Down the Halls of (Geologic) Time

North Carolina Geological Survey
Amy Pitts - amy.pitts@ncdenr.gov

Background

Earth formed nearly **4.6 billion** years ago! That's a huge number for us Earthlings to wrap our heads around. We throw around numbers in the millions and billions without really comprehending how large these numbers are. According to the National Park Service, counting once per second, 24 hours a day, seven days a week (with no time off), it would take 11 days and 14 hours to count to one million. If you do the math, it would take approximately 32 years to count to one billion in the same manner. Now, get this - it would take 147 years of non-stop counting to reach 4.6 billion (or 4,600,000,000 or 4,600 million)!

As a way to explain and manage time, humans have divided time into manageable units - minutes, hours, days, weeks, months, years, etc. Clocks and calendars are tools we use to understand time. The tool that Earth scientists and geologists use to describe geologic time (or time since Earth was formed) is the geologic time scale. The time scale is a way to describe the timing and relationships of Earth events. Rather than minutes, hours, months, and years, the geologic time scale is divided into Eons, Eras, Periods, and Epochs. Each of these time divisions is based on significant events in Earth history - appearance (or disappearance) of certain life, significant events like formation or breakup of supercontinents, or even when humans began to affect Earth systems. A copy of the Geologic Time Scale is included with this activity.

Materials

- A long hallway or a long open space, at least 50 feet in length, 100 feet would be better
- Tape measure
- List of important dates in geologic time (provided)
- Tape, sticky pad paper, printed or drawn images for the timeline, colored pencils, markers, or crayons

Pre-Activity

Before you begin this activity, use the tape measure to determine the length of your timeline in your hallway or open space (50 ft, 70 ft, 100 ft, etc.). You can choose any length you'd like. Side note: keeping the tape measure in place during the entire activity allows students an easy way to count feet or inches when placing events on the timeline. Use one sticky note to write "NOW/TODAY" and place it at the beginning of the tape measure (at zero inches). On another sticky note, write "BEGINNING OF EARTH" and place it at the end of your tape measure (50 ft, 70 ft, 100 ft. - whichever length you chose at the beginning).

Activity

Creating a scaled model of geologic time in a hallway can provide students with an awareness of just how old Earth is, the large expanses of time between Earth events, and how Earth events relate to each other. Choose the events you'd like your students to place on the hallway timeline from the "Important Dates in Geologic Time" sheet that has been provided. As alternatives, you could have your students focus on interesting fossils and their place in the geologic past, important geologic events in North Carolina, or even just mass extinctions. There are so many possibilities! Have the students draw, write, or print these events (or images) for placement on the timeline. To take the activity a step further, you could assign each student a specific event, fossil, or organism and have them do additional in-depth research to provide to the whole class.

For any version of this activity, you will need to know the geologic date/time of the event, fossil or organism. You or your students will complete a few simple calculations, shown below, to determine where to place the event, fossil, or organism on the hallway timeline.

Activity Calculations

The calculations shown below are based on a 100 foot long hallway. To modify the calculations if you don't have 100 feet available, just swap out '100' for the length of your hallway. You could do these calculations before class or have the students do them as an added math activity.

- To determine how much geologic time is represented by each foot on your 100 foot hallway timeline:

  Age of Earth (years) / Length of hallway (feet) = Years per foot of hallway timeline
  4,600,000,000 yrs / 100 ft = 46 million years per foot of hallway
  Each foot on the hallway timeline represents 46 million years. This number never changes for a 100 foot hallway.

- To calculate where to place an event, fossil, or organism on the timeline, you will need to know the date of the event, fossil, or organism. Examples:

  - The oldest fossils of sharks are from 409 million years ago. Where do we place this on the timeline?
    409 million years / 46 million years per foot = 8.8 feet
    You will be counting back in time, so place the marker or image of a shark **8.8 feet** from the **NOW/TODAY** end of the hallway. 8.8 feet now represents 409 million years ago.

  - The oceans formed 3,800,000,000 years ago. Stated another way, the oceans formed 3,800 million years ago. Where do we place this on the timeline?
    3,800 million years / 46 million years per foot = 82 feet
    You will be counting back in time, so place the marker or image of an ocean **82 feet** from the **NOW/TODAY** end of the hallway. 82 feet now represents 3.8 billion years ago.

When choosing which events, fossils, or organisms to place on the timeline, keep in mind that the NOW/TODAY end of the hallway will get very crowded with recent events. In just an inch of a 100 foot hallway timeline, there can be too many events to fit. Space your events on the timeline so that they extend the length of the hallway.

