CHAPTER 2 The Way the Earth Works: Plate Tectonics

LEARNING OBJECTIVES

2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place.
2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading.
2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading.
2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.
2E. Use a map of earthquakes to locate plate boundaries and triple junctions.
2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each.
2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today.
2H. Characterize the processes driving plate motion, the rates at which this motion takes place, and how rates can be measured.

MULTIPLE CHOICE

1. _________ proposed the continental-drift hypothesis, suggesting that the arrangement of continents on the planet has changed over geologic time.
   a. Harry Hess
   b. Robert Dietz
   c. Alfred Wegener
   d. Harry Hess and Robert Dietz

   ANS: C DIF: Easy REF: 2.1
   OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Remembering

2. The idea that the continents had once fit together as a single supercontinent called Pangaea was rejected when first proposed because
   a. geologists did not know of a force great enough to move continents.
   b. the continents did not fit together tightly enough.
   c. the fossil evidence was inconclusive.
   d. the distribution of climatic belts did not make sense in that configuration.

   ANS: A DIF: Easy REF: 2.1
   OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Understanding

3. The term and concept of seafloor spreading were developed by
   a. Harry Hess and Alfred Wegener.
   b. Robert Dietz and Alfred Wegener.
   c. Alfred Wegener.
   d. Harry Hess and Robert Dietz.

   ANS: D DIF: Easy REF: 2.1 | 2.3
   OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Remembering

4. Wegener's evidence for a united Pangaea comes from the fossil record of which type of organisms?

   a. plant pollen

b. plankton
c. marine animals
d. land animals

ANS: D DIF: Easy REF: 2.2
OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Understanding

5. Limestone reefs and salt deposits are important in the reconstruction of the Earth’s history because they
a. can be used to infer the ancient climate of the Earth; they are deposited in environments that are restricted to warm climates.
b. automatically provide age information; all such deposits occurred between 200 and 400 million years ago.
c. are deposited in warm climates today, but there is good reason to think that they were deposited in cold climates millions of years ago.
d. pinpoint the locations of old subduction zones.

ANS: A DIF: Difficult REF: 2.2
OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Applying

6. Distinctive rock sequences such as Archean crust and Proterozoic mountain belts in South America terminate at the Atlantic Ocean but reappear on the continent of
a. Africa.
b. Europe.
c. North America.
d. Australia.

ANS: A DIF: Medium REF: 2.2
OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Understanding

7. If we mentally align the continents to fit Wegener’s concept of Pangaea, evidence of Late Paleozoic glacial deposits
a. is more difficult to explain than if continents are in their modern configuration.
b. is much more readily explained than if continents are in their modern configuration.
c. makes very little sense in either the Pangaea configuration or the modern configuration.
d. is consistent with both Pangaea and the modern continental configuration.

ANS: B DIF: Medium REF: 2.2
OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Analyzing

8. Which of these is a result of plate tectonics?
a. glaciation
b. seafloor spreading
c. extinction
d. convection in the outer core

ANS: B DIF: Easy REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Analyzing

9. Much of the ocean floor in all major oceans consists of broad, flat regions called
a. abyssal plains.

b. continental rises.
c. fracture zones.
d. seamounts.

ANS: A DIF: Easy REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Remembering

10. Mid-ocean ridges are
a. associated with continental hot spots.
b. underwater volcanic mountain ranges.
c. topographic low points on the ocean floor.
d. difficult to discern from the abyssal plains.

ANS: B DIF: Easy REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Remembering

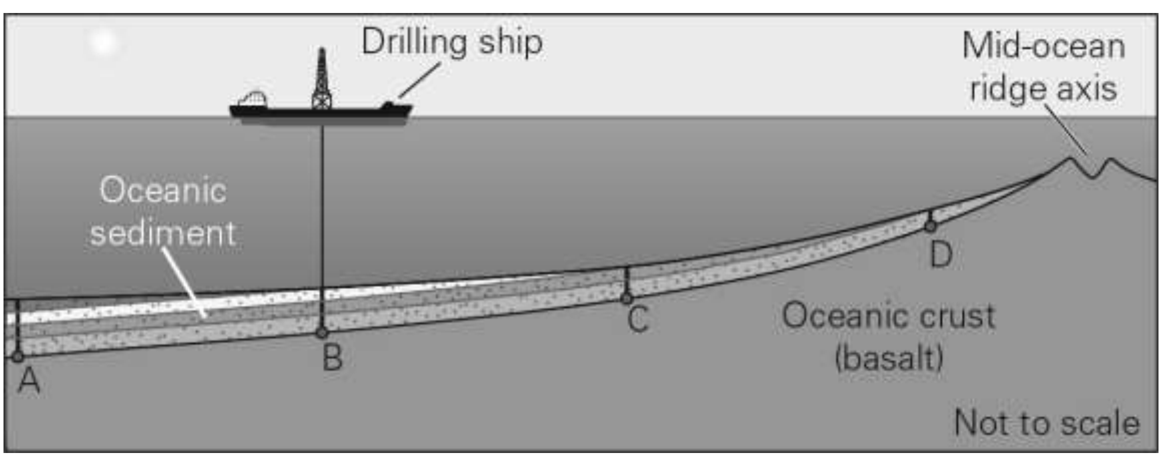
11. Deep-sea trenches are likely to be located near
a. fracture zones.
b. mid-ocean ridges.
c. volcanic arcs.
d. seamounts.

