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Dinosaurs of Antarctica Educator Guide

INTRODUCTION TO GUIDE

The Dinosaurs of Antarctica Educator Guide, created by Discovery Place Education Studio in Charlotte, North Carolina, in partnership with Giant Screen Films, is appropriate for students in grades kindergarten through eighth. The guide is most beneficial when used as a companion to the film but also useful as an independent resource. Educators are encouraged to modify the learning activities included in this guide to meet the needs of their students’ functional level and to support specific state standards. Activities developed for this guide support the Next Generation Science Standards (NGSS) and national Common Core ELA and math standards. However, educators will find that the Dinosaurs of Antarctica film and guide align with other content areas such as geography. This guide focuses on the scientific understanding of Antarctica’s geological and ecological history while exploring the career understandings of scientists who studied Antarctica. Students will examine the roles of a climatologist, paleontologist, and geologist by completing hands-on activities related to work in the field. This guide consists of sixteen engaging lessons that have been approved by teachers.

Dinosaurs of Antarctica is a story about Antarctica’s geological and ecological history, specifically focusing on the Permian and Triassic extinction and Antarctica’s climate transition from Icehouse to Greenhouse, creating a connection to present-day climate science. The film highlights the expedition to Shackleton Glacier featuring scientists from the Natural History Museum of Los Angeles and Field Museum, Chicago, along with other academic institutions. During the exploration, scientists uncover Antarctica’s past through the discovery of ancient animal and plant fossils. Utilizing computer-generated imagery, Dinosaurs of Antarctica brings to life the eras of Antarctica’s history and utilizes attributes of the giant screen to convey challenging scientific concepts such as plate tectonics, geological time, climate processes, etc. During the film viewers will shadow a team of scientists as they encounter extreme weather conditions to excavate fossils that will deepen our understanding of life on Earth.
ABOUT ANTARCTICA

Antarctica is the coldest, windiest, and driest southernmost continent near the South Pole and contains 90% of all of the ice on Earth. Antarctica is a desert because it only receives two inches of rain per year. The small amount of rainfall received each year does not soak into the ground, causing it to accumulate as ice and snow. The Antarctic ice sheet is the largest single piece of ice in the world, covering more than 5 million square miles. Although Antarctica’s temperature makes it difficult for many animals to survive, it is still home to some animals such as seals, whales, penguins, fish, and krill. Also, organisms such as algae and moss can survive the icy conditions. No permanent residents are living in Antarctica. However, Antarctica attracts thousands of scientists each year during the summer months to conduct research. Scientists and early explorers have been researching Antarctica since the late 1800’s and each century uncovers new findings.

Although 98% of Antarctica is covered in snow and ice making it an icehouse, 200 million years ago, it was a greenhouse with wooded, lush habitat where dinosaurs and other living things thrived. Scientists have discovered fossils and other data that confirm the theory of plate tectonics, the movement of continents over time, and the impact on Antarctica’s climate. Fossil records provide paleontologists a global perspective to dinosaur origin, enhancing their understanding of the End-Permian and End-Jurassic extinction events.
ANTARCTIC GEOLOGICAL TIMELINE

Geologists have divided Earth’s history into a series of time intervals known as a geological time scale. The geological time scale consists of three eras: Cenozoic, Mesozoic, and Paleozoic. Each era splits into periods. Fossils found in Antarctica provide clues to the changing climate and position of the continent during each phase of the geological time scale.

<table>
<thead>
<tr>
<th>ERA</th>
<th>PERIOD</th>
<th>ABOUT ANTARCTICA</th>
<th>TIMEFRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleozoic</td>
<td>Permian</td>
<td>The continents were connected as Pangaea. Scientists found fossils of the same species on all continents, including Antarctica.</td>
<td>299-252 million years ago</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Triassic</td>
<td>Antarctica plants and animals experienced climate patterns similar to today, consisting of sunlight in the summer and darkness in the winter.</td>
<td>252-201 million years ago</td>
</tr>
<tr>
<td></td>
<td>Jurassic</td>
<td>Over time, Pangaea split into two supercontinents, Gondwana and Laurasia. Antarctica became part of Gondwana.</td>
<td>201-145 million years ago</td>
</tr>
<tr>
<td></td>
<td>Cretaceous</td>
<td>Antarctica split away from Africa but was still connected to South America and Australia which created a gap filled by the ocean over time.</td>
<td>145-66 million years ago</td>
</tr>
<tr>
<td></td>
<td>Paleogene</td>
<td>Antarctica began transitioning from a greenhouse to an icehouse.</td>
<td>62-23 million years ago</td>
</tr>
</tbody>
</table>
ANTARCTIC EXPEDITIONS

