

History of the Earth Lesson 2 Extension: *The Make* Educator's Lesson Plan

Objective

In *The Make*, students will complete three activities to construct an explanation, based on evidence from rock strata, for how the geologic time scale is used to organize Earth's history.

Students will:

1. Observe a demonstration of rock layers to discover the Law of Superposition.
2. Conduct a mystery word sequencing activity to apply the Law of Superposition.
3. Apply their knowledge of the Law of Superposition to sequence fossil cards in a rock column, and construct an explanation for how the column can show the progression of life on Earth.

Time Required: 140 minutes

Materials Required
<p>If doing this remotely, no materials are required.</p> <p>If doing this in person:</p> <ul style="list-style-type: none">● Construction paper● Glue● Colored pencils/markers● Large clear container (soda bottle, graduated cylinder)*● Materials to simulate rock layers: instant ground coffee, uncooked rice, dried black beans, dried pinto beans, dried pasta <p>*This container will be for the superposition demo, so any clear container, such as a soda bottle, graduated cylinder, or large clear cup, will work.</p>
Safety Considerations
None
Science & Engineering Practices
<ul style="list-style-type: none">● Developing and Using Models● Constructing Explanations or Arguments From Evidence

Inquiry Scale

Level 1: most teacher-driven (*recommended for grades 4-5*)

Lead the demonstration and model for students how to complete their diagram. Discuss questions as a class. Ensure students understand the Law of Superposition before moving on with the activity.

Complete the mystery word card sequencing activity as a class by projecting it onto the board. Discuss analysis questions as a class.

Complete the fossil card sequencing as a class. Discuss the analysis questions as a class.

Level 2 (*recommended for grades 5-6*)

Lead the demonstration while students complete their diagram. Discuss the questions as a class. Ensure students understand the Law of Superposition before moving on with the activity.

Complete the mystery word card sequencing activity as a class by projecting it onto the board. Discuss analysis questions as a class.

Complete the fossil card sequencing in small groups. Discuss the analysis questions as a class. Teachers will support students and facilitate as needed.

Level 3 (*recommended for grades 6-7*)

Lead the demonstration while students complete their diagram. Think-pair-share the questions and then review as a class. Ensure students understand the Law of Superposition before moving on with the activity.

Model the mystery word card sequencing activity for the class by projecting it onto the board. Students will then complete the activity in small groups. Discuss analysis questions as a class.

Students complete the fossil card sequencing in their small groups. Discuss the analysis questions as a class.

Level 4: most student-driven (*recommended for grades 7-8*)

Lead the demonstration. Students will answer questions independently but check for understanding of the Law of Superposition.

Students will independently complete the card sequencing activities and analysis questions. As the facilitator, check in on group progress. Provide suggestions and support to individuals or specific groups, as needed.

Agenda

I. Show PowerPoint to introduce *The Make* Activity (120 minutes)

Note: The PowerPoint will review essential concepts learned in *The Solve* and provide context for the students' upcoming *Make* challenge. In this lesson, it will be used in conjunction with the activity itself.

PowerPoint Slide Guide

Slide 1: Introduction

Slide 2: How can rock tell the story of Earth's ~4.5 billion year old history?

1. Think-pair-share
2. Students share out answers

Facilitating questions could include: *What can we learn from looking at rocks? What types of rocks are there? What can be preserved in some rocks?*

Possible answers: From rocks we can learn about the environment of an area and what types of organisms lived there. Types of rocks include sedimentary, igneous and metamorphic. Fossils and traces of organisms can be preserved in some rocks, usually sedimentary rocks.

Slide 3: Rock layers contain clues to our past. Let's investigate...

1. When looking at rock, fossils in different layers can help us learn about Earth's history. But how can we determine the *relative* ages of rock layers?
2. Ask students what they think relative age means. If they are having trouble understanding the idea of relative aging, explain that everyone in the class has a specific age (i.e. Manny is 12 and Elena is 11). This is known as their absolute age. Their relative age is their age as it relates to others in the classroom (i.e. Manny is older than Elena)
3. Let's do a demo where we can dig into this idea further

Note: Complete the demonstration on superposition by pouring in layers of different materials (see teacher card below). As students follow along in their Student Guide Planning Organizers they will illustrate the layers and record the time of each layer being poured. At the conclusion of the demo, go to the next slide.

If doing this remotely, students will view this demonstration online.

Answer: Just like in the demonstration, we can tell the relative age of a rock by its depth. The older rocks are deeper in the earth, while the younger rocks are not as deep.

Background information for the teacher: Preserved in the rock strata are fossils documenting the history of life on this planet. By using relative dating, fossils can be sequenced into the correct order, showing the progression of life on the planet as the Geologic Time Scale.

Slide 4: Law of Superposition

1. Think-pair-share: How does this demonstration relate to rock layers?
2. Students share out answers
3. Review the law of superposition: in an undisturbed column of rock, the rock on the bottom layer is the oldest while the rock on the top layer is the youngest

MOSA MACK SCIENCE

Teacher note: The reveal at the end of the demonstration is that students have experienced the Law of Superposition. Use this slide to have students fill this answer in on their Student Guide for question 4.

Slide 5: The next part of your *Make Challenge*

1. After discussing the demonstration, have students complete Part 2: Mystery Words according to your chosen level of inquiry. When the class is done, you can check answers with Appendix A: Teacher Answer Key. Then continue with slide 6.

If students are doing this remotely, they will complete the activities online.

Slide 6: Buried within layers of sedimentary rock, fossils provide evidence of life on Earth.

1. Remind students that fossils are the remains or traces of organisms from an earlier geological time period. If students have not yet learned about fossils during the year, pause for clarifying questions about fossils.

Slides 7-8: The final step to your challenge

1. Students will study and sequence fossils from rock strata in order to establish a timeline of the history of life on Earth. They will then arrange fossils into an annotated rock column. Follow the directions for your chosen level of inquiry.

II. The Make Activity

***Note: The Powerpoint will be used in conjunction with the *Make Activity*. (120 minutes)**

As guided by the organizer, students will:

1. Observe a rock layer demonstration to understand that the youngest rock layers are closest to the surface and the oldest rock levels are farther away from the surface. If students are doing this remotely, students will view this demonstration. You can view the remote demo [here](#).
2. Complete a mystery word sequencing activity. If students are doing this remotely, they will sequence the words online.
3. Complete a fossil sequencing activity. Students paste their rock layers and annotate what the fossil evidence in these layers tells us about Earth's history. Refer to the example below.

Planning Organizer

Brainstorm: What resources did Mosa Mack learn about in her mystery?

As a group, come up with a definition of a Renewable Resource. Research one example of a renewable resource for your model.

As a group, come up with a definition of a Nonrenewable Resource. Research one example of a nonrenewable resource for your model.

Explain how each resource is distributed throughout the world and how this impacts environment and society. Your teacher will give you instructions on how to research this topic.

Nonrenewable Resource	Renewable Resource

MOSA MACK SCIENCE

Youngest

↑

↑

↑

Oldest

P

Ca

D

S

O

C

Approximate age of rock column
Paleozoic era
(540- 248 Million Years Ago)

Progression of life on Earth during this time period as shown by fossil evidence
According to fossil evidence, life during the Paleozoic era began with organisms that had shells and exoskeletons, such as trilobites and brachiopods. These organisms most likely lived in aquatic environments, such as the ocean. As time progressed, more complex species developed, such as antiarch and placoderms. These animals appeared to be fish-like, with fins and tails. As time progressed, fossils of four-legged animals, such as *Dimetrodon* and *Eryops*, were found in top layers of rock. This indicates that life likely moved to land during the later stages of the Paleozoic era.

Index fossil
The graptolite is an index fossil that only existed during the Silurian period of the Paleozoic era. Therefore, fossils found within the same layer of rock as the graptolite will be relatively the same age. Fossils found **below** the rock layer in which the graptolite fossils are located will be **older** than 435 million years old and fossils found in the rock layer **above** will be **younger** than 410 million years of age.

Law of Superposition
By uncovering patterns that exist between fossils found in different layers of rock, layers can be sequenced into the correct order. By applying the Law of Superposition, fossils found in layers of rock deeper in the ground will be older than fossils found in layers of rock toward the top.

IV. Exit Ticket (10 minutes)

Students complete the exit ticket that summarizes their understanding of *The Make* and connects students to the upcoming *Engineering* challenge.

Note: In collaborative classrooms, this serves as the individual accountability in an otherwise group project.

Exit Ticket Answer Key

1. What is an index fossil?

Index fossils are from species that existed on the planet during a known period of time. When you find an index fossil and know the specific period of time in which it existed, you can then date surrounding fossils and rock layers.











MOSA MACK SCIENCE

2. If a scientist found a rock layer that contained an index fossil that we know dates to 25 million years ago, what does this tell us about the age of the rock layer?

Possible answers: With the age of an index fossil being known, the age of the rock layer would be the same. Example: A graptolite is an index fossil, dated to 425 million years ago. When uncovering a graptolite, scientists know that the rock layer and other fossils within the layer are dated to be around 425 million years old as well.

3. Locate and circle the *Pecten gibbus* and *Scaphites hippocrepis* on the chart below. Which fossil is older? Explain your answer.

The Scaphites hippocrepis is older than the Pecten gibbus. According to the Law of Superposition, the older fossils appear in the lower layers of rock.

CENOZOIC ERA (Age of Recent Life)	Quaternary Period	<i>Pecten gibbus</i> 	<i>Neptunea tabulata</i> 
	Tertiary Period	<i>Calyptrophours velatus</i> 	<i>Venericardia pianicosta</i> 
MESOZOIC ERA (Age of Medieval Life)	Creaceous Period	<i>Scaphites hippocrepis</i> 	<i>Inoceramus labiatus</i> 
	Jurassic Period	<i>Perisphinctes tiziani</i> 	<i>Nerinea trinodosa</i> 
	Triassic Period	<i>Trochites subbullatus</i> 	<i>Monotis subcircularis</i> 

4. If you found another fossil in the rock layer containing a *Nerinea trinodosa* fossil, what period is this fossil from? In which era is this period? *The fossil would be from the Jurassic period. The Jurassic period is part of the Mesozoic era.*

5. Bonus: In the rock strata, we can see that the history of life on Earth is marked by mass extinctions and the appearance of new organisms. What factors do you think could have led to the mass extinctions that have occurred on our planet?

Scientists believe mass extinctions on Earth may be due to a variety of factors, including volcanic eruptions, asteroid collisions, and changes in sea levels, as well as major climate changes, including global warming and cooling events.

The Make Assessment: Project Grade and Rubric Score Sheet - History of the Earth

Project Submitted by _____

History of the Earth The Make Checklist: Content Concepts and Practices

Your Challenge: Use relative dating to sequence a series of fossils throughout Earth's History

Project Completion:

- Completion of all parts of the Student Planning Guide including:
 - Part 1: Demonstration diagram and analysis questions
 - Part 2: Mystery word data chart and analysis questions
 - Part 3: Fossil data chart and analysis questions
 - Rock Column Diagram
 - Includes all six fossil rock cards
 - Labels included for oldest and youngest rock layers
 - Written explanation explaining progression of life on Earth according to fossil record
 - Diagram design is well-organized, neat, and in color

DCI Standards Checklist:

- Part 1: Demonstration diagram sketch accurately depicts layers from oldest to youngest
- Part 2: Mystery word data reflects accuracy of sequencing according to the Law of Superposition
- Part 3: Fossil data reflects accuracy of sequencing according to the Law of Superposition

Rock Column Diagram:

- All six fossil rock cards properly sequenced
- Labels accurately depict oldest and youngest rock layers
- Written explanation accurately explains:
 - The approximate age of rock column and progression of life on Earth during era shown by fossil evidence.
 - Identification of at least one index fossil and explanation of how it helps scientists understand the age of the rocks
 - How the Law of Superposition was used to determine proper sequence of rock layers and fossil evidence

MOSA MACK SCIENCE

Science & Engineering Practices Rubric				
	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Developing and Using Models	Drawings, diagrams, or visual models include major misconceptions or have missing parts. Explanation of the model is minimal or not present.	Drawings, diagrams, or visual models include minor misconceptions or have missing parts. Explanation of the model is minimal.	Drawings, diagrams, or visual models are complete, but contain a minor misconception. Explanation of the model is complete but lacking complexity.	Drawings, diagrams, or visual models have no misconceptions and contain all details. Explanation of the model is complete and complex.
Constructing Explanations or Arguments From Evidence	Constructs an explanation with no clear sources of evidence.	Uses scientific principles and/or data from at least one source to construct or evaluate an explanation, but explanation contains minor misconceptions.	Uses accurate but incomplete scientific principles and/or data from multiple sources to construct or evaluate an explanation.	Uses accurate and complete scientific principles and/or data from multiple sources to construct or evaluate an explanation.
Teacher Comments:				
Final Score:		Final Grade:		

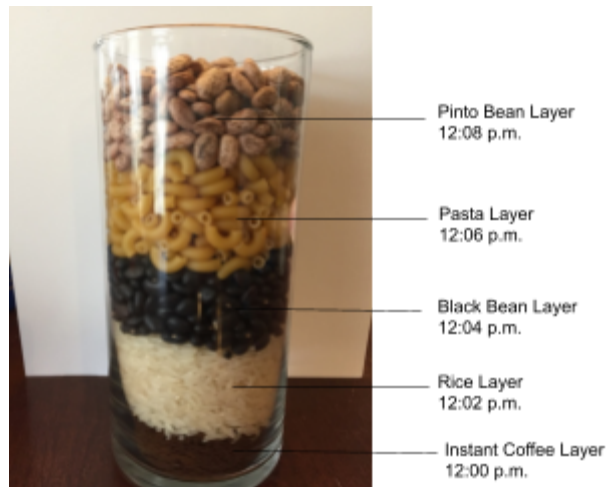
Appendix A: Teacher Answer Key

Note: The demonstration directions below are for in-person use. If students are doing this remotely, students will view the demonstration online and interact with the activities online. You may view the remote demo [here](#). Answers for the remote activity will show on the “grading page” when students submit their work. For more information on grading work online, view this [helpful article](#).

Demonstration

In the container below, sketch each item as it’s added. Label each layer with its contents and the time it was poured. For example: “Pasta Layer, 1:43pm”

Drawing of “Geologic Column” layers






Questions:

1. Is the pasta layer older or younger than the rice layer in this activity? Use evidence to support your answer.
The pasta layer is younger than the rice layer. As shown by the time, the rice layer was added at 12:02 PM, which is earlier than the pasta layer, which was added at 12:06 PM. The pasta layer is nearer the top of the jar than the rice layer is.
2. Which bean layer (pinto beans or black beans) is the oldest according to this demonstration? Explain. *Black beans would be oldest because they are located farther down in the column. Looking at the time, we can also see that the black beans were poured earlier (12:04 PM) than the pinto beans (12:08 PM).*
3. What rule can you come up with that describes the relationship between the age of the rock and its location in the layers? *Older rock is located below younger rock; younger rock is located above older rock. The oldest layer is at the bottom of the column while the youngest layer is at the top.*

	<p>3. How might this practice activity apply to how scientists use fossils to sequence the history of life on Earth?</p> <p><i>If the mystery words were fossils, than fossils found in bottom layers of rock would be older than fossils found in top layers of rock. By studying the fossil progression in rock, the history of life on Earth can be revealed.</i></p>
--	--

Fossil Sequencing

1. Study the fossil cards in Appendix B. Just like in Part 2, the oldest rock layer has been marked with a * Mosa symbol.
2. As with part 2, to find the sequence, look for the most similarities between the cards. But be careful: some fossils appear in more than two cards!
3. Record the letter shown on the bottom left of each card in your chart. Make sure you start at the bottom of the chart and work your way up to the top!

<p>Fossil Sequencing Results</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; text-align: center; vertical-align: top;">Youngest Fossils Card</td> <td style="width: 70%; text-align: center;">P</td> </tr> <tr> <td style="text-align: center;">↑</td> <td style="text-align: center;">Ca</td> </tr> <tr> <td></td> <td style="text-align: center;">D</td> </tr> <tr> <td></td> <td style="text-align: center;">S</td> </tr> <tr> <td></td> <td style="text-align: center;">O</td> </tr> <tr> <td style="text-align: center; vertical-align: bottom;">Oldest Fossils Card</td> <td style="text-align: center;">C </td> </tr> </table>	Youngest Fossils Card	P	↑	Ca		D		S		O	Oldest Fossils Card	C 	<p>Analysis Questions</p> <ol style="list-style-type: none"> 1. Explain how your team determined the order of cards. <i>The order of the cards was determined based on discovering the pattern that existed in the fossils. Each new layer of rock contains at least one fossil from the layer below. For example, in the oldest layer marked by a picture of Mosa, the trilobite and brachiopod fossils appeared. In the layer above, the trilobite and brachiopods appeared again, making this the next logical layer of rock.</i> 2. Explain your observations of the progression of life on Earth during this time period according to the fossils found in rock layers. <i>The younger layers contain many marine fossils. The fossils of land animals appear in older rock layers.</i>
Youngest Fossils Card	P												
↑	Ca												
	D												
	S												
	O												
Oldest Fossils Card	C 												

MOSA MACK SCIENCE

3. a. What species existed in multiple rock layers?
The Eurypterid fossil appears in four layers.
b. What does this tell you about when the species existed?
It tells us that this species existed for many millions of years.
4. Find the fossils that only appear in one layer: *Syringopora coral or Graptolite, Eryops or Dimetrodon*
5. Based on this information, which fossils could be considered index fossils? Explain.
The Syringopora coral or Graptolite could be considered index fossils because they only appear in one rock layer from one time period. The Eryops or Dimetrodon fossils would not be considered index fossils based on this evidence, because we do not know if they appear in younger layers.
6. If you found a layer of rock that contained a *Syringopora coral* from the Carboniferous period, how old could this rock be? *This fossil is from the Carboniferous time period so the rock layer would be between 290 and 360 million years old. Note: When the students sequence their cards correctly, the fossils will align with the time periods in this chart.*

Era	Period	mya*
Paleozoic	Permian	240
	Carboniferous	290
	Devonian	360
	Silurian	410
	Ordovician	435
	Cambrian	500
		570