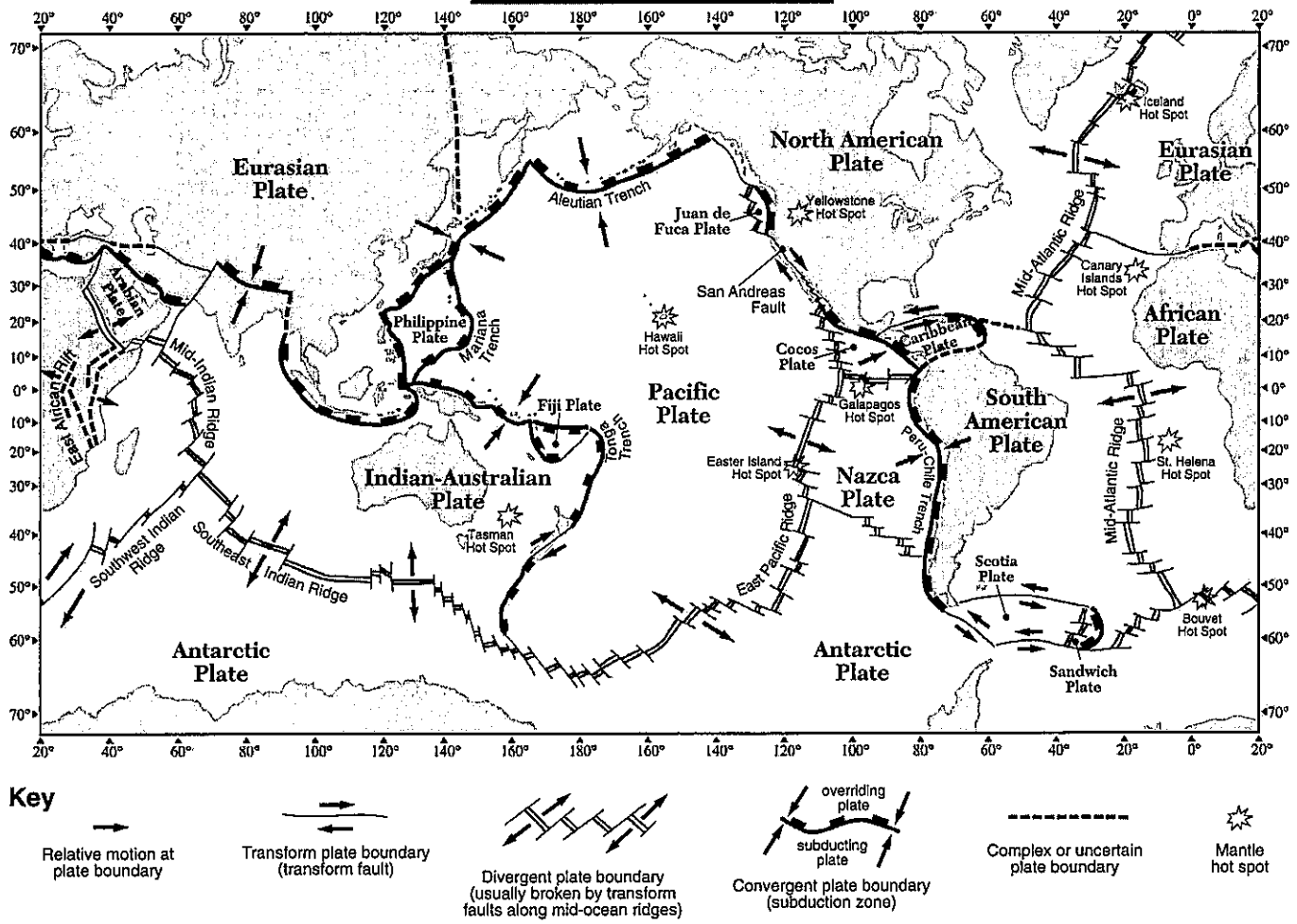
Tectonic Plates



NOTE: Not all mantle hot spots, plates, and boundaries are shown.

Overview:

The Earth's crust consists of major tectonic plates that are being pushed/pulled by forces within the Earth. The net results of this "bumper car" action are earthquakes, volcanoes and mountain ranges, along with many other geologic processes that have their origin with the movement and collisions involving these plates. Three major plate boundaries are recognized:

(1) *Divergent Plate Boundary* – "The spreading boundary" – Along this boundary two plates are moving apart, thus forming a ridge where lava exits, creating new ocean floor. The Mid-Atlantic Ridge is a well-known and studied divergent boundary. At all ocean ridges, the newest rocks of the ocean floor are made as the molten rock (lava/magma) surfaces and quickly solidifies into igneous basaltic rocks. Moving away from these ocean ridges, the ocean floor (ocean plate) gets increasingly older.

