APPROACH – ANSWER: G. S. MAINS MOCK TEST - 2064 (2023)

Answer all the questions in NOT MORE THAN 200 WORDS each. Content of the answers is more important than its length. All questions carry equal marks. ***12.5X20=250***

1. Give a brief account of various erosional and depositional landforms created by movement of glaciers.

Approach:

- Briefly explain what you understand by a glacier.
- Write about the erosional landforms created by it.
- Discuss the depositional landforms created by it.

Answer:

Masses of ice moving as sheets over the land or as linear flows down the slopes of mountains in broad trough-like valleys are called glaciers. They are formed through the processes of **accumulation, compaction** and **recrystallisation** of snow. The movement of a glacier is very slow and it moves from a few centimetres to a few metres in a day. During this movement, a glacier forms various landforms.

Erosional landforms created by the movement of a glacier are the following:

- **Glacial Valleys/Troughs**: Glaciated valleys are **trough-like and U-shaped** with broad floors and relatively smooth, and steep sides.
- **Cirque**: These are **bowl shaped depressions** found at the head of glacial valleys. For most alpine glaciers, cirques are the areas where snow first accumulated and was modified into glacial ice. A lake found in a cirque is called a **tarn.**
- **Horns:** These are **pyramidal peaks** that form when several cirques chisel a mountain from three or more sides. The highest peaks of Alps (Matterhorn) and Himalayas (Everest) are in fact horns formed through headward erosion of radiating cirques.
- **Arete**: These are formed as a **spiky high land between two glaciers.**
- **Valley step**: It is an **abrupt change in the longitudinal slope** of a glacial valley.
- **Bergschrund**: These form when **a crevasse or wide crack opens along the headwall** of a glacier; most visible in the summer when covering snow is gone.

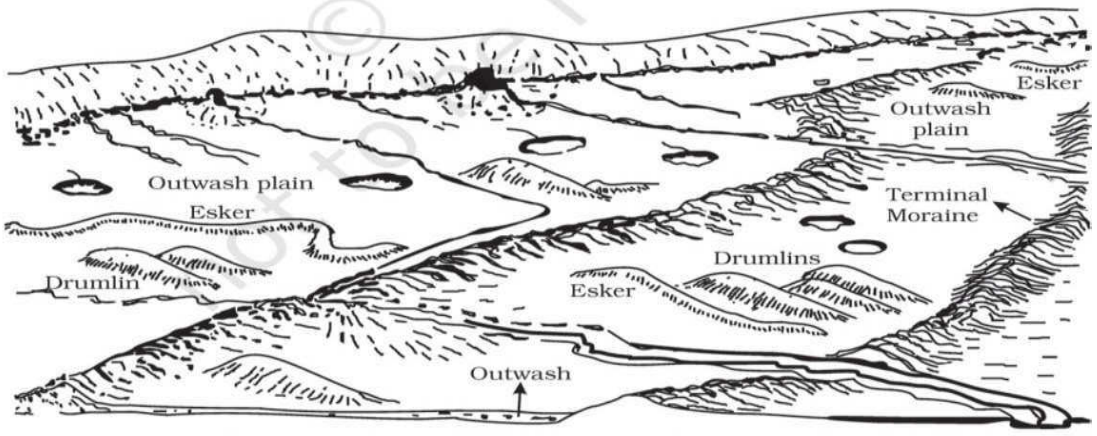


Figure 7.14 : A panoramic diagram of glacial landscape with various depositional landforms (adapted and modified from Spencer, 1962)

Depositional landforms created by the movement of glaciers include:

- **Till deposits:** The unassorted coarse and fine debris dropped by the melting glaciers is called **glacial till**. Most of the rock fragments in the till are angular to subangular in form.
- **Outwash plains:** Streams form by melting ice at the bottom, sides or lower ends of glaciers. Some amount of rock debris small enough to be carried by such melt-water streams is washed down and deposited. Such glaciofluvial deposits are called outwash plains.
- **Moraines**: They are long ridges of deposits of glacial till. Based on their orientation with the glacier, they are termed as terminal moraines, lateral moraines, horse-shoe shaped ridge, ground moraines and medial moraine.
- **Eskers:** These are sinuous ridges formed as a result of melting of ice. During summers, the water accumulates beneath the glacier and flows like streams in a channel beneath the ice. This causes very coarse materials like boulders and blocks along with some minor fractions of rock debris carried into these streams and settle in the valley of ice beneath the glacier giving rise to eskers.
- **Drumlins**: Drumlins are smooth oval shaped ridge-like features composed mainly of glacial till with some masses of gravel and sand.

2. Highlighting the different types of earthquake waves, discuss the emergence of shadow zones.

Approach:

- Write about the different types of earthquake waves.
- Discuss the concept of shadow zone and its emergence.
- Conclude accordingly.

Answer:

Earthquake waves, also called seismic waves, are basically of **two types- body waves and surface waves.** Body waves are **generated due to the release of energy** at the focus and move in all directions travelling through the body of the earth. **Body waves are of two types:**

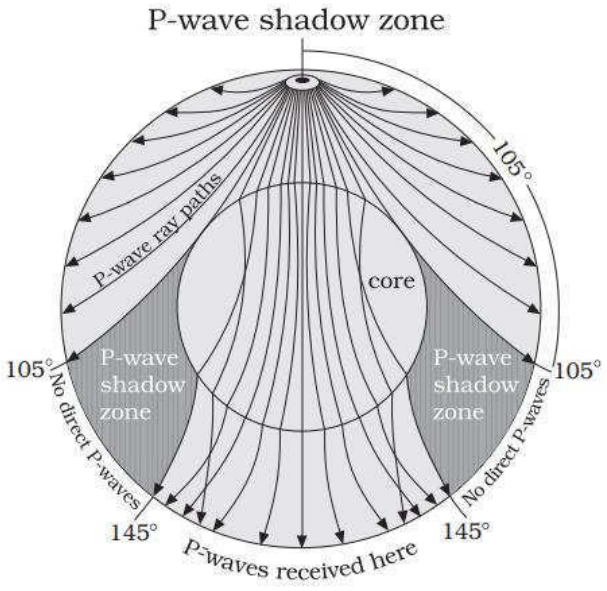
- **P-waves**: They are the **first to arrive** at the surface. They **travel through gaseous, liquid and solid materials**. P-waves **vibrate parallel to the direction of the wave**.
- **S-waves**: They arrive at the surface with some **time lag**. S-waves can **travel only through solid materials**. The direction of vibrations of S-waves is **perpendicular to the wave direction** in the vertical plane. Hence, they **create troughs and crests** in the material through which they pass.

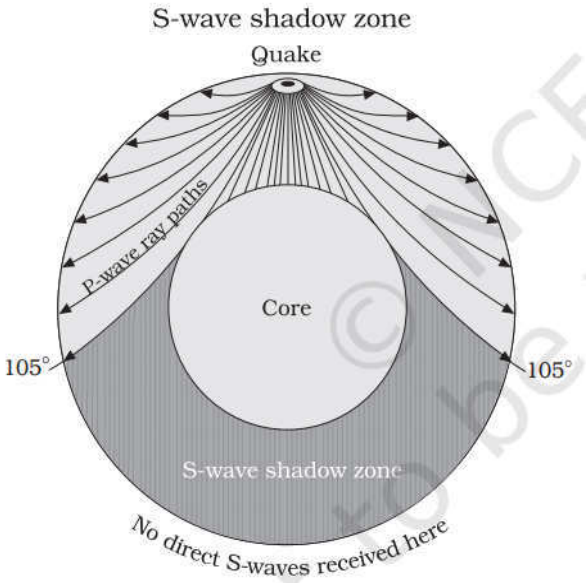
When body waves interact with the surface rocks, they generate a new set of waves called **surface waves**. These waves move along the surface. They cause displacement of rocks, and hence, the collapse of structures occurs. **Surface waves are of two types**:

- **Love waves**: They have a particle motion, which, like the S-wave, is transverse to the direction of propagation but with no vertical motion. Their side-to-side motion causes the ground to twist from side to side.
- **Rayleigh waves**: They create a rolling, up and down motion with an elliptical and retrograde particle motion confined to the vertical plane in the direction of propagation.

Shadow zone:

Though earthquake waves get recorded in seismographs located at far off locations, there exist some specific areas where the waves are not reported. Such zones are called **'shadow zones'.** It was observed that seismographs located at any distance within 105° from the epicentre, recorded the arrival of both P and S-waves. However, the seismographs located beyond 145° from epicentre, record the arrival of P-waves, but not that of S-waves. Thus, a zone between 105° and 145° from epicentre was identified as the shadow zone for both the types of waves. The entire zone beyond 105° does not receive S-waves. The shadow zone of S-wave is much larger than that of the P-waves, and is a little over 40 per cent of the earth surface.





Seismologists have concluded that the emergence of the shadow zone is because of the internal **structure of the earth which is not homogeneous**. Earth's interiors have **uneven density** which leads to emergence of shadow zones. **The shadow zone of P waves have led to identification of boundaries between the mantle and core**. Further, it has also been deduced that the outer core is made of liquid, as **S-waves** cannot travel through liquid mediums and **P-waves** are refracted by the liquid core. Thus, the concept of the shadow zone has helped seismologists get information about the interior of the earth's surface.

