

College Guild
PO Box 6448, Brunswick ME 04011

~ SCIENCE SAMPLER ~

Unit 4 of 5

Geology

Over the past three units we have learned about the birth of the universe, the laws of nature, and the structure of matter. Now we will be studying our planet Earth from its early years until the present. With that said, we will need to travel back in time. Let's travel back 4.6 billion years! That's how long ago astronomers and geologists believe Earth was formed. Here are pictures of Earth during its young age¹ and now²:



1. Describe the Earth's transition from its early age to now, including both its surface and atmosphere.
2. Use the science that we discussed in the first three units to explain one of the changes you described.

Part 1: The Study of Rocks

After looking at those pictures, one might be puzzled as to how we know what the Earth looked like billions of years ago. Undeniably, our planet was unrecognizable in comparison to the Earth we see at the present time. But by studying rocks, scientists can learn a lot about our planet's condition during its youth.

Most of the time we ignore rocks—sometimes we just kick them or step on them, and sometimes we even play with them. But for geologists, rocks are like travel machines. In the same way that we take photographs so we can recall our own history, and in the same way that astronomers collect light to learn about the history of the universe, geologists collect rocks to study the history of the Earth. Rocks record time and information.

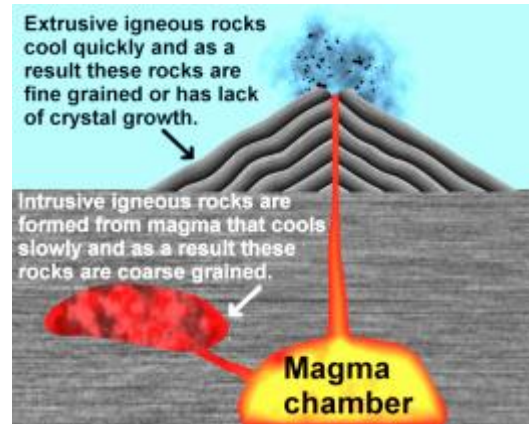
3. Talk about one of your most memorable photographs. Where and when in time does that photograph bring you? (If you want to be a time traveler, you can describe a photograph from a different time or galaxy.)
4. Pretend you are a rock collector. Describe the rock you would like to have as a souvenir. Would you care more about its age or beauty?
5. Using your chemistry knowledge, why do you think that there are many different types of rocks?

Rocks are a combination of one or more minerals. They can be classified into three different types: igneous, sedimentary, and metamorphic. These classifications are based on the processes by which rocks are formed.

Igneous: igneous rocks form when lava cools down. Lava is the super hot, liquid rock (known as magma) that flows from a volcano during an eruption. Igneous rocks make up 64.7 % of Earth's crust. Igneous rocks are subdivided into two groups:

- *Extrusive Igneous* rocks, which form when the lava cools very quickly.
- *Intrusive Igneous* rocks, which form when the lava cools down slowly.

Below is an illustration of the formation of the two types of igneous rocks.³



Sedimentary rocks: sedimentary rocks are formed at the earth's surface or within water when fragments of mineral or organisms accumulate. They make up 7.9% of the Earth's crust.⁴



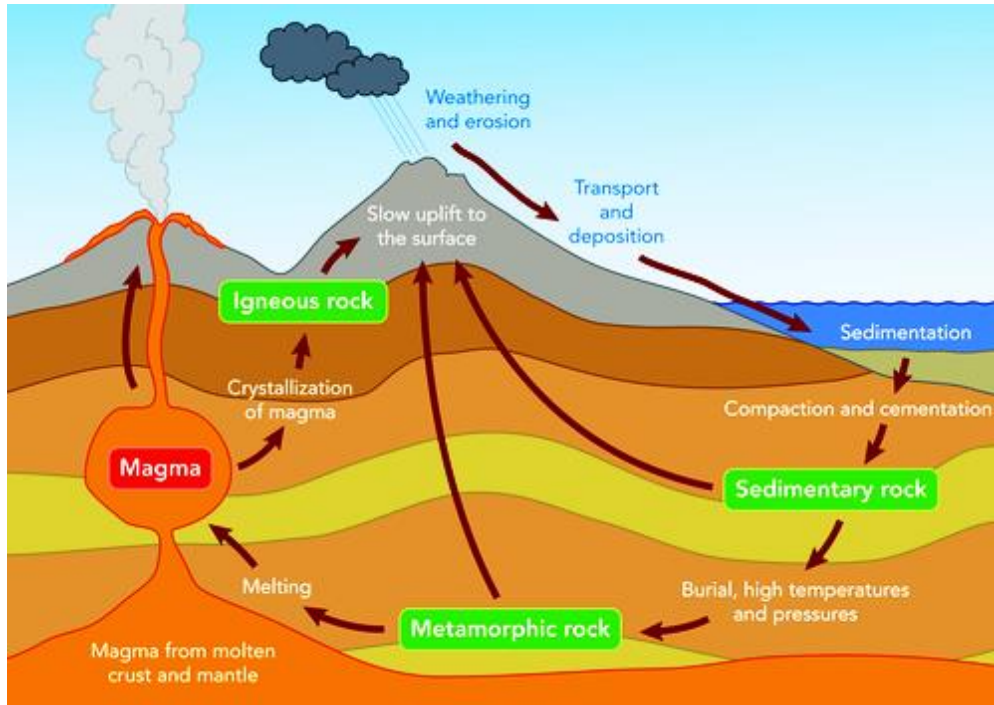
Metamorphic rocks: metamorphic rocks are formed when any type of rocks—sedimentary, igneous rocks or even old metamorphic rocks—are subject to different pressures and temperature, causing them to change. 27.4% of the Earth's crust is formed by metamorphic rocks.⁵



