TOPIC 1: THE LITHOSPHERE

- The word "***Lithosphere***" comes from a Greek word "***Lithos***" which means rock or stone.
- So, lithosphere means a sphere of rocks.

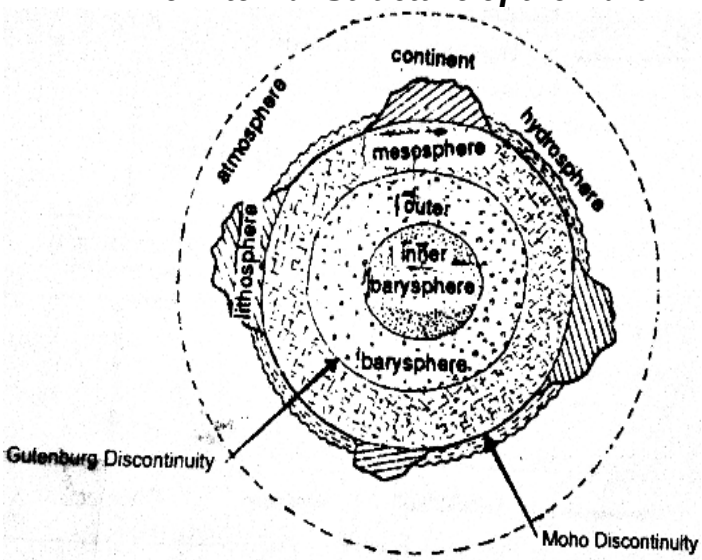
LITHOLOGY

- This is the study of rocks.

THREE MAIN PARTS OF THE EARTH

1) The Core (Barysphere)
2) The Mesosphere (Mantle)
3) The Lithosphere (Crust)

The Internal Structure of the Earth



CHARACTERISTICS OF THE CORE (BARYSPHERE)

i. It is the most interior layer of the earth.
ii. It is divided into the outer and inner core.
iii. It is 3476 kilometres in radius.
iv. It is made up of **Nickel (Ni)** and **Iron (FE)** minerals**.** This is why it is also called the "**NIFE zone"**.
v. It has very high temperatures (about 1927°C) and high pressure.
vi. It is the source of gravitational force (centripetal force).
vii. By volume, it is 16% of the earth.
viii. It is in a liquid state due to high temperatures.

CHARACTERISTICS OF THE MESOSPHERE (MANTLE)

i. It is found between the core and the crust.
ii. It is about 2900 kilometres thick.
iii. It is composed of dense rocks rich in Olivine and Silicate minerals.
iv. The upper part is capable of flowing.
v. There are a lot of convectional currents which cause the earth to move.
vi. It is separated from the core by the Gutenburg Discontinuity.

vii. It is made up of **peridotite**, **dunite** and **eclogite** minerals.
viii. It supports continents.
ix. It is warm and rocky.
x. By volume it is 82.5% of the earth.

CHARACTERISTICS OF THE LITHOSPHERE (CRUST)

a) It is the solid crust that surrounds the mantle of the earth.
b) It is separated from the mantle by the Moho-discontinuity.
c) It consists of soil.
d) It projects above the hydrosphere to form continents.
e) It is the thinnest layer (about 5 kilometres to 48 kilometres thick).
f) It is made up of two distinct parts, (the **Upper part** and the **Lower part**).

1) The Upper Part

- ✓ It is made up of Silica and Alumina **(SIAL)** minerals.
- ✓ This forms the continents.
- ✓ It is made up of granite rocks.

2) The Lower Part

- ✓ It is made up of Silica and Magnesium **(SIMA)** minerals.
- ✓ The rocks are denser basaltic, which forms the ocean floor.
- ✓ It is made up of basaltic rocks.

SOME THEORIES IN GEOGRAPHY

1) THE CONTINENTAL DRIFT THEORY

- This theory was coined (presented) by **Alfred Wegner**, a German scientist.

