**Clam Beds Hike**
**Field Trip Program**
*Revised December, 2016*

**Petrified Forest Focus:** Geology and Paleontology
**School Subjects:** Science
**Grade Levels:** **3rd – 8th**

**AZ Science Standards**

- **SC03-S1C2-01, SC04-S1C2-01, SC05-S1C2-01, SC06-S1C1-0, SC07-S1C1-01**: Demonstrate safe behavior and appropriate procedures.
- **SC03-S1C4, SC04-S1C4, SC05-S1C4**: Communication; communicate results of investigations
- **SC03-S2C1-02, SC04-S2C1-02**: Identify science related career opportunities
- **SC03-S2C1-02, SC04-S1C1, SC05-S1C1**: Observations, Questions, and Hypotheses: Observe, ask questions, and make predictions.
- **SC03-S2C2, SC04-S2C2, SC05-S2C2, SC06-S2C2, SC07-S2C2, SC08-S2C2**: Nature of scientific knowledge; Understand how science is a process for generating knowledge.
- **SC03-S1C4-03, SC04-S1C4-03, SC05-S1C4-03**: Communicate with other groups or individuals to compare the results of a common investigation.
- **SC03-S5C1, SC04-S5C1:** Properties of objects and Materials: Classify objects and materials by their observable properties.
- **SC03-S6C1-02:** Describe the different kinds of rocks and how they are formed: metamorphic, igneous and sedimentary
- **SC03-S6C1-03:** Classify rocks based on the following physical properties: color, texture
- **SC03-S6C1-04**: Describe fossils as a record of past life forms
- **SC03-S6C1-05:** Describe how fossils are formed
- **SC04-S4C3-02:** Differentiate renewable resources from nonrenewable resources.
- **SC04-S4C3-04:** Identify/describe ways to conserve natural resources (eg. Reduce, reuse, recycle, find alternatives.)
- **SC04-S6C2-01:** Identify the earth processes that cause erosion**.**
- **SC04-S6C2-02:** Describe how currents and wind cause erosion and land changes.
- **SC04-S6C2-03**: Describe the role that water plays in the following processes that alter the Earth's surface features: erosion, deposition; weathering
- **SC04-S6C2-06**: Analyze evidence that indicates life and environmental conditions have changed. (e.g. tree rings, fish fossils in desert regions, ice cores.)
- **SC06-S1C1-02, SC07-S1C1-01, SC08-S1C1-01**: Formulate questions based on observations that lead to the development of a hypothesis.

- **SC07-S1C1-03**: Explain the role of a hypothesis in a scientific inquiry.
- **SC07-S6C1-01**: Classify rocks and minerals by the following observable properties: Grain; color; texture; hardness
- **SC07-S6C1-03:** Explain the following processes involved in the formation of the Earth's structure: Erosion; deposition; plate tectonics; volcanism
- **SC07-S6C1-04:** Describe how the rock and fossil record show that environmental conditions have changed over geologic and recent time.
- **SC07-S6C2-01:** Explain the rock cycle.
- **SC07-S6C2-02:** Distinguish the components and characteristics of the rock cycle for the following types of rocks: Igneous, metamorphic, and sedimentary.

**AZCCR Standards**

- (3.MP.7) Look for and make use of pattern.
- For Informational Text:
    - (3.SL.3)Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
    - (3.SL.1)Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
    - (3.SL.6)Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification.

**Program Overview**

Pre-visit Activity: Create sedimentary rocks in jars and make predictions about how the layers will form. Observe and record how they actually form. 45-60 min

In-Park Activity: Students will participate in a guided 1 mile off-trail hike with a ranger within the park. They will use observation and inference skills to create hypotheses about the Late Triassic environment, simulating the work that geologists and paleontologists have done, and continue to do at Petrified Forest. This hike involves a small amount of uphill walking in potentially muddy conditions. Group size is limited to 25 students. 60-90 min

Post Visit Activity: Students use the geologic reference text to complete the geology puzzle activity. 15-30 mins

## Lesson Goals

- Develop an understanding of the sciences of paleontology and geology by learning the skills and concepts involved
- Be introduced to geological time periods represented within Petrified Forest NP
- Explore the basic goals of paleontology and geology through participation in a guided off-trail hike with a ranger
- Use observation and inference skills to determine how clues from rocks and fossils can provide insight into past environments.
- Become aware of the importance of preservation of natural and scientific resources
- Understand the role of the National Park Service in the preservation and protection of natural, cultural, and scientific resources.

