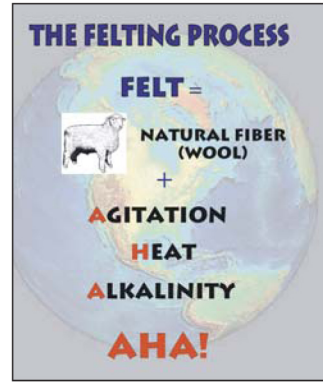


hot tap water (OPTION: You can stand at your sink and use hot water directly from the tap instead of filling a container. It should be as hot as your hands can stand.)

- Paper towels
- Hand towel
- Dishwashing liquid (I prefer *Dawn*)
- Sharp scissors
- Serrated knives and cutting board

PROJECT TIME: Once you have set up, this project can be done in 45 minutes to 1 hour in a group or about 30 minutes individually.

ABOUT FELTING: Before you begin crafting, you need to understand the basics of felting because you are creating a model of the Earth in felt. You will



learn about the different layers that make up the Earth by naming each of the colorful woolen layers used to build it with.

So what is felt? Do you know what it is made of? Have you ever done this or seen your Mom or Dad throw a pair of woolen socks or a wool sweater in the wash machine and then the dryer? What happens to it? Your parents' sweater ends up shrinking small enough to fit you!

Almost anything made of 100% natural protein fiber (wool, in our case) 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.

How will you felt this wool? Let me give you a basic formula for felting so you can understand that it happens whenever you have a combination of two or more of the three following things together: See the above picture.

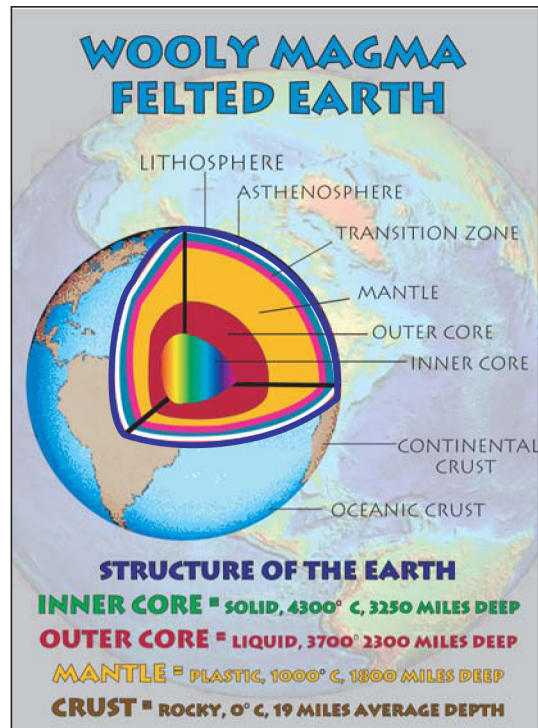
Basically, three factors are needed to felt wet/moist wool: ALKALINITY, HEAT, and

AGITATION. In short AHA! Any two of them together will lead to a natural fiber or fabric felting.

Let me give you an example – Do you have or know a dog, cat, rabbit, or other pet? Especially if it has 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 pet, you'll notice how hard and dense those clumps of fur become. That's because you've added the ALKALINITY: part of our "AHA" formula and intensified the felting process. Today you will be using your muscles and a lot of "elbow grease" for the AGITATION. The HEAT part comes in when you shock your wool when dunking it into ice cold water and then into hot water. Dishwashing liquid will provide the needed ALKALINITY for the process.

Let's get on with making the project. First, take a look at the picture showing the layers of the Earth.

Starting from the inside with the Earth's core, you'll create your ball by wrapping colorful layers of wool roving around it. A color of the layer on the picture corresponds to a piece of wool roving (a wool strip) in your kit. For example, the gold = the mantle.



THE ACTIVITY

Inner Core (ball): You begin with the INNER CORE. It's represented by the ball in your kit. Please take it out.

The INNER 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 (red) 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, and electric current in, the OUTER CORE causes the Earth's magnetic field.

