

Inside the Earth

What's inside the Earth?

Introduction

Discuss, or get students to draw and then share their ideas of what is inside the earth, and evidence to justify their ideas.

Eg -volcanoes show that there must be heat to melt the rock and there must be water because steam and hot water come out of the ground in parts of New Zealand. Digging in the ground or exposed hillsides (roadworks) reveals different layers.

How far down have scientists drilled?

The deepest drill so far is the Kola Hole in Russia. After 24 years of drilling scientists reached a depth of just over 12km.

The deepest geothermal boreholes in New Zealand are 3km deep.

Could we travel to the centre of the Earth?

No, we would be melted long before we got past the crust.

Activities

- Examine a recently boiled egg and explain that it represents the Earth. Egg shells could be decorated first with continents and oceans.

Discuss

Is it hotter on the inside or the outside? Which part will cool faster?

The inside is hotter and the outside will cool faster.

- Cut the egg in half with a sharp knife. Some shattering of the shell is inevitable but don't peel the egg or students may not see how thin the shell is in relation to the inner layers.

How many layers does it have?

3 main layers, some students will say 4 if they include the thin membrane just under the shell.

The shell represents the **crust** –it is very thin and rigid so it breaks easily. On average the crust of the Earth is only 8km thick under the oceans and 35 km thick under the continents.

In the Taupo Volcanic Zone the Earth's crust is very thin (25-30km) and this is one of the reasons why volcanoes have formed there.

The white represents the **mantle**, this is the largest part of the Earth's interior. It is made of rock that is so hot it can flow but only extremely slowly. If we could see the mantle moving, it would flow about as fast as your fingernails grow. The mantle is hotter close to the core and cools a little as it nears the crust just as the egg is hot in the middle and cooler on the outside.

The yolk of the egg is the Earth's **core**. Scientists think that the core has two parts. The inner core is the hottest part of the planet but it is under so much pressure that it is solid and made mainly of iron. The outer core is almost as hot but the metal is slightly softer.

Activity Instructions

- Label the layers of the egg and the Earth on the worksheet.
- Draw continents (green) and oceans (blue) on the crust of the Earth making sure they are shown as very low features. If the Earth were the size of a basketball its surface would be smoother than the ball because the features on the Earth's surface are so small when compared with the size of the whole Earth.
- Make sure students show land (green) under the ocean. A common misconception is that there is no rock under the ocean, just sand.

Learning Intentions

- Find out what scientists think is inside of the Earth
- Use an egg as a model to represent the Earth

Success Criteria

Students can

- Explain the layered structure and heat inside the Earth by relating it to an everyday item such as an egg.
- Correctly label the Earth's layers in a diagram
- Use descriptive language to describe the crust, mantle and core.

Resources

- Hard boiled eggs for individuals, groups or teacher.
- Activity sheet.

Vocabulary

crust, mantle, core, rock, melt, temperature, drill, continent, ocean, cross section, rigid, flow, pressure, interior, inner, outer, layer

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The Earth's structure is the key to understanding volcanoes.

We live on the only cool part of the planet, everything inside the Earth is hot. Volcanoes are places where hot molten rock (magma) has risen to the surface, broken through and been rapidly cooled.

There are many simple models of the Earth's layered structure, a recently boiled egg is perhaps the best because it shows both the heat and the layering of the Earth's interior. An apple, an avocado, human skin and even a slice of Mars bar could all be used to show the thin, hard crust above larger, denser (heavier), less rigid, internal layers.

Ideally students would have an egg each to examine and could decorate it to resemble the Earth, before cutting it open, but this is not essential.

Many children will know that the hotter things get the runnier they get. This is true on the surface of the Earth but the pressure is so great inside the Earth that even hot rocks are too dense to move easily. The mantle is not all magma, the huge pressures inside the Earth mean that most rock is solid despite the high temperature. It is only in isolated pockets that the crust and mantle melt to form magma. The inner core is the hottest part of the Earth but it is under so much pressure that it is believed to be completely solid. If we travelled to the core the pressure would be so great we would be compressed to about the size of a marble.

