

Spheres of the Earth

The Earth:

- The earth, our homeland, is a dynamic Planet.
- The earth's surface has lofty mountains, High plateaus, large plains and deep valleys etc.
- The earth's surface is constantly undergoing Changes inside and outside.
- What lies in the interior of the earth? What is the earth made up of?
- Let us learn about its earth is called as blue Planet.
- 71% of the earth is covered by Water, so it's called as Blue Planet.

Spheres of the Earth:

- Earth's surface is a vast area of 510 million sq.km, where four spheres of the Earth interact.
- The abiotic spheres are the Lithosphere, atmosphere and hydrosphere.
- The biotic sphere is the biosphere.
- Together, these spheres constitute the planet, Earth.
- The lithosphere is the solid outer Part of the Earth.
- The atmosphere is a thin layer of Gases that surrounds the Earth.
- The hydrosphere is the watery Part of the Earth's surface including oceans, Rivers, lakes and water vapour.
- The biosphere is the layer of Earth Where life exists.
- The terms 'lithosphere' and 'crust' are not the same.
- The lithosphere includes the crust and the uppermost Part of the mantle.
- All terrestrial planets have Lithosphere.
- The lithospheres of Mercury, Venus, and Mars are much thicker and more rigid than that of the Earth.

Lithosphere (Endogenetic Process):

Interior of the Earth:

- The structure of the earth may be compared to that of an apple.
- On the basis of the study of earthquake waves the spherical Earth is found to be three concentric layers. They are:
 - The crust,

- The mantle and
- The core.

The Crust:

- The crust is the outermost layer of the Earth.
- Its thickness varies from 5 to 30 km.
- It is about 35 km on the continental masses and only 5 km on the ocean floors.
- Despite greater thickness, the continental crust is less dense than the oceanic crust because it is made of both light and dense rock types.
- The oceanic crust is composed mostly of dense rocks such as basalt.
- The crust comprises two distinct parts.
- The upper part consists of granite rocks and forms the continents.
- It has the main mineral constituents of silica and alumina.
- So, it is referred to as Sial.
- It has an average density of 2.7g/cm^3 .
- The lower part is a continuous zone of denser basaltic rocks forming the ocean floors, comprising mainly of silica and magnesium.
- It is therefore called Sima.
- It has an average density of 3.0g/cm^3 .
- The sial and the sima together form the earth's crust.
- Since the sial is lighter than the sima, the continents can be said to be 'floating' on a sea of denser sima.

The Mantle:

- The next layer beneath the crust is called the mantle.
- It is separated from the crust by a boundary called Mohorovicic discontinuity.
- The mantle is about 2,900 km thick.
- It is divided into two parts.
 - The upper mantle with a density of $3.4 - 4.4\text{g/cm}^3$. Extends down to 700 km.

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- The lower mantle having a density of $4.4 - 5.5 \text{ g/cm}^3$ extends from 700 to 2,900 km.

The Core:

- The innermost layer of the earth is called the core.
- It is also known as barysphere.
- It is separated from the mantle by a boundary Called Weichert-Gutenberg discontinuity.
- The Core is also divided into two parts
 - The outer core, which is rich in iron, is in Liquid state. It extends between 2,900 – 5,150 km
 - The inner core, composed of Nickel and Ferrous (Nife), is solid in state. The central Core has very high temperature and pressure. It Extends from 5,150 km to 6,370 km. The average Density of core is 13.0 g/cm^3

The Earth Movements:

- The lithosphere is broken into a number of plates known as the Lithospheric plates.
- Each plate, oceanic or continental moves Independently over the asthenosphere.
- The Movement of the Earth's lithospheric plates is termed as tectonic movements.
- The energy required to move these plates is produced by the Internal heat of the earth.
- These plates move in Different directions at different speed.
- At places, these plates move away from Each other creating wide rifts on the earth's Surface.
- At some places, these plates come Closer and collide.
- When an oceanic plate Collides with a continental plate, the denser Oceanic plate is forced below the continental Plate.
- As a result of the pressure from above the rocks heats up and melts.
- The molten rocks Rise again forming volcanic mountains along the continental edge.

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- Alternatively, a trench may be formed between two plates in some cases when two continental plates Converge, neither plate can be forced under the other.
- Instead, folds may be created.
- Great Mountain ranges like the Himalayas have been Formed in this way.
- The movement of these plates causes Changes on the surface of the earth.
- The earth Movements are divided on the basis of the forces Which cause them.
- The forces which act in the Interior of the earth are called as Endogenic Forces and the forces that work on the surface of the earth are called as Exogenic forces.
- Endogenic forces produce sudden Movements and Exogenic forces produce slow Movements.
- Endogenic movements produce Earthquakes and volcanoes that cause mass Destruction over the surface of the earth.

Internal Processes:

- The internal processes Generate heat and eject Materials from deep below the Earth's crust.
- Internal Radioactivity is the principal source of power for this process.

Plate Tectonics:

- The lithosphere is divided into a number of huge slabs of rocks called 'Tectonic Plates.'
- These tectonic plates are divided into Major and minor plates.
- These plates float independently over the mantle.
- Collisions of these plates produce mountain ranges and other irregular surface features, both on Land and the ocean floor.
- This phenomenon is called 'plate tectonics'.
- The movement of tectonic plates is due to thermal energy from the mantle.

Types of Plate Boundaries:

- **Convergent Boundary** – Here the plate moves toward each other and sometimes, a plate Sinks under another. The location where the Sinking of a plate occurs is called a subduction Zone. (eg) Fold Mountain-Himalayas.
- **Divergent Boundary** – Here the plates pull Away from each other as magma pushes up from the mantle. (eg) Mid Atlantic Ridge
- **Conservative / Transform Boundary** – Here The plates slide horizontally past each other. (eg) San Andres Fault

Movements of Continental Plates:

- Due to lateral compressional forces, the plates are forced to move upwards and downwards. This is called 'Folding'
- Mountains formed by folding are called fold Mountains.
- The process of folding creates Lofty Mountain ranges such as the Himalayas and the Alps According to plate tectonics, the plates are in constant motion with an average rate of few centimetres per year.
- The movement Might seem slow, but over millions of years, the plates and the continents riding on them move a long way.
- **For example**, about 250 million years ago, the Indian Plate was a part of the Gondwana land, which comprised of Modern Africa, Australia, Antarctica, and South America.
- Approximately 140 million years Ago, the Indian plate broke away from the Ancient super continent 'Gondwana' and began moving north and collided with Asia.
- The collision with the Eurasian Plate along the boundary between India and Nepal Formed the Orogenic belt that created the Tibetan Plateau and the mighty Himalayan Mountains.

