

The Evidence Jury: Twelve Clues, Two Eras, One Verdict

Learning target: I can work with a team to sort evidence for moving plates by type, date and strength, decide when the evidence became strong enough to accept, and defend that decision on my own.

Collaborative investigation

About 50 min

Jigsaw

MS-ESS2-3 · assesses

collaboration

discussion

data analysis

Name _____

Date _____

Period _____

Directions

Work in home groups of four. Step 1, expert round (10 minutes): each member takes one family of three cards (Fossils: cards 1-3; Rocks: cards 4-6; Shapes and ages: cards 7-9; Seafloor: cards 10-12), reads them, and meets with the other students holding the same family to agree on what each card shows and how strong it is. Step 2, home round (20 minutes): return to your group, teach your cards, and complete the jury table and the group questions. Step 3, verdict (8 minutes): present your verdict to a neighboring group, who will challenge it. Step 4, individual (12 minutes): answer Part C alone.

You will need: Twelve evidence cards per group, cut from the card sheet, Jury table, Pencils, A projected world map or globe for reference

Twelve evidence cards (real findings; dates given)

1 Card 1: Mesosaurus (Fossils)

A reptile about 1 m long that lived in shallow coastal and inland waters about 280 million years ago. Its fossils occur in southern Brazil and Uruguay and in South Africa and Namibia, in rocks of the same age. It was not built for open ocean. Known to scientists before 1900; Wegener used it.

2 Card 2: Glossopteris (Fossils)

An extinct seed plant, a tree with tongue-shaped leaves, that lived 250 to 300 million years ago. Its leaves are found in South America, Africa, India, Australia and Antarctica. Its seeds were too large and heavy to blow across an ocean. The Antarctic leaves were collected by Scott's party in 1912 and described in 1914; Wegener used the plant's spread as evidence.

3 Card 3: Lystrosaurus (Fossils)

A pig-sized plant-eating reptile that lived on land about 250 million years ago and could not swim an ocean. Its bones are found in southern Africa, India, China and Russia, and, since a dig at Coalsack Bluff in December 1969, in Antarctica.

4 Card 4: Matching rock belts (Rocks)

Belts of old folded rock in eastern North America continue, with the same rock types, ages and order of layers, in northwest Africa and in Scotland and Norway. Placed side by side, the belts line up as one. Geologists had noticed this before 1912; Wegener used it.

5 Card 5: Ancient glacial scratches (Rocks)

Rocks about 300 million years old in South America, Africa, India, Australia and Antarctica carry the rubble and bedrock scratches left by ice sheets, although most of these places are warm today. When the lands are placed together, the scratch directions point outward from one center. Wegener used this evidence; a South African geologist strengthened it in the 1930s.

6 Card 6: Coal under Antarctic ice (Rocks)

Seams of coal, which forms only from thick layers of dead plants, occur in the Transantarctic Mountains, where no plant larger than a moss grows today. Coal was found there by a 1908 expedition and again by Scott's party in 1912. It shows that Antarctica's climate, or its position, has changed.

7 Card 7: The coastline fit (Shapes and ages)

The east coast of South America and the west coast of Africa look like two pieces of a torn page. A mapmaker noticed it in 1596; Wegener made it part of his 1912 argument. The fit is rough, because coastlines shift whenever sea level rises or falls.

8 Card 8: The continental shelf fit (Shapes and ages)

In 1965 a Cambridge team used a computer to fit the continents along the edge of the continental shelf, at a water depth of about 900 m, which is the true rim of each landmass. The shelf edges of South America and Africa fit with only small gaps and overlaps along more than 5,000 km.

9 Card 9: Young oceans, old continents (Shapes and ages)

Drilling in the 1970s and later showed that no seafloor in the open oceans is older than about 200 million years, while rocks on the continents reach about 4,000 million years. The oceans are far younger than the lands they separate, which means the ocean floor keeps being replaced.

