

Case File: Pinecrest Valley. Which Processes Shaped It, and How Fast?

Investigation question: Using only twelve pieces of field evidence, which geoscience processes shaped Pinecrest Valley, at what space and time scales did each one work, and in what order did they happen?

Evidence-based mystery

Groups of 4

1 session

Setup 5 · Activity 42 · Cleanup 3 min

MS-ESS2-2 · assesses

MS-ESS2-1 · supports

Name _____

Group _____

Date _____

Your role today

- ☐ **Lead investigator:** Reads each card aloud, keeps the group arguing from the card's words, and makes sure every claim in the final explanation names a card number.
- ☐ **Scale keeper:** Places each card number in one cell of the space-time grid and defends the placement with the card's numbers.
- ☐ **Timeline builder:** Arranges the events from oldest to youngest on the order table and writes the reason for each position.
- ☐ **Rate checker and reporter:** Does every calculation on the calculation table (rates, ages, how long), checks units, and leads the writing of the final explanation, which every member signs.

Safety

- No hazards beyond ordinary classroom materials; no chemicals, heat or sharp tools are used.
- Keep walkways clear if groups spread out on the floor to arrange cards.

Procedure

1. Read the case file introduction on the recording sheet. Shuffle the twelve cards and deal them around the group. Each person reads their cards aloud, one at a time, and the group paraphrases what each card actually says before anyone names a process.
2. First pass (process table): for each card, agree on the process (weathering, erosion, deposition, uplift, or 'other' with a name) and the agent (water, ice, wind, gravity, living things, chemical reaction, forces inside Earth). Write both in the table. Some cards show two processes; write both.
3. Second pass (space-time grid): for each card, decide how much space the change covers (millimeters to meters; tens to hundreds of meters; kilometers; regional or larger) and how long the change took (seconds to minutes; hours to days; years to decades; thousands of years; millions of years). Use sticky notes on the group grid first, argue, then copy card numbers into the grid on your own sheet. Color each number: one color for slow processes, the other for sudden events.

4. Third pass (calculation table): use the numbers on cards 5, 7, 9 and 10 to compute a rate or an age.
Show every calculation with units. Decide what each number tells you about the time scale of that card.
5. Fourth pass (order table): arrange all the events from oldest to youngest. Some cards describe something still going on; mark those 'ongoing' and place them by when they started. For each position write one sentence of reasoning that names the card.
6. Draw the group's cross-section of the valley on the large sheet: the U-shaped floor, the tilted layers with the ash bed, the cave, the fan, the fault line, the hoodoo, the fresh scar. Label each feature with its card number.
7. Write the explanation individually: how Pinecrest Valley got its shape and features. Name at least three slow processes and two sudden events, give each a space scale and a time scale, cite card numbers for every claim, and state which sudden events had slow causes you can point to in the cards.
8. Compare your explanation with one other group's. Record one place where you disagree and what evidence would settle it.

Record your observations

Lab 2 recording sheet: Case file, Pinecrest Valley

About this case — Pinecrest Valley is invented for this investigation. Every feature and number on the cards is a teaching example designed to resemble real field evidence. Do not look anything up; the only evidence is the cards.

You are a survey team sent to a valley about 45 km long with a flat floor, steep walls and a stream. You have twelve observations. Your job is to explain, with evidence, how the valley got its shape and its features, which changes were slow and which were sudden, and in what order they happened.

Evidence cards (teacher prints and cuts apart; 12 cards)

Card 1

CARD 1. The valley has a flat, wide floor and steep walls; seen from the end, its shape is a U, not a V. The bare bedrock on the lower walls carries long, straight, parallel scratches, all pointing down-valley. The scratches are polished smooth in places.

Card 2

CARD 2. Boulders of pink granite, some as big as a car, sit scattered on the valley floor. The bedrock of the valley is gray. The nearest pink granite outcrop is 40 km up-valley, at the head of the valley.

Card 3

CARD 3. On the south wall there is a pale, fresh-looking scar about 30 m across and 20 m tall, surrounded by darker, lichen-covered rock. Below it lies a pile of sharp-edged blocks with no soil, moss or plants on them. A hiker's photograph taken three years ago shows the same wall with no scar.

Card 4

CARD 4. The north wall is made of layered rock: bands of sandstone alternating with softer gray mudstone. The layers are tilted about 20 degrees. The surfaces of some sandstone layers show ripple marks like those on a sandy stream bed today. Some layers hold the shells of sea creatures.

Card 5

CARD 5. Near the valley mouth a cave opens in a limestone layer. Formations hang from the ceiling; the longest is 40 cm. A dated sample from one formation shows it has grown at about 0.1 mm per year. The cave walls are dissolved into smooth, rounded shapes, and water drips from the ceiling.

