tpo_19_passage_1

In the middle of the nineteenth century, Louis Agassiz, one of the first scientists to study glaciers, immigrated to the United States from Switzerland and became a professor at Harvard University, where he continued his studies in geology and other sciences. For his research, Agassiz visited many places in the northern parts of Europe and North America, from the mountains of Scandinavia and New England to the rolling hills of the American Midwest. In all these diverse regions, Agassiz saw signs of glacial erosion and sedimentation. In flat plains country, he saw moraines (accumulations of earth and loose rock that form at the edges of glaciers) that reminded him of the terminal moraines found at the end of valley glaciers in the Alps. The heterogeneous material of the drift (sand, clay, and rocks deposited there) convinced him of its glacial origin. The areas covered by this material were so vast that the ice that deposited it must have been a continental glacier larger than Greenland or Antarctica. Eventually, Agassiz and others convinced geologists and the general public that a great continental glaciation had extended the polar ice caps far into regions that now enjoy temperate climates. For the first time, people began to talk about ice ages. It was also apparent that the glaciation occurred in the relatively recent past because the drift was soft, like freshly deposited sediment. We now know the age of the glaciation accurately from radiometric dating of the carbon-14 in logs buried in the drift. The drift of the last glaciation was deposited during one of the most recent epochs of geologic time, the Pleistocene, which lasted from 2.6 million to 11,700 years ago. Along the east coast of the United States, the southernmost advance of this ice is recorded by the enormous sand and drift deposits of the terminal moraines that form Long Island and Cape Cod. It soon became clear that there were multiple glacial ages during the Pleistocene, with warmer interglacial intervals between them. As geologists mapped glacial deposits in the late nineteenth century, they became aware that there were several layers of drift, the lower ones corresponding to earlier ice ages. Between the older layers of glacial material were well-developed soils containing fossils of warm-climate plants. These soils were evidence that the glaciers retreated as the climate warmed. By the early part of the twentieth century, scientists believed that four distinct glaciations had affected North America and Europe during the Pleistocene epoch. This idea was modified in the late twentieth century, when geologists and oceanographers examining oceanic sediment found fossil evidence of warming and cooling of the oceans. Ocean sediments presented a much more complete geologic record of the Pleistocene than continental glacial deposits did. The fossils buried in Pleistocene and earlier ocean sediments were of foraminifera-small, single-celled marine organisms that secrete shells of calcium carbonate, or calcite. These shells differ in their proportion of ordinary oxygen (oxygen-16) and the heavy oxygen isotope (oxygen-18). The ratio of oxygen-16 to oxygen-18 found in the calcite of a foraminifer's shell depends on the temperature of the water in which the organism lived. Different ratios in the shells preserved in various layers of sediment reveal the temperature changes in the oceans during the Pleistocene epoch. Isotopic analysis of shells allowed geologists to measure another glacial effect. They could trace the growth and shrinkage of continental glaciers, even in parts of the ocean where there may have been no great change in temperature-around the equator, for example. The oxygen isotope ratio of the ocean changes as a great deal of water is withdrawn from it by evaporation and is precipitated as snow to form glacial ice. During glaciations, the lighter oxygen-16 has a greater tendency to evaporate

from the ocean surface than the heavier oxygen-18 does. Thus, more of the heavy isotope is left behind in the ocean and absorbed by marine organisms. From this analysis of marine sediments, geologists have learned that there were many shorter, more regular cycles of glaciation and deglaciation than geologists had recognized from the glacial drift of the continents alone.

question 1

According to paragraph 1, what persuaded Louis Agassiz that glaciation in the past had been widespread?

A Geologic differences between mountain valleys and flat plains

B The presence of similar glacial material in many different regions

C Geologic research on mountain glaciers in the Alps

D Evidence of regional differences in the drift caused by glacial erosion

question 2

It can be inferred from paragraph 2 that Agassiz and other geologists of his time were not able to determine

A which geographic regions had been covered with ice sheets in the last ice age

B the exact dates at which drifts had been deposited during the last ice age

C the exact composition of the drifts laid during the last ice age

D how far south along the east coast of the United States the ice had advanced during the last ice age

question 3

According to paragraph 3, what did geologists conclude as a result of finding well-developed soils containing warm-climate plant fossils between layers of glacial drift?

A There had been only one warm period before the Pleistocene epoch.

B There had been multiple periods of mild weather between ice ages.

C Several glacial periods occurred after the Pleistocene epoch.

D Some earlier epochs were warmer than the Pleistocene.

question 4

According to paragraphs 3 and 4, scientists modified their theory about the exact number of glaciations because of evidence obtained from

A ocean sediments

B interglacial soils

C glacial deposits

D air samples

question 5

According to paragraph 4, scientists use foraminifera shells to learn about Pleistocene ocean conditions by

A measuring the amount of calcium carbonate present in the shells

B determining the proportion of shell in each layer of sediment

C comparing shells deposited during the Pleistocene with those buried earlier

D calculating the relative quantity of two oxygen isotopes in the calcite

question 6

It can be inferred from paragraph 5 that foraminifera fossil shells containing calcite with high percentages of oxygen-16 were deposited at times when

A polar ice extended as far as equatorial regions of land and sea

B extensive glaciation was not occurring

C there were no great increases in ocean temperature

D there was heavy snowfall on continental glaciers

question 7

In paragraph 5, why does the author include the information that the " oxygen isotope ratio of the ocean changes as a great deal of water is withdrawn from it by evaporation and is precipitated as snow to form glacial ice" ?

