Teacher Guide
Archaeology and the Rock Cycle

Grade Level: 4th – 8th Grade
Time Requirement: 60 – 90 minutes

Introduction
In Part 1 of this activity, students will model sediment deposition by reading a story that transports them through time. They will create layers of sediment and deposit some of the objects used by people living in the area as well. In Part 2, students will become amateur archaeologists. They will excavate an archaeological site, catalogue artifacts they find, and make inferences about the people who left them behind.

Required Materials
- 32-oz. Plastic Containers (12)
- Mica Powder (5 Jars)
- Paper Artifacts
- Deposition Story Flipbooks
- 6-in Rulers (12)
- Flour
- Vegetable Oil
- Paper Artifact Tags
- Wooden Trowels (30)
- Tweezers (12)
- Brushes (12)

Science Standards
- 4.10(B) model and describe slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice.
- 5.10(B) model and describe the processes that led to the formation of sedimentary rocks
- 6.10(C) describe how metamorphic, igneous, and sedimentary rocks form and change through geologic processes in the rock cycle
- 7.10(A) describe the evidence that supports that Earth has changed over time, including fossil evidence, plate tectonics, and superposition

Objectives
- Demonstrate how sediment deposition can occur and lead to sedimentary rock formation.
- Identify relative ages of strata and archaeological artifacts using the Law of Superposition.
- Infer how people lived in past eras based on the artifacts they excavate.

Art Extension: Story Illustrations
After creating their strata in Part 1, students can illustrate a single Deposition Event or make a comic panel of the whole Deposition Story. Alternatively, after excavating, students can create an illustration based on the artifacts in a single stratum or a comic panel representing the whole excavation site and each layer.

Historical Context

Archaeology is the study of the human past through material remains. We call those remains the archaeological record. Archaeologists examine objects humans of the past left behind, such as tools and pottery. Those objects are known as **artifacts**. Through the examination of artifacts and their context, archaeologists are able to identify patterns that can aid in the interpretation of the site. For example, pottery can have distinct designs or forms that are specific to a certain time period, which can, in return, provide a time range for a site.

Artifacts are not isolated. They are surrounded by context. **Context** refers to the exact location, what other artifacts, if any, are associated, and what kind of sediment the artifact is found in. Archaeologists use two key scientific concepts in understanding artifacts and context: the law of association and the law of superposition. The **law of association** tells us that artifacts found in the same stratigraphic layer were deposited at the same time. The **law of superposition** states that stratigraphic layers closer to the surface are younger than layers below. Both of these concepts are vital in understanding chronology. For example, imagine there are 4 layers of sediment. At the bottom is a dark brown clay, on top of that is a gray sandy clay, then there is a light brown sand, and the top layer is grayish-brown loam. Within the brown clay, there are stone tools, and within the light brown sand, there are painted potsherds and stone tools. Using the law of association, we know that the painted potsherds and stone tools are from the same time period. Using the law of superposition, we know the stone tools from the dark brown clay are from a different time period and are the oldest artifacts.

At the Alamo, archaeologists use artifacts and context to identify the various time periods and activities that occurred throughout the 300-year history of the site. **Excavations** have identified depositional layers that directly correspond with the mission life of the Alamo, the Battle of 1836, and the occupation of the U.S. Military. Creating a chronology using stratigraphy first requires an examination of the soil deposition and identifying the distinct layers. Once the layers are identified, archaeologists then look at the artifacts within those layers. In addition to creating a chronology, those layers can assist in determining what type of activities were occurring at the time. In the Battle layer there are musket balls and gunflints, but there are also the byproducts (such as sprue and lithic debitage) of manufacturing those items! This tells us that people were making musket balls and gunflints in certain areas of the site.

Background

The **rock cycle** describes how the three rock types, **igneous**, **metamorphic**, and **sedimentary** rocks, are formed, broken down, and changed from one type to another. There is no direct pathway through the rock cycle that all rocks must take, and since it is a continuous process, there is no specific starting or endpoint.

