Geography KP PMS Paper I 2018

Q1. Discuss the endogenic and exogenic geomorphic process in detail.

GEOMORPHIC PROCESSES

The endogenic and exogenic forces cause physical stress and chemical actions on the earth material and bring the changes in the configuration of the earth surface is called GEOMORPHIC PROCESSES. Diastrophism and volcanism are endogenic geomorphic processes. Weathering, mass wasting, erosion and deposition are exogenic geomorphic processes.

ENDOGENIC PROCESS: the energy generating from within the earth is the main force behind the endogenic geomorphic processes. The energy is mostly generated by 1. Radioactivity 2. Rotational and Tidal Friction and Primordial Heat from The Origin of The Earth

- Diastrophism and volcanism are endogenic processes.

Diastrophism And Volcanism Are Due to Geothermal Gradients and Heat Flow from Within the Earth.

Crustal Thickness, Strength, Action of Endogenic Forces Are Due to Variations in Geothermal Gradients and Heat Flow Are Uneven.

DIASTROPHISM: All processes that move, elevate or build up portions of the earth's crust come under *diastrophism*.

They include:

(i) *orogenic* processes involving mountain building through severe folding and affecting long and narrow belts of the earth's crust;

Orogenic forces cause deformation of the Earth's lithosphere and result in the occurrence of several geological processes. This process can take place over a period of several million years. As a result, mountains get formed from the seabed or plains. In the process of orogeny, the crust is severely deformed

(ii) *epeirogenic* processes involving uplift or warping of large parts of the earth's crust; Epeirogenic forces cause depressions or upheavals of land with long wavelengths and broad ripples and the result can be either transient or permanent

(iii) earthquakes involving local relatively minor movements;

(iv) plate tectonics involving horizontal

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

Volcanism

Volcanism includes the movement of molten rock (magma) onto or toward the earth's surface and formation of many intrusive and extrusive volcanic forms. it is the process in which volcanoes takes place Volcanoes are the land forms formed due to volcanic process

EXOGENIC PROCESSES

They derive their energy from atmosphere determined by the prime source the sun and the gradients created by tectonic factors.

Gravitational force create gradient towards down slope direction.

Force applied per unit area is called STRESS. Stress can be produced in a sold body pushing or pulling

This includes deformation. Forces acting along the faces of earth materials are shear stresses. (Separating forces). It is this stress that breaks rocks and other earth materials. The shear stress result in angular displacement/slippage. Besides gravitational stress there is molecular stress which is caused by temperature change, crystallization and melting. chemical processes normally lead to loosening of bonds between grains, dissolving of soluble minerals or cementing materials. The basic reason for weathering, mass movement erosion and deposition are the development of stress in the earth materials. Since there are different climatic regions there is variation in the exogenic process from region to region. Temperature and precipitation are the two major elements that control various processes.

All the exogenic process are covered under general term DENUDATION. The word denude means uncover. Weathering, mass wasting erosion and transportation are included in denudation.

What are Exogenic Forces

The forces which derive their strength from the earth's exterior or originate within the earth's atmosphere are called as exogenic forces or external forces.

The action of exogenic forces results in wearing down and hence they are considered as land wearing forces

Exogenic Processes or Denudation

The processes which occur on the earth's surface due to the influence of exogenic forces are called exogenic processes or exogenic geomorphic processes.

Weathering, mass wasting, erosion, and deposition are the main exogenic processes.

All the exogenic processes are covered under a general term- denudation, which means strip off or uncovers.

The elements of nature capable of doing these exogenic processes are termed geomorphic agents (or exogenic geomorphic agents). E.g., the wind, water, waves etc.

Gravity and gradients are the two things that make these agents mobile.

All the movements either within the earth or on the surface of the earth occur due to gradients– from higher levels to lower levels, from high pressure to low pressure etc.

The exogenic forces derive their energy from the atmosphere determined by the ultimate energy from the sun and the gradient created by tectonic factors.

Stress

We know that force applied per unit area is called stress. Stress is produced in a solid by pushing or pulling.

The gravitational force acts upon all earth materials having a sloping surface and tends to produce movement of matter in the down-slope direction. This creates stress and induces deformation to the particles.

Weathering

Weathering is the process of disintegration and decomposition of rocks. It is due to the action of climate, plants, animals and other living organisms which cause the rocks to break down physically, chemically and biologically.

There are three types of weathering. They are physical weathering, chemical weathering and biological weathering.

(1) Physical / Mechanical weathering

Physical or mechanical weathering processes depend on some applied forces.

The applied forces could be (i) gravitational forces such as overburden pressure, load, and shearing stress; (ii) expansion force due to temperature changes, crystal growth or animal activity; (iii) water pressure controlled by wetting and drying cycles.

Causes: Most of the physical weathering are caused by thermal expansion and pressure.

- **Exfoliation:**

Rocks generally heat or cool more on the surface layers. The alternate changes in temperature could cause their outer layers to peel off from the main mass of the rock in concentric layers just as the skin of an onion. The process by which curved layers of rock breakaway from the rock beneath them leaving behind dome shaped monoliths is called exfoliation (Figure 4.2). It is also called as 'onion weathering'. Exfoliation occurs commonly in the arid areas.

C) FREEZING, THAWING AND FROST WEDGING:

- Rapid freezing of water causes its sudden expansion and high pressure. The resulting expansion affects joints, cracks, and small intergranular fractures to become wider and wider till the rock breaks apart.
- Cycles of freezing and thawing (the weather becomes warmer and causes snow and ice to melt) cause frost weathering.
- It is most effective at high elevations in mid-latitude where freezing and melting is often repeated.

D) SALT WEATHERING:

- Salts in rocks expand due to thermal action, hydration and crystallization.
- Many salts like calcium, sodium, magnesium, potassium and barium have a tendency to expand.
- The expansion depends on temperature and thermal properties. High temperature ranges between 30-50 ^{o}C of surface temperatures in desert favours such salt expansions.
- Salt crystallization is the most effective of all salt weathering processes. It is favoured in areas of alternative wetting and drying conditions.

(2) Chemical weathering

Chemical weathering is the decomposition of rock. For example, it creates altered rock substances, such as kaolinite (China clay) from granite. The types of chemical weathering are as follows:

A) SOLUTION:

- Some soluble minerals in the rock get dissolved when come in contact with water. Over a long period, minerals get washed away from rock and sometimes leading to the formation of caves.
- This process involves solubility of a mineral in water or weak acids.
- When coming into contact with water, many solids disintegrate and mix up as a suspension in water.
- Soluble rock-forming minerals like nitrates, sulphates, potassium etc are affected by this process.
- Minerals like calcium carbonate and magnesium bicarbonate present in limestone are soluble in water containing carbonic acid (formed with the addition of carbon dioxide in water) and are carried away in the water as a solution.
- Common salt is also a rock-forming mineral and is susceptible to this process of solution.

B) CARBONATION:

- *Carbonation is the mixing of water with carbon dioxide to make carbonic acid. This acid reacts with minerals in the rocks. This type of weathering is important in the formation of caves.*
- Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping to break down feldspar and carbonate minerals.
- Carbon dioxide from the atmosphere and soil air is absorbed by water to form carbonic acid that acts as a weak acid.
- Calcium carbonates and magnesium carbonates are dissolved in carbonic acid and are removed in a solution without leaving any residue resulting in cave formation.

C) HYDRATION:

- *It is the absorption of water into the mineral structure of the rock. Hydration expands volume and also results in rock deformation. A good example of hydration is the absorption of water by anhydrite, resulting in the formation of gypsum.*
- Hydration is the chemical addition of water.
- Minerals take up water and expand; this expansion causes an increase in the volume of the material itself or rock.
- The process is reversible and long, continued repetition of this process causes fatigue in the rocks and may lead to their disintegration.
- g. calcium sulphate takes in water and turns to gypsum, which is more unstable than calcium sulphate.

D) OXIDATION AND REDUCTION:

- *When oxygen combines with water and iron, it weakens the rock and breaks it. Example, rusting of iron*.
- In weathering, oxidation means a combination of a mineral with oxygen to form oxides or hydroxides.
- Minerals most commonly involved in this are iron, manganese, Sulphur etc.
- The red Colour of the iron upon oxidation turns to brown and yellow.
- In this process of oxidation, rock breakdown occurs due to the disturbance caused by the addition of oxygen.
- When oxidized minerals are placed in an environment where oxygen is absent, reduction takes place.

(3) Biological weathering:

- This kind of weathering is caused by several biological activities like the growth or movements of organisms.
- They also bring conditions for physical or chemical weathering.
- Grazing of animals, ploughing by human beings etc are examples of biological weathering.

Mass Movements:

these movements transfer the mass of rock debris down the slopes under the direct influence of gravity. Air water ice do not carry debris, but debris carry them. The movements of mass may range from slow to rapid.

These movements transfer the mass of rock debris down the slope under the direct influence of gravity.

it is gravity, which is the main driving force.

Mass movements are classified into slow movements and rapid movements.

(1) Slow movements:

A) CREEP:

It occurs on moderately steep, soil-covered slopes (does not need to be lubricated with water as in solifluction). The movement is extremely slow and imperceptible except through extended observation. We might notice that some of the electric posts in our region which are posted in sloppy areas deviated from their horizontal linearity. This is an effect of creep.

