Package Title: Testbank
Course Title: Visualizing Geology, 4e
Chapter Number: 03

Question Type: Multiple Choice

01) When we see sedimentary rock units that are twisted or tilted, we know that some force must have disturbed the strata after they were deposited. The principle upon which we base this inference is the principle of _____.

a) stratigraphic superposition
b) cross-cutting relationships
c) original horizontality.
d) stratigraphic correlation

Answer: C

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age
Section Reference: Relative Age

02) The principle of stratigraphic superposition tells us that _____.

a) a rock stratum is older than any geologic feature that disturbs or cuts it.
b) the oldest rock strata in any undisturbed sedimentary sequence are on the bottom, and the youngest are on the top.
c) sedimentary rock strata are deposited in flat-lying layers.
d) All of the above are true.

Answer: D

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

03) If you see a vertical magmatic intrusion embedded in horizontal layers of sedimentary rocks, which principle will help you determine the relative age of the intrusion?

a) principle of original horizontality
b) principle of stratigraphic superposition
c) principle of cross-cutting relationships
d) principle of lateral continuity

Answer: C

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.

Section Reference: Relative Age

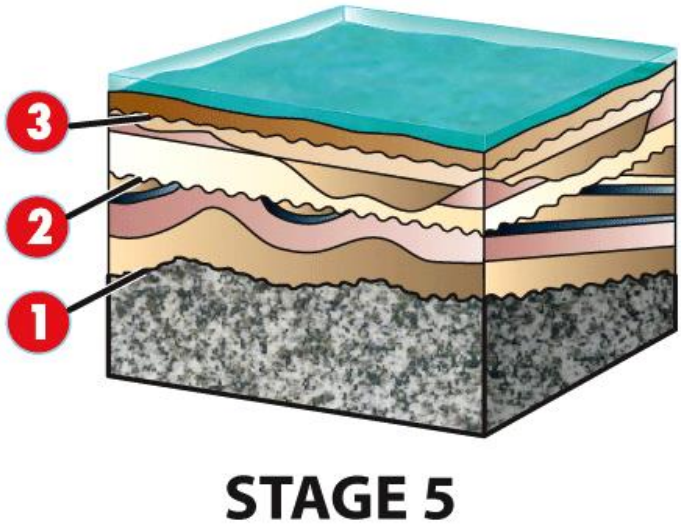
04) What is the principle that helps geologists determine the age of strata that are separated by distance?

a) principle of original horizontality
b) principle of stratigraphic superposition
c) principle of cross-cutting relationships
d) principle of lateral continuity

Answer: D

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

05) For the block diagram below, what type of unconformity is labeled as 2?

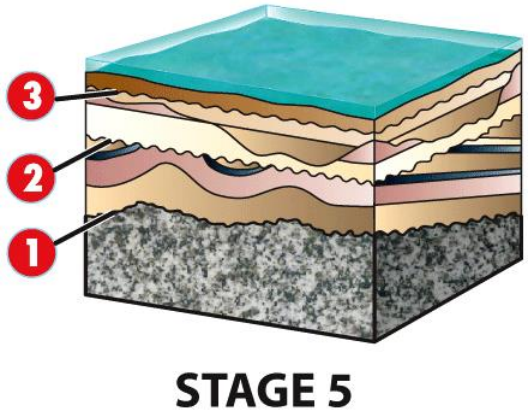


a) disconformity
b) nonconformity
c) angular unconformity
d) None of the above, the contact is conformable.

Answer: C

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age
Section Reference: Relative Age

06) For the block diagram below, what type of unconformity is labeled as 1?

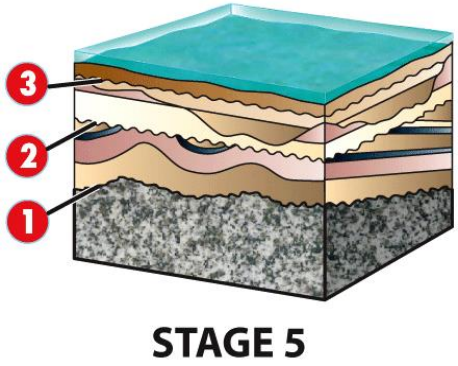


a) disconformity
b) nonconformity
c) angular unconformity
d) None of the above, the contact is conformable.

Answer: B

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

07) For the block diagram below, what type of unconformity is labeled as 3?

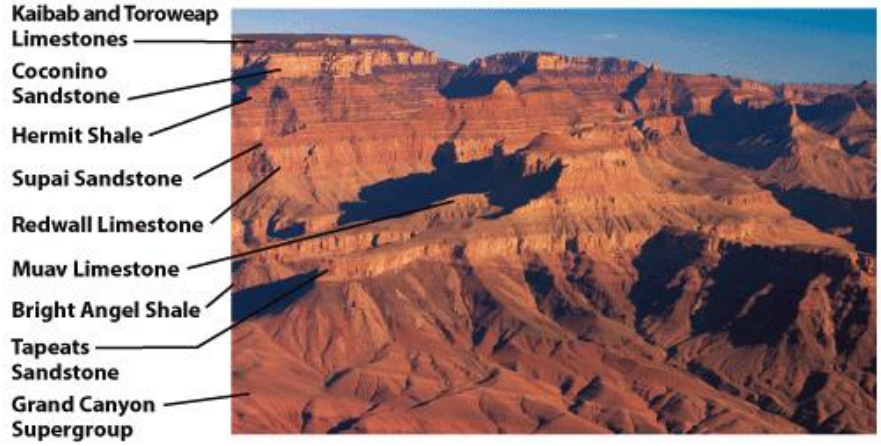


a) disconformity
b) nonconformity
c) angular unconformity
d) None of the above, the contact is conformable.

