

Core the Hidden Layers: Reconstruct Strata You Cannot See

Investigation question: How well can a few narrow cores reveal the order of hidden layers and the events that changed them, and what can a single core never tell you?

Physical model

Groups of 4

1 session

Setup 5 · Activity 40 · Cleanup 8 min

MS-ESS1-4 · practice

MS-ESS2-2 · supports

Scientific purpose

Students build a stack of play-dough strata from a secret recipe, including fossil markers and one disturbing event (a dike, a fault or a missing layer), then swap models and reconstruct another group's hidden stack from clear-straw cores. They apply superposition, lateral continuity, cross-cutting relationships and the index-fossil idea to real physical evidence, and they measure how much their reconstruction improves from one core to three.

Why this helps students with this chapter

Geologists rarely see a whole cliff; they drill cores and reason sideways between them. Students who have tried to work out a hidden stack from three narrow straws understand why lateral continuity matters, why a missing fossil in one core proves nothing, and why a dike shows up as an odd column that does not belong to any layer. Building the model first also makes superposition physical: the last layer pressed in is on top, every time.

Standards connections

MS-ESS1-4 (practice, reading relative ages and events from strata evidence; a Grade 8 PE in California's sequence): Students use the relative-dating rules on physical evidence they gather themselves and explain the order of layers and events in another group's model. This builds the strata-reading half of the PE; it does not yet organize events on the geologic time scale.

MS-ESS2-2 (supports, how deposition, intrusion, faulting and erosion leave readable marks): Each recipe event models a geoscience process changing a stack of layers, which supports later explanations of how processes change Earth's surface at different scales.

Roles (rotate each session)

- **Builder:** Rolls each play-dough layer to the thickness on the recipe card and presses it into the container in order; applies the event (dike, fault base or missing layer) exactly as the card says.
- **Marker:** Places the pasta fossil markers in the layers named on the recipe, counts them in, and seals the container with the foil lid; keeps the recipe card hidden in the envelope.
- **Driller:** During the coring phase, pushes each straw straight down at the marked position, twists a quarter turn, lifts it out and holds it against the ruler for reading.

- **Logger:** Reads each core from the top down with the Driller, records colors, thicknesses and markers in the core log, and leads the group's reconstruction.

Materials

Item	Quantity	Per	Note
Play-dough in six colors (red, yellow, blue, green, white, black)	about 80 g of each color	group	Store-bought tubs or homemade salt dough; black is for the dike only and can be shared between groups.
Opaque plastic food container, about 10 to 12 cm across and at least 5 cm deep	1	group	A paper cup trimmed to 6 cm tall also works for a round model.
Aluminum foil square for the lid, with five coring positions A to E marked in a line across the middle	1	group	
Clear wide straws (boba or smoothie straws, about 12 mm diameter)	5	group	Clear straws let students read the core inside without pushing it out.
Plastic knife and a small rolling tool (marker barrel or dowel)	1 each	group	
Ruler marked in millimeters	1	group	
Small pasta shapes: tiny shells and tiny stars	about 1 tablespoon of each	group	Shells are the long-lived marker, stars the short-lived index marker. Rice and lentils work as substitutes.
Recipe card and envelope	1	group	Three different recipes rotate around the class; see prep.
Recording sheet and colored pencils	1 set	student	
Zip bags for sorting dough by color at cleanup	6	class	

Estimated cost: 20 to 45 per class, reusable (an estimate; Store-bought play-dough in six colors for eight groups runs about \$30; homemade salt dough costs under \$8. Clear boba straws are about \$6 per 100, pasta about \$2, and food containers can come from home.)

Safety

- Play-dough and pasta are not food: store-bought dough contains wheat and a lot of salt, and homemade dough is very salty. Nothing goes in mouths. Students with wheat allergy should wear gloves or use a gluten-free dough; use rice or lentils instead of pasta if needed.
- Cut straw ends can be sharp; cut them square and push with the palm, not a fingertip.
- Plastic knives only. Keep dough off the floor; stepped-on dough is a slip hazard on hard floors.
- Wash hands after handling dough and before leaving the room.

Teacher preparation and setup

1. Write three recipe cards. All three use the same five layers, bottom to top: red 10 mm (no markers), yellow 8 mm (shells), blue 10 mm (shells and stars), green 8 mm (shells), white 6 mm (no markers). Recipe 1 adds a dike: after stacking, push a 5-mm-wide black snake diagonally from the top surface to the bottom. Recipe 2 adds a fault: build the left half of the container on a 5 mm base of gray-mixed scrap dough so every layer on the left sits 5 mm higher than on the right, with a straight vertical boundary between the halves. Recipe 3 leaves out the blue layer on the left half only, so yellow meets green directly there. Print each recipe on a card with a labeled sketch.
2. Mark five coring positions on each foil lid before class: A at the left edge, C in the center, E at the right edge, B and D between, all in one line across the container. Positions A and E must fall on opposite halves for Recipes 2 and 3.
3. Plan the swap so that each group cores a model built from a different recipe than the one it built. With eight groups, assign recipes 1-2-3-1-2-3-1-2 and swap group 1 with 2, 3 with 4, and so on.
4. Build one model yourself and core it to check that your straws cut cleanly through the dough; soft, fresh dough cores best. If a core sticks, students can slit the straw with scissors to read it.
5. Pre-cut straws to 8 cm so they are easy to push straight down, and have a few spares for cores that collapse.

Investigation design

Independent variable	Number of cores used for the reconstruction (one core at C, then three cores at A, C and E)
Dependent variable	Reconstruction accuracy: how many of the four scoring items (layer order, event type, event position, index-marker layer) match the builders' recipe
Controlled	Same five-layer recipe in every model, so only the event differs; Same container size, straw diameter and coring positions; Cores pushed straight down to the bottom and read against the same ruler; Builders follow the thickness on the card, checked with a ruler
Trials	One build and one coring round per group; the class pools accuracy scores after one core and after three cores on the board.
Comparison	Accuracy from a single center core versus accuracy from three cores across the model, and which events each number of cores can detect.

Student procedure

1. Build phase (12 minutes). Open your recipe envelope. The Builder rolls the bottom layer to the thickness on the card, checks it against the ruler, and presses it flat into the container. The Marker adds any pasta markers for that layer, spreading them across the whole layer. Repeat for each layer in order, bottom to top.
2. Apply the event on your card exactly as drawn: the diagonal dike, the raised left half, or the missing blue layer on the left half. Then press the foil lid on with the A to E marks running left to right across the container, write your group name on the lid, and seal the recipe card back in the envelope.

3. Swap models with your assigned partner group. Do not open the envelope you receive. Before coring, each student writes a prediction on the recording sheet: what could one core tell you, and what could it not?
4. Core 1 at position C (center). The Driller pushes a clear straw straight down until it touches the bottom, twists a quarter turn, and lifts it out. Hold the straw against the ruler. The Logger records, from the top down, each color, its thickness in millimeters and any pasta markers visible in the core.
5. Write your first reconstruction from this single core: the order the layers were deposited, oldest first, and the rule you used. Note anything odd in the core, such as a color that does not form a flat band.
6. Core 2 at position A and core 3 at position E (the two edges). Log each the same way. Lay the three straws side by side in order A, C, E and look across them: are the same layers at the same depths? Is any layer missing in one core? Does any color appear as a column rather than a band?
7. Revise your reconstruction. Decide which event happened to this model (a dike, a fault or a missing layer), say which core comparison revealed it, and write the full order of events with the rule for each step. If the group disagrees, take one more core at B or D to test the disagreement, and record it.
8. Draw the three (or four) cores to scale as side-by-side columns on the recording sheet, with depths in millimeters and markers shown.
9. Open the envelope and compare the recipe with your reconstruction. Fill in the scoring table: layer order, event identified, event placed correctly in the sequence, index-marker layer identified. Record how many of these you had right after one core and after three.
10. Cleanup: pull the lid, peel the layers apart and sort dough by color into the class zip bags; pasta-contaminated dough and cores go in the discard bag. Rinse straws for reuse or recycle them.

Expected observations

- Single cores show five flat bands in the recipe order, red at the bottom, white at the top, with shells in three bands and stars in the blue band when the core happens to catch them.
- Fault models: the same color bands appear about 5 mm deeper in core E than in core A, with core C sometimes showing a smeared boundary where it hits the vertical join.
- Dike models: one or two cores contain a black section that cuts obliquely across the bands and sits at a different depth in each core, while another core may miss the dike entirely.
- Missing-layer models: cores on one side show yellow directly under green with no blue and no stars; cores on the other side show the full sequence.
- Groups typically get the layer order right from one core and the event right only after comparing three cores; a few need a fourth core to settle a disagreement.

Likely difficulties

- Dough compresses when the straw is pushed, so thicknesses in the core read a little thinner than the recipe; have students compare ratios between cores rather than exact millimeters.
- Pasta markers are sparse, so a core often misses them; this is intended, but warn groups so they do not conclude the markers are absent.
- Builders roll uneven layers, which makes small depth differences between cores look like faults. Set a threshold: treat differences under 3 mm as building error.

- Cores sometimes stick in the straw or fall apart; slit the straw lengthwise with scissors to read a stuck core, and recore if it collapses.
- Groups that built a dike expect to find a dike and read a smeared boundary as one. Insist on the test: a dike cuts across bands and appears at different depths in different cores.

Structured debrief

1. Pool the scoring data: how many groups had the layer order right after one core (most), and how many had the event right after one core (few, unless the core hit the dike). Ask why: one core shows superposition perfectly but cannot show anything that varies sideways.
2. Have a group that cored a fault model explain how two cores showed the same layers at different depths, and what rule turned that into 'a fault happened after the white layer'. Then ask whether the cores show which side moved; they do not, only the relative offset.
3. Have a group that cored a dike model describe what the dike looked like in a core: a black section that does not line up with any flat layer, usually appearing at a different depth in each core it crosses. Connect to the rule: the dike cuts the layers, so it came after the white layer was pressed in, which the builders can confirm.
4. Have a group that cored a missing-layer model explain what they saw: yellow directly under green on one side, blue in between on the other. Discuss both possible stories (the blue sediment never reached that side, or it was eroded before green formed) and agree that the cores alone cannot decide between them.
5. Close on the stars and shells: stars were in one layer, shells in three. A star pins a core to the blue layer; a shell could be yellow, blue or green. That is the whole logic of index fossils, and the core that missed the stars shows why absence is weak evidence.

Recording sheet: what students fill in

Lab 1 recording sheet: Core the hidden layers

You are reconstructing another group's hidden stack. Read every core from the **top down**, record exactly what you see, and separate what you observed from what you infer. Write your prediction before the first core goes in.

1. Prediction before coring: what could one core at the center tell you about the hidden stack, and what could it not tell you?

Answer: One core can show the order of the layers at that spot (which is on top of which), their colors and rough thicknesses, and any markers it happens to hit. It cannot show whether the layers change sideways: a fault, a missing layer elsewhere, or a dike that the core misses, and it cannot prove a marker is absent.

Why: This prediction sets up the independent variable; the lab tests it by comparing one-core and three-core accuracy.

- Says one core gives vertical order at one spot
- Says one core cannot show sideways changes or prove absence

Core log (fill a row for each layer in each core, top layer first)

Core position	Layer number from top	Color	Thickness (mm)	Pasta markers seen (shells, stars, none)	Anything odd
C	1				
C	2				
C	3				
C	4				
C	5				
A	1				
A	2				
A	3				
A	4				
A	5				
E	1				
E	2				
E	3				
E	4				
E	5				
Extra core (B or D)					

- 2.** First reconstruction, from core C only: list the layers in the order they were deposited, oldest first, and name the rule you used.

Answer: Oldest first: red, yellow, blue, green, white (or with the blue layer missing if the center core fell on that side of a Recipe 3 model). Rule: superposition, assuming the stack was built bottom up and not flipped.

Why: The center core almost always gives the full sequence; the stated rule and assumption are what earn credit.