B) SOLIFLUCTION:

It is the process of slow downslope flowing of soil mass or fine-grained rock debris saturated or lubricated with water. It can be said as a type of creep with lubricated water influences the movement. It mainly occurs in permafrost regions as the layers of groundwater are occupied in between permanently frozen soil and rocks.

(2) Rapid movements

A) EARTHFLOW:

The movement of water-saturated clayey or silty earth materials down low angle terraces or hillsides is called earthflow.

B) MUDFLOW:

In the absence of vegetation and cover and with heavy rainfall, thick layers of weathered materials get saturated with water and either slow or rapidly flow down along definite channels is called as a mudflow.

C) DEBRIS AVALANCHE:

It is more in humid regions with or without vegetation. It occurs in narrow tracks on steep slopes and is similar to snow avalanche.

D) LANDSLIDES:

In landslides, the materials involved are relatively dry irrespective of the above said rapid mass movements. Landslides can be classified into a slump, debris slide, rockslide etc

- Slump: It is a type of landslide in which the slipping of several units of rock debris occurs with a backward rotation with respect to the slope over which the movement takes place.
- Debris slide: In this type of landslide, there is no backward rotation. The fall is almost vertical.
- Rockslide: It is nothing but the slide of individual rock masses.

Erosion and Deposition

Erosion is the acquisition and transportation of rock debris by geomorphic agents like running water, the wind, waves etc.

Though weathering aids erosion, it is not a pre-condition for erosion to takes place. (i.e., erosion can take place in unweathered conditions also)

The deposition is a consequence of erosion. The erosional agents lose their velocity and energy on gentle slopes and materials carried by them start to settle themselves.

Note: Deposition is not the work of any agents. It is just the end result of erosion.

Q: *How can we identify the different types of map and why the study of maps is so important in Geography and note down the characteristics of Cylindrical and Conical Projection?*
Q: *Define Map. What are the essential of a map? Why we need projection for drawing a map?*
Q: *Merits & demerits of Mercator's Projection*.
Q: What are Map Projections? Give merits and demerits of Cylindrical Projections?
Q: Define map and its types along with the uses.
Q: The coastal system is the scene of complex tidal fluctuation winds, wave and ocean currents Discuss. **Describe the different types of map and explain the process of each.**
Q: Explain with the help of map the major ocean current of the Indian, Pacific and Atlantic oceans.
Q: Define cartography and mapping basics: map scale and map projections.

1) Define Map

A map is a visual representation of an entire world or a part of the earth, represented on a flat surface drawn to scale. Maps attempt to represent both physical and cultural features like relief, climate, natural resources, political boundaries, roads, population, economic activities and so on.

***2)* Define cartography and mapping basics**

cartography (the science of making maps)**Cartography is the study and practice of making and using maps.**

***3)* map types along with the uses**

Types of maps –

i) **Topographical maps**

Topographic Maps (aka-contour Maps) show *elevation* (height above or below sea level) and *shape* by using *contour lines.*

A topographical map shows the surface features of the earth. Most topographic maps show natural features (streams, rivers, mountains, hills) & man-made items, like buildings and roads.

What is contour line?

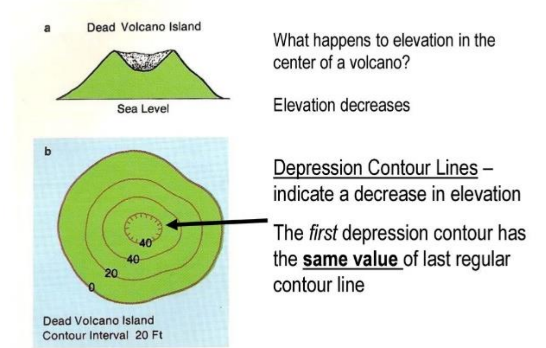
A contour line connects all the points on the map that have the same elevation. These lines not only show elevation but also show the shape of the land.

a) *Contour interval:* The difference in elevation between consecutive contour lines. The spacing is always equal.
b) *Index contour lines:* These help the map reader determine elevation. Every fifth line is darker and has an elevation printed on it.
c) *Relief:* Amount of change in elevation from the highest point on the map to the lowest.
d) *compass rose:* A compass rose is a symbol on a map that shows the cardinal directions. The cardinal directions are the main compass points—north, south, east, and west.

Rules:

1) *Contour lines never cross each other.*
2) *Contours always form closed loops even if not shown on the map.*
3) *The closer the lines are, the steeper the slope. The more spread out the lines are, the gentler the slope.*
4) *Contour lines bend upstream and form a* ***"V"*** *when crossing a stream, river, or creek.*
5) *Rings of consecutively smaller contour lines represent mountains or hills.*
6) *The highest possible elevation of hill is just below the value of what the next contour line would be.*
7) *Contour lines that show a depression, crater, or sinkhole on a map are represented by dashed lines (hachure marks) on the inside of a contour line.*

Examples volcanic craters, meteor impact craters



7.8 (a) Sketch of an island volcano, (b) contour map of the same island with contours showing its crater

8) The elevation of the first depression contour is the same as the nearest regular contour line.

Uses:

Topographical maps can be used to determine where the landscape is flat and where it is dominated by mountains. You can also identify valleys, canyons, and hillsides. A normal map is a flat model of all or part of Earth's surface drawn to a specific scale. Topographic maps show the elevation of different landforms above sea level.

ii) aerial photographs,
iii) weather maps.

4) How can we identify the different types of map

5) essential of a map

i) ***Title:*** The title of the map indicates the area and purpose of the map.

ii) ***Grid:*** *The imaginary vertical and horizontal lines which collectively forms the grid.*

Set of
-Vertical line
-Horizontal lines

Example: latitudes & longitudes

Uses:

used to locate places
Draw an area to proportion on map
Could be used to determine area

iii) ***Key/legend:*** *A map legend or key is a visual explanation of the symbols used on the map. The symbol Sch means School. Symbols and colors can also represent different things like roads, rivers and land height.*

iv) **Direction: NESW. Never Eat Soggy Waffles**
is another major element of a map. North, South, East and West are the four major directions. Magnetic compass is an instrument to find out directions.

v) **Scale:** The scale shows the relation b/w a **certain distance on the map** & the **actual distance in real life**. For example, **one inch** might represent **one mile**, or **10 mile**.
RF=Representative Fraction (1:50000)

6) Map scale and map projections.
7) What are Map Projections?
8) Why we need projection for drawing a map?
9) characteristics of Cylindrical and Conical Projection
10) Give merits and demerits of Cylindrical Projections?
11) Mercator's Projection
12) Merits & demerits of Mercator's Projection.
13) why the study of maps is so important in Geography
14)

Q2. What are the major erosional and depositional land form produced by river?

Definition of river

A river is a large stream of fresh water flowing downhill within a channel to enter another river or a lake or sea.

• **Source of the River :** Rainfall, Snowfall

Landforms

Landform-a feature on the surface of Earth, such as a valley, mountain range, plain, or plateau

• Landforms are different shapes of the land on Earth.

• Earth's landforms are the result of internal and external forces. Some force cause very fast changes while others take many, many years to change the surface of the land.

• Internal forces that shape Earth's land include plate tectonics, volcanoes, and earthquakes.

• External forces that shape Earth's land include weathering, erosion, deposition and glaciers.

• Some force are constructive (build land up) and others are destructive (tear land down).

• landforms shaped by running water are called fluvial landforms

• Examples of landforms include: mountains, valleys, canyons, plateaus, islands, volcanoes, deltas, peninsulas, etc.

forces that cause change in landforms over time:

– Water and Ice
– Wind
– Gravity

Major Mountain Ranges:

- **Rocky Mountains**
- **Appalachian Mountains**
- **Himalayan Mountains**
- **Andes Mountains**

☞ **Constructive Processes** that create landforms (deposition, landslides, volcanic eruptions, floods)

☞ **Destructive Processes** that destroy landforms (weathering, erosion, landslides, volcanic eruptions, earthquakes, floods)

☞ **Erosion**

Erosion is the movement of sediments and soil by wind, water, ice, and gravity.

☞ **Deposition**

Deposition is the dropping, or depositing, of sediments by water, wind, or ice. It builds new land on Earth's surface, like a delta at the end of a river or the pile up of a sand dune in the desert. Shells on the beach are deposition by ocean waves. **Deposition begins with a "D" and Dunes and Delta begin with a "D".*

1.River Processes by rgamesby

Erosion - the wearing away of the land by moving forces - in this case the river. Processes include;

Hydraulic action - where the sheer force of the water erodes the stones, bed and banks of the river

Corrasion or abrasion- where stones in transport are thrown into the bed and the banks eroding them

Corrosion - where weak acids within the water react with the rocks and bed and bank of the river

Attrition - where stones in transport are thrown into one another

Rivers - Upper Course

- Steep Gradient
- Narrow Channel
- Steep valley sides (V shape)

The upper course of a river is where the river begins its path toward the sea. It is usually found at one of the highest points of a region's landform.

