

# THINKING AND ACTING LIKE A SCIENTIST

## TEACHER'S GUIDE

# The Ages of Rocks

What can rock layers of the Grand Canyon show about how geoscience processes have changed Earth over time?

GRADES 6–8

Earth & Space





# The Ages of Rocks

<b>Grade Level/Content</b>	6–8/Earth and Space Science
<b>Lesson Summary</b>	In this lesson, students will analyze rock layers of the Grand Canyon to determine how geoscience processes have changed Earth's surface over time.
<b>Estimated Time</b>	1, 45-minute class period
<b>Materials (per team)</b>	a long piece of paper (8 ½ x 14 or larger), pencil, colored pencils or markers, Internet access, <a href="#">Investigation Plan</a> , <a href="#">Observation Form</a> , <a href="#">Assessment</a> , journal
<b>Secondary Resources</b>	<a href="#">Views of the National Parks: The Grand Canyon</a> <a href="#">Fossils – Grand Canyon National Park</a> <a href="#">How the Grand Canyon Formed (Video)</a>
<b>NGSS Connection</b>	<b>MS-ESS2-2</b> Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
<b>Learning Objectives</b>	<ul style="list-style-type: none"><li>• Students will analyze images of rock layers in the Grand Canyon.</li><li>• Students will make a connection between rock layers and geoscience processes.</li><li>• Students will develop a timeline to explain how geoscience processes have changed Earth's rock layers over time.</li></ul>

## What can rock layers of the Grand Canyon show about how geoscience processes have changed Earth over time?

It's wide. It's deep. It's the Grand Canyon, and it tells the history of the Southwest one rock layer at a time. It took millions of years for the sedimentary rock in the Grand Canyon to form. It also took millions of years for the Colorado River to carve the canyon and reveal each historical layer. The canyon's rock is a treasure chest of fossil remains, and every fossil tells a story about the plants and animals that once lived there. In this lesson, students investigate the ages of rock that make up the Grand Canyon. This is a river-rafting journey into North America's past.

**Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science.**  
**In all investigations:**



Students don't know the "answer" they are supposed to get.



Students play a driving role in determining the process for learning.



Teachers and students construct meaning together by journaling.



Students are working as hard as the teacher.

# Part 1

## INVESTIGATION SETUP

Each group will receive:

- Internet access
- Long piece of paper (8 ½ x 14 or larger)
- Pencil
- Colored pencils or markers
- Observation Form
- Investigation Plan
- Assessment
- Journal

# Part 2

## INVESTIGATION FACILITATION



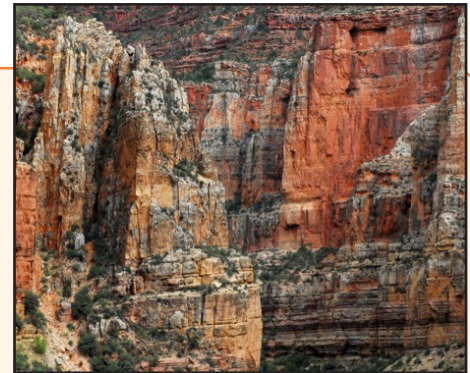
### Question

*Introduce the investigation question.*

**What can rock layers of the Grand Canyon show about how geoscience processes have changed Earth over time?**

#### CURIOSITY

Show students an image of the Grand Canyon where the layers of rock are clear. Ask students why they think people find the Grand Canyon so interesting. Students may wish to know what makes the rocks so colorful or why the canyon's walls are not smooth like a polished stone. Encourage students to voice their curiosity about the geology of the Grand Canyon.



Grand Canyon



### Personal Knowledge

*Students capture what they already know about layers of rock and geoscience processes.*

- Have students share what they already know about different types of rock. (*For example, students may know that rocks can be igneous, metamorphic, and sedimentary.*)
- Ask students to share what they know about how geoscience processes change Earth's surface.

#### DISCOURSE

Use a *Think-Pair-Share* activity to have students list the different processes that can change Earth's surface. For example, students may remember that erosion due to wind or water causes changes to Earth's surface. Students can compare their lists with a partner, and then compare their results as a class.



### Prediction

*Students communicate an expected outcome, based on prior knowledge.*

- Students may predict what geoscience processes caused specific layers of rock within the Grand Canyon.
- Predictions are presented as *I predict \_\_\_\_\_ because \_\_\_\_\_.*

#### RISK-TAKING

All of the students' predictions should be taken as correct during the prediction stage. If any predictions are challenged, encourage students to revisit those predictions during the appropriate part of the investigation (when the timelines are being created).

## Investigation Plan

Students investigate to determine the geoscience processes that caused different rock layers to form in the Grand Canyon.