So there you have it - a scaled model of geologic time! We hope you enjoy traveling back into Deep Time!

Discussion

Have your students make observations about the timeline and ask questions such as:

- What observations do you have about the timeline?
- Does seeing the time that elapsed between early Earth events (Precambrian Eon) and present day give you a perspective on how long Earth history is?
- How long did the dinosaurs live on Earth, based on the earliest dino fossils and their extinction 65.5 million years ago?
- What is the percentage of time that life (in any form) has existed on Earth?
- Using knowledge that you already have, can you guess the process that cyanobacteria used to produce oxygen in the atmosphere? How long from that point did it take for the atmosphere to be oxygenated at today's levels?
- It took 800,000,000 (800 million years) after Earth formed for the oceans to form. Where do you think the water for the oceans came from?

Important Dates in Geologic Time

Precambrian Eon (4,600 my - 542 my)

- 4,600 my: Earth forms
- 4,500 my: moon forms
- 3,800 my: oldest dated rocks on Earth's surface; first oceans form
- 3,600 my: first continents form
- 3,500 my: first fossil evidence of cyanobacteria (first life!); oxygen production in atmosphere begins
- 1,750 my: oldest fossils of single-cell life (eukaryotes)
- 1,500 my: oldest fossils of multi-celled organisms (algae)
- 1,100 my: first supercontinent forms (Rodinia)
- 670 my: oldest fossils of jellyfish and marine worms

Phanerozoic Eon (542 my - present)

- 542 my: the Cambrian Explosion of life on Earth, brachiopods and trilobites appear
- 530 my: oldest fossils of vertebrate fish (*Myllokunmingia*)
- 500 my: oxygen present in atmosphere at today's levels
- 470 my: oldest fossils of land plants (moss, liverwort, lichen)
- **440 my**: end of Ordovician mass extinction event

- 412 my: oldest fossils of insects (*Rhyniognatha hirsti*)
- 409 my: oldest fossils of sharks (*Doliodus problematicus*)
- 375 my: oldest fossils of amphibians (*Acanthostega)*
- **360 my**: end Devonian mass extinction event

- 320 my: oldest fossils of reptiles (*Hylonomus*)
- 300 my: supercontinent Pangea forms
- 299 my: first mammal-like reptiles appear (synapsids, *Lystrosaurus*); human ancestors
- **251 my**: end Permian mass extinction (The Great Dying; nearly 90% of all life went extinct)

- 228 my: oldest fossils of dinosaurs (*Eoraptor*)
- 221 my: oldest fossils of early mammals (*Morganucodon*)
- 201 my: Pangea begins to rift apart, Atlantic Ocean begins forming
- **199 my**: end Triassic mass extinction

- 155 my: oldest fossils of birds (*Archeopteryx*)
- 142 my: oldest fossils of flowering plants (*Archaefructus*)
- 75 my: oldest fossils of *Tyrannosaurus rex* and *Giganotosaurus*
- **65.5 my**: end Cretaceous mass extinction (bye, bye dinos!)

- 55 my: oldest fossils of primates (*Teilhardina*)
- 52 my: oldest fossils of whales (*Pakicetus*)
- 37 my: oldest fossils of dogs (*Hesperocyon*)
- 25 my: oldest fossils of cats (*Proailurus*)
- 15 my: oldest fossils of largest shark (*Carcharodon megalodon*)
- 4 my: oldest fossils of human-like ancestors from Africa (*Australopithecus*)
- 1.2 my: oldest fossils of humans outside of Africa (*Homo erectus*)
- 0.06 my: beginning of last N. American ice age
- 0.006 my: beginning of Neolithic Age ("Stone Age:)

