Lesson 2 Introduction to Paleontology

Objectives

- Understand what paleontology is and how it is studied;
- Develop preliminary concepts about paleontology within the park; and
- Develop skills and mathematical concepts for scientific investigation and interpretation.

Main Idea

To introduce concepts about paleontology that relate it to the study of geology, with connections to biology, and ecology.

Essential Skills

- writing
- cooperating
- brainstorming
- communicating
- reporting
- classifying
- comparing
- observing
- interpreting

Mathematical Skills

- recording data
- measuring
- making diagrams

Materials

- sediment mixture
- clear jars with tight fitting lids
- paper towels or petri dishes
- water
- spoons
- student journals

Pages to Photocopy

- *Sorting Sediment* Student Activity Sheet pages 18-20

The following table aligns this lesson with the Arizona Science Standards (5-24-04). Most curriculum connections shown are implicit within the lesson. Others are achieved through teacher interaction with the class, including discussion of the background information provided. Teachers are encouraged to expand on the lesson to increase its potential as an educational tool and a fun learning experience.

Curriculum Connections: Paleontology Lesson 2
INTRODUCTION TO PALEONTOLOGY

Arizona Science Standards (5-24-04)

	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Strand 1: Inquiry Process	C2-PO1 C2-PO3 C2-PO4 C2-PO5 C3-PO1 C3-PO5 C4-PO1	C2-PO1* C2-PO3 C2-PO4* C2-PO5* C3-PO1 C4-PO1*	C2-PO1* C2-PO3 C2-PO4 C2-PO5 C3-PO1 C3-PO2 C4-PO2	C2-PO1* C2-PO4* C2-PO5* C3-PO1* C3-PO2* C3-PO5 C4-PO2*	C2-PO1* C2-PO3 C2-PO4* C2-PO5* C3-PO1* C3-PO2* C3-PO5 C3-PO8* C4-PO4*
Strand 2: History & Nature of Science	C1-PO2	C2-PO1 C2-PO3	C2-PO1 C2-PO2 C2-PO3	C2-PO3*	C2-PO1*
Strand 5: Physical Science		C2-PO1 C2-PO2			C1-PO1
Strand 6: Earth & Space Science	C2-PO2 C2-PO3 C2-PO4 C2-PO6			C1-PO1 C1-PO3 C1-PO4 C2-PO2	

* repetition of a performance objective from an earlier grade level

Introduction

Paleontology is a science that investigates the remains of ancient life and the changing forms of life through time. Paleontologists must have an understanding of geology, biology, and ecology to interpret the clues of the ancient past. They piece together information from rocks - how rocks form, how they change over time, and what environments they represent - in order to know which layers of rock might contain fossils. They must understand both animal and plant anatomy, physiology, and behavior in order to interpret the fossils they find. With an understanding of the relationships between organisms and their environment, paleontologists become "paleoecologists" and can create images of entire ancient ecosystems.

Because the past can never be recreated, paleontological resources are considered nonrenewable and are in need of protection and preservation.

Lesson Framework

1. Terminology
A list of defined terms for teachers.

2. Geology and Fossilization
Background information for teachers about geology and fossilizaton.

3. Activity: ***Brainstorm***
A class activity that assesses student knowledge of paleontology at Petrified Forest National Park.

4. Activity: ***Sorting Sediment***
An in-class activity led by the teacher that allows students to investigate sediment and the development of sedimentary layers.

