What are fossils?

3rd-5th
NGGS: 3-LS4-1, 4-ESS1-1

Background

Read Pre-Lesson Preparation Before Class

Lesson Description

This lesson covers types of fossils and how they form. Then it introduces students to a three-point plan that paleontologists use to find the particular fossils that they are most interested in studying. Finally, the student becomes the paleontologist by planning their own expedition to find the fossils that most intrigue them.

Driving Phenomenon

Knowledge and understanding about Earth's past prior to human existence has been learned by studying fossils. Before humans understood what fossils were, they were fascinated by them and made up strange myths about where they came from

Fossils of many different types of organisms have formed over the Eons, and yet the process of fossilization is dependent on so many things going just right that **only a tiny percentage of all of the organisms that ever lived became fossils. So, how do paleontologists continue to find new fossils to uncover more knowledge about the past?**

Driving Questions

- How have we learned about animals that no longer exist?
  - How do fossils form?
  - How do we find fossils?
  - What can we learn from fossils?

Learning Objectives

- Students use models to understand processes that are beyond the limit of direct human observation.
- Students will gain knowledge of the types of data used to substantiate the biological and geological history of the Earth.

Time Requirements

- Four 40 minute sessions

Prerequisite Knowledge

- Some animals that used to live on Earth no longer live (are extinct).
- Erosion is a process in which wind and water break down rocks in to smaller pieces of sediment and dirt.

Teacher Resources

1. Fossil Journal
2. Trackways Modeling Guide
3. USGS Maps of North America
4. GSA Geological Timescale

Teacher Resources

1. Fossil Observation Guide
2. Modeling Fossil Formation
3. Field Expedition Planner

What are fossils?

Full lesson procedures begin on page 4.

Engage | 10 minutes	
Students explore imagery and/or actual fossils, and connect with the idea that they were once living things.	Notes
Teacher Resources: 1 Student Resources:	
Explore | 15 minutes	
Students will explore the fossils in more depth using a graphic organizer to record observations.	Notes
Teacher Resources: 1 Student Resources: 1	
Explain | 40 minutes	
Students explore the question of how fossils form by engaing in a hands on activity to create impression fossils of trackways.	Notes
Teacher Resources: 2 Student Resources: 2	
Elaborate | 40 minutes	
Introduce students to the idea that rocks are different ages, and that geologists have mapped most of the Earth's rock ages. Guide students in uncovering the process paleontologists use to find particular fossils.	Notes
Teacher Resources: 3 Student Resources:	
Evaluate | 40 minutes	
After researching and deciding on an extinct animal that they would like to search for, students will plan a field expedition to the appropriate place to search for that type of organism.	Notes
Teacher Resources: 3 & 4 Student Resources: 3	

Pre-Lesson Preparation

Review the Teacher Resources and decide which ones you will project and which ones you will want to print and laminate. Each resource has suggested presentation guidelines.

Materials

- Print Student Resources (one copy per student)
- Two or more of the following modeling media:
  - Kinetic sand
  - Play sand
  - Clay or Play-doh
  - Plaster of Paris
- Plastic spoons or popsicle sticks to stir
- Paper or plastic cups
- Small clear plastic food containers
- Plastic dinosaur or animal models
- Leaves and/or pine needles

Lesson Enrichment Ideas

DO

Plan a trip to explore the history of life on Earth in the Griffin Halls of Evolving Planet, and see fossil specimens from all over the world up close at the Field Museum in Chicago.

Rent real specimens, and bring them to your classroom. If you live in the Chicago area, the *N. W. Harris Learning Collection* at the Field Museum offers numerous specimens that can be rented for study in the classroom.

