Louisiana STUDENT STANDARDS SCIENCE

Scope and Sequence

Fourth Grade

CADDO SCIENCE

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About the Scope and Sequence

The Louisiana Student Standards for Science represent the knowledge and skills needed for students to successfully transition to postsecondary education and the workplace. The standards call for students to:

- Apply content knowledge
- Investigate, evaluate, and reason scientifically
- Connect ideas across disciplines

This scope and sequence document is designed to assist Caddo educators with the implementation of the Louisiana Student Standards for Science. Based on the instructional shifts, this organization of the standards uses phenomenon to drive 3-dimensional science instruction. ***Phenomena*** are observable events that occur in the universe and can be explained by science. They establish the purpose for learning and help students to connect their learning to real-world events.

Purpose of the Scope and Sequence

This scope and sequence document was developed to assist teachers with the implementation of the Louisiana Student Standards for Science. This tool is not full curriculum and will need to be further built out by science educators. It has been designed to help in the initial transition to the new standards. This document is considered a "living" document and will be updated throughout the school year. Please note:

- The standards are bundled into units.
- The units are built around an ***anchor phenomenon***.
- The units also contain at least one ***investigative phenomenon*** which can be used for a lesson or multiple lessons.
    - Sample resources and activities are provided. These sample resources and activities are not meant to be the sole resource for classroom instruction.
- This scope and sequence is a guide; it **is not** a curriculum.

Parts of the Scope and Sequence

- About the Scope and Sequence- *Explanation of the purpose of the scope and sequence*
- Year at a Glance- *A quick view of how the standards are bundled for the school year*
- How to Use the Anchor and Investigative Phenomena- *An article about phenomena*
- Unit Details
    - ★ Overview: *unit time frame, story line, and sample phenomena (anchor and investigative)*
    - ★ Sample Resources and Activities: *A list of suggested (not required) resources for teachers to use.*
    - ★ Teacher Notes
        - *Background*- The background knowledge of what is being studied.
        - *Common Misconceptions*- Common misunderstandings students have about science concepts.
        - *Unit Unpacked*- A multidimensional breakdown of the essential concepts and skills students should know, be able to do, and connections they need to be able to make.

Year at a Glance

Grade 4: Science Scope and Science

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
The Earth Changes	**Earth's History and Processes**	**Organisms Process Information**	**Human Impact on Earth**	**Converting Energy**	**Force, Motion, and Design**
August - September	September-October				
4-ESS2-1 4-ESS2-2* 4-ESS2-3 4-ESS3-2 4-PS4-1*	4-ESS1-1 4-ESS2-2*	4-LS1-1 4-LS1-2 4-PS4-2	4-ESS3-1 4-ESS2-2*	4-PS3-2 4-PS3-4* 4-PS4-1*	4-PS3-1 4-PS3-3 4-PS3-4*

*Standard will be addressed in multiple units.

All About Anchor and Investigative Phenomena

Natural phenomena are observable events that occur in the universe. Phenomena can be explained or predicted by using our science knowledge. The goal of building knowledge in science is to develop general ideas based on evidence, and those ideas can explain and predict phenomena. Therefore, the focus is not just on the phenomenon itself; it is the phenomenon plus the student-generated questions about the phenomenon that guides the learning and teaching. Engineering involves using explanations of phenomena to design solutions to real-world problems.

Not all phenomena need to be used for the same amount of instructional time. Teachers use an ***anchor phenomenon*** as the overall focus for a unit. An anchoring phenomenon is complex and requires an entire unit for students to be able to explain the science behind it. ***Investigative phenomena*** are used as the focus of an instructional sequence or lesson. By centering science education on phenomena that students are motivated to explain, the focus of learning shifts from learning about a topic to figuring out why or how something happens.

How to Use Anchor and Investigative Phenomena

1. Explore the anchor phenomenon
2. Attempt to make sense of the phenomenon
3. Identify related phenomena
4. Develop questions and next steps
5. Explore investigative phenomena to help make sense of the anchor phenomenon
6. Communicate scientific reasoning around the anchor phenomenon

Sources:

'*Using Phenomena*' by Achieve

Adapted from How do we bring 3-dimensional learning into our classroom?