Answer: A

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

08) For the stratigraphic section of the Grand Canyon depicted in the photograph below, which stratigraphic unit is oldest?



a) Muav Limestone
b) Kaibab Limestone
c) Coconino Sandstone
d) Tapeats Sandstone

Answer: D

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age
Section Reference: Relative Age

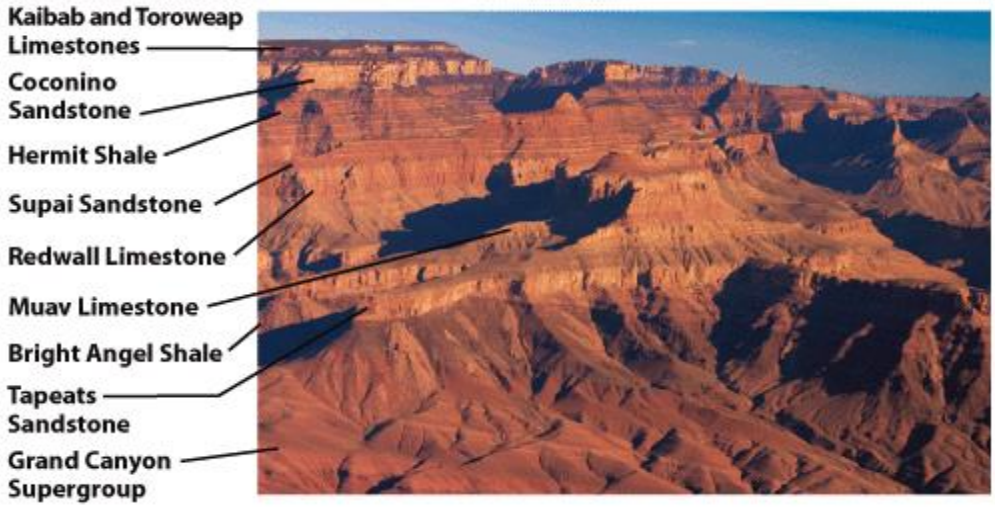
09) What principle would allow you to determine the relative ages of different parts of the stratigraphy of this section of the Grand Canyon?

a) principle of superposition
b) principle of faunal succession
c) principle of original horizontality
d) principle of cross-cutting relationships

Answer: A

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

10) The contact beneath the Tapeats Sandstone and the underlying Grand Canyon Supergroup is an example of a(n)

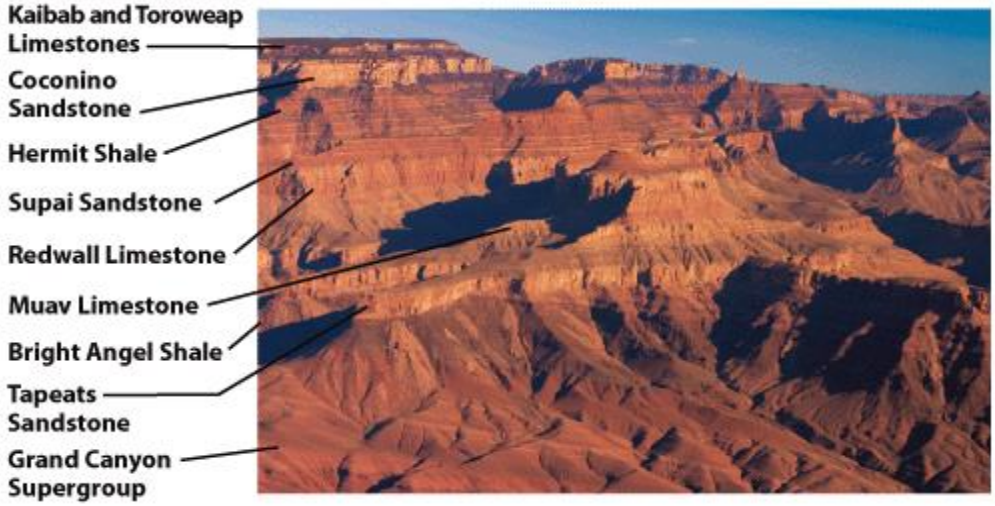


a) disconformity.
b) nonconformity.
c) angular unconformity.
d) a conformable depositional contact.

Answer: C

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

11) In the stratigraphic sequence of the Grand Canyon, depicted below, the contact between the Muav Limestone and the overlying Redwall Limestone spans two missing periods of geologic time. The contact between these two stratigraphic units represents a(n)



a) disconformity.
b) nonconformity.
c) angular unconformity.

d) a conformable depositional contact.

Answer: A

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

12) Periods of geologic time lasted for

a) a few millions of years.
b) tens of millions of years
c) hundreds of millions of years.
d) billions of years.

Answer: B

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

13) The geologic era in which animals with hard shells first appeared is the:

a) Mesozoic.
b) Cenozoic
c) Paleozoic.
d) Pre-Cambrian.

Answer: C

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

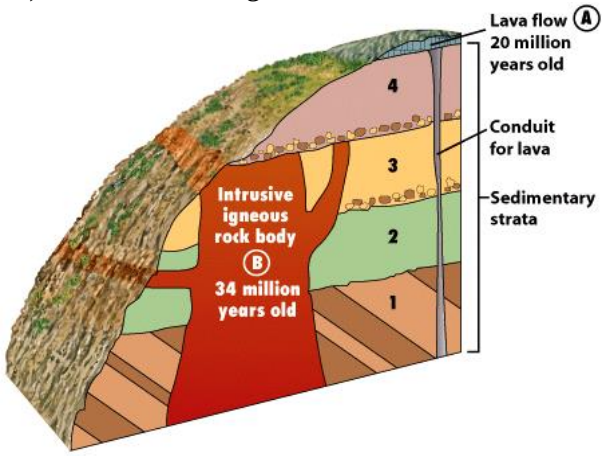
14) The time needed for half of the parent atoms of a radioactive substance to decay into daughter atoms is termed the _____ .

a) numerical age
b) relative age
c) isotopic age
d) half-life

Answer: D

Difficulty: Easy
Learning Objective: Outline the process of radioactive decay and its use in determining numerical age,
Section Reference: Numerical Age

15) For the block diagram below, which of the following statements is(are) true?