Earthquake:

- Earthquakes are generally caused by the sudden vibrations in the Earth's crust, which spreads outward in all directions as Waves from the source of disturbance.

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- The Point of origin of an Earthquake is called ‘Focus’ (Hypocentre) which generates a Series of elastic waves.
- ‘Epicentre’ is a point On the Earth’s surface that lies directly above the focus.
- The impact of the Earthquake is felt the most at the epicentre.

Seismic Waves:

- Earthquakes generate seismic waves.
- The Nature, force and speed of these seismic waves depend on the nature of the medium through which it passes.
- Accordingly, there are three Major types of waves.

Primary or P-waves:

- It is the fastest of all the earthquake waves and the first to reach the epicentre.
- These waves pass through solids, Liquids and gases, either through push or pull with an average velocity of 5.3km per second to 10.6 km per second.

Secondary or S-waves:

- It travels only through solids.
- These transverse waves shake the ground perpendicular to the direction in which they propagate.
- The average velocity of these waves is 1Km per second to 8 km per Second.

Surface Waves (or) L-waves are similar:

- To P-waves but they travel primarily along the ground surface.
- These waves travel Comparatively slower and are the most Destructive waves.
- The average velocity of these waves are 1 km per second to 5 km per Second.
- The earthquake waves are recorded by an instrument known as seismograph.
- The Magnitude of an earthquake is measured by the Richter scale.
- The numbers on this scale range from 0 to 9.

Causes of Earthquake:

- The chief cause of earthquake is the sudden Slipping of the portion of the earth’s crust along Fractures or faults.

- The movement of the molten Rocks underneath the surface produce strains Which break the rocks apart.
- The sudden shifting of landmass causes upheavals in the crust of the earth sending vibrations or waves into the Surrounding portions of the earth.
- Sometimes the surface of the earth itself cracks.

Effects of Earthquakes:

- Earthquakes may cause changes in the Earth's surface.
- Vibrations often set landslides in mountainous regions.
- A greater danger in an earthquake is the falling of buildings.
- Most of the houses which collapsed were made of Mud and bricks and proved to be death traps.
- Underground water system is naturally disturbed by such movements.
- Fire is another great danger.
- An earthquake which originates below or near the sea causes great disturbance in the water.
- The floods and waves cause great loss of life, sometimes more than the earthquake itself.
- Tsunami, a Japanese term, is the name given to the huge waves caused in the sea by an Earthquake.
- Tsunamis are quite common along the coasts of Japan and other regions in the Pacific Ocean.

Distribution of Earthquakes:

- The world's distribution of earthquakes Coincide very closely with that of volcanoes.
- Regions of greatest seismicity are circum-Pacific Areas, with the epicentres and the most frequent Occurrences along the Pacific Ring of Fire.
- It is Said that about 68 % of earthquakes occur in this belt.
- Remaining 31 % of earthquakes take Place in the Mediterranean-Himalayan belt Including Asia Minor, the Himalayas and parts of north-west China.
- The remaining percent of earthquakes occur in Northern Africa and Rift Valley areas of the red sea and Dead Sea.

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- In India, the Himalayan region and the Ganga-Brahamaputra valley are prone to earthquakes.
- A number of earthquakes have been experienced in this region.
- Some of them were very severe and caused extensive damage, e.g.,
- The earthquake of Uttar Kashi in 1991 and Chamoli in 1999.
- The Deccan Plateau, which was supposed to be comparatively free from the dangers of the earthquakes, has experienced two severe earthquakes in the past, the Koyna (Maharashtra) earthquake in 1967 and the Latur earthquake in 1993.

Tsunami:

- The word 'Tsunami' is a Japanese term, Meaning harbour waves.
- It is adopted to describe large seismically generated sea waves caused.
- By Earthquakes, submarine explosions and Landslides.
- These waves travel at a great speed (more than 500 km per hour) and the length of the waves exceeds 600 km.
- These waves reach to a height of more than 15 m near the sea shore and are capable of causing destruction along the Coastal area.
- The 2004 Indian Ocean Earthquake that Caused tsunami is the sixth-deadliest natural Disaster which travelled at a speed of 600 Km per hour with an estimated death toll of 2,80,000.
- The Earthquake which occurred Near Indonesia at 00.58 hours took nearly 7 Hours to reach Chennai.
- On 26 December 2004 a tsunami occurred in the Indian Ocean.
- It was the result of the Indio-Australian Plate Subducting below the Eurasian Plate.
- It was caused by an Earthquake Measuring a magnitude of above 9 in the Richter scale.
- The Earthquake caused the Seafloor to uplift, displacing the seawater above.

Volcanoes:

- A volcano is a vent or an opening on the Surface of the Earth crust, through which hot Solid, liquid and gaseous materials (Magma) Erupt out to the surface from the Earth's Interior.
- Magma rises up and ejects on the Surface as Lava.
- Volcanoes are also formed When plates move apart.
- Volcanoes generally have the following Major components. They are:
 - **Magma chamber** – a large pool of liquid Rock found beneath the surface of the Earth
 - **Vents** – an opening serving as an outlet for air, smoke, fumes, magma etc
 - **Volcanic cone** – a landform built by the Magma ejected from the vent in the Shape of a cone.
 - **Crater** – a bowl shaped depression found at the top of the volcano through which the magma flows out.

Causes of Volcanic Activity:

- The temperature increases as the depth increases at the rate of 1°C for every 32 metres.
- There is also great pressure.
- At a depth of about 15 km the pressure is about 5 tonnes per cm² of Rock.
- Under these circumstances, the interior of the earth is in a semi-molten state called magma.
- The magma, under great pressure has the Capacity to dissolve great volume of gas; some Gases are also combustible.
- This makes volcanic Material burst forth through the weak spots in the earth's crust.