## Learning Objectives

**Students will be able to:**

- describe paleontology as the study of ancient life on earth through fossils
- describe geology as the study of the rocks and earth processes
- list geological time periods represented at the park
- explain why choices have consequences
- use observation skills to create hypotheses about the natural world
- recognize that paleontological resources are nonrenewable
- describe at least one thing they learned about Petrified Forest National Park and/or the National Park Service.

## Related Vocabulary

- **Chinle Formation** - rock formation within Petrified Forest National Park and the larger area of the Painted Desert, containing several distinct rock layers, dating to over 200 million years ago; represents the Late Triassic Period
- **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
- **Conglomerate** - a coarse-grained sedimentary rock composed of rounded fragments (> 2 mm) within a matrix of finer grained material.
- **Context** - the circumstances that form the setting for an event, statement, or idea, and in terms of which it can be fully understood and assessed. In geology and paleontology context can refer to the entirety of knowledge available at one time that scientists can use to create hypotheses or theories about the past.
- **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

- **Epoch** – a division of geologic time that is a subdivision of a *period* and is itself subdivided into *ages* (the Triassic Period has contains three epochs; the Early, Middle, and Late Triassic.)
- **Fossil** - any record of past life found preserved in rock; can be plant materials such as stems, seeds, or cones, and pollen, 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 *(evidence of life preserved by a geologic process)*
- **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
- **Hypothesis** - a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.
- **Limestone** - type of sedimentary rock composed of calcium carbonate, usually formed in shallow marine or freshwater environments and often containing invertebrate fossil evidence.
- **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
- **Pangaea** - a supercontinent in existence during the Mesozoic and Paleozoic Eras that contained all seven continents present on Earth's surface today in a single land mass
- **Permineralization** - fossilization through in-filling of pore spaces in organic material by minerals; organic material is encased within the mineral (scientific term for petrification)
- **Period** - division of geologic time smaller than an era, based on rock layers and the fossils they contain
- **Relative Dating** - dating of events or substances in comparison with one another, in chronological order; comparing types of fossils is often a relative dating technique
- **Sand** - loose, granular, gritty particles of worn or disintegrated rock, finer than gravel, **c**ommonly 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
- **Triassic Period** - the first geologic timespan within the Mesozoic Era, dating from 248-206 million years ago; the Late Triassic Period is well represented at Petrified Forest National Park

**Student Assessment Questions**

Use the following questions to help your students prepare for their trip and to assess what they learned after visiting the park.

1. Can you think of two facts you know about Petrified Forest or the National Park Service?

2. What is a fossil? Give an example of a fossil found at Petrified Forest National Park.

3. It is important to protect our natural resources. Fossils are an example of resources that are in danger of being destroyed. Can you list two reasons for why fossils are being destroyed?

4. Geologic time is how scientists measure the age of the earth, the age of rocks, and the age of fossils. The Jurassic Period is the geologic time period when dinosaurs ruled the earth. Petrified Forest National Park represents the time before the dinosaurs. Do you know the geologic time period represented at the park?

5. What kinds of fossils and types of rocks indicate that water once existed in a particular area within Petrified Forest?

6. National parks were created to protect natural and cultural resources for future generations. Can you explain why this is important?

**Background Knowledge** (For teachers and students. Can be read as a class)

Petrified Forest National Park is an excellent place for studying paleontology and geology of the Late Triassic. The information gained in these studies has enabled scientists to create a picture of what the environment and landscape was like over 200 million years ago. Because the past can never be recreated, paleontological resources are considered nonrenewable and are in need of protection and preservation.

