

Dynamic Crust Multiple Choice

1. When two tectonic plates collide, oceanic crust usually subducts beneath continental crust because oceanic crust is primarily composed of igneous rock that has

- (1) low density and is mafic
- (2) low density and is felsic
- (3) high density and is mafic
- (4) high density and is felsic

The data table below shows the origin depths of all large-magnitude earthquakes over a 20-year period.

Data Table

Depth Below Surface (km)	Number of Earthquakes
0–33	27,788
34–100	17,585
101–300	7,329
301–700	3,167

2. According to these data, most of these earthquakes occurred within Earth's

- (1) lithosphere
- (2) asthenosphere
- (3) stiffer mantle
- (4) outer core

3. Alternating parallel bands of normal and reversed magnetic polarity are found in the basaltic bedrock on either side of the

- (1) Mid-Atlantic Ridge
- (2) Yellowstone Hot Spot
- (3) San Andreas Fault
- (4) Peru-Chile Trench

3. Which part of Earth's interior is inferred to have convection currents that cause tectonic plates to move?

- (1) rigid mantle
- (2) asthenosphere
- (3) outer core
- (4) inner core

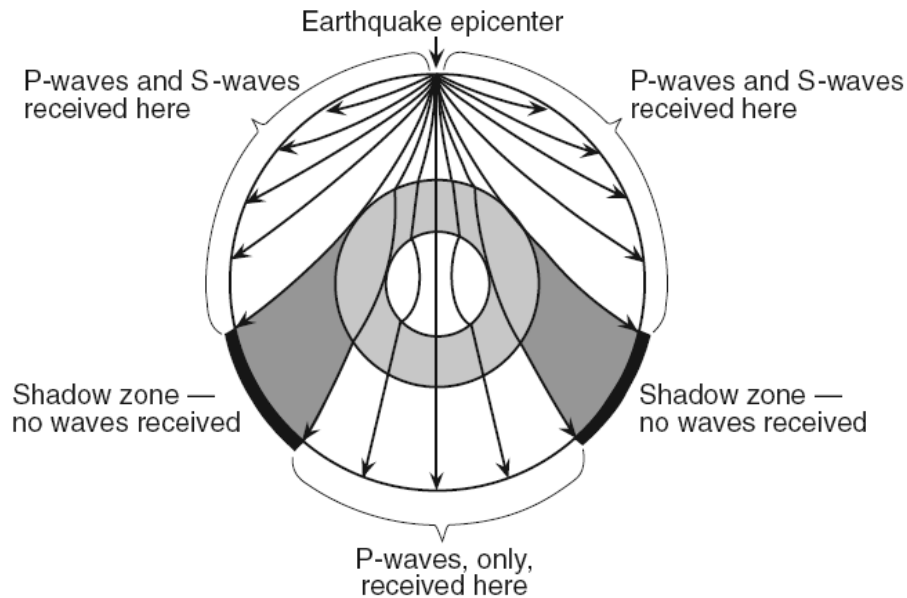
4. Active volcanoes are most abundant along the

- (1) edges of tectonic plates
- (2) eastern coastline of continents
- (3) 23.5° N and 23.5° S parallels of latitude
- (4) equatorial ocean floor

5. Compared to the continental crust, the oceanic crust is

- (1) less dense and less felsic
- (2) less dense and less mafic
- (3) more dense and more felsic
- (4) more dense and more mafic

Base your answers to questions 6 and 7 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.



6. No *P*-waves or *S*-waves are received in the shadow zone because

- (1) *P*-waves are absorbed and *S*-waves are refracted by Earth's outer core
- (2) *P*-waves are refracted and *S*-waves are absorbed by Earth's outer core
- (3) both the *P*-waves and *S*-waves are refracted by Earth's outer core
- (4) both the *P*-waves and *S*-waves are absorbed by Earth's outer core

7. 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?

- (1) 4 minutes and 20 seconds
- (2) 7 minutes and 10 seconds
- (3) 9 minutes and 0 seconds
- (4) 16 minutes and 10 seconds

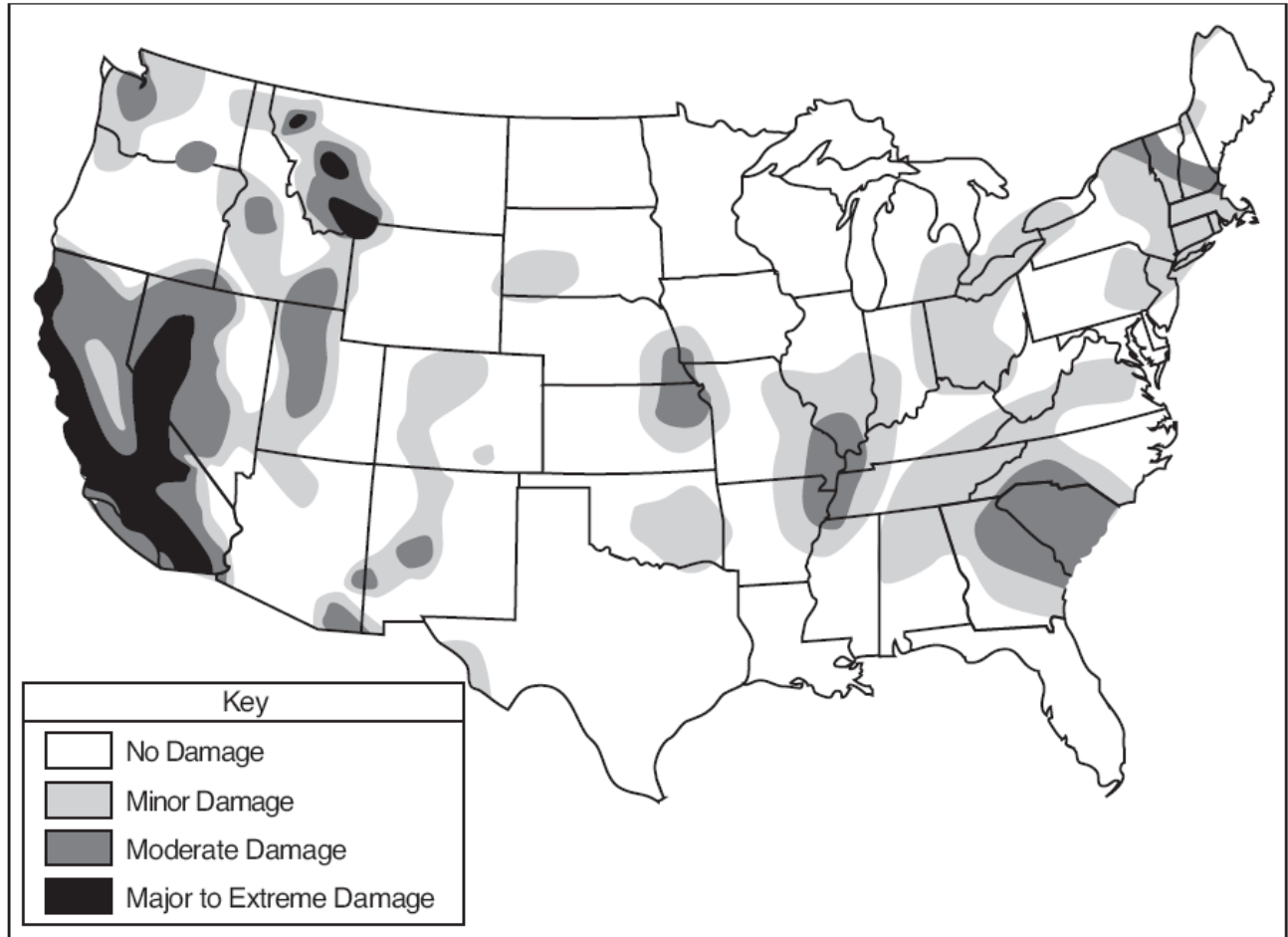
8. Why does the oceanic crust sink beneath the continental crust at a subduction boundary?

- (1) The oceanic crust has a greater density.
- (2) The oceanic crust is pulled downward by Earth's magnetic field.
- (3) The continental crust has a more mafic composition.
- (4) The continental crust is pulled upward by the Moon's gravity.

9. A seismic station 4000 kilometers from the epicenter of an earthquake records the arrival time of the first *P*-wave at 10:00:00. At what time did the first *S*-wave arrive at this station?

- (1) 9:55:00
- (2) 10:05:40
- (3) 10:07:05
- (4) 10:12:40

Base your answers to questions 10 and 11 on the map below, which shows the risk of damage from seismic activity in the United States.



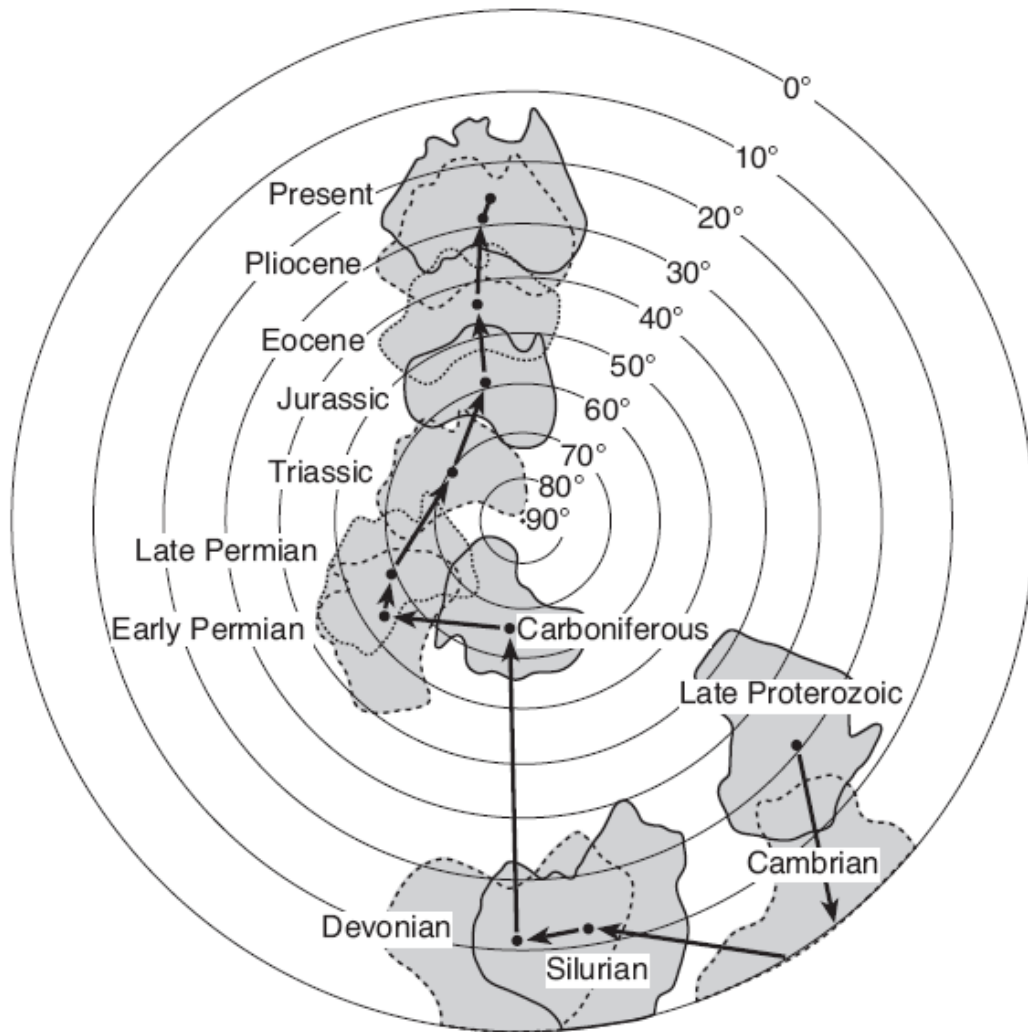
10. In the United States, most of the major damage expected from a future earthquake is predicted to occur near a

- (1) divergent plate boundary, only
- (2) convergent plate boundary, only
- (3) mid-ocean ridge and a divergent plate boundary
- (4) transform plate boundary and a hot spot

11. Which New York State location has the greatest risk of earthquake damage?

- (1) Binghamton
- (2) Buffalo
- (3) Plattsburgh
- (4) Elmira

Base your answers to questions 12 and 13 on the map below, which shows Earth's Southern Hemisphere and the inferred tectonic movement of the continent of Australia over geologic time. The arrows between the dots show the relative movement of the center of the continent of Australia. The parallels of latitude from 0° to 90° south are labeled.



12. The geographic position of Australia on Earth's surface has been changing mainly because

- (1) the gravitational force of the Moon has been pulling on Earth's landmasses
- (2) heat energy has been creating convection currents in Earth's interior
- (3) Earth's rotation has spun Australia into different locations
- (4) the tilt of Earth's axis has changed several times

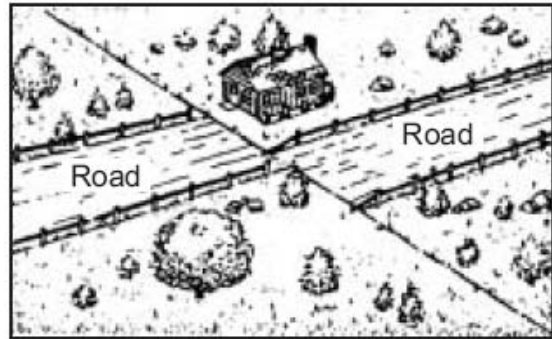
13. During which geologic time interval did Australia most likely have a warm, tropical climate because of its location?

- (1) Cambrian
- (2) Carboniferous
- (3) Late Permian
- (4) Eocene

14. Which statement correctly describes the density of Earth's mantle compared to the density of Earth's core and crust?

- (1) The mantle is less dense than the core but more dense than the crust.
- (2) The mantle is less dense than both the core and the crust.
- (3) The mantle is more dense than the core but less dense than the crust.
- (4) The mantle is more dense than both the core and the crust.

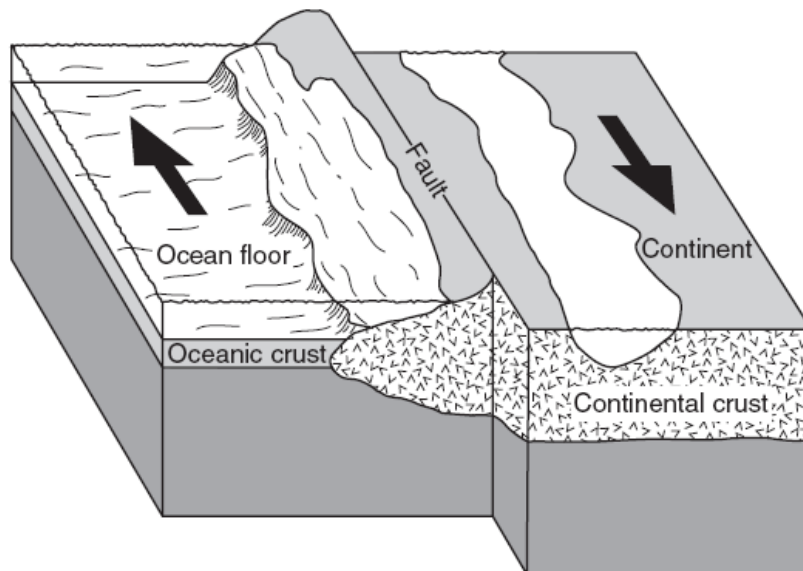
The diagram below shows land features that have been disrupted by an earthquake.



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

- (1) vertical lifting of surface rock
- (2) folding of surface rock
- (3) down-warping of the crust
- (4) movement along a transform fault

Arrows in the block diagram below show the relative movement along a tectonic plate boundary.