- Fossils
- 300 Million Years Ago in Illinois

READ

Rock Man Vs. Weather Man: The Magic School Bus Rides Again
by Samantha Brooke
This book offers an excellent scaffold for younger students being introduced to the rock cycle for the first time.
http://worldcat.org/oclc/1034931999

Boy Were We Wrong About Dinosaurs
by Kathleen Kudlinski
An engaging introduction to the nature of science through the lens of dinosaur discoveries.
http://worldcat.org/oclc/221152330

WATCH

Brain Scoop Episode: Fossils in the Floor
The distant past is closer than we think. Fossils can be found in unexpected places in our everyday lives
https://youtu.be/lS_DmyotQeE

Brain Scoop Episode: Fossil Myths: Cyclopes, Griffins, & Magic Fairy Bread
Before knowing what fossils represented humans came up with some pretty crazy myths about what they were and where they came from.
https://youtu.be/i_FJC_xGuAE

Fossil Hunting 101
What is it *really* like to go out on an expedition and search for fossils? See for yourself, as our paleontologists roll up their sleeves and get their hands dirty in this quick guide
https://vimeo.com/185656705

Engage

1 Use the imagery provided in Teacher Resource 1: Fossil Journal or acquire some real fossils for students to look at and touch. If you are located in the Chicago area, you can borrow fossils from the N. W. Harris Learning Collection at the Field Museum.

2 Allow students to wonder and share ideas about what these items represent. Prompt discussion with questions like:

1. What is familiar about these objects?
   Listen for students to recognize that they look like rocks as well as plants or animals at the same time.
2. What is something that all of these things have in common?
   They are all hardened (feel hard); can see parts of living things, but they don't seem to be alive anymore.

3 If no one has said it yet, state that these objects are all types of fossils. Fossils are the remains of living things that lived long ago. Today we will explore the different types of fossils and how fossils form or are made.

Explore

1 Distribute the images of various types of fossils to groups of three to four students. You can use the images in the Teacher Resource 1: Fossil Journal or utilize one of the *N. W. Harris Learning Collection* experience boxes as recommended in the Pre-lesson Preparation.

2 Allow students a few minutes to explore the imagery and/or specimens with their small group. Write the following questions on the board for them to discuss as the groups observe the specimens.

- Observe the specimens closely and find evidence of the living thing that is recorded by this fossil.
- Find at least one piece of evidence for every person in your group.

3 Pass out Student Resource 1: Fossil Observation Guide. This is a graphic organizer that will help them organize and record their observations.

4 Some examples of the types of fossils represented in the Fossil Journal are:

- Fossilized bones (bones where original minerals have been replaced by minerals from the surrounding rock) from vertebrate animals such dinosaurs and other prehistoric vertebrates
- Fossilized body parts that were hard like a carapace of a trilobite or ancient snails
- Trace fossils of soft-bodied plants and animals such as Tully Monster, leaf, or sea jelly.
- Trace fossils of animal movement (trackways) or animal poop.

Explain

1 Ask the students to share some questions that they wondered about while looking at the specimens. Write their questions on the board or on some chart paper.

2 If no one asks the question, "How are fossils formed?" or a similar question, add it at the end of student sharing.

3 Ask if anyone knows how fossils form. Listen for students to share their ideas, some may know a lot about how fossils form and some may not know at all. Listen for student to share any of the following elements of the process.
   - The living thing dies, or leaves something behind in the environment (like a footprint, a leaf, or poop).
   - It gets covered up by sediment or sinks to the bottom of a body of water.
   - It continues to be covered up more and more layers form on top over time.
   - It stays in the ground a long, long,...,long time.
   - The dirt around it gets compressed and hardens to rock.
   - As it continues to be trapped like this underground it exchanges nutrients and minerals with the rock so it may become hard like the rock.

4 Record these steps in the process as students share them so that everyone can see. Supplement the knowledge where there are gaps.

5 If you have time and space, follow the instructions in Teacher Resource 2: Trackways Modeling Guide to illustrate this process to students. If for whatever reason, you cannot engage in the modeling activity, have students create a comic strip of the process. There is a comic frame copy master on the last page of Teacher Resource 2: Trackways Modeling Guide.

6 Have students discuss the questions on Student Resource 2: Modeling Fossil Formation with their small group, to help them unpack how the modeling process is similar but not exactly like natural fossil formation.

Elaborate

1. Remind students that we've explored what fossils are and a little bit about how they are formed. Now we are going to explore how they are found by paleontologists.

2. Show or project the U.S. Geological Service map of geological rock ages (Teacher Resource 3) and explain that this is a tool that paleontologists use to help them find fossils. What do we see here?

3. Guide students to identify the shape of North America and recognize major geographic features like the coasts, the great lakes, and the Mississippi river.

4. Guide them in noticing the different colors, and help them make the connection to the key which explains which colors match to particular geological time periods.

