Lesson 2.4
Layers in a Rocky Outcrop
Lesson Overview

In this lesson, students apply their understanding of how rocks can be used to learn about a place in the past by exploring what differences in rock layers suggest about environmental changes. Students get new information about the rocky outcrop in Desert Rocks National Park—samples of rocks taken from two different sedimentary rock layers in the rocky outcrop. They then investigate in the Sim to find what multiple layers of different types of sedimentary rock in a single location suggests about how the environment in that place has changed. Students then gather more information about the rock samples collected from the rocky outcrop from Fossil Hunter’s Handbook in preparation for making inferences about what the environment of Desert Rocks National Park may have been in the past. Students think about Desert Rocks National Park through the lens of the crosscutting concept of Stability and Change as they consider how a place can change over a long period of time even though it appears to be unchanging day by day. The purpose of this lesson is for students to apply evidence about sedimentary rock layers to the idea that environments change over time.

Anchor Phenomenon: A rocky outcrop in Desert Rocks National Park has a fossil in it and layers of different sedimentary rock.

Students learn:

- Different sedimentary rock layers in a place mean that the environment in that place has changed.
- Any place may appear to be stable day by day, but over a long period of time it can change.
Forming Rock Layers in the Simulation

Students investigate in the Sim to help them explain what different sedimentary rock layers in the same place can tell us about the past.

Instructional Guide

1. **Project the Sim.** Open the Student Apps Page, select *Earth’s Features*, and then select the Simulation. Load Mode 2, and demonstrate how to change the environment in a location. Ask students to share what they notice. [When the sea level rises or falls, the environments in each location change.]

   Changing the sea level is what causes the environments in the Sim to change. This is also one way that environments on Earth can change. Over long periods of time the sea level can go up or down and this can cause environments on Earth to change.

2. **Discuss the difference between location and environment.** Point out locations 1, 2, and 3. Show students that when you change the sea level the location does not move but the environment of each location changes.

   The location is the physical place and the environment is what the place is like. For example, if I lower the sea level in location 3, I can change the environment from a deep ocean to a shallow ocean to a beach. It is still location 3, but the environment in location 3 has changed.

3. **Introduce notebook page 34.** Have students turn to page 34, Rock Layers in the Simulation, in their notebooks. Review the instructions for completing the investigations and answering the questions. Make sure students know they should load Mode 2 before beginning the activity.

   - Step 1: Load Mode 2 using the menu in the upper lefthand corner of the Sim.
   - Step 2: One partner completes Investigation 1.
   - Step 3: Press RESET.
   - Step 4: The other partner completes Investigation 2.
   - Step 5: Talk with your partner about the questions at the bottom of the page. Then, record your responses.
4. Highlight the two investigations students will do. Make sure students understand that first one partner will complete one investigation, then the other partner will complete the second. Point out that the partner that is not “driving” the Sim should still be sure to observe carefully and think about what is happening.

- **Investigation 1**: Pick location 2 or 3. In that location, make a very thick rock layer with all the same kind of rock.
- **Investigation 2**: In the same location, make as many layers of different kinds of rock as you can.

5. Assign pairs and distribute digital devices. Distribute one digital device to each pair of students and have them access the Earth’s Features Sim via the Student Apps page.

6. Students complete the investigations. Give students 10 minutes to complete the investigations. Remind students to answer the questions.

7. Collect digital devices. Ask students to make sure that their digital devices are turned off.

8. Lead a whole-class discussion of what student found out.

   - **Question**: What did you do differently in the two investigations?
     - [To make just one kind of rock I had to keep the environment the same. To make different rock layers in the same location, I had to change the environment by changing the sea level.]

   - **Question**: If you see different kinds of rock layers in one location, what can you infer about what has happened in that location over time?
     - [Different sediment built up at different times; the location had multiple different environments in the past; the environment has changed over time.]

**Teacher Support**

**Rationale**

**Pedagogical Goals: Purpose of This Sim Investigation**

Though this activity is similar to the Sim investigation in Lesson 2.2, it serves its own distinct purpose in students’ development of core content. The Sim investigation in Lesson 2.2 requires students to examine the relationship between sediment, rock, and environment, and notice that different rock forms in different environments because the sediment they are made of builds up in specific places. In that lesson, students observe the sediment that builds up and the rock that forms in multiple different locations. In this activity, students are tasked with focusing on a single location, which supports them to understand that multiple different rock layers in a single rocky outcrop suggests that the environment of that place has changed over time. It also supports students to develop an understanding of the dramatic environmental changes that can occur in a single location over very long periods of time.