Grade 4: Science Scope and Science

Unit 1: The Earth Changes

Overview

Time Frame: Approximately 20 days

Unit Storyline:

In this unit of study, students develop understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans. They describe patterns of Earth's physical features. Students analyze and interpret data from maps. They ask questions to discover how organisms affect the physical characteristics of their environment. Students evaluate how water waves and earthquake waves cause destruction. Fourth grade students research how earthquakes produce seismic waves.

The crosscutting concepts of *patterns and cause and effect* are called out as organizing concepts for these disciplinary core ideas. Students demonstrate grade-appropriate proficiency in *asking questions*, *planning and carrying out investigations*, *designing solutions*, and *analyzing and interpreting data*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Standards that appear in this unit: **4-ESS2-1**, **4-ESS2-2***, **4-ESS2-3**, **4-ESS3-2***, and **4-PS4-1***
*Note: **4-ESS-2-2** and **4-PS4-1** are only partially addressed in this unit. Please read the unit description for clarification.*

Anchor Phenomena *Possible Phenomena for Unit*	**Sample Guiding Questions for Phenomena** *These questions can be asked as learning progresses.*
1. Louisiana Coastal Erosion 2. PBS Louisiana's Disappearing Delta (video)	• What is causing the Louisiana coastline to disappear? • How do natural hazards such as hurricanes and flooding impact Louisiana's coastline? • Besides erosion, what other factors contribute to the loss of Louisiana's coastline? • What are scientists and engineers doing to try to decrease the rate of the loss of the land? • How has the rate of land loss changed over time? • Can Louisiana's coastline reappear? Support your answer with evidence and reasoning. • What other natural Earth processes change the land? • **What do you wonder?**

Investigative Phenomena *Possible Phenomena for Lesson(s)*	**Sample Guiding Questions for Phenomena**
1. Flight Into Grand Canyon 2. Grand Canyon and the Colorado River 	• How did water and wind impact weathering and erosion of the Grand Canyon? • Is the Grand Canyon continuing to erode? • What do the formation of the Grand Canyon and the disappearance of the Louisiana coastline have in common? How are they different? • **What questions did you develop?**
Volcanoes 101: National Geographic	• Describe the process by which volcanoes are formed. • What causes volcanoes to form along particular parts of Earth's surface? • Compare the process that formed the Grand Canyon to the process that formed the volcanic islands in the Pacific Ocean. • Why are volcanoes dangerous for humans living near them? • **What other questions do you have about volcanoes?**

1. Glaciers
2. Glacier Cave
 
	• Why would scientists need to monitor the growth of a glacier?
	• Why would scientists need to monitor a glacier's movement?
	• What might cause a glacier to…
	  ○ grow?
	  ○ shrink?
	  ○ move?
	• What affect does the movement of a glacier have on the Earth's surface?
	• Compare the movement of glaciers to movement of flowing water.
	• **What questions do you have for the scientists that study glaciers?**

Grade 4: Science Scope and Science

Unit 1: Earth's Processes
Sample Resources and Activities

1. **A Closer Look Textbook:** Unit 6 Lesson 2
2. **Sample Lesson Plans:**
    - Shake It Up with Seismographs- Students work in teams to design their own seismographs using everyday materials, (string, wire, paper, pencil, marker, pen, paper clips, glue, cardboard, poster board, foil, rubber bands, tape, pan or tray, clay) then test their design to record a simulated classroom "earthquake". Students evaluate the effectiveness of their designs, present their findings to the class, and learn how the best designed seismograph will record small disturbances. Students will also develop an understanding of ways that engineering design/technology may impact human life with respect to natural hazards.
    - Earthquake in the Classroom- Students learn how engineers design and construct buildings to withstand earthquake damage by building their own model structures using toothpicks and marshmallows. They experiment to see how earthquake-proof their buildings are by testing them in an earthquake simulated in a pan of Jell-O.
    - Erosion Challenge The intro will be 10 minutes, and consistent of a brief discussion on erosion. Introduce the activity, and then break out into small groups. The next ten minutes will be devoted to the planning phase, in which students decide what materials they want to purchase and discuss their "plan of attack". The actual creating and testing will take up most of the lesson, clocking about 20 minutes. During this students will place objects and subsequently have the tutor test the design with water to see what happens. The lesson wrap-up will take up the last 10 minutes, and during this students will debrief on what worked and what didn't, as well as discuss with the class real world applications and scenarios. This will help tie in the lesson to the real world.
    - Tsunami Attack! Students learn about tsunamis, discovering what causes them and what makes them so dangerous. They learn that engineers design detection and warning equipment, as well as structures that that can survive the strong wave forces. In a hands-on activity, students use a table-top-sized tsunami generator to observe the formation and devastation of a tsunami. They see how a tsunami moves across the ocean and what happens when it reaches a coastline. They make villages of model houses to test how different material types are impacted by the huge waves.
3. **Informational Article: "***Nutria Change the Land" Adapted from LSU's LAMER*
4. **Trade Book:** *Tsunami* by Kimiko Kajikawa
5. **Websites:**
    - Scholastic Study Jams: Volcanoes
    - Scholastic Study Jams: Weathering and Erosion