- Divide students into pairs or small groups. Distribute the [Investigation Plan](#) and [Observation Form](#) for this investigation. Review the information students need to complete this lesson.
- Advise students about credible searches on the Internet, such as using *.gov* or *.edu* sites. Students should be able to access some of the information needed from National Park Service websites.
- Have pairs or teams research the needed information on the Internet (or other resources) and record their information on the **Observation Form**.

### SHARED CONTROL

Giving each team an **Investigation Plan** helps facilitate a shared control of learning. If students ask you what to do next, refer them back to the **Investigation Plan** so they learn to direct their own learning.

### CRITICAL THINKING

Use the [Fair Test](#) checklist to help students think critically about the investigation plan. Help them understand that a good investigation involves significant research and use of credible sources. The more critically students think about their investigation plan, the more confident they can be in their results.

INVESTIGATION PLAN  
THE AGES OF ROCKS

1. Conduct research to find at least four different layers of rock in the Grand Canyon.
2. Remember to use reputable sources, such as *.gov* and *.edu* sites. You may find the information needed from National Park Service websites.
3. For each layer of rock, record the name of the layer, when it was formed, and its cause on the **Observation Form**.
4. When you complete your form, compare your data with others. If you find discrepancies, continue your research until you are confident in your data.

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Investigation Plan

OBSERVATION FORM  
THE AGES OF ROCKS

NAME: \_\_\_\_\_  
DATE: \_\_\_\_\_

Name of Layer	When Formed	How Formed

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Observation Form



## Observation

Students record the data they collect about layers of rock in the Grand Canyon.

- Students should capture all the data they collect on the **Observation Form**.
- If students have difficulty finding the information, you can provide sources, specific layers to search for, or both.

### INTEGRITY

Encourage students to record data objectively. Discourage them from trying to represent their data visually too soon. Disciplined researchers collect data first and then analyze it. This helps to avoid biased data.

OBSERVATION FORM  
THE AGES OF ROCKS

NAME: \_\_\_\_\_  
DATE: \_\_\_\_\_

Name of Layer	When Formed	How Formed
Vishnu Schist	1.75 billion	plate collision
Piedwall Limestone	335 million	deposition of sea shells
Bright Angel shale	530 million	deposition of sea shells
Muav Limestone	515 million	deposition of sea shells
Tapeats Sandstone	1 billion	deposition of sand

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Sample Data

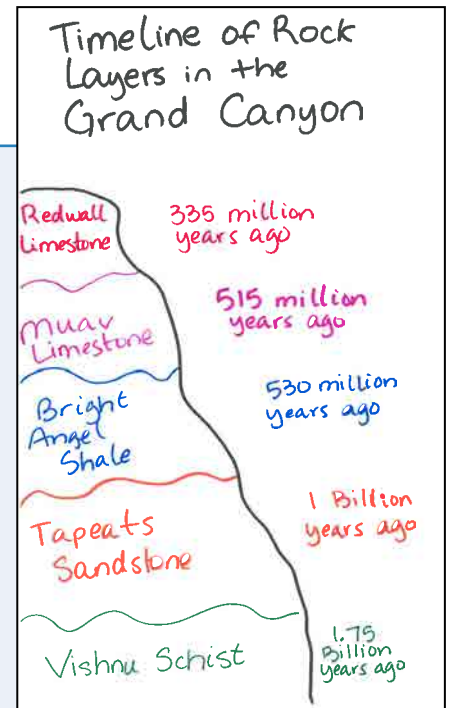


## Data Analysis

*Students make sense of their data by organizing it and representing it as a visual timeline.*

Have students analyze their data. They may wish to use the [Data Analysis](#) prompt as a guide.

- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They should **organize** the data and **represent** it visually to construct meaning.
  - On a large piece of paper, have students draw a timeline to show at least four layers of rock in the Grand Canyon. At a minimum, they should include the name of the layer and when it formed.
- Have students **interpret** what the identified patterns or trends mean. As they create their timeline, they should think about how geoscience processes have caused Earth's surface to change over time.
- Ensure they have enough data that it can be used as evidence to support a claim.



Sample Representation

### CREATIVE THINKING

Students will determine the best way to draw their timeline to show the requested information. Encourage students to add information to the timeline by drawing fossil remains found in different rock layers.

### CRITICAL THINKING

Challenge students to think deeply about their work. Ask how the scale they used affected their representation of the data. Ask them to explain any shortcomings of the drawings they created.

### STUDENT CHOICE

If students collected data on many layers, they may not be able to fit them on one timeline. As a group, they should determine which 4–5 rock layers to include to best convey the geoscience processes over time.



## Secondary Knowledge

*Students use secondary sources to understand how geoscience processes have shaped the layers of the Grand Canyon.*

- Use these resources (or your own) to help clarify misconceptions or to give students a broader understanding of the processes that formed the rock layers.

