**Williamson Fellows Lesson Planning Template**

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| **Grade(s):** *What grade level(s) is this lesson appropriate for?* 6-8 | **Topic:** Stratigraphy | **Lesson #** \_2\_\_\_ **in a series of** \_3\_\_\_ **lessons** |
| **Brief Lesson Description**: *Briefly describe what this lesson is about, what will happen throughout the lesson, and how the lesson fits into the bigger module.*In this lesson, students will learn about the principles of stratigraphy and use their knowledge to unravel a geologic riddle. The principles of stratigraphy help geologists understand how different rock units are related. There are three covered in this lesson (Law of Superposition, Law of Original Horizontality, and Cross-cutting Relationships) and an additional important concept (Unconformities). This lesson will explore how we understand relationships between rock layers and prepare students for the next lesson in the module, in which students will stratigraphic principles to understand the geologic history of the Colorado Plateau. |
| **Learning Outcome(s):** *List 3-6 learning outcomes. These are the big things that a student should* ***know*** *and/or* ***be able to do*** *by the end of the lesson.*SWBAT:1. Create a model to simulate stratigraphic relationships
2. Describe and demonstrate the principles of stratigraphy
3. Interpret a geologic history using the principles of stratigraphy
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| **Background Information**  |
| *Provide necessary background information about ideas or concepts that students need to know* ***before*** *beginning this lesson (e.g., students should know that CO2 is a major greenhouse gas, or students should understand the role that water plays in weathering and erosion, etc.). You may want to describe why these ideas are important.*Students should know that sedimentary rocks form in layers, as we will be looking at sedimentary rock layers specifically.Students should be familiar with the contents of the previous lesson, particularly continental vs marine environments and grain size.  |
| **Science & Engineering Practices:** *List up to three Science & Engineering Practices that students will engage in during this lesson.**Analyzing and interpreting data**Engaging in argument from evidence**Developing and using models* | **Disciplinary Core Ideas:** *List up to three Disciplinary Core Ideas that are addressed in this lesson.**ESS2: Earth’s Systems* | **Crosscutting Concepts:** *List up to three Crosscutting Concepts that are addressed in this lesson.*Cause and EffectPatterns |
| **Possible Preconceptions/Misconceptions:** *Identify any common misconceptions that students might have about the subject. For example, students often think that the only source of carbon is the atmosphere, or that scientists disagree on the causes of climate change, or that the amount of water on the planet is declining due to climate change, or that all rocks with layers are sedimentary, etc.*Students may not know how rocks are dated.Students may not know how to recognize different rock layers. |
| **LESSON PLAN** *This template uses the “5E” model to help with planning: Engage, Explore, Explain, Elaborate and Evaluate* |
| **ENGAGE** *Describe how you will start the lesson. How will get students engaged? What prompts will you use to help students access prior knowledge? How will you stimulate their interest and generate questions? This could be an interesting picture, a video with background information, an activity, a game, or even just a series of questions that you ask the students. You can include a pre-assessment here as well – this could be a written “quiz” or just asking questions of the students to gauge what they already know about the subject.*Start with an introduction activity, where students look at an outcrop of the Grand Canyon and write down their observations in the handout. Ask them what patterns they see, what rocks they think formed first, etc. Ask how we can tell what came first. Use this activity to introduce that we want to understand relationships between rock layers, because then we can understand how the environment changed over time.  |
| **EXPLORE Lesson Description** *This is the “meat” of the lesson. Give step-by-step instructions of what will be said (prompts) and done. Make sure to indicate what the teaching is doing AND what the students are doing. Include prompts or probing questions to get students thinking on the right track, troubleshooting tips, and what you expect to happen (e.g., students will struggle at first to come up with a model so it might help to show them a few simple examples). Identify the materials that you will be using during each step (there is a place for a detailed list of materials below) and include links for any online videos, maps, etc.*The teacher will give out kits containing at least three colors of playdough and toothpicks. With each concept, explain what it means, then have the students create a model and write down the time order of the model layers. Think of this like making a sandwich, laying first a “bread” layer, and then other layers sequentially on top (if there isn’t enough time to make playdough, a quick easy alternative can be done with different slices of bread- white, wheat, rye, etc.). Then, to check their understanding, go through the real outcrop examples and have the students identify the order of events.1. **Law of superposition.** Have students make flat layers of the three colors, then stack them on top of each other. Ask students to label the time order in which it happened in their handout (layer 1, layer 2, layer 3). Show an image of the example outcrop, and go through step by step to identify the order of events with them.
2. **Original horizontality**. Have students put down the layer in the first color, then stack the second color. Then have them tilt the two layers and stack the third color on top. Ask them to write down in the handout the time order sequence of the model (layer 1, layer 2, tilting event, layer 3). Show image of outcrop with tilted rocks and discuss time order sequence of the outcrop.
3. **Cross-cutting relationships.** Have students make flat layers of the three colors, then stack them on top of each other. Then, have them put a toothpick through the stack. Ask them to label the order in which things happened (layer 1, layer 2, layer 3, toothpick). Show an image of an outcrop and point out this occurring in rocks – when something cuts through rocks, you know that it happened after those rocks were deposited. Examples of this include faults, volcanic dikes, and veins.
4. **Unconformities**. For the next example, have students put down layer 1 and 2, then ask what happens if layer 2 is eroded. Have them scrape off the top of layer 2, then put layer 3 on top. Ask them if erosion counts as event (yes, it does!) In the other scenarios, no erosion happened and it is implied that all of these things happened in order. Now, that erosion event is part of the time order. Have them label the time order sequence of the model (layer 1, layer 2, erosion, layer 3). Explain that unconformities show that either a pause in deposition (hiatus) or erosional event occurred. Show outcrop image with labeled unconformity and walk through the time order sequence of the outcrop. Note: point out that the wavy line is used to denote an unconformity!