Antarctica has been an area of interest for explorers for hundreds of years. Antarctica was the last of the seven continents discovered, and early explorers were interested in learning more about the continents’ natural resources. Some early explorers hoped to find new locations to hunt for whales and seals, while others wanted the glory of being the first to visit the continent. Regardless of the reason for expeditions to Antarctica, explorers faced incredible hardships, and many lost their lives in the process. Modern scientists utilize early explorers’ findings to conduct further research to understand the history of Earth.

THE EARLY 1900S EXPEDITIONS

to Antarctica focused on competition to reach the South Pole.

1900

1901
British Discovery Expedition: Captain Scott and his team led their first Antarctic expedition with the goal of reaching the South Pole. The scientists turned around due to the extreme weather they encountered.

1907-1909
Ernest Shackleton led an expedition to the South Pole but was forced to turnaround after he runs out of supplies.

1910-1912
Norwegian Antarctic Expedition: Roald Amundsen and his team became the first group of people to reach the South Pole.

1910-1913
Terra Nova Expedition: Captain Robert Falcon Scott, along with his team, set out to reach the South Pole again, hoping to be the first people to accomplish the task, but they found out they were a couple of months too late. Scott and his team reached the South Pole but perished during the return trip home.

1915-1917
Endurance Expedition: Ernest Shackleton and his team set out on a journey to reach Antarctica again with the goal of crossing the continent. However, his ship was crushed by ice and destroyed. The team was rescued five months later.
THE MID 1900’S EXPEDITIONS

1957-1958
McMurdo Station, the first permanent research station in Antarctica, was built by the U.S. military to support the scientific study of over sixty nations.

1959
The Antarctic Treaty was established to make Antarctica a scientific preserve that banned military activity but supported freedom of research.

THE LATE 1900’S & EARLY 2000’S EXPEDITIONS

1990
Geologist, David Elliot, and his team discovered a set of large bones on Mount Kirkpatrick in Antarctica.

1994
Dr. William Hammer, along with other scientists, began excavating Mount Kirkpatrick and retrieved a skull and thigh bone of a dinosaur described as *Cryolophosaurus ellioti*.

2000
2003
Scientists continued to excavate *Cryolophosaurus* bones but ended the expedition early due to harsh weather.

2010
2011
Dr. Nate Smith and Dr. Pete Makovicky, along with other scientists, retrieved the remaining fossils of the dinosaur, *Cryolophosaurus*, and discovered new dinosaur fossils.
BACKGROUND

ABOUT THE SCIENTISTS IN THE FILM

DR. NATHAN SMITH
Paleontologist, Associate Curator, Dinosaur Institute
Natural History Museum of Los Angeles County

Originally from Crystal Lake, Illinois, Nate grew up fascinated with dinosaurs, science, and baseball. He received his B.A. in Biology from Augustana College, a M.S. in Geoscience from the University of Iowa, and a Ph.D. in Evolutionary Biology from the University of Chicago. Nate also served as a Postdoctoral Research Scientist at the Field Museum of Natural History and an Assistant Professor of Biology at Howard University before joining the Natural History Museum of Los Angeles County in 2015.

Nate conducts paleontological research for the museum’s Dinosaur Institute, focusing on the evolution and biogeography of Triassic–Jurassic dinosaurs, among other topics. He has made many significant finds in Antarctica and is responsible for naming Glacialisaurus (featured in Dinosaurs of Antarctica). Nate’s work has taken him to Antarctica, Argentina, China, and the southwestern and western United States, and he appeared in the giant screen film Dinosaurs Alive, featuring his collaborative dinosaur dig at Ghost Ranch in New Mexico.

LIBBY IVES
PhD Student, Geosciences—Physical Sedimentology
University of Wisconsin—Milwaukee

Libby grew up in Wisconsin and always had a strong love of the outdoors. She spent many summers camping and exploring wilderness areas as a counselor at YMCA camps. She completed a B.S. in Earth Science at Northern Michigan University, and holds an M.S. in Geology from Iowa State University. She has studied geological formations across the world, from volcanoes in Russia to Ice Age deposits in Argentina. Libby is trained as a Wilderness First Responder, a special type of medical certification that’s useful for remote field work expeditions.