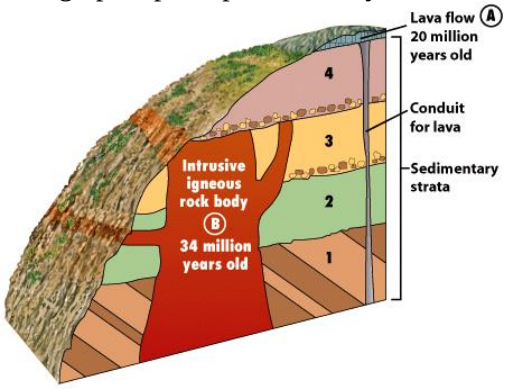


a) The igneous intrusion labeled B is older than Unit 2.
b) The igneous intrusion labeled B is younger than Unit 2.
c) The igneous intrusion labeled B is younger than the tilted sequence 1.
d) Both A and C are true statements.
e) Both B and C are true statements.

Answer: E

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

16) Based on the block diagram below, the igneous intrusion labeled B is younger than Unit 2. What stratigraphic principle allowed you to determine this observation?

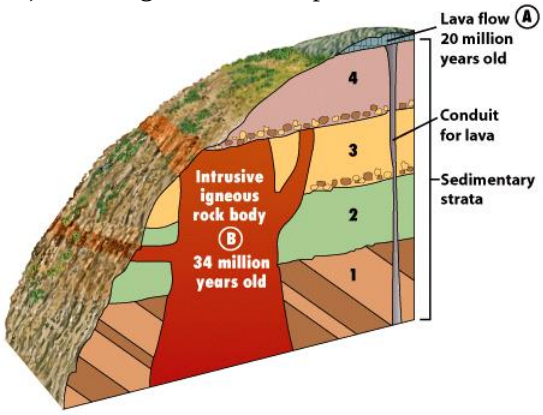


a) principle of superposition
b) principle of faunal succession
c) principle of original horizontality
d) principle of cross-cutting relationships

Answer: D

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

17) In the figure below, deposition of unit 4 occurred

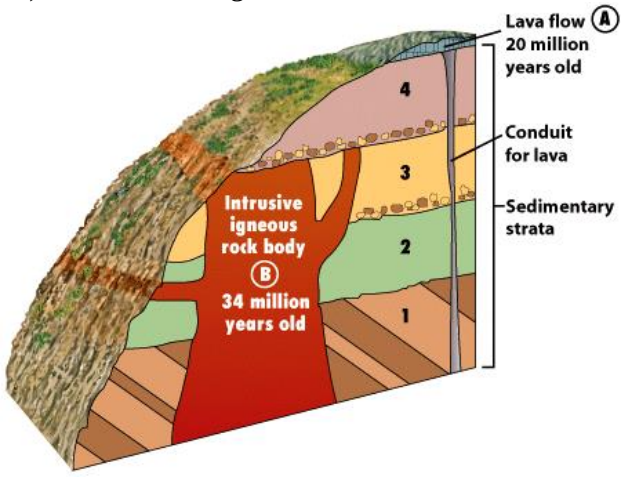


a) between 34 million and 20 million years ago.
b) prior to 34 million years ago.
c) within the last 20 million years.
d) Cannot be determined from the information given.

Answer: A

Difficulty: Medium
Learning Objective: Explain how and why radioactive decay can be used to date igneous rocks.
Section Reference: Numerical Age

18) In the block diagram shown below, deformation of the stratigraphic sequence labeled 1



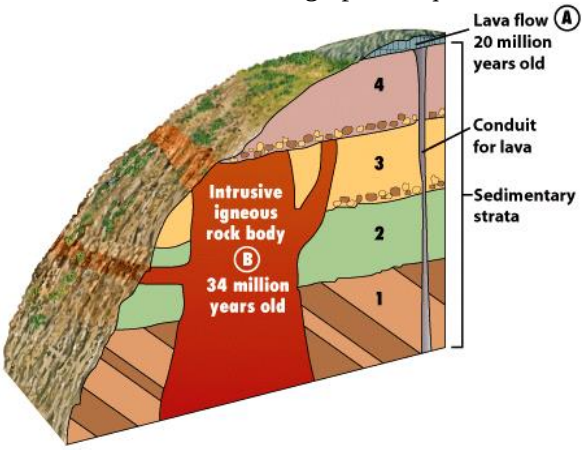
a) occurred prior to 34 million years ago
b) before the intrusion of the igneous rock body labeled B.

c) before the deposition of unit 2.
d) All of the previous statements are true.

Answer: D

Difficulty: Medium
Learning Objective: Explain how and why radioactive decay can be used to date igneous rocks.
Section Reference: Numerical Age

19) For the block diagram below, what stratigraphic principle allowed you to determine the relative age of the intrusion and the stratigraphic sequence labeled 1?

