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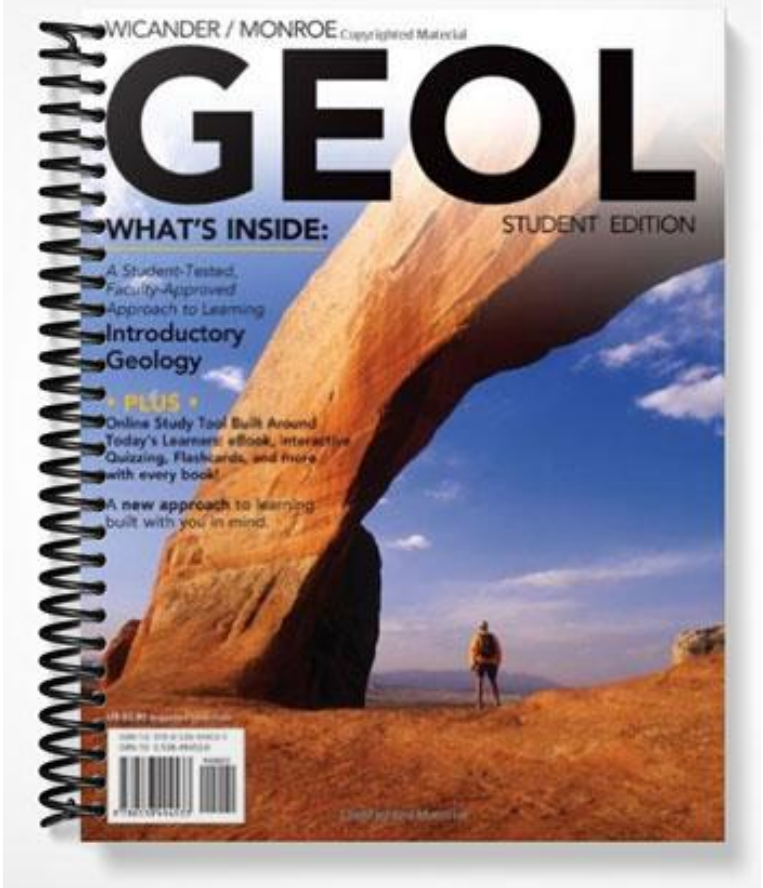
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Chapter 2--Plate Tectonics: A Unifying Theory

Student: _____

1. What were the major lines of evidence for continental drift as presented by Wegener in the early 20th century?

2. Explain how mountain ranges can be used as evidence to support continental drift.

3. How does fossil evidence support continental drift?

4. Why were glacially deposited strata important in the development of continental drift theory?

5. How is the phrase "the present is the key to the past" used in creating evidence for continental drift?

6. Briefly explain why apparent polar wandering is "apparent".

7. Briefly explain why the movement of continents over geologic time was the best explanation for polar wandering.

8. Briefly describe what happens when divergent plate boundaries form within a continent.

9. How are the two models for the driving force of plate motion the same, and how are they different?

10. How does seafloor spreading explain the movement of the continents?

11. Briefly explain the roles of magma and hydrothermal activity in forming ore deposits along convergent and divergent plate boundaries.

12. Draw a cross-section of an oceanic-oceanic convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Put triangles with smoke out the top for the locations of volcanoes. Label the trench, back arc basin, and subduction complex.

13. What are four of the many things that plate tectonics theory explains or whose explanations it has influenced?

14. Draw a cross-section of an oceanic-continental convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Put triangles with smoke out the top for the locations of volcanoes. Label the trench and subduction complex.

15. Draw a cross-section of a continental-continental convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Show the location of the mountain range. Label the subduction complex.

16. Briefly explain how magnetic reversals in oceanic crust and fossils in ocean sediments are used to construct a magnetic time scale.

17. What is a method by which the present rate of motion between two plates can be measured accurately?

18. How are hot spots used for determining the absolute motions of plates?

19. Briefly explain why there is so much oil in the Persian Gulf region.

20. How does the introduction of a geographic barrier encourage the evolution of species?

21. Who was the first person to suggest that all of the continents had been once joined together as a supercontinent called Pangaea and when was that idea proposed?