Metaphors for Geologic Time

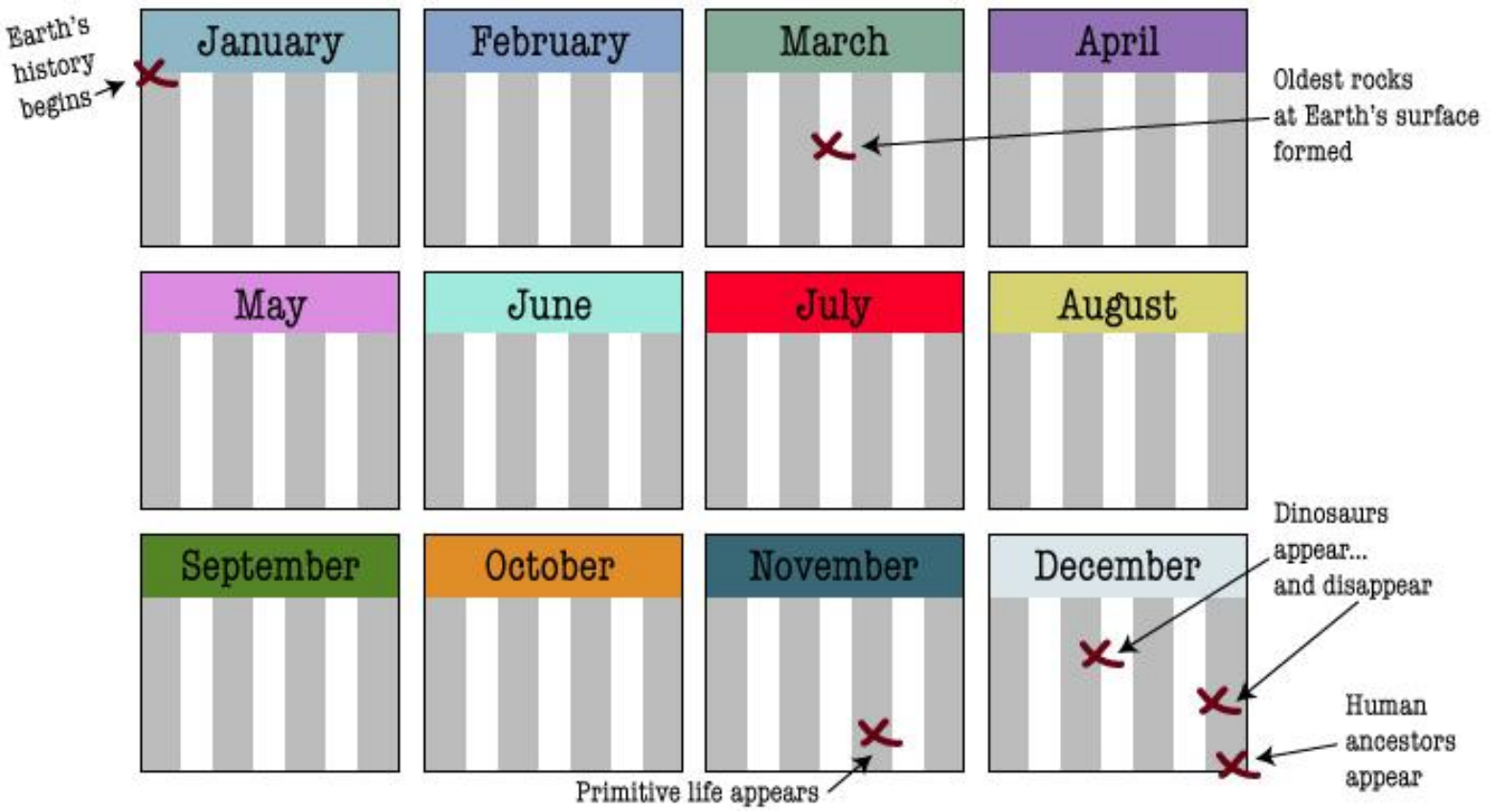


Image: Kansas Geological Survey (https://www.geokansas.ku.edu/geologic-time-a-metaphor)

