-Atlantic Ridge between points X and Y. The Atlantic Ocean is above the asthenosphere. Arrows in the asthenosphere indicate horizontal convection: material moves from the center (under the ridge) outwards towards the sides (under North America and Europe).

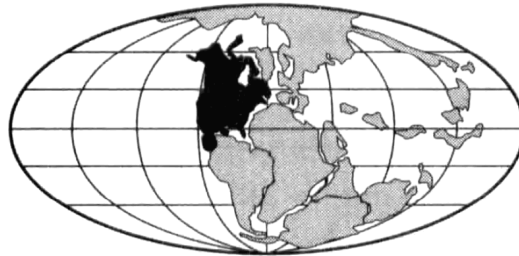
Topic 12: Dynamic Earth Pracatice

29. Which map best indicates the probable locations of continents 100 million years from now if tectonic plate movement continues at its present rate and direction?

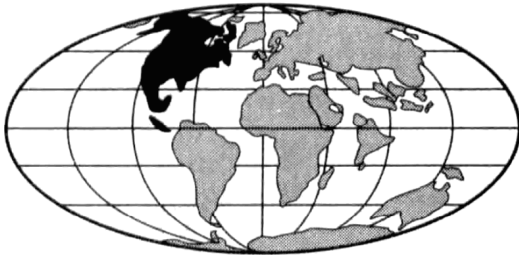
A)



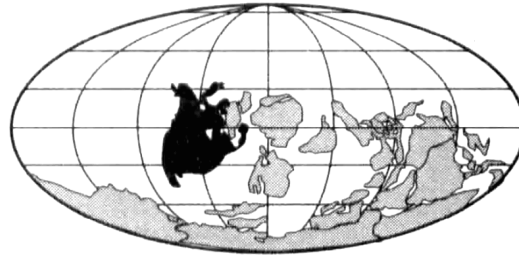
B)



C)

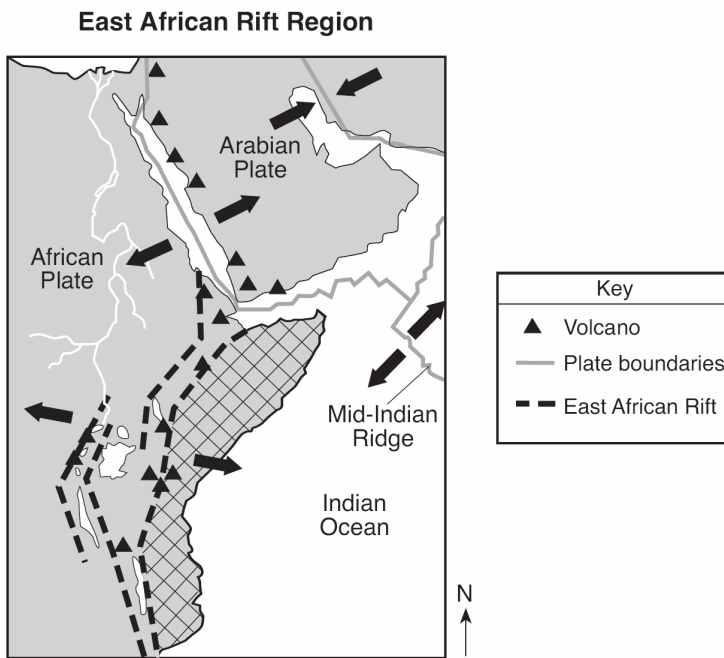


D)

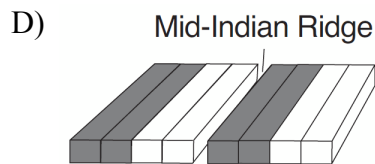
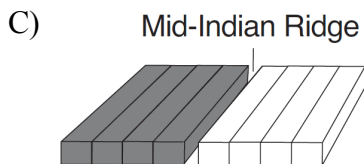
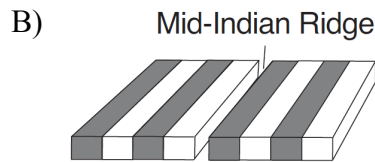
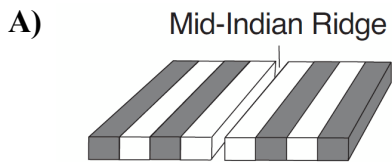
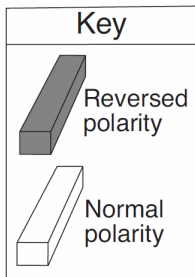


Topic 12: Dynamic Earth Pracatice

30. Base your answer to the following question on the map below, which shows the tectonic plate boundaries near the East African Rift. Arrows show relative tectonic plate movement. A region of Africa is crosshatched.



Which diagram best represents the polarity of the magnetic field preserved in the ocean-floor bedrock found on both sides of the Mid-Indian Ridge?



Answer Key
Topic 12: Dynamic Earth

1. **B**
 2. **B**
 3. **A**
 4. **C**
 5. **C**
 6. **A**
 7. **D**
 8. **B**
 9. **B**
 10. **C**
 11. **B**
 12. **D**
 13. **C**
 14. **D**
 15. **B**
 16. **B**
 17. **A**
 18. **B**
 19. **C**
 20. **C**
 21. **B**
 22. **A**
 23. **D**
 24. **B**
 25. **B**
 26. **A**
 27. **C**
 28. **B**
 29. **A**
 30. **A**
-