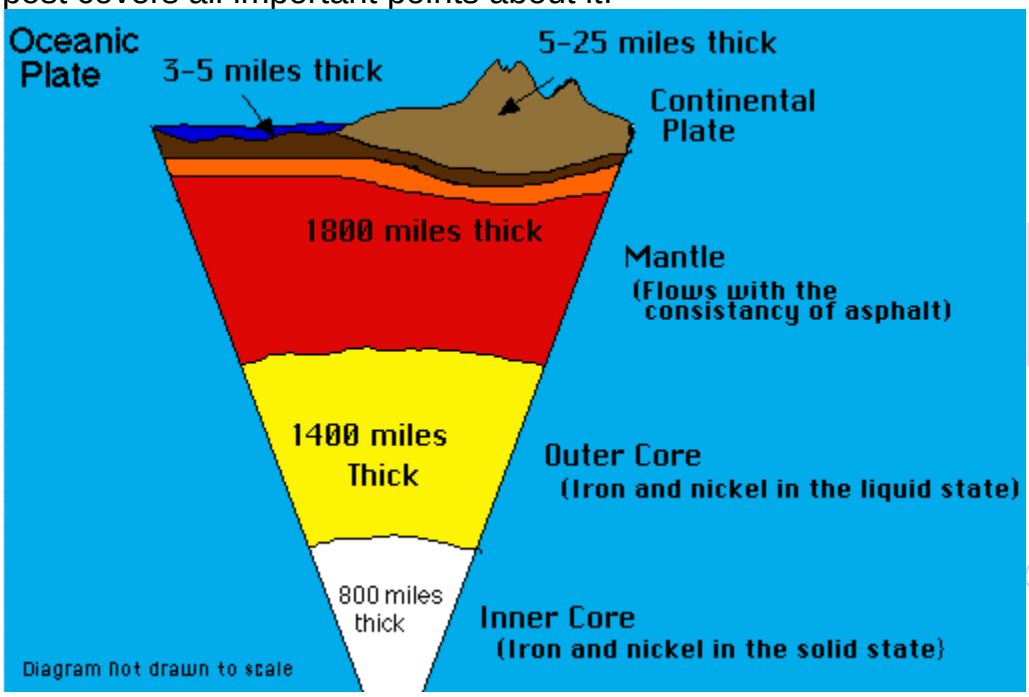
Chapter- 1

The Interior of the Earth

Study Note

Interior Of The Earth : Complete Study Notes

Interior of the earth is an important topic for UPSC CSE preparation. This blog post covers all important points about it.



Earth has 3 major layers namely**:**

- Crust
- Mantle
- Core (Outer Core & Inner Core)

Topics Covered

- The Core

How do we get information about the earth's composition/ interior layers?

The radius of the earth is 6,370 kms. Thus, it is impossible to reach the center of the earth and find out about the composition. Also, this composition is changing in nature. The rapid increase in temperature is also one of the factors that put a limit to direct observation of the earth's interior.

Sources of information are of two types: Direct & Indirect.

Some Direct Sources:

1. Rocks (Mining)
2. Volcanic Eruptions

Some Indirect Sources:

1. Rate of change of temperature and pressure from the surface towards the interior
2. Gravitation
3. Gravity anomaly (gravity changes according to the mass of material thus giving us information about the materials in the earth's interior).
4. Meteors (they are made up of similar materials as earth's)
5. Seismic Waves (the shadow zones of body waves give us information about the state of materials in the interior)
6. Magnetism

The Crust

- Earth's hard outer layer and is brittle in nature. It is less than **1%** of Earth's volume. The crust is made up of different types of rocks: igneous, metamorphic, and sedimentary rocks.
- The crust is of two different types. One is the continental crust (under the land) and the other is oceanic crust (under the ocean).
- The continental crust has an upper part called granitic rock and forms the continents. Silica and alumina (**Sial**) are its main constituents.

- The lower part has basaltic rock forming Oceanic floor. Silica, iron and magnesium (**Sima**) are its main constituents.
- The thickness of the crust varies from 5 to 70 kilometers. The continental crust is thicker, and the oceanic crust is thinner. The mean thickness of oceanic crust is 5 km whereas that of the continental is around 30 km.
- The temperature of the crust increases with depth because of geothermal energy. Where the crust meets the mantle the temperatures can be between 200 °C (392 °F) to 400 °C

(752 °F). The crust is the coldest among all layers because it is exposed to the atmosphere.

- The oldest oceanic basalt crust today is only about 200 million years. Most of the continental crust is much older. The oldest continental crustal rocks on Earth are cratons between 3.7 to 4.28 billion years old.

The Mantle

- The mantle is the mostly-solid bulk of Earth's interior. The mantle lies between Earth's dense, super-heated core and its thin outer layer, the crust. The mantle is about 2,900 kilometers (1,802 miles) thick, and makes up a whopping 84% of Earth's total volume.
- It is composed mainly of dense rocks rich in olivine.
- The rocks that make up Earth's mantle are mostly silicates—a wide variety of compounds that share a silicon and oxygen structure. Common silicates found in the mantle include olivine, garnet, and pyroxene. The other major type of rock found in the mantle is magnesium oxide. Other mantle elements include iron, aluminum, calcium, sodium, and potassium.
- The temperature of the mantle varies greatly, from 1000° Celsius (1832° Fahrenheit) near its boundary with the crust, to 3700° Celsius (6692° Fahrenheit) near its boundary with the core. In the mantle, heat and pressure generally increase with depth.
- The transfer of heat and material in the mantle helps determine the landscape of Earth. Activity in the mantle drives plate tectonics, contributing to volcanoes, seafloor spreading, earthquakes, and orogeny (mountain-building).
- The upper portion of the mantle is called asthenosphere extending upto 400 km. It is the main source of magma and has a density higher than the crust's.
- Repetti discontinuity separates the outer and the inner mantle. The lower mantle extends beyond the asthenosphere. It is in solid state.

