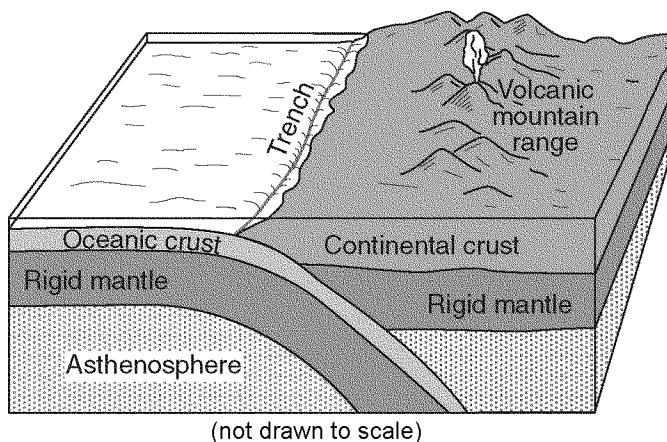


Name: _____

- 1) Earth's internal heat is the primary source of energy that
 - A) warms the lower troposphere
 - B) pollutes deep groundwater with radioactivity
 - C) moves the lithospheric plates
 - D) melts glacial ice at lower altitudes
- 2) The Indian-Australian tectonic plate is moving
 - A) away from the Philippine Plate
 - B) toward the Pacific Plate
 - C) toward the Antarctic Plate
 - D) away from the Fiji Plate

Questions 3 and 4 refer to the following:

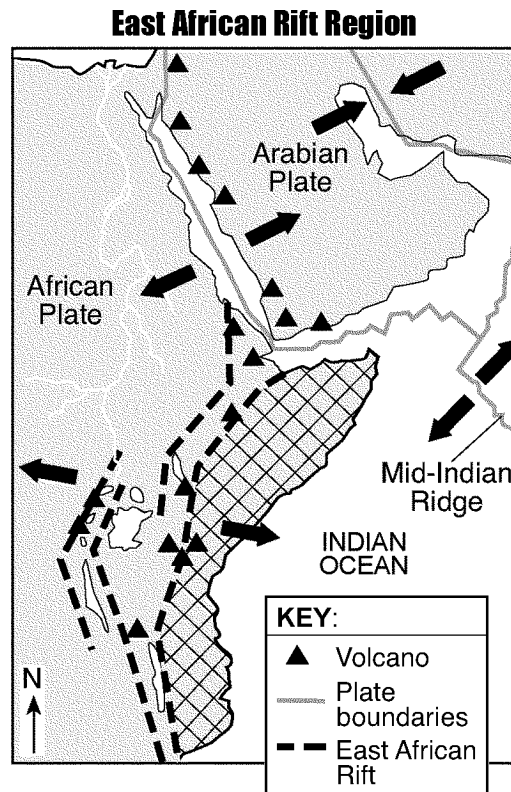
The block diagram below shows a tectonic plate boundary.



- 3) Which tectonic plate boundary is *best* represented by the given diagram?
 - A) Antarctic Plate and Indian-Australian Plate boundary
 - B) Nazca Plate and Pacific Plate boundary
 - C) Juan de Fuca Plate and North American Plate boundary
 - D) Scotia Plate and South American Plate boundary
- 4) Compared to the oceanic crust, the continental crust is

A) less dense and more felsic	C) more dense and more felsic
B) more dense and more mafic	D) less dense and more mafic

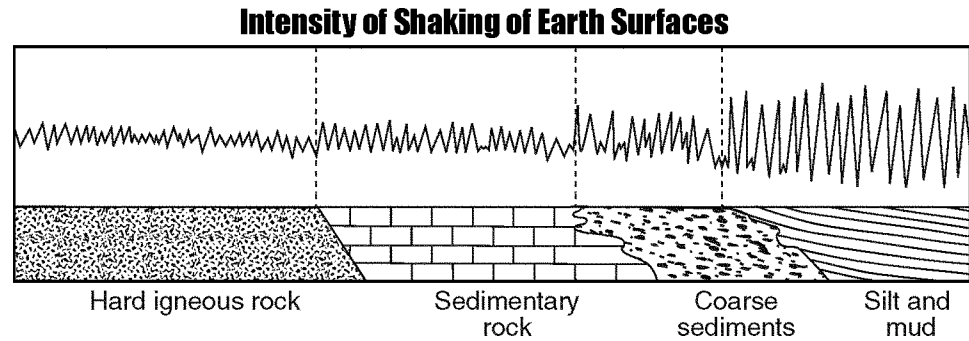
- 5) The map below shows the tectonic plate boundaries near the East African Rift. Arrows show relative tectonic plate movement. A region of Africa is crosshatched (X).



What appears to be happening to the crosshatched region of eastern Africa in the given map?

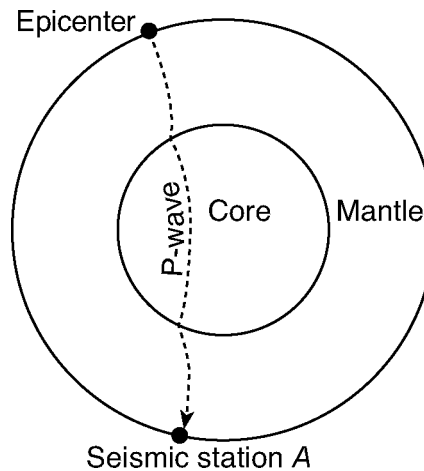
- A) Several volcanic mountains are forming as the rest of Africa subducts under this region.
- B) This region is moving eastward relative to the rest of Africa.
- C) This region is moving northward relative to the rest of Africa.
- D) A folded mountain range is forming as this region collides with the rest of Africa.

- 6) The diagram below represents the intensity of the shaking that occurs on different Earth surfaces during the same earthquake.



The *greatest* earthquake hazard to homes exists when they are built on

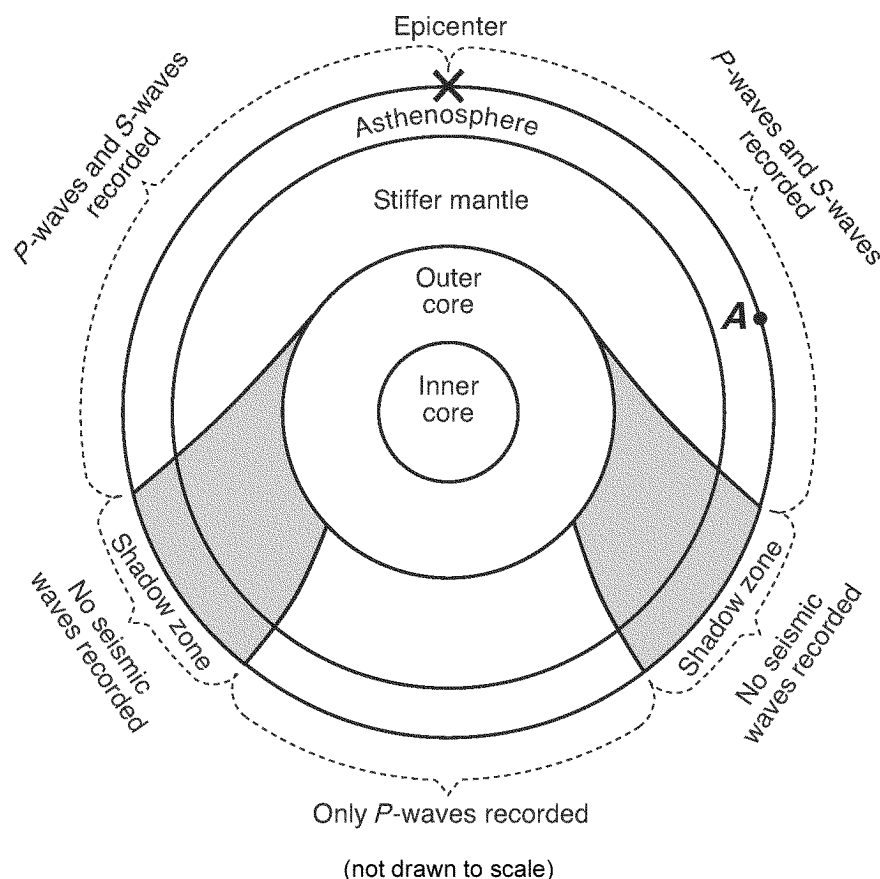
- A) hard igneous rock C) coarse sediments
 B) silt and mud D) sedimentary rock
- 7) The cross section of Earth below shows a *P*-wave moving away from an earthquake epicenter to seismic station *A*.