Petrified Forest National Park contains a wealth of fossils from the Late Triassic epoch that are over 200 million years old. These fossils are contained in the layers of the Chinle Formation, also known as The Painted Desert. The process of science and field work is very important to telling the story of Petrified Forest because the first paleontological research began in the early 1900's and continues today. Both the geology and paleontology within the park have been and continue to be extensively studied. The park strives to foster public appreciation for the new information that is learned as part of a larger appreciation for protecting and learning in public lands.

Geology is a science that concentrates on the origin, structure, and processes of the earth. Geologists study the composition, distribution, formation, and changes 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.**

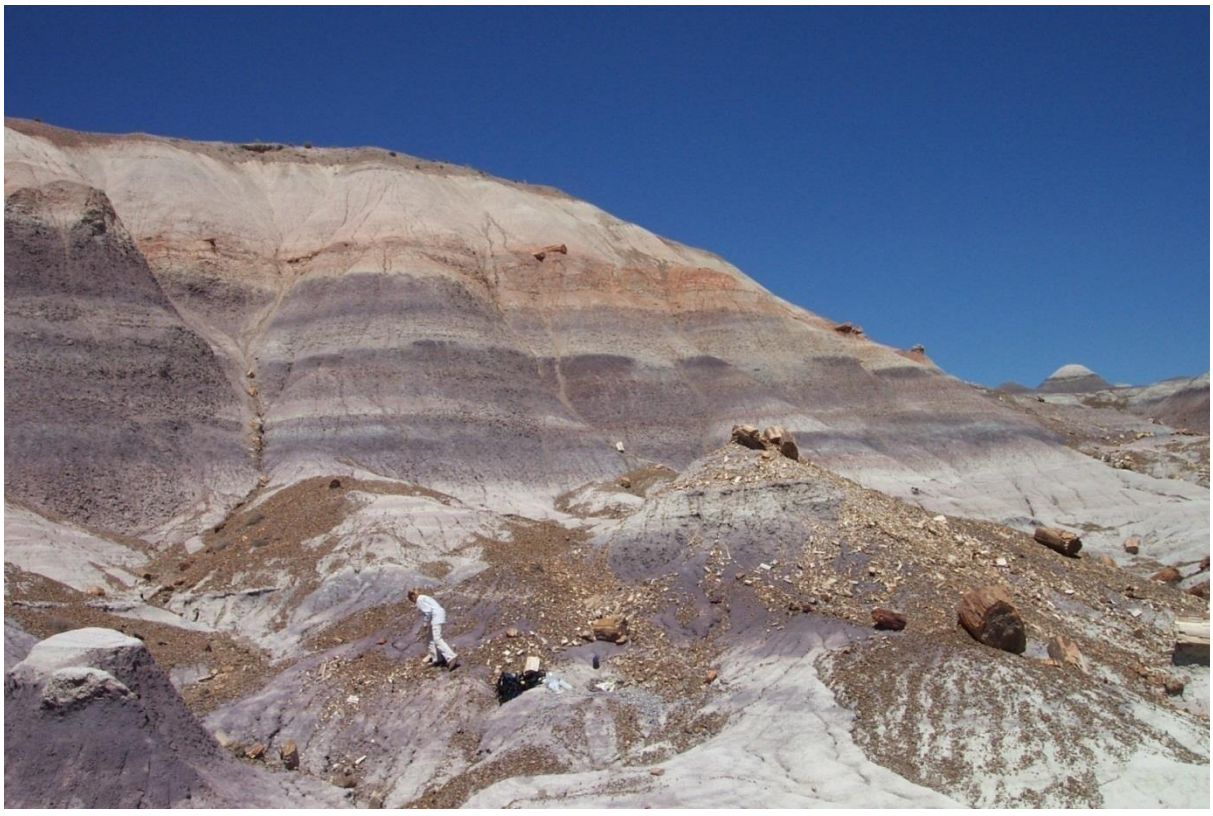
- **Igneous** rocks are heat-formed rocks, originating from magma, or molten rock, found underground. Lava is magma that has flowed onto the Earth's surface. (Obsidian and pumice are examples of igneous rock.)