As a PhD student, Libby is studying the sedimentology and stratigraphy of Late Paleozoic (320 – 250 million year old) Ice Age deposits at sites in Antarctica (Transantarctic Mountains), Tasmania (Wynyard Formation), and Argentina (Tepuel Basin). Her aim is to better understand the type, timing, and extent of glaciation during the Late Paleozoic.
BACKGROUND

**DR. PATRICIA RYBERG**

*Paleobotanist, Associate Professor of Biology; Honors Academy Director*
*Park University*

Although she was on a pre-med career track as an undergraduate student, Dr. Ryberg found her passion for paleobotany on a biology class field trip in Nebraska, where on an excursion to find fossil shark teeth, she also discovered fossil plants. She realized that field research would allow her to travel and spend time outside, discovering plants that are totally unlike anything that exists today. Dr. Ryberg’s bachelor’s degrees are in biological sciences and history from the University of Nebraska, and she completed her doctoral degree in botany at the University of Kansas.

Dr. Ryberg specializes in studying *Glossopteris*, an extinct plant species from about 260 million years ago. She’s especially interested in ecology and the evolution of plant life at high latitudes, and what the ancient past might signal about the future. Her work has taken her on research adventures around the world, from South Africa to Australia to Antarctica.

**DR. PETER MA KovICKY**

*Paleontologist, Professor, Department of Earth and Environmental Sciences, University of Minnesota*

Dr. Makovicky is a paleontologist whose research focuses on dinosaur evolutionary history. He received his PhD in Earth and Environmental Sciences from Columbia University, and spent 18 years as a Curator of Paleontology at the Field Museum in Chicago, where he was the lead curator of the Antarctic Dinosaurs exhibition. Prior to that he received his BSc and MSc degrees from Copenhagen University in Denmark, where he grew up.

He has conducted fieldwork on four continents and described more than 15 new dinosaur species from the US, China, Mongolia, Argentina, and Antarctica. Dr. Makovicky uses dinosaurs as model systems to study broader topics in evolutionary biology. His current research focuses on understanding how carnivorous dinosaurs evolved herbivory, and how dinosaur evolution and biogeography were shaped by major geological events. He has also studied biomechanics, scaling, dinosaur trackways, and behavior.
LESSON 4.1
EXPLORING ANTARCTICA

STANDARDS:
• CCSS.ELA-LITERACY.RI.4.7. Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
• CCSS.ELA-LITERACY.SL.5.2. Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

FROM THE FILM:
In the film Dinosaurs of Antarctica, you will learn that Antarctica has been an area of interest for explorers dating back to the 1800’s. The film provides several timelines, a representation of important events in the order in which they occurred, to help viewers understand more about Antarctica’s past. We are able to use early explorers’ successes and challenges to advance current research efforts.

LESSON OVERVIEW:
In this lesson, students will use an internet resource to review a timeline of Antarctica’s explorations to summarize important events that occurred in the continents’ history.

GRADE LEVEL 4-5
(1) 45 MINUTE LESSON

MATERIALS:
• Exploring Antarctica Timeline Student Resource Sheet 4.1
• Exploring Antarctica Timeline Student Resource Sheet 4.1a
• Technology to access the following resources:
  Video: Dr. Nate Smith Talks about Dinosaur Expeditions to Antarctica by the Natural History Museum of Los Angeles County [2:28 minutes] http://bit.ly/DrNateJourney
• Cover of the Dinosaurs of Antarctica Education Guide
LESSON 4.1
EXPLORING ANTARCTICA

EDUCATOR PREP:
Assign partners. Print a copy of “Exploring Antarctica Timeline Student Resource Sheet 4.1” and cut out the event cards. Be sure that you have enough event cards to provide each partner with one card. Print a copy of “Exploring Antarctica Timeline Student Resource Sheet 4.1a” for each student.

EDUCATOR GUIDE:
1. In the film Dinosaurs of Antarctica, students will learn that Antarctica has been an area of interest for explorers dating back to the 1800’s. Explain to students that early explorers were interested in learning about the continents’ landscape and resources. Findings from several expeditions led to more research topics that future scientists will begin to investigate. Ask students:

   Based on the title, Dinosaurs of Antarctica, and the picture, what do you think scientists in the film were researching in Antarctica?

2. Introduce the vocabulary word expedition to students. Ask students to raise their hands if they remember hearing the word expedition before.