(Not drawn to scale)

16. Between which two tectonic plates does this type of plate boundary exist?

- (1) Nazca Plate and South American Plate
- (2) Eurasian Plate and Indian-Australian Plate
- (3) North American Plate and Eurasian Plate
- (4) Pacific Plate and North American Plate

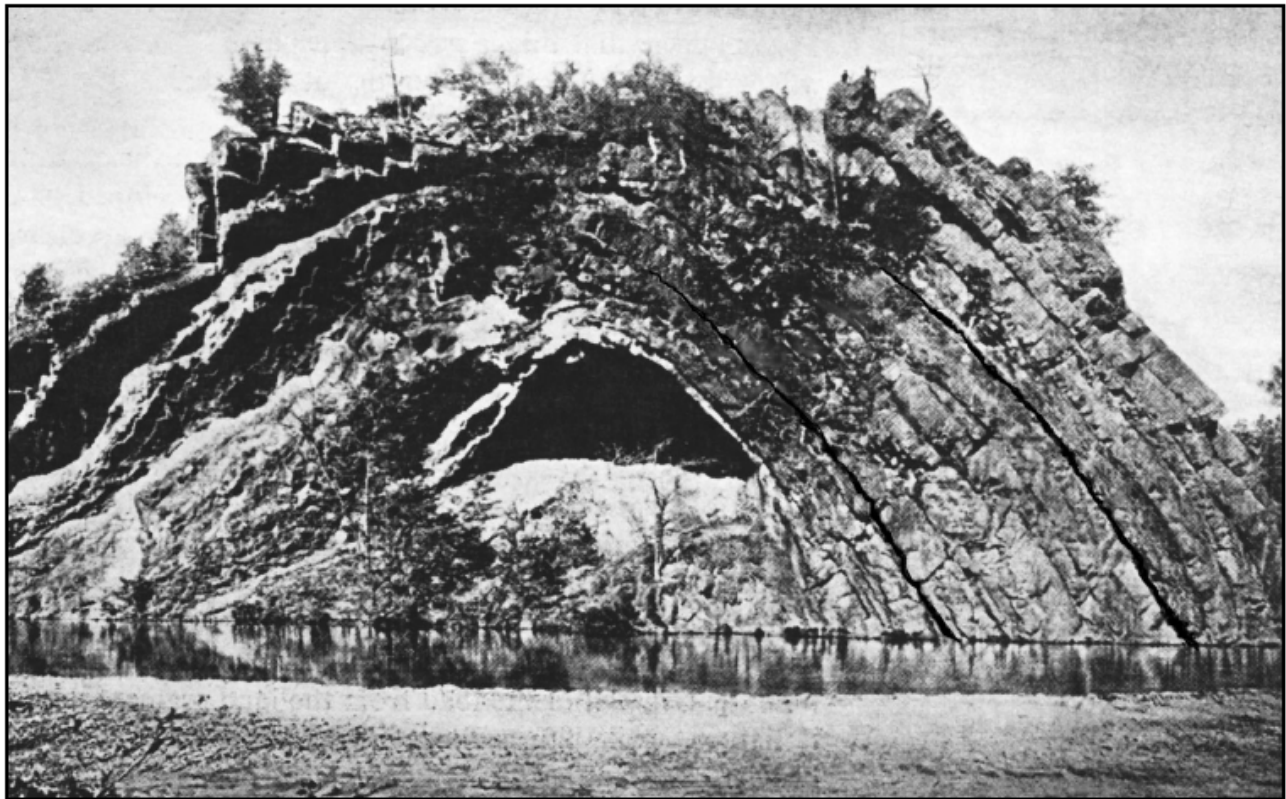
17. Convection currents in the plastic mantle are believed to cause divergence of lithospheric plates at the

- (1) Peru-Chile Trench
- (2) Mariana Trench
- (3) Canary Islands Hot Spot
- (4) Iceland Hot Spot

18. Which coastal area is most likely to experience a severe earthquake?

- (1) east coast of North America
- (2) east coast of Australia
- (3) west coast of Africa
- (4) west coast of South America

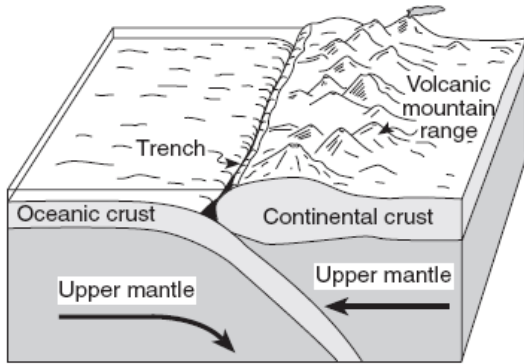
The photograph below shows deformed rock structure found on Earth's surface.



19. Deformed rock structure like this is most often caused by

- (1) crustal plate collisions
- (2) deposition of sediments
- (3) extrusion of magma
- (4) glacial movement

20. The diagram below shows the interaction of two tectonic plates.

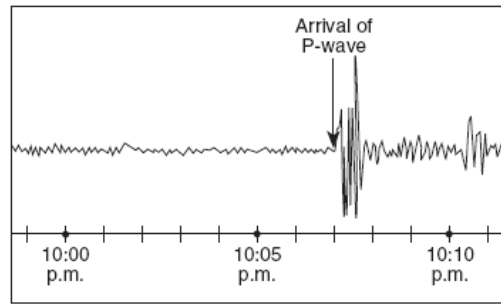


(Not drawn to scale)

The type of plate boundary represented in the diagram most likely exists between the

- (1) Antarctic Plate and the African Plate
- (2) Antarctic Plate and the Indian-Australian Plate
- (3) South American Plate and the Nazca Plate
- (4) South American Plate and the African Plate

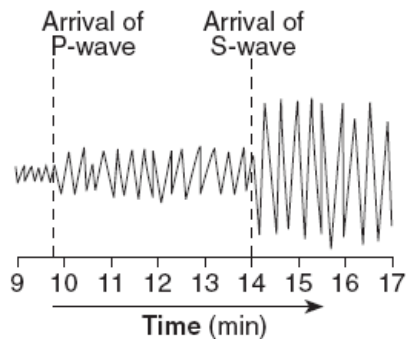
21. The seismogram below shows the time that an earthquake *P*-wave arrived at a seismic station in Albany, New York.



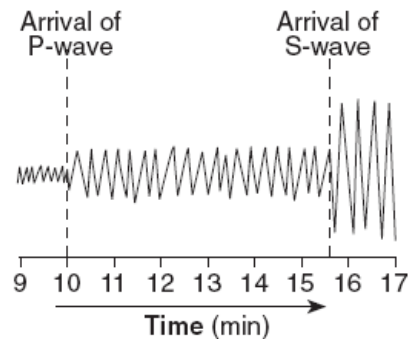
If the earthquake occurred at exactly 10:00 p.m., approximately how far from the earthquake epicenter was Albany, New York?

- (1) 1,900 km
- (2) 3,200 km
- (3) 4,000 km
- (4) 5,200 km

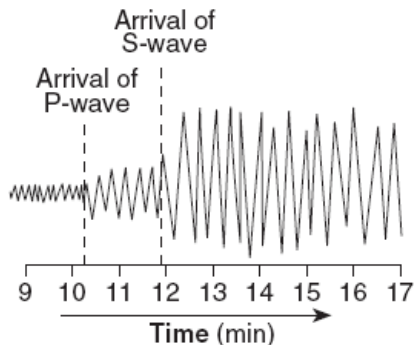
22. Which seismogram was recorded approximately 4,000 kilometers from an earthquake epicenter?



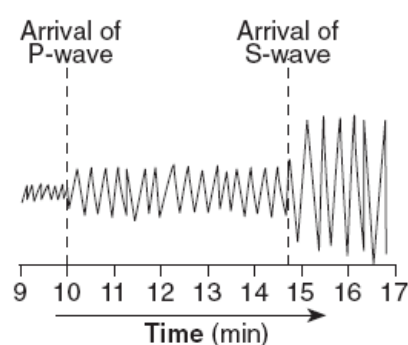
(1)



(3)

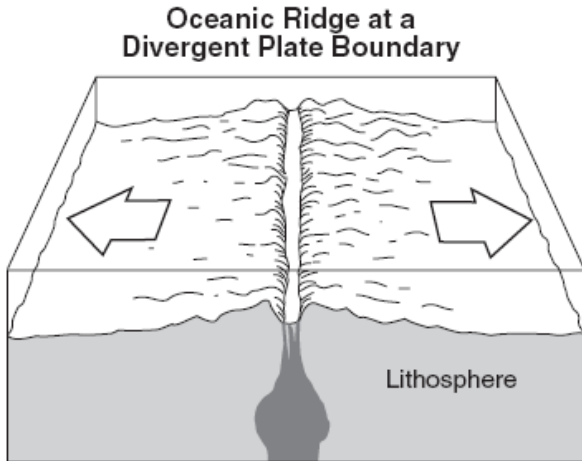


(2)



(4)

The diagram below shows a tectonic plate boundary.



23. Which mantle hot spot is at a plate boundary like the one shown in this diagram?

- (1) Hawaii Hot Spot
- (2) Yellowstone Hot Spot
- (3) Galapagos Hot Spot
- (4) Canary Hot Spot

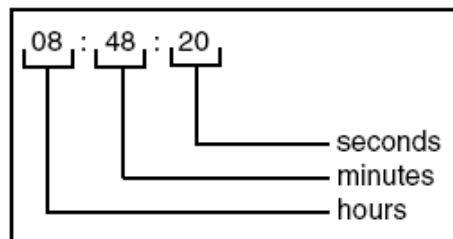
24. The observed difference in density between continental crust and oceanic crust is most likely due to differences in their

- (1) composition
- (2) thickness
- (3) porosity
- (4) rate of cooling

Base your answers to questions 25 through 27 on the data table below, which gives information collected at seismic stations *A*, *B*, *C*, and *D* for the same earthquake. Some of the data has been deliberately omitted.

Seismic Station	<i>P</i> -Wave Arrival Time	<i>S</i> -Wave Arrival Time	Difference in Arrival Times	Distance to Epicenter
<i>A</i>	08:48:20	No <i>S</i> -waves arrived		
<i>B</i>	08:42:00		00:04:40	
<i>C</i>	08:39:20		00:02:40	
<i>D</i>	08:45:40			6,200 km

Key for Reading Time on the Table



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

- (1) *S*-waves cannot travel through liquids.
- (2) *S*-waves were not generated at the epicenter.
- (3) Station *A* was located on solid bedrock.
- (4) Station *A* was located too close to the epicenter.

26. What is the approximate distance from station *C* to the earthquake epicenter?

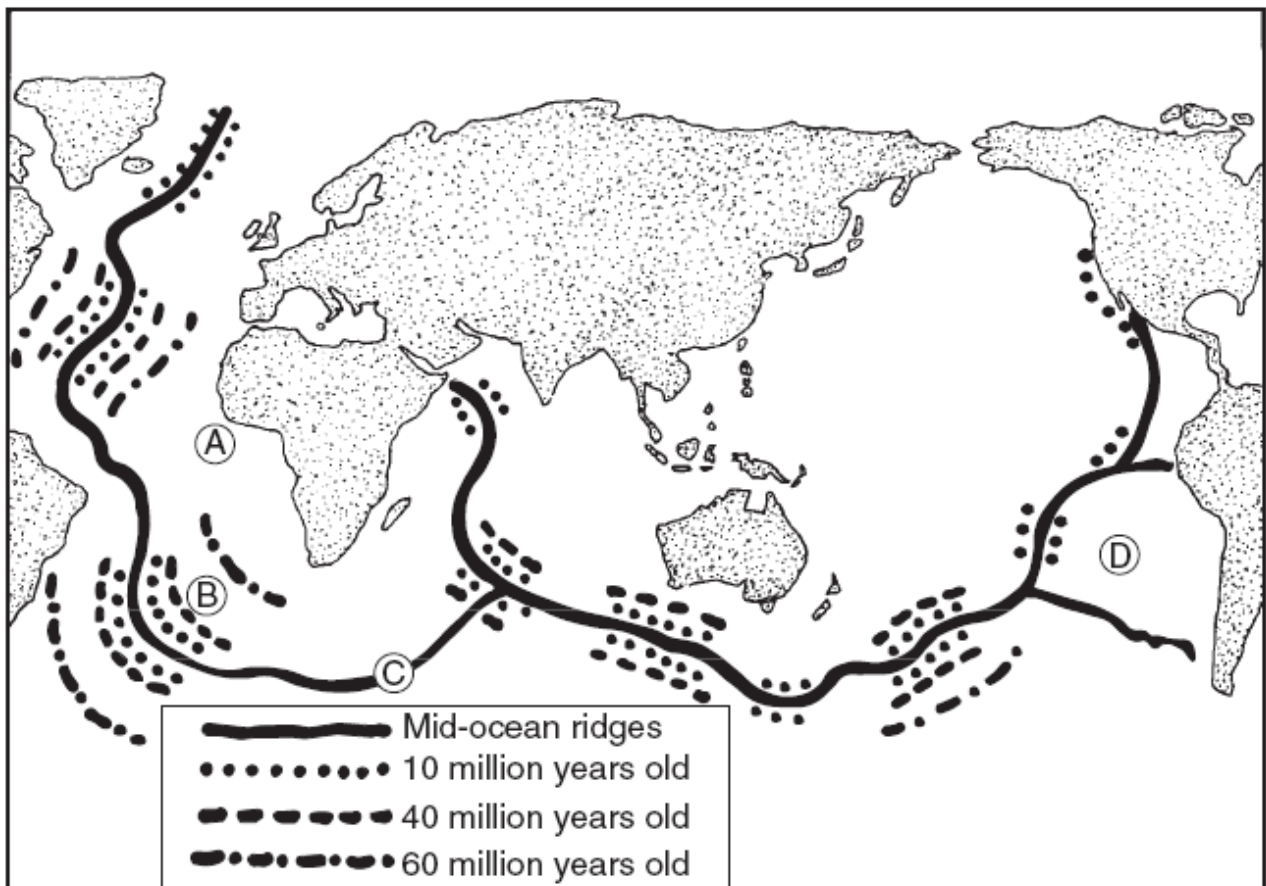
- (1) 3,200 km
- (2) 2,400 km
- (3) 1,600 km
- (4) 1,000 km

27. How long did it take the *P*-wave to travel from the epicenter of the earthquake to seismic station *D*?

- (1) 00:46:20
- (2) 00:39:20
- (3) 00:17:20
- (4) 00:09:40

Base your answers to questions 28 through 30 on the map below, which shows the location of mid-ocean ridges and the age of some oceanic bedrock near these ridges. Letters *A* through *D* are locations on the surface of the ocean floor.

Age of Rocks on the Sea Bottom Relative to Ridges



28. What is the most probable age, in millions of years, of the bedrock at location *B*?

- (1) 5
- (2) 12
- (3) 48
- (4) 62

29. Rising convection currents in the asthenosphere would most likely be under location

- (1) *A*
- (2) *B*
- (3) *C*
- (4) *D*

Base your answers to questions 29 and 30 on the photograph below, which shows an outcrop of sedimentary rock layers that have been tilted and slightly metamorphosed.



31. The tilted rock structure shown in the photograph is most likely the result of the

- (1) deposition of rock fragments on a mountain slope
- (2) reversal of past magnetic poles
- (3) passage of seismic waves
- (4) collision of crustal plates

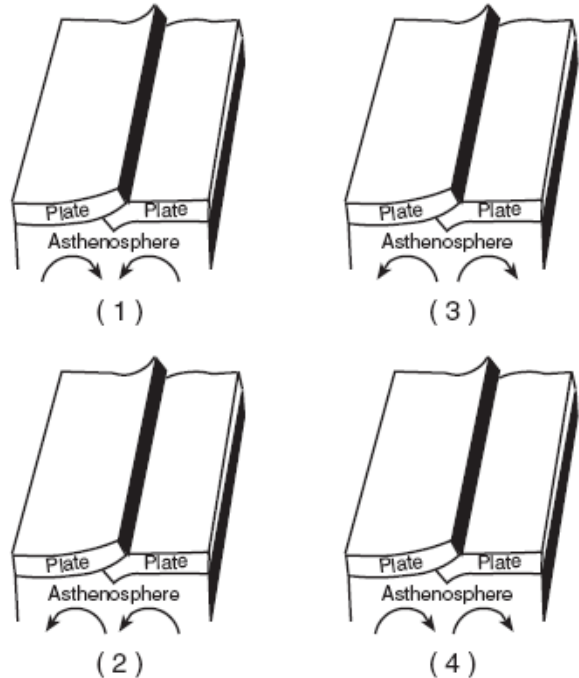
32. Tilted, slightly metamorphosed rock layers such as these are typically found in which New York State landscape region?

- (1) Taconic Mountains
- (2) Atlantic Coastal Plain
- (3) Tug Hill Plateau
- (4) Erie-Ontario Lowlands

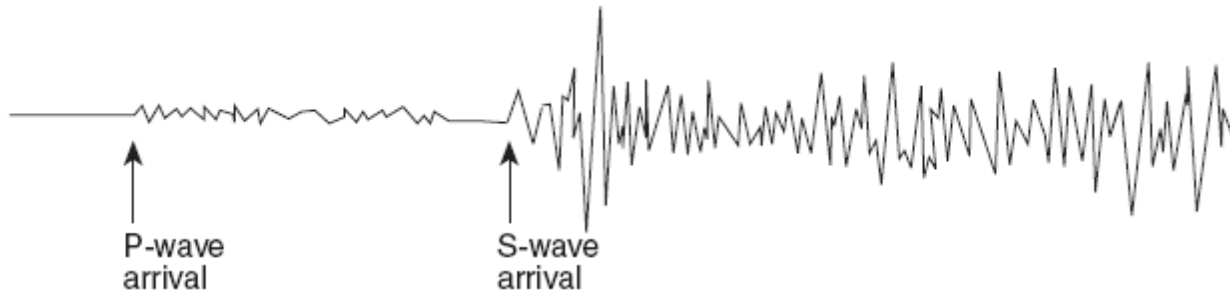
30. The age of oceanic bedrock on either side of a mid-ocean ridge is supporting evidence that at the ridges, tectonic plates are

- (1) diverging
- (2) converging
- (3) locked in place
- (4) being subducted

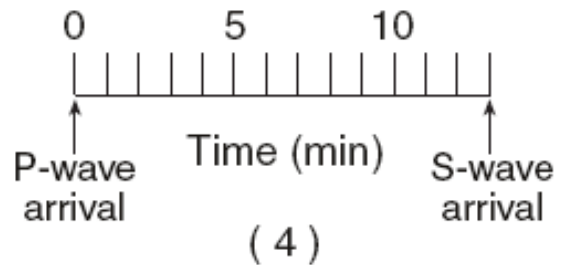
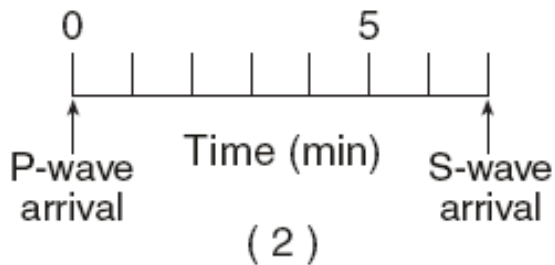
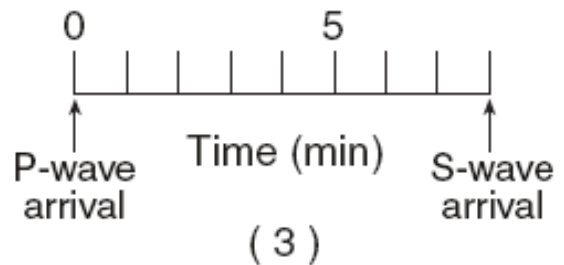
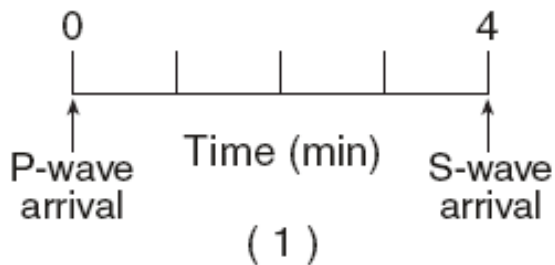
33. Which diagram correctly shows how mantle convection currents are most likely moving beneath colliding lithospheric plates?



