

Three Sites, One History: When Did the Sea Creatures Vanish?

Investigation question: Three outcrops a few kilometers apart each show only part of the region's rock record. Can you stitch them into one sequence, find the levels where whole groups of fossils disappear, and explain how that sequence organizes the region's history?

Evidence-based mystery

Groups of 4

2 sessions

Setup 5 · Activity 75 · Cleanup 5 min

MS-ESS1-4 · assesses

MS-ESS2-2 · supports

Name _____

Group _____

Date _____

Your role today

- ☐ **Site reader:** Reads each site log aloud, layer by layer from the top, and makes sure every layer's rock type, thickness, fossils and notes are heard before any matching begins.
- ☐ **Matcher:** Proposes which layers at different sites are the same, states the evidence for each match, and records the match in the matching table.
- ☐ **Column drafter:** Draws the composite column to scale on graph paper (1 cm = 2 m of rock, with the two thin beds drawn as lines), labels every layer and marks the fossil disappearances.
- ☐ **Skeptic and reporter:** Challenges each match ('could that be a different gray limestone?'), checks the final order against all three logs, and presents the column to the class.

Safety

- Paper, glue and colored pencils only; no chemicals or heat. Keep glue sticks capped between uses.
- If scissors are used to cut strips in class, cut away from fingers and pass them handle first.
- No physical hazards beyond ordinary classroom materials; the fictional sites are described, not visited.

Procedure

1. Open envelope A. Use the 'position at this site' column to put Site A's strips in order, top (youngest) to bottom (oldest). Repeat for Sites B and C. Each site is a separate stack of its own; do not mix sites yet.
2. Read each stack aloud. For every layer, note the rock type, thickness, fossils and any note about dating or a chemical fingerprint. Write in the first recording-sheet box which site shows the youngest rock and which shows the oldest, with your reason.
3. Find layers that appear at two sites. For each proposed match, write the evidence in the matching table: rock type, fossils, thickness and any fingerprint or date. A match needs at least two lines of evidence; rock type alone is not enough.
4. Slide the three stacks sideways so that matched layers sit level with one another. Check: does every layer above a match stay above it at both sites, and every layer below stay below? If not, the match is wrong.

- Once the stacks line up, read off the complete order from the oldest layer at the bottom of Site C to the youngest at the top of Site A. Write the nine layers in order on the recording sheet.
- Draw the composite column on graph paper at 1 cm = 2 m of rock, oldest at the bottom. Draw the two beds thinner than 10 cm as single lines and label them. Color each layer by rock type and sketch a symbol for each fossil type in the layers where it occurs.
- Mark with an arrow every level above which a fossil type never appears again. Decide which of these levels are large enough to call a mass extinction (several types vanish together) and label them.
- Write the two laboratory dates beside their layers. Then write an age range (older than, younger than, or between) beside every other layer, using only those two dates and the date of the basement rock.
- Session 2: write your explanation (q9 on the analysis sheet) of how the composite sequence organizes the region's history. Mark each sentence E (something the logs record) or X (something you concluded). Present the column to another group and have their skeptic challenge one match.

Record your observations

Lab 2 recording sheet: Three sites, one history

The three sites below are fictional and simplified for this investigation, but the method is the one geologists use. Thickness is given in meters (m) or centimeters (cm). 'Lab date' means an age measured in years from the layer's own minerals; Ma means million years ago.

Site logs (print on card stock and cut into one strip per layer)

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

Site	Position at this site (1 = top)	Rock type and color	Thickness	Fossils	Notes
A: Dry Wash cliff	1	yellow mudstone	5 m	mammal teeth, broad leaves	top of cliff
A: Dry Wash cliff	2	gray clay with tiny glassy beads	1 cm	none	lab date 66 Ma
A: Dry Wash cliff	3	gray mudstone	8 m	dinosaur bones, conifer wood	
A: Dry Wash cliff	4	red sandstone with cross-bedding	10 m	reptile footprints	base of cliff; lower layers buried
B: Highway road cut	1	gray mudstone	8 m	dinosaur bones, conifer wood	top of road cut
B: Highway road cut	2	red sandstone with cross-bedding	10 m	reptile footprints	
B: Highway road cut	3	white volcanic ash	2 cm	none	chemical fingerprint Z-7; lab date 252 Ma

Site	Position at this site (1 = top)	Rock type and color	Thickness	Fossils	Notes
B: Highway road cut	4	brown sandy limestone	3 m	crinoids, brachiopods, trilobites	
B: Highway road cut	5	gray limestone	6 m	crinoids, brachiopods, trilobites	base of road cut; lower layers buried
C: Quarry	1	white volcanic ash	2 cm	none	chemical fingerprint Z-7; top of quarry wall
C: Quarry	2	brown sandy limestone	3 m	crinoids, brachiopods, trilobites	
C: Quarry	3	gray limestone	6 m	crinoids, brachiopods, trilobites	
C: Quarry	4	black shale	4 m	trilobites, brachiopods	rests on a worn, uneven granite surface
C: Quarry	5	speckled granite	more than 20 m	none	lab date 1,100 Ma; quarry floor

Matching table: layers that are the same at two sites

Layer at first site (site and position)	Same layer at second site (site and position)	Evidence 1	Evidence 2	Confidence (high / medium / low)

The composite sequence, with age ranges

Order (1 = oldest)	Layer (rock type)	Fossils	Age in years: measured, or range from the dated layers	Fossil types that never appear above this layer
1				
2				
3				
4				
5				
6				
7				
8				
9				

 Draw the composite column to scale (1 cm = 2 m), oldest layer at the bottom. Draw the two thin beds as labeled lines. Color by rock type, add a symbol for each fossil type, write the two lab dates and the granite date beside their layers, and mark every mass-extinction level with an arrow and a label.

1. Which site exposes the youngest rock and which exposes the oldest? Give the evidence from the logs.
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2. Which match did your group make first, and why was it the easiest one to trust?

Analysis questions

3. Site B has a 'gray limestone' and Site A has a 'gray mudstone'. Why would matching those two be a mistake? What rule for matching does this show?

4. At what level do the trilobites and crinoids disappear for good, and at what level do the dinosaur bones? For each, say which dated layer sits closest and what that tells you about when the disappearance happened.

5. Give the age range of the red sandstone and explain how you got it. Could the sandstone be 100 million years old? 300 million? 10 million?

6. The red sandstone is 10 m thick and the volcanic ash is 2 cm thick. Which took longer to form, and how do you know? What does this say about using thickness to measure time?

- 7.** The black shale rests on a worn, uneven surface of 1,100-million-year-old granite. Does the composite column record every year from 1,100 Ma to today? Explain what the worn surface tells you.

- 8.** A classmate says, 'Site B and Site C both have an ash bed, so of course they are the same layer.' What evidence makes the ash match stronger than 'both are ash'? What would weaken it?

- 9.** Write a scientific explanation (one paragraph) of how your composite sequence organizes this region's history, from oldest to youngest. Use evidence from the order of layers, the matched key bed, the fossil disappearances and the dated layers. Label each sentence E (observed in the logs) or X (your conclusion).

- 10.** How is this activity like what geologists did to build the geologic time scale, and how is it different? Give one likeness and two differences.