   What does the word expedition mean?
   An expedition is a journey or voyage taken by a group of people with a particular purpose such as an exploration or scientific research.

   Explain to students that participating in expeditions allows people to experience new discoveries first hand versus just reading about it in a book or online. Ask students if they have ever read about a place and then actually had the opportunity to visit. Ask students to share how the experience of reading about a place is different from visiting the location. If students are unable to come up with an example, share about a local attraction. For example, some students may have seen advertisements for a local carnival that may have sparked their interest.

   Therefore, reading or hearing about the carnival may have made them curious about the rides, food, people, games, etc. Help students make the connection that explorations are often influenced by people’s desire to solve a problem, to discover something new or to satisfy general curiosity.

The Endurance was one of the two ships used for the Imperial Trans-Antarctic expedition to Antarctica from 1914-1917.
3. Share with students that they will have an opportunity to view the film *Dinosaurs of Antarctica* and that by now they may have guessed that scientists were interested in learning about dinosaurs. It’s okay if students are unable to figure out why scientists were researching dinosaurs. The aim is to prepare them for the general idea of the movie. Explain to students that they will complete a timeline activity to learn more about expeditions that occurred in Antarctica.

4. Provide students with a copy of “Exploring Antarctica Timeline Student Resource Sheet 4.1.” Explain to students that they will collaborate with a partner to research an event in history using an online resource. Tell students that they will have seven minutes to read about various expeditions that occurred in Antarctica. Allow seven minutes for students to read the timeline on the website. [http://bit.ly/coolantarctica](http://bit.ly/coolantarctica)

5. After the allotted time expires, give each set of partners one event card. Explain to students that their task is to determine when their specific event occurred in history (ex: date). They can refer back to the website for support. Allow three minutes for students to determine their event date. Circulate to provide support if needed.

6. After students determine their event date, direct students to organize themselves as a human timeline starting from the earliest date to the most recent date. After students form a human timeline, they are to quickly explain what happened that year in their own words. Turn the task into a fun challenge by telling students the goal is to get through the entire timeline in two minutes and set a timer.

7. Provide students with a copy of “Exploring Antarctica Timeline Student Sheet 4.1a.” Ask students:

   *How is this timeline different from the one you just reviewed?*
   This timeline has additional exploration dates from the 1990’s to 2000’s whereas the other timeline stopped in the mid-1900’s. Also, the timeline mentions the finding of dinosaur fossils.

   Review the additional events with students. Explain to students that in the film *Dinosaurs of Antarctica*, they will learn more about the findings of dinosaur fossils and how the discovery has led to additional research about climate science.
LESSON 4.1
EXPLORING ANTARCTICA

8. Using “Exploring Antarctica Timeline Student Sheet 4.1a” allow students to work with their partner to record responses to the following questions:

Why did so many explorers have a difficult time reaching the South Pole?
The extreme weather conditions and lack of resources made it difficult for explorers on the journey to the South Pole.

Who was the first team credited to reach the South Pole?
Roald Amundsen and his team were credited as the first group of people to reach the South Pole.

What happened in the 1990’s that had a significant impact on research in Antarctica?
Scientists began the process of excavating dinosaur fossils from Antarctica.

Why do you think researchers wanted to originally explore Antarctica?
Example: They were curious about the continents’ landscape and resources.

Why do you think researchers continue to explore Antarctica?
Example: They want to learn more about the life of dinosaurs, plants or other things that lived in ancient Antarctica.

Allow students to share their responses to the questions. Clarify misconceptions when necessary.

9. To conclude the lesson, show students the video, “Dr. Nate Smith Talks about Dinosaur Expeditions to Antarctica” by the Natural History Museum of Los Angeles County [2:28 minutes]. Facilitate a discussion using the following question prompts:

Where did Dr. Nate Smith and other scientists conduct their field research in Antarctica?
They searched for fossils in the Transantarctic Mountains.

Where do paleontologists find fossils in Antarctica?
Although Antarctica is mostly covered in ice, scientists search for dinosaur fossils in frozen rock.

Why did Dr. Nate Smith say that Antarctica felt like being in another world?
Although the process of retrieving fossils is similar to when working in other places, Antarctica’s unique weather and landscape is extremely different from anywhere else in the world.
Exploring Antarctica Timeline Cards

1901
Captain Scott and his team led their first Antarctic expedition to the South Pole. The scientists turned around due to the extreme weather they encountered.