MAIN ARGUMENTS IN THE CONTINENTAL DRIFT THEORY

- The theory states that the continents move apart due to the movement of the tectonic plates.
- Wegner believes that at one point, the earth was a single supper continent called **Pangea**, which was surrounded by a large body of water called **Panthalassa**.
- These two existed together more than 300 million years ago *(This was during the Carboniferous period).*
- Later on, the two, (Pangea and Panthalassa) split apart due to convectional currents or cells that operate in the upper part of the mantle.

SOME SPECIFIC OCCURENCES IN SOME PERIODS

a) Permian Period

- This period existed 225 million years ago.

Physical Occurrences

- There was a single supper continent called ***Pangea***, surrounded by a single supper ocean called ***Panthalassa***.

b) Early Triassic Period

- This period existed 200 million years ago.

Physical Occurrences

- The Pangea broke apart and the land blocks separated slowly in a sideways direction (horizontal rotation).

c) Late Triassic Period

- This period existed 180 million years ago.

Physical Occurrences

- The land blocks formed two main land masses called **Laurasia** in the north and **Gondwanaland** in the south.

Land masses that broke from Laurasia

- ✓ North America
- ✓ Greenland
- ✓ Europe
- ✓ Asia

Land masses that broke from Gondwanaland

- ✓ South America
- ✓ Africa
- ✓ Australia
- ✓ Antarctica
- ✓ Madagascar
- ✓ India

d) Late Jurassic Period

- This was 135 million years ago.

Physical Occurrences

- Land masses formed from Laurasia and Gondwanaland gradually move apart.

e) Late Cretaceous Period

- This period existed 65 million years ago.

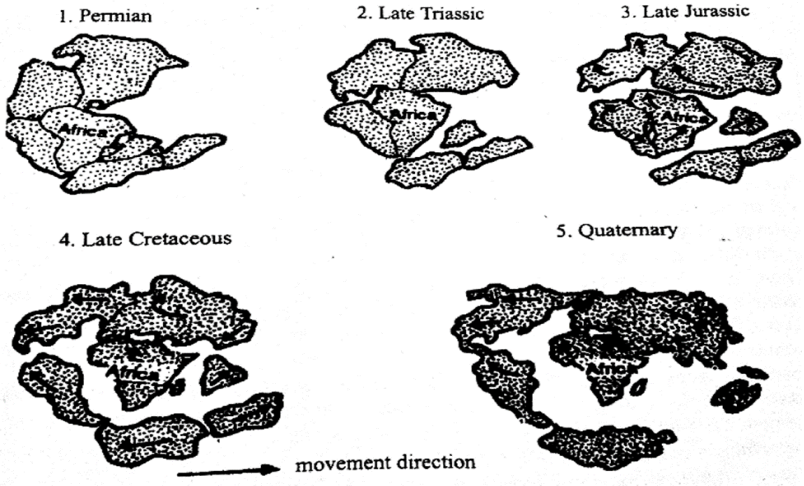
Physical Occurrences

- India moved northwards to join Asia.
- South America drifted (moved) northwards to join North America which was moving westwards.
- Australia detaches itself from Antarctica and drifts eastwards.
- Antarctica moves southwards.

f) Quaternary Period

- This period existed less than 1 million years ago.
- ***Physical Occurrences***
- The continents attain their present positions but continue to drift apart.

The Continental Drift Process and Physical Occurrences



EVIDENCE FOR THE CONTINENTAL DRIFT THEORY

i. The southern continents fit into a jig-saw puzzle.
   - This means that they can easily be fit if brought together.

ii. There is almost an identical geological sequence of rock layers in South Africa, Deccan Plateau (in India), plateaus of South America and Antarctica.
   - This shows that the continents were once joined.

iii. Folded ranges of Argentina are similar in structure and age to the folded cape ranges of Southern Africa.
   - This shows that the continents were once joined.

iv. West African rocks and those of Brazil are similar.
   - This shows that the two were once joined.

v. Magnetism of ancient rocks indicates that the continents were once a single continent.
   - The rocks are magnetized in the direction of the magnetic north when solidifying. All ancient (old) rocks on all continents show a similar magnetism pattern.

vi. Climatic changes as continents drift from one latitude to the other.
   - Rocks formed under different climatic conditions are also different.

vii. There are glacial (ice) deposits in Congo Basin.
   - Such deposits are impossible today because the basin is influenced by equatorial (warm and hot) conditions.

viii. Fossilized trees in Antarctica show that the land mass might have experienced climatic conditions different from those of today.
   - The present day Antarctica is frozen and covered with ice.

