Earth's Missing Pages

Build an early Earth history from evidence that survived.

ES.ESS1.6 "Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of changes in Earth's formation and early history."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline one observation about each source, meteorites, Earth materials, and the Moon; number the dated observations from oldest to youngest, and circle one statement about what the evidence cannot show.

Clues to Earth's Earliest History

1. Imagine trying to reconstruct a fire after the ashes have been swept away. Earth's earliest rocks are similarly hard to find because heat, pressure, erosion, and moving plates have changed or destroyed much of the original crust. Scientists therefore study surviving fragments and materials from elsewhere in the solar system. Some primitive meteorites contain minerals that formed about 4.56 billion years ago. Their radiometric ages record when those minerals solidified, near the start of the solar system. This date helps set the time frame for Earth's formation, but it is not a direct measurement of Earth's birth.

2. Some 4.4-billion-year-old zircon crystals from Western Australia have oxygen isotope ratios consistent with their source rocks having interacted with liquid water. These tough crystals survived even though the older rocks around them did not. In the same region, sedimentary rocks about 3.5 billion years old contain layers deposited in water. Zircons offer a clue about conditions early in Earth's history, while the younger sediments provide more direct evidence that water existed at their time of deposition. Neither observation alone tells scientists the exact date when Earth's first oceans formed.

3. The Moon's ancient highlands have many impact craters. Earth has far fewer visible craters of similar age, but its active crust and erosion can erase impact scars. Because the Moon and Earth occupy the same region of the solar system, lunar craters help scientists investigate impacts that may also have affected early Earth. A crater count cannot establish exactly how many impacts struck Earth or prove that every lunar impact had an Earth counterpart. Taken together, the meteorite ages, ancient terrestrial minerals and sediments, and lunar surface record allow a history with gaps rather than a complete diary.

2 ANSWER WITH EVIDENCE

Use the passage

1. What does the meteorite date suggest about the time frame of Earth's formation, and why is it not Earth's exact age?

2. How do the zircons and sedimentary rocks support an account of early water? Explain why they do not give the date of the first ocean.

3. Why might the Moon's craters reveal something about early Earth even though Earth has fewer visible old craters? Give one limit of this comparison.

4. Use evidence from meteorites, Earth materials, and the Moon to write a brief account of Earth's formation and early history. Identify one gap in that account.

3 YOUR TURN

Your own words

Imagine scientists discover a 4.2-billion-year-old sedimentary rock on Earth that was deposited in water. In four sentences, revise the account of early water using this new rock and two different pieces of evidence from the passage, then state one thing the evidence still cannot prove.

ANSWER KEY

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HIGH SCHOOL · ES.ESS1.6

PART 1 · READ AND MARK

Underline one observation about each source, meteorites, Earth materials, and the Moon; number the dated observations from oldest to youngest, and circle one statement about what the evidence cannot show. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What does the meteorite date suggest about the time frame of Earth's formation, and why is it not Earth's exact age?	**The 4.56-billion-year date places Earth's formation near the early solar system. It dates minerals in meteorites, not Earth itself.**
2	How do the zircons and sedimentary rocks support an account of early water? Explain why they do not give the date of the first ocean.	**The 4.4-billion-year-old zircons suggest that their source rocks interacted with liquid water. The 3.5-billion-year-old sediments were deposited in water. Neither finding identifies when the first ocean formed.**
3	Why might the Moon's craters reveal something about early Earth even though Earth has fewer visible old craters? Give one limit of this comparison.	**Earth and the Moon share a region of the solar system, and Earth can lose crater evidence through crustal activity and erosion. Lunar craters cannot show the exact number of impacts on Earth.**
4	Use evidence from meteorites, Earth materials, and the Moon to write a brief account of Earth's formation and early history. Identify one gap in that account.	**Meteorite minerals date to near the solar system's beginning, setting a time frame for Earth's formation. Ancient zircons and sediments indicate water on early Earth, while lunar craters suggest impacts may also have affected it. The evidence does not establish the exact date of Earth's first oceans or the number of impacts Earth experienced.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The new rock would provide direct evidence that water existed on Earth 4.2 billion years ago. The older, 4.4-billion-year-old zircons also suggest that liquid water interacted with their source rocks. The 3.5-billion-year-old sediments show that water was present much later, too. None of these findings proves exactly when Earth's first ocean formed.

Accept accounts that distinguish a dated observation from an inference about Earth. For Your Turn, students should recognize that the hypothetical rock strengthens evidence for water by 4.2 billion years ago without establishing the first ocean's date.