

Check out the path below or go online to choose one of the other paths shown.

Exploring the Ashfall Fossil Beds

- Hands-on Labs 
- Exploring Local Geology
- Propose Your Own Path

Go online to choose one of these other paths.

Although most fossils are preserved by sedimentary rock, some are preserved by igneous rock. Look at these fossils of ancient animals from the Ashfall Fossil Beds in Nebraska. The animals were killed by hot volcanic ash that covered the area during an eruption. As the ash settled into thick layers, it cooled and hardened into rock. Volcanic ash can fall from the sky or flow downhill during an eruption. Ash flows can burn everything in their path, but sometimes they will preserve animals such as these.



These rocks contain fossils of rhinos and horses that died in a volcanic ash flow.

-  young adult male rhino "Tusker"
-  rhino calf
-  large three-toed horse "Cormo"
-  rhino calves (possibly twins) "T.L." and "R.G.C."
-  adult female rhino "Sandy" with baby "Justin"

The following field notes were recorded in the area:

Date: October 9

Location: Ashfall Fossil Beds State Historical Park, Nebraska

Observations and Notes:

- The fossils in the photo were uncovered in the ash layer.
- Other fossils exist above and below the ash layer as shown in the table.
- The ash layer is as thick as three meters in some places.
- Absolute dating shows that the ash layer formed 12 million years ago.

Rocks and Fossils from the Ashfall Fossil Beds State Historical Park	
Rock Layers	Fossils Found
loose sand and gravel	zebras, lemmings, giant camels, muskrats, giant beavers
sandstone layer	barrel-bodied rhinos, giant land tortoises, camels, rodents, horses
ash layer	
sandstone layer	
sandy and silty sedimentary rock layers	alligators, fish, hornless rhinos, giant salamanders

Source: The University of Nebraska State Museum and Nebraska Game and Parks Commission, "Geologic Setting of Ashfall Fossil Beds and Vicinity," 2015

1. The ash layer is igneous rock. Absolute dating shows the ash layer is 12 million years old. What can you infer about the animals found in the ash layer?



2. Language SmArts Write a short informative report applying what you've learned to explain the history of the area.

- Use the observations and notes to explain what happened in the area over time.
- How old are the fossils in the ash layer? What was the area like before the ash flow that formed the fossil beds?
- How can absolute and relative dating help you explain how the area changed?

3. Collaborate Many articles about the Ashfall Fossil Beds are available in magazines and on the Internet. Find several articles. In a group discussion, cite specific evidence that could help you identify the article that provides the most accurate and thorough information. Discuss the evidence with the group.

Sedimentary rock layers—and the fossils in those rock layers—help us to understand Earth's history.



A. Summarize how sedimentary rock and fossils form.

Geologists use relative dating to compare the ages of different rock layers and the fossils in those layers.

