

Geography – Part 4

4] Earth – It's Structure and Tectonic Movements

Notes

- The earth is a unique planet that sustains life on it.
- There are several theories explaining the formation of the earth.
- The most accepted one is the big bang theory.
- **The Egyptians visualized that earth was a floating sphere on the sea.**
- **It suddenly struck me that that tiny pea, pretty and blue, was the earth** said by Neil **Armstrong.**
- Many experts had brought out theories on formation of earth and other planets.
- **The first creatures appeared on the earth in the oceans and blue green algae was the first living creature appeared in the earth.**
- The Earth has a layered structure, including the core, mantle and crust.
- **The crust and upper mantle are cracked into large pieces called tectonic plates.**
- These plates move slowly, but can cause earthquakes and volcanoes where they meet.
- The Earth's atmosphere has changed over billions of years, but for the past 200 million years it has been much as it is today.

- The **earth** appeared **4.6 billion years ago**.
- The **average temperature of the earth's surface** is **14^oc**

Plate tectonics

- The **Earth's crust and upper part of the mantle** are **broken into large pieces** called **tectonic plates**. These are **constantly moving** at a few **centimetres each year**.
 - Although this doesn't sound like very much, over millions of years the movement allows whole continents to shift thousands of kilometres apart. This process is called continental drift.
 - **The plates move** because of **convection currents in the Earth's mantle**. These are **driven by the heat produced by the decay of radioactive elements** and **heat left over from the formation of the Earth**.
 - Where **tectonic plates meet**, the **Earth's crust** becomes **unstable** as the plates push **against each other**, or **ride under** or **over each other**.
Earthquakes and **volcanic eruptions** happen at the **boundaries between plates**, and the **crust may 'crumple'** to form **mountain ranges**.
 - It is difficult to predict exactly when an earthquake might happen and how bad it will be, even in places known for having earthquakes.

Alfred Wegener

The **theory of plate tectonics (1968)** and **continental drift theory (1912)** were **proposed** at the beginning of the last century by a **German scientist, Alfred Wegener**. Before his time it was believed that the planet's features, such as mountains, were caused by the crust shrinking as the Earth cooled after it was formed. The **sea floor spreading theory** was proposed in **1960**.

Big Bang Theory

- Many experts had brought out theories on the formation of earth and other planets.
- Among them , **Big Bang theory** is the **most accepted one**.
- It proposes that the universe was once extremely compact, dense and hot.
- **Around 10 billion to 20 billion years ago** there was a **cosmic explosion called big bang**.
- **An American astronomer Edwin hubble** explained that the existing **universe is being expanding**.
- On **30th may 2010** the scientists made a **large hadron collider machine** to test the **big bang theory**.

Formation Of Continents and Oceans

- The land and water bodies were not always distributed on the surface of the earth as they are today.

- A few million years ago all the present **continents were clustered together** around the **south pole**. This **super continent** was called **Pangaea**.
- **In greek , Pangaea means “all earth”**.
- The **Pangaea** was surrounded by a **mega ocean** called the **Panthalassa** or the **super ocean**.
- **In greek , Panthalassa means “all water”**.
- The **Pangaea** was broken into a **number of plates known as the lithosphere plates**. These plates move around slowly , from a few millimeters to a centimeter a year.
- **The pacific plate is the largest plates** and it covers about **1/5th** of entire earths surface.
- The **Himalayas is rising by about 5mm per year, due to the movement of Indo-Australian plate, and the plate is still moving at the rate of 67mm/year**.
- **The Pangaea split into seven major plates and smaller plates**.
- The **major plates** were the **Eurasia, Antarctica, North America, South America, Pacific, Africa and Indo-Australian plates**.
- The **smaller plates** include the **Arabian, Caribbean, Philippine, Cocos, Nazca and so on**.

Interior Of The Earth

- **Sir Isaac Newton** was one of the first scientists to **theorize** about the **structure of the earth**.
- The part of the earth we live on is a very thin layer compared to the interior of the earth.
- The **interior of the earth** can be divided into **three major layer's** based on chemical composition and characteristics.
- They are the **crust, mantle and the core**.
- **Suess**, an **Australian geologist** named the **crust, mantle, and core** as **sial, sima and nife** respectively.