- Scholastic Study Jams: Earthquakes
- Tectonic Plate Map Interactive
- Weathering, Erosion, Deposition Chant/Motions
- Weathering and Erosion (full) Video from Discovery Education
  - If you need assistance logging into Discovery Education, ask your librarian for help.
  - Pro tip: You can show shorter segments of the video as you teach your unit. This resource comes with a teacher's guide.
- Earthquakes Video from Discovery Education
- National Park Service: The Grand Canyon
- Grand Canyon: Location, Formation, and Facts
- The Colorado River Map
- Why do rivers curve? (video)

6. **Other Louisiana Resources:**
   - USGS – Louisiana Coastal Wetlands: A Resource at Risk
   - Losing Ground
   - Louisiana's Coastline is Disappearing at the Rate of a Football Field an Hour
   - USGS Louisiana Land Loss Simulation
   - 30 Years of Time Lapse of Louisiana's Coast
   - A New Subsidence Map for Coastal Louisiana
   - Google Earth: Chandeleur Islands
   - PBS Learning Media Wetland Destruction
   - Beaver Sized Rodents are Devouring Louisiana
   - Louisiana's Love-Hate Relationship with Nutrias
   - National Geographic: Nutria
   - Assessing the Impact of Hurricane Katrina in Louisiana
   - Land Area Changes in Coastal Louisiana After Hurricanes Katrina and Rita
   - Historical Hurricane Tracks
   - Scholastic News Article: "Remembering Hurricane Katrina"

7. **Guidebook 2.0 Connection**: Hurricane Unit
   - *Hurricanes: Earth's Mightiest Storms* by Patricia Lauber and *Surviving Hurricanes* by Elizabeth Raum

Grade 4: Science Scope and Science
Unit 1: Earth's Processes
Teacher Notes

Background

Earth's surface features have changed and continue to change over time. The surface of the earth is changed as rock material is broken, carried, and dropped in new locations. Small changes to the surface of the Earth caused by wind and water can add up to large changes over long periods of time (i.e., over thousands to millions of years). Some changes take place quickly. Some changes take place over a long period of time.

Water, ice, wind, and vegetation can affect how fast *weathering* and *erosion* occur. The primary difference between weathering and erosion is that weathering occurs in place whereas erosion involves movement to a new location. Both are caused by similar factors of wind, water, ice, temperature, and even biological action. They can also occur together. *(**Note: Focus on the effects of weathering and erosion rather than the semantics of how they are different**.)* As rocks and land formations erode, we are able to see into the rock formations, which helps explain how the landscape has changed over time. Furthermore, plants and animals can change the land in a variety of ways. By looking at maps and identifying changes in the landscape from these maps, students should identify patterns.

In this unit of study, students analyze and interpret data from maps to describe patterns of Earth's features. Students can use topographic maps of Earth's land and ocean floor in order to locate features such as mountains, mountain ranges, deep ocean trenches, and other ocean floor structures. As students analyze and interpret these types of maps, they begin to notice patterns in the types of structures and where these structures are found. Students learn that major mountain chains often form along or near the edge of continents. Once students locate continental boundaries, a further analysis of data can show students that there is a noticeable pattern of Earth events, including volcanoes and earthquakes, which occur along these boundaries. A variety of hazards result from natural processes (e.g. earthquakes, floods, tsunamis, volcanic eruptions).

