mystery science

Anchor Layer Teacher Guide

A curriculum companion for Anchor Layer users

Grade 4

Earth's Features & Processes

Unit Web Link • Pacing Guide • Other Units



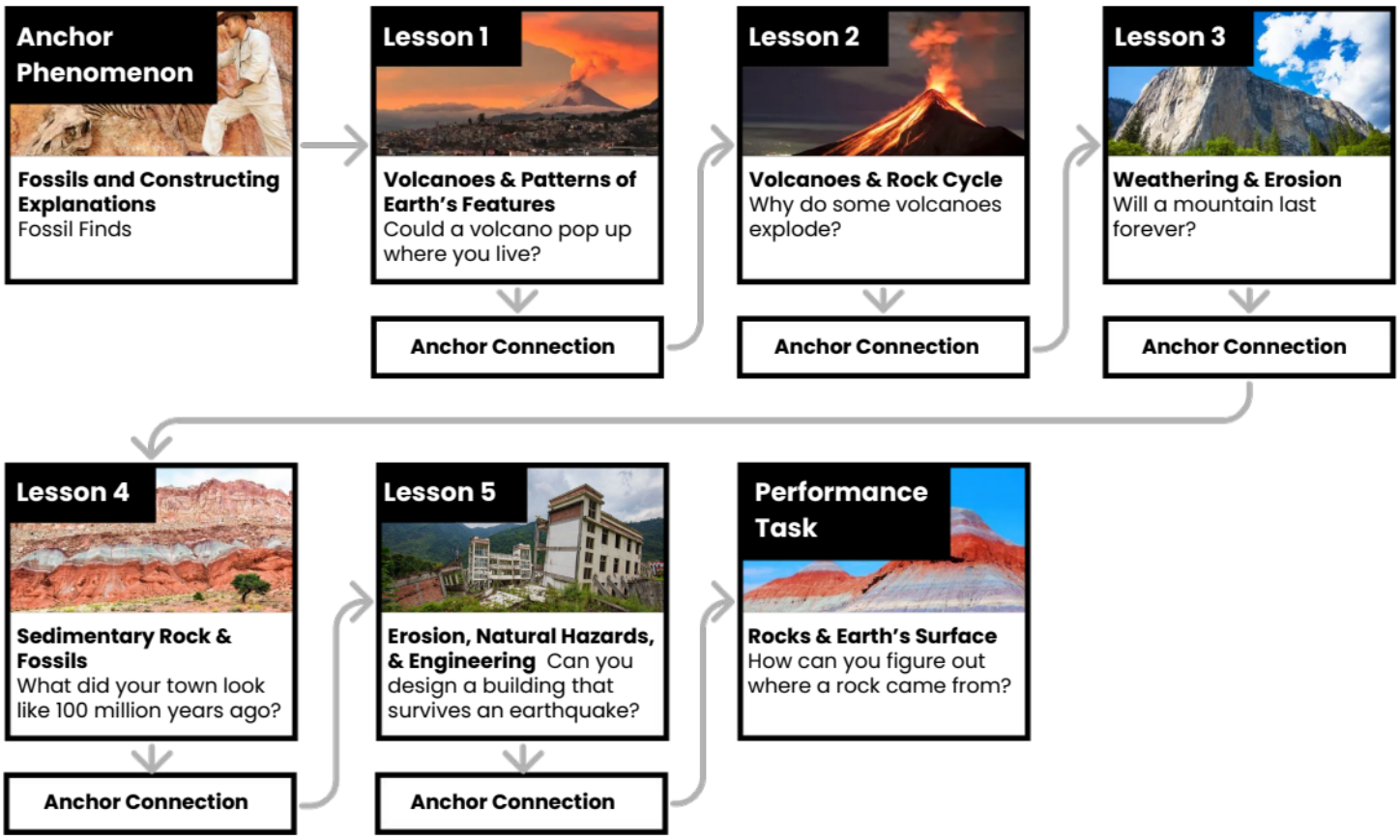
Unit Summary

In this unit, students investigate features and processes of the Earth's surface. Students explore the rapid process of volcanic eruptions! In contrast, students also explore the gradual Earth processes of weathering and erosion. Students apply their knowledge and design solutions to mitigate the impacts of these processes on humans. Assessments