No *S*-waves arrive directly at seismic station *A* because

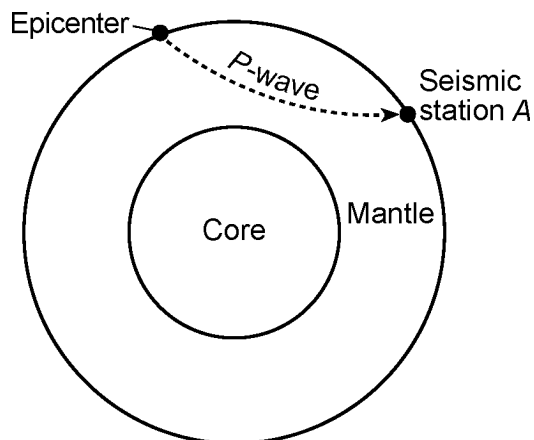
- A) seismic station *A* is located on glacial ice
 B) *S*-waves travel too slowly
 C) some parts of the core are liquid
 D) the distance to seismic station *A* is too great

The cross section below shows the type of seismic waves recorded at various locations after an earthquake has occurred. Point A is location on Earth's surface and **X** is the epicenter of the earthquake.



- 8) How many kilometers did the seismic waves shown travel from the earthquake directly to the outside of the outer core?
- A) 800 km C) 1,400 km
B) 2,900 km D) 6,400 km
- 9) Point A on the given cross section is located 7,600 kilometers from the epicenter of this earthquake. How many minutes did it take the *first S-wave* to reach point A?
- A) 16 min B) 9 min C) 20 min D) 11 min

- 10) The cross section of Earth below represents a *P*-wave moving away from an earthquake epicenter. Seismic station A is shown on Earth's surface.



At station A, the first *P*-wave arrives 11 minutes 40 seconds after the earthquake. How long after the first *P*-wave arrives will the first *S*-wave arrive?

- A) 9 minutes 40 seconds C) 5 minutes 00 second
 B) 8 minutes 40 seconds D) 21 minutes 20 seconds
- 11) What is the approximate time difference between the first *P*-wave and the first *S*-wave recorded at a seismic station located 8,000 kilometers from an earthquake's epicenter?
- A) 9 minutes 20 seconds C) 11 minutes 20 seconds
 B) 20 minutes 40 seconds D) 8 minutes 40 seconds
- 12) An earthquake occurs at 12:02 p.m. A seismic station records the first *S*-wave at 12:19 p.m. Which set of data shows the approximate arrival time of the first *P*-wave and the distance to the epicenter?
- A) 12:19:40 p.m. and 4,000 km C) 12:11:25 p.m. and 4,000 km
 B) 12:19:40 p.m. and 6,000 km D) 12:11:25 p.m. and 6,000 km
- 13) The epicenter of an earthquake is located 6,500 kilometers away from a seismic station. If the first *S*-wave arrived at this seismic station at 1:30 p.m., at what time did the first *P*-wave arrive?
- A) 1:20 p.m. C) 1:22 p.m.
 B) 1:38 p.m. D) 1:40 p.m.
- 14) The arrival time of the first earthquake *P*-wave at a seismograph station was 10:11:20 (hours: minutes: seconds). If the epicenter of the earthquake is 8,000 km away, what was the approximate arrival time of the first *S*-wave from this earthquake?
- A) 10:20:40 C) 10:02:00
 B) 10:32:00 D) 10:09:20

Questions 15 through 17 refer to the following:

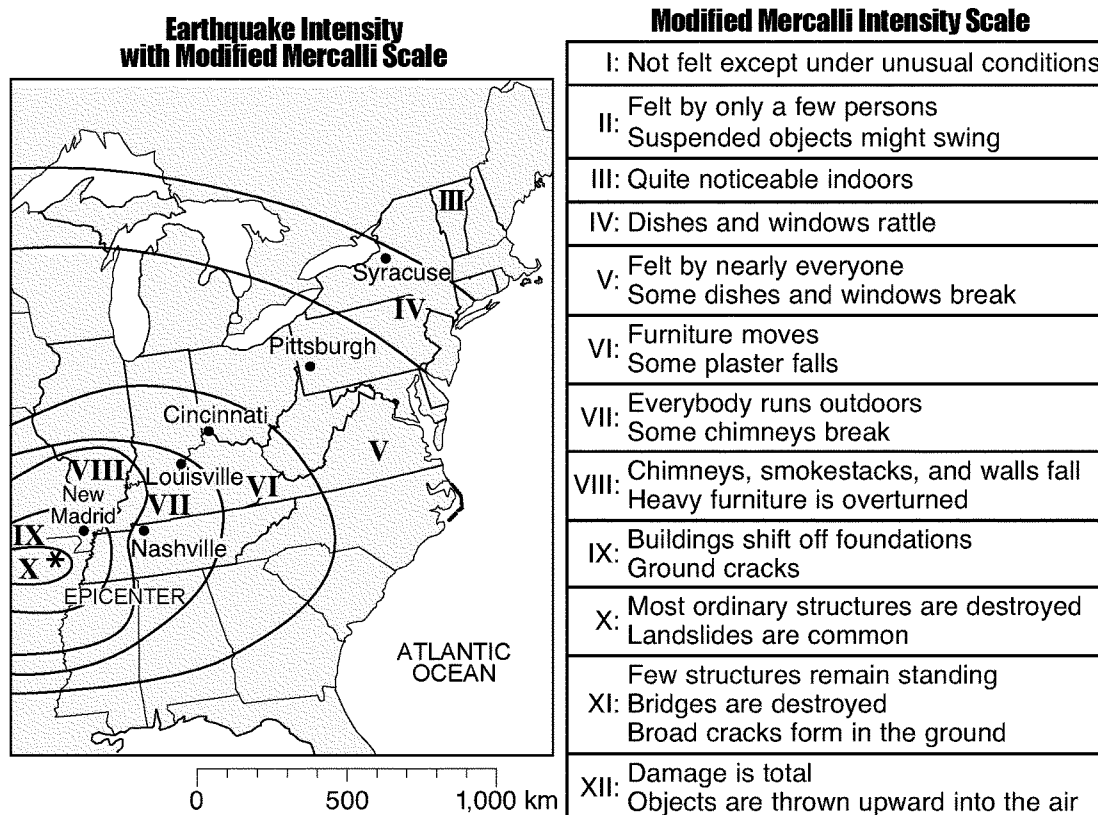
The data table below gives information collected at seismic stations *W*, *X*, *Y*, and *Z* for the same earthquake. Some of the data have been omitted.

