

The Geological Timescale and Earth History

Learning Objectives

- Explore major events through Earth's history.
- Appreciate the magnitude of geologic time.
- Become familiar with the geologic time scale

Pre-Lab Resources

- An EXCELLENT video on the history of life and the geo-timescale: Will help you progress through this lab with a much better understanding (~12 min.)
 - o <https://www.youtube.com/watch?v=rWp5ZpJAIAE>

ACTIVITY #1 – Becoming familiar with the time scale

Study the geologic timescale and its divisions. Check out how the geologic timescale is divided into different units/segments of time. The four columns - eons, eras, periods, and epochs – are organized according to nested levels of time, going from left to right, with eons the broadest chunks of time, and epochs the smallest. Time runs from **bottom to top – oldest to youngest**, respectively. The eons, eras, periods, and epochs each have a number of uniquely named time segments. For example, the Era column includes the Paleozoic, Mesozoic, and Cenozoic, and the Mesozoic era includes the Triassic, Jurassic, and Cretaceous periods. **The divisions and subdivisions for eons, eras and periods – post-Archean - are primarily defined by the unique assemblages of various types of fossil species** that are found in the rocks of respective age range, and the **boundaries between the time periods are defined by sharp changes in the types of fossils**, most likely a consequence of massive extinction events. Good examples include the beginning of the Proterozoic eon, the beginning of the Cambrian period, the Permian-Triassic period boundary, and the Cretaceous-Tertiary period boundary.

QUESTIONS: Use the summary above and figures on the following pages to help answer questions.

1) List the four **Eons** on the geologic timescale and their numeric age when they started (millions years = MY or billions years = BY)

<u>Eon Name</u>	<u>Start age</u> (<i>millions (MY) or billions (BY) of years ago</i>)
_____	_____ MY
_____	_____ BY
_____	_____ BY
_____	_____ BY

2) List the three **Eras** on the geologic timescale and their numeric age when they started (millions years = MY)

<u>Era Name</u>	<u>Start age</u> (<i>millions (MY) of years ago</i>)
_____	_____ MY
_____	_____ MY
_____	_____ MY

3) Which of the four time units – eons, eras, periods, or epochs, spans the longest amount of geologic time?

4) Which of the four time units span the shortest amount of geologic time? _____

5) What is the oldest **Eon** in the geologic timescale? _____

6) The **Phanerozoic Eon** represents the time span on Earth with abundant, complex life. Roughly **what percentage of Earth's geologic time does the Phanerozoic Eon take up** on the geological timescale?

_____ %

Data and Calculation: Earth age: _____ MY Time span of Phanerozoic: _____ MY

Hint: Time span of Phanerozoic / Earth Age x 100 **Show work::**

7) The **Paleozoic Era** represents the "**Age of Complex Life**". It was time of great changes in the evolution of complex, multi-cellular life with the appearance and rapid development of most invertebrate phyla, land plants, fishes, and ultimately amphibians and reptiles. This Era ended with the Earth's greatest extinction event.

How many years did this Era last? _____ MY

This Era came to a tragic end (90% of all life wiped out) at what time? _____ MY ago

8) The **Mesozoic Era** represents the "**Age of the Dinosaur**". How many years of geologic time did the dinosaurs get to reign on Earth before they were suddenly wiped out at the end of the Cretaceous Period?

_____ MY *Hint: It spans the time across the entire "middle life" Era.*

This Era also came to a tragic end (dinosaurs wiped out) at what time? _____ MY ago

9) The **Cenozoic Era** represents the "**Age of the Mammals**". How many years of geologic time have the mammals been reigning on Earth so far? *Hint: It spans the time across the entire "new life" Era.*

_____ MY

11) Which **Era** has the most **Periods**? _____ What's the most likely reason this Era has the most Periods?

12) The **Quaternary Period** represents the current interglacial interval and when human civilizations arose, referred to as the "**Age of the Humans**". *Homo sapiens* evolved during this period, when did it begin?

_____ MY

ACTIVITY #2 – The History of Earth...on paper!

