Smithsonian

How Earth Tells Us Its Age

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TCM Teacher Created Materials

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Our Mysterious Planet

Are we alone in the universe, or is there life beyond our solar system? How did life begin, and exactly how many species call Earth home? For centuries, humans have grappled with **existential** questions like these. Humans are naturally curious creatures. We love to contemplate and ponder questions that seem unanswerable at first. We have dedicated countless time to one question in particular: How old is planet Earth?

This hasn't been an easy mystery to solve. That's because much of Earth's origin story remains uncertain. Scientists know that Earth formed out of a collision of stardust and gas that circled our sun. However, Earth cannot give us its birth certificate. Scientists do not have a neat stack of written records to piece together an exact time line of early events. Yet over the years, scientists have discovered some answers about Earth's earliest days.

Today, scientists widely agree that Earth is about 4.54 billion years old—plus or minus about 50 million years. But, how did scientists figure out the age of Earth? Experts throughout the last century have tugged on their detective hats and looked at the clues Earth left us. Rocks, Earth's layers, and tree growth rings are the three ways that Earth tells us its age. We just have to study and observe them closely.

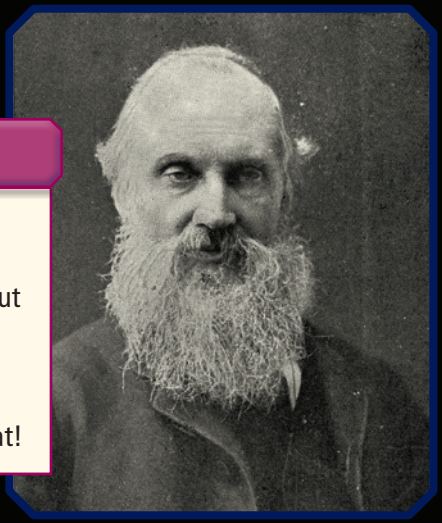
Rocks like this one are found all over Earth.

The trunks of all trees have visible growth rings.

Earth

FUN FACT

Lord Kelvin was a British mathematician. In 1862, he guessed that Earth was about 20 to 400 million years old. His estimate was very low. Scientists today know that Earth is much older than that!

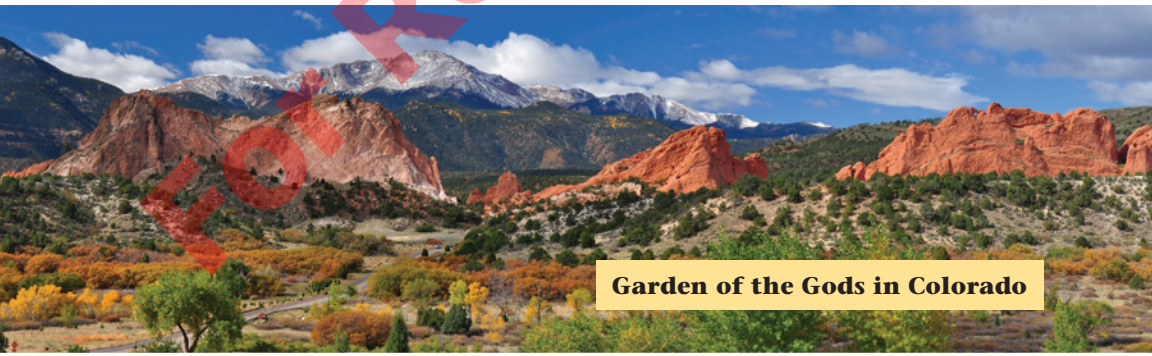


Clue 1: Investigate the Rocks

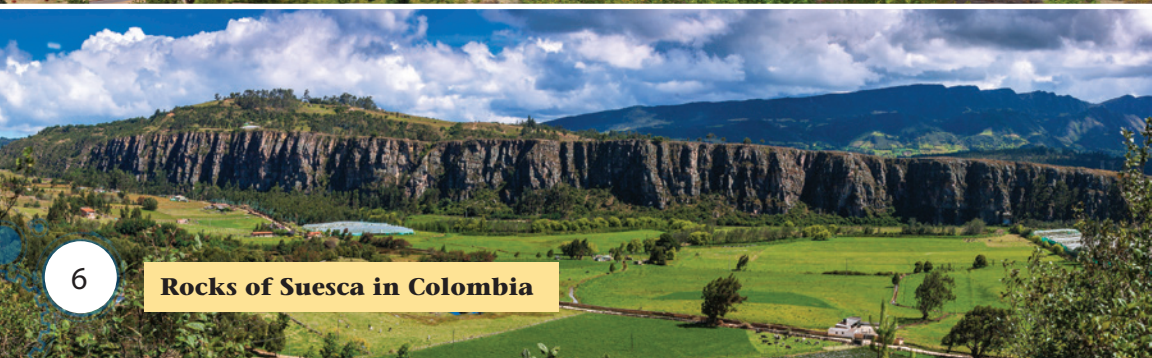
What items across the planet hold the biggest clues to Earth's age? One might first think that mountain ranges or vast forests would have the most tales to tell about Earth. However, a range of ordinary, hard materials holds the most clues to Earth's age—rocks!