WEAKNESSES OF THE CONTINENTAL DRIFT THEORY

i. There is a problem in matching some of the continents.
   - For example, Central America has to be removed for North America and South America to match if brought together.

ii. The theory lacks satisfactory evidence on what caused the motion (drifting process).
   - Some theories may be used to explain it better.

iii. The theory is very general.
   - It is not specific.

iv. The fossil plants might have been spread to the drifted continents by wind or ocean currents and not by the drifting process.

v. Ancient animal fossils, plant fossils and climatic studies suggest that continents have never drifted.
   - A significant body of paleontological (ancient animal fossils), paleobotanical (ancient plant fossils) and paleoclimatical (ancient climatic) data show that the continents have never moved.

vi. The separation of the continents has been strongly opposed on physical grounds.
   - There is no topographic evidence of disruption of the sea floor that would be expected from this process.

2) THE PLATE TECTONICS THEORY

Introduction to the Theory

- The earth's crust is composed of oceans and continents.
- These continents are carried on six large and many other small plates which float on a soft layer called **Asthenosphere.**
- These continents in the asthenosphere are continuously moving due to convectional currents operating in the upper part of the mantle.

TECTONIC THEORY

- This theory deals with the study of the causes and effects of the breaking and folding of the rocks of the crust.

TECTONIC ACTIVITIES (DIASTROPHISM)

- It is the breaking and folding of the rocks of the earth's crust.

TECTONICS

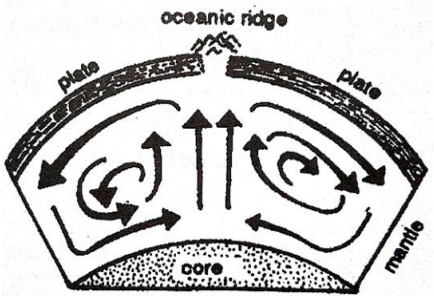
- It is the study of the breaking and folding of the rocks of the earth's crust and the structures they produce, such as volcanoes and mountains.
- In most cases, earthquakes and volcanoes outline plate boundaries.

CAUSES OF TECTONIC ACTIVITIES

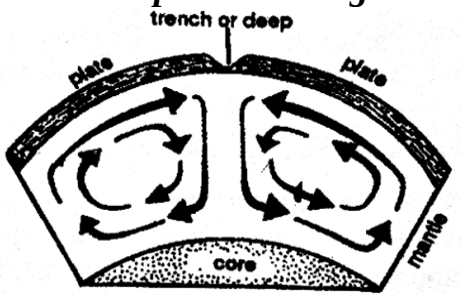
1) Convectional currents that operate within the upper part of the mantle.
   - These currents cause plates to diverge, converge or shear.

Convectional Currents in the Mantle

Currents that cause plate Divergence



Currents that cause plate Convergence



TYPES OF PLATES

1. Continental plates
2. Oceanic plates

CONTINENTAL PLATES

- These are plates which are lighter and they carry continents.

