Teaching Paleontology in the National Parks and Monuments

A Curriculum Guide for Teachers of the Fourth, Fifth and Sixth Grade Levels

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Table of Contents

Teaching Paleontology

Track 3
Sixth Grade
Our Changing Earth

Classroom Activities

Outdoor Activities

Index of Activities by Concept
National Park Service Fossil Sites

Introduction

Teaching Paleontology in the National Parks and Monuments is a fossil education program designed by National Park Service staff for use in the classroom and in the Parks.

Teaching Paleontology consists of three units for fourth, fifth, and sixth grades. The units are designed as building blocks for increasing the student's knowledge and understanding of fossils. The program focuses on the different types of fossil formation, how we use the information from fossils to put together a picture of the past, the earth forces that have contributed to the changing life and climate we find reflected in the fossil record and the role the National Park Service plays in fossil protection. The three units are:

1. Fourth Grade; What Are Fossils
2. Fifth Grade; Putting Together the Pieces
3. Sixth Grade; Our Changing Earth

Each unit includes goals and objectives, a teacher's introduction to the subject matter covered in the unit, sources for further information, vocabulary and concepts, classroom activities and outdoor activities. While the units are designed to be used as building blocks from fourth grade through sixth grade, each unit can stand on its own.

Each activity includes objectives, materials list and background information so it can be conducted without having to review the relevant material in the **Teacher's Introduction**. Any handouts associated with an activity are on pages to be removed for photocopying. You may choose to do some or all of the activities in each unit. An appendix is included at the end of Teaching Paleontology with concepts and objectives for each activity so that you can better meet your class needs. If your class is limited by time, you may choose to split the group into teams, with each team completing an activity and then reporting back to the rest of the class about their findings.

While Teaching Paleontology contains many activities designed to give students a hands-on experience, nothing can replace a visit to a fossil site. Also, each unit has a slide show to reinforce the principles. The script has been included to provide further information for your unit. You can arrange a visit to a National Park site or a showing of the slide show by contacting the park nearest your school. A list of NPS fossil sites, including phone numbers, is found in the index.

The National Park Service (NPS) was created in 1916 and since that time it has been preserving, protecting and managing the cultural, natural, historical and recreational areas of the National Park system. Many different types of areas make

up the Park System. In addition to National Parks, the System contains natural preserves, historic sites, battlefields, seashores and lakeshores, national rivers, parkways and recreation areas. The System also contains national monuments, including natural preserves, historic fortifications, fossil remains, prehistoric ruins, and memorials.

As diverse as they are, these places share a common element; they are all unique expressions of our national heritage, preserved and protected for the future by the National Park Service. Since preservation and protection is the goal of the National Park Service, it is an ideal agency to take care of the important fossil areas in our country. Eight areas have been set aside as part of the Park system specifically to preserve fossils. However, there are more than 100 National Park areas with fossil resources. An example is Grand Canyon National Park. This park was created because of the scenic beauty and natural history of the canyon itself. However, the different rock layers of the canyon yield a variety of fossils dating back to 3 billion years ago. So, while the Grand Canyon is not thought of as a “Fossil Park”, fossils are an important part of the story of the Grand Canyon. The fossils are protected by the National Park Service along with all the other aspects of the Grand Canyon, like the plants, animals, the Colorado River and the entire ecosystem.

In addition to preservation and protection, the NPS Mission has an additional element; to provide for the enjoyment of the visitor. At times this dual mission can prove to be contradictory. It has been said that the National Parks are being “loved to death”, with the tremendous increase in visitation undermining the very values that the parks were created to preserve.

Education has been shown to be a vehicle for meeting this dual mandate, and that is the underlying purpose of this curriculum. By teaching the public about these fossil parks that are part of our shared heritage, the NPS can instill a sense of appreciation for the parks. This can lead to a sense of protection and so the dual mandate is met; visitors enjoy the resource and help to protect it. We hope you will use this curriculum guide with this spirit in mind, and help to convey the sense of wonder and pride that our National Parks inspire.

Teacher's Introduction

Fossils are fascinating. To hold a fossil in your hand and realize that it once was part of a living organism, one that existed millions of years ago, is awe-inspiring. Fossils don't represent the same time periods in the earth's history, nor are they formed in the same circumstances. This unit is designed to put the several types of fossils and the geologic times they represent into a framework or perspective.

For a fossil to form there has to be a specific sequence of events. Rapid and complete burial is a must in all types of fossil formation. This ensures that bacteria and fungi will not begin attacking and decaying the organism. A lack of oxygen in the burial environment is also significant because it limits the rate of decay of organic materials.

Most fossils are found in sedimentary rocks. These types of rocks are formed when many layers of silt, volcanic ash or precipitates build up on the bottom of lakes or seas. Because of the unique chain of events that are necessary for fossil formation to occur, very few organisms turn into fossils. The fossils that we find represent only a small fraction of the life that has existed on earth and are only glimpses into the past. We have to use scientific reasoning and imagination to see a more complete picture.

