## 6.ESS2.2 How Water Shapes the Earth's Surface

### *Pattern Analysis of Student Thinking (PAST): Sand From Mountains Assessment Task*

**Performance Expectation (PE) | 6.ESS2.2**
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

**Targeted Disciplinary Core Idea (DCI) | The Roles of Water in Earth's Surface Processes**
Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

**Associated Disciplinary Core Idea (DCI) | Earth's Materials and Systems**
The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.

**Task 1**
Provide an explanation that shows how each of four different pieces of information (data) provide evidence for the white sand on the beaches of Apalachicola, Florida.

| Purpose | Student Response Themes | Examples of Student Responses | Possible Teaching Moves |
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| This task is designed to determine whether students can use scientific reasoning to connect specific pieces of evidence to explain how Earth materials are weathered and eroded from inland mountains and then deposited in coastal areas. Student responses to questions A–D also can be used to determine whether they understand the difference between weathering, erosion, and deposition. | **Question A**<br>Student explains that weathering resulted in the wearing down of the Appalachian Mountains and that this weathered material could have been deposited in another location (through the process of erosion). | • Since the Appalachian Mountains are old and used to be taller, they clearly have been weathered down over time. All the weathered material had to go somewhere. (Erosion)<br>• The rock that made up the mountains was broken down into sand over time. (Weathering)<br>• The sediment was carried away and deposited somewhere else. (Deposition term is used) | Facilitate a whole-class discussion about the processes of weathering, erosion, and deposition as related to questions A–D. Provide students with opportunities to view the weathering of rock and explain how the shape of mountains can provide evidence of the age of the mountain range.<br><br>Provide students with opportunities to explore erosion through online simulations or through hands-on investigations with stream tables. Focus these discussions and investigations on energy's role … |

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| | **Question B**<br>Student explains that the quartz from the interior of the mountains, through weathering and erosion, could be the source of the material that composes the white beaches of Apalachicola, Florida. | • It takes millions of years to break down quartz.<br>• Quartz is broken down via weathering. (Abrasion)<br>• Quartz is usually broken down into small particles called sand.<br>• Weathering occurs due to rain and/or wind. | … in breaking down the rock and transporting the sediment.<br><br>Additionally, you may have students investigate the formation and geologic history of the Appalachian Mountains and the beaches of the Gulf Coast. |
| | **Question C**<br>Student explains the river provides a possible pathway to transport quartz sand particles from the Appalachian Mountains to the beaches of Apalachicola, Florida. | • The river provided a pathway for the weathered mountain rock (sand) to reach the Gulf Coast beaches.<br>• Weathered rock particles were eroded from the mountains and the river carried them to the beaches, where the particles were deposited. | |
| | **Question D**<br>Student explains the shallow ocean basin and the movement of the waves could lead to the deposition of quartz sediment on the beaches.<br><br>Students might also relate the motion of the waves to further weathering of the rocks. | • After the sand reaches the ocean, the waves can deposit the sand along the shore.<br>• Consistent waves cause abrasion.<br>• Abrasion acts on larger rocks to form smaller rocks and eventually fine sand. | |

**Focus SEP/CCC**: Students use empirical evidence and scientific reasoning to support a written explanation of the formation of the sand that composes the beaches of Apalachicola, Florida.

### Task 2

Draw a scientific model that explains how the quartz rock from the Appalachian Mountains transformed into the small grains of white sand found on the beaches of Apalachicola, Florida.

| Purpose | Student Response Themes | Examples of Student Responses | Possible Teaching Moves |
|---|---|---|---|
| This task is designed for students to construct a model to communicate their understanding of the processes involved in shaping the Earth's surface. Students should be able to construct a model that describes the geoscience processes involved (i.e., weathering, erosion, deposition), how energy is involved in these processes, and how matter is moving as a result of these processes. | Students provide a complete model that shows the rocks of the Appalachian Mountains breaking down into sand particles (weathering), the resulting sediment being transported down the Apalachicola River (erosion), and the sediment being deposited in the ocean basin and then being distributed by the waves along the Gulf Coast shoreline.<br><br>Students also identify the sources of energy (the sun and gravitational energy) and how this energy is related to weathering, erosion, and deposition. Students indicate how these processes shape the surface of the Earth. | • Drawing includes the three main processes (weathering, erosion, deposition), as well the three structures (mountains, river, ocean/beach shoreline).<br><br>• The sun as an energy source is shown and labeled.<br><br>• The mountain height decreases as weathering occurs.<br><br>• The sediment amount increases as weathering occurs.<br><br>• A before-and-after depiction may be present as well.<br><br>• Depicted sediment shows initial larger rock becoming smaller in size and then sand particles eventually.<br><br>• The sediments flowed to the Gulf via the river (process of erosion).<br><br>• It takes millions of years for mountains to break down into sand.<br><br>• Weathering → Erosion → Deposition | Beforehand, review all the necessary components of scientific models to ensure students' understanding and accuracy of their models. Afterward, you may collaboratively draw a model as a class that includes proper labels and sequential order of events leading up to the formation of the white sand beaches of Apalachicola.<br><br>Consider giving students the option to create three-dimensional models (e.g., using clay, cardboard, paper, etc.) or oral presentations. Be sure students understand that energy drives the processes at play. Review the roles of both the sun and gravity in the processes of weathering, erosion, and deposition and how energy is transferred in the system during these processes. |

**Focus SEP/CCC**: Students use provided evidence to construct an explanation using a model to describe how the processes of weathering and erosion shape Earth's surface over long time periods.

### Task 3

Write a claim about whether it is possible for the Apalachicola beach sand to become part of a different mountain in the next 10,000 years.

| Purpose | Student Response Themes | Examples of Student Responses | Possible Teaching Moves |
|---|---|---|---|
| This task is designed to determine if students understand the scale at which geologic processes occur. Students should be able to construct a claim with supporting evidence and logical reasoning about how long it takes for mountains to form. Students should be able to use evidence to communicate that the process of mountain building takes much longer than 10,000 years. | Students write a claim stating which student's idea they agree with. Students then provide a logical explanation including evidence that supports their claim. | Barry's view is the most correct, as the time scale needed for a new mountain to form would be much greater than 10,000 years. | Facilitate a whole-class discussion or small-group discussions in which students construct a timeline for common geologic processes. It may be important to incorporate the rock cycle so students understand compaction and cementation is also possible once rock has been weathered down into sand.<br><br>Allow students to investigate the time scale of geologic processes through written texts, online simulations, and multimedia. This can help students see that geologic processes such as weathering, erosion, deposition, and mountain building are ongoing processes that continually reshape the surface of the Earth. |

**Focus SEP/CCC**: Students construct a written argument—supported by empirical evidence and scientific reasoning—to support or refute the idea that geologic processes could result in the Apalachicola beach sand becoming part of a different mountain in the next 10,000 years.