**Questions 42-52 are based on the following passage and supplementary material.**

This passage is adapted from Carolyn Gramling, "Source of Mysterious Medieval Eruption Identified." ©2013 by American Association for the Advancement of Science.

About 750 years ago, a powerful volcano erupted somewhere on Earth, kicking off a centuries-long cold snap known as the Little Ice Age. Identifying the volcano responsible has been tricky.

That a powerful volcano erupted somewhere in the world, sometime in the Middle Ages, is written in polar ice cores in the form of layers of sulfate deposits and tiny shards of volcanic glass. These cores suggest that the amount of sulfur the mystery volcano sent into the stratosphere put it firmly among the ranks of the strongest climate-perturbing eruptions of the current geological epoch, the Holocene, a period that stretches from 10,000 years ago to the present. A haze of stratospheric sulfur cools the climate by reflecting solar energy back into space.

In 2012, a team of scientists led by geochemist Gifford Miller strengthened the link between the mystery eruption and the onset of the Little Ice Age by using radiocarbon dating of dead plant material from beneath the ice caps on Baffin Island and Iceland, as well as ice and sediment core data, to determine that the cold summers and ice growth began abruptly between 1275 and 1300 C.E. (and became intensified between 1430 and 1455 C.E.). Such a sudden onset pointed to a huge volcanic eruption injecting sulfur into the stratosphere and starting the cooling. Subsequent, unusually large and frequent eruptions of other volcanoes, as well as sea-ice/ocean feedbacks persisting long after the aerosols have been removed from the atmosphere, may have prolonged the cooling through the 1700s.

Volcanologist Franck Lavigne and colleagues now think they've identified the volcano in question: Indonesia's Samalas. One line of evidence, they note, is historical records. According to Babad Lombok, records of the island written on palm leaves in Old Javanese, Samalas erupted catastrophically before the end of the 13th century, devastating surrounding villages—including Lombok's capital at the time, Pamatan—with ash and fast-moving sweeps of hot rock and gas called pyroclastic flows.

The researchers then began to reconstruct the formation of the large, 800-meter-deep caldera [a basin-shaped volcanic crater] that now sits atop the volcano. They examined 130 outcrops on the flanks of the volcano, exposing sequences of pumice—ash hardened into rock—and other pyroclastic material. The volume of ash deposited, and the estimated height of the eruption plume (43 kilometers above sea level) put the eruption's magnitude at a minimum of 7 on the volcanic explosivity index (which has a scale of 1 to 8)—making it one of the largest known in the Holocene.

The team also performed radiocarbon analyses on carbonized tree trunks and branches buried within the pyroclastic deposits to confirm the date of the eruption; it could not, they concluded, have happened before 1257 C.E., and certainly happened in the 13th century.

It's not a total surprise that an Indonesian volcano might be the source of the eruption, Miller says. "An equatorial eruption is more consistent with the apparent climate impacts." And, he adds, with sulfate appearing in both polar ice caps—Arctic and Antarctic—there is "a strong consensus" that this also supports an equatorial source.

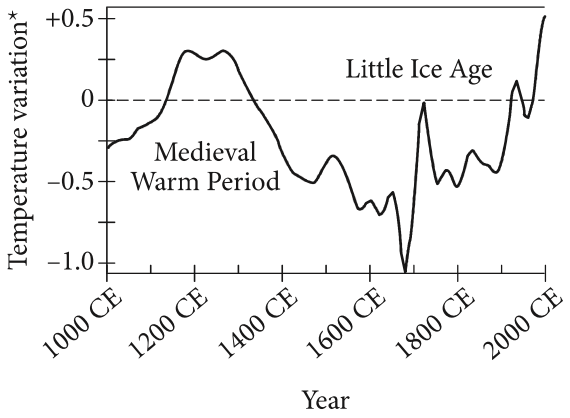
Another possible candidate—both in terms of timing and geographical location—is Ecuador's Quilotoa, estimated to have last erupted between 1147 and 1320 C.E. But when Lavigne's team examined shards of volcanic glass from this volcano, they found that they didn't match the chemical composition of the glass found in polar ice cores, whereas the Samalas glass is a much closer match. That, they suggest, further strengthens the case that Samalas was responsible for the medieval "year without summer" in 1258 C.E.