To simplify things, follow the story of one rock. It enters the rock cycle when molten rock makes its way to Earth's surface through a volcano. When the lava cools, it becomes an **igneous rock.** Over time, the igneous rock is broken down into smaller pieces by wind and water to form **sediment**. The sediment is transported, deposited, and later buried. The sediment then cements together to create a **sedimentary rock**. The sedimentary rock is buried deeply under other rocks, exposing it to high pressure and temperature. The minerals in the sedimentary rock can change shape and size and even sometimes partially melt, transforming into a **metamorphic rock.** Countless other scenarios describe how rock can move through the rock cycle. One small part includes weathering, erosion, and deposition.

Weathering is the breaking down of rock into smaller pieces, or **sediment**. Every rock type can be weathered, no matter if it’s igneous, metamorphic, or sedimentary. **Erosion** is the transport of the weathered sediment away from its source to a different location. There are many causes of weathering and erosion, including wind, water, and ice. For example, the waves on a beach can weather a stone cliff by breaking the rock into smaller pieces and erode it by carrying the sediment away.

After being carried, sediment can settle in a process called **deposition**. An example of this can be seen when a river, carrying sediment in the water, meets the sea. As the river slows, the sediment is deposited as it settles at the bottom of the delta. Another example is when the wind in a desert transports sand grains which accumulate to form dunes. When sediment is deposited, it does so in layers forming **strata.** According to the **law of superposition,** as newer sediment is introduced, it lays on top of the older layer, or **stratum**.

Procedures

Teacher Notes

Sediment: To create the "sediment" students will use for creating their strata, follow the steps below. The amounts mentioned make enough for about 25 students.

1. Mix about 10 cups of flour with about 1 teaspoon of mica powder.
2. Mix vegetable oil with the flour and mica powder until it is the consistency of wet sand, about 1 cup to 1.5 cups.
    a. If the mixture cannot hold any shape when packed together, you may need to add more oil. If it completely retains its shape when molded and squeezed, you have likely added too much oil and can mix in more flour.
    b. If you'd like a more vibrant color, you can mix in more mica powder.
3. Repeat steps one and two with at least three other colors.

Deposition Story Flipbooks: For Part 1, each student group will get one of the three Deposition Stories. Cut out each Event Card and staple them together.

Student Procedures

Part 1

1. Get all the necessary materials for your group.
2. Read the Introduction of your Deposition Story.
3. Read through each Event and deposit sediment and artifacts as directed.
    a. *Note that not all layers will have artifacts!*
4. Once you have completed your Deposition Story, you should have four distinct layers of sediment, each a different color.

Part 2

1. Before beginning your excavation, sketch and color a diagram of the strata in your container.
2. With your trowel, carefully scrape sediment and place it in a cup, on a plate, or a paper towel.
    a. *Note that you are not digging but scraping a very thin layer at a time.*
3. When you find an artifact, use your tweezers to pick it up and place it to the side.
4. Use your brush to dust any sediment from the artifact.
5. Label the layer from your sketch with the artifacts found in it.
6. Using your ruler, measure how deep the artifact was buried from the top of the container. Note the depth on your sketch.
7. Continue excavating and remove a whole layer (color) before moving into the next.
8. Once you have excavated the entire site, complete an Artifact Tag for each artifact you found.

Safety and Disposal

It is recommended that students wear gloves, goggles, and aprons during this activity. The plastic containers, tweezers, wooden trowels, and brushes can be cleaned and reused, and the remaining "sediment" can be thrown away.

Contributors

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Name: _____ Date: _____

Part 1: Archaeology and the Rock Cycle

Introduction

Deposition is the process in which sediment is transported and settles in a new place. In this part of the activity, you will model this process by reading a story that transports you through time. Your story will describe different depositional events and provide some insight into the people living in the area. In addition to creating **strata**, or layers of sediment, you will deposit some of the objects people used, called **artifacts**.