Just as humans impact the earth by using resources, the earth also impacts human life. During this unit, students also learn that engineers develop or improve technologies to solve societal problems. Although we cannot eliminate the hazards, we can take steps to reduce their impacts. Students must have the opportunity to engage in the engineering design process in order to generate and compare multiple solutions that reduce the impacts of natural Earth processes on humans. Natural disasters such as hurricanes and tornadoes can have a tremendous effect on human life; however, humans can design solutions to reduce the impact these natural disasters have on humans and human societies. Students should research and discuss possible solutions that could minimize the impact of these hazards on human life. Students should be able to construct different possible solutions and compare the effectiveness of these solutions.

Common Misconceptions

- Wind and water cannot wear away the solid rock of a mountain.
- Landforms look similar today as they did many millions of years ago.
- Wind doesn't have that much of an impact on the land. Wind can only wear down solid rock over long time periods.
- Water can wear down the solid rock of a river valley only a small amount (feet or inches) over millions of years.
- Changes to Earth are not happening over short time periods (i.e., a day or a year).
- Glaciers cannot move and change the land.
- Louisiana's coastal areas can reappear.
- Tsunamis are caused by weather.

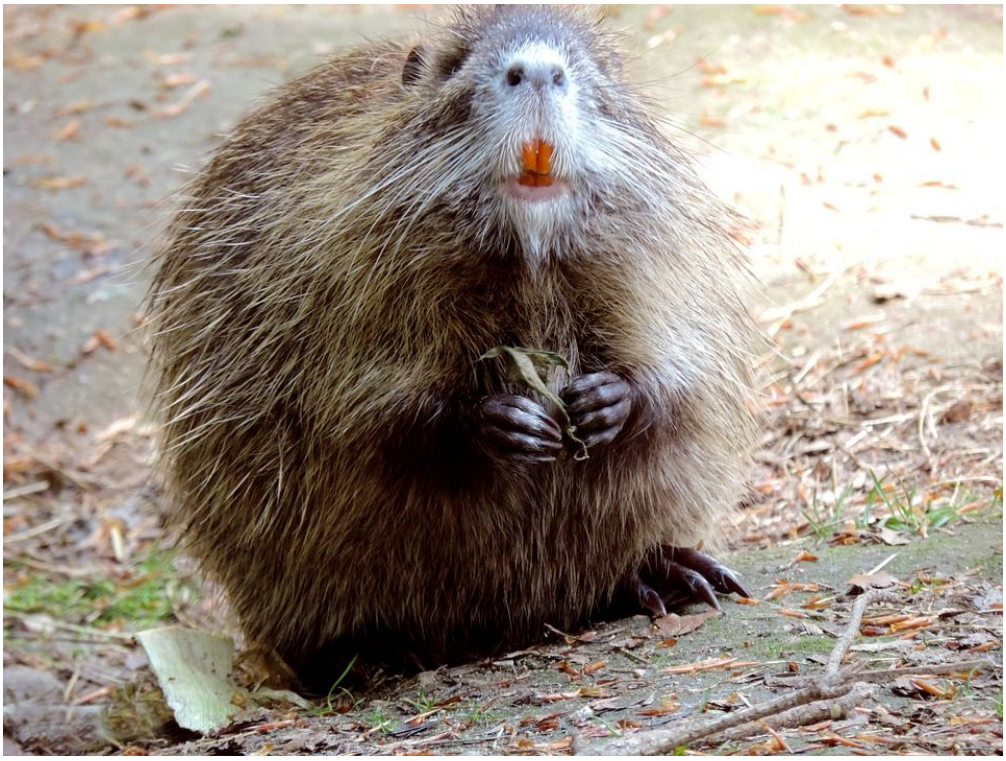
Standards Unpacked

- Students can collect data to explain that natural occurrences such as rain, wind, ice, and gravity etc. break rocks, soils, and sediments into smaller pieces.
    - Erosion is the movement of rocks, soil, and sediment from one place to another
    - Water can break down rock and soil, increasing the rate of erosion
    - Wind, or the movement of air, also causes erosion
    - Ice erosion occurs when a large chunk of ice, usually a glacier, is moved (often due to gravity) and wears away the rocks or soil
    - Some natural substances erode faster than others.
- Students can collect data to explain that living things (plants and animals) impact the movement of rocks, soil, and sediments in different ways
    - Animals affect the environment in many ways: some eat plants, they disturb rocks, soil, and sediment, some build dams or nests, others burrow into the ground.
    - Some living things impact their environment more than others.
- Students can develop and use a model to show that rain, wind, ice, and gravity move rocks, soils, and sediments around from place to place on Earth's surface.
- Students can conduct investigations that show rainfall, wind, or gravity helps to shape the land and affects the types of living things found in a region.
- Students can analyze and interpret data to determine that most earthquakes and volcanoes often occur along the boundaries between continents and oceans.
- Students can obtain and evaluate information about how earthquakes produce seismic waves.
- Students can analyze data to determine that patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.
- Students can obtain and evaluate information from maps to help locate the different land and water features of Earth.
    - While this unit incorporates maps and geographic data regarding land and water, it does not focus on mountain ranges, deep ocean trenches, and most other geographical landforms mentioned in 4-ESS2-2. Students will study that further in Unit 2.
- Students can explain using evidence how Earth processes, such as natural disasters, impact humans.