DATA TABLE:

Seismic Station	<i>P</i> -Wave Arrival Time (h:min:s)	<i>S</i> -Wave Arrival Time (h:min:s)	Difference in Arrival Times (h:min:s)	Distance to Epicenter (km)
<i>W</i>	10:50:00	no <i>S</i> -waves arrived		
<i>X</i>	10:42:00	10:46:40		
<i>Y</i>	10:39:20		00:02:40	
<i>Z</i>	10:45:40			6,200

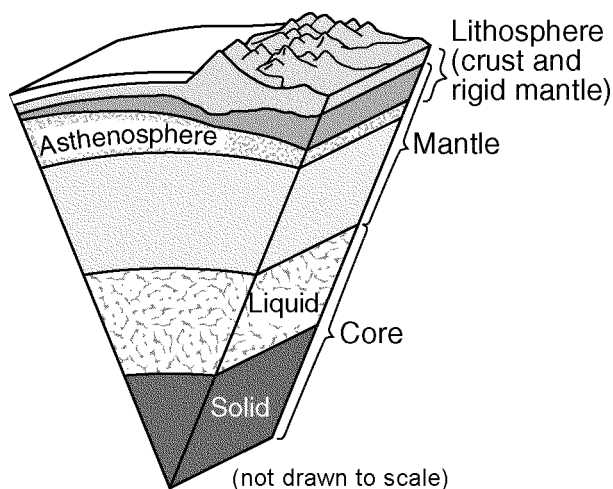
- 15) Which of the seismic stations represented in the data table was *farthest* from the earthquake epicenter?
 A) *Y* B) *W* C) *Z* D) *X*
- 16) What is the *most* probable reason for the absence of *S*-waves at station *W*?
 A) Station *W* was located on solid bedrock.
 B) *S*-waves were not generated at the epicenter.
 C) Station *W* was located on an island.
 D) *S*-waves cannot travel through liquids.
- 17) At what time did the *S*-wave arrive at station *Y*?
 A) 10:42:00 C) 10:45:20
 B) 10:36:40 D) 10:39:20

The map below shows the intensities of the earthquake that occurred slightly southwest of New Madrid, Missouri, on December 16, 1811. The epicenter of this earthquake is represented by *. The Roman numerals on the map show zones of earthquake intensities determined by using the modified Mercalli scale.



- 18) Which location on the given map would most probably have issued the report:
"Many structures shifted off foundations"?
- A) Nashville C) Syracuse
B) New Madrid D) Pittsburgh
- 19) The intensity numbers shown on the map were determined by
- A) the recorded time difference in the arrival of the first *P*-wave and *S*-wave at each city
B) observations made only at the earthquake epicenter
C) observations made at different locations during and after the earthquake
D) the arrival time of the first *P*-wave recorded at each city

- 20) A model of Earth's internal structure is shown below.



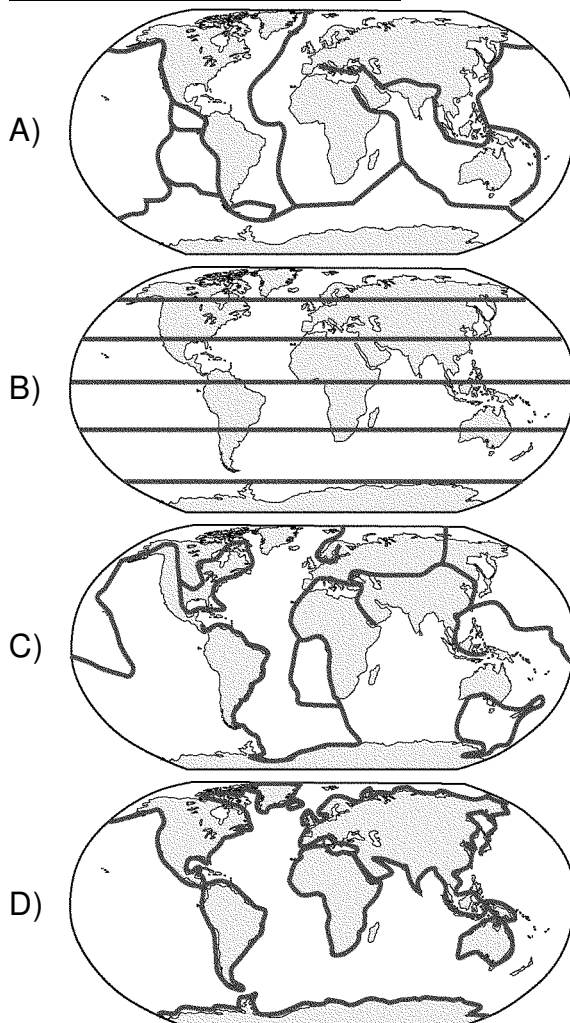
Analysis of which type of data led to the development of this model?

- | | |
|------------------------------|---------------------|
| A) electromagnetic radiation | C) isobar gradients |
| B) depth of Earth's oceans | D) seismic waves |
- 21) What caused the interior of Earth to separate into layers?
- A) collisions with meteors and comets
 B) a decrease in the rate of rotation of Earth
 C) variations in heating by the Sun due to Earth's tilt
 D) the gravitational pull on materials of varying densities
- 22) The inferred temperature and pressure of Earth's interior at a depth of 3,000 kilometers are approximately
- A) 1,000°C and 0.5 million atmospheres
 B) 5,000°C and 3.0 million atmospheres
 C) 5,000°C and 1.5 million atmospheres
 D) 1,000°C and 1.0 million atmospheres
- 23) Which mineral is most frequently found in *both* granitic continental crust and basaltic oceanic crust?
- | | |
|------------|-------------------------|
| A) olivine | C) potassium feldspar |
| B) quartz | D) plagioclase feldspar |

- 24) Which world map shows the locations where *most* earthquakes and volcanoes occur on Earth?