22. What do glacial striations indicate?

23. Where is the best place to try to fit the continents together?

24. Why were glacially deposited strata important in the development of the continental drift hypothesis?

25. The Appalachian Mountains of the eastern United States are thought to have once been joined with mountains located in which other continental regions?

26. List two ways that glacial deposits give strong evidence of the existence of Gondwana.

27. What is the reason that the presence of *Glossopteris* flora fossils was strong evidence for the existence of Gondwana?

28. What is the principal reason why Wegener's hypothesis of continental drift was rejected?

29. What are the three possible explanations for the distribution of paleomagnetic data?

30. Why was the paleomagnetic striping of the seafloor not evidence for Wegener's continental drift hypothesis?

31. What other geological processes could have resulted in the configuration of coastlines so that South America and Africa appeared to fit together?

32. If rocks and mountain ranges were once joined together but were split apart, what features would you expect in each?

33. What is it about a cooling lava that allows geologists to determine the location of past magnetic poles?

34. What two features of the magnetic field do magnetic iron-bearing minerals that crystallize out of magma record?

35. What evidence is there that ocean basins are young and old oceanic crust must be destroyed?

36. Where in the ocean basins is ocean crust youngest?

37. What is the driving mechanism for plate tectonics?

38. What are the heat sources for each of the two mantle convection models for plate tectonics?

39. In what ways does plate tectonics theory have economic applications?

40. Briefly explain how convection transfers heat.

41. Why is plate tectonic theory so widely accepted?

42. Paleomagnetism is the study of the _____ magnetism in rocks.
_____

43. When magma cools, the magnetic iron-bearing minerals align themselves with the Earth's magnetic field and record _____ and _____.
_____

44. Wegener proposed that the continents were once all together as a supercontinent he named _____, which then split into a northern supercontinent called _____ and a southern supercontinent called _____.
_____

45. The group of plant fossils that provides important evidence for the existence of Gondwana is _____.
_____

46. The temperature at which iron-bearing minerals gain their magnetic property is the _____ _____.
_____

47. Paleomagnetic data plotted on a map suggested that the magnetic pole had moved over time; this phenomenon was called _____ _____.
_____

48. At deep-sea trenches, _____ is subducted back into the _____.
_____

49. At mid-oceanic ridges, hot magma rises from the _____ and forms new _____.
_____

50. Magnetic stripes in oceanic basalts are _____ and _____ around ocean ridges.
_____

51. Radiometric dating shows that the oldest ocean crust is _____ years old and the oldest continental crust is _____ years old.
_____

52. The three kinds of boundaries there can be between adjacent plates are _____, _____, and _____.
_____

53. At divergent plate boundaries, plates are moving _____. At these locations, new _____ forms.
_____

54. Where divergent plate boundaries form beneath continental masses, low areas known as _____ _____ form.
_____

55. At a convergent plate boundary, oceanic crust is _____.
_____

56. The three types of convergent plate boundaries are _____-_____, _____-_____, and _____-_____.
_____

57. Volcanoes are found at these two types of plate boundaries: _____ and _____.
_____

58. The type of plate boundary that runs through California is called _____, and the name of this plate boundary is the _____.
_____

59. The names of the plates on either side of the plate boundary that passes through California are _____ and _____.
_____

60. Mountain building events occur along _____-_____ or _____-_____ plate boundaries.
_____

61. Rock sequences found on land that consist of deep-sea sediment, oceanic crust, and upper mantle are called _____. These sequences are used to identify _____ plate boundaries.
_____

62. One of the most general conclusions to be drawn from plate tectonic theory is that:
A. the Earth is gradually losing heat.
B. the Earth's geography has continually changed.
C. the Earth is slowly expanding.
D. the Earth is slowly shrinking.
E. all of the ocean basins are gradually enlarging.

63. Plate tectonic processes have influenced:
A. the distribution of earthquakes and volcanoes.
B. the locations of ore deposits and mountain systems.
C. climatic patterns and ocean circulation.
D. the geographic distribution, evolution, and extinction of life forms.
E. all of the above

64. That the northern continents were once joined and located along the equator was shown by the:
A. coal-age plant fossils of North America and Europe.
B. *Glossopteris* flora.
C. distribution of mountain ranges.
D. distributions of Permian and Triassic reptiles.
E. distributions of northern hemisphere glacial tillites.