The diagram below is a seismogram of the famous San Francisco earthquake of 1906, recorded at a seismic station located 6,400 kilometers from San Francisco.



34. Which time scale best represents the arrival-time difference between *P*-waves and *S*-waves at this station?



35. An earthquake's *P*-wave arrived at a seismograph station at 02 hours 40 minutes 00 seconds. The earthquake's *S*-wave arrived at the same station 2 minutes later. What is the approximate distance from the seismograph station to the epicenter of the earthquake?

- (1) 1,100 km
- (2) 2,400 km
- (3) 3,100 km
- (4) 4,000 km

36. The edges of most lithospheric plates are characterized by

- (1) reversed magnetic orientation
- (2) unusually rapid radioactive decay
- (3) frequent volcanic activity
- (4) low *P*-wave and high *S*-wave velocity

Base your answers to questions 37 through 39 on the map below, which shows the location of the Peru-Chile Trench.



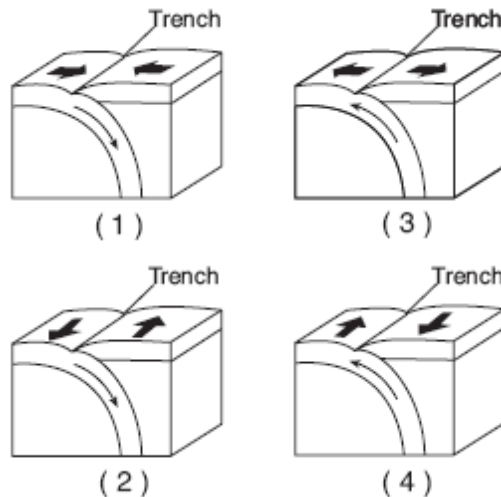
37. The Peru-Chile Trench marks the boundary between the

- (1) Pacific Plate and the Antarctic Plate
- (2) Nazca Plate and the South American Plate
- (3) North American Plate and the Cocos Plate
- (4) Caribbean Plate and the Scotia Plate

38. Which observation provides the best evidence of the pattern of crustal movement at the Peru-Chile Trench?

- (1) the direction of flow of warm ocean currents
- (2) the mineral composition of samples of mafic mantle rock
- (3) comparison of the rates of sediment deposition
- (4) the locations of shallow-focus and deep focus earthquakes

39. In which diagram do the arrows best represent the motions of Earth's crust at the Peru-Chile Trench?



40. Compared to Earth's continental crust, Earth's oceanic crust is

- (1) thinner and more dense
- (2) thinner and less dense
- (3) thicker and more dense
- (4) thicker and less dense

41. The Himalayan Mountains are located along a portion of the southern boundary of the Eurasian Plate. At the top of Mt. Everest (29,028 feet) in the Himalayan Mountains, climbers have found fossilized marine shells in the surface bedrock. From this observation, which statement is the best inference about the origin of the Himalayan Mountains?

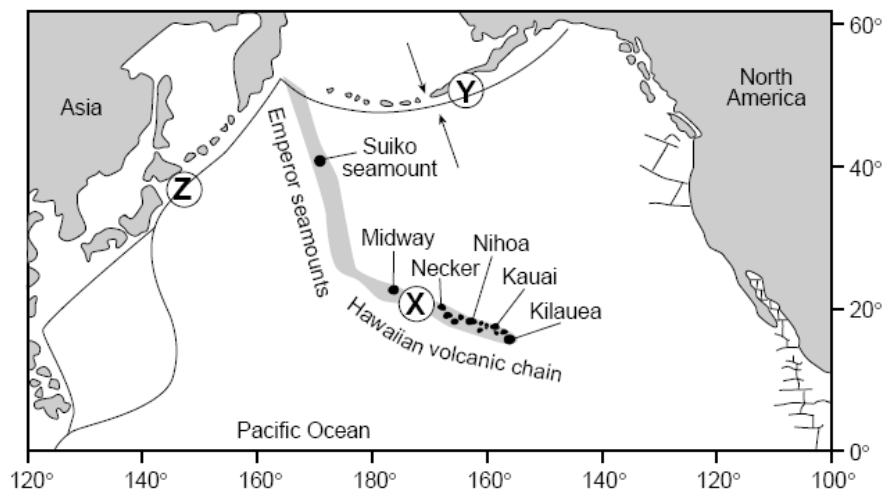
- (1) The Himalayan Mountains were formed by volcanic activity.
- (2) Sea level has been lowered more than 29,000 feet since the shells were fossilized.
- (3) The bedrock containing the fossil shells is part of an uplifted seafloor.
- (4) The Himalayan Mountains formed at a divergent plate boundary.

42. Which statement correctly compares seismic *P*-waves with seismic *S*-waves?

- (1) *P*-waves travel faster than *S*-waves and pass through Earth's liquid zones.
- (2) *P*-waves travel faster than *S*-waves and do not pass through Earth's liquid zones.
- (3) *P*-waves travel slower than *S*-waves and pass through Earth's liquid zones.
- (4) *P*-waves travel slower than *S*-waves and do not pass through Earth's liquid zones.

Base your answers to questions 43 through 45 on the map and data table below. The map shows the locations of volcanic islands and seamounts that erupted on the seafloor of the Pacific Plate as it moved northwest over a stationary mantle hotspot beneath the lithosphere. The hotspot is currently under Kilauea. Island size is not drawn to scale. Locations X, Y, and Z are on Earth's surface.

Map of Volcanic Features



Data Table
Age of Volcanic Features

Volcanic Feature	Distance from Kilauea (km)	Age (millions of years)
Kauai	545	5.6
Nihoa	800	6.9
Necker	1,070	10.4
Midway	2,450	16.2
Suiko seamount	4,950	41.0

43. Approximately how far has location X moved from its original location over the hotspot?

- (1) 3,600 km
- (2) 2,500 km
- (3) 1,800 km
- (4) 20 km

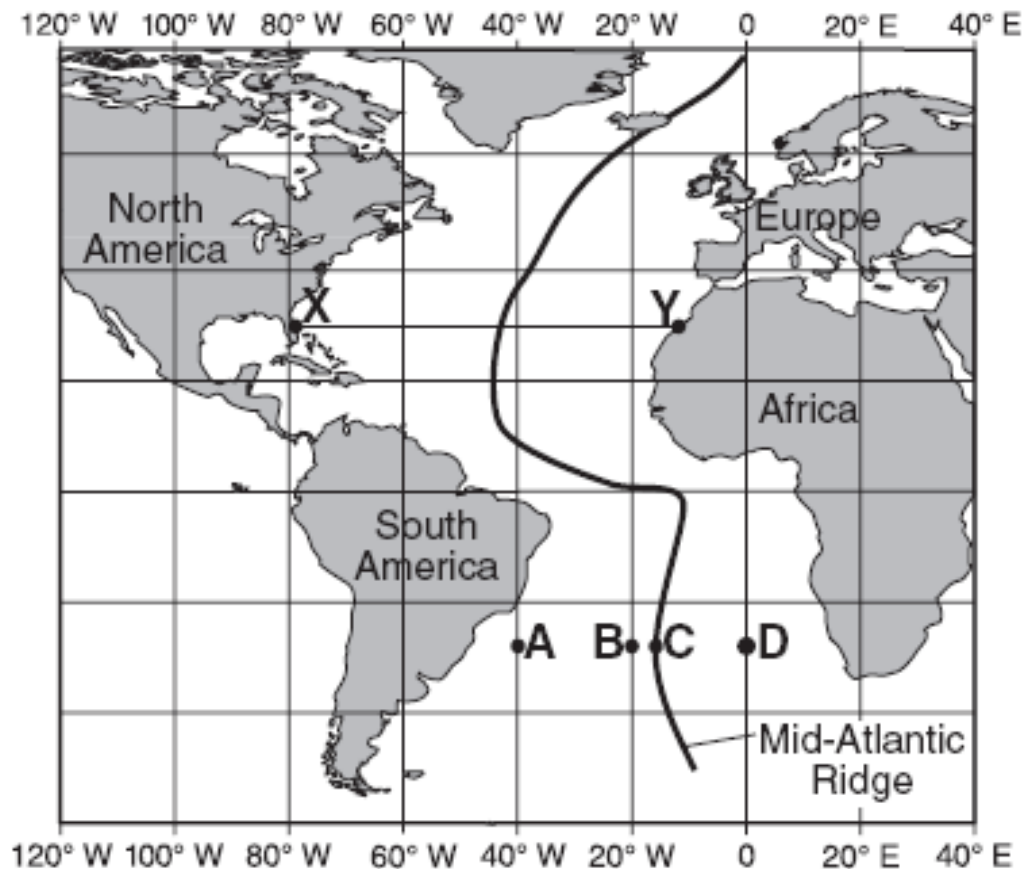
44. According to the data table, what is the approximate speed at which the island of Kauai has been moving away from the mantle hotspot, in kilometers per million years?

- (1) 1
- (2) 10
- (3) 100
- (4) 1,000

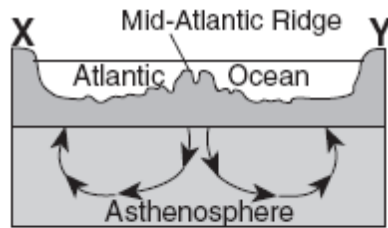
45. Which lithospheric plate boundary features are located at Y and Z?

- (1) trenches created by the subduction of the Pacific Plate
- (2) rift valleys created by seafloor spreading of the Pacific Plate
- (3) secondary plates created by volcanic activity within the Pacific Plate
- (4) mid-ocean ridges created by faulting below the Pacific Plate

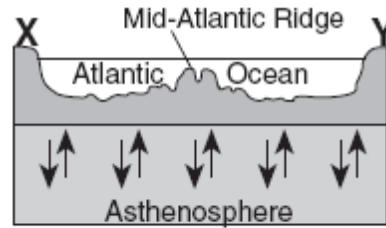
Base your answers to questions 46 through 48 on the map of the Mid-Atlantic Ridge shown below. Points A through D are locations on the ocean floor. Line XY connects locations in North America and Africa.



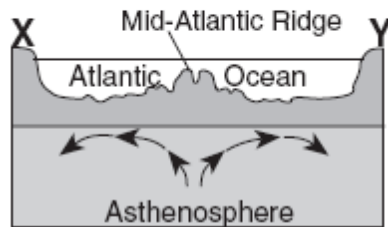
46. In which cross section do the arrows best show the convection occurring within the asthenosphere beneath line XY?



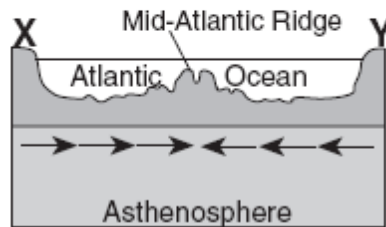
(1)



(3)



(2)



(4)

47. Samples of ocean-floor bedrock were collected at points *A*, *B*, *C*, and *D*. Which sequence shows the correct order of the age of the bedrock from oldest to youngest?

- (1) $D \rightarrow C \rightarrow B \rightarrow A$ (3) $C \rightarrow B \rightarrow D \rightarrow A$
 (2) $A \rightarrow D \rightarrow B \rightarrow C$ (4) $A \rightarrow B \rightarrow D \rightarrow C$

48. The boundary between which two tectonic plates is most similar geologically to the plate boundary at the Mid-Atlantic Ridge?

- (1) Eurasian and Indian-Australian (3) Pacific and Nazca
 (2) Cocos and Caribbean (4) Nazca and South American

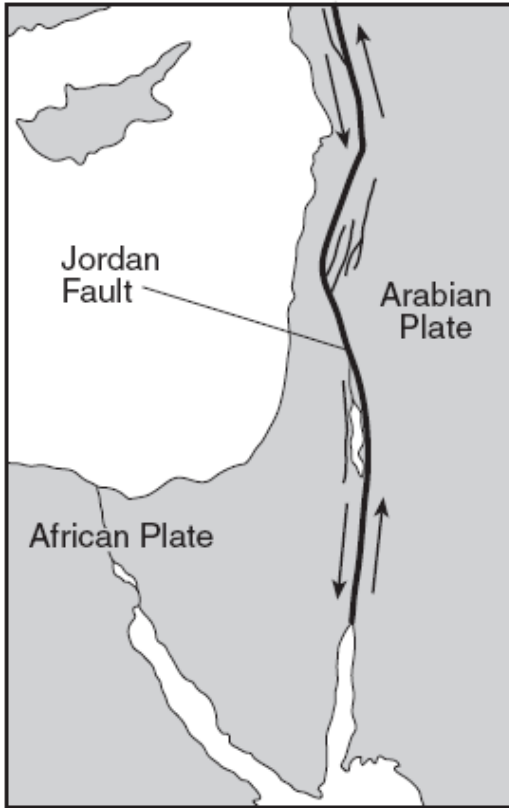
49. A seismograph station recorded the arrival of the first *P*-wave at 7:32 p.m. from an earthquake that occurred 4000 kilometers away. What time was it at the station when the earthquake occurred?

- (1) 7:20 p.m. (3) 7:32 p.m.
 (2) 7:25 p.m. (4) 7:39 p.m.

50. In which Earth layer are most convection currents that cause seafloor spreading thought to be located?

- (1) crust (3) outer core
 (2) asthenosphere (4) inner core

The map below shows the northern section of the boundary between the Arabian Plate and the African Plate. Arrows show the relative direction of plate motion.



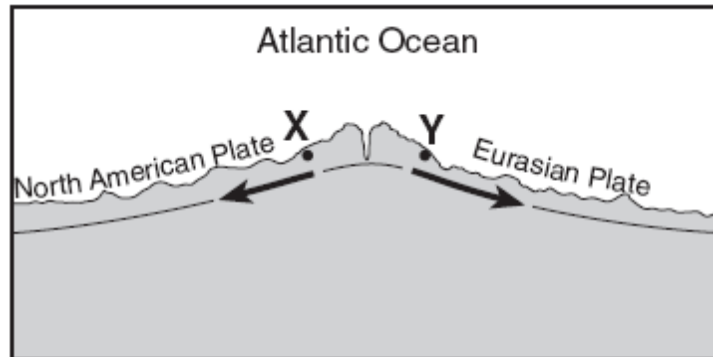
51. Which type of plate boundary is located at the Jordan Fault?

- (1) divergent
- (2) subduction
- (3) convergent
- (4) transform

52. Based on the theory of plate tectonics, it is inferred that over the past 250 million years North America has moved toward the

- (1) northwest
- (2) southwest
- (3) southeast
- (4) northeast

Base your answers to questions 53 and 54 on the cross section below, which shows an underwater mountain range in the Atlantic Ocean. The oceanic bedrock is composed mainly of basalt. Points *X* and *Y* are locations in the bedrock that have been diverging at the same rate. The movement of the North American Plate and Eurasian Plate is shown by the two arrows.

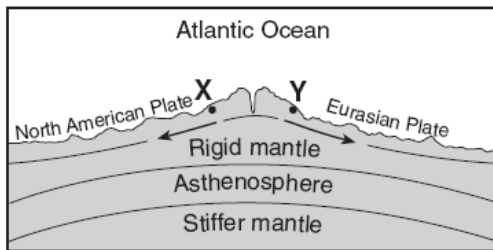


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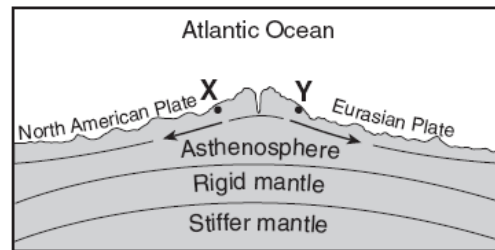
53. Which statements best describe the age and magnetic orientation of the basalts found at locations *X* and *Y*?