ANS: C DIF: Medium REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Applying

12. Beneath a blanket of sediments, oceanic crust is primarily composed of
a. granite.
b. basalt.
c. limestone.
d. coal.

ANS: B DIF: Easy REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. | 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere. MSC: Remembering

13. What can be said about the ocean sediments collected from location B as compared to location D?



a. They are thicker and older.

b. They are thinner and older.
c. They are thinner and younger.
d. They are thicker and younger.

ANS: A DIF: Medium REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Analyzing

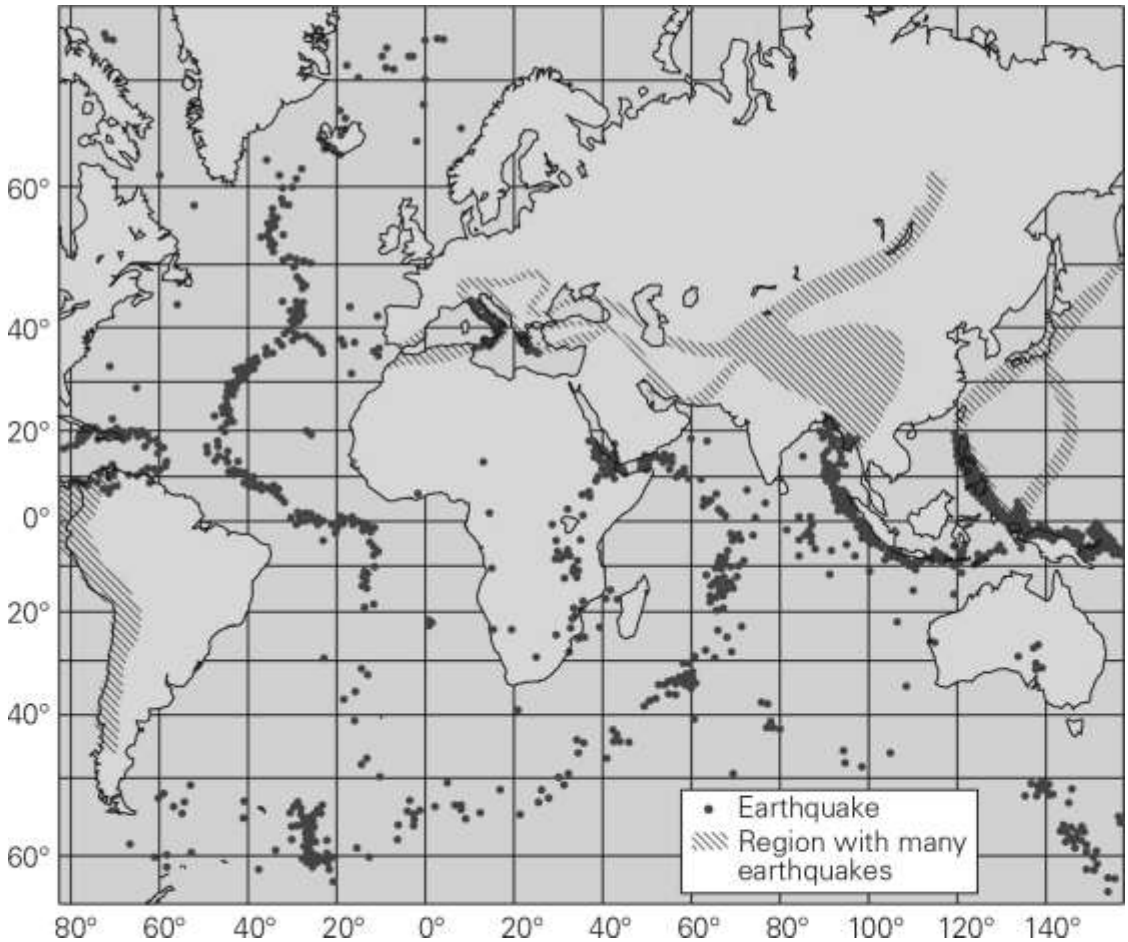
14. Seafloor spreading is driven by volcanic activity
a. in the middle of abyssal plains.
b. along mid-ocean ridges.
c. at the edges of continental shelves.
d. along fracture zones.