INTRODUCTION:

The Earth has changed dramatically and repeatedly over a history that spans nearly 5 billion years. Such immense spans of time are difficult for most of us to comprehend. They fall outside our range of human experience. We normally deal with much shorter time intervals, like the time of our next class or the number of days until the next exam, or even the number of years until graduation!

It is important for students of the Earth Sciences to expand their sense of time. Extremely slow geologic processes, considered only in terms of human experience, have little meaning. To appreciate the magnitude of geologic time and the history of our incredible planet, you will be creating a timeline of important geologic events scaled to a size more tangible and familiar.

INSTRUCTIONS:

1. Construct a timeline of Earth's history on a long strip of adding machine tape. The timeline should be done to scale.
 - 1 meter (100 cm) = 1 billion years (1000 million years)
 - 10 cm = 100 million years
 - 1 cm = 10 million years
 - 1mm = 1 million years
 - There are ten 100 million years in one billion years, or 100 cm in 1 meter.
 - There are ten 10 million years in 100 million years.
- a) **Measure out a strip of adding machine tape 5 meters long.** A meter stick will be provided in lab.
- b) Refer to the **Geologic time scales** in this exercise. Dates might vary slightly.
- c) Select one end of the tape to represent **today**. . Beginning at that end, **mark off and write each billion years** (1 billion, 2 billion, etc.) at 1 meter increments.
- d) Draw a **bold line and label** (in color) to **show the beginning of Earth at 4.6 billion yrs. ago**. *To help you get started: 4.6 billion yrs. **Go to the 5 billion mark and plot 4.6 billion: $5 - 4.6 = .4$ billion = 400 million = 40 cm. Measure 4 cm “up, or towards today, from 5 billion”, draw a line and label “Beginning of Earth”***
- e) **Draw a bold line and label** (in color) to **show the beginning of the three eras (Paleozoic, Mesozoic, Cenozoic)**. *To help you get started: 542 Million yr. ago from today would be (50 cm+ 4cm + 2mm) from the “today” end of the paper roll.*
- f) **Mark off and write numbers** at 10 cm increments **ONLY WHEN NECCESARY** (plotting boundaries or events)
- g) **Starting with the oldest event** (Event #1), mark off all of the important events in Earth's history shown in the list on the next page. In each case you should **write the date and event directly on the timeline**.
- h) Come up with your own Earth-shattering event (do some research), plot the event on your time scale, and present to the class.

Event #	Date in years before present	Event
1	4.56 billion	Earth forms
2	4.1 billion	Oldest rock
3	3.9 billion	Oldest evidence of a continent
4	3.8 billion	First evidence of life
5	3.5 billion	First fossils (algae and bacteria)
6	1.8 billion	Free oxygen in atmosphere
7	1.1 billion	First fossil of a complex organism (a worm)
8	540 million	First abundant life found in the rock record
9	460 million	First fish
10	440 million	First land plants
11	410 million	First land animals
12	250 million	Largest mass extinction occurs
13	247 million	First dinosaurs
14	240 million	First mammals
15	220 million	Breakup of super-continent Pangaea begins
16	145 million	First flowering plants
17	65 million	Dinosaurs and other animals go extinct
18	1.8 million	First primate in genus <i>Homo</i>
19	40,000	First <i>Homo sapiens</i>
20	13,000	Humans first inhabit North America
21	10,000	End of last Ice Age
22	500	European rediscovery of the Americas
23	?	Your birthday

(Please note that some of these ages may differ slightly from those given in your text or that you found in another source. These dates change, but the general order and rough position stay constant.)