The main types of fossil formation are:

Petrification (Permineralization): This type of fossilization occurs when certain parts of an organism are saturated with a mineral-rich solution. The solution (water that has dissolved minerals in it) penetrates into the organism and gradually the minerals begin to fill in the cell walls of the organism. Highly porous materials such as bone and wood are often permineralized. Examples of petrified fossils are the petrified wood found at Petrified Forest National Park and dinosaur bones found at Dinosaur National Monument.

Carbonization or Imprint Fossils: In this process the organism becomes buried in layers of sediment. As the layers of sediment build up, the sediment becomes pressurized from the weight, squeezing out water and gasses from the organism. Eventually the organism disintegrates except for the carbon. This carbon leaves an imprint or residue. Examples of carbon or imprint fossils are found at Florissant Fossil Beds National Monument and Fossil Butte National Monument.

Molds and Casts: Molds are fossilized replicas of the structure of an organism. The best examples of this type of fossil are clams or brachiopods. When a clam dies, over time, the soft parts of the animal decay. The shell is left empty and this becomes filled with sediment. Eventually the shell dissolves away, but the sediments have hardened and remain as a fossil. An external mold shows the outer surface of the shell and an internal mold shows the inside surface.

The difference in casts and molds lies in what happens when the shell dissolves away. If the shell dissolves before its empty cavity is filled it leaves a void in the surrounding rock, which then becomes filled with sediment. The “cast” fossil that forms in the cavity shows signs of the outer shell features.

Trace Fossils: Trace fossils are the preserved remains or signs of animals left behind as they went about their lives. They include footprints, or tracks, burrows, nests, eggs and feces.

Geologic Time

Geologic time is very difficult to comprehend, especially for children who are used to thinking of time in terms of minutes and hours and to whom summer vacation, which lies only months away, seems an eternity. The time line activities included in this unit can make geologic time units more real to them and put time into a perspective they can understand. Before the mid 1900’s, it was impossible for even scientists to comprehend the vast amounts of time involved in our earth’s history. That was because the only method for dating different rock layers was relative dating. This dating method is based on the assumption that rock layers build up in a chronological sequence, with the younger rock layers lying on top of older layers. Thus, fossils found in two different layers of rocks could be dated relative to one another, with the older fossils found in the lower layer. However there was no way to tell how old either fossil actually was.

Index fossils are fossils that are indicators of a particular time in the earth’s history. Plants and animals that evolved quickly and flourished for a short period of time before becoming extinct are indicator species. If they became fossilized and occur in a particular rock formation, they are an indication of the relative age of the rock. While these index fossils can be accurately dated with radiometric dating, they are also very useful in relative dating. In the middle part of this century a new technique, called radiometric dating was developed.

This method is based on the observation that radioactive elements, radioisotopes, break down into other elements at a fixed rate. By measuring the amount of radioactive elements in a rock, figuring out what proportion of radioisotopes have broken down into other elements and using the rate at which this breakdown is known to occur, scientists can estimate the approximate age of a layer of rocks. When scientists began to discover the vast amounts of time involved in the earth’s history, it became necessary for them to develop a means for dividing time into more manageable periods of time. A system was then created that divided stages of time based upon the evolving changes in life on the planet. The chart provided gives the breakdown of time and life forms associated with different eras and epochs and the activity “When in the World” lets students obtain a hands-on sense of geologic time.

Fossils and the National Park Service

We can learn about ancient life only if that life is preserved as a fossil. That process is very rare, so only small portions of fossilized life are here today as clues to the past. Just because something has been fossilized doesn’t mean it can last forever. When fossils are exposed to the elements, they will weather away just like any other rock. Also, if they are dug up and removed from the rocks around them, the context is lost, with all the clues and

information that could be gained from that context. Thus, it is very important, if we are to learn from fossils, that they be protected.

