Earth's Composition and Structure

Students will build a detailed rock cycle using maps and samples of Georgia rocks.	
Student Science Performance	
Grade or course: Earth Systems	**Title:** Rockin' Around (the Cycle)
Topic: Type of Rocks	

Performance Expectation for GSE:

SES2. Obtain, evaluate, and communicate information to understand how plate tectonics creates certain geologic features, landforms, Earth materials, and geologic hazards.

d. Ask questions to compare and contrast the relationship between transformation processes of all rock types (sedimentary, igneous, and metamorphic) and specific plate tectonic settings. (Clarification statement: The plate tectonic settings to be considered here are continental collision, subduction zone, mid-ocean ridge, transformation fault, hotspot, and passive zone.)

SES4. Obtain, evaluate, and communicate information to understand how rock relationships and fossils are used to reconstruct the Earth's past.

a. Use mathematics and computational thinking to calculate the absolute age of rocks using a variety of methods (e.g., radiometric dating, rates of erosion, rates of deposition, and varve count).
b. Construct an argument applying principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) to interpret a geologic cross-section and describe how unconformities form.
c. Analyze and interpret data from rock and fossil succession in a rock sequence to interpret major events in Earth's history such as relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity.
d. Construct an explanation applying the principle of uniformitarianism to show the relationship between sedimentary rocks and their fossils to the environments in which they were formed.
e. Construct an argument using spatial representations of Earth data that interprets major transitions in Earth's history from the fossil and rock record of geologically defined areas.
(*Clarification statement*: Students should use maps and cross-sections with a focus on Georgia.)

Additional notes on student supports

Performance Expectations for Instruction:

The GSE for Earth Systems requires that students continually develop and use models in order to better explain concepts across the various instructional segments. Students will work with provided models and will interpret and analyze data from these models that will further reinforce core concepts. In Earth Systems, models commonly consist of scaled and unscaled 2 and 3-dimensional surface maps and cross-sectional maps.

This lesson will build on students' knowledge of rocks from elementary and middle school to understand how geologists use the types of rocks to map the surface of the Earth. Students probably have only learned the rock cycle. The goal of this segment is to take the rock cycle and make it come alive by injecting the course of study with rocks, how they came into existence, and from what rock. An example is sandstone metamorphosing (recrystallizing) into quartzite through heat and pressure from high energy plate tectonic motion.

<table>
<tr><td colspan="2">Materials
Rock kits or samples listed below
Ideally, a kit for each: igneous, metamorphic, and sedimentary rocks
Large sheets of paper
GA Geology Maps: SM-3, SM-4, SM-5 found at
Georgia Geologic Survey maps
Optional: Granite, marble, slate, gneiss, shale, limestone, sandstone, quartzite, phyllite, schist. Preferably use Georgia granite as it is very different than the granite used in kitchens. If available, granite is available from Kennesaw or Elberton quarries.</td></tr>
<tr><td colspan="2">Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.</td></tr>
<tr><td rowspan="4">Engaging Learners</td><td>Phenomenon
Options:
1. Give students a random set of rocks and let them make observations. This is good for those in the coastal plains where there are few to no rocks.
2. Show students a video of an active volcano, such as the recent activity in Hawaii or Iceland. Remember cooling magma/lava is the start of the rock cycle since all rocks when the Earth first cooled were igneous. At this point in the Earth's history there is no starting point.</td></tr>
<tr><td>Obtaining
Students obtain the type of rock that is forming as a result of the volcanic eruption. Focus on the type of rock, not the rock that is actually formed.

Type of rock is igneous. The rock itself depends on the cooling rate and minerals present in the lava which cannot be accessed from a picture.</td></tr>
<tr><td>Evaluating
Students should have a basic understanding of the rock from middle school earth science. During the beginning of the segment, let students communicate their level of understanding through small group discussions and brainstorming a class list of questions on what happened to the lava as it cools.
Teacher Notes: During teacher monitoring of discussion ask: From what you have seen - why would we not find fossils in these types of rock?</td></tr>
<tr><td>Communicating
Students will communicate the type of rock they would expect to find on islands formed by volcanoes or under glaciers.