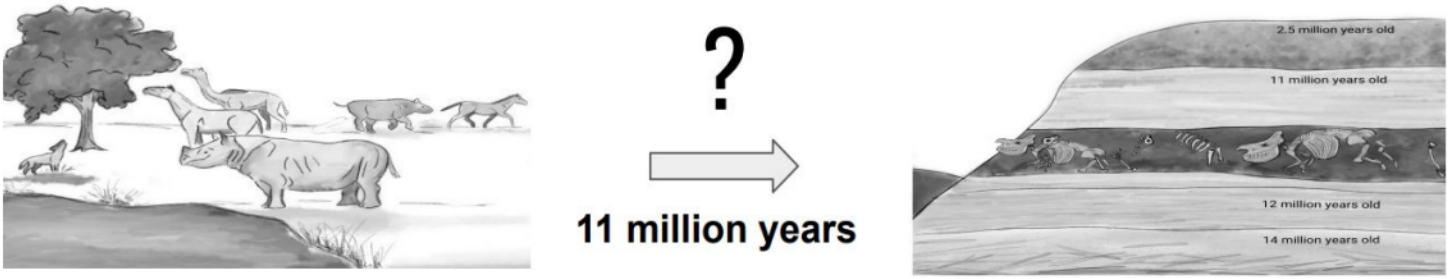
Performance Expectations	Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. • 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation • 4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. • 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. • 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem	• Analyzing and Interpreting Data • Engaging in Argument from Evidence • Constructing Explanations and Designing Solutions • Planning and Carrying Out Investigations • Constructing Explanations and Designing Solutions • Developing and Using Models	• ETS1.B: Designing Solutions to Engineering Problems • ESS1.C: The History of Planet Earth • ESS2.A: Earth Materials and Systems • ESS2.B: Plate Tectonics and Large-Scale System Interactions • ESS2.E: Biogeology • Ess3.B: Natural Hazards •ETS1.B: Designing Solutions to Engineering Problems	• Patterns • Cause and Effect

Earth's Features & Processes Lesson Flow on Next Page

Earth's Features & Processes Lesson Flow



Anchor Phenomenon Background



How did the land at the Ashfall Fossil Beds change over time?

11 million years ago, a volcano in Idaho (over 1,000 miles from Nebraska) erupted. The volcano had thick lava that was explosive and spewed ash for miles. The ash traveled to Nebraska, and slowly, the animals at the Ashfall Fossil Beds site suffocated. The smaller animals that had less lung capacity died first, and after a few weeks, the larger animals died.

A layer of ash settled over the bodies of the animals immediately following their death. Over time, nearby mountain ranges weathered and were broken down into sand, clay, gravel, and small rocks. This sediment was carried by rivers running through the Ashfall Fossil Beds and deposited on top of the fossil layer.

In 1971, a heavy rainfall occurred, washing away land. This exposed the first fossil of a baby rhino's skull on the side of a ravine on a farm in Nebraska.

Paleontologists have uncovered over 100 fully intact skeletons of prehistoric animals that died from the volcanic eruption 11 million years ago. The Ashfall Fossil Beds site is an active dig site that is open to visitors.