- Students can explore ways to minimize the impact to humans by Earth processes.
    - Natural weather events such as tornados, hurricanes, strong winds, and excessive rain

can cause damage to natural and man-made structures.

- Humans cannot control natural weather events but can take steps to prevent those events from causing as much damage.
- Among other things, structures can be built outside of the natural floodplains; structures can be built to prevent areas from flooding (levees, barrier islands); and forecasting can prevent loss of life.

Nutria Change the Land



Impacts on the Environment

The ***nutria*** is a non-native species that has become invasive. Although nutrias live in a burrow on land, they have webbed feet and spend much of their lives in the water. They are ***marsh*** dwellers.

At first, when nutria escaped to the wild from fur farms, they did not disrupt the existing ecosystem. However, as time passed and their numbers increased exponentially, nutria began to do serious damage to Louisiana's wetlands. Nutria have huge appetites. It can eat 25% of its own weight every day. Many hoped that the natural predators of nutria, such as the American alligator, would eat enough of the rodents to keep the population in check. This simply did not happen. The large populations of nutria continue to cause two types of damage in ***estuaries*** in coastal Louisiana: herbivory and burrowing damage.

In the late 1980s, increasing complaints from land managers regarding herbivory damage by nutria became routine in southeast Louisiana. A 1993 survey by the Louisiana Department of Wildlife and Fisheries of six parishes (counties) detected 91 damaged areas that covered more than 15,000 acres. "Eatouts," or areas where marsh grass was completely grazed, were easily recognized from the air. Some eatouts measured up to 500 acres in size. Another study, located in the newly forming

Atchafalaya and Wax Lake deltas, used exclosures to document that grazing by nutria and waterfowl seriously slows the development of wetland vegetation. Interestingly, duck herbivory created an approximately equal amount of damage as the nutria did to emergent vegetation. However, reduction of duck populations in the marshes of south Louisiana conflicts with the interests of wildlife managers interested in maintaining large duck populations for recreational hunting. In order to maximize growth of newly created marsh environments, control of the nutria population is considered essential.

Nutria burrowing is also causing significant damage in areas of infestation. Large underground tunnels built by nutria have weakened the sides of drainage canals, dams, and levees. Nutria overgrazing exacerbates cave-ins and ***erosion*** problems in these areas. It is estimated that since 1990 in Jefferson Parish, Louisiana, more than $8 million in damages to the parish canal system can be attributed to nutria damage. In Florida, nutria burrowing into the banks of golf course ponds has caused cave-ins. Also, large numbers of nutria sunning themselves on some of the golf course's tees, especially in the summer, have scared golfers who often mistake them for giant rats.

Prevention & Control Measures

Methods of directly controlling the nutria population include trapping (e.g., live trapping, leg-hold trapping), poisoning (zinc phosphide is the only chemical approved for nutria) and shooting. There are often arguments for and against lethal methods of control. The most cost-effective control measure is trapping, which benefits the economy and lowers the population of nutria in the environment.