**Instructional Suggestion**

**Going Further: Mathematical Thinking**

Once students are finished with their Sim investigations, invite them to solve word problems related to the passage of time. For instance, if a river deposits 1 m of sediment in 1,000 years, there would be ___ m of sediment after 10,000
years. If 0.5 m of sediment is deposited every 1,000 years, there would be ___ m of sediment after 10,000 years. Depending on student ability with decimals and multi-digit numbers, a variety of word problems of this type can be created. The purpose of this activity is to provide students with an opportunity to use the four operations as they solve for unknowns in a real-world context.

Background

Science Note: Causes of Sea Level Change
Over time changes to sea level can cause changes to environments on Earth. The sea level can change due to shifts in tectonic plates which caused ocean basins to change size. Rifting at divergent boundaries, subduction at ocean trenches and convergent boundaries, continent formation, and volcanic eruptions can all change the size of ocean basins leading to changes in sea level. Climate change can also lead to changes in sea level by two mechanisms. Warmer ocean temperatures lead water to expand, increasing the sea level. Cooler ocean temperatures lead water to contract, decreasing the sea level. A change to global average temperatures also leads to more or less land ice which affects the amount of water in the ocean. Warmer temperatures lead to less land ice and more water in the ocean, increasing sea level. Cooler temperatures lead to more land ice and less water in the ocean, decreasing sea level.

Background

Science Note: Environmental Changes Resulting from Changing River Speed
Changing the river speed in the Simulation affects the environment in ways that are less apparent than the changes that result from raising or lowering the sea level. Changing the river speed from FAST to SLOW causes the environment of the location where the river meets the sea to change from a beach into a river delta (conversely, reverting the river speed to FAST results in the environment of that location changing back to a beach). Changing the river speed from FAST to SLOW also causes the floodplain to drain in the location just above sea level (and thus, reverting the river speed will cause the floodplain to flood). These changes are related. A slow river carries only silt sediment, but a fast river can also carry sand as well as silt sediment. Rivers can flow faster when there is an increased volume of water upstream, which can also cause a floodplain to flood. This results in silt sediment being deposited in the slower-moving water areas surrounding the river channel and the larger sand sediment moving through the floodplain and being deposited farther downstream at the beach. This process is greatly simplified in the Sim, as the water in the entire floodplain is depicted as moving at an equal speed. A slow river carries a decreased volume of water through a floodplain, causing it to drain. This results in silt sediment no longer being deposited in the floodplain, but continuing on through the floodplain and being deposited in the slow-moving water of the river delta.

Possible Responses

What students should do and notice:
Students should load Mode 2 of the Sim. To complete Investigation 1, students should move time forward multiple times without changing the sea level or river speed. This will keep the environments in all the locations the same, which means the sediment that builds up and rock that forms in each location will remain the same. To complete Investigation 2, students should alternate between moving time forward and changing the sea level. Students should notice that
when they change the sea level the environment in each location changes and the type of sediment that builds up and 
rock that forms in each location changes. Students might also notice that they can change the river speed to change a 
location between beach and river delta environments to make alternating layers of sandstone and siltstone.

What did you do differently in the two investigations?
In Investigation 1 we kept the environment the same. We did not change sea level. In Investigation 2 we switched 
between moving time forward and changing the environment.

If you see different kinds of rock layers in one location, what can you infer about what has happened in that location 
over time?
The environment must have changed.
Gathering Information About the Rocky Outcrop

Students gather information about the rock layers in Desert Rocks National Park using Fossil Hunter’s Handbook.

Instructional Guide

1. Project Rocky outcrop with rock samples again.

We know there are at least two different sedimentary rock layers at Desert Rocks National Park. If we learn more about the rock samples the park director collected we can learn more about what Desert Rocks National Park was like in the past. Where can we look to learn more about the rock samples that the park director collected? [We can look in the reference book.]

2. Distribute books to pairs. Distribute Fossil Hunter’s Handbook to students.
3. Direct students to read about mudstone and siltstone. Remind students to use the index to find the page numbers for mudstone and siltstone. Allow time for partners to read over the information.

4. Introduce notebook pages 36–37. When students have finished reading, have them turn to page 36, Upper Layer: Data and Ideas, and page 37, Lower Layer: Data and Ideas, in their notebooks. Review the tables and the instructions together.

   One thing geologists do is record data and ideas that will help them in their investigations. This table will help you organize data and ideas about the rock samples and fossils from the rocky outcrop. The left-hand column of each table in your notebook has the data collected by the park director at Desert Rocks National Park.

   Note that students will only complete the first row of each table, about the rock samples, today.