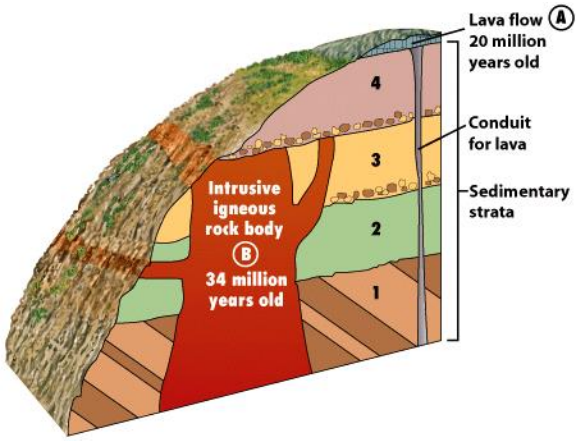


a) principle of superposition
b) principle of faunal succession
c) principle of original horizontality
d) principle of cross-cutting relationships

Answer: D

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

20) In the block diagram below, the contact between rock unit 4 and the underlying intrusion B is an example of a(n)

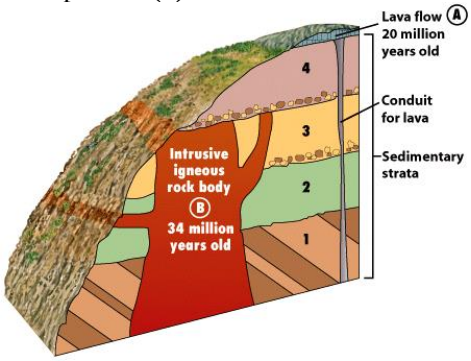


A) disconformity.
B) nonconformity.
C) angular unconformity.
D) a conformable depositional contact.

Answer: B

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

21) In the block diagram below, the contact between rock unit 4 and the underlying rock unit 3 is an example of a(n)

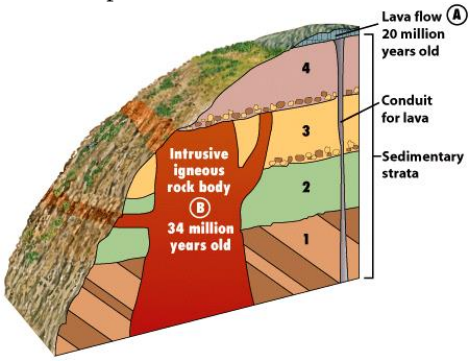


a) disconformity.
b) nonconformity.
c) angular unconformity.
d) a conformable depositional contact.

Answer: A

Difficulty: Low
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

22) In the block diagram below, the contacts between layers in the tilted stratigraphic sequence labeled 1, are examples of

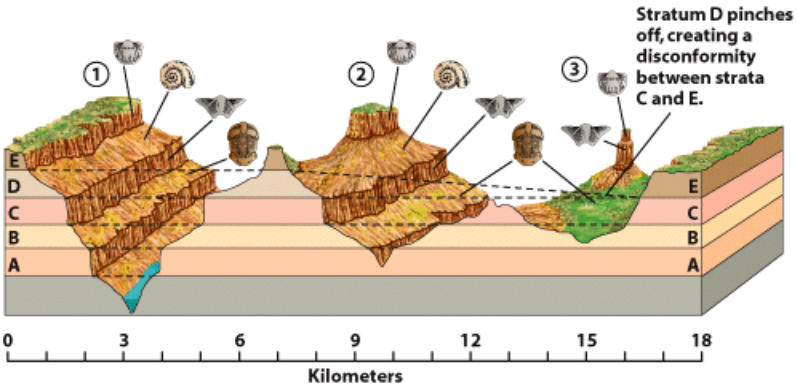


a) disconformities.
b) nonconformities.
c) angular unconformities.
d) conformable depositional contacts.

Answer: D

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

23) In the diagram below, the contact between C and E is a(n)



a) disconformity.
b) nonconformity.
c) angular unconformity.
d) a conformable depositional contact.

Answer: A

Difficulty: Easy
Learning Objective: Describe how fossils make it possible for geologists to correlate strata in different places.
Section Reference: Relative Age

24. The oldest radiometric date reported for an individual mineral grain from a sedimentary rock is approximately _____.

a) 4.4 billion years
b) 4.56 billion years
c) 4.4 million years
d) 4.56 million years

Answer: A

Difficulty: Easy
Learning Objective: Explain why the oldest rocks are not necessarily the same age as the planet
Section Reference: The Age of the Earth

25) The most ancient rock body on Earth has a radiometric age of _____.

a) 4.4 billion years
b) 4.56 billion years
c) 4.4 million years
d) 4.0 billion years.

Answer: D

Difficulty: Easy
Learning Objective: Explain why the oldest rocks are not necessarily the same age as the planet
Section Reference: The Age of Earth

26) Our best estimate for the age of the Earth is _____.

a) 4.4 billion years
b) 4.56 billion years
c) 4.4 million years
d) 4.56 million years

Answer: B

Difficulty: Easy
Learning Objective: Summarize the evidence that has lead scientists to conclude that Earth is about 4.56 billion years old.
Section Reference: The Age of Earth

Question Type: True/False

27) Numerical age is the age of a rock or geological feature in years.

Answer: True

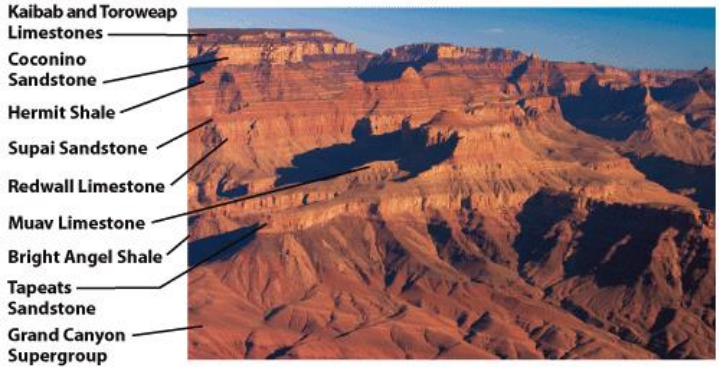
Difficulty: Easy
Learning Objective: Explain how and why radioactive decay can be used to date igneous rocks.
Section Reference: Numerical Age

28) An unconformity is a gap in the stratigraphic sequence.