Terminology

clay - fine-grained material, slippery when wet, widely used in making bricks, tiles, and pottery; particle size is < 1/256 millimeters; found in mudstone and shale
deposition - a natural process in which sediments are laid down layer by layer through wind, water, gravity, or ice movements
erosion - the movement of earth material from one place to another due to forces such as water, wind, gravity, or ice movements
fossil - any record of past life found preserved in rock; can be plant materials such as stems, seeds, or cones, or animal parts such as bone, shells, or teeth; can be trace impressions, such as tracks, footprints, trails, burrows, leaves, etc.
fossilization - a process by which plant and animal remains or their impressions are preserved in rock
geology - a science that concentrates on the origin, history, and structure of the earth including the study of rocks and the forces acting upon the earth
limestone - type of sedimentary rock composed of calcium carbonate, usually formed in shallow marine or freshwater environments and often containing numerous invertebrate fossil evidence
magma - molten rock beneath the Earth's surface; surface magma is called lava
mineral - naturally occurring chemical element or compound with specific physical properties, composition, and crystal form
mudstone or shale - fine grained sedimentary rock composed of silt and clay sized particles
organic material - dead plant and animal matter in various stages of decomposition or fossilization
permineralization - fossilization through in-filling of pore spaces in organic material by minerals; organic material is encased within the mineral
petrification - fossilization by the complete replacement of organic material and the in-filling of pore spaces by minerals carried by water
sand - loose, granular, gritty particles of worn or disintegrated rock, finer than gravel, commonly composed of silica; particle size is 1/16 - 2 millimeters
sandstone - type of sedimentary rock composed of cemented sand grains
sediment - material suspended in water or air that eventually settles out, usually in layers
sedimentary - rock formed from the deposition, accumulation, and cementation of sediments, usually forming layers, often including fossils
silt - sedimentary material consisting of fine mineral particles intermediate in size between sand and clay; particle size is 1/256 - 1/16 millimeters
variable - something subject to change, such as light intensity by time of day or season, rainfall, temperature, etc.

Geology and Fossilization

Geology is a science that concentrates on the origin, structure, and processes of the earth. Geologists study the composition, distribution, formation, and change of rocks in order to better understand the earth and its ancient and modern environments. Without geology, paleontologists would have little understanding of the fossilized remains of ancient life.

The earth is composed of three major rock types: igneous, sedimentary, and metamorphic. Igneous rocks are heat-formed rocks, originating from magma, or molten rock, found underground. Lava is magma that has flowed onto the Earth's surface. Sedimentary rocks are formed from sediment, or small particles (clay, silt, sand, gravel) of existing rock. The sediment is cemented together over time. Sediment is transported and deposited by earth forces such as water, wind, gravity, and ice movements. Fossils are often found in sedimentary rock, where organic material was deposited along with the sediment. Metamorphic rocks were formed under intense heat and pressure, squashing, stretching, and/or cooking existing igneous or sedimentary rock, changing the appearance and mineral composition.

Petrified Forest National Park contains primarily sedimentary rocks collectively known as the Chinle Formation. By examining this rock formation and the fossils it contains, an image of the ancient environment of the Late Triassic Period, over 200 million years ago, can be obtained. The Chinle Formation is composed of several types of sedimentary rock, including mudstone, sandstone, limestone, shale, and volcanic ash. The sediments of these rocks were laid down in water-rich environments - meandering streams, raging rivers, quiet lakes, and muddy marshes. Where water was found, abundant plant and animal life also occurred - palm-like trees, lush ferns, giant horsetails, large and small amphibians, fish, and reptiles. Paleontologists find evidence of this ancient life within the fossilized bones, teeth, armored plates, trees, roots, and other fossils that lie within the Chinle Formation.

Brainstorm

Teacher Instructions

Objective

To have students understand what they already know about Petrified Forest National Park, specifically about paleontology.

Main Idea

As a class brainstorming activity, students will create a list of what they know about Petrified Forest National Park, narrowing the topic down to what they know about paleontology.

Materials

- chalkboard, large sheets of paper, or other method of recording and displaying list of topics as they are presented by the class

Procedure

1. Explain the process of brainstorming to students. They will be thinking together as a class.

2. Ask students to think about what they know of Petrified Forest National Park. You can have students call out ideas as they think of them, raise their hands, or go around to each person for one idea.

3. Record all the ideas presented. A good way to do this and still be organized is to plan how you will record topics as they are presented. For example, some topics that may be presented are paleontology, archeology, geology, wildlife, and historic events. As ideas under these topics are presented, you could write them in different colors or on different sheets of paper or different sections of the chalkboard. Don’t tell students the topics until all ideas have been presented. Then let them guess how you have organized their ideas and label them appropriately.

4. Identify the paleontology and/or geology category and try to expand the ideas presented. Ask students what they know about the science of paleontology and how it is studied. Make sure that they understand how the study of ancient ecosystems is intimately linked with the study of modern ecosystems through geology, biology, and ecology.

Sorting Sediment

Teacher Instructions

Objective

To develop an understanding of sediment types and rates of sedimentation.

Main Idea

Students will add water to a dirt sample and monitor the sedimentation (settling) process. By answering the questions on the student activity sheet, students should develop an understanding of different types of sediment and how their size results in different rates of sedimentation.

Materials

- copies of Student Activity Sheet - one per cooperative group or per person
- see materials list on Student Activity Sheet

Procedure

1. Ask each student to bring a large ziploc bag of dirt from home. Combine all the dirt samples to get a good mixture. Hopefully the mix will include all the sediment types: clay, silt, sand, and gravel.

2. Choose an area in or out of the classroom that can get wet. You'll need to have access to water or have containers of water.

3. Follow the instructions on the Student Activity Sheet.

Notes

- Since most schools do not have a caliper to measure actual particle size, just eyeball it. You can see individual particles of sand and gravel, but clay and silt are a bit trickier. One way to tell the difference between clay and silt is to taste them. Clay melts in your mouth and has an almost chocolately flavor. Silt has a more gritty texture.

clay = < 1/256 mm
silt = 1/256 - 1/16 mm
sand = 1/16 - 2 mm
gravel = larger than 2 mm

You may, of course, have samples that are mixed clay and silt, so you'll experience both the melting and gritty sensations. Just don't taste anything larger than silt - it tastes like rock!

- Fast moving water maintains smaller sediments in solution, but larger sediments like sand and gravel can drop out. Slow moving or stagnant water allows the smallest particles like clay and silt to settle out. The settling out is called deposition. Geologists look at rock layers and their composition of sediment particles to determine what the ancient environment was like when they were deposited. For example, a conglomerate with heavy gravel particles indicates a fast moving stream or riverbed. A softer claystone or mudstone indicates a marsh, lake or swampy area. Looking at the distribution of these different rock layers over a landscape, geologists can determine the direction of water travel in the ancient environment.

Student Questions Guidelines

- Sediments will settle out with the largest/heaviest particles on the bottom (gravel/sand) and the smallest/lightest particles on top (silt/clay). Organic material, or *detritus*, often floats on the surface.

- Variables that may affect the rate of sedimentation in a natural system may include:

water movement: In moving water, large particles can settle out. In slow moving or stagnant water, smaller particles can settle out. A river that is fast moving at its headwaters and slower moving as it spreads out into a floodplain will leave this pattern of deposition (large to smaller sediments) in its channel bed.

disturbance: If a puddle is disturbed (a car drives through it, animal walks through it), the water and dirt are mixed together and little deposition takes place. Once the water becomes still, however, the dirt particles in the puddle settle out and the water clears.

- In natural systems, water is removed from sediment layers through evaporation into the atmosphere and absorption into the ground.

Activity Extensions

- Adding organic material to the sample, ie. bone, shell, or plant material, will allow students to see how the material is trapped and buried as sediment is deposited. If nothing organic is available, use a button, small nail, nut, bolt, washer, or anything else that will be heavy enough to sink as the sediment settles out of the water. When removing the layers, tell students to be extra careful - they are now excavating a "fossil."

NOTE: If the added organic material floats, discuss with students how, over time, it would become water-logged or decomposed enough to sink. The water would evaporate, leaving the organic material embedded in the sediment. If additional sedimentation were to occur, the material would be buried deeper and deeper and decay would be slowed. Sediment grains around the material would eventually be cemented together by minerals dissolved out of groundwater to form a solid rock tomb. Eventually fossilization of the material could occur through mineral replacement, but only if everything were left undisturbed and all the right conditions were present.

- Have students place prepared jars in a sunny spot, inside or outside, and monitor the changes as the water evaporates over several days or weeks. After the sediment has dried completely, have students carefully "excavate" the sample. If they added organic material have students excavate more carefully, searching for their "fossil." This will be much more difficult than when the sediment was wet and should encourage discussion of how paleontologists excavate fossils from actual rock.

- ***Cookie Excavation***: Using both hard and soft chocolate chip and oatmeal raisin cookies, give the students toothpicks to "excavate" the chips/raisins from the cookies. Have them compare the results from the hard cookies versus the soft cookies. Paleontologists can excavate large sections of rock containing fossils using jackhammers or large rock-breaking tools. They must use small instruments like rock hammers and dental picks to remove the fossils from the rock. The hardness of the rock and the changes it has undergone over time also affects the preservation and condition of fossilized remains.

Sorting Sediment

Student Activity Sheet

In this activity you will be geologists studying ***sediment*** (dirt) and learning how it ***deposits*** (settles out of water or air) in layers. Working in your student groups, follow each step and answer the questions as you go.

Materials each group will need

- ❍ water
- ❍ spoon with long handle
- ❍ paper towels or petri dishes
- ❍ sediment mixture (dirt)
- ❍ clear glass or plastic jar with a tight fitting lid and wide mouth (a fish bowl and large spoon could also work)

1 Fill the jar 1/2 to 3/4 full of dirt. Add water until the jar is almost full. Put the lid on the jar, making sure it is on very tight, and shake the jar gently. You may want to go outside the classroom or shake the jar over a sink to avoid having to clean up a mess. Set the jar down in a place where it will not be disturbed, write down the time, and watch what happens.

2 After several minutes, you should see the dirt settling out to the bottom of the jar. Watch as different layers of ***sediment*** (types of dirt) form. Write down how long it takes for each layer to form. This is the ***rate of sedimentation*** for each type of sediment. If possible, leave the jar undisturbed until the water is clear. Measure the width of each layer. Make a diagram using the jar below. Show the width of the layers and the time it took each to form.

3

How many layers formed?

How long did it take for all the sediment to settle out of the water, leaving the water clear?

Which do you think is larger, the sediment in the bottom layer or the top layer?

Is there anything floating on the surface of the water? What do you think it is?

What might affect the rate of sedimentation (how fast the dirt settles out) in a river? a lake? a puddle?

4

Very carefully pour out as much of the water from your jar as possible *without disturbing the layers*. With a spoon take out the dirt layer, by layer. Place each layer on a separate paper towel or in different petri dishes. Look at each closely and compare the particles.

Which was larger, the sediment in the bottom layer or the top layer?

Because gravity affects the rate of sedimentation, why do you think the layers contain different sized sediment particles?

What size sediment do you think might settle out of moving water?

Which size sediment do you think might settle out of water that is not moving?

Once water is removed from the sediment layers, they will slowly cement into rock. How do you think the water is removed in natural systems?

5

On your jar diagram, go back and label the layers by sediment type. For example, the smallest size of sediment is ***clay***. ***Silt*** is a little larger. When looking at ***sand***, you can see each sand grain. ***Gravel*** is larger than sand. Sometimes you'll have ***organic material***, pieces of leaves, bark, etc., that floats to the surface.

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Summing It Up

Think about what might happen to these layers of sediment in a natural system. Over time more and more dirt would be deposited on top. Does the dirt have weight? You bet! It becomes so heavy that it squeezes all the air and all the water out of the layers below, changing what was loose sediment into solid rock.

What happens to organic material that was deposited with the sediment layers? If it does not rot away, it may become fossilized. It must be left undisturbed for many years. Water slowly oozes into the sediment. The minerals carried by the water very slowly replace or fill in the structure of the organic material. The minerals leave a rock replica of the original form.

Geologists study ancient sediment layers by looking at sediment size to determine what the ancient environment was like. Claystone or mudstone was formed when the smallest particles settled out of water that was not moving, like a lake or swamp. Sandstone was formed by water moving a little faster or by wind blowing across a desert and leaving sanddunes behind. Where gravel is found in the rock, a faster moving river may have once been present.

Paleontologists then look at fossils in the rocks to determine what type of life existed within the ancient environment. A combination of the geology of the rocks, the biology of the animals and plants, and the ecology of their relationships, provides a paleontologist with an idea of what the ancient ecosystem may have been like.

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Your Thoughts

Use this space to add additional ideas, questions, or diagrams you developed during this experiment.