Wooly Magma

Descend into the crater of Yocul of Sneffels, which the shade of Scartaris caresses, before the kalends of July, audacious traveler, and you will reach the center of the earth. I did it.

"All scientific teaching, theoretical and practical, shows it to be impossible," I said.

"I care nothing for theories," retorted my uncle.

"But is it not well-known that heat increases one degree for every seventy feet you descend into the earth? Which gives a fine idea of the central heat. All the matters which compose the globe are in a state of incandescence; even gold, platinum, and the hardest rocks are in a state of fusion. What would become of us?"

"Don't be alarmed at the heat, my boy."

"How so?"

"Neither you nor anybody else know anything about the real state of the earth's interior. All modern experiments tend to explode the older theories."

~ from A Journey to the Center Of the Earth, by Jules Verne
http://jv.gilead.org.il/vt/c_earth/

Most of what Jules Verne wrote about the center of the Earth in 1864 is now considered to be wrong. While it is still true that no one has actually seen the Earth's interior, today's "scientific teaching, theoretical and practical" agrees more with young Harry than with his adventurous uncle. The center of the Earth is now believed to have an average temperature of 7,000°F, with maximum temperatures as high as 13,000°F. Here's a way to show what scientists think we might find if we could really take a journey to the center of the Earth.

Overflow from Mauna Ulu Crater. View east at overflow from trench into main Mauna Ulu crater on March 19, 1972. Note partially cooled skin on lake. Photo credit: R.T. Holcomb, Hawaiian Volcano Observatory, U.S. Geological Survey

What You Will Do

Make a colorful model of Earth's structure

What You Will Need

- ❒ Two containers that will each hold about eight quarts (pots or bowls are fine)
- ❒ Paper towels
- ❒ Hand towel
- ❒ Dishwashing liquid
- ❒ Sharp scissors
- ❒ Serrated knife and a cutting board
- ❒ Rubber ball, about 1-1/4 inches diameter
- ❒ Wool roving in six colors; about 2/3 ounce of each color (red, gold, pink, green, white, and blue are suggested, but any colors will work)
- ❒ Hot and cold tap water
- ❒ Ice (about seven pounds)

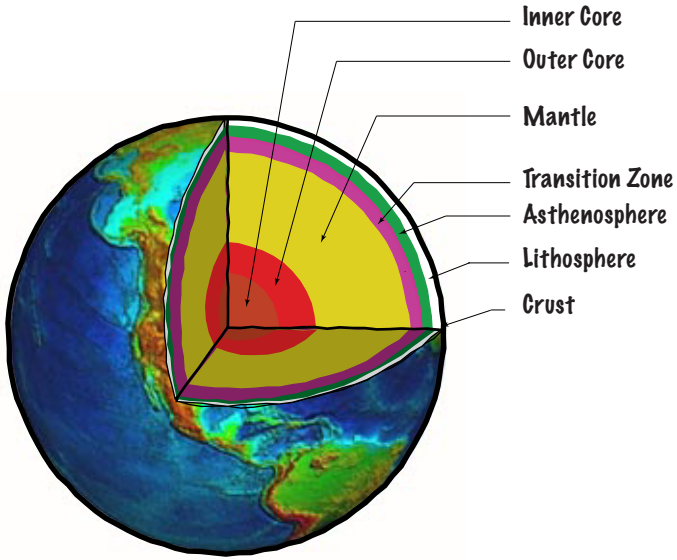
Warnings

1. Be careful with scissors and hot water!
2. Get help from an adult to use the serrated knife!

How to Do It

To make your model, you will use a process called "felting." You can read more about felting and how it works under "What's Happening" at the end of this section.

1. Here is a drawing that shows the layers of Earth's structure that will be included in your model. Since no one has actually seen Earth's interior, we don't know what the true colors are. So for your model, choose some colors that you like, and that are different enough so that the layers can be easily seen.