65. The northern supercontinent consisted of:
A. North America, Europe, Asia, India, and Greenland.
B. North America, Greenland, and Europe.
C. North America, Europe, Asia, and India.
D. North America, Greenland, Asia, and India.
E. North America, Europe, Asia, and Greenland.

66. The southern supercontinent consisted of:
A. South America, Africa, Australia, Antarctica, and India.
B. Africa, South America, Antarctica, and Australia.
C. South America, Africa, India, and Australia.
D. South Africa, India, Africa, and Australia.
E. South America, Central America, India, Antarctica, Africa, and Australia.

67. Fossil evidence linking the Gondwana continents includes the:
A. lake-dwelling *Mesosaurus* and large land-dwelling reptile *Lystrosaurus and Cynognathus.*
B. freshwater *Mesosaurus* and dinosaurs *Brontosaurus* and *Tyrannosaurus.*
C. freshwater crocodiles and the large amphibian *Eryops.*
D. reptile *Dimetrodon* and the first bird *Archaeopteryx.*
E. lake-dwelling *Mesosaurus* and the large land-dwelling reptiles *Dimetrodon* and *Edaphosaurus.*

68. Fossil evidence of the links among Gondwana continents was compelling because the species:
A. should have been found over wide regions if they were able to migrate among continents.
B. should have exhibited evidence of tolerance for climatic extremes.
C. should have shown mechanism for widespread dispersal.
D. A and C
E. A, B, and C

69. Studies of paleomagnetism document:
A. changes in the Earth's gravitational field.
B. how the inner/outer core boundary has evolved.
C. how the mineral magnetite has varied through time.
D. how the Earth's magnetic poles have varied through time.
E. none of the above

70. The study of paleomagnetism is possible because:
A. the magnetic minerals in rocks create the Earth's magnetic field.
B. most rocks contain no magnetic minerals.
C. the magnetic minerals in rocks disrupt the Earth's magnetic field.
D. the magnetic minerals in a cooling lava point toward the north magnetic pole.
E. none of the above

71. The differing paleomagnetic records for each continent showed:
A. each continent had its own magnetic pole during successive geological periods.
B. that the magnetic poles for each continent had moved over geological time.
C. that the magnetic poles have remained in one location and each of the continents has moved.
D. that both the poles and the continents have moved over time.
E. none of the above

72. The symmetrical pattern of magnetic polarities about spreading ridges in oceanic crust basalts indicates that:
A. each plate has had an independent set of magnetic reversals.
B. basalt retains its magnetic signature for only a few million years.
C. new ocean crust is created by volcanism at oceanic ridges and old crust moves laterally away from the ridge.
D. the oceanic crust is geologically young.
E. magnetic polarity reverses but northern and southern hemispheres do not.

73. Lithospheric plates move on the Earth's surface because:
A. warm mantle ascends at ridges and cool mantle descends at subduction zones.
B. convection occurs only in the asthenosphere.
C. cool mantle ascends at ridges and warm mantle descends at subduction zones.
D. A and B
E. B and C

74. The mechanism for plate movement is:
A. conduction of heat from the core.
B. friction created by tidal forces generated by the Moon.
C. conduction of heat within the mantle.
D. convection of heat within the mantle.
E. convection of heat within the core.

75. Geologists recognize three major types of plate boundaries, which are:
A. resurgent, divergent, and emergent.
B. convergent, divergent, and transform.
C. transcurrent, oblique, and resurgent.
D. emergent, transform, and convergent.
E. transform, transcurrent, and translateral.

76. At divergent plate boundaries, the operating forces are:
A. compressional.
B. lateral shearing.
C. tensional.
D. thrusting.
E. normal.

77. At a mid-oceanic ridge spreading center:
A. the plates are moving past each other.
B. the plates are moving away from each other.
C. the plates are moving toward each other.
D. one plate is being subducted beneath another.
E. both plates are being subducted.

