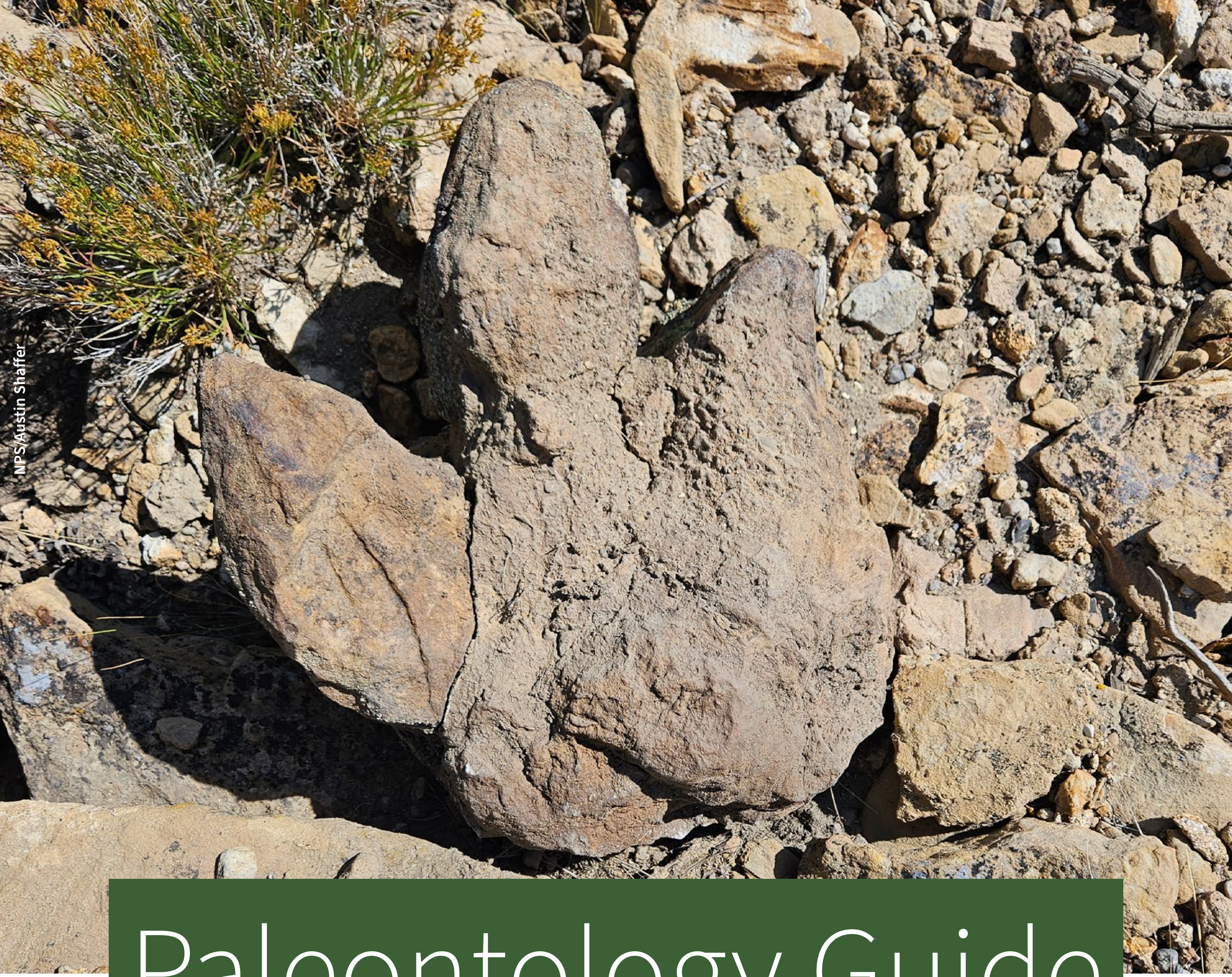
NPS/Austin Shaffer

Paleontology Guide

National Park Service, Geologic Resources Division

American Geosciences Institute

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Introduction to the National Park System

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The National Park System consists of over 430 recognized locations that tell the story of America. These national parks, historical parks, historic sites, monuments, recreation areas, and sites with other designations (all informally called "national parks") contain natural, cultural, and recreational resources that have national significance. The National Park Service (NPS), the agency in the Department of Interior that manages all national parks, "was established in 1916 to preserve the natural and cultural resources and values of the national parks for the enjoyment, education, and inspiration of present and future generations" (**NPS Mission**). More than 331,900,000 people visited the national parks in 2024 (**NPS Visitor Use Data**).

National parks are in all 50 states, as well as in U.S. territories and commonwealths. National parks range from Yellowstone National Park, established in 1872 as the world's first national park, to Amache National Historic Site, a site that preserves the memory of incarceration of Japanese people during World War II, that was established in 2014.

National parks contain many kinds of natural and cultural resources, such as the tallest mountain in North America (Denali National Park and Preserve), the lowest elevation on the continent (Death Valley National Park), the longest known cave system in the world (Mammoth Cave National Park), the site of the battle considered the turning point of the Civil War (Gettysburg National Military Park), the monuments of our nation's capital (e.g., the Lincoln and Jefferson memorials, the Washington Monument), and more. Most national parks also contain natural resources including trees, flowers, and other plants, wildlife including birds, fish, reptiles, and mammals, as well as geologic features like rocks, caves, mountains, plateaus, coasts, volcanoes, and fossils.

National parks can be thought of as America's largest classroom. Whether through formal education in a visitor center classroom, field trips and virtual visits, or during family vacations, people of all ages continue to learn about the ecological, geologic, cultural, and historic elements that are highlighted within the parks. Most of all, they are places of wonder and discovery for adults and children alike.

Paleontological resources within the parks include body fossils and trace fossils (evidence of the activities of living things) found in place, transported by rivers, glaciers, and other

Image from the NPS Fossils and Paleontology Photos and Multimedia Galleries processes, embedded in building stone, or brought there by people for various reasons. They are known from 288 national parks and NPS affiliates (along with many National Natural Landmarks and National Historic Landmarks). The ages of paleontological resources in parks range from 1.4-billion-year-old stromatolites in Glacier National Park to records of life from the past few thousand years found in lake sediments or packrat nests in many parks. Paleontological resources are a focal resource at a small number of parks. Although less abundant at many others, they are no less important. The fossil record of the parks captures a great sweep of evolutionary history in North America and shows the response of life to changing conditions. Many parks have significant connections to the history of paleontology as a science, including historic localities and various "firsts". Paleontological resources also have significant human dimensions and geoheritage values, including those in the artistic, cultural, economic, educational, and recreational realms.

Some of the most significant paleontological sites and fossil-producing areas in the United States are in national parks, including:

- **Carnegie and University Hills in Agate Fossil Beds National Monument** (Nebraska),
- **The White River Badlands in Badlands National Park** (South Dakota),
- **The Carnegie Quarry in Dinosaur National Monument** (Utah),
- **Lake Florissant in Florissant Fossil Beds National Monument** (Colorado),
- **Fossil Lake in Fossil Butte National Monument** (Wyoming),
- **The quarries in Hagerman Fossil Beds National Monument** (Idaho),
- **The John Day Fossil Beds in John Day Fossil Beds National Monument** (Oregon),
- **The Petrified Forest in Petrified Forest National Park** (Arizona),
- **Tule Springs in Tule Springs Fossil Beds National Monument** (Nevada), and
- **Waco Mammoth site in Waco Mammoth National Monument** (Texas).

Other national parks established in part for their paleontological resources include:

- **Bering Land Bridge National Preserve** (Alaska),
- **Channel Islands National Park** (California),
- **Death Valley National Park** (California),
- **Grand Canyon-Parashant National Monument** (California),
- **Joshua Tree National Park** (California),
- **Katahdin Woods and Waters National Monument** (Maine),

- **White Sands National Park** (New Mexico),
- **Yukon-Charley Rivers National Preserve** (Alaska), and
- **Zion National Park** (Utah).

This is just a partial list. Many other parks have significant fossils, from shells at Santa Monica Mountains National Recreation Area (California), to fossil forests at Yellowstone National Park (Idaho, Montana, and Wyoming), to ancient marine seafloors at Mississippi National River and Recreation Area (Minnesota), to shark fossils in the caves of Mammoth Cave National Park (Kentucky), to fossils in the shadows of battles at Colonial National Historical Park (Virginia) and Vicksburg National Military Park (Louisiana and Mississippi), to bone caves on the Potomac Heritage National Scenic Trail (Maryland) and at Valley Forge National Historical Park (Pennsylvania).

This guide makes use of the many online resources developed by NPS related to the locations described above, and more. The guide is intended to introduce students to how fossils are formed, studied, named, and monitored.

EDUCATIONAL CONTEXT FOR FOSSILS

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Fossils have played a crucial role in shaping our understanding of Earth's history and the evolution of life, providing valuable insights into ancient ecosystems. The activities in this guide each include a background section and educator instructions, along with corresponding handouts for learners. The educator instructions offer guidance for facilitating the activities and include additional resources, discussion questions, and hands-on exercises to enhance students' comprehension. These activities are supported by diagrams and images on the handouts, illustrating various aspects of fossil discovery and analysis. Beyond scientific significance, learning about fossils fosters a deeper appreciation for the history of life on Earth and encourages environmental education and stewardship. For these reasons, each activity in this guide has been connected with educational standards (based on the **K-12 Framework** and the Next Generation Science Standards--**NGSS**) and the United Nations Sustainable Development Goals (**SDGs**).

Science Education Connections

Studying fossils provides learners with the opportunity to explore key science concepts, such as the process of fossilization, the evolution of life over time, and the environmental conditions of past eras. These concepts can also be examined through the perspective of how geoscientists understand the natural world: temporal and spatial thinking, the interpretation of past life forms and their environments, and the practice of science – conducting fieldwork and developing models to analyze fossil evidence.

Temporal and Spatial Thinking: Temporal thinking allows learners to explore the vast timescales of fossil formation, from the sudden extinction events to the gradual processes of sediment accumulation that lead to fossilization. Temporal and spatial thinking can be developed across grades, starting with an understanding of how geological events impact life at different time scales, and later incorporating spatial thinking by encouraging middle and high school learners to visualize the global distribution of fossilized life forms. Learners can deepen their understanding of how fossils and other geological processes interact at various scales by developing and using models, fostering a comprehensive understanding of the role of fossils in Earth's systems.