Answer: True

Difficulty: Easy
Learning Objective: Explain why gaps are common in the stratigraphic record.
Section Reference: Relative Age

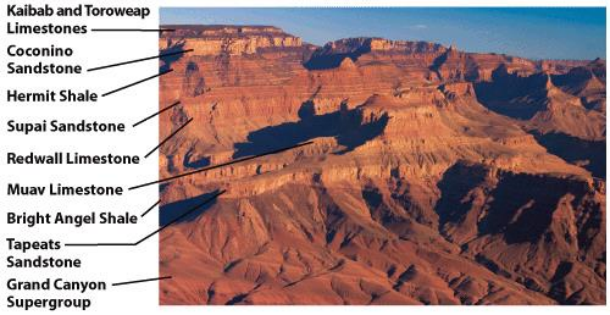
29) In the photo of the stratigraphic sequence of the Grand Canyon, below, tilting of the Grand Canyon Super Group occurred after deposition of the Tapeats Sandstone.



Answer: False

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

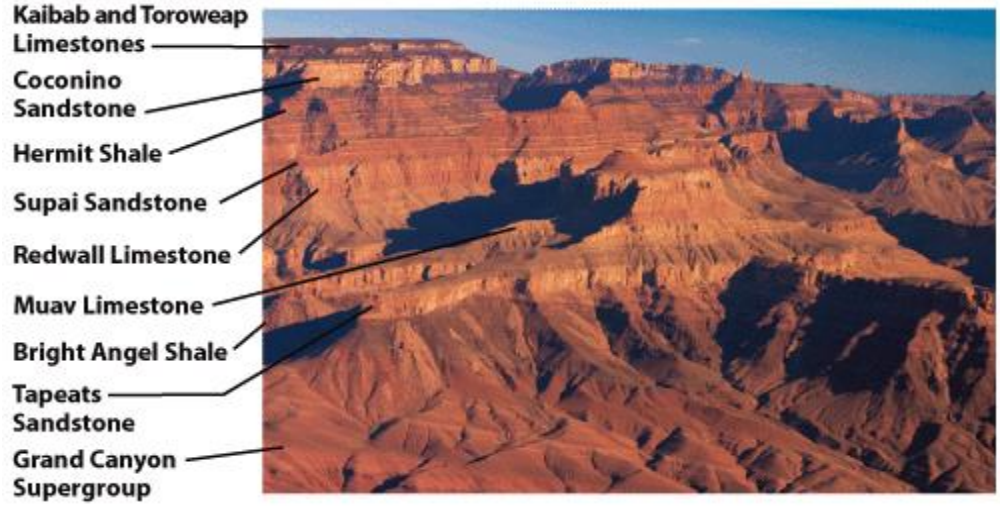
30) In the stratigraphic sequence of the Grand Canyon shown below, the Tapeats Sandstone is sitting on top of an angular unconformity.



Answer: True

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

31) In the stratigraphic sequence of the Grand Canyon shown below, the Tapeats Sandstone is the oldest rock unit.



Answer: False

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

32) Geologists have divided the three eras of the Phanerozoic Eon into a number of shorter units called periods.

Answer: True

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

33) Periods of geologic time last for hundreds of millions of years.

Answer: False

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

34) Lord Kelvin based his estimate of Earth's age on how long it must have taken Earth to cool by conduction.

Answer: True

Difficulty: Easy
Learning Objective: Recount how scientists attempted to quantify geologic time.
Section Reference: Numerical Age

35) The Allende meteorite is classified as a carbonaceous chondrite.

Answer: True

Difficulty: Easy
Learning Objective: Explain why the oldest rocks are not necessarily the same age as the planet.
Section Reference: The Age of Earth

36) A magnetic reversal is a period of time in which Earth’s magnetic polarity reverses itself.

Answer: True

Difficulty: Easy
Learning Objective: Describe how magnetic polarity can be used to date both igneous and sedimentary rocks.
Section Reference: Numerical Age

Question Type: Fill in the blank

37) The three basic principles which can be used to determine the relative ages of rock units in a stratigraphic sequence are principle of _____, principle of original horizontality; and principle of cross-cutting relationships.

Answer: superposition

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

38) Strata in which the layers of sediment have been deposited one on top of another, in sequence with no significant gaps in time, are said to be _____.

Answer: conformable

Difficulty: Easy

Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

39) A(n) _____is a gap in the rock record across which there is a significant amount of missing time.

Answer: unconformity

Difficulty: Easy
Learning Objective: Explain why gaps are common in the stratigraphic record.
Section Reference: Relative Age

40) A(n) _____is a surface of erosion between two groups of sedimentary rocks in which the orientation of the older strata below are at an angle to younger strata above.

Answer: angular unconformity

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

41) A(n) _____is a surface of erosion that separates younger strata above from older igneous or metamorphic rocks below.

Answer: nonconformity

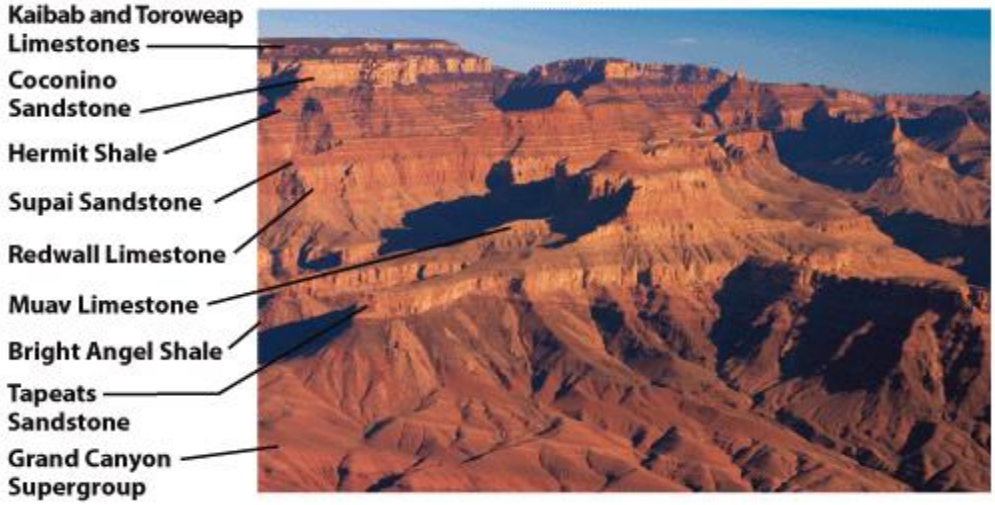
Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

42) A(n) _____is a surface of erosion in which the orientation of older strata, below, are parallel to younger strata, above.