78. Which are *not* associated with a mid-oceanic ridge?
A. old ocean crust
B. shallow-depth earthquakes
C. volcanic eruptions
D. transform faults
E. hot water

79. Large, high mountain ranges without volcanoes are built at which type of plate boundary?
A. divergent: oceanic-oceanic
B. convergent: oceanic-continental
C. convergent: continental-continental
D. transform: continental-continental
E. A and C

80. At transform plate boundaries:
A. lithosphere is neither created nor destroyed.
B. plates move laterally past each other.
C. active volcanism occurs.
D. A and B
E. A, B, and C

81. A transform plate boundary may connect:
A. a spreading ridge and subduction zone.
B. two spreading ridges.
C. two subduction zones.
D. A and C
E. A, B, and C

82. Changes in the Earth's magnetic field have occurred throughout geologic time, and these are called magnetic reversals.
True False

83. The theory of seafloor spreading was proposed by Harry Hess.
True False

84. The cause of magnetic reversals is a change in the structure of the Earth's inner core.
True False

85. Paleomagnetic studies show that the ocean basins are older than the continents.
True False

86. Features associated with ancient continental rift zones include andesite volcanoes and strike slip faulting.
True False

87. During the Triassic, a number of rift related fault basins formed along the eastern margin of North America.
True False

88. Convergent plate boundaries are characterized by the formation of new oceanic crust.
True False

89. Hot spots move with continental plates.
True False

90. Volcanic island chains that form along the trace of a hot spot are called aseismic ridges.
True False

91. The west coast of South America is a convergent boundary.
True False

92. A transform plate boundary underlies the Alps in southern Europe.
True False

93. There is a divergent plate boundary within the region of east Africa.
True False

94. Old, cold, and dense oceanic crust sinks into the mantle at subduction zones.
True False

95. At divergent plate boundaries, oceanic crust is transformed.
True False

96. The forces that operate at a continental-continental convergent plate boundary are called transpressional.
True False

Chapter 2--Plate Tectonics: A Unifying Theory Key

1. What were the major lines of evidence for continental drift as presented by Wegener in the early 20th century?

The glaciations on the Gondwana continents could only have occurred if the continents were joined, since the centers of the glaciers would have been in the ocean if they were not. Also, the continents, such as South America and Africa, match like a jigsaw puzzle. Fossil plant and animals are separated by oceans, when the organisms must have lived in adjacent regions when they were alive. Finally, similar rock sequences and mountain ranges could be connected across oceans.

2. Explain how mountain ranges can be used as evidence to support continental drift.

A mountain range forms under the same geological conditions along its length. This means that the same or nearly the same rock types are found along the range's length in the same or nearly the same sequence. The processes that form mountain ranges tend to create somewhat linear elevated features. So a mountain range that has been split, even if it has been separated by an ocean, is fairly easy to recognize.

3. How does fossil evidence support continental drift?

The distribution of fossils is such that it would be impossible for the plants and animals not to have lived in contiguous land areas. *Glossopteris* seeds are too heavy to be dispersed by wind and would not have remained viable if they had traveled far across the oceans. The plants associated with *Glossopteris* do not match the climate zones the fossils are found in. As for the animals, it's hard to imagine a freshwater reptile like *Mesosaurus* swimming across the Atlantic. And the land-dwelling reptiles, *Lystrosaurus* and *Cynognatuus*, could not have swum at all!

4. Why were glacially deposited strata important in the development of continental drift theory?

The glacial deposits indicated that all southern continents must have been contiguous and closer to the south pole. Glaciers cannot form in the middle of an ocean, which is where they would have originated if the continents were not together.

5. How is the phrase "the present is the key to the past" used in creating evidence for continental drift?

Organisms probably lived in the types of environments where they live today, so a freshwater species would probably not be found in salt water and a seed that would now be too heavy to float in the atmosphere would have been too heavy in the past. Glaciers probably formed in the same environments that they do now and not in the middle of the ocean. Similar rock sequences probably indicate that the rocks are related to each other geologically and did not randomly generate the same sequence.