Nature of volcanic eruptions:

- Sometimes, magma rises slowly to the Surface and spreads over a vast area.
- This is known as fissure eruption.
- Some plateaus and plains have been formed in this way, e.g., Deccan Plateau in India and the Colombian Plateau in North America.

- If the magma rises quickly to the surface, lava is thrown high into the atmosphere.
- Besides lava, ash, steam, gases and pieces of rocks are also thrown out.
- This Type of eruption is known as explosive eruption.
- The terrible explosion on 27th August 1883 in the island of Krakatoa, Indonesia is an example for explosive type of eruption.
- The viscosity of lava is determined by the Amount of silica and water in magma.
- Highly Viscosity lava is rich in silica and has little water.
- Low viscosity lava has little silica, but a lot of Water.
- It moves rapidly forming smooth flows.
- Barren Island is situated in the Andaman Sea, and lies about 138 Km northeast of the territory's Capital.
- It is only in active volcano along the chain from Sumatra to Myanmar.
- Last Eruption occurred in 2017.
- Based on the periodicity of eruptions, Volcanoes are classified into
 - Active volcano,
 - Dormant volcano,
 - Extinct volcano.

Active Volcano:

- Volcanoes that erupt frequently are called Active volcanoes.
- Most of the active volcanoes lie in the Pacific Ring of Fire belt which lies along the Pacific coast.
- There are about 600 active volcanoes in the world, such as Mt. Stromboli in Mediterranean Sea, St.Helens in USA, Pinatubo in Philippines.
- Mauna Loa in Hawaii is the World's biggest active volcano.

Dormant Volcano:

- These volcanoes have shown no sign of Activity for many years but they may become Active at any time.
- These are called Sleeping Volcanoes.

- Vesuvius mountain of Italy, Mt Fujiyama of Japan, Mt. Krakatoa of Indonesia are famous examples of this type.

Extinct volcano:

- A Volcano has not erupted in past 1000 Years is often listed as Extinct volcanoes.
- The top of extinct volcanic mountains have Been eroded.
- Mt. Popa of Myanmar and Mt. Kilimanjaro and Mt. Kenya of Africa are Examples of extinct volcanoes.
- Volcanoes can also be classified based on their structure and composition as composite Volcano, shield volcano and dome volcano

Composite Volcano:

- Composite volcano, also known as strata Volcano, is a conical volcano built by many Layers of hardened lava, pumice and volcanic Ash.
- These are commonly found in the Pacific Ocean Eg. Mt. Fujiyama, Japan

Volcanic Dome:

- A lava dome or volcanic dome is roughly a circular mound formed due to the slow Ejection of viscous lava from a volcano.
- As the Lava is rich in silica with intense viscosity;
- It is Prevented from flowing far from its vent. E.g., Parícutin, Mexico

Shield Volcano:

- Shield volcanoes are formed by intense Viscous lava.
- These are shallow Depositions with Gently sloping sides.
- Hence the lava flows out in all directions to create a shield. E.g., Mauna Loa, Hawaii

Distribution of Volcanoes in the world:

- Volcanoes are located in a clearly-defined Pattern around the world.
- They are closely Related to regions that have been intensely Folded or faulted.
- There are about 600 active Volcanoes and thousands of dormant and extinct ones.

- They occur along the coastal Mountain ranges, as off-shore islands and in the midst of oceans, but there are a few in the interior of continents.
- The volcanic belts are also the principal earthquake belts of the World.
- There are three major zones of volcanic Activities in the world. They are:
 - The Circum – Pacific belt
 - The Mid continental belt
 - The Mid Atlantic belt

Circum Pacific Belt:

- This is the volcanic zone of the convergent Oceanic plate boundary.
- It includes the Volcanoes of the eastern and western coastal Areas of Pacific Ocean.
- This zone is popularly termed as the Pacific Ring of Fire which has Been estimated to include two-thirds of the World's volcanoes.

Mid continental belt:

- This is the volcanic zone of convergent Continental plate boundaries that includes the volcanoes of Alpine Mountain chains, the Mediterranean Sea and the fault zone of eastern Africa.
- The important volcanoes are Vesuvius, Stromboli, Etna, Kilimanjaro and Kenya.
- Surprisingly, the Himalayas have no active Volcanoes at all.

Mid Atlantic Belt:

- This belt represents the divergent Boundary of plates located along the mid-Atlantic ridges.
- Volcanoes of this area are Mainly of fissure eruption type.
- Iceland is the most active volcanic area and is located on the mid-Atlantic ridge.
- St. Helena and Azores Island are other examples.

Effect of Volcanoes:

Constructive Effects:

- Volcanic materials enrich the soil fertility that promotes agricultural activities.

- The Hot volcanic region helps in generating geothermal energy.
- Many dormant and active Volcanoes are the most attractive tourist spots of the world.
- Most of the volcanic materials are used as building materials.

Destructive Effects:

- Volcanic eruption causes Earthquakes, flash Floods, mud slide and rock fall.
- Lava can travel Very far and burn, bury, or damage anything in its path.
- The large amount of dust and ash Makes breathing hard and irritable.
- Volcanic Eruptions can alter the weather conditions and disrupt transport (Iceland volcanic Eruption) in and around the volcanic region.

Exogenetic Processes:

- Exogenetic Processes the Earth is a dynamic system that Undergoes various changes due to internal and external processes.
- The continuous Interaction of these two processes controls the Structure of the earth's surface.
- The external Processes are the consequence of solar energy and gravitational forces, whereas the internal Processes are an outcome of the earth's internal Heat.

Weathering:

- Weathering is the breaking, disintegration and decomposition of materials of the earth's Crust by their exposure to atmosphere.
- There are three types of weathering
 - Physical weathering,
 - Chemical weathering and
 - Biological weathering

Physical weathering

- It is the breakdown of rocks without changing their chemical composition, through the action of physical forces.
- The constant Freezing and thawing of rocks during the Night and day leads to the expansion and Contraction of rocks.
- Cracks are formed and Disintegration occurs eventually.

- Exfoliation, Block disintegration, granular disintegration, are the Major types of physical weathering.