Ask: What makes one rock different from another rock? Work in pairs to develop a list of characteristics to use when examining a rock to determine its composition. Have pairs share their lists to combine and post a class list of rock characteristics.</td></tr>
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Exploring	*Obtaining* Students obtain geologic maps of Georgia. *The maps can be found at [Georgia Geologic Survey maps](#) and are available for printing at no cost. Download and use the following maps: SM-3, SM-4, SM-5.* *Teacher Notes: Print on the largest paper possible and laminate for reusability. By laminating, students can write on the maps and erase. If possible, make multiple copies of each map so the students can work in groups. The maps can be downloaded and viewed on a computer, but paper is the optimum medium.*
	Communicating Using the maps, students identify igneous rocks along with their locations in Georgia. Instruct students to record the location and rock type on their individual map or in a journal. Students will brainstorm how these igneous rocks formed. *There is a common misconception that ALL igneous rocks are the result of volcanoes. Students often comment that Stone Mountain granite is a result of a volcano. The next video and links should lead students to understanding how Stone Mountain formed. Also note that Stone Mountain is NOT the largest granite outcrop in the world.*
	Evaluating Students will evaluate their idea of how Stone Mountain formed. They should realize Stone Mountain is not a result of a volcano and that igneous rocks can form above or below ground. Research to use: ● Intrusive igneous formations ● Identifying Igneous Rocks -- Earth Rocks! ● Stone Mountain *There is more information with an online search for students to use for independent or small group research.*
Explaining Finalizing Model	*Obtaining* Students will continue to use the Georgia Maps and other rock samples following the same procedure as they did with the igneous rocks. A guide to locations of rock sites and ideas: [Rock Hunting in Georgia](#)
	Evaluating Students will evaluate the other types (sedimentary and metamorphic) rocks in Georgia. Using a rock cycle diagram have students identify each rock as to the type (igneous, sedimentary, and metamorphic)
	Communicating Students will communicate their understanding of the rock cycle by explaining how each rock is made using the terms on the rock cycle diagram.

Elaborating	*Obtaining* Students will obtain a large sheet of paper and work in small groups. Have students bring in samples of common rocks found in Georgia.
	Evaluating Students will use the skills they learned working with igneous rocks to identify the other kinds of rock, label and locate their possible origin on a map. Students will take images of the labeled rocks. Students can use any of the videos or articles below to assist in the identification and learn how the rocks were formed. Students can use these to research to help with their evaluation ● Identifying Metamorphic Rocks -- Earth Rocks! ● How Rocks Form ● AMA Geology (Pilot) - How does flint form? ● Classification of Metamorphic Rocks ● How sedimentary rocks are made - Providence Canyons
	Communicating In small groups, the students will produce a model of a rock cycle with proper action steps. Students will include rock samples where appropriate in the cycle. The students will communicate that * limestone (sedimentary rock) becomes marble (metamorphic rock) through heat and pressure. * Sandstone (sedimentary rock) becomes quartzite (metamorphic rock) through heat and pressure. * Shale (sedimentary rock) becomes slate (metamorphic rock) through heat and pressure. * Slate (metamorphic rock) becomes phyllite (metamorphic rock) through heat and pressure. * Phyllite (metamorphic rock) becomes schist (metamorphic rock) through heat and pressure. * Granite (igneous rock) becomes gneiss (metamorphic rock) through heat and pressure. (Note that gneiss can also form from schist.) Emphasize that the story of the rocks is more important than the cycle sketch. Have students use the different types of plate boundaries to further understand how rocks are made and reformed to produce other rocks. Other plate tectonic settings are: continental collision, subduction zone, mid-ocean ridge, transformation fault, hotspot, and passive zone.
	How do scientists find out the age of a rock? Have students research radiometric dating, rates of erosion, rates of deposition and varve formation to find out more about geochronology. Geochronology is the science of determining the age of rocks, fossils, and sediments using signatures inherent in the rocks themselves.

	Absolute geochronology can be accomplished through radioactive isotopes, whereas relative geochronology is provided by tools such as paleomagnetism and stable isotope ratios. By combining multiple geochronological (and biostratigraphic) indicators the precision of the recovered age can be improved. Research: Absolute Ages of Rocks - Information article Paleontological Map of Georgia One way of telling the age of a rock is by studying the fossil record. Absolute aging of rocks is a lesson that can be used to help students understanding along with this link. *Teacher Notes: A varve formation is typically thin band of sediment deposited annually in glacial lakes consisting of a light layer and a dark layer deposited at different seasons. Geochronology is the branch of geology concerned with the dating of rock formations and geological events.*
	Have students found out more about uniformitarianism to show the relationship between sedimentary rocks and their fossils to the environments in which they were formed. Research information on James Hutton and Uniformitarianism Have them apply this principle to the Paleontology of Georgia and rocks found in various locations to an explanation of their relative age.
	Ask: What can the fossil record of Georgia and other places in the world tell us about how scientists interpret Earth's history? Have students found out more about ● Mass extinction ● Major climate change ● Tectonic events Have the students work individually or in small groups to design a poster of their findings with explanations of their research.
	Phenomenon: Show students this picture and the inferences about the rock layers: Unconformities of Rock Layers Studying a cross section of a rock layer can give students another way to find the relative age of a rock. Have students research relative ages of rocks and find other pictures of rock layers and make inferences based on the principles of relative age: superposition, original horizontality, cross-cutting relations, and original lateral continuity. Have students construct an argument based on their evidence and present to the class for discussion and insight.

