**Geologic Time Scale Assignment**

**Objectives of Lab:**

* To create a model of the geologic time scale and its major events
* To use the time scale to answer questions about earth history

**Materials needed:**

* Pre-measured piece of adding machine paper

***Instructor Note:*** *You may want to measure out 5 meters of adding machine paper, giving a bit of extra on either end. It’s easier to work with the time scale that way. The actual time scale will take up 4.6 meters (460cm) corresponding to the 4.6 billion year age of the earth.*

* Masking tape
* Colored pencils
* Extinction #5 Cretaceous
* Ruler and meter stick *(an alternative is a* [*measuring reel*](https://www.amazon.com/Champion-Sports-Closed-Reel-Measuring/dp/B000GBCXWQ?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=ATVPDKIKX0DER)*, which can be taped down to the floor next to the time scale)*
* Geologic Time Scale handout

***Instructor Note:*** *Steps 1-4 can be done ahead of time to save time since sometimes it takes a while for students to catch on to the assignment.*

*\*Variation on a theme: Instead of having students break into groups, the class could go to a large area (a gym, cafeteria, or outside on a sidewalk or athletic field) and do the exercise as a class, with a long measure of rope instead of a piece of paper. In this version, the scale would be multiplied by 10 (instead of 4.6 meters, it would be 46 meters long, with each meter representing 100 million years) to provide a bigger scale to accommodate the class size. Each 100 million years can be pre-marked with electrical tape on the rope. Events could be placed along the rope at the appropriate spots, with events represented by laminated, labeled arrows. Students could still complete the same question prompts on Worksheet 3 after this exercise.*

**Step 1)** Stretch out the paper and tape it to the floor with the masking tape.

**Step 2)** Label one end of the paper with “Today” and the other end with “Origin of the Earth”

For the scale you are making: 1 millimeter = 1 million years. 1 centimeter =10 million years

10 centimeters= 100 million years 1 meter= 1 billion years

**Step 3)** Using the meter stick, mark the paper with 1 billion, 2 billion 3, billion and 4 billion years ago, working back from the present day. You are assigning an age of “0” to “Today” and 1 meter=1 billion years ago.

**Step 4)** Draw a line and label the “0” line with “Today” and draw a line across the paper at the other end of the paper at 4.6m (460 cm) before the present. This will be the “Origin of the Earth” at 4.6 billion years ago.

**Step 5)** Using the dates listed below, label the time periods on the paper with your colored pencils, drawing boundaries where the different geologic eras begin and end. Use your geologic time scale handout as a guide for what this should look like. Note: It is possible to have multiple time intervals starting or ending at the same time—for example, if you look at your time scale handout, you will see that the Phanerozoic Eon and the Paleozoic Era start at the same time.

* Precambrian Eon (4.6 billion years ago-542 million years ago “mya”)
* Phanerozoic Eon (542 mya- Present)
* Paleozoic Era (542 mya to 251 mya)
* Mesozoic Era (251 mya to 66 mya)
* Cenozoic Era (66 mya-present day)

Other events to put on your time scale:

* + Oldest rocks on earth- 4.1 billion years (410cm before “today”)
  + Oldest fossils- 3.5 billion years (350cm before “today”)
  + First fish ~525 million years (52.5cm before “today”)—*note there is a BIG gap from oldest fossils to this point, and that is normal. Most of earth history does not have much going on in the fossil record.*
  + First plants on land- 460 million years ago (46cm before “today”)
  + First amphibians 375 million years ago (37.5cm before “today”)
  + First reptile 315 million years ago (31.5 cm before “today”)
  + First dinosaur 228 million years ago (22.8cm before "today”)
  + First mammals 210 million years ago (21cm before "today”)
  + First birds 150 million years ago (15 cm before "today”)
  + First flowers 130 million years ago (13cm before "today”)
  + First horses 50 million years ago (5cm before “today”)
  + First hominins (human ancestors that walked on two legs) 7 million years ago (7mm before “today”)
  + First anatomically modern humans—300,000 years ago. 0.3mm—Won’t be possible to put on time scale at this resolution, pretty much coincident with “today” on timeline

Using the geologic time scale handout to determine the dates, draw stars on the timeline when of each of the five largest mass-extinctions occurred on our planet. They take place near the end boundary of each of the time periods that they are named for.