It is 6300km to the centre of the Earth and drilling has only reached 12km into the crust. Shallow drillholes at a few kilometres depth show temperature increases of up to 25°C per kilometre but this could not continue at that rate or the middle of the Earth would be hotter than the Sun.

The student activities limit the explanation of the Earth's interior to crust, mantle and core. Of course there are many deeper levels of explanation.

The crust and the upper layer of the mantle together make up a zone of rigid, brittle rock called the lithosphere. The layer below the rigid lithosphere is a slightly softer zone called the asthenosphere. The asthenosphere is the part of the mantle that flows very slowly and moves the plates of the Earth. In Lesson 3 some students may assume that it is just the thin crust that is broken into plates, it is actually the crust and the upper part of the mantle (the lithosphere). The lithosphere averages about 100km thick, ranging from 6km at mid ocean ridges to 200km under continents.

This lesson and the following one on plate tectonics provide opportunities to demonstrate to students the 'understanding about science' aspect of the Nature of Science strand. Scientists cannot directly observe the inside of the Earth so they must formulate theories and models from indirect evidence such as seismology. Students need to be aware that these explanations have and will continue to change over time.

For a more thorough explanation of the Earth's interior and additional useful websites see:
http://www.sciencelearn.org.nz/contexts/earthquakes/science_ideas_and_concepts/inside_the_earth

Curriculum Links

Planet Earth and Beyond

Science Concept	NOS
Earth Systems L3/4-develop an understanding of what makes up our planet	Understanding about Science- appreciate that science is a way of explaining the world.
	Investigating in Science-explore simple models

Inside the Earth

What's inside the Earth?

Where did the Earth come from/how was it made?

Scientists believe that about 4600 million years ago the Earth was a huge ball of hot, glowing gases. As the gases cooled down they changed to liquid and Earth got smaller. The heavier liquid sank to the middle of the Earth. As cooling continued a solid crust formed like a scum over the liquid material. The crust kept cooling and shrinking. Cracks appeared in the crust.

Water vapour that formed under the Earth's crust escaped through the cracks and led to cloud formation and the first rainfalls. As the Earth continued to cool the rain didn't all evaporate from the hot surface, it began to form lakes and oceans. At first the water was all fresh water, but as chemicals from the Earth's crust mixed in, the oceans became salty. At one time the Earth was completely covered in water.

Later pressure and heat from the centre pushed up lighter, solid portions of the Earth that became land. These land areas floated on the heavier, more fluid mantle layers underneath. The land areas moved and changed over time and are still moving slowly today. The heavier parts of the crust floated lower in the mantle and water drained to these lower areas causing oceans.

Slowly over thousands of millions of years the interaction between the atmosphere, the land, the oceans and eventually living things led to the planet we know today.

The Earth continues to change but the process is so slow it is only when volcanoes erupt or earthquakes give us a jolt that we are reminded nothing is permanent, not even the Earth.

For a great visual explanation see:
<http://www.youtube.com/watch?v=QDqskltCixA>

What makes the heat inside the Earth?

Some of the heat is left over from the Earth's creation and the rest is from the decay of radioactive elements such as uranium inside the Earth.

How do scientists know what's inside the Earth?

The study of earthquake (seismic) waves tells scientists a lot about the inside of the Earth. They can use real earthquakes or create their own seismic waves by setting off explosives buried in the ground. The different types of rock that they meet inside the Earth cause the waves to change speed and reflect in different ways. This produces a type of echo picture of the Earth. The echo of your voice sounds different because it is changed by the surfaces it reflects from. A seismic wave is changed in the same way and scientists can make deductions about what the wave has travelled through by differences in the arrival times of the waves.

There is a network of seismographs all around the Earth that are used for accurately pinpointing the size and location of seismic events such as earthquakes or bomb blasts.

Volcanoes also provide information through eruptions, by bringing to the surface molten rock from deep inside the Earth.

