GEOGRAPHY

Origin of the Earth

Hot Origin – Initially hot/heated up in the process
Cold Origin – Initially cold/ Always remained cold

Big Bang Theory: [Expanding Universe Theory]

Everything in the universe emerged from a point known as singularity.

All the matter in the universe was created in one instant at a fixed moment in time.

- Big bang took place 13.7 billion years before present
- Stars formed 5-6 billion years ago. [sun – 5 billion years ago]
- Earth formed 4.6 billion years ago
- Oceans formed 4 billion years ago
- Life began to evolve about 3.8 billion years ago
- Photosynthesis evolved about 2.5 – 3 billion years ago.
- Oxygen in atmosphere evolved about 2 billion years ago.

ASTRONOMY

Planets:

1. Mercury
2. Venus → Hottest planet, Earth's Twin (Similar Size)
3. Earth → Blue planet
4. Mars → Red planet, Olympus mons (Highest volcano)
5. Jupiter → Largest planet
6. Saturn → Ringed planet, most no. of satellites
7. Uranus→ Green planet
8. Neptune → A Twin

SIZE: J S U N E V Ma Me

VENUS	URANUS
Duration of day > year	Rotation motion appears rolling rather than spinning
Rotation period > Revolution period	Axis is tilted almost 90° to vertical plane

Satellites:

Mercury, Venus → No satellites
Earth → Moon
Mars → phobos, Deimos
Jupiter → Io, Europa, Calisto, Ganymede
Saturn → Tethys, Titan, Lapetus, Mimas, Enceladus, Cassini
Uranus → Titania, oberon, Ariel, Umbriel, Miranda
Neptune → Triton, Nereid
Pluto → Charna

Big spot/Giant Impact: Origin of Moon

Distance b/w Earth + sun → $\frac{150\ million\ km}{8.3\ LY}$ [AV = $1.496 X 10^8$ KM]

Density: Earth> Mercury> Venus> Mars>N>U>J>S

Exception: Except Venus + Uranus, all the planets of solar system rotate on their axis in the same direction as their revolution around the sun.

Asteroids: Present b/w Mars + Jupiter

Titius bode Rule: Distance of each planet from the sun is approximately twice that of the next planet close to the sun.

AGE OF THE EARTH

Geological Clock: [Frank press + Raymond siever]
Revolution (1 billion years)
Hours (100 million years)
Minutes (10 million years)

Geological History of Earth: [5 Eras + 17 periods]
Order: Aeon> Era > Period > Epoch
Cambrian – place (wales)
Ordorician – Tribe (N. wales)
Silurian – Tribe (S.wales)
Devonian – Place + Religion (U.K.)
Permian – place (Perm, Urals)

Aeon	Era	Period
Phanerozoic	Neozoic (4°)	2. Holocene
		1. Pleistocene 1 My BP
	Cenozoic (3°)	5. Pliocene 11 My BP
		4. Miocene
		3. Oligocene
		2. Eocene 70 My BP
		1. Paleocene
	Mesozoic (2°)	3. Cretaceous 135 My BP
		2. Jurassic 180 My BP
		1. Triassic 225 My BP
	Paleozoic (1°)	6. Permian 270 My BP
		5. Carboniferous 350 My BP
		4. Devonian
		3. Silurian
		2. Ordovician
		1. Cambrian 600 My BP
Proterozoic	Pre-paleozoic	1. Pre-cambrian/Algonican

Paleozoic Era:

1. Cambrian:
- Cambrian rocks of wales, N.W. Scotland, W. England, Canada and USA
- Europe was characterized by Vulcanicity

2. Ordovician:
- Ordovician rocks formed in N.W. Europe and N. America
- Initiation of mountain building (orogeny)
  First fish → originated

3. Silurian:
- Age of coral reefs.
- Leafless plants were evolved on land
- Mt. building continued + Volcanicity less active.

4. Devonian
- Mt. building + Vulcanicity more active
- Age of Fish
- Amphibians originated
- Fern Vegetation evolved

5. Carboniferous:
- Age of coal
- Coal formation in Northern hemisphere
- Reptiles evolved
- Glaciation in the southern hemisphere

6. Permian:
- Age of oil
- Inland lakes formed due to faulting
- Evaporation of these lakes led to formation of majore potash reserves of world
- High mountains formed due to tectonic movements in Europe, Asia + E. North America (Applachians). Atlantic ocean closed.

Mesozoic Era: [Age of Mammals]

1. Triassic:
- ❖ Mammals evolved on land

2. Jurassic: [Age of Dinosaurs]
- ❖ Flowering plants evolved. First birds + mammals evolved.
- ❖ Widespread deposition of lime in France, S. Germany + Swiss
- ❖ Mountains denuded into low hills.

3. Cretaceous:
- ❖ Age of chalk
- ❖ Delta formation active
- ❖ Alpine/Territory mountains orogeny initiated
- ❖ Widespread Vulcanicity
  1. Deccan trap
  2. Columbia Plateau
  3. Colorado Plateau
- ❖ Dinosaurs became dominant + extinct

Cenozoic Era:

1. Eocene:
- ❖ Himalayan orogeny initiated → Greater Himalayas (Himadri)

2 Oligocene:
- ❖ Alps orogeny initiated
- ❖ Apes originated

3. Miocene:
- ❖ Alps originated
- ❖ Origin of lesser Himalayas (Himachal)
- ❖ Greater Himalayas was further uplifted

4. Pliocene:
- ❖ Origin of Siwalik ranges
- ❖ Continents + ocean basins attained their present position.

Neozoic Era:

1. Pleistocene:
- ❖ Glaciation in Northern Hemisphere → Fall in Sea level
- ❖ Glacial periods of North America: [South to North]
  1. Nebraskan → Aftonian (Inter – Glacial periods)
  2. Kansan → Yarmouth
  3. Illinoin → Yarmouth
  4. Wisconsin → Sangaman

Glacial Periods in Europe:
1. Gunz
2. Mindel
3. Riss
4. Wurn
- ❖ Retreat of ice sheets formed great lakes of North America, Glacial lakes of Europe & fiords of Norway coast.

2. Holocene: [10,000 years B.P]
- ❖ Man began forming + animal domestication

Longest duration:
1. Pre-cambrian
2. Cambrian – 100 M.Y
3. Carboniferous – 80 M.Y
4. Cretaceous – 65 M.Y

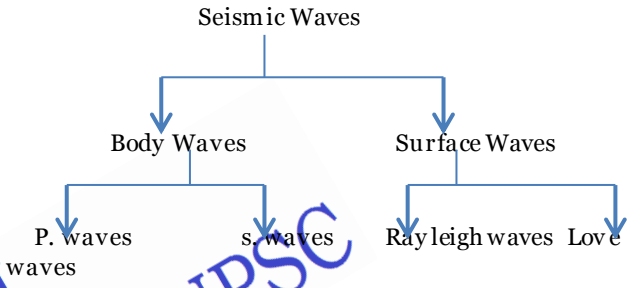
Interior of the Earth

Density:
Average density of the earth = 5.5 g cm^{-3}
Average density of earth's surface = 2.6 to 3.3 g cm^{-3}
Average density of core = 11 g cm^{-3} / Mantle = 4.6 g cm^{-3}
Very high density of core is due to heavy metallic minerals → NIFE

Temperature:
Rate of increase of temperature downwards decreases with increasing depth.
Asthenosphere = Partially molten (plastic)
Outer core = Molten
Inner core = solid

Pressure:
Inner core is solid b'coz of superincumbent load which increases the melting point of rocks.