Source: Adapted from http://www.lamer.lsu.edu/invasivespecies/nutria/impacts.htm

Nutria Change the Land Questions

1. *What environmental factors make the wetlands a good home for nutria?*

2. *How do nutria impact the Louisiana wetlands?*

3. *How are scientists and engineers trying to control the nutria?*

4. *What solution could be designed to better control the nutria population?*

5. *What other living things negatively impact the Louisiana wetlands?*

Grade 4: Science Scope and Science

Unit 2: Earth's History and Processes

Overview

Time Frame: Approximately 20 days

Unit Storyline:

In this unit of study, students deeper understandings of the effects of weathering and the rate of erosion by water, ice, wind, or vegetation. Students analyze and interpret data from maps to describe patterns of Earth's features. They use evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in landforms over time. The crosscutting concepts of *pattern*s and *cause and effect* are called out as organizing concepts. Students demonstrate grade-appropriate proficiency in *planning and carrying out investigations, analyzing and interpreting data,* and *constructing explanations*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Standards that appear in this unit: 4-ESS1-1 and 4-ESS2-2*

Anchor Phenomena *Possible Phenomena for Unit*	**Sample Guiding Questions for Phenomena**
The Grand Canyon: The Top Two Rock Layers (Video and Other Resources)  *Background Essay can be found in the Unit 2 Scope and Sequence document.	• Consider the light sandstone of the Coconino Formation. What do the composition of the rock and the fossil evidence within it tell us about the environment in which the rock formed? Explain. • How has the land around the Grand Canyon changed over time? How has this affected the fossil that appear in the different rock layers? • What are some characteristics of an animal that scientists can determine just from its tracks? • How can the force of water and wind change rocks and the land? What evidence do you have to support your claim? • How is it possible that rock layers in the same location can have different fossil patterns? • **What questions should scientists ask when studying fossils?**

Sample Investigative Phenomena	Sample Guiding Questions for Phenomena
Fossilization    	• How can you use fossils to determine the order in which the rock layers were formed? • How do fossils help us understand what happened long ago? • Fossils provide evidence of the past. Explain why that is important to scientists. • Describe how fossils are formed. • What could have happened to these plants and animals? Explain and support your answers. • **What questions do you have about fossils and their importance?**
Undersea Volcanoes  ***Note: See NatGeo Map (under Websites) for a complimentary resource to this phenomena.***	• Explain how volcanoes undersea and on land can change the earth's surface. How can these forces affect fossil patterns? • Where are volcanoes and earthquakes most likely to form? • Explain what happens when lava is cooled. • Besides volcanoes, what other landforms can you find under large bodies of water? • **What question(s) would you ask your classmates about undersea volcanoes?**

Grade 4: Science Scope and Science

Unit 2: Earth's History

Sample Resources and Activities

1. **A Closer Look Textbook:** Unit 6 Lesson 1 and Lesson 2 (pp. 314-315) *Students are not required to master the mechanism of rock formation (rock cycle) or memorize specific rock formation and layers. Students are not required to master plate tectonics.*
2. **Sample Lesson Plans:**
    - Cupcake Core Sampling: Trying to "see" what is beneath the surface of the Earth is one of the jobs of a geologist. Rather than digging up vast tracts of land to expose an oil field or to find some coal-bearing strata (rock layers), core samples can be taken and analyzed to determine the likely composition of the Earth's interior. In this activity, students model core sampling techniques to find out what sort of layers are in a cupcake.
    - Secrets of the Past: Students will be able to describe how the Badlands rock layers were deposited over time by ancient environments. Students will match ancient environments and fossilized animals to the correlating rock layer/time period in Earth's history. Students will be able to describe how the modern processes of weathering and erosion shape the Badlands.

3. **Informational Articles:** "The Shaking, Quaking Earth" Article from ReadWorks.org (Free Account Required)
    - ★ **Newsela: Earth's Systems: What Are Fossils?** (Free Account Required)
    -
    - Even More Articles from ReadWorks.org (Free Account Required):
        - Clues About the Continents
        - Earth's Changing Surface
        - All About Rocks

4. **Trade Book:** *Fossils: Uncovering the Past* by Tom Greve and Precious McKenzie (Book from *Ebsco's Discovery Service* database - access through your school's Destiny page. Ask your librarian for assistance.**)**
    - Focus on chapters 2-3**.** Other chapters can be used, but these chapter are a priority.