Rocks come in all shapes and sizes, and they are found across the planet. Investigating the structure of rocks helps scientists learn about Earth and its history.

Wadi Rum Desert in Jordan



Garden of the Gods in Colorado



Rocks of Suesca in Colombia

Scientists examine igneous rocks.

The Rock Cycle

Rocks are the oldest objects on the planet. Some rocks on Earth are billions of years old. Scientists have different ways to discover the ages of rocks.

Rocks go through a life cycle, and understanding how rocks form and change is a key part of knowing how to find their ages. Scientists date minerals in rocks, which means figuring out their exact ages or how they fit into a time line of events. When scientists can pinpoint the age of a rock, they can use this information to develop a time line of Earth's earliest days.

While rocks offer useful clues to Earth's age, they do have some drawbacks. Rocks do not stay the same over their lifetimes because they often go through the rock cycle. In this cycle, rocks form, fall apart, change appearances, and re-form as other types of rocks. These changes can take thousands of years. Sometimes, they can even take millions, or hundreds of millions, of years!

Three Types of Rocks

Three main types of rocks circle through the rock cycle. Different processes help form, break down, and change rocks.

Igneous rocks start as magma, which is hot, molten, liquid rock tucked under Earth's surface. Magma might creep up through cracks in the planet's surface or erupt from a volcano. As magma cools on Earth's surface, it transforms into igneous rocks.

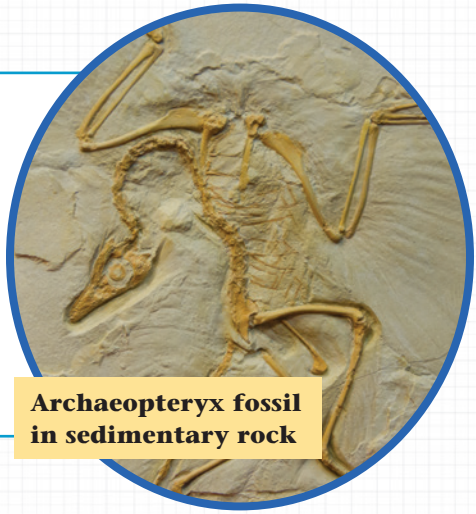
Sedimentary rocks are a creative **mosaic**. Over long periods of time, wind and water wear away at existing rocks. This process is known as **erosion**. Tiny bits of rocks, sand, and other materials get squeezed and solidified together. The result is sedimentary rocks, which form in layers. The bottom layers are older than the top layers.

Metamorphic rocks are rocks that have transformed from the other two types. In other words, metamorphic rocks were once igneous or sedimentary rocks. Sometimes, metamorphic rocks can change into new forms of metamorphic rocks! These rocks form in places where tectonic plates, or large sections of Earth's outer layer, collide. When two plates crash together, some of the rocks are forced deep into the ground, increasing temperature and pressure. This creates the perfect conditions for metamorphic rocks to form.

SCIENCE

Fossil Finds

Fossils contain rich details of life from long ago. Fossils are the preserved remains of ancient plants and animals. Leaves, skeletons, animal footprints, and even eggs can turn into fossils. The majority of fossils are found in sedimentary rocks.



Archaeopteryx fossil in sedimentary rock

The Rock Cycle

STEAM CHALLENGE

Define the Problem

Geologists are working to demonstrate how rocks are cycled over time. They are seeking models to display in various museums of natural history throughout the country. The exhibit will be called "Mock Rocks" and will include the most accurate models you and other groups can create.

Constraints: You may only use the materials supplied to you.

Criteria: You will create three models that begin as one type of rock. Your models should be able to fit into the palm of your hand and should clearly model three distinct types of rocks (igneous, metamorphic, and sedimentary).

CAREER ADVICE
from Smithsonian

Do you want to be a geologist?

Here are some tips to keep in mind for the future.

"Look closely at the rocks around you and think about how they formed. Each one tells part of Earth's story."

– Benjamin Andrews, Geologist, National Museum of Natural History

"Next time you take a trip–across town or across the world–look around at the land. Do you see volcanoes? A river delta? A large lake? Try to learn when and how the landforms you see developed, and begin your journey into Earth's past."

– Elizabeth Cottrell, Geologist and Chair of the Department of Mineral Sciences, National Museum of Natural History

Read and Respond

1. Describe the three main types of rocks. How are they similar to or different from one another?
2. How does relative dating compare to absolute dating?
3. Why is the theory of plate tectonics significant to understanding Earth's age?
4. What are the three layers of Earth, and how would you describe them?
5. How do growth rings tell a story about a tree's age and an area's climate?
6. What do you predict scientists will find as they map more of the seafloor?