[Views of the National Parks: The Grand Canyon](#)

[Fossils – Grand Canyon National Park](#)

[How the Grand Canyon Formed \(Video\)](#)

- After reviewing and discussing the secondary resources, students should understand the various geoscience processes that affect Earth's surface.
- Allow students to expand their understanding by looking at the fossils found in each layer and determining what the layer looked like when it formed.

### CURIOSITY

When curious people learn new information, they continue to ask questions and make connections. Develop curiosity by encouraging students to share their learning from secondary resources using a *Fact-Question-Connection* format. They should share one fact they learned, one question they still have, and one connection from what they learned to something they already know, something they are interested in, or something another classmate said.



## Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the [Explanation](#) prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: What can rock layers of the Grand Canyon show about how geoscience processes have changed Earth over time?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

### Claim

*The rock layers in the Grand Canyon show that rising and lowering sea levels in this area changed Earth's surface over time.*

### Evidence

*The Bright Angel Shale, Tapeats Sandstone, Muav Limestone, and Redwall Limestone were all formed partly through water erosion and deposition; however, the type of rock formed shows that the water was at different levels, and, in some cases, such as with the Redwall Limestone, physical weathering helped form the rocks, showing that the water levels were likely shallow.*

### Reasoning

*Investigation: We used credible and reputable sources to investigate the rock layers of the Grand Canyon. Our investigation gave us the details about when each rock layer formed and how it was formed. For example, we learned that the Muav Limestone layer is 515 million years old and was caused by the deposition of shells and other remains of sea creatures. While the Vishnu Schist layer is 1.75 billion years old and was caused by plate collisions.*

*Science: The composition of the different layers helped me understand more specifics, such as how deep the water was and what type of organisms played a role in forming the layers. From our class discussions, videos, and readings, we learned that various geoscience processes, such as weathering, erosion, and deposition formed the Grand Canyon over time.*

- Once the explanation is written, have students discuss their results using a [Present and Defend](#).

### DISCOURSE

Have students conduct a [Present and Defend](#) to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning.



## Evaluation

Students reflect on the investigation.

Have students discuss:

- What surprised me about the Grand Canyon?
- How did producing a timeline help me understand how geoscience processes have changed Earth's surface over time?

**Application**

Students demonstrate understanding of how geoscience processes have changed Earth's surface.

- Have students look at a sample of images of Earth over time. For example, these [images from the Ganges River](#).
- Students can discuss how the changes in the images are similar to the changes they saw in the Grand Canyon.
- How does the amount of time affect the changes that can be seen?

**Extension**

- Encourage students to continue their understanding of how geoscience processes have changed Earth's surface by developing their own related investigation question. They can explore geoscience processes at different time and spatial scales. Some geoscience process include:
  - plate motions
  - mountain ranges
  - earthquakes
  - volcanoes
  - meteor impacts

**Assessment**

Students assess their knowledge by analyzing evidence to explain how geoscience processes have changed Earth's surface.

- Evaluate this investigation for how well students:
  - analyze images of rock layers in the Grand Canyon.
  - make a connection between rock layers and geoscience processes.
  - develop a timeline to explain how geoscience processes have changed Earth's rock layers over time.
- After students complete the extension investigations and share information, use the [Assessment](#) to evaluate student learning about how geoscience processes change Earth's surface.

ASSESSMENT	
<b>THE AGES OF ROCKS</b>	NAME: _____ DATE: _____
Read the following scenario and use it to answer the questions.	
A group of hikers was following a trail up a large mountain near the ocean coast. The trail the hikers were following ran beside a flowing stream. The mountain itself sat on a well-known fault line. As the hikers continued up the mountain, they noticed that the path of the trail appeared to have changed some since they had hiked the trail ten years before. They also noticed that the layers of rock near the bottom of the trail looked significantly different than the layers of rock near the top of the trail.	
1. What processes most likely caused the mountain to form?	
2. What processes were likely involved in the shaping of the mountain?	
3. What processes could have caused the path of the trail to change?	
4. What likely explains the differences in the rock layers at the bottom and top of the mountain?	
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**Assessment**

Sample answers:

1. The mountain may have formed by uplift when an earthquake occurred, by folding at the meeting of two tectonic plates, or by volcanic activity.
2. The mountain was most likely shaped by wind, water, and ice weathering the rock and then eroding away the weathered material.
3. The path of the trail may have changed due to an earthquake that changed the sequence of rock layers or caused uplift to expose new layers.
4. The rock layers at the bottom of the trail were most likely older layers than those at the top of the trail. Each layer was laid down at a different time, so the makeup of the rock would be different.

# INVESTIGATION PLAN

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DATE: \_\_\_\_\_

Name of Layer	When Formed	How Formed

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