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**Helping Kids Learn – Post #18 6/16/20**

# STEM: Science & Engineering – Earth & Space

## Science and Civil Engineering

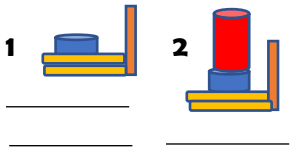
Civil engineers design and build things on the Earth and *in* the Earth. They are responsible for roads, railways, airports, bridges, pipelines, and sewer systems, to name a few. But, before they can build or repair something on the Earth, they must know a great deal *about* the Earth. So, students in civil engineering study Geology, among many other things.

This lesson is adaptable to a range of learners. See **Lift the Level** below.

### Be a Civil Engineer – Modeling the Earth

Have you ever wondered why some places have tall buildings, skyscrapers, and other places have only low buildings a few stories tall? One reason is under earth's surface: bedrock.

**Investigation 1** You'll need a couple of cans of vegetables, soup, or whatever (***metal, not glass***), a blanket, a book about 0.5 inch or more thick, and a ruler or a straight strip of stiff paper that you can mark on.

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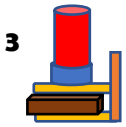
**Step 1:** Fold the blanket in four layers. Place the ruler or measuring strip next to it (see the orange "stick" in picture **1**. Measure how thick the blanket is (the yellow rectangles in picture **1**). Write it down under the picture. Put one can on the blanket. Measure again and write it on the line below.

**Step 2:** Put a can on top of the first can (be careful that they don't fall). See picture **2**. Measure and write the thickness of the blanket now.




**Step 3:** Put the book under the top layer of the blanket (brown in picture **3**). Measure. Then repeat Step 2. See **What's the Science?** for more information.

Thickness without cans _____

Thickness with cans _____

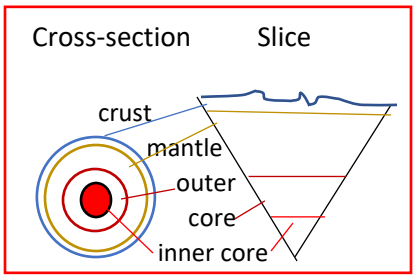
**Investigation 2** To find out what is below the surface of the Earth, scientists have used many techniques over centuries. If you wanted to know what's under your feet when you stand on the ground, how would you find out?

_____

_____

Once they know what lies below the surface, engineers can build a **model of the Earth** to help with their planning. Models can be 2- or 3-dimensional. You will make two 2-D models.

**4 What's in the Earth?**




To make your models, you will need an 8.5 x 11-inch sheet of paper, a ruler, a pencil and some color pencils, crayons or markers if you have them. A compass (to draw circles) is useful but not essential.

Turn the paper so the long sides are top and bottom (landscape as in picture **4**), and fold in half the short way. You could use a ruler but this is easier and faster. Give your paper a title such as *What's in the Earth?* Label the left side "Cross-section." Draw a circle about 4 inches in diameter (across at the center). If you're using a compass, set it at 2 inches (the radius is half of the diameter). If you're using a ruler, find a can about 4 inches in diameter and trace around it. On the right side of your paper, draw a V with the point about 0.5-inch from the bottom of the page and the top about 2 inches from the top of the page. Label it "Slice."

The surface of the Earth is called the ***crust.*** It contains the mountains, valleys, oceans, trenches and so on that we can see and explore. It is represented by your 4-inch circle on the left. On the right, draw a slightly squiggly line segment connecting the tops of the V. The crust is the thinnest section, at its thickest about 62 miles. Draw a straight line segment from one side of the V to the other just below the squiggly one. Label the section "crust."

The thickest layer of the Earth is the ***mantle***. It is about 1,865 miles thick and solid. Make a circle about 3.75 inches in diameter inside the crust circle. Draw a straight line segment in the slice model about 2.75 inches from the squiggly segment. Label just inside the second circle and the trapezoid on the slice model "mantle."

The only liquid layer of the Earth is the ***outer core.*** It is about 1,367 miles thick. Draw a circle inside the mantle circle and a straight line segment just about half way between the inner mantle segment and the point of the V. Label them "outer core."