- (1) The basalt at location *X* is younger than the basalt at location *Y*. Both locations have the same magnetic orientation.
- (2) The basalts at locations *X* and *Y* are the same age. Both locations have the same magnetic orientation.
- (3) The basalts at locations *X* and *Y* are the same age. Location *X* has normal magnetic orientation and location *Y* has reversed magnetic orientation.
- (4) The basalt at location *X* is older than the basalt at location *Y*. Location *X* has reversed magnetic orientation and location *Y* has normal magnetic orientation.

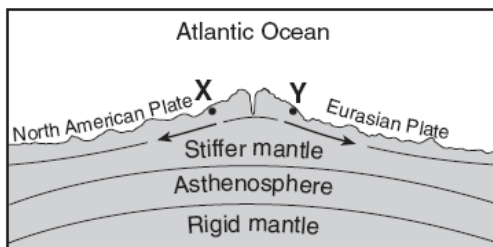
54. Which cross section best represents the relative locations of Earth's asthenosphere, rigid mantle, and stiffer mantle? (The cross sections are not drawn to scale.)



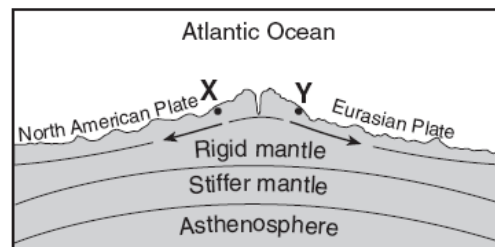
(1)



(3)



(2)



(4)

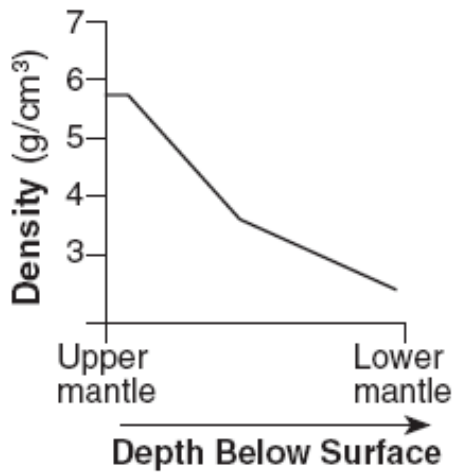
55. An earthquake's magnitude can be determined by

- (1) analyzing the seismic waves recorded by a seismograph
- (2) calculating the depth of the earthquake faulting
- (3) calculating the time the earthquake occurred
- (4) comparing the speed of *P*-waves and *S*-waves

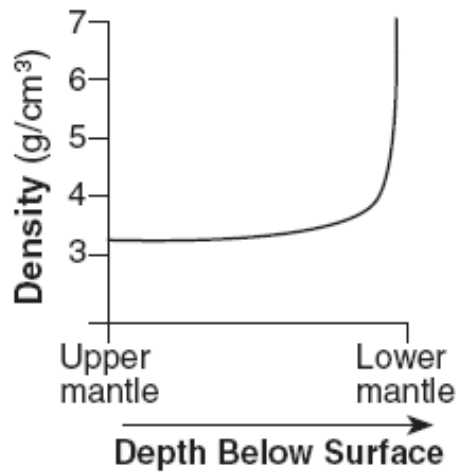
56. A seismic station is recording the seismic waves produced by an earthquake that occurred 4200 kilometers away. Approximately how long after the arrival of the first *P*-wave will the first *S*-wave arrive?

- (1) 1 min 05 sec
- (2) 5 min 50 sec
- (3) 7 min 20 sec
- (4) 13 min 10 sec

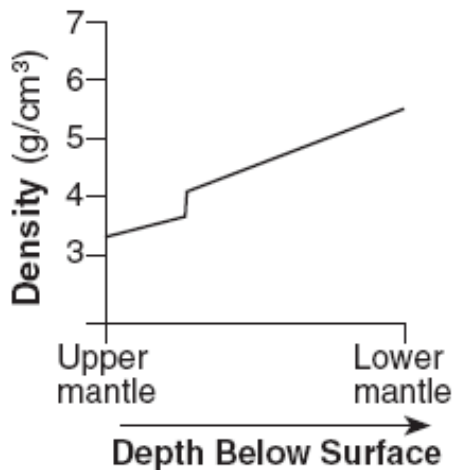
57. Which graph best shows the inferred density of Earth's interior as depth increases from the upper mantle to the lower mantle?



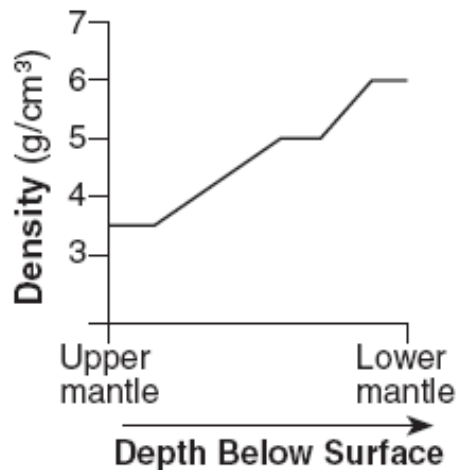
(1)



(3)

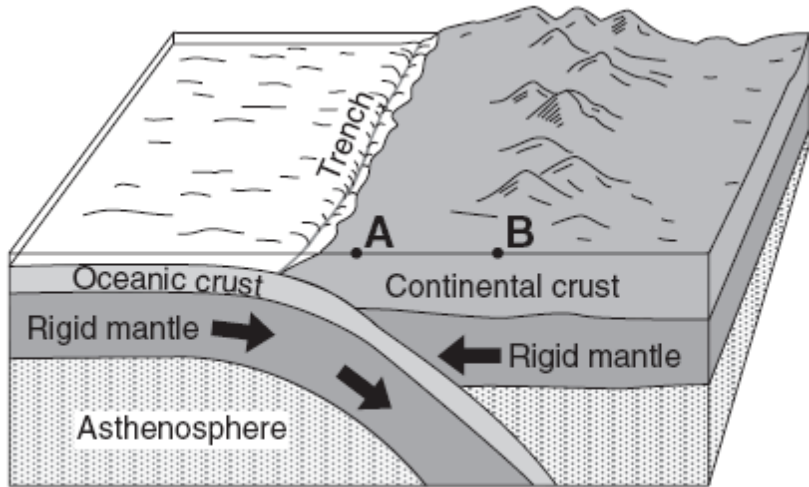


(2)



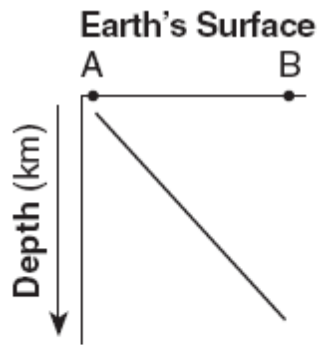
(4)

The block diagram below shows a tectonic plate boundary. Points *A* and *B* represent locations on Earth's surface.

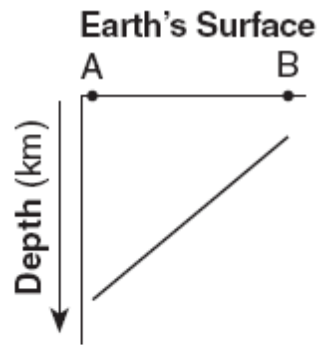


(Not drawn to scale)

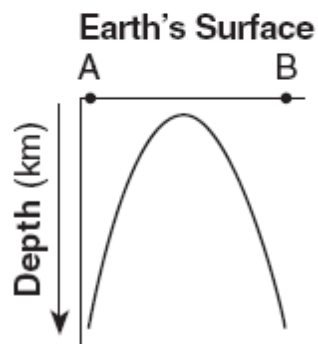
58. Which graph best shows the depths of most major earthquakes whose epicenters lie between *A* and *B*?



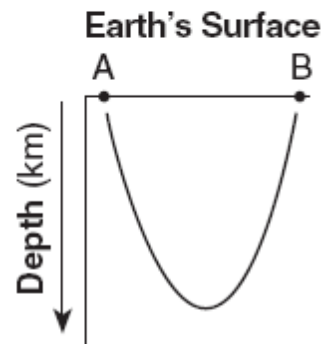
(1)



(3)



(2)



(4)

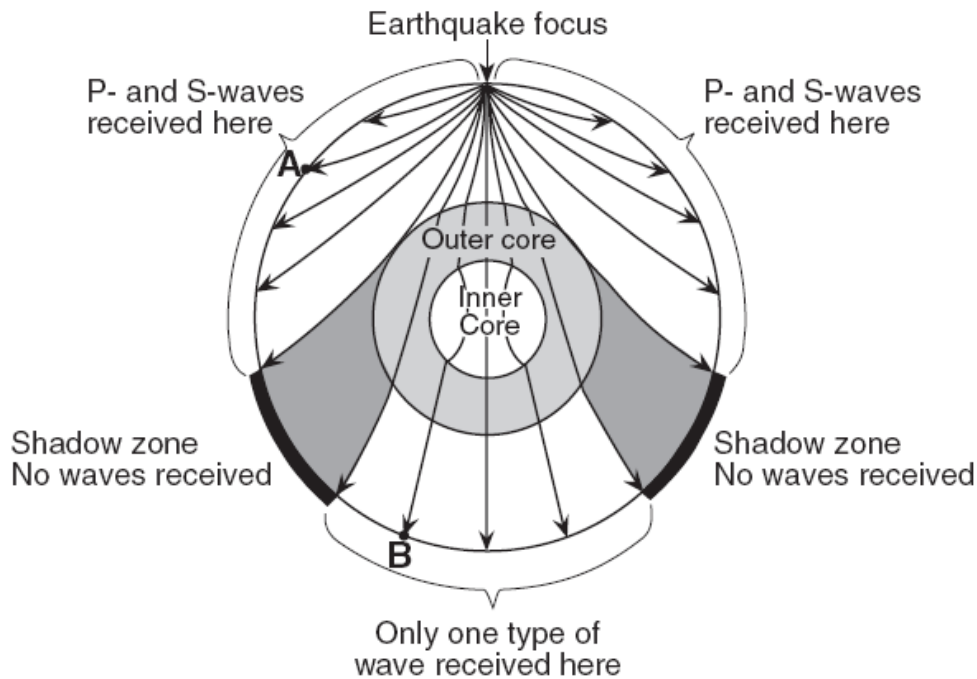
59. According to tectonic plate maps, New York State is presently located

- (1) at a convergent plate boundary
- (2) above a mantle hot spot
- (3) above a mid-ocean ridge
- (4) near the center of a large plate

60. According to plate tectonic theory, during which geologic time interval did the continents of North America and Africa separate, resulting in the initial opening of the Atlantic Ocean?

- (1) Mesozoic Era
- (2) Paleozoic Era
- (3) Proterozoic Eon
- (4) Archean Eon

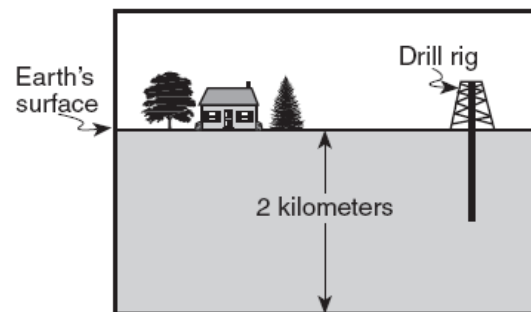
Base your answers to questions 61 and 62 on the cross-sectional view of Earth below, which shows seismic waves traveling from the focus of an earthquake. Points A and B are locations on Earth's surface.



61. Which statement best explains why only one type of seismic wave was recorded at location B?

- (1) S-waves cannot travel through the liquid outer core.
- (2) S-waves cannot travel through the liquid inner core.
- (3) P-waves cannot travel through the solid outer core.
- (4) P-waves cannot travel through the solid inner core.

62. The cross section below shows a drill rig used to collect rock samples from below Earth's surface.



(Not drawn to scale)

The rock samples collected from the bottom of the drill hole came from which Earth layer?

- (1) lithosphere
- (2) hydrosphere
- (3) asthenosphere
- (4) stiffer mantle

63. A seismic station located at point *A* is 5400 kilometers away from the epicenter of the earthquake. If the arrival time for the *P*-wave at point *A* was 2:00 p.m., the arrival time for the *S*-wave at point *A* was approximately

- (1) 1:53 p.m.
- (2) 2:07 p.m.
- (3) 2:09 p.m.
- (4) 2:16 p.m.

64. Which mountain range resulted from the collision of North America and Africa, as parts of Pangea joined together in the late Pennsylvanian Period?

- (1) Appalachian Mountains
- (2) Acadian Mountains
- (3) Taconic Mountains
- (4) Grenville Mountains

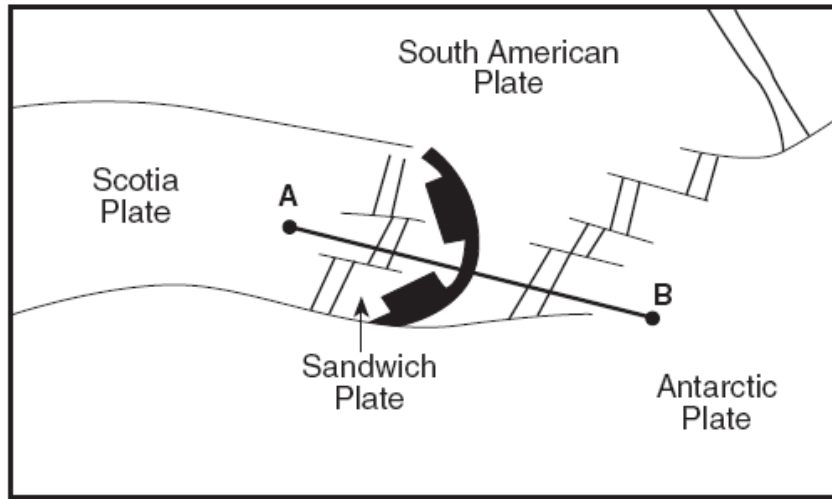
The photograph below shows an escarpment (cliff) located in the western United States. The directions for north and south are indicated by arrows. A fault in the sedimentary rocks is shown on the front of the escarpment.



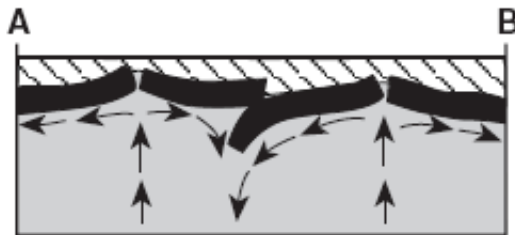
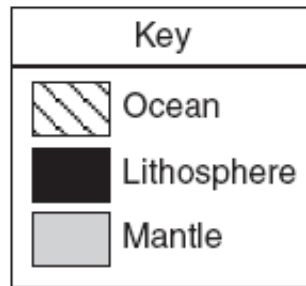
65. The photograph shows that the fault most likely Formed

- (1) after the rock layers were deposited, when the north side moved downward
- (2) after the rock layers were deposited, when the north side moved upward
- (3) before the rock layers were deposited, when the south side moved downward
- (4) before the rock layers were deposited, when the south side moved upward

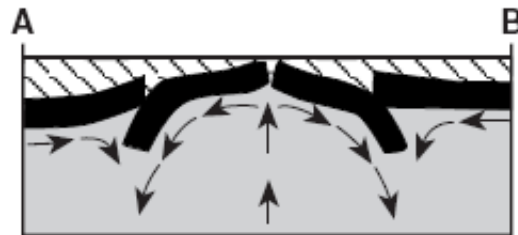
On the map below, line *AB* is drawn across several of Earth's tectonic plates in the South Atlantic Ocean.



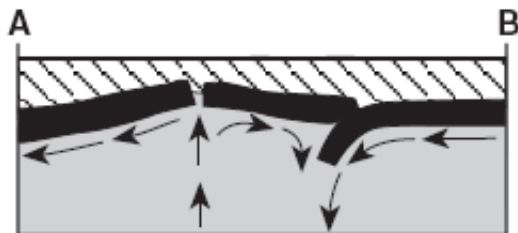
66. Which cross section best represents the plate boundaries and mantle movement beneath line *AB*?



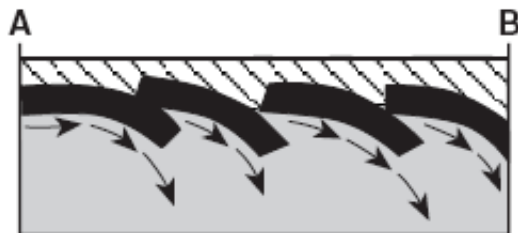
(1)



(3)

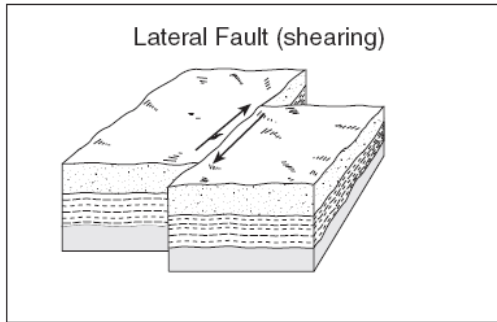


(2)

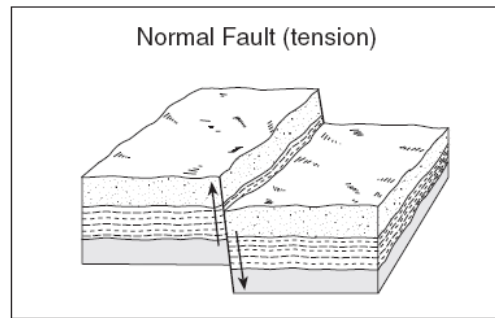


(4)

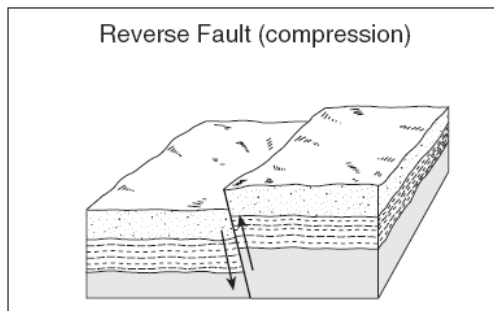
67. The diagrams below show four major types of fault motion occurring in Earth's crust. Which type of fault motion best matches the general pattern of crustal movement at California's San Andreas fault?



