

Two Geologists, Two Clocks: Hutton's Slow Time and Bretz's Fast Flood

Learning target: I can explain, with evidence from a passage, how scientists learned to read both slow and sudden change in landscapes, and what uniformitarianism does and does not claim.

Reading with evidence

About 40 min

Individual

MS-ESS2-2 · practice

reading

writing

Name _____

Date _____

Period _____

Directions

Read the passage once straight through. Then read it again with a pencil, numbering the paragraphs 1 to 6 and underlining each date, each name and each number. Answer the questions in complete sentences. When a question asks for evidence, quote or closely paraphrase the words from the passage and give the paragraph number.

You will need: This worksheet, Pencil, Scrap paper for the two columns, Calculator (optional)

Two Geologists, Two Clocks

[1] Earth's surface keeps two kinds of time. One is so slow that nothing seems to happen in a human lifetime. The other is so fast that a landscape can change before lunch. Scientists took a long while to accept that both clocks are real. That story involves two stubborn geologists, a rocky point in Scotland and a dry, scarred plateau in Washington.

[2] In 1788 James Hutton, a Scottish farmer and doctor, rowed along the coast near Edinburgh with two friends, John Playfair and James Hall. At Siccar Point they found gray rock layers standing almost on end, like books on a shelf, with nearly flat layers of red sandstone resting on their broken edges. Hutton reasoned from what he could watch happening on any beach. Sand and mud settle in flat layers, so the gray layers had once been flat. They had hardened into rock, been tipped upright, been worn down to a flat surface, and then been buried under new sand that also hardened into rock. Each step, he argued, had to be done by processes he could see at work today: rivers carrying sand, waves wearing at cliffs, layers slowly turning to stone. Those processes are slow. Playfair later wrote that looking at the point made him feel dizzy, as if he were staring into a bottomless well of time.

[3] Hutton's idea was later named uniformitarianism: the processes we observe today also shaped the past. In 1830 Charles Lyell began publishing *Principles of Geology*, which spread the idea across the world; a young Charles Darwin took the first volume aboard the *Beagle* in 1831. The principle gave geologists a powerful tool. If you measure how fast a river deepens its channel today, you can estimate how long it took to cut a canyon. But the idea also hardened into a habit. For the next hundred years many geologists treated anything sudden or enormous with suspicion, because sudden and enormous sounded like the old stories of worldwide floods that Hutton had replaced.

[4] That habit ran straight into J Harlen Bretz. In the 1920s Bretz spent his summers mapping a strange region of eastern Washington he called the Channeled Scablands. It was crossed by huge dry canyons, some with dry waterfalls hundreds of feet high, and dotted with gravel hills far too large for any river that flows there now. In 1923 he published his conclusion: the whole landscape had been carved by a gigantic flood in a matter of days. Other geologists rejected the idea. A flood that size seemed to break the rule that landscapes are built slowly, and Bretz could not say where so much water had come from.

[5] The answer lay in Montana. During the last ice age a lobe of the northern ice sheet dammed a river valley and backed up a lake, now called glacial Lake Missoula, holding roughly 2,000 cubic kilometers of water. When the ice dam failed, the lake emptied within about two days, and the water tore across Washington toward the Pacific. In 1940 geologist Joseph Pardee described ripples on the old lake floor that were up to about 10 meters high, a thousand times taller than the finger-high ripples a creek leaves in sand. Later air photographs showed the same giant ripples on the Scablands. The floods had happened not once but dozens of times, as the ice dam re-formed and broke again. In 1979, when Bretz was in his nineties, the Geological Society of America gave him its highest award.

[6] Hutton and Bretz were not really enemies. Both read a landscape by asking what process could produce what they saw, and both trusted processes that can be observed today. Ripples in a creek and ripples 10 meters tall are made the same way by moving water; one is simply larger and faster. What Bretz added to Hutton is now part of the modern principle: the same processes and the same natural laws have always been at work, but their rates can vary, and a sudden event is as real as a slow one. A hoodoo's pillar thins for thousands of years, and its cap falls in a second. Both clocks are telling the truth.

Questions: cite the passage

1. According to paragraph 2, what sequence of events did Hutton infer had happened to the gray rock layers at Siccar Point? List the steps in order.

2. Paragraph 2 says Hutton reasoned 'from what he could watch happening on any beach.' Explain why that way of reasoning led him to conclude that Siccar Point recorded an enormous amount of time.

3. Paragraph 3 describes uniformitarianism as 'a powerful tool' and also as 'a habit.' Using the paragraph, explain the difference between the tool and the habit.

4. Give two reasons from paragraph 4 that other geologists rejected Bretz's flood. Quote or closely paraphrase the passage for at least one of them.

5. Paragraph 5 says the lake held roughly 2,000 cubic kilometers of water and emptied in about two days. Calculate the average volume of water that left the lake per hour. Show your work.

6. What two pieces of evidence in paragraph 5 finally supported Bretz? For each, say what it showed.

7. Paragraph 6 says Hutton and Bretz 'were not really enemies.' Using evidence from at least two different paragraphs, explain what the two scientists had in common and what Bretz added to Hutton's idea.

8. The last paragraph ends with a hoodoo. Using the modern version of uniformitarianism described in paragraph 6, explain how a scientist today would use **both clocks** to explain the hoodoo's pillar and its fallen cap, and what evidence from the present they would rely on.

Two columns before you write

On scrap paper make two columns headed 'Hutton (slow)' and 'Bretz (fast).' As you reread, write every date, place, number and piece of evidence in the matching column. Questions 1-2 use the Hutton column, 4-6 use the Bretz column, and 7-8 ask you to compare the two. For q5, remember that two days is 48 hours, and write the division as volume divided by hours.

Grand Canyon or Scablands?

The Grand Canyon is often described as the work of a river over millions of years; the Scablands were carved in days. Write a short paragraph explaining what evidence you would look for in a canyon to decide which clock carved it. Consider the shape of the channel, the size of the rocks the water moved, whether layers of flood deposits repeat, and whether the river flowing there today could do the work. Then explain why both answers are consistent with uniformitarianism.