

# Interior of the Earth



Have you ever thought what lies beneath the land where you live? What is there in the interior of the Earth? Let us begin our exploration to learn about the interior of the Earth and the materials forming it.

Our Earth, home planet of living beings, is unique and dynamic in nature. It is constantly changing due to internal and external forces that act upon it.

## INTERIOR OF THE EARTH

From space, the surface of the Earth looks blue and cool. But inside it is so hot that rocks get melt. The temperature in the interior centre is over  $5000^{\circ}\text{C}$ . On account of this extremely high temperature, it is not possible for us to study the Earth's interior directly. So our knowledge about the interior of the Earth is based on **seismology**. Seismology is the study of the behaviour of seismic or earthquake waves measured by seismographs. This study has revealed that :

- The Earth's interior is not same all throughout.
- The density of the materials forming the Earth increases gradually from the surface to the interior.
- The physical and chemical properties of these materials vary.

### DID YOU KNOW?

**Geology** is the study of the Earth's structure, its interior, and the rocks and minerals composing it.

**Geologists** are the scientists who study about the formation and composition of the Earth.

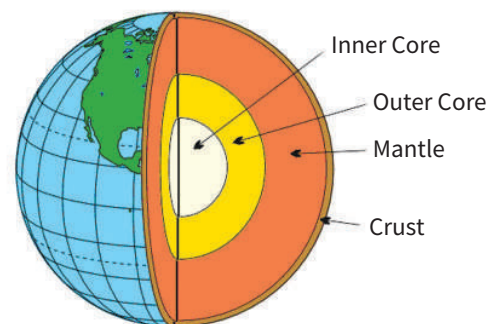
The radius of the Earth is 6371 km.

## INTERNAL STRUCTURE OF THE EARTH

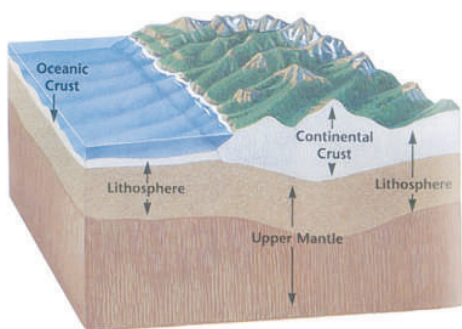
From this study it has become clear that the Earth is made up of three main layers — the **crust**, **mantle** and **core**.

### Crust

The uppermost outer, solid layer of the Earth is the crust. As you already know, it is also termed as **lithosphere**. **Characteristics of the crust** are :



**Fig. 2.1** : Inner structure of the Earth



**Fig. 2.2 :** Crustal Layers

1. It is the thinnest of all layers comprising only 0.5 per cent of the Earth's volume.
2. The thickness of the Earth's crust varies widely. It is about 35 km on the continental masses and only 5 km on the ocean floor.
3. The material of which the crust is composed can be divided into light continental material and heavier oceanic material. The main elements of the continental crust are silicon (Si) and aluminium (Al). This layer is, therefore, termed as **Sial**. The denser oceanic crust is termed as **Sima** because the main elements comprising it are silicon (Si) and magnesium (Ma).
4. Its temperature varies between **30°C** at the surface to **1100°C** at its deepest part.
5. The crust is broken up into plates that move. These plates are called lithospheric plates.

### Mantle

Below the Earth's crust lies a thick, mostly solid layer called **mantle**.

#### Characteristics of Mantle

1. It is thicker than the crust comprising 84 per cent of Earth's volume.
2. It extends up to an average depth of 2900 km below the crust.
3. The upper mantle contains pockets of molten material called **magma**. It is a mobile, semi-molten layer over which crustal plates can move. The inner mantle is entirely solid.

4. It is a transitional layer of mixed metals and silicates.
5. Temperature in this layer ranges from 1000°C – 3700°C.

### Core

The innermost layer of the Earth is the core. It comprises an outer liquid core and an inner solid core.

1. The core is made of heavy materials comprising 15 percent of the Earth's volume.
2. It has a radius of about 3500 km.
3. The main elements or constituents of the core are Nickel (Ni) and Iron (Fe) and the layer is called **Nife**.
4. The temperature of the core ranges between 4,400°C to 6000°C.
5. This zone accounts for Earth's magnetism.

### Interesting Fact

Man has been able to travel long distances in space and has landed on the moon. But he has not been able to go much deep below his feet. Even the deepest mines in the world, i.e. in South Africa, are not deeper than 6 km. It is impossible to reach the centre of the Earth, viz. about 6750 km deep from the continental crust. It is because temperature inside the core ranges from 3600°C to 4200°C.

### ROCKS AND MINERALS

The Earth's crust is made up of rocks. These rocks are formed of single mineral or by a combination of minerals. Rocks may be of various types and may be formed in different

### WORDOLOGY **W**

The word 'igneous' originated from the Latin word 'ignis' which means 'fire'.

The word 'sedimentary' has been derived from the Latin word 'sedimentum' which means 'settling down' (of sediments).

The word 'metamorphic' has been taken from the Greek word 'metamorphose' which means 'change of form.'

ways. They may be solid and hard like granite or marble. They may be loose materials like sand or silt. They do not have definite chemical composition.

Minerals are naturally occurring chemical substances. They are inorganic in nature. They have definite chemical composition and certain physical properties.

### TYPES OF ROCKS

All rocks differ in colour, hardness, size and texture. They vary in composition and physical properties. These variations can be attributed to their origin, i.e., the process of their formation. They can be classified into three major categories, i.e., **igneous rocks, sedimentary rocks and metamorphic rocks.**



Fig. 2.3 : Igneous Rocks — Rock-cut temple in Maharashtra

### IGNEOUS ROCKS

Igneous rocks are formed from the **solidification**

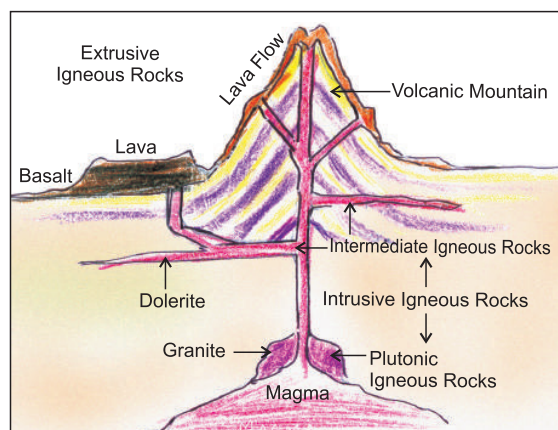


Fig. 2.4 : Formation and Classification of Igneous Rocks

**of molten magma.** Igneous rocks are formed when magma (molten rock) rises from deep underground chambers and cools and solidifies at or near the Earth's surface. Rocks of this category are **compact** and **massive**. They are **resistant, impervious** and relatively **hard**.

These rocks appeared first on Earth and all other types of rocks are formed from them. So igneous rocks are also called **primary rocks**.

Igneous rocks may be classified as below :

- (a) **Extrusive** igneous rocks are formed from solidification of lava spread on the surface of the Earth, e.g. basalt.
- (b) **Intrusive** igneous rocks are formed when magma solidifies beneath the Earth's crust. Intrusive igneous rocks may be further categorised into :
  - (i) **Plutonic** igneous rocks are formed deep below the crust, e.g. **granite**.
  - (ii) **Intermediate** intrusive igneous rocks are formed at intermediate depth, e.g. **dolerite**.

You must have seen documentaries on volcanic eruptions on the Discovery channel. Fiery, red-hot, molten magma pours out from the vents or cracks on the Earth's surface as lava. When this **lava** spreads on the **Earth's surface**, it cools down rapidly and becomes hard, solid rock. The rocks of this type are usually dark, **fine grained** and have **small crystals**. These rocks are called extrusive igneous rocks. **Basalt**, one of the most common rocks found on the Earth's surface, belong to this category. The Deccan Plateau of India is formed mainly of basaltic rocks.