A To explain how scientists were able to calculate how frequently the continental ice sheets expanded and contracted

B To explain how scientists have determined that there was no great change in ocean temperatures at the equator during past glaciations

C To provide evidence that oxygen-16 has a greater tendency to evaporate than does oxygen-18

D To suggest that equatorial marine organisms absorb more heavy isotopes than do marine organisms elsewhere

question 8

According to the passage, when did scientists begin to realize that more than one ice age had occurred?

A In the mid nineteenth century

B In the late nineteenth century

C In the early twentieth century

D In the late twentieth century

question 9

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

In the middle of the nineteenth century, Louis Agassiz, one of the first scientists to study glaciers, immigrated to the United States from Switzerland and became a professor at Harvard University, where he continued his studies in geology and other sciences. For his research, Agassiz visited many places in the northern parts of Europe and North America, from the mountains of Scandinavia and New

England to the rolling hills of the American Midwest. [] In all these diverse regions, Agassiz saw signs of glacial erosion and sedimentation. [] In flat plains country, he saw moraines (accumulations of earth and loose rock that form at the edges of glaciers) that reminded him of the terminal moraines found at the end of valley glaciers in the Alps. [] The heterogeneous material of the drift (sand, clay, and rocks deposited there) convinced him of its glacial origin. [] The areas covered by this material were so vast that the ice that deposited it must have been a continental glacier larger than Greenland or Antarctica. Eventually, Agassiz and others convinced geologists and the general public that a great continental glaciation had extended the polar ice caps far into regions that now enjoy temperate climates. For the first time, people began to talk about ice ages. It was also apparent that the glaciation occurred in the relatively recent past because the drift was soft, like freshly deposited sediment. We now know the age of the glaciation accurately from radiometric dating of the carbon-14 in logs buried in the drift. The drift of the last glaciation was deposited during one of the most recent epochs of geologic time, the Pleistocene, which lasted from 2.6 million to 11,700 years ago. Along the east coast of the United States, the southernmost advance of this ice is recorded by the enormous sand and drift deposits of the terminal moraines that form Long Island and Cape Cod. It soon became clear that there were multiple glacial ages during the Pleistocene, with warmer interglacial intervals between them. As geologists mapped glacial deposits in the late nineteenth century, they became aware that there were several layers of drift, the lower ones corresponding to earlier ice ages. Between the older layers of glacial material were well-developed soils containing fossils of warm-climate plants. These soils were evidence that the glaciers retreated as the climate warmed. By the early part of the twentieth century, scientists believed that four distinct glaciations had affected North America and Europe during the Pleistocene epoch. This idea was modified in the late twentieth century, when geologists and oceanographers examining oceanic sediment found fossil evidence of warming and cooling of the oceans. Ocean sediments presented a much more complete geologic record of the Pleistocene than continental glacial deposits did. The fossils buried in Pleistocene and earlier ocean sediments were of foraminifera-small, single-celled marine organisms that secrete shells of calcium carbonate, or calcite. These shells differ in their proportion of ordinary oxygen (oxygen-16) and the heavy oxygen isotope (oxygen-18). The ratio of oxygen-16 to oxygen-18 found in the calcite of a foraminifer's shell depends on the temperature of the water in which the organism lived. Different ratios in the shells preserved in various layers of sediment reveal the temperature changes in the oceans during the Pleistocene epoch. Isotopic analysis of shells allowed geologists to measure another glacial effect. They could trace the growth and shrinkage of continental glaciers, even in parts of the ocean where there may have been no great change in temperature-around the equator, for example. The oxygen isotope ratio of the ocean changes as a great deal of water is withdrawn from it by evaporation and is precipitated as snow to form glacial ice. During glaciations, the lighter oxygen-16 has a greater tendency to evaporate from the ocean surface than the heavier oxygen-18 does. Thus, more of the heavy isotope is left behind in the ocean and absorbed by marine organisms. From this analysis of marine sediments, geologists have learned that there were many shorter, more regular cycles of glaciation and deglaciation than geologists had recognized from the glacial drift of the continents alone.

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. Evidence of a pattern of glacier-like deposits eventually convinced most geologists that an enormous continental glacier had extended into the temperate zone.

B. Nineteenth-century geologists came to accept the idea that the areas covered by polar ice had reached as far as the equator, a far larger area than Agassiz had thought.

C. Glacial research showed that many layers of ice were deposited, with each new period of glaciation extending farther south than the one before.

D. Nineteenth-century geologists studying the layers of drift concluded that during the Pleistocene epoch, several glaciations had occurred with warm periods between them.

E. Isotopic analysis of marine sediments showed that periods of glaciation and deglaciation were more frequent, shorter, and more cyclic than previously thought.

F. Research involving foraminifera fossil shells shows that ocean temperatures in the Northern

Hemisphere varied greatly during the most extensive periods of glaciation.