For the final exercise, students will use their knowledge to determine which rock layer of a cross-section likely has dinosaur fossils. Give students the cross-section with identified rock units. First, they will write the geologic history listing the relative timing of layers and events. Then, based on the additional information on rock types contained in the handout, they will determine which rock layers are the correct age and type to contain dinosaur fossils.For this exercise, students will need to use their knowledge to discover which layer likely contains dinosaur fossils. Based on the information given, they should be looking for rock layers that formed on land (**continental environments**, not marine), and are younger than 66 million years old. There is one non-sedimentary rock (rock G, the volcanic intrusion), which has been chemically dated. Any rock layers the intrusion cuts through are older than that date. Based on the stratigraphic principles, students should figure out that Layers A, H, and E are too old, while layers I, B, and F are too young. Layers C and D are the correct age to potentially contain dinosaur fossils. Based on the rock information from the handouts, Layer D is most likely to contain fossils because it is a sandstone, and fossils are usually found in sedimentary rocks with sand sized grains or smaller. Layer C is a conglomerate, so the layer probably does not contain fossils, even though it is the correct age. |
| **EXPLAIN** **Concepts:** *Describe the major concepts that will be covered in this lesson.*Stratigraphic principles lay out clear ways to identify relationships between rock units. This is one way to determine the relative ages of rocks (x is older than y, but younger than w). Geologists use these ideas to investigate geologic history.**Vocabulary:** *List and define key vocabulary words for this lesson.*Stratigraphy – the study of rock layers and their relationshipsOutcrop – an exposed rock unitUnconformity – a surface of contact between two rock units that are not continuous Fault – a crack that displaces layers of rock units |
| **ELABORATE:** *Here you can talk about applications of the concepts learned in the lessons or options for further exploration. This is where you can talk about some of the ideas you have that would be great to do but won’t fit into the time frame of this lesson. You may want to provide a list of websites, books, or articles to read for further information.* |
| **EVALUATE:** **Formative Assessment:** *Explain how you will assess how things are going throughout the lesson. This is often a quick check-in to see if students are engaged and are grasping the big concepts. Some of the ways to do this include holding a discussion, doing a think-pair-share activity, or asking students to write down 1 thing that is confusing to them.*Throughout the lesson, the teacher will ask the students to explain the time ordered events for each outcrop. This will allow the teacher to check in and emphasize the concept of each principle.**Summative Assessment:** *Explain how you will assess if students met the learning outcomes. This is often a quiz, homework assignment, project, report, or even just a drawing.*The final exercise will have the students use their knowledge to discover which layer in an outcrop likely contains dinosaur fossils by creating a written geologic history of a cross-section. The final question on the handout asks them which layer they would target and asks them to explain why. |
| **Notes for Instructors:** *This can be anything from where to find more information, to troubleshooting activity problems, to where to find certain supplies.* |

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| **Materials Required for This Lesson/Activity** |
| *Insert any diagrams, handouts, pictures, or other materials that aren’t available online HERE.**Include any hyperlinks to online videos, maps and other resources in the “Explore” part of the lesson.**List any other materials, including quantity, potential supplier and price if it is significant.*ToothpickScraping tool Cutting tool (serrated knife?)Playdough, in at least 3 colors. Can be purchased or made via these recipes:Non-cooked recipe:[**https://www.bbcgoodfood.com/howto/guide/playdough-recipe**](https://www.bbcgoodfood.com/howto/guide/playdough-recipe)Cooked recipe (requires cream of tartar):[**https://livingwellmom.com/easy-homemade-playdough-recipe/**](https://livingwellmom.com/easy-homemade-playdough-recipe/)***\*\* A quick, easy alternative to the recipes is to use different slices of bread that can be sequentially stacked (white, wheat, rye, etc.). \*\*******Note: if possible, having actual rocks for the final activity would be very useful. If samples of sandstone, shale, conglomerate, basalt, and limestone are available, use them in the second part of the final exercise.*** |