The "center of the Earth" is a solid ball about 1,516 miles thick called the ***inner core.*** That makes it about 0.75 the diameter of our moon. It is made up mostly of the minerals iron and nickel and it is almost as hot as the surface of our sun, 9,800°F (Fahrenheit). Draw a circle with a diameter about half the outer core's and label it and the bottom triangle on the slice "inner core."

Next, see **What's the Science?**.

## What's the Science?

Investigation 1: It may not seem that way when you jump up and down in your yard, but the Earth's crust has flexibility. If you build something heavy on the surface, such as a tall building, you can compress the crust below it. The blanket's layers represent the crust without much bedrock. The more mass (represented by weight of the cans) you put on the crust, the more it impacted by downward force and can compact, so the blanket is thinner in **2** than in **1.** The book in **3** represents bedrock. It absorbs more force than the crust with little bedrock. So, you should see the cans' mass have less effect on the thickness in **3** than in **1** or **2.** For more about this, see **Lift the Level** below.

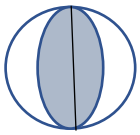
Investigation 2: Any time you made a model, you are simplifying something from the original object. A 2-D model of a 3-D object gives you only a basic idea of the "real thing." The cross section and slice give you two different ways of thinking about the Earth's layers, just as slicing an apple horizontally (parallel to the table) and cutting a vertical slice or wedge give you two very different ideas of what the inside of an apple is like. For example, the layers are divided into sublayers. There is much more detail to the Earth's layers which you can explore in **Lift the Level** below.

You could have read about the layers of the Earth, but there are several advantages to actually making even these simple models. You become more engaged in the information by measuring and drawing (known as *kinesthetic* learning). There is a chemical reaction in your brain when you use your hands to create the models. The result stores the information in your brain in a way that is easier to access later. Some people call this Hands-On, Minds-On learning.

## Lift the Level

You can make this lesson deeper and/or suitable for older students by any of the following. Some suggested resources are listed in **STEM Online** below:

1. Vary the conditions in Investigation 1 or 2 to include water in the crust below the surface. Carry out the Investigation again. How do your results change?
2. Explain the physics, particularly mass, energy (potential and kinetic), and force, in Investigations 1 and 2. Include a description of vertical and lateral forces involved.
3. Research more about the Earth's layers – the lithosphere and asthenosphere. Create a more detailed 2-D model to explain them.
4. Each layer has a particular composition and important properties. Examine one layer in detail and create an accurate model. For example, *plate tectonics,* the movement of the plates that make up the Earth's mantle, are one example of the *dynamic* (ever changing) nature of the Earth. *Thermal convection* is another.
5. Make a 3-D model of the Earth's layers with a quarter-cutaway perspective.



6. There is a phenomenon that occurs about every 200,000 to 300,000 years called Geomagnetic Reversal in which the magnetic fields of the North and South Poles reverse. Some scientists have presented evidence that the phenomenon may occur relatively soon. The outer core appears to play a role. Research the role and create a 1-page summary or poster to explain what we know about it.
7. Some scientists believe that there is another mass within the inner core, called the inner, inner core. Research it and include it in a 3-D model.
8. Explain the physics involved in the core spinning faster than Earth's surface.

## STEM Online

These are suggestions only and no endorsement is implied. Although they have been screened for appropriateness before posting, parents should vet the websites their children use as they may change over time and advertisements on the sites may change, also.

**Earth's Structure** https://en.wikipedia.org/wiki/Structure_of_Earth
https://earthhow.com/inside-earth-crust-core-mantle/
Downloadable book *The Street Beneath My Feet* by Charlotte Guillain https://topshelftext.org/the-street-beneath-my-feet

**Geomagnetic Reversal** https://magneticreversal.org/
https://www.theorganicprepper.com/magnetic-pole-shift/
https://www.npr.org/2019/02/05/691734652/the-north-magnetic-pole-is-shifting-east-fast

**Thermal Convection** https://en.wikipedia.org/wiki/Convective_heat_transfer
https://www.khanacademy.org/partner-content/amnh/earthquakes-and-volcanoes/plate-tectonics/a/mantle-convection-and-plate-tectonics

## NJ Student Learning Standards

Earth and Space Science 2-ESS2-2; 4-ESS1-1, 4-ESS2-2; 3-5-ETS1-1; MS-ESS1-4, MS-ESS3-1; HS-ESS1-6, HS-ESS2-3.