6-12 South Carolina Rocks & Fossils Activity

South Carolina Aquarium

Overview

Focus Question
What type of rocks are found in South Carolina? Where can fossils be found in South Carolina? Why are we more likely to find fossils at some locations than others?

Activity Synopsis
Students will act as paleontologists trying to get grant funding for their fossil exploration. Students determine the best sites to look for fossils here in South Carolina. Students will explore the basic geology and rock makeup in various areas of South Carolina. Students will then write a funding request to persuade others to give financial support to excavate the area.

Time Frame
1 hour

Objectives
The learner will be able to:
- Identify the types of rocks found throughout SC.
- Delineate and describe areas that are more likely to have fossils.
- Persuade others to care about fossil research and argue for research locations based on geologic data and analysis.

Key Terms
- Appalachian Mountains
- Blue Ridge Mountains
- Coast
- Coastal Plain
- fossil
- igneous
- metamorphic
- Mountains
- Piedmont
- rock cycle
- Sandhills
- sedimentary

Standards

South Carolina College- and Career-Ready Science Standards 2021

6th Grade: 6-ESS1-4, 6-ESS2-1, **6-ESS2-2, 6-ESS2-3**
7th Grade: 7-LS2-3, 7-LS2-4, 7-ESS3-1
8th Grade: **8-LS4-1**
Biology: B-LS2-3, B-LS4-1, B-LS4-5
Earth and Space Science: E-ESS1-5, E-ESS2-2, **E-ESS2-3**, E-ESS2-5, **E-ESS2-7**, E-ESS3-1

***Bold standards are the main standards addressed in this activity**

2014 Academic Standards and Performance Indicators for Science

6th Grade: 6.S.1A.2, 6.S.1A.6, 6.S.1A.8
7th Grade: 7.S.1A.2, 7.S.1A.6, 7.S.1A.8

6-12 South Carolina Rocks & Fossils Activity

8th Grade: 8.S.1A.2, 8.S.1A.6, 8.S.1A.8, 8.E.5A.1, **8.E.6A.3,** 8.E.6A.4, **8.E.6A.5**
Biology: H.B.1A.1, H.B.1A.2, **H.B.1A.4**, H.B.1A.8, H.B.6C.1
Earth Science: H.E.1A.1, H.E.1A.2, **H.E.1A.4,** H.E.1A.8, **H.E.3A.5**, H.E.3A.6, H.E.4A.2, H.E.4A.3, **H.E.4A.4**

*** Bold standards are the main standards addressed in this activity**

South Carolina College- and Career-Ready Science Standards 2021

<u>Sixth Grade Performance Expectations</u>
6-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.
6-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
6-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
6-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

<u>Seventh Grade Performance Expectations</u>
7-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
7-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
7-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

<u>Eighth Grade Performance Expectations</u>
8-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operated in the past as they do today.

<u>Biology Performance Expectations</u>
B-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
B-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
B-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

<u>Earth and Space Science Performance Expectations</u>
E-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
E-ESS2-2 Analyze data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
E-ESS2-3 Develop a model based on evidence of Earth's interior that describes cycling of matter through convection processes.
E-ESS2-5 Investigate the ways that water (given its unique physical and chemical properties) impacts various Earth systems.
E-ESS2-7 Communicate scientific information that illustrates how Earth's systems and life on Earth change and influence each other over time.
E-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources and occurrence of natural hazards have influenced human activity.

2014 Academic Standards and Performance Indicators for Science

<u>Sixth Grade Performance Indicators</u>

6.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
6.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
6.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs, or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

Seventh Grade Performance Indicators
7.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
7.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
7.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs, or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

Eighth Grade Performance Indicators
8.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
8.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.
8.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs, or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.
8.E.5A.1 Develop and use models to explain how the processes of weathering, erosion, and deposition change surface features in the environment.
8.E.6A.3 Construct explanations from evidence for how catastrophic events (including volcanic activities, earthquakes, climatic changes, and the impact of an asteroid/comet) may have affected the conditions on Earth and the diversity of its life forms.
8.E.6A.4 Construct and analyze scientific arguments to support claims that different types of fossils provide evidence of (1) diversity of life that has been present on Earth, (2) relationships between past and existing life forms, and (3) environmental changes that have occurred during Earth's history.
8.E.6A.5 Construct explanations for why most individual organisms, as well as some entire taxonomic groups of organisms, that lived in the past were never fossilized.

Biology Performance Indicators
H.B.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims.
H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
H.B.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.
H.B.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

H.B.6C.1 Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.

Earth Science Performance Indicators
H.E.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims.
H.E.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.
H.E.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.
H.E.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.
H.E.3A.5 Analyze and interpret data to describe the physical and chemical properties of minerals and rocks and classify each based on the properties and environment in which they were formed.
H.E.3A.6 Develop and use models to explain how various rock formations on the surface of Earth result from geologic processes (including weathering, erosion, deposition, and glaciation).
H.E.4A.2 Construct explanations for how various life forms have altered the geosphere, hydrosphere and atmosphere over geological time.
H.E.4A.3 Construct explanations of how changes to Earth's surface are related to changes in the complexity and diversity of life using evidence from the geologic time scale.
H.E.4A.4 Obtain and evaluate evidence from rock and fossil records and ice core samples to support claims that Earth's environmental conditions have changed over time.

Cross Curricular Standards

South Carolina College and Career Standards for ELA
Writing (W) – 1.1a, 1.1b, 1.1c, 1.1d, 1.1g

Background

Key Points
Key Points will give you the main information you should know to teach the activity.

- SC has a variety of different rocks which are made from minerals. There are three basic types of rocks: igneous, metamorphic and sedimentary.
- The **rock cycle** is an ongoing process through which one of the three types of rocks becomes another of the three types of rocks. This is a slow ongoing process.
- **Igneous rocks** form when molten rock (magma) cools and hardens under or at the Earth's surface.
- **Metamorphic rocks** form under the surface of the Earth when other types of rocks are changed by great heat and/or pressure.
- **Sedimentary rocks** form when rocks are weathered or eroded, deposited, compacted, cemented together and harden forming rock.
- A **fossil** is the preserved remains or traces of an organism that lived in the past, usually more than 10,000 years ago.
- While fossils are rare, they are more likely to form in sedimentary rocks.
- South Carolina is divided into six separate geographic land regions, each with its own unique topography. These regions are the **Mountain**s, the **Piedmont**, the **Sandhills**, the **Coastal Plain** (Inner and Outer) and the **Coast**.