Materials

- Deposition Story Flipbook
- Container
- 6-in Ruler
- Sediment – 4 Colors
- Artifacts

Lab Procedure

1. Get all the necessary materials for your group.
2. Read the Introduction of your Deposition Story.
3. Read through each Event and deposit sediment and artifacts as directed.
    a. *Note that not all layers will have artifacts!*
4. Once you have completed your Deposition Story, you should have four distinct layers of sediment, each a different color.

Reflection

1. Sketch a diagram of the strata you created.
    a. Color each layer
    b. Label them with how they were deposited (e.g. flood, ice, etc).
    c. Label the layers from youngest to oldest.
2. Your story outlined a few ways sediment can be deposited. Describe two other ways deposition can happen.
3. Deposition is just one part of the rock cycle. Write or sketch how the sediment that was deposited in your story can move through the rock cycle over time and become each type of rock.

Name: _____ Date: _____

Part 2: Archaeology and the Rock Cycle

Introduction

Archaeology is the study of the human past through material remains. Archaeologists examine objects humans of the past leave behind, known as **artifacts**. They can gain insight into how people lived in the past by examining artifacts and their context. In this part of the activity, you will **excavate** an archaeological site, catalogue artifacts you find, and make inferences about the people who left them behind.

Materials

- Archaeological Site Container
- Trowel
- Tweezers
- 6-inch Ruler
- Brush
- Artifact Tags

Lab Procedure

1. Before beginning your excavation, sketch and color a diagram of the strata in your container.
2. With your trowel, carefully scrape sediment and place it in a cup, on a plate, or a paper towel.
    a. *Note that you are not digging but scraping a very thin layer at a time.*
3. When you find an artifact, use your tweezers to pick it up and place it to the side.
4. Use your brush to dust any sediment from the artifact.
5. Label the layer from your sketch with the artifacts found in it.
6. Using your ruler, measure how deep the artifact was buried from the top of the container. Note the depth on your sketch.
7. Continue excavating and remove a whole layer (color) before moving into the next.
8. Once you have excavated the entire site, complete an Artifact Tag for each artifact you found.

Reflection

1. Which artifacts are likely the oldest? Youngest? How can you tell?
2. What can you infer about the way of life of the different people who lived here over time? Provide specific examples for each layer in which you found artifacts.
3. Choose three artifacts and describe what you think they were used for.
4. Not every layer has artifacts. Why do you think this is?

Artifact Tags

Artifact Sketch

What is it? _____

Stratum Color: _____

Depth: _____

Description:

_____

_____

Artifact Sketch

What is it? _____

Stratum Color: _____

Depth: _____

Description:

_____

_____

Artifact Sketch

What is it? _____

Stratum Color: _____

Depth: _____

Description:

_____

_____

Artifact Sketch

What is it? _____

Stratum Color: _____

Depth: _____

Description:

_____

_____

Staple Here

Deposition Story 1

Introduction

During the Eocene Epoch, from about 56 million to 34 million years ago, the planet's temperature was warm. There was heavy rainfall and no glaciers. The sea covered much of Texas, including the location of your strata. In your area, sand was deposited on the shoreline and buried by other sediment.

Over time, the sand is compacted and cemented to form sandstone, a sedimentary rock. Other rock and sediment layers overlay the sandstone but are eroded over time, leaving your sandstone back at the surface.

READ

Over time, the exposed sandstone is weathered by water, wind, and other factors, leaving the rock cracked and broken into smaller pieces. Living things, like moss and fungi, can begin growing in the weathered material and the cracks in the rock. As more vegetation grows and decomposes, the rock and sediment are weathered more. As more time passes, soil has formed, with trees, shrubs, and grasses growing.

As people begin living in the area, they hunt small game, such as rabbits and squirrels. They also gather marine animals from the nearby river, such as mussels and snails, as well as pecans, prickly pears, and other edible plants.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Bury one **snail shell**, one **pecan**, and one **rabbit** in the sediment layer. Be sure the artifacts are completely covered!