5. **Websites:**

★ **NatGeo Mapmaker** (highly suggested website)

- Click 'Add Layer' and select 'Earth Systems'.
- Add earthquake and volcanic eruptions layers together and/or separately.
- Have a classroom discussion about what students observe. *Hint: Earthquakes and volcanoes often occur between continents and oceans. Students should observe and figure this out for themselves first.*

- TES Fossils
- Scholastic Study Jams: Fossils
- Rancho La Brea Tar Pits
- Bill Nye: Erosion
- Fossils: Clues to the Past
- Highest Peaks (map)

Grade 4: Science Scope and Science

Unit 2: Earth's History

Teacher Notes

Background

Fossils provide us with evidence of organisms and the environment from the past in which they lived. We see differences in the system components of earth and types of organisms from a short period of time compared to a long period of time. We can see evidence of past components of our earth systems and the impact on plants and animals. Habitats can cause some organisms to survive well, less well, or not at all. Fossils help us see how the earth has changed over time and help us solve problems that have an impact on plants and animals today.

Earth's history can be investigated by looking closely at the changes in Earth's surface over time. This includes plate tectonics and their movement contributing to changes in the mountain ranges and ocean trenches. Earthquakes and volcanoes add to these changes as well.

Since the earth's surface has and always will be changing, investigating the layers of the earth and the fossils. The order of the fossil types found in digs indicates the order the rock layers were formed.

In this unit, students will be engaging in investigations and discussions about the layers of Earth and how they were formed, gain a very general understand of plate tectonics, observe patterns of rock layers with shell fossils and plant fossils, use maps to identify patterns in the location of some landforms, and investigate that water cuts through rock to change the Earth's surface features.

Common Student Misconceptions

- Mountains stay at the same height and never change.
- Oceans stay at the same depth and never change.
- Earth's land had looked basically the same throughout its history.
- Dinosaur bones are the only type of fossils.
- There are no mountains, volcanoes, or other landforms under the oceans.
- Geologic time occurs in short periods of time.
- Earthquakes and volcanoes cannot take place in similar locations.

Unit Unpacked

Standards that appear in this unit: 4-ESS1-1 and 4-ESS2-2*

- Students can observe plant and animal fossils.
- Students can record, analyze, and interpret data about the plant and animal fossils.
- Students can compare and contrast plants and animal fossils to the plants and animals that live today.
- Students can provide evidence of the types of plants and animals that lived long ago.
- Students can provide evidence of the nature of the environments the plants and animals lived.
- Students can describe characteristics of different types of environments.
- Students can argue from evidence that layers in some sedimentary rocks can describe the living and nonliving things that lived long ago.

- Students can collect data about environments and how they have changed over time.
- Students can collect data about how irregularities in the patterns of rock layers indicate disruptions due to Earth forces (e.g., a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through or eroded the rock).
- Students can observe through research from resources or digital media physical changes, temperature changes, and availability of resources of an environment over time.
- Students can explain that populations of organisms live and have lived in a variety of habitats.
- Students can engage in argument from evidence that changes in habitats affects the organisms living there.
- Students can collect data about how the pattern of rock layers indicate which organisms lived during a certain time period and how the land has changed over time.
    - (e.g., lower marine fossils indicate that, at one point, the landscape was covered by water, and upper land fossils indicate that later the landscape was dry land).
- Students can analyze data to make a claim about where earthquakes and volcanoes mostly occur.
- Students can make a claim that fossils can provide evidence of how the earth has changed over time.

Understanding Rocks and Fossils

All of Earth's rock types fall into one of three categories: ***igneous***, ***metamorphic***, and ***sedimentary***. Most of the Grand Canyon's exposed rocks belong to the third category: sedimentary rock. When mineral grains are ***eroded*** from surface materials, transported by water or wind, and eventually laid down on the ground or seafloor, a loose deposit of sediments forms. Over time, the mounting pressure and heat from subsequent layers compact these soft sediments. Squeezed of their water, the sediment grains are cemented together, or lithified, to form solid -- though brittle -- rock.

The telltale feature of sedimentary rocks is horizontal bedding, or layering, that ranges in thickness from several millimeters to several meters. As a rule, deeper layers are older than those above them. Because sediments form from different minerals and may be deposited on land or in water, there are many kinds of sedimentary rocks. Sand becomes sandstone, mud becomes shale, and the calcified remains of marine organisms become limestone.