- The **Blue Ridge Mountains**, a part of the larger **Appalachian Mountains,** was formed more than 300 million years ago when ancient Africa collided with ancient North America. The young Appalachian was once towering as high as the Rocky Mountains, but weather and erosion have worn them down from their earlier heights. The Blue Ridge consist predominantly of the metamorphic rocks schists ("SHist") and gneisses ("nīs").
- The Piedmont or foot of the mountains consist of a mix of metamorphic and igneous rocks throughout its rolling hills.
- The Sandhills region was once an ancient coastline about 55 million years ago. The rocks of this area consist mostly of igneous and even some sedimentary rocks.
- The Coastal Plain (Inner and Outer) and Coast consist of sedimentary rocks from the eroded rocks from the upstate and make for the best location in the stat for fossil formation.

Detailed Information

Detailed Information gives more in-depth background to increase your own knowledge, in case you want to expand upon the activity or you are asked detailed questions by students.

Rocks are made of minerals and are all around us. They make the foundations of our mountains and sit below the soil we walk across and the oceans we swim in. The rocks among us are constantly being recycled between their different forms – **igneous**, **sedimentary** and **metamorphic** in a slow and gradual **rock cycle**. The rocks we have today are the same rocks we have always had, but the rocks themselves have changed from one rock type to another. Each rock tells us clues on how it was formed. The story is hidden in the size and shape of its grain, what minerals it's made of, how the grains and crystals fit together, or even the bubble like voids in its texture. Sometimes we are even lucky enough to find rocks that preserve clues and parts of organisms from our past. **Fossils** can tell us what life was once like on Earth, how it has changed, and clues for helping us protect our ecosystems for the future.

Types of Rocks

Igneous Rocks

Igneous means fire. Igneous rocks form as a result of cooling and solidified molten rock (magma and lava). Magma that solidifies underground creates intrusive (plutonic) igneous rocks. Examples of intrusive igneous rocks include serpentinite, diorite, peridotite, granite, and gabbro. Lava that cools and solidifies above ground is extrusive (volcanic) igneous rocks. Examples of extrusive igneous rocks include basalt, pumic, obsidian, rhyolite and andesite. Igneous rocks are classified based on the size and crystallization of their mineral composition. Generally, the longer the igneous rocks take to cool and crystallize, the larger the mineral crystals will become.

Igneous rocks vary greatly in their appearance from fine-grained to course-grained to big crystals to glass-like rocks. It's hard to identify them based on their look, but the look of a rock tells you about how it was formed. Extrusive igneous rocks that form rapidly at the Earth's surface often have a fine-grained texture and some have a holey-look where gas bubbles where trapped during the cooling process. These holes are known as vesicles. Other extrusive igneous rocks have a glassy texture like obsidian that cools almost instantly when a volcano erupts. In this case there isn't enough time for crystallization to occur. Often below the surface, intrusive igneous rocks can cool slow and gradually which allows for a course-grained texture and larger mineral crystals present on the rocks. Granite is a great example of this slow cooling intrusive igneous rock.

There is a small possibility of trace fossils of a footprint or tracks in the extrusive igneous rocks, but most fossils are not found in igneous rocks.

Metamorphic Rocks

Metamorphic means change in form. Metamorphic rocks form deep below the Earth's surface when other rocks are physically and chemically changed by heat and pressure. Metamorphic rocks are often found where mountain ranges form due to tectonic plate activity. This extreme metamorphic process changes the minerals, texture, and chemical composition of the rocks. Examples of metamorphic rocks include -schist, slate, gneiss, phyllite, marble. Metamorphic rocks are classified based on their appearance and mineral composition.

The appearance of metamorphic rocks can be broken into two types – foliated metamorphic rocks and non-foliated metamorphic rocks. Foliated metamorphic rocks have a layered or banded appearance that is formed by extreme heat and directed pressure.

Examples of foliated metamorphic rocks are gneiss, schist, slate, and phyllite. Non-foliated metamorphic rocks do not have the banded appearance because they are formed in extreme heat with pressure that is relatively low and equal in all directions. This non-directed pressure is why we don't see the bands that we do in the foliated metamorphic rocks. Examples of non-foliated metamorphic rocks include marble, quartzite, hornfels, novaculite.

Metamorphic rocks are unique to explore and to find out what rocks they form from. For example quartzite (the non-foliated metamorphic rock) is metamorphosed sandstone (sedimentary rock). Marble (the non-foliated metamorphic rock) is metamorphosed limestone (sedimentary rock). Gneiss (foliated metamorphic rock) could be metamorphosed granite (igneous rock). Slate (foliated metamorphic rock) is metamorphosed shale (sedimentary rock).

Every rock has its own story, but metamorphic rocks will not be a good place to look for fossils with a story. Due to the extreme conditions of heat and pressure fossils would not stand a chance as metamorphic rocks.

Sedimentary Rocks

Sedimentary rocks form when a combination of rock fragments, mineral grains, or seashells are compressed in layers and hardened. The sediments form by the weathering and erosion of rocks on the Earth's surface. Once the sediments pile up, the pressure causes compaction and cementation as minerals seep through. You can often see the layering of sedimentary rocks. Examples of sedimentary rocks include conglomerate, sandstone, limestone, shale, and dolomite.

There are three basic types of sedimentary rocks: clastic, chemical, and organic sedimentary rocks. Clastic sedimentary rock formed from mechanical weathering debris. Chemical sedimentary rocks form when dissolved materials precipitate from solution. Organic sedimentary rocks form from the accumulation of plant or animal debris.