ANS: B DIF: Easy REF: 2.3 | 2.6
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. | 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Understanding

15. Which of the following best describes the distribution of earthquakes around the globe?
a. They tend to occur randomly on the continents.
b. They tend to occur randomly in the ocean basins.
c. They tend to occur randomly both on the continents and in the ocean basins.
d. They occur in distinct zones.

ANS: D DIF: Easy REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Understanding

16. The map below depicts the locations of earthquakes in the ocean basins. Which of the following locations is most likely to be located along a plate boundary?



a. the interiors of continents, where there are few or no earthquakes
b. the middle of the north Atlantic Ocean, where there is a north-south belt of earthquakes
c. the southwest Atlantic Ocean, far away from any earthquakes
d. None of these are likely locations for plate boundaries.

ANS: B DIF: Medium REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. | 2E. Use a map of earthquakes to locate plate boundaries and triple junctions.
MSC: Applying

17. With increasing distance from a mid-ocean ridge, the age of oceanic crust
a. increases.
b. decreases.
c. stays constant.
d. varies randomly.

ANS: A DIF: Easy REF: 2.4 | 2.6
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Understanding

18. The majority of new oceanic crust is created
a. at subduction zones.
b. along fracture zones.
c. at mid-ocean ridges.
d. by hot spot volcanism.

ANS: C DIF: Medium REF: 2.4

OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. | 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

19. The angle on the globe or on a map between the direction a compass needle points and a line of longitude is called
    a. declination.
    b. inclination.
    c. subduction.
    d. striation.

ANS: A DIF: Easy REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Remembering

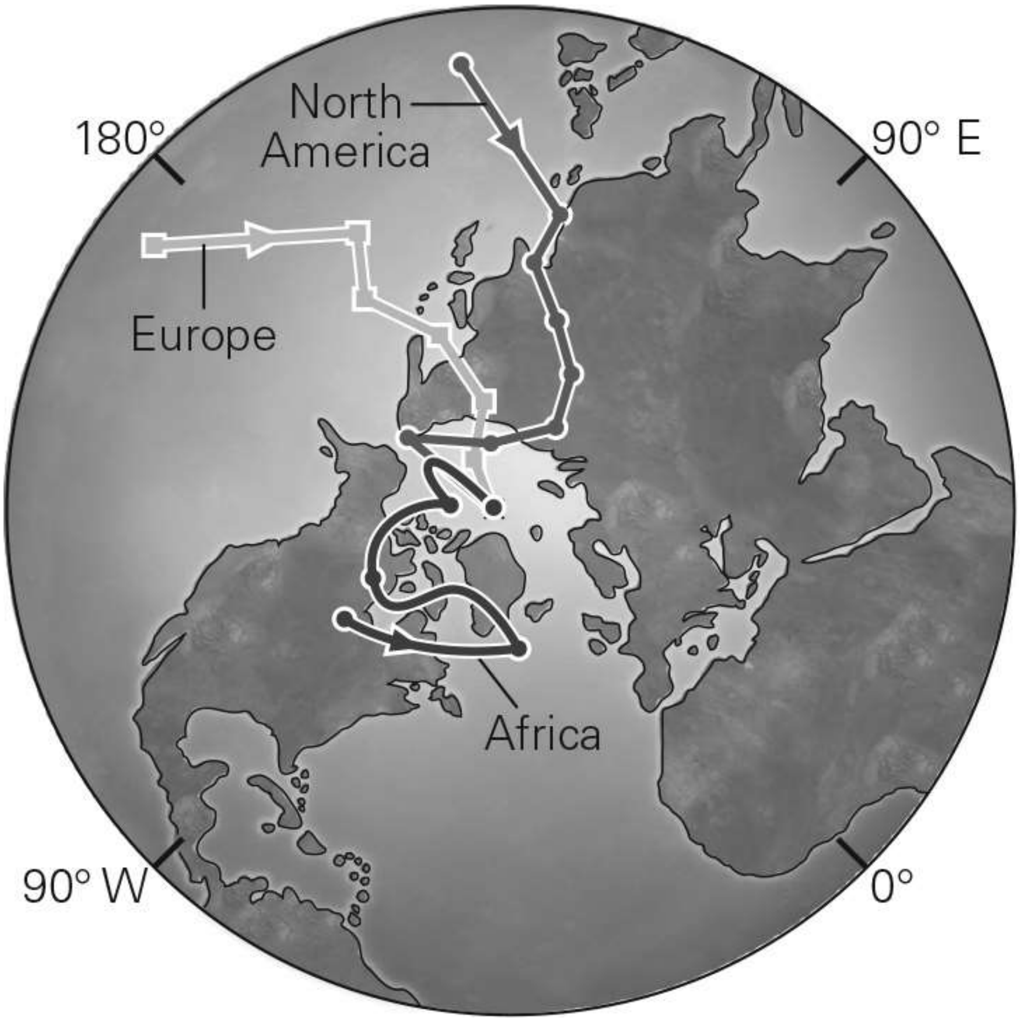
20. The apparent tendency of the north and south magnetic poles to vary in position over time is termed
    a. dipole.
    b. declination.
    c. inclination.
    d. polar wander.