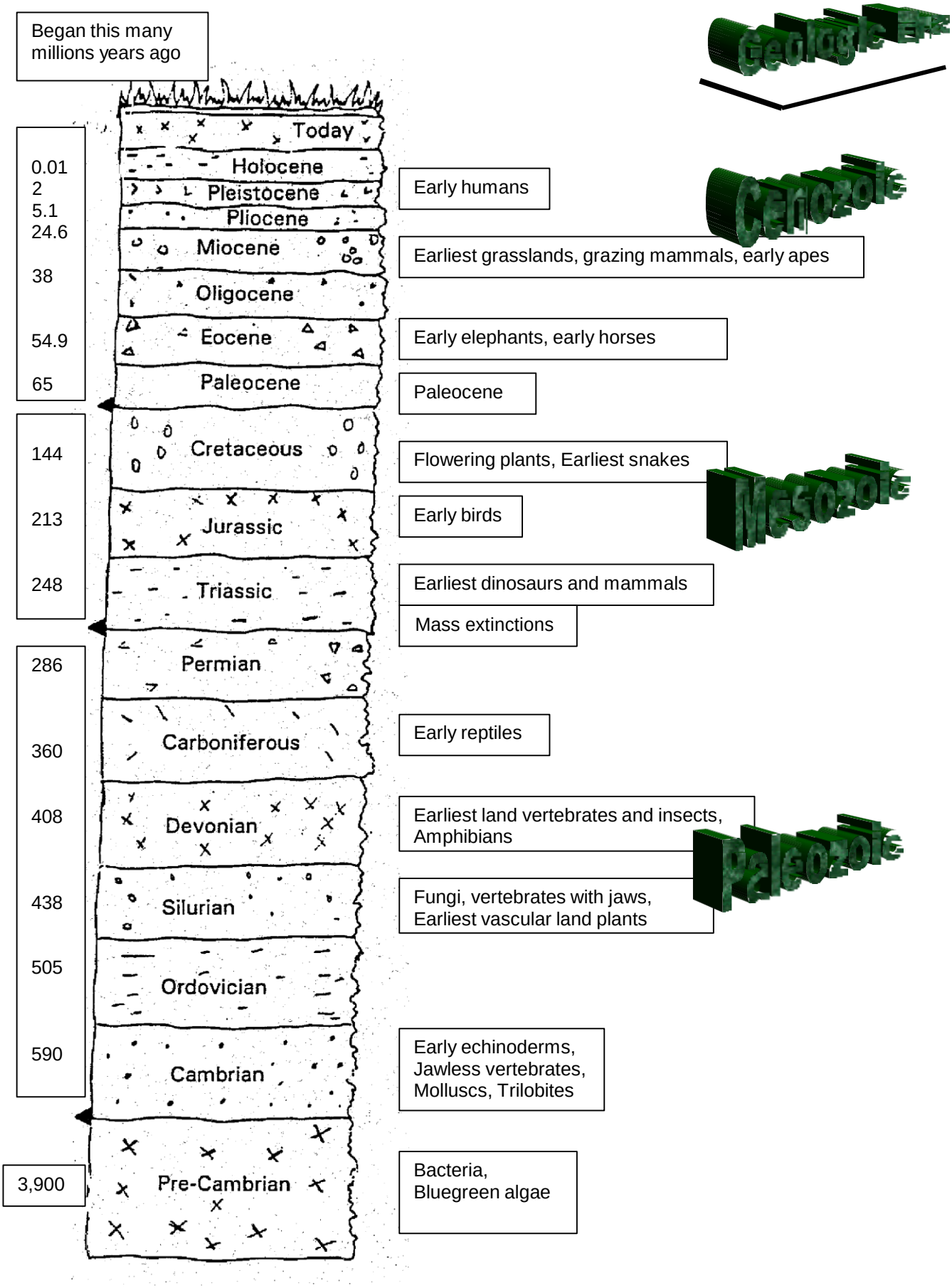
Since the job of the National Park Service is to preserve and protect our national treasures, it is an ideal agency to take care of the important fossil areas in our country. The National Park Service (NPS) was created in 1916 and since that time it has been preserving, protecting and managing the cultural, natural, historical and recreational areas of the NPS system. Many different types of areas make up the Park System. In addition to National Parks, the System contains natural preserves, historic sites, battlefields, seashores and lakeshores, national rivers, parkways and recreation areas. The System also contains national monuments, including natural preserves, fossils, historic fortifications, prehistoric ruins, and memorials. As diverse as they are, these places share a common element; they are all unique expressions of our national heritage, preserved and protected for the future by the management of the National Park Service.

Eight areas have been set aside as part of the Park System specifically to preserve the fossils found there; however, there are more than 100 National Park System areas with fossil resources. An example is Grand Canyon National Park. This park was created because of the scenic beauty and natural history of the Canyon itself. However, the different rock layers of the canyon, some dating to 2 billion years old, yield a variety of fossils. So, while the Grand Canyon is not thought of as a “Fossil Park”, fossils are an important part of the story of the Grand Canyon. The fossils are protected by the National Park Service along with all the other aspects of the Grand Canyon, like the plants, animals, the Colorado River and the entire ecosystem.

As an introduction to the eight fossil parks, students are asked to research these areas as an activity. Names and addresses are provided in the activity “Our Fossils”. Also, a copy of the Organic Act (of 1916), the founding legislation of the National Park Service is provided so that the students can better understand the important mission of the National Park Service.

Organic Act of 1916

The National Park Service shall promote and regulate the use of Federal Areas known as national parks, monuments and reserves. The purpose is to preserve the scenery, natural and historical objects, and wildlife, and to provide for the future enjoyment of these areas in such a way that will leave them unimpaired for the enjoyment of future generations (August 25, 1916).


