tpo_35_passage_3

One of the first recorded observers to surmise a long age for Earth was the Greek historian Herodotus, who lived from approximately 480 B.C.to 425 B.C. He observed that the Nile River Delta was in fact a series of sediment deposits built up in successive floods. By noting that individual floods deposit only thin layers of sediment, he was able to conclude that the Nile Delta had taken many thousands of years to build up. More important than the amount of time Herodotus computed, which turns out to be trivial compared with the age of Earth, was the notion that one could estimate ages of geologic features by determining rates of the processes responsible for such features, and then assuming the rates to be roughly constant over time. Similar applications of this concept were to be used again and again in later centuries to estimate the ages of rock formations and, in particular, of layers of sediment that had compacted and cemented to form sedimentary rocks. It was not until the seventeenth century that attempts were made again to understand clues to Earth's history through the rock record. Nicolaus Steno (1638–1686) was the first to work out principles of the progressive depositing of sediment in Tuscany. However, James Hutton (1726–1797), known as the founder of modern geology, was the first to have the important insight that geologic processes are cyclic in nature. Forces associated with subterranean heat cause land to be uplifted into plateaus and mountain ranges. The effects of wind and water then break down the masses of uplifted rock, producing sediment that is transported by water downward to ultimately form layers in lakes, seashores, or even oceans. Over time, the layers become sedimentary rock. These rocks are then uplifted sometime in the future to form new mountain ranges, which exhibit the sedimentary layers (and the remains of life within those layers) of the earlier episodes of erosion and deposition. Hutton's concept represented a remarkable insight because it unified many individual phenomena and observations into a conceptual picture of Earth's history. With the further assumption that these geologic processes were generally no more or less vigorous than they are today, Hutton's examination of sedimentary layers led him to realize that Earth's history must be enormous, that geologic time is an abyss and human history a speck by comparison. After Hutton, geologists tried to determine rates of sedimentation so as to estimate the age of Earth from the total length of the sedimentary, or stratigraphic, record. Typical numbers produced at the turn of the twentieth century were 100 million to 400 million years. These underestimated the actual age by factors of 10 to 50 because much of the sedimentary record is missing in various locations and because there is a long rock sequence that is older than half a billion years that is far less well defined in terms of fossils and less well preserved. Various other techniques to estimate Earth's age fell short, and particularly noteworthy in this regard were flawed determinations of the Sun's age. It had been recognized by the German philosopher Immanuel Kant (1724–1804) that chemical reactions could not supply the tremendous amount of energy flowing from the Sun for more than about a millennium. Two physicists during the nineteenth century both came up with ages for the Sun based on the Sun's energy coming from gravitational contraction. Under the force of gravity, the compression resulting from a collapse of the object must release energy. Ages for Earth were derived that were in the tens of millions of years, much less than the geologic estimates of the time. It was the discovery of radioactivity at the end of the nineteenth century that opened the door to determining both the Sun's energy source and the age of Earth. From the initial work came a suite of discoveries leading to radioisotopic dating, which quickly led to the realization that Earth must be billions of years old, and to the discovery of nuclear fusion as an energy source capable of sustaining the Sun's luminosity for that amount of time. By the 1960s, both analysis of meteorites and refinements of solar evolution models converged on an age for the solar system, and hence for Earth, of 4.5 billion years.

question 1

According to paragraph 1, Herodotus' observations of the Nile River Delta were significant because they allowed him to

A provide detailed records of the most significant floods in the history of the Nile

B develop a way of calculating the age of geologic features

C conclude that the Nile River Delta was as old as Earth

D predict when the river would flood and when it would not

question 2

According to paragraph 2, James Hutton was the first person to

A understand clues to Earth’s history through the rock record

B work out principles of the progressive depositing of sediment

C realize that geologic processes happen in cycles

D describe the forces associated with subterranean heat

question 3

Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.

A Hutton realized that if these geologic processes have always occurred at about the same rate as they do today, Earth’s history is huge in comparison with human history.

B Hutton’s examination of sedimentary layers led him to conclude that throughout Earth’s long history, geologic processes have been generally the same as they are today.

C In spite of Hutton’ s contributions to the understanding of geologic processes, what is known about Earth’ s history is minor compared with what is known about human history.

D Hutton’ s examination of sedimentary layers was quite vigorous for his day, and his conclusions about geologic processes are among the most significant in human history.

question 4

According to paragraph 4, what happened when geologists at the turn of the twentieth century tried to estimate Earth's age?

A They ignored Hutton’ s findings about rates of sedimentation and thus tended to underestimate the age by a factor of 10 to 50.

B Using the sedimentary record, they were able to guess the correct age within 100 million to 400 million years.

C They did not realize that much of the sedimentary record is missing and thus assumed that Earth is much younger than it actually is.

D They did not correctly calculate the rates of sedimentation and thus concluded that Earth is much older than it actually is.

question 5

Why is "gravitational contraction" mentioned in the passage?