Structure of the Earth

2. Begin constructing your model with the rubber ball, which represents the INNER CORE. Wrap a piece of red wool roving around the ball. The red roving represents the OUTER CORE. Be sure to wrap the wool roving tightly, and try to switch directions as often as possible. Pull the fiber as thin as you can. When you've reached the end, pull the fibers out to be as light and transparent as cotton candy; smooth those ends over the ball by stretching and patting them into place so they neatly stick to the ball. This will make the felting process easier because the fibers can be interlocked better that way.

3. Fill one of the containers about 2/3 full with hot tap water (the water should be as hot as your hands can stand). Fill the other container about 1/2 full with ice, then add cold tap water until the container is about 2/3 full.

4. Now for the felting! Dunk your woolen ball into either the hot or ice cold water. Hold the ball under the water and squeeze it hard to make sure water penetrates all the way to the inner core ball. Lift the woolen ball out of the water and squeeze again. Put a couple of drops of dishwashing liquid on the woolen ball, and roll the ball in your hands lightly, quickly and evenly. After the fibers have joined, begin to slightly increase presssure. The harder and faster you roll, the faster the felting process takes place.

5. After about a minute, dunk the ball into the other water container (so if you dunked it in cold water first, dunk it in hot water now.) The change of temperature shocks the wool fibers and makes them cling together.

6. Repeat the rolling process, adding more dishwashing liquid only if you need to. Too much soap will make the ball slippery and hard to press against. If the ball gets too soapy, rinse or blot off the excess dishwash-

ing liquid with a paper towel. After about 5 minutes, you should have a hard, tight ball. Now you are ready to add the next layer.

7. Wrap the gold-colored roving around the ball to represent the lower Mantle layer. Remember to wrap the wool tightly, roll it in different directions, pull the end fibers out to be very thin, and smooth those ends over the ball.

8. Repeat Steps 4, 5, and 6.
Are you feeling tired? Felting is hard work – if you're not feeling your muscles, you're not working hard enough!

9. Wrap pink roving around the ball to represent the Transition Zone, remembering to wrap the wool tightly, roll it in different directions, pull the end fibers out to be very thin, and smooth the ends over the ball.

10. Repeat Steps 4, 5, and 6.

11. Next, add a layer of green roving to represent the Asthenosphere. You guessed it —Repeat Steps 4, 5, and 6.

12. Only two layers to go! Wrap the white roving around your ball to represent the Lithosphere, and repeat Steps 4, 5, and 6.

13. At last! It's time to add the final layer to represent the Crust. This could be blue, since most of Earth's surface is covered with water, or multi-colored to represents both continental and oceanic crusts. Wrap the last piece of roving and repeat Steps 4, 5, and 6.

14. When you have finished your model, the felted wool ball should feel as firm as a tennis ball. Now, ask your adult partner to cut around the globe with a serrated knife to open the model up. **WARNING—Be sure to ask your partner not to cut all the way through! Leave a hinge area about 1/2 inch wide, or the whole thing will fall apart!** Carefiully pull your model open and remove the ball. Trim any loose ends with scissors to make it uniform and smooth. Put the ball back in and ADMIRE your Wooly Magma—it's yours and it's unique! No two are alike.

What's Happening

More about Felting

What is felt? Do you know what it is made of? Have you ever seen someone throw a pair of woolen socks or a wool sweater in the washing machine and then the dryer? What happens to it? It shrinks! Almost anything made of 100% natural fiber can be felted. During felting, the tiny fibers that make up the wool interlock; tightening and closing the small holes that are also part of its make up. The felting process is basically a compacting of the material that makes the fibers very dense.