Seismic Waves:



Body waves: Travel through the solid body of the earth
Surface waves: Move along the free upper crusts of earth

P Waves:
- ❖ A.K.a longitudinal or compressional waves
- ❖ Analogous to sound waves
- ❖ Pass thro' liquid but at lesser speed.

S. waves:
- ❖ A.K. a Transverse or Distortional waves
- ❖ S waves can't pass thro' liquid materials.

Love waves:
- ❖ Motion is entirely horizontal, at right angles to the direction of wave motion.
- ❖ Cover the longest distances of all seismic waves.
- ❖ Speed is lower than P + S waves but are most violet and destructive waves.

Layering of Earth by E. Suess:
1. SIAL Layer: Composed of granites. Dominated by Silica + Aluminium. Average density is 2.7
2.SIMA Layer: Composed of basalt. Dominated by Silica + Magnesium
Average density ranges b/w 2.9 to 4.7
3. NIFE Layer: Dominated by Iron + Nickel.
Responsible very high density of core = 11g cm^{-3}

Lithosphere: Solid crust (0 – 100 km)
Floats over plastic asthenosphere
Consists of Upper crust + Lower crust + Upper part of Upper Mantle

Asthenosphere:
Partially Molten/Plastic state
Discovered by Beno Gutenberg
Extends upto 300 – 400 km
Seismic waves slow down here known as zone of low velocity → 100 to 200 km.

Inner core:
High density → Heavy metallic minerals, Nickel + Iron
Solid → Super incumbent load (pressure)

Outer core:
Molten / Liquid state
Thickest layer of earth [2250 km]
S waves are absent.

Continental crust → Thicker; Granite → Less dense
Oceanic crust → Thinner; Basalt → More Dense

ISOSTASY

Dutton: First proposed the term, "Isostasy"
Isostasy: Mechanical stability b/w upstanding parts and lowlying basins on a rotating earth.

Origin of Continents and Oceans

Distribution:
1. 71% ocean and 29% land → Earth
2. Dominance of land areas in Northern hemisphere → 75% land area of globe and water bodies dominate in southern hemisphere
3. Pacific Ocean occupies one-third of entire surface area of the globe.

Continental Drift Theory – Alfred Wegener:

Plate Tectonics Theory:
Plate:
- Coined by J.T. Wilson
- Rigid lithospheric slab is called plate
- There are 7 major plates + 22 minor plates
- Pacific plate: Composed of oceanic crust almost entirely and covers 20% of the earth's surface.
- No plate consists of only continental crust
- Plates are not permanent features → change in size and shape, can split or weld with another adjoining plate.
- Plates range in thickness from about 70 km beneath oceanic areas to 150 km beneath continents.

Plate Boundaries
i) Constructive/Diverging/Accreting Plate Margins:
- Zones of divergence where there is continuous upwelling of molten lava.
- New oceanic crust is continuously formed
- **Features:** a) Active vulcanism → Fissure Volcanoes.
  b) Shallow Focus Earthquakes.
  c) Rift valley
  d) Mid – oceanic Ridges

ii) Destructive/Convergent/consuming Plate Margins:
- 2 plates converge, denser plate is overmidden by lighter plate. Overridden plate is subducted into mantle
- Part of crust (plate) is lost in the mantle
- **Features:** a) Explosive volcanoes
  b) Shallow to deep focus earthquakes
  c) Mountain building
  d) Oceanic trenches
  e) Island Arcs + Festoons

iii) Conservative / Shear plate Margins
- 2 plates pass or slide past one another along transform faults.
- Crust is neither created nor destroyed
- **Features:** a) Most severest Earthquakes
  b) Transform fault Ex: San Andreas Fault, California

Sea Floor Spreading:
- Propounded by Harry Hess + Deitz
- Sea-floor spreads along the mid-oceanic ridges and the expanding crusts (plates) are destroyed along the oceanic trenches.
- New basaltic crust is continuously formed along the mid-oceanic ridges.
- East Pacific Rise: Maximum spreading place in Pacific ocean @ 6 to 9 cm / year. (Total expansion → 12 to 18 cm / year)
- Rate of seafloor spreading calculated by the age of isochrones + distance b/w 2 isochrons
- **Isochrons:** Lines joining points of equal dates of magnetic stripes
- **Red Sea** spreads @ 1cm/year (Total spread → 2cm/yr)
- **Gulf of Aden** spreads @ 0.9 to 1.1cm /year (Total → 1.8 to 2.2)
- **Gulf of California** is spreading.

Continental Displacement + Plate Tectonics:
[Valentine + Moors]
700 – 600 My BP → Pangaea I (United landmass)
600 – 500 My BP → Disruption of Pangaea I
500 – 400 My BP → Caledonian Mountains orogeny [CSD]
400 – 300 My BP → Hercynian Orogeny [HCP]
300 – 200 My BP → Pangaea II (United landmass)
200 – 100 My BP → Disruption of Pangaea II during Jurassic Period
100 – 0 My BP → S. America + Africa separated during middle cretaceous period
→ Alpine mountains formed in tertiary period
Ocean Formations: → Indian ocean formed in tertiary period
→ Atlantic ocean formed cretaceous period

Endogenetic Forces
- Both slow and sudden forces are constructive forces.

Sudden Forces:
- These forces are the result of long period preparation deep within the earth. Only their cumulative effects on the earth's surface are quick and sudden.

Diastrophic/slow/ Secular Forces:
- These forces operate very slowly and their effects become visible after thousands and millions of years.

Epeirogenetic Movements:
- Continent building movements
- **Vertical Movements** causing upliftment or subsidence of continental masses.

- Affects larger parts of the continents

Orogenetic Movements:

- Mountain building movements
- Caused by endogenetic forces operating in horizontal manner.
- Horizontal forces are also known as tangential forces.
- Tangential forces working in opposite directions are called Tensional forces.
- Tangential forces working towards each other/ face to face are called compressional / convergent forces.

Compressional Forces:

- Crustal warping affects larger areas of the crust
- Folding: Bucking and squeezing of crustal rocks by the compressive horizontal forces.
- **Folds:** Wave-like bends having anticlines + synclines
- Folds are minor forms of broad warping
- **Dip:** Inclination of rock beds wr.t horizontal plane
- **Strike:** Direction of any horizontal line along a bedding plane.
- The direction of dip is always at right angles to strike
- Angle of dip is measured by clinometer.
- **Anticline:** Upfolded rock beds
  Dip angle < 40° → Gentle Anticline
  Dip angle b/w 40° +90° → steep anticline
- **Syncline:** Downfolded rock beds
  On intense folding, syncline assumes the form of canoe.

Right Valley + Block Mountain:

Right Valley: Long, narrow and very deep through / depressions bounded by steep sides, caused by horizontal and vertical movements.