- **NGSS Performance Expectations: 4-ESS1-1, MS-ESS1-4, MS-ESS2-3, HS -ESS1-5**

Past Life Forms and Environments: Geoscientists understand the natural world by studying Earth's historical features and ecosystems through the lens of fossils. Fossils provide critical evidence of past life forms and their environments, allowing scientists to reconstruct ancient ecosystems and better understand the evolution of life on Earth. By examining fossilized remains, geoscientists can explore how species adapted to environmental changes over time and how ecosystems evolved in response to geological events. This understanding helps to reveal patterns in Earth's history, such as the rise and fall of species, shifts in climate, and the impact of mass extinctions. Fossils also serve as markers of time, aiding scientists in the development of a timeline for Earth's history and the processes that have shaped its landscapes and ecosystems.

- **NGSS Performance Expectations: 3-LS4-1, MS-LS4-2, HS-LS4-1**

Conducting Fieldwork and Using Models: Geoscientists conduct fieldwork to study fossils by exploring sedimentary rock formations and other geological sites where fossils are commonly found. During field expeditions, they carefully examine the layers of rock and soil to identify fossil-bearing strata, using tools such as hammers, chisels, and brushes to carefully extract and preserve fossils. By documenting the location, depth, and orientation of fossils, scientists gain valuable information about the environments in which these organisms lived. Fieldwork allows geoscientists to observe the spatial distribution of fossils and how they relate to other geological features, such as volcanic deposits or tectonic boundaries. This hands-on research helps to build a more complete understanding of Earth's history, offering insights into past climates, ecosystems, and the evolution of life.

- **NGSS Performance Expectations: 4-ESS1-1, MS-LS4-2, HS-LS4-1**

SDG Connections

The following SDGs are related to the study of fossils and their role in understanding Earth's history and the evolution of life. These goals offer real-world contexts in which learners can apply their understanding of fossils to global challenges, such as conservation, biodiversity, and the responsible use of natural resources.

SDG 4: Quality Education: The study of fossils can enhance learners' understanding of Earth's history, evolution, and environmental changes. Fossils offer a hands-on approach to learning, promoting critical thinking, problem-solving, and scientific inquiry.

SDG 8: Decent Work and Economic Growth: The fossil industry, including fossil fuel exploration and paleontological research, creates jobs and economic opportunities. Sustainable management of these resources can contribute to local economies and employment.

SDG 12: Responsible Consumption and Production: Fossils, particularly those found in sedimentary rock formations, can provide information about the sustainable use of natural resources and guide practices for responsible resource extraction.

SDG 13: Climate Action: Fossils provide critical insights into past climates, helping scientists predict future climate patterns and understand the effects of climate change on ecosystems and species.

SDG 14: Life Below Water and SDG 15: Life on Land: The study of fossils helps scientists understand past biodiversity and the impact of environmental changes on species over time, contributing to efforts to conserve biodiversity in terrestrial, aquatic, and marine ecosystems.

INTRODUCTORY ACTIVITY: Where are Fossils Located?

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Objective: Learners will analyze maps to identify the distribution of fossils and fossil sites across the United States.

Introduction: Many rocks within the United States contain fossils, which are evidence of past ecosystems, biodiversity, and even human activity. Studying fossils helps us to understand how Earth has changed and the effects those changes have had on living organisms. The National Park Service (NPS) has 288 parks that contain fossil resources. These fossils represent the variety of organisms that have lived throughout every major geologic time from the Proterozoic (2.5 billion to 539 million years ago [mya]) all the way up to Quaternary (2.58 mya to today).

Have learners:

1. Study the map of the age of rocks throughout the United States. The key is in order of geologic age, starting with the oldest at the top (Precambrian), and getting younger as you go down the list. Discuss:
   - *Describe any patterns or trends that you see.*
   - *How do fossils from different geological periods relate to one another?*
   - *In which rocks do you think you would find fossils that look least like organisms living today? Why do you think this?*
2. Study the map of **National Park Service Units with Paleontological Resources**.
   - *Describe any patterns or trends that you see.*
   - *Compare the map of NPS Units with fossils to the map that shows the ages of rocks. What age fossils do you think are most common in NPS Units? Use evidence from the maps to support your answer.*
   - *Can you think of some reasons there might be fossils within some National Parks that do not match the ages of rocks located there? Discuss how some areas in which "young" (Quaternary age) surface deposits that contain fossils are not shown on the bedrock map, or the stones used in the construction of buildings on NPS lands may contain fossils from geologic ages that differ from those of the bedrock.*
   - *How many NPS Units with fossils are close to where you live? What types of fossils do you think they have?*

   a. Explore the National Park Service Master List of parks with fossil resources:

      i. Look through the table "Master List of Parks with Fossil Resources."

ii. Click on “State” to sort the list. Scroll to your state to find the names of the parks (Park Unit) that have fossils in your state. If your state does not have fossils (or has very few), choose another state of interest to you.

iii. Click on the link for the “Park Website” and look through the dropdown menu to learn about the park and its notable features (e.g., history, nature, education).

iv. Discuss what information you found on fossils in the park you chose to learn about.

b. Look through other pages created by NPS to highlight parks with significant fossil resources:

- **Primary Fossil Parks**- parks designated primarily because of their fossil resources.
- **Must See Fossil Sites**- information on some of the most significant and most visited fossil sites in NPS Units.
- **Fossil Site Points of Interest**- a list of trails, trail stops, and informational kiosks that highlight fossil resources in National Parks and National Natural Landmarks.

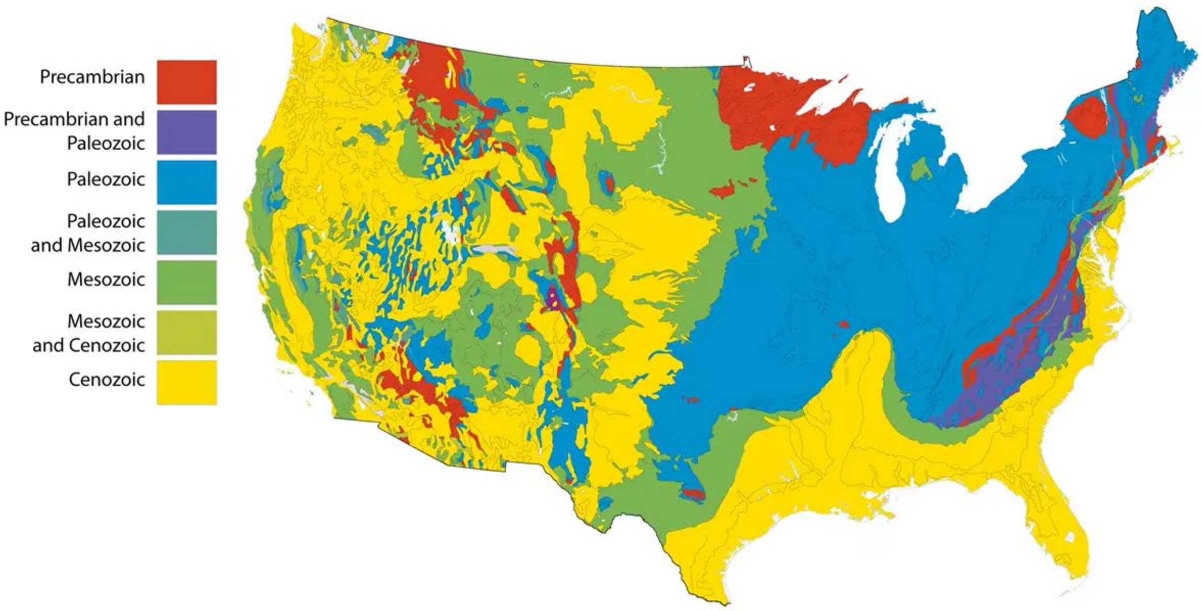
c. Discuss:

- *Why do you think some fossils are significant enough to have a National Park established around them?*
- *What kinds of fossil features make these parks special?*
- *Why do you think so many fossil sites are preserved in NPS units?*

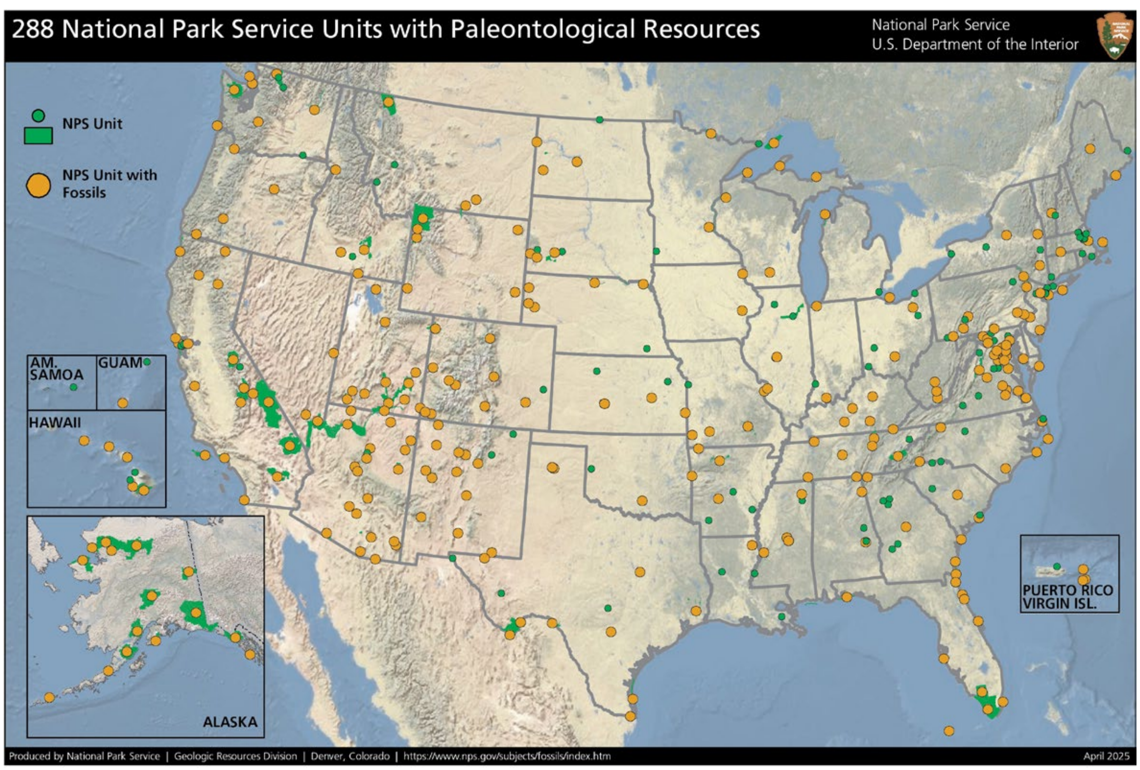
3. Scroll to the bottom of the **Visit Park Fossils** webpage to read the statement about “Leave No Trace.” Optionally, read the **Leave No Trace Seven Principles** to learn more.

