2. INTERIOR OF THE EARTH

Let's recall.

In the previous classes, you have been introduced to rock types, volcanoes and earthquakes. Answer the following questions on the basis of that.

- When earthquake occurs, what happens exactly ?
- How are igneous rocks formed?
- What is a volcano ?
- Which materials come out during a volcanic eruption?
- In which state of matter are these materials?
- Are these materials cool or hot? Why?

Try this.

Boil half a liter of milk. When the milk comes to a boil, switch off the gas Keep a lid on the vessel. *(The latter part of the experiment is very important. You have to use your observational skills and arrive at some conclusions.)*

After ten minutes , remove the lid, take it to a side and tilt it. Observe what happens. What can you see on the milk? In what form do you see the layer of matter on the milk? Remove this layer of matter. Take note of the difference in temperature of this matter and the milk and answer the following questions.

- When the milk was kept for boiling, in which state was it?
- When the milk was boiling, what did you observe?
- What had accumulated over the lid of the vessel?
- Tell whether the matter accumulated on the milk is liquid or solid?
- Was it cooler or hotter than the milk below?
- On which other substances can similar experiments be carried out?

Geographical explanation

Before boiling, the milk was in the liquid state. After it came to a boil, steam started coming out from it. After some time, a thick layer of cream develops over the milk. The temperature of the cream is lesser than the milk below. Thus, it can be implied that the creamy layer cooled faster than the milk below it, which remained hot and in a liquid form. A similar process occurred when the earth cooled.

The scientists unanimously believe that the Earth was formed out of the solar system itself. Initially, earth was a gaseous hot balloon. It cooled down as it rotated around itself. The process of cooling took place from the outer surface towards the earth's center. As a result, the outer layer (crust) of the earth become cooler and soild but as we move from surface to the core, heat increases and at certain depths, the interior of the earth is semi liquid.

Man has always been inquisitive about what lies in the interior of the earth. A direct observation of the earth's interior has not been possible as yet. Through various methods, the scientists have tried to estimate about the same. To infer about these, study of the materials coming out of a volcanic eruption and the seismic waves is most important.

Matter coming out of volcanic eruptions consists of hot magma, gases, steam, etc. When lava cools and solidifies, igneous rocks are formed. Through the estimates of the study of temperature, density, gravitational force and pressure the interior of the earth was understood. For instance, when we go deep into a mine, we feel an increase in temperature. Similarly, the magma coming out of volcanoes from the earth's interior is hot. Such estimations were made by the geologists. Several earthquakes occur in various places on the earth every year. Seismic waves are generated. These waves travel through the interior of the earth.

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The study of their direction and velocity helps us to estimate about the interior of the earth. Man has also tried to dig deep bore holes in the interior to know more about the same.

Think about it.

Can we dig deep from one side of the earth and come out from the other side? Write your imaginations in your notebooks and discuss in class.

(Note: Teachers should listen to the ideas of the students and direct the topic towards the earth's interior)

Do you know?

Our earth was formed approximately 4.6 billion years ago. Initially, the earth was in a gaseous state. It started cooling through the process of radiation. The earth then liquefied. With time, the outermost part of the earth cooled first and became solid. This outermost layer of the earth is called the crust. Even today outer planets of the solar system are in a gaseous state.

The Composition of The Earth's Interior :

Try this.

(Carry out the following activity by dividing the students into two groups. Use the pictures on the back cover for reference.)

- ✓ Take clay balls of 3 colors- red, yellow and blue. (As available in the market)
- ✓ Make the red ball bigger.
- ✓ Roll out the yellow colour ball. You will get a flat roti-like structure. Place the red colour ball inside the yellow one like you fill puran in a puranpoli. Give it the shape of a sphere.
- ✓ Now roll out the blue ball and fill the yellow one in it as done earlier. Make a sphere out of this too.
- ✓ Show the continents in yellow on this sphere like a globe. Now your globe made from clay is ready.
- ✓ To see the interior of the earth, cut the sphere exactly in half. You can see various layers of colors inside like the layers of the earth's interior. Name these layers.