Examples:

1. Rhine rift valley b/w Vosges (France) and Black forest mountain (Germany)
2. Great African rift valley [L. chi/wa to dead sea]
3. Death valley, California – USA
4. Narmada valley
5. Tapi valley
6. Damodar valley
7. Son valley
8. Central plain of Scotland
9. Spencer Bay of South Australia
10. Ocean Deeps: i) Bortlet Trough → South of cuba
    ii) Java Deep

Block Mountains: Stable blocks adjoining rift valleys.

Examples:

1. Wasatch range, USA
2. Serra Domar
3. Serra de Mantigueira
4. Vosges, France
5. Black Forest Mt, Germany
6. Salt Range, Pakistan
7. Sierra Nevada, USA → Most extensive block Mt. of the world.
8. Hunsruck Mts.

The Rocks

The materials of the crust or lithosphere are called rocks.

Elements of whole Earth	Elements of Earth's Crust
1. Iron	1. Oxygen
2. Oxygen	2. Silicon
3. Silicon	3. Aluminium
4. Magnesium	4. Iron
5. Nickel	5. Magnesium
6. Sulphur	6. Calcium
7. Calcium	7. Potassium
8. Aluminium	8. Sodium

Silicate Minerals:

- 87% of the minerals in earth's crust are silicates.
- Quartz, Fieldspar + Ferromagnesium are important minerals.
- **Quartz:** composed of silicon + oxygen
  Hard + resistant mineral
- **Feldspar:**

Most abundant + most important rock forming mineral
Very weak mineral + susceptible to weathering
Used in ceramics + glass industry.

- **Ferromagnesium:** Easily weathered and eroded away.

Classification of Rocks:

On the basis of mode of origin,

1. Igneous Rocks:

Formed due to coding, solidification and crystallization of molten earth materials.

2. Sedimentary Rocks:

Formed through the lithification, compression and cementation of the sediments deposited in particular place.

3. Metamorphic Rocks:

Formed due to change in the form or composition of either igneous or sedimentary rocks but without disintegration and decomposition of the rocks.

Igneous Rocks:

Primary rocks: Igneous rocks originated first of all the rocks during the formation of upper crust of the earth.

Parent rocks: All subsequent rocks are formed, directly or indirectly from the igneous rocks.

Characteristics :

1. Most of igneous rocks are hard and water percolates with great difficulty. But, Basalt is softer.
2. Igneous rocks are granular or crystalline rocks.
3. Igneous rocks don't have strata like sedimentary rocks.
4. Less affected by chemical weathering since H_2O doesn't percolate the rocks easily. But affected by Physical or mechanical weathering.
   Exception: Basalt is affected by chemical weathering.
5. Do not contain fossils
6. No. of joints increases upward in any igneous rock
7. Associated with volcanic acitivities + are found in volcanic zones.

Intrusive Igneous rocks:

Formed due to coding + solidification of magma below the earth's surface. Ex. Granite, Dolerite, Diorite, Zeolite.

a) Plutonic rocks: Ex. Granite, Diorite.

b) Hypabyssal rocks:

i) Batholiths:

ii) Laccoliths:

- Karnataka Plateau, India.

iii) Phacoliths:

iv) Lapoliths:

v) Sills:

vi) Dykes:

Extrusive Igneous rocks:

Formed due to cooling and solidification of lavas at the earth's surface. Also known as volcanic rocks.

- Generally find grained or glassy basalts.
- Ex. Basalt, obsidian

a) Explosive Type:

i) Bombs: Big fragments of rocks.
ii) Lapilli: Fragments of Peas sized.
iii) Tuffs: Fine volcanic materials deposited in aquatic condition.

b) Quiet Type:

Deccan Plateau, India [Cretaceous period]

Sedimentary Rocks:

Characteristics:

1. Contains fossils of plants + animals
2. 75% of earth's surface is covered with sedimentary rocks but they make up only 5% of volume of earth's crust. They are important for extent but not for depth.
3. Size of particles decrease from coastal lands towards the oceans.
Boulder → cobble → pebble → granule → sand → silt → clay → lime
4. Contains layers / strata. Loss is an exception
5. Rarely crystalline rocks.
6. Not found in massive forms like Igneous rocks.
7. Layers are rarely horizontal b'coz they are deformed due to lateral compressive and tensile forces.
8. Joints are generally perpendicular to bedding planes.
9. Mud cracks/ Sun cracks: soft muds + alluvia deposited by rivers during flood period develop cracks on exposure to the sun.
10. Most of the sedimentary rocks are permeable and porous. Shales are imperimeable rocks.

Ex: **Sandstones, Conglomerates, Breccia, Shales, Loess**

Metamorphic Rocks:

Remetamorphism: Already formed metamorphic rocks are again metamorphased.
Intense Metamorphism: Rocks are metamorphosed to the greatest intensity.
Ex.: Dharwarian Sedimentary rocks of peninsular India

Characteristics:

1. **Foliation:** Parallel arrangement of the constituent crystals in the rock.
Gneiss → Imperfectly foliated
Schists → Perfectly foliated.
2. **Lineation:** Mineral grains are drawn out into long, thing, pencil – like objects, all in parallel alignment.
3. **Banding:** Minerals of different groups are segregated into alternate layers. Also known as schistocity.
Ex. Gneiss + schist have well marked banded structure.
4. **Fissility:** To part or split along the bedding planes.
5. **Clearage:** Numerous closely spaced parallel planes of splitting. It is a special type of foliation.
6. **Recrystallisation of minerals:** occurs in both igneous + sedimentary rocks.
7. No fossils

Types of Metamorphisms:

i) Contact Metamorphisms: (Thermal metamorphism)
Ex. Marble from limestone, Quartzite from sandstone.
ii) Regional Metamorphism (Dynamic Metamorphism)
Ex: schist from shales + clay
Slate from shales + clay
Gneiss from granite

Rock types by depth: (Top to bottom)

1. Shale
2. Slate
3. Schist
4. Gneiss
5. Granite

VOLCANOES

Components of Volcano:

- Volcanic crater / vent
- Volcanic cone
- Volcanic pipe

Volcano → vent or opening
Vulcanicity (vulcanism) → All phenomena connected with the movements of heated material from the interior to the surface of the earth.

Classification: On the basis of mode of eruption:

Hawaiin Type

- Erupt quietly due to less viscous lavas and non-violent nature of gases.
- Pele's hair
- Ex: Kilavea volcano of Hawaii

Strombolian Type:

- Erupt with moderate intensity
- Eruptions are almost rhythemic in nature
- Ex: Stromboli volcano of Lipari Island in Mediterranean Sea

Vulcanian Type:

- Erupt with great force and intensity
- Lavas are so viscous and pasty
- Volcanic clous of dark and black colour assuming a convoluted / cauliflower shape.
- Ex. Vulcano of Lipari Island, Mediterranean sea

Peleean Type:

- Most violent and most explosive type of volcanoes
- Lavas are most viscous and pasty
- Disastrous violent eruptions known as nuee ardente
- Ex. Pelee volcano, Martinque Is.
Krakatao volcano, Indonesia

Visuvious Type:
- Extremely violent expulsion of magma due to enormous volume of explosive gases.
- Most destructive type of eruption known as plinian type
- Form cauliflower shaped clouds on eruption
- Ex. Mt. vesuvious, Italy.