Answer: disconformity

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

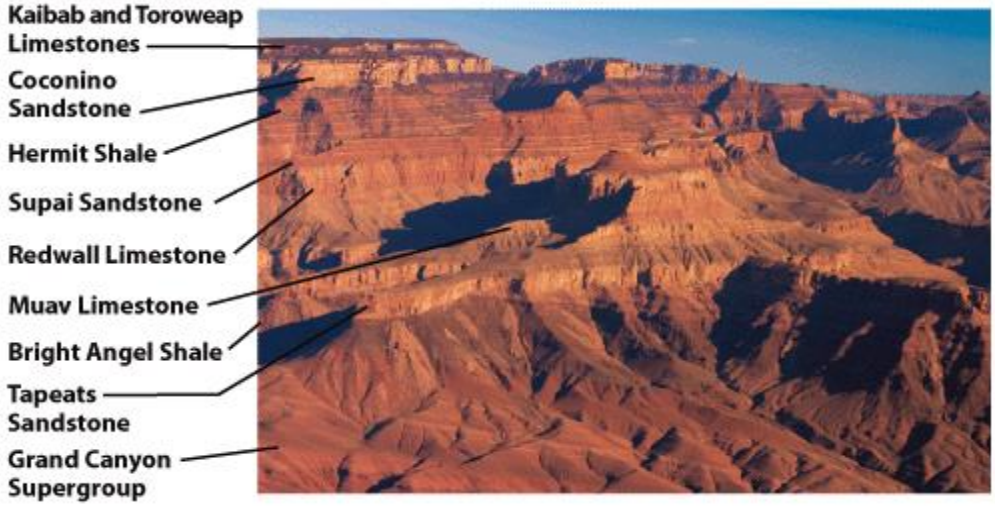
43) In the photo of the sedimentary sequence of the Grand Canyon shown below, the _____ is/are the youngest sedimentary strata.



Answer: Kaibab and Toroweap Limestones

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

44) In the photo below, the _____is the oldest group of strata within the sequence of the Grand Canyon.



Answer: Grand Canyon Supergroup

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

45) The principle of _____ states that a layer of sediment will extend horizontally as far as it was carried by the water that deposited it.

Answer: lateral continuity

Difficulty: Easy
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

46) The contact between the Grand Canyon Supergroup and the overlying Tapeats Sandstone is a type of unconformity known as a(n)_____.

Answer: angular unconformity

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

47) A(n) _____ is a unit of geologic time across which you would expect to find the greatest changes in the fossil record.

Answer: Era

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

48) Eras of geologic time are subdivided into a number of smaller divisions called _____.

Answer: periods

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

49) An isotope that is undergoing radioactive decay is called a parent, and an isotope that forms as a result of radioactive decay is called a _____.

Answer: daughter

Difficulty: Low
Learning Objective: Outline the process of radioactive decay and its use in determining numerical ages.
Section Reference: Numerical Age.

50) _____ is the process in which an element spontaneously transforms into another isotope of the same element, or into a different element.

Answer: Radioactivity; Radioactive decay

Difficulty: Easy
Learning Objective: Outline the process of radioactive decay and its use in determining numerical ages.
Section Reference: Numerical Age

51) A period of time in which Earth's magnetic polarity reverses itself is termed a _____.

Answer: magnetic reversal

Difficulty: Easy
Learning Objective: Describe how magnetic polarity dating can be used to date both igneous and sedimentary rocks.
Section Reference: Numerical Age

52) Magnetic _____ is the north-south directionality of Earth's magnetic field.

Answer: polarity

Difficulty: Easy
Learning Objective: Describe how magnetic polarity dating can be used to date both igneous and sedimentary rocks.
Section Reference: Numerical Age

53) Paleomagnetic studies can be useful in dating both igneous and _____ rocks.

Answer: sedimentary

Difficulty: Easy
Learning Objective: Describe how magnetic polarity Dating can be used to date both igneous and sedimentary rocks.
Section Reference: Numerical Age

54) Of the many radiometric dates obtained from Precambrian rocks, the oldest is about _____ billion years.

Answer: 4.0

Difficulty: Easy
Learning Objective: Explain why the oldest rocks are not necessarily the same age of the planet.
Section Reference: The Age of Earth

55) Our best estimate for the age of Earth is_____ billion years.

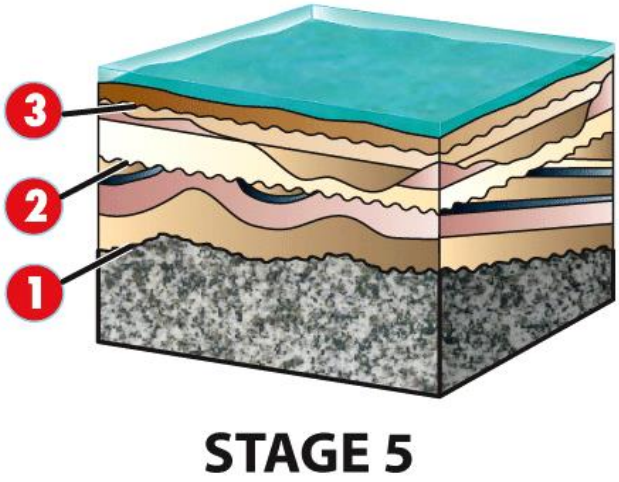
Answer: 4.56

Difficulty: Easy

Learning Objective: Summarize the evidence that has lead scientists to conclude that Earth is about 4.56 billion years old.
Section Reference: The Age of Earth.