Began this many millions years ago
Geologic Era
Today
Holocene
Pleistocene
Pliocene
Miocene
Oligocene
Eocene
Paleocene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Pre-Cambrian
0.01
2
5.1
24.6
38
54.9
65
144
213
248
286
360
408
438
505
590
3,900
Early humans
Cenozoic
Earliest grasslands, grazing mammals, early apes
Early elephants, early horses
Paleocene
Flowering plants, Earliest snakes
Mesozoic
Early birds
Earliest dinosaurs and mammals
Mass extinctions
Early reptiles
Earliest land vertebrates and insects, Amphibians
Paleozoic
Fungi, vertebrates with jaws, Earliest vascular land plants
Early echinoderms, Jawless vertebrates, Molluscs, Trilobites
Bacteria, Bluegreen algae

Unit Goals and Objectives

Goal: Students will become familiar with different types of fossils and their formation.
Objectives: Students will identify three fossil types.
Students will name a NPS area associated with each fossil type.
Students will describe how each type of fossil forms.
Goal: Students will understand the purpose of the National Park Service.
Objectives: Students will list two reasons why National Parks are important.
Goal: Students will gain an understanding of geologic time. **Objectives:**
Students will compare and contrast units of geologic time with time units conceivable to them.
Students will be able to list three significant events in the earth's history.
Students will name a dating method.

Vocabulary

Mineral: A substance found in the earth that always has the same properties. These properties include color, hardness, shininess, and the way the mineral breaks or splits.
Solution: A substance dissolved in another substance, in this case water.
Sediment: Any substance that settles out of water.
Element: A substance made up of only one kind of atom.
Carbon: An element. Atoms of carbon are the building blocks of living cells.
Petrify: A process that replaces living materials with mineral matter.
Paleontologist: A scientist that studies ancient life through fossils.
Paleozoic: A geologic era that is the time of ancient life. The Paleozoic era is divided into seven periods designated by inundations of seas.
Mesozoic: This geologic era represents the time of "Middle" life.
Cenozoic: The "Age of Mammals", this geologic era is the most recent.
Relative Dating: A method of dating rock layers by their relationships or proximity to each other.
Radiometric Dating: A dating method that measures the amount of radioactive decay that has taken place in the rocks being studied.

Sources for further Information

Children's Atlas of Earth Through Time, Rand McNally.

Prehistoric Life, Steve Parker, See and Explore Library, Darling Kindersley Inc. London, N.Y., Stuttgart.

Fossils. A Golden Guide, Rhodes, Zim and Shaffer, Golden Press, N.Y. 1962. ISBN 0-3-7-24411 –3

The Fossil Factory, Niles, Douglas and Gregory Eldredge, Addison Wesley Publishing Co, Inc. New York. ISBN 0-201-18599-7

Understanding and Collecting Rocks and Fossils, Martyn Bramwell, 1983, Usborne Publishing Ltd. Saffron Hill, London ECIN 8RT England. ISBN 0-86020-765X

Audubon Society Field Guide to North American Fossils, Alfred A. Knopf Publishing. ISBN 0-394-52412-8

A Field Guide to Dinosaurs Coloring Book, Houghton Mifflin Co. Boston. This book has excellent illustrations, with fossils from other time periods in addition to the dinosaurs. ISBN 0-395-49323-4

Fossils. A New True Book, A New True Book, Childrens Press, Chicago; Regensteiner Pub. Enterprises Inc. ISBN 0-516-41678-2

The Usborne Book of Prehistoric Facts, EDC Publishing; contains records, lists, comparisons. ISBN 0-86020-9733

Fossils, Eyewitness Handbooks; A visual guide to more than 500 species of fossils from around the world, Dorling Kindserley Inc. ISBN 1 -56458-071 –7

Prehistoric Animals- A fun to learn activity book; Watermill Press. ISBN 08167-0426-0

Classroom Activities

Classroom Activity 1
Grow A Crystal

Objectives: Students will be able to describe how petrified fossils are formed. They will explain what a solution is and will observe what happens when an object is surrounded by a mineral solution.

Background: While it is impossible to duplicate the petrification process this activity will help students see how an organism becomes petrified. Petrified and replaced fossils are formed when a dead organism, or part of one, is surrounded by a saturated solution of dissolved minerals. Solutions are formed when a substance, in this case a mineral, is dissolved in water. A saturated solution is achieved when the liquid contains so much dissolved substance that no more can be dissolved at the given temperature. The petrification process takes place as the water evaporates or changes in concentration and the minerals are deposited in the cells of the organism.

Materials:

Small pan
Heat source
Plastic container (two cup capacity)
Water
Walnut shells (2 to 4 halves)
Spoon
4 ounces Alum (aluminum ammonium sulfate). This can be purchased from a drugstore. **Note:** *Alum isn't toxic but should still be handled carefully.*

Procedure:

1. Review the concepts of solution and saturated liquids.
2. Put about one half cup of water in the pan and stir in about 2 ounces of alum (about 6 tablespoons).
3. Heat the solution but don't let it boil.
4. Remove the pan from the heat and stir in more alum until no more will dissolve. When no more will dissolve, you will start to see some of the alum on the bottom of the pan. At this point you have a saturated solution.
5. Pour the saturated solution into the plastic container. Place the halves of the walnut shells into the container, open side up. Set the container in a draft free place where it won't be disturbed.