While sedimentary rocks only make up around 8% of the earth's crust, they actually make up about 75% of the earth's surface. The crust of the earth consist of approximately 8% sedimentary, 65 % igneous, and 27% metamorphic. The Earth's crust is made of rock and averages 22 miles (35 km) deep under the continents, but it averages only 5 miles (8 km) beneath the oceans. With sedimentary rocks forming from the weathering and erosion of minerals and pieces of rocks, it is no surprise that sedimentary rocks will form only at the surface and shallow depths of the Earth's crust. Unlike igneous and metamorphic rocks, sedimentary rocks form at temperatures and pressures that do not destroy fossil remains. That is why most fossils are found in sedimentary rock. The compaction and cementation of the layers is often a great setting with less extreme conditions to preserve parts of the organisms. Sedimentary rocks formation can allow for organisms to be quickly covered before being consumed by scavengers or decaying by decomposers. This makes the ideal setting for looking for fossils.

South Carolina Geology by Region:

South Carolina is divided into six separate geographic land regions, each with its own unique topography. These regions are the **Mountain**s, the **Piedmont**, the **Sandhills**, the **Coastal Plain** (Inner and Outer) and the **Coast**.

The topography of South Carolina ranges from moderately high mountains to rolling hills to some of the flattest areas in the United States. In the first geography of the state, *A View of South Carolina,* written in 1802, John Drayton divided South Carolina into the "lower, middle, and upper country." These general terms are still used, but more frequently the state is organized into the six landform regions: **Mountains**, **Piedmont**, **Sandhills, Coastal Plain** (which can be divided into Inner and Outer Coast Plains) and **Coast**. This regionalization is based on a number of criteria, including relief, rock types, and geologic history.

**For a detailed, interactive map that breaks down the geology of SC, go to SCDNR's website at (http://scdnr.maps.arcgis.com/apps/Viewer/index.html?appid=735411a2f5714f28a424422296f77bb1).*
**A generalized geological map of SC can be found on the SCDNR website at (http://www.dnr.sc.gov/geology/images/gifs/GGMS1.gif).*

Blue Ridge Mountains

South Carolina's **Blue Ridge Mountains** are a small portion of the **Appalachian Mountain** system. Situated in the extreme northern parts of Oconee, Pickens, and Greenville counties, these 600 sq mi (1,554 sq km) of rugged terrain constitute only about 2 percent of the state's surface area. With elevations ranging from 1,400 to over 3,500 ft (427 to 1,067 m), the Blue Ridge provides the greatest relief and steepest slopes in the state. The highest peaks include Sassafras Mountain, at 3,554 ft (1,083 m) the highest point in the state, and Pinnacle Mountain, 3,425 ft (1,044 m), the highest mountain totally within the state. Even though elevations in South Carolina do not approach Mount Mitchell's 6,684 ft (2,037 m) in the Blue Ridge of North Carolina, the area is described accurately as rugged and truly mountainous. However, South Carolina's mountains certainly are not as impressive as those in Alaska and western North America, which soar to altitudes of 15,000 to 20,000 ft (4,572 to 6,096 m) with steep walls and angular peaks. Not only are they lower, but they appear more rounded in form and worn down. One reason for this is that the Rockies, Sierra Nevadas, and Cascades were uplifted only about 100 million years ago, whereas the Blue Ridge was formed more than 300 million years ago.

The Blue Ridge is a portion of the larger Appalachian Mountains chain that extends over 600 miles along eastern North America. The groundwork for the Appalachians began roughly 480 million years ago during the Ordovician Period (of the Paleozoic Era). A change in plate movement allowed for the first Paleozoic mountain building event in North America, referred to as the Taconic Orogeny. The weathering and erosion of sediment from this mountain chain can still be found throughout the piedmont of the Eastern US. The Alleghanian Orogeny or Appalachian Orogeny is a mountain building event that occurred in the late Paleozoic (in the Carboniferous to Permian period) put together the supercontinent Pangea. The Alleghanian Orogeny occurred around 300 million years ago when ancient Africa (Gondwana) approached and collided with ancient North America creating the large mountain chain known as the Appalachian. This collision of continents created the supercontinent of Pangea. The Appalachian Mountains once reached elevations similar to those of the Alps and the Rocky Mountains (which formed later in the Jurassic to Cenozoic Periods) before they were eroded. The young Appalachian Mountains were as high as the Himalayas Mountains, which are the youngest mountain range forming on the planet when the Indian and Eurasian Plates began colliding just 50 million years ago. The supercontinent, Pangea began to break up about 220 million years ago. The tall peaks of the Appalachian Mountains became worn down over the years and now just show the roots of those once towering mountains. The run off of the rocks and sediment can be found throughout the lower elevations below the mountain range. The geological signature of the land reliefs and rocks tell the story and the age of this range. The South Carolina foothills where once part of the large Appalachian mountains, but due to the weathering and erosion, now consist of just rolling hills.

The rocks that form the Blue Ridge are predominantly crystalline schists and gneisses. These metamorphic rocks were formed hundreds of millions of years ago by the subjection of igneous and sedimentary rocks to the tremendous heat and pressure associated with mountain building. Most are very resistant to erosion, and this accounts for the steep slopes and narrow stream valleys that form the area's rugged topography.

<u>Piedmont</u>

The Piedmont (from a French word meaning "foot of the mountains") consists of a 100-mi-wide (161-km) belt between the Blue Ridge and the Sandhills. It covers some 10,500 sq mi (27, 195 sq km) within South Carolina, one-third of the state's total area. Elevations range from about 300 ft (91 m) at the Sandhills margin to 1,200 ft (366 m) toward the northwest near the Blue Ridge, which is separated from the Piedmont by a northeast-southwest trending fault line called the Brevard Zone. The land surface varies from gently rolling in its southeastern part to extremely hilly toward the northwest.

The Piedmont and Blue Ridge have a complex geologic history. The basement rock of both regions is an estimated 1 billion to 1.3 billion years old. Current explanations for the formation of the Blue Ridge and Piedmont rely on concepts of continental drift and global tectonics, and these new theories have invalidated many of the traditional interpretations of mountain building. The rock types are primarily metamorphic, mainly schists, gneisses, and slates, with some granite igneous rocks where intrusive activity took place. Metamorphism, the tremendous heat and pressure that transformed sedimentary and igneous rocks into the crystalline schists and gneisses that characterize the Blue Ridge and Piedmont today, occurred a number of times as a result of major continental movements. *The Piedmont and Blue Ridge Mountain regions are known for their Precambrian and Paleozoic igneous and metamorphic rocks. The Igneous and metamorphic rocks of the Carolinas are referred to as the crystalline rocks.*

During the late Precambrian, some 600 million years ago, what is now the Piedmont existed as a continental fragment, an island off the coast of the proto-North American continent. But about 470 million years ago this island joined North America in a collision that began the formation of the Blue Ridge Mountains. Metamorphism recurred when the proto-North American continent, whose leading edge was the Piedmont, continued to drift eastward and collided with northwest Africa to form the massive ancient continent of Pangaea about 350 million years ago. The continents began to separate some 225 million years ago, and present-day North America began to take shape as the landmass drifted westward and northward to its present location.

Another process going on about the same time, which complicated matters, was intrusive activity. Magma, the molten material below the earth's crust, can move toward the surface of the earth in response to pressure and heat. In the South Carolina Piedmont, it did not reach the surface but instead moved between large and small cracks and joints in the existing stata and filled large cavity areas, where it eventually cooled to form isolated granitic plutons that are now the concentrations for the state's granite quaries. These forces of metamorphism and intrusion soon settled down, and running water became the major agent of earth sculpture. Streams have flowed across the region for millions of years, removing material and cutting into the land to create the forms we see today.

Although both the Blue Ridge and Piedmont have a similar geologic history and are underlain by basically the same rock types, the two are differentiated by topography, elevation, and relief. The Blue Ridge is characteristically rugged with steep-sided, almost V-shaped stream valleys separated by narrow ridge tops. Streams are short and fast flowing, with clear water, many rapids and waterfalls and few tributaries. The Piedmont, on the other hand, has a more rolling, hilly topography. Its river valleys, although quite steep walled in some cases, usually are sloped more gently and are much wider. Piedmont rivers are long, have many tributaries, and their waters are discolored by a heavy sediment load. The valleys are separated by broad upland areas, or interfluves, whose elevations do not vary significantly within local areas and whose relief is much less than that of the mountains.

One interesting feature found in the Piedmont landscape is the monadnock, or inselberg. Looking like a small isolated mountain that stands above the surrounding uplands, a monadnock is a residual feature that is formed because the rock of the monadnock is more resistant to erosion than the rock surrounding it; monadnocks frequently are of granite. Perhaps the most well-known is Stone Mountain, Georgia, but the best examples in South Carolina are Paris Mountain and Glassy Mountain near Greenville, King's Mountain east of Blacksburg, and Table Rock Mountain north of Pickens. Most monadnocks in South Carolina occur within 20 mi (32 km) of the Blue Ridge and all are within 100 mi (161 km). Some were probably spurs or extensions of the main ridge that were separated from it by stream erosion; the common rock material and similar trend of structure support such an interpretation. Other monadnocks are of granitic rocks and sometimes quartzite that formed beneath the surface of the original landscape. As the overlying material eroded, these structures were exposed. Their more-resistant composition retarded erosion, and they became prominent as the surrounding land surface was worn down more rapidly. Commonly, erosion of these features is in the form of exfoliation, and slabs of granite are scattered on their lower slopes.

Sandhills

The Sandhills are a narrow, discontinuous northeast-southwest trending band of rolling hilly topography situated in portions of Aiken, Lexington, Richland, Kershaw, Sumter and Chesterfield counties. The rounded hills have gentle slopes and generally moderate relief, although in certain places the relief can be as great as 200 ft (61 m). These hills generally define the Midlands of South Carolina, and they constitute a distinctive landscape formed by sands and clays deposited millions of years ago.

The Sandhills overlap what is called the Fall Line, which runs northeast-southwest through the Midlands and separates the Piedmont and Coastal Plain. Along the Fall Line the resistant crystalline igneous rocks of the Piedmont are abundant along with the more easily eroded sedimentary rocks of the Coastal Plain. This difference in resistance to erosion results in rock outcrops and many rapids that may extend more than a mile (1.6 km) along some river course. The exact position of the Fall Line is difficult to define because some rivers have cut through the sedimentary into the underlying crystalline rock, and rapids can shift locations during periods of high and low water. Many geographers, therefore, feel that the Fall Line is a misnomer and prefer Fall Zone as a more accurate term.

We usually associate sand with ocean beaches, but the Atlantic is over 100 mi (161 km) away from the Sandhills. Millions of years ago, however, this was not the case. As late as the Eocene, about 55 million years ago, the sea covered a large portion of eastern and southern South Carolina, and its shoreline corresponded to the present-day Sandhills. Marine sediments were laid down beneath the ocean to form the near-horizontal strata of sedimentary rocks that today constitute the Coastal Plain.

The weathering and erosion of the Piedmont and the Blue Ridge provided the clays and sand that were carried by rivers and deposited at their mouths. The ocean waves reworked these materials to form beaches and sand dunes along this ancient coastline, just as the oceans are forming shore-zone features along South Carolina's present-day coast. The sea began retreating about 40 million years ago to approximately its present location. Examples of old dunal features may be seen along State Route 261 south of Wedgefield and north of Pinewood in the Manchester State Forest. In several areas the road cuts through the top of old beach ridges; along both sides of the road, these ridges appear in profile as a series of small hills.

Coastal Plain (Inner and Outer)

The Coastal Plain is the largest landform region in South Carolina. It extends 120 to 150 mi (193 to 241 km) from the Sandhills to the Atlantic Ocean and covers nearly 20,000 sq mi (51, 800 sq km), about two-thirds of the state's total area. Its topography varies from nearly flat and featureless to a rolling surface similar to the lower Piedmont. Elevations range from sea level near the coast to about 300 ft (91 m) at the edge of the Sandhills.