5. Clarify the difference between data and ideas. Point out that the tables on pages 36–37 have a column for data and a column for ideas.

   Data are observations or measurements recorded in an investigation. The park director sent us data—observations of the rock samples.

   Scientific ideas are descriptions of how things usually are or happen in the natural world. We might learn scientific ideas from books we read, or figure them out from our observations of a simulation or hands-on activity. For this activity, we will get ideas from *Fossil Hunter’s Handbook* that describe the environments that different kinds of sedimentary rock usually form in. Those ideas will help us make inferences about the environments that the rock samples formed in.

6. Gather ideas about mudstone together.

   • Remind students of the goal.

   We are trying to find out more about the past environments of Desert Rocks National Park, so as I read, listen for the ideas about the environment.

   • Have students open *Fossil Hunter’s Handbook* to page 36, the page about mudstone.

   • Read page 36 aloud.

   What ideas that I read about mudstone might be most helpful for making an inference about the environment? [It can be formed in floodplains, lakes, or the deep part of the ocean.]

   • Fill in this idea in the column to the right of mudstone on the Upper Layer: Data and Ideas chart. Write “can be formed in floodplains, lakes, or in the deep ocean” in the second column. Have students do the same in their notebooks.

   • Remind students that they are only filling in the first row of each table. They will fill in information about the fossils and make inferences later.
7. Have students complete the table for the siltstone.

8. Share. Ask students to share what they wrote about siltstone. As students share what they wrote, add to the Lower Layer: Data and Ideas chart.

9. Debrief what these ideas about the rocks tell us about the environment in Desert Rocks National Park.

   What types of environments might have been at Desert Rocks National Park in the past?
   [At some point it was a floodplain, lake, or deep ocean. At another time it was a floodplain or a river delta.]

10. Return to the Investigation Question and post the key concept.

   What have we learned to help us answer our Investigation Question? How can there be different sedimentary rock layers in the same place?
   [Different sedimentary rock layers in a place mean that the environment in that place has changed.]

Post the key concept.

Teacher Support

Background

Science Note: About Mudstone and Siltstone
Fossil Hunter’s Handbook describes both mudstone and siltstone, two different but very similar sedimentary rocks. Both rocks are made of sediment that is too small to be seen in the rock with the naked eye. Both are made up of clay- and silt-sized sediment: siltstone is more silt than clay, and mudstone is equal parts silt and clay. Fossil Hunter’s Handbook, however, simplifies this content by referring to siltstone as being made of silt and mudstone as being made of clay. Clay has a smaller grain size than silt and usually requires completely still water to settle and be deposited. Therefore, the more clay in the rock, the lower the energy of the water in the environment. Very little silt is deposited in the deep ocean, but clay can be deposited in the ocean (and therefore, mudstone can form in the ocean) because of the stillness of the water.

Rationale

Pedagogical Goals: Modeling Gathering Information from Fossil Hunter’s Handbook
We suggest that you lead students through the first part of this activity, gathering information from Fossil Hunter’s Handbook. This will allow for explicit teacher modeling of gathering relevant general ideas to explain why data is meaningful and to draw inferences from that information. Students will then have an opportunity to practice these skills themselves in this activity, as well as a future lesson. Supporting students with this practice will prepare them for upcoming argument writing, in which they will link different pieces of evidence together to show how they support a claim.
Rationale

Pedagogical Goals: About Firsthand and Secondhand Evidence
One of the guiding principles of our curriculum is the emphasis on involving students in connecting firsthand inquiry experiences and secondhand text-based experiences. Enabling students to make connections between experience and text motivates engaged reading, helps students develop deep understanding of science concepts, improves reading comprehension, and provides authentic opportunities for experience with nonfiction and informational text. This activity is an excellent chance to have students discuss and connect evidence from firsthand investigations in the Sim and secondhand evidence from Fossil Hunter’s Handbook.

Possible Responses

Refer to the Upper and Lower Layer Data and Ideas charts teacher reference (in Digital Resources) for possible student responses specific to pages 36–37 in the Investigation Notebook.
Rock Layers in the Simulation

1. Load Mode 2 using the menu in the upper left-hand corner of the Sim.
2. One partner completes Investigation 1.
3. Press RESET.
4. The other partner completes Investigation 2.
5. Talk with your partner about the questions at the bottom of the page. Then, record your responses.

Investigation 1: Pick location 2 or 3. In that location, make a very thick rock layer with all the same kind of rock.

Investigation 2: In the same location, make as many layers of different kinds of rock as you can.