Anchor Phenomenon: Fossil Finds
Fossils and Constructing Explanations



Anchor Phenomenon
10 mins

Guided Inquiry
20 mins

Hands-On Activity
30 mins

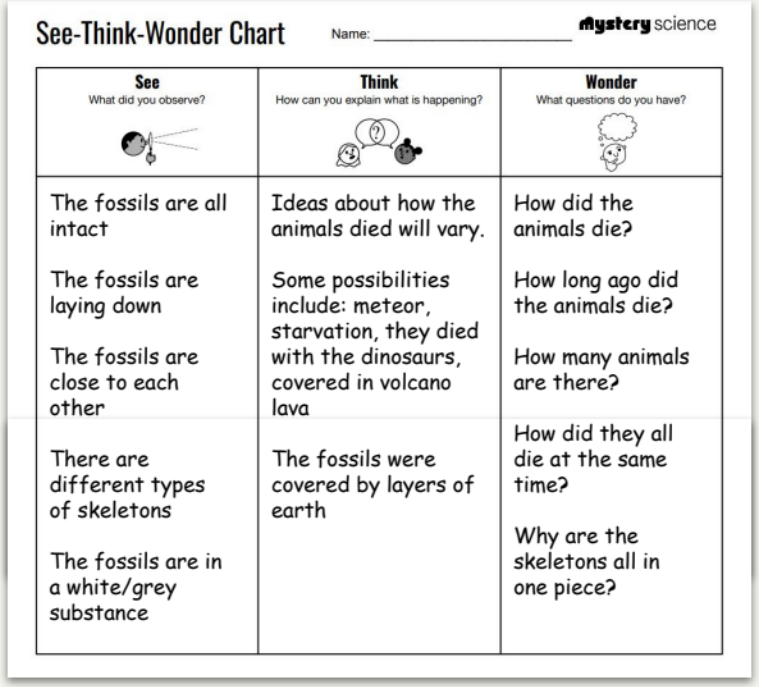
Anchor Phenomenon Lesson Overview

Note: This lesson is part of this unit's Anchor Layer. If you have the Anchor Layer turned on, we recommend teaching all lessons in the remainder of this unit in order.

The anchor phenomenon for this unit is the Ashfall Fossil Beds. Students generate observations and questions about the phenomenon and create an initial explanation to explain what killed the prehistoric animals, how their bones ended up underground, and what changes happened to the land that uncovered their fossils.

Student Work Samples & Notes

It is important to encourage students to recognize that even if they don't know the perfect answer yet, they are going to learn a lot throughout the unit and have an opportunity to change or add to their first explanation.



See-Think-Wonder Chart

Name: _____

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See What did you observe?	Think How can you explain what is happening?	Wonder What questions do you have?
The fossils are all intact The fossils are laying down The fossils are close to each other There are different types of skeletons The fossils are in a white/grey substance	Ideas about how the animals died will vary. Some possibilities include: meteor, starvation, they died with the dinosaurs, covered in volcano lava The fossils were covered by layers of earth	How did the animals die? How long ago did the animals die? How many animals are there? How did they all die at the same time? Why are the skeletons all in one piece?

Lesson 1: Could a volcano pop up where you live? (pg 1 of 2)
Volcanoes & Patterns of Earth's Features



Exploration
7 mins

Hands-On Activity
40 mins

Wrap-up
8 mins

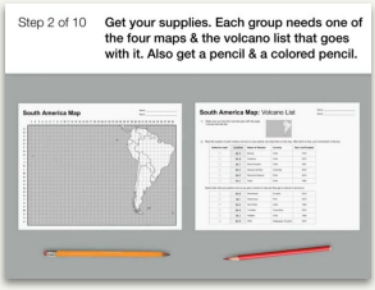
Anchor Connection
30 mins

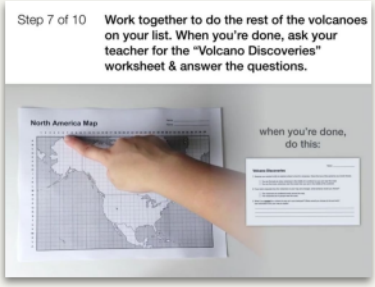
Assessment
25 mins

Overview

In this lesson, students explore the past and present pattern of where volcanoes exist on the earth.

In the activity, Mapping Volcanoes, students plot volcano locations on a world map and look for patterns. Students analyze these maps to discover that volcanoes form a "Ring of Fire" around the Pacific Ocean.





Activity Notes

We suggest students work in pairs. Each pair of students will work on one quarter of the Volcano Map. At the end of the activity, four pairs of students will bring their maps together to form one complete Volcano Map.

You will need enough wall space to display the completed maps. There will be one map for every 8 students, so a class of 32 students will have 4 completed maps. Each complete map measures approximately 22" x 17".

Display Maps (Optional): At the end of the activity, you may want to display the completed Volcano Maps. Depending on the wall surface, attach the maps using tape or push pins.

Anchor Connection on Next Page

Lesson 1: Could a volcano pop up where you live? (pg 2 of 2)
Volcanoes & Patterns of Earth's Features



Exploration
7 mins

Hands-On Activity
40 mins

Wrap-up
8 mins

Anchor Connection
30 mins

Assessment
25 mins

Anchor Connection

The Ashfall Fossil Beds site is far from where any volcanoes are found today. Students consider if a volcano could be responsible for the death of the prehistoric animals.