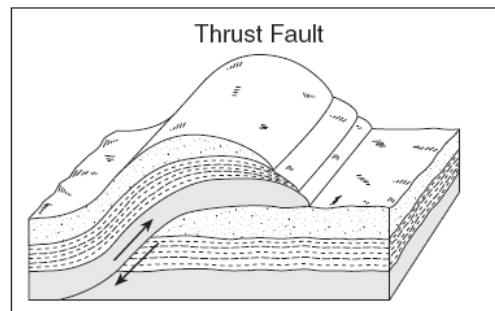
(1)



(3)

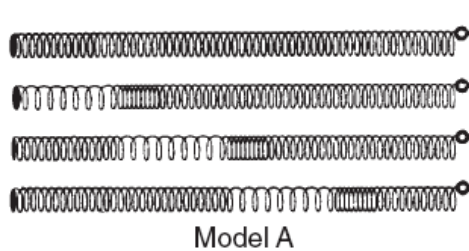


(2)

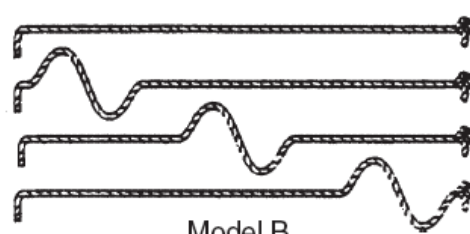


(4)

Base your answers to questions 68 and 69 on the diagram below, which shows models of two types of earthquake waves.



Model A



Model B

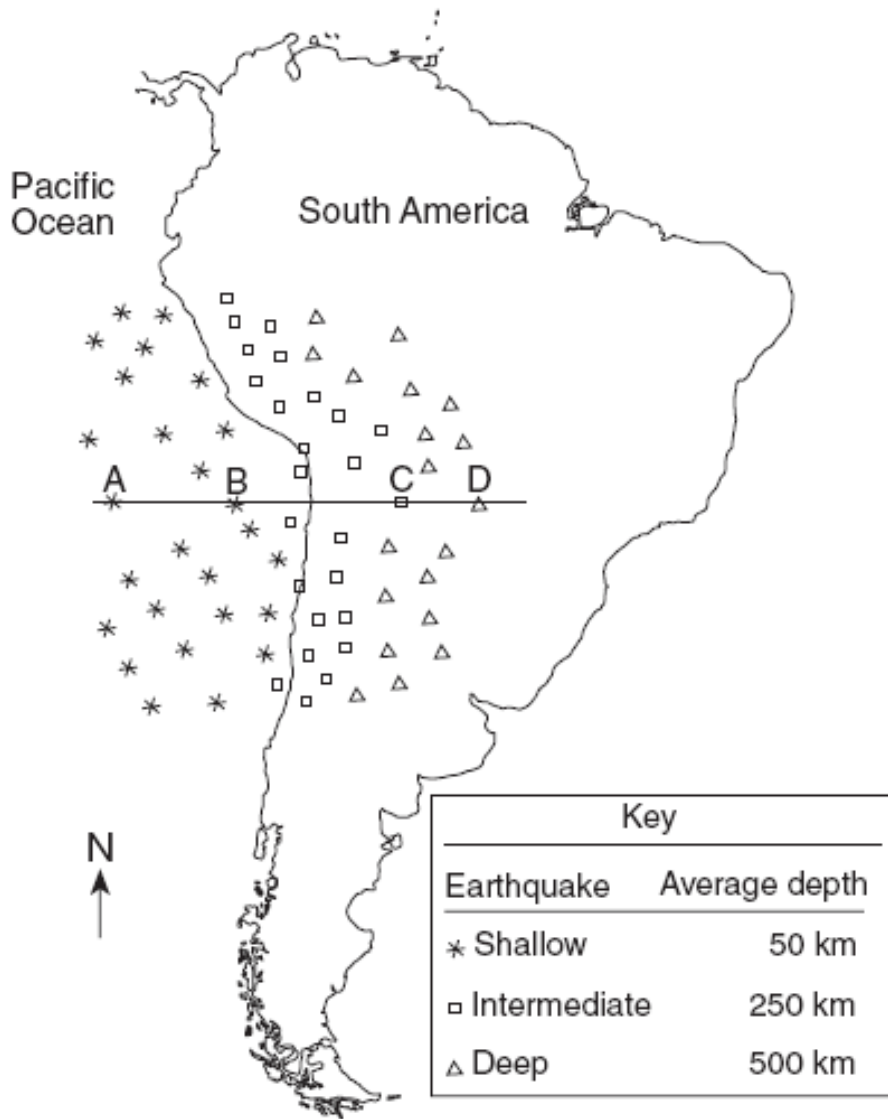
68. Model A best represents the motion of earthquake waves called

- (1) *P*-waves (compression waves) that travel faster than *S*-waves (shear waves) shown in model B
- (2) *P*-waves (compression waves) that travel slower than *S*-waves (shear waves) shown in model B
- (3) *S*-waves (shear waves) that travel faster than *P*-waves (compression waves) shown in model B
- (4) *S*-waves (shear waves) that travel slower than *P*-waves (compression waves) shown in model B

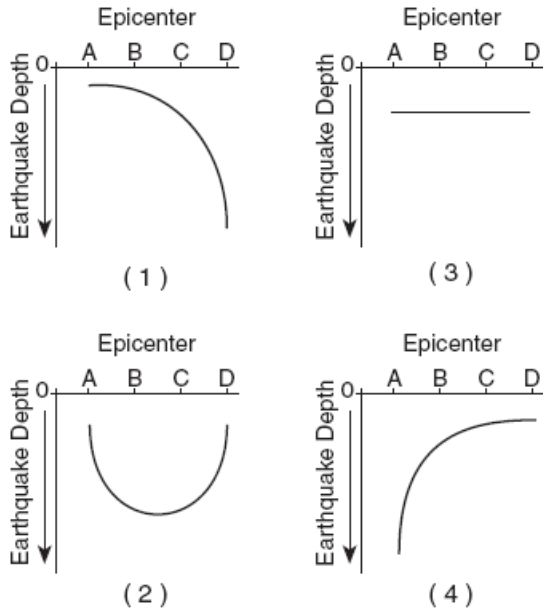
69. The difference in seismic station arrival times of the two waves represented by the models helps scientists determine the

- (1) amount of damage caused by an earthquake
- (2) intensity of an earthquake
- (3) distance to the epicenter of an earthquake
- (4) time of occurrence of the next earthquake

Base your answers to questions 70 and 71 on the map below, which shows the depths of selected earthquakes along the crustal plate boundary near the west coast of South America. Letters *A*, *B*, *C*, and *D* are epicenter locations along a west-to-east line at the surface. The relative depth of each earthquake is indicated.



70. Which graph best shows the depth of earthquakes beneath epicenters A, B, C, and D?



72. The study of how seismic waves change as they travel through Earth has revealed that

- (1) *P*-waves travel more slowly than *S*-waves through Earth's crust
- (2) seismic waves travel more slowly through the mantle because it is very dense
- (3) Earth's outer core is solid because *P*-waves are not transmitted through this layer
- (4) Earth's outer core is liquid because *S*-waves are not transmitted through this layer

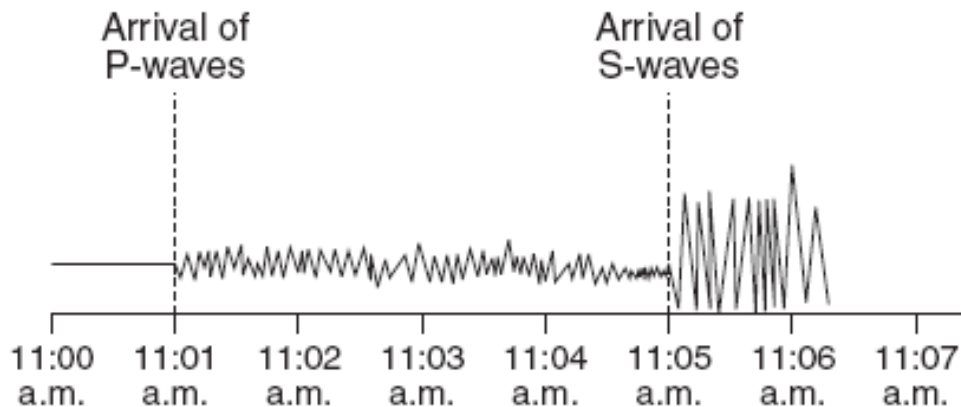
71. The earthquake beneath epicenter D occurred in which part of Earth's interior?

- (1) crust
- (2) rigid mantle
- (3) asthenosphere
- (4) stiffer mantle

73. The edges of most lithospheric plates are characterized by

- (1) reversed magnetic orientation
- (2) unusually rapid radioactive decay
- (3) frequent volcanic activity
- (4) low *P*-wave and high *S*-wave velocity

Base your answers to questions 74 and 75 on the earthquake seismogram below.



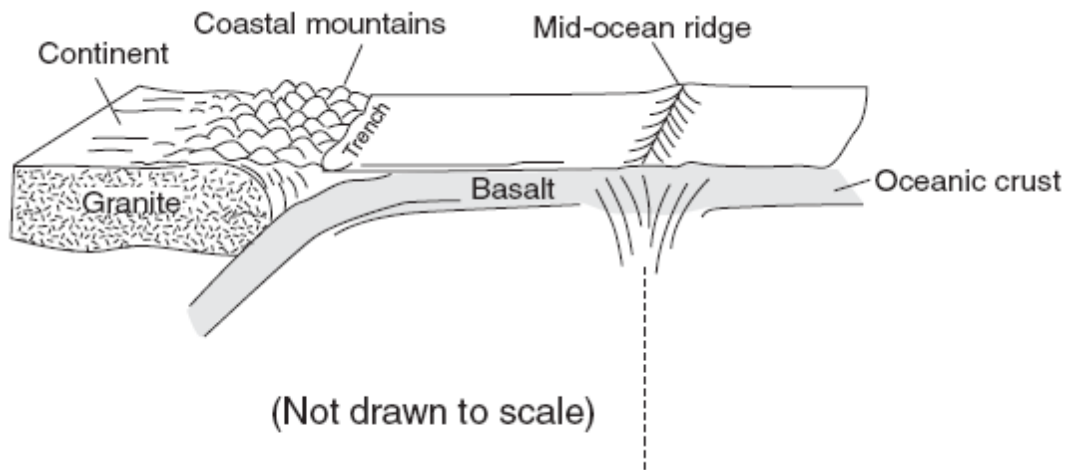
74. When did the first *P*-waves arrive at this seismic station?

- (1) 3 minutes after an earthquake occurred 2,600 km away
- (2) 5 minutes after an earthquake occurred 2,600 km away
- (3) 9 minutes after an earthquake occurred 3,500 km away
- (4) 11 minutes after an earthquake occurred 3,500 km away

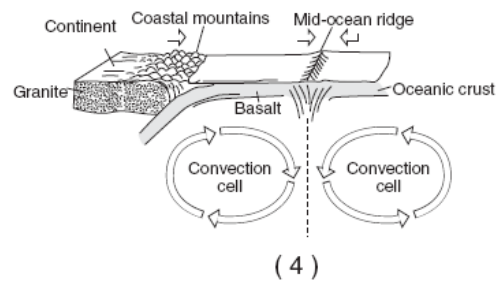
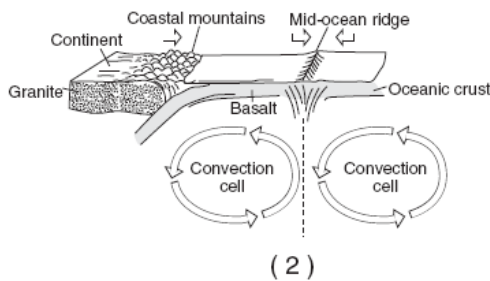
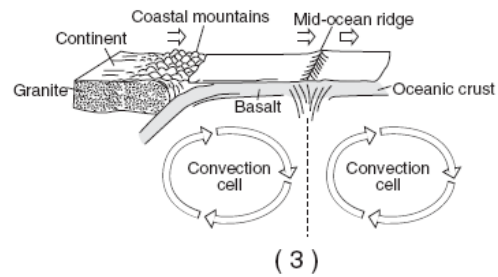
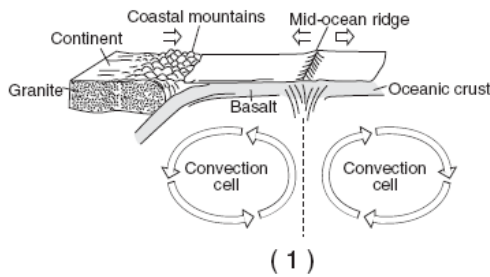
75. How many additional seismic stations must report seismogram information in order to locate this earthquake?

- (1) one
- (2) two
- (3) three
- (4) four

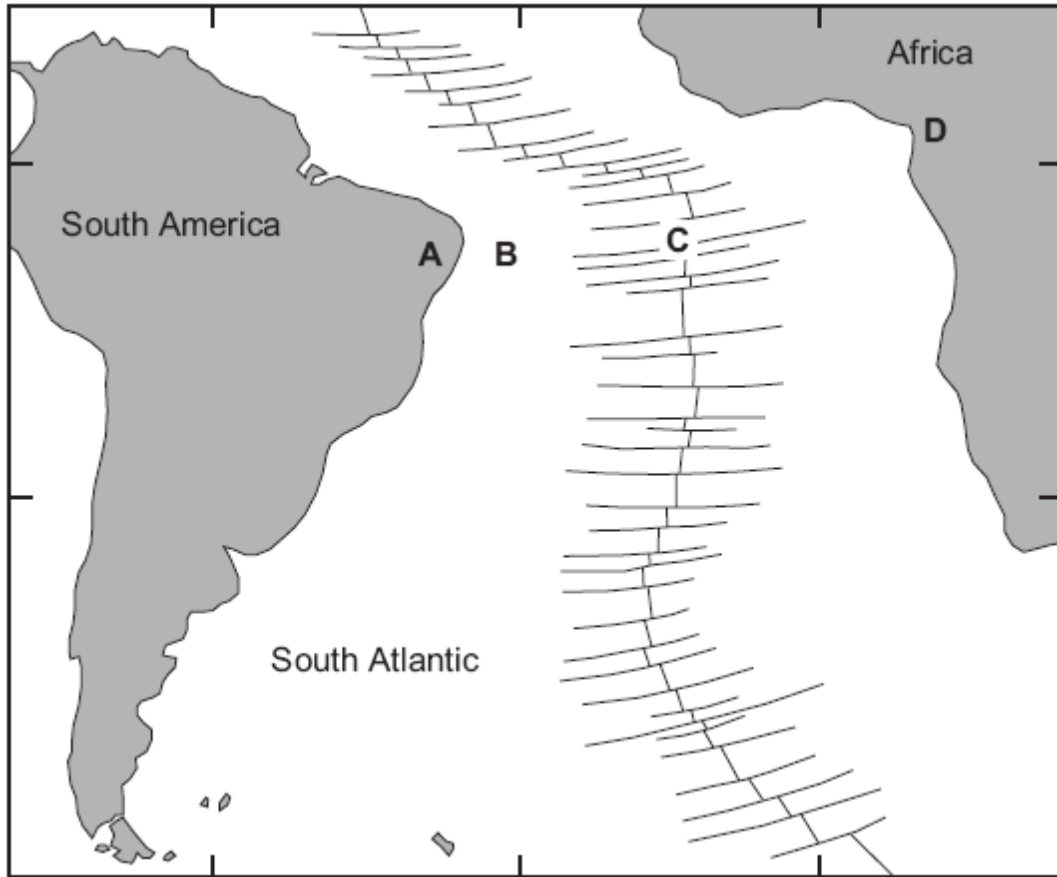
The diagram below shows some features of Earth's crust and upper mantle.



76. Which model most accurately shows the movements (arrows) associated with the surface features shown in the diagram?



Base your answers to questions 77 through 79 on the map below. The map shows the continents of Africa and South America, the ocean between them, and the ocean ridge and transform faults. Locations *A* and *D* are on the continents. Locations *B* and *C* are on the ocean floor.