- Order matches the core, bottom to top
- Names superposition

-  Draw cores A, C and E (and any extra core) side by side as columns to scale, with a depth scale in millimeters down the left side. Color each layer, mark pasta markers with small symbols, and draw lines connecting the same layer across the cores. Label the event you identified.

Answer: Three columns to scale with a millimeter depth axis, colored bands, marker symbols, lines joining the same band across cores, and the event labeled: a black oblique section (dike), bands stepped down from A to E (fault), or a band present in one core and absent in another (missing layer).

Why: The correlation lines are the lateral-continuity reasoning made visible; the drawing should make the event obvious at a glance.

- Depth scale and to-scale bands
- Correlation lines between cores
- Event labeled and consistent with the logs

Scoring: your reconstruction against the builders' recipe

Item	Your answer after one core	Your answer after three cores	Builders' recipe	Correct after one core? (yes/no)	Correct after three? (yes/no)
Order of layers, oldest first					
Type of event (dike, fault, missing layer)					
Where the event goes in the order of events					
Which layer holds the star markers					

Analysis questions: answer key

3. Which layer in the model you cored was deposited first? State the rule that tells you, and state the assumption the rule depends on.

Answer: The red layer. By the law of superposition, in a stack that has not been flipped or disturbed the lowest layer was deposited first. The assumption is that the model was built from the bottom up and never turned over, which the builders can confirm.

Why: Students must name the rule and its condition; the condition matters because slide 12 shows an overturned fold breaking it.

- Red layer
- Superposition
- States the undisturbed assumption

4. Describe how comparing cores A, C and E revealed the event in your model. Name the rule (superposition, lateral continuity or cross-cutting relationships) that let you interpret the difference between cores.

Answer: Fault model: the same bands appear about 5 mm deeper in one edge core than the other; lateral continuity says those matching bands were one layer, so a break with offset must lie between the cores, and cross-cutting says the fault is younger than every band it offsets, including the top white layer. Dike model: one core holds a black section that cuts obliquely across the bands and does not line up with any flat layer; cross-cutting says the dike is younger than all the layers it crosses. Missing-layer model: one edge core shows yellow directly under green while the other shows blue between them, so lateral continuity fails for the blue layer on one side; either the blue sediment never reached that side or it was removed before green was deposited.

Why: Full credit requires the specific difference between cores, the rule that interprets it, and the placement of the event in the sequence.

- Describes the specific difference between cores
- Names the correct rule
- Places the event after the layers it affects

5. Suppose a core from a different group's model shows one star marker. Which layer must that core have passed through, and how sure can you be? Which marker, stars or shells, is the better index fossil, and why?

Answer: The core must have passed through the blue layer, because stars were placed only there. You can be quite sure, as long as the builders followed the recipe and no star fell into another layer during building. Stars are the better index fossil: they occur in one layer only, so one star pins the position. Shells occur in yellow, blue and green, so a shell only narrows the position to three layers.

Why: This is the short-lived versus long-lived species logic in physical form.

- Blue layer
- Explains why stars pin the position and shells do not

6. A core passes through the blue layer but shows no star markers. A classmate concludes that the blue layer in that model has no stars. Is that conclusion justified? What does this tell you about using the absence of a fossil as evidence?

Answer: Not justified. Markers are sparse, and a 12 mm core samples a tiny fraction of the layer, so missing a star is likely even when stars are present. Absence of a fossil in one sample is weak evidence; presence is strong evidence. More cores, or a wider sample, would be needed before concluding the markers are absent.

Why: Students should distinguish absence of evidence from evidence of absence, which matters for real fossil-based correlation.

- Says the conclusion is not justified
- Explains sampling: a narrow core can miss sparse markers
- Presence is stronger evidence than absence

7. In a fault model, the top of the blue layer is at 18 mm depth in core A and at 23 mm depth in core E. How much were the layers offset? Can you tell from these two cores which side moved up and which moved down? Explain.

Answer: Offset = 23 mm – 18 mm = 5 mm. No, the cores show only that the layers on the E side sit 5 mm lower relative to the A side. Either side could have moved, or both; the cores give relative displacement, not which block moved.