- **Sedimentary** rocks are formed from sediment, or small particles (clay, silt, sand, gravel) of existing rock. The sediment is compressed cemented together over time. Sediment is transported and deposited by earth forces such as water, wind, gravity, and ice movements. Fossils are most often found in sedimentary rock, where organic material was deposited along with the sediment. (Sandstone, limestone, and shale are examples of sedimentary rock.)

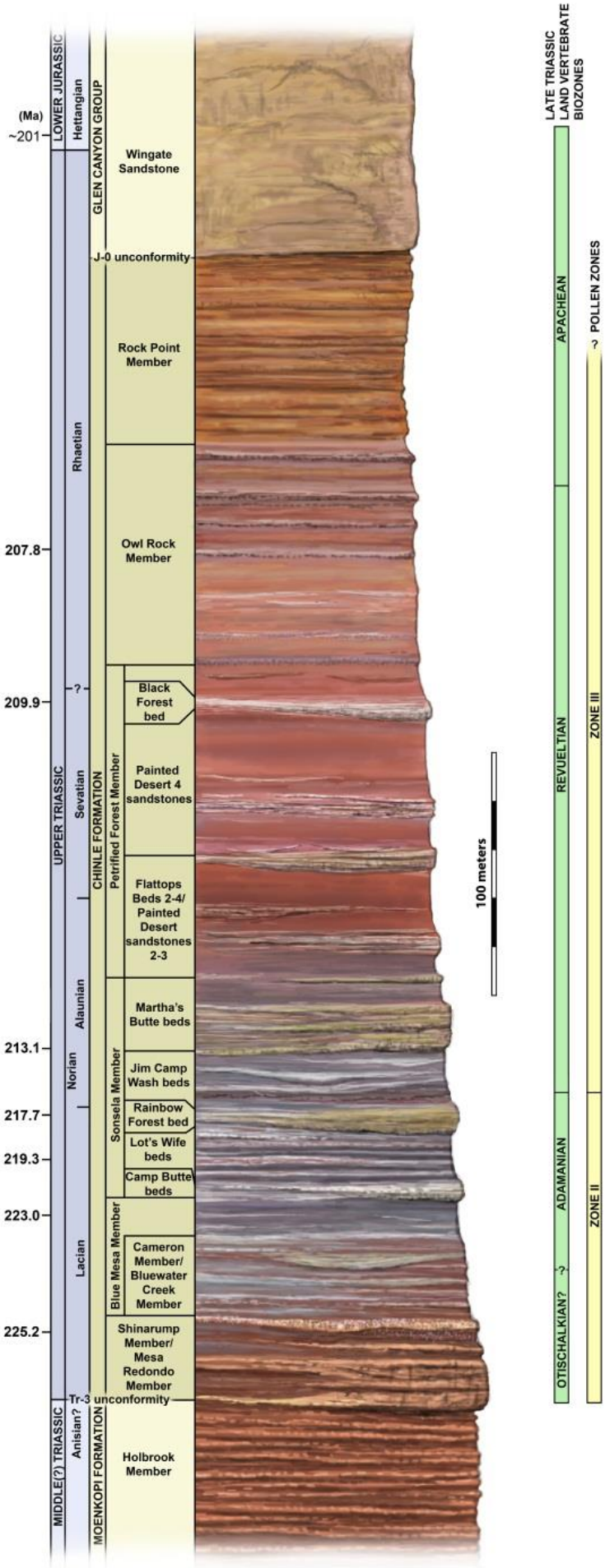
- **Metamorphic** rocks were formed under intense heat and pressure, squashing, stretching, and/or cooking existing igneous or sedimentary rock, changing the appearance and mineral composition. (Marble is an example of a metamorphic rock that used to be the sedimentary rock limestone.)