What did you do differently in the two investigations?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

If you see different kinds of rock layers in one location, what can you infer about what has happened in that location over time?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
You can use this page to record notes or create drawings.
Upper Layer: Data and Ideas

1. Use what you read in Fossil Hunter’s Handbook to gather ideas about each rock and fossil shown in the first column of the table below.
2. In the first row, record ideas about the environment in which the rock formed.
3. In the second row, identify the fossil using Fossil Hunter’s Handbook. Then, record ideas about the organism that the fossil is from.
4. In the third row, record ideas about the organism the fossil is from.
5. Make inferences by putting the data and ideas together. Record your inferences in the last row.

<table>
<thead>
<tr>
<th>Data</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Mudstone" /></td>
<td>The rock is mudstone.</td>
</tr>
<tr>
<td><img src="image" alt="Fossil" /></td>
<td>The fossil is a</td>
</tr>
<tr>
<td><img src="image" alt="Mosasaurus" /></td>
<td>The fossil is a Mosasaurus.</td>
</tr>
</tbody>
</table>

Inferences:
**Lower Layer: Data and Ideas**

1. Use what you read in *Fossil Hunter’s Handbook* to gather ideas about each rock and fossil shown in the first column of the table below.
2. In the first row, record ideas about the environment in which the rock formed.
3. In the second row, identify the fossil using *Fossil Hunter’s Handbook*. Then, record ideas about the organism the fossil is from.
4. Make inferences by putting the data and ideas together. Record your inferences in the last row.

<table>
<thead>
<tr>
<th>Data</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Rock Image]</td>
<td>![Fossil Image]</td>
</tr>
</tbody>
</table>

The rock is siltstone.

The fossil is a [Blank]

Inferences:
Capas de roca en la simulación

1. Carga Mode 2 (modo 2) usando el menú en la esquina superior izquierda de la simulación.
2. Un/a compañero/a completa la investigación 1.
3. Oprime RESET (reiniciar).
4. El/la otro/a compañero/a completa la investigación 2.
5. Habla con tu compañero/a sobre las preguntas en la parte inferior de la página. Después, apunta tus respuestas.

Investigación 1: Elige Location 2 o 3 (ubicación 2 o 3). En esa ubicación, haz una capa de roca muy gruesa con todo el mismo tipo de roca.

Investigación 2: En la misma ubicación, haz tantas capas de diferentes tipos de roca como puedas.

¿Qué cosa hiciste de manera diferente en las dos investigaciones?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Si ves diferentes tipos de capas de roca en una ubicación, ¿qué puedes inferir sobre lo que ha sucedido en esa ubicación a lo largo del tiempo?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Nombre:____________________________ Fecha: ______________

Puedes usar esta página para apuntar notas o crear dibujos.
Capa superior: datos e ideas

1. Usa lo que leíste en el Manual del buscador de fósiles para recolectar ideas sobre cada roca y fósil mostrados en la primera columna de la tabla debajo.
2. En la primera fila, apunta ideas sobre el ambiente en el cual se formó la roca.
3. En la segunda fila, identifica el fósil usando el Manual del buscador de fósiles. Luego apunta ideas sobre el organismo del cual viene el fósil.
4. En la tercera fila, apunta ideas sobre el organismo del cual viene el fósil.
5. Haz inferencias reuniendo los datos y las ideas. Apunta tus inferencias en la última fila.

<table>
<thead>
<tr>
<th>Datos</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Roca" /></td>
<td>La roca es <em>mudstone</em>.</td>
</tr>
<tr>
<td><img src="image2.png" alt="Fósil" /></td>
<td>El fósil es un</td>
</tr>
<tr>
<td><img src="image3.png" alt="Fósil" /></td>
<td>El fósil es un <em>Mosasaurus</em>.</td>
</tr>
<tr>
<td>Inferencias:</td>
<td></td>
</tr>
</tbody>
</table>

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Capa inferior: datos e ideas

1. Usa lo que leíste en el *Manual del buscador de fósiles* para recolectar ideas sobre cada roca y fósil mostrados en la primera columna de la tabla debajo.
2. En la primera fila, apunta ideas sobre el ambiente en el cual se formó la roca.
3. En la segunda fila, identifica el fósil usando el *Manual del buscador de fósiles*. Luego apunta ideas sobre el organismo del cual viene el fósil.
4. Haz inferencias reuniendo los datos y las ideas. Apunta tus inferencias en la última fila.

<table>
<thead>
<tr>
<th>Datos</th>
<th>Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /> La roca es limolita.</td>
<td></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /> El fósil es un</td>
<td></td>
</tr>
</tbody>
</table>

Inferencias: