

The Evolution of Earth through Time

Part I: Events throughout Earth history

1. What percent (%) of Earth history passed before earliest life appeared on Earth roughly 3.5 billion years ago?

$$4.6 \text{ bill} - 3.5 \text{ bill} = 1.1 \text{ bill}$$

$$1.1 \text{ bill} / 4.6 \text{ bill} = 0.239 \text{ or roughly } 24\%$$

2. Based on your answer to #1, what percent (%) of Earth history was life-free?

$$24\%$$

3. Based on your answers to #'s 1 and 2, what percent (%) of Earth history has included life forms living on Earth?

$$\text{Roughly } 75\% \text{ (76\%)}$$

4. The first hard fossils are approximately 540 million years old. What percent (%) of Earth history passed before this first evidence was preserved?

$$4600 \text{ mill} - 540 \text{ mill} = 4060 \text{ mill}$$

$$4060 \text{ mill} / 4600 \text{ mill} = 0.88 \text{ or } 88\%$$

5. Which type of organisms colonized the land first, plants or animals? Why do you think this is?

Plants – make their own food, are a food source for animals (food source on land before the animals who need it), they can adapt to land life more easily (don't require shelter or external food sources)

6. The dinosaurs were wiped out 65 million years ago. What percent of Earth history had already passed when this happened?

$$4600 \text{ mill} - 65 \text{ mill} = 4535 \text{ mill}$$

$$4535 \text{ mill} / 4600 \text{ mill} = 0.985 \text{ or roughly } 99\%$$

7. What percent of Earth history AGO did this happen?

$$65 \text{ mill} / 4600 \text{ mill} = 0.141 \text{ or roughly } 1\%$$

$$\text{Alternately, } 100\% - 99\% \text{ (from above)} = 1\%$$

8. Refer to the geologic time scale on page 2. The dinosaurs existed during the Mesozoic era. For what percentage of Earth history did the dinosaurs exist?

$$\text{Existed from } 251 \text{ Ma} - 65 \text{ Ma} = 186 \text{ million years}$$

$$186 / 4600 = 0.04 \text{ or } 4\%$$

9. Our earliest human ancestors appeared about 5 million years ago. What percent of Earth history is 5 million years?

5 mill / 4600 mill = 0.001 or 0.1%

10. Did dinosaurs and humans coexist? Explain your reasoning.

NO!!!

Part II: Geological time

Consider the table of geological time shown below. The Earth’s history is divided into eons, eras, and periods. These divisions represent millions, tens of millions, hundreds of millions, or even thousands of millions of years!

Eon	Era	Period	Start*	End*
Phanerozoic	Cenozoic	Quaternary	2.6	0
		Neogene	23	2.6
		Paleogene	65	23
	Mesozoic	Cretaceous	145	65
		Jurassic	200	145
		Triassic	251	200
	Paleozoic	Permian	299	251
		Carboniferous	359	299
		Devonian	416	359
		Silurian	444	416
		Ordovician	488	444
		Cambrian	542	488
Precambrian			3,850	542

*Millions of years ago (Ma)

11. During the Precambrian Eon, constant crustal movement due to plate tectonics caused Arizona to be located deep under the ocean at the South Pole. Undersea volcanic eruptions were the main source of heat (and thus energy) in this setting. What types of organisms would you expect to find living in such harsh conditions? Explain your reasoning.

Bacteria type organisms – think about stories in the news today about looking for life on other planets. Harsh environments. Expect to find simple life forms, not complex life forms.

12. At the end of the Precambrian Eon, the future continent of North America began to shift northward. By the beginning of the Ordovician Period, Arizona had moved to the equator but was still underwater. How was Arizona's climate at this time different from the climate during the Precambrian Eon?

Warmer, wetter, tropical (equatorial region)

13. A paleontologist working in Arizona uncovers fossils from the Ordovician Period. Using the scientific method, make some predictions about the fossils.

a) Is it possible that these fossils had hard body parts? YES (ordovician is post Cambrian explosion)

b) Can you tell if the fossil represents a land organism? A sea organism? Only if it is a plant could it be a land organism, as animals did not populate land until 300 Ma. Sea organism – shells, hard parts?

c) Using your answer to question 12, what was the local climate like during the time that this organism lived?