Evaluation	***Assessment of Student Learning***
	Create a diagram of the Rock Cycle that is incomplete. Challenge students to find the gaps and produce a complete rock cycle. For example, metamorphic rock can also be under heat and pressure and become a new metamorphic rock. *Rock Cycle* ● Student journals ● Map studies ● Presentations ● Posters ● Explanations and Data Evidence
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Asking questions and defining problems. ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations ● Engaging in argument from evidence ● Obtaining, evaluating, and communicating information
Crosscutting Concepts	● Patterns ● Cause and Effect ● Energy and Matter
Disciplinary Core Ideas	From *A Framework for K-12 Science Education*: ● ESS2.A: EARTH MATERIALS AND SYSTEMS ● ESS1.C: THE HISTORY OF PLANET EARTH

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. Provide calculators as needed. 2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should consider doing both options that are listed as options in this lesson. Each of the options has upsides for different types of learners.
2. The teacher should consider giving students sources for students to use in determining what type of rocks they are observing.
3. The teacher should have clear and consistent guidelines in place for group work. This should help students feel more comfortable and be more likely to participate.

4. The teacher should use intentional and flexible grouping. Best practice is to use data to drive grouping of students.
5. Students may need additional time to complete their list of characteristics.
6. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.

Exploring:

1. The teacher should consider giving students resources to find the geologic maps and any other research that the students need to complete.
2. The teacher should consider giving students an organizer to record data, observations, research and questions.
3. The teacher should use intentional and flexible grouping. Best practice is to use data to drive grouping of students.
4. Students may need additional time to construct their explanations.
5. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.

Explaining:

1. The teacher should consider providing students with a diagram of the rock cycle. The students can label and explain the parts of the rock cycle. Then students can use the diagram to help them identify the types of rocks and explain how the rocks are made.
2. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
3. Students may need additional time to complete this assignment.

Elaborating:

1. The teacher should consider giving students resources to use for their research.
2. The teacher should use intentional and flexible grouping. Best practice is to use data to drive grouping.
3. The teacher should have clear and consistent guidelines in place for group work. This should help students feel more comfortable and be more likely to participate within the group.
4. Students may need additional time to create their model.
5. The teacher should consider providing a rubric to students so that they students can self-evaluate their work. This increases student's ownership and may lend to better models.
6. The teacher should consider having students share and revise their model.
7. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
8. The teacher should consider giving students resources for their research.
9. The teacher should consider using a text to speech program or videos as ways to allow struggling readers to access the material.
10. Students may need additional time to research and create an explanation of the dating of rocks.
11. The teacher should use flexible and intentional grouping. Best practice is to use data to drive the grouping of students.
12. The teacher should remind students of the definition of a scientific argument.

Evaluating:

1. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
2. Students may need additional time to complete their diagram.
3. The teacher should consider providing students with a rubric to self-evaluate their work. This increases student ownership and makes it more likely that they will produce better quality work.

Rock Hunting in Georgia

Enter these coordinates into Google Maps:

- Murphy Marble belt marble: 34.5781492, -84.5072291
- Western Blue Ridge phyllite: 34.783721, -84.629683
- Valley and Ridge Conasauga shale: 34.l6749698, -84.7254323
- Valley and Ridge chert: 34.612061, -85.047346
- Valley and Ridge Red Mountain sandstone: 34.664637, -85.0593943
- Valley and Ridge limestone (Newala limestone): 34.8014633, -85.3505303
- Cumberland Plateau fossiliferous shale: 34.8653.021, -85.41911

Share other coordinates for other rock sites with fellow Earth Science teachers.

Search for rock quarries in Georgia for field trip ideas and samples.