Follow Up:

After a week or so (the time span will depend on the humidity of your classroom and the relative saturation point that was reached in step 4) have the students observe the shells. They should observe crystals of alum that have formed in the empty space of the interior of the shell. Point out that this is what occurs when the cell spaces of an organism are filled in, or permineralized, in the fossilization process. In this manner of fossilization, it is the hard parts of an organism that are fossilized bones or teeth in animals and the woody part of plants. The crystals formed because there was room for them to grow in the open spaces of the walnut shell. When minerals are deposited in the cells of bone or wood the spaces are usually too small for this to occur. But, if there is a large enough space in the fossil, crystals are able to form and can be observed. Look at the fossils that your class has available to them or see when they visit the National Park. Can they observe these phenomena?

Some of the biggest petrified fossils in the world are found at Florissant Fossil Beds National Monument in Colorado. Giant sequoia trees that grew there 35 million years

ago became petrified when the bases were surrounded by mudflows from a nearby volcano. The flows hardened into a rock called tuft that protected the trunks and kept them from decaying. Over time, water penetrated into the tuft, dissolved some of the minerals in it, mostly silica from the volcanic rock, and this mineral rich solution penetrated into the trunks of the trees and petrified them. Where there were cracks in the wood, veins of quartz can be seen and if there was enough space for crystals to grow, you can find quartz crystals that look very similar to the crystals you grew in the activity. If you visit Florissant Fossil Beds, you can see the trunks still standing in place, some of them nearly 12 feet tall. Are redwood trees found in Colorado today? Where do they grow and what is the climate like there?

Classroom Activity 2

Make a Fossil

Background: This activity gives students a better understanding of how two other types of fossil are formed; impression fossils and cast fossils.
Impression Fossils (Carbonization): In this process the organism becomes buried in layers of sediment. As the layers build up they become heavier, pressing down on the organism and squeezing out water and gasses. Eventually the organism disintegrates but the carbon remains behind, leaving an imprint or residue. Carbon is a major building block for all living cells, and all living things.

Molds and Casts: Molds are fossilized replicas of the internal structure of an organism. The best examples of this type of fossil are clams or brachiopods. When a clam dies, over time the soft parts of the animal decay. The shell is left empty and this becomes filled with sediment. Eventually the shell dissolves away, but the sediments have hardened and remain as a fossil. An external mold shows the outer surface of the shell and an internal mold shows the inside surface.

The difference in casts and molds lies in what happens when the shell dissolves away. If the shell dissolves before its empty cavity is filled, it leaves a void in the surrounding rock, which then becomes filled with sediment. The "cast" fossil that forms in the cavity shows signs of the outer shell features.

Trace Fossils: Trace fossils are the preserved remains or signs of animals left behind as they went about their lives. They include footprints, or tracks, burrows nests, eggs and shells and feces.

Materials for Part one:
empty cardboard milk container 1 quart size (or plastic)
shell or a plastic Easter egg one half per student or team
petroleum jelly
plaster of paris and water
container for mixing the plaster of paris and water
food coloring

Procedure: For each team or student have them:

1. Cut off the milk carton so it's approximately 5 inches tall.
2. Grease with petroleum jelly the interior of the milk carton, the half of the Easter egg or other object that they wish to "fossilize"; a stick, leaf, or even their hand
3. Mix up3 cups of plaster of paris and pour it into the carton.
4. Place the half of the Easter egg so it is sitting upright in the plaster, forming a dry well
5. Press in any other object that is to be fossilized.
6. Let the mixture harden, and then cover the surface of the first layer with petroleum jelly.
7. Mix a second batch of plaster of parts, but this time add food coloring to tint the mix. Pour it on top of the hardened 1st batch.
8. After the mixture has hardened overnight, remove the plaster block from the carton. You now have a piece of "fossil bearing rock".

Materials for part two:
paint brush
spoon
dull knife
wood block for hammering

Procedure: Students will excavate their fossils, using the knife and spoon to chisel, and paint brush to brush dust from the specimens. When finished, they will have a cast fossil, an impression fossil and a trace fossil.

Follow-up: Discuss the three types of fossils they have made. What are the conditions necessary for fossils to form (rapid and complete burial). What would have happened to the fossils if the top layer had not been added? What if the things that were fossilized had been dead organisms? How did they excavate the fossils? Were any of the fossils destroyed when they uncovered them?

Use **Classroom Activity 4, Our Fossils** as a follow-up to this experiment to name fossil sites where the different types of fossils are found.