When **molten materials** lying **deep within** Earth's crust cool and solidify, **plutonic (intrusive) igneous rocks** are formed. The rocks formed in this manner have **large crystals** of minerals, because of slow cooling. They are **coarse grained** and usually light coloured. **Granite** is the most common plutonic rock. It is also the most widespread rock of the continental crust.

Some molten magma may solidify at **intermediate depths**, in the channels or cracks through which it comes out. These intrusions may cut through other rocks. **Dolerite** is an example of intermediate intrusive igneous rocks.

Igneous rocks are used for building purposes, for constructing roads, making grinding stones etc. Valuable minerals can be derived from igneous rocks.

## SEDIMENTARY ROCKS

Rocks on the Earth's surface are exposed to agents of **erosion** like wind, running water or glaciers. They are **worn down** and broken into smaller fragments. Temperature changes also wear down the rocks, breaking them into smaller pieces. These broken fragments of rock particles are carried by wind, rivers and glaciers and deposited in lakes, sea beds, ocean floor, etc. Gradually layer upon layer of fine **sediments** are collected. Due to weight of the overlying layers, heat of the interior and chemical reactions, the sediments are **compressed, cemented and hardened**. The rocks formed in this manner are called **sedimentary rocks**.

When the sediments are deposited, animals, plants and micro-organisms get trapped within the layers. They are preserved as **fossils**. This is a unique characteristic of sedimentary rocks and is very useful in the study of the past.

Large deposits of dead plants and animals trapped within the sediments get changed into coal and petroleum over long geological



Fig. 2.5 : Sedimentary Rocks

## DID YOU KNOW?

- Talcum Powder, that we use for dressing up, is made of Talc, a metamorphic rock.
- The branch of science concerned with origin, structure and composition of rocks is called petrology.

periods. These are called **fossil fuels**. Sandstone made of grains of sand and shale are examples of mechanically formed sedimentary rocks. Limestone may be chemically formed by settling down of calcium carbonate. It may also be formed from organic deposits, i.e., from clustering of seashells.

Sedimentary rocks contain various valuable minerals like iron ore, manganese and bauxite (ore of aluminium). Sandstone and limestone are used as building material. They provide us with fossil fuels and raw materials for cement and fertiliser industries.

## Metamorphic Rocks

Metamorphic rocks are formed when existing igneous and sedimentary rocks are changed by great pressure or intensive heat or both. The physical properties, appearance and chemical composition of the new rock is much different from the original rock. These rocks are very **hard**. Some examples of such metamorphism or transformation are :

- (i) **Granite** changes into **gneiss**.
- (ii) **Sandstone** changes into **quartzite**.



Fig. 2.6 : Metamorphic Rocks — Outcrop of rocks in Bhutan

- (iii) **Shale** changes into **slate**.
- (iv) **Limestone** changes into **marble**.
- (v) **Coal** changes to **graphite**.

Two important building materials, marble and slate are metamorphic rocks. The slate, used to make blackboards; chalk, used for writing on blackboard; and graphite, used for making pencils, are metamorphic rocks.

## THE ROCK CYCLE

The rocks that form the Earth's crust undergo a continuous process of change. They are **continually destroyed** and **remade** in an endless process. This is called the rock cycle. It represents the **continuous recycling** of rock materials and their conversion into different rock types. Let us understand it with the help of Fig 2.7.