Geographical explanation

While going from the earth's surface to its core, major changes occur in temperature and density. With respect to these two elements, the earth's interior can be divided into following layers.

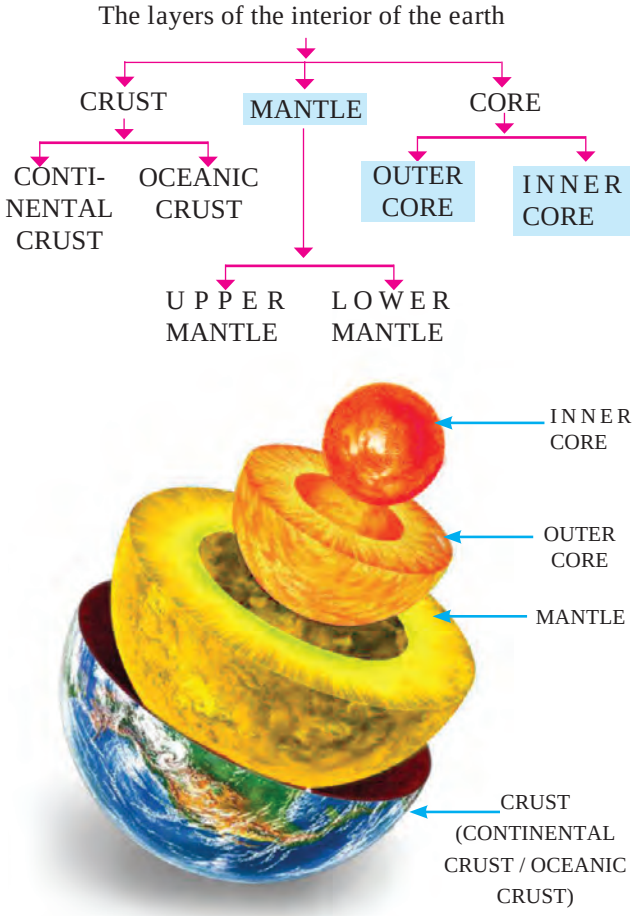

Figure 2.1 Diagram showing the structure of the earth's interior

THE CRUST :

The uppermost layer of the earth's surface is in solid state and is called the crust. The thickness of the crust is not the same everywhere. On an average, it is 30 to 35 km

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Steps in the process of knowing the interior of the earth

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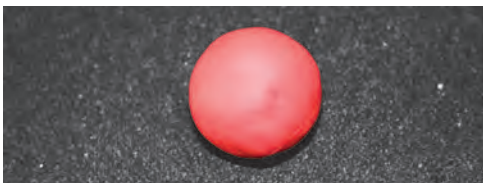

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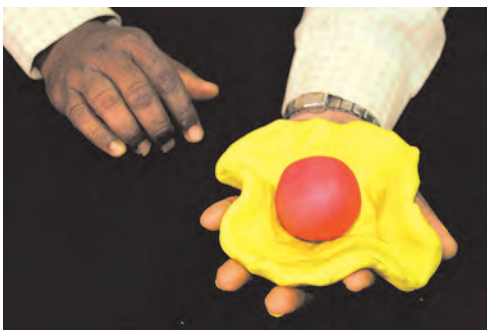

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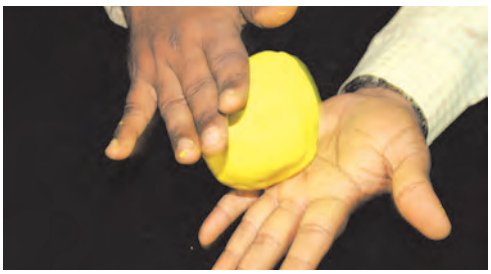

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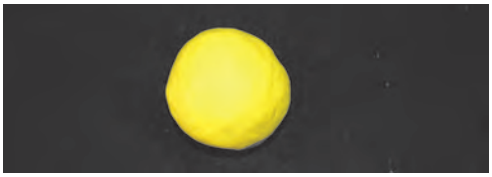

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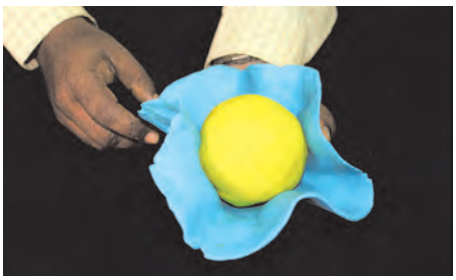

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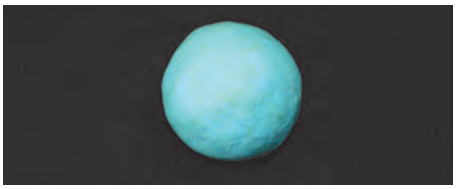

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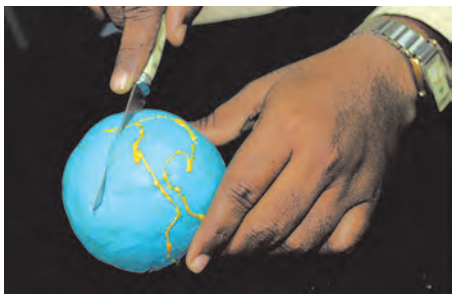

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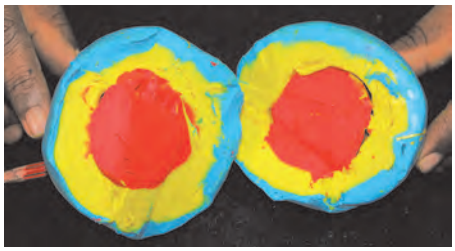

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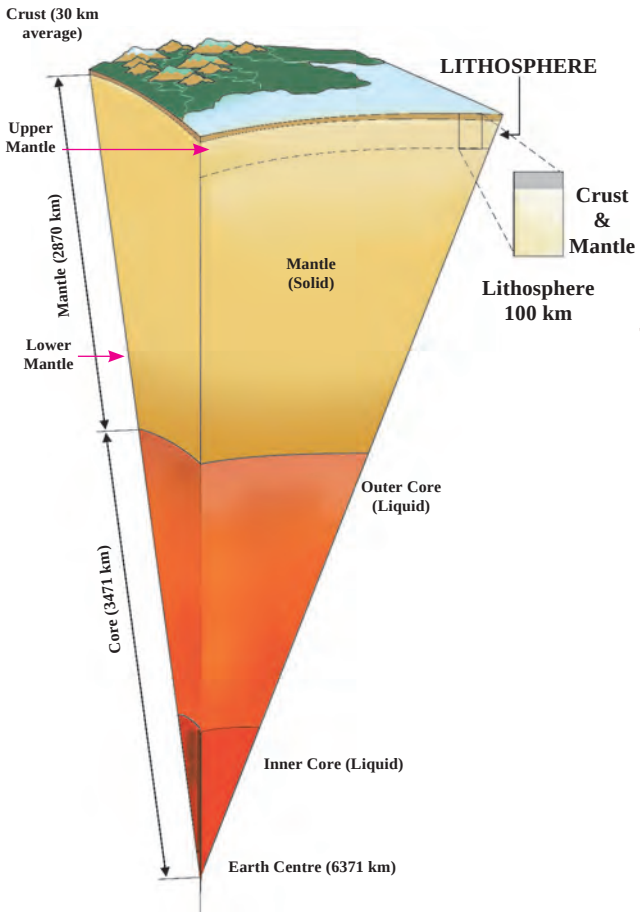

Figure 2.2 : Image showing earth's interior

thick. The thickness of the crust below the continents is from 16 to 45 km, 40 km under the mountain ranges and less than 10 km under the oceans.

As we move deeper under the surface, temperature increases. After that, the rate of increase in temperature reduces and again increases in the core. At the centre of the earth, the temperature is around 5500^0 to 6000^0 C.

The crust is the thinnest of all the layers when compared to the mantle and the core. It can be divided into two sub-layers.