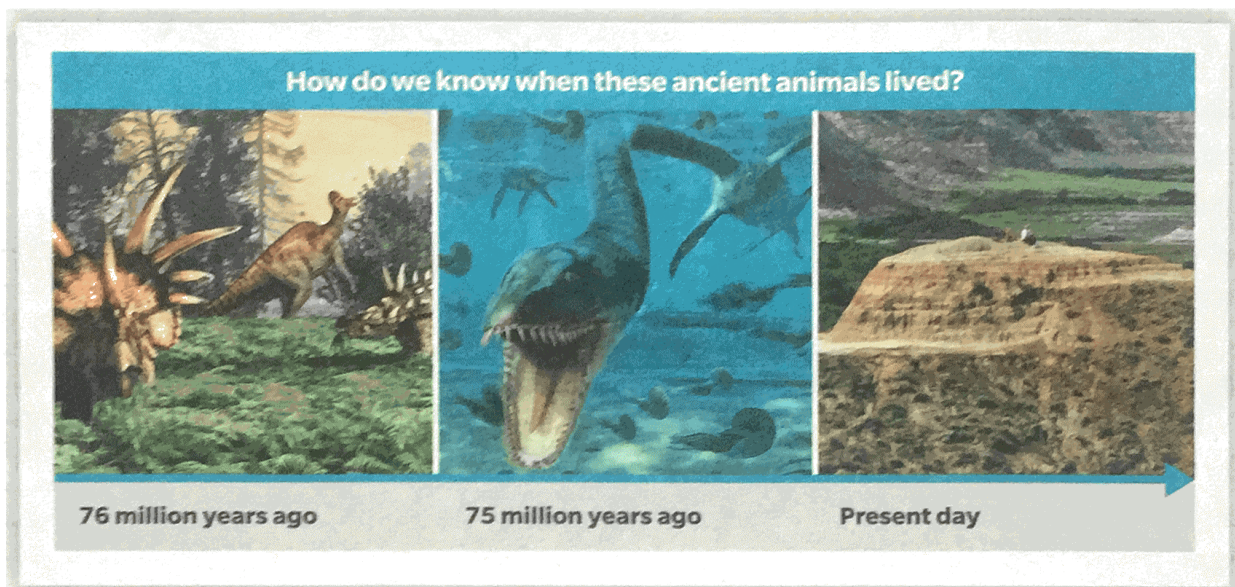


B. A student makes a sandwich with several layers of bread and cheese. Then the student cuts the sandwich and says it models how a fault cut through rock layers after the rock layers formed. Explain how the example of the sandwich relates to relative dating.

The combination of absolute and relative dating allows scientists to determine the ages of rocks and fossils. Absolute dating provides evidence that helps us estimate the age of Earth.



C. How can scientists find the absolute ages of igneous rocks?



EVIDENCE NOTEBOOK

Refer to the notes in your Evidence Notebook to help you construct an explanation for when these ancient animals lived.

1. State your claim. Make sure your claim fully explains how the ages of the animals shown above were determined.
2. Summarize the evidence you have gathered to support your claim and explain your reasoning.

Checkpoints

Answer the following questions to check your understanding of the lesson.

Use the photo to answer Questions 3 and 4.

3. Which rock layer or feature of the cliff formed most recently?
 - A. the thick black rock layer at the top
 - B. the fault running through the center
 - C. the white rock layer near the bottom
 - D. the gray rock layer at the very bottom

4. Which of the following questions could be answered from the information in the photo? Choose all that apply.
 - A. Which is the oldest rock layer?
 - B. When did the oldest rock layer form?
 - C. What are the relative ages of the rocks?
 - D. What is the absolute age of the most recent layer?
 - E. What year did the fault form?



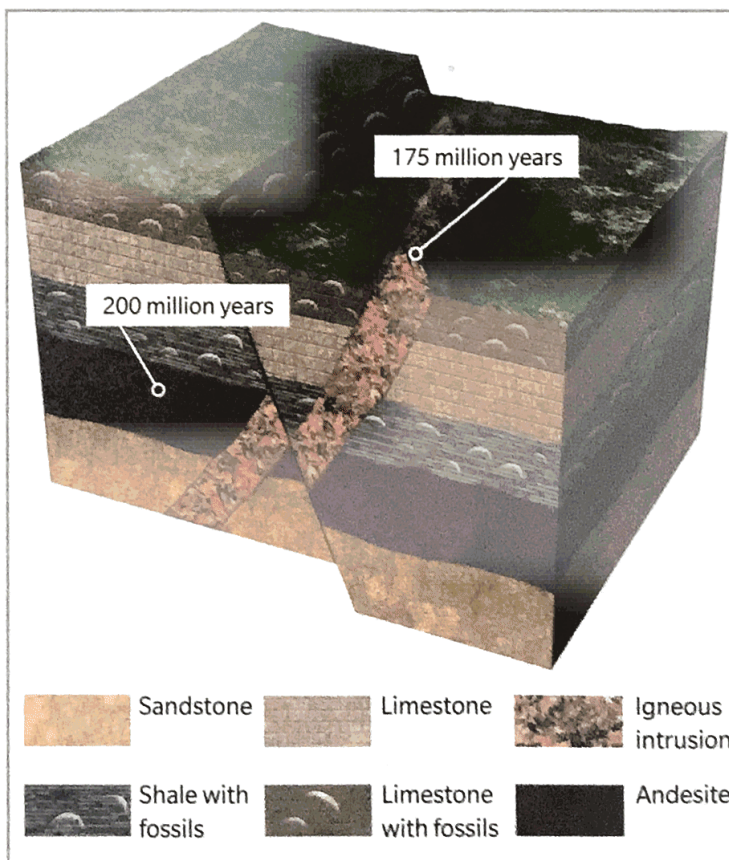
Use the diagram of undisturbed rock layers and features to answer Questions 5 and 6.