Exfoliation:

- The alternate heating and cooling on Rounded rock surfaces leads to the peeling of rocks, layer by layer like an onion.
- This is Called exfoliation.
- Sheeting and shattering are the other forms of exfoliation.

Granular Disintegration:

- Granular disintegration takes place in crystalline rocks where the grains of the rocks become loose and fall out.
- This is due to the Action of temperature.

Block Disintegration:

- Repeated expansion and contraction of rocks during day and night respectively Causes stress on the joints of the rocks which Results in block disintegration

Chemical Weathering:

- Disintegration and decomposition of Rocks due to chemical reactions is called Chemical Weathering.
- This is predominantly high in the hot and humid regions such as the equatorial, tropical and sub-tropical Zones.
- Chemical weathering takes place through the processes of oxidation, Carbonation, solution, and hydration.
- The Agents of Chemical weathering are Oxygen, Carbon-dioxide, Hydrogen and water.

Oxidation:

- Oxygen in the atmosphere reacts with the iron found in rocks, thus leads to the formation of iron oxide.
- This process similar to the rusting of iron, pressure of air and water is known as oxidation, which results in the weakening of rocks.

Carbonation:

- Carbonation is the mixing of water with the atmospheric carbon-dioxide, forming Carbonic acid.
- Carbonation is important in the formation of caves, in limestone region.
- When the carbonic acid reacts with the Carbonate rocks, the rocks get disintegrated.

Solution:

- The dissolution of rock substances in water result in the loosening of the rock particles.
- This in turn breaks down the rocks.

Hydration:

- Absorption of water into the mineral Structure, certain chemicals in the rock Enlarge in size in humid conditions.
- These Minerals found in the rock swell and this Results in the development of cracks and the rock wears down.
- This type of weathering is Called hydration.

Biological Weathering:

- Biological weathering occurs due to the Penetration and expansion of plant roots, Earthworms, burrowing animals (rabbits, Rats) and some human activities.

Gradation:

- Gradation is the process of levelling of the land by means of natural agents like Rivers, ground water, winds, glaciers, and Sea waves.
- These agents produce various Gradational relief features in due course of Time.
- Gradation takes place in two ways:
 - Degradation and aggradation.
 - Gradation is the levelling land surface by Various natural agents. Aggradation is building up of landforms Due to natural agents.
 - Degradation is eroding of land surface.

Agents of Gradation:**Running water (River)-(Fluvial Land forms)**

- The work of running Water (rivers) is the most Extensive among all the other Agents of gradation.
- Rivers originate on Higher landforms like, mountains, hills and Plateaus that receive water from various Sources like the rain, glaciers, springs, lakes, Etc.
- The place where the river originates is called catchment area and where it joins the Sea is known as mouth.

Courses of River:

- Rivers generally originate from Mountains and end in a sea or lake.
- The whole Path that a river flows through is called its Course.
- The course of a river is divided into:
 - The upper course
 - The middle course and
 - The lower course

The Upper Course:

- Erosion is the most dominant action of river in the upper course.
- In this course, a river usually tumbles down the steep Mountain slopes.
- The steep gradient increases the velocity and the river channel Performs erosion with great force to widen and deepen its valley.
- The land features carved by a river in its upper course are V-Shaped valleys, gorges, canyons, rapids, Pot holes, spurs, and waterfalls.

The Middle Course:

- The river enters the plain in its middle Course.
- The volume of water increases with the confluence of many tributaries and thus increases the load of the river.
- Thus, the predominant action of a river is Transportation.
- Deposition also occurs due to the sudden decrease in velocity.
- The river in the middle course develops some typical Landforms like flood plains, meanders, ox-Bow lakes etc.,

The Lower course:

- The river, moving downstream across a Broad, level plain is loaded with debris, Brought down from its upper and middle Courses.
- Large deposits of sediments are Found at the level bed and the river, splits into a number of channels called Distributaries.
- The main work of the river here is deposition and it develops typical Landforms like delta and estuary.
- **Tributary** – Small streams that join the Main River. **E.g.**, River Bhavani
- **Distributary** – River channels that get Separated from the main river. **E.g.**, River Kollidam.

Erosional Landforms of River:

Gorges and Canyons:

- When the river flows through a Mountainous region made up of hard rocks, it forms a valley with almost vertical sides Called gorge.
- In India, deep gorges have been Formed by Brahmaputra and Indus in the Himalayas.
- A deep gorge with steep sides that runs for hundreds of kilometres is referred to as canyon **e.g.**, Grand Canyon of the river Colorado in the U.S.A.

Waterfall:

- When a river flows in a region where Hard rocks lie over soft rocks horizontally, the soft rocks get eroded quickly and the Hard rocks projects outwards.
- Thus, the river Falls vertically from a steep slope to form a Waterfall.
- When the water falls with great force, it erodes the rock material beneath and creates a depression called a plunge pool.
- Shallow fast flowing water in a stream is Called a rapid or river jumps the highest waterfalls in the world is Angel falls (979 m) in Venezuela.

V-shaped valley:

- A 'V'- shaped valley is formed by the Vertical erosion of the river where the valley Is deepened and widened.

Pot hole:

- Due to the river action, cylindrical Holes are drilled vertically in the river Bed, with varying depth and diameter. These are called pot holes.

Meander:

- As the river loaded with debris flows Slowly, it forms sweeping loops and bends. It is referred to as meanders.

Ox bow lake:

- Meanders in due course of time become almost a complete circle with narrow necks.
- This in turn gets abandoned and forms a lake.
- This is called an Ox-bow lake
- The world's largest oxbow lake is Lake Chicot is Arkansas of USA.
- Lake Kanwar in Bihar (India) is Asia's largest fresh water ox Bow Lake.

Depositional Landforms of River:**Alluvial Fan:**

- A fan shaped deposition made by the river at the foothills is called an alluvial plain Flood Plain Fine sediments are deposited on river Banks when a river floods.
- These sediments Make the region rich and fertile.
- This is called a flood plain.
- As the height of the river banks Gets increases due to continuous deposition of a flooded river, levees are formed.