HANDOUT: Where are Fossils Located?

www.nps.gov



Credit: **NPS**



Credit: **NPS**

Fossil Formation

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Fossil formation (also known as fossilization) requires specific conditions that preserve the remains of organisms within the Earth's crust, offering a glimpse into past life on Earth. This process typically begins when an organism is quickly buried by sediments, protecting it from decay. Soft tissues are rarely able to be protected and break down, leaving only the bones that mineralize and become fossils. Over millions of years, the process of permineralization results in minerals replacing the organic material, turning the remains into a combination of stone and original inorganic bone material. Fossilization can also occur through the formation of molds and impressions of the original organism in the surrounding rock. In extremely rare conditions, soft tissues can leave fossil impressions.

Image from the NPS Fossils and Paleontology Photos and Multimedia Galleries

ACTIVITY: How Body Fossils Form

www.nps.gov

Objective: Learners will describe conditions in which fossils can form and be preserved.

Introduction: Fossils are the remains of organisms or traces of their activities that have been preserved in rocks over time. Fossil formation occurs under specific conditions that allow parts of an organism's remains to be preserved through a variety of different processes.

Have learners:

1. Gently roll out a layer of **salt dough** that is about a 4" square and ½" thick.
   a. Press various small items into the salt dough to see what will leave an impression. Try out items that range from soft to firm to hard and flat to textured.
   b. Discuss which items make an impression easily and which do not. Also, discuss how much detail can be seen in the impression.
2. Read about **Impression and Compression** fossils.
   - *Discuss the similarities and differences and which type of fossil the activity in Step 1 mimicked most closely.*
   - *Consider how you might change the setup in Step 1 to model the other type of fossil.*
3. Roll out the salt dough again so there are no impressions in it.
   a. Place a small, thin item on one layer that has both hard and soft parts (e.g., **craft bird feather**, leaf, flower, pine needles), or use two different thin items, one soft and one hard.
   b. Roll out another color of salt dough that is about the same size as the first. Place this on top of the other layer so it covers the items.
   c. Gently and evenly press down on the top layer and/or place a book on top of it to compress the layers.
   d. Carefully remove the top layer of salt dough to see what happened.
   e. Discuss which part(s) of the item(s) left a fossil and how detailed it is.
   f. Optionally, use brown paint to paint the parts of the compression fossil to show where you would most likely expect to find organic material if the item had been a real organism.
4. Read about **Mold and Cast** fossils.

a. Discuss the similarities and differences between these and impression fossils.

b. Consider how you might change the setup in Step 1 to model these types of fossils.

5. Roll out two new pieces of salt dough. Repeat Step 3 a-e with a larger object (e.g., shell, walnut, small pinecone).

    a. Compare this fossil with the one made in Step 3.

    b. Discuss similarities and differences.

6. View the images on the handout and try to categorize them as impressions, compressions, molds, or casts. Note that most images will contain an “everyday” object (e.g., pencil, coin, ruler) as a scale for the viewer to be able to imagine the size of the fossil.

    a. Additionally, view 3D models of molds and casts:

        - **Crinoid** (**more information** from Grand Canyon National Park)
        - **Fish plate** (**more information** from Grand Canyon National Park)
        - ▸ *Categorize each as either a mold or a cast, giving evidence for your answers.*
        - ▸ *Consider and discuss the benefits (and possible drawbacks) of viewing 3D models of fossils.*

7. Consider what fossils are made of:

    a. Feel samples of both shells and shell fossils, noting differences in texture. Consider why you think they might differ.

    b. Study images of fossil specimens on the handout and describe possible evidence of the changes that occurred to each organism during the fossilization process.

        - Tree trunks: petrification
        - Dragonfly: carbonization of the imprint
        - Jawbone with teeth: permineralization (the jawbone and teeth being different colors is due to replacement by different types of minerals)
        - Brachiopod: permineralization (replacement of shell [originally made of calcium carbonate] with silica)

    c. Read about processes that change the composition of organisms, leading to fossilization:

        - **Permineralization and Replacement**
        - **Recrystallization**

d. Look at 3D models of fossils and consider how processes like permineralization help preserve details of organisms:

- **Petrified Tree Stump**
- **Dragonfly wing**

e. Discuss:

- *How do you think processes like permineralization and recrystallization help preserve organisms as fossils?*
- *What if these processes did not occur? How might this affect the number of fossils that exist? How might this affect our ability to locate fossils? Explain your answers.*

8. Consider what processes and factors affect the formation of a fossil.

a. Look back at the images on the handout and look for evidence of the type(s) of environments these fossils likely formed in.

b. Discuss:

- *What are the ideal conditions for fossilization?*
- *What processes might lead to a fossil becoming exposed naturally? How might these same processes affect the fossil?*
- *How common do you think it is for a dead organism to fossilize? Why do you think this?*

c. Read about **Taphonomy**, the study of the decay and fossilization of organisms.

9. Read more about **how body fossils form**.

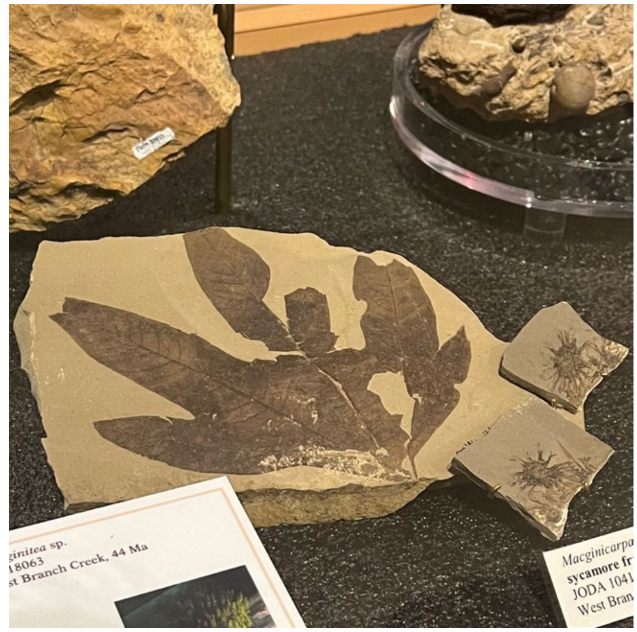
HANDOUT: How Body Fossils Form

Categorize the fossils in the following images as impressions, compressions, molds, or casts.

Dinosaur skin
(Denali National Park & Preserve, Alaska).*

Fossilized sponge in a building stone
(Chesapeake & Ohio Canal National Historical Park, Washington D.C., Maryland, & West Virginia).*

Fossilized fish
(Fossil Butte National Monument, Wyoming).*



Sycamore leaf and fruits
(John Day Fossil Beds National Monument, Oregon).*

- Which fossils were hardest to categorize and why?

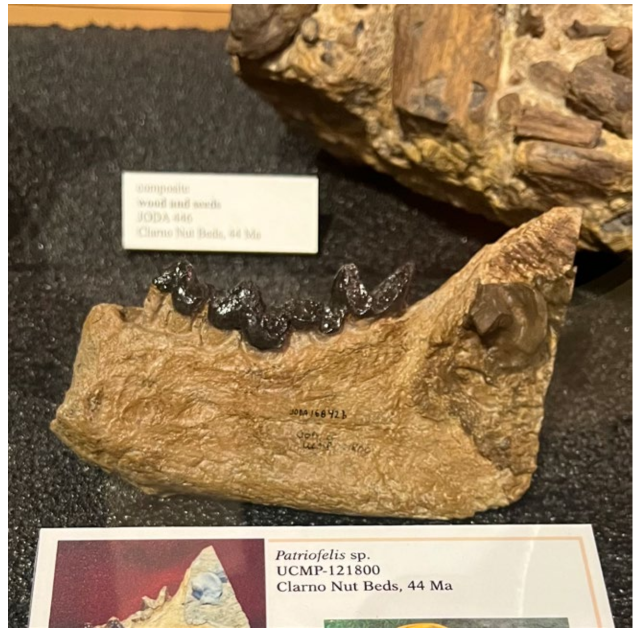
- What additional information would you want to know about each fossil to be sure that they were classified properly?

Study the following images to look for evidence that processes have changed the organism that made the fossil.

Tree trunks
(Petrified Forest National Park, Arizona).*

A brachiopod shell
(Tallgrass Prairie National Preserve, courtesy of Justin Tweet).*

Dragonfly
(Fossil Butte National Monument, Wyoming).*



***Patriofelis* jaw with teeth**
(John Day Fossil Beds National Monument, Oregon).*

- For each fossil, describe how you think they likely differ from the appearance of the organism that made them.

- What other information might you want to collect to show that changes occurred to the organisms as these fossils formed?

*All images were sourced from the NPS Fossils and Paleontology Photos and Multimedia Galleries.

ACTIVITY: Trace Fossils

www.nps.gov

Objective: Learners will investigate how trace fossils form and how they can be used to understand past environments and organisms.

Introduction: Trace fossils are preserved evidence of ancient organisms' activities, rather than their actual remains. Trace fossils offer insights into behaviors such as movement, feeding, and dwelling habits, revealing the ancient ecological roles of organisms within their environments.

Have learners:

1. Make trace fossils:
    a. Roll out a piece of play dough that represents land.
    b. Observe the available small animal toys and use one or more of them to write a short story (a few sentences) about the animals' behavior (e.g., a predator hunting its prey, two animals of the same species playing).
    c. "Walk" or move the animals across the play dough to make tracks that match the story from the previous step.
2. Read each other's stories and observe the fossil sites to try to match which story goes with which site.
3. Discuss how the:
    a. play dough will harden over time, much like rocks, and will make a record of the tracks, much like trace fossils.
    b. size, depth, and other features of the trace fossils show evidence of life in the past (e.g., the tracks could help determine the size or speed of the animal).
4. Look at a 3D model of **Felid and Camelid Tracks** from Death Valley National Park, California.
    a. Write a short story about how you think these tracks were made.
    b. These trace fossils were found in an area that has been off-limits to visitors since the 1940s.
        - *Why do you think this area has been made off-limits?*
        - *How can technological advancements, like 3D modeling, help with the preservation of fossil specimens?*

5. View images of trace fossils on the handout and describe what type(s) of animal(s) could have made them.

   a. Discuss what evidence could be used to determine the identity of the animal that made each trace fossil (listed in order to match the images):

      - Dinosaur footprints (tracks) (**additional information**)
      - Worm burrows and trilobite feeding tracks
      - Grasshopper eggs (**additional information**)

   b. Discuss how each of these examples qualifies as a trace fossil.