ANS: D DIF: Easy REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Remembering

21. Paleomagnetic evidence for seafloor spreading is found in:
    a. basaltic rocks.
    b. ocean floor sediments.
    c. continental sediments.
    d. all rocks and minerals.

ANS: A DIF: Difficult REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Understanding

22. The discovery that each continent had different and separate apparent polar-wander paths, such as those in the figure below, proved that



a. the continents move independently of each other relative to fixed magnetic poles.
b. the magnetic poles move but the relative positions of continents to each other remain constant.
c. both the poles and continents move, but only one at a time.
d. both the poles and continents move, and do so together.

ANS: A DIF: Difficult REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Understanding

23. Marine magnetic anomaly belts run parallel to
a. mid-ocean ridges.
b. fracture zones.
c. continental coastlines.
d. continental shelves.

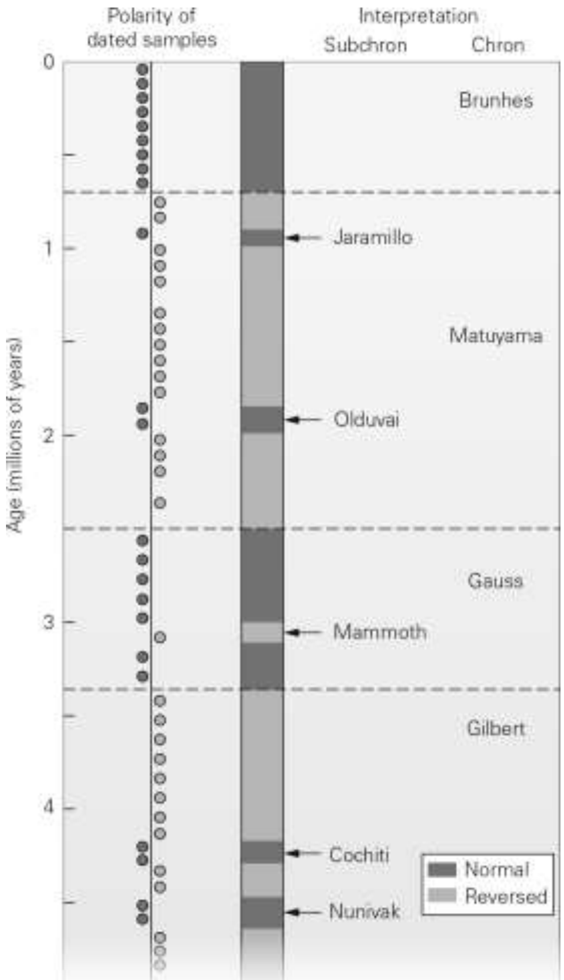
ANS: A DIF: Medium REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Applying

24. Marine magnetic anomalies in oceanic crust result from seafloor spreading in conjunction with
a. global warming.
b. magnetic storms on the surface of the Sun.
c. magnetic polarity reversals.

d. apparent wander of the magnetic poles.

ANS: C DIF: Easy REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Understanding

25. During the past 5 million years, approximately how long have chrons lasted before the next major magnetic polarity reversal?



a. 10 to 20 years.
b. 500 to 1000 years.
c. 700,000 to 1.5 million years
d. There has not been a magnetic polarity reversal during the past five million years.

ANS: C DIF: Medium REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Evaluating

26. According to the theory of plate tectonics, plates are
a. pieces of lithosphere that move over the surface of the Earth with respect to one another.
b. layers of lithosphere that are stacked one atop the other from the surface to the outer core.
c. pieces of continental rocks that move through the weaker oceanic rocks.
d. very thick (approximately one-quarter of the Earth’s radius).

ANS: A DIF: Easy REF: 2.5
OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.

MSC: Understanding

27. Which of the following is true of the lithosphere?
    a. It is the same thing as the crust.
    b. It is composed of the crust and the uppermost rigid part of the mantle.
    c. It is a very ductile layer in the upper part of the mantle.
    d. It is the layer of the mantle directly below the asthenosphere.

ANS: B DIF: Medium REF: 2.5
OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.
MSC: Analyzing

28. Which of the following is true of continental lithosphere compared to oceanic lithosphere?
    a. Continental lithosphere is thicker than oceanic lithosphere.
    b. Continental lithosphere contains more mafic rocks than oceanic lithosphere.
    c. Continental lithosphere is denser than oceanic lithosphere.
    d. Continental lithosphere and oceanic lithosphere have similar compositions, densities, and thicknesses.