1907-1909
Ernest Shackleton led an expedition to the South Pole but was forced to turn around after he ran out of supplies.

1912
Captain Robert Falcon Scott, along with his team, set out to reach the South Pole again, hoping to be the first people to accomplish the task, but they found out they were a couple of months too late. Scott and his team reached the South Pole but perished during the return trip home.

1911
Roald Amundsen and his team became the first group of people credited to reach the South Pole.

1915-1917
Ernest Shackleton and his team set out on a journey to reach Antarctica again to cross the continent. However, his ship was crushed by ice and destroyed. The crew was rescued five months later.

1990
Geologist, David Elliot discovered a set of large bones on Mount Kirkpatrick in Antarctica.
Exploring Antarctica Timeline

Review the timeline of Antarctica’s explorations and answer the questions below.

1901
Captain Scott and his team led their first Antarctic expedition to the South Pole. The scientists turned around due to the extreme weather they encountered.

1911
Roald Amundsen and his team became the first group of people credited to reach the South Pole.

1915-1917
Ernest Shackleton and his team set out on a journey to reach Antarctica again to cross the continent. However, his ship was crushed by ice and destroyed. The crew was rescued five months later.

1990
Geologist David Elliot discovered a set of large bones on Mount Kirkpatrick in Antarctica.

1994
Dr. William Hammer, along with other scientists, began excavating Mount Kirkpatrick and retrieved a skull and thigh bone of a dinosaur described as Cryolophosaurus.

2011
Dr. Nate Smith and Dr. Pete Makovicky, along with other scientists, retrieved the remaining fossils of the dinosaur, Cryolophosaurus.

Why did so many early explorers have a difficult time reaching the South Pole?

Why do you think early researchers desired to explore Antarctica?

Why do you think researchers continue to explore Antarctica?
LESSON 4.2
MODELING FOSSILS

STANDARDS:
• 4-EESL-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

FROM THE FILM:
In the film Dinosaurs of Antarctica, students learned that paleontologists and paleobotanists analyze fossils of plants, animals, and rock minerals to understand Antarctica’s landscape millions of years ago. Researchers in Antarctica study fossils to understand the history of life on ancient Earth.

LESSON OVERVIEW:
In this lesson, students will explore how fossils are formed by simulating molds and casts.

MATERIALS:
• Plaster of Paris
• Play Doh or modeling clay
• Paper or foam bowl
• Disposable circle-shaped tub
• Water
• Leaf
• Seashell
• Technology to show the following video:
  Dig Into Paleontology by SciShow Kids
**EDUCATOR PREP:**
Assign partners. Provide each partner with materials for the lesson activity.

**EDUCATOR GUIDE:**

1. In the film *Dinosaurs of Antarctica*, students discovered that scientists have conducted numerous expeditions to excavate dinosaur fossils in Antarctica. In the previous lesson, students learned that the first set of dinosaur fossils wasn’t found in Antarctica until 1986. Explain to students that today they will explore how fossils are formed.

2. Introduce the vocabulary word *fossil* to students. Ask students to raise their hands if they remember hearing the word fossil before.

*What does the word fossil mean?*

A fossil is any impression, remains or trace of an organism of past geologic ages that has been preserved in the earth’s crust.

Explain to students that there are many types of fossils and they can form in different ways. Share with students that most fossils are modified impressions, remains, mold and casts of parts of the organism versus actual body parts. Tell students the following:

Fossils help scientists learn about plants and animals that existed long ago. Trace fossils are fossils of a footprint, trail, or other traces of an animal rather than of the animal itself. Trace fossils are formed when an organism makes an imprint in the sand or mud and it hardens over time. This type of fossil can provide information about how the animals behaved when they were alive.

Body fossils are the remains of the body parts of ancient animals and they tell researchers about the appearance of ancient life forms. Body fossils include bones, claws, and teeth.

*Scientist Roger Smith shows a small amphibian fossil found in Antarctica. Photo courtesy of Akiko Shinya.*
LESSON 4.2
MODELING FOSSILS

3. Split the class into partners and provide each set of partners with materials for the lesson activity. Guide students through the lesson activity.

Say: Grab a handful of clay or dough. Spread the clay across the bottom of the circular container and flatten the clay so that it’s one inch deep.

Say: Using one of the objects provided, press the object into the clay. Tell students that organisms may leave an impression of their body outline in the sediment when they become buried. In this simulation, the clay represents sediment.