ARTIFACTS

Event 1

READ

After consistent heavy rainfall, the nearby river overflows and floods the area many times. The traveling water deposits a layer of sand and silt, burying the soil and objects left behind.

The plants in the area are frequently waterlogged, causing many to die. The area is abandoned by the people who had lived there; therefore, no objects are deposited in this stratum.

Event 2

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layer! No artifacts are deposited.

ARTIFACTS

No artifacts are deposited.

READ

Following the period of frequent flooding, rainfall lessens, and vegetation can grow again in the area. As more plants grow and decompose, new soil forms.

With the return of vegetation and animals to hunt, people return to the area. Using bows and arrows, they hunt large game like bison and deer. In the river, mussels and snails are collected. Pecans and prickly pear cacti, along with mesquite beans, are still prominent food sources. Pottery is made from clay found near the river.

Event 3

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layers! Bury one **clay jug**, one **bison**, and one **arrowhead** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS



READ

After a period of frequent flooding, the area experiences a long, severe drought. Without as much vegetation, wind erosion increases, transporting sediment from nearby areas and depositing it in this area.

With the arrival of European colonists came new trade goods, animals, and plants. People still hunt deer and other wildlife, but bison no longer visit the area. Europeans brought horses to the area for transportation. Some trade goods used in the region are porcelain dishes, metal eating utensils, and weapons like muskets and cannons.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layer! Bury one **porcelain plate**, one **horseshoe**, and one **clay marble** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS



Event 4

Staple Here

Deposition Story 2

Introduction

During the Cretaceous Period, between about 146 and 66 million years ago, the Earth's climate was warm, the sea level was high, and dinosaurs roamed the earth. Most of Texas was underwater, beneath the Western Interior Seaway. This shallow sea divided North America, running from the Arctic Ocean all the way to the Gulf of Mexico. Teeming with life, various animals lived in the Western Interior Sea, including mosasaurs and sharks. Many creatures with calcium carbonate shells and skeletons, like mollusks and coral lived there as well.

When these organisms died and sank to the seafloor, their shells and skeletons were broken down into small pieces, buried, and compacted to form limestone rock. This limestone was buried by other rock and sediment layers, but over time they eroded, leaving the limestone layer exposed at the surface.

READ

After heavy rainfall, the nearby river overflows and floods the area. The traveling water deposits a layer of sand and silt, burying the bedrock.

No people have been through this area; therefore, no artifacts have been left behind.

DO

Deposit a layer of sediment that’s from 0.5in - 0.75in thick. No artifacts are deposited.

ARTIFACTS

No artifacts are deposited.

Event 1

READ

After a period of frequent flooding, the area experiences a drought. Without as much vegetation, wind erosion increases, transporting sediment from nearby areas and depositing it in this area.

As people begin living in the area, they hunt small game, such as rabbits, squirrels, lizards, and snakes. The river nearby offers mussels and snails for them to gather as well. In addition to animals, plants like agave and buckeye seeds were eaten. In addition to its use as food, fibers from agave were used to weave baskets, sandals, and even animal traps.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layer! Bury one **basket**, one **snake**, and one **agave** within the sediment layer. Be sure the artifacts are completely covered!

ARTIFACTS



Event 2

READ

As the drought comes to an end, the area's climate cools slightly and rainfall increases. With increased rainfall, plants like sotol, yucca, and grasses become abundant. As more vegetation grows and decomposes, desert soil develops, allowing more grasses to grow.

Bison make their way to the area and are hunted with bows and arrows, along with deer and smaller animals. The prickly pear cactus becomes a significant food source, as the fruit was harvested in late summer, and the pads could be eaten year-round. In addition to prickly pear, people harvested the stem of sotol for food and its leaves for weaving baskets and mats.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layers! Bury one **prickly pear**, one **bison**, and one **arrowhead** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS



Event 3

READ

The cooler, wetter period comes to an end, bringing in a drier and warmer climate. As some of the vegetation dies, erosion by wind increases again, depositing sediment in this area.