3. Explain the concept of diastrophism and the processes involved.

Approach:

- Explain the concept of diastrophism
- Discuss the various processes involved in it.
- Conclude accordingly.

Answer:

Diastrophism is an endogenic process and consists of all processes that **move, elevate or build up portions of the earth's crust.** It is the process that brings about changes in the configuration of the surface of the earth. They move, elevate or build up portions of the earth's crust owing to the energy emanating from within the earth. This energy is mostly generated by **radioactivity, rotational and tidal friction and primordial heat** from the origin of the earth.

The process of diastrophic movements are of the following types:

- **Orogenic processes:** These involve mountain building through severe folding and affecting long and narrow belts of the earth's crust. This process takes place when tectonic plates collide, separate or slide along one another. This causes mountain building through severe folding and affects long and narrow belts of the earth's crust. Some examples of ongoing orogenic processes are the Mediterranean ridge, Andean orogeny, the Himalayan orogeny etc.
- **Epeirogenic processes**: These processes involve uplift or warping of large parts of the earth's crust. They involve a strict vertical movement of a continent rather than horizontal movement and also uplifting or warping large parts of the earth's crust. These processes lift the whole region evenly and result in the formation of gentle arches and structural basins.
- **Plate tectonics:** These involve horizontal movements of crustal plates. The outer shell of the earth i.e., the lithosphere is broken up into tectonic plates. Plates are classified as major, minor and micro. Plate tectonics is simply the process of horizontal movement of these plates. The current physical map of the world with distribution of continents and oceans is the result of the plate tectonic process.

- **Earthquakes:** They involve relatively local minor movements. Earthquakes occur when the surplus accumulated stress in rocks in the earth's interior due to folding, faulting or other physical changes is relieved through the weak zones over the earth's surface in the form of kinetic energy (seismic waves). Such movements may result in uplift or subsidence in coastal areas.

Through the processes of orogeny, epeirogeny, earthquakes and plate tectonics, there can be faulting and fracturing of the crust. All these processes cause pressure, volume and temperature (PVT) changes which in turn induce metamorphism of rocks.

4. How are landslides in Western Ghats different from that in the Himalayas?

***Approach**:*

- Define landslides in the introduction.
- Mention the differences between landslides in the Western Ghats and the Himalayas.
- Conclude accordingly.

***Answer**:*

Landslide is the movement of a mass of rock, debris, earth, or soil (soil being a mixture of earth and debris) on downslope. **Landslides occur when gravitational and other types of shear stresses within a slope exceed the shear strength (resistance to shearing) of the materials that form the slope.** They often take place in conjunction with earthquakes, floods and volcanoes. Prolonged rainfall is one of the most important triggers. The two regions most vulnerable to landslides in India are the Himalayas and the Western Ghats.

There are several differences between the landslides of the two regions, including:

- **Reasons for the occurrence of landslides**:
  - The Himalayan mountain belt comprises of **tectonically unstable younger geological formations subjected to severe seismic activity.** Also, the northward movement of the Indian plate causes continuous stress on the rocks rendering them friable, weak and prone to landslides.
  - In the Western Ghats, almost all mass movements occur during monsoons (South-West and North-East monsoons) in the western flank and, during occasional cyclonic events in the eastern flank indicating **that main triggering mechanism is the over- saturation of overburden caused by heavy rains.** Their **steep seaward slopes** are deeply dissected by **streams and canyonlike valleys**. Further, pronounced **mechanical weathering** due to temperature changes and ranges along with **high intensity rainfall** during the monsoon trigger landslides.
- **Nature of landslides**: Compared to the Western Ghats region, the landslides in the Himalayan region are **huge and massive** and in most cases, the overburden along with the **underlying lithology is displaced** during sliding particularly due to the seismic factor.
- **Frequency of occurrence**: Landslides occur **very frequently in the Himalayas** whereas they are not that frequent in the Western Ghats.
- **Slope instability:** The Himalayan region has **high slope instability due to the immature and rugged topography**. Compared to that, the Western Ghats are **geologically stable** and are mostly made up of very hard rocks, but have **uplifted plateau margins** influenced by neo-tectonic activities that provides gradient for the landslides.

Although the causes of the landslides in the regions are different, the devastation caused by them are similar. Other than that, increased anthropogenic activities in terms of infrastructure development, construction of dams, and quarrying and mining in the both the regions are inflicting heavy damages to the slopes**.** Thus, management of landslides would require coordinated efforts by limiting anthropogenic activities, as well as closely cooperating with all the stakeholders in the disaster management cycle.

5. Highlight how tourism impacts other sectors in India, with special focus on infrastructure and art and craft.

Approach:

- Give a brief introduction on tourism in India.
- Explain how the sector has impact over other sectors like infrastructure industries, retail trading and the craft industries.
- Conclude accordingly.

Answer:

India is a large market for travel and tourism. It offers a diverse portfolio of niche tourism products such as cruises, adventure, medical, wellness, sports, MICE (meetings-incentives-conferences and exhibitions), eco-tourism, films, rural and religious/spiritual tourism. The travel and tourism industry's contribution to the GDP of India was around **$121.9 billion** in 2020.

Impact of tourism over other sectors in India:

- **Fosters growth of infrastructure industries**: To attract tourists, adequate infrastructure is required, such as:
  - **Connectivity**: It requires well-maintained all-weather connectivity leading to construction of roads, railways, airways and shipping. The Indian airline travel market at $20 billion in 2020, is projected to double in size by FY27 due to improving airport infrastructure and growing access to passports.
  - **Hospitality infrastructure**: Demand for both luxury stays and affordable stays are increasing. In October 2021, firms such as Accor and Wyndham Hotels and Resorts announced to increase their footprints in India. Further, OYO estimates India to present a US$ 26 billion opportunity by 2030.
  - **Medical infrastructure**: The availability of affordable treatment through modern medicines and development in the streams of alternative medicines like Ayurveda, Naturopathy, Unani, Siddha, Sowa-Rigpa and Homoeopathy, have made India a thriving destination for medical value tourism. The sector is expected to grow at a CAGR of 21.1% from 2020 to 2027.
  - **Digital infrastructure**: Tourism was one of the first sectors to digitalize business processes, bringing flight and hotel booking online, on a global scale. The government is also facilitating the development of digital infrastructure to promote Ease of Doing Business for the hospitality & tourism sector through schemes such as National Integrated Database of Hospitality Industry (NIDHI) 2.0.
  - **Amusement infrastructure**: There has been a focus on the development of water sports, cruise, light and sound shows, wild safari, etc. to provide thrilling experience to the tourists. For instance, the Ministry of Tourism is planning to develop an international-level infrastructure in Kargil (Ladakh) to promote adventure tourism and winter sports.
- **Promotes art and craft:** According to the UNEP and UNTWO (2005), it is estimated that tourists spend around 40 percent of their budget on souvenir purchases and other craft products. The government has taken several initiatives to promote local art and craft among the tourists. **These include:**
  - The economy of Kutch, a desert city is highly dependent upon the art, crafts, music and dance of the region, and gets a boost due to the annual **Kutch Rann Utsav** that attracts thousands of tourists.
  - The government promotes **craft experience tourism model** these days. For instance, **the government holds craft safari** to promote local handicrafts in Srinagar. Also, **Kerala and Tamil Nadu governments have initiated ambitious Craft Tourism Village projects** such as at Vellar and at Mamallapuram respectively.
  - **'Heritage Walks'** such as in Agra, Delhi, Hyderabad, Hampi, Ajanta, etc. also promote the tangible and intangible cultural legacies.

In 2020, the Indian tourism sector accounted for 31.8 million jobs, which was 7.3% of the total employment in the country. By 2029, it is expected to account for about 53 million jobs. Thus, India's travel and tourism industry has huge growth potential. Keeping that in mind, several branding and marketing initiatives of the Indian government such as 'Incredible India' and 'Atithi Devo Bhava' campaign are steps forward in the right direction.

6. Give an account of the global distribution of volcanoes and explain why they are mainly concentrated along the Pacific Ring of Fire.

Approach:

- Start by introducing volcanoes.
- Give an account of the global distribution of volcanoes.
- Explain why they are mainly concentrated along the Pacific Ring of Fire.
- Conclude answer.

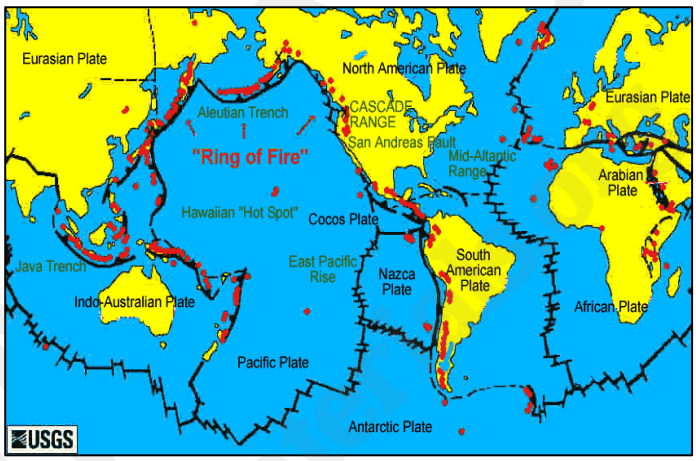
Answer:

A volcano is a rupture in the crust of the Earth where gases, ashes and/or molten lava escape from a magma chamber below the crust. The process of eruption of volcanoes is called Volcanism.