77. The hottest crustal temperature measurements would most likely be found at location

- (1) *A*
- (2) *B*
- (3) *C*
- (4) *D*

78. Which table best shows the relative densities of the crustal bedrock at locations *A*, *B*, *C*, and *D*?

Relative Densities of Crust

More Dense	Less Dense
<i>A</i> , <i>B</i>	<i>C</i> , <i>D</i>

(1)

Relative Densities of Crust

More Dense	Less Dense
<i>C</i> , <i>D</i>	<i>A</i> , <i>B</i>

(3)

Relative Densities of Crust

More Dense	Less Dense
<i>B</i> , <i>C</i>	<i>A</i> , <i>D</i>

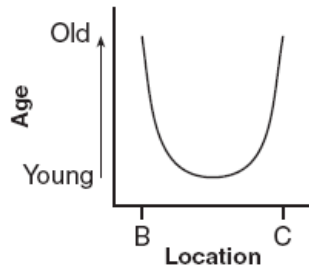
(2)

Relative Densities of Crust

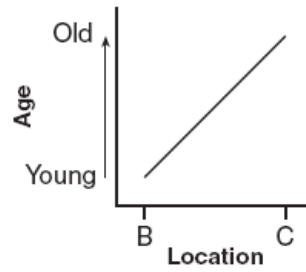
More Dense	Less Dense
<i>A</i> , <i>D</i>	<i>B</i> , <i>C</i>

(4)

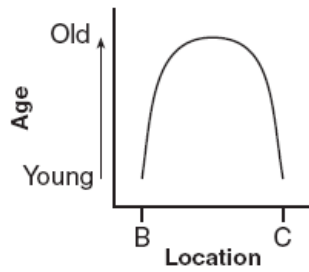
79. Which graph best shows the relative age of the ocean-floor bedrock from location *B* to location *C*?



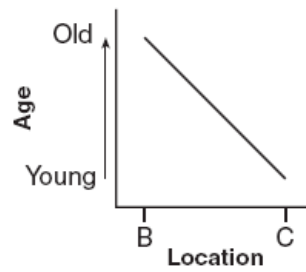
(1)



(3)

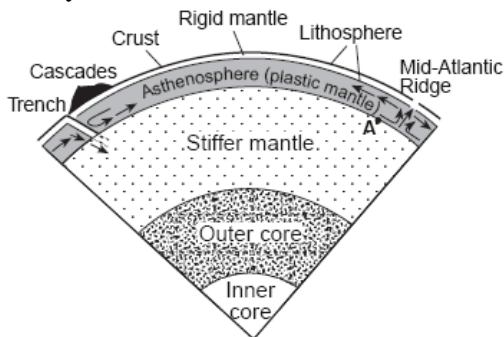


(2)



(4)

Base your answers to questions 30 and 31 on the diagram below, which shows a portion of Earth's interior. Point *A* is a location on the interface between layers.



(Not drawn to scale)

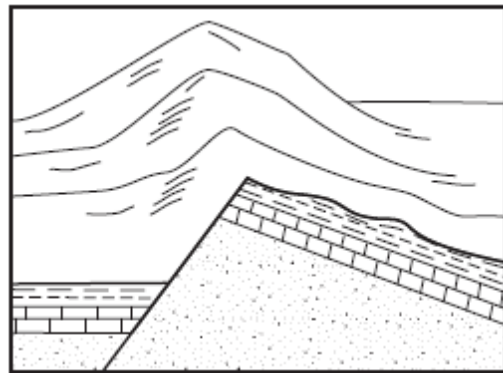
80. The arrows shown in the asthenosphere represent the inferred slow circulation of the plastic mantle by a process called

- (1) insolation
- (2) convection
- (3) conduction
- (4) radiation

81. The temperature of rock at location *A* is approximately

- (1) 600°C
- (2) 1,000°C
- (3) 2,600°C
- (4) 3,000°C

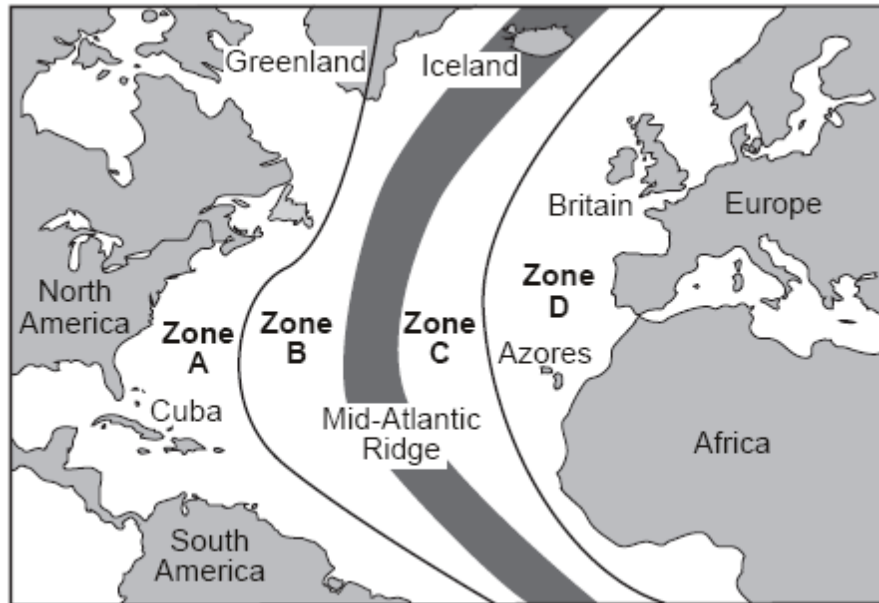
The diagram below shows the bedrock structure beneath a series of hills.



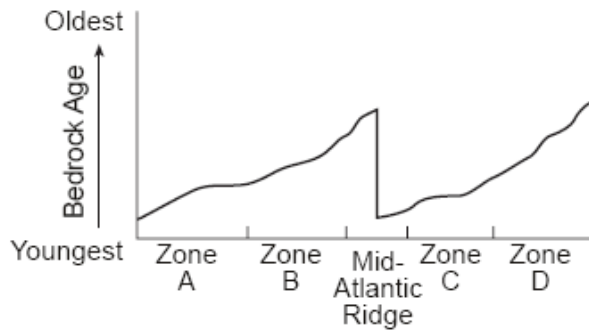
82. Which process was primarily responsible for forming the hills?

- (1) folding
- (2) faulting
- (3) deposition
- (4) vulcanism

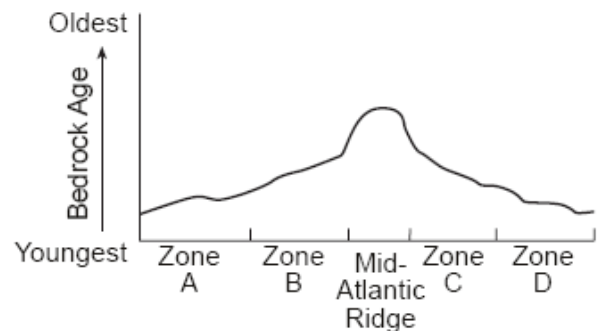
The map below shows the Atlantic Ocean divided into zones A, B, C, and D. The Mid-Atlantic Ridge is located between zones B and C.



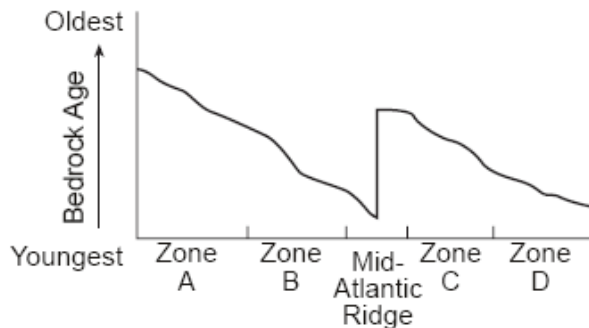
83. Which graph best represents the geologic age of the surface bedrock on the ocean bottom?



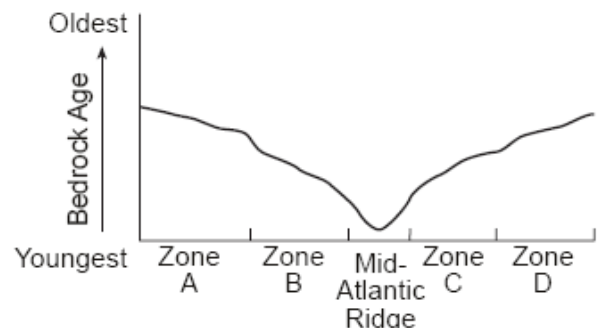
(1)



(3)

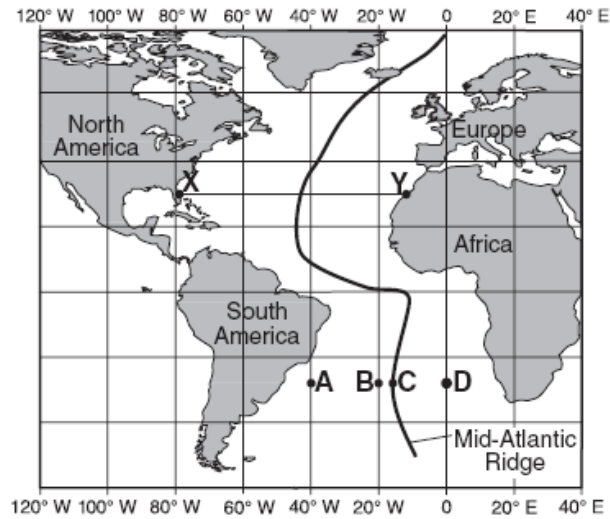


(2)

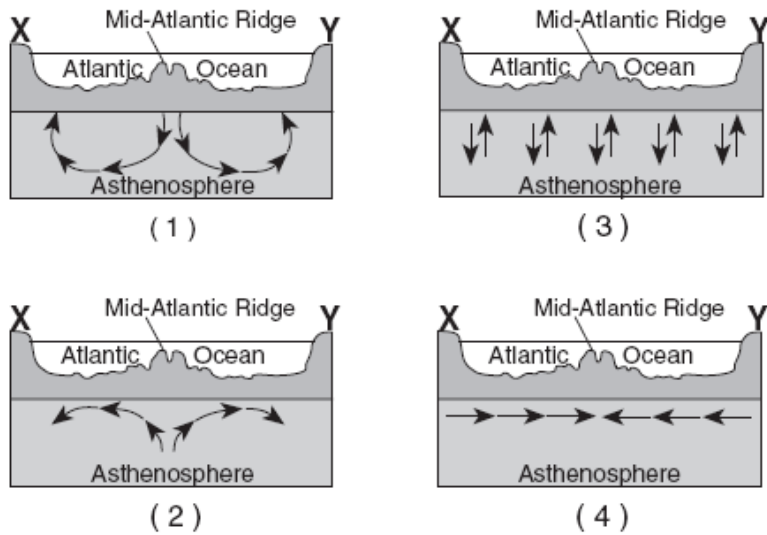


(4)

Base your answers to questions 84 through 86 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.



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



85. Samples of ocean-floor bedrock were collected at points A, B, C, and D. Which sequence shows the correct order of the age of the bedrock from oldest to youngest?

- (1) $D \rightarrow C \rightarrow B \rightarrow A$
- (2) $A \rightarrow D \rightarrow B \rightarrow C$
- (3) $C \rightarrow B \rightarrow D \rightarrow A$
- (4) $A \rightarrow B \rightarrow D \rightarrow C$

86. The boundary between which two tectonic plates is most similar geologically to the plate boundary at the Mid-Atlantic Ridge?

- (1) Eurasian and Indian-Australian
- (2) Cocos and Caribbean
- (3) Pacific and Nazca
- (4) Nazca and South American

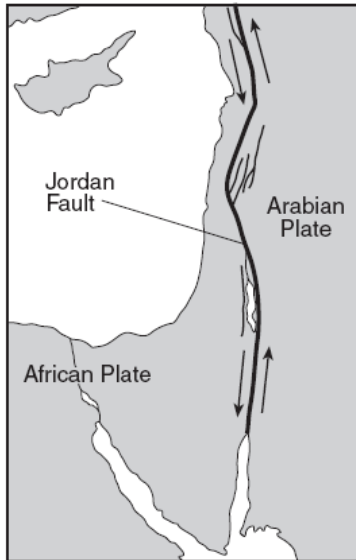
87 Compared to Earth's continental crust, Earth's oceanic crust is

- (1) thinner and more dense
- (2) thinner and less dense
- (3) thicker and more dense
- (4) thicker and less dense

88 Which statement correctly compares seismic *P*-waves with seismic *S*-waves?

- (1) *P*-waves travel faster than *S*-waves and pass through Earth's liquid zones.
- (2) *P*-waves travel faster than *S*-waves and do not pass through Earth's liquid zones.
- (3) *P*-waves travel slower than *S*-waves and pass through Earth's liquid zones.
- (4) *P*-waves travel slower than *S*-waves and do not pass through Earth's liquid zones.

The map below shows the northern section of the boundary between the Arabian Plate and the African Plate. Arrows show the relative direction of plate motion.



89 Which type of plate boundary is located at the Jordan Fault?

- (1) divergent (3) convergent
- (2) subduction (4) transform

90 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?

- (1) 7:20 p.m. (3) 7:32 p.m.
- (2) 7:25 p.m. (4) 7:39 p.m.

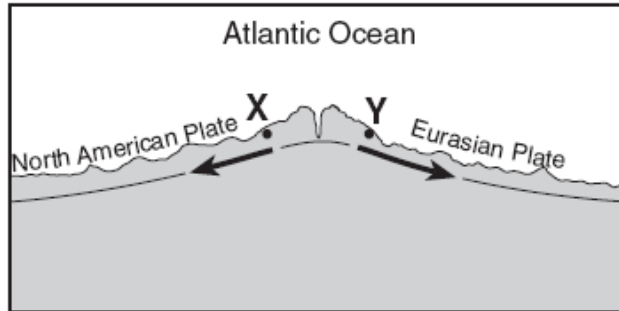
91 Which temperature is inferred to exist in Earth's plastic mantle?

- (1) 2000°C (3) 5000°C
- (2) 3000°C (4) 6000°C

92 Which observation about the Mid-Atlantic Ridge region provides the best evidence that the seafloor has been spreading for millions of years?

- (1) The bedrock of the ridge and nearby seafloor is igneous rock.
- (2) The ridge is the location of irregular volcanic eruptions.
- (3) Several faults cut across the ridge and nearby seafloor.
- (4) Seafloor bedrock is younger near the ridge and older farther away.

Base your answers to questions 93 and 94 on the cross section below, which shows an underwater mountain range in the Atlantic Ocean. The oceanic bedrock is composed mainly of basalt. Points *X* and *Y* are locations in the bedrock that have been diverging at the same rate. The movement of the North American Plate and Eurasian Plate is shown by the two arrows.

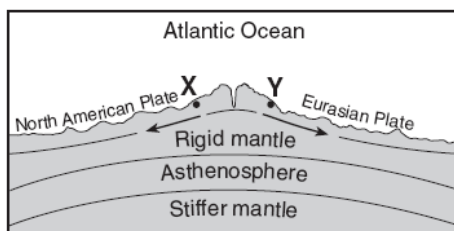


(Not drawn to scale)

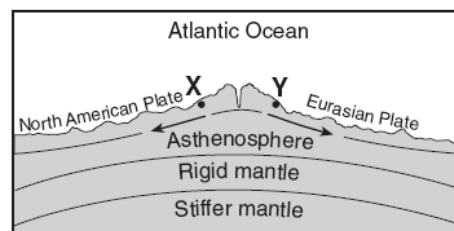
93 Which statements best describe the age and magnetic orientation of the basalts found at locations *X* and *Y*?

- (1) The basalt at location *X* is younger than the basalt at location *Y*. Both locations have the same magnetic orientation.
- (2) The basalts at locations *X* and *Y* are the same age. Both locations have the same magnetic orientation.
- (3) The basalts at locations *X* and *Y* are the same age. Location *X* has normal magnetic orientation and location *Y* has reversed magnetic orientation.
- (4) The basalt at location *X* is older than the basalt at location *Y*. Location *X* has reversed magnetic orientation and location *Y* has normal magnetic orientation.

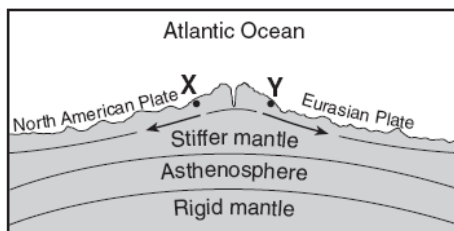
94 Which cross section best represents the relative locations of Earth's asthenosphere, rigid mantle, and stiffer mantle? (The cross sections are not drawn to scale.)



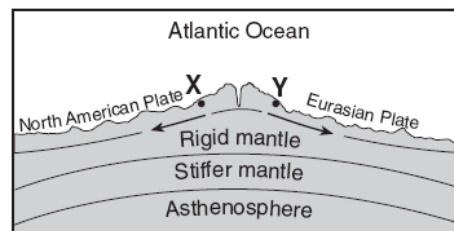
(1)



(3)

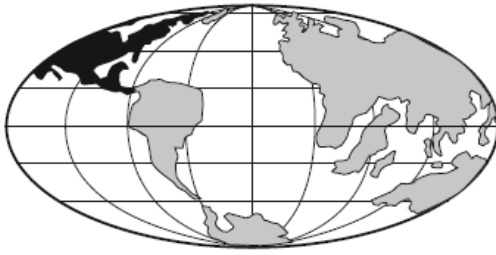


(2)



(4)

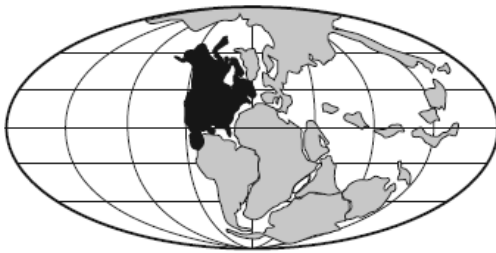
95 Which map best indicates the probable locations of continents 100 million years from now if tectonic plate movement continues at its present rate and direction?