Lava flow:
- Slow upwelling of magma along a long fracture, fault and fissure forms lava plateau, lava plains, etc.
- Ex. Columbia – snake plateau, USA, Deccan plateau, India Parana plateau, Argentina – Brazil, Antorim plateau, N. Ireland.

Fumaroles:
- Vent through which there is emission of gases and water vapour
- Emission of gases + vapour begins after the emission of volcanic materials is terminated in an active volcano.
- Fumaroles are the last signs of the activeness of a volcano
- Sulphur is the most important mineral
- Fumaroles dominated by sulphur → Solfatora
- Ex. Valley of Ten thousand smokes, Alaska

1. Circum – pacific Belt:
- Known as pacific ring of fire
- Ex. Mt. Erebus, Antarctica, Mt. contropaxi, Ecuador, Mt. Chimbarazo, Ecuador, Mt. Shastra, Mt. St. Helens, Mt. Rainier, Mt. Hood → U.S.A.
- Fuji, Japan
  Mt. Taal, Mt. Pinatubo, Mt. Mayon → Philippines
  Valley of 10,000 smokes - Alaska

2. Mid – continental Belt
- Includes volcanoes of Alpine mountain chains, Mediterranean Sea and volcanoes of faultzone of eastern Africa.
- Ex. Mt. Etna, Mt. visuvious, Mt. Stromboli → Medi sea
- Mt. Kilimanjaro, Meru, Elgon, rungwe, Mt. Kenya, Mt. Cameroon → Fault zone E. Africa
- Mt. Ararat, Mt. Elbruz → Asia mirror

3. Mid-Atlantic Belt
- Fissure eruption type of volcanoes
- Ex. Hekla volcano, Laki fissure → Iceland
  Azores, St. Helena, Madeira, Ascension capeverde, canary is, Tristan da cunha → Atlantic ocean.

4. Intra-plate volcanoes
- Hot spot concept: Propounded by W.J. Morgan
- Intra-plate volcanoes are due to hotspots
- Ex.: Mauna Kea, Mauna Loa → Hawali

Intrusive Topography

i) Geysers:
- Intermittent hot springs which spouts hot water and vapour from time to time.
- Ex. Grand geyser, Iceland, old Faithful, Yellowstone National Park – Wyoming, USA, Rotorua Dt of North Island, New Zealand.

ii) Hot springs
- Continuous spouting of hot water
- Water rises to the surface without any explosion.

Earthquakes

Focus/Hypocentre:
- Place of origin of an earthquake
- Most of the earthquake originate at a depth of 50-100km.
- Deepest earth quakes have focus at 700 km below ground surface.

Epicentre: The place on ground surface, perpendicular to the buried focus recording seismic waves for the first time.
Seismometer/Seismograph: Record the Seismic waves at the epicentre
Seismic waves: waves generated by an earthquake

Types of scales:

i) Richter Magnitude Scale:
- Magnitude of seismic waves
- Lograthmic scale, hence has no upper limit
- Open ended scale
- 1 pt increase in Richter scale indicates
  →10 times increase in amplitude
  →32.5 times increase in the amount of energy releases

ii) Mercallisacle: (0 - 12)
- Measure the intensity of seismic waves
- Based upon damage caused by the earthquake

iii) RF Scale → Rossi – Feral Scale
iv) JMA Scale → Japan Scale

Seismic Waves:
P Waves → Fastest waves
L Waves → Highest amplitude waves, Most violent + destructive waves.

Causes of Earthquakes
1. Vulcanicity
2. Faultiny
3. Anthropogenic Causes:
Marathon Dam – Greece
Hoover Dam – USA
Koyna – India
Monteynard + Grandvale – France
Mangla – Pakistan
Kariba – Zambia
Manic – Canada
Hendrick Verwoerd – South Africa
Nourek – USSR
Kurobe – Japan

4. Plate Tectonic Theory:
Divergent Plate Boundaries:
- Shallow focus Earthquakes → 25 to 35 km focus
- Moderate Earthquakes

Convergent Plate Margins:
- Shallow to deep focus Earthquakes → Upto 700 km focus

- High Magnitude Earthquake

Conservative Plate Margin:
- Creation of Transform fault → Severest Earthquakes
- Ex. San Andreas Fault, California

Distribution of EQ:
1. circum-pacific belt → 65 -70 % EQ
2. Mid-continental belt → 21% EQ

Mountain Building

2nd order relief: Mountains, Plateaus, Plains
Plateaus = 33%
Plains = 41%
Hills = 14%
Mountains = 12%
Uplifted portion of the earth's surface → Hill / Mountain
Height more than 900 m → Mountains
Height < 900 m → Hills

Mts on the basis of period of origin:

Pre-cambrian	Caledonian	Hercynian	Alpine
*Pre-paleozoic *Territory Period	*silurion + Devonian period	* Permian + Carboniferous period	

i) Pre-cambrian Mountains
- Laurentian mountains, algoman mountains, kilarnean mountains. Mountains of Feno-Scandia, North-west Highlands + Anglesey.
- **Ancient Shield:** Canadian shield, Baltic shield / Russian shield, Siberian shield, chinese Massif, Peninsular India, African shield, Brazilian Mass, Australian shield + Antarctic shield.

ii) Caledonian Mountains:
- **Ex:** Taconic mountains of Applachian system, Mountains of Scotland, Ireland + Scandinavia (Europe), Brazilides of South America, Aravallis, Mahadeo + Satpura of India

iii) Hercynian Mountains
- Ex: Ural mts, Appalachian mts, Pennines + welsh highlands of Britain, Harz mt of Germany, Altai, Tein shan

iv) Alpine Mountains
- Rockies → North America
- Andes → South America
- Alps, carpathians, Pyrenees, Balkans, Caucasus, Cantrabrians, appenines, Dinaric Alps, Atlas mts (N.W. Africa) → Europe
- Himalayas, Pontic, Tauurs, Elburz, Zagros, Kunlun shan → Asia

Block Mountains: (Horst)
- Product of faulting caused by tensile + compressive forces
- Compressional forces produce thrust/reverse fault and shortens the crust.
- Large scale block mountains + rift valleys are due to tension rather than compression.

Fold Mountains:
- Product of folding caused by compressive forces.
- Highest + most extensive mountains of the world + are found in all the continents.
- Classification:

i) Nature of Folds:
simple fold mts with open folds, Complex fold mts (nappers, recumbent fold)
ii) Age:
Young fold mts, Mature fodl Mts (Monodinal ridges + valleys)
iii) Period of origin:
Old fold mts (Caledonian + Hercynina period), New fold Mts (Tertiary period)

Characteristics of Fold Mountains:
i) Youngest mountains on the earth surface
ii) Formed due to folding of sedimentary rocks due to compressive forces.
iii) Have fossils derived from shallow seas.
iv) Fold mountains extend for greater lengths but their widths are far smaller than their lengths.
v) Fold mountains are formed from geosynclines → long narrow and shallow depressions of water characteristics by gradual sedimentration and subsidence.
vi) Found in arch shape having one side concave slope and the other side convex slope.
vii) Found alay the margins of continents facing oceans.