Examples of Continental Plates

i. North American Plate
ii. South American Plate
iii. African Plate
iv. Australian Plate
v. Eurasian Plate

OCEANIC PLATES

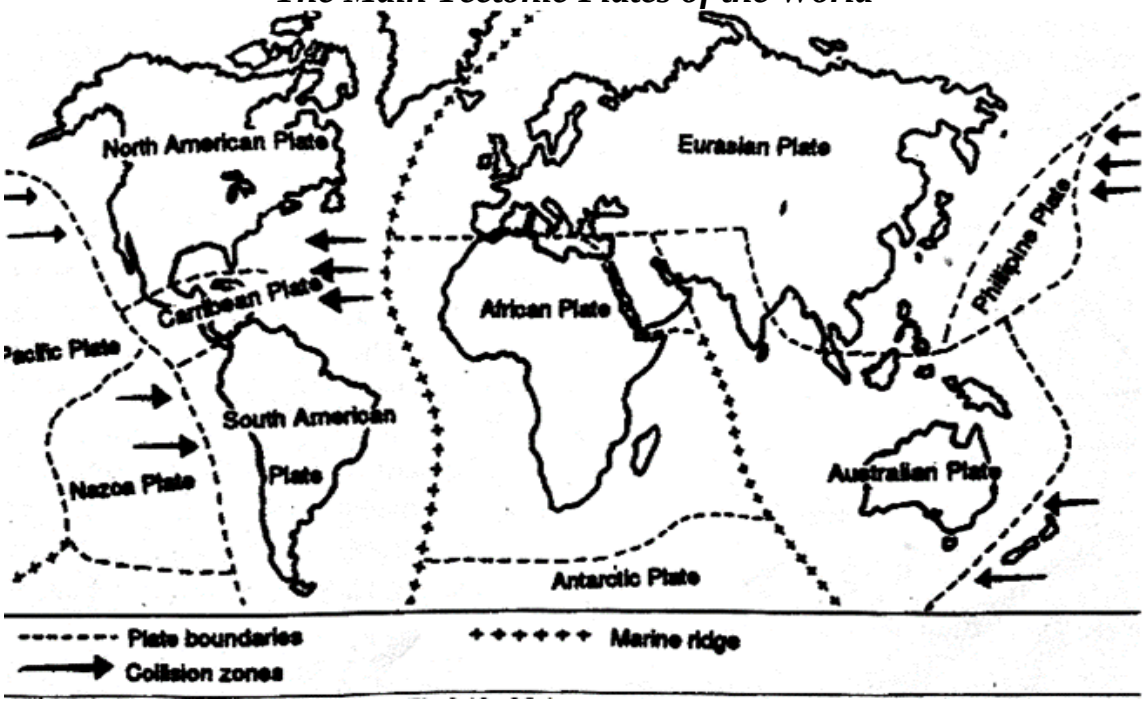
- These are plates which are denser because they contain heavier basaltic rocks and they form the oceanic floor.

Examples of Oceanic Plates

i. Pacific Plate
ii. Antarctic Plate

iii. Philippines Plate
iv. Nazca Plate

The Main Tectonic Plates of the World



MAIN TECTONIC PLATES AND THEIR DIRECTIONS OF MOVEMENT

NAME OF PLATE	DIRECTION OF MOVEMENT
Nazca Plate	Eastwards
Pacific Plate	Westwards
Australian Plate	North Eastwards
Eurasian Plate	Eastwards
South American Plate	Westwards
North American Plate	Westwards
Philippines Plate	Eastwards
African Plate	North Eastwards

PLATE BOUNDARIES

- These are found on the margins of two adjacent margins.
- They are usually zones of instability and the changes that take place in the margins lead to the formation of landforms such as mountains, oceanic ridges, oceanic Islands and volcanoes.

TYPES OF PLATE MOVEMENTS

- There are there main types of plate movements as follows:

a. Spreading or diverging plate movements
b. Convergence or colliding plate movements
c. Shearing or sliding plate movements

A. SPREADING OR DIVERGING PLATE MOVEMENTS

- These are also called **constructive plate margins** because new crust is formed in these zones.

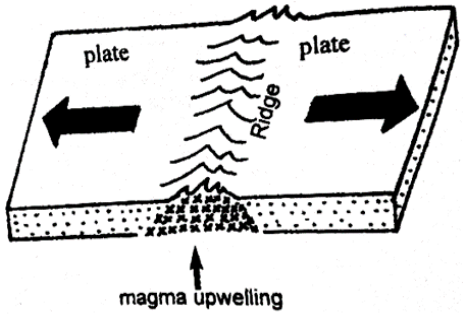
☞ This is where the plates move away from each other.

