

Tinker Creek Canyon Jigsaw: Twelve Clues, One Timeline

Learning target: I can combine evidence held by different experts to reconstruct the order of events at a canyon, name the rule or method that fixes each event's place, and defend the timeline to another group.

Collaborative investigation

About 50 min

Jigsaw

MS-ESS1-4 · practice

MS-ESS2-2 · practice

collaboration

discussion

visual modeling

Name _____

Date _____

Period _____

Directions

Work in home groups of four. Step 1, expert round (10 minutes): each member takes one expert set of three cards (Set A: cards 1-3, the stack; Set B: cards 4-6, cutting features and the ash; Set C: cards 7-9, fossils and environments; Set D: cards 10-12, limits and the youngest layers). Read your three cards, then meet with the students from other groups who hold the same set and agree on what each card proves. Step 2, home group (20 minutes): return, teach your cards to your group, and build the timeline table together. Step 3, defend (10 minutes): swap timelines with a neighboring group and challenge one placement. Step 4, individual (10 minutes): complete Part C alone.

You will need: Twelve cards per home group, cut from the card sheet, Group record table, Sticky notes, Pencils

The site

Tinker Creek Canyon (an invented place) is a 40-meter-deep canyon cut by a small creek. Its walls expose six layers, labeled A at the bottom through F at the rim, plus a dike (K) and a fault (Z). Each card below holds one observation made at the site or in a lab. No single card tells the whole story; the group's job is to put twelve clues together.

Twelve evidence cards (teaching data; cut apart before class)

1 Card 1: The stack

From the creek upward the wall shows: A, dark shale, 4 m; B, gray limestone, 3 m; C, red sandstone, 2 m; D, white volcanic ash, 0.3 m; E, gray mudstone, 2 m; F, loose brown gravel, 1 m, at the rim.

2 Card 2: Tilt and a flat surface

Layers A and B lean 30 degrees to the east. Layers C, D, E and F are nearly flat. The surface between B and C is flat, and the bottom 10 cm of C is packed with rounded pebbles of B's gray limestone.

3 Card 3: Both walls

The north wall and the south wall of the canyon show the same six layers in the same order and thicknesses. Every layer ends abruptly at the canyon wall, as if sliced.

4 Card 4: Dike K

A 1-meter-wide band of dark, fine-grained igneous rock rises from below A straight up through A, B, C, D and E. Its edges are baked. Its top is covered by layer F, which it does not enter.

5 Card 5: Fault Z

A nearly vertical break. West of it, layers A through E sit 3 m higher than east of it. Dike K is also offset by 3 m where the fault crosses it. Layer F runs across the fault unbroken.

6 Card 6: Ash D in the lab

Zircon crystals from ash layer D formed when the ash erupted. The lab measured their uranium and lead and reports an age of 93 million years, give or take 2 million.

7 Card 7: Fossils in A and B

Layer A holds shelled sea animal species S1 and never S2. Layer B holds species S2 and never S1. Both species lived in the sea.

8 Card 8: A quarry 300 km away

In a quarry 300 km north, a sandy layer with S1 lies beneath a sandy layer with S2. The rocks look nothing like A and B, but the fossil order is the same.

9 Card 9: Environments

Layer C has sloping internal stripes like those in desert sand dunes. Layer E holds leaf fossils and freshwater fish bones. So by the time C formed, this place was dry land, not sea floor.

10 Card 10: The lab says no

A sample of sandstone C sent for absolute dating came back untested with a note: 'The grains in this sandstone are pieces of older rocks. Their clocks started long before the sand was laid down, so a date on them would not be the layer's age.'

11 Card 11: Layer F

Layer F is loose gravel, not yet cemented into rock. It holds a bone from a land mammal. It rests on an uneven surface that cuts across the tops of E and dike K.

12 Card 12: Regional note

A mountain range 50 km east has layers tilted the same direction as A and B. Geologists there have shown the mountains rose when two plates collided, after B formed and before C formed.

Part A: Expert round (one set per person)

1. My expert set: _____ (A, B, C or D). For each of your three cards, write one sentence that says what the card proves and which rule or method it uses (superposition, original horizontality, lateral continuity, cross-cutting, fossil succession, absolute dating, or 'limit of the evidence'). 3 pts

Part B: Home group task

- 1. Each expert teaches their three cards to the group in under two minutes each. Listeners may ask questions but not read the cards themselves.
- 2. Lay the cards on the desk. Start with the stack (cards 1 and 2): put the deposition of each layer in order, oldest first.
- 3. Insert each cutting or bending event (tilt, flat surface, dike, fault, canyon) just after the youngest thing it affects and just before the oldest thing it does not affect.
- 4. Attach the one age in years (card 6) to its event, and decide which other events it puts limits on.
- 5. Fill in the group record table. Every event needs at least one card number as evidence and one rule or method.
- 6. Swap tables with a neighboring group. Challenge one placement with a card number; answer their challenge with a card number. Record the exchange in q3.

Group record: Tinker Creek timeline (fill in; 1 = first event)

Order	Event	Evidence (card numbers)	Rule or method used
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

2. Group answer: Which event was the hardest to place, and which two cards finally settled it? 2 pts

3. Group answer: Write the strongest challenge the neighboring group made to your timeline and the card you used to answer it. 2 pts

Part C: Individual accountability (complete alone)

4. Dike K and fault Z both cut the stack. Which is older? Name the card and explain the rule that proves it. 2 pts

5. What can you say about the age in years of layer E and of layer C? Which cards and which rule give you those limits? 2 pts

6. Explain in your own words why the lab refused to date sandstone C (card 10), and name a layer in the canyon that the same lab could date directly. 2 pts

7. When did the creek cut the canyon, compared with every other event? Use cards 3 and 11 and the rule that supports each. Then explain what the matching walls (card 3) tell you about the layers that used to be where the canyon is now. 3 pts

8. Suppose fossil S2 turns up in a layer in another state. Using cards 7 and 8, what could you say about that layer's age, and what could you not say? 2 pts

Three questions for every card

If a card is hard to teach, answer three questions about it on a sticky note: What does it describe (a layer, a cut, a fossil, a lab result)? What does it prove is older or younger than what? Which rule or method says so? For the timeline, remember that something must exist before it can be tilted, cut, eroded or dated, and that a layer lying unbroken across a feature is younger than that feature.

A thirteenth card

Write a thirteenth evidence card that would settle something the twelve cards cannot: for example, whether the tilting of A and B happened before or after fault Z moved, or how long ago layer F was deposited. Describe the observation or lab result on your card in the same style as the others, then explain exactly which placement in the timeline it would fix and why.