Card 6

CARD 6. Where a side canyon meets the valley, a fan-shaped apron of gravel and sand spreads about 600 m across the floor. The fan is covered by a layer of cracked, dried mud 3 cm thick. In the mud the team found a plastic bottle cap and flattened grass still partly green.

Card 7

CARD 7. The stream crossing the valley bends sharply where it meets a straight line of crushed rock that runs across the valley. The stream channel on one side of the line is offset 12 m from the channel on the other side. Old maps from 300 years ago show a smaller offset.

Card 8

CARD 8. Beside the north wall stands a pillar of soft gray rock 8 m tall with a slab of hard sandstone on top like a cap. Twenty meters away a second slab of the same sandstone lies on the ground, with crumbled gray rock scattered around it and the stump of a pillar beside it.

Card 9

CARD 9. Two GPS stations, one on each side of the line of crushed rock in Card 7, show that the east side is moving north at about 2 cm per year compared with the west side. The motion is steady from year to year.

Card 10

CARD 10. On a gentle grassy hillside above the valley, a line of wooden fence posts is tilted downhill. The post tops have moved about 40 cm downhill from their bases. A survey made 20 years ago recorded the fence as straight and upright. There is no sign of a slide or a scar.

Card 11

CARD 11. Inside the layered rock of the north wall, between two sandstone layers, lies a bed of fine volcanic ash 2 m thick. Dating shows the ash is about 760,000 years old. The nearest volcano is 300 km away.

Card 12

CARD 12. Along the cliff top above the fresh scar (Card 3), cracks in the granite run parallel to the cliff face. Winter photographs show the cracks filled with ice. Each spring the team finds new chips and small slabs of granite at the cliff base.

Process table: what each card shows

Card	Process (weathering, erosion, deposition, uplift, other)	Agent (water, ice, wind, gravity, living things, chemical, forces inside Earth)	Slow process or sudden event?	One phrase from the card that proves it
1				
2				
3				
4				
5				
6				

Card	Process (weathering, erosion, deposition, uplift, other)	Agent (water, ice, wind, gravity, living things, chemical, forces inside Earth)	Slow process or sudden event?	One phrase from the card that proves it
7				
8				
9				
10				
11				
12				

Space-time grid: write each card number in one cell (a card with two events may appear twice)

How long it took	Millimeters to meters	Tens to hundreds of meters	Kilometers	Regional or larger
Seconds to minutes				
Hours to days				
Years to decades				
Thousands of years				
Millions of years				

Calculation table: rates and ages from the cards

Card	What you are finding	Numbers from the card	Calculation with units	Result	What it tells you about the time scale
5	Age of the 40 cm formation				
7 and 9	Years of motion stored in the 12 m offset				
10	Rate of soil movement				
9	Distance the east side moves in 1,000 years				

Order table: oldest to youngest (write 'ongoing' where a process is still happening)

Position	Event (card number)	Why it goes here (what evidence puts it before or after its neighbors)
1 (oldest)		
2		
3		
4		

Position	Event (card number)	Why it goes here (what evidence puts it before or after its neighbors)
5		
6		
7		
8		
9		
10 (youngest)		

-  Draw a cross-section of Pinecrest Valley as seen from its mouth: the U-shaped floor and steep walls, the tilted layers with the ash bed on the north side, the cave, the gravel fan, the fault line, the hoodoo and the fresh scar. Label each feature with its card number and mark each as slow (S) or sudden (X).



1. Which card was hardest to place on the grid, and what made it hard?

2. Name one sudden event in the cards and the slow process in the cards that led up to it.

Analysis questions

3. Card 5: show the calculation for how long the 40 cm formation took to grow at 0.1 mm per year. What does the result say about the time scale of the cave?

4. Cards 7 and 9: if the ground moves 2 cm per year on average, how many years of motion are stored in the 12 m offset? Then explain how the stream can be offset in sharp jumps (Card 7's old maps) even though the GPS motion is steady.

5. Cards 1 and 2 together: what carved the valley, and what is the evidence? Explain how boulders of pink granite ended up 40 km from the nearest pink granite.

6. Card 4 and Card 11: these layers started as sand and mud with ripple marks and sea shells and now stand tilted on a valley wall far from any sea. List, in order, the processes that must have happened, and say roughly how long the whole sequence took using the ash date.

7. Card 6 shows one feature built by a slow process and one built by a sudden event. Identify both, give each a time scale, and say what evidence tells you the mud layer is recent.

8. Write your explanation of how Pinecrest Valley got its shape and features. Name at least three slow processes and two sudden events, give each a space scale and a time scale, cite the card number for every claim, and identify a slow cause for at least one sudden event.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

9. Uniformitarianism says today's processes explain the past. Pick one card where you used a process you can watch today to explain something ancient, and one thing about the past that the cards cannot tell you.