6. Briefly explain why apparent polar wandering is "apparent".

Paleomagnetic studies of ancient rocks point to different locations for the north pole at different times. When this is mapped out, it makes the pole appear to wander over time. The alternative to a wandering magnetic pole, for which there is no other evidence at all, is that the continents move and, with them, the rocks that contain the paleomagnetic data.

7. Briefly explain why the movement of continents over geologic time was the best explanation for polar wandering.

Since the Earth has only one magnetic north pole now, it is extremely unlikely that there would have been more than one in the past, but this would have been required to explain the different polar wander paths of the different continents. The only other possible explanation is that the continents were once joined and have since moved.

8. Briefly describe what happens when divergent plate boundaries form within a continent.

High heat flow elevates the continent and a rift valley forms, with normal faults and a central valley called a graben. Magma is intruded into fractures. As the plates diverge, basalt erupts in the rift, creating new ocean crust. Ultimately, as the plates continue to diverge, a new ocean basin forms.

9. How are the two models for the driving force of plate motion the same, and how are they different?

Both models involve thermal convection in the mantle. In both models, where two adjacent convection cells have upwelling limbs, there is a divergent plate boundary. Where there is a descending limb of a convection cell, there is a convergent boundary. The models differ in the location of the convection cells. In one, the convection cells are restricted to the asthenosphere. In the other, the convection cells take up the entire mantle.

10. How does seafloor spreading explain the movement of the continents?

With seafloor spreading, the continents and oceanic crust move together as part of large plates. The plate is pushed by the formation of new ocean crust and pulled by the subduction of old ocean crust. New crust forms due to seafloor spreading.

11. Briefly explain the roles of magma and hydrothermal activity in forming ore deposits along convergent and divergent plate boundaries.

Magma contains valuable elements, some of which leave the magma in gases and fluids. These substances transport the elements and facilitate their exchange for other elements in the surrounding rock. The surrounding rock may then have enough of the valuable elements to become an ore deposit. At convergent plate boundaries, partial melting at the subducting plate allows magma and valuable minerals to rise up in fluids and erupt at volcanoes or cool beneath the surface as plutons. At divergent plate boundaries, hydrothermal vents form. In these locations, seawater filters past hot magma, picks up valuable elements, and then the hot fluids flow onto the seafloor and drop their valuable elements.

12. Draw a cross-section of an oceanic-oceanic convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Put triangles with smoke out the top for the locations of volcanoes. Label the trench, back arc basin, and subduction complex.

See Figure 2.14a.

13. What are four of the many things that plate tectonics theory explains or whose explanations it has influenced?

Plate tectonics explains, at least to some extent, all of the following phenomena: the distribution of earthquakes and volcanoes, the locations of ore deposits and mountain systems, climate and ocean circulation patterns, and the geographic distribution, evolution and extinction of life forms.

14. Draw a cross-section of an oceanic-continental convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Put triangles with smoke out the top for the locations of volcanoes. Label the trench and subduction complex.

See Figure 2.14b.

15. Draw a cross-section of a continental-continental convergent plate boundary. Show the directions of relative plate motion. Put stars for the locations of earthquakes. Show the location of the mountain range. Label the subduction complex.

See Figure 2.14c.

16. Briefly explain how magnetic reversals in oceanic crust and fossils in ocean sediments are used to construct a magnetic time scale.

A terrestrial sequence of magnetic reversal in volcanic deposits was dated radiometrically. These dates were extrapolated to regions which were not dated, but showed the same pattern of normal and reversed magnetic polarities. Ages of ocean-floor basalts lying within a zone of normal or reversed polarity are dated by the ages of the fossils found in the sediments that directly overlie the basaltic crust. These fossils have already been incorporated within a biostratigraphic zone.

17. What is a method by which the present rate of motion between two plates can be measured accurately?

The travel of a laser beam can be timed from one plate to another by bouncing it from a satellite and by calculating the difference in arrival times of a quasar signal at two plates over a period of time.

18. How are hot spots used for determining the absolute motions of plates?

Hot spots appear to be fixed in the mantle relative to each other, so they can be used as a reference frame. If the age of a basalt and its distance from the hot spot is determined, then the rate of movement of that rock can be calculated. If a number of these samples are taken from various distances from the hot spot, the calculation can be quite accurate.