- These movements are caused by a kind of convectional currents that move away from the centre of the plumes, outwards.

FEATURES FORMED DUE TO PLATE SPREADING (DIVERGING)

i. Marine (oceanic ridges), such as the Mid-Atlantic ridge, pacific ridge, Chagos-Laccadive, Indian Ocean ridges, etc.
ii. Volcanic mountains
iii. Rift valleys
iv. Block mountains

Diverging (Spreading) Plates



B. CONVERGENCE (COLLIDING) PLATE MOVEMENTS

- These are also called **destructive plate margins** because the crust is destroyed or broken.

☞ This is where the plates move towards each other under compressional forces and finally collide.

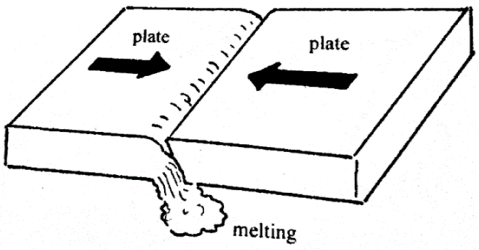
- These movements are caused by convectional currents that originate from different plumes and come together.

FEATURES FORMED DUE TO CONVERGENCE (COLLISSION) PLATE MOVEMENTS

i. Block Mountains
ii. Rift Valleys
iii. Oceanic Islands
iv. Fold Mountains s
v. Volcanic Mountains
vi. Trenches

- In colliding plates, the leading edge of one plate sinks into the mantle under another edge.
- The sinking edge melts and is destroyed due to great heat and pressure. This creates volcanoes and earthquakes.

Converging (Colliding) Plate



C. SHEARING (SLIDING) MOVEMENTS

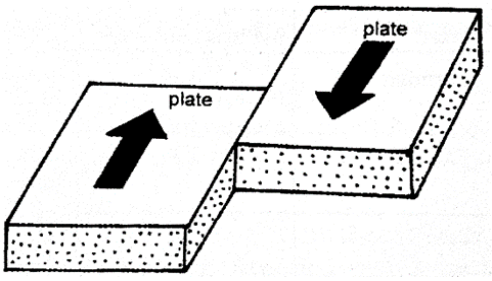
☞ This is where plates move past each other.

- These movements are caused by convectional currents that operate in the opposite directions.
- The boundary is called a ***fault boundary***.

Example of Fault Boundaries along Shearing Plates

✓ San Andreas Fault in California

Shearing (Sliding) Plates



RESULTS OF TECTONIC ACTIVITIES

i. Formation of trenches
ii. Formation of oceanic ridges
iii. Formation of volcanoes and earthquakes
iv. Formation of block mountains and fold mountains
v. Formation of oceanic islands
vi. Formation of volcanic islands

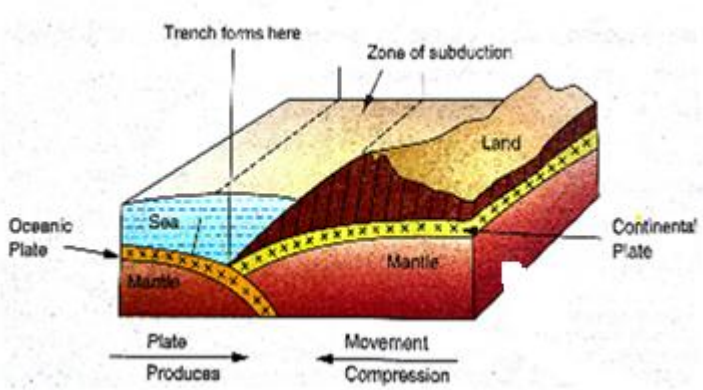
1. FORMATION OF TRENCHES

These are formed when oceanic plates and continental plates converge. Since the oceanic plate has high density, its margin is drawn beneath the margin of a continental plate which has low density. Trenches are formed where the two plates meet, in the zones of subduction.