KEY:

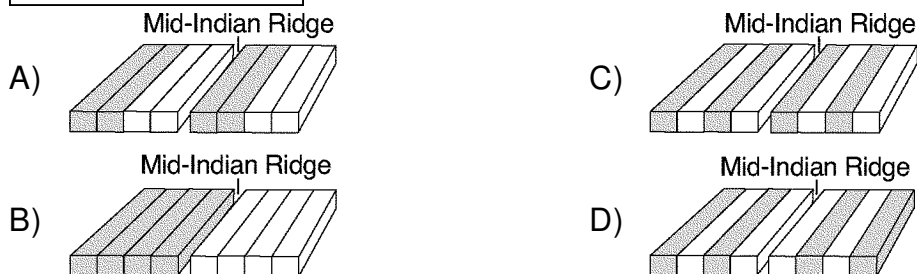
— Location of most earthquakes and volcanoes



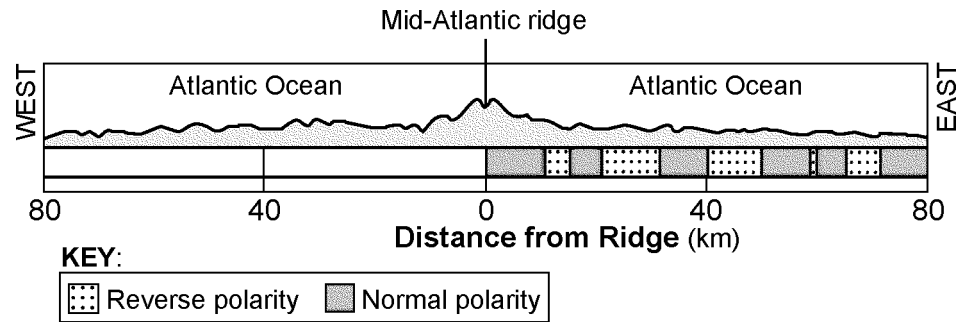
- 25) Which diagram *best* represents the polarity of the magnetic field preserved in the ocean-floor bedrock found on both sides of the Mid-Indian Ridge?

KEY:

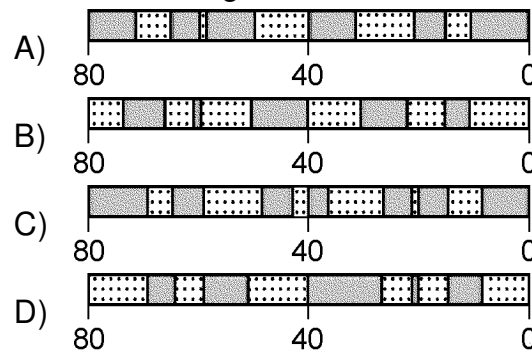
Reversed polarity Normal polarity



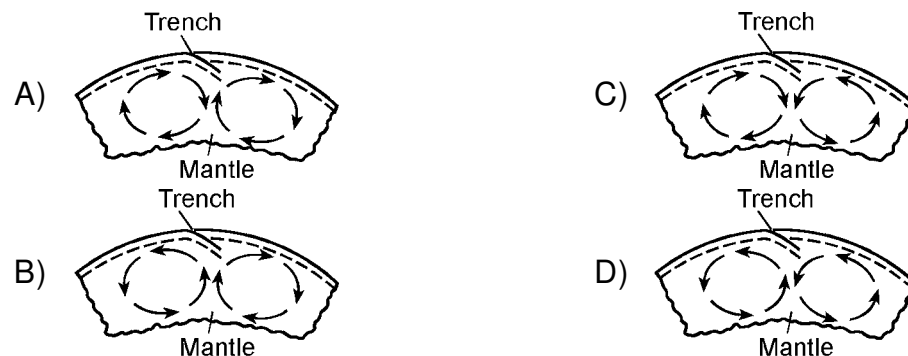
- 26) The cross section below represents a pattern of magnetic field reversals preserved in the igneous bedrock of the oceanic crust east of the Mid-Atlantic ridge.



Which cross section best represents the magnetic field pattern west of the Mid-Atlantic ridge?



- 27) Which cross section *best* represents the convection currents in the mantle beneath the Peru-Chile Trench?



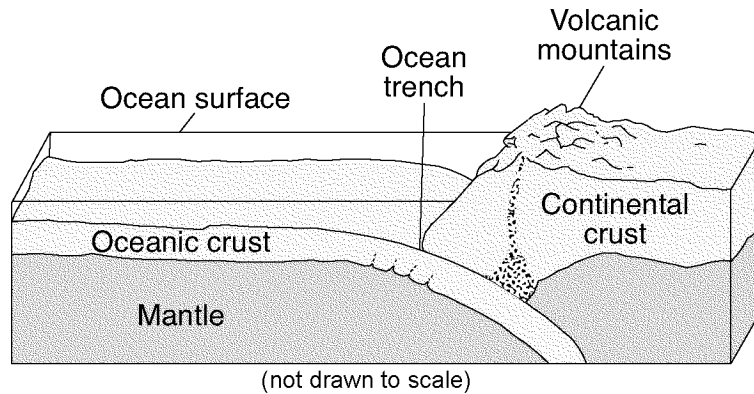
- 28) Which surface feature was produced by crustal movements at a transform plate boundary?

- A) Tasman Hot Spot C) Aleutian Trench
B) San Andreas Fault D) East African Rift

- 29) Which one of the following landmasses is moving northward with Australia as part of the same tectonic plate?

- A) South America C) North America
B) Antarctica D) India

- 30) A ship is at a location of 40DS 77DW. Which type of surface ocean current and tectonic plate boundary are located beneath this ship?
- A) cool ocean current and a transform boundary
 - B) warm ocean current and a convergent boundary
 - C) cool ocean current and a convergent boundary
 - D) warm ocean current and a transform boundary
- 31) The block diagram below shows the boundary between two tectonic plates.

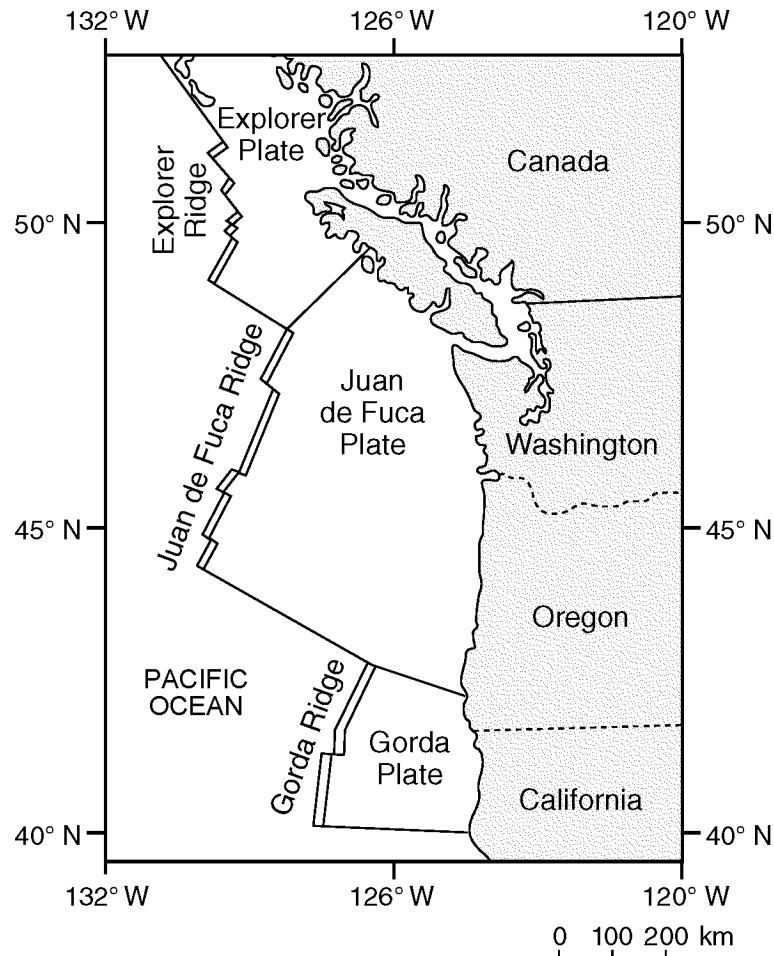


Which type of plate boundary is shown?