By studying the geology and the fossils in the park, scientists can create an image of the past environment of the Late Triassic. Different sedimentary layers of sandstone, mudstone, conglomerates, and bentonite clay (clay and volcanic ash), as well as the different minerals with these rocks tell us that a large body of moving water existed for about 18 million years, changing in size, and depth, and flow pattern throughout that time. Fossils of fresh water animals such as mussels, snails, crayfish, sharks, and lungfish show that this body of water was an extensive river system. Fossils of plants such as ferns, cycads, giant horsetails, gingkoes, and tropical conifer trees (the now petrified wood) show that the Late Triassic environment, in what is now Northern AZ, was a sub-tropical forest. Fossils of larger vertebrate animals show reptiles, not dinosaurs, to be the dominant animals of the time. Some very early dinosaur bones have been found in some of the youngest layers in the park showing that dinosaurs began to evolve at the very end of the Triassic. Each summer new fossils are collected from within the park showing either new species never found anywhere in the world, new species not previously found within the park, or additional fossils of known species that tell us more about those animals or plants.

The area where this hike is conducted is within the Rainbow Forest/Jasper Forest beds of geology at the southern side of the park which are approximately 217 million years old. This layer contains a large concentration of color petrified wood as well as large amounts of invertebrate fossils of fresh water mussels (a common name for a type of freshwater clam) and snails. These fossil remains are large clues for scientists, indicating that large amounts of water once existed. The type of rocks that these fossils are contained in, including fine grained and conglomerate sandstone, are clues to the dynamic nature of the river system during the Triassic.

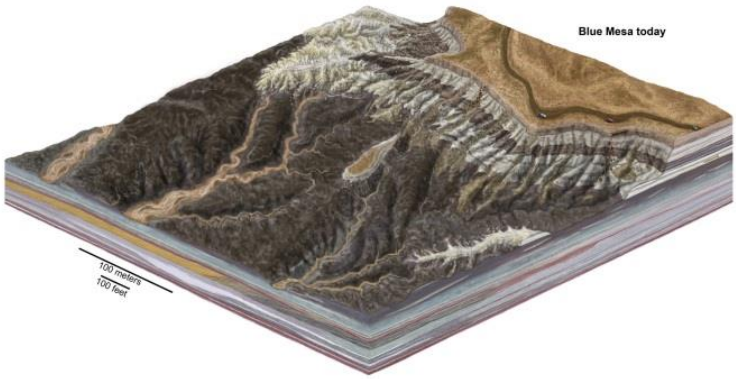


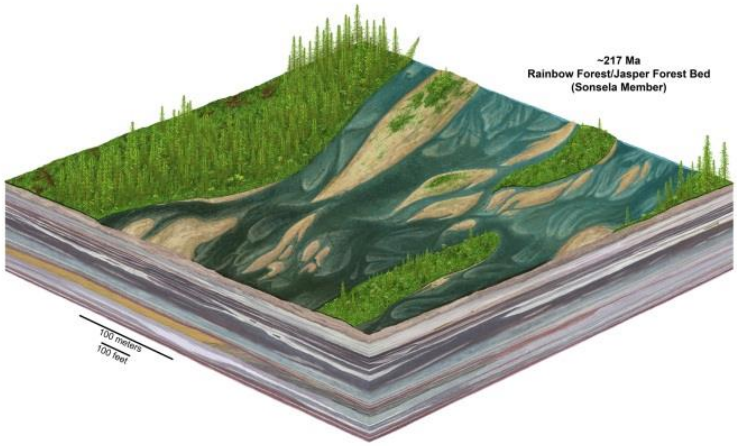
# Geology Exposed in Petrified Forest

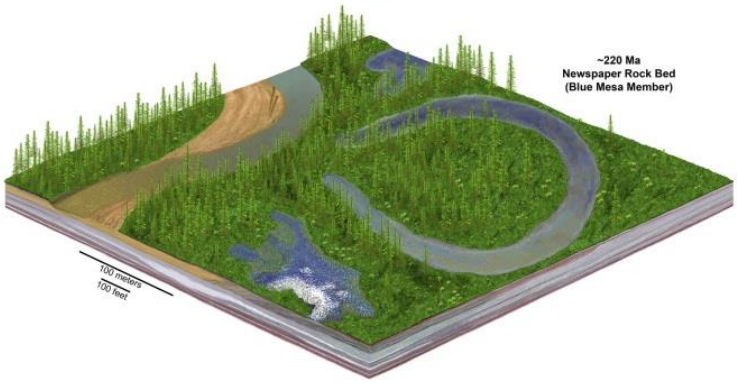








**Pre-visit Activity**

Time Required:

- 15 mins for watching videos
- 45 minutes for Sedimentary Rock Jars over two days.