Agent of erosion: vertical corrosion

Landforms in upland regions are dominantly created by erosion processes, where land is worn away. Generally, the volume and discharge of rivers in upland regions tends to be low, and the river uses much of it's energy in overcoming friction. The erosion direction here is vertical, or straight down into the bed of the river. This has the effect of destabilizing the slopes on either side of the river, creating a steep landscape.

VERTICAL EROSION is the main process in the upper course of the river, as the river wants to get to sea level. This process creates five distinctive features; a V-shaped valley, interlocking spurs, waterfalls, gorges and rapids

valleys

A valley is a low area of land between hills or mountains typically with a river or stream flowing through it. Valleys are formed when water or ice causes erosion over time. They are also made by glaciers and movement of the earth's crust.

Types of valleys:

- V-shaped valleys
- Gorge
- Canyon

Gorge:

- Gorge is a deep valley with steep straight sides.
- Gorge has equal width of its top and bottom.
- It is generally formed in the region where hard rocks are present.

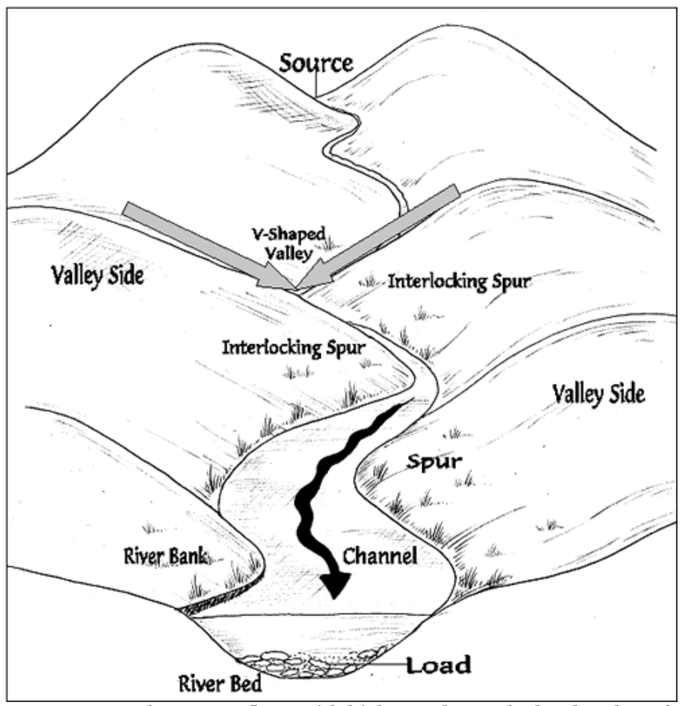
Canyons:

- It has a Steep side but is not as straight as the gorge.
- The tops are wider than the bottom.
- Canyons are formed in the region where sedimentary rocks are prominent.
- Canyons are made by erosion (wind and/or water)
- **Agent of erosion: Flowing water**
- The Grand Canyon of the river Colorado of U.S.A. is one of the best examples.

Interlocking Spurs

Interlocking Spurs are caused because the river wants to erode vertically. It therefore winds it way around areas of hard rock, avoiding them in favour of softer rock which is more easily eroded and leaves them as ridges of interlocking spurs.

Rapids



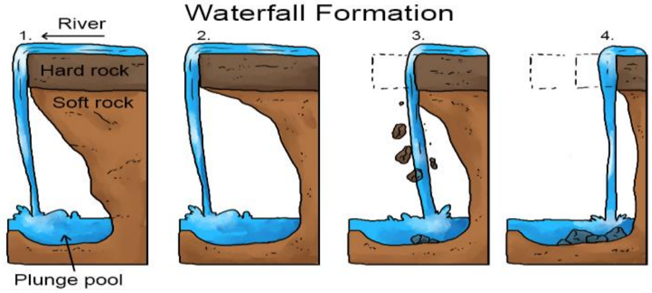
When water flows with high speed over the hard rock surface it is called rapids and when the water falls vertically downward it is called waterfalls.

When water moves into, by, or over alternating layers of hard and soft rock in the landscape, it causes each to erode at different rates. Soft rock erodes quickly and more smoothly, and hard rock tends to stay firm and erodes more steeply. As the river encounters these alternating layers, it erodes the soft rock faster which can create waterfalls and plunge pools (the undercut pool underneath a waterfall), as well as rapids.

Waterfalls **Niagara waterfall**

Waterfall's landforms found in the upper valley and are created by erosion processes. They occur where a band of hard rock (e.g. granite) overlies a softer rock (e.g. sandstone). Erosion processes such as Hydraulic

Action and Abrasion dominate. This creates a plunge pool where water is swilled around, potholing can occur here and any rocks and debris swept into the plunge pool by the river will be swirled around and rub against the bed and banks of the plunge pool (called corrasion), deepening it further.

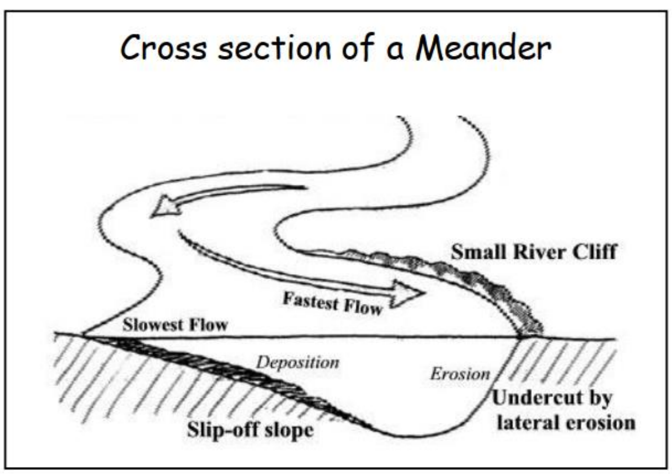


Rivers - Middle Course – Lateral Erosion

LATERAL EROSION is the dominant process in the middle course of the river, as it is getting closer to sea level, so doesn't want to erode downwards, but has more energy due to increased volume of water. Therefore the river erodes sideways. This process creates four distinctive features; **meanders, oxbow lakes, floodplains and levees**

- Less steep gradient
- Wider River Channel
- Less energy (but quite a lot still)
- Quite a lot of erosion (lateral)
- Fast flow
- Smaller load
- Wider Valley

1. Meanders:. The curved snaking shape of a river is called a **meander. (A bend in a river)** On the outside of the bend the river is fastest flowing and therefore erosion is greatest. This creates a deep area of water and a river cliff. On the inside of the bend water is forced to slow down, which reduces its energy, making it deposit its material. This creates a shallow slip of slope.



2. Ox-bow lakes:

Oxbow lakes are created through erosion and deposition processes. An **oxbow lake** is a U-shaped Lake that forms when a wide meander of a river is cut off, creating a free-standing body of water. oxbow lakes are Stillwater lakes, with no current flowing through them, the entire lake gradually silts up, becoming a swamp and then evaporating completely.

3. Floodplains:

Floodplains are wide flat areas of low altitude land around the river.

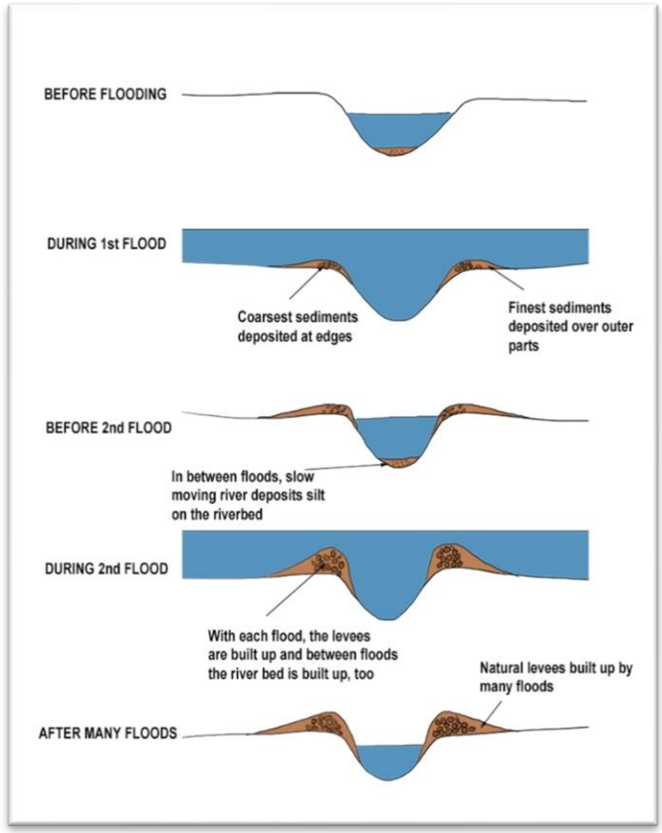
Floodplains are formed by the river channel changing its position due to meandering.

When the river discharge exceeds the bank full level the floodplain will flood.

Floodplains give the valley a wide and flat cross profile. A floodplain is the wide, flat area of land either side of the river. It is formed by erosion and deposition. As meanders slowly move downstream, lateral erosion widens the floodplain, whilst deposition of the slip off slopes provides sediment to build up the floor. In addition, when the rivers floods sediment is deposited on the floodplain, making it very fertile. This makes it perfect for agriculture and is why many farmers are found on floodplains.