Classroom Activity 3
When in the World

Objective: Students will compare and contrast units of geologic time with spatial units conceivable to them. They will list three events that were significant in the natural history of the earth.

Background: Students will use math skills to construct a time line. This activity will give them perspective on the span of time associated with the earth's history and some of the important events in the evolution of life. Preview the activity with a discussion of dating methods from the "Teacher's Introduction".

Materials:
list of measurements
measuring tape
wooden stakes or wire flags for outdoor time line

Procedure: Students will use table of measurements provided to make a time line. For the indoor time line, they can mark the significant events on computer paper. For the outdoor-time line, they can mark the significant events with flags or wooden stakes.

Follow Up: Have the students find objects or pictures to represent the important events on the time line. When these are compiled, have the students discuss these events and what they mean. Topics for discussion include:

Life on Earth Begins: Scientists believe that the first life forms on the planet were very SIMPLE life forms; algae, bacteria, fungi. What do algae need to live? How about bacteria and fungi? What do algae produce as a by-product? As the first plants on earth, algae were extremely important in producing oxygen.

1st Fossils: Discuss the special conditions necessary for fossils to form (rapid and complete burial before decomposition). Since those conditions tend to be rare, are fossils a good representation of all of the life forms that existed at that time? Why not?

1st Amphibians: What is an amphibian? Amphibians have been on the planet for a very long time but have been rapidly disappearing in recent years. Why? What could this mean? Why does it matter to us?

Swamp Forests: Why are these swamps important to us? They formed the coal and fossil fuels that are major sources of energy for us. What kind of forces transformed these organic materials into coal and oil? This shows us that fossil fuels are limited and take a very long time to form.

Age Of Dinosaurs: A look at the long portion of the time line that represents the Age of Dinosaurs shows you that dinosaurs were very successful as a life form. What do you think could have caused their demise? New discoveries and research are indicating that they may have been very active and quick, and had fairly elaborate social interaction with another. How does this compare with the ways people used to view dinosaurs?

Age Of Mammals: What does the term Age of" mean? Did mammals exist before this point? What is a mammal? What are the characteristics that make mammals

different from dinosaurs? What differences between mammals and dinosaurs might have helped mammals survive while the dinosaurs became extinct?

1st Humans: Look at the sign representing today. Compare the "Age of Humans" to the Age of Dinosaurs. What makes humans unique? At the time of the first humans their brains were only half the size they are now but they were still much bigger than the brains of most other animals. Also, humans have opposable thumbs, allowing them to grasp. Have the students tie their shoes or write without their thumbs to see how important this development is. Talk about all the scientific discoveries/inventions that have been made in the last two hundred years. How have those discoveries changed our lives? Changed the lives of other species of plants and animals? What is "progress"? Is it always beneficial to us and/or the living beings we share the planet with?

When in the World: Measurements

(Length from present)

INDOOR	OUTDOOR	YEARS AGO *	EVENTS
38 feet	45.7 meters	4.57 billion	Earth begins
29 feet	35 meters	3.5 billion	Life begins
28.25 feet	34 meters	3.4 billion	First fossils form
3.75 feet	4.5 meters	450 million	First primitive fish
41 inches	4.1 meters	410 million	Earliest land plants
30 inches	3 meters	300 million	Early amphibians Swamp forests
29 inches	2.9 meters	290 million	First reptiles
24.8 inches	248 centimeters	248 million	Beginning of Age of Dinosaurs
16 inches	160 centimeters	160 million	Early birds (Archaeopteryx)
13 inches	130 centimeters	130 million	Flowering plants develop
6.5 inches	65 centimeters	65 million	Dinosaurs extinct Age of Mammals begins
5 inches	50 centimeters	50 million	Mammals/birds abundant
.2 inch	2 centimeters	2 million	First humans
.15 inch	1.5 centimeters	1.5 million	Ice Age begins
.0001 inch	.0002 cms	220 (1776)	United States created

Scale: Indoor: 1/10 inch = 1 million yrs Outdoor: 1cm = 1 million yrs

*"Years Ago" are approximate and based on fossil evidence

Classroom Activity 4
Our Fossils

Background: The National Park Service was established in 1916 in order to preserve and protect the natural and cultural treasures of the country. Read or pass out a copy of the Organic Act. The job of preservation and protection makes the NPS unique from other land management agencies.

Procedure: Locate each of the Fossil NPS areas on a map. Have teams research the sites by contacting the parks. Ask them to describe the type of fossils found at their site, how the fossils were formed, the animals or plants that are found as fossils, the ancient environment, and the present environment of their site.