Geosynclines:
- Mobile zones of water
- Geosynclines bordered by 2 rigid masses → Forelands

Plateaux

Plateaux: Extensive upland areas characterized by flat and rough top surface, steep side walls that rise above the neighbouring ground surface.

Glacial Plateaux: Garhwal plateau – India

Fluvial Plateaux: Kaimur plateau → consists of panna plateau, bhander plateau, Rewa plateau and Rohtas plateau (w → e)
Aeolian Plateaux: Potwar plateau – Pakistan
Loess plateau – china

Intermontane plateaux:
1. Tibetan plateau → Most extensive + highest plateau of world
2. Mexican plateau
3. Peru – Bolivian plateau
4. Anatidian plateau – Turkey

Piedmont Plateaux: Malwa plateau – India Patagonia plateau – Argentina [wind eroded pl] Appalachians – USA

Dome-shaped plateaux: Ozark plateau – USA chotanagpur plateau – India

Volcanic plateaux: Deccan plateau → cretaceous period
Columbian – snake plateau – USA antrim plateau – N. Ireland
Patagonian plateau – Argentina

Plateaux based on cycle of erosion:
i) Young plateaux → Mahabaleswar plateau, India
ii) Mature plateaux → Ranchi, Hazaribagh plateaux – India

Plains

Earth surface:
Plains > Plateaus > Hills > Mountains
41% 33% 14% 12%

Structural Plains:
⇒ Structurally depressed areas of the world
⇒ Ex. Russian platform, Great plains of USA, Central lowlands of Australia.

Erosional plains:

Peneplains	Pediplains
➢ Humid regions	➢ Arid/Semi-Arid regions
➢ Monadnocks	➢ Inselbergs
➢ Downwasting and Backwasting	➢ Backwasting

Depositional Plains:
1. River Deposited Plains:
i) Piedmont Alluvial plains:
Alluvial cones → Alluvial Fans → Piedmont alluvial fan plain (Bhabar)
➢ Bhabar → Water disappears in the large sized boulders, cobbles + pebbles known as dry delta plain.
➢ Tarai → Rivers reappear in this zone south of Bhabar

ii) Flood Plain:
➢ Khadar → Newer alluvial plain, affected by floods each year.
➢ Bangar → Older alluvial plain, not affected by flood, has Kankar modules.

iii) Delta Plain
➢ Gangetic Delta → Largest delta of world in India – Bangladesh.
➢ West Bengal: Char → Higher parts of delta
Beels → Lower parts

2. Aeolian Plains:
➢ Loess Plain → China (Shanxi Province) [Shensi, Shansi]
➢ Sandy Plain/ Desert Plains → Sahara Desert, Thar Desert

3. Glacial Plains:
Till Plains: Eskers + Drumlins
Outwash Plains: Formed due to deposition of materials after the ablation of glaciers + ice sheets. Consists of mixture of Sands, gravels, silts + clays.

Median Mars Plain:
Hungarian Plain → Between Dinaric Alps (w) and Carpathian Mts (E)

Plains formed by Sea Movt:
Transgression of Sea → East coast Plains of India
Regression of Sea → Kutch Plain of India

Lakes

➢ Temporary features of earth's crust.

TSO Sekuru, Tibet: Highest lake of the world
Gaurikund: 2nd highest lake of the world.
L. Titicaca, Peru-Bolivia : Highest navigable lake in world.
Dead Sea: Lowest lake of the world
L. Baykal, Russia: Deepest + Oldest lake of the world
L. Tanganyika Africa: 2nd deepest lake of world
Devtal, Garhwal Himalaya: Highest glacial lake of India
Caspian Sea: Largest lake of the world
Great Lakes, N. America: 2nd largest lake of the world

Rift Valley lakes: (S→N)
L. Chilwa → L. Malawi → L. Tanganyika → L. Kivu → L. Edward
(L. Nyasa) ↓
Dead ← Red Sea ← L. Tana ← L. Turkana (Rudolf) ← L. Albert

Cirque lakes/Tarns: Red Tarn, England

Crater lakes:
Crater - Oregon, USA
L. Toba - Sumatra, Indonesia
L. Avernus - Naples, Italy
Tonle Sab - Cambodia

Deltaic lakes:
L. Pontchartrain - Lousiana, USA (Mississippi Δ)
L. Manzala - Egypt (Nile Delta)
L. Kolleru - India (Godavari Delta)
L. Marigot - Nigeria (Niger Delta)

Lava dammed lakes:
L. Nicaragua - Nicaragua
L. Van Golu - Turkey
Sea of Galilee - Israel

Playas/Salt lakes:
L. Disappointment - Australia
L. Moore - Australia
Sambhar lake - India
Great Salt lake - Utan, USA

Karst lakes:
L. Skhoder - Montenegro
L. Balton - Austria

Ox-bow lake:
Wular lake - Kashmir, India

Lakes made by Animal:
L. Beaver – Yellow stone National Park, USA

Wind blown lake:
L. Chad ← Chad, Niger, Nigeria, Cameroon

L. Urmia, Iran:
Largest lake in W. Aisa

L. Assal, Djibouti:
Lowest point in Africa

L. Victoria:

Largest lake in Africa, Tectonic lake shared by Kenya, Uganda + Tanzania source of white Nile.

Lagoon lake:

Chilika, Pulicat lakes → East coast
Vembanad lake → West coast

Largest lakes: (High to Low)

1. Caspitan Sea → Asia
2. L. superior → N. America
3. L. Victoria → Africa
4. Aral Sea → Asia
5. L. Huron → N. America

Weathering + Mass Movement

Weathering:

- In situ disintegration + decomposition of rocks.
- No large scale transport of weathered materials except mass movement down the slopes under the impact of gravity.
- static process

Cycle of Erosion

James Hutton:

- Uniformitarianism → Hutton + Lyell
- Cyclic nature of the earth history
- No vestige of a beginning, no prospect of an end
- Present is the key to the past.

W.M. Davis:

- Geographical cycle of Erosion → Landforms undergo sequential changes through time.
- Landscape is a function of structure, process and time.

Concepts:

1. Peneplain → W.M. Davis
2. Pan plain → C.H. Crickmay
3. Pediplain → L.C. King
4. Endrumpf → W. Penck

GEOGRAPHY

ATMOSPHERE

Composition

- Atmosphere → Gases, Particulate matter

Gases:

- Nitrogen → 78%
- oxygen → 21%
- Argon → 0.93%
- Co_2 → 0.03%

Krypton, Xenon, Methane → Trace.

N_2 > O_2 > Argon > Co_2 > Neon > Helium > Ozone > Hydrogen

- Green House Gases → carbon – dio – oxide, Methane, CFC, SHF, water vapour, Nitrous oxide, ozone.
- Ozone Depleting substances → CFC, Freons, Nitrogen oxides.

Water Vapour

- varies b/w 0 and 5% by volume
- Most variable gas in the atmosphere
- water vapour α Temperature
- water vapour decreases → from equator poleward and from below upward.
- More than 90% of total atmospheric vapour is found upto the height of 5 km.
- Absorbs both insolation & terrestrial radiation.