With the arrival of European colonists came new trade goods, animals, and plants. People still hunt deer and other wildlife, but bison no longer visit the area. Europeans brought horses to the area for transportation. Some trade goods used in the region are porcelain dishes, metal eating utensils, and weapons like muskets and cannons.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layers! Bury one **horseshoe**, one **metal fork**, and one **glass bead necklace** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS

Event 4

Staple Here

Deposition Story 3

Introduction

Over 100,000 years ago, the Last Glacial Period began, marked by advancing glaciers, cooler temperatures, and the roaming of mammoths and other megafauna. With much of Earth's water locked in ice, sea levels were over 300 feet lower than today, and the Texas shoreline was much farther east. In this area, a dynamic braided river system developed. As this river made its way to the Gulf of Mexico over thousands of years, it experienced numerous flooding events and other changes to its stream channels, depositing large amounts of sediment, like sand, gravel, and clay.

Near the end of this period, at around 20,000 years ago, average temperatures slowly began to increase, causing many glaciers to start melting. As glaciers retreated, sea level rose, and the Texas shoreline slowly made its way westward.

READ

With sea level still rising and the shoreline creeping farther inland, the river meets the ocean much closer to your area. A shallow bay forms nearby, and as the river meets the ocean, it deposits sediment. Over time, grasses and other plants can take root as a marsh develops. Soon the marsh is populated with a variety of flora and fauna.

The people in the area periodically visit to gather oysters and clams for food and leave shell waste behind. Small amounts of fishing occur, and a few bones are left behind.

DO

Deposit a layer of sediment that’s from 0.5in - 0.75in thick. Bury one **clamshell**, one **fish**, and one **crab** in the sediment layer. Be sure the artifacts are completely covered!

ARTIFACTS

Event 1

READ

A period of rapid sea level rise begins, inundating the area with seawater and depositing silty, muddy sediment. Salty water submerges the marsh for long periods of time, cutting the marsh plants off from oxygen and killing them.

With the decreased availability of food sources like oysters and clams, the people in the region do not travel to this area and, therefore, do not leave anything behind.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layer! No artifacts are deposited.

ARTIFACTS

No artifacts are deposited.

Event 2

READ

As sea level decreases again, the shallow bay nearby re-forms. Sediment is deposited in your area by the river and from the ocean's wave action. The marsh ecosystem develops again, serving as a habitat for numerous animals. Among these are marine animals like shellfish, crustaceans, and fish and terrestrial animals like coyotes, rodents, and deer. Not too far from this area, bison can also be found periodically.

Sea level remains stable, and people inhabit the area. They fish extensively, dig for shellfish, and hunt larger game like deer and bison with bows and arrows and spears. Shells are used to make ornaments, like necklaces and beads, and pottery is made from local clay.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layers! Bury one **clamshell**, one **bison**, and one **clay jug** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS



Event 3

READ

A strong storm hits the area. After heavy rain, the river overflows and floods the marsh. Additionally, seawater floods the marsh as high winds push ocean water to the shore. Water from both areas carries large amounts of sediment that deposit over the marshy soil, burying the objects left behind. After the high water recedes, a new layer of marsh soil develops as vegetation puts down new roots. The diverse mix of flora and fauna repopulate the area, attracting people to return and resettle.

With the arrival of European colonists came new trade goods, animals, and plants. The people who returned to the area still mostly relied on hunting and fishing for sustenance. Europeans brought horses to the area for transportation. Some trade goods used in the region are porcelain dishes, metal eating utensils, and weapons like muskets and cannons.

DO

Deposit a layer of sediment that's from 0.5in - 0.75in thick. Be sure it is a different color than the previous layers! Bury one **deer**, one **coin**, and one **horseshoe** within the sediment layer**.** Be sure the artifacts are completely covered!

ARTIFACTS

Event 4