Now find your red piece of roving (the red strip of wool in your kit) and start wrapping it around your inner core. This is the OUTER CORE. When you wrap your wool roving, be sure to do so 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; smoothing those ends over the ball by stretching and patting them into place so they nearly adhere to the ball. This will make the felting process easier because the fibers can be interlocked better that way.



Now Let's Felt!

First dunk your woolen ball into either the hot or ice cold water (holding it under water squeeze it hard to make sure water penetrates to the inner core ball.) Lift out and squeeze again. Add a small bit of liquid soap: a couple of drops and begin rolling the ball in your hands applying equal and hard pressure. The harder and faster you roll – the faster the felting process takes place.



After a minute or less, dunk the ball back into the water (the opposite of what you just did – that is, if you had dunked it in cold before, change to hot now.) It's the change of temperature (the shock to the fibers) that makes them cling together and felt more. Repeat the rolling process (adding more soap only if you need to). Too much soap makes the ball slippery and hard to press against so if it gets too soapy, try to rinse it or blot it off with a paper towel.



In about 5 minutes, you should have a relatively compacted and hard ball; ready to add the next layer.

The Mantle (gold): With the gold-colored roving in your kit, you will add the **LOWER MANTLE**. Before wrapping it tightly around the red, learn about it by reading this description:

*The **Mantle** is the largest layer of the Earth and is approximately two thirds of the 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).*

So now add your lower mantle layer. **Remember to wrap the wool tightly, roll it in different directions, and draft and feather the ends.**

Repeat felting instructions: text highlighted in gray. NOTE: Felting is hard work – if you're not feeling your muscles, you're not working hard enough!

The Transition Zone (pink): Please find your hot pink roving that you will use to represent the transition zone. Read about it first:

*The **TRANSITION ZONE** divides the lower mantle from its upper portion. This zone transitions upward to the partially molten, weak, asthenosphere. **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.*

Repeat instructions: text highlighted in gray.

The Asthenosphere (Spruce): Take your green or spruce-colored roving out to wrap around the pink transition zone. This will be your asthenosphere.

*The **ASTHENOSPHERE** is in the upper region of the mantle, and is the part of the mantle 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".*

Repeat instructions: text highlighted in gray.

The Lithosphere (white): Your white roving will form this layer.

*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 (sliding side-by-side). It is the upper layer of the mantle and in part the **CRUST**. This zone is composed of rigid, brittle rock.*

Now add your lithosphere layer. **Remember to wrap the wool tightly, roll it in different directions, draft, and feather the ends.**

Repeat instructions: text highlighted in gray.

The Crust: The final layer and multi-colored piece of roving represents the crust of the Earth, both the continental and oceanic crusts. Please read the following before you wrap your final layer.



*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**.*

Repeat instructions: text highlighted in gray.

When the Earth balls have compacted and felted enough (they will feel firm as a tennis ball), the instructor, assistant, or parent **only** will use a serrated knife to cut around the globe to open it up.

CAUTION

**Don't cut all the way through!
Leave a hinge area about 1/2 inch in size
or the whole thing will fall apart.**



Pull open woolen earth and remove the ball. With a sharp scissors, trim areas to make it uniform and smooth. Put the ball back in and ADMIRE your Wooly Magma – it will be unique to you! No two are alike.

Please note: 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.



"WOOLY MAGMA" A Felted Earth Kit



By Annie Reiser • NOAA Earth System Research Laboratory/Global Systems Division • 303-497-6634 • ann.m.reiser@noaa.gov

It is becoming more and more evident to scientists that they must view Earth as a system of interrelated systems. NOAA studies how these systems interact, and by doing so, we are better able to understand and predict changes in the Earth's environment, and conserve and manage our natural resources. This activity introduces kids (in a simplified way) to the fundamental structure of the planet on which we live. For more information about the Earth and its structure see:

<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>

INSTRUCTIONS

(Activity designed for ages 10 and older.)

YOU WILL NEED:

- A container (like an 8-quart pot or bowl) to hold cold water that you fill 2/3 with ice
- A container (like an 8-quart pot or bowl) to hold