The Coast Plain has a geologic history that is much less complicated than that of the Blue Ridge and Piedmont. The sedimentary rocks that underlie it are made up of muds, silts, sands, and other substances of marine origin. After deposition, these materials were consolidated by compaction and cementation to form shales, sandstones, conglomerates, and coquinas. Over the tens of millions of years during which Coastal Plain sedimentary rocks were laid down, they formed a series of horizontal layers. Because the underlying crystalline basement structure slopes at a steep angle toward the coast, the sedimentary layer is only a few feet thick at the Fall Zone, but attains a thickness of about 3,500 ft (1,067 m) at the coastline. The oldest surface rocks in the Coastal Plain are found nearest to the Piedmont margin, and the youngest occur adjacent to the coast. *Cretaceous and Cenozoic sedimentary rocks can be found throughout the Coastal Plain.*

This landform region can be divided into the Inner Coastal Plain and the Outer Coastal Plain. The topography of the Inner Coastal Plain is rolling and hilly and is very difficult, in most cases, to differentiate from the topography of the Sandhills and the lower Piedmont. Elevations range from about 300 ft (91m) near the Sandhills to 220 ft (67 m) at the Citronelle Escarpment (Orangeburg Scarp). Some 20 to 30 million years ago, this terrace marked a temporary shoreline as the ocean gradually retreated to its position. Southeast of the escarpment lies the Outer Coastal Plain, whose topography is flatter and almost feature-less. The land slopes almost imperceptibly towards sea level at the coast in a series of 10 broken terraces formed by marine and fluvial processes. Among the sediments that formed beneath this ancient ocean are the phosphate beds that extend through the Outer Coastal Plain. Formed by insoluble phosphate material and marine fossils, these deposits became the focus of the state's phosphate industry after the War Between the States and continued to be mined into the early twentieth century.

Despite its relative flatness, the Outer Coastal Plain is not without features. The sea withdrew initially from the Sandhills and then from the Citronelle Escarpment, but during the 2-million-year Pleistocene Epoch sea level rose and fell in response to advances and retreats of the glaciers. The glaciers themselves did not reach into South Carolina, extending only about as far south as the Ohio River, but they did affect the state's physical geography. As they formed and grew, these continental sheets of ice locked up great quantities of water, and sea level fell as much as 450 ft (137 m) below what it is today, exposing South Carolina's continental shelf up to 50 mi (80 km) beyond the present-day coastline. When the glaciers melted, water was returned to the ocean, and sea level was even higher than it presently stands, reaching perhaps as far as 60 mi (97 km) inland of the modern coastline. This advance and retreat of the ocean across the Coastal Plain formed a number of temporary shorelines, which persist today as terraces.

Beside the terraces, various other coastal features were formed as the ocean moved inland and then stabilized with each retreat of the glaciers. But as the glaciers renewed their growth, the sea withdrew once more; and the former shorelines and their beach ridges, ocean terraces, and deltas were abandoned far inland. Some of these remnant features have diverted rivers and streams from a straight course to the sea. The abrupt northeastward turn of the Black River is due to old beach ridges, whereas the sharp southward bend in the Edisto River at Givhan's Ferry apparently results from it following an old distributary channel in an ancient delta formation.

Although seismic activity characterizes almost the entire state, the most sever episode occurred in the Coastal Plain-the famous Charleston earthquake of August 31, 1886, which probably ranked a 10 on the Mercalli 12-point scale of earthquake intensity. The epicenter of the Charleston quake lay between the city and Summerville, about 20 mi (32 km) to the northwest. The shocks lasted more than four days, caused damage estimated at about $23 million, and left 60 dead. Tremors were felt as far west as the Mississippi River. Many rural people who experienced the quake developed a folk calendar around its occurrence, referring to events as so many years before or after the "Shake."

Some 300 aftershocks were recorded during the 35 years after 1886, and mild earth tremors continue to characterize the Piedmont. Over the last decade, seismic activity again has occurred in the Coastal Plain. Studies have indicated the existence of a major South Carolina-Georgia seismic zone that runs northwest-southeast for more than 300 mi (483 km) across the entire state. Among the faults that form it is the northeast- southwest trending Woodstock Fault near Charleston. No other earthquake in the state has equaled the severity of the one at Charleston, and few seismologists predict a recurrence any time soon. Nevertheless, the history of the

Charleston episode has resulted in the classification of eastern South Carolina as a major earthquake risk area. Old Charleston houses bear scars of the experience. After the earthquake, long rods were inserted between the opposite walls of a house to brace them and were held in place by plates placed on the outside of the walls. The plates are visible on these houses today.

Coast

South Carolina's coastline is about 185 mi (298 km) long. The Coastal Zone extends some 10 mi (16 km) into the interior to encompass about 1.2 million acres (486,000 ha) of land and water. South Carolina's coast may be seen as a transition from North Carolina's strand to Georgia's Sea Islands and can be divided into three zones. The first is the 60-mile-long (96 km) arcuate strand that extends, almost unbroken by tidal inlets, from the North Carolina boundary to the area of Winyah Bay. The relatively stable strand is built on a 100,000-year-old barrier sand formation and is paralleled by the Waccamaw River, which flows southward just inland from it. This section of South Carolina's coast is called the Grand Strand and today is the focus of the state's major recreational development that includes large hotels, motels, and resort condominiums. Despite the shoreline's stability, erosion does occur along its beaches and especially endangers the hotels that are built near the water's edge. A series of storms in the winter of 1982-1983 caused considerable erosion, and hundreds of sandbags were used to protect these structures. In the spring of 1986 Myrtle Beach began a beach nourishment program and trucked sand from inland relic dunes to replenish the resort's beaches.

The Santee delta forms the second subdivision of the Coastal Zone. It is about 20 mi (32 km) wide and is the largest deltaic complex on the east coast. It is a cuspate, or pointed, delta, but is has suffered severe erosion over the last 40 years, retreating almost 900 ft (274 m) at certain locations. This is largely because of the decreased sediment load in the Santee River that has resulted from the completion of Lakes Marion and Moultrie in 1942 and the diversion of the Santee's waters into the Cooper River and Charleston Harbor, as well as the creation of other reservoirs on the Piedmont tributaries of the Santee system. As a stream enters one of these lakes, the velocity of its flow drops sharply, and this reduces its ability to carry sediment. The reservoirs, therefore, accumulate much of the alluvial material that otherwise would have been deposited on the coast.