Estuary:

- Estuary is formed where the rives Meets the sea.
- Deposition of silt by the river is Not possible here in the estuaries like delta as if the waves keep on eroding the deposits. **Ex.** River Narmada and Tapti.

Delta:

- A triangular shaped low lying area formed by the river at its mouth is called delta.
- Deltas have fine deposits of sediments Enriched with minerals. **E.g.,** Cauvery Delta, Tamil Nadu.

Karst Topography:

- As an agent of gradation, underground water creates distinct landforms in lime-Stone regions called Karst Topography.
- Ground water is an Active agent in limestone Regions.
- Karst topography is formed due to the Dissolution of soluble Rocks such as limestone, Dolomite and gypsum.
- Limestone topography of Western Slovenia extends for a distance of 480 km in Length and 80 km in width which is termed as Karst in the Slavic language.
- The world's largest karst area is the Nullarbar located on The Great Australian Coast.
- Karst regions are also found in Southern France, Spain, Mexico, Jamaica, Western Cuba, Central New Guinea, Sri Lanka and Myanmar.

Karst Areas in India:

- Western Bihar – Guptadham caves
- Uttarakhand – Robert cave and Tapkeshwar temple
- Madhya Pradesh – Pandav caves Pachmari Hills
- Bastar district in Chattisgarh – Kutumsar
- Andhra Pradesh(Visakhapatnam) – Borra caves

Erosional Landforms of Underground Water:

- Most of erosion takes place due to the Process of solution.
- When rain water mixes with carbon-di- oxide and enters into a Limestone region, it dissolves and destroys much of the limestone.
- As a result, landforms Such as Terra rossa, Lappies, sinkholes, Swallow holes, dolines, uvalas, poljes, caves and caverns are formed.
- Terra Rossa (Italian term for red soil) Deposition of red clay soil on the surface of the Earth is due to the dissolution of limestone Content in rocks.
- The redness of the soil is due to the presence of iron oxide.

Lappies:

- When the joints of limestone rocks are corrugated by groundwater, long furrows are formed and these are called LAPPIES.

Sinkhole:

- A funnel shaped depressions formed due to dissolution of limestone rock is Called sinkholes.
- Their average depth ranges between three and nine meters
- The World's deepest sinkhole is China's xianozhai Tienkang at 2172 feet.
- There are as many as 15000 Sinkholes in Illinois.

Caves and Caverns:

- Caves and caverns are subterranean Features of karst topography.
- Caves are hollows that are formed by the dissolution of limestone Rocks when carbon di oxide in air turns into Carbonic acid after its reaction with water.
- They Vary in size and shape.
- Caverns are the caves with irregular floors. **E.g.,** Guptadham caves in Western Bihar.
- All types of deposits in the caves and Caverns are collectively called speleothems Which includes travertines, tufa, dripstones Swallow Holes, Uvalas, Dolines, Poljis Are other erosional Features of karst regions Predominant in other parts of the world.

Depositional Landforms of Underground Water:

- It is interesting to know that a variety of Depositional features are formed on the floor, Ceiling and walls of the caves and caverns of the Karst Topography Stalactite, Stalagmite and Column.
- When the water containing dissolved Calcite gradually drips from the ceiling of the Caves, water evaporates and the remaining Calcite hangs from the ceiling.
- Thus, Stalactites are formed.
- When the calcite deposits rises Upward like a pillar Stalagmites are formed.
- Sometimes, Stalactites and Stalagmites meet together to form Columns or Pillars.

Glaciers:

- A Glacier is a large mass of ice that moves slowly over the land, from its place of accumulation.
- It is also known as ‘River of ice’.
- The Place of accumulation is Called snowfield.
- The height above which there is a permanent snow Cover in the higher altitude or latitude is Called snowline.
- Higher the latitude, lower the snowline from sea level.
- The gradual transformation of snow into Granular ice is called ‘firn’ or ‘neve’ and finally It becomes solid glacial ice.

Erosional Landforms of Glacier:

- Glaciers are powerful erosive agents.
- Some of the important erosional landforms are Cirque, Aretes, Matterhorn, U-shaped valley, Hanging valley, Fiords etc., Most of these glacial Features are predominantly seen in countries like Switzerland, Norway etc

Cirque:

- The glacier erodes the steep side walls of the Mountain and forms a bowl-shaped armchair like Depression, it is termed as Cirque

Arete:

- Aretes are narrow ridges formed when two Cirque walls joined together back to back, and Forms narrow knife like ridges.

Pyramidal Peak:

- The pyramidal peaks formed when three or more cirques meet together (e.g.) Matterhorns.

U-Shaped Valley:

- When the glacier moves down along a River valley, the valley further gets eroded deep and wide to form a ‘U’ shaped valley.

Hanging Valley:

- These are valleys eroded by tributary Glacier and that hangs over the main valley.

Fjord:

- Fjords are glacial valleys that are partly submerged in the sea.

Depositional Landforms of glacier:

- After getting eroded, fragments of rocks and boulders along with dirt form glacial Debris.
- Glacial debris gets deposited in the Low lying areas and form depositional features like moraines, drumlins, eskers, kames and Outwash plains.

Moraine:

- A material deposited by Glaciers is called Moraines.
- Based on the location, they are classified into Ground moraine, Terminal moraine and Lateral moraine.

Drumlin (Basket of Egg Topography):

- Drumlins are deposits of glacial moraines that resemble giant inverted teaspoons or half Cut eggs.

Esker:

- Long narrow ridges composed of Boulders gravel and sand deposited by Streams of melting water which run parallel to a glacier are called eskers.

Outwash Plain:

- An outwash plain consists of glacial Sediments deposited by the melting ice at the Terminus of a glacier.
- It appears as an extensive Accumulation of sand, gravel and silt.

Wind:

- When air blows horizontally at or near the earth's surface is called wind.
- The erosional, Transportational and depositional action of Wind is predominant in arid regions.
- This is called as Aeolian Process.
- Erosional Landforms of wind some of the erosional landforms of wind are Mushroom rocks, Inselbergs and yardangs.
- Mushroom rocks are made up of hard and soft layers.
- When a rock's bottom is soft, the sand-laden Winds blow against it and wear it down.