The Core

- The **Earth's core** is the central inner part of our planet. It has a solid inner core and a liquid outer core.
- The **outer core** of the Earth is a liquid layer about 2,260 kilometers thick. It is made of iron and nickel.
- Accounts for **16 per cent** of the earth's volume.

- Core has the heaviest mineral materials of highest density.
- Its outer boundary is 2,890 km (1,800 mi) beneath the Earth's surface. The transition between the inner core and outer core is approximately 5,000 km (3,100 mi) beneath the Earth's surface.

- The temperature of the outer core ranges from 4400 °C in the outer regions to 6100 °C near the inner core. Eddy currents in the nickel iron fluid of the outer core are believed to influence the Earth's magnetic field.
- The average magnetic field strength in the Earth's outer core was measured to be 25 Gauss, 50 times stronger than the magnetic field at the surface
- Without the outer core, life on Earth would be very different. Convection of liquid metals in the outer core creates the Earth's magnetic field.This magnetic field extends outward from the Earth for several thousand kilometers, and creates a protective bubble around the Earth that deflects the Sun's solar wind.
- The **inner core** of the Earth, as detected by seismology, is a solid sphere about 1,216 km (760 mi) in radius, or about 70% that of the Moon. It is believed to be an iron–nickel alloy, and may have a temperature similar to the Sun's surface, approximately 5778 K (5505 °C).

What are Rocks?

Rocks are mineral aggregates with a combination of properties of all the mineral traces. Any unique combination of chemical composition, mineralogy, grain size, texture, or other distinguishing characteristics can describe rock types. Additionally, different classification systems exist for each major type of rock. There are different types of rocks existing in nature.

Rocks which are found in nature rarely show such simple characteristics and usually exhibit some variation in the set of properties as the measurement scale changes.

Types of RocksTypes of Rocks in India

Types of Rocks

There are three types of rocks:

- Igneous Rocks
- Sedimentary Rocks
- Metamorphic Rocks

Igneous Rock

Igneous rock is one of the three main rock types. Igneous rock is formed through the cooling and solidification of magma or lava. Igneous rock may form with or without crystallization, either below the surface as intrusive (plutonic) rocks or on the surface as extrusive (volcanic) rocks.

This magma can be derived from partial melts of existing rocks in either a planet's mantle or crust. Typically, the melting is caused by one or more of three processes: an increase in temperature, a decrease in pressure, or a change in composition.

Types of Igneous Rock

Following are the two types of igneous rock:

1. **Intrusive igneous rock:** These rocks crystallize below the earth's surface resulting in large crystals as the cooling takes place slowly. Diorite, granite, pegmatite are examples of intrusive igneous rocks.
2. **Extrusive igneous rock:** These rocks erupt onto the surface resulting in small crystals as the cooling takes place quickly. The cooling rate is for a few rocks is so quick that they form an amorphous glass. Basalt, tuff, pumice are examples of extrusive igneous rock.

Igneous Rock Examples

Basalt	Diorite
Granite	Mica and quartz

Sedimentary Rock

The sedimentary rocks are formed by the deposition and subsequent cementation of that material within bodies of water and at the surface of the earth. The process that causes various organic materials and minerals to settle in a place is termed as sedimentation.

The particles that form a sedimentary rock by accumulating are called sediment. Before being deposited, the sediment was formed by weathering and erosion from the source area and then transported to the place of deposition by water, wind, ice, mass movement or glaciers, which are called agents of denudation. Sedimentation may also occur as minerals precipitate from water solution or shells of aquatic creatures settle out of suspension.

Types of Sedimentary Rock

Following are the three types of sedimentary rock:

1. **Clastic sedimentary rocks:** These rocks are formed from the mechanical weathering debris. Sandstone, siltstone are examples of clastic sedimentary rocks.
2. **Chemical sedimentary rocks:** These rocks are formed from the dissolved materials that precipitate from the solution. Iron ore, limestones are examples of chemical sedimentary rocks.
3. **Organic sedimentary rocks:** These rocks are formed from the accumulation of plant and animal debris. Coal, some dolomites are examples of organic sedimentary rocks.

Sedimentary Rock Examples

Halite	Limestone
Sandstone	Siltstone

Metamorphic Rocks

The metamorphic rocks make up a large part of the Earth's crust and are classified by texture and by chemical and mineral assemblage. They may be formed simply by being deep beneath the Earth's surface, subjected to high temperatures and the great pressure of the rock layers above it.

Metamorphic rocks arise from the transformation of existing rock types, in a process called metamorphism, which means "change in form". The original rock is subjected to heat with temperatures greater than 150 to 200°C and pressure around 1500 bars, causing profound physical and/or chemical change.

Types of Metamorphic Rock

Following are the two types of metamorphic rock:

1. **Foliated metamorphic rocks:** These rocks are produced by the exposure to heat and pressure which makes them appear layered. Phyllite, gneiss are examples of foliated metamorphic rocks.
2. **Non-foliated metamorphic rocks:** These rocks don't have layers. Marble, quartzite are examples of non-foliated metamorphic rocks.

Metamorphic Rock Examples

Marble	Quartzite
Slate	Phyllite