History of the Earth/Geologic Time 5E Unit

Description: Students will create a timeline of Earth history in the classroom and learn about major changes to the Earth and life through time.

Standards Targeted:

-ESS4: Earth's Surface – *Earth's surface has specific characteristics and landforms that can be identified*
-LS4: Earth's Living History – *Using fossil evidence and living organisms to observe that suitable habitats depend on a combination of biotic and abiotic factors*
-LS4: Earth's Living History – *Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful*
-LS4: Earth's Living History – *Fossils can be compared to one another and to present day organisms according to their similarities and differences.*
-LS6: Cellular to Multicellular – *Cells are the fundamental units of life*
-LS6: Cellular to Multicellular – *All cells come from pre-existing cells*
-ESS8: Physical Earth – *Earth's crust consists of major and minor tectonic plates that move relative to each other.*
-ESS8: Physical Earth – *Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.*
-ESS8: Physical Earth – *A combination of constructive and destructive geologic processes formed Earth's surface.*
-LS8: Species and Reproduction – *Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.*
-LS8: Species and Reproduction – *Reproduction is necessary for the continuation of every species.*
-LS8: Species and Reproduction – *The characteristics of an organism are a result of inherited traits received from parent(s).*

Skills Targeted: Conceptualizing time, comprehending inter-relatedness of Earth systems

Goals:

1. To provide students with a visual comprehension of the scale of geologic time
2. To provide students with an overview of major events in Earth history and how they connect to each other (e.g., evolution of photosynthesis and the rise of atmospheric oxygen).
3. To demonstrate to students that processes that occur slowly on human time scales, such as evolution and mountain building, can have dramatic outcomes when played out over geological timescales.

Objectives—By the end of this activity, students will be able to:

1. Describe major events in Earth history
2. Understand the scale of Earth history in relation to human timescales

Time Needed: One 45-60 minute class period or longer; activity can be adjusted for shorter or longer class times.

Materials:

- Computer(s) with internet access
- Reference materials/list of websites
- Meter stick or measuring tape
- Masking tape
- String or yarn (at least 5 meters long)
- Event print outs (pdf)
- Colored printer paper (not required)

Structure of the 5E Unit

5E Phase	Description	Assessment	Literacy
Engage	Begin by asking students to share what they know about geologic time. Ask the following questions: How old is the Earth? How long did dinosaurs live on Earth? How long have people lived on Earth? How do scientists learn about the history of the Earth? Discuss students' responses. Show any of this series of videos about history of Earth/life: Our story in one minute video: http://youtu.be/ZSt9tm3RoUU Evolution of life on Earth in a 24 hour day: http://youtu.be/H2_6cqa2cP4 Scaled history of Earth in 60 seconds: http://youtu.be/YXSEyttblMI Ask students to write a response, which video do they think is the most accurate portrayal of Earth/life history? Why?	Class discussion, I will find out student's ideas about geologic time concepts through discussion. Video reaction answers – I will look over their answers after the first class period and find out the nature of their conceptions.	
Explore	**Create a timeline of the Earth** Tell students that they will make a timeline showing the history of the Earth. Have students work in groups. Each group is responsible for creating the timeline for one of the following eras: Precambrian, Paleozoic, Mesozoic, or Cenozoic. Explain that each era is further divided into periods, which should also appear on the timeline (distribute geologic timescale handout). Divide a bulletin board into four sections, one for each era. Have students use reference books, the internet (key reference list handout), and library resources to research their era. Students should address 4 topics: 1. Landmasses What did the surface of the Earth look like? Illustrate the arrangement of landmasses and/or continents. 2. Climate What was the climate like? Was there an ice age? Was it very warm? 3. Earth Events What major Earth events occurred during the	Students turn in summary for their time interval Could employ: Poster Presentation Drawings Graphic Organizers *This aspect of the lesson could be modified into a large project or a quick classroom exercise	Writing, summarizing data and locating information sources, visual aid development

	period? Was there widely distributed volcanic activity, an asteroid impact, or the formation of large mountain belts? 4. Organisms What plant and animal groups lived during the period? What organisms became extinct?		
Explain	Each group will present their Era to the other groups. Begin a class discussion by asking what patterns students observed within Earth history. Explain the key patterns that occur in the Earth-life system: • Prerequisites to next level of biotic organization (oxygen before metazoan life, plants on land before animals) • Change in climate through time (icehouse vs hot house) • Supercontinent cycle (amalgamation and fragmentation of continents) • 5 major mass extinctions • Impact of earth system on biotic system (mass extinctions due to tectonics, climate change, asteroids) • Earth is very old, animal life and (particularly) humans are very recent phenomena *Example questions:* 1) Explain to the students that the evolution of life must logically pre-date the rise of atmospheric oxygen. Ask the students why this must be to get them to think about the link between these two events. 2) Engage the students in questions of process. For example, ask students what they think the rate of continental spreading is. The answer is about 2 cm / year. If students guessed much faster, discuss how even though the rate of plate movement is very slow, over many millions of years, it results in a huge ocean. 3) Discuss the relationship between plants and animals moving on to land. Why do you think animals came second?	Students turn in handout with logical constructs for the order of events Could employ: Meaningful paragraphs Make a claim Maxur's ConcepTest	Emphasize use of logical principles/scientific reasoning (no life in oceans before water, no land critters before oyxgen in atmosphere, etc.)
Elaborate	**Geological Timeline Challenge** **Before Class:** Measure out 4.6 meters in a straight line. Place a piece of tape every half	Checking for understanding – I informally check on students' developing	Emphasize use of logical principles/scientific reasoning (no life in