In the lesson 1 Anchor Connection, students map the location of 6 prehistoric volcanoes. They evaluate distance of the volcanoes from the Ashfall Fossil Beds in Nebraska.

Students revisit the explanation that they worked on during the Anchor Phenomenon. They should understand that there were prehistoric volcanoes located in North America, but they are not near the Ashfall Fossil Beds.

Students can update their explanations by adding new evidence and thinking:

- Question 1: How did the prehistoric rhinos and other animals die?
  The animals weren't near a volcano at the Ashfall Fossil Beds site. Maybe they weren't killed by a volcano?
- Question 2: Why did it take 11 million years to find the fossils of the animals?
  The earth can change over time.
- Question 3: How were the fossils eventually found?
  --

Connecting Storyline Question

How could the volcanoes have killed the rhinos even if they are far away?

Lesson 2: Why do some volcanoes explode? (pg 1 of 2)
Volcanoes & Rock Cycle



Exploration
15 mins

Hands-On Activity
35 mins

Wrap-up
5 mins

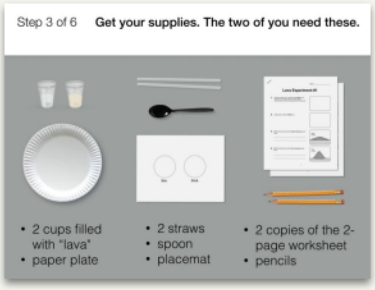
Anchor Connection
30 mins

Assessment
25 mins

Overview

In this lesson, students will investigate how differences in lava types explain differences in the shape and eruption patterns among volcanoes.

In the activity, Bubble Trouble, students compare two different types of "lava" -- thin and thick. They use this information to figure out why volcanoes have different shapes and how the type of lava explains why some volcanoes explode.





Activity Notes

You will need access to water for this activity. We suggest students work in pairs.

To prepare the "lava," you will need water, flour, a 1-gallon Ziploc bag (or large mixing bowl), measuring cups, scissors, and (optionally) red food coloring. For thin lava, use plain water. You can optionally add a drop or two of red food coloring to make it look more like lava. To make thick lava, mix up the flour with water and (optionally) red food coloring. See the lesson page for more detailed prep instructions.

Fill half of the cups about halfway with the "thin lava." Fill the other half of the cups about halfway with the "thick lava."

Anchor Connection on Next Page

Lesson 2: Why do some volcanoes explode? (pg 2 of 2)
Volcanoes & Rock Cycle



Exploration
15 mins

Hands-On Activity
35 mins

Wrap-up
5 mins

Anchor Connection
30 mins

Assessment
25 mins

Anchor Connection

Students update their Ashfall Fossil Beds Evidence Chart to show which of the prehistoric volcanoes had thick lava. The ash from a thick lava volcano could have traveled the distance to Nebraska.

In the lesson 2 Anchor Connection, students evaluate the list of prehistoric volcanoes, considering the type of lava the volcano had and how long ago it erupted. They determine which volcano may have caused the death of the animals.

Students revisit the explanationthat they worked on during the Anchor Phenomenon. They should understand that the volcanoes closest to the Ashfall Fossil Beds site erupted thick lava. These eruptions create huge explosions and the ash could have made it all the way to Nebraska.

Students can update their explanations by adding new evidence and thinking:

- Question 1: How did the prehistoric rhinos and other animals die?
  The animals could have been killed by the ash of a thick lava volcano.
- Question 2: Why did it take 11 million years to find the fossils of the animals?
  --
- Question 3: How were the fossils eventually found?
  --

Connecting Storyline Question

If ash fell on top of the rhinos, how did the bones end up so far underground, underneath other rocks?

Lesson 3: Will a mountain last forever? (pg 1 of 2)
Weathering & Erosion



Exploration
20 mins

Hands-On Activity
45 mins

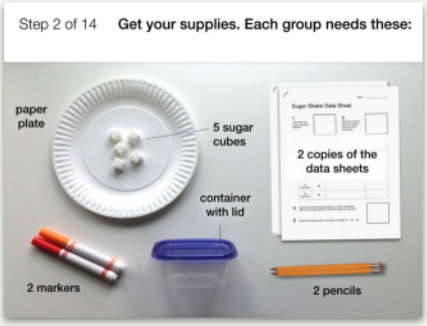
Anchor Connection
30 mins

Assessment
25 mins

Overview

In this lesson, students will explore how solid rock breaks apart into smaller pieces through a process called weathering (including root-wedging and ice-wedging).