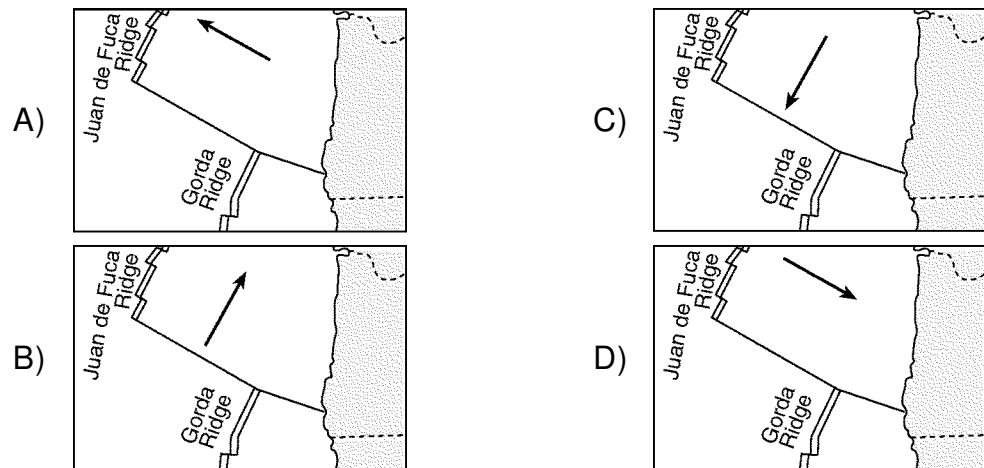
- A) convergent
 - B) divergent
 - C) complex
 - D) transform
- 32) The Aleutian Islands extend westward from southern Alaska to form the northern boundary of the Pacific Ocean. These volcanic islands were formed by the nearby
- A) divergence of an oceanic plate
 - B) subduction of an oceanic plate
 - C) divergence of a continental plate
 - D) subduction of a continental plate

Questions 33 and 34 refer to the following:

The map below shows the coast of the northwestern United States. The Explorer and Gorda ridges and plates are parts of the Juan de Fuca tectonic system.



- 33) The arrow on which map below *best* shows the direction of movement of the Juan de Fuca Plate in relation to the Juan de Fuca Ridge?



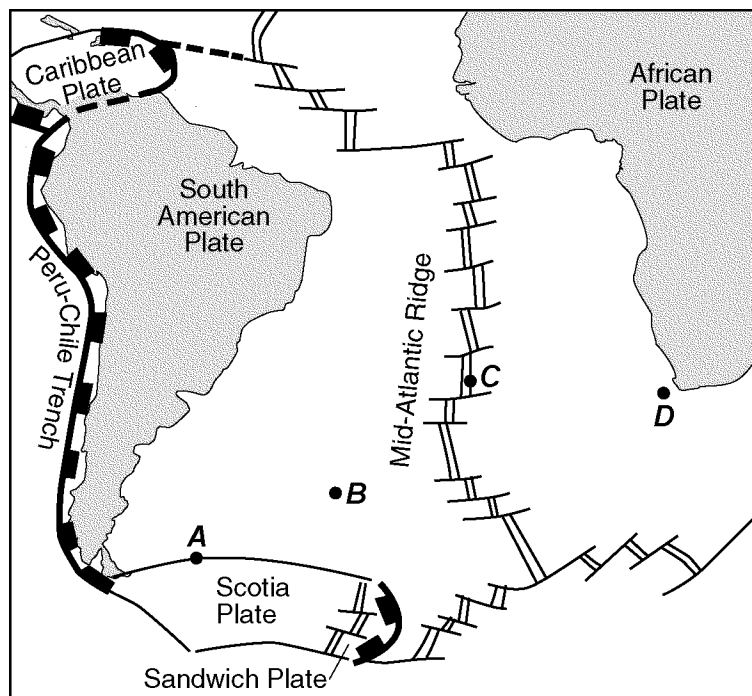
- 34) Based on the data shown on the map, the Explorer Ridge is the boundary between the Explorer Plate and the
- A) Pacific Plate
 - B) North American Plate
 - C) Gorda Plate
 - D) Juan de Fuca Plate

Questions 35 through 37 refer to the following:

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.

- 35) Based on the reading passage, which type of tectonic plate boundary is located at mid-ocean ridges?
- A) convergent
B) divergent
C) complex
D) transform
- 36) Which mantle hot spot is located *closest* to a mid-ocean ridge?
- A) Hawaii
B) Tasman
C) Canary Islands
D) Easter Island
- 37) The map below shows a part of Earth's surface. Points *A* through *D* are locations on the ocean floor.



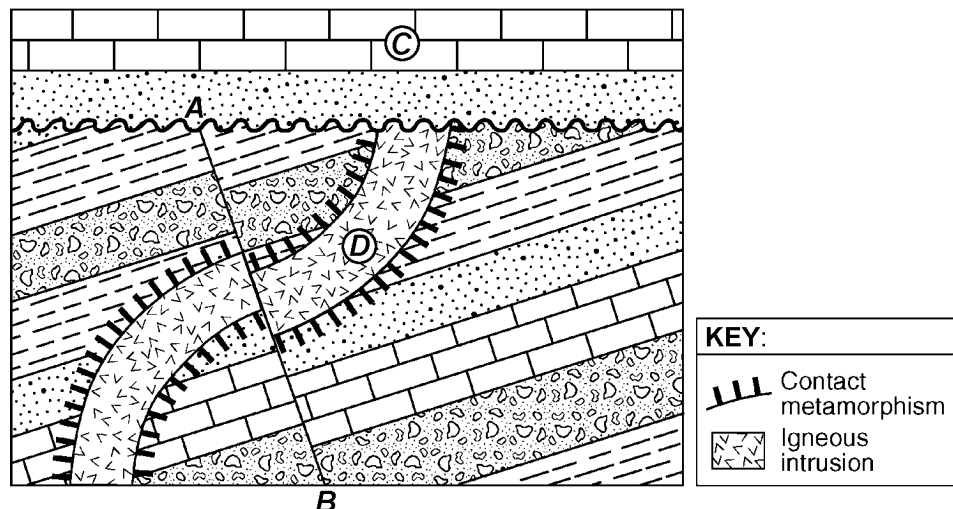
Based on the reading passage, at which location is the temperature of the ocean floor bedrock most likely *highest*?

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

In 1641, the crew of the ship *Concepcion* used the Sun and stars for navigation. The crew thought that the ship was just north of Puerto Rico, but ocean currents had carried them off course. The ship hit a coral reef and sank off the coast of the Dominican Republic. The **X** on the map marks the location of the sunken ship.



The cross section below represents several geologic structures. Line AB represents a fault. Letters C and D represent rock units.