19. Briefly explain why there is so much oil in the Persian Gulf region.

During the Mesozoic, the Persian Gulf was a broad, stable marine shelf. Countless microorganisms lived in the surface water and their remains accumulated in the bottom sediments and were buried. The collision between Arabia and Iran has tilted the Arabian plate and crumpled rocks on the edges of both plates. The tilting of Arabia allows oil to migrate upslope to accumulate in traps created by folding.

20. How does the introduction of a geographic barrier encourage the evolution of species?

A population that is not separated will interbreed, so there will be little opportunity for different species to form. If a barrier separates that population and if conditions are different on either side of the barrier, natural selection will favor certain traits over others, and over time the two different populations of organisms may evolve to become different species.

21. Who was the first person to suggest that all of the continents had been once joined together as a supercontinent called Pangaea and when was that idea proposed?

The German meteorologist Alfred Wegener proposed the existence of Pangaea in 1915.

22. What do glacial striations indicate?

Glacial striations indicate the general direction that a glacier was moving.

23. Where is the best place to try to fit the continents together?

Along the continental slope at a depth of 2000 m.

24. Why were glacially deposited strata important in the development of the continental drift hypothesis?

The glacial deposits indicated that all of the southern continents were once closer to the south pole and were contiguous.

25. The Appalachian Mountains of the eastern United States are thought to have once been joined with mountains located in which other continental regions?

Canada, eastern Greenland, Ireland, Great Britain, and Norway.

26. List two ways that glacial deposits give strong evidence of the existence of Gondwana.

Without Gondwana, the glaciers would have been at a much lower latitude than glaciers are found today, and the glacial striations indicated that the ice flowed from a central location rather than from a separate glacier on each continent.

27. What is the reason that the presence of *Glossopteris* flora fossils was strong evidence for the existence of Gondwana?

The seeds of the *Glossopteris* ferns could not have been carried long distances by wind or water, so the plants must have lived on adjacent lands.

28. What is the principal reason why Wegener's hypothesis of continental drift was rejected?

Wegener lacked a plausible mechanism to explain how continental crust could move through the sea floor.

29. What are the three possible explanations for the distribution of paleomagnetic data?

(1) The continent remained fixed, and the north magnetic pole moved; (2) the north magnetic pole stayed still, and the continent moved; (3) both the continent and north magnetic pole moved.

30. Why was the paleomagnetic striping of the seafloor not evidence for Wegener's continental drift hypothesis?

Because it was several decades before scientists knew anything at all about the seafloor.

31. What other geological processes could have resulted in the configuration of coastlines so that South America and Africa appeared to fit together?

Wegener's critics pointed out that erosional and depositional processes could have created that configuration of the coastlines.

32. If rocks and mountain ranges were once joined together but were split apart, what features would you expect in each?

The same rock sequences, the same age rocks, the same structural trends.

33. What is it about a cooling lava that allows geologists to determine the location of past magnetic poles?

Iron-bearing minerals in a cooling lava align themselves in the direction of the current magnetic field as they cool below the Curie Point.

34. What two features of the magnetic field do magnetic iron-bearing minerals that crystallize out of magma record?

The minerals record the strength and direction of the Earth's magnetic field at the time of crystallization.

35. What evidence is there that ocean basins are young and old oceanic crust must be destroyed?

The maximum age for oceanic crust is 180 million years, but the continents contain rocks both younger and much older than 180 million years. The older oceanic crust must go somewhere.

36. Where in the ocean basins is ocean crust youngest?

At the crests of the mid-oceanic ridges.

37. What is the driving mechanism for plate tectonics?

Thermal convection cells.

38. What are the heat sources for each of the two mantle convection models for plate tectonics?

With whole mantle convection, the heat source is the core. With convection only in the asthenosphere, the heat source is harder to identify.

39. In what ways does plate tectonics theory have economic applications?

By understanding the geologic history of a region, geologists can predict whether it will be a worthwhile place to search for petroleum or ore deposits.