Agate Fossil Beds National Monument P.O. Box 427 Gering, NE 69341 (308) 436-4340	Fossil Butte National Monument P.O. Box 592 Kemmerer, WY 83101 (303) 877-4455
Badlands National Park P.O. Box 6 Interior, SD 57750 (605) 433-5361	Hagerman Fossil Beds National Monument P.O. Box 570 Hagerman, ID 83332 (208) 733-8398
Dinosaur National Monument P.O. Box 210 Dinosaur, CO 81610 (303) 374-3000	John Day Fossil Beds National Monument 420 W. Main St. John Day, OR 97845 (503) 575-0721
Florissant Fossil Beds National Monument P.O. Box 185 Florissant, CO 80816 (719) 748-3253	Petrified National Forest Park Petrified Forest, AZ 86028 (602) 524-6228

Outdoor Activities
Activity 1
How We Perceive Time

Background: Let's look at how we perceive time. One way to perceive it is to measure it. We humans have come up with many different ways to designate different periods of time: milliseconds, seconds, minutes, hours, days, weeks, years, decades, millennia. But these are just arbitrary units, chosen to represent periods of time that fit into our framework, our lifetimes. This exercise will help students to widen their perceptions of the passage of time and enable them to better conceive of the passing of geologic time.

Materials: A copy of the exercise to read to the students.

Procedure: Have everyone close their eyes. Ask them to remain perfectly still but open their eyes when they think a minute has passed.

Now, choose someone to be "it" and have the group play a game of tag, stopping when they think a minute is up. Is everyone's sense of time exactly the same? Are there circumstances when time seems to pass more quickly than at other times? What about when you are waiting for someone? During the last half-hour of the school day? When you are having fun? When you are bored?

How do you think time might pass for other animals? For a hummingbird? For a turtle? For a fly? How about a tree or a rock?

Have everyone stand quietly with arms outstretched, eyes closed. Now, imagine that you are all pine trees. Your head and arms are the tree's branches and your legs are its roots. Your branches are warmed by the sun. You can feel the warmth pass from your hands slowly up your arms, to your shoulders, into your trunk, and down into your roots. Your roots are cold and damp. As water is absorbed by your feet, coolness slowly passes up your legs to your trunk. The water slowly warms as it spreads out to your branches in the sun. You've grown for 300 years, standing in the sun and snow, breeze and gale. How do you experience time? What about the rocks, millions of years old, that the pine tree's roots are growing around? If they were able to experience the passing of time, what would a minute seem like to them?

Outdoor Activity 2
The Ancient Treasures Hunt

Objectives: This activity will give the students an idea of the variety of fossils that are protected by the National Park Service. It combines math and compass skills with fun. The most enjoyable part of this game is that everyone is a winner. Even if a team doesn't reach the designated goal, they are bound to find something of interest in the area that they reach.

Background: Give the students a brief introduction to compass usage. The red portion of the needle points north because it has been magnetized and is drawn to the magnetic pole.

Materials: For each group of students: List of measurements Compass Measuring tape A treasure. This can be some object that your students will find interesting, to be placed at the end of the trail.

Procedure: Before the activity begins, measure off the following distances: From the starting point go south 200 feet, then west 109 feet. Place a sign or marker at the starting point and some interesting object at the end of the trail.

When you are ready to start the activity, divide the students into teams of 6 and pass out the instructions and materials.

There are three sets of clues provided. Each group will start at the same point and end at the same point, but the teams will reach the goal by different routes. These different sets of clues ensure that each team will have to find their own route rather than following another group that is doing all the work.

Ancient Treasures Hunt Directions Set One:
Split up into groups of 6 students. Two students read the clues and do the math. Two hold the measuring tape. Two use the compass to find directions. Follow the clues to find a hidden treasure. When you reach the mystery item, leave it there for the next group to discover.

Clues:
1. The fossil of a fish, a gar, that is 5 feet long, was discovered at Fossil Butte National Monument, in Wyoming. Go south for three gar lengths.

2. Fossil remains of *Mesohippus* are found at Badlands National Park in South Dakota. *Mesohippus* was an ancestral horse. It had three toes instead of one (hoof). Continue south the number of *Mesohippus* toes on a foot times one yard.

3. At Florissant Fossil Beds National Monument in Colorado you can see the petrified remains of redwood trees that grew 35 million years ago. One petrified stump measures 12 feet tall and 38 feet in circumference (the distance around). Continue south for the length of the circumference of a redwood tree.

4. *Daemonhelix*, Devil's corkscrews, are trace fossils, the fossilized burrows of a ground burrowing beaver, *Paleocastor*. Some *Daemonhelix* are nearly 6 feet tall. They are found at Agate Fossil Beds National Monument in Nebraska. Go west 4 *Daemonhelix* lengths.

5. The sabertooth cat was a fierce predator that was found in John Day Fossil Beds National Monument in Oregon. These animals had canine teeth nearly 6 inches long. Continue west for 30 fangs.

6. In Dinosaur National Monument in Colorado are found the fossil remains of *Apatosaurus*. It got its name, which means deceptive lizard, because of its unbelievable size. Adults were 70 feet long from nose to tail. Go west 1 *Apatosaurus* length.