	meter from the beginning. Each meter represents 1 billion years of earth's history, each centimeter represents 10 million years, and each millimeter represents 1 million years. Mark the first piece of tape as the present, the next piece as 500 million years ago, the next as 1 billion years ago, and continue on – the last piece of tape will read 4.5 billion years ago, add one extra piece of tape at the end to represent 4.567 billion years ago and the formation of the planet. Break students up into small groups (3-5 students is ideal). Each group will get a subset of the 15 event cards (see included PDF "Timeline Cards" – these should be cut up along the black lines). Ideally, each group will get a set of cards printed out on different colored paper, or the sets can be marked with colored markers to distinguish between each group. All groups can place their 'formation of planet Earth' card at the beginning of the timeline. Ask students to work together to place the rest of the event cards in the appropriate place along their timeline. The students do not need any prior knowledge to put their events on the timeline – the idea is for them to work together to figure out their events. After each group has placed their events on the timeline, have students transfer their locations to a handout and provide a justification for the relative order of events Start a classroom discussion on where each group placed each event. Did everyone agree? If not, have groups try to justify their decisions. After the discussion, work with the students to place the events in their correct location along the timeline. As you re-place each event, engage the students in a brief discussion. If time permits, discuss any events that the students were surprised by. Note that the last two events will be totally indistinguishable from each other and from the end of the timeline – this is key! Events that we think of as being really old, like the extinction of mammoths, are actually very recent when compared to the entire history of the Earth.	ideas by walking around asking them questions to challenge their thinking. Could involve: Card sort task Think-pair-share	oceans before water, no land critters before oyxgen in atmosphere, etc.)

Evaluate	Revisit the initial videos. Which represented Earth history best, why? Have students write short biography of the Earth outlining the major events from each Era, be that students include how long each of the different eras with respect to total Earth History. ($1/10^{th}$, $1/4^{th}$ of Earth history, etc.)	Revised answers to videos combined with story of the Earth response allows assessment of understanding of the magnitude of geologic time and the relative duration of key intervals Could involve: Comparison essay Final reflection	writing

Key web references for Geologic Time Explore Activity

University California Museum of Paleontology: Geologic Time Scale with links for each time interval
http://www.ucmp.berkeley.edu/help/timeform.php

Advent of Complex Life from NASA Astrobiology Institute
http://www.complex-life.org/timeline_events

The Paleontology Portal: Exploring Time and Space
http://www.paleoportal.org/index.php?globalnav=time_space

National Geographic: Prehistoric Time Line
http://science.nationalgeographic.com/science/prehistoric-world/prehistoric-time-line/

PaleoMap Project: Images of plate reconstructions and climate history for all intervals in Earth history
www.scotese.com

Colorado Plateau Geosystems, Inc.: Fantastic paleogeographic reconstructions
http://cpgeosystems.com/index.html

San Diego Natural History Museum: condensed page of key geologic events
http://www.sdnhm.org/archive/exhibits/mystery/fg_timeline.html

The Ohio Historical Society's Ohio History Central website: Ohio's Geologic Periods
http://www.ohiohistorycentral.org/w/Ohio%27s_Geologic_Periods

Geological Time Scale Challenge Answers

Events:

1. Oceans and continents start to form – 4400 million years ago – 4.4 meters from present day (end of timeline)

2. First evidence of life –3500 million years ago – 3.5 meters from present day

3. Initial of atmospheric oxygen –2400 million years ago – 2.4 meters from present day

4. Evolution of eukaryotic (non-bacterial) life—1800 million years ago – 1.8 meters from present day

5. Cambrian Radiation of Animals—542 million years ago – 54.2 centimeters from present day

6. Plants move on to Land—450 million years ago – 45 centimeters from present day

7. Animals move on to Land—430 million years ago – 43 centimeters from present day

8. Permo-Triassic Mass Extinction – largest known!—251 million years ago – 25.1 centimeters from present day

9. Evolution of Mammals –195 million years ago – 19.5 centimeters from present day

10. Opening of the Atlantic Ocean—160 million years ago - 16 centimeters from present day

11. Extinction of the Dinosaurs—65 million years ago – 6.5 centimeters from present day

12. Rise of the Himalayan Mountains—20 million years ago - 2 centimeters from present day

13. Evolution of our species, *Homo sapiens*—200,000 years ago - 0.2 million years ago – 0.02 centimeters from present day (0.2 mm)

14. Extinction of the Wooly Mammoth—10,000 years ago – 0.01 million years ago – 0.001 centimeters from present day (0.01 mm)

Name _____

Geological Time Scale Challenge

Place these events in the correct relative position on the geologic time scale:

A. Evolution of mammals	F. Oceans and continents start to form	K. Opening of the Atlantic Ocean
B. Plants move on to land	G. Evolution of our species, *Homo sapiens*	L. Extinction of the Wooly Mammoth
C. First evidence of life	H. Initial atmospheric oxygen	M. Animals move on to land
D. Cambrian radiation of animals	I. Permo-Triassic mass extinction	N. Evolution of eurkaryotic (non-bacterial)
E. Rise of the Himalayan Mountains	J. Extinction of the dinosaurs	life