Why: A subtraction plus a clear statement of what relative offset does and does not reveal.

Also acceptable: Accept 'about 5 mm' with the subtraction shown and any correct statement that the direction of absolute movement is unknown.

8. Your group spent about the same time pressing in the 6 mm white layer as the 10 mm red layer. In real rock, does a thicker layer mean it took longer to form? Use the model and one real-world example in your answer.

Answer: No. In the model every layer took about the same time regardless of thickness, and in real rock deposition rates vary enormously: an ash fall or a flood can leave a thick layer in a day, while deep-sea mud builds a millimeter in a century. Thickness tells you nothing reliable about time.

Why: Targets the thickness-equals-time misconception using both the model and a real case.

- Says no
- Uses the model (equal time, different thickness)
- Gives a real example of varying deposition rate

9. List two ways the play-dough model is unlike real strata and one way it behaves like them. For each unlike, say what a geologist would need to consider that your model skipped.

Answer: Unlike: the layers never hardened (a geologist must consider compaction and cementation); events were applied in seconds, so the model shows nothing about time (a geologist needs radiometric dates on igneous layers); the dike was pushed in cold rather than injected as magma, and the fault was built as a step rather than produced by movement (a geologist looks for signs of heating or crushed rock along the break); the core is huge relative to the model (real cores sample a far smaller fraction). Like: each layer could only be placed on top of what was already there, so the order of layers records the order of deposition, and features that cut across the layers came after them.

Why: Any two sound 'unlike' points with the matching geologist consideration, plus one sound 'like' point, earn full credit.

- Two valid differences with what the geologist must consider
- One valid similarity about order or cutting features

Individual evidence of learning

Each student submits their own prediction (q1), core logs, first reconstruction (q2), scaled core drawing, scoring table and answers to q3 through q9. The core drawing with correlation lines and q4 are the primary evidence for the lateral-continuity and cross-cutting targets; q5 and q6 are the evidence for the index-fossil idea.

Assessment criteria

Criterion	Proficient looks like
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Core logging	All cores logged top down with colors, thicknesses and markers; drawing is to scale with a depth axis and correlation lines between cores.
Use of rules	Names superposition for the layer order, lateral continuity for matching bands between cores, and cross-cutting relationships for the dike or fault, each tied to a specific observation.
Reasoning about evidence limits	Explains what one core cannot show, why a missing marker is weak evidence, and that a fault's offset does not reveal which side moved.
Index-fossil logic	Explains that the star marker pins a core to one layer because it occurs in only one, while shells occur in three and so narrow the position less.

Accessibility adaptations

- Use high-contrast colors and thicker layers (12 mm) for students with low vision; cores can be read by touch if a partner slits the straw open.
- Let a partner push the straw while a student with limited hand strength reads and logs; the Driller and Logger roles are designed to be swapped.
- Provide a core-log template with depth lines pre-printed every 5 mm and a rule-reference strip phrased as questions (What is on top? Does it match across? What does it cut?).
- Accept a spoken explanation for q4 and q9 recorded on a device, and offer a multilingual card for core, layer, offset and marker.

Low-cost alternative

Make salt dough from flour, salt, water and food coloring (about \$8 for a class), use paper cups as containers, and use ordinary clear drinking straws with two cores per position instead of wide straws. Rice and lentils replace the pasta markers.

Model limitations

Play-dough layers are pressed in minutes and never harden, so the model shows order but nothing about the time each layer took or about compaction and cementation. The fault is built as a step rather than produced by movement, the dike is pushed in rather than injected as magma, and the missing layer is left out rather than eroded, so the model shows the result of each event, not the process. Real cores are also far narrower relative to the rock body than a 12 mm straw in a 10 cm container. This activity has not been physically tested by the authors; the 5 mm fault offset and sparse markers are estimates that may need adjusting after a trial run.

Teacher notes

Score the reconstruction tables leniently on thickness and strictly on order and event. The most common error is reading a smeared boundary in the center core as a dike; the test is whether the odd color cuts across bands and appears at different depths in different cores. Keep one set of cores from each recipe in the straws for the next class as a reference display beside the slide 15 diagram.