7. *Phytosaurus* were crocodile-like reptiles that lived 220 million years ago in what is now the Petrified Forest National Park in Arizona. The average length of a phytosaur was 17 feet. Go south for 4 phytosaurs.

8. At Hagerman Fossil Beds National Monument in Idaho are found the fossil remains of a Pronghorn antelope that lived there nearly 3.4 million years ago. Modern pronghorns are the fastest land animal and can run at nearly 70 miles an hour. Go south 70 feet. Do you see anything special? Is it a fossil?

Ancient Treasures Hunt Directions Set Two:
Split up into groups of 6 students. Two students read the clues and do the math to figure them out. Two students hold the measuring tape. Two students use the compass to determine direction. Follow the clues to find a hidden treasure. When you reach the mystery item, leave it where you find it for the next group to discover.

Clues:
1. The sabertooth cat was a fierce predator that was found in John Day Fossil Beds National Monument in Oregon. These animals had canine teeth nearly 6 inches long. Go west for 30 fangs.

2. At Florissant Fossil Beds National Monument in Colorado you can see the petrified remains of redwood trees that grew there 35 million years ago. One petrified stump measures 12 feet tall and 38 feet in circumference (the distance around). Go south for the length of the circumference of a redwood tree.

3. The fossil of a fish, a gar that is 5 feet long was discovered at Fossil Butte National Monument, in Wyoming. Go south for 3 gar lengths.

4. Fossil remains of *Mesohippus* are found at Badlands National Park in South Dakota. *Mesohippus* was an ancestral horse. It had three toes instead of one (hoof). Continue south the number of *Mesohippus* toes on a foot times 1 yard.

5. Phytosaurs were crocodile-like reptiles that lived 220 million years ago in what is now the Petrified Forest National Park in Arizona. The average length of a phytosaur was 17 feet. Go south for 4 phytosaurs.

6. *Daemonhelix*, Devil's corkscrews, are the fossilized burrows of a ground burrowing beaver, *Paleocastor*. Some *Daemonhelix* are nearly 6 feet tall. They are found at Agate Fossil Beds National Monument in Nebraska. Go west 4 *Daemonhelix* lengths.

7. In Dinosaur National Monument in Colorado are found the fossil remains of

Apatosaurus. It got its name, which means deceptive lizard, because of its unbelievable size. Adults were 70 feet long from nose to tail. Go west 1 *Apatosaurus* length.

8. At Hagerman Fossil Beds National Monument in Idaho are found the fossil remains of a Pronghorn antelope that lived there nearly 3.4 million years ago. Modern pronghorns are the fastest land animal and can run at nearly 70 miles per hour. Go south for 70 feet. Do you see anything special? Is it a fossil?

Ancient Treasures Hunt Directions Set Three:
Split up into groups of 6 students. Two students will read the clues and do the math to figure them out. Two students will hold the measuring tape. Two students will use the compass to determine direction. Follow the clues to find a hidden treasure. When you reach the mystery item, leave it where you find it for the next group to discover.

Clues:
1. The sabertooth cat was a fierce predator that was found in John Day Fossil Beds National Monument in Oregon. These animals had canine teeth nearly 6 inches long. Go west for 30 fangs.

2. *Daemonhelix*, Devil's corkscrews, are the fossilized burrows of a ground burrowing beaver, *Paleocastor*. Some *Daemonhelix* are nearly 6 feet tall. They are found at Agate Fossil Beds National Monument in Nebraska. Go west 4 *Daemonhelix* lengths.

3. At Hagerman Fossil Beds National Monument in Idaho are found the fossil remains of a Pronghorn antelope that lived there nearly 3.4 million years ago. Modern pronghorns are the fastest land animal and can run at nearly 70 miles per hour. Go south for 70 feet.

4. At Florissant Fossil Beds National Monument in Colorado you can see the petrified remains of redwood trees that grew there 35 million years ago. One petrified stump measures 12 feet tall and 38 feet in circumference (the distance around). Go south for the length of the circumference of a redwood tree.

5. The fossil of a fish, a gar that is 5 feet long was discovered at Fossil Butte National Monument, in Wyoming. Go south for 3 gar lengths.

6. Fossil remains of *Mesohippus* are found at Badlands National Park in South Dakota. *Mesohippus* was an ancestral horse. It had three toes instead of one (hoof). Continue south the number of *Mesohippus* toes on a foot times 1 yard.

7. Phytosaurs were crocodile-like reptiles that lived 220 million years ago in what is now the Petrified Forest National Park in Arizona. The average length of a phytosaur was 17 feet. Go south for 4 phytosaurs.

8. In Dinosaur National Monument in Colorado are found the fossil remains of *Apatosaurus*. It got its name, which means deceptive lizard, because of its unbelievable size. Adults were 70 feet long from nose to tail. Go west 1

Apatosaurus length. Do you see anything special? Is it a fossil?