

Fossils Across a Line, and 4.54 Billion Years on a Meter Stick

Learning target: I can graph fossil counts across a boundary, calculate how much life changed and how fast it recovered, and convert Earth's history to a scale model to show how the eons really compare.

Data and graphing

About 45 min

Individual

MS-ESS1-4 · practice

MS-LS4-1 · practice

data analysis

independent practice

Name

Date

Period

Directions

Part A uses a teaching dataset: the numbers were invented to show a realistic pattern and were not collected at a real cliff. Part B uses real reference values for the eons and eras. Plot with a ruler, label every number with its unit, and show every calculation on the lines provided. Round answers to one decimal place unless told otherwise.

You will need: This worksheet, Pencil, Ruler, Calculator

Part A: How many kinds of fossils in each layer?

A survey team sampled ten layers in a cliff, counted how many different kinds of shelled sea animals appeared as fossils in each layer, and estimated each layer's age from dated ash bands above and below. Layer 1 is the lowest (oldest). A thin dark line separates layer 5 from layer 6.

Kinds of fossils in ten sampled layers (teaching dataset)

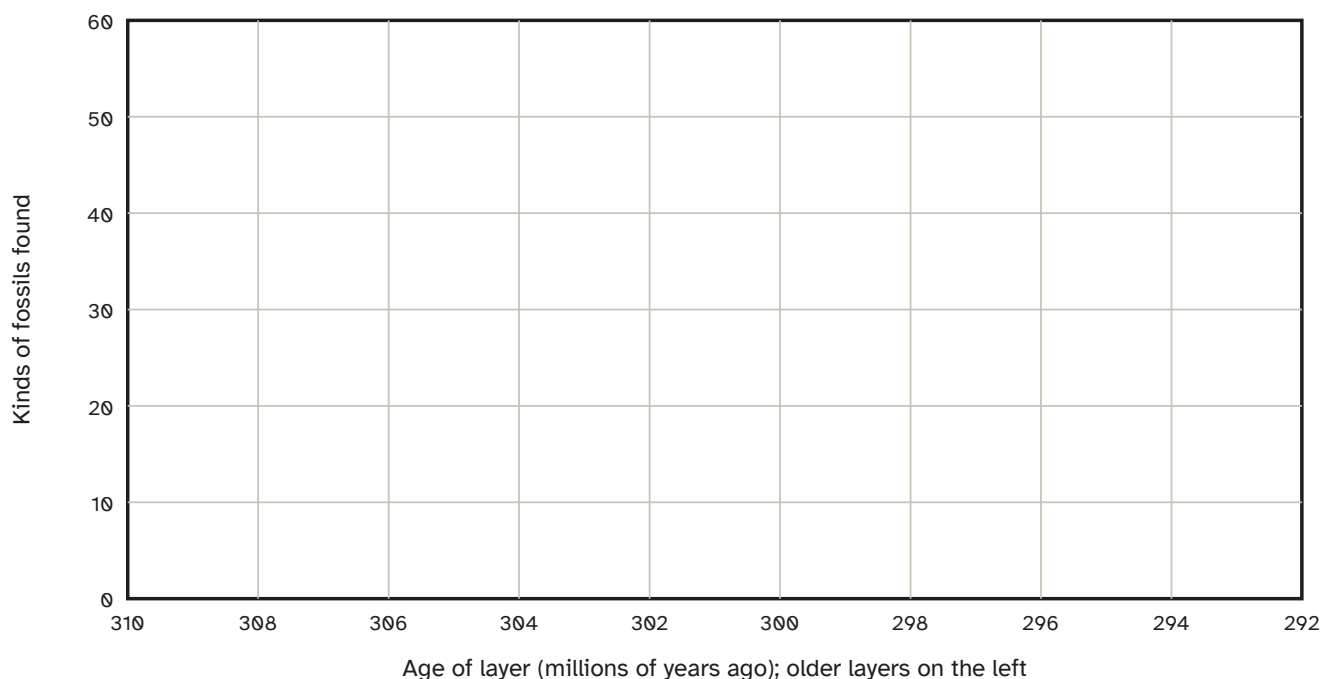
Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Layer (1 = bottom)	Estimated age (millions of years ago)	Kinds of fossils found	Rock type
1	310	48	limestone
2	308	50	limestone
3	306	49	shale
4	304	51	shale
5	302	50	limestone
6	300	14	shale (just above the dark line)
7	298	16	shale

Layer (1 = bottom)	Estimated age (millions of years ago)	Kinds of fossils found	Rock type
8	296	19	limestone
9	294	23	limestone
10	292	27	sandstone

Simulated data for teaching. The ages are estimates bracketed by dated ash bands; the pattern is modeled on real extinction-and-recovery records.