- By the constant Wearing down action of the wind, the bottom gets eroded away to form a mushroom like Structure.
- This is called a mushroom or Pedestal rock. Such rocks are found near Jodhpur in Rajasthan.

Inselberg:

- Inselberg is a German term which means an Island Mountain.
- Certain hard rocks like igneous rocks are more resistant to wind action.
- Such isolated residual hills Rising abruptly from their surroundings are termed as inselbergs. **E.g.**, Uluru or Ayers Rock, Australia.

Yardang:

- In arid regions, certain rocks have hard and soft layers arranged vertically.
- When Winds blow over these rocks, the soft layers get eroded leaving irregular crests. These are Called yardangs.

Depositional Landforms of wind:

- Some of the depositional landforms are Sand dunes, barchans and loess.

Sand Dune:

- In deserts, during sandstorms, wind Carries loads of sand.
- When the speed of Wind decreases, huge amount of sand gets deposited.
- These mounds or hills of sand are Called sand dunes.
- There are different types of Sand dunes.

Barchan:

- Barchan are isolated, crescent shaped Sand dunes.
- They have gentle slopes on the windward side and steep slopes on the Leeward side.

Transverse Dunes:

- Transverse dunes are asymmetrical in shape.
- They are formed by alternate slow and fast winds that blow from the same direction.

Longitudinal Dunes (Seif dunes):

- Longitudinal dunes are long narrow Ridges of sand, which extend in a direction parallel to the prevailing winds.

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- These dunes are called Seifs in Sahara

Loess:

- The term loess refers to the deposits of Fine silt and porous sand over a vast region.
- Extensive loess deposits are found in Northern and Western China, the Pampas of Argentina, in Ukraine and in the Mississippi Valley of the United States.

Wave:

- A steady up (crest) and down (trough) Movement of surface water are called waves.
- Sea waves are the most powerful agents of Gradation and their erosional, transformational and depositional processes are confined to a very Narrow belt along coastal areas.

Erosional Land Forms of Waves:

- Some of the erosional landforms of sea Waves are sea cliff, sea cave, arch, stack, Beach, bar and spit and wave cut platform.

Sea Cliffs:

- Sea cliffs are steep rock faces formed when Sea waves dash against them.
- The rocks get Eroded to form steep vertical walls.

Sea Cave:

- Prolonged wave attack on the base of a Cliff erodes rock materials, which result in the Formation of caves.

Sea Arch:

- When two caves approach one another from either side of a headland and unite, they Form an arch. (E.g.) Neil Island, Andaman and Nicobar.

Sea Stack:

- Further erosion by waves ultimately leads to the total collapse of the arch.
- The seaward Portion of the headland will remain as a pillar of rock known as stack. E.g. the Old man of Hoy in Scotland.

Wave Cut Platforms:

- Flat surface found at the foot of sea cliffs are Called as wave cut platforms.

- Wave cut platform Is also referred as wave cut benches terrace.

Depositional Landforms of Waves:

Beach:

- Sand and gravel are moved and deposited by waves along the shore to form beaches.
- This is the most dominant and constructive Work of the sea. (E.g.) Juhu beach along Mumbai coast, Puri beach in Odisha and Marina beach in Chennai.

Bar:

- A bar is an Elongated deposit of sand, shingle or mud found in the sea, almost Parallel to the Shoreline.

Spit:

- A spit Is a ridge or Embankment of sediment, attached to the Land on one End and terminating in open water on the other end.
- Spits are common at the mouth of Estuaries. E.g. Kakinada spit.

Atmosphere:

- Atmosphere is a mixture of gases, Water vapour and dust particles in different Proportions.
- Nitrogen (78%) and Oxygen (21%) are permanent gases of the atmosphere.
- They constitute 99% of the total composition and their percentages always remain the Same without any change.
- The remaining one Percentage is occupied by Argon (0.93%), Carbon-dioxide, (0.03%), Neon (0.0018%), Helium (0.0005%), Ozone (0.00006%) and Hydrogen (0.00005%).
- Krypton, Xenon and Methane are also present in trace.
- Water vapour (0 – 0.4%) is also found in the Atmosphere, which plays an important role in Predicting weather phenomenon.
- The other Solid particles present in the atmosphere Includes dust particles, salt particles, pollen Grains, smoke, soot, volcanic ashes etc.,
- Oxygen is most important for living Organisms. CO₂ absorbs heat and keeps the Atmosphere warm by insulation and radiation.

- Nitrogen acts as a diluent and is chemically Inactive.
- Ozone helps in protecting the earth from harmful ultra violet radiation.
- The solid Particles in the atmosphere acts as nuclei on which water vapour condense to form Precipitation.

Structure of the Atmosphere:

- The atmosphere is thick near the earth Surface and thins out until it eventually merges with space.
- The five atmospheric layers are: Troposphere, stratosphere, Mesosphere, Thermosphere and Exosphere.

Troposphere:

- The lowest layer of the atmosphere is the Troposphere.
- The Greek word ‘tropos’ means ‘turn’ or change.
- The layer extends up to 8 kms at the poles and up to 18 kms at the Equator.
- The Temperature decreases with increasing height.
- Almost all weather phenomenons take place in this layer.
- Hence it is called weather making Layer.
- The upper limit of the troposphere is called as tropopause.

Stratosphere:

- Stratosphere lies above the troposphere.
- It extends to a height of about 50km above Earth surface.
- Since this layer is a concentration of ozone molecules, it is also referred as Ozonosphere.
- The temperature increases with increase in height in this layer.
- Large jet Planes normally fly here.
- The upper limit of the Stratosphere is called as stratopause.

Mesosphere:

- Mesosphere extends between 50km and 80km.
- The temperature decreases with increasing height.
- Most of the meteors nearing the earth get burned here.
- The upper most limit of the mesosphere is the mesopause.

Thermosphere:

- Thermosphere exists above the mesosphere.
- It extends to about 400 km.
- The composition of Gases in the lower thermosphere is more or less uniform, hence it is called “Homosphere”.
- The Upper portion of the thermosphere has uneven Composition of gases and hence it is referred as “Heterosphere”.
- Here the temperature increases with increasing height.
- Ionosphere is a layer of the thermosphere that contains Ions and free Electrons.
- Radio waves transmitted from earth are reflected back to earth from this layer.