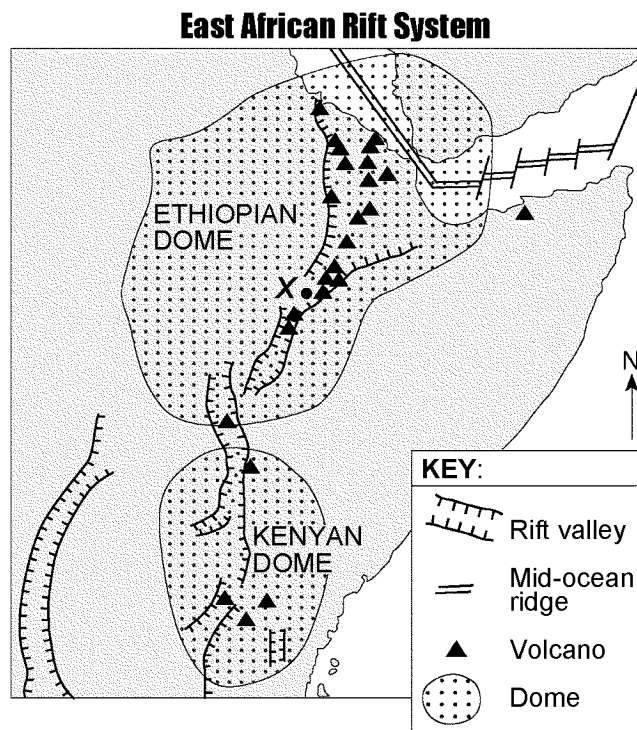
- 39) On the cross section provided, place an **X** on the unconformity.
- 40) On the cross section provided, place *two* arrows, one on *each* side of fault *AB*, to show the relative movement of the rock units on each side of the fault.

Questions 41 through 43 refer to the following:

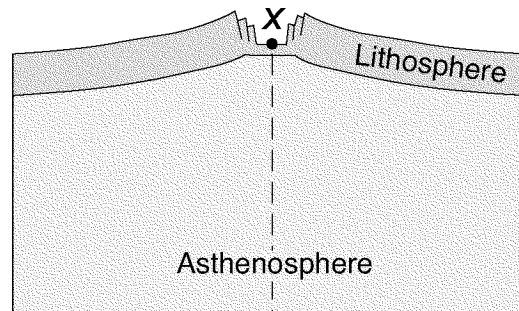
The map below shows a portion of the East African Rift system. Point *X* represents a location on Earth's surface within a rift valley on the Ethiopian Dome.

THE GREAT RIFT VALLEY:

Rifting of Earth's crust in eastern Africa began during the Neogene Period as the Ethiopian and Kenyan Domes formed. These two huge domes were created as Earth's mantle pushed up the overlying crust. As the crust was forced upward, the resulting tension cracked the crust, resulting in the eruption of volcanoes and the formation of large rifts. The crust continued to pull apart, forming rift valleys. These valleys have become deeper and are currently becoming filled with sediments, igneous rock, and water.



- 41) On the cross section below, draw two curved arrows, one on each side of the dashed line, to show the direction of movement of the convection currents within the asthenosphere that caused the formation of the dome and the rift valley near location X on the given map.



- 42) Based on the reading passage, how many million years ago did the Ethiopian and Kenyan Domes form?
- 43) Which *two* lithospheric plates are separated by a mid-ocean ridge in the northeastern portion of the Ethiopian Dome?

Questions 44 through 46 refer to the following:

The passage below describes unusual lava from a volcano in Africa.

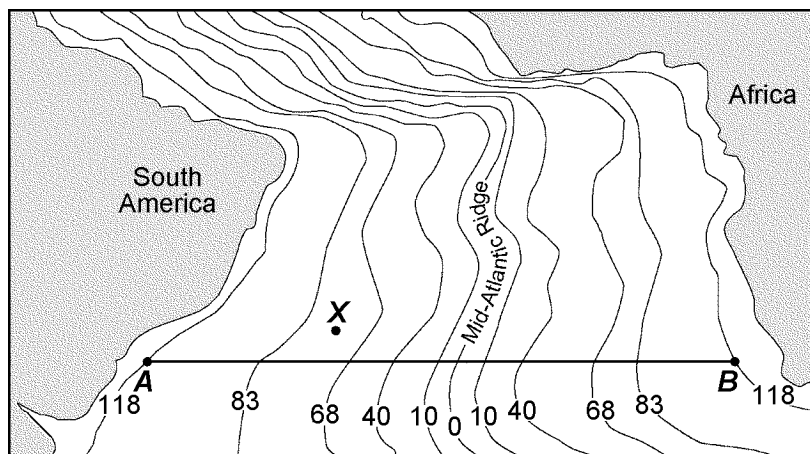
UNUSUAL VOLCANO:

Nyiragongo, located at 2D S 29D E, is an active African volcano. It has the most fluid lava on Earth. The lava has a composition unlike any other lava in the world. The rare isotopes found in the lava are similar to those found in ancient asteroids. This fact leads scientists to infer that the lava may be as old as our solar system and that it comes from deep inside the mantle near Earth's outer core. Nyiragongo is one volcano in a ring of many volcanoes surrounding an area that is domed upward nearly a mile above sea level, causing scientists to infer that a new mantle hot spot is forming there.

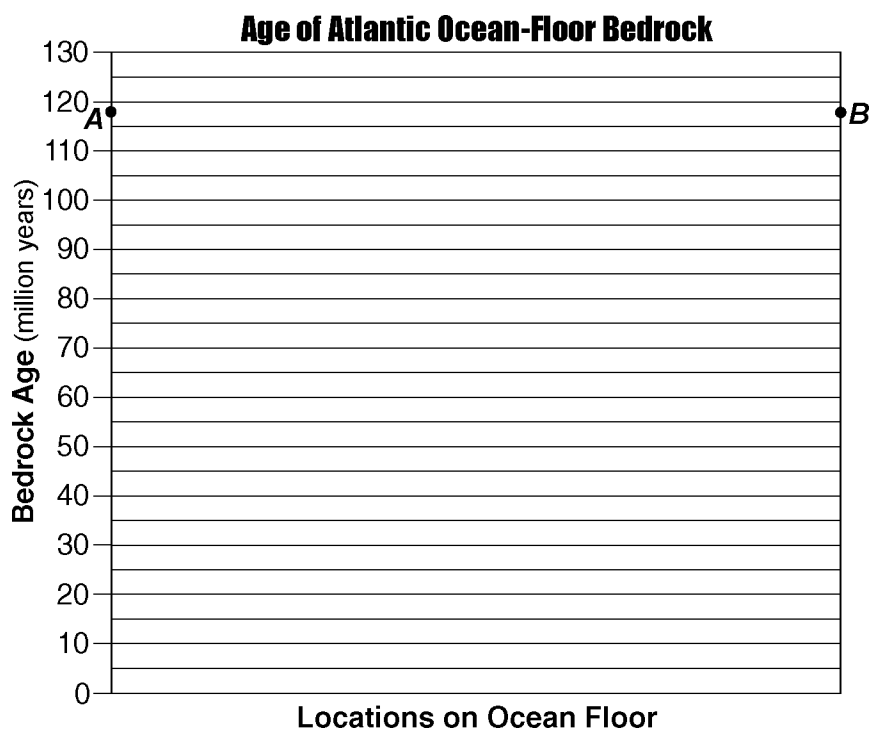
- 44) Two rocks, scoria and basalt, have formed from the cooled lava that erupted from Nyiragongo. Describe the texture of *each* rock.
- 45) Based on the information in the reading passage, identify the type of tectonic plate boundary found in the vicinity of Nyiragongo.
- 46) Identify *two* other locations on Earth, not on a plate boundary, where mantle rock is rising to Earth's surface.