Particulate matter: scattering of light, Hygroscopic nuclei. Higher concentration of dust particles occur due to drywinds in subtropical + temperate regions.

Structure:

- height of atmosphere → B/w 16 to 29,000 km from the sea-level.
- 97% of atmosphere confined upto height of 29 km.
- 50% of atmosphere lies below height of 5.6 km

Layers of Atmosphere:

1) Troposphere:

- Weather phenomena associated with this layer.
- Temperature decreases with increasing height @ 6.5° C per km → Normal Lapse Rate
- Troposphere is thicker at Equator than the poles.
  Ground surface → Temperature decreases from Equator to poles.
  Tropopause → Temperature increases from Eq. poleward.
- Troposphere means zone/ region of mixing and Tropopause means where the mixing stops.

2) Stratosphere

- **Ozonosphere:** lower part of stratosphere (15 to 35 km) having ozone concentration absorbs UV rays.
- **Temperature inversion:** Temperature increases with increasing height in this layer. due to ozone layer.
- **Thickness of ozone:** thickest at Equator → More heat. Thin at poles → Less heat.

3) Mesosphere:

- Temperature decreases with height → Normal Lapse rate.
- Lowest temperature is recorded in this layer.

4) Thermosphere

- Temperature increases rapidly with increasing height.
- Temperature cannot be measured by ordinary thermomoter b'coz the gases become very light due to low density.
- Thermosphere → Ionosphere – 80 km to 640 km
  Exosphere - More than 640 km.

Ionosphere:

D Layer → 60 to 99 km
→ Reflects low γ radio waves.
→ Disappears with sunset b'coz it is associated with solar radiation.

E Layer → 99 km to 130 km
→ Reflects medium & high γ radio waves
→ produced by UV photons + N_2 molecules and disappears with sunset

i) Sporadic E Layer → High velocity winds.
→ Reflected V.H. F radio waves.

ii) E_2 Layer → 150 km height
→ Produced by UV Solar photons + O_2
→ Disappear during night.

F Layer → 150 to 380 km
→ Reflect medium + high γ radio waves.

G Layer → Above 400 km
→ Persists day + night but undetectable

Chemical composition:

i) Homosphere ii) Heterosphere

i) Homosphere:

- Extends upto 90 km from sea level
- Includes Troposphere, Stratosphere & Mesosphere
- Homogenity of proportion of various gases.

ii) Heterosphere:

- Extends from 90 km to 10,000 km.
- Different layers vary in physical + chemical properties.
- 4 distinct layers:
  1. Molecular nitrogen layer → 90 to 200 km
  2. Atomic oxygen layer → 200 to 1100 km
  3. Helium layer → Upto 3500 km
  4. Atomic hydrogen layer (Top most layer of atmosphere) → 3500 to outer limit of atmosphere

Insolation and Heat Budget

- Earth receives heat → Solar radiation, Gravity and Endogenetic forces
- **Solar constant:** 2 gcal cm^{-2} min^{-1} / 2 langley min^{-1}.
- Velocity of light → 3 lakh kms^{-1} / 1,86,000 miles s^{-1}.
- Time taken by light from sun to Earth → 8 min 20 sec.
- Average distance b/w Sun & Earth → 150 million Km.
- Insolation → Incoming short wave solar radiation.

GEOGRAPHY

Electromagnetic waves: (Low γ to High γ)
Radio waves → Microwaves → IR rays → visible light → UV rays

↓
Gamma rays [shortest λ] ← X rays

$\gamma \alpha \frac{1}{\lambda}$

- UV rays forms 6% of insolation
- IR rays forms 43% of insolation

Distribution of Insolation:

- Summer solstice - June 21
- winter solstice - December 22
- Spring Equinox - March 21
- Autumn Equinox - September 23.
- Insolation decreases from equator towards the poles.
- **Summer solstice (June 21):**
  Maximum insolation @ upper atmosphere → North pole
  maximum insolation @ ground surface → 30° - 40 ° N
- Total amount of insolation received at equator is roughly about 4 times of that received at poles
- Poles receive about 40% of insolation received at the equator.
- **Seasonal variation of insolation:**
  Little → Tropics
  High → Temperate regions

Factors affecting distribution of insolation:
1) Angle of sun's rays.

2) Length of Day

- length of day varies at all places except at equator.
- Length of day is always of 12 hours at the equator.
- length of day increases poleward with northward migration of sun in the northern hemisphere while it decreases in the southern hemisphere.
- 6 months day at North pole from March 21 to Sept. 23.
- 6 months day at South pole from set 23 to March 21.

3) Distance b/w Earth + Sun:

- Earth revolves in an elliptical orbit and hence its distance changes.
  Perihelion (Nearest) → January 3
  Aphelion (Farthest) → July 4

Southern Hemisphere:

- 7% sev ere winter than N. Hemisphere
- 7% sev ere summer than N. Hemisphere
- More affected due to inclination of the earth.

4) Sunspots:

- Ev ery 11th year maximum no. of sunspots occur.
- Insolation α sunspots.

5) Effects of Atmosphere:
* Absorption (14%)
* Scattering (23%)
* Reflection (35%)

Absorption:

- 14% of insolation is absorbed by atmosphere gases.

Scattering:

- 23% is scattered in the atmosphere.
- smaller dust particles cause scattering of light.
- Blue light is more scattered than red light.

Reflection:

- Larger dust particles cause reflection of light.
- About 35% of insolation is reflected back from earth. It is known as Abledo.

Albedo of planets:

Mercury	Venus	Earth	Mars	J S U N
6%	76%	35%	16%	73 to 94%
		Moon 7%		

Heat Budget
Insolation → Incoming solar radiation [short wave]
Terrestrial radiation → Outgoing radiation [Long wave]

- 35% of insolation sent back to space:
  Scattering by dust - 6%
  Reflection by ground - 2%
  Reflection by clouds - 27%
  35% (Albedo of Earth)

- 51% of insolation reaches the earth surface
  i) Direct radiation (34%)
  ii) Diffuse radiation (17%)

Temperature

- Heat → Form of energy
- Temperature → Degree of hotness / coldness of any substance.
- Atmosphere heated through → conclusion
  → convection
  → Radiation
- **Counter-radiation**: Re-radiation of terrestrial radiation from the atmosphere back to earth's surface. Effected mainly by Co_2 + water vapour
- Air is a poor conductor of heat.
- Atmosphere is mainly heated by terrestrial radiation.
- Green house effect keeps the atmosphere + earth surface warmer
- Co2 → Absorbs Terrestrial Radiation
  water Vapour → Absorbs Insolation + Terrestrial Radiation
- 90% of water vapour in atmosphere is concentrated upto height of 5 km from the sea-level.
- High mountains are called as radiation windows.

Temperature Inversion (Ti):

- Temperature increases with increasing height in troposphere.
- Warm air lies over cold air → Ti

Pressure and Winds

Pressure:

- Atmospheric pressure is maximum at sea level.
- Normal pressure @ sea level → 1013.25 (76 cm Hg)
- Atmospheric pressure decreases with increasing height @ 1 mb / 10 m
  Highest Pressure → Irkutsk
  Lowest Pressure → Mariana Is.