ANS: A DIF: Easy REF: 2.5
OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.
MSC: Applying

29. Which is likely to slowly flow when subjected to a geologic force?
    a. continental lithosphere
    b. oceanic lithosphere
    c. asthenosphere
    d. Neither the lithosphere nor asthenosphere flows when subjected to stress.

ANS: C DIF: Easy REF: 2.5
OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.
MSC: Understanding

30. Continental lithosphere is approximately 150 km thick, while old oceanic lithosphere away from mid-ocean ridges is
    a. 1 km thick.
    b. 100 km thick.
    c. similar in thickness to continental lithosphere.
    d. unpredictable, because the thickness of old lithosphere is highly variable.

ANS: B DIF: Easy REF: 2.5
OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere.
MSC: Remembering

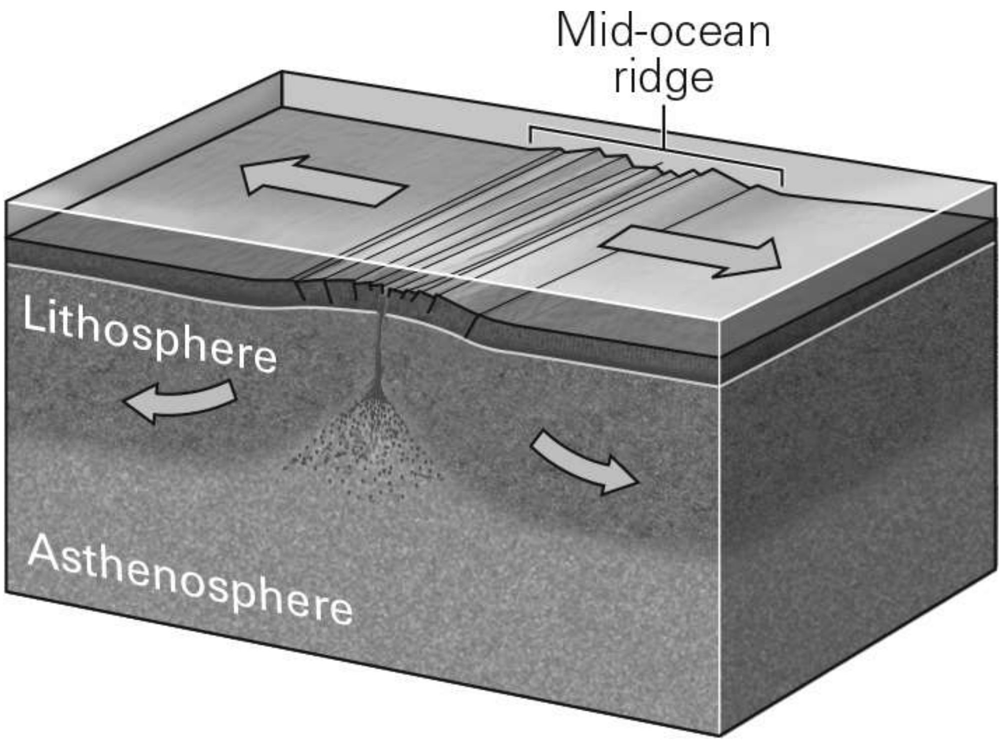
31. The distribution of __________ around the globe provides the primary indicator of the boundaries between lithospheric plates.
    a. basalt
    b. earthquakes
    c. mountains
    d. ocean basins

ANS: B DIF: Easy REF: 2.5
OBJ: 2E. Use a map of earthquakes to locate plate boundaries and triple junctions.
MSC: Understanding

32. Continental coastlines that occur within the interior of a lithospheric plate are called ___________ margins.
a. internal
b. passive
c. active
d. inert

ANS: B DIF: Easy REF: 2.5
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Remembering

33. Which basic type of plate boundary is shown in the image below?



a. convergent
b. divergent
c. transform
d. submerged

ANS: B DIF: Easy REF: 2.6
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

34. The rock produced at mid-ocean ridges consists of
a. entirely basalt.
b. entirely gabbro.
c. basalt at shallow depths and gabbro at deeper depths.
d. gabbro at shallow depths and basalt at deeper depths.

ANS: C DIF: Medium REF: 2.6
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Understanding

35. Oceanic lithosphere thickens as it moves away from mid-ocean ridges primarily because of

a. the addition of new crust due to hot-spot volcanism.
b. the addition of new crust due to sedimentation.
c. the addition of new lithospheric mantle as a result of cooling.
d. reasons that geologists cannot determine at present.

ANS: C DIF: Medium REF: 2.6
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Understanding

36. On either side of a mid-ocean ridge, oceanic lithosphere slowly _________
a. rises because it becomes thicker away from the ridge.
b. rises because it becomes buoyant.
c. sinks into the asthenosphere because it cools and thickens, increasing in density.
d. sinks into the asthenosphere because convection pulls it downward.