Crust

- The **uppermost layer of the earth's surface** is called the **“crust or lithosphere”**.
- The **continental crust** is composed of a layer called **“SIAL”** which is made up of **silica and aluminium**.
- The **oceanic crust** is composed of **basaltic layer** called the **“SIMA”** which is made up of **silica and magnesium**.
- **Crust is thicker on the continental floors** and **thinner** on the **ocean floors**.
- The **sial layer** is **floating on the sima layer**.
- The **average depth of sial** is about **20km** and the **average depth of sima** is about **25km**.

- The average **density** of the crust is about **3gm/cc**.

Mantle

- **Mantle lies** between the **crust and core**.
- It comprises about **83% of the earth's volume**.
- It is made up of plates that move and create continental drift.
- **Beyond 900 km**, this layer is completely **homogenous**.
- **Upper mantle** is known as "**Asthenosphere**".
- It extends upto a depth of **700km**.
- **Lower mantle is semisolid** and is **plastic in nature**.
- The **average density** of the mantle is about **8gm/cc**.

Core

- **The innermost layer** of the earth is called the core or **barysphere**.
- It is otherwise known as **NIFE**, because the **presence of nickel and ferrous**.
- This layer produces **earth's magnetic field**.
- There are **two main divisions**; they are the **outer core and the inner core** .
- The **particles present** here **resemble liquid**. It may be in a **solid state due to excessive pressure of the surrounding layers**.
- The **density** of the core is about **12gm/cc**.

Temperature at Interior of the Earth

- The experience of volcanic eruption, hot springs and mines indicate that heat increases as we move downwards into the earth.
- The **temperature** is estimated at the **centre of the earth** to be as high as **5000°c**.
- The **normal temperature** is **1°c** for every **32 metres of descent**.
- The **Tethys sea** was a **shallow sea between the Angara and gondwana land**.

Forces of Earth Movements

- The **crust of the earth is not stable**. Several areas of the present land masses were once beneath the sea.
- **Continuous changes are taking place on the surface of the earth**. In ancient geological part of the place where the Himalayas lies was occupied by the **shallow Tethys sea**.
- A few of the **changes are gradual and slow, some of them are sudden**.
These changes are brought on by **two different forces**. They are, **Endogenic and Exogenic forces**.

The Endogenic or Internal Forces

- It **originates and acts from within the earth's crust**.
- It gives **rise to deformation and irregularities on the crust of the earth**.

- The **earth movements** which bring about **vast changes within the crust** of the earth are called the **endogenic or tectonic movements**.
- These movements are **of two types**. They are **Diastrophism and sudden movement**.

Slow Movements Or Diastrophism

- It is the general term applied to **slow bending, folding, wrapping and fracturing**.
- It is classified into **Orogenic and Epirogenic**.

Epirogenic or Continental Movement

- The **vertical movement leads to either uplift or subsidence** of the earth's crust, along **lines of weakness** which are called "**FAULTS**".
- **Displacement of the earth's crust takes place along the fault line**. When displacement takes place along two adjoining fault lines, **a portion between them may get uplifted to form a block mountain or plateau or subside to form a basin or rift valley**.
- **Large scale vertical movements** of the earth's crust are also called **epirogenic movements**.

Orogenic or Mountain Building Movements

- **Horizontal movements** of the earth's crust are **responsible for folding and displacement of the layers of rocks.**
- **Simple folding** consists of **alternating upfolds** called “**Anticlines**” and **down folds** called “**Synclines**”.
- **Large scale horizontal movements** are called **orogenic movements**. They are **responsible for** the formation of **fold mountains** of the world.

The Exogenic or External Forces

It **originates and acts on the surface**. It **removes the irregularities** to make a **levelled land**.