Global distribution of volcanoes:

Volcanoes are located in a fairly defined pattern around the world, mostly associated with the weaker zones of the earth's crust and generally overlap with zones of seismic activities like earthquakes. They also occur along coastal mountain ranges, as off-shore islands and in the midst of the oceans, but there are few in the interiors of continents.

The main volcanic belts are as under:



- **Circum-Pacific Belt:** It includes the volcanoes of the eastern and western coastal areas of the Pacific Ocean. This belt is also known as the Ring of Fire of the Pacific Ocean. **Most of the high volcanic cones and volcanic mountains are found in the Circum-Pacific Belt**. Examples include Cotopaxi in Andes (the highest volcanic mountain in the world), Fujiyama (Japan) Shasta, Rainier, Mt. St Helena (USA).
- **Mid-Continental Belt:** These are volcanoes of the Alpine mountains and the Mediterranean Sea. **The volcanic eruptions are caused due to the convergence and collision of the Eurasian plate and the African and Indian plates**. Examples include Stromboli, Vesuvius, Etna etc.
- **Mid-Atlantic Belt:** It includes the volcanoes along the mid-Atlantic ridge which is **the divergent plate zone**. They are mainly of the fissure eruption type. Iceland is the most active volcanic area.

As per the US Geological Survey, there are around 1,350 potentially active volcanoes worldwide and 75% of them are found along the Circum-Pacific Belt or the Ring of Fire. Also, about 90 per cent of the world's earthquakes occur here. **The abundance of volcanoes along the Ring of Fire is caused by:**

- **Presence of large number of tectonic plates:** The area is along several tectonic plates including the Pacific plate, Philippine plate, Juan de Fuca plate, Cocos plate, Nazca plate, and North American plate. The movement of these plates or tectonic activity leads to abundant earthquakes and tsunamis every year.
- **The amount of movement of tectonic plates in the area:** Along much of the Ring of Fire, plates overlap at convergent boundaries called **subduction zones**. That is, the plate that is underneath, is pushed down, or subducted, by the plate above. As rock is subducted, it melts and becomes magma. The abundance of magma this close to Earth's surface gives rise to conditions ripe for volcanic activity. For example, in the case of Tonga (January 2022 eruption), the Pacific plate was pushed down below the Indo-Australian plate and Tonga plate, causing the molten rock to rise above and form the chain of volcanoes.

The entire Pacific Ring of Fire has active volcanoes except at some gaps in the Ring such as at the **San Andreas Transform plate boundary,** where the Pacific plate and the North American plate move sideways. This type of boundary generates a large number of shallow earthquakes as tension in the Earth's crust builds up and is released, but sufficient magma is not formed to create volcanic eruptions.

7. State the major types of soils in India and their characteristics. Also, give an account of the spatial distribution of soil in India.

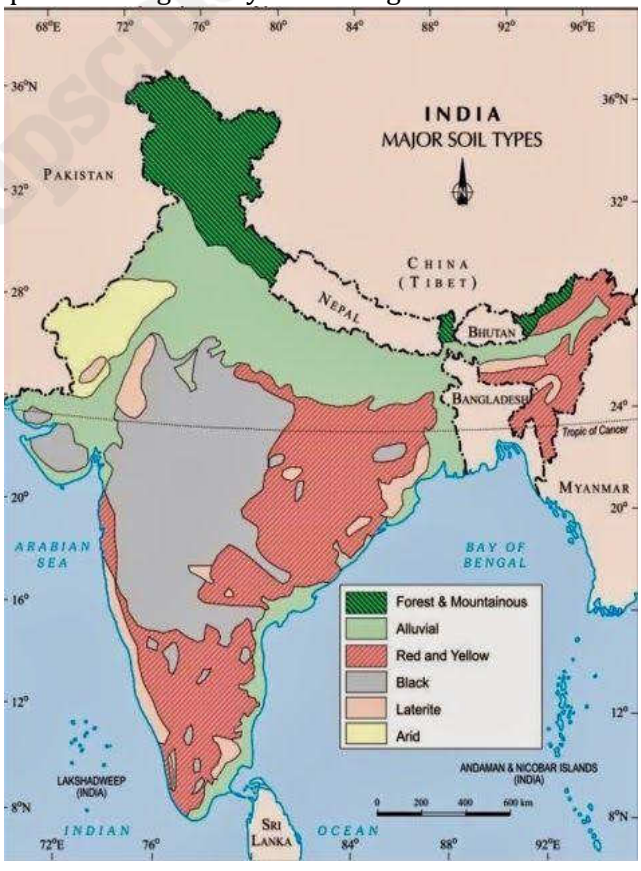
Approach:

- Introduce by mentioning the major types of soils in India.
- Explain each type of soil and its characteristics in brief.
- Give an account of the spatial distribution of soil in India.

Answer:

The Indian Council of Agricultural Research (ICAR) has classified Indian soils into eight types on the basis of their formation, colour, composition and location:

- **Alluvial soil** is depositional soil formed by silt deposited by Indo-Gangetic-Brahmaputra rivers. It varies in nature from sandy loam to clay. It is generally rich in potash but poor in phosphorus. The colour varies from light grey to ash grey.
- **Black soil** is also known as the 'Regur Soil' or the 'Black Cotton Soil'. It is generally clayey, deep and impermeable. It shows a feature of 'self-ploughing'. It is rich in lime, iron, magnesia and alumina and also contain potash. But they lack in phosphorous, nitrogen and organic matter.
- **Red and yellow soil** wherein the soil develops a reddish colour due to a wide diffusion of iron in crystalline and metamorphic rocks. It looks yellow when it occurs in a hydrated form. Thse soils are generally poor in nitrogen, phosphorous and humus.
- **Laterite soil** develops due to intense leaching in areas with high temperature and high rainfall. These soils are poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess. Hence, laterites are not suitable for cultivation; however, are widely used as bricks in house construction.
- **Arid soils** range from red to brown in colour. They are generally sandy in structure and saline in nature. Due to the dry climate, high temperature and accelerated evaporation, they lack moisture and humus. Nitrogen is insufficient and the phosphate content is normal. These soils are poor and contain little humus and organic matter.
- **Saline soil** is also known as Usara soil. It contains a larger proportion of sodium, potassium and magnesium, and thus, is infertile, and does not support any vegetative growth. Saline soils have more salts, largely because of dry climate and poor drainage. They lack nitrogen and calcium.
- **Peaty soil** is found in the areas of heavy rainfall and high humidity, where large quantities of dead organic matter accumulates. This gives a rich humus and organic content which may go even up to 40-50 per cent. These soils are normally heavy and black in colour.
- **Forest soils** vary in structure and texture depending on the mountain environment where they are formed. They are loamy and silty on valley sides and coarse-grained in the upper slopes.



Spatial distribution of these soils in India:

- **Alluvial soil:** It covers about **40 per cent of the total area of the country** and mainly widespread in the northern plains and the river valleys. Also, in the peninsular region, they are found in deltas of the east coast and in the river valleys.
- **Black soil:** It covers most of the **Deccan Plateau** which includes parts of Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and some parts of Tamil Nadu.

- **Red and yellow soil:** Red soil is found in the eastern and southern part of the Deccan Plateau. Yellow and red soils are also found in parts of Odisha and Chhattisgarh and in the southern parts of the middle Ganga plain.
- **Laterite soil:** They are found in the higher areas of the peninsular plateau such as Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Odisha and Assam.
- **Arid soil:** These are characteristically developed in western Rajasthan, which exhibit characteristic arid topography.
- **Saline soil:** These are more widespread in western Gujarat, deltas of the eastern coast and in Sunderbans of West Bengal.
- **Peaty soil:** It occurs widely in the northern part of Bihar, southern part of Uttarakhand and the coastal areas of West Bengal, Odisha and Tamil Nadu.
- **Forest soil:** It is formed in the mountain ranges of Himalayas, Purvanchal, and Sahaydri etc. where sufficient rainfall is available.

8. Differentiate between endogenic and exogenic geomorphic processes. Also, highlight the significance of weathering.

Approach:

- Start with a brief introduction about geomorphic processes.
- Differentiate between endogenic and exogenic processes.
- Highlight the significance of weathering.
- Conclude accordingly.

Answer:

The endogenic and exogenic forces causing physical stresses and chemical actions on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes. While, diastrophism and volcanism are endogenic geomorphic processes, weathering, mass wasting, erosion and deposition are exogenic geomorphic processes.