40. Briefly explain how convection transfers heat.

When a material is heated, it expands. Its density decreases, so it rises. After having risen some distance, it begins to cool, contract, and become denser. Thus, the material sinks and returns to the original level, where it will eventually be heated and rise again.

41. Why is plate tectonic theory so widely accepted?

Plate tectonic theory is supported by diverse lines of evidence from many scientific disciplines, such as geology and biology, and it explains many seemingly unrelated geological phenomena.

42. Paleomagnetism is the study of the _____ magnetism in rocks.
remanent

43. When magma cools, the magnetic iron-bearing minerals align themselves with the Earth's magnetic field and record _____ and _____.
strength, direction (of the north pole)

44. Wegener proposed that the continents were once all together as a supercontinent he named _____, which then split into a northern supercontinent called _____ and a southern supercontinent called _____.
Pangaea, Laurasia, Gondwana

45. The group of plant fossils that provides important evidence for the existence of Gondwana is _____.
Glossopteris

46. The temperature at which iron-bearing minerals gain their magnetic property is the _____ _____.
Curie point

47. Paleomagnetic data plotted on a map suggested that the magnetic pole had moved over time; this phenomenon was called _____ _____.
polar wandering

48. At deep-sea trenches, _____ is subducted back into the _____.
lithosphere, mantle

49. At mid-oceanic ridges, hot magma rises from the _____ and forms new _____.
mantle, seafloor

50. Magnetic stripes in oceanic basalts are _____ and _____ around ocean ridges.
parallel, symmetrical

51. Radiometric dating shows that the oldest ocean crust is _____ years old and the oldest continental crust is _____ years old.
180 million, 3.96 billion

52. The three kinds of boundaries there can be between adjacent plates are _____, _____, and _____.
divergent, convergent, transform

53. At divergent plate boundaries, plates are moving _____. At these locations, new _____ forms.
apart, lithosphere

54. Where divergent plate boundaries form beneath continental masses, low areas known as _____ _____ form.
rift valleys

55. At a convergent plate boundary, oceanic crust is _____.
destroyed

56. The three types of convergent plate boundaries are _____-_____, _____-_____, and _____-_____.
oceanic-oceanic, oceanic-continental, continental-continental

57. Volcanoes are found at these two types of plate boundaries: _____ and _____.
divergent, convergent

58. The type of plate boundary that runs through California is called _____, and the name of this plate boundary is the _____.
transform, San Andreas Fault

59. The names of the plates on either side of the plate boundary that passes through California are _____ and _____.
Pacific, North American

60. Mountain building events occur along _____-_____ or _____-_____ plate boundaries.
oceanic-continental, continental-continental

61. Rock sequences found on land that consist of deep-sea sediment, oceanic crust, and upper mantle are called _____. These sequences are used to identify _____ plate boundaries.
ophiolites, convergent

62. One of the most general conclusions to be drawn from plate tectonic theory is that:
A. the Earth is gradually losing heat.
B. the Earth's geography has continually changed.
C. the Earth is slowly expanding.
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C. North America, Europe, Asia, and India.
D. North America, Greenland, Asia, and India.
E. North America, Europe, Asia, and Greenland.

66. The southern supercontinent consisted of:
A. South America, Africa, Australia, Antarctica, and India.
B. Africa, South America, Antarctica, and Australia.
C. South America, Africa, India, and Australia.
D. South Africa, India, Africa, and Australia.
E. South America, Central America, India, Antarctica, Africa, and Australia.

67. Fossil evidence linking the Gondwana continents includes the:
A. lake-dwelling *Mesosaurus* and large land-dwelling reptile *Lystrosaurus and Cynognathus.*
B. freshwater *Mesosaurus* and dinosaurs *Brontosaurus* and *Tyrannosaurus.*
C. freshwater crocodiles and the large amphibian *Eryops.*
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B. how the inner/outer core boundary has evolved.
C. how the mineral magnetite has varied through time.
D. how the Earth's magnetic poles have varied through time.
E. none of the above