Sudden Movements

- These movements bring **sudden changes on and below the crust**.
- These movements are **destructive in nature**.
- Major destructions have **occurred due to sudden movement like earthquakes and volcanic activities**.

Earthquakes

- An **earthquake is a sudden shake or tremble** of a **part of the earth's crust which results in tremors or vibrations**.
- They are classified as **volcanic earthquakes and the tectonic earthquakes**.

- The **volcanic earthquakes** occur along with **eruption**.
- The **tectonic earthquakes** are caused by **erumbling or displacement of rocks**.
- **The point of origin of the earthquake** is called the **focus**.
- **The point directly above the focus on the surface earth** is called the **epicentre**.
- There are annually **8000-10,000 earthquakes** occurring in the world.
- An **earthquake occurs for every one hour**. There are many more undetected, because of their low intensity.
- **The earthquake waves are recorded** by the instrument known as **seismograph**.
- **The richter scale** is used to **measure the intensity of an earthquake**. Its scale **ranges from 0 to 9**.
- On **January 26 , 2001** earthquake occurred in **bhuj** situated in **Gujarat**.

Types of Earthquake Waves

- Basically it is **divided into body waves and surface waves**.
- **Body waves** are produced by **the release of energy at the focus and move in all directions through the body of the earth**.
- There are **two types of body waves**. They are **primary waves and secondary waves**.

Primary Waves

- **Primary waves or p-waves move faster** and are the first to be **recorded** by the **seismograph**.
- It is similar to **the sound waves and travel through gaseous, liquid and solid materials**.
- The primary waves **travel** by the **compression of earth materials forward and backward in its direction**.
- It travels at a speed of **8Km/Sec**.

Secondary Waves

- **Secondary waves or S-waves are slower** than the **P-waves**.
- It can **travel** through **solid materials**.
- During the occurrence of the secondary waves, **particles oscillate in the direction of wave travel**.
- It is similar to the movement of a rope shaken from side to side.
- It travels at a speed of **5Km/sec**.

Surface waves

- Surface waves are last to be **recorded** on the **seismograph**.
- These waves **cause most of the damages on the surface**.
- They are also known as **L-waves**.

- They travel at a speed of **4Km/sec**.

Volcanoes

- A **volcano is a vent or an opening** on the **earth's crust**, through which **hot molten materials erupt from the interior**.
- When the **magma erupts out of the earth** on to the surface, it is called "Lava".
- **The eruption of materials from the interior of the earth's crust** may occur with **huge explosions or silently** through the **tissues of rocks**.

Types of Volcanoes

Volcanoes can be classified into **three types** based on the **frequency of eruption**.

They are **Active volcanoes, Dormant volcanoes and Extinct volcanoes**.

Active Volcanoes

- **Eruptions occur at frequent intervals**.
- Most of the **active volcanoes** are found along the **mid-Atlantic oceanic ridges**.
- **Mauna loa in Hawaii Island** is the **largest active volcano** in the **world**.
- The **barren Island** is the only **active volcano** in **india**.

- The **Northwestern part** of the **deccan plateau** of india has been made up of **volcanic lava**.
- **Mount fuji** is located in **japan**.
- **St.Helens** is located in **Northwest America**.
- **Mount Mayon** is situated in **Philippines**.

Dormant Volcanoes

- The **dormant volcanoes** are also called as **sleeping volcanoes**.
- These volcanoes have been **active in past, stopped ejecting lava now**, but it **may erupt in the future**.
- The **Vesuvius of Italy** and **mauna loa in Hawaii** are the best examples.

Extinct volcanoes

- **Extinct volcanoes** are also called as **dead volcanoes**.
- They would have **erupted in the past** but have **stopped erupting now**.
- **Mt.Kilimanjaro in Africa** and **Narcondam Island** near **the north-east of North Andaman Island** of the indian territory are some examples of extinct volcanoes.
- The famous **Tiruvannamalai hills** of **Tamil Nadu** and **panaka hills** of **Andhra Pradesh** are also considered as extinct volcanoes.
- The **crater of a volcano** filled with **water** is known as **crater lake**.