(2) *Convergent Plate Boundary* – "The collision of plates" – Along this boundary two plates are moving toward each other. Geologists have classified plates as being either oceanic or continental. The ocean plate, consisting of mostly basalt, is thinner but denser than the continental plate. At a convergent boundary, the denser (oceanic) plate will dive or sink under the other plate.

This produces a subduction zone, making an ocean trench. The subducting plate will eventually melt as it enters the hot mantle, recycling this ocean floor into new magma. Some of this magma may reach the surface above this subducting zone, producing volcanoes. When two continental plates collide, instead of subducting, they undergo uplifting (being less dense than an ocean plates), producing large folded mountains that reach heights over 20,000 feet. The Himalayas, the highest mountain range in the world, was formed by this process.

(3) *Transformed Plate Boundary* – "The slipping boundary"– Along this boundary, two plates are moving past each other. The most famous one is in California, known as the San Andreas Fault line. Here the North America Plate and the Pacific Plate are slipping by each other. The trouble associated with these boundaries is that the plates become stuck, building up much pressure. Eventually, when the plates move, they release huge amounts of energy, causing major earthquakes, as California knows all too well.

How were the plate boundaries discovered and mapped? The answer to this took years of research by many contributing geologists and scientists. A simple but efficient answer was by plotting the location of earthquakes. The boundary regions of plates are constantly grinding and moving, setting off numerous earthquakes. Volcanoes and mountain ranges are also located along plate boundaries.

The Map:

Key Area – On the bottom are located different symbols used on the map. The divergent plate boundary has opposite arrows showing the spreading action along mid-ocean ridges. The key for the convergent plate boundary shows which plate is the overriding plate (the less dense one) and which plate is the subducting plate (the denser one). For example, at the Aleutian Trench (by Alaska), the overriding plate is the northern part of the North American Plate and the subducting plate is the Pacific Plate. This subducting Pacific Plate has produced the Aleutian Ocean Trench, a very deep part of the ocean floor. The transform plate boundary key shows the slippage of the plates by two arrows side-by-side going in opposite direction. The most famous one is in California - the San Andreas Fault line.

World Map – On the world map are outlined the major known plate boundaries. The given arrows are showing the relative motions at plate boundaries. Along these plate boundaries major earthquakes, volcanoes and mountain ranges are found. The Himalayan Mountains were formed when two continental plates collided, producing a convergent plate boundary. This boundary is shown on the map in northern India.

Mantle Hotspots – This chart shows nine hotspots. A hotspot is a volcanically active area that often is not on a plate boundary. Hotspots remain in the same position generating lava and producing volcanoes, while the plate drifts over this area. Overtime, as the plate moves, the volcano will be move off the hotspot and become extinct. However, a new volcano will slowly be formed over the hotspot as magma rises from the hotspot. This is how the Hawaiian Island chain developed. These stationary hotspots are believed to have their volcanism energy source within the mantle.

Additional Information:

- Moving away in both directions from the ridge at a divergent plate boundary, the ocean floor increases in age and magnetic reversal patterns are found here. This same magnetic reversal pattern appears on opposite sides of the ridge. This is a major proof of seafloor spreading.

- Latitude and longitude readings are given along the map edge. Remember, latitude is measured N and S from the equator while longitude is measured E and W from the Prime Meridian (0 degree line). When giving the coordinates of a position, always give the latitude reading first. (See Latitude, Longitude and Time Zones chapter in the last section of this book.)

- The term "The Ring of Fire" is referring to the volcanoes located around the Pacific Ocean. The abundance of these volcanoes are due to the many convergent boundaries that surround this ocean.

- Iceland was formed on the Mid-Atlantic Ridge and is labeled a Mantle Hot Spot. Active volcanoes, earthquakes, and hot springs can be found in Iceland.