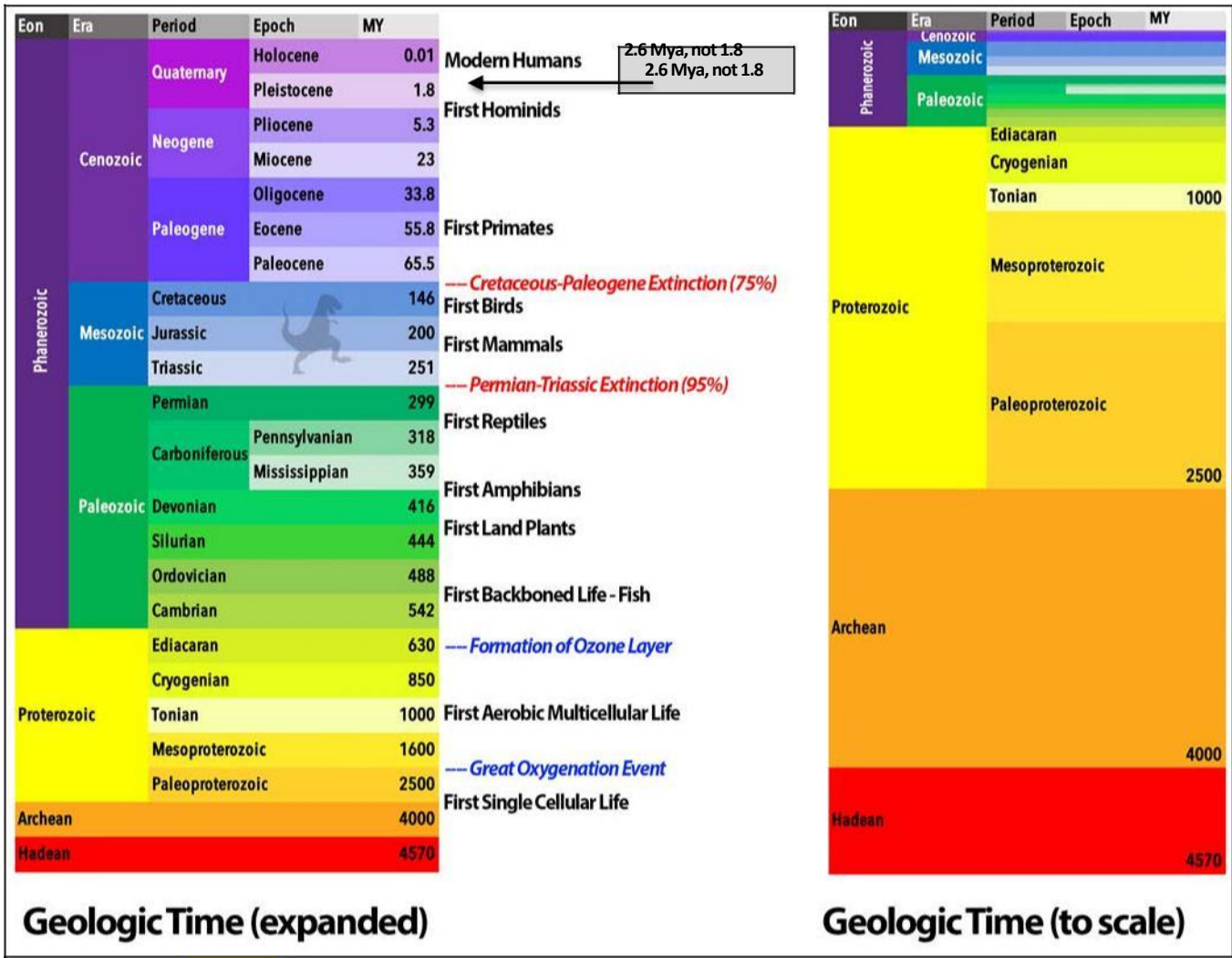


Figure 1 – Geological Timescale (Ga = billions of years; Ma = millions of years)