Exosphere:

- The uppermost layer of the atmosphere is Called exosphere.
- This layer is extremely rarefied with gases and gradually merges with the outer Space.
- This zone is characterized by aurora Australis and aurora borealis.

Hydrosphere:

- The Earth is covered by water which occupies 71 percent and land that occupies 29 percent of the Earth’s Surface.
- The surface of the Earth is not even, because it has lofty mountains, Deep oceans and other landforms Continents and oceans are grouped as First order landforms.
- The vast land masses on Earth are called Continents and huge Water bodies are called Oceans.
- There are seven continents. They are Asia, Africa, North America, South America, Antarctica, Europe and Australia.
- Asia is the largest continent, whereas Australia Is the smallest one.
- Apart from continents, there are five Oceans located on the Earth’s surface.
- They are the Pacific, Atlantic, Indian, Southern and Arctic Oceans.

- Among these oceans, the Pacific Ocean is the Largest and the Arctic Ocean is the smallest.

Pacific Ocean:

- The Pacific Ocean is the largest and Deepest Ocean on the Earth.
- It covers about One-third of the Earth Total area and spreads for about 168.72 million sq.km.
- It is bounded by Asia and Australia in its west and North America and South America in its east.
- It stretches From the Arctic Ocean in the north to the Southern Ocean in the south.
- This ocean's shape is roughly Triangular with its apex in the north at the Bering Strait which connects the Pacific Ocean with the Arctic Ocean.
- The Bering Sea, the China Sea, the Sea of Japan, Tasman Sea and the Philippine Sea are some of the marginal seas of the Pacific Ocean.
- Indonesia, Philippines, Japan, Hawaii, New Zealand are some of the islands located in this Ocean.
- The deepest point Mariana Trench is 10,994 m- and is located in the Pacific Ocean.
- A chain of volcanoes is located Around the Pacific Ocean called the Pacific Ring of Fire.

Atlantic Ocean:

- The Atlantic Ocean is the second largest ocean on Earth.
- It covers one sixth Of the Earth's total area and spreads for About 85.13 million sq.km.
- It is bounded By North America and South America in the west and Europe and Africa in the East.
- Like the Pacific, it stretches from the Arctic Ocean in the north to the Southern Ocean in the south.
- The shape of the Atlantic Ocean resembles the letter 'S'.
- The Strait of Gibraltar connects the Atlantic Ocean with the Mediterranean Sea.

- The Atlantic Ocean is the busiest Shipping route between the Eastern and Western hemispheres.
- The deepest point is the Milwaukee Deep in the Puerto Rico Trench.
- It has a depth of about 8600 m-.
- The Caribbean Sea, the Gulf of Mexico, The North Sea, the Gulf of Guinea and the Mediterranean Sea are important marginal Seas of the Atlantic Ocean.
- St. Helena, Newfoundland, Iceland and Falkland are Some of the islands found in this ocean.

Indian Ocean:

- The Indian Ocean is the third largest ocean on the Earth's surface.
- It covers an area of about 70.56 million sq.km.
- It is named after India.
- It is triangular in shape and bounded By Africa in the west, Asia in the north and Australia in the east.
- The Andaman and Nicobar Islands, Lakshadweep, Maldives, Sri Lanka, Mauritius and the Reunion Islands are some of the islands located in the Indian Ocean.
- Malacca strait connects the Indian Ocean and the Pacific Ocean.
- The Bay of Bengal, the Arabian Sea, the Persian Gulf and the Red Sea are some of the important marginal seas of the Indian Ocean.
- The Java trench (7,725m-) is the Deepest point in the Indian Ocean.
 - Palk Strait connects the Bay of Bengal and Palk Bay.
 - 6° Channel Separates Indira Point and Indonesia
 - 8 Channel separates Maldives and Minicoy islands
 - 9° Channel separates Lakshadweep Islands and Minicoy Islands
 - 10° Channel separates Andaman and Nicobar Islands

Southern Ocean:

- The Southern Ocean surrounds the Continent of Antarctica and is enclosed by the 60°S latitude.
- It covers an area of 21.96 million sq.km.

- It is bordered by the Southern parts of the Pacific, the Atlantic and the Indian Oceans.
- The Ross Sea, the Weddell Sea and the Davis Sea are the Marginal seas of this Ocean.
- Farewell Island, Bowman Island and Hearst Island are some of the islands located in this ocean.
- The Water in this ocean is very cold. Much of it is covered by sea ice.
- The deepest point in this ocean is South Sandwich Trench with a depth of 7,235 m-

Arctic Ocean:

- The Arctic Ocean is the smallest ocean.
- It covers an area of 15.56 million sq.km.
- It lies within the Arctic Circle.
- It remains Frozen for most of the year.
- The Norwegian Sea, the Greenland Sea, the East Siberian Sea and the Barents Sea are some of the Marginal seas of this ocean.
- Greenland, New Siberian Island and Novaya Zemlya Island are some of the islands located in the Arctic Ocean.
- The North Pole is situated in the middle of the Arctic Ocean.
- The Eurasian Basin is the deepest Point in the Arctic Ocean, which is above 5,449 m- In depth.

Island: A land Surrounded by Water on all Sides.

- **Bay** - A broad inlet of The Sea where the land curves inwards.
- **Strait** - A narrow stretch of water linking two large water Bodies.
- **Trench** - The deepest part of the ocean.
- **Peninsula** - The land Surrounded by Water on three Sides.
- One of the most indispensable natural Resources on earth is water.
- The Earth is also called the blue planet, as it holds water in Abundance and thus stands unique among all other planets.
- Hydrosphere consists of water in various forms found on the earth.
- Over 97% of the water on the Earth's surface is confined to Oceans.

- Less than 3% of water is held on land glaciers, ice caps, groundwater, rivers, lakes, And also as the water vapour in air.

Hydrological Cycle:

- The Earth's water is not static.
- It is always in Motion.
- This continuous Movement of water on, above and below the Earth's surface is called the Hydrological Cycle.
- The three major processes involved in the Water cycle are evaporation, condensation and precipitation.
- Water changes its form constantly i.e., Ice, water and water vapour.
- This process happens in the blink of an eye or even over millions of years.
- Water resources of the Earth can be broadly Divided into fresh water and salt water.