Metaphors for Geologic Time

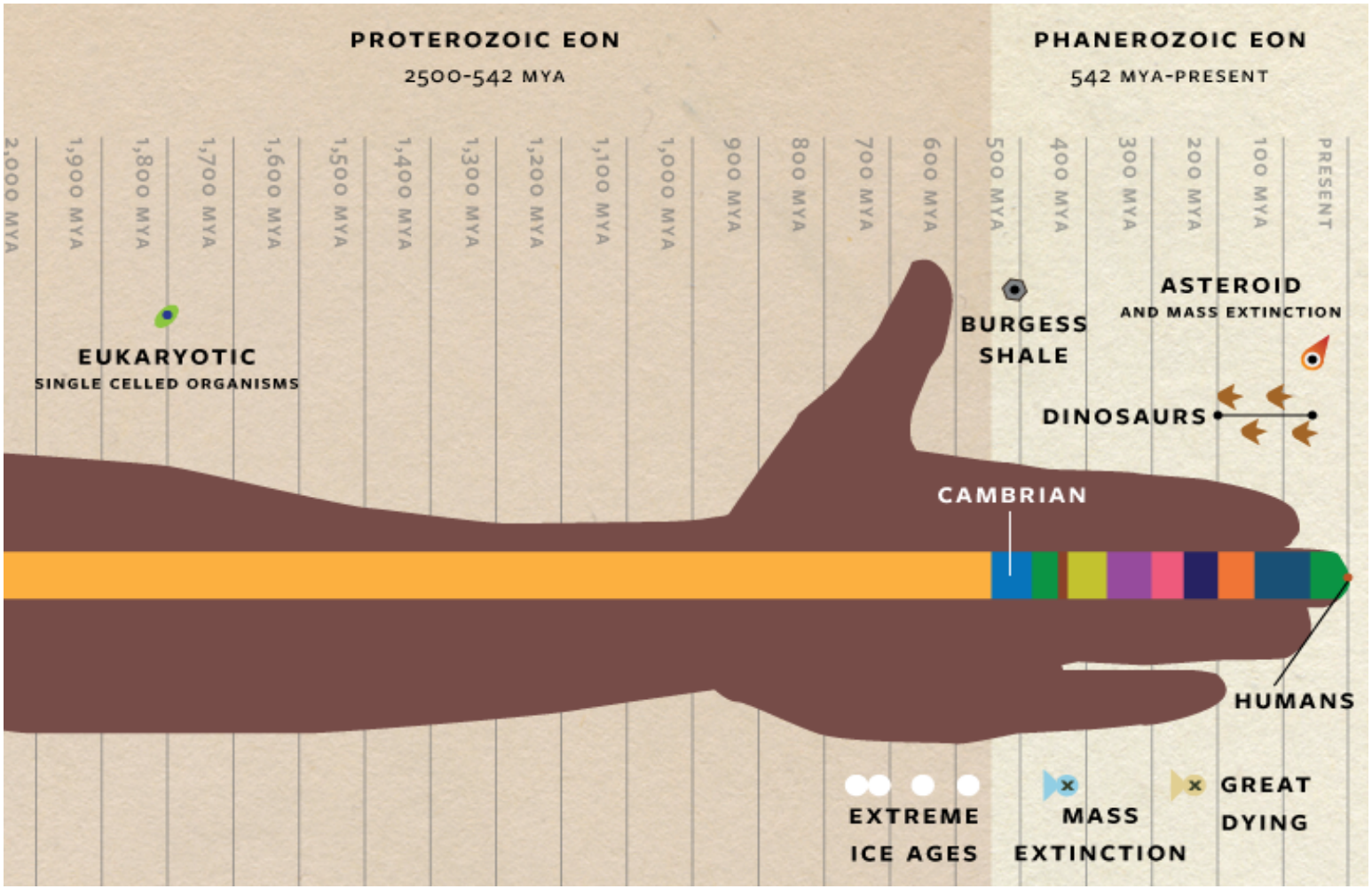