4. Levees:

Levees are natural embankments that form by the banks of the river. They are created by deposition. When a river floods, the velocity of the river slows down as it travels over the floodplain. The river cannot hold all its sediment and is forced to deposit it. It deposits the largest material first and the smallest furthest from the river bank: this is called sorting. This process repeats over time creates a levee



Rivers - lower Course – Lateral Erosion

- Flat gradient
- Very wide river channel
- Little energy
- Little erosion (lateral)
- Very wide valley

In the lower course, the river has a high volume and a large discharge. The river channel is now deep and wide and the landscape around it is flat. However, as a river reaches the end of its journey, energy levels are low and deposition takes place.it also has one additional feature; deltas. River is at its widest

Delta:

Deltas are often triangular in shape. Deltas form at the mouth of river. The velocity of the river is reduced, so it deposits its material. This begins to choke the mouth of the river, and so it splits into smaller channels called distributaries. There are three types of delta; fan, tooth and bird's foot. **Deltas** are found at the mouth of large rivers - for example, the Mississippi. A delta is formed when the river deposits its material faster than the sea can remove it

Differentiate between Valley Glacier and Ice Sheet.
Discuss the depositional landforms of Valley Glacier in detail.

Glaciers

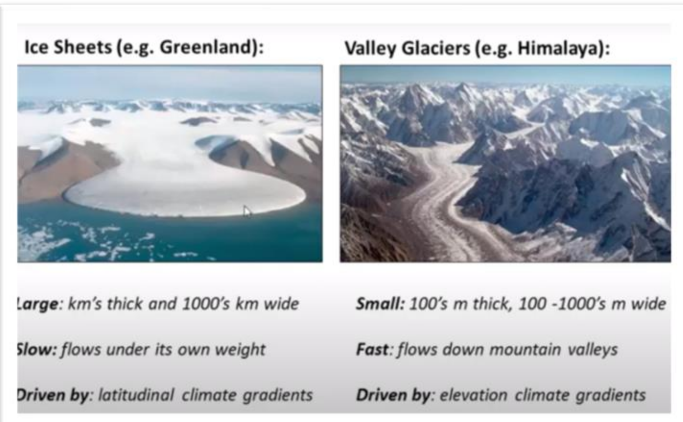
Glaciers form over land in the poles and on mountaintops. They are large ice masses created by snowfall that has transformed into ice and compressed over the course of many years. Glaciers are known for their ability to move, acting as a slow-moving river. Ice sheets, ice streams, and ice shelves are a few types of glaciers.

Ice sheets

- Ice sheets are large masses of glacial ice, also known as continental glaciers, that cover at least 20,000 square miles of land.
- Ice sheets are found only in Greenland and Antarctica. They are huge continental masses of glacial ice and snow that cover areas over 50,000 square kilometres.

Formation of Ice sheets

- Ice sheets form from partially melted snow that has accumulated over thousands of years. Each layer of snow slowly builds a thick and dense



ice mass. Because the packed snow traps dust particles and gases, ice sheets contain an excellent historical record of Earth's climate for researchers to analyze.

Example

- Two major ice sheets exist today, in Greenland and Antarctica. Greenland's ice sheet is about three times the size of Texas, and Antarctica's could cover the surface area of the United States and Mexico combined.

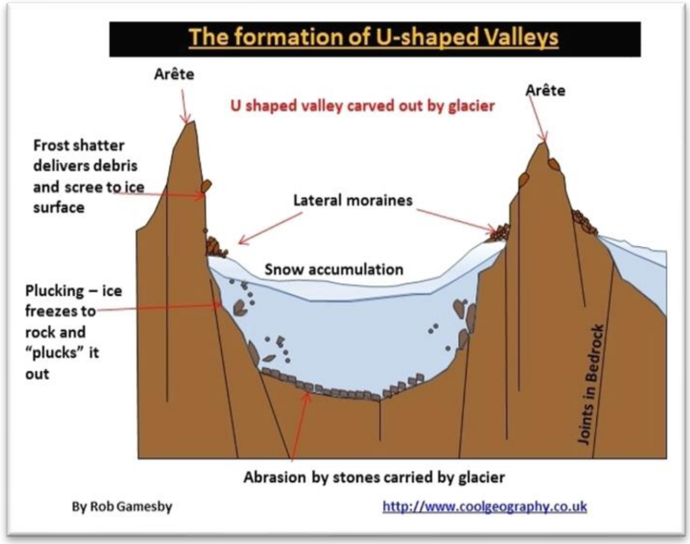
Valley glaciers

- Valley glaciers are streams of flowing ice that are confined within steep walled valleys, often following the course of an ancient river valley. The downward erosive action of the ice carves the valley into a broad U shape, in contrast to the steeper V shape that is produced during the early stages of erosion by rivers. A U shape valley with a flat floor is good evidence of the past glaciation of an area.
- Valley glaciers usually start life in ~~either~~ ***corries*** or ***ice sheets***. Glacial ice flowing downhill from either of these sources will erode and enlarge valley as it moves.
- Often several ***corrie glaciers*** will combine to feed a single valley glacier.

Glacial Erosion: Processes

The wearing away of the landscape by glaciers is called Glacial erosion. There are three main processes that cause glacial erosion. These processes may work together or on their own, depending on conditions at the time:

- **Freeze-thaw** can only work where day time temperatures allow water to melt, and it is cold enough at night for the water to freeze again. It works on cracks, weaknesses and hollows in rock. During the day, whilst the sun is shining, rocks, hollows and other weaknesses get wet or filled with water as glacial ice melts and soaks the rocks.
  - ➢ At night the temperatures become colder and the water in the cracks freezes.
  - ➢ As the water freezes it expands and causes the cracks to widen.
  - ➢ The next time the temperature is warm enough for the ice to melt, the water thaws and contracts.
  - ➢ This cycle continue, each time widening or enlarging the cracks and hollows but a tiny amount.



- ➢ Eventually this continuous process causes rocks to break up.

2) **Plucking** happens when rocks and stones around the glacier become frozen to the base or sides of the ice. They are then attached to the ground (that doesn't move) and the glacier (which is moving). One of two things will happen; EITHER the rock is so strongly attached to the ground that the ice breaks off it as the glacier moves, OR the ice pulls or plucks the rock out of the ground. When the ice wins, plucking has occurred.

- **Abrasion** is wearing something down by rubbing it against something else.
  In glaciers abrasion occurs then rocks and stones are picked up by the glacier (by plucking), and are rubbed against the bedrock at the bottom and side of the glacier as it moves. This turns the ice from a smooth surface into something like a gigantic scouring pad. As the glacier moves the rocks scour the bedrock and erode it away.

- **EROSIONAL LANDFORMS:** Cirque, Horns and Serrated Ridges and Glacial Valleys/Troughs.
- **DEPOSITIONAL LANDFORMS:** Moraines, Eskers, Outwash Plains and Drumlins.

1. *Landform of Highland Glaciation:*

a) ***Corrie, Cirque or Cwm*:**

- ➢ Starting location for mountain glaciers
- ➢ Corrie glaciers, larger than niche glaciers, and are smaller than valley glaciers.
- ➢ Cirques are ***bowl-shaped***, amphitheater-like depressions that glaciers carve into mountains and valley sidewalls at high elevations.
- ➢ glacier can ***flow*** up hills beneath the ice as long as the ice surface is still sloping downward. Because of this, glaciers are able to flow out of bowl-like cirques and over deepening in the landscape.
- ➢ There is a rocky ridge at the exit of the corrie and, when the ice eventually melts, water collects behind this barrier, to form a corrie lake or tarn.

b) **Aretes and Pyramidal Peaks**:

- ➢ When two corries cut back on opposite sides of a mountain, knife-edged ridges are formed called aretes (a French word).
- ➢ An arête is a knife-edge ridge. It is formed when two neighboring corries run back-to-back. As each glacier erodes either side of the ridge, the edge becomes steeper and the ridge becomes narrower.
- ➢ When three or more cirques erode toward one another, a **pyramidal peak** is created.

c) U-Shaped Valleys:

When a glacier erodes its valley, a classic U shape is formed, the side walls tending to be steep and possibly curving inwards at the base, and the valley floor almost flat.