- Pressure $\alpha \frac{1}{Temperature}$

Pressure Belts:

- 7 Pressure Belts → 4 Dynamically induced, 3 Thermally induced.
- Dynamically induced → Sub-tropical High, Sub-polar low
- Thermally induced → Equatorial low, polar high

1. Equatorial low:

- Dodlrums → Belt of calm air
- zone of convergence of NE & SE trade winds → ITCZ
- surface winds are generally absent since winds.
- approaching this region begin to rise vertically near its margin.

2. Sub-tropical high:

- Anticyclonic conditions cause stability + aridity.
- Horse latitudes: calm condition with variable + feeble winds.
- Not a continuous belt but broken into high pressure cells in summer → pacific high, Azores high & Indian high

3. Sub-Polar Low:

- More developed and regular in southern hemisphere due to overdominance of oceans.
- Northern hemisphere
  Summer → Icelandic low only
  Winter → Aleutian low, Icelandic low

4. Polar High:

- Very low temperature year round
- 2-4 PM → Maximum temperature, Lowest Pressure
- 4-5 AM → Minimum temperature, Highest Pressure

- **Coriolis Force:** Rotation of earth causes deflection of winds & hence they flow at acute angles to isobars.
- Cyclones → Anti-clockwise in Northern Hemisphere. CAN

Beaufort scale of winds:

Speed: Hurricane> storm > Gale > Breeze

- Speed of Hurricane → 64 – 71 knots (B. scale-12)
- Speed of storm → 56-63 knots (B-scale-11)

Wind → Air moving parallel to ground. [Horizontal]
Current → Vertical air movement.

Winds

Primary winds

- Trade winds
- Westerlies
- Polar Easterlies

Secondary winds

- cyclones
- Anticyclones
- Monsoons
- Air masses
- Fronts

Tertiary winds

- Local winds
- Land + Sea Breeze
- Mountain + Valley breeze

Primary Winds: [Planetary winds/ Prevailing winds]

- Formed due to Pressure gradient force, coriolis force, frictional force & centripetal force.

1. Doldrums: [5° N - 5° S]

- Equatorial Low having light & feeble air circulation.
- It is a zone of calm.
- Crowe identified 3 doldrums → Indo-Pacific, African west coast, Central American west Coast.

2. Trade Winds: [Hadley cell]

- Blow from sub-tropical high to Equatorial Low.
- **ITCZ:** Formed due to convergence of N.E. Trades & S.E. Trades near the equator.
- There is westerly air circulation in ITCZ known as Equatorial westerlies, called by Flohn.

3. Westerlies: [Ferrel cell]

- Blow from sub-tropical high to sub-Polar low.
- Polar front created due to convergence of warm westerlies & cold polar Easterlies thus forming temperate cyclones.
- In N.H, more vigorous during winter.
- More effective in S. H. →Roaring forties, Furious fifties, Shrieking sixties.

4. Polar Easterlies: [Polar Cell]

- Blow from Polar high to sub-polar low.
- This zone shrinks due to northward shifting of pressure belts during summer solstice.

Shifting of Pressure + Wind belts:

- Except Polar high, all belts migrate with the movements of sun.
- Shifting of Pressure belts gives rise to:

1. Mediterranean climate → winter Precipitation, 30° - 45° latitudes, Dry summer, wet winter.
2. 60° - 70° Latitudes → Wet summer through westerlies and associated cyclones.
   → Dry winters due to polar easterlies.
3. Monsoon climate → shifting of NITC & equatorial westerlies due to national migration of sun. Equatorial westerlies extend as SWM in summer.

Local winds:

Warm winds:

1. Chinook	- Eastern Rockies
2. Foehn	- Northern Alps
3. Harmattan	- Guinea
4. Sirocco	- Italy
Khamsin	- Egypt
Gibli	- Libya
Leveche	- Spain
Chili	- Tunisia
5. Simoom	- Arabian desert
6. Norwester	- New Zealand
7. Brickfielder	- Victoria, Oz.
8. Black roller	- Great Plains, USA

9. Shamal - Iraq + Persian Gulf
10. Santa Ana - USA
11. Yamo - Japan
12. Zonda - Argentina
13. Loo - India
14. Southerly Buster – Australia

- Harmattan → doctor
- Sirocco → Blood Rain
- Chinook → Snow eater

Cold winds

1. Mistral - Rhone valley
2. Bora - North Italy
3. Blizzard - Canada
Northern - S. USA
Burran - Siberia
4. Purga - Russian Tundra
5. Bise - France
6. Levanter - South Spain
7. Pampero - Pampas of S. America
8. Gregale - Medi Sea
9. Tramontana - Medisea
10. Gravity / Katabatic / Fall / drainage winds.
11. Friagem – Amazon valley
12. Haboob - sudan
13. Papagayo - Costa Rica

Swiss → Climatic Oasis due to Foehn

Jet Streams: [Rossby Waves]

- Strong + rapidly moving circumpolar westerly air circulation in a narrow belt of few hundred km width in upper troposphere.
- Circulation of westerly Jet stream is confined b/w poles + 20° latitudes in both hemispheres @ height of 7.5 – 14 km.
- WHO: A strong narrow current concentrated along a quasi-horizontal axis in upper troposphere by stong vertical + lateral wind shear & featuring one/more velocity maxima.

Properties:

1. Flow west to east @ 7.5 – 14 km ht in upper troposphere.
2. Thousands of km → length
Few hundred km → width
Few km (2-4) → depth
Vertical wind shear is more than Lateral wind shear
3. **Circum – polar winds:** confined b/w Poles + 20° latitudes.
4. wavy + meandering path
5. wind velocity twice that of summer season in winter & becomes strong in winter.
Max. velocity → 480 kmph
Min. Velocity → 108 kmph
6. Shifts northward with northward migration of sun

Forms of condensation

Dew, Fog/Mist, Frost, clouds

3 Properties to classify clouds:

i) Basic shape
ii) Height above ground
iii) Whether or not precipitation is generated

1) Dew: [Ground surface]

- Clear skies, calm weather & winter night.
- Dew point above freezing point.
- Condensation in the form of water droplets.

2. Frost: [Ground Surface]

- Condensation in the form of tiny ice crystals.
- Dew point at or below freezing point.

3. Fog:

- Due to cooling of air from below → T_i
- Warm air above & cold air below.
- Known as clouds near the earth surface / Low clouds.
- Visibility reduced to less than 1 Km.
- Mist: Light fog with visibility > 1 Km < 2 Km

4. Clouds: [Luke Howard]

- WMO → International cloud Atlas → 10 Genera, 26 species, 31 varieties. 10G, 26S, 31V
- **Clouds based on height**
High clouds (5 to 14 km)
1. Cirrus 2. Cirro-Cumulus 3. Cirro-Stratus
- **Medium Clouds (2 to 7 km)**
1. Alto – Cumulus 2. Alto – Stratus 3. Nimbo – Stratus
- **Low Clouds (0 to 2 Km)**
1. Strato-cumulus 2. Stratus 3. Cumulus
4. Cumulo – Nimbus

1. Cirrus:

- Dry weather

2. Cirro-cumulus:

- Not common type of clouds. (Rare cloud)

3. Cirro-stratus:

- Milky thin sheets.
- Produce halo around sun & moon.
- signs of approaching storms

4. Alto-cumulus

- Woollen, bumpy clouds in wavy arrangement.
- Larger globular masses → sheep/ wool pack clouds

5. Alto – stratus:

- Thin sheet of gray / bluish cloud with a watery look.
- Yield widespread + continuous precipitation.