Continental Crust : The continents are mainly composed of Silica (Silica is the compound of Silicon Elements) and Aluminum. Because of their high proportion in this layer, the layer was earlier known as Sial. The density of continental crust is 2.65 to 2.90 gm/cm^3. The thickness of this layer is approximately 30 kilometers. Granite rocks are mainly found in this layer.

Oceanic Crust : This is the second layer of the crust. It is made up of silica and magnesium. It was earlier called Sima. This layer is approximately 7 to 10 km thick. The density of this layer is 2.9 gm/cm^3 to 3.3 gm/cm^3. In this layer, basalt and gabbro rocks are mainly found.

Always remember -

Elements found in various layers of the earth's interior

Low	Silicon	(Si)
DENSITY	Aluminium	(Al)
	Silicon	(Si)
	Magnesium	(Mg)
	Nickel	(Ni)
High	Ferrous (Iron)	(Fe)

Do you know?

There is a discontinuity between the continental crust and oceanic crust. It was first deduced by a scientist called Conrad and is named after him as Conrad discontinuity.

There is discontinuity between crust and mantle too. This discontinuity was deduced by a scientist called Mohorovicic. It has been named after him as Moho discontinuity.

There is discontinuity between mantle and core too. It has been named after Gutenberg, a scientist, who discovered it.

MANTLE :

Below the crust lies the mantle. Mantle can be divided into two layers: upper and lower mantle.

The upper layer is more in liquid state. Here, one finds magma chambers. It is through these chambers that magma comes out on the earth's surface during volcanic eruptions.

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This layer is also known as asthenosphere. Epicenters of deep seated earthquakes are usually found here. Mantle begins at a depth of around 42km from the earth's surface.

The internal energy released due to endogenetic movements occurring in this layer is responsible for mountain-building, rifts, volcanic eruptions, earthquakes, etc.

In this layer, it is inferred that the temperature at a depth of 2400 to 2900 km would be around 2200° C to 2500° C. Here, there is a sudden change in the structure and density of material. It is estimated that this layer extends upto a depth of 2870 km. Average density of this layer is 4.5 gm/cm^3 and it increases with depth. Increasing pressure is the reason behind this. The density of lower mantle is about 5.7 gm/cm^3.

CORE :

The core starts from around the depth of about 2900 km from the earth's surface. The part of the earth's interior extending from the mantle upto the centre of the earth is the core. The thickness of the core is about 3471 km. This layer can be divided into outer core and inner core.

OUTER CORE : Outer core extends from around 2900 km to 5100 km. The secondary waves cannot pass-through the core. They get absorbed in this region. This has led the scientists to believe that the core could be liquid or semi-liquid in nature. The primary waves travel through this layer. But their speed reduces when passing through this layer. The density of outer core is 9.8 gm/cm^3. The temperature of the liquid outer core is around 5000° C.

We have learnt that the outer core of the earth's interior is in a liquid state and the proportion of iron is more in this layer. Vertical currents originate in this liquid layer. This is another characteristic of this area.

The difference between the temperatures of the outer and inner core gives rise to vertical currents. The earth's rotation gives them eddy (circular) motion. Electric currents develop in these spiral eddies of liquid iron and thus magnetic field is generated. It is sometimes called the geo-dynamo too. This magnetic field of the earth is functional even outside the earth's surface for quite a distance. As a result, a cover develops around the earth because of the magnetic field. The earth's atmosphere is protected from solar winds coming from the sun. The magnetic field thus developed around the earth, is called magnetosphere. This is the fifth and an important sphere of the earth. See fig 2.3.