* Extinction #1 Ordovician
* Extinction #2 Devonian
* Extinction #3 Permian
* Extinction #4 Triassic
* Extinction #5 Cretaceous

***Instructor Note:*** *If the students**are really engaging with the activity, they should all have this “AHA!!” moment when they do this activity—to see how truly old the Earth is, and how we as humans have been here for such a short time. It’s hard to articulate this in a presentation or a video clip, but this activity should give them a greater appreciation for the true age of our planet. If they haven’t gotten the “AHA!!” make sure you go around to the groups and point this out to them.*

Questions and Review based on the scale you created and your guided notes:

1. Are the eras of the Phanerozoic equal in length of time?

| No. Paleozoic (542-251)=291 million years. Mesozoic: 251-66= 185 Cenozoic-= 66million years and counting |
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2) Why do you think they are or are not equal in time?

| The boundaries between Eons, Eras, Periods and Epochs are largely defined by events and changes in Earth history. These events do not happen on a regular schedule. |
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1. Spend some time looking up information on the internet about the “Big Five” mass extinctions. This is a good resource: <https://www.discovermagazine.com/planet-earth/mass-extinctions>

3a) Which of the “Big-5” was the largest?

| Permian Extinction |
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3b) What do scientists think caused this extinction?

| Large volcanoes (flood basalts) associated with global climate change (Global warming) More about it here: https://www.discovermagazine.com/the-sciences/the-late-permian-mass-extinction-explained |
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4) Which of the extinctions wiped out the dinosaurs?

| The Cretaceous Extinction (also sometimes referred to as the K-T or the K-Pg extinction). |
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5) Stromatolites, which are among the first fossils to appear in the fossil record, appear approximately 3.5 billion years ago. What percentage of earth history do stromatolites represent (they still exist today)? (Hint: divide their length of time on the earth by the age of the earth and then multiply by 100 to transform to a percentage)

| 3,500,000,000/4,600,000,000= 0.76\*100= 76% of earth history |
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6) As you indicated on the time scale, the modern humans appear in the fossil record approximately 300,000 years before the present. What percentage of the age of the earth does 300,000 years represent?

| 300,000/4,600,000,000=0.0000652 \*100= 0.00652% of earth’s history (6.5 thousandth of a percentage) |
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7) Now take a minute to look over the entire time scale. Reflect in a few sentences how the age of the earth compares to the length of time that humans have been on our planet. How does that change the way you think about humanity as it compares to our ancient earth?

| Many acceptable answers that may include ideas like:   * Humans here an extremely short time compared to age of the earth * Humans a product of billions of years of evolutionary change * Humans and rise of consciousness may have needed millions if not billions of years to evolve * Many creatures have come and gone, entire prehistoric worlds (dinosaurs!) existed before we were on the planet * We live in just one particular era of time on our planet. It has not always looked like it does today (think plate tectonics, changes to climate, sea level, ocean and atmospheric chemistry, animals and plants, etc.) * May get answers about how we have affected the Earth but that is better addressed in the next question prompt |
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8) As you discovered, anatomically modern humans did not arise until 300,000 years before the present. We began to grow our own food around 12,000 years ago, and progressively started to use more technology, with a large leap forward during the industrial revolution in the mid-19th century.

Considering that the earth is much, much older than these time frames, reflect in a few sentences about the ways that humans have changed our planet and how this relates to the rest of the history of the Earth.

| Examples of how we have changed our planet:   * Agricultural effects * Climate changes * Concrete/asphalt * Built environment (houses, skyscrapers, dams, bridges, power plants, industrial farm complexes, factories) * Plastic in oceans and elsewhere, also microplastics * Ozone hole * Nuclear pollution/nuclear waste * Excess nutrients in ocean * Widespread deforestation * Accelerated extinction rates (possibility of sixth extinction?)   How this relates to the rest of the history of the earth?  The answer the students should land on here is that we have, as a species, changed the earth in significant ways in an extremely short period of time (as they discovered, 0.00652% of earth’s history). We have been entrusted by God to be caretakers, or stewards of creation, but it is clear that humanity has (so far) largely failed in this regard. Most of the effects that we have had on the planet have no natural cause (e.g., nuclear pollution, hole in ozone layer, plastics) and therefore have no precedent in the 4.6 billion year history of the planet. |
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***Instructor note:*** *Two of the four essential questions from the lesson plan are nice extensions to this assignment and are included in the homework assignment that follows. They are:*

* *Humanity is a product of an ancient, evolving planet. What does this mean for our understanding of our connection to creation?*
* *Geological evidence reveals many creatures that have come and gone through evolutionary processes before humanity was on the planet ~300,000 years ago. How does our scientific knowledge of prehistory and of time impact the way that we understand ourselves?*

*You may want to include them as question prompts here, and take them out of the homework assignment, leaving the two theological essential questions. This would in-effect make the homework assignment an pre-exploration of the theological topics that will be covered on day 3.*

*There are obvious connection points to* [*Laudato Si’*](https://www.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html)*. They are not explicitly included in this lesson plan, but this would be a good companion activity to an exploration of that papal encyclical if covered in class.*