Clues to First Earth

Use solar system evidence to reconstruct Earth's earliest history.

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

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each observation or measurement that counts as evidence. Number each sentence that uses evidence to infer when or how early Earth changed.

Evidence From a Lost World

1. Scientists cannot collect a rock from Earth's first surface, because plate tectonics, erosion, and melting have recycled most early crust. Instead, they build an account from clues that survived. Some meteorites contain calcium-aluminum-rich inclusions dated by radiometric methods to about 4.567 billion years old. These objects formed at the beginning of the solar system, so their ages set a time frame for Earth's formation. Earth's oldest known minerals, zircon crystals from Australia, are about 4.4 billion years old. Their chemistry shows that solid crust and liquid water may have existed surprisingly early.

2. Earth and its neighboring planets formed from material orbiting the young Sun. Gravity pulled dust and rock together into larger bodies. Repeated collisions helped build early Earth and released heat. Dense iron sank toward the center, while lighter rock remained nearer the outside, creating layers. Because Earth was active, meteorites are especially valuable: many are fragments of small bodies that did not melt completely or undergo Earth-like recycling. Their radiometric ages provide a common clock for the early solar system. They support the conclusion that Earth formed about 4.6 billion years ago, soon after the oldest dated solar-system materials.

3. Other planetary surfaces preserve a record that Earth largely lost. The Moon has no atmosphere or active plate tectonics to erase most impact craters. Its heavily cratered highlands are generally older than smoother volcanic plains, because older surfaces have usually been exposed longer. Radiometric dates from returned Moon rocks connect crater patterns to numerical ages. Scientists then compare crater densities on the Moon, Mars, and Mercury to infer periods of intense early impacts. This comparison does not give an exact date for every Earth event, but it supports an early history in which Earth also experienced frequent large impacts, including the collision that likely helped form the Moon.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why are meteorites useful evidence for dating Earth's formation, even though they did not come from Earth?

2. What does each source reveal: ancient zircon crystals and dated meteorite inclusions?

3. How do dated Moon rocks and the Moon's craters work together as evidence about early Earth?

4. Construct a claim about early Earth's history using two different kinds of evidence from the passage.

3 YOUR TURN

Your own words

Use this evidence set to write exactly four sentences that reconstruct part of Earth's early history: chondrites have radiometric ages of 4.56 billion years, a zircon is 4.3 billion years old, and lunar highlands are older and more heavily cratered than lunar plains. Use all three pieces of evidence, and explain at least one inference rather than only listing facts.

ANSWER KEY

Clues to First Earth

PART 1 · READ AND MARK

Underline each observation or measurement that counts as evidence. Number each sentence that uses evidence to infer when or how early Earth changed. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why are meteorites useful evidence for dating Earth's formation, even though they did not come from Earth?	**Many meteorites preserve early solar-system material without Earth-like melting or recycling. Their radiometric ages provide a time frame showing that Earth formed about 4.6 billion years ago.**
2	What does each source reveal: ancient zircon crystals and dated meteorite inclusions?	**Zircon crystals indicate that solid crust and possibly liquid water existed on Earth by about 4.4 billion years ago. Meteorite inclusions provide an age for the beginning of the solar system and a time frame for Earth's formation.**
3	How do dated Moon rocks and the Moon's craters work together as evidence about early Earth?	**Dates from Moon rocks connect crater patterns to numerical ages. The heavily cratered, older lunar surfaces support the inference that early Earth also experienced many large impacts.**
4	Construct a claim about early Earth's history using two different kinds of evidence from the passage.	**Earth formed about 4.6 billion years ago and changed quickly afterward. Dated meteorites set the formation time frame, and 4.4-billion-year-old zircons show that solid crust and possibly liquid water existed early.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Radiometric ages of 4.56-billion-year-old chondrites indicate that solid material formed very early in the solar system. Because Earth formed with the other planets, this evidence supports an Earth age of about 4.6 billion years. A 4.3-billion-year-old zircon shows that some solid Earth crust existed by then. The older, more heavily cratered lunar highlands suggest that early Earth also received many impacts, although Earth's surface record has been recycled.

Accept scientifically supported claims that connect evidence to an inference about Earth's formation, early crust, or early impacts. Students should distinguish direct observations, such as ages or crater density, from conclusions drawn from those observations.