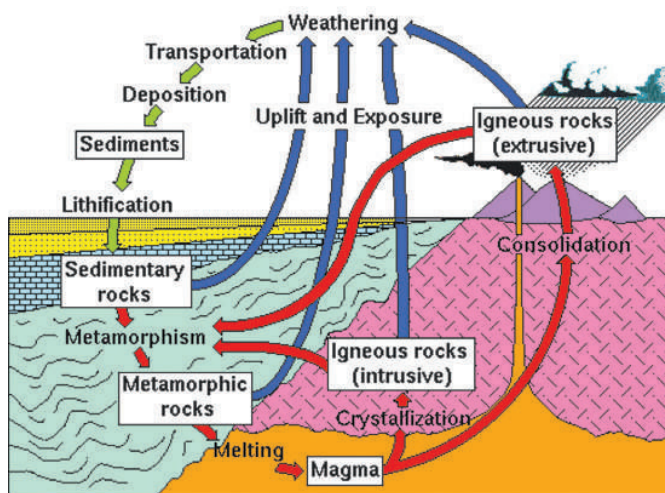


Fig. 2.7 : Rock Cycle

## INFOBITS

- The inner core of the earth is believed to be solid. It is believed to be made up of iron and some nickel.
- The inner core is nearly as hot as the surface of the sun, and the pressure down there is 3 million times what it is on the surface.
- Earthquake waves that pass through the inner core travel faster north-south than they do east-west.
- The world's deepest mine is in South Africa that reaches 3.9km below the earth's surface.

Observe how igneous rocks are formed from cooling and solidification of magma. Rock fragments eroded from igneous rocks are transported and deposited to form sedimentary rocks. Existing igneous and sedimentary rocks are changed into metamorphic rocks due to great heat, pressure and resulting chemical and physical changes. When the metamorphic rocks are buried deep beneath the Earth, intensive heat and pressure change them into magma which gradually change to igneous rocks. Thus, the rock cycle continues.

## IMPORTANCE OF ROCKS AND MINERALS

Have you been to Delhi and Agra? Have you seen the historical monuments there? Well, you must have observed that most of them are made of stones. Taj Mahal, one of the Seven Wonders of the World, is made of white marble. The Red Fort of Delhi is made of red sandstone. The Fatehpur Sikri near Agra is also made mainly of sandstone. Similarly, the famous Dilwara Temple at Mount Abu is made of marble while the Jaisalmer Fort of Rajasthan is made of yellow limestone. The rock-cut temples of Odisha and Tamil Nadu are made of igneous rocks like charnockite and granite. If you visit hilly areas like Ladakh or Sikkim, you will see that local houses are made of stones. Throughout the world the great wonders have been sculpted on rocks.

Since long, man has used rocks, minerals and stones in various ways. The stone age, copper age, iron age, all are based on use of rocks and minerals by man. Rocks constitute the solid crust. They form the different landforms. Minerals derived from rocks are economically very important for us. Iron, aluminium, manganese, copper, etc., are used in industries. Gold and silver are precious metals used for making jewellery. Some minerals like coal and petroleum are used as fuels. Atomic minerals like uranium and radium are used for generating energy and for medical purposes. Some minerals are used as fertilisers.

## POINTS TO REMEMBER

- Our earth is dynamic in nature and it is constantly changing due to internal and external forces that act upon it.
- Earth is made up of three main layers, i.e. the crust, mantle and core.
- Uppermost solid layer of the earth is crust. Below the crust lies a thick solid layer called mantle and the innermost layer is called core.
- Rocks are classified into three main categories, i.e. igneous rocks, sedimentary rocks, metamorphic rocks.
- Igneous rocks are formed from the solidification of molten lava. These are classified as intrusive and extrusive igneous rocks.
- Sedimentary rocks are formed from consolidation and compactness of sediments eroded from igneous rocks. They contain valuable minerals.
- Metamorphic rocks are formed due to chemical and physical changes or metamorphosis of existing rocks due to great heat and pressure.
- Rock cycle represents the continuous recycling of rock materials and their conversion into different rock types.

## GLOSSARY

<b>CORE</b>	- Innermost layer of the Earth, mostly in molten condition due to high temperature.
<b>CRUST</b>	- Uppermost, solid, outer layer of the Earth, also termed as lithosphere.
<b>IGNEOUS ROCKS</b>	- Rocks formed by cooling and solidification of molten magma.
<b>MAGMA</b>	- Red-hot molten rock found deep within the Earth.
<b>METAMORPHIC ROCKS</b>	- Rocks formed due to chemical and physical changes or metamorphosis of existing rocks on the Earth due to great heat and pressure.
<b>MINERALS</b>	- Naturally occurring chemical substances, inorganic in nature.
<b>ROCK CYCLE</b>	- Continuous recycling of rock materials from one type to another.
<b>ROCKS</b>	- Solid materials making up the crust, formed of single mineral or by combination of minerals.
<b>SEDIMENTARY ROCKS</b>	- Rocks formed from consolidation and compaction of sediments eroded from igneous rocks.
<b>SEDIMENTS</b>	- Fine broken rock fragments deposited in water bodies.
<b>SEISMOLOGY</b>	- The study of the behaviour of earthquake waves.