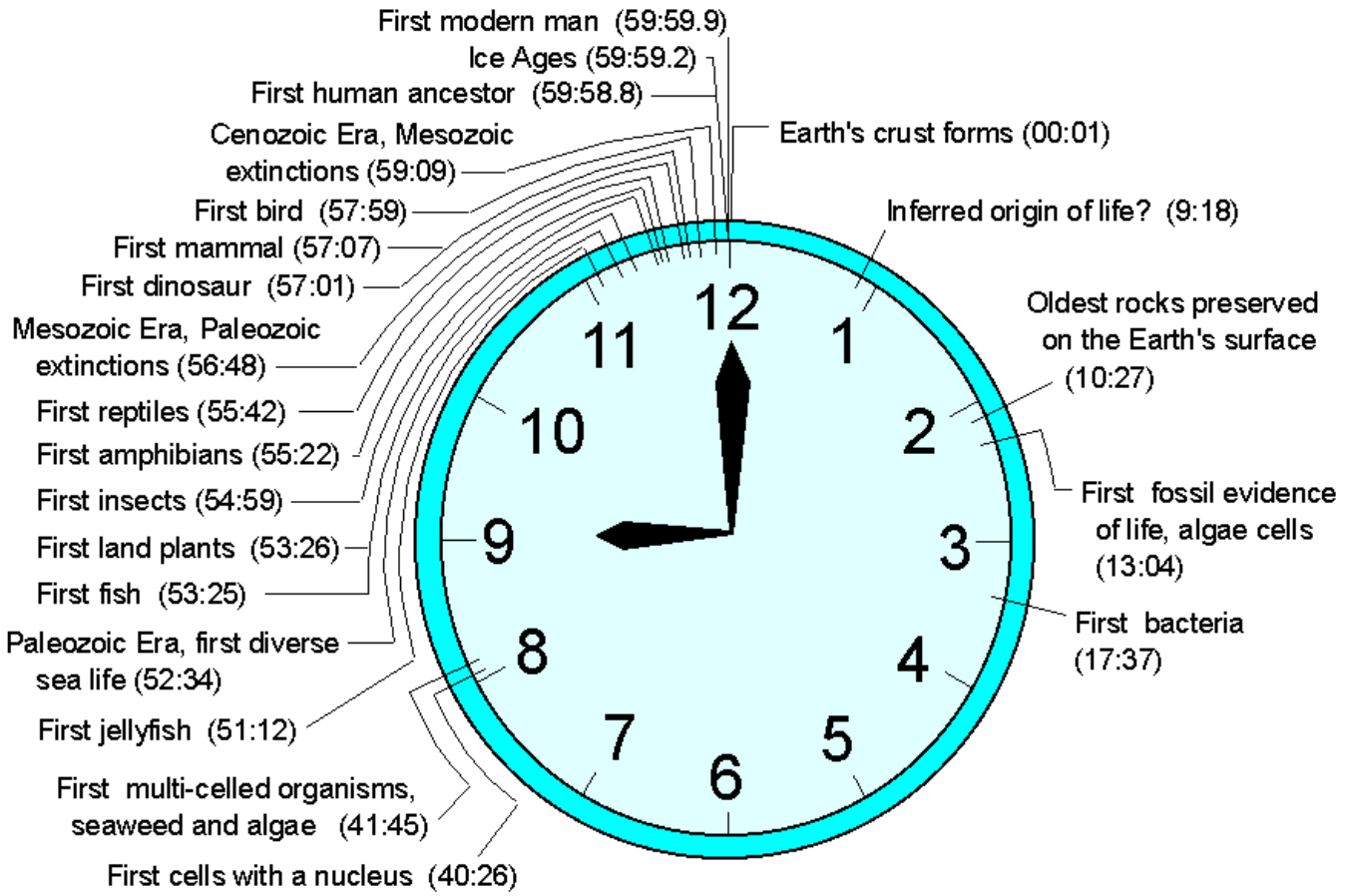