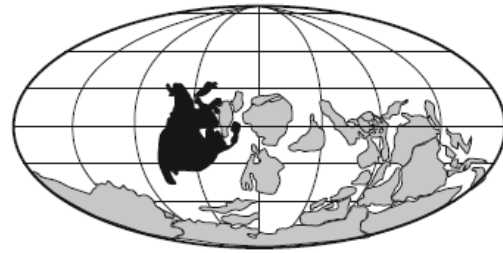
(1)



(3)



(2)



(4)

96 What is Earth's inferred interior pressure, in millions of atmospheres, at a depth of 3500 kilometers?

- (1) 1.9
- (2) 2.8
- (3) 5500
- (4) 6500

97 Which two tectonic plates are separated by a mid-ocean ridge?

- (1) Indian-Australian and Eurasian
- (2) Indian-Australian and Pacific
- (3) North American and South American
- (4) North American and Eurasian

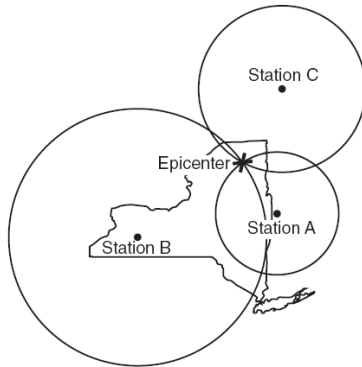
98 The movement of tectonic plates is inferred by many scientists to be driven by

- (1) tidal motions in the hydrosphere
- (2) density differences in the troposphere
- (3) convection currents in the asthenosphere
- (4) solidification in the lithosphere

99 An earthquake's first *P*-wave arrives at a seismic station at 12:00:00. This *P*-wave has traveled 6000 kilometers from the epicenter. At what time will the first *S*-wave from the same earthquake arrive at the seismic station?

- (1) 11:52:20
- (2) 12:07:40
- (3) 12:09:20
- (4) 12:17:00

The map below shows the location of an earthquake epicenter in New York State. Seismic stations A, B, and C received the data used to locate the earthquake epicenter.



100 The seismogram recorded at station A would show the

- (1) arrival of *P*-waves, only
- (2) earliest arrival time of *P*-waves
- (3) greatest difference in the arrival times of *P*-waves and *S*-waves
- (4) arrival of *S*-waves before the arrival of *P*-waves

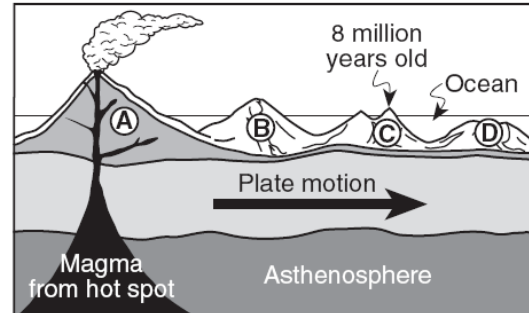
101 A *P*-wave takes 8 minutes and 20 seconds to travel from the epicenter of an earthquake to a seismic station. Approximately how long will an *S*-wave take to travel from the epicenter of the same earthquake to this seismic station?

- | | |
|------------------|-------------------|
| (1) 6 min 40 sec | (3) 15 min 00 sec |
| (2) 9 min 40 sec | (4) 19 min 00 sec |

102 Beneath which surface location is Earth's crust the thinnest?

- (1) East Pacific Ridge
- (2) the center of South America
- (3) Old Forge, New York
- (4) San Andreas Fault

The cross section below shows the direction of movement of an oceanic plate over a mantle hot spot, resulting in the formation of a chain of volcanoes labeled A, B, C, and D. The geologic age of volcano C is shown.



103 What are the most likely geologic ages of volcanoes B and D?

- (1) B is 5 million years old and D is 12 million years old.
- (2) B is 2 million years old and D is 6 million years old.
- (3) B is 9 million years old and D is 9 million years old.
- (4) B is 10 million years old and D is 4 million years old.

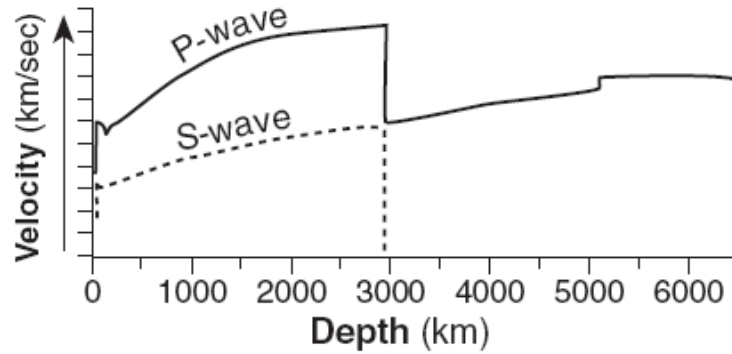
104 Scientists have inferred the structure of Earth's interior mainly by analyzing

- (1) the Moon's interior
- (2) the Moon's composition
- (3) Earth's surface features
- (4) Earth's seismic data

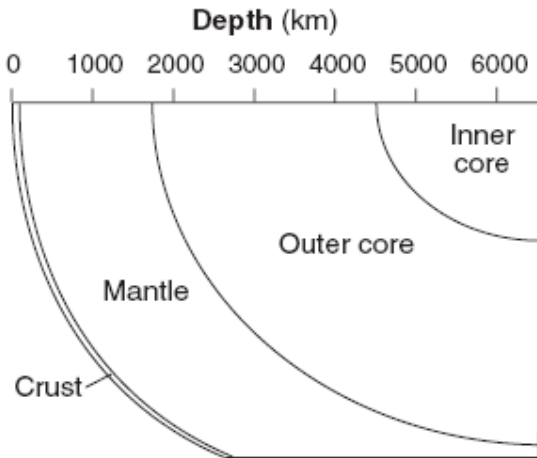
105 Which conditions normally can be found in Earth's asthenosphere, producing a partial melting of ultramafic rock?

- (1) temperature = 1,000°C; pressure = 10 million atmospheres
- (2) temperature = 2,000°C; pressure = 0.1 million atmospheres
- (3) temperature = 3,500°C; pressure = 0.5 million atmospheres
- (4) temperature = 6,000°C; pressure = 4 million atmospheres

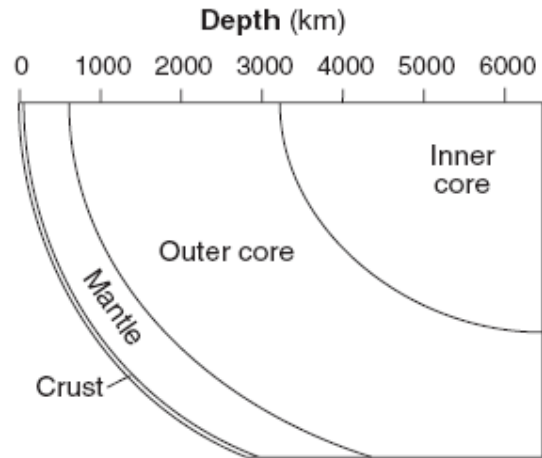
The graph below shows the different velocities of *P*-waves and *S*-waves through Earth's interior.



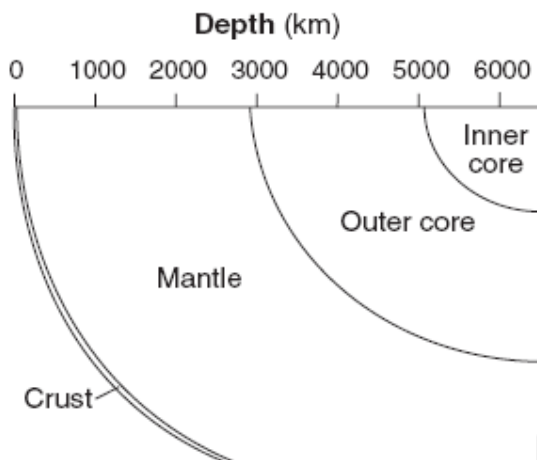
106 Which cross section best shows the inferred thickness of Earth's interior layers that cause these different velocities?



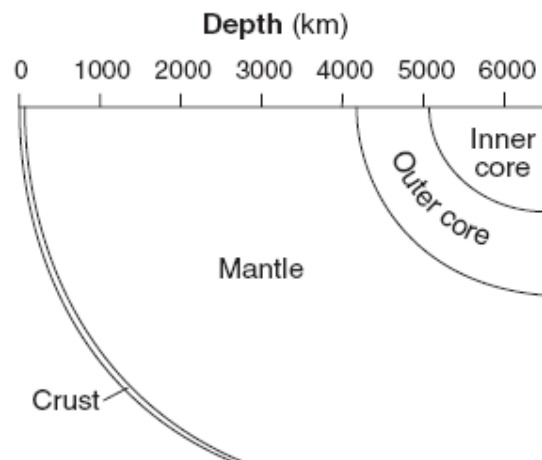
(1)



(3)

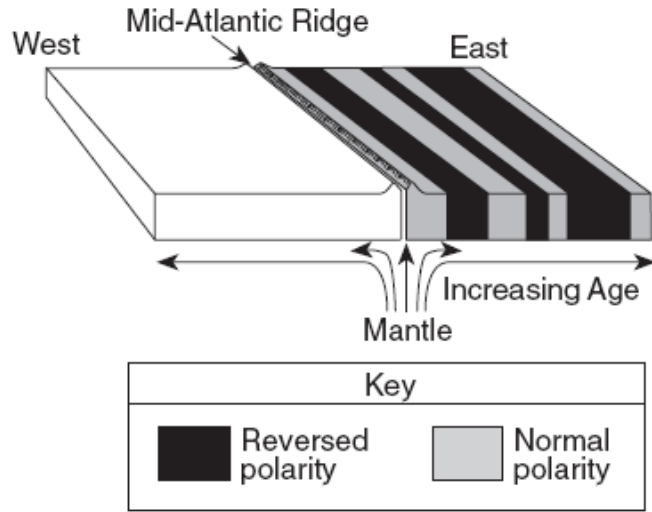


(2)

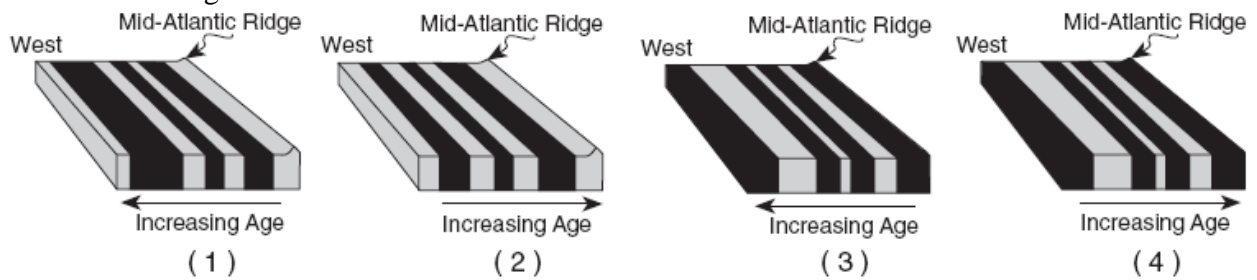


(4)

The diagram below represents the pattern of normal and reversed magnetic polarity and the relative age of the igneous bedrock composing the ocean floor on the east side of the Mid-Atlantic Ridge. The magnetic polarity of the bedrock on the west side of the ridge has been deliberately left blank.

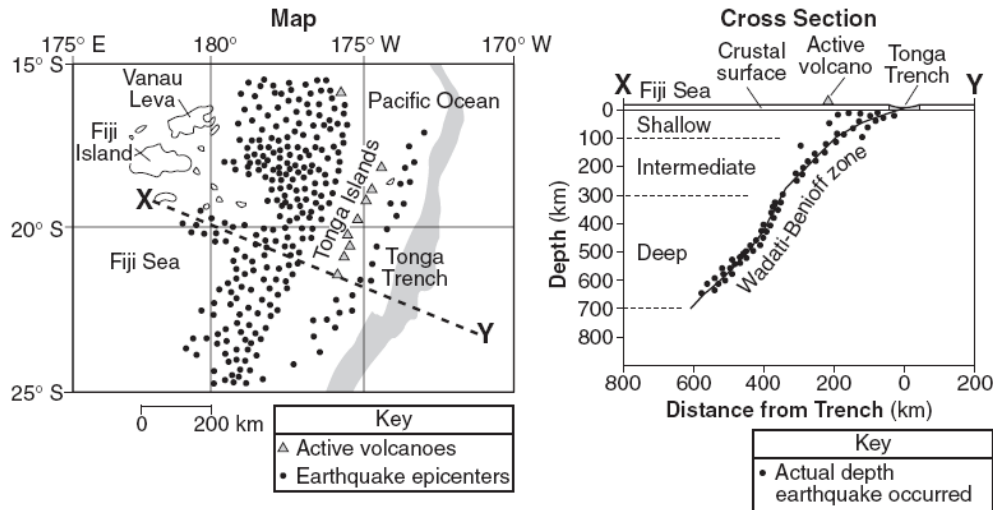


107 Which diagram best shows the magnetic pattern and relative age of the igneous bedrock on the west side of the ridge?



Base your answers to questions 108 through 111 on the information, map, and cross section below. The map represents a portion of Earth's surface in the Pacific Ocean. The positions of islands, earthquake epicenters, active volcanoes, and the Tonga Trench are shown. Lines of latitude and longitude have been included.

The cross section shows earthquakes that occurred beneath line XY on the map. Depth beneath Earth's surface is indicated by the scale along the left side of the cross section, as are the range of depths for shallow, intermediate, and deep earthquakes. Distance from the trench is indicated by the scale along the bottom of the cross section.



108 The Tonga Trench is located at the tectonic boundary between the Pacific Plate and the

(1) Antarctic Plate (3) Indian-Australian Plate

(2) Philippine Plate (4) Nazca Plate

109 The greatest number of earthquakes shown in the cross section occurred

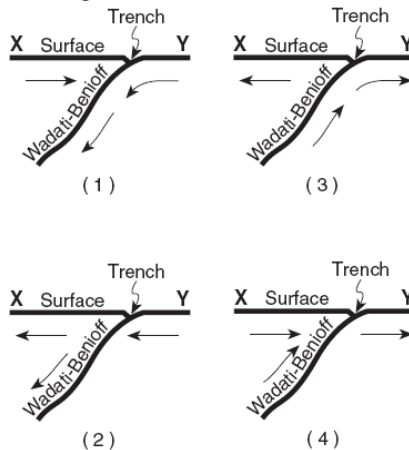
(1) at sea level

(2) between sea level and a depth of 100 km

(3) at a depth between 100 and 300 km

(4) at a depth between 300 and 600 km

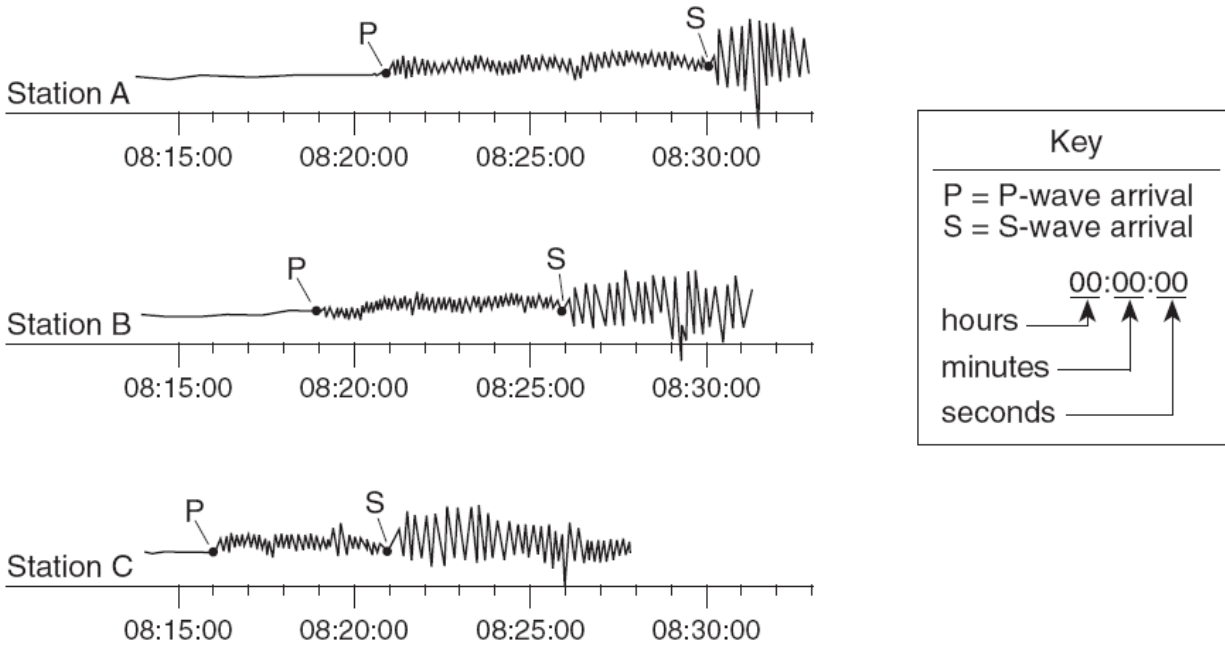
110 Which cross section has arrows that best represent the relative motion of the crustal plates along the Wadati-Benioff zone beneath the Tonga Trench?



