

Two Wells, One Oil Field: A Claim-Evidence-Reasoning Case

Learning target: I can construct a scientific explanation, based on rock-core evidence, for why petroleum is found at one site and not at another 200 kilometers away.

Claim, evidence, reasoning

About 45 min

Individual

MS-ESS3-1 · assesses

writing

data analysis

Name _____

Date _____

Period _____

Directions

Read the scenario and the two core logs. A core log is a record of the rock a drill passes through, from the surface down. Answer the warm-up questions first; they organize the evidence. Then write your Claim, Evidence and Reasoning. A strong response names specific rock layers and depths from the logs and explains, step by step, the past processes that made oil at one site and made it impossible at the other.

You will need: This worksheet, Pencil, Scrap paper for the step list

The scenario

An energy company drilled two exploration wells in the same state, about 200 kilometers apart. Site A is in the Harlow Basin, a region of low rolling hills. Site B is in the Kessler Highlands, a region of worn, rounded mountains. Both wells reached 3,000 meters, and the rock temperature at 2,500 meters was almost identical. Site A found oil; Site B found nothing. The company's board has asked for an explanation that a non-geologist can follow, and for a prediction about whether drilling deeper at Site B could ever succeed. The core logs below are simulated for this case, but every rock type and every clue in them is the kind geologists really use.

Core log, Site A (Harlow Basin), surface to 3,000 m (teaching data)

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

Depth (m)	Rock	What the geologist noted
0 - 300	Loose river sand and gravel	Recent; fresh groundwater
300 - 1,500	Limestone	Fossil shells of sea creatures throughout; layers tilt gently, forming a broad arch under the drill site
1,500 - 1,800	Dense gray shale	No pores a liquid could pass through; same arch shape
1,800 - 2,300	Sandstone, porous	Pores filled with oil in the upper 120 m; below that, pores filled with salty water
2,300 - 2,900	Black shale	Microscopic fossils of ocean plankton; about 5 percent of the rock's mass is organic carbon; smells faintly of oil
2,900 - 3,000	Older sandstone	Water-filled; no oil

Simulated core log written for this case; the rock types and clues are the kinds geologists really record.

Core log, Site B (Kessler Highlands), surface to 3,000 m (teaching data)

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

Depth (m)	Rock	What the geologist noted
0 - 40	Thin soil over weathered rock	Rocky, well drained
40 - 2,100	Granite	Crystallized from magma; no layers, no fossils, no pores a liquid could pass through except a few cracks
2,100 - 3,000	Gneiss (banded metamorphic rock)	Formed deep in the crust under great heat and pressure long before the granite; no fossils; organic carbon near zero

Simulated core log written for this case; the rock types and clues are the kinds geologists really record.

Measured at both sites — Rock temperature at 2,500 m: Site A, 82 °C; Site B, 80 °C. Age of the deepest rock: Site A, about 150 million years; Site B, more than 1 billion years. Rainfall today: Site A, 600 mm per year; Site B, 900 mm per year. Neither site has had a volcano or a sea in the last 100 million years.

Warm-up: organize the evidence

1. Which layer at Site A is the source rock (the rock in which the oil formed)? Give its depth and two clues from the log that identify it.

2. Which layer at Site A is the reservoir, and which is the cap rock? Explain why the oil sits in the top 120 m of the reservoir and not at its bottom.

3. The temperatures at 2,500 m are nearly the same at both sites (82 °C and 80 °C). Explain why the heat at Site B could not make oil anyway. Which requirement is missing?

4. Site B gets more rain than Site A. Is rainfall today relevant to whether oil exists at either site? Explain in one or two sentences.

Your explanation

CLAIM

Claim: State, in one or two sentences, why petroleum is found at Site A and not at Site B, and whether drilling deeper at Site B could ever find oil.

EVIDENCE

Evidence: Give at least four specific pieces of evidence from the core logs or the measured values, with depths, rock names or numbers. For each piece, say what it shows about one step in how oil forms (source, burial and heat, reservoir, cap rock and trap).

REASONING

Reasoning: Walk through the past processes in order: what the Harlow Basin was like about 150 million years ago, what happened to the remains of sea life, how burial and heat changed them, where the oil moved, and why it stopped. Then explain why that chain could never have started at Site B, using what granite and gneiss are and how they form. Finish by stating what your explanation predicts about other places made of ancient granite.

5. A third well, Site C, is drilled in the Harlow Basin 30 km from Site A. Its log shows the same black shale and the same porous sandstone, but the layers above are flat instead of arched, and the gray shale is missing. Predict what Site C found and justify your prediction with the formation steps.

Match each layer to a step

Before writing, copy this list on scrap paper and fill in the depth from Site A's log next to each step: (1) ancient sea with plankton, buried in low-oxygen mud, becomes source rock: _____ m; (2) buried deep and heated so the organic matter turns to oil: temperature _____ °C at 2,500 m; (3) oil rises into porous reservoir rock: _____ m; (4) cap rock stops it and the arch traps it: _____ m. Now do the same for Site B and write 'none' wherever a step has no matching layer. Every blank you fill for Site A and every 'none' you write for Site B is a piece of evidence.

What the board should ask next

Oil companies use the four-step chain not only to explain but to search. Write three questions the company's board should ask before drilling a fourth well anywhere in the Harlow Basin, each tied to one step of the chain, and say what evidence (a rock type, a fossil, a temperature, a shape of the layers) would answer it. Then explain, in two sentences, why no amount of money could turn the Kessler Highlands into an oil field, and what that tells you about the difference between where a resource is *wanted* and where it *is*.