6. Look at a 3D model of an ***Anchisauripus* track** from Gettysburg National Military Park, Pennsylvania (**more information**).

   a. Make observations of the fossil and describe the foot of this organism. What might this tell you about how it walked, its size, or other information about this animal?

   b. The bottom of the block (from Points 1 to 2) is 17.5 centimeters (~6.9 inches) long. Zoom in on the model so that you are viewing the footprint at its actual size.

   c. Compare the size of the fossil to the length and width of your foot. What might this tell you about the size of the animal that made this track?

   d. Examine **additional *Anchisauripus* tracks**. The size and other features of the fossils are noted in the captions.

      - *Does this collection of images change your thoughts on the size or behavior of the Anchisauripus? Why or why not?*
      - *Why is it beneficial to have more than one fossil of an extinct organism?*

7. Read more about:

   a. **Trace Fossils** (the variety of trace fossils that exist),

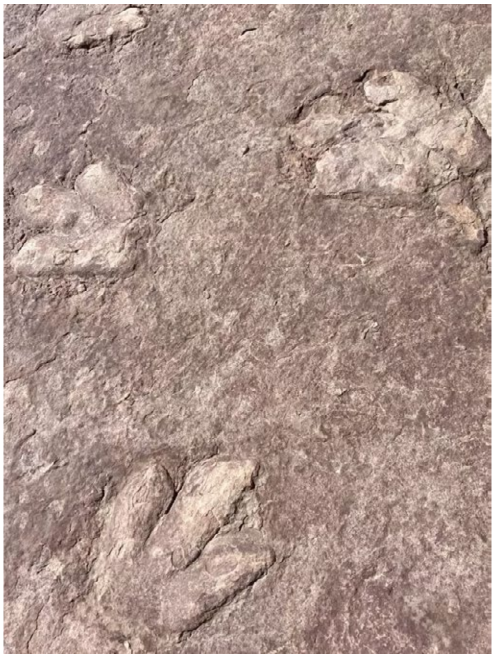
   b. **Utilizing Trace Fossils to Fill in Paleoecological Gaps at Curecanti National Recreation Area**, and

   c. **Ancient Forest Pests** (how paleontologists study plant fossils to determine what types of insects may have fed on them).

HANDOUT: Trace Fossils

www.nps.gov

For each of the following images, describe what animal(s) could have made them and how.



Credit: Kelsey Shores, Glen Canyon National Recreation Area, Arizona and Utah

Credit: Cassi Knight, Grand Canyon National Park, Arizona

- What else might you be able to tell about the organism from the fossils?

Credit: John Day Fossil Beds National Monument, Oregon

- Choose one image to answer this question: What else would you want to know about the fossil or the area around it, and how could this new information help you understand more about the organism that made the fossil you chose?

ACTIVITY: Preserved Organic Remains

www.nps.gov

Objective: Learners will explore different ways organisms can be preserved and how this provides additional evidence for paleontologists to understand ancient life.

Introduction: Preserved remains are the actual parts of organisms that have been preserved in exceptional conditions, such as amber, desiccating conditions, ice, or tar pits. These rare preservation environments protect the organism from decay, allowing delicate details like skin, fur, and even DNA to remain intact, offering a rare glimpse into ancient life.

Have learners:

1. Consider what conditions might cause an organism's body to be preserved.
   a. Observe the images of preserved materials found in National Parks.
      i. If possible, observe models of examples (e.g., flower in a block of ice, **insect in a lollipop**). Relate these conditions to how people preserve food (e.g., drying, freezing).
      ii. Read about the **various ways remains can be preserved**.
2. Discuss where on Earth these conditions might be found.
   a. Explore a map of climate zones within the U.S. (such as from the **U.S. Energy Information Administration**) and compare it to the map of NPS Units on the handout.
   b. Consider "microclimates" that could preserve remains. For example, this **brief description of caves** gives insight into why they are good locations paleontologists to find preserved materials (caves are also good sites for archaeologists to find human artifacts).
3. Use what you have learned to make a list of potential **NPS Units that have fossil resources** and that might contain preserved remains.
   a. Consider parks with cold or dry conditions, as well as parks that are likely to have undisturbed areas (or some combination of these factors).
   b. Circle or highlight areas on the map where these preservation conditions might be found.
   c. Then, look through the master list of NPS Units with fossil resources to get the names of at least three parks that could have these preservation conditions.
4. Read about preserved specimens found in National Parks:
   a. **Packrat middens (nests) with preserved organic material**

b. Preserved bats in caves in Grand Canyon National Park

5. Observe the image of fossilized shark cartilage found in Mammoth Cave and answer the questions that accompany it.

a. Use the **3D model of this fossil** to explore it further.

b. Discuss:

- How shark skeletons are made of cartilage, which is soft tissue that does not normally fossilize.
- How this fossil was found in a cave, which formed long after the fossil was deposited, meaning the cave's conditions are unrelated to the formation of this fossil.
- How the original depositional processes in the shallow marine sediments in which the shark was buried allowed for the cartilage to be preserved long enough that it was able to eventually fossilize as it was replaced by minerals (mineralization).

HANDOUT: Preserved Organic Remains

Observe the following images of preserved materials and note evidence of preserved materials.

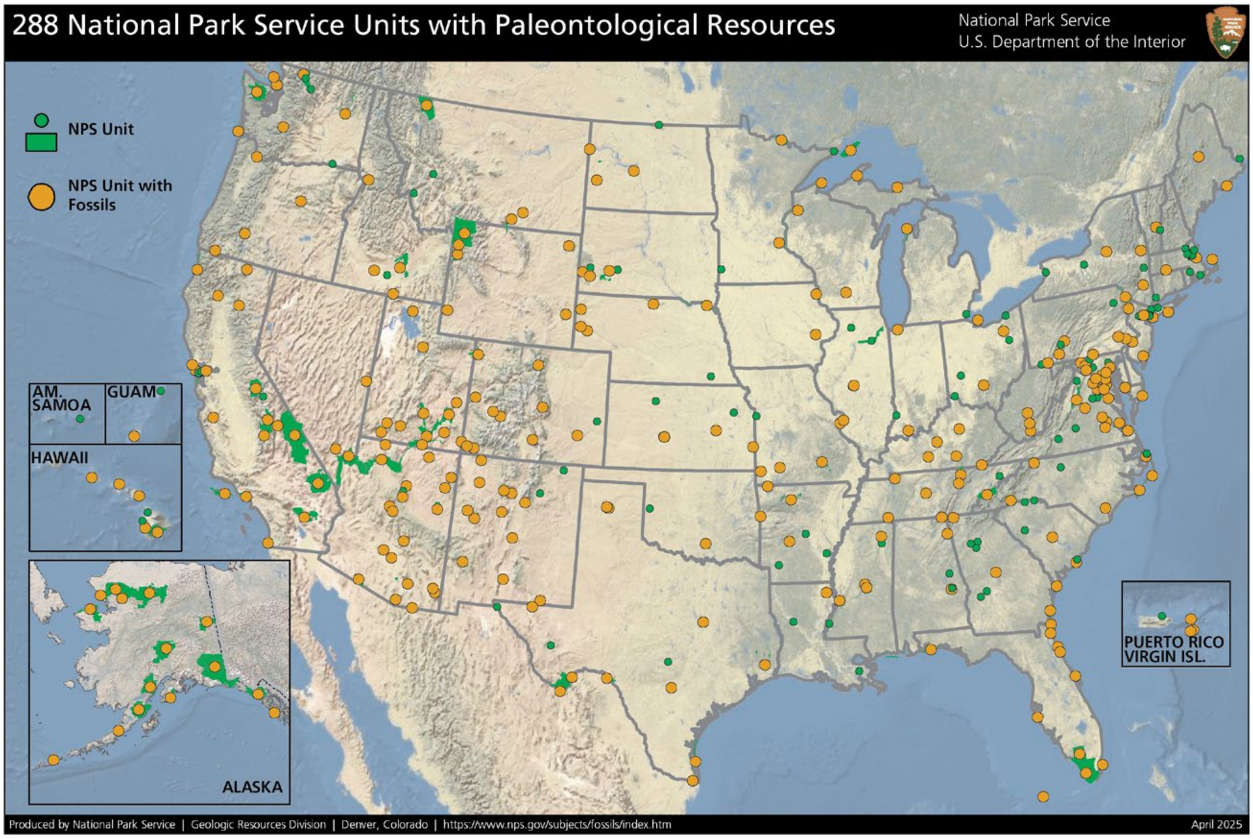
Shasta ground sloth dung, Grand Canyon National Park Museum. Credit: NPS/Mike Quinn

A packrat midden at Wupatki National Monument, Arizona that contains material possibly as old as a few thousand years. Credit: NPS/Justin Tweet

- How do these preserved materials differ from what people think of as fossils?

- What evidence might they provide regarding past life?

Identify at least three NPS Units that you think are most likely to have conditions in which you might discover preserved organisms.



Credit: NPS

- Which NPS Units, states, or regions did you identify as locations that might have preserved remains?

- What preservation methods do you think might occur in each location and why?

Observe the shark skeleton discovered in Mammoth Cave.

Credit: NPS

- While this fossil was found in Mammoth Cave, the shark that fossilized lived in a marine environment that existed long before the cave formed (first the sediment was deposited and turned to rock, then many millions of years later groundwater dissolved areas of the rock to form the cave). What conditions might have existed on the sea floor that allowed for the preservation of the shark's cartilaginous skeleton long enough for it to be fossilized?

ACTIVITY: Determining the Age of Fossils

www.nps.gov

Objective: Learners will model fossil dating methods to understand how fossils are studied.