5. Ask students why knowing the ages of the rocks would be important for paleontologists. Help guide students to the idea that most organisms on Earth have only lived during certain time periods in the history of the Earth. Each paleontologist specializes in specific types of animals, so to find the specific fossils they need to study they must look in the rocks that are the age that matches when the animals would have lived and died.

6. You can further reinforce this concept by showing the sedimentary rock image again along with Stratigraphic Diagram in Teacher Resource 3. This image diagrams sedimentary rock layers showing various fossils inside.

7. Remind students that when we created our fossil models we learned about a type of rock that makes up fossils, and ask what this type of rock is called. Listen for students to recall that it is called sedimentary rock.

8. Now ask students to think back to the fossil model that they created, again. The fossils were embedded in the block of rock. How would our fossils have been found if they had been hiding in that rock for millions of years? Allow students to think about his question, and give them time to write or draw how they think a fossil might become exposed through a natural process based upon what they learned by creating the model, and what they know about sedimentary rock.

Elaborate

9 Have students share their ideas with a partner and discuss the likelihood of each other's speculation.

10 Invite students to share their ideas. Listen for students to share about ideas of erosion from wind and rain eating away at the rocks.

11 Now invite students to help you summarize the three main points that we've just explored about how to find fossils.

1. Find rocks of the right age.
2. Find sedimentary rocks.
3. Get to a desert or very dry arid place.

12 Inform students that during the next class period they will be using this knowledge to help them plan an expedition to find fossils of a particular ancient animal.

Evaluate

1 Invite students to investigate an extinct animal of their choosing.

2 Allow students to have some research time in the library, online, or in other resources you are able to provide.

3 In their research students will identify the time period that the organism lived (died), a few other facts about how the animal lived and features detailing what it might have looked like.

4 Then using a GSA Timescale and North American U.S.G.S. Geological map they will use Student Resource 2.0: Field Expedition Planner tool to guide them in planning an expedition into the field where they would be most likely to find fossils of their ancient animal.

ENRICHMENT IDEA

Evaluate | Step 1

If you have the opportunity to visit the Field Museum on a field trip, students could choose the animal they wish to research while visiting the Griffin Halls of Evolving Planet.

Teacher Resource 1.0

Use the following images as a focus for inquiry into fossils. Print, project, or make them available to students digitally.

Dinosaur corprolite - fossilized poop

Snail fossil

Pterosaur finger bone

Tully monster fossil

Tullimonstrum gregarium, PE11595 © The Field Museum, GEO84975_ Tullyc, Photographer Ron Testa.

Teacher Resource 1.0: Fossil Journal

Sea jelly fossil

Marine bristle worm fossil

Pieckonia helenae, PE23803 © The Field Museum, GEO84975_Cc, Photographer John Weinstein.

Fern Fossil

Alethopteris serlii, PP41955 © The Field Museum, GEO86328c, Photographer John Weinstein.

Clam fossil

Teacher Resources

Teacher Resource 1.0: Fossil Journal

Annularia leaves fossil

Section of dinosaur bone

Trilobite fossil

Trilobite, PE25600 © The Field Museum, GEO86067_5c, Photographer John Weinstein.

Brachiopod fossil

Brachiopod © The Field Museum, GEO80462

Teacher Resources

Sea Lilly or Crinoid fossil

Pentacrinus subangularis, PE1890 © The Field Museum, GEO85107c, Photographer Diane Alexander White.

Scouring rush (plant) fossil

Dinosaur track fossil

Anchisauripus exsertus fossilized footprint, UR260
© The Field Museum, GEO86782_02d, Photographer John Weinstein

Horn coral fossil

Teacher Resource 1.0: Fossil Journal

Nautiloid fossil

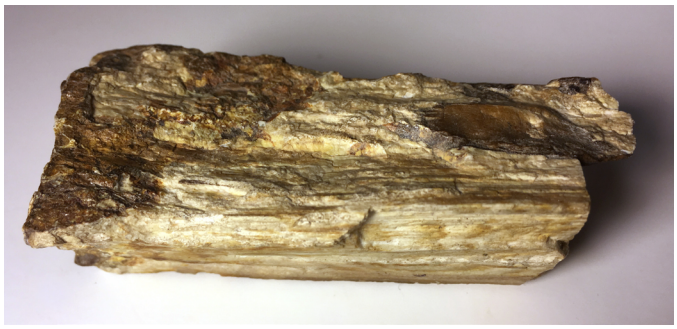
Nautiloid, P2463 © The Field Museum, GEO85680_5c, Photographer John Weinstein.

