LESSON 6:
LAYERS OVER TIME

Students will make models of a section of the earth and practice identifying the age of the rock layers relative to each other.

Grade Level(s): 3–5

Lesson Length: 60 minutes

NGSS alignment: 4-ESS1-1

Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

In the Film

In Bryce Canyon National Park, Rachel, Max, and Conrad run past tall rock formations called "hoodoos." These stone spires formed gradually as winter snows and frost carved away the surrounding rock. The processes of erosion have revealed ancient layers of stone in the hoodoos. Some of these layers date back to the time of the dinosaurs.

Key Words/Vocabulary

Relative dating: Determining the age of a rock or geologic event in comparison to another rock or event

Absolute dating: Giving an exact age for a rock or geologic event

Stratigraphy: The study of rock layers

Stratum: A rock layer (pluralized as "strata")

Law of superposition: A scientific principle stating that in an undisturbed sequence of rock layers, the lower layers of strata are older than the layers above

Materials

☐ Golf ball-sized piece of soft Play-Doh or clay for each student

☐ Small, dry, consumable materials such as pasta, beans, rice, pony beads, or pop tabs (at least 4 different options)

☐ Dry ground cover materials, such as Spanish moss, faux or real leaves, faux or real grass, sand, or small shells

☐ 1 copy of the "Layers Over Time" Activity Sheet for each student

Materials

Teacher Prep Notes

For each student, prepare a golf ball-sized lump of Play-Doh, clay, or homemade modeling dough. (If you use homemade dough along with beans, pasta, or other foods, you'll be able to compost your creations when done.) Place dry goods in separate containers so that students can easily choose four options. Consider copying the Student Activity Sheet onto cardstock for better durability.

> ***The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value.***
>
> **—Theodore Roosevelt**

Background

Stratigraphy is a branch of geology that involves the study of rock layers. Earth's history is "written" in these layers. They allow paleontologists and geologists to study the relationships between the objects they find embedded/events they find recorded in stone. The law of superposition states that lower strata (layers of stone) are older than those closer to the surface. Before the development of absolute dating techniques, scientists relied on this principle to determine the relative ages of the materials they found—a stone, bone, or artifact in a lower level of rock or soil was older than the stones, bones, or artifacts in the layers above.

Today, we're also able to use the absolute dating technique of radiometric dating. Radiometric dating gives a more exact age for an object based on the amount of naturally occurring radioactive material it contains. (After their formation, radioactive materials decay at a constant rate. The ratio between the remaining radioactive material and the material it becomes after decaying allows scientists to determine how long decay has taken place, i.e., the age of the object.)

The national parks offer many excellent, clearly visible examples of stratification. The Grand Canyon displays evidence of stratigraphy even more obvious and spectacular than the hoodoos seen in the film. Within Grand Canyon National Park, it's possible to observe nearly 40 major layers of sedimentary rock, ranging in age from 200 million to 2 billion years.

The lower strata of the Grand Canyon walls contain remains of marine animals. This is evidence of a time, about 500 million years ago, when the area was deep underwater. Higher strata contain the remains of land animals, showing a gradual transition to a new dry land environment, about 320–270 million years ago. This sequence of fossils has allowed scientists to understand what the area looked like in the distant past and how it changed over time.

Stratigraphy helped early paleontology develop from an amateur hobby into a legitimate science. And even though techniques like radiometric dating now allow us to date materials to within 5% of their actual age, stratigraphic dating techniques remain useful. Radiometric dating requires lots of lab work and special equipment, but scientists in the field can quickly establish dates through stratigraphy. Scientists familiar with the geology of a given area can use stratigraphy to determine fairly accurate dates, and it's a useful tool for students who don't have access to a laboratory at all.

To Do

1. As a class, discuss the formation of sedimentary rocks, and the law of superposition.

Weather and geological forces like volcanoes, erosion, and deposition constantly shift and move the materials of the earth around, creating new layers on top of the old.