CONTINUE

Estimated Temperature in Central England
1000 CE to 2000 CE




*Variation from the 1961-1990 average temperature, in °C, represented at 0.

Adapted from John P. Rafferty, "Little Ice Age." Originally published in 2011. ©2014 by Encyclopedia Britannica, Inc.

**42**

The main purpose of the passage is to

A) describe periods in Earth's recent geologic history.

B) explain the methods scientists use in radiocarbon analysis.

C) describe evidence linking the volcano Samalas to the Little Ice Age.

D) explain how volcanic glass forms during volcanic eruptions.

**43**

Over the course of the passage, the focus shifts from

A) a criticism of a scientific model to a new theory.

B) a description of a recorded event to its likely cause.

C) the use of ice core samples to a new method of measuring sulfates.

D) the use of radiocarbon dating to an examination of volcanic glass.

**44**

Which choice provides the best evidence for the answer to the previous question?

A) Lines 17-25 ("In 2012 . . . 1455 C.E.")

B) Lines 43-46 ("The researchers . . . atop the volcano")

C) Lines 46-48 ("They examined . . . material")

D) Lines 55-60 ("The team . . . 13th century")

**45**

The author uses the phrase "is written in" (line 6) most likely to

A) demonstrate the concept of the hands-on nature of the work done by scientists.

B) highlight the fact that scientists often write about their discoveries.

C) underscore the sense of importance that scientists have regarding their work.

D) reinforce the idea that the evidence is there and can be interpreted by scientists.

**46**

Where does the author indicate the medieval volcanic eruption most probably was located?

A) Near the equator, in Indonesia

B) In the Arctic region

C) In the Antarctic region

D) Near the equator, in Ecuador

**47**

Which choice provides the best evidence for the answer to the previous question?

A) Lines 1-3 ("About 750 . . . Ice Age")

B) Lines 26-28 ("Such a . . . the cooling")

C) Lines 49-54 ("The volume . . . the Holocene")

D) Lines 61-64 ("It's not . . . climate impacts")





CONTINUE

48

As used in line 68, the phrase "Another possible candidate" implies that

A) powerful volcanic eruptions occur frequently.

B) the effects of volcanic eruptions can last for centuries.

C) scientists know of other volcanoes that erupted during the Middle Ages.

D) other volcanoes have calderas that are very large.

49

Which choice best supports the claim that Quilotoa was not responsible for the Little Ice Age?

A) Lines 3-4 ("Identifying . . . tricky")

B) Lines 26-28 ("Such a . . . cooling")

C) Lines 43-46 ("The researchers . . . atop the volcano")

D) Lines 71-75 ("But . . . closer match")

50

According to the data in the figure, the greatest below-average temperature variation occurred around what year?

A) 1200 CE

B) 1375 CE

C) 1675 CE

D) 1750 CE

51

The passage and the figure are in agreement that the onset of the Little Ice Age began

A) around 1150 CE.

B) just before 1300 CE.

C) just before 1500 CE.

D) around 1650 CE.

52

What statement is best supported by the data presented in the figure?

A) The greatest cooling during the Little Ice Age occurred hundreds of years after the temperature peaks of the Medieval Warm Period.

B) The sharp decline in temperature supports the hypothesis of an equatorial volcanic eruption in the Middle Ages.

C) Pyroclastic flows from volcanic eruptions continued for hundreds of years after the eruptions had ended.

D) Radiocarbon analysis is the best tool scientists have to determine the temperature variations after volcanic eruptions.

# STOP

**If you finish before time is called, you may check your work on this section only. Do not turn to any other section.**