Set 1 — Tectonic Plates

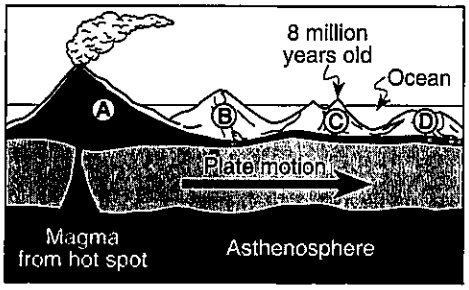
1. Seafloor spreading is occurring at the boundary between the

   (1) North American Plate and the Pacific Plate
   (2) Nazca Plate and South American Plate
   (3) Indian–Australian Plate and the Antarctic Plate
   (4) Indian–Australian Plate and Eurasian Plate 1_____

2. Which feature is commonly formed at a plate boundary where oceanic crust converges with continental crust?

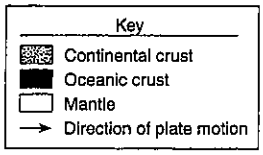
   (1) a mid-ocean ridge
   (2) an ocean trench
   (3) a transform fault
   (4) new oceanic crust 2_____

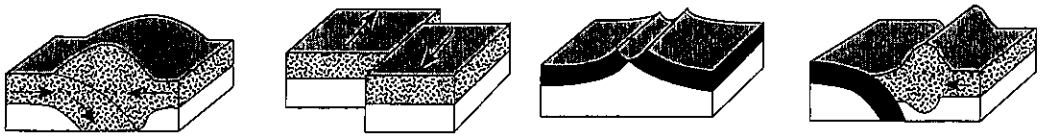
3. The cross section below shows the direction of movement of an oceanic plate over a mantle hot spot, resulting in the formation of a chain of volcanoes labeled *A*, *B*, *C*, and *D*. The geologic age of volcano *C* is shown. What are the most likely geologic ages of volcanoes *B* and *D*?



   (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. 3_____

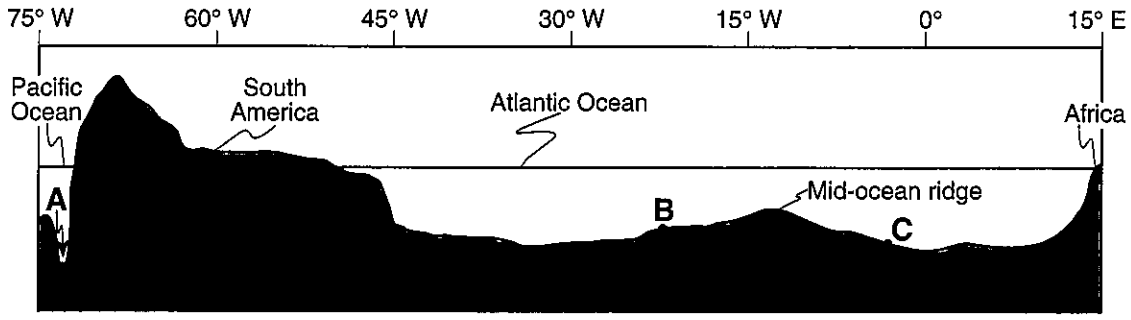
4. Which cross section below best represents the crustal plate motion that is the primary cause of the volcanoes and deep rift valleys found at mid-ocean ridges?





(1) (2) (3) (4) 4_____

Base your answers to questions 5 through 7 on the cross section below, which shows the major surface features of Earth along 25° S latitude between 75° W and 15° E longitude. Points *A*, *B*, and *C* represent locations on Earth's crust.



(Not drawn to scale)

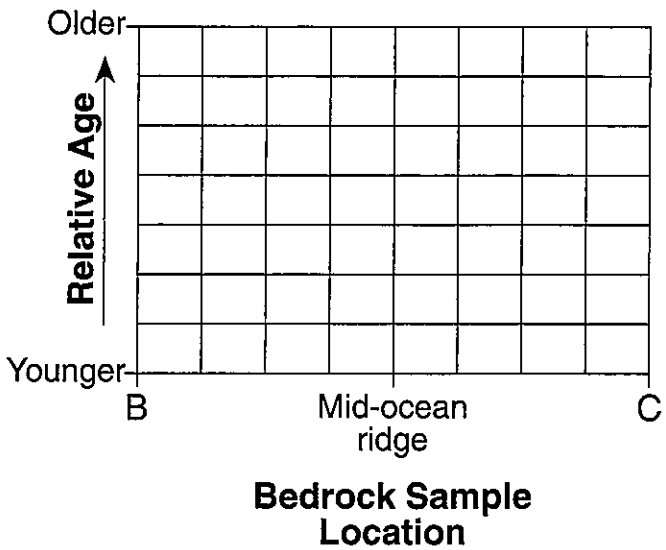
5. Identify the crustal feature located at point *A*. _____

6. Identify the tectonic plate motion that is causing an increase in the distance between South America and Africa.

_____

_____

7. Bedrock samples were taken at the mid-ocean ridge and points *B* and *C*. On the grid, draw a line to show the relative age of the bedrock samples between these locations.