Kinds of fossils versus age of layer



1. Calculate the percentage drop in kinds of fossils from layer 5 to layer 6. Formula: $(\text{before} - \text{after}) \div \text{before} \times 100$. Show your work.

2. Describe the shape of your graph in three parts: before the dark line, at the dark line, and after it. Use numbers from the data.

3. Calculate the average rate of recovery from layer 6 to layer 10, in kinds of fossils gained per million years. Show your work.

4. If recovery continued at the rate from q3, how many million years after layer 10 would it take to reach 50 kinds again, and what would that layer's age be? Show your work.

5. A geologist wants to divide this cliff's history into two chapters. Where should the boundary go, and why? Use the word *evidence* and at least one number.

6. The drop happens between two layers that touch. Describe two different histories that could produce the same drop (one in which the organisms really disappeared quickly, and one in which something is wrong with the record), and say what evidence would tell the two apart.

Part B: Earth's history on a one-meter strip

The table gives current reference values for the four eons and the three eras of the most recent eon. Imagine a paper strip exactly 1.00 meter (100 cm) long that represents all 4,540 million years, with Earth's formation at the left end and today at the right end.

Eons and eras (real reference values, rounded to the nearest million years)

Unit	Began (millions of years ago)	Ended (millions of years ago)	Length (millions of years)
Hadean Eon	4540	4000	540
Archean Eon	4000	2500	1500
Proterozoic Eon	2500	539	1961
Phanerozoic Eon	539	0	539
Paleozoic Era (in the Phanerozoic)	539	252	287
Mesozoic Era (in the Phanerozoic)	252	66	186
Cenozoic Era (in the Phanerozoic)	66	0	66

7. Find the scale of the strip: how many centimeters represent 100 million years? Show your work. (Hint: 100 cm stands for 4,540 million years.)

8. Complete the table using your scale from q7. The four lengths should add up to 100 cm (allow rounding).

Length in million years	Length on the strip (cm)
Hadean	
Archean	
Proterozoic	
Phanerozoic	
Check: total	

9. Calculate the percentage of Earth's history that belongs to the Phanerozoic Eon, to the nearest whole percent. The textbook says 'about 10 percent.' Is that a fair rounding? Explain.

10. Modern humans have existed for about 300,000 years (0.3 million years). How long is that on the strip, in millimeters? Show your work and compare the result to the width of a pencil line (about 0.5 mm).

11. On most classroom charts the Phanerozoic Eon takes up about three-quarters of the space. Using your numbers from q8 and q9, explain what the strip shows that the chart hides, and give one good reason the chart is drawn the way it is anyway.

Percent and rate, one step at a time

Percent change: subtract to find the change, divide the change by the starting number, multiply by 100.
Example with made-up numbers: 40 to 10 is a change of 30; $30 \div 40 = 0.75$; $0.75 \times 100 = 75$ percent.
Rate: divide the change in fossils by the change in time; the unit is 'kinds per million years.' Scale: if 100 cm stands for 4,540 million years, then 1 million years is $100 \div 4,540$ cm, which you can multiply by any number of million years.

Zooming in on the last centimeter

Design a second strip that shows only the Cenozoic Era (the last 66 million years) stretched to a full meter. Calculate the new scale in centimeters per million years, then place three events on it with calculations: the first primates at about 55 million years ago, the growth of a permanent Antarctic ice sheet at about 34 million years ago, and the start of the current ice-age cycles at about 2.6 million years ago. Finally, calculate how long 300,000 years is on this second strip and explain why scientists use nested time scales (a strip inside a strip) instead of one strip for everything.