Rock Layers in Salta, Argentina

Fossils, the preserved body parts or impressions left by once-living organisms, can be found in sedimentary rocks. Though discoveries of bones and even whole bodies entombed in ice, tar, or amber may be more celebrated, far more common in the fossil record are trace fossils -- burrows, footprints, and other impressions left by everything from plants to dinosaurs in soft, sandy, or muddy sediments. When these

traces are quickly filled in by younger sediment and later lithified, they can be protected from destruction and preserved until they resurface through uplift, erosion, and weathering of ancient sedimentary rock layers or strata.

A leaf fossil of the European beech (deciduous tree) from approximately 3 million years ago

By studying fossils, scientists learn a great deal about life forms that once inhabited Earth. From its fossilized skeleton and impression, researchers can often discern how an organism looked, moved, and obtained food. By studying the rock layer in which the fossil was found, they can also understand the climate in which the organism lived, and even the circumstances by which it died.

Sources:

1. PBS LearningMedia (Support Materials)
2. Strata Image
3. Leaf Fossil

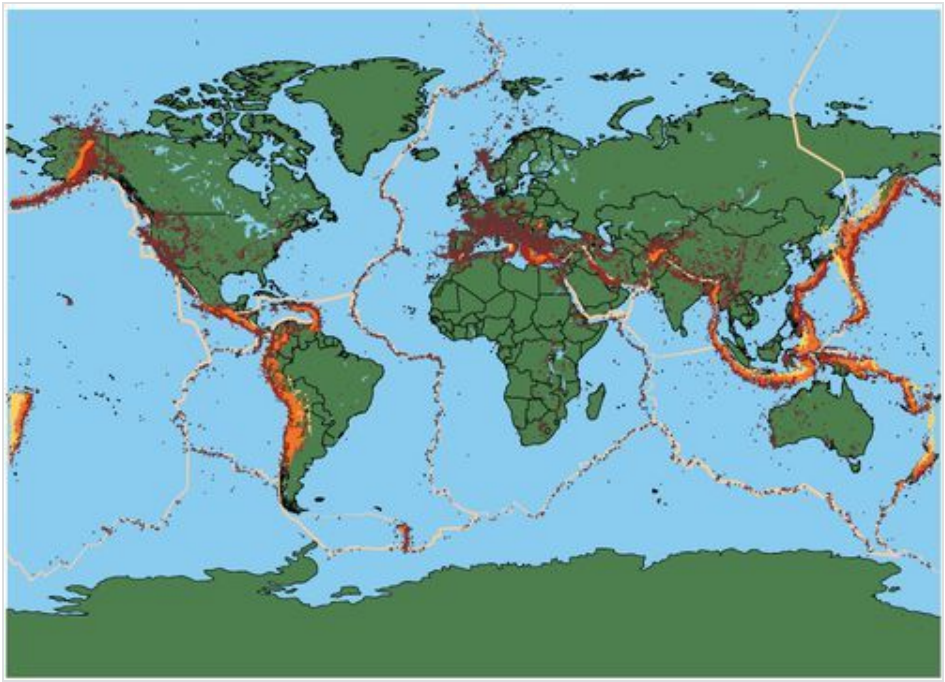
The Shaking, Quaking Earth

Italian writer Francesco Petrarch penned the following eyewitness account in the Middle Ages. Can you guess what he was writing about?

"The floor trembled under my feet; when the books crashed into each other and fell down I was frightened and hurried to leave the room. Outside I saw the servants and many other people running anxiously to and fro. All faces were pale."

If you said an earthquake, you're correct! People in northern Italy had good reason to be pale and frightened on a winter's day in 1348 CE. On that day, a large earthquake struck. Thousands of people lost their lives.

Earthquakes are violent natural disasters that strike without warning. Suddenly, the ground begins to shake. Furniture topples, objects tumble from shelves, and buildings may even collapse. In 1348 CE, people had no idea what caused earthquakes. Today we know that earthquakes are the result of powerful natural forces at work in Earth's crust and mantle.



Locations of plate boundaries and past earthquake epicenters

Scientists developed the theory of plate tectonics in the 1960s. The theory explains how Earth's surface and interior change over very long periods of time. Some plates are pulling apart at their boundaries, other plates are colliding, and still others are sliding past each other. A lot happens at plate boundaries, including most earthquakes. In fact, one of the easiest ways to locate plate boundaries is to determine where earthquakes are occurring!

Source: Readworks.org