Say: Slowly remove the object from the clay to make a clear imprint. Tell students that in nature sometimes organisms may be eaten by bacteria and rot. In this simulation, physically removing the object represents the bacteria.

Say: Mix half of a cup of plaster of Paris and pour it over the clay so that it covers the impression. Tell students that when animals decay underneath the soil, the space they once possessed become filled with minerals from groundwater. In this simulation, the plaster of Paris represents the minerals.

Say: Now it’s time to let the plaster of Paris dry for thirty minutes. The deeper the impression, the longer it will take for the plaster to dry.

After 30 minutes say:

Use a spoon to pop out the piece of clay and plaster. Remove the clay to uncover the “fossil.” In this simulation, the plaster represents a cast of the object and fossils are often protected as molds and casts.

4. To check for understanding, ask students:

*If a dead animal was buried in the mud, what parts do you think would make good impressions?*

*In this simulation, what does the clay represent?*

*In this simulation, what does the plaster of Paris represent?*
5. Share with students that they will watch a video to learn more about how paleontologists discover and excavate dinosaur fossils. Show students the video, Dig Into Paleontology by SciShow Kids [4 minutes]. After students view the video, lead a discussion using the following question prompts:

   - *How do paleontologists remove fossils out of rocks and sand?*  
     Scientists use tools such as shovels, big diggers, and picks.

   - *Where do paleontologists take the fossils they find?*  
     Scientists take the fossils back to the lab to analyze their findings.

   - *How do paleontologists share their findings?*  
     Scientists share their work with museums and universities among other places.

   - *Why is the role of a paleontologist important?*  
     They study how life on planet Earth changed over time.

6. To conclude the lesson, remind students that in the film *Dinosaurs of Antarctica*, scientists found fossils of early reptiles and plant materials. Explain to students that scientists take fossils found during field research back to their labs to analyze and classify them.
STANDARDS:
• 4-ESS1-1. Identify the evidence that supports particular points in an explanation from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

FROM THE FILM:
The film *Dinosaurs of Antarctica* mentioned how scientists used plants, animals, and rock minerals to understand Antarctica’s landscape during the early Jurassic period. Geoscientists such as Libby Ives study the Earth’s composition, structure, and other physical aspects of the Earth such as physical sedimentology and glacial geology. Analyzing Earth’s landscape helps scientists understand how our planet changes over time.

LESSON OVERVIEW:
In this lesson, students will investigate changes in a landscape over time by creating a model of rock layers.

MATERIALS:
• Safety mask
• Safety goggles
• Plaster of Paris
• Measuring spoon
• Sand
• 3 plastic spoons
• Food coloring (red, blue, and green)
• Paper cup
• Pebbles
• Stopwatch
• Sandpaper
• Hand lens
• Modeling Rock Layers Student Resource Sheet 4.3
• Modeling Rock Layers Student Resource Sheet 4.3a
• Technology to play the following video:
  *Geology: Relative Dating of Rocks by Earth Rocks.* Stop the video at 2:22
LESSON 4.3
MODELING ROCK LAYERS

EDUCATOR PREP:
Split your class into small groups with a maximum of four students in each group. Based on your decision, gather enough materials for the group size. Decide how you want students to experience the learning activity. During a teacher-guided experience, students are led through each step of the process. During a self-guided experience, students utilize “Modeling Rock Layers Student Resource Sheet 4.3” and “Modeling Rock Layers Student Resource Sheet 4.3a” to complete the lesson activity.

EDUCATOR GUIDE:
1. In the film Dinosaurs of Antarctica, we learned that scientists worked to understand the story of Antarctica by researching how plants, animals and the climate changed over time.
   
   What do you know about rocks?
   A rock is a naturally occurring solid mineral material forming part of Earth’s surface and is often found on the surface or underneath soil or oceans.

   How many types of rocks can you recall?
   The three main types of rock classifications are sedimentary, metamorphic, and igneous. The differences between each type of rock are based on how they are formed. Sedimentary rocks are formed from sediments such as particles of sand, pebbles, shells, and other fragments of material. Metamorphic rocks are formed under the surface of the earth due to high heat and high pressure. Igneous rocks are formed through the cooling and hardening of magma or lava.

2. Explain to students that scientists learn about Earth’s history by examining records of past events that are often preserved in the rocks. Tell students that today they will investigate rock layers.