6. Based on statistics, there are more igneous rocks on the Earth's crust. Can you explain why it is easier for igneous rocks to form?

7. Imagine a use for each of the types of rock described above.

8. Scientists claim that our planet Earth is like a giant rock recycling machine. Sometime they go as far as claiming that Earth is like a “treadmill”. Can you explain why? Please use the picture below for reference. ⁶



Part 2: The Structure of the Earth

Earth is divided into three distinct layers, which differ in their structure and chemical composition. Imagine that we could slice our planet Earth right down the middle. What will we find deep in the Earth’s core?

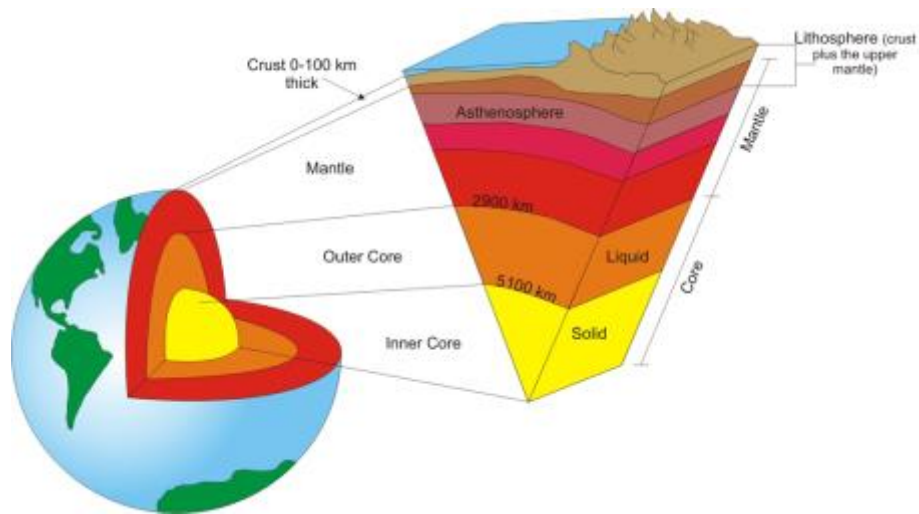


As you can see from the picture above⁷, our planet Earth is divided into four major layers, which scientists have named as follows: the crust, mantle, outer core, and inner core.

The **crust** is the outermost layer, and it ranges from 5-70 km in depth. There is where we find the rocks and the tectonic plates. The **mantle** is 2890 km deep; its upper layer is subdivided into the lithosphere and the asthenosphere.

The Earth's **core** is the center of the Earth. Scientists believe that it is subdivided into the **inner core**, which they believe is solid, and the **outer core**, which they believe is liquid. There is a lot of pressure down there and it is incredibly hot!!

Below is a picture of the Earth's structure⁸:



9. Even with great machines, scientists have never gone as deep as the mantle. Can you offer an explanation as to how scientists know the structure of the earth, given their limited access?

Part 3: The Geologic Timeline

So far we have been studying rocks and the Earth's structure. But now we will focus on the evolution of the Earth, starting from its early age until the present. As mentioned earlier, rocks record time and information. The oldest rocks are at the bottom of the rock layers, or strata, each representing different times. Geologists study the chemical composition of each layer, and also the fossils in them, which allow them to describe Earth's condition during a certain period. Even so, this method is tricky because, as we saw above, the Earth is like a giant, circulating rock machine. Niel DeGrasse, a great astrophysicist, said, "Even the deepest layers of rocks are not the oldest things on Earth."

Geologists also use asteroids from space to get more information about the age of the Earth and its condition during its early age.