5. Which of the following statements are true? Choose all that apply.
 - A. All fossils are over 175 million years old.
 - B. The fault shifted the rocks more than 175 million years ago.
 - C. All fossils formed between 175 and 200 million years ago.
 - D. The sandstone is older than 200 million years old.
 - E. The sandstone is 201 million years old.

6. Circle the correct term to complete each statement.

The igneous intrusion is *younger / older* than the fault.

The fossils found in the shale are from animals that lived *before / after* the animals that formed fossils in the limestone.



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Name: _____

Date: _____

Use the photograph of the river delta to answer Questions 1–2.

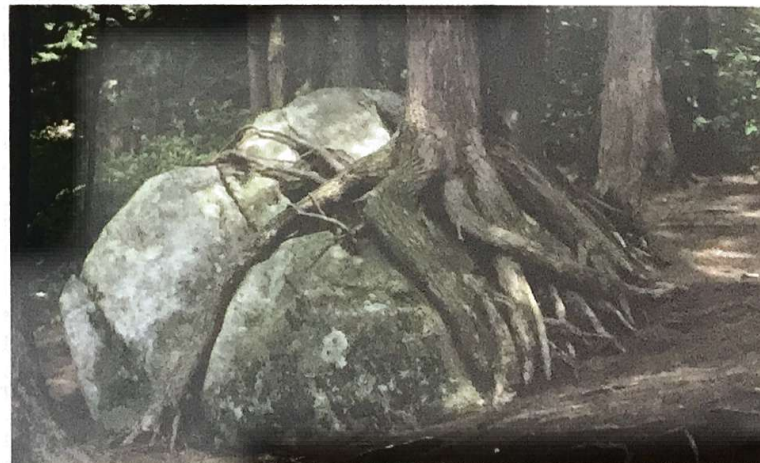


1. At the mouth of a slow-flowing river, a broad, flat delta can form, often extending many kilometers into the sea. Which geologic processes are responsible for the formation of a river delta? Select all that apply.
 - A. weathering
 - B. erosion
 - C. deposition
 - D. plate movement
2. Which statement best describes the time and spatial scales of the formation of a delta at the mouth of a large river?
 - A. rapid and local
 - B. rapid and global
 - C. slow and local
 - D. slow and global

3. Energy from the sun / Earth's hot interior / the sun and Earth's hot interior drives the processes involved in the rock cycle.

Use the photograph to answer Question 4.

4. The tree's roots physically / chemically weather the rock, breaking the rock apart. This process is an example of an interaction between the geosphere and the atmosphere / biosphere / hydrosphere.



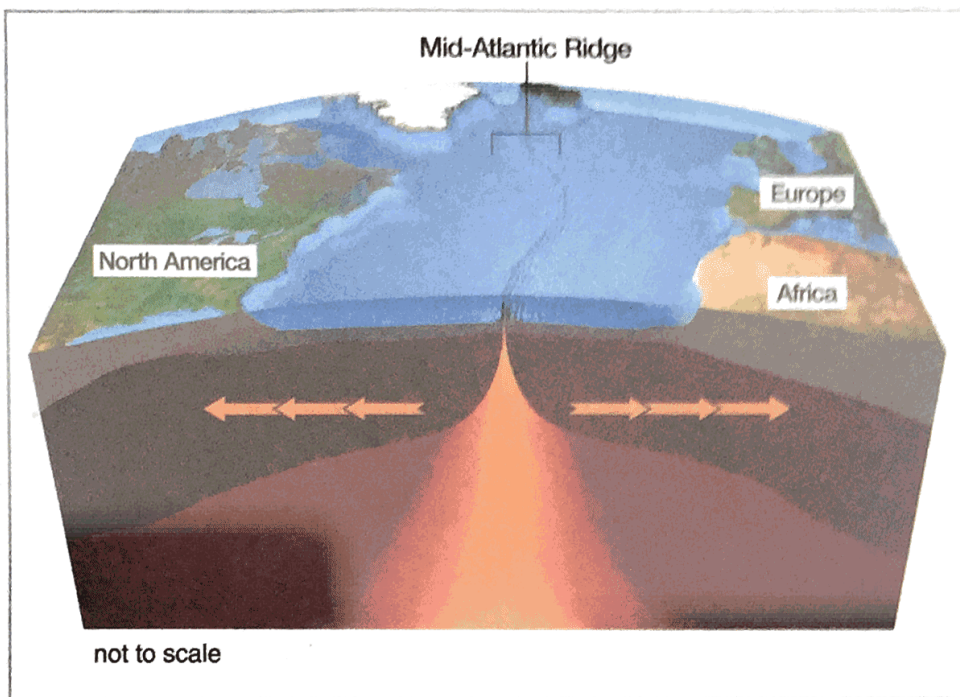
5. Complete the table by providing at least one example of how these geologic processes relate to each big concept.