Knightia (fish) fossil

Knightia, PF15385 © The Field Museum, GEO86782_02d, Photographer John Weinstein

Shark tooth fossil

Perimineralized wood



Trackways Modeling Guide

Teacher Resource 2.0

Modeling how a trackway trace fossil forms can be a straightforward way to help students visualize fossil formation. Right before this activity you should have reviewed each of the steps with the class. This activity could be done as a demo for students, or each small group could make their own model. The instruction set is written as if you were performing a demo, so if each group is working on their own you work through it together step-by-step.

1. Place wet play sand or kinetic sand at the bottom of a small clear plastic box (like a snack/sandwich container), and explain to students that this is the ground that the dinosaurs walked on and ate on and lived their whole life on.
2. Have one of the toy dinosaurs make footprints in the sand and place a leaf on the surface.
3. Explain that over a very long period of time this landscape changed and the area flooded, muddy clay and silt covered the area. Now take the piece of clay that is about the size of the box and about a quarter to a half inch thick and press it into the box on top of the sand layer. Make sure to press firmly over the leaf. This clay represents that layer of silt, and now the leaf is trapped between the sandy layer and the clay-silt layer.
4. Many years later the flooding subsided and land animals came back into the area. Now we have a new set of dinosaurs in the area walking around (have a different dinosaur toy make footprints in the clay). There are also new plants in this environment. Add some pine needles and press them into the clay to embed firmly.
5. Mix plaster of paris in a cup off to the side.
6. Now explain that our area is experiencing a new flooding and our footprints are going to be caught up in the flood of water and sediment. Pour the plaster over the clay layer.
7. Now we wait, after all it takes millions of years for fossils to form. Have students carefully set their boxes off to the side.
8. Allow the plaster about 72 hours to dry before attempting to excavate and investigate your models.

Teacher Resource 2.0: Trackways Modeling Guide

Tips on working with the materials.

No matter how many hints we can give you on paper nothing will give you as much confidence as experience. We highly recommend doing a run-through of this activity before trying with students.

Sand
Kinetic sand holds the foot prints better than wet play sand. If you don't want to pay a lot of money for kinetic sand, you can make it with wheat flour and mineral oil (baby oil works too, and smells better).

Clay
We recommend air drying clay or cheap modeling dough from a dollar store. The goal is to have this layer dry out with the plaster.

When you place the clay layer in the box, try to pinch it against the wall of the box to form a seal. That way the plaster layer will be less likely to bleed down into the sand.

Plaster
Plaster can be the trickiest material, and potentially the messiest. If you use it with the students, set up one location in the room where they will come to mix and pour the plaster rather than having it spread out all over.

Each model only needs a very small quantity of plaster, so mix up small batches (1-2 cups) at a time and pour 3-4 models.

Plaster of paris goes through a chemical change as it sets up, so you may notice it producing a little bit of heat as it is setting up.

Follow the instructions for how much water to mix with the plaster, and stir well.

For more detailed results pour the plaster while it's still soupy. Once the plaster becomes "muddy" you have very little time to work with it.

Allow multiple days for everything to dry out, remember, this is a lot less time than natural fossilization!

How Fossils Form

1

A living thing dies, or leaves something behind.

2 It gets covered up by sediment, or sinks to the bottom of a body of water.

3

More and more layers of dirt and rock form on top over time.

4 It stays in the ground a long, long,...,long time.

5

The dirt gets compressed and hardens to rock.