The differences between the two processes are as follows:

Parameter	Endogenic Processes	Exogenic Processes
Location	Inside the surface of the Earth.	Outside the surface of the Earth.
Driving Forces	The energy emanating from within the earth, mostly by radioactivity, rotational and tidal friction and primordial heat from the origin of the earth, is the main force behind endogenic geomorphic processes.	The exogenic processes derive their energy from the atmosphere determined by the ultimate energy from the sun and also the gradients created by tectonic factors.
Effects	The energy due to geothermal gradients and heat flow from within induces diastrophism and volcanism in the lithosphere.	Gravitational force acts upon all earth materials having a sloping surface and tend to produce movement of matter in down slope direction.
Nature	Constructive forces as they create relief features on the surface of the Earth.	Destructive forces as they result in destruction via weathering, denudation and erosional processes.
Examples	Earthquake, Volcanoes, etc.	Wind, Rivers, Glaciers, etc.

Significance of Weathering:

Weathering is the action of elements of weather and climate over earth materials. There are a **number of processes within weathering which act either individually or together to affect the earth materials** in order to reduce them to fragmental state.

- Weathering processes are responsible for **breaking down the rocks into smaller fragments and preparing the way for formation** of not only regolith and soils, but also erosion and mass movements.

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- Weathering is an important process in the formation of soils. Biodiversity depends upon **vegetation, which is in turn, is dependent upon the depth of weathering mantles.**
- W**eathering aids mass wasting, erosion and reduction of relief.** Also, **changes** in landforms are a consequence of erosion.
- Weathering of rocks and deposits **helps in the enrichment and concentrations of certain valuable ores of iron, manganese, aluminium, copper** etc., which are of great importance for the national economy.

Weathering processes are conditioned by many complex geological, climatic, topographic and vegetative factors.

9. Enumerate the significance of running water in evolution of landforms. Additionally, elaborate on the various depositional features of running water.

Approach:

- Explain the phenomenon of erosion and deposition by running water.
- Mention the significance of running water in the evolution of landforms.
- Discuss the depositional features of running water like delta, alluvial fans, etc.
- Conclude accordingly.

Answer:

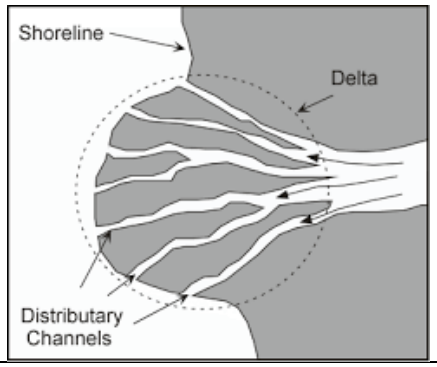
Running water is **considered one of the most important** geomorphic agents bringing about the degradation of the land surface. There are **two components of running water**. One is overland flow on the general land surface as a sheet and another is linear flow as streams and rivers in valleys.

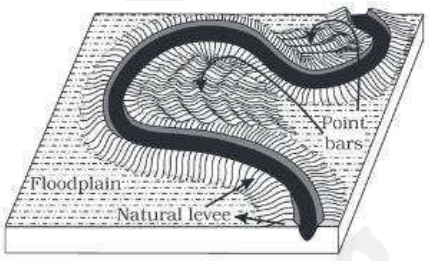
Significance of running water in evolution of landforms:

- Most of the erosional landforms made by running water are associated with **vigorous and youthful rivers flowing** over steep gradients**.**
- With time, **stream channels over steep gradients turn gentler** due to continued erosion, and as a consequence, **lose their velocity**, facilitating active **deposition**.
- There may be **depositional forms** associated with streams flowing over **steep slopes.** But these phenomena will be on a small scale compared to those associated with rivers flowing over medium to gentle slopes.
- The gentler the **river channels in gradient or slope, the greater is the deposition**. When the stream beds turn gentler due to continued erosion, downward cutting becomes less dominant and lateral erosion of banks increases and as a consequence the hills and valleys are reduced to plains.
- **Overland flow causes sheet erosion**. Depending upon irregularities of the land surface, the overland flow may concentrate into narrow to wide paths forming rills, gullies and ultimately valleys.

Depositional Features of Running Water

Feature	Characteristics	Diagram
Alluvial Fans	Alluvial fans are formed when streams flowing from **higher levels break into foot slope** plains of low gradient. Normally very coarse load is carried by streams flowing over mountain slopes. This load becomes too heavy for the streams to be carried over gentler gradients and gets dumped and spread as a broad low to high cone shaped deposit called alluvial fan.	

<table>
<tr><td>Deltas</td><td>Deltas are like alluvial fans but develop at a different location. The load carried by the rivers is dumped and spread into the sea. If this load is not carried away far into the sea or distributed along the coast, it spreads and accumulates as a low cone. Unlike in alluvial fans, the deposits making up deltas are very well sorted with clear stratification.</td><td rowspan="4"> 


</td></tr>
<tr><td rowspan="3">Floodplains, Natural Levees and Point Bars</td><td>Deposition develops a floodplain just as erosion makes valleys. Floodplain is a major landform of river deposition. Large sized materials are deposited first when the stream channel breaks into a gentle slope. Thus, normally, fine sized materials like sand, silt and clay are carried by relatively slow moving waters in gentler channels usually found in the plains and deposited over the bed and when the waters spill over the banks during flooding above the bed.</td></tr>
<tr><td>Natural levees are found along the banks of large rivers. They are low, linear and parallel ridges of coarse deposits along the banks of rivers, quite often cut into individual mounds.</td></tr>
<tr><td>Point bars are also known as meander bars. They are found on the concave side of meanders of large rivers and are sediments deposited in a linear fashion by flowing waters along the bank.</td></tr>
</table>

The study of running water in the evolution of landforms helps us understand and appreciate the diversity of landforms on the surface of the earth.

10. What are ferrous minerals? Give an overview of the distribution of iron ore in India with examples.

Approach:

- Explain what you understand by ferrous minerals.
- Discuss the locational distribution of iron ore in India.
- Conclude accordingly.

Answer:

Ferrous minerals are **those metallic minerals which contain iron** in them. Some examples of ferrous minerals include **iron, manganese, chromite** etc. which provide a strong base for metallurgical industries. India has sufficiently large reserves as well as production capacity of ferrous minerals. In fact, **India has one of the largest reserves of iron ore in Asia.** The types of iron ore found in India are **hematite and magnetite** which, due to their superior quality, are in high demand in the international markets.

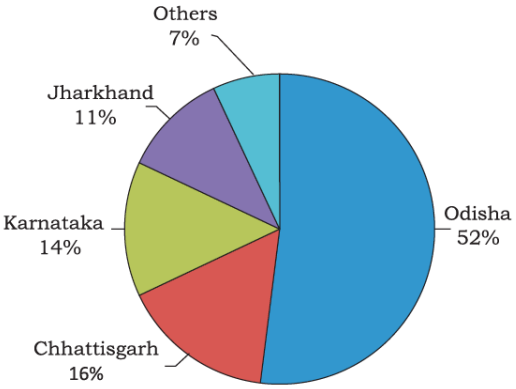
Distribution of Iron ore in India

Iron ore mines in India occur mostly in close proximity to the coal fields in the **north eastern plateau region of the country** and almost **95%** of total reserves are located in the States of

Odisha, Jharkhand, Chhattisgarh, Karnataka, Goa, Telangana, Andhra Pradesh, and Tamil Nadu.

Odisha-Jharkhand Belt:

- **In Odisha**, the hill ranges of Sundergarh, Mayurbhanj, and Jhar contain most of the iron ore deposits. The major mines in the state are Gurumahisani, Sulaipet, Badampahar (Mayurbhanj), Kiruburu(Kendujhar), and Bonai(Sundergarh).
- **In Jharkhand,** similar hills contain some of the oldest and most important iron ore mines of the country such as Noamundi and Gua, which are located in east and west Singhbhum district.



Durg-Bastar-Chandrapur Belt:

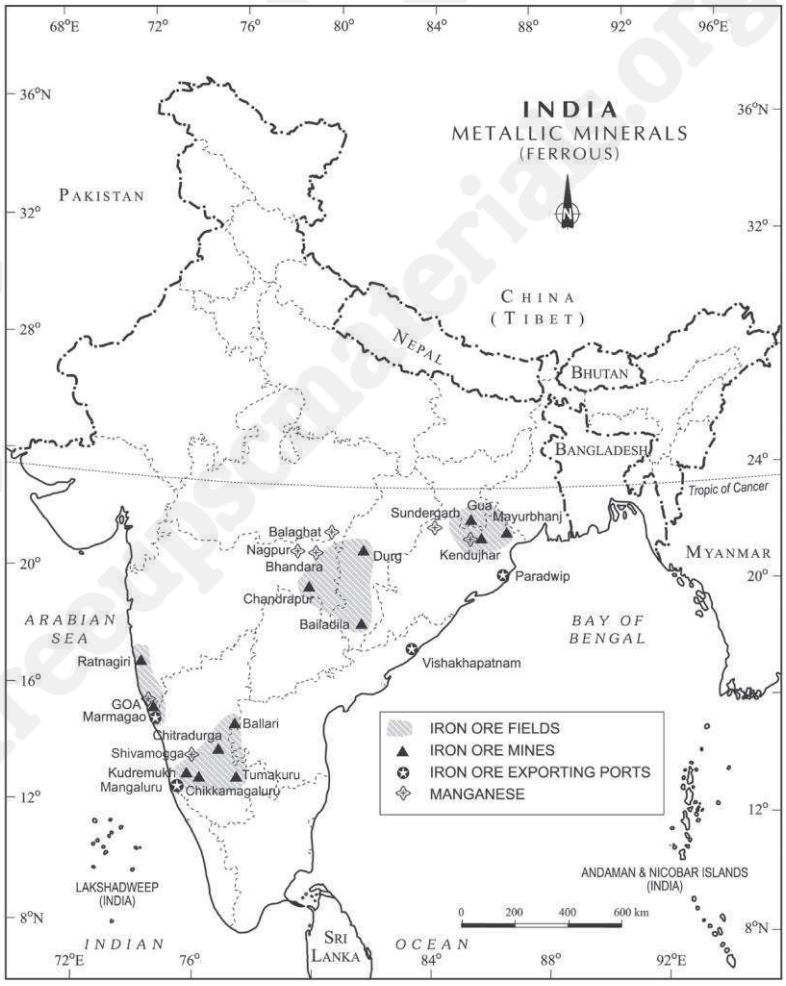
- The Jharkhand belt further extends to Durg, Dantewada, and Bailadila in Chattisgarh and high-quality hematite ore is found in the Bailadila hills of the Bastar district.
- Dalli and Rajhara in Durg district are the important mines of the Country.
- Chandrapur lies in the State of Maharashtra.

Ballari-Chitradurga-Chikkamagaluru-Tumakuru belt in Karnataka:

- It has large reserves of iron ore. Iron ores are found in Sandur-Hospet area of Ballari district, Baba Budan hills and Kudremukh in Chikkamagaluru district and parts of Shivamogga, Chitradurg and Tumakuru districts.

Maharashtra-Goa belt:

- This includes the state of Goa and Ratnagiri district of Maharashtra, which contain ores of not very high quality but are exploited very efficiently.
- Chandrapur and Bhandara are other districts with notable iron ore deposits in the State of Maharashtra.



Other regions:

- Karimnagar and Warangal districts of Telangana, Kurnool, Cuddapah and Anantapur districts of Andhra Pradesh, Salem and Nilgiris districts of Tamil Nadu are other iron mining regions.

Most of these mines are located in regions which are also abundant in coal and manganese deposits, which are important for production of the steel. Consequently, most of India's steel production capacity is located in these regions.

11. What is continental drift theory? Discuss the evidence that supports it.

Approach:

- Explain continental drift theory.
- Mention the evidences in support of the theory.
- Conclude accordingly.

Answer:

Continental drift is the **movement of the Earth's continents relative to each other**. The hypothesis that continents 'drift' was fully developed by Alfred Wegener in 1912. However, it was not until the development of the **theory of plate tectonics in the 1960s**, that a **sufficient geological explanation** of that movement was understood.

According to Wegener**,** all the continents formed a single continental mass named **Pangaea**, which was surrounded by a mega-ocean **Panthalassa**. He argued that, around 200 million years ago, the supercontinent, Pangaea, began to split and the drift started. Pangaea first broke into two large continental masses as **Laurasia and Gondwanaland** forming the northern and southern components respectively. Subsequently, Laurasia and Gondwanaland continued to break into various smaller continents that exist today.

Wegener suggested that the movement responsible for the drifting of the continents was caused by **pole-fleeing force and tidal force**. **Following evidences in support of the continental drift theory was given by him**:

- **Matching of continents (jig-saw-fit)**: The shorelines of Africa and South America facing each other have a remarkable and unmistakable match. Similarly, when matched, Africa, Madagascar, and India's east coast all fit together.
- **Rocks of same age across the oceans:** The belt of ancient rocks of 2,000 million years from Brazil coast matches with those from western Africa. The earliest marine deposits along the coastline of South America and Africa are of the Jurassic age. This suggests that the ocean did not exist prior to that time.
- **Tillite deposits:** The glacial tillite found in Gondwana system of sediments from India has its resemblance to six different landmasses of the Southern Hemisphere. Counterparts of this succession are found in Africa, Falkland Island, Madagascar, Antarctica and Australia besides India.
- **Placer deposits:** Rich placer deposits of gold are found in Ghana coast despite the absolute absence of source rock in the region. The gold deposits of the Ghana seem to have been derived from the Brazil plateau when the two continents were once joined.
- **Distribution of fossils:** Identical species of plants and animals adapted to living on land or in fresh water are found on either side of the marine barriers. For example, skeletons of Mesosaurus a small reptile adapted to shallow brackish water are found only in Southern Cape province of South Africa and Iraver formations of Brazil. But, the two localities are presently 4,800 km apart with an ocean in between them.

Wegener's theory was criticised on the grounds of the forces such as pole-fleeing force and tidal force, which are considered to be too weak to be able to move continents. Plate tectonics accommodated continental motion through the mechanism of seafloor spreading. There is now considerable evidence that the continents are parts of lithospheric plates and these plates move over the asthenosphere and cause continents to drift. New rock is created by volcanism at mid-ocean ridges and returned to the Earth's mantle at ocean trenches.

12. Enumerate the conditions favourable for the formation of tropical cyclones. Also, differentiate between tropical and temperate cyclones.

Approach:

- In the introduction, explain cyclones along with their features.
- Mention the conditions favourable for the formation of tropical cyclones.
- Bring out the difference between tropical and temperate cyclones.

Answer:

Cyclones are caused by atmospheric disturbances around a low-pressure area distinguished by swift and often destructive air circulation. They are usually accompanied by violent storms and bad weather. The air circulates inward in an anticlockwise direction in the Northern hemisphere and clockwise in the Southern hemisphere. Based on the position of occurrence of cyclones, they are categorized as tropical (10–30 degree N and S of equator) and temperate (35 – 65 degree N and S of equator) cyclones.

Various conditions favourable for the formation of tropical cyclones are:

- **Large sea surface** provides supply of moist air which helps form the clouds.
- **Temperature higher than 27° C** is needed for tropical cyclone formation. The high temperature provides required heat for the cyclone.
- **Presence of the Coriolis force** is necessary for tropical cyclones so that air starts and continues spiralling around a center.
- **Small variations in the vertical wind speed** are necessary for the maintenance of air flow system.
- **A pre-existing weak or low-pressure area** to attract the flow of moist air to the center.
- **Upper divergence** above the sea level system is necessary so that the low-pressure system is maintained at the center.

Differences between Tropical and Temperate Cyclones:

Basis	Tropical Cyclone	Temperate Cyclone
Origin	It has thermal origin and derives its energy from the latent heat of condensation.	It has dynamic origin involving Coriolis force and movement of air masses.
Latitude	It is confined to 10 – 30 degree N and S of equator.	It is confined to 35 – 65 degree N and S of equator. It is more pronounced in Northern hemisphere due to greater temperature contrast.
Formation	They form only on seas with temperature more than 26-27 degree Celsius. They dissipate on reaching the land.	Temperate cyclones can be formed on both land and sea.
Size	It is limited to small area. Its typical size is 100 – 500 kms in diameter.	It covers a larger area. Its typical size is 300 –2000 kms in diameter.
Wind Velocity	Wind velocity is much higher (100 – 250 kmph).	Wind velocity is comparatively low (30-150 kmph).
Movement	These cyclones move from east to west.	These cyclones move from west to east.
Frontal system	Fronts are not present and get energy from warm and moist air of ocean.	They have a clear frontal system and get energy from the horizontal temperature contrasts that exist in the atmosphere.
Influence of Jet streams	The relationship between tropical cyclones and the upper level air-flow is not very clear.	It has a distinct relationship with upper level air flow (jet streams, Rossby waves etc.)
Calm region	The center of a tropical cyclone is known as the eye. The wind is calm at the center with no rainfall.	There is not a single place where winds and rains are inactive.

It is being projected that with ongoing climate change, there is greater likelihood of future increase in tropical cyclone precipitation rates; tropical cyclone intensity and increase in the frequency of very intense tropical cyclones.

13. Enlist the factors responsible for the location of jute industry in India. Also, discuss the challenges faced by the industry.

Approach:

- Introduce by briefly explaining the jute industry in India.
- Mention the factors responsible for their location in India.
- Discuss the challenges faced by this industry.
- Conclude accordingly

Answer:

India is the world's biggest producer of jute, followed by Bangladesh. Jute is primarily grown in West Bengal, Odisha, Assam, Meghalaya, Tripura, and Andhra Pradesh.

Factors responsible for the location of the jute industry in India:

- **Raw material**: These industries are located in close proximity of the jute-producing areas. For instance, in West Bengal the jute mills are located along the banks of Hugli River.
- **Means of transportation**: Inexpensive water transport, supported by a good network of railways, roadways, and waterways facilitates movement of raw material to the mills.
- **Water requirement**: The availability of abundant water facilitates the processing of raw jute. For example, the Hugli river supplies the adequate water for jute mills in West Bengal.
- **Labour**: Cheap labour from West Bengal and adjoining states of Bihar, Odisha and Uttar Pradesh make this region attractive for industries.
- **Other factors:** A large urban centre providing banking, insurance, and port facilities for the export of jute goods, for example, Kolkata.