Geologic Processes	Energy Source(s)	Time and Spatial Scales	Stability and Change	Patterns
Weathering, erosion, and deposition				
The rock cycle				
Tectonic plate motion				
Mountain formation				

Name: _____

Date: _____

Use the diagram to answer Questions 6–9.



6. Identify the type of plate boundary shown in this diagram and use evidence to explain your reasoning.

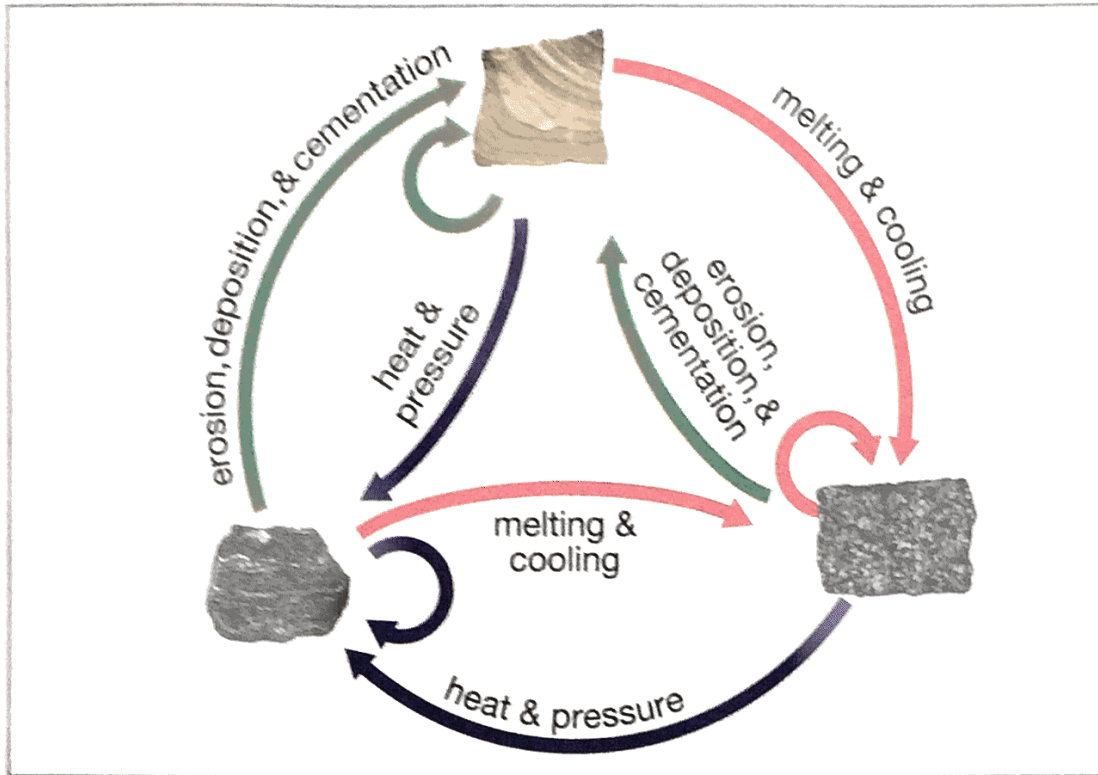
7. Describe at least two ways that the movement of these plates could change the Earth's surface, including a description of the time scales.

8. Iceland is an island located between North America and Europe. There are many springs where hot water comes to the surface in Iceland. Use the diagram to explain how these springs could occur.

9. The western coast of the United States has many volcanoes and frequent earthquakes. Why are these features not common along the eastern coast of the United States or the western coast of Europe?

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Use the rock cycle diagram to answer Questions 10–13.