South of the Santee delta lies the Sea Island complex that extends for more than 100 mi (160 km) to the Savannah River and into Georgia. There is considerable diversity among these islands in size, origin, and development. Some, such as Kiawah, Fripp, and Hilton Head, have been developed commercially, whereas others, including Bull, Hunting, and Daufuskie, remain in a more pristine state. North of the Edisto River, extensive marsh areas separate the islands from the mainland, but toward the south the islands are separated from the mainland and from each other by an embayment, such as Port Royal Sound and St. Helena Sound; numerous tidal inlets; and extensive interior waterways.

The Sea Island province comprises two types of islands: erosion remnant islands and active barrier islands. For example, St. Helena Island, off Beaufort, is inland from the ocean and is classified as an erosion remnant. This means that it was at once time part of the mainland. But as sea level declined during the glacial advances of the Pleistocene Epoch, streams began cutting down behind it to from river valleys. As the ocean returned at the end of the Ice Age, about 10,000 years, these river valleys were flooded, and St. Helena and similar areas became islands.

Hunting and Fripp are right on the ocean and are referred to as barrier or beach ridge islands. They are anchored by beach ridges and sand dune complexes, and, in contrast to the erosion remnant islands, they are dynamic and constantly changing. The origin of barrier islands has been much debated. The classic theory explains their formation from offshore sandbars built up by wave action, but a new theory based on emergence and submergence of the coast during the Pleistocene Epoch has been offered. As sea level declined during the glacial period and the ocean retreated from the coast, dunes were built along the new coastline, and the old dunes were left inland. But, as the ocean returned and inundated the former dune ridges, parts of them remained above water to become the cores of coastal islands. Wind and wave action built additional sand dunes on them, and the barrier islands developed.

These islands are still subject to active modification by marine processes. Waves and tidal action constantly alter their beaches; storms bring marked changes, and the prevailing currents slowly wash material away and transform their shapes.

Generally, the northern ends of the islands experience erosion, whereas deposition occurs on the southern ends. This erosion is a natural process that will continue to occur, but people seem unaware of this as they vigorously but ineffectively try to arrest the changes with jetties, groins, seawalls, and beach nourishment programs. A very limited success sometimes is realized, but it must be emphasized that the coast is naturally a dynamic area and that barrier islands are always subject to change.

6-12 South Carolina Rocks & Fossils Activity

The Barrier Islands Act, initiated by the federal government in 1983, removed undeveloped barrier islands from federal flood insurance programs and ended subsidies for the construction of roads and sewer systems on them. The act affected 13 locations in the Sea Islands of South Carolina (Waites Island complex, Litchfield Beach, Pawley's Inlet, Debidue Beach, Dewees Island, Morris Island complex, Bird Key complex, Captain Sam's Inlet, Edisto complex, Otter Island, Harbor Island, St. Phillips Island, and Daufuskie Island) and will make their development more difficult. Though opposed initially by some groups, this action is seen now as logical recognition of the peculiarities of barrier islands and their susceptibility to sudden and pronounced changes. The Sea Island landscape may be seen along various coast roads, especially U.S. Route 21 north and south of Beaufort and U.S. Route 278 approaching Hilton Head Island. A spectacular view of a barrier island may be had from atop the old lighthouse in the Hunting Island State Park.

Along South Carolina beaches you rarely find rocks. However, the sand has a story of its own. Sand is formed by the weathering and erosion of rocks, which become tiny particles. These tiny particles are picked up the wind and more often water and become collections of sand. The makeup of sand varies from one place to another depending on the rocks that eroded and created the sand. The most common ingredient is silica. Silica generally comes from quartz which is uniquely resistant to weathering due to its chemical makeup. Quartz is also one of the most commonly naturally occurring mineral on Earth. Other common components of sand consist of feldspar, fragments of igneous, and fragments of metamorphic rocks. Sand can consist of a variety of rock particles and minerals. Because of this, it's easy to determine where sand originates from. The makeup of sand can provide the sand's history. The sources of the sand along our beaches can be traces upstream and often to the Appalachian Mountains. Mountains that once towered high over 200 million years ago, now are now weathered and worn forming our barrier island and beaches. From the mountains to the sea, the rocks and minerals of SC have a story to tell.

Procedure

Materials

- Rocks of SC Map (with cities)
- Rocks of SC Map (without cities) - optional
- Rocks of SC Images
- Rocks of SC Answer Key (for teacher only)
- Funding Request Form

Procedure

1. Tell students that it's time for them to put together all their geology and paleontology knowledge. They will act as a paleontologist trying to get grant funding for their fossil exploration. Grant writing is a "real world connection" where you have to convenience funders why your project is important, how it is well thought through, and the greater significance of the project.

2. Give each student a copy of the Funding Request Form. They can work as individuals or in groups. Let students brainstorm what might be important in selecting a potential fossil site. What questions would they have? Examples: Have fossils been found there in the past? What has been found? Is it a good setting for fossils to be found? What kind of rocks are fossils typically found in?

3. Give each student or group the Rocks of SC Map (with cities) marked. The map marks three possible sites for a fossil dig. Students have to decide which site would be best and why. The map has a key with examples of typical rocks that can be found throughout various areas of SC. Review the rock cycle and the different types of rocks: metamorphic, igneous and sedimentary.

Note: There is a second option, Rocks of SC Map (without cities) marked. Students or teachers can use this option for flexibility to mark their hometown or individualize the sites for the students to pick from.

4. Pass out the SC Rocks Images, or even better, real examples of the rocks. Using the rock images or examples allow students to make predictions on what type of rock it is - igneous, metamorphic, or sedimentary – and why they think it would be that type.

5. Have students check their educated guesses through research or the teacher can reveal each type of rock that are represented on the map and in their images.