INNER CORE : Inner core extends from around 5150 km to the depth of around 6371 km (earth's centre.) It is the core of the earth which is in a solid state. The density of this sphere is around 13.3 gm/cm^3. Iron and nickel are the major elements found here. Therefore,

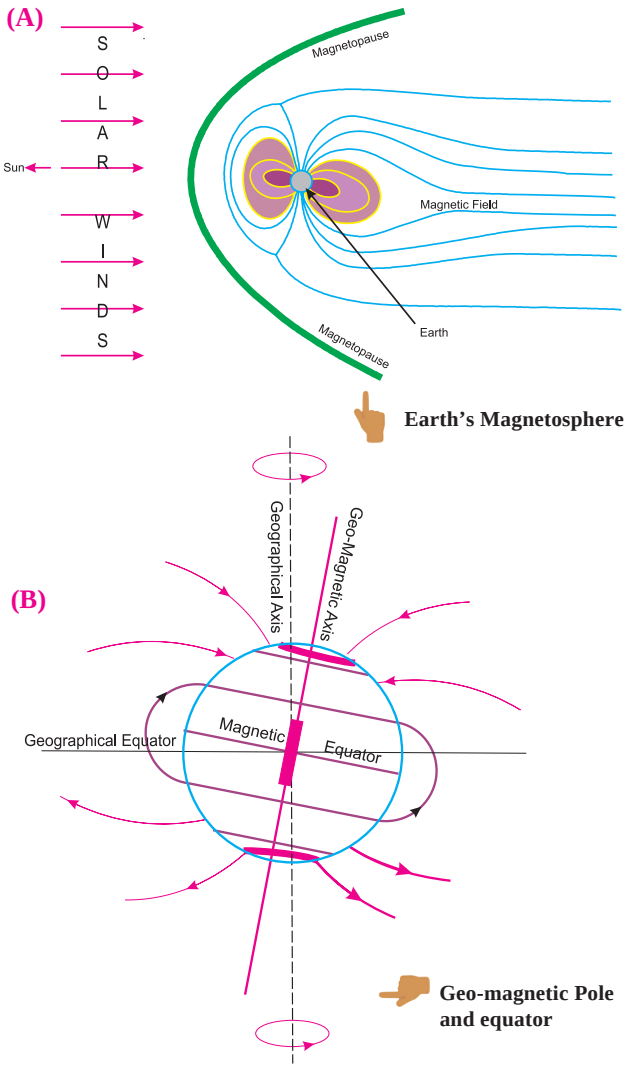

Figure 2.3 (A) and (B) : Earth-a magnet

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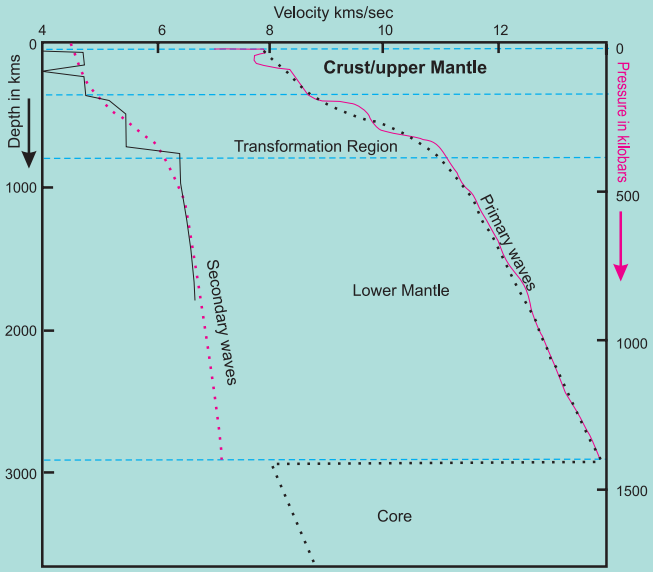
this layer is also called Nife. As the materials in this layer are under extreme pressure, the inner core is in solid state. The temperature here is almost equivalent to the surface temperature of the sun.

Use your brain power !

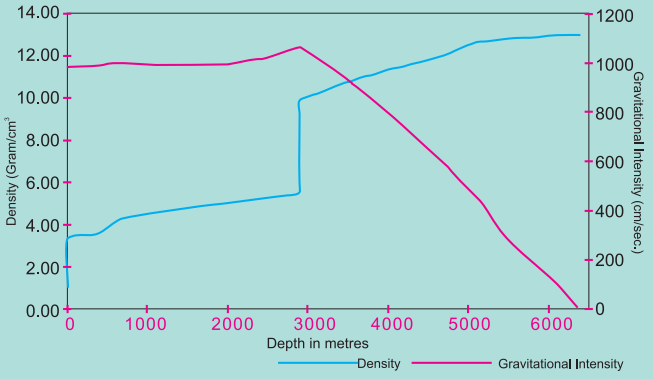
As you go in the interior of the earth, guess what changes will you notice in your weight? Try to find out the reason behind it.