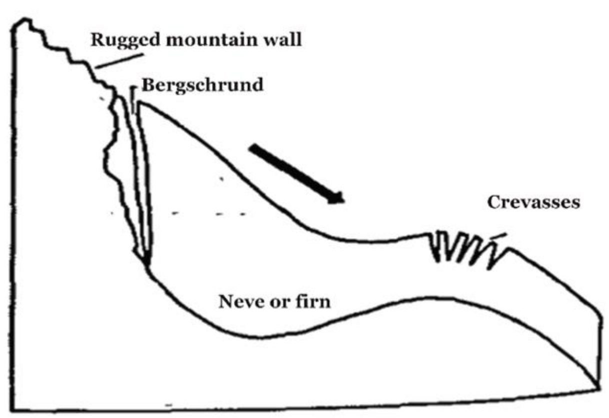
U shaped valleys often start life as river valleys that existed before glaciation occurred. The glaciers then followed the existing V shaped valleys, eroding and deepening them as the ice moved. Over time the valleys became straightened, widened and deepened, keeping the steep sides and acquiring a flat base. U shaped valleys are also known as glacial troughs.
The flat floor is roughly shaped by the ice which tends to cut down more evenly than flowing water. A thick layer of glacial debris (ground moraine) is deposited as the ice retreats, smothering any minor irregularities, and creating a well-drained and fertile soil.

d) **Bergschrund:**
At the head of a glacier, where it begins to leave the snowfield of a corrie, a deep vertical crack opens up called a bergschrund (in German). This happens in summer when, although the ice continues to move out of the corrie, there is no new snow to replace it.

e) Hanging Valleys:
The main valley is eroded much more rapidly than the tributary valleys as it contains a much larger glacier. After the ice has melted a tributary valley therefore 'hangs' above the main valley so that its stream plunges down as a waterfall (Fig. 50). Such tributary valleys are termed hanging valleys and may form a natural head of water for generating hydro-electric power.

f) **Rock basins or rock steps** – A glacier erodes and excavate the bedrock in an irregular manner. The unequal excavation gives rise to many rock basins later filled by lakes in the valley trough where a tributary valley joins the main valley, the extra weight of the ice in the main valley cuts deeper into the floor of the valley at the point of convergence forming a rock step. A series of such rock steps may also be formed due to different degrees of resistance to glacial erosion of the bedrocks.

g) **Moraines** – These are made of the pieces of rock or rock debris that is carried along by glacier and usually consist of round particles which can be big like boulders and small like the particle of flour. Lateral moraines develop at the side of the ice flow and terminal moraines at the foot, indicating the maximum advance of the glacier.



Development of Corrie

2. Depositional Landform of low land Glaciation:

Most of the glaciated lowlands have depositional features, but where rock masses project above the level surface, they result in striking features of erosion. Depositional glacial features are created when glaciers retreat and leave behind their freight of crushed rock and sand (glacial drift), they created characteristic depositional landforms.

- Piles of debris formed at the ice margin, such as moraines;
- Till plains formed underneath the ice sheet;
- Fluvioglacial landforms such as kames, outwash plains, meltwater channels.

a) Eskers:

- Eskers are snake-like ridges of sand and gravel that form when sediment fills meltwater tunnels at the base of a glacier.
- These waters amass underneath the glacier and flow like streams in a channel beneath the ice. Such streams flow over the ground with ice forming its banks.
- Very coarse materials like stones and blocks along with some minor segments of rock debris transported into this stream settle down in the valley of ice underneath the glacier and after the ice melts can be found as a winding ridge called Esker.

b) Outwash Plains:

- Made up of fluvio glacial deposits washed out from the terminal moraines by the streams of stagnant ice mass.
- The melt waters sort & redeposit the material mainly consisted of layers of sand and other fine sediments.
- Such plains with their sandy soils are often used for specialized kinds of agriculture, such as the potato.

c) Drumlins:

- These are swarms of oval, elongated 'whaleback' hummocks composed wholly of boulder clay, with their elongation in the direction of the ice flow, that is on the downstream side.
- These are smooth oval-shaped ridge-like topographies composed primarily of glacial till with masses of gravel and sand.
- It forms due to the dumping of rock debris underneath heavily loaded ice through fissures in the glacier.
- The long axes of drumlins are parallel to the direction of ice movement.
- Drumlins give an indication of the direction of glacier movement.
- The Stoss end is the steeper of the two ends and used to face into the ice flow.

c) BOULDER CLAY:

- This is an unsorted glacial deposit comprising a range of eroded materials —boulders, angular stones, sticky clay, and fine rock flour.
- It is spread out in sheets, not mounds, & forms gently undulating till or drift plains with monotonous landform.
- The degree of fertility of such glacial plains depends very much on the composition of the depositional materials.

d) ERRATICS:

- These are boulders of varying sizes that were transported by ice. They came with the advancing glaciers or ice sheets but when the ice melted, they were left 'stranded' in the regions of deposition. They are called erratic because they are composed of materials entirely different from those of the region in which they are found. Their presence in large numbers is a hindrance to farming.

TERMINAL MORAINES

- These are made up of the coarse debris deposited at the edge of the ice-sheet, to form hummocky and hilly countries such as the Baltic Heights of the North European Plain.

e) Roche Moutonnee:

- Basically a resistant residual rock hummock or mound, striated by the ice movement
- Its upstream or stoss side is smoothened by abrasion & its downward or leeward side is roughened by plucking & is much steeper.
- It is believed that plucking may have occurred on leeward side due to a reduction in pressure of the glacier moving over the stoss slope
- Therefore providing the opportunity for water to refreeze on the lee side and pluck the rock away

f) Crag & Tail:

- A crag and tail is a larger rock mass than a Roche moutonnee
- Like a Roche moutonnee, it is formed from a section of rock that was more resistant than its surroundings.
- Crag is a mass of hard rock with a steep slope on the upward side, which protects the softer leeward slope from being completely worn down by the oncoming ice.
- It therefore has a gentle tail strewn with the eroded rock debris.

Q – 2 Describe the mechanism and types of seismic waves? Define the most probable cause of earthquake and write an account of the Earthquake in Pakistan?

Two main types of seismic waves:

• ***Body waves* travel through** Earth's interior
—Primary waves (P-waves)
—Secondary waves (S-waves)

• ***Surface waves* travel on** Earth's surface
—Rayleigh waves
—Love waves

Body Waves: *Primary Waves*

• Primary waves are ***longitudinal***:
—They ***compress and expand*** the material through which they move.
—Compression/expansion occurs parallel to the wave's direction of travel.
• Primary waves travel through any type of material—solid rock, magma, water, or air.
• Primary waves are the fastest of all seismic waves—first to register on a seismograph

Body Waves: *Secondary Waves*

• Secondary waves are ***transverse:***
—They ***vibrate the rock in an up-and-down or side-to-side motion.***
—Transverse motion occurs perpendicular to a wave's direction of travel.
• Secondary waves travel through solids—they are unable to move through liquids.
• Secondary waves are slower than P-waves—second to register on a seismograph.
•These waves are more destructive as they cause displacement of rocks, and hence, the collapse of structure occurs.

Seismic Waves: Surface Waves

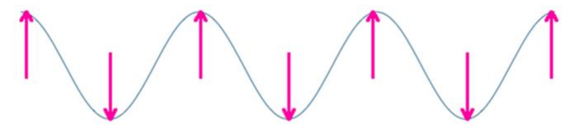
• Surface waves are the slowest seismic waves and the last to register on a seismograph.
• Rayleigh waves have a rolling-type of motion:
—They roll over and over in a tumbling motion, similar to ocean wave movement.
—Tumbling motion occurs backward compared to wave's direction of travel.
—Ground moves up and down.
• Love waves have similar motion to S-waves:
—Horizontal surface motion is side to side.
—Whip-like, side-to-side motion occurs perpendicular to the wave's direction of travel.

Cause

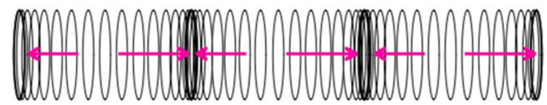
• Any physical disturbance that causes the Earth to vibrate
– Earthquakes (most commonly)
– Volcanoes
– Landslides (terrestrial or undersea)
– Extraterrestrial impacts (asteroids
– and meteorites)

The **focus** of an earthquake is the point of failure of rocks at the depth where an earthquake originates.
– The **epicenter** of an earthquake is the point on Earth's surface directly above the focus.

TRANSVERSE WAVE



LONGITUDINAL WAVE



Transverse waves:
• Vibrations of medium particles are perpendicular to the direction of the propagation of wave.
•Consists of crest and trough.
•Speed of this wave is more.
•Secondary waves travel through solids—they are unable to move through liquids.

Longitudinal waves
•Vibrations of medium particles are along the direction of the propagation of the wave.
•Consists of compression and rarefaction.
•Speed of this wave is less.
• Primary waves travel through any type of material—solid rock, magma, water, or air.

MEASURING EARTHQUAKES
• The earthquake events are scaled either according to the magnitude or intensity of the shock.

Richter Scale
• The magnitude scale is known as the Richter scale. The magnitude is expressed in absolute numbers, 0 10.

Mercalli Scale
• The intensity scale is named after Mercalli, an Italian seismologist. The range of intensity scale is from 1-12.

Seismograph:
• instrument used to record the energy released by an earthquake. Recording time of wave arrival.
Seismic Waves

When an earthquake occurs the seismic waves (P and S waves) spread out in all directions through the Earth's interior. Seismic stations located at increasing distances from the earthquake epicenter will record seismic waves that have traveled through increasing depths in the Earth.
Seismic velocities depend on the material properties such as composition, mineral phase and packing structure, temperature, and pressure of the media through which seismic waves pass. Seismic waves travel more quickly through denser materials and therefore generally travel more quickly with depth. Anomalously hot areas slow down seismic waves. Seismic waves move more slowly through a liquid than a solid. Molten areas within the Earth slow down P waves and stop S waves because their shearing motion cannot be transmitted through a liquid. Partially molten areas may slow down the P waves and attenuate or weaken S waves.
When seismic waves pass between geologic layers with contrasting seismic velocities (when any wave passes through media with distinctly differing velocities) reflections, refraction (bending), and the production of new wave phases (e.g., an S wave produced from a P wave) often result. Sudden jumps in seismic velocities across a boundary are known as seismic discontinuities.