3. Provide each group with a set of lab materials and “Modeling Rock Layers Student Resource Sheet 4.3” and “Modeling Rock Layers Student Resource Sheet 4.3a.” Consider assigning group roles and responsibilities for each role. To promote student voice, allow students to decide who will perform each task in advance.

4. Whether you decide that students will be teacher-led or self-guided through the learning activity, ensure that each group has “Modeling Rock Layers Student Resource Sheet 4.3.” Review lab safety rules if necessary.
5. Restate to students that the purpose of the lab is to investigate rock layers by making a model. Tell students that they should be able to answer the following questions after completing the lab activity.

   Can you explain the process you used to create your rock layer model?

   How would you describe the layers of your model?

   How is your rock model similar or different from other students?

   What else do you wonder about rock layers?

6. Coach or facilitate the process of creating a rock layer model.

PART 1 STUDENT DIRECTIONS

• Wearing your lab equipment (ex: mask and safety goggles), place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.

• Using the same bowl, add 5 drops of green food coloring with 10mL of sand. Mix the ingredients until it appears blended.

• Pour your mixture from the bowl into a paper cup.
  Use your spoon to scrape the material from the bowl.

Educator note: Circulate the room to verify that each group has completed the previous steps correctly. Assist students as necessary. Explain to students that they created the bottom layer of their model rock. Ask students the following questions:

   What do you notice?

   What do you wonder?

Tell students that they will use a similar procedure to create the middle and top layers.
7. PART 2 STUDENT DIRECTIONS:

- Using a clean bowl and spoon, place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.

- Using the same bowl, add 5 drops of red food coloring with 10mL of pebbles. Mix the ingredients until it appears blended.

- Pour your mixture from the bowl into the paper cup. Use your spoon to scrape the material from the bowl.

Educator note: Circulate the room to verify that each group has completed the previous steps correctly. Assist students as necessary. Explain to students that they created the middle layer of their model rock. Ask students the following questions:

What do you notice?

What do you wonder?

Tell students that they will use a similar procedure to create the top layer.

8. PART 3 STUDENT DIRECTIONS:

- Using a clean bowl and spoon, place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.

- Using the same bowl, add 5 drops of blue food coloring. Mix the ingredients until it appears blended.

- Pour your mixture from the bowl into the paper cup. Use your spoon to scrape the material from the bowl.

Educator note: Students will need to wait 30 minutes for the rock model to set. Utilize the time frame by having students work on the “Modeling Rock Layers Student Resource Sheet 4.3a” with their group.

9. To further explain how geologists use relative dating principles for arranging rock layers into their order of formation, show students the first two minutes of the video, “Geology: Relative Dating of Rocks.” Stop the video at 2:22 minutes. As students view the video, instruct them to complete the video reflection section on the “Modeling Rock Layers Student Resource Sheet 4.3a.” Review the answers with students and allow time for corrections if necessary.
10. PART 4 STUDENT DIRECTIONS:

• After 30 minutes, retrieve the rock model by tearing away the paper cup. Place the sandpaper flat on the desk and lay the rock model on its side. Rub the entire rock model across the sandpaper 6 times.

• Observe the rock model by touching it and using the hand lens to view it closely.

• Complete “Modeling Rock Layers Student Resource Sheet 4.3a” with your group.

11. Set up a rotation format and allow students to conduct a gallery walk to view their classmates’ rock models. Set a timer for 5 minutes to allow students to rotate around the room. Encourage students to observe every rock model. Tell students to observe their classmates’ rock model by touching it and using the hand lens to view it closely. When the timer sounds, tell students to return to their seats.

12. To conclude the lesson, lead a whole-class discussion by asking students the following questions presented at the beginning of the lesson.

*Can you explain the process you used to create your rock layer model?*

*How would you describe the layers of your model?*

*How is your rock model similar or different from other students?*

*What else do you wonder about rock layers?*
Modeling Rock Layers Lab

Use the directions below to create a model rock layer.

☐ **Part 1: Student directions**
  - Wearing your lab equipment (ex: mask and safety goggles), place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.
  - Using the same bowl, add 5 drops of green food coloring with 10mL of sand. Mix the ingredients until it appears blended.
  - Pour your mixture from the bowl into a paper cup. Use your spoon to scrape the material from the bowl.