Introduction: Fossil dating is the process of determining the age of fossils to understand the history of life on Earth. Scientists use different methods, such as relative dating and radiometric dating, to estimate how old a fossil is. In relative dating, fossils are compared to other fossils or rock layers to establish their age based on their position in the Earth's strata. Radiometric dating, on the other hand, measures the decay of certain isotopes in the fossil or surrounding rocks to provide a more precise age. The most famous of these techniques is radiocarbon dating, which works for organic materials up to about 50,000 years old, but there are several other techniques using different elements that can be used for much older rocks. These techniques help scientists piece together the timeline of life on Earth and track the evolution of different species over millions of years.

Have learners:

1. Make observations of the image of the Grand Canyon on the handout (**also available here**). Discuss:
   - *What observations did you make? What evidence is there that the rock layers differ from each other?*
   - *What similarities can be seen in different parts of the canyon (i.e., layers correlate from one area to another)?*
   - *What other evidence might be in the rocks that could help identify or describe them that can't be seen on the image?*
2. Complete the **Layers of Time** activity developed by Walnut Canyon and Wupatki National Monuments. This activity is focused on archaeology and uses examples of buried human artifacts, but is also relevant to paleontology and the burial of fossilized organisms.
   a. Discuss how horizontal layers are deposited, as well as processes that can change them (e.g., the stepped surfaces above and below layer D shows faulting, where the left side of the layer has moved up in relation to the right side).
   b. Discuss how the fossils or artifacts found within layers can help determine the age of the rock layers.
   c. Read the **section of this website on trilobites** as a good example of index fossils. Discuss how trilobite species fit each part of the definition of an index fossil:
      - easily identifiable species
      - lived for a relatively short time (in geologic terms)
      - widely distributed (geographically)
   d. Look over other examples of **index fossils** and the geologic times during which each lived.

3. Return to the image of the Grand Canyon in Step 1.

    a. Discuss the relative age of the rock layers, then look at an **image of Grand Canyon with select formations labeled**.

    b. If you want to look at the Grand Canyon in more detail, **use a diagram with all formations labeled**.

    c. Use a **diagram** to compare the ages of the Grand Canyon rock formations with four other parks.

4. Study the abbreviated Geologic Time Scale on the handout.

    a. Discuss how the start and end of different geologic times correlate to significant geologic and biologic events.

    b. Pose ideas about how scientists discovered various events on the time scale (e.g., a significant decline in fossils over a large area could be evidence of a mass extinction).

    c. You may also want to view the detailed **Geologic Time Scale** from The Geological Society of America (GSA).

5. Read about the **Geologic Timescale, Geologic Dating Techniques, and Numeric Ages**.

6. Watch a video on **Radiocarbon Dating** (view the entire video, or watch from 4:37-5:52 to focus on carbon dating).

7. Complete an activity on determining the absolute age of rocks and fossils:

    - **U.S. Geological Survey (USGS)**
    - **Association of American State Geologists (AASG)**

8. Read about how dating of geologic features, like **volcanic ash**, can also help determine the age of nearby fossils.

9. Research fossils of varying ages that have been found in National Parks: **Fossils Through Geologic Time**.

HANDOUT: Determining the Age of Fossils

Study the image of the Grand Canyon and make observations about the rock layers. You may want to use a pencil to make notes or mark areas that stand out to you.

Grand Canyon National Park, Michael Quinn

Study the abbreviated Geologic Time Scale. Note that the subdivisions of the Precambrian are not shown, and that time is reported in MYA (millions of years ago).

Eon	Era	Period	Epoch	MYA		Life Forms	North American Events
Phanerozoic	Cenozoic (CZ)	Quaternary (Q)	Holocene (H)	0.01	Age of Mammals	Extinction of large mammals and birds Modern humans	Ice age glaciations; glacial outburst floods
			Pleistocene (PE)	2.6			Cascade volcanoes (W)
		Tertiary (T) Neogene (N)	Pliocene (PL)	5.3			Linking of North and South America (Isthmus of Panama)
			Miocene (MI)	23.0		Spread of grassy ecosystems	Columbia River Basalt eruptions (NW) Basin and Range extension (W)
		Tertiary (T) Paleogene (PG)	Oligocene (OL)	33.9			
			Eocene (E)	56.0			Laramide Orogeny ends (W)
			Paleocene (EP)	66.0		Early primates Mass extinction	
	Mesozoic (MZ)	Cretaceous (K)		145.0	Age of Reptiles	Placental mammals Early flowering plants	Laramide Orogeny (W) Western Interior Seaway (W) Sevier Orogeny (W)
		Jurassic (J)		201.3		Dinosaurs diverse and abundant	Nevadan Orogeny (W) Elko Orogeny (W)
		Triassic (TR)		251.9		Mass extinction First dinosaurs; first mammals Flying reptiles Mass extinction	Breakup of Pangaea begins Sonoma Orogeny (W)
	Paleozoic (PZ)	Permian (P)		298.9	Age of Amphibians		Supercontinent Pangaea intact
		Pennsylvanian (PN)		323.2		Coal-forming swamps Sharks abundant First reptiles	Ouachita Orogeny (S) Alleghany (Appalachian) Orogeny (E) Ancestral Rocky Mountains (W)
		Mississippian (M)		358.9		Mass extinction	Antler Orogeny (W)
		Devonian (D)		419.2	Fishes	First amphibians First forests (evergreens)	Acadian Orogeny (E-NE)
		Silurian (S)		443.8		First land plants Mass extinction	
		Ordovician (O)		485.4	Marine Invertebrates	Primitive fish Trilobite maximum Rise of corals	Taconic Orogeny (E-NE) Extensive oceans cover most of proto-North America (Laurentia)
		Cambrian (€)		541.0		Early shelled organisms	
Proterozoic		Precambrian (PC, W, X, Y, Z)		2500		Complex multicelled organisms Simple multicelled organisms	Supercontinent rifted apart Formation of early supercontinent Grenville Orogeny (E) First iron deposits Abundant carbonate rocks
Archean				4000		Early bacteria and algae (stromatolites)	Oldest known Earth rocks
Hadean				4600		Origin of life Formation of the Earth	Formation of Earth's crust

NPS, Geologic Resources Inventory, 2018

Note that the dates on the geologic time scale are approximations that are revised as dating techniques and technologies are improved.

- Which division of geologic time is the longest: eon, epoch, era, or period? Which is the shortest? How can you tell?

- Which period shown on the geologic time scale is the longest? What events mark the beginning and end of this period?

ACTIVITY: Extinction Events

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Objective: Learners will analyze evidence of mass extinction events and compare how life forms differ after each of these events.

Introduction: Extinction events occur when multiple species disappear completely from the Earth, often due to significant environmental changes or catastrophic events. Fossil evidence provides a window into extinction events, helping scientists piece together the causes and effects of these events over millions of years, such as how they cause significant changes in biodiversity.

Have learners:

1. Make observations of an artist's rendering of a paleoenvironment on the handout.
   a. Discuss observations and inferences about the area (e.g., using the mountains as context for where in the U.S. this scene might have existed).
   b. Observe an image of what the area looks like today: **Landscape photos from page 9 of the photo gallery of White Sands, New Mexico**.
   c. Note the similarities between the paleoenvironment and the current environment (e.g., a relatively flat landscape with mountains in the distance). You may also want to view other images in the gallery that show times when water is in the area.
   d. Hypothesize what effect environmental changes likely had on the organisms in the White Sands area.
2. Read about **mass extinction events**:
   a. First, study the graph "Big Five Mass Extinctions in Earth's History" and discuss the relative size of each extinction event.
   b. Under "The Big Five Mass Extinctions," read about one or more mass extinction event, focusing on why they occurred.
   c. Optionally, read about the minor and mass extinction events during the **Triassic, Jurassic, and Cretaceous**, including the event that led to the extinction of the dinosaurs.
3. Return to the discussion of the White Sands area from Step 1.
   a. Read about the animals that used to live in the area on the **White Sands Paleontology webpage**.
      - *What was the environment like when they lived, and what adaptations did they have that helped them to survive?*

- *Did each type of animal in the area go extinct around the same time? What do scientists think is the cause of their extinction?*

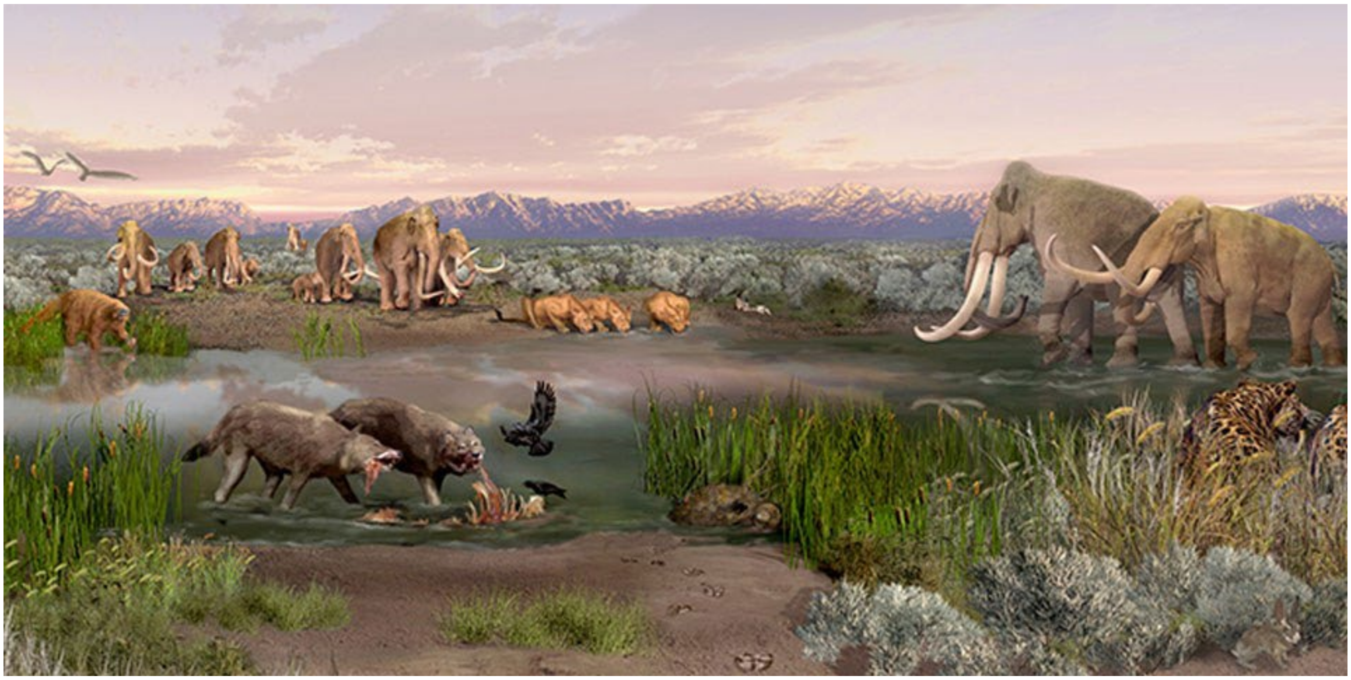
b. View images in the **NPS photo gallery** that depict animals living in White Sands today.