## TIME TO LEARN

### A. Multiple Choice Questions (MCQs)

1. Rocks formed from the solidification of molten magma are :  
(a) Igneous rocks (b) Sedimentary rocks  
(c) Stratified rocks (d) Metamorphic rocks
2. The main elements of the continental crust are :  
(a) Silicon and Aluminium (b) Silicon and Magnesium  
(c) Mixed metals and Silicates (d) Nickel and Iron
3. The zone which accounts for the Earth's magnetism is :  
(a) Crust (b) Sima (c) Mantle (d) Core
4. After metamorphism limestone changes into :  
(a) Gneiss (b) Quartzite (c) Marble (d) Slate

5. It is impossible to reach the centre of the Earth because the core is :  
 (a) Extremely cold      (b) Extremely hot      (c) Very deep      (d) Molten

**B. Match the following**

Column A	Column B
1. The innermost layer of the Earth	(a) Seismology
2. Molten rocks inside the Earth	(b) Fossil
3. Study of earthquake waves	(c) Core
4. Plants and animals of the past preserved in sedimentary rocks	(d) Rock cycle
5. Recycling and conversion of rocks	(e) Sediments
6. Fine, broken, rock fragments	(f) Magma

**C. Arrange the following rocks according to their origin :**

Limestone, granite, shale, sandstone, gneiss, coal, basalt, slate, quartzite, dolerite, marble

Igneous Rocks	Sedimentary Rocks	Metamorphic Rocks
Extrusive _____	Mechanically formed _____	_____
Intermediate _____	Organic deposits _____	_____
Plutonic _____	Fossil fuel _____	_____

**D. Very short answer type questions**

1. Approximately, what is the temperature of the interior centre of the earth?
2. What are the main elements of 'Sima'?
3. What type of rocks are formed by the solidification of molten magma?
4. Name the most common Plutonic rock.
5. Which type of rocks are formed by large deposits of plants and animals.

**E. Short answer type questions**

1. Which rocks are called Primary Rocks? Why?
2. How are sedimentary rocks important to us?
3. How are metamorphic rocks formed?
4. Give two characteristics of the uppermost outer solid layer of the earth.
5. Why the thickness of the earth's crust varies widely between continental masses and the ocean floor? **[HOTS]**

**F. Long answer type questions**

1. What is Mantle? Give the characteristics of Mantle.
2. Distinguish between metamorphic rocks and igneous rocks.
3. "Rock cycle represents the continuous recycling of rock materials and their conversion into different rock types." How it is beneficial to us? **[Value Based Question]**
4. With the help of diagram explain the formation of extrusive igneous rocks.
5. What do you know about the structure of the earth? Explain.

### G. Activity

Collect a few specimen of rocks from your surroundings.  
Try to find out whether they are igneous, sedimentary or metamorphic rocks.

### H. Project

Collect pictures of igneous, metamorphic and sedimentary rocks. Paste these pictures in the project file. Write down the characteristics of each. Which type of rock is the most useful? Give reasons for your answer.

## LIFE SKILLS

Explore the layers of the earth. Do the following activity.

**Material Needed :** Hard boiled eggs, plastic knives, plates, napkins.

**Procedure :** Perform the activity with 10 children. Each one of them should be given one hard boiled egg, a plate, a napkin and a plastic knife. Ask each one to set the egg on the plate. Now, we assume that the shell of the egg represents the **Crust**. By tapping lightly break the shell. The inner white part of the egg represents **Mantle**. With the help of the knife, cut through the egg and the innermost yellow part of the egg represents **Core**.

On the basis of this activity, have a group discussion on characteristics of Interior of the Earth. Highlight the main features of core, mantle and crust of the earth.



## MIND MAP