In the activity, Sugar Shake, students use sugar cubes as a model for rocks. They perform an experiment with this model to understand the process of weathering and how this process explains why rocks at the tops of mountains are jagged, while those at the bottom are rounded.



Activity Notes

We suggest students work in pairs.

Each pair of students will experiment with 5 sugar cubes. You may want to count out 5 sugar cubes and place each on a paper plate prior to class for easier distribution.

Anchor Connection on Next Page

Lesson 3: Will a mountain last forever? (pg 2 of 2)
Weathering & Erosion



Exploration
20 mins

Hands-On Activity
45 mins

Anchor Connection
30 mins

Assessment
25 mins

Anchor Connection

The fossils at the Ashfall Fossil Beds were found in a layer of ash. Below and above the ash layer were layers of sand, gravel, and clay. The sediment was carried from weathered mountains by the river and deposited at the fossil site over time.

In the lesson 3 Anchor Connection, students analyze the the fossil layers at the Ashfall Fossil Beds and the location of mountains and rivers nearby to predict why the fossils were covered for so long.

Students revisit the explanation that they worked on during the Anchor Phenomenon. They should understand that pieces of rock fall down nearby mountains and are smoothed as they tumble. Over time these rocks, along with sediments, were carried by a river to the Ashfall Fossil Beds site, piling on top of the rhino fossils.

Students can update their explanations by adding new evidence and thinking:

- Question 1: How did the prehistoric rhinos and other animals die?
  --
- Question 2: Why did it take 11 million years to find the fossils of the animals?
  The layers below and above the ash layer are made of sediment carried from mountains by the river and deposited over time. This buried the fossils.
- Question 3: How were the fossils eventually found?
  --

Connecting Storyline Question

How did the fossils end up inside of solid rock?

Lesson 4: What did your town look like 100 million years ago?
Sedimentary Rock & Fossils (pg 1 of 2)



Exploration
20 mins

Hands-On Activity
35 mins

Wrap-up
15 mins

Anchor Connection
15 mins

Assessment
25 mins

Overview
In this lesson, students gather evidence to describe how environments on Earth have changed over time. Students explore how the process of sedimentary rock formation preserves a record of those past environments.

In the activity, Canyon Explorer, students observe fossils found within a model canyon. The characteristics of those fossils provide evidence to support the explanation that the landscape has changed numerous times.

Activity Notes
We suggest students work in pairs. If you have limited time, you can divide this lesson into two sessions. We have marked a natural stopping point after the construction of the model canyon.

Teacher Background
Colossal Canyon is a model, but if you and your students are curious, each layer roughly corresponds to a real geologic time period. If you want to learn more, be sure to check out our Extension with links to help you explore rocks and fossils throughout the National Park System in the United States.

Layer 6: Tertiary Period 65-2 million years ago
Layer 5: Cretaceous Period 145-65 million years ago
Layer 4: Triassic & Jurassic Periods 250-145 million years ago
Layer 3: Permian Period 300-250 million years ago
Layer 2: Carboniferous Period 350-300 million years ago
Layer 1: Devonian Period 400-350 million years ago

Anchor Connection on Next Page

Lesson 4: What did your town look like 100 million years ago?
Sedimentary Rock & Fossils (pg 2 of 2)



Exploration
20 mins

Hands-On Activity
35 mins

Wrap-up
15 mins

Anchor Connection
15 mins

Assessment
25 mins

Anchor Connection

When sediment collects in an area, it can bury and protect objects for millions of years. This is how we find fossils of plants and animals from the deep past.

In the lesson 4 Anchor Connection, students consider that most living things quickly break down after they die. The animals at the Ashfall Fossil Beds were completely buried. While this is what killed the animals, it is also what preserved their remains so that we can observe them 11 million years later.

Students revisit the explanation that they worked on during the Anchor Phenomenon. They should understand that as sedimentary rock forms, it can trap and preserve the remains of living things. This is why we can still see ancient fossils in the Ashfall Beds.