6

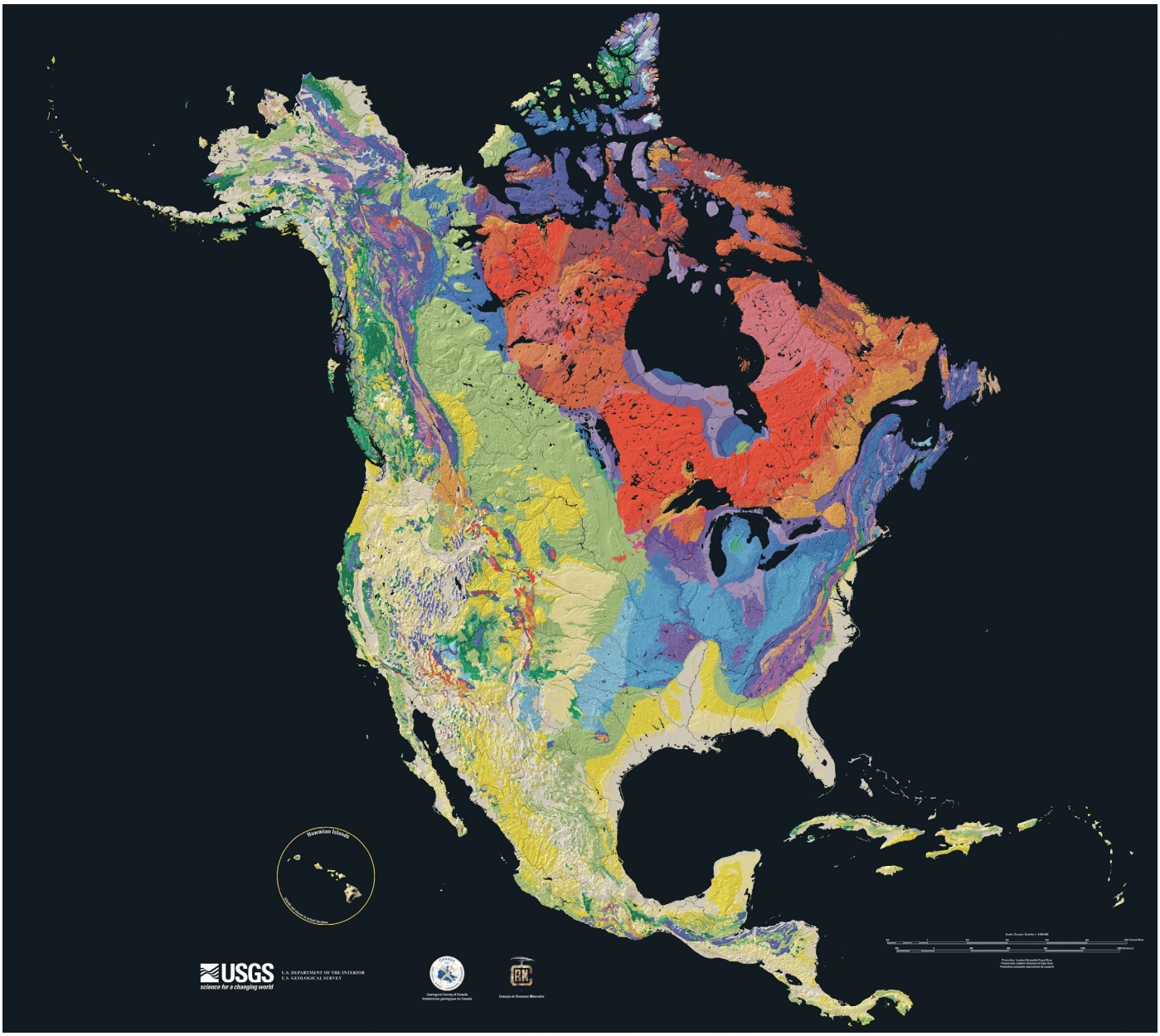
As it continues to be trapped like this underground it exchanges nutrients and minerals with the rock so it may become hard like the rock.