111 The latitude and longitude of the center of Vanau Leva is closest to

- (1) 17° N 179° W
- (2) 17° N 181° W
- (3) 17° S 179° E
- (4) 17° S 181° E

The diagram below represents three seismograms showing the same earthquake as it was recorded at three different seismic stations, *A*, *B*, and *C*.



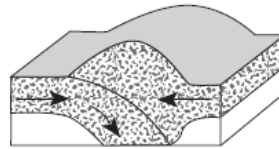
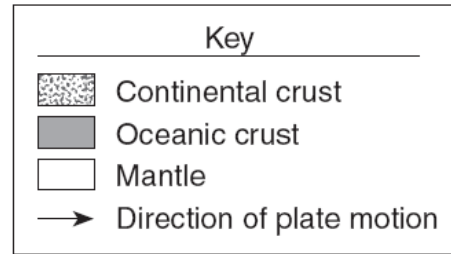
112 Which statement correctly describes the distance between the earthquake epicenter and these seismic stations?

- (1) *A* is closest to the epicenter, and *C* is farthest from the epicenter.
- (2) *B* is closest to the epicenter, and *C* is farthest from the epicenter.
- (3) *C* is closest to the epicenter, and *A* is farthest from the epicenter.
- (4) *A* is closest to the epicenter, and *B* is farthest from the epicenter.

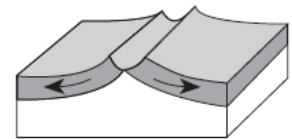
113 When a continental crustal plate collides with an oceanic crustal plate, the continental crust is forced to move over the oceanic crust. What is the primary reason that the continental crust stays on top of the oceanic crust?

- (1) Continental crust is less dense.
- (2) Continental crust deforms less easily.
- (3) Continental crust melts at higher temperatures.
- (4) Continental crust contains more mafic minerals.

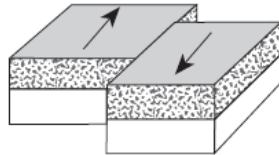
114 Which cross section below best represents the crustal plate motion that is the primary cause of the volcanoes and deep rift valleys found at midocean ridges?



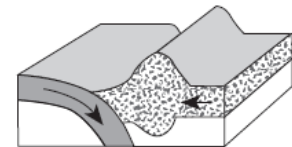
(1)



(3)

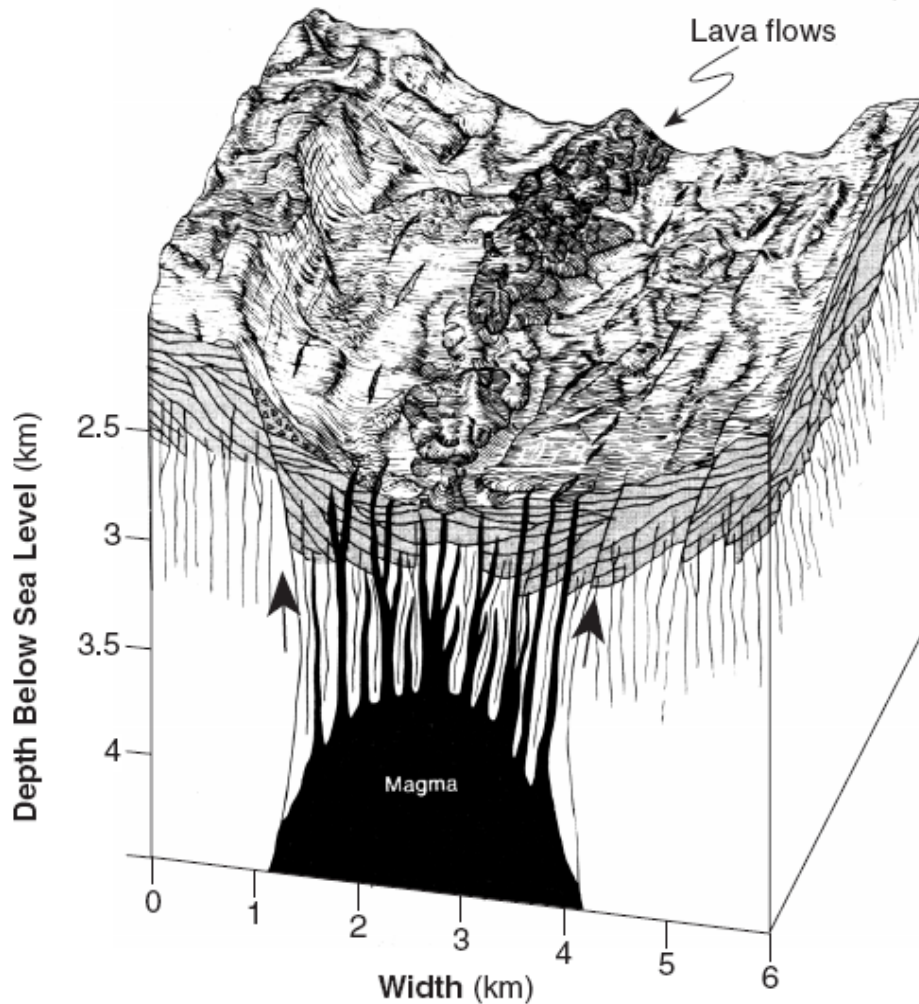


(2)



(4)

Base your answers to questions 115 through 117 on the diagram below, which shows details of a section of a rift valley in the center of a mid-ocean ridge. The vertical lines in the diagram represent faults and fractures within the ocean floor bedrock.



115 What will be the primary result of the continuation of the geologic processes indicated at this location?

- (1) Earth's magnetic field will reverse direction.
- (2) Continental crust will be forced downward.
- (3) Earth's circumference will increase.
- (4) New oceanic crust will form.

116 Which type of crustal plate boundary is shown in this diagram?

- (1) divergent
- (2) convergent
- (3) universal
- (4) transform

117 The dark-colored lava flows shown in the diagram were pushed from the magma chamber onto the surface of the ocean floor. Which characteristics are present in the solid rock that formed when the lava flows cooled?

- (1) generally small grain size and mafic composition
- (2) generally small grain size and felsic composition
- (3) generally large grain size and mafic composition
- (4) generally large grain size and felsic composition

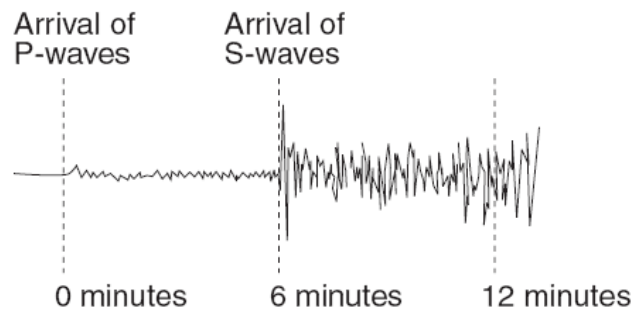
Most inferences about the characteristics of Earth's mantle and core are based on

- (1) the behavior of seismic waves in Earth's interior
- (2) well drillings from Earth's mantle and core
- (3) chemical changes in exposed and weathered metamorphic rocks
- (4) comparisons between Moon rocks and Earth rocks

118 Compared to Earth's crust, Earth's core is believed to be

- (1) less dense, cooler, and composed of more iron
- (2) less dense, hotter, and composed of less iron
- (3) more dense, hotter, and composed of more iron
- (4) more dense, cooler, and composed of less iron

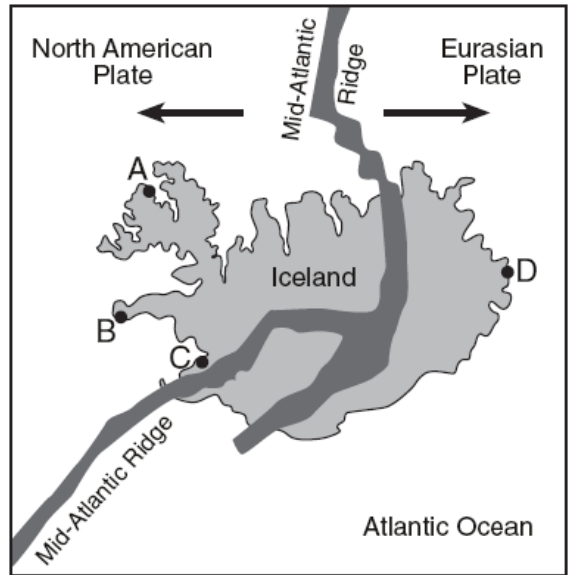
The seismogram below shows *P*-wave and *S*-wave arrival times at a seismic station following an earthquake.



119 The distance from this seismic station to the epicenter of the earthquake is approximately

- (1) 1,600 km
- (2) 3,200 km
- (3) 4,400 km
- (4) 5,600 km

Base your answers to questions 120 and 121 on the map below of Iceland, a country located on the Mid-Atlantic Ridge. Four locations are represented by the letters *A* through *D*.



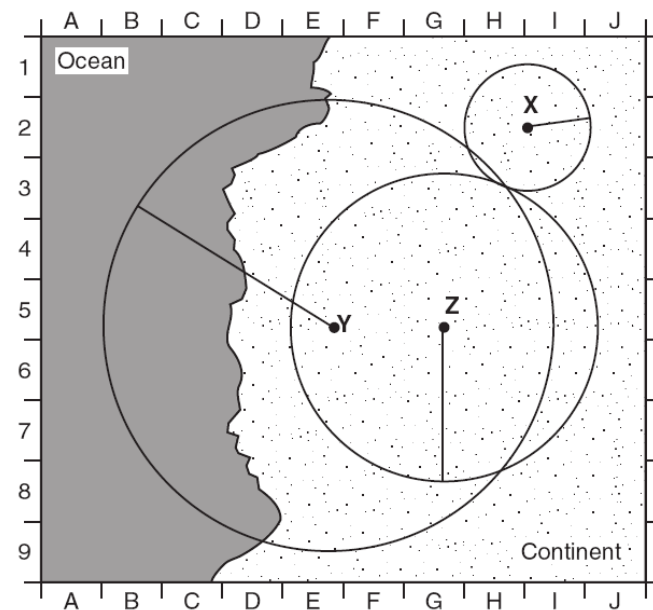
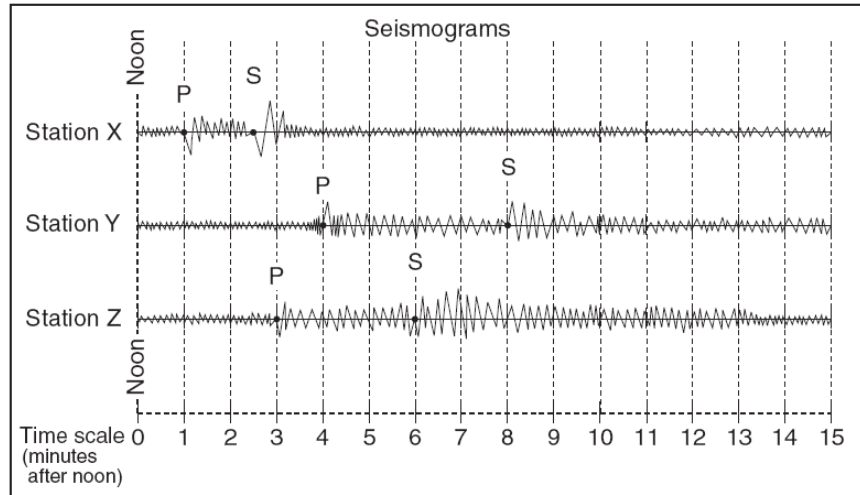
120 The fine-grained texture of most of the igneous rock formed on the surface of Iceland is due to

- (1) rapid cooling of the molten rock
- (2) high density of the molten rock
- (3) numerous faults in the island's bedrock
- (4) high pressure under the island

121 The youngest bedrock is most likely found at which location?

- (1) *A*
- (2) *B*
- (3) *C*
- (4) *D*

Base your answers to questions 122 through 146 on the diagram and map below. The diagram shows three seismograms of the same earthquake recorded at three different seismic stations, X, Y, and Z. The distances from each seismic station to the earthquake epicenter have been drawn on the map. A coordinate system has been placed on the map to describe locations. The map scale has not been included.



122 Approximately how far away from station Y is the epicenter?

- (1) 1,300 km
- (2) 2,600 km
- (3) 3,900 km
- (4) 5,200 km

123 The S-waves from this earthquake that travel toward Earth's center will

- (1) be deflected by Earth's magnetic field
- (2) be totally reflected off the crust-mantle interface
- (3) be absorbed by the liquid outer core
- (4) reach the other side of Earth faster than those that travel around Earth in the crust

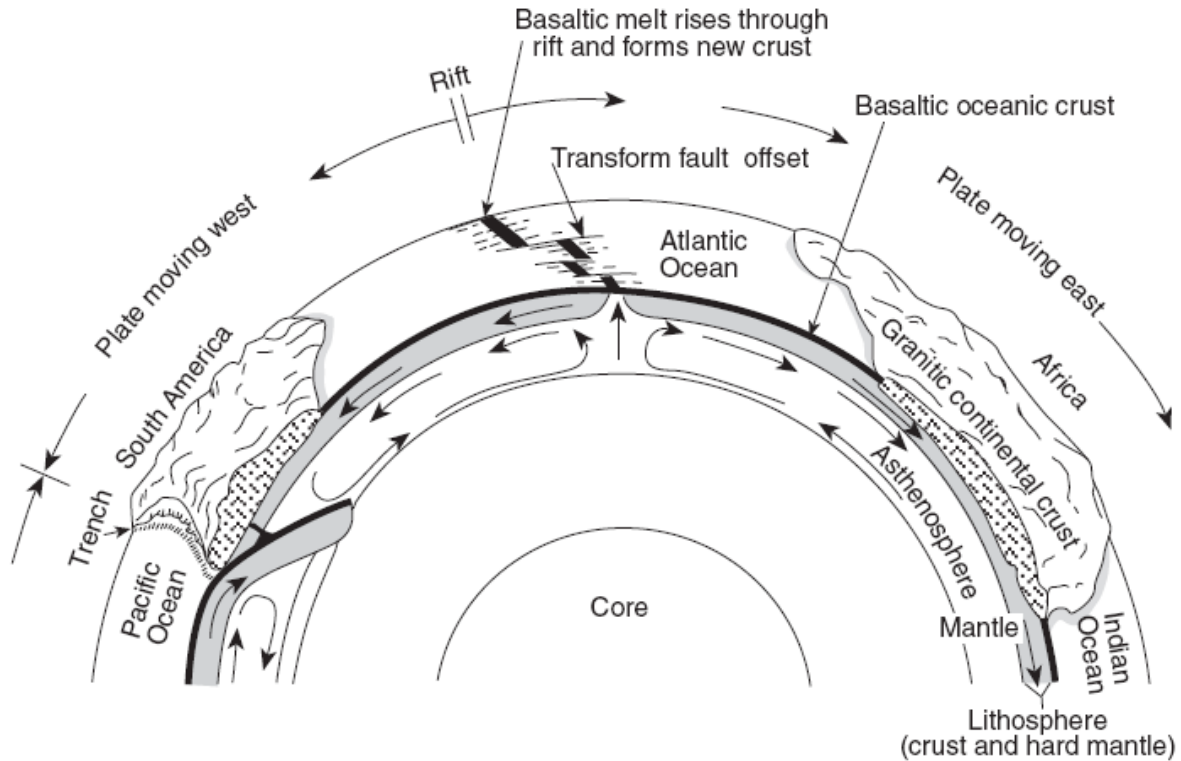
124 Seismic station Z is 1,700 kilometers from the epicenter. Approximately how long did it take the P-wave to travel to station Z?

- (1) 1 min 50 sec
- (2) 2 min 50 sec
- (3) 3 min 30 sec
- (4) 6 min 30 sec

125 On the map, which location is closest to the epicenter of the earthquake?

- (1) E-5
- (2) G-1
- (3) H-3
- (4) H-8

Base your answers to questions 126 through 128 on the diagram below. The diagram shows a model of the relationship between Earth's surface and its interior.



(Not drawn to scale)

126 Mid-ocean ridges (rifts) normally form where tectonic plates are

- (1) converging
- (2) diverging
- (3) stationary
- (4) sliding past each other

127 The motion of the convection currents in the mantle beneath the Atlantic Ocean appears to be mainly making this ocean basin

- (1) deeper
- (2) shallower
- (3) wider
- (4) narrower

128 According to the diagram, the deep trench along the west coast of South America is caused by movement of the oceanic crust that is

- (1) sinking beneath the continental crust
- (2) uplifting over the continental crust
- (3) sinking at the Mid-Atlantic ridge
- (4) colliding with the Atlantic oceanic crust