Answer Key: Quartzite (non-foliated metamorphic rock); Gneiss (foliated metamorphic rock); Mica Schist (foliated metamorphic rock aka schist rich in mica); Slate (foliated metamorphic rock); Granite (intrusive igneous rock); Gabbro (intrusive igneous rock); Limestone (sedimentary rock); Marl (sedimentary rock); Sandstone (sedimentary rock)

6. Have students discuss in groups or in writing which types of rocks they are likely to find fossils in and why. Have students watch one of the following videos and see if this supports their answer.

Why Don't All Skeletons Become Fossils? BrainStuff – How Stuff Works 4:33 (https://www.youtube.com/watch?v=Av21EY6rGWs)
How To Fossilize…Yourself – Phoebe A. Cohen TED-Ed 5:13 (https://www.youtube.com/watch?v=yDIQzUSezmA)

Note: While fossils in general are rare to form they are most likely to be found in sedimentary rocks. Fossils are more likely to form in conditions where the animal or organism dies and is covered quickly. Desserts, aquatic areas, and even swamps are great places to increase the potential of a fossil forming. Trace fossils can be found in igneous extrusive rocks, but this is very rare. A majority of fossils found around the world are found in sedimentary rocks. Metamorphic rocks will not contain fossils because of the extreme conditions that it takes to form this type of rock. Any fossil remains would be destroyed under that amount of heat and pressure.

7. Once students have identified the types of rock, let them look back at the Rocks of SC Map and determine which site would be the best to look for fossils.

Note: The upper SC area consist heavily of the following metamorphic rocks - quartzite, gneiss, schist and slate. The middle area on the map contains igneous rocks - granite and gabbro. However, the lower area along the coastline on the SC map contains sedimentary rocks – limestone, marl and sandstone. Sedimentary is the rock type that is most suitable for fossil formation. Therefore, the Summerville site would be the best option of the sites given.

8. Have the students complete the Funding Request Form. Students are writing as if they are the paleontologist team looking for funding. Many paleontologists are trying to get funding to help with exploration and excavation projects around the world. Why should the funder give money toward this request? Students should explain how they chose their potential fossil site, what types of organisms or parts could have been preserved, and the scientific significance of this project.

Follow-up Questions

- If you could study fossils anywhere in the United States, where would you choose and why?
- If you could study fossils anywhere in the world, where would you choose and why?

Assessment

Assessment 1: SC Rocks & Fossils

The student's final product with the activity can be used as an assessment tool. Students work should neatly and professionally represent where they would want to explore as a paleontologist. For activity assessment, use the following materials:

- Funding Request From Answer Key

Scoring rubric out of 100 points

Fill in their name, date, project title and selected a fossil site location	**10 points**
Correctly chosen fossil site location	**20 points**
In complete sentences, persuasively justify site selection	**25 points**

In complete sentences, write examples of expected fossil finds of what could be preserved	**20 points**
In complete sentences explain significance of fossil research	**25 points**

Assessment 2: Paleontology Background Research Assessment

Now that the students completed the group activity, they can become paleontology consultants. A team of paleontologist are planning to explore the Island of Jersey off the northern coast of France. They have sent you a geological map with three possible fossil exploration sites. Advise them on which site would be the best choice and why. For this Paleontology Consulting Assessment, use the following materials:

- Assessment
- Assessment Answer Key

Scoring rubric out of 100 points

Fill in their name and selected a fossil site location (5 points each)	**10 points**
Correctly chosen recommended fossil site location	**25 points**
In complete sentences justify site selected	**30 points**
In complete sentences write why the other sites are not selected	**20 points**
In complete sentences explain how the formation rock types impact fossil formation	**15 points**

Cross Curricular Extensions

STEAM Extension
Allow students to research or give students pictures of fossils that have been found or that could be found in SC. Give students air-dry clay like Model Magic to create replicas of featured fossils. Have student write out what time period the species is from and what we can learn from finding a fossil like this. *Note: Students can explore general fossil finds at the PaleoPortal's gallery (http://paleoportal.org/index.php?globalnav=fossil_gallery&sectionnav=main) or South Carolina specific finds at local fossil group websites like http://www.blackriverfossils.org/GoFossilHunting/tabid/65/Default.aspx.*

Science Extension
Have students explore the age of a variety of South Carolina rocks on the USGS (United States Geological Survey) website at (http://mrdata.usgs.gov/geology/state/fips-unit.php?state=SC). They can put those ages on the geological time line and learn the vast history and story of the stones of SC.

Language Arts Extension
Have students write letters to classes in the other areas of South Carolina. In the letters, students should describe what rock and soil features are of their area. They can also research and describe fossil finds if applicable in their area. Students should ask the other classes to send back descriptions of the area they live in, as well as any materials they can send, such as soil samples, rocks, pictures of fossils, etc.

Resources

Teacher Reference Books
Plummer, Charles C. and David McGeary. Physical Geology, Wm. C. Brown Publishers, Dubuque, IA, 1991.
This college textbook explains the geologic processes that have created the different landscapes of the different regions of South Carolina as well as other places in the world.

Murphy, Carolyn Hanna. Carolina Rocks!: The Geology of South Carolina, Sandlapper Publishing Co., Inc., Orangeburg, 1995.
Information on the geology, topography and formation of all of the regions in South Carolina.

Weidensaul, Scott. Mountains of the Heart: A Natural History of the Appalachians, Fulcrum Publishing, Golden, Colorado, 1994.
An in-depth look at the biotic and abiotic features of the mountain range that intersects South Carolina to form its mountain region.

Teacher Reference Websites
Geology and Paleontology of South Carolina
http://www.clemson.edu/public/geomuseum/sc_geology.html
Clemson has this page with a breakdown of South Carolina geology and paleontology resources.

Geology.com
http://geology.com/rocks/
Geoscience News and information with great images of a variety of rocks.

How Do Fossils Form?
http://www.livescience.com/37781-how-do-fossils-form-rocks.html
Live Science wrote out an article describing how different fossils form from minerals and how organic remnants could be preserved.