Teacher Resources

United States Geological Survey Geologic Map of North America

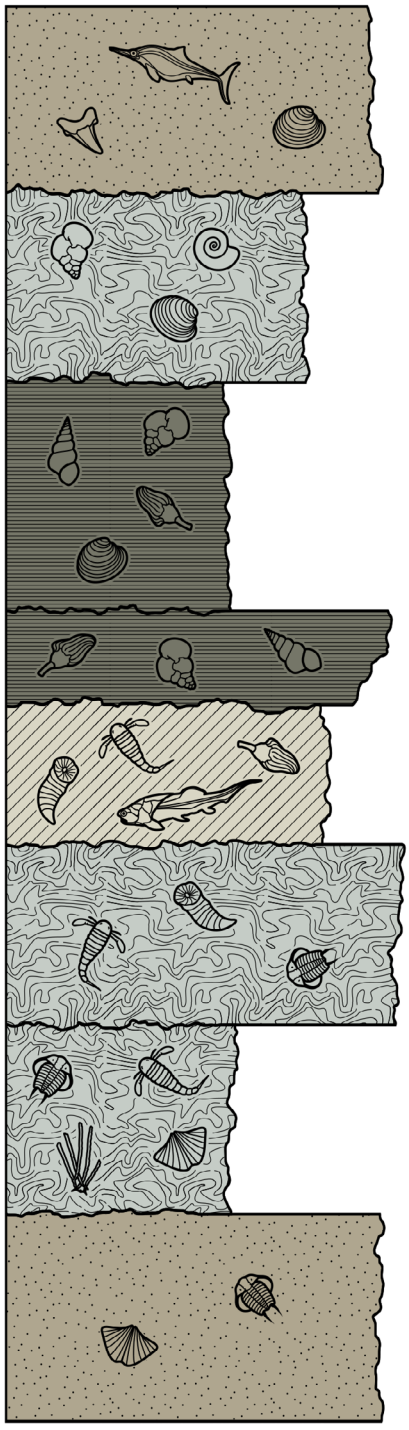
Teacher Resource 3.0

This map illustrates the age of bedrock throughout North America.
The full-resolution pdf can be downloaded for free at the following web address
https://www.geosociety.org/documents/gsa/timescale/timescl.pdf