Lesson Goals:

- Use observation and inference skills to determine how clues from rocks and fossils can provide insight into past environments.
- become aware of the importance of preservation of natural and scientific resources

Learning Objectives:

- Describe geology as the study of the earth and rock processes
- Use observation skills to create inferences or hypotheses about the natural world
- Be familiar with the three categories of rocks.
- Describe how sedimentary rocks are formed.

Materials Needed:

- Smart Board or computer with internet to play YouTube videos
- 'Making Observations' worksheet (1 per student)
- Mason jars with lids or large clear plastic cups (at least 12oz)
- Spoons
- Fine and coarse grained sand of different colors
- Leaves and twigs
- Small pebbles
- Epsom salt (1/4 C for each jar)
- Warm Water (can be in cups or from a tap if the classroom has a sink)
- Dry measuring cups
- Other objects students want to embed in their 'sandstone' (Small shells work great!)

Procedure:

- View all four videos below as a class for some background in the three types of rocks and making observations vs inferences. (15 mins)
    - https://youtu.be/fBlR7taW9jk - Observations v Inferences
    - https://www.youtube.com/watch?v=kRPpVPTFmVQ – Observation v Inference
    - https://www.youtube.com/watch?v=6qaG3MqI-4o – 3 Types of Rocks
    - https://www.youtube.com/watch?v=BsIHV__voMk – Bill Nye - Rocks Rock!

- Pass out 'Making Observations' worksheet to students and have them read the short introduction.
    - Explain that they will be using the observation and inference skills they just learned for the next part of the activity where they will be making a simulation of sedimentary rocks.
    - Students will pair up to make the simulation but record their observations individually.

- Pass out all other materials for making the Sedimentary Rock Jars
    - Mason jars with lids or clear plastic cups
    - Spoons
    - Fine and coarse grained sand of different colors
    - Small pebbles
    - Epsom salt (1/4 C per jar)
    - Warm Water (can be in cups or from a tap if the classroom has a sink)
    - Dry measuring cup
    - Leaves and twigs
    - Other objects to make a part of the 'sandstone'

- Students should spend five minutes making observations on their worksheet about the materials they will be putting in their jar. These should be observations about the physical properties and characteristics of the materials.
    - Then they make inferences based on their observations about what they think will happen when they mix everything up with the water.

- Instruct students to fill 1/3 of the jar (or cup) with sand, ½ cup Epsom salt, two spoons of pebbles, a few leaves and twigs, & other objects.




- Fill the jar or cup with warm water, leaving 2 inches of space at the top.


- Students will then put the lids of the jars on tightly and shake the contents for 1 min (If using cups, students should gently stir the sediments in their cup for 1 min.)
- Set the jars aside on a level surface overnight.
- The next day students will gently pour out the water in the jar and then make their second set of observations and inferences on their worksheet about how the sediments settled in the jar.

**Extensions** - Using plastic cups will allow students to remove the 'rocks' from their mold after they are completely dry but cutting the cup with scissors. Weathering and erosion experiments can be done with the 'rocks' by pouring water over them.

**Land Formations and Erosion** –

- https://www.youtube.com/watch?v=FN6QX43QB4g
- https://www.youtube.com/watch?v=R-Iak3Wvh9c&index=6&list=PLhz12vamHOnYmvLSYtQvuxDrWSi795yDa

# Making Observations

We make observations all the time in our daily lives. We use our senses (smell, touch, taste, sight, & sound) to answer questions about everything around us, although we may not always know we are doing it. Making observations is very important to scientific research. The difference is that scientific observations are written down and recorded as data. This data is then used to answer research questions and to make inferences.