4. Discuss how paleontologists might recognize when a mass extinction occurred as they study the fossil record (e.g., looking through rock layers and no longer finding certain fossil types beyond a certain layer; and/or sudden changes in the body form of fossils).

HANDOUT: Extinction Events

www.nps.gov

Study the artist's rendering of an ancient environment (paleoenvironment) showing what they think the area around an NPS Unit looked like.



NPS

- What part of the U.S. do you think the artist who made this is trying to depict? Why do you think this?

- Visit the map of all **NPS Units**. What park(s) are near this area?

Studying Fossils

www.nps.gov

Studying fossils provides scientists with critical information about ancient life and the environments in which these organisms lived. By examining fossilized bones, shells, and other body structures, researchers can determine how species changed over time in terms of adaptations and biodiversity. By using trace fossils—like animal burrows, tracks, and feces—scientists can reconstruct ancient habitats, including the behaviors and interactions of organisms. When combined with other geologic evidence, such as rock types and geochemistry, fossil studies also aid in understanding how life responded to significant environmental events, such as climate shifts and geological changes. Through the lens of fossils, we uncover the history of life on Earth and gain a deeper understanding of the processes that have shaped our planet over millions of years.

Paleontologists play a crucial role in fossil preservation by carefully excavating and documenting fossil specimens. They also work with museums and research institutions to develop proper conservation techniques, ensuring fossils are preserved for future study and public education. Detailed imaging has been developed to aid in the study of fossils without having to disrupt their natural setting. Preservation of fossils and other resources is part of the mission of the National Park Service. Removing fossils from NPS units not only disrupts the historical record but also violates federal regulations aimed at safeguarding valuable paleontological resources for future generations.

Side image credit: National Park Service

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ACTIVITY: Fossil-Related Careers

Objective: Learners will be introduced to fossil-related careers and the work that they do to locate, study, and preserve fossils.

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Introduction: Studying fossils opens doors to diverse careers spanning paleontology, museum curation, and education. These careers offer exciting opportunities to explore Earth's past and inspire future generations of scientists.

Have learners:

1. Look at the images on the handout.

   a. Brainstorm a possible title for each image.

   b. Discuss what the people in each image are doing, and clarify their roles using the context for each image (in the order in which they occur on the handout):
      - A park ranger teaching about a fossil that is *in situ* (has been left in place where it was found).
      - Paleontologists carefully excavate a recently discovered fossil specimen.
      - A collection curator catalogs fossil specimens being stored at a park facility.
      - A lab technician tests a fossil for radiation.
      - Paleontologists work on interpreting fossils using observation techniques, including looking under the microscope.

2. Brainstorm a list of ways people might interact with fossils, including but not limited to:
   - Locating
   - Excavating (digging them up)
   - Studying their anatomy
   - Studying the rocks or environment of the area for context
   - Collecting
   - Preparing
   - Preserving
   - Describing (writing or teaching about fossils)

3. Read about **why fossil collections are maintained**.

4. Watch a **video on Hagerman Fossil Beds**, an NPS site used for scientific research.

   ► *Why is this site of particular interest to researchers?*

   ► *How do field work and lab work differ in terms of studying fossils? Why are both necessary?*

5. Read about different roles in NPS and how they contribute to locating, understanding, and preserving fossils:

    a. **NPS Careers: Resource Management**

    b. **NPS Careers: Interpretation, Education, and Visitor Services**

    c. **Who are the People Behind National Park Paleontology?**

    d. **Paleontology in the Parks Fellowships**

    e. **Museum curator**

6. Optionally, use the **What Kind of Scientist Are You? Matching Game** (pages 12-14 of the document) to discuss various fields of paleontology.

7. Choose one fossil-related career and research their background and roles. Possible options include: paleontologist (or specific foci like invertebrate paleontologist), paleoclimatologist, the NPS careers listed above, museum curator or collections manager, preparator or lab technician, scientific illustrator, or others:

    - *What level of education or training does this career require?*
    - *Where might someone in this career work (e.g., university, museum, park)?*
    - *What tasks or roles do they have that are related to fossils?*
    - *What other tasks or roles do they have as part of their job?*

8. Optionally, discuss the **difference between paleontology and archeology** to distinguish the two fields and to address the misconception that they are interchangeable.

HANDOUT: Fossil-Related Careers

As you view each image, consider what each person's role might be when it comes to collecting, studying, or preserving fossils.

Credit: NPS

Credit: Annette Rousseau, NPS

Credit: F. Brown, NPS

Credit: Jared Infanger, NPS

Credit: NPS

Describe what you think each person is doing in their fossil-related career. Add a descriptive title above or next to each image.

ACTIVITY: Fossil Excavation and Identification

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Objective: Learners will observe and model various jobs that paleontologists do to understand how fossils are located and identified.

Introduction: Paleontologists study fossils to understand the history of life on Earth, focusing on how ancient organisms lived and interacted with their environments. They use a variety of tools and techniques at field sites to excavate and analyze fossils. Through their research, paleontologists help piece together Earth's evolutionary history, providing insights into past climates, ecosystems, and the development of life over millions of years.

Have learners:

1. View the images on the handout to make observations of the work done by paleontologists. Discuss:
   - *What tools do you see in the images? How and why do you think they are used?*
   - *What do the images have in common? What do these similarities reveal about the process of excavation?*
   - *How do the images differ? Why do you think not every excavation is the same?*
   - *What surprised you the most about these images and why?*
2. Watch the video **Digging for fossils at Petrified Forest National Park** to see an excavation in action.
3. Complete one or more activity from the NPS Educator Resources database to learn more about the work of paleontologists:
   a. To mimic how paleontologists locate fossils, complete: **So You Wanna Be a Paleontologist?**
   b. To model excavation, complete: **Paleo Fossil Cookie Dig**. (Tip: In addition to rounded toothpicks, it is helpful to have small paintbrushes to use during excavation.)
   c. To analyze an excavated outcrop, complete: **Inventory + Monitoring Evaluations**. (The video and evaluation sheet can be accessed here: **I&M Evaluations**.)
   d. To learn about identifying fossils and using them to describe past environmental conditions, complete: **So You Wanna Be a Paleobotanist?**

4. Learn about two fossils that were discovered by visitors of Badlands National Park:

a. Watch the presentation **Kylie's Fossil Find**.
- **Supplementary documents**
- **Images from the Saber Site**
- **Additional information on the saber fossil**

b. Read about and view photos from The Big Pig Dig.
- **Read the story**
- **View the interpretive sign at "The Pig Dig"**
- **Access the Photo Gallery** (look for items labeled "Big Pig Dig")

c. Discuss why it is important to report fossil finds within National Parks to rangers.

5. Optionally, complete the activity, **Coordinates and Gridding in Archeology**, to compare and contrast what paleontologists and archeologists do.

HANDOUT: Fossil Excavation and Identification

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Observe the images showing paleontologists at work.

Credit: NPS/Bill Faulkner

Credit: NPS

Credit: NPS

Credit: NPS

Credit: NPS

Credit: NPS

Credit: NPS

Credit: NPS

Credit: NPS/Brent Sumner

Credit: NPS

▶ Note the similarities and differences between each fossil excavation site.

▶ How do paleontologists ensure that they do not damage fossils during excavation?

ACTIVITY: Using Fossils as Evidence

www.nps.gov

Objective: Learners will relate the traits of organisms to what environmental conditions may have existed and/or what behavioral traits the organism may have had.

Introduction: By studying fossils found in different National Parks and Monuments, scientists can compare the ages of fossils and how different ecosystems have changed over time, including changes in biodiversity. Fossils can also reveal interactions between ancient organisms, which gives insight into organism behavior and details about the environment.

Have learners:

1. Print out the complete **geologic time scale**. Cut apart the four columns that represent the four major divisions of geologic time.

    a. Tape the columns together so they are stacked vertically in time order, with the present day on top.

    b. Tape your vertical geologic time scale onto poster paper.

    ▸ *Did each of these divisions last the same amount of time? How can you tell?*

    ▸ *If you found rock layers from each division, in which age do you think you would find the most fossils: Cenozoic, Mesozoic, Paleozoic, or Precambrian? Why do you think this?*

2. Visit **Fossils Through Geologic Time** to read short descriptions of the organisms that lived in each of the four major divisions of the geologic time scale.

    a. Click on each major division to learn more about organisms that lived in each time range and the parks that have fossils from each division.

    b. Choose 4–6 national parks or monuments (other than Florissant Fossil Beds National Monument and Grand Canyon National Park, which are used later in this activity) and determine the age range of fossils that have been found at each of them.

    c. Label the age range of the fossils from each park you chose on the geologic time scale you assembled in Step 1. (You may want to **view an example** of a diagram like the one you are constructing, but please note that it is not updated for recent findings).

    d. For the parks or monuments that you chose labeled on your diagram:

    ▸ *Which has fossils that represent the longest timespan? What has the shortest? What factors could affect the age range of fossils within an NPS unit?*

- *Which is most likely to have fossils that look similar to the organisms that exist within the area today? Which is least likely? Explain your answer.*

3. Study the diagrams of fossils found within rock layers at Florissant Fossil Beds National Monument.

a. Identify the oldest and youngest layers that contain fossils.

b. Add the time range of fossils found at Florissant Fossil Beds National Monument to your geologic time scale diagram.

4. Observe and discuss an **outcrop diagram of the Grand Canyon** (created by Anne Miller, paleontologist at Grand Canyon National Park) that shows layers of rock that were deposited over 1.5 billion years.