Teacher Resource 3.0

Sedimentaria Rock Units Each Containing Different Fossils



Key to Fossils

- Sandstone
- Shale
- Limestone
- Dolomite

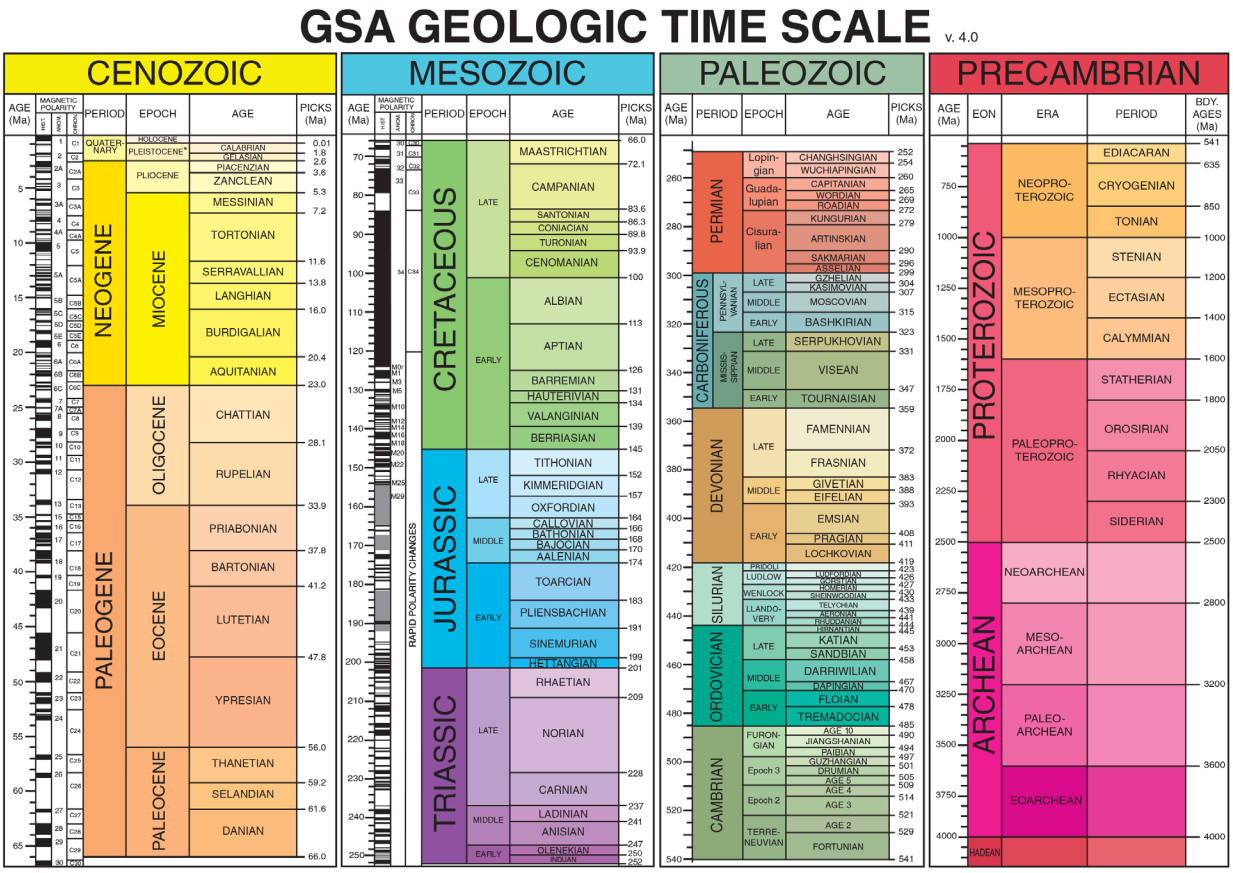
Key to Rock Units

- Shark's tooth
- Placoderm
- Foraminifera
- Ammonite
- Brachiopod
- Crinoid
- Eurypterid
- Gastropod
- Graptolite
- Pelecypod
- Horn Coral
- Trilobite
- Icthyosaur

Geological Society of America Geological Timescale

Teacher Resource 4.0

This time scale is maintained and published byt Geological Society of North America.
A pdf can be downloaded for free at the following web address
https://www.geosociety.org/documents/gsa/timescale/timescl.pdf



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*The Pleistocene is divided into four ages, but only two are shown here. What is shown as Calabrian is actually three ages—Calabrian from 1.8 to 0.78 Ma, Middle from 0.78 to 0.13 Ma, and Late from 0.13 to 0.01 Ma.

Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2012, Geologic Time Scale v. 4.0: Geological Society of America, doi: 10.1130/2012.CTS004R3C.

The Cenozoic, Mesozoic, and Paleozoic are the Eras of the Phanerozoic Eon. Names of units and age boundaries follow the Gradstein et al. (2012) and Cohen et al. (2012) compilations. Age estimates and picks of boundaries are rounded to the nearest whole number (1 Ma) for the pre-Cenomanian, and rounded to one decimal place (100 ka) for the Cenomanian to Pleistocene interval. The numbered epochs and ages of the Cambrian are provisional.

REFERENCES CITED Cohen, K.M., Finney, S., and Gibbard, P.L., 2012, International Chronostratigraphic Chart: International Commission on Stratigraphy, www.stratigraphy.org (last accessed May 2012). (Chart reproduced for the 34th International Geological Congress, Brisbane, Australia, 5–10 August 2012.)

Gradstein, F.M, Ogg, J.G., Schmitz, M.D., et al., 2012, The Geologic Time Scale 2012: Boston, USA, Elsevier, DOI: 10.1016/B978-0-444-59425-9.00004-4.

Student Resource

Fossil Observation Guide

Student Resource 1.0

Draw a detailed sketch of one of the fossil specimens, and label the sketch with these four features.

1. The most interesting or beautiful part of the specimen.
2. This is the most confusing or strange feature.
3. The feature that shows it was once alive.
4. A feature that has changed since the organism died.

1 How is this specimen different that when it was alive, or when it first died?

2 What features can identify on this fossil that tells you it was once part of a living thing?

Modeling Fossil Formation

Student Resource 2.0

1 What is a model?

2 How was this model similar to the natural process of fossil formation?

3 How was this model different from the natural process of fossil formation?

Field Expedition Planner

Student Resource 3.0

1 What organism did you choose to study on your field expedition:

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2 When did this animal live? How long ago?

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3 In looking at the Geological Map of North America, name some places that you can find rocks of that time period today?

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4 Which place with the right rocks is also dry and arid?

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5 When during the year would you plan the expedition? (Remember you'll probably have to camp out near the dig site.)

THE GRIFFIN DINOSAUR EXPERIENCE

FIELD MUSEUM

The Educator Toolkit is part of the Griffin Dinosaur Experience, made possible by the generous support of the Kenneth C. Griffin Charitable Fund.