A To show that questions about the Sun’ s energy source were as interesting to early scientists as questions about Earth’ s age

B To provide evidence that Hutton’ s ideas led to advances in physics and astronomy as well as in geology

C To explain why there is such a tremendous amount of energy flowing from the Sun

D To cite a method for estimating the age of the Sun that was used to determine Earth’ s age question 6

According to paragraph 4, Immanuel Kant recognized that the Sun's energy

A could not be sustained through chemical reactions over the long term

B came from compression resulting from the force of gravity

C was largely the result of chemical reactions that took place over a period of more than a millennium

D was necessary to fuel most of the chemical reactions on Earth

question 7

According to paragraph 6, which of the following is NOT true about scientists' most recent estimate of Earth's age?

A It is based on information taken from the examination of meteorites.

B It is surprisingly consistent with estimates from the nineteenth century.

C It is confirmed by solar evolution models.

D It puts the age of Earth at about 4.5 billion years.

question 8

Which of the following can be inferred from paragraph 6 about the formation of the solar system?

A The Sun was already billions of years old when the planets were formed.

B The planets closest to the Sun formed first.

C Meteorites entered the solar system sometime after the planets were formed.

D All parts of the solar system formed at approximately the same time.

question 9

Look at the four squares [ ] that indicate where the following sentence could be added to the passage.

One of the first recorded observers to surmise a long age for Earth was the Greek historian Herodotus, who lived from approximately 480 B.C.to 425 B.C. [] He observed that the Nile River Delta was in fact a series of sediment deposits built up in successive floods. [] By noting that individual floods deposit only thin layers of sediment, he was able to conclude that the Nile Delta had taken many thousands of years to build up. [] More important than the amount of time Herodotus computed, which turns out to be trivial compared with the age of Earth, was the notion that one could estimate ages of geologic features by determining rates of the processes responsible for such features, and then assuming the rates to be roughly constant over time. [] Similar applications of this concept were to be used again and again in later centuries to estimate the ages of rock formations and, in particular, of layers of sediment that had compacted and cemented to form sedimentary rocks. It was not until the seventeenth century that attempts were made again to understand clues to Earth's history through the rock record. Nicolaus Steno (1638–1686) was the first to work out principles of the progressive depositing of sediment in Tuscany. However, James Hutton (1726–1797), known as the founder of modern geology, was the first to have the important insight that geologic processes are cyclic in nature. Forces associated with subterranean heat cause land to be uplifted into plateaus and mountain ranges. The effects of wind and water then break down the masses of uplifted rock, producing sediment that is transported by water downward to ultimately form layers in lakes, seashores, or even oceans. Over time, the layers become sedimentary rock. These rocks are then uplifted sometime in the future to form new mountain ranges, which exhibit the sedimentary layers (and the remains of life within those layers) of the earlier episodes of erosion and deposition. Hutton's concept represented a remarkable insight because it unified many individual phenomena and observations into a conceptual picture of Earth's history. With the further assumption that these geologic processes were generally no more or less vigorous than they are today, Hutton's examination of sedimentary layers led him to realize that Earth's history must be enormous, that geologic time is an abyss and human history a speck by comparison. After Hutton, geologists tried to determine rates of sedimentation so as to estimate the age of Earth from the total length of the sedimentary, or stratigraphic, record. Typical numbers produced at the turn of the twentieth century were 100 million to 400 million years. These underestimated the actual age by factors of 10 to 50 because much of the sedimentary record is missing in various locations and because there is a long rock sequence that is older than half a billion years that is far less well defined in terms of fossils and less well preserved. Various other techniques to estimate Earth's age fell short, and particularly noteworthy in this regard were flawed determinations of the Sun's age. It had been recognized by the German philosopher Immanuel Kant (1724–1804) that chemical reactions could not supply the tremendous amount of energy flowing from the Sun for more than about a millennium. Two physicists during the nineteenth century both came up with ages for the Sun based on the Sun's energy coming from gravitational contraction. Under the force of gravity, the compression resulting from a collapse of the object must release energy. Ages for Earth were derived that were in the tens of millions of years, much less than the geologic estimates of the time. It was the discovery of radioactivity at the end of the nineteenth century that opened the door to determining both the Sun's energy source and the age of Earth. From the initial work came a suite of discoveries leading to radioisotopic dating, which quickly led to the realization that Earth must be billions of years old, and to the discovery of nuclear fusion as an energy source capable of sustaining the Sun's luminosity for that amount of time. By the 1960s, both analysis of meteorites and refinements of solar evolution models converged on an age for the solar system, and hence for Earth, of 4.5 billion years.

question 10

Directions: An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. This question is worth 2 points.

A. Herodotus attempted to calculate Earth’ s age by observing sediment deposits, but modern principles for estimating Earth’ s age from geologic processes arose from the work of Steno and Hutton.

B. Hutton described the effects of wind and water on masses of uplifted rock and was the first to

suggest that much of the sedimentary record was missing due to erosion.

C. Gaps in the sedimentary record began to be recognized by Kant and were later made clear by physicists studying the Sun’ s sources of energy.

D. Early estimates of Earth’ s age based on the rates of geologic processes were inaccurate, and

calculations based on estimates of the Sun’ s age and energy source were also extremely low.

E. Radioisotopic dating, made possible by the discovery of radioactivity, and the discovery of nuclear fusion cleared up questions about both Earth’ s age and the Sun’ s energy source.

F. In the 1960s scientists moved from analysis of meteorites to refinements of solar evolution models and determined the age of the solar system to be at least a billion years.