Three things are needed to felt wet/moist wool: ALKALINITY, HEAT, and AGITATION. In short AHA! Any two of them together will lead to a natural fiber or fabric felting. If you have a dog, cat, rabbit, or other pet with long fine hair, you've probably noticed mats or clumps behind its ears or on the body wherever the hair is exposed to AGITATION and moisture. That's felt! If you've shampooed those spots on your animal, you'll notice how hard and dense those clumps of fur become. That's because you've added the ALKALINITY and intensified the felting process. To make your model, you use your muscles and a lot of "elbow grease" for the AGITATION. The HEAT part comes in when you shock your wool by dunking it into ice cold water and then in hot water. Dishwashing liquid provides the needed ALKALINITY for the process.

Why would people want to make felt on purpose? It can be beautiful and decorative, but more important, it is much warmer than a loosely woven garment. It can become nearly impenetrable; almost waterproof, and was especially important for the people who lived in the day when there were no synthetic fibers like nylon, polyester, or acrylic that our winter garments are made of now.

More About Earth's Layers

Earth's CORE is made out of iron and nickel and is about 1,550 miles in diameter. The temperature of the INNER CORE is on average about

7,000 degrees Fahrenheit, but it can go up to 13,000 degrees Fahrenheit. To give you an idea of how hot that is, you can bake a loaf of bread in your oven at 350 degrees and rock begins to melt at 1,600 degrees. Under the immense pressures in the INNER CORE, the metals do not flow as a liquid despite the high temperatures, but behave and vibrate like a solid.

The OUTER CORE is a sphere of iron and nickel, under less pressure than the inner core and nearly as hot. Here the metals are in a liquid state; between 4,000 and 9,000 degrees Fahrenheit. The Outer Core is 1,400 miles thick, located about 1,800 miles beneath the crust. Scientists believe that the circulation of an electric current in the Outer Core causes the Earth's magnetic field.

The MANTLE is Earth's largest layer, and is approximately two thirds of Earth's total mass. It is divided into several parts. The LOWER MANTLE (our gold layer) is very dense and hot (4,000 degrees Fahrenheit).

The TRANSITION ZONE divides the lower mantle from its upper portion. The Transition Zone starts at a depth of 250 miles and is roughly 190 miles thick. The temperatures here are much cooler than the lower mantle, around 1,600 degrees Fahrenheit.

Two automobiles are all that remain after this section of Royal Gardens subdivision was overrun by lava (October 7, 1987). During October the footpath from a road into the housing area was covered, cutting residents off from the few homes that remained. Photo credit: J.D. Griggs, Hawaiian Volcano Observatory, U.S. Geological Survey

The ASTHENOSPHERE is in the upper region of the mantle, and is the part that flows like asphalt. It both moves the plates of the Earth and permits their motion. This ability of a solid to flow is called "plasticity".

The LITHOSPHERE is a slab about 45 miles thick in which the continents are embedded. It gives us mountains and trenches (collisions), seafloor spreading and new oceans (separation), and long earthquake faults, like the San Andreas Fault (sliding side-by-side). This zone is composed of rigid, brittle rock.

The EARTH'S CRUST is the thinnest layer of the Earth at only 3-5 miles thick under the oceans and about 25 miles thick under the continents. It is composed of two basic rock types: granite and basalt. The CONTINENTAL CRUST is mostly granite while the OCEANIC CRUST consists of a volcanic lava rock called basalt. Temperatures vary from air temperature to 1,600 degrees Fahrenheit. It is here that volcanoes are started and where we find rich soil, jewels, and rocks. We live on the Earth's Crust.

Please note that the layers we use in this project are not in scale to the Earth's real layers. They are too similar in size. Also, the colors have nothing to do with how the Earth looks underneath. No one really knows what the layers look like. We've used color just for fun and to make a contrast so we can pick out each layer more easily.

Want to Do More?

For more information about Earth and its structure, visit:

http://pubs.usgs.gov/gip/dynamic/inside.html

http://www.windows.ucar.edu/tour/link=/earth/Interior_Structure/overview.html&edu=elem

http://www.pbs.org/wnet/savageearth/animations/hellscrust/main.html

This activity was created by Annie Reiser, Global Systems Division Visitor Information Specialist at NOAA's Earth System Research Laboratory