Fresh Water:

- Rain water is considered to be the purest Form of water, as it contains very less proportion of salts when compared to the oceans and Seas.
- In the form of ice caps and glaciers.
- Around 1% of it is found in the liquid state as rivers, Streams, lakes, ponds etc.
- Surface water may also penetrate through porous rocks and gets Collected beneath the Earth's surface. This is Called groundwater.
- Finland is known as the land of thousand Lakes.
- There are 1,87,888 lakes in Finland.
- Water table is a level below the Ground, where water is found Collected beneath the Earth's Surface.
- Aquifers are porous rock Strata filled with water, found below the Earth's surface.

Oceans:

- The continents and oceans are however, Not evenly distributed in the northern and the southern hemispheres.

- The northern Hemisphere holds 61% of land whereas the Southern hemisphere holds 81% of water.
- It is because of this pattern of land and water Distribution, the northern hemisphere is called as the land hemisphere and the Southern hemisphere is called as the water Hemisphere.
- Oceans and seas are considered as resource Bowl of the earth because of the immense Availability of food, minerals etc., Present Distribution of the world's oceans and major Seas

Relief of the Ocean Floor:

- The ocean basins are Characterised by the following

Major relief features:

- Continental shelf
- Continental slope
- Continental rise
- Deep sea plain or Abyssal plain
- Oceanic deep
- Oceanic ridge

Continental Shelf:

- A shallow and gently sloping platform extending out from the adjoining continental land mass into the sea is called Continental Shelf.
- It is almost a Uniform zone of sea bed with a gentle gradient.
- The continental shelf is of great significance for the following reasons:
 - They are shallower, thus enables sunlight to Penetrate through the water.
 - This encourages Abundant growth of grass, sea weeds and Plankton.
 - Hence these zones become the Richest fishing grounds in the world. Eg. The Grand Banks of Newfoundland.
 - The continental shelves have extensive Deposits of minerals and mineral fuels.
 - Hence, this zone becomes accessible for Oil drilling and mining activities. E.g., Mumbai High in Arabian Sea.

Continental Slope:

- A steep slope which descends from the edge of the continental shelf to the deep ocean-bed is Called continental slope.
- It forms a boundary Between the Continental Crust and the oceanic Crust.
- This zone is free from deposits as they are steep.
- The most important characteristic of continental slope is the presence of deep Canyons and trenches.
- Due to the low Penetration of sunlight, the slope has nearly Freezing temperature.
- Hence aquatic life has Very slow rate of metabolism.

Continental Rise:

- At the base of the continental slope is a gently sloping Layer of sediments which merge into the deep-Sea floor.
- This underwater feature found between Continental slope and abyssal plains is called the Continental rise.
- It consists of submarine fans Which are similar to the alluvial fans found on land.

Deep Sea Plains or Abyssal Plains:

- The deep sea plains or abyssal Plains are underwater plains found on the deep ocean floor.
- These plains extend from Continental rise to the mid Oceanic ridges.
- The gradient of the slope is very gentle and it appears as a uniform flat and featureless plain.
- These plains are usually covered by the thick layer of sediments composed of clay, silt and sand, Brought by the rivers.
- These are often characterized by features like abyssal hills, sea mounts, guyots, Coral, atoll etc.
- Abyssal plains in the Atlantic and Indian Oceans tend to Be extensive than the Pacific Oceans because, majority of the world's largest rivers Empty their sediments into either Atlantic or Indian Ocean. E.g., Amazon, Ganga and Brahmaputra rivers.

Oceanic Ridge:

- Oceanic ridge is a continuous submarine Mountain chain.
- They are made of young basaltic rock formed when two tectonic plates Moves apart.
- The mid-ocean ridge is probably the most extensive single feature of the earth's Topography.
- Two of the most well known mid-Ocean ridges are the Mid-Atlantic Ridge and the East Pacific Ridge.
- The Mid-Atlantic Ridge is the largest unbroken oceanic ridge.

Fathoms:

- A nautical Measurement of the depth of Water in the ocean.

Isobath:

- An imaginary line on a map joining the points of equal depths.

Isohaline:

- An imaginary line on a map Joining the points of equal salinity in oceans.

Movement of the Ocean Water:

- The ocean water is dynamic.
- Temperature, Salinity, density, external forces of the sun, Moon and the winds keep the ocean waters in Movement, both horizontally and vertically.
- Waves and currents are in horizontal motion while tides have vertical motion.

Waves:

- All the movements of the oceans, sea waves are considered to be the strongest.
- Sea waves are Ripples on water caused when winds blow over the sea.
- The height of these waves depends on the speed of wind, its duration and the direction from which they blow.
- Sometimes waves are also caused by tremors felt on the ocean floor.
- Such Waves are quite destructive and called Tsunami.

Tides:

- The periodic rise and fall of sea water due to the gravitational pull of the sun and moon on earth are called tides.
- They are classified Broadly into Spring tides and Neap tides.
- When the Sun, Moon and Earth are aligned in the same line, the collective gravitation pull of the sun and moon on earth's water strengthens to Form a high tide known as spring tide.
- Such tides Always occur on full moon and new moon days.
- When the sun and the moon are at right Angles, their gravitational forces work against Each other, causing a low tide called neap tide.
- A neap tide occurs between two spring tides i.e., Twice a month, when the first and last quarter Moon appears.

Oceans Currents:

- The movement of oceanic water on the Surface and at the depths in a definite direction is called ocean current.
- Ocean currents are in clockwise motion in the northern hemisphere and in the anti-clockwise motion in the southern Hemisphere.

The factors that generate ocean currents are:

- Earth's rotation
- Prevailing winds and
- Differences in temperature and salinity of Ocean water.
- On the basis of temperature, ocean currents are classified as warm currents and cold currents.
- The movement of ocean currents from the high latitudes (temperate and Polar zones) towards low latitudes (tropical Zones) is called cold current. E.g., Labrador in Atlantic Ocean and Peruvian cold current in South Pacific Ocean.