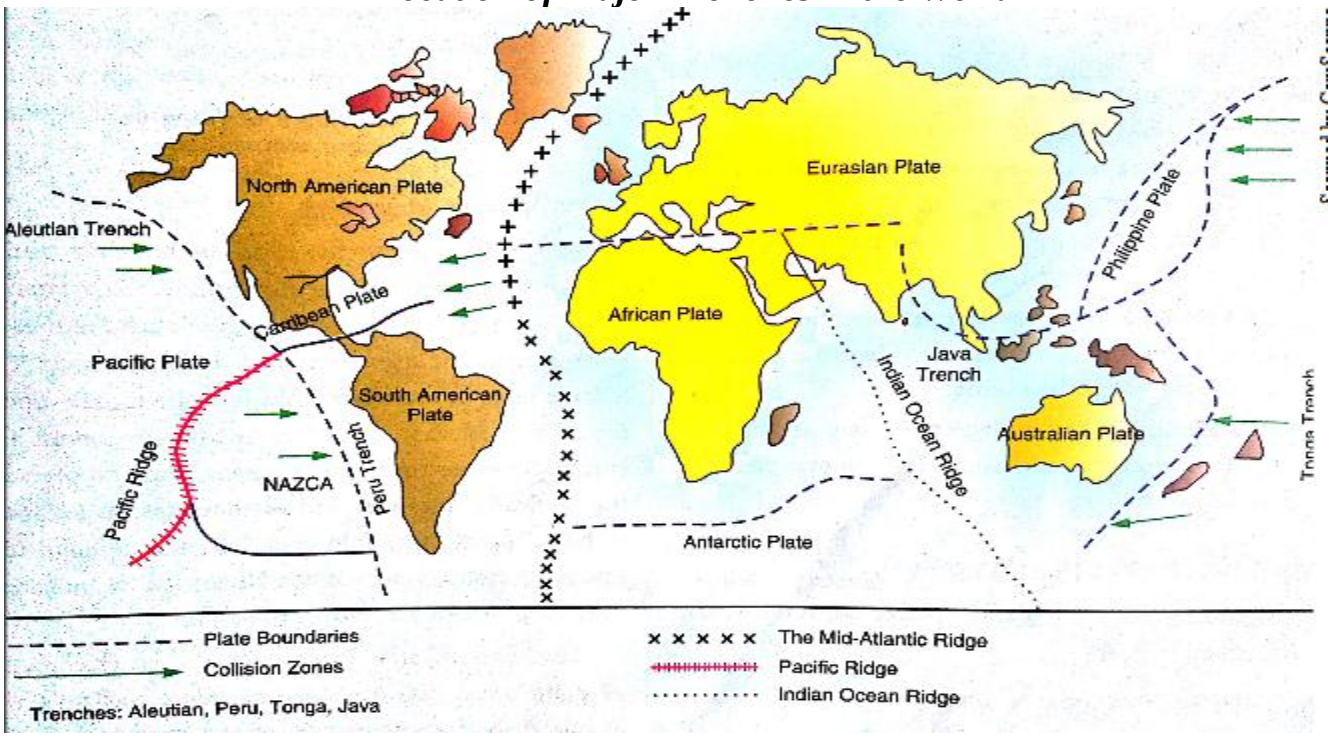
EXAMPLES OF TRENCHES IN THE WORLD

a) Peru trench
b) Aleutian trench
c) Java trench
d) Mariana trench
e) Tonga trench