Question type: Essay

56) For the figure below what types of unconformities are represented by the contacts marked as 1, 2 and 3.?



STAGE 5

Answer: Contact number 1 represents a nonconformity, contact number 2 an angular unconformity, and contact number 3 a disconformity.

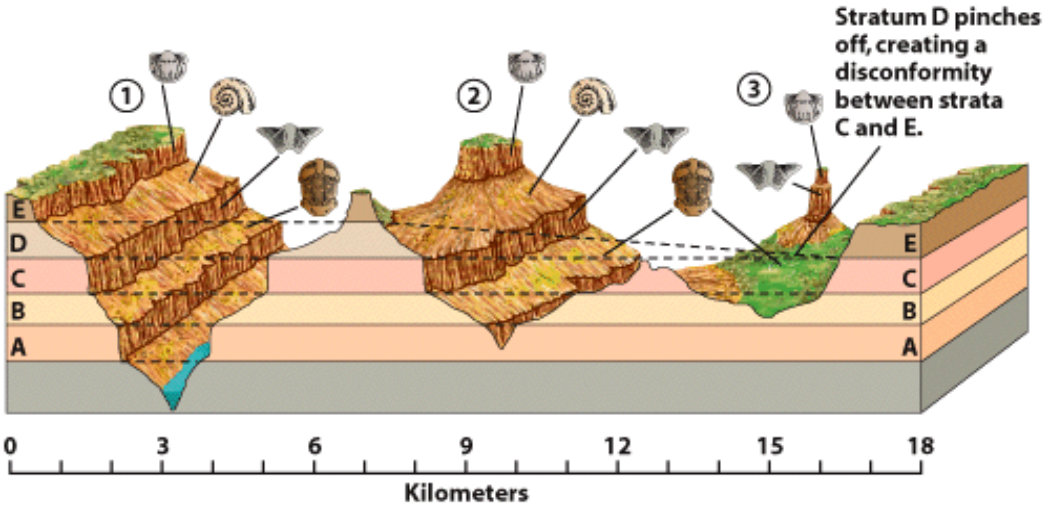
Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

57) How did William Smith's discovery of faunal succession lead to the correlation of rock strata and eventually the geologic column?

Answer: Based on Smith's discovery that each group of strata contained a specific assemblage of fossils, geologists were able to show that the faunal succession in northern France was the same as the faunal succession in southern England where Smith worked. Soon, worldwide correlations were made. This provided a means of equating the ages of rocks from different localities, which eventually led to the establishment of the geologic column (time scale).

Difficulty: Medium
Learning Objective: Describe how fossils make it possible for geologists to correlate strata in different places.
Section Reference: Relative Age

58) For the figure below give two possible explanations for the stratigraphy at site 3, in which unit E sits directly on top of C.



Answer: Stratum D is missing at site 3 either because it was never deposited at that location (nondeposition), or because erosion removed it prior to the deposition of stratum E.

Difficulty: Medium
Learning Objective: Describe how fossils make it possible for geologists to correlate strata in different places.
Section Reference: Relative Age

59) Name the eras of Phanerozoic time, starting from oldest to youngest.

Answer: The eras comprising the Phanerozoic eon from oldest to youngest are: the Paleozoic, the Mesozoic, and the Cenozoic.

Difficulty: Easy
Learning Objective: Distinguish four units of geologic time: eons, eras, periods, and epochs.
Section Reference: The Geologic Column

60) If you know the half-life of a radioactive isotope that occurs in an igneous rock, what must you measure to determine the age of the rock?

Answer: You must measure the amount of daughter isotope present in the rock. You must also have some way to measure the original amount of parent and daughter element within the rock.

Difficulty: Medium
Learning Objective: Outline the process radioactive decay and its use in determining numerical ages.
Section Reference: Numerical Age

61) Why is the half-life of a radioactive element important in considering the choice of a method to be used for determining the radiometric age of a mineral or rock?

Answer: If the age of the rock is very old, then an element with a short half-life cannot be used, as there will be too little or none of the parent element remaining. If the age of the rock is very young, then an

element with too long a half-life will cause there to be too little to measure of the decayed parent element even with sensitive analytical techniques.

Difficulty: Medium
Learning Objective: Explain how and why radioactivity can be used to date igneous rocks.
Section Reference: Numerical Age

62) Discuss the importance of the Ediacaran Period.

Answer: The Ediacaran Period is the last period of the Proterozoic Eon (and therefore that last of the Precambrian), and the only period of the Proterozoic defined by macroscopic fossils. All the periods of the Phanerozoic Eon were defined by geologists in the 19th century. The fossils that define the Ediacaran were first discovered in Australia in the 1940s, then found later in Canada, Namibia, and other locations around the world. The Ediacaran Period was finally defined in 2004, the first such addition to the Geologic Column in 120 years.

Difficulty: Medium
Learning Objective: Explain how worldwide observations of strata and the fossils they contain, led to a single sequence of relative ages called the geologic column.
Section Reference: The Geologic Column

63) What are magnetic reversals, and how often do they occur?

Answer: Magnetic reversals represent a period of time in which Earth's magnetic polarity reverses itself. Earth's magnetic field reverses its polarity at irregular intervals, but on average, about once every half million years. This means that the magnetic pole that had been in the northern hemisphere moves to a position near Earth's South Pole, and the magnetic pole that had been in the south moves to the north. Scientists are still working out details of how or why magnetic reversals happen. The two most important points are that the reversal happens quickly by geologic time standards, and any iron-bearing mineral in an igneous rock retains or "remembers" the magnetic polarity of Earth at the time that the rock was formed—that is, a change in the magnetic field does not affect already formed minerals.

Difficulty: Medium
Learning Objective: Describe how magnetic polarity dating can be used to date igneous and sedimentary rocks.
Section Reference: Numerical Age

64) Scientists claim that Earth is 4.56 billion years old. Why hasn't a rock been found that is this old?