6. Nimbo-stratus

- Dark cloud with copious precipitation → rain cloud.
- Not accompanied by lighting, thunder or hailstorm.

7. Strato – Cumulus:

- Rough bumpy cloud
- Great contrast b/w bright + shaded parts

8. Stratus:

- Very low cloud composed of uniform layers.
- Thin stratus clouds produce corona.
- Dull weather with light drizzle.

9. Cumulus:

- Vertical cloud with rounded top & horizontal base → cauliflower shape.
- Fair weather clouds.

10. Cumulo-Nimbus:

- clouds with great vertical development.
- Bring lightning, thunder & hailstorms → Thunderstorm clouds.
- Anvil top is characteristic feature

Precipitation:

- Forms of Precipitation.
- Rainfall - Virga
- Snowfall
- Sleet
- Hailstorm
- Drizzle

Theories of Rainfall

1. Cloud Instability / Ice –crystal theory → Bergeron, Findeisen
2. Collision / Coalescence theory → E.G. Bowen, Longmuir.

Types of Rainfall:

i) Convectional Rainfall
ii) Orographic Rainfall
iii) Frontal / Cyclonic Rainfall

i) Convectional Rainfall: [Maximum RF with Minimum Cloudness]

- Due to insolational heating of earth.
- Daily in the afternoon (2-3 PM) in Equatorial regions.
- Cu-Ni clouds → Thunder, lightning & very short duration.
- Temperate, tropical + Sub-tropical regions → Summer rainfall.

ii) Orographic Rainfall: [Relief Rainfall]

- Most of the world precipitation occurs through it.
- **Conditions:**
  - Mountain across wind direction.
  - Mountains parallel to sea coast
  - Inland Mts should be of more ht.
- **Characteristics:**
  - Windward slope + Leeward side (Rain shadow)
  - Maximum RF near slopes + decreases away from the foothills
  - Windward slope → cumulus clouds
  - Leeward slope → Stratus clouds
  - Inversion of Rainfall: Amt of RF decreases with increasing height beyond contain height due to decrease in moisture content of air. It is known as Maximum Rainfall Line.
  - occurs in any season & is more widespread & of longer duration.
  - occurs in conjuction with convectional & frontal rainfall.
  - **Moderate ht of mountain:** RF occurs in leeward side than that of windward side.

iii) Frontal / cyclonic Rainfall:

- **Frontal RF:** Temperate cyclones due to fronts, convergence of warm westerlies + cold polar easterlies.
- **Cyclonic RF:** Develops over warm tropical oceans with low pressure centre.s

Distribution of Rainfall:

- Mean annual rainfll of earth → 970 mm
- Mediterranean region → winter rainfall
- Equatorial climate, British climate, Tropical marine climate → Year round RF
- Monsoon climate, Savanna climate → summer RF

Sleet:

- Mixture of snow train (U.K)
- Frozen raindrops, melting + re-freezing on their way down.

Hail:

- Larges pellets or spheres of ice.
- Concentric layers of ice due to strong vertical convective currents.

Drizzle:

- Numerous uniform minute droplets of water (< 0.5 mm)
- Falls continuously from low stratus clouds.

Patterson:

- Physical Atlas (pattermann)
- Divided the globe into 15 rainfall zones.

Virga:

- Precipitation from cumulus clouds in summer is evaporated before reacing the ground surface.

Air Masses

- **Air mass:** Large body of air whose physical properties, especially temperature, moisture content and lapse rate, are more or less uniform horizontally for hundreds of kilometres.

Fronts

- **Front** → sloping boundary formed due to convergence of warm airmass + cold airmass.
- **Characteristics:**
  - Large differences in air temperature across front.
  - Bending isobars [steep thermal gradient]
  - Abrupt shift in wind direction.
  - Cloudiness + Precipitation.
- Frontogenesis: Creation of new fronts or regeneration of decaying fronts already in existence.
- Frontolysis: Destruction or dying of fronts

Cyclones

- Cyclones are centres of low pressure surrounded by closed isobars.
- Air blows inward in anti-clockwise in NH and clockwise in S.H.
- Cyclones are known as atmospheric disturbances.
- Cyclonic storm: Cyclones with velocity of gale.

- 2 types → Extra-tropical [Temperate/wave] cyclones, Tropical cyclones.

Types of Tropical cyclones:

1. Tropical disturbances [Easterly waves]
2. **Tropical depressions:**

- 40 to 50 kmph
- Low pressure centre surrounded by more than one closed isobar.

3. **Tropical Storms:** 40 to 120 kmph
4. **Hurricanes:**
   - velocity > 120 kmph
   - Symmetrical + circular isobars.
   - steep pressure gradient
   - Names:

Hurricanes → Caribbean Sea
Typhoons → China
Willy-willy → Australia
Cyclones → Indian Ocean
Baguio → Phillippines
Nowaki / Taifu → Japan

Sl. No.	TEMPERATE CYCLONES	TROPICAL CYCLONES
1	Land + Ocean origin	Originates over ocean only
2	Moves eastwards	Moves westwards
3	Ni-St, Cu-Ni clouds	Cu-Ni clouds
4	Frontal origin	Thermal origin
5	Occurs in any season	Summer only
6	Larger size	Smaller size
7	Less velocity	High velocity
8	Temperature Variations	No temp variations
9	Gentle Pressure gradient	Steep Pressure gradient
10	Wind direction changes	Constant wind direction
11	Death: Occlusion Front, warm air taken over by cold air	Death: Landfall of the cyclone
12	35° – 60° latitudes	8° - 20° latitudes
13	Less destructive	More destructive
14	No role of latent heat	Latent heat is the major driving force.
15	Affects larger area	Affects smaller area comparitively

Anti Cyclones

- Winds blow outwards from the high pressure centre, clockwise in N.H & anti-clockwise in S.H.
- Known as weatherless phenomena due to high pressure systems.

Size:

Anti –cyclones > Temperate cyclones > Tropical cyclones

Climate

Wet-dry tropical climate → Largest annual temperature range.
Dry tropical Climate → Largest diurnal temperature range.

Newfoundland:

Experiences more drizzles than any other part of the world.

Terms

Isobronts	- Thunderstorm
Isochrones	- Travelling time from a point
Isohalines	- Salinity
Isohypse	- Contour lines
Isobaths	- Depth below sealevel
Isonif	- Snowfall
Isohels	- Sunshine
Isarithm	- Same value or quantity (Isopleth)
Isotherm	- temperature
Isobars	- Pressure
Isotropes	- Potential temperature
Isopaches	- Cumulonimbus
Isohyets	- Rainfall
Isogonic line	- Magnetic declination
Isochrones	- Spatial travel time diagram [places located at equal travel time from a point]
Isobase	- Equal elevation or depression of land
Isocheim	- winter temperature
Isogon/Isogonic	- Magnetic variation
Isozeismal line	- Earthquake intensity