Formation of a Trench



Location of Major Trenches in the World



2. FORMATION OF OCEANIC RIDGES

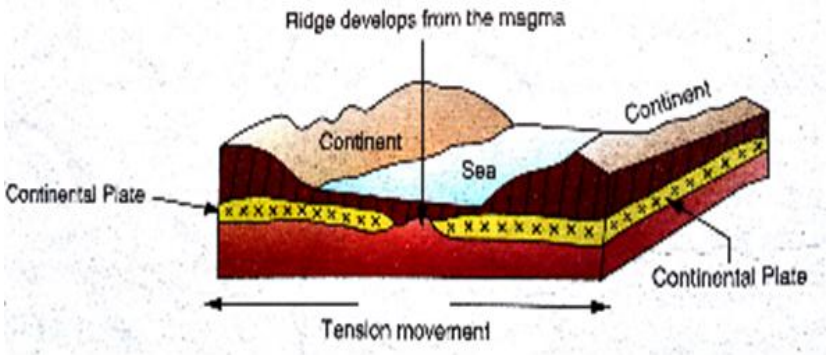
A ridge is formed where the two plates diverge. When this happens, the crust between the two plates break, which makes magma to be forced out to the surface. When this happens on the ocean floor, the magma spreads out and solidifies to form an oceanic ridge.

- The zones between diverging plates are also called ***spreading zones***.

EXAMPLE OF AN OCEANIC RIDGE FORMED DUE TO DIVERGING PLATES

- ✓ The Mid-Atlantic Ridge
- *It was formed as the African plate and American plates were diverging.*

Formation of an Oceanic Ridge



3. FORMATION OF VOLCANOES AND EARTHQUAKES

- Volcanic eruptions and volcanic islands are common along plate boundaries, especially in areas where oceanic ridges form.

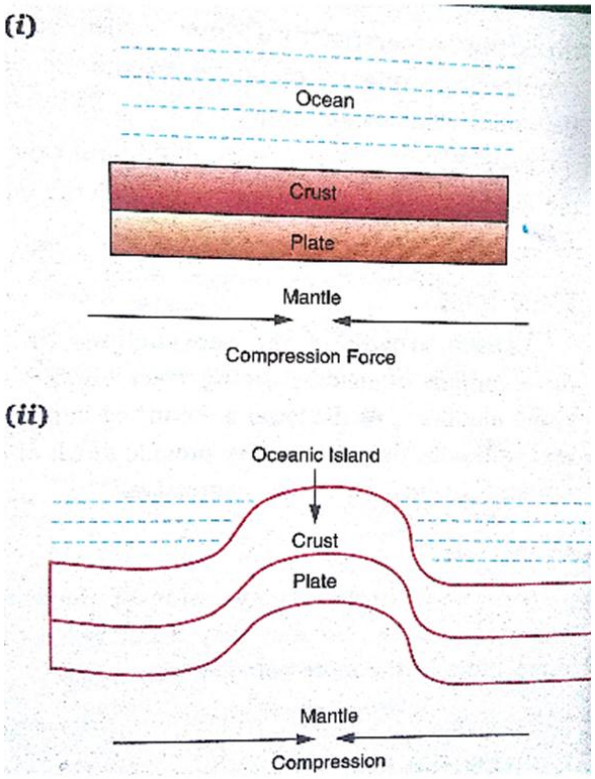
4. FORMATION OF BLOCK MOUNTAINS AND FOLD MOUNTAINS

- Fold mountains are common in areas where plates converge.
- Block mountains mainly form where compressional forces and tensional forces operate on the section of the earth.

5. FORMATION OF OCEANIC ISLANDS

Oceanic islands are formed when compressional forces operate on the section of the earth, such that folding occurs. When this folding takes place in water masses such as oceans, the land mass may be projected above the surface of the water. This may give rise to oceanic islands.

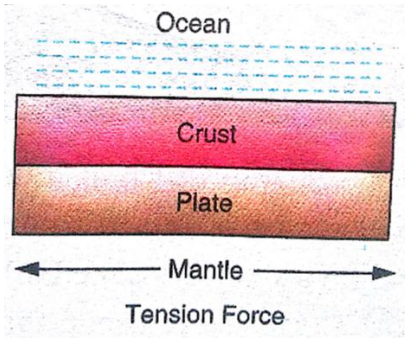
Formation of an Oceanic Island