Answer: The continual recycling of Earth's surface by erosion and plate tectonics means that very few remnants of Earth's original crust, if any, remain. Of the many radiometric dates obtained from Precambrian rocks, the oldest is about 4.0 billion years. Although no older rocks than this have been found, an individual mineral grain from a sedimentary rock in Australia has been dated to 4.4 billion years, so igneous rocks older than 4.0 billion years may someday be located.

Difficulty: Easy
Learning Objective: Explain why the oldest rocks are not necessarily the same age as the planet.
Section Reference: The Age of Earth

65) What are carbonaceous chondrites?

Answer: Meteorites that are believed to contain unaltered material of the kind that accreted to form Earth from the solar nebula. It is termed “carbonaceous” because it contains tiny amounts of carbon, some of which is in chemical compounds called amino acids—organic components that are essential for life. The ages of carbonaceous chondrites, as a group, cluster closely around 4.56 billion years, the currently postulated age of Earth.

Difficulty: medium
Learning Objective: Summarize the evidence that has led scientists to conclude the Earth is about 4.56 billion years old.
Section Reference: The Age of Earth

66) Would the principles of stratigraphy used to determine relative ages on Earth be useful tools for determining relative ages on the Moon or Mars? Explain your answer.

Answer: The principles of stratigraphy would still be useful in determining relative ages on the Moon or Mars. The processes acting on these planetary surfaces may differ from those acting on Earth, or may have occurred at different rates over time, but the resulting products of these processes will still follow fundamental physical laws. For example, craters of the lunar highlands that are superimposed on others are younger – an example of “cross-cutting” relationships. Similarly, lake deposits filling a crater on Mars show that lake deposition is younger than the crater in which the sediments were deposited. This is an example of the principle of superposition. All of the stratigraphic principles we use on Earth for relative dating can be used on other terrestrial planetary bodies.

Difficulty: Medium
Learning Objective: Define Stratigraphy and Relative Age.
Section Reference: Relative Age

67) Nineteenth century geologists tried to estimate the absolute age of rock strata by calculating how long it would take to deposit a stratigraphic sequence of a given thickness. What was wrong with this approach?

Answer: Nineteenth century geologists' attempts to quantify the amount of time represented by a single layer of sediment based on its thickness are fundamentally flawed. There are three basic assumptions that are not necessarily true that form the basis of their methodology. First, sedimentation rates may be highly variable, even within a single system. Second, the thickness of the sedimentary rock layer is not solely related to the amount of material deposited. The thickness is also a function of the compaction of the layers, which is dependent on the overburden. It may be impossible to estimate the amount of overburden that has contributed to the compaction of the layers, because many may have been removed by erosion. A third assumption is that the amount and distribution of pore space is unimportant in the calculation of thickness.

Difficulty: Medium
Learning Objective: Explain why gaps are common in the stratigraphic record.
Section Reference: Relative Age

68) Explain the methods used by geologists to approximate the numerical ages of the stratigraphic time scale. How are these ages being continually refined?

Answer: By integrating relative dating techniques with rock units that can yield numerical ages, the geologic time scale can be calibrated. This technique requires rock units with critical relationships, at or near key stratigraphic boundaries, to be dated by radiometric methods. By dating units that bracket these key stratigraphic horizons, it is possible to estimate the relative age boundaries of the stratigraphic time scale. By using this technique at many locations around the world, it is possible for geologists to refine the dates applied to the various ages of the stratigraphic time scale.

Difficulty: Medium
Learning Objective: Outline the process of radioactive decay and its use in determining numerical ages.
Section Reference: Numerical Age

69) Generally describe the methods by which numerical dates can be determined for igneous rocks. What assumptions are used in these dating methods?

Answer: Radiometric dating methods for igneous rocks measure the amount of elapsed time since minerals in the rock crystallized. When a new mineral grain forms—for example, a grain of feldspar in cooling lava— all the atoms in the grain become locked into the crystal structure and isolated from the environment outside the grain. In a sense, the atoms in the mineral grain, including any radioactive atoms, are sealed in an atomic time capsule. The trapped radioactive parent atoms decay to daughter atoms at a rate determined by their half-life. In the simplest case, if no daughter atoms were present in the mineral at the time of formation, we can work backward and determine how long ago the time capsule was sealed. For example, if the mineral crystal contained some daughter atoms at the time of formation, the process is more difficult. Geologists have developed several ways to estimate the initial contamination of a sample by daughter atoms. Once that is done, and provided we know the half-life of the radioactive parent, it is a simple matter to calculate how long ago the mineral crystallized.

A few assumptions are used in the dating technique. One assumption is that the rate of radioactive decay is a constant over time. A second assumption is that there is no loss of daughter product over time. To validate this assumption, geologist take great care to get “fresh” rock samples for dating and to insure that there has been no alteration.

Difficulty: Difficult
Learning Objective: Explain how and why radioactive decay can be used to date igneous rocks
Section Reference: Numerical Age

70) Some people believe that the age of Earth is very young. What evidence supports the conclusion of scientists that Earth is much older, approximately 4.56 billion years?

Answer: Geologic evidence supports the conclusion that Earth is approximately 4.56 billion years old. Radiometric dates of the oldest rocks on Earth yield an age of 4.0 billion years. Although no older rocks than this have been found, an individual mineral grain from a sedimentary rock in Australia has been dated to 4.4 billion years. This means that at least some rocks existed prior to 4.0 billion years. There is also strong evidence that Earth and the Moon formed at the same time, along with the other planets and meteorites. Radiometric ages of the oldest material brought back from the Moon and from the oldest meteorites cluster closely around 4.56 billion years.

Difficulty: Difficult
Learning Objective: Summarize the evidence that has led scientists to conclude that Earth is about 4.56 billion years old.
Section Reference: The Age of Earth