More information can be gained from rocks exposed in cliffs and mountainsides. Because the crust of the Earth has been buckled and broken by folding and faulting these places can reveal rock structures that were once deep in the crust.

For more information on seismic waves see:
http://www.sciencelearn.org.nz/contexts/earthquakes/science_ideas_and_concepts/seismic_waves

How deep have scientists drilled into the earth?

12.3km

See http://en.wikipedia.org/wiki/Kola_Superdeep_Borehole

How hot does it have to be to make rock melt?

Most rocks are made from mixtures of minerals and each mineral has its own melting point, so different parts of a rock melt at different temperatures. The amount of water in the rock and the pressure the rock is under, also affect the melting point. Magma is a mixture of molten rock, gas bubbles and suspended unmelted crystals. Most magmas melt between 700 & 1300°C, that's at least 4 times hotter than the temperature needed to bake a cake.

Details & diagrams of Earth's layers

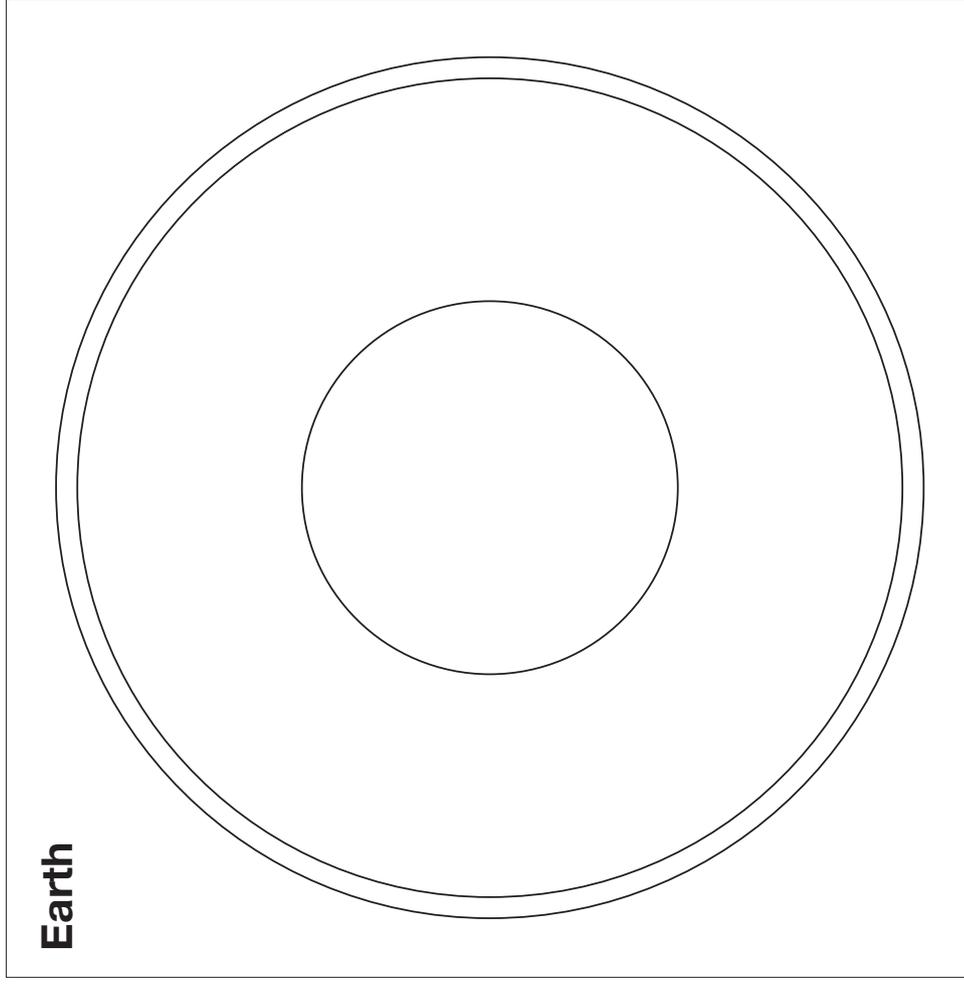
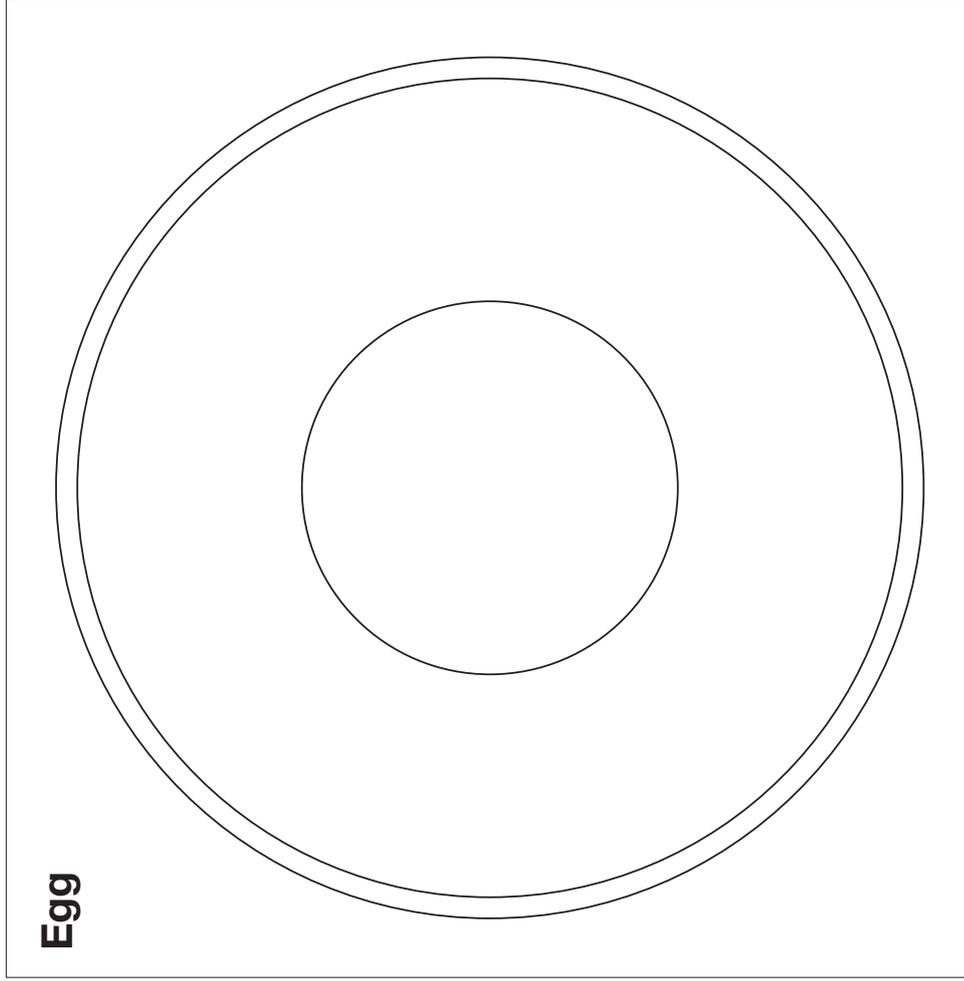
http://volcano.oregonstate.edu/vwdocs/vwlessons/lessons/Earths_layers/Earths_layers4.html

A whole class art activity to show the Earth's structure:

<http://web.ics.purdue.edu/~braile/edumod/earthint/earthint.htm>

1. Add the following labels to the correct diagram: core, white, crust, mantle, shell, yolk.
2. Show the hottest part of the Earth by colouring it red, colour the mantle orange.
3. Show the surface of the Earth by colouring the crust blue and green to represent oceans and continents. Remember it is 6300 kilometres to the centre of the Earth but Earth's tallest mountain is less than 9 kilometres high so even the highest mountain will be almost invisible on your diagram.

Name:



Activity sheet 2

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