8. 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 8_____

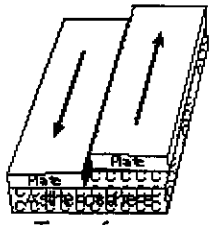
9. According to tectonic plate maps, New York State is presently located

(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 9_____

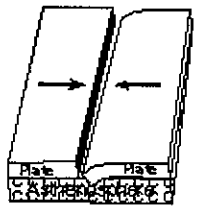
10. Which evidence causes most scientists to believe that seafloor spreading occurs at the mid-Atlantic Ridge?

(1) Oceanic crust is oldest at the ridge.
(2) Large sedimentary folds exist in the mantle near the ridge.
(3) Oceanic crust on both sides of the ridge is less dense than continental crust.
(4) Oceanic crust on both sides of the ridge shows matching patterns of reversed and normal magnetic polarity. 10_____

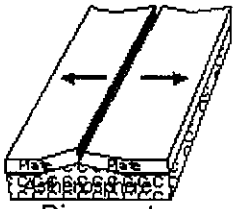
11. Which diagram best shows the type of plate boundary found between the Eurasian Plate and the Philippine Plate?



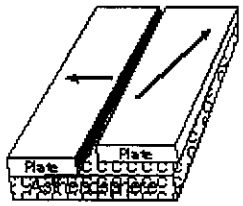
Transform
(1)



convergent
(3)



Divergent
(2)



Complex
(4) 11_____

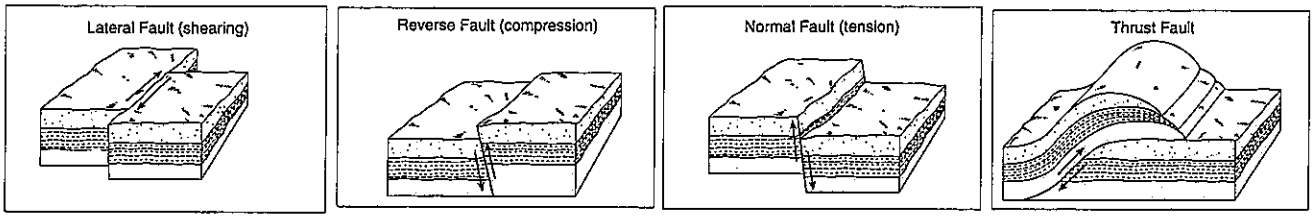
12. Compared to oceanic crust, continental crust is generally

(1) older and thinner
(2) older and thick
(3) younger and thinner
(4) younger and thicker 12_____

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

(1) crust
(2) asthenosphere
(3) outer core
(4) inner core 13_____

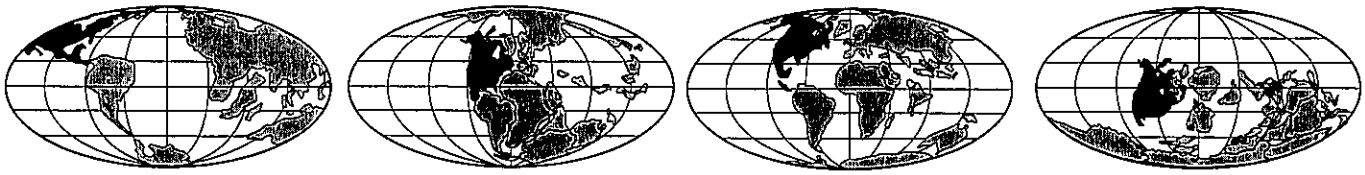
14. The diagrams below show four major types of fault motion occurring in Earth's crust. Which type of fault motion best matches the general pattern of crustal movement at California's San Andreas Fault?



(1) (2) (3) (4)

14_____

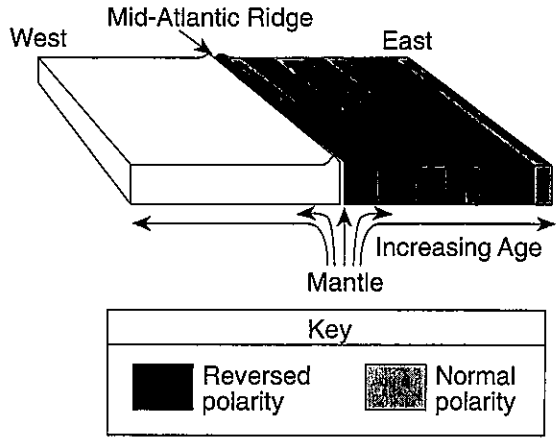
15. Which map best indicates the probable locations of continents 100 million years from now if tectonic plate movement continues at its present rate and direction?