10. Why would asteroids help geologist study Earth?

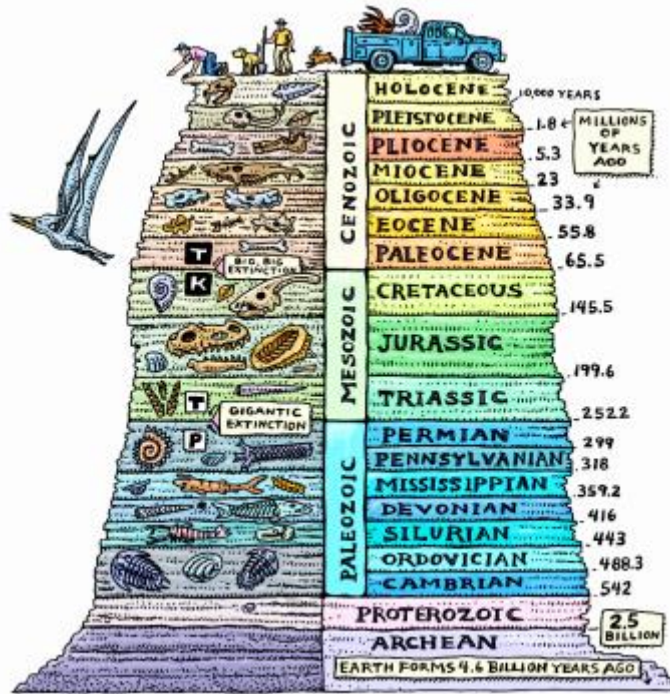
11. Is there a risk in using asteroids to make assumptions about Earth? Explain.

After using all this information, geologists came up with a geological timeline of the Earth's evolution, which is divided into *eons*, *eras*, *periods* and sometimes, *epochs*. **Eon** refers to a half billions years or more, **era** refers to several hundred millions years, **period** refers to ten to one hundred million years, and **epoch** refers to tens of millions of years.

In the geologic timeline, there are 4 eons: Hadean, Archean, Proterozoic, and Phanerozoic. Each of those four eons is subdivided into several eras. There are 10 defined eras. The Hadean eon is divided into the Cryptic, Basin groups, Nectarian, and Early Imbrian eras; the Archean eon into the Eoarchean, Paleoarchean, Mesoarchean, and Neoarchean eras; the Proterozoic eon into the Paleoproterozoic, Mesoproterozoic, and Neoproterozoic eras; and finally, the Phanerozoic eon is divided into the Paleozoic, Mesozoic, and Cenozoic eras.

Furthermore, each era is subdivided into several periods, totaling 22 periods. There are a total of 34 Epochs.

Here is a simple drawing of the geologic timeline⁹:



12. Pick a period and create a story! You might include your own animals and create your own geography.

Let's look at important events that happened during several eons, eras and periods.

The **Hadean eon** is marked from 4.6 to 4 billion years ago. There are no rocks from that time on Earth; there are only asteroids. During that time, the solar system was forming. This eon marks the birth of the Earth.

13. Pretend you are a tourist visiting Earth during the Hadean eon. Write a postcard home describing the scenery.

The **Archean eon** goes from 4 to 2.8 billion years ago. During this time, our atmosphere was unbreathable. Earth's crust had started to cool down, forming rocks. The first forms of life, bacteria, appeared during this time, including the first oxygen-producing bacteria. Those bacteria were able to use the sun's energy to produce food.

14. Why would bacteria be the first creatures to inhabit Earth?

15. Do you think the survival of bacteria that use the sun's energy would be more or less at risk for survival than the bacteria that don't depend on the sun? Why?

The **Proterozoic eon** is marked from 2.5 billion years to 542 million years ago. During this eon, we start to see more stable continents and abundant living organisms. As we see more oxygen-producing bacteria, we start seeing more oxygen in the atmosphere. Moreover, we start seeing multicellular algae, and at the end of the eon, the first animals.

16. What do you imagine these first animals looked like?

The **Paleozoic era** is marked by two big events. During this era, we had the "Cambrian explosion" where there was a big increase in the diversity of animals in the ocean. Unfortunately, by the end of this period almost all of those species were gone. 90% of the animals

were extinct! Scientists also believe that all the continents came together, forming a big continent called Pangaea. Plants started to colonize the land, and we start seeing reptiles and synapsids.

17. Come up with a theory for the animals' extinction.

18. Why do you think so many of the original animals began life in the ocean?

The **Mesozoic era** is marked by the existence of dinosaurs. They appeared during the Triassic period, but they became very diverse during the Jurassic period. The single "super continent" Pangaea started to break up, slipping into small continents. By the end of the Cretaceous period, an asteroid hit Earth, marking the extinction of dinosaurs.

19. What would happen if man had evolved at the same time as dinosaurs? Create a fictional story or poem in which both humans and dinosaurs existed during the same period

The **Cenozoic Era** runs from 65.5 million years ago to now. It is sometimes referred to as the age of mammals. Humans came into existence during this era.

20. As you might notice, it took a long time before mankind came into existence. Why?

21. Why do you think other mammals evolved before humans?

22. List five of the conditions necessary to support mammalian life.

23. What additional, unique conditions are necessary for humans to survive?

Remember: First names only & please let us know if your address changes

Photo Credits

- 1. Wonder Whizkids, Planet Earth
- 2. Solarviews.com, Earth Introduction
- 3. Wikipedia.org, Igneous Rocks
- 4. Wikipedia.org, Sedimentary Rocks
- 5. Wikipedia.org, Metamorphic Rocks
- 6. Mstworkbooks.co.za
- 7. Gridgit.com, Earth's interior layers diagram
- 8. Leeds.ac.uk, Ruskin Rocks Earth Structure
- 9. Greenforecast