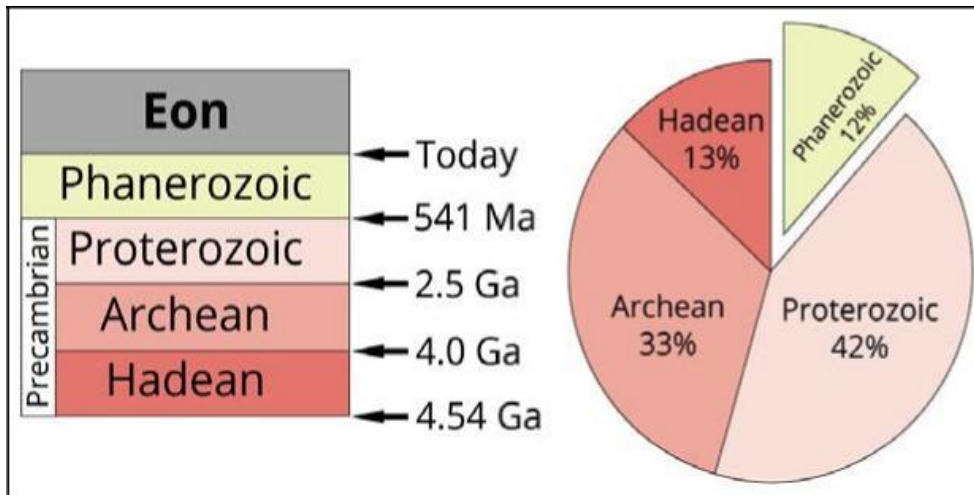


Figure 2: The Eon Time Divisions of the Geologic Timescale.

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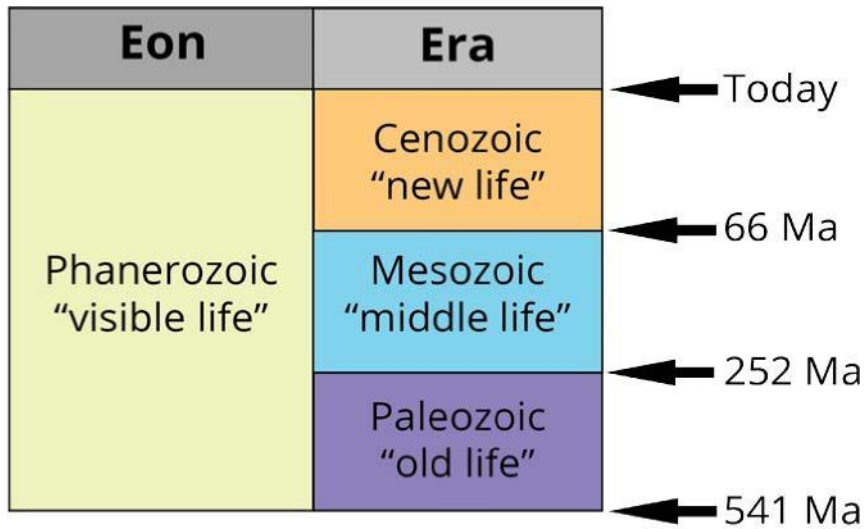


Figure 3: The Era Time Divisions of the Geologic Timescale
 Image by Jonathan R. Hendricks. Creative Commons License This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Era	Prd	Epoch	Time Scale
CENOZOIC	QUATER-NARY	HOLOCENE	Present
		PLEISTOCENE	10,000 yrs ago
	NEOGENE	PLIOCENE	2.6 mya
		MIOCENE	5.3 mya
		OLIGOCENE	23 mya
	PALEOGENE	EOCENE	33.9 mya
		PALEOCENE	56 mya
MESOZOIC	CRETACEOUS	LATE CRETACEOUS	66 mya 100 mya

Figure 4: The Epochs of the Cenozoic Era

<https://floridadep.gov/fqs/fqs/media/house-graphics-dep-data-portal-screenshot-icon>

Geologic Time Scale

Eon	Era	Period	Epoch	Boundary Dates (Ma)	
Phanerozoic	Cenozoic	Quaternary	Holocene	0.012	
			Pleistocene	2.6	
		Tertiary	Neogene	Pliocene	5.3
				Miocene	23.0
			Paleogene	Oligocene	33.9
				Eocene	55.8
				Paleocene	66
	Mesozoic	Cretaceous			146
		Jurassic			200
		Triassic			251
	Paleozoic	Permian			299
		Carboniferous	Pennsylvanian		318
			Mississippian		359
		Devonian			416
		Silurian			444
		Ordovician			488
		Cambrian			542
Proterozoic	Neo-	Ediacaran		~ 635	
	Meso- Paleo-			2500	
Archean				4000	
Hadean		No Rock Record on Earth		~ 4600	
ORIGIN OF EARTH					