ANS: C DIF: Difficult REF: 2.6
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Applying

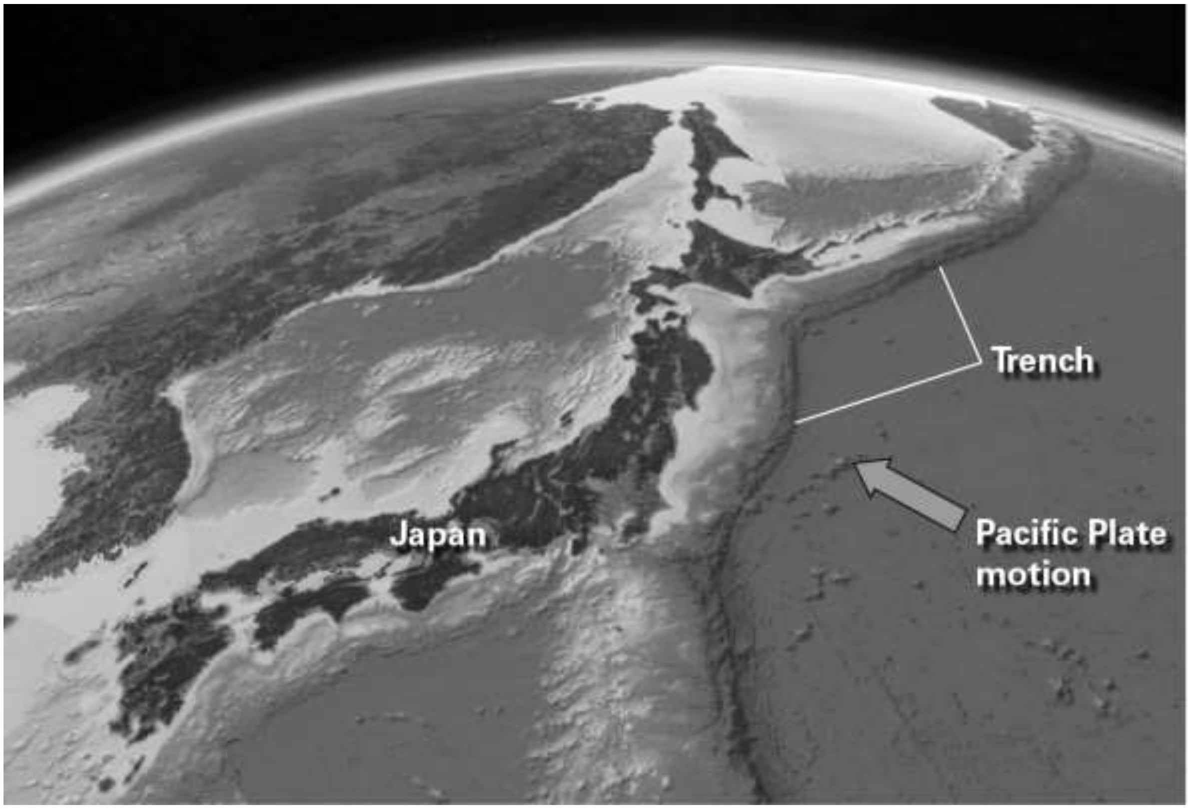
37. Subduction zones are found at _________ plate boundaries.
a. divergent
b. transvergent
c. convergent
d. transform

ANS: C DIF: Easy REF: 2.7
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Remembering

38. At a subduction zone, the downgoing (subducting) plate
a. is always composed of continental lithosphere.
b. is always composed of oceanic lithosphere.
c. may be composed of either oceanic or continental lithosphere.
d. is composed entirely of asthenosphere.

ANS: B DIF: Easy REF: 2.7
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Applying

39. At the subduction zone where the Pacific Plate is subducting under the islands of Japan, the Wadati-Benioff zone of deep earthquakes



a. extends from the trench westward underneath Japan.
b. extends from the trench eastward underneath the Pacific Plate.
c. is confined to the trench.
d. is absent because there are no earthquakes at subduction zones.

ANS: A DIF: Difficult REF: 2.7
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Evaluating

40. Continental lithosphere does not subduct because it is too
a. thick.
b. buoyant.
c. young.
d. warm.

ANS: B DIF: Easy REF: 2.7
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Understanding

41. At transform plate boundaries,
a. earthquakes are common but volcanoes are absent.
b. volcanoes are common but earthquakes do not occur.
c. both earthquakes and volcanoes are common.
d. neither earthquakes nor volcanoes are common.