B. STRUCTURE OF THE EARTH

Q: Define the internal structure of the earth from Asthenosphere to inner core and give reasons for. "Core is probably composed of iron"?

Q3. What are the different layers of the earth? Relate the three types of plate collisions associated with seismicity, Volcanism and mountain building.

The lithosphere (litho: rock; sphere: layer)

- Lithosphere is composed of the crust and upper most solid mantle.
- Lies beneath the atmosphere and above the asthenosphere
- The physical structure consists of a rigid outer layer that is divided by tectonic plates. It is regarded as rigid, brittle, and elastic.
- Characterized as elastic and less ductile
- Ranges from a depth of 80km and 200 km below the earth's surface
- Approximate temperature of 400 degrees Celsius
- Has a lower density than the asthenosphere
- Allows for conductive heat transfer
- Seismic waves travel at faster speeds across lithosphere
- Rocks are under much less pressure forces
- Chemical composition consists of 80 elements and approximately 2000 minerals

Asthenosphere (a: without; stheno: strength)

- The asthenosphere concept was proposed in 1926
- Asthenosphere is composed of the upper weaker part of the mantle
- Lies beneath the lithosphere and above the mesosphere
- The physical structure is mostly solid with some regions containing partially molten rock, which exhibits plastic properties
- Has a higher degree of ductility than the lithosphere
- Extends to a depth of 700km below the earths' surface
- Approximate temperature ranging from 300 to 500 degrees Celsius
- Asthenosphere is denser than the lithosphere
- Allows for advective heat transfer
- Seismic waves travel 5 to 10% slower in asthenosphere than in lithosphere
- Rocks are under immense pressure forces
- Asthenosphere is mainly composed of iron-magnesium silicates

Mesosphere

- The mesosphere is beneath the asthenosphere.
- This can be attributed to increased pressure with depth
- Between approximately 410 and 660 km depth,
- The mesosphere makes up most of the volume of the mantle.
- The mesosphere is entirely solid.
- The temperature and pressure of the rock in the mesosphere keep it from breaking; therefore, no earthquakes originate from the mesosphere.
- The upper mesosphere is a transition zone in which the rock rapidly becomes denser with depth in response to the increasing lithostatic pressure.

Beneath the asthenosphere is the *mesosphere*, another strong layer.

Layers based on composition:

The Crust

- The crust is the outermost layer of the earth making up **0.5-1.0 per cent of the earth's volume** and **less than 1 per cent of Earth's mass**.
- Density increases with depth, and the average density is about **2.7 g/cm³** (average density of the earth is 5.51 g/cm³).
- The thickness of the crust varies in the range of range of **5-30 km in case of the oceanic crust** and as **50-70 km in case of the continental crust**.
- The continental crust can be thicker than 70 km in the areas of major mountain systems. It is as much as 70-100 km thick in the Himalayan region.
- The temperature of the crust increases with depth, reaching values typically in the range from about 200 °C to 400 °C at the boundary with the underlying mantle.
- The temperature increases by as much as 30 °C for every kilometre in the upper part of the crust.
- The outer covering of the crust is of **sedimentary material** and below that lie crystalline, igneous and metamorphic rocks which are acidic in nature.
- The lower layer of the crust consists of basaltic and ultra-basic rocks.
- The continents are composed of lighter silicates — **silica + aluminium** (also called **sial**) while the oceans have the heavier silicates — **silica + magnesium** (also called **sima**) [Suess,1831–1914 – this classification is now obsolete (out of date)].
- The continental crust is composed of lighter (**felsic**) **sodium potassium aluminium silicate** rocks, like **granite**.
- The oceanic crust, on the other hand, is composed of dense (**mafic**) **iron magnesium silicate** igneous rocks, like **basalt**.

The Mantle

- It forms about **83 per cent of the earth's volume and holds 67% of the earth's mass**.
- It extends from Moho's discontinuity to a depth of 2,900 km.
- The density of the upper mantle varies between **2.9 g/cm³ and 3.3 g/cm³**.
- The lower mantle extends beyond the **asthenosphere**. It is in a solid state.
- The density ranges from **3.3 g/cm³** to **5.7 g/cm³** in the lower mantle.
- The mantle is composed of **silicate rocks that are rich in iron and magnesium** relative to the overlying crust.
- Regarding its constituent elements, the mantle is made up of **45% oxygen, 21% silicon,** and **23% magnesium (OSM)**.
- In the mantle, temperatures range from approximately 200 °C at the upper boundary with the crust to approximately 4,000 °C at the core-mantle boundary.

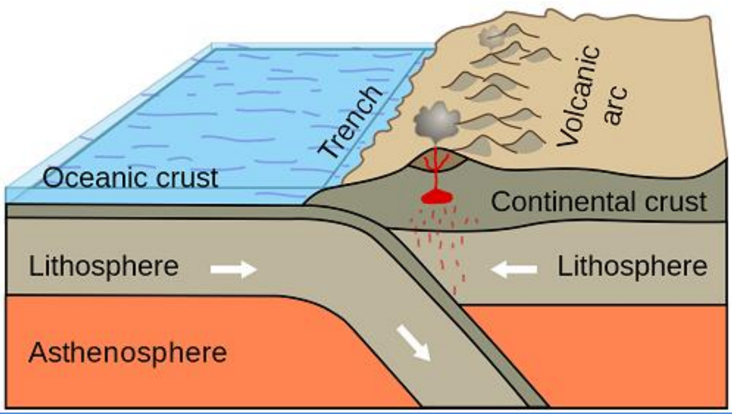
- Because of the temperature difference, there is a **convective material circulation** in the mantle (although solid, the high temperatures within the mantle cause the silicate material to be sufficiently ductile).
- Convection of the mantle is expressed at the surface through the motions of tectonic plates.
- High-pressure conditions ought to inhibit seismicity in the mantle. However, in subduction zones, earthquakes are observed down to 670 km (420 mi).

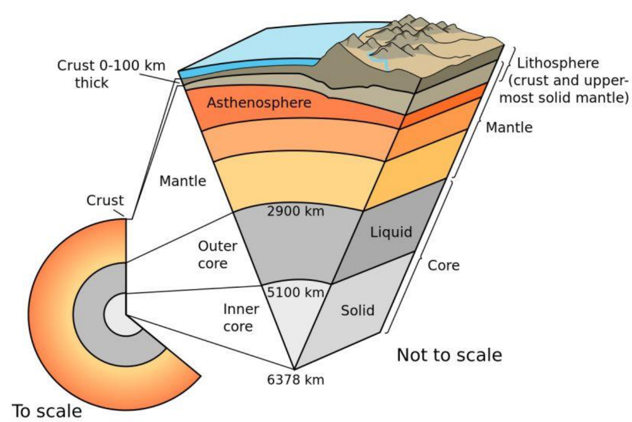
The Outer Core

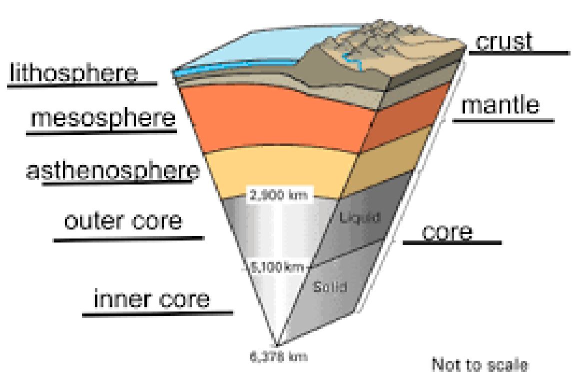
- The outer core, surrounding the inner core, lies between 2900 km and 5100 km below the earth's surface.
- The outer core is composed of iron mixed with nickel (nife) and trace amounts of lighter elements.
- The outer core is not under enough pressure to be solid, so it is liquid even though it has a composition similar to the inner core.
- The density of the outer core ranges from 9.9 g/cm³ to 12.2 g/cm³.
- The temperature of the outer core ranges from 4400 °C in the outer regions to 6000 °C near the inner core.
- Dynamo theory suggests that convection in the outer core, combined with the Coriolis effect, gives rise to Earth's magnetic field.