Minerals and Rocks: Formation and Classification of Igneous Rocks
http://elearning.stkc.go.th/lms/html/earth_science/LOcanada2/205/1_en.htm
This site breaks down the steps and types of igneous rocks.

South Carolina Department of Natural Resources (SCDNR)
http://www.dnr.sc.gov/
Information on the wildlife and geology of all of South Carolina. SC Geological Maps and Kits can be purchased at http://www.dnr.sc.gov/geology/publications.htm#rockandmineral

U.S. Geological Survey
www.usgs.gov/
This site offers valuable earth science information on a variety of topics.

International Chronostratigraphic Chart – Geologic Scale Chart
http://www.stratigraphy.org/index.php/ics-chart-timescale
The International Commission on Stratigraphy published an updated geologic scales chart annually to account for new fossil finds and research.

Birth of the Mountains (The Geologic Story of the Southern Appalachian Mountains) http://pubs.usgs.gov/gip/birth/birth.pdf
This is a book that goes into detail on the history and development of the Appalachian Mountains.

Horton, Wright. The Geology of the Carolinas: Carolina Geological Society Fiftieth Anniversary Volume. Univ. of Tennessee Press, Knoxville, TN. 1991. https://books.google.com/books/about/The_Geology_of_the_Carolinas.html?id=1lNFLn9YVMwC

North America rock types map
http://www.newworldencyclopedia.org/entry/Rock_(geology)

Geologic Time Scale for South Carolina
http://www.dnr.sc.gov/geology/images/gifs/OFR108.gif

Student Reference Books
Pellant, Chris. Smithsonian Handbooks: Rocks & Minerals. DK Publications. 2002.
This book does the best job of set by step identifying rock type and then more details. It also helps with identification for more than 500 rocks and minerals.

National Audubon Society. National Audubon Society Field Guide to North American Rocks and Minerals. 1979.
This field guide has colored photographs to help identify rocks and fossils from throughout North America.

Thompson, Ida. National Audubon Society Field Guide to North American Fossils. 1982.
This field guide has great hundreds of photographed fossils to make identification easier and covers fossils found throughout North America north of Mexico.

Evert, Laura. Rocks, Fossils & Arrowheads (Take Along Guides). Northwood Press, 2002.
This quick guide introduces students to identifying a variety of rocks and minerals from limestone and conglomerate to granite and gneiss.

Perrault, Chris. The Best Book of Fossils, Rocks, and Minerals. Kingfisher Publications, Boston, 2000.
A reader-friendly book that addresses a variety of geology aspects - age of the earth, rocks, gems, minerals, fossil fuels, and a great overview on fossils.

Student Online Games and Interactives
Fossil Hunting Game – Dinosaur Cove – National Geographic Kids (http://www.dinosaurcove.co.uk/fossilhunter.html **or** http://www.ngkids.co.uk/games/dinosaurCove**)**
Students can challenge friends and see how many fossils they can find at the fossil site before the tide comes in.

Interactive Fossil Games – My Learning (http://www.mylearning.org/fossils-game/interactive-intro/4-944/**)**
Resources allow students to quickly see how fossils are made and then play a fossil matching game with the living animal card and the fossil remains card. Journey allows students to go through the Silurian, Devonian, Carboniferous, Jurassic, and Cretaceous periods of history with interactives and what they might find in each.

Fossil Movie – Sheppard Software (http://www.sheppardsoftware.com/scienceforkids/dinosaurs/fossils.htm**)**
This movie quickly describes fossils, how they are made, and different types of fossils including trace, mold, resin, and body fossils. It also has a link to explore an Archaeopetryx fossil site and what you can learn from different parts and fossil finds.
Note: The timeline tab goes over the Triassic, Jurassic, and Cretaceous Periods and shows a few examples of organisms of those times.

Layers of Time Interactive Fossil Game – (http://www.amnh.org/ology/features/layersoftime/**)**
Sort the rock layers for the Cretaceous, Jurassic and Triassic rock layer sets.

Identification Adventure – American Museum of Natural History – InfoQuest (http://www.amnh.org/explore/ology/paleontology/identification-adventure2**)**
Now that you've discovered your fossil skeleton, discover what type of animal it is. Go through the characteristics that help us group different taxonomic animals.

Anatomy Adventure – American Museum of Natural History (http://www.amnh.org/explore/ology/paleontology/anatomy-adventure**)** *Reconstruct the skeleton of a fossil animal that you found on an expedition and use the human skeleton to guide you.*

Online Videos
How Does a Dinosaur Become a Fossil? By The Dinosaur Show - 6:12 mins (https://www.youtube.com/watch?v=9f5HehQovx8)

What's a fossil? By Fiona Passantino - 2:34 mins (https://www.youtube.com/watch?v=3rkGu0BItKM)

Curricula
Teacher-Friendly Guides to the Earth Science of the United States.
The Paleontological Research Institute has created detailed curricula guides for regional locations throughout the US including the Southeast. The guide is available as free PDF downloads. It addresses geological history, rocks, fossils, topography, mineral resources,

energy, soils, climate, hazards, and fieldwork.
For more information click on http://geology.teacherfriendlyguide.org/

Berkeley Fossil Record
Learning from the Fossil Record is a series of resources from Berkeley University.
For more information click on: http://www.ucmp.berkeley.edu/fosrec/Learning.html

Stories in Stone
Stories in Stone is an earth science curricula unit by the Great Explorations in Math and Science (GEMS) Program at Lawrence Hall of Science (LHS). The hands-on activities deepen the understanding of the processes that lead to the formation of igneous, sedimentary, and metamorphic rocks.
For more information click on: http://lhsgems.org/GEM408.html

SEPM K-12 Geology Resources
SEPM (the Society for Sedimentary Geology) published three volumes of geology and paleontology curriculum. The site has several selections available free online.
For more information click on https://www.beloit.edu/sepm/publications.html

Earth Science Week Activities
The American Geosciences Institute has a database of activities that you can search by grade or topic.
For more information click on: http://www.earthsciweek.org/classroom-activities