ANS: A DIF: Difficult REF: 2.8
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

42. Transform plate boundaries are unlike other plate boundaries because

a. all movement of plates along transform boundaries is vertical.
b. they are always very short in length.
c. they do not penetrate into the lithosphere.
d. old plate is not consumed nor is new plate created.

ANS: D DIF: Medium REF: 2.8
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

43. In plate tectonics, a triple junction is a place on the Earth's surface where
a. three volcanoes form a tight, triangular cluster.
b. glacial ice, continental rocks, and the ocean can be found together.
c. the boundaries of three lithospheric plates meet at a single point.
d. all three of the basic rock types are found in the same location.

ANS: C DIF: Easy REF: 2.9
OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Remembering

44. Hot spots are caused by
a. friction due to the lithosphere sliding atop the asthenosphere.
b. unusually dense concentrations of radioactive isotopes at various points in the crust.
c. hot plumes of mantle material that rise up through cooler, denser surrounding rock.
d. zones of localized subduction that produce melting of the mantle.

ANS: C DIF: Medium REF: 2.9
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Understanding

45. In a hot-spot volcanic island chain, such as the Hawaiian Islands, which of the following is true?
a. All volcanoes in the chain can be simultaneously active.
b. The ages and distance between volcanoes can be used to calculate plate velocities.
c. The presence of volcanism is related to a plate boundary.
d. The magma source moves to form a hot-spot track.

ANS: B DIF: Difficult REF: 2.9
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Applying

46. A ________ is a linear feature in continental lithosphere where a plate is pulled apart, resulting in a deep valley, extensive faulting and volcanism, and if sustained, division into two plates separated by new oceanic lithosphere.
a. forearc basin
b. volcanic island arc
c. continental rift
d. mid-ocean ridge

ANS: C DIF: Medium REF: 2.10
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Remembering

47. Large, thick-crusted, nonvolcanic mountain belts, like the Himalayas, are associated with
a. mid-ocean ridges.
b. subduction zones.
c. hot spots.

d. continent–continent collisions.

ANS: D DIF: Easy REF: 2.10
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Applying

48. Most of the pulling force driving plate motion is produced
    a. at mid-ocean ridges.
    b. at collision zones.
    c. at subduction zones.
    d. in the interiors of continental plates.

ANS: C DIF: Medium REF: 2.11
OBJ: 2H. Characterize the processes driving plate motion, the rates at which this motion takes place, and how rates can be measured. MSC: Understanding

49. Slab pull occurs because subducting slabs are _________, and therefore are _________ dense than the surrounding asthenosphere.
    a. hotter; less
    b. cooler; more
    c. hotter; more
    d. cooler; less

ANS: B DIF: Medium REF: 2.11
OBJ: 2H. Characterize the processes driving plate motion, the rates at which this motion takes place, and how rates can be measured. MSC: Applying

50. Lithospheric plates move relative to other along plate boundaries at velocities between ___________
    a. 1 and 15 meters per year
    b. 50 and 80 centimeters per year
    c. 1 and 20 centimeters per year
    d. 0.1 and 0.8 centimeters per year

ANS: C DIF: Medium REF: 2.11
OBJ: 2H. Characterize the processes driving plate motion, the rates at which this motion takes place, and how rates can be measured. MSC: Remembering

SHORT ANSWER

1. What evidence did Alfred Wegener use to support his continental-drift hypothesis and the formation and break-up of Pangaea? Was the evidence compelling? Why or why not?

ANS:
Wegener’s evidence for his continental-drift hypothesis included the fit of the continents, locations of past glaciations, distribution of climate belts in the past, distribution of fossils, and matching geologic units. These distributions made sense if the continents were not separated, but instead were joined together as one supercontinent that he called Pangaea. Pangaea later broke apart and was split by the Atlantic and Indian Oceans. His evidence was compelling because it explained many observations, but it lacked a mechanism to move continents through the oceans.

DIF: Medium REF: 2.2
OBJ: 2A. Explain Alfred Wegener's continental-drift hypothesis and the evidence he used to show that it takes place. MSC: Evaluating

2. Describe the process of seafloor spreading, making sure to address why the diameter of the Earth is not growing.

ANS:
Magma rises and erupts onto the surface at mid-ocean ridges, forming new oceanic crust. The new crust slowly moves the plates apart. Because this is balanced by the return of old oceanic crust into the Earth's interior during subduction, the Earth is not actually growing in size.

DIF: Medium REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Applying

3. Describe how the thickness and age of sediments on the seafloor change with distance from a mid-ocean ridge. What can be learned from this?

ANS:
Seafloor sediments everywhere are too thin to have been accumulating for the entirety of the Earth's history. They are thickest at the margins of continents and thinnest near the mid-ocean ridge axes, and become thicker with increasing distance from the ridge. The deepest sediments are older at locations further from ridges. These observations support seafloor spreading. As new oceanic crust moves away from the ridge, sediments begin to accumulate. The older the oceanic crust becomes, the more sediment accumulates.