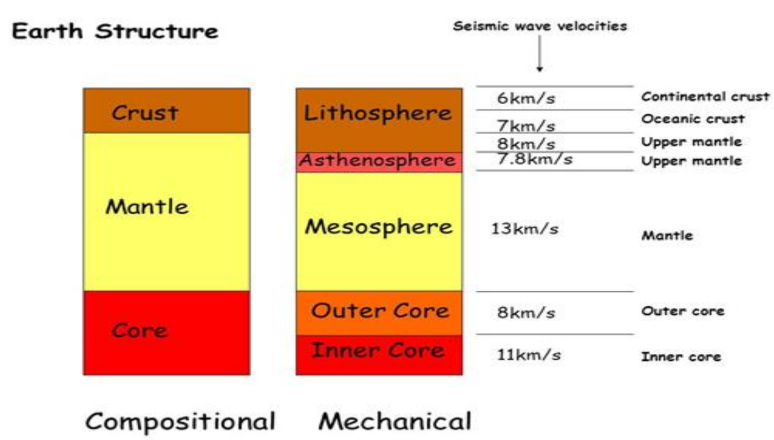
The Inner Core

- The inner core extends from the centre of the earth to 5100 km below the earth's surface.
- The inner core is generally believed to be composed primarily of **iron (80%) and some nickel** (**nife**).
- Since this layer can transmit shear waves (transverse seismic waves), it is solid. (When P-waves strike the outer core – inner core boundary, they give rise to S-waves)
- Earth's inner **core rotates slightly faster** relative to the rotation of the surface.
- The solid inner core is too hot to hold a permanent magnetic field.
- The density of the inner core ranges from **12.6 g/cm³** to **13 g/cm³**.
- The core (inner core and the outer core) accounts for just about **16 per cent of the earth's volume but 33% of earth's mass**.
- Scientists have determined the temperature near the Earth's centre to be 6000° C, 1000° C hotter than previously thought.
    - At 6000°C, this iron core is as hot as the Sun's surface, but the **crushing pressure caused by gravity prevents it from becoming liquid**.









Q-4 What is an earthquake, and how does it arise? Describe the relationship between earthquake plate tectonic?

Q – 2 Describe the mechanism and types of seismic waves? Define the most probable cause of earthquake and write an account of the Earthquake in Pakistan?

Q3. What are the different layers of the earth? Relate the three types of plate collisions associated with seismicity, Volcanism and mountain building.

Definition: Sudden movement or vibration on the earth surface is called earthquake. In other words, sudden release of energy due to tectonic activity is called earthquake. An earthquake may be produced due to: a) movement of plates, b) rising of magma, c) folding and faulting, d) violent volcanic eruption etc. When earthquake occurs, three types of wave are produced called as seismic waves. These are: a) P or Primary Wave, b) S or Secondary Wave, and c) L or Long or Surface Wave. **The earth is made up of three different layers: the crust, the mantle and the core.**

P and S waves are combinedly called as _Body Wave as they move inside the body of the earth.

- P wave is the fastest wave. It is also called as longitudinal wave. These waves move forth and back. In other words, P waves move parallel to the direction of wave. These waves can move in both solid and liquid.
- S wave is slower than P wave. It is also called as transverse wave. It moves perpendicular to the direction of the wave. These waves move only in solid and disappear in liquid.
- L wave is the slowest wave. It moves on the earth surface. It causes maximum destruction on the earth surface.

Plate Tectonics

•Plates are made of rigid lithosphere, which floats on a ductile layer called asthenosphere (upper part of the mantle)

• lithosphere Plate move by gravity & convention currents being generated in the upper mantle.

•The lithosphere is made up of two parts. The upper part is made of granite or basalt. The lower part is made of solidified mantle rock. Granite has a lower density that basalt. Since the bedrock of the continents is made of granite while the ocean floor is made of basalt, continental lithosphere has a lower density than oceanic lithosphere

1) Divergent plate boundaries or *spreading ridges*

– Occurs when 2 oceanic plates move apart and new oceanic lithosphere is forming. ***Constructive /Separate***

– Divergent boundaries are places where the crust is extended, thinned, and fractured as magma, derived from the partial melting of the mantle, rises to the surface.

– Magma from the mantle rises through the new crack.

– The magma cools and new ocean floor is created.

– Lava cools to form basalt at the top of the seafloor. Deeper in the crust the magma cools more slowly to form gabbro.

2) Convergent plate boundaries / *destructive*

• 2 plates push against each other. – 3 types

– **Continent-Continent collision:** making folds which create mountains, e.g., European Alps, Himalayas

– **Continent-Oceanic crust collision:**

• Oceanic lithosphere subducts underneath the continental lithosphere

• Oceanic lithosphere heats and dehydrates as it subsides

• The melt rises forming volcanism • Ex. - The Andes

– Oceanic-Oceanic collision• When two oceanic plates collide, one runs over the other which causes it to sink into the mantle forming a **subduction zone**.

• The subducting plate is bent downward to form a very deep depression in the ocean floor called a **trench**.

• The deepest parts of the oceans are found along trenches. – Ex. -The Mariana Trench is 11 km deep!

3) Transform plate boundaries / *destructive*

– 2 plates slide against each other, The motion of the two plates is parallel but in opposite directions

– Fault lines created • Cracks in the earth's crust

Lithosphere is neither created nor destroyed along a transform boundary, the movement between plates results in a zone of intensely shattered rock and numerous shallow-depth earthquakes. e.g., The San Andreas fault in California is a transform boundary between the Pacific and North American Plates.

The significance of Plate Tectonics

• Almost all major landforms formed are due to plate tectonics.

• New minerals are thrown up from the core with the magmatic eruptions.

• Economically valuable minerals like copper and uranium are found near the plate boundaries.

Plate and Volcanism

• volcanoes form when one tectonic plate moves under another. Usually a thin, heavy oceanic plate subducts, or moves under, a thicker continental plate. the ocean plate sinks into the mantle. This causes some of the rocks to melt. The melted rock, or magma, is lighter than the surrounding rock and rises up. This magma collects in magma chambers, but it is still miles below the surface. When enough magma builds up in the magma chamber, it forces its way up to the surface and erupts, often causing volcanic eruptions.

• Melting is common at convergent plate boundaries.

•Melting at divergent plate boundaries is due to pressure release.

•Divergent plate boundaries: Main source of new crustal formation along volcanic spreading ridges

• Convergent plate boundaries: Volcanoes are common near subduction zones. "(Pacific) Ring of Fire" is a dramatic string of volcanoes.

• Hot spots: Chimney like columns of rising hot rocks from lower mantle or even the core-mantle boundary (cf. bubbles coming to the surface in water being heated on a stove). A chain of volcanoes is formed as a tectonic plate slowly moves over a fixed hot spot (ex. The Hawaiian Islands)

• Convergent plate boundaries: Volcanoes are common near subduction zones. "(Pacific) Ring of Fire" is a dramatic string of volcanoes

Earthquake

• An earthquake is the sudden movement of Earth's crust. Earthquakes occur along fault lines, cracks in Earth's crust where tectonic plates meet. They occur where plates are subducting, spreading, slipping, or colliding. As the plates grind together, they get stuck and pressure builds up. Finally, the pressure between the plates is so great that they break loose. Depending on how much pressure has built up, the ground may tremble slightly or shake forcefully. Scientists describe the intensity of an earthquake using the Richter Scale. It measures earthquakes on a scale of 1 to 10

• Earthquakes may be felt near any plate boundary.

• Minor shallow ones occur near divergent plate boundaries as two plates move apart.

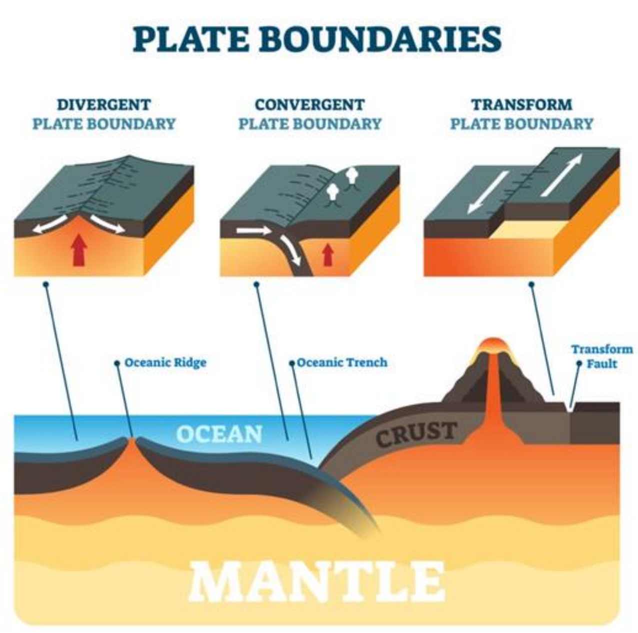
• Strong earthquakes occur near subduction zones. (**Many of Japan's**)

• Earthquakes along the transform plate boundaries in the USA.

• Transform fault earthquakes have shallow focus because the plates meet near the surface.

Mountains

Mountains form where two continental plates collide. Since both plates have a similar thickness and weight, neither one will sink under the other. Instead, they crumple and fold until the rocks are forced up to form a mountain range. As the plates continue to collide, mountains will get taller and taller. Continental crust is too buoyant to subduct. When two continental plates converge, they smash together and create mountains. The amazing Himalaya Mountains are the result of this type of convergent plate boundary.



Rocks and the Rock Cycle

Q: Discuss the main types of rocks along with example. 2008

Rocks-origin, formation and classification

Q: describe the Rock cycle how can we identify the igneous rocks on the basis of mineral contents explain the types of sedimentary rocks based on chemical and mechanical characteristics. 2008

Q: define Rocks and Minerals discuss the circumstances under which sedimentary rocks are formed. 2013

Q: discuss the main type of rocks along with example"2018

What is a rock?