- *Note the four geologic times indicated on the left side of the diagram. Which section has the most differences compared to the other times)?*

- *View an* **image of the outcrop** *and compare the diagram to it. The red line represents a non-conformity where erosion has worn away rocks so that part of the geologic history of the Grand Canyon is missing. You may also want to view a* **close-up image of the non-conformity** *in another part of the canyon. How do the rocks below the non-conformity differ from those above it?*

- *Where on the outcrop diagram do you think this non-conformity is located? Explain your reasoning.*

- *In which rock layer(s) do you think fossils might be found? Why do you think this?*

a. Optionally, view another image that **relates the outcrop diagram to the rock layers of the Grand Canyon**.

b. Look at the names of specific rock layers (called formations) within the **Grand Canyon Outcrop**, then view images of select layers. Consider which rocks you think might contain fossils and why.

- **Basement rock (specifically, the Elves Chasm pluton)**
- Two layers within the Unkar Group: **stromatolites in the Bass Limestone** (the bottom layer of this group), and **ripples preserved in the Dox Formation** (near the top of this group)
- **Chuar Group**
- **Bright Angel Shale**
- **Redwall Limestone**
- **Surprise Canyon Formation**
- **Hermit Siltstone** (the layer above the researcher's head), and **raindrop impressions in the Hermit Formation**
- **Coconino Sandstone**

c. Optionally, you may want to read about the formation of some of these layers in the article, **Numeric Ages of Grand Canyon Rocks**.

d. Cut apart and make observations of the images of fossils found in Grand Canyon National Park.

e. Arrange the fossils in the order in which you think the organisms lived in the area that is now the Grand Canyon.

f. Consider grouping organisms that you think lived at the same time.

g. Discuss your chosen order, and if possible, compare it to the order that others decided on.

h. Obtain a copy of the **Grand Canyon outcrop diagram with stars** to match the images to the rock layer that each specimen is from.

▸ *How did your original order compare to the actual order?*

▸ *Explain your thinking for one specimen you got incorrect—why did you think it was older or younger than it turned out to be?*

i. Add the time range of fossils found at Grand Canyon National Park to your geologic time scale diagram.

▸ *How does the age range of fossils at Grand Canyon National Park compare to the other parks on the diagram? What might this tell you about the environment of the Grand Canyon?*

▸ *Think about the climate and ecosystem that exist at the Grand Canyon today. Based on the fossil images and rock types on the outcrop diagram, has this area always had the same climate as it does now? How can you tell?*

j. Obtain images of fossils found within caves located in the Grand Canyon. Consider how they compare to the other fossil specimens and make a claim about their age, including an explanation of why you think that.

5. Optionally, complete an activity on **Biodiversity and Adaptation** to introduce or review the concepts that:
   - Organisms survive best when they have traits that are suited to their environment.
   - Ecosystems benefit from biodiversity, in which different species fill specific roles (niches) and interact with other species in certain ways (e.g., food chains, symbiotic relationships).

6. Read more about **fossils found in the Grand Canyon**. Discuss:

▸ *How has the climate/ecosystem of the area changed over time, and how has that affected the organisms that have lived there?*

   i. Optionally, return to **Fossils Through Geologic Time** and choose at least one other park that has fossils from more than one division. Based on the types of fossils found there over time, describe (and/or research) how the climate/ecosystem around that park has changed.

  ii. Alternatively, complete the activity **Tule Spring Fossil Beds National Monument Past vs. Present**.

7. Read about the **Diversification of Life**.

   a. Add the four significant evolutionary events from this article to the geologic time scale.

   b. Describe how these events relate to the divisions of time on the geologic time scale.

   c. Then, describe the spacing of these events over time and explain why you think each evolutionary shift took as long as it did.

HANDOUT: Using Fossils as Evidence

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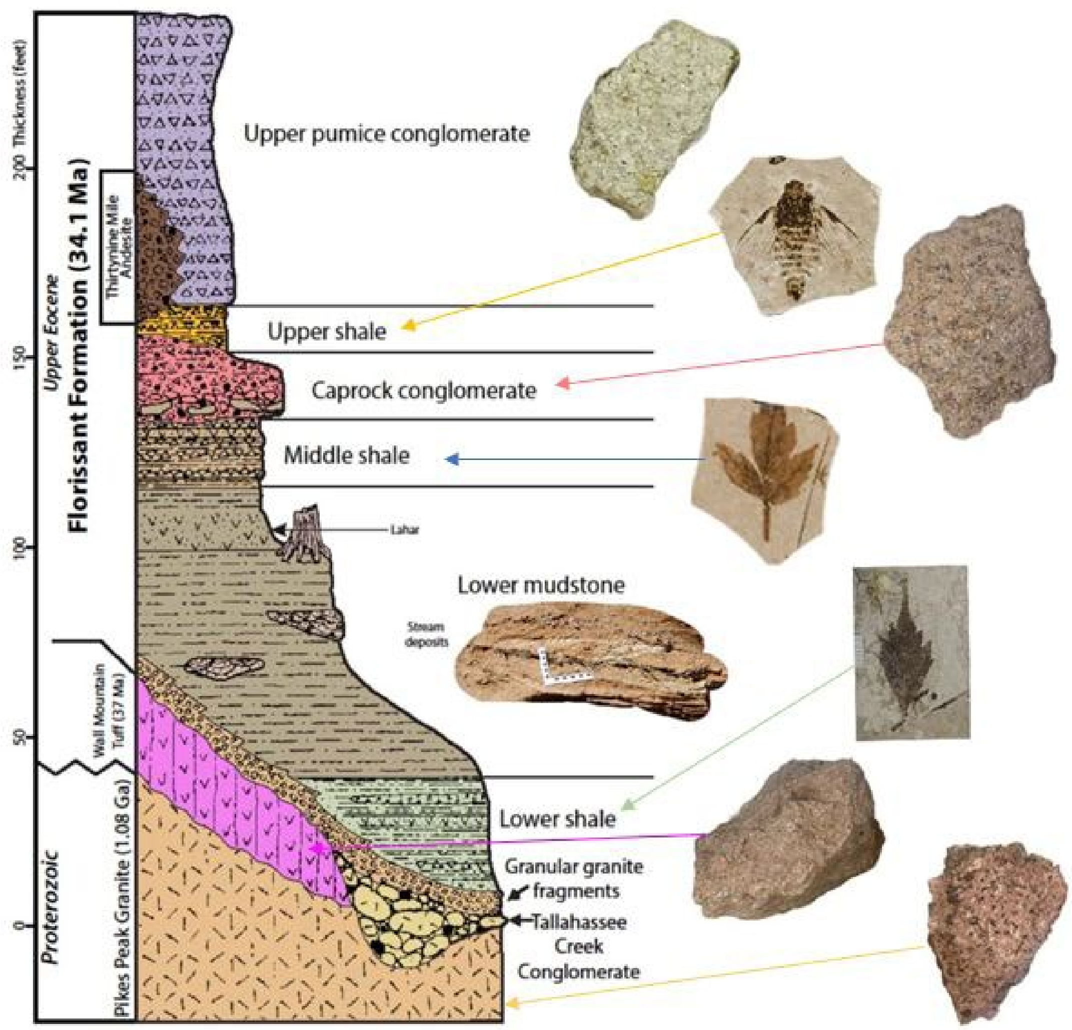
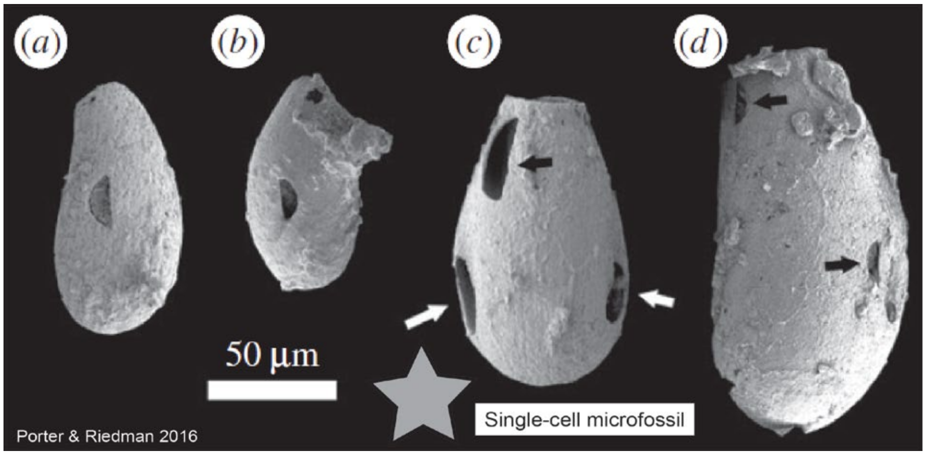
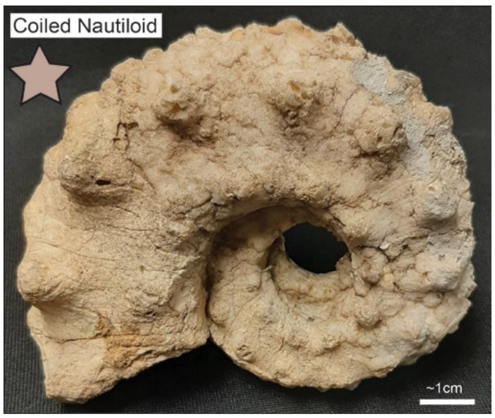
Make observations of the partial geologic time scale and compare the age range of fossils from select National Parks.