Questions 47 through 50 refer to the following:

The generalized map below shows a portion of the Atlantic Ocean floor located between South America and Africa. Isolines show the approximate age, in million years, of the ocean-floor bedrock on each side of the Mid-Atlantic Ridge. Points A, B, and X represent locations on the ocean floor.



- 47) On the grid below, construct a line graph of bedrock age by plotting the age of the bedrock shown by each isoline that crosses line AB. Points A and B are plotted on the grid. Connect the plots from points A to B with a line.

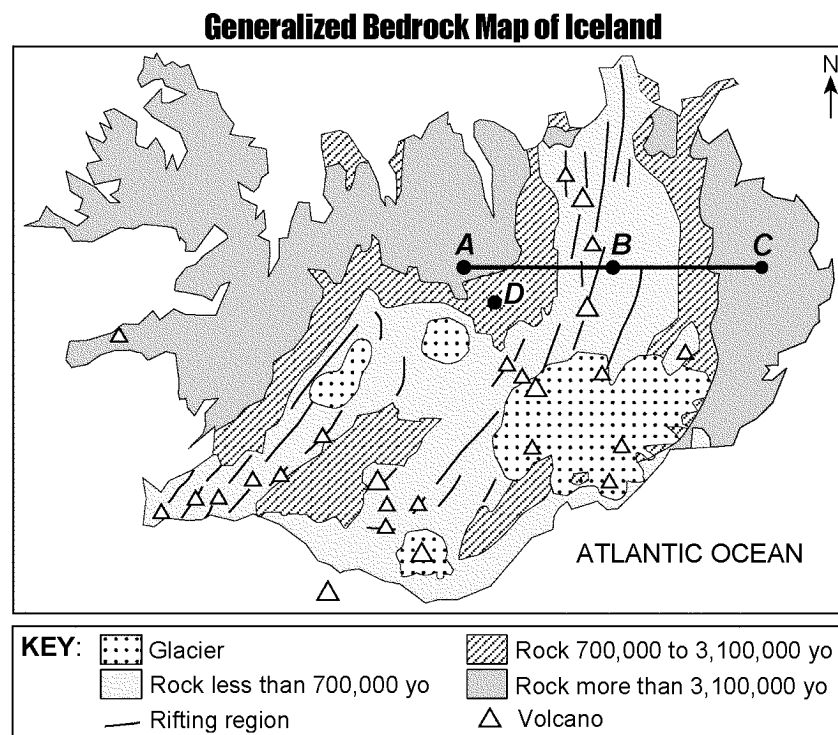


- 48) Estimate the age of the ocean-floor bedrock at point X on the given map.

- 49) Explain why the age of the ocean-floor bedrock increases as the distance from the Mid-Atlantic Ridge increases.
- 50) The Mid-Atlantic Ridge separates pairs of crustal plates, such as the South American Plate and the African Plate. Identify *one* other pair of crustal plates separated by the Mid-Atlantic Ridge.

Questions 51 and 52 refer to the following:

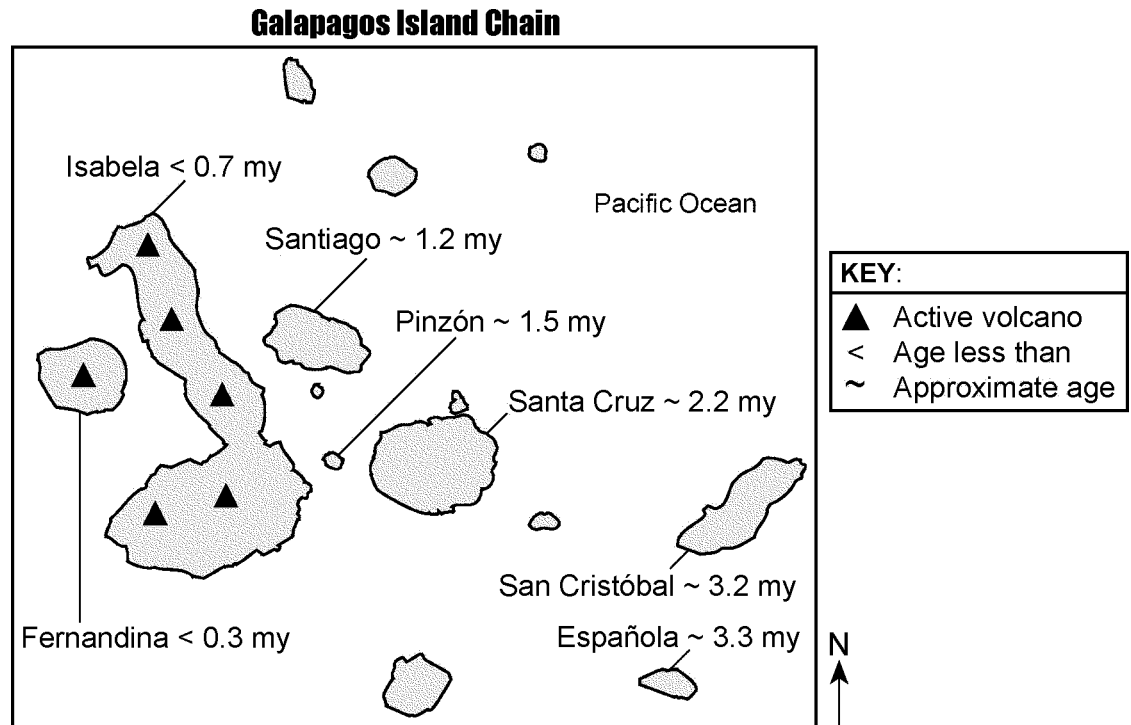
The map below shows the generalized surface bedrock geology of Iceland, an island located on the Mid-Atlantic Ridge. Points *A*, *B*, *C*, and *D* are locations on surface bedrock which is igneous in origin. Glaciers cover some surface bedrock.



- 51) Based on the given information, state the names of the two crustal plates that are diverging at Iceland.
- 52) In addition to crustal plate divergence, what feature located in the mantle beneath Iceland may be causing Iceland's volcanic activity?