DIF: Medium REF: 2.3
OBJ: 2B. List observations from studies of the ocean floor that led Harry Hess to propose seafloor spreading. MSC: Evaluating

4. What are magnetic anomalies? Why are these important supports for the theory of seafloor spreading?

ANS:
Magnetic anomalies are the differences between the expected strength of the Earth's magnetic field at a location and the observed strength of the magnetic field at that location. Field strengths that are greater than expected are positive anomalies, whereas field strengths that are less than expected are negative anomalies. These anomalies are recorded in igneous rocks, including seafloor basalts. There are symmetrical patterns of magnetic anomalies recorded in seafloor basalts on either side of mid-ocean ridges. This tells us that new oceanic lithosphere is continually being created at mid-ocean ridges and pushed apart; ridges are the locations of seafloor spreading.

DIF: Difficult REF: 2.4
OBJ: 2C. Explain how studies of paleomagnetism and marine magnetic anomalies prove continental drift and seafloor spreading. MSC: Evaluating

5. What does the distribution of earthquakes around the globe tell us about plate tectonics? How do earthquakes differ among the three types of plate boundaries?

ANS:
Earthquakes do not occur randomly and are not evenly distributed. They occur in distinct zones along seismic belts. These belts coincide with all three types of plate boundaries. Convergent boundaries show deep earthquakes that follow the path of the subducting plate. Transform boundaries have movement that is horizontal and not vertical. Divergent boundaries have earthquakes and faults that result from tension (pulling apart).

DIF: Difficult REF: 2.5
OBJ: 2E. Use a map of earthquakes to locate plate boundaries and triple junctions. | 2F. Distinguish

among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

6. Why is it possible for oceanic lithosphere to subduct under continental lithosphere at a convergent boundary but continental lithosphere cannot subduct under oceanic lithosphere?

   ANS:
   Although the mantle portions of oceanic and continental lithosphere are similar in composition and thickness, the crustal portion of continental lithosphere is much thicker and lower in density than oceanic crust. As a result, continental lithosphere is too buoyant to sink into the asthenosphere, while oceanic lithosphere is actually more dense than asthenosphere and can subduct. If continental and oceanic lithosphere meet at a convergent boundary, it is always the oceanic lithosphere that will subduct.

   DIF: Difficult REF: 2.7
   OBJ: 2D. Sketch a cross section of the lithosphere, and contrast oceanic and continental lithosphere. | 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Analyzing

7. Compare and contrast a convergent boundary involving two continental plates with a convergent boundary involving two oceanic plates.

   ANS:
   At an ocean–ocean convergent plate boundary, one of the oceanic plates will be subducted beneath the other and island arc volcanism will result. At a continent-continent plate boundary, subduction cannot take place because continental crust cannot be subducted. Collision and mountain building take place instead.

   DIF: Medium REF: 2.7
   OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. | 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Analyzing

8. What are deep sea trenches and volcanic island arcs, and why are these features commonly adjacent to each other?

   ANS:
   Deep sea trenches are elongate troughs of very deep ocean, and represent where the subducting plate bends downward under the overriding plate. Volcanic island arcs are lines of islands with active volcanoes that are supplied by magma created during subduction; the magma rises through the overriding plate to create a line of volcanoes. Trenches and arcs are adjacent because they are parallel features associated with subduction zones.

   DIF: Medium REF: 2.7
   OBJ: 2F. Distinguish among the three types of plate boundaries, and characterize geologic features associated with each. MSC: Understanding

9. How can hot-spot volcanoes be used to measure past plate velocities?

   ANS:
   Hot-spot volcanic islands form on the surface of the Earth directly above hot spots. As tectonic plates slowly move over time, these volcanic islands are moved away from the hot spot. The volcanic islands become extinct and slowly subside below sea level, becoming seamounts. The chain of inactive volcanic islands and seamounts is known as a hot-spot track. Using the ages and distances between the islands and seamounts, average plate velocity can be calculated.

DIF: Medium REF: 2.9 | 2.11
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today.| 2H. Characterize the processes driving plate motion, the rates at which this motion takes place, and how rates can be measured. MSC: Applying

10. How does continental rifting lead to the formation of a new plate boundary and new ocean basin?

ANS:
During rifting, continental lithosphere is pulled apart to create a low area called a rift valley. This leads to faulting and eruption of volcanoes in the rift valley. If rifting continues, the continental lithosphere is fully split into two pieces separated by an ocean. The volcanoes in the rift valley become a new mid-ocean ridge, and seafloor spreading creates new oceanic lithosphere between the split pieces of continental lithosphere.

DIF: Medium REF: 2.10
OBJ: 2G. Discuss rifting, continental collision, and hot-spot formation, and show where these processes happen today. MSC: Evaluating