Students can update their explanations by adding new evidence and thinking:

- Question 1: How did the prehistoric rhinos and other animals die?
  –
- Question 2: Why did it take 11 million years to find the fossils of the animals?
  Once the fossils were buried, the layers of sand and rock above them grew taller and taller. Those layers protected the fossils.
- Question 3: How were the fossils eventually found?
  –

Connecting Storyline Question

How did the rhino fossils become exposed after being buried for so long?

Lesson 5: Can you design a building that survives an earthquake? (pg 1 of 2)
Earthquakes, Natural Hazards, & Engineering



Exploration
15 mins

Hands-On Activity
30 mins

Wrap-up
10 mins

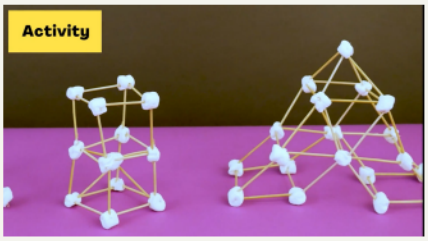
Anchor Connection
30 mins

Assessment
25 mins

Overview

In this lesson, students explore earthquakes and the hazards they cause to buildings.

In the activity, Earthquake Engineers, students design, build, and test earthquake-resistant model buildings with a specific set of criteria and constraints. They compare the effectiveness of their designs to real-world building solutions.



Activity Notes

We suggest students work in pairs.

For further notes on how to prepare for the activity, see the lesson page.

Anchor Connection on Next Page

Lesson 5: Can you design a building that survives an earthquake? (pg 2 of 2)

Earthquakes, Natural Hazards, & Engineering



Exploration
15 mins

Hands-On Activity
30 mins

Wrap-up
10 mins

Anchor Connection
30 mins

Assessment
25 mins

Anchor Connection

Many different processes can lead to the surface of the Earth changing, which can either cover and hide things, or expose things that were previously underground.

In the lesson 5 Anchor Connection, students consider what might have exposed the fossils by looking back at everything they learned in this unit. A volcanic eruption is what originally covered the fossils, and the area around the Ashfall Fossil Beds does not experience earthquakes. Therefore, those are unlikely explanations for what exposed the fossils. The best explanation is that soil above the fossils was washed away by erosion and/or weathering. This exposed the fossils after 11 million years of being buried.

Students revisit the explanation that they worked on during the Anchor Phenomenon. They should understand that years of heavy rain could have eroded the earth on the hillside of the farm, eventually exposing the rhino jaw fossil.

Students can update their explanations by adding new evidence and thinking:

- Question 1: How did the prehistoric rhinos and other animals die?
  --
- Question 2: Why did it take 11 million years to find the fossils of the animals?
  --
- Question 3: How were the fossils eventually found?
  Erosion and weathering exposed the fossils that had been buried for 11 million years.

Connecting Storyline Question

How can we figure out where a rock comes from?

Performance Task: How can you figure out where a rock came from?

Rocks & Earth's Surface

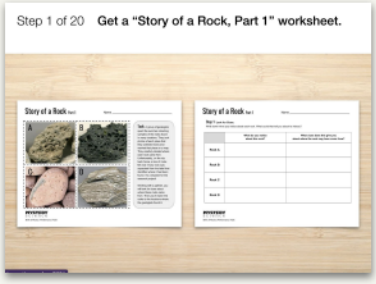


Unit Review
20 mins

Hands-On Activity
120 mins

Overview

In this performance task, students use their knowledge of how rocks form and how the earth changes over time to help geologists solve a puzzle. They analyze maps and photos from four locations to figure out which rocks were found in each place. Then, they support their claims with evidence. If you have time to extend the performance task, there is an optional writing extension in the last step.



Performance Task Notes

Each student will need:

- One Story of a Rock worksheet (Part 1 and 2).
- One Story of a Rock Rubric

The Story of a Rock Answer Key will help you support students throughout the unit. Students are not expected to have these answers until the end of the unit.

Crosscutting Concepts

Patterns: Patterns can be used as evidence to make predictions and support explanations. Patterns in the Ashfall Fossil Beds give clues to how the earth's surface has changed over time.

Cause & Effect: Cause and effect relationships are used to explain change. Weathering and erosion cause the earth's surface to change over time.