Note #1: Vertical timeline of boundary dates *is not* drawn with a uniform scale.
 Note #2: Boundary dates from the International Commission on Stratigraphy 2010 Geologic Time Scale
 Note #3: Carboniferous, Paleogene, and Neogene are more commonly used outside of the U.S.
 Note #4: Epochs for the Mesozoic and Paleozoic are too numerous to be shown.
 Note #5: The Hadean Eon is not formally recognized.

Figure 5: Geological Timescale.

by Roger Steinberg, Department of Natural Sciences, Del Mar College
https://serc.carleton.edu/NAGTWorkshops/time/visualizations_teachtips/60786.html

Eon	Era	Period	Epoch	MYA	Life Forms	North American Events						
Phanerozoic	Cenozoic (CZ)	Quaternary (Q)	Holocene (H)	0.01	Age of Mammals	Extinction of large mammals and birds Modern humans	Ice age glaciations; glacial outburst floods					
			Pleistocene (PE)									
		Neogene (N)	Pliocene (PL)	2.6				Spread of grassy ecosystems	Cascade volcanoes (W) Linking of North and South America (Isthmus of Panama)			
			Miocene (MI)	5.3								
			Oligocene (OL)	23.0								
		Paleogene (PG)	Eocene (E)	33.9				Early primates	Laramide Orogeny ends (W)			
				Paleocene (EP)						56.0		
										66.0	Mass extinction	
			Mesozoic (MZ)	Cretaceous (K)							Age of Reptiles	Laramide Orogeny (W) Western Interior Seaway (W)
								145.0				
	Jurassic (J)	201.3		Early flowering plants Dinosaurs diverse and abundant	Sevier Orogeny (W) Nevadan Orogeny (W) Elko Orogeny (W)							
	Triassic (TR)		251.9	Mass extinction First dinosaurs; first mammals Flying reptiles	Breakup of Pangaea begins Sonoma Orogeny (W)							
	Paleozoic (PZ)	Permian (P)		Age of Amphibians	Supercontinent Pangaea intact							
						298.9						
			Pennsylvanian (PN)			323.2	Coal-forming swamps Sharks abundant First reptiles	Ouachita Orogeny (S) Alleghany (Appalachian) Orogeny (E) Ancestral Rocky Mountains (W)				
		Mississippian (M)			Antler Orogeny (W) Acadian Orogeny (E-NE)							
						358.9						
		Devonian (D)	419.2		Mass extinction First amphibians First forests (evergreens)							
		Silurian (S)			Taconic Orogeny (E-NE)							
						443.8						
	Ordovician (O)		485.4	Primitive fish Trilobite maximum Rise of corals		Extensive oceans cover most of proto-North America (Laurentia)						
	Cambrian (C)		541.0	Marine Invertebrates	Early shelled organisms							
	Proterozoic				Complex multicelled organisms	Supercontinent rifted apart Formation of early supercontinent Grenville Orogeny (E)						
Archean	Precambrian (PC, W, X, Y, Z)		2500	Simple multicelled organisms	First iron deposits Abundant carbonate rocks							
			4000	Early bacteria and algae (stromatolites)	Oldest known Earth rocks							
Hadean				Origin of life	Formation of Earth's crust							
				4600	Formation of the Earth							

Figure 6: Geologic time scale showing the geologic eons, eras, periods, epochs, and associated dates in millions of years ago (MYA). The time scale also shows the onset of major evolutionary and tectonic events affecting the North American continent.

From the National Park Service

Part III. Geologic Timescale Laboratory Reflection

Directions: Write a reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this geologic timescale and earth history lab (3 points possible). Answer the following 3-point question reflection set

1) What was the purpose of this lab? What did you discover and learn during this lab?

2) What did you enjoy most about this lab? Also, what was challenging or thought-provoking?

3) What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.