Challenges faced by the industry:

- **Fragmentation**: Indian Jute industry is highly fragmented and is dominated by the unorganized sector and small and medium industries.
- **Increasing input costs**: Unpredictable market conditions, weather, policies, etc. have resulted in a supply shortage of raw materials and an increase in their material costs.
- **Highly competitive export market**: In the global market, tariff and non-tariff barriers coupled with lack of free/preferential trade agreements are posing a major challenge to these Industries.
    - For instance, there is stiff competition in the international market from synthetic substitutes and from other competitors like Bangladesh, Brazil, Philippines, Egypt, and Thailand.
- **Other issues**:
    - Poor access to the latest technology and low automation.
    - Social issues like child labour and personal safety norms.

It must be noted that the growing global concern for environment-friendly, biodegradable materials, has once again opened the opportunity for jute products. In order to give an impetus to the jute industry, the government has approved that 100% of the food grains and 20% of the sugar shall be mandatorily packed in jute bags.

14. What are the factors that affect the location of manufacturing industries in India? Highlight the major industrial regions of India.

Approach:

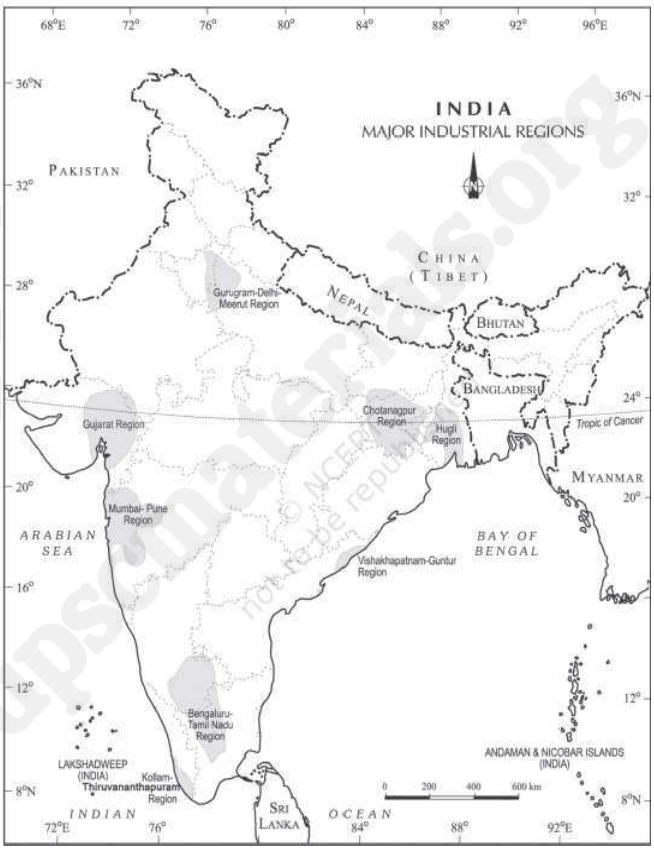
- Give brief information on manufacturing industries.
- Discuss the factors affecting the location of the manufacturing industry.
- Highlight the major industrial regions of India.
- Conclude accordingly.

Answer:

Manufacturing industries come under the secondary sector of the economy and form the backbone of economic development by modernizing agriculture, providing employment, expanding trade and commerce.

There are various factors affecting the location of manufacturing industries:

- **Raw Material**: Industries using **weight-losing raw materials** are located in the regions where raw materials are easily available. For example, most of the **steel and iron industries** are located near coalfields (Bokaro, Durgapur, etc.) or near iron ore (Bhadravati, Bhilai, and Rourkela).
- **Market:** It provides outlets for manufactured products. **Heavy machinery and chemical industries** tend to be located near high-demand areas. Industries using **non-weight losing raw materials such as cotton textiles** are located in large urban centres such as Mumbai, Surat, and Ahmedabad. Similarly, **petroleum refineries** locate themselves so that they are usually located near ports along the coasts.
- **Specialized labour:** Most of the manufacturing industries are located near urban centres where skilled labour is easily available.
- **Power:** It is the life force behind industries. Examples include iron and steel, cement, and semiconductor industries.
- **Transport:** Initially most of the industries were located around metro cities. However, as **railway lines and highways** expanded to interior locations, industries also shifted inwards from these areas.
- **Government policies:** They play an important role in giving incentives and support to industries. For example, the **Special Economic Zones, National Manufacturing Industrial Zones, Mega Food Processing Parks** have attracted investors to set up plants in specific areas.
- **Historical factors**: Various industries were started at different locations by the colonial government and European traders.



As a result of the above factors, industries in India are not distributed evenly across the country and some **major industrial regions** have emerged.

- **Mumbai-Pune Region:** Cotton textiles, petroleum, drugs, fertilizers, electrical, shipbuilding, electronics, software, transport equipment, food industries, etc. are important industries developed in the region.
- **Hugli Region** is known for jute industry, paper, engineering, textile machinery, electrical, fertilizer and petrochemical industries, among others.
- **Bengaluru-Tamil Nadu Region:** Important industries are textiles, rail wagons, diesel engines, engineering goods, rubber goods, medicines, sugar, cement, paper, etc.
- **Gujarat Region:** Easy access to ports and markets, historical factors, and availability of raw materials have led to high concentration of cotton, textiles, petrochemicals, gems and jewellery, pharmaceuticals, chemicals, etc. industries in this region.
- **Chotanagpur Region:** Proximity of coal, iron ore and other minerals facilitated the location of heavy industries in this region and is home to heavy metallurgical, cement, power, engineering goods, locomotives, and heavy electricals industries with important centres being Ranchi, Dhanbad, Bokaro, Rourkela, etc.
- **Vishakhapatnam-Guntur Region:** Developed agriculture and rich reserves of minerals and easy access to power have facilitated the development of shipbuilding, petroleum refinery, sugar, textile, jute, paper, fertilizer, cement, aluminium, and light engineering industries in this region.

- **Gurugram-Delhi-Meerut Region: Being far away from the mineral and power sources**, the industries are light and market-oriented such as electronics, cotton, woollen, and synthetic fabrics, hosiery, sugar, cement, machine tools, etc.
- **Kollam-Thiruvananthapuram Region:** Plantation, agriculture, and hydropower provide a base to industries such as cotton textile, sugar, rubber, matchbox, glass, chemical fertilizer, etc.

With the changing needs of the economy and society and the government policy in response to these changes and individual initiatives in the form of start-ups, the nature of industries and their location would continue to evolve with time and new regions would emerge while other older regions would either adapt or transform themselves.

15. Elaborate on the different types of plate tectonic boundaries.

Approach:

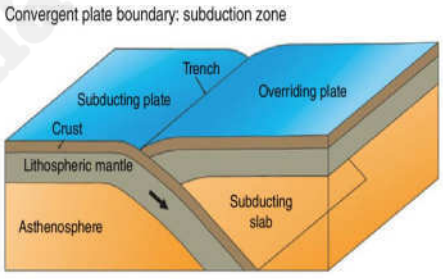
- Introduce by briefly giving a definition of tectonic plates.
- Elaborate on 3 types of plates i.e. convergent, divergent and transform.
- Conclude appropriately.

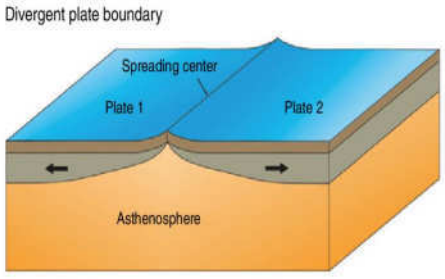
Answer:

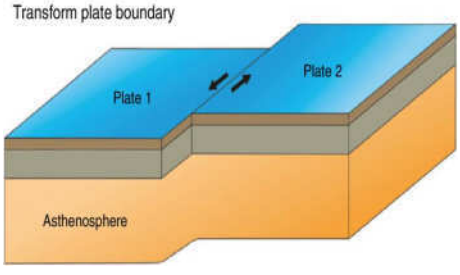
The Earth's lithosphere, which includes the crust and upper mantle, is made up of a **series of pieces, or tectonic plates, that move slowly over time.** A tectonic plate (also called a lithospheric plate) is a **massive, irregularly-shaped slab of solid rock,** generally composed of both continental and oceanic lithosphere.