Questions 53 through 57 refer to the following:

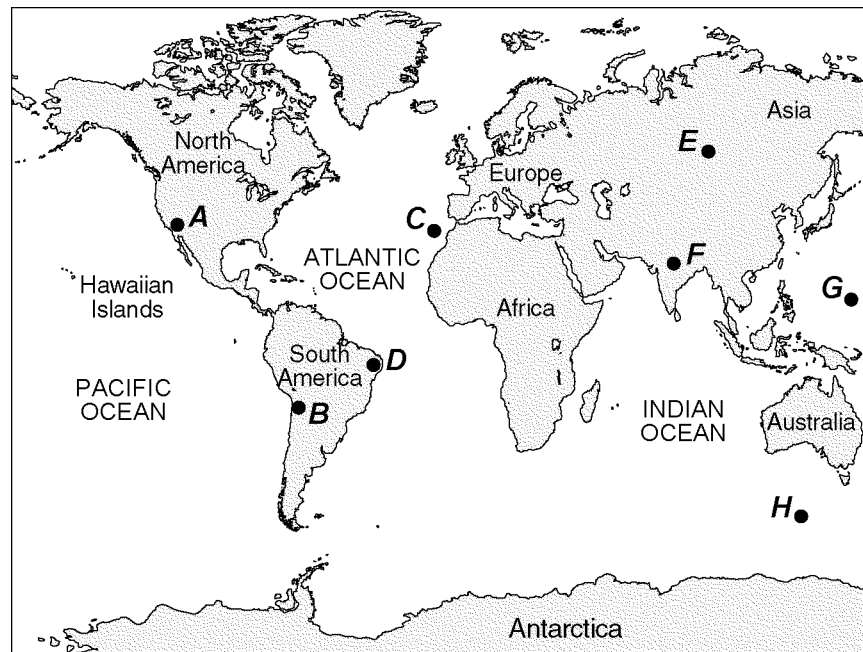
The map below shows the major islands in the Galapagos Island chain. These islands were formed by volcanic eruptions as the tectonic plate passed over the Galapagos Hot Spot. The age of the volcanic bedrock on certain islands is shown in millions of years (my).



- 53) During what geologic epoch did the bedrock on the island of San Cristóbal form?
- 54) Based on the age of the bedrock of the Galapagos Islands, in which direction does the tectonic plate containing the islands appear to be moving away from the Galapagos Hot Spot?
- 55) The Galapagos Hot Spot is located closest to what type of tectonic plate boundary?
- 56) Describe what caused a vesicular texture in some of the volcanic rocks that formed when lava cooled on the islands shown on the map.
- 57) Some of the magma at the Galapagos Hot Spot is believed to originate 1000 kilometers below Earth's surface. What is the approximate temperature of Earth's interior at that depth?

Questions 58 and 59 refer to the following:

On the world map below, points *A* through *H* represent locations on Earth's surface.



- 58) Identify the *two* lettered locations from the given map that are least likely to experience volcanic activity or earthquakes.
- 59) Identify the tectonic feature responsible for the formation of the Hawaiian Islands.

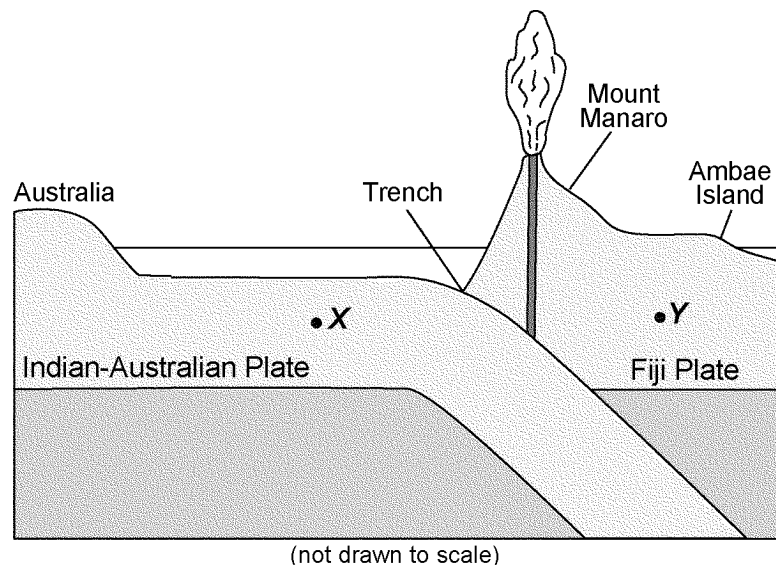
Questions 60 through 62 refer to the following:

MOUNT MANARO ERUPTS!

Mount Manaro is a volcano on Ambae Island about 1,400 miles northeast of Australia. Ambae Island is located in the South Pacific Ocean at 15D south latitude, 168D east longitude.

After Mount Manaro had erupted in 1995, Ambae Island residents developed an evacuation plan. When Mount Manaro began erupting gas, steam, and ash on November 27, 2005, scientists and residents watched the volcano carefully.

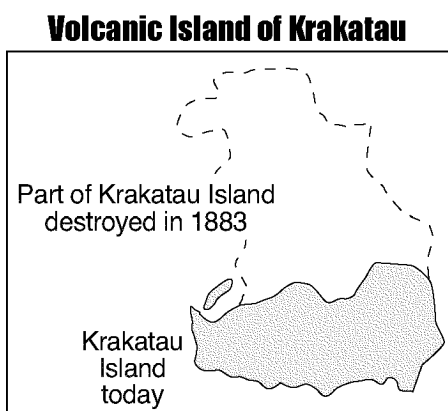
The eruption became more severe on December 9, 2005, when steam and gases rose 1.8 miles up into the air. Rocks and ash began to fall on nearby farms and homes. Thousands of people left their homes, making it the largest evacuation ever on Ambae Island.



- 60) Based on the given information, name the *highest* layer of the atmosphere into which the steam from the volcanic eruption rose on December 9, 2005.
- 61) Based on the given information, identify the ocean current off the northeast coast of Australia that *most* affects the climate of Ambae Island.
- 62) On the diagram provided, draw one arrow through point X and one arrow through point Y to indicate the direction of tectonic plate motion near Mount Manaro.

Questions 63 through 68 refer to the following:

The map below shows the volcanic island, Krakatau, before and after the 1883 eruption.



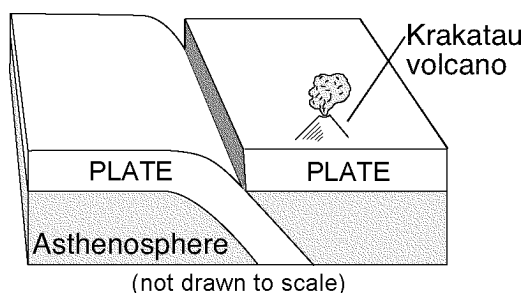
KRAKATAU:

On August 27, 1883, one of the largest volcanic eruptions ever recorded in history occurred. Krakatau, a volcanic island nearly 800 meters in height, located at 6°S 105.5°E, exploded. Two-thirds of the island was destroyed by the blast. Blocks of pumice produced by the eruption were found floating in the ocean for months afterward.

Tsunamis produced by the eruption reached heights of 40 meters as they came ashore on nearby islands. These destructive waves traveled 6360 kilometers in just 12 hours. Over 36,000 people died and 165 coastal villages were destroyed.

Volcanic ash was blasted into the atmosphere to heights between 36 and 48 kilometers. Global temperatures cooled as the ash traveled on air currents around the world.

- 63) The diagram below shows where Krakatau formed, then exploded. Draw one arrow on each lithospheric plate to show the relative direction that both plates are moving to produce this type of volcano.



- 64) Based on the given information, determine the rate the tsunamis traveled across the ocean. Label your answer with the correct units.
- 65) Identify the layer of the atmosphere into which the *highest* volcanic ash was blasted from the Krakatau eruption described in the reading passage.
- 66) Explain how the volcanic ash from the Krakatau eruption caused global temperatures to decrease.
- 67) Describe the texture and density of the pumice mentioned in the reading passage that allowed these blocks of pumice to float on the ocean.

- 68) The diagram below represents an average size person standing next to a tall building. Draw a horizontal line across the building to show the maximum height of the tsunami waves produced by the 1883 eruption of Krakatau.