70. The study of paleomagnetism is possible because:
A. the magnetic minerals in rocks create the Earth's magnetic field.
B. most rocks contain no magnetic minerals.
C. the magnetic minerals in rocks disrupt the Earth's magnetic field.
D. the magnetic minerals in a cooling lava point toward the north magnetic pole.
E. none of the above

71. The differing paleomagnetic records for each continent showed:
A. each continent had its own magnetic pole during successive geological periods.
B. that the magnetic poles for each continent had moved over geological time.
C. that the magnetic poles have remained in one location and each of the continents has moved.
D. that both the poles and the continents have moved over time.
E. none of the above

72. The symmetrical pattern of magnetic polarities about spreading ridges in oceanic crust basalts indicates that:
A. each plate has had an independent set of magnetic reversals.
B. basalt retains its magnetic signature for only a few million years.
C. new ocean crust is created by volcanism at oceanic ridges and old crust moves laterally away from the ridge.
D. the oceanic crust is geologically young.
E. magnetic polarity reverses but northern and southern hemispheres do not.

73. Lithospheric plates move on the Earth's surface because:
A. warm mantle ascends at ridges and cool mantle descends at subduction zones.
B. convection occurs only in the asthenosphere.
C. cool mantle ascends at ridges and warm mantle descends at subduction zones.
D. A and B
E. B and C

74. The mechanism for plate movement is:
A. conduction of heat from the core.
B. friction created by tidal forces generated by the Moon.
C. conduction of heat within the mantle.
D. convection of heat within the mantle.
E. convection of heat within the core.

75. Geologists recognize three major types of plate boundaries, which are:
A. resurgent, divergent, and emergent.
B. convergent, divergent, and transform.
C. transcurrent, oblique, and resurgent.
D. emergent, transform, and convergent.
E. transform, transcurrent, and translateral.

76. At divergent plate boundaries, the operating forces are:
A. compressional.
B. lateral shearing.
C. tensional.
D. thrusting.
E. normal.

77. At a mid-oceanic ridge spreading center:
A. the plates are moving past each other.
B. the plates are moving away from each other.
C. the plates are moving toward each other.
D. one plate is being subducted beneath another.
E. both plates are being subducted.

78. Which are *not* associated with a mid-oceanic ridge?
A. old ocean crust
B. shallow-depth earthquakes
C. volcanic eruptions
D. transform faults
E. hot water

79. Large, high mountain ranges without volcanoes are built at which type of plate boundary?
A. divergent: oceanic-oceanic
B. convergent: oceanic-continental
C. convergent: continental-continental
D. transform: continental-continental
E. A and C

80. At transform plate boundaries:
A. lithosphere is neither created nor destroyed.
B. plates move laterally past each other.
C. active volcanism occurs.
D. A and B
E. A, B, and C

81. A transform plate boundary may connect:
A. a spreading ridge and subduction zone.
B. two spreading ridges.
C. two subduction zones.
D. A and C
E. A, B, and C

82. Changes in the Earth's magnetic field have occurred throughout geologic time, and these are called magnetic reversals.
TRUE

83. The theory of seafloor spreading was proposed by Harry Hess.
TRUE

84. The cause of magnetic reversals is a change in the structure of the Earth's inner core.
FALSE

85. Paleomagnetic studies show that the ocean basins are older than the continents.
FALSE

86. Features associated with ancient continental rift zones include andesite volcanoes and strike slip faulting.
FALSE

87. During the Triassic, a number of rift related fault basins formed along the eastern margin of North America.
TRUE

88. Convergent plate boundaries are characterized by the formation of new oceanic crust.
FALSE

89. Hot spots move with continental plates.
FALSE

90. Volcanic island chains that form along the trace of a hot spot are called aseismic ridges.
TRUE

91. The west coast of South America is a convergent boundary.
TRUE

92. A transform plate boundary underlies the Alps in southern Europe.
FALSE

93. There is a divergent plate boundary within the region of east Africa.
TRUE

94. Old, cold, and dense oceanic crust sinks into the mantle at subduction zones.
TRUE

95. At divergent plate boundaries, oceanic crust is transformed.
FALSE

96. The forces that operate at a continental-continental convergent plate boundary are called transpressional.
FALSE