Image: Nautilus (https://nautil.us)

Metaphors for Geologic Time



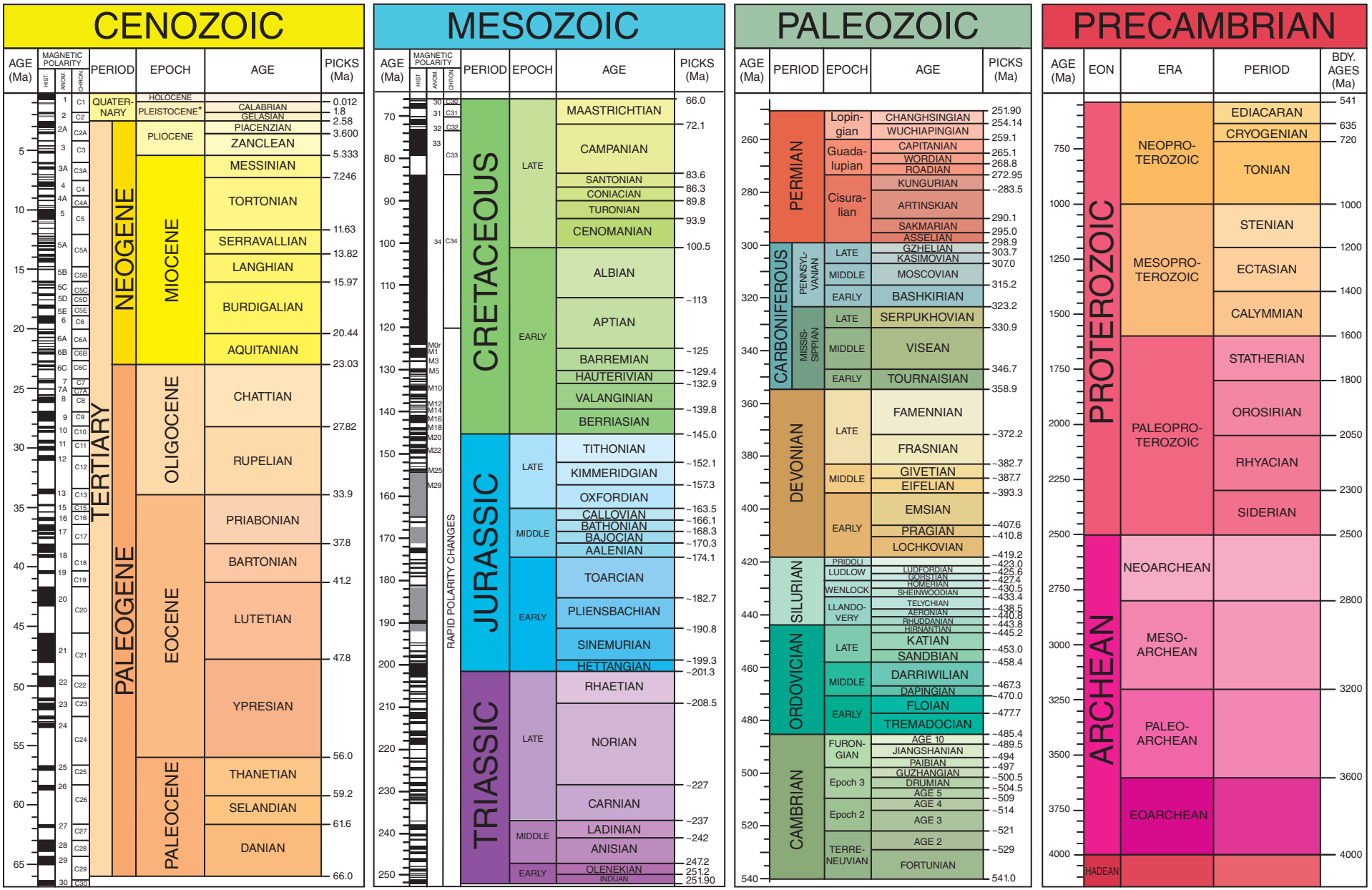
4.6 billion years in one hour

Image: Kentucky Geological Survey (https://www.uky.edu/KGS/education/clockstime.htm)

Interesting Facts about Geologic time

- The time between the oldest dino fossil (228 my) and the dino extinction (66 my) means that dinosaurs ruled Earth for about 162 million years. Modern humans have only existed for 200,000 years.
- Bacteria were the only life on Earth for almost 3 billion years! That is about 68% of Earth's history.
- Earth's atmosphere has not always contained oxygen. For billions of years, the atmosphere consisted of toxic gasses like ammonia, sulfur dioxide, and methane.
- The moon formed between 50-100 million years after Earth formed (4.5 billion years ago) and is thought to be a result of a collision of a Mars-sized protoplanet with the newly forming Earth.
- The largest mass extinction in Earth's history occurred at the end of the Permian Period, about 251 million years ago. Scientists believe that Earth went through a period of global glaciation followed by a period of global warming. Aquatic creatures that adapted to the cold were not able to evolve and adapt to a hot Earth, which resulted in nearly 90% of all life on Earth going extinct.

GSA GEOLOGIC TIME SCALE v. 5.0



Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0: Geological Society of America, https://doi.org/10.1130/2018.CTS005R3C.

*The Pleistocene is divided into four ages, but only two are shown here. What is shown as Calabrian is actually three ages—Calabrian from 1.80 to 0.781 Ma, Middle from 0.781 to 0.126 Ma, and Late from 0.126 to 0.0117 Ma.

The Cenozoic, Mesozoic, and Paleozoic are the Eras of the Phanerozoic Eon. Names of units and age boundaries usually follow the Gradstein et al. (2012), Cohen et al. (2012) , and Cohen et al. (2013, updated) compilations. Numerical age estimates and picks of boundaries usually follow the Cohen et al. (2013, updated) compilation. The numbered epochs and ages of the Cambrian are provisional. A "~" before a numerical age estimate typically indicates an associated error of ±0.4 to over 1.6 Ma.

REFERENCES CITED

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

Cohen, K.M., Finney, S.C., Gibbard, P.L., and Fan, J.-X., 2013, The ICS International Chronostratigraphic Chart: Episodes v. 36, no. 3, p. 199–204 (updated 2017, v. 2, http://www.stratigraphy.org/index.php/ics-chart-timescale; accessed May 2018).

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

Previous versions of the time scale and previously published papers about the time scale and its evolution are posted to http://www.geosociety.org/timescale.

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