If new layers are constantly forming over the top of old layers (that is, forming on surface of the earth), are the layers way underground older or younger? Why?

The law of superposition describes how the deeper you go into the ground, the older the material there is. Superposition tells geologists how old rocks are in comparison to the rocks above and below them. It does not give specific dates. It is a relative dating technique.

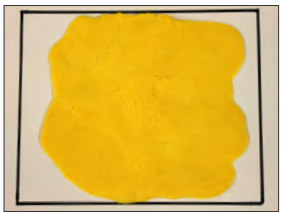
If the dinosaurs are millions of years older than humans, would we find dinosaur fossils next to human fossils? Why or why not?

2. Tell students that they are going to be creating their own section of earth with four different layers.

3. Explain to students how to create their section of earth.

Give each student a copy of the "Layers Over Time" activity sheet.

Show the students how to flatten and place the dough or clay into the box on the activity sheet.



How to spread dough into the box on the activity sheet.

Example of placement of dry, small consumable materials into the dough or clay

Students will then choose four of the dry, small, consumable materials to push into the dough or clay. They will need to place them in layers, pretending that the bottom of the box on the paper is the bottom of the earth section and the top of the box is the top of the earth section.

4. Allow time for students to create their section of the earth.

5. Once students are finished, have them leave their creations at their seats and switch places with other students.

> Everyone should now be looking at another student's work.

6. First, students should write their name on the paper in front of them. On the lines below, they should record three statements about the age of the various layers. For example, "The bean layer is older than the rice layer," or "The pasta layer is the oldest."

7. Once students are done with their statements, have the students switch seats again and repeat step 6.

8. Have students go back to their original seats and discuss the following:

Besides rocks, what can you find in rock layers? (e.g., sand, water, shells, fossils, etc.)

The fossils found in a stratum can tell scientists a lot about the environment thousands and even millions of years ago.

What kinds of fossils would an archaeologist find in a desert layer? An ocean layer? A tropical forest layer?

9. Show students the ground cover materials that are available. Let the students know that these will represent the fossils of shells, grass, plant material, leaves, Spanish moss, sand, or other ground covers. Have the students choose two of these materials and then add them to two of the layers of dry, consumable materials on their dough. On their student activity sheet, they will write a description of the types of environments that may have left these "fossils" behind.

LAYERS OVER TIME

Student Activity Sheet

Student Reviewer 1 _____

_____

_____

_____

_____

Student Reviewer 2 _____

_____

_____

_____

_____

My layer story:

_____

_____

_____

Taking It Further

NGSS ALIGNMENT MS-ESS1-4

Discuss with students that while relative dating, like the activity they have just done, gives geologists a lot of information about sedimentary strata, it doesn't give specific dates. Geologists must also use absolute dating in order to determine exactly how old a rock layer or fossil will be.

Radiometric dating is a form of absolute dating. Radiometric dating is used on very old rocks, like in the Grand Canyon. Radiometric dating techniques take advantage of the fact that some atoms of radioactive materials decay over time. Radioactive atoms decay by ejecting subatomic particles like protons, neutrons, electrons, and positrons. Scientists know how long it takes for certain types of atoms to decay, so based on how much of that type of atom is left in a rock, they can estimate how long ago the rock was formed.

For example, if it takes a million years for half of the radioactive atoms to decay, a one-million-year-old rock would have half the radioactive material you'd see in a newly formed rock. After another million years, it would have half of that amount, so a two-million-year-old rock would have one quarter (half of half) of the radioactive material you'd see in a newly formed rock. And so on. . .

What kinds of really old fossils would scientists want to study and know how old they are?

Why would it be helpful for scientists to find a date for the rocks in a stratum near other fossils like footprints or plant impressions?

Recommended Reading

Archaeologists Dig for Clues
Kate Duke

The Best Book of Fossils, Rocks and Minerals
Chris Pellant

Dirtmeister's Nitty Gritty Planet Earth
Steve Tomecek