Different types of plate tectonic boundaries:

- **Convergent boundaries:** When **two plates come together**, it is known as a convergent boundary.
  - The impact of the colliding plates can cause the edges of one or both plates **to buckle up into a mountain range or one of the plates** may bend down into a deep seafloor trench.
  - A **chain of volcanoes often forms parallel** to convergent plate boundaries and powerful earthquakes are common along these boundaries.
  - The location where the sinking of a plate occurs is called a **subduction zone**. There are three ways in which convergence can occur. These are between an oceanic and continental plate, between two oceanic plates, between two continental plates.
  - At convergent plate boundaries, oceanic crust is often forced down into the mantle where it begins to melt. Magma rises into and through the other plate, solidifying into granite, the rock that makes up the continents. Thus, at convergent boundaries, **continental crust is created and oceanic crust is destroyed.**
  - The **Pacific Ring of Fire** is an example of a convergent plate boundary.
- **Divergent boundaries:** It is formed when two tectonic plates **move away from each other. New crust is generated** as the plates pull away from each other.
  - The sites where the plates move away from each other are called **spreading sites.**
  - Along these boundaries, **earthquakes are common and magma (molten rock) rises** from the Earth's mantle to the surface, solidifying to create the new oceanic crust. For example, **Mid-Atlantic Ridge**.
- **Transform boundaries: Two plates sliding past each other** form a transform plate boundary.







- Rocks that line the boundary **are pulverized as the plates grind along**, creating a linear fault valley or undersea canyon. Natural or human-made structures that cross a transform boundary are offset—**split into pieces and carried in opposite directions**.
- **Earthquakes are common along these faults**.
- In contrast to convergent and divergent boundaries, **the crust is cracked and broken at transform margins but is not created or destroyed.**
- **Ex: San Andreas fault zone**, which extends underwater.

Even though plates move very slowly, their motion has a huge impact on our planet. Plate tectonics leads to the formation of oceans, continents, and mountains. It also helps us understand the reasons behind events like earthquakes and volcanoes.

16. What are the different non-conventional energy sources available in India? Highlight their importance in providing eco-friendly energy.

Approach:

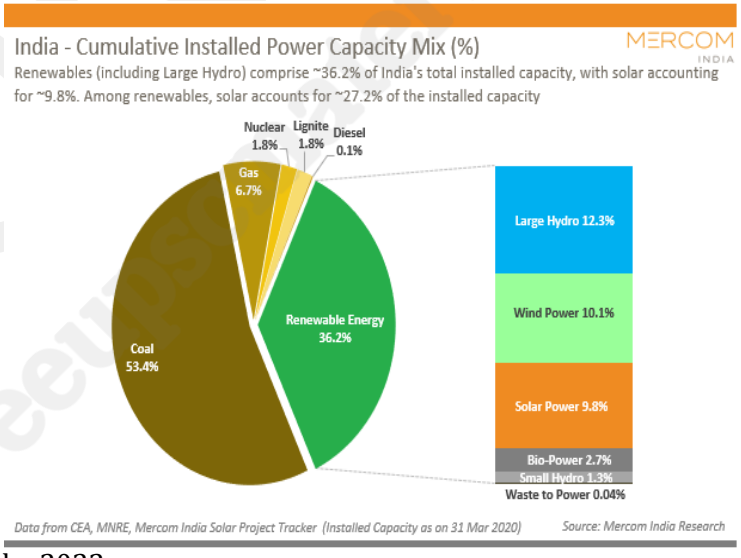
- Introduce the meaning of non-conventional energy sources.
- Elaborate on different non-conventional energy sources in India.
- Highlight its importance and conclude appropriately.

Answer:

The sources of energy which are being produced continuously in nature and are inexhaustible are called non-conventional energy sources (or) renewable sources of energy.

Various non-conventional energy sources available in India include:

- **Solar Energy:** India receives solar energy in the range of **5 to 7 kWh/m2 for 300 to 330 days in a year**. This energy is sufficient to set up 20 MW solar power plant per square kilometre land area. India targets to achieve 100GW of solar energy by 2022. The potential to harness solar energy lies greatly in Tamil Nadu, Karnataka, Gujarat, and Rajasthan. The world's biggest solar power park lies at Bhadla in Jodhpur.



- **Wind Energy:** As per MNRE, India has a gross wind power potential of 302 GW in the country at 100 meter and 695.50 GW at 120 meter above ground level. Favourable conditions for harnessing wind energy exist **in Rajasthan, Gujarat, Maharashtra and Karnataka**. India intends to achieve 60 GW energy through Wind by 2022.
- **Bio-energy:** Bio-energy refers to energy derived from biological products which includes agricultural residues, municipal, industrial and other wastes. As per MNRE, the current availability of biomass in India is estimated at about 750 million metric tonnes per year. The surplus biomass availability is estimated at about 230 million metric tonnes per annum corresponding to a potential of about **28 GW of energy**. India targets to produce 10GW energy from bio-power by 2022.
- **Hydro-energy:** Hydro power plants of **25MW or below capacity** are classified as small hydro and come under renewable energy. Existence of various streams, especially in hilly areas all across India provides an estimated small hydro power potential of 20 GW. India targets to achieve 5 GW of energy from small Hydro power by 2022.
- **Tidal and Wave Energy:** As per MNRE, in India, the tidal power potential is estimated at around 12,500 MW and Wave Energy potential is 41,000 MW. Promising locations for Tidal

Energy are Gulf of Khambhat & Gulf of Kutch (GJ), Sundarbans (WB), Western Ghats (MH), etc., while that of Wave energy are Western Coast of Maharashtra, Goa, Karnataka, and Kerala. **However, these energies are not being utilised at commercial scale in India.**

- **Geothermal Energy:** India is still at **nascent stage** of geothermal energy utilization. The promising geothermal sites for direct heat use applications are Rajgir in Bihar, Manikaran in Himachal Pradesh, Surajkund in Jharkhand, Tapoban in Uttarakhand & Sohana region in Haryana.

Importance in providing eco-friendly energy:

- **Non-polluting:** Unlike the other sources like coal and petroleum, non-conventional sources of energy are either non-polluting or are carbon neutral.
- **Inexhaustible:** Conventional sources take millions of years to be renewed and replenished and are scarce, while non-conventional sources are renewable and do not get exhausted.
- **Indigenous:** Non-conventional/renewable energy is an indigenous source available in considerable quantities in all developing nations and is capable of having a significant local, regional or national economic impact.
- **Cheaper alternative**: Non-conventional power plants prove to be more cost-effective in the long run.

Due to huge population and rapidly increasing urbanization, India's energy requirement is very high. The potential shortages of oil and gas due to price rise raises uncertainties about the security of energy supply in future. Also, it is important to limit the consumption of fossil fuel in the light of increased global warming. Therefore, many countries including India are committed to shift towards renewable energy sources and are making efforts to achieve SDG-12 towards responsible consumption and production by 2030.

17. Provide a detailed account of coal distribution in India.

Approach:

- Briefly discuss about coal and its importance in the introduction.
- Give a detailed account of coal distribution in India.
- Use map, wherever necessary.

Answer:

Coal is a sedimentary rock having high amount of carbon and hydrocarbons. It is combustible in nature and is classified under non-renewable source of energy. It is found as **Anthracite (90-95% Carbon content), Bituminous (60-80% Carbon content), Lignite (40-45% Carbon content) and Peat (>40% Carbon content).** Coal is the most important and abundant fossil fuel present in India. It accounts for more than 50% of the India's energy needs.

The coal bearing strata of India are geologically classified into two main categories, viz., Gondwana coal fields and Tertiary coal fields.

- **Gondwana Coal Fields:** It comprises about 98 percent of the total reserves and 99 percent of the production of coal in India. In this system, there are 113 major coal fields found all over India. Gondwana coal is said to be about 250 million years old. Such fields are exclusively found in the peninsular region.
- **Tertiary Coal Fields:** This rock system bears coals of younger age; from 15 to 60 million years. It shares only about 1% of the total coal production in India.

Distribution and production of Gondwana coal in India:

- **Jharkhand:** It has over 28 percent of the coal reserves and produces more than 20 percent coal of India. There are 21 prominent coal fields in Jharkhand among which **Jharia, Bokaro, Rajmahal coalfields** are famous.
- **Odisha:** It is the second largest state with regard to coal reserves possessing 24.64 percent of the total reserves of India but is the third largest producer of coal contributing about 19 percent of the total coal production of the country. **Talcher coalfields** are one of the major deposits.

- **Chhattisgarh:** It has 16 percent of the coal reserves and produces over 21 percent coal of India. Most of the coal fields of Chhattisgarh are located in the northern part of the state. Major coal fields include **Korba and Tatapani**.
- **West Bengal:** It has over 11 percent of the coal reserves of the country but produces just over 4 percent of India's coal**. Raniganj** is the largest coalfield of West Bengal.
- **Madhya Pradesh:** It has about 8 percent of the coal reserves but contributes about 13 percent of the total coal production of India. Currently Madhya Pradesh is the fourth largest coal producing state of India. Major coalfields include **Singrauli and Jhingurda**.
- **Andhra Pradesh and Telangana:** With only 7 percent of the reserves Andhra Pradesh and Telangana produce about 10 percent of India's coal. Most of the coal reserves are in the Godavari valley (**Singreni coalfields**).

- **Maharashtra:** It has only 3 percent reserves, but accounts for over 7 percent of the production of coal in India. **Kamptee coalfields** has the major coal deposits.

Distribution and production of Tertiary Coal in India:

This type of coal is present in **Assam** (Makum, Nazira, Mikir Hills), **Meghalaya** (Garo, Khasi and Jaintia hills), **Arunachal Pradesh** (Namchick-Namrup coalfield), **Jammu and Kashmir** (Udhampur and Kalakot area) and in the Chamba district of **Himachal Pradesh**.