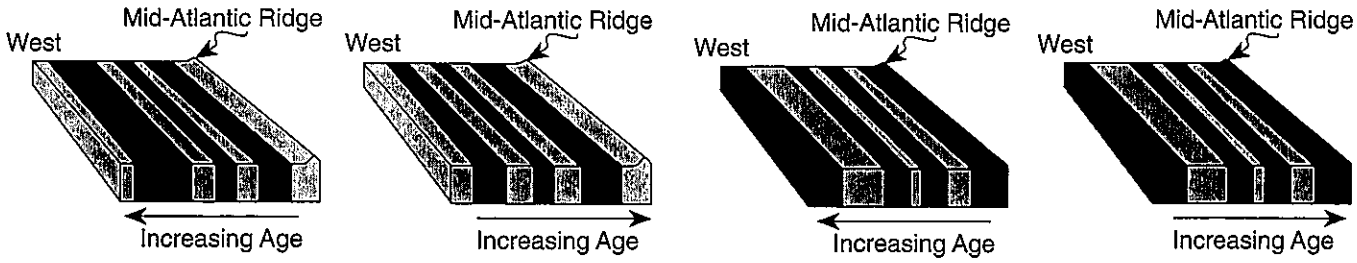
(1) (2) (3) (4)

15_____

16. The accompanying diagram 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.



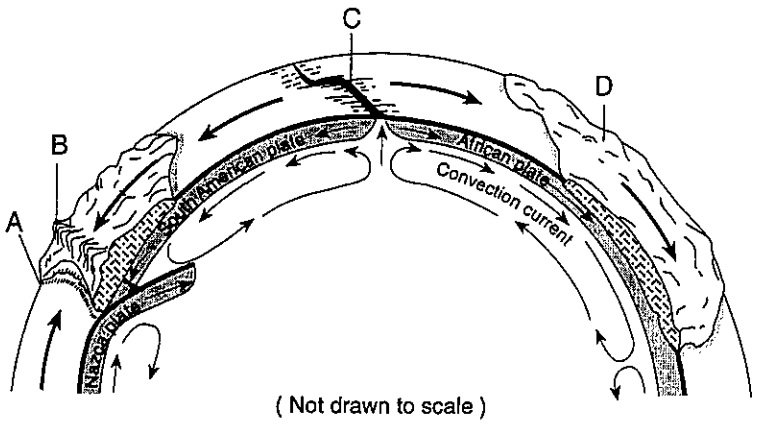
Which diagram best shows the magnetic pattern and relative age of the igneous bedrock on the west side of the ridge?



(1) (2) (3) (4)

16_____

Base you answers to questions 17 and 18 on the accompanying diagram which shows a cross section of a portion of Earth. The inferred motions of crustal plates are shown. Letters *A* through *D* represent locations at Earth's surface.



(Not drawn to scale)

17. Which letter represents the location of the mid-Atlantic Ridge?

(1) *A* (2) *B* (3) *C* (4) *D* 17_____

18. The diagram shows convection currents. What are their roles with plate tectonics?

_____

19. Give the latitude and longitude of the Canary Islands Hot Spot. _____latitude _____longitude

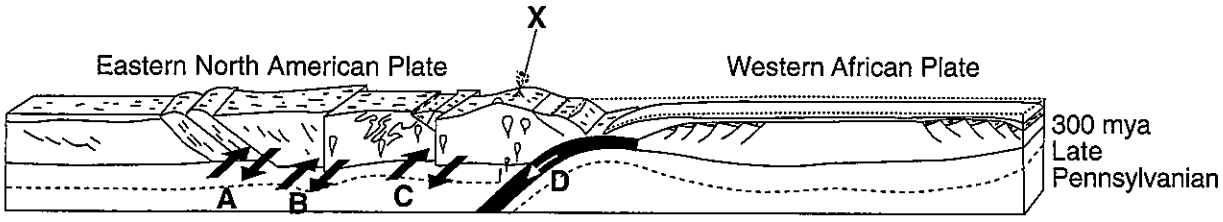
20. Identify the type of tectonic plate boundary that borders on the western side of the Juan de Fuca plate.

_____

21. Why does Iceland experience major volcanic activities?

_____

Base your answers to questions 22*a* and *b* on the block diagram below. The diagram shows the tectonic plate boundary between Africa and North America 300 million years ago, as these two continents united into a single landmass. The arrows at letters *A*, *B*, *C*, and *D* represent relative crustal movements. Letter **X** shows the eruption of a volcano at that time.



(Not drawn to scale)

22. *a*) Identify the type of tectonic plate motion represented by the arrow shown at *D*. _____

b) Identify the type of tectonic motion represented by the arrows shown at *A*, *B*, and *C*. _____