Warm, wet, tropical

d) Can you think of any modern environments that are similar to the one in which the fossil organism lived?

Any tropical, equatorial environment will do

14. You're out hiking in the Grand Canyon with your family. A sign at the top of the canyon says that the trail goes through rocks from the Permian Period. How long ago were the rocks deposited?

Some time between 299 and 251 million years ago

15. A company hires you to prospect for coal deposits as part of a plan to install a new power plant near Phoenix. From taking this class, you know that Arizona's coal deposits were formed about 300 Ma when the climate was warm and wet. The company suggests that you start your prospecting in rocks from the Devonian Period. How do you feel about this plan? Support your position with scientific evidence.

Shouldn't support the plan. Devonian rocks are too old – coal forming conditions don't begin until about 300 Ma (Carboniferous – Permian)

Part III: Human perspectives on Earth history

Many Earth processes occur on such a long scale that they are difficult for us, as human beings with finite lives, to comprehend. The Earth that we observe may not appear to change much during our lifetimes but can undergo incredible changes over longer timescales.

16. The State of Arizona celebrates its first centennial anniversary (100 year birthday) on February 14, 2012. If the average generation interval of a family is 30 years, how many generations of humans have come and gone since Arizona became a state?

$100 / 30 = 3.3$ so roughly 3 generations

17. Anthropologists believe that humans first migrated to North and South America about 13,000 years ago. How many generations of humans have come and gone since the Americas were first populated?

$13,000 / 30 = 433$ so roughly 430 generations

18. The Yellowstone Caldera catastrophically erupted 640,000 years ago and covered much of North America with deadly volcanic ash. If such an eruption occurred today, millions would perish instantly due to the eruption. Countless millions around the globe would perish because the ash cloud would block sunlight and affect climate and food production. How many generations of humans could have theoretically come and gone during this time frame?

$640,000 / 30 = 21,333$ so roughly 20,000 generations

19. Earthquakes are constantly occurring on Earth, but most are low magnitude (3 or less), and are not felt. In 1989, the Loma Prieta earthquake, a magnitude 7.1 earthquake on the San Andreas Fault, struck the San Francisco Bay Area. It killed 63 people, injured thousands, and cost \$6 billion in damage. Another section of the fault in central California is known to experience one magnitude 6 earthquake approximately every 25 years.

a) Using the average rate from above, how many magnitude 6 earthquakes would you expect to occur along this fault over a period of 100 years?

4

b) Using the average rate from above, how many magnitude 6 earthquakes would you expect to occur along this fault over a period of 1,000 years?

40

c) Seismologists believe that the San Andreas Fault has been active for about 5 million years. If this is the case, how many magnitude 6 earthquakes have occurred along this single section of the fault?

$5,000,000 / 1,000 = 5000$ and $5,000 \times 40$ (from above) = 200,000

d) Do you believe that your answer from above (Part C) represents ALL of the earthquakes that have occurred along this single section of the San Andreas Fault? If not, how would you adjust your number to reflect the total number of earthquakes along this section of the fault? Explain your reasoning.

NO! This is an average for magnitude 6 earthquakes, but lower magnitude earthquakes are occurring all the time. Many more could have occurred on this section of fault in the past 5,000,000 years.

20. Two students are discussing extreme news events:

Student 1: I hear all the time that the world is ending. It seems like every week there are earthquakes, tsunamis, hurricanes, tornadoes, and other disasters in the news. People are dying left and right due to the wrath of mother nature. Maybe something is occurring within our planet to cause all of these bad things to happen?

Student 2: I disagree. The Earth does not have it in for us. Our planet has been changing for billions of years. Natural disasters have always been a threat to Earth's life, but humans are relative newcomers to the scene.

Do you agree with student 1, 2, or both? Explain your reasoning.

Student 2 – Earth history is LONG. Earth processes happen over long periods of time. We have been around for such a short time. Changes on Earth will continue to happen over long time scales.