There has also been a phenomenal increase in the production of lignite coal in India. Although lignite deposits are found in Tamil Nadu, Gujarat, Jammu and Kashmir, Kerala, Rajasthan, West Bengal and Puducherry; **Tamil Nadu (Neyveli coalfields)** account for 90% of lignite reserves.

18. Give an account of Global Atmospheric Circulation.

Approach:

- Briefly highlight the general circulation of the atmosphere.
- Mention various cells that are formed due to global atmospheric circulation.
- Conclude accordingly.

Answer:

The Earth is surrounded by a thin layer of air called the atmosphere. The air in the atmosphere moves in response to differences in temperature at the equator (warm) and the poles (cold). This movement of air is called global atmospheric circulation.

The movement of air across the planet occurs in a specific pattern that is dependent on:

- Latitudinal variation of atmospheric heating.
- The emergence of pressure belts.
- The migration of belts following the apparent path of the sun.
- The distribution of continents and oceans.
- The rotation of the Earth.

The whole system is driven by the equator, which is the hottest part of the Earth. Air rises at the equator, leading to the creation of low pressure and rainfall. When the air reaches the edge of the troposphere (tropopause), it cannot go any further and so it travels to the north and south. The air becomes colder and denser, and falls, creating high pressure and dry conditions at around 30° north and south of the equator. Large cells of air are created in this way.

Following are the 3 major cells:

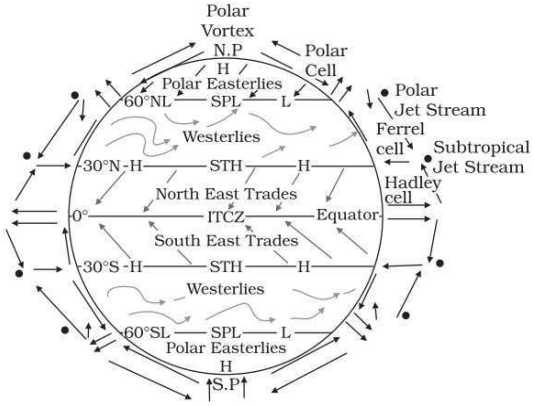


Figure 10. 6 : Simplified general circulation of the atmosphere

- **The Hadley Cell:** This is driven by warm rising air. The Coriolis effect causes the air that has risen at the equator and moving to the poles to deflect and become increasingly westerly high up in the atmosphere that the circulation breaks down and the air sinks back towards the ground in the subtropics (30° – the 'horse latitudes'). Once the air has descended back to the ground, it returns to the equator and is deflected to the east – they are known as the **easterly trade winds**.
- **Polar Cell:** The same thing happens in the polar regions, but it is driven by sinking cold air. The sinking, cold air at the poles moves back towards the equator, but because it is slow-moving, it becomes increasingly easterly as the underlying earth moves faster, and the circulation eventually breaks down at around 70° latitude. The air then rises again and returns to the poles, resulting in another atmospheric cell.
- **Ferrel Cell:** This lies in between the Polar and Hadley cells, and is a little more complicated. Put simply, it is the net effect of air motions from all the storms or 'depressions' that occur in the mid-latitudes. Air sinks in the sub-tropics and rises around 60-70°. In this region, westerly surface winds occur.

These cells drive airflow, atmospheric pressure and rainfall. The rising and sinking of air cause high and low pressure at the surface, respectively. The large-scale winds of the atmosphere initiate large and slow-moving currents of the ocean. Oceans in turn provide input of energy and water vapour into the air. These interactions take place rather slowly over a large part of the ocean.

19. Give an overview of the location of sugar industry in India. Also, highlight the reasons for the shift of sugar industry from North to South India.

Approach:

- Briefly introduce with facts related to sugar industry in India.
- Mention the factors behind the location of the sugar industry in India and highlight the regions where the industries are located.
- Bring out the reasons for the shift of the sugar industry from North to South India.
- Conclude accordingly.

Answer:

Sugar industry is an important agro-based industry that impacts the rural livelihood of about 50 million sugarcane farmers and around 5 lakh workers directly employed in sugar mills. India is the second-largest producer of sugar in the world after Brazil and is also the largest consumer. The Indian sugar industry's annual output is worth approximately Rs. 80,000 crores and there are 732 installed sugar factories in the country, as of 2017.

Location of the sugar industry in India:

- Since sugarcane is a **weight-losing crop** and better recovery of sugar is dependent upon it being **crushed within 24 hours** of its harvesting, sugar factories are located within the cane-producing regions.
- **Uttar Pradesh and Maharashtra** are the leading sugar producers in the country. The sugar factories are concentrated in two belts – the Ganga-Yamuna doab and the Tarai region.
- In **Tamil Nadu**, sugar factories are located in Coimbatore, Vellore, Tiruvannamalai, Villupuram, and Tiruchchirappalli districts. Belagavi, Ballari, Mandya, Shivamogga, Vijayapura, and Chitradurga districts are the major producers in **Karnataka**.
- The industry is distributed in the **coastal regions** i.e. East Godavari, West Godavari, Vishakhapatnam districts of Andhra Pradesh, and Nizamabad and Medak districts of Telangana.

The other States which produce sugar are Bihar, Punjab, Haryana, Madhya Pradesh, and Gujarat. The sugar industry is comparatively new in Gujarat.

The sugar industry is gradually shifting from North India to South India due to the following reasons:

- **The tropical climate of Peninsular India:** The tropical climate of Southern India gives a higher yield per unit area in sugarcane production as compared to north India.
- **Longer crushing seasons:** The crushing season is also much longer in the south than in the north. For example, the crushing season is for nearly four months (November to February) only in the north, whereas it is for nearly 7-8 months in the south where it starts in October and continues till May and June.
- **Crop quality:** The sucrose content is also higher in the tropical variety of sugarcane in South India.
- **Better mills:** The co-operative sugar mills are better managed in the south than in the north. Most of the mills in the south are new and are equipped with modern machinery.

With the help of several government-led initiatives, currently, sugar production exceeds domestic consumption by 60 lakh tonnes and the focus has shifted to managing the surplus. Experts argue that the industry is on the cusp of becoming globally competitive and financially independent.

20. What do you understand by a biome? Provide an account of the major biomes of the world and their characteristics.

Approach:

- Briefly introduce an answer with the definition of the biome.
- Write major classification of biomes.
- Explain each biome in detail with its characteristics.

Answer:

A biome is a plant and animal community that covers a large geographical area. The boundaries of different biomes on land are determined mainly by climate. Therefore, a biome can be defined as the total assemblage of plant and animal species interacting within specific conditions such as rainfall, temperature, humidity, and soil conditions.

There are **five major biomes** i.e. forest, desert, grassland, aquatic and altitudinal biomes. Their characteristics can be outlined as under:

- **Aquatic biomes:** These include **both freshwater and marine biomes**. Freshwater biomes are bodies of water surrounded by land—such as ponds, rivers, and lakes—that have a **salt content of less than one percent**. Marine biomes cover close to three-quarters of Earth's surface. Marine biomes include the ocean, coral reefs, and estuaries.
- **Grasslands:** These are open regions dominated by grass, having a warm, dry climate. They can be of two types: **tropical grasslands/Savannas** and **temperate grasslands**.
    - Savannas are found closer to the equator and can have a few scattered trees. Temperate grasslands are found further away from the equator. They do not have any trees or shrubs and receive less precipitation than savannas. For instance, prairies and steppes are two types of temperate grasslands.
- **Forests:** Forests are dominated by trees, and cover about one-third of the Earth. They contain much of the world's terrestrial biodiversity, including insects, birds, and mammals. Based on latitudinal location and climate, the three major forest biomes are **temperate forests, tropical forests, and boreal forests** (also known as the taiga).
    - Tropical forests are warm, humid, and found close to the equator. Temperate forests are found at higher latitudes and experience all four seasons. Boreal forests are found at even higher latitudes and have the coldest and driest climate, where precipitation occurs primarily in the form of snow.
- **Deserts:** Deserts are dry areas where **rainfall is less than 50 cms** (20 inches) **per year.** They cover around 20 percent of Earth's surface. Because of their extreme conditions, there is **not as much biodiversity found in deserts** as in other biomes. Any vegetation and wildlife living in a

desert must have special adaptations for surviving in a dry environment. Here, wildlife consists primarily of **reptiles and small mammals**. According to their geographic location or climatic conditions, deserts can fall into four categories: **hot and dry, semiarid, coastal, and cold.**

- **Altitudinal Biomes:** These have extremely inhospitable conditions, with the lowest measured average yearly temperatures of any of the five major biomes ranging from -34 to 12 degrees Celsius. Precipitation is just **15–25 centimeters (six to ten inches) per year,** as soil nutrients are of poor quality and summers are short. They can be classified into **arctic and alpine.**
    - The arctic biome is found north of boreal forests and the alpine biome is found on mountains where the altitude is too high for trees to survive. These do not have much biodiversity and vegetation is simple, including shrubs, grasses, mosses, and lichens. This is partly due to a frozen layer under the soil surface, called permafrost.