☐ **Part 2: Student directions**
  - Using a clean bowl and spoon, place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.
  - Using the same bowl, add 5 drops of red food coloring with 10mL of pebbles. Mix the ingredients until it appears blended. Pour your mixture from the bowl into the paper cup. Use your spoon to scrape the material from the bowl. Using the same bowl, add 5 drops of green food coloring with 10mL of sand. Mix the ingredients until it appears blended.
  - Pour your mixture from the bowl into a paper cup. Use your spoon to scrape the material from the bowl.

☐ **Part 3: Student directions**
  - Using a clean bowl and spoon, place 3 spoonfuls of plaster of Paris in the bowl using a measuring spoon for accuracy. Using a graduated cylinder, pour 20mL of water in the bowl with the plaster of Paris. Using a plastic spoon, mix the ingredients by slowly stirring the water and plaster of Paris in the bowl.
  - Using the same bowl, add 5 drops of blue food coloring. Mix the ingredients until it appears blended.
  - Pour your mixture from the bowl into the paper cup. Use your spoon to scrape the material from the bowl.

☐ **Part 4: Student directions**
  - After 30 minutes, retrieve the rock model by tearing away the paper cup. Place the sandpaper flat on the desk and lay the rock model on its side. Rub the entire rock model across the sandpaper 6 times.
  - Observe the rock model by touching it and using the hand lens to view it closely.
  - Complete “Modeling Rock Layers Student Resource Sheet 4.3a” with your group.
Modeling Rock Layers Lab

Lab notes: Use the table to record your observations.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Materials Used</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lab reflection: Respond to the questions below using complete sentences.

Can you explain the process you used to create your rock layer model?

________________________________________________________________________

________________________________________________________________________

How would you describe the layers of your model?

________________________________________________________________________

________________________________________________________________________

How is your rock model similar or different from other students?

________________________________________________________________________

________________________________________________________________________

What else do you wonder about rock layers?

________________________________________________________________________

________________________________________________________________________

Video reflection: As you view the “Relative dating of rocks” video, fill in the blank.

The three main types of rock classifications are sedimentary, metamorphic, and igneous. The differences between each type of rock are based on how they are formed. Each rock type tells a story. 

___________ rocks tell us a story about deposition. ___________ rocks tell us a story about volcanic events occurring in an area. ___________ rocks tell us about an area with a high temperature or pressure. ___________ is a geologic record of past events. Scientists determine the order of events through ___________ and ___________ dating. Relative dating describes which events happen ___________ or ___________ another. Rock layers on the bottom will be older than layers at the top.
Modeling Rock Layers Lab

Lab notes: Use the table to record your observations.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Materials Used</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom</td>
<td>plaster of Paris and water</td>
<td>explanation will vary</td>
</tr>
<tr>
<td>Middle</td>
<td>plaster of Paris, red food coloring, pebbles and water</td>
<td>explanation will vary</td>
</tr>
<tr>
<td>Top</td>
<td>plaster of Paris, blue food coloring, and water</td>
<td>explanation will vary</td>
</tr>
</tbody>
</table>

Lab reflection: Respond to the questions below using complete sentences.

Can you explain the process you used to create your rock layer model?

How would you describe the layers of your model?

How is your rock model similar or different from other students?

What else do you wonder about rock layers?

Video reflection: As you view the “Relative dating of rocks” video, fill in the blank.

The three main types of rock classifications are sedimentary, metamorphic, and igneous. The differences between each type of rock are based on how they are formed. Each rock type tells a story.

Sedimentary rocks tell us a story about deposition. Igneous rocks tell us a story about volcanic events occurring in an area. Metamorphic rocks tell us about an area with a high temperature or pressure. Stratigraphy is a geologic record of past events. Scientists determine the order of events through relative and numeric dating. Relative dating describes which events happen before or after another. Rock layers on the bottom will be older than layers at the top.
Geology Crossword Puzzle

Select a word that matches the definition below. Match the number beside the definition to the boxes placed across or down the grid. If correct, the word will fit perfectly in the puzzle.

Across
2. a journey or voyage taken by a group of people with a particular purpose
5. rocks formed by heat and pressure
6. rocks formed through the cooling of magma or lava
7. a series of processes that create and transform the types of rocks in Earth’s crust
8. a scientist who studies the Earth, its history, nature, materials, and processes
9. rocks formed by years of sediment compacting together and becoming hard
10. a place or environment where a plant or animal usually lives and grows

Down
1. the preserved remains or traces of a living organism from the past
3. a scientist who studies fossils
4. a solid made up of a bunch of different minerals
Geology Crossword Puzzle

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Dinosaurs of Antarctica Educator Guide

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