Always remember -

Observe the velocity curves of the given seismic waves.



(A)



(B)

The left curve in figure 'A' shows the velocity of secondary (S) waves, while the curve on the right shows Primary (P) waves. There are many changes occurring in the curve of the secondary waves. The curve drawn with the help of dots shows the average velocity of the waves. The curve of the secondary waves seems to have ended around the depth of 2900 km. Changes are visible even in the curves of the primary waves. The velocity of the primary waves increases according to depth till 2900 km. The velocity of secondary waves is around 6 to 8 km/sec around the boundary of the outer core and the curve has stopped there. These waves do not enter the core. At 2900 km, the velocity is around 12 km/sec. But when it enters the core, the velocity reduces to 8 km / sec. See this as shown in the dot curve. On the basis of these curves, the scientists have inferred the densities at various depths.

The density curve of the earth's interior is shown in figure 'B'. Red curve in figure 'B' shows gravitational force at various depths. Gravitational force increases at certain depth from the surface and then reduces according to depth. At the centre, it is zero as is visible from the curve.

Observe these figures minutely, find various discontinuities in the density curve and show them on the figure.

Think about it.

Imagine the earth's interior and write 10-12 sentences on it.

Find out.

What is World Earth Day? Why is it celebrated?

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Exercises

Q 1. Tick ✓ the correct options in the box

(A) There are two layers in the crust.
- (i) Inner and outer crust ☐
- (ii) Continental and oceanic crust ☐
- (iii) Surface and oceanic crust ☐
- (iv) Mantle and Core ☐

(B) Which element is found in both mantle and crust ?
- (i) Silica ☐
- (ii) Magnesium ☐
- (iii) Aluminium ☐
- (iv) Iron ☐

(C) Which of these minerals are found in the core of the earth?
- (i) Iron-magnesium ☐
- (ii) Magnesium-nickel ☐
- (iii) Aluminium- Iron ☐
- (iv) Iron-nickel ☐

(D) The inner core is in which state?
- (i) Gaseous ☐
- (ii) Solid state ☐
- (iii) Semi-solid state ☐

(E) The outer core is made up of
- (i) Iron ☐
- (ii) Gold ☐
- (iii) Hydrogen ☐
- (iv) Oxygen ☐

(F) The layer of the earth on which we live.
- (i) Mantle ☐
- (ii) Core ☐
- (iii) Crust ☐
- (iv) Continental crust ☐

(G) Which seismic waves can travel through liquid medium?
- (i) Primary waves ☐
- (ii) Secondary Waves ☐
- (iii) Surface waves ☐
- (iv) Oceanic waves ☐

Q 2. Tell whether right or wrong. Correct the wrong statement

(A) The density of various materials is not the same in the interior of the earth.

(B) The core of the earth's interior is made up of hard rock

(C) Secondary waves cannot pass through outer core.

(D) Continental crust is made up of silica and magnesium

Q 3. Answer the following

(A) What are the two parts of the crust? What is the basis of classification?

(B) Why is the upper mantle called the asthenosphere?

(C) Magnetosphere of the earth is a result of rotation. Explain.

Q 4. Draw neat diagrams, label them and explain.

(A) The interior of the earth

(B) Magnetic pole and equator

Q 5. Give geographical reasons:

(A) There is variety in the interior of the earth.

(B) There is correlation between the density of metals and their location in the interior of the earth.

(C) Mantle is the centre of earthquake and volcanic eruptions.

(D) The thickness of the crust below the continents is less as compared to oceans.

(E) Earth is protected because of the magnetosphere.

ACTIVITY :

Prepare a model of the earth's interior.

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