- A rock is nothing but a composition of minerals.
- They (Rocks) are physical mixture of one or more minerals.
- Rocks may be hard or soft and in varied colours.
- Feldspar and quartz are the most common minerals found in all type of rocks.
- The science dealing with the study of rocks is called as Petrology.
- There are three major types of rocks: **Metamorphic, Igneous, and Sedimentary.**
- **Q: how can we identify the igneous rocks on the basis of mineral contents? 2008**

1. **Igneous Rocks**:

- Igneous rocks form when molten rock (magma or lava) cools and solidifies.
- Asthenosphere, which is just below the upper mantle, a region beneath Lithosphere is the main source of magma.
- They might be formed directly by cooling of magma from the interior of the earth itself or by cooling of lava from the surface of the earth.
- Igneous rocks comprise the earth's crust and all other rocks are derived from them, they are also called as the **parents of all rocks or the Primary Rocks**.
- Igneous rocks are the **most abundant rocks in the earth's crust**.
- On the basis of their mode of occurrence, igneous rocks can be classified as Intrusive and Extrusive Igneous Rocks.
- Examples of igneous rocks include basalt and granite.

1. INTRUSIVE IGNEOUS ROCKS:

- They are formed when magma solidifies below the earth's surface.
- The rate of cooling below the earth's surface is very slow which gives rise to the formation of large crystals in the rocks.
- The mineral grains of intrusive igneous rocks are very large..
- **Ex: Granite, dolerite, etc**

2. EXTRUSIVE IGNEOUS ROCKS:

- They are formed by the cooling of the lava on the earth's surface.
- As lava cools very rapidly on the surface, the mineral crystals are very fine.
- E.I rocks are also called as **Volcanic Rocks**.
- Ex: Gabbro, Basalt, etc

2) **Metamorphic Rocks**: –

Rocks that are formed under the influence of heat, pressure or both from pre-existing rocks are called Metamorphic rocks.

Metamorphic rocks are formed due to complete alternation in the appearance and constitution of pre-existing rock due to change in mineral composition and texture through temperature and pressure.

The process of metamorphism does not melt the rocks, but instead transforms them into denser, more compact rocks.

- Metamorphic rocks originate from both **igneous and sedimentary rocks.** They are formed from other rocks.
- The salient feature of metamorphic rocks is that it is crystalline.
- They undergo changes as a result of ultimate **pressure and heat.**
- Metamorphosed forms of **igneous rocks** are **gneiss, schist, amphibolite**.
- Metamorphosed forms of **sedimentary rocks** are **slate, marble, quartzite**.
- Metamorphosed forms of **metamorphic rocks** are **phyllite, serpentinite**
- Ex: Marble is a metamorphic rock that is formed when limestone is subjected to heat and pressure. It is composed primarily of the calcite (the key component of limestone) and other minerals such as clay, micas, iron oxides, and graphite.

Metamorphic rocks can form in different conditions, in different temperatures (up to 200 °C) and pressures (up to 1500 bars). By being buried deep enough for a long enough time, a rock will become metamorphic. They can form from tectonic processes such as continental collisions, which cause horizontal pressure, friction and distortion; they can also form when the rock is heated up by the intrusion of magma from the Earth's interior.

The most common metamorphic rocks are:

eclogite	gneiss	hornfels
serpentinite		phyllite

- **Sedimentary Rocks** –
  - Sediments are transported and deposited by wind and water. These loose sediments are compressed and hardened to form layers of rocks. These rocks are called sedimentary rocks e.g., sandstone and limestone.
  - These rocks are made from sediments formed by the erosion and weathering of other rocks. Sediments are fragmented minerals or organic matter derived directly or indirectly from pre-existing rocks and from geomorphic processes, transported and deposited by air, water or snow. Deposited in the layers, then compressed and hardened due to pressure, to form sedimentary rock. Example - sandstone, shale

Why sedimentary rocks are also called stratified rocks?

- Sedimentary rocks are formed due to deposition of sediments in layers.
- They harden over the years because of weight of layers one above the other. So, it has various layers of sediments; therefore, it is called stratified rocks.

Which type of sedimentary rock is formed when the sediments are round in shape?

Conglomerate is the sedimentary rock which is formed when the sediments are round in shape. It is used as a fill material in the construction and transportation industries.

In which type of rocks, coal is found?

- **Coal** is classified as a sedimentary rock as it is mainly derived from the fossilization of ancient plants and debris.
- **Sedimentary rocks** are generally formed by the periodic accumulation of debris.
- Limestone is a sedimentary rock composed primarily of calcium carbonate. The chemical formula of calcium carbonate is $CaCO_3$. It most commonly forms in clear, warm, shallow marine waters. It is usually an organic sedimentary rock that forms from the accumulation of shell, coral, algal, and fecal debris.
- Some of the minerals found in sedimentary rocks are: Halite, Gypsum, Quartz, Mica, clay minerals etc.

There are three basic types of sedimentary rocks.

Clastic sedimentary rocks form from the accumulation and lithification of mechanical weathering debris. Examples include: breccia, conglomerate, sandstone, siltstone, and shale.

Chemical sedimentary rocks form when dissolved materials precipitate from solution. Examples include: chert, some dolomites, flint, iron ore, limestones, and rock salt.

Organic sedimentary rocks form from the accumulation of plant or animal debris. Examples include: chalk, coal, diatomite, some dolomites, and some limestones.

under which sedimentary rocks are formed. 2013

Erosion Destructive forces are constantly breaking up and wearing away, or weathering, all the rocks on Earth's surface. These forces include heat and cold, rain, waves, and grinding ice. The forces of erosion form sediment. In erosion, running water, wind, or ice loosen and carry away fragments of rock.

Deposition Eventually, the moving water, wind, or ice slows and deposits the sediment in layers. If water is carrying the sediment, rock fragments and other materials sink to the bottom of a lake or ocean. Deposition is the process by which sediment settles out of the water or wind carrying it.

Compaction The process that presses sediments together is compaction. Thick layers of sediment build up gradually over millions of years. These heavy layers press down on the layers beneath them. The weight of new layers further compacts the sediments, squeezing them tightly together. The layers often remain visible in sedimentary rock.

Cementation While compaction is taking place, the minerals in the rock slowly dissolve in the water. Cementation is the process in which dissolved minerals crystallize and glue particles of sediment together. In cementation, dissolved minerals seep into the spaces between particles and then harden.

The Rock Cycle

Rocks are constantly changing in what is called the rock cycle. It takes millions of years for rocks to change from igneous to sedimentary to metamorphic over time. Here is an example of the rock cycle describing how a rock can

1. Melted rock or magma is sent to the earth's surface by a volcano. It cools and forms an igneous rock.
2. Next the weather, or a river, and other events will slowly break up this rock into small pieces of sediment.
3. As sediment builds up and hardens over years, a sedimentary rock is formed.
4. Slowly this sediment rock will get covered with other rocks and end

Definition Minerals

- A **mineral** is a solid, inorganic, naturally-formed substance that has a crystalline structure and specific chemical composition.
- First of all, minerals are solid and formed naturally in the earth. Natural solids can be familiar things like sand, granite, salt and wood. Minerals are **inorganic**, which means that they do not consist of tissues from living things. So, that means that wood is not a mineral.
- Granite may be made up of minerals, but it's not a mineral itself. It's a rock.

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1. **Rock Cycle**

The rock cycle is a process that explains the basic relationships among igneous, metamorphic, and sedimentary rocks.

What is a mineral?

Minerals are solid substances that occur naturally. They can be made from a single element (like gold or copper) or from a combination of elements. The Earth is made up of thousands of different minerals.

What is the difference between a mineral and a rock?

Minerals have a specific chemical structure which is the same throughout the entire mineral. Rocks, on the other hand, are composed of a variety of different minerals and are not consistent throughout their structure.

Minerals found in the crust are in solid form where as in intrior they are in liquid form98% of
the crust consist of eight elements
1.oxygen 2. Silicon 3. Aluminium 4. Iron. 5. Calcium 6. Sodium 7. Potassium 8. Magnes
the rest is constituted by titanium, hydrogen, phosphorous, manganese, sulphur carbon, nickel
& other elements

up deep in the Earth's crust.

5. When the pressure and heat get high enough, the sedimentary rock will metamorphose into a metamorphic rock and the cycle will start over again.

One thing to note is that rocks do not need to follow this specific cycle. They may change from one type to another and back again in practically any order.

Space Rocks

There are actually some rocks that come from space called meteorites. They may have different elements or mineral make up than a typical earth rock. Typically, they are made up mostly of iron.

The process depends on temperature, pressure, time, and changes in environmental conditions in the Earth's crust and at its surface

The Rock Cycle

The rock cycle is a concept used to explain how the three basic rock types are related and how Earth processes, over geologic time, change a rock from one type into another. Plate tectonic activity, along with weathering and erosional processes, are responsible for the continued recycling of rocks.

Yes, salt is a mineral — and it can be quite beautiful. In this context, it is called halite and can be classified as a sedimentary rock