10 Card 10: A ridge with a valley down its middle (Seafloor)

In 1952 Marie Tharp, plotting sonar depth readings by hand, found a deep valley running along the crest of the Mid-Atlantic Ridge. The 1957 map she made with Bruce Heezen showed the ridge winding down the middle of the Atlantic, halfway between the continents, following the bends of both coasts.

11 Card 11: Drill-core ages (Seafloor)

Between December 1968 and January 1969 the drill ship Glomar Challenger drilled 17 holes at 10 sites in a line across the South Atlantic ridge. The seafloor was youngest at the ridge crest and grew steadily older with distance on both sides, at about 2 cm per year on each side.

12 Card 12: Earthquake belts and trenches (Seafloor)

A worldwide network of seismographs set up in the early 1960s showed that most earthquakes fall in narrow belts: along mid-ocean ridges, and along deep trenches that ring the Pacific, where the earthquakes get deeper inland from the trench. The belts outline the edges of the plates.

Part A: Expert round (one family per person)

1. Your family: _____. For each of your three cards, write one sentence that says what the card shows about the continents or the seafloor, and give it a strength score: 3 = very hard to explain without moving plates; 2 = supports moving plates but another explanation is possible; 1 = consistent with moving plates but weak on its own.

Part B: Home group task

1. Each expert teaches their three cards in under two minutes each: what it shows, its strength score, and the reason for the score.
2. Sort all twelve cards into two piles by date: 'Available to Wegener by 1915' and 'Found after 1945'. Use the dates on the cards.
3. Fill in the jury table: for each card, its family, its pile, its agreed strength score, and the one other explanation (if any) that could account for it without moving plates.
4. Add up the strength scores in each pile. Then decide, as a group: if you had been a geologist in 1926, with only the first pile, would you have accepted that the continents move? And in 1970, with both piles?
5. Agree on the one card you would show a doubter first, and why. Every member must be able to give the verdict and defend the chosen card.

Jury table (fill in)

Card	Family	By 1915 or after 1945?	Strength (1-3)	Another explanation without moving plates?
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Card	Family	By 1915 or after 1945?	Strength (1-3)	Another explanation without moving plates?
12				

2. Group answer: Which cards went in the 'by 1915' pile and which in the 'after 1945' pile? What was the total strength score of each pile?

3. Group verdict: Would your group have accepted moving continents in 1926? In 1970? Give the main reason for each answer, and name the card you would show a doubter first.

4. Group answer: Write the strongest challenge the neighboring group made to your verdict or your first-card choice, and how you answered it.

Part C: Individual accountability (complete alone)

5. Choose one card from a family that was **not** yours. Explain in your own words what it shows and why it supports the idea that plates have moved.

6. Card 1 (Mesosaurus) and Card 11 (drill-core ages) both support moving plates. Explain why most juries give Card 11 a higher strength score. Use the phrase 'another explanation' in your answer.

7. Card 6 (coal) and Card 2 (Glossopteris in Antarctica) could each be explained by 'the whole Earth was warmer back then' instead of by moving plates. Which **other** card shows that a warmer Earth cannot be the whole explanation, and how?

8. Write a paragraph for a doubter who says, 'Scientists changed their minds about drift once, so they might change them again.' Use at least three cards from at least two families to explain why plate tectonics is now a theory, and explain what, in science, would be needed to overturn it.

The 'another explanation' test

To score a card, ask: could this pattern exist if the continents and seafloor had never moved? If you can think of a reasonable other story (a land bridge that sank, a warmer planet everywhere, a coincidence of shapes), the card is a 2. If the only story that fits is moving plates, it is a 3. If the card would look the same either way, it is a 1. Write the other story in the last column of the jury table; if the column is empty, the score should be 3.

Order the after-1945 pile

Put the six after-1945 cards in date order and write a short timeline that shows how each discovery made the next one possible: how the ridge map led to the spreading idea, how the spreading idea led to a prediction, how the drill ship tested it, and how the earthquake belts and the age limit on seafloor completed the picture. Then explain which single discovery, if it had come out the other way, would have ended the idea of seafloor spreading.