10. Based on the diagram, what changes between types of rock can occur as part of the rock cycle process?

11. What type of rock would have been formed first during Earth's history? Explain your reasoning.

12. Identify parts of the rock cycle that can only occur deep beneath the surface, and provide evidence to support your reasoning.

13. Close examination of a rock sample shows that it has many tiny fossils of seashells. Explain how you could determine whether the rock is igneous, metamorphic, or sedimentary.

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Westwood



high bridge

Appleville



clay

limestone

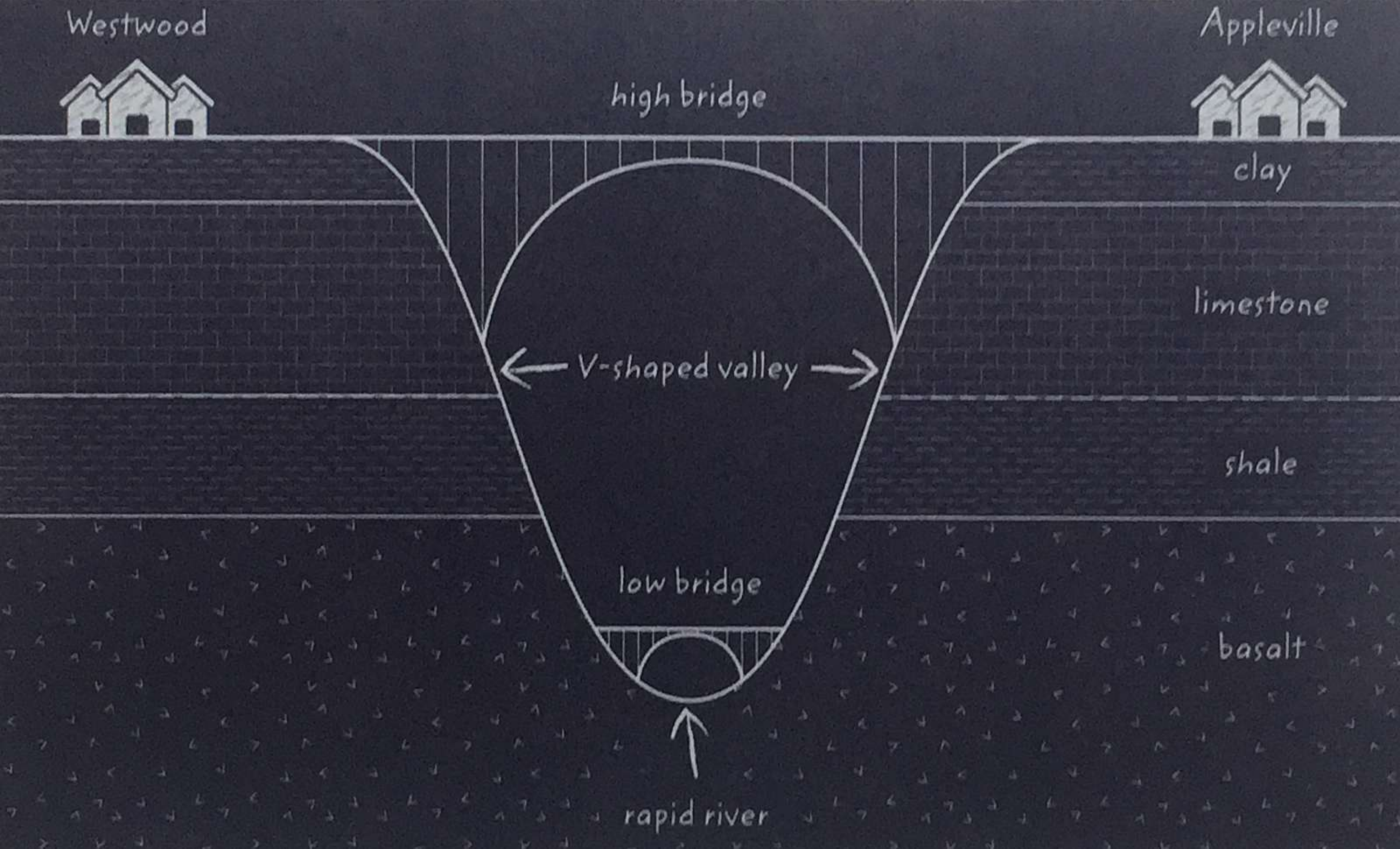
shale

basalt

V-shaped valley

low bridge

rapid river



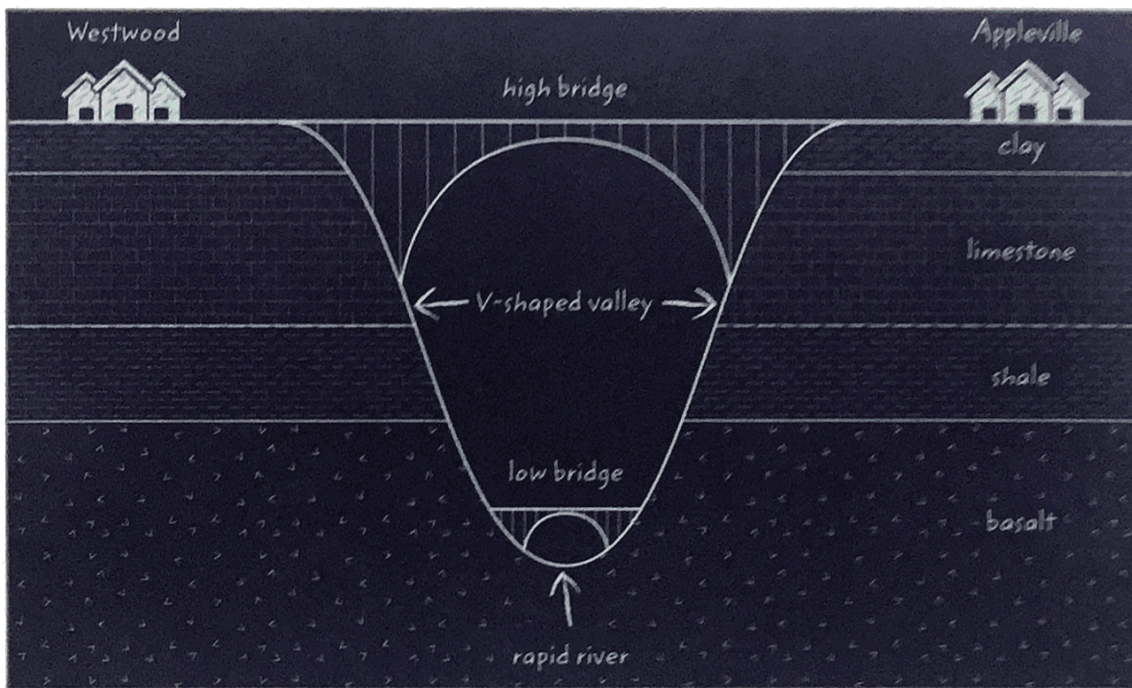
Name: _____

Date: _____

What is the best location for a new bridge?

The state highway department is building a road that will directly connect the cities of Appleville and Westwood. The department has asked for local input into design decisions, and a planning committee has been formed, which includes citizens of both communities.

Two designs are being considered: a high bridge and a low bridge. Your team has been assembled to provide advice to the committee. Your job is to use the diagram below to analyze the geology of the two locations. As you develop your report, consider the criteria of the problem and constraints imposed by geology. You will then recommend a preferred location for the new bridge.



The steps below will help guide your research and develop your recommendation.



Engineer It

- 1. Define the Problem** Write a statement defining the problem you have been asked to solve. What are the criteria and constraints involved in determining the bridge location?



Engineer It

2. Conduct Research What types of geologic processes are at work in the area, and how might each process affect the area?

3. Analyze Data The state highway department wants the bridge to last at least 100 years. Identify how you expect these processes to change the area over the next 100 years.

4. Identify and Recommend a Solution Make a recommendation based on your research. Should the cities build the high bridge or low bridge? Explain your reasoning.

5. Communicate Present your research to the bridge committees of Appleville and Westwood. Your presentation should show the evidence of the geologic processes at work in the area and illustrate how you expect these processes to change the area over the next 100 years. Your information will help the engineers specify requirements and constraints to build a lasting bridge.



Self-Check

	I defined the bridge location problem by identifying the criteria and the constraints.
	I researched how different geologic processes could affect conditions in the proposed locations of the bridge.
	My solution is based on evidence gathered from research and data analysis.
	My solution and recommendation was clearly communicated to others.



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