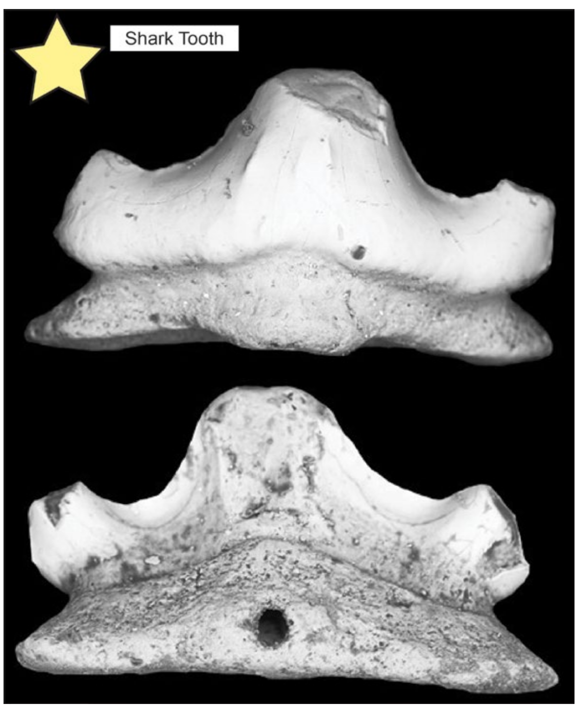


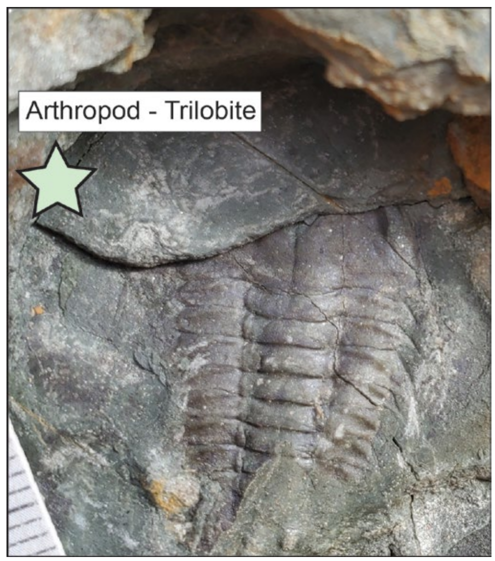
Credit: Florissant Fossil Beds National Monument



Credit: NPS-Grand Canyon National Park/Porter and Riedman





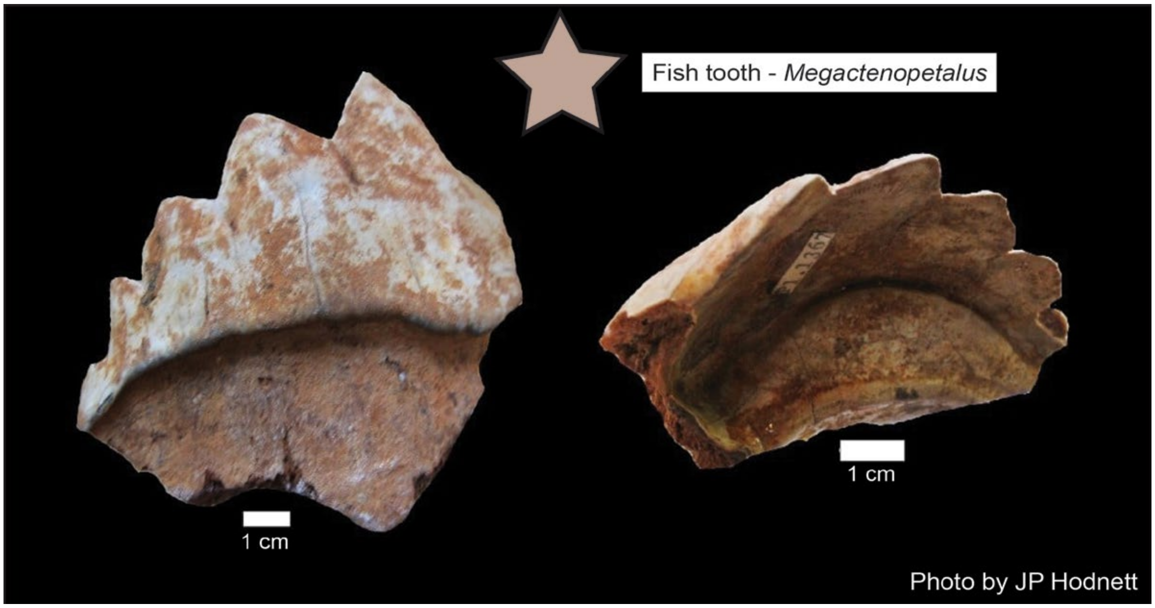


Left middle and bottom credit: NPS-Grand Canyon National Park

Right middle and bottom credit:
NPS-Grand Canyon National Park/Anne Miller

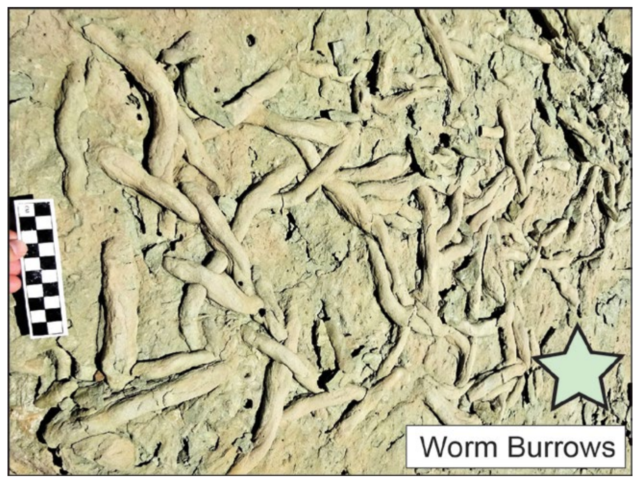
Credit: NPS-Grand Canyon National Park

Credit for all images on this page:
NPS-Grand Canyon National Park/Anne Miller
(except as noted)

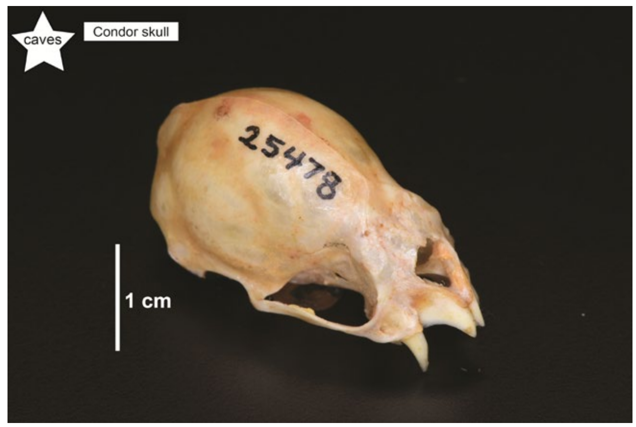


Credit: NPS-Grand Canyon National Park/JP Hodnett

Credit: NPS-Grand Canyon National Park/Anne Miller



Credit: NPS-Grand Canyon National Park/Anne Miller



Credit: NPS-Grand Canyon National Park/Anne Miller

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NPS-Grand Canyon National Park (except as noted)

ACTIVITY: Paleontology and Geoheritage

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Objective: Learners will explore the intersection of geoheritage and paleontology, emphasizing the cultural and scientific significance of fossils and the work of paleontologists to understand past environments.

Introduction: Fossils are not only crucial for understanding the history of life on Earth, but also serve as essential markers of past environments and ecosystems. Fossil sites offer valuable insights into the evolution of species and the processes that shaped Earth's surface. These locations, often protected as part of national parks and heritage sites, provide a window into past geological periods and support unique ecosystems. Fossil discoveries also have cultural significance, offering connections to ancestral lands and historical events. Additionally, these sites can hold economic value, contributing to tourism and educational opportunities. For more background, please read **Fossils & Geoheritage**, and watch "**Preserving America's Paleontological Heritage with the U.S. National Park System**" (22:08–34:07).

Have learners:

1. Explore the **geoheritage values defined by the National Park Service** and how they relate to fossil sites and paleontological discoveries. Brainstorm on the handout about the scientific, economic, cultural, and aesthetic/artistic value of fossils.

   a. Choose one or more videos to watch to learn about paleontological resources found in specific National Parks and Monuments and to add to your list about how fossils relate to geoheritage values:
      - **Petrified Forest National Park**, Arizona (~20 minutes)
      - **Dinosaur National Monument**, Colorado and Utah (~ 5 minutes)
      - **John Day Fossil Beds National Monument**, Oregon (~4 minutes)

   b. Discuss your connections between fossils and the geoheritage values, which may include:

      i. Scientific Value:
         - Fossil sites offer vital insights into evolutionary processes and allow for study of extinct species.
         - The traits of fossils can be interpreted to help scientists understand past climates, ancient ecosystems, and environmental changes over time.
         - Paleontological studies support broader geological research by providing context for Earth's surface changes, like shifts in landforms and climate.

      ii. Economic Value:
         - Fossil sites contribute to tourism and paleontology-related educational efforts, including museums and educational programs.
         - Specific fossils can aid the extraction industry in locating fossil fuels buried underground, enhancing exploration and resource development efforts.
         - Funding of fossil hunting and excavation can support universities and research institutions.
         - Fossils and their associated minerals can also be valuable for scientific research and conservation efforts.

iii. Cultural Value:
- Fossils often hold cultural significance for Indigenous communities, representing important connections to ancestral lands and spiritual beliefs.
- Stories of ancient creatures and the events leading to fossilization are passed down through generations, connecting cultures to Earth's deep history.
- Paleontological discoveries can also reflect cultural shifts in human understanding of the natural world and our place within it.

iv. Aesthetic/Artistic Value:
- Fossils are often visually striking, inspiring both scientific inquiry and artistic expression.
- Building stones with prominent fossils are sometimes placed to be particularly visible in a construction.
- Fossilized remains, from intricate plant impressions to immense dinosaur skeletons, hold aesthetic value that connects people with the ancient past.
- Paleontological digs can reveal fascinating, often dramatic, changes in the landscape, leading to artistic and scientific exploration.

2. Read a pamphlet on **Geoheritage from Florissant Fossil Beds**.

a. Discuss how the discovery of fossils at Florissant contributed to the settlement of the area and affected human populations over time.

3. Optionally, read and summarize one or more of the following time periods and how people's lives and knowledge have been impacted by the discovery of fossils, considering both cultural and scientific shifts:
- **Pre-1492 AD: Fossils & Native People**
- **1492–1800 Colonial & Early National Period**
- **1800–1865: Antebellum through American Civil War**
- **1865–1916: Early National Parks & Monuments**
- **1916–1966: First 50 Years of the National Park Service**
- **1966–2008: Filling the Gaps in the Fossil Record**
- **2009–Present: A New Beginning for NPS Fossils**

4. Write an argument for the conservation/preservation of fossil sites, emphasizing their value as geoheritage landmarks, including their cultural, scientific, and educational importance.

HANDOUT: Paleontology and Geoheritage

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Fossils and Geoheritage Values

Aesthetic/Artistic	Scientific

Economic	Cultural

Use the information you collected above to write an argument for the conservation/preservation of fossil sites, emphasizing their value as geoheritage landmarks.

National Park Service

The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

The Geologic Resources Division assists the National Park Service and partners in the servicewide coordination, support, and guidance necessary to understand and implement science-informed stewardship of geologic and associated park resources; reduce impacts from energy, mineral, and other development; and protect visitor values.

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