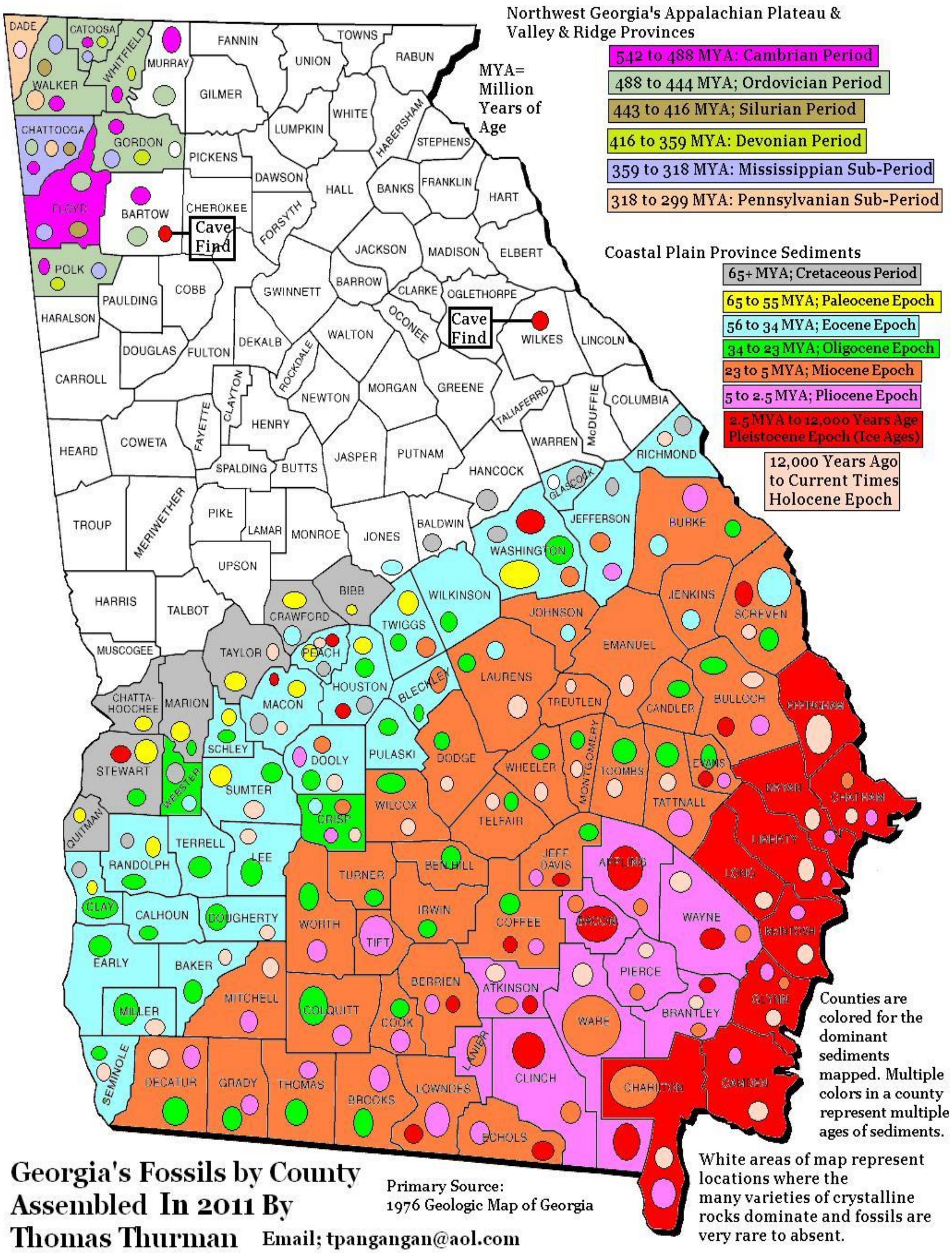
Find out about the Georgia Mineral Society in Norcross.

Visit Tellus Museum in Cartersville, Georgia.

Visit Stone Mountain Park in Atlanta.

Return to Instructional Segment

Paleontological Map of Georgia



Return to Instructional Segment

Unconformities in Rock Layers

Based on this picture, at least nine geological events can be inferred:

1. A series of sedimentary beds is deposited on an ocean floor.
2. The sediments harden into sedimentary rock.
3. The sedimentary rocks are uplifted and tilted, exposing them above the ocean surface.
4. The tilted beds are eroded by rain, ice, and wind to form an irregular surface.
5. A sea covers the eroded sedimentary rock layers.
6. New sedimentary layers are deposited.
7. The new layers harden into sedimentary rock.
8. These layers are tilted.
9. Uplift occurs, exposing the new sedimentary rocks above the ocean surface.

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