The science of geology gathers information about Earth's past history and what changes have occurred. For example we can look at the many layers of rocks around the world and observe times of volcanic activity, where oceans once were, or how mountains formed. Observation is just the first step in scientific inquiry but it is arguably one of the most important. From making observations and gathering data we can then make hypotheses and inferences about the Earth.

**Write 3 observations about the physical properties of the materials for your jar. (ex. color, shape, weight, surface texture)**

1.

2.

3.

**Write two inferences based on the observations above (Ex. The pebbles are heavier than the sand. When I mix my jar the pebbles will……):**

1.

2.

**<u>After your materials have settled:</u>**

**Write 3 observations of what occurred in your sediments jar.**

1.

2.

3.

**Write two inferences based on the observations above (Ex. The shells are on the bottom because…..):**

1.

2.

**Did the inferences you made before you mixed up the materials match what actually occurred?**

**What was different/the same?**

**Post Visit Activity:** Students use the geologic reference text and the knowledge gained from the field trip to complete the geology puzzle activity.

Time Required: 15-30 mins

## Lesson Goals

- Review of time periods and geology represented within Petrified Forest NP

## Learning Objectives

- Describe geology as the study of the earth and its rocks
- List geological time periods represented at the park
- Use observation skills to create hypotheses about the natural world

**Geology Puzzle Reference Text**

During the Late Triassic Epoch large river systems flowed northwest through this region to the sea. These rivers deposited thick layers (over 900 feet/300 meters) of silt, sand, and gravel which built up into layers over time. Modern erosional forces have re-exposed these deposits as the colorful badland hills, flat-topped mesas, and buttes we call the Chinle Formation. The Painted Desert is another name for the color layers found in the Chinle Formation.

Within Petrified Forest National Park, the layers of the Chinle are divided into smaller groups of layers called members:

**The Mesa Redondo Member** consists mainly of reddish sandstones with some minor mudstones. This layer represents the lowest (and thus oldest) member of the Chinle Formation found in the park. Unfortunately, it is restricted only to a small area in the Tepees section of the park. The Mesa Redondo Member is approximately 226 million years old.

**The Blue Mesa Member** consists of thick deposits of grey, blue, purple, and green mudstones and minor sandstone beds, the most prominent of which is the Newspaper Rock Bed. This unit is best exposed in the Tepees area of the park. The Blue Mesa Member is approximately 223-225 million years old.

**The Sonsela Member** consists of five parts: 1) the lower Camp Butte beds consisting of white sandstone and conglomerates; 2) the Lot's Wife beds consisting of purple mudstones and gray sandstones; 3) the Jasper Forest bed (at Crystal and Jasper Forests, Blue Mesa) and the Rainbow Forest Bed (at Rainbow Forest), consists of thick gravelly sandstones and conglomerates which contain the majority of the colorful petrified wood; 4) the Jim Camp Wash beds, another unit of mudstone and sandstone with numerous calcareous lenses; and 5) the Martha's Butte beds, purple mudstones and massive brown colored sandstones termed the Flattops One Sandstones. The Sonsela Member was deposited about 213-219 million years old.

**The Petrified Forest Member** consists of thick sequences of reddish mudstones and brown sandstone layers. This member is exposed in the Flattops and the red hills of the Painted Desert. The Black Forest Bed, part of the Petrified Forest Member north of Kachina Point, has been determined to be about 209 million years old.

**The Owl Rock Member** consists of pinkish-orange mudstones mixed with hard, thin layers of limestone. This member is exposed at Chinde Mesa at the northernmost border of the park. The Owl Rock Member is approximately 207 million years old.

**Geology Puzzle** – Cut out the sections of layers from the Chinle below and put them in order vertically from youngest to oldest. Then label them with the correct Member names. Use the reference text and key to determine the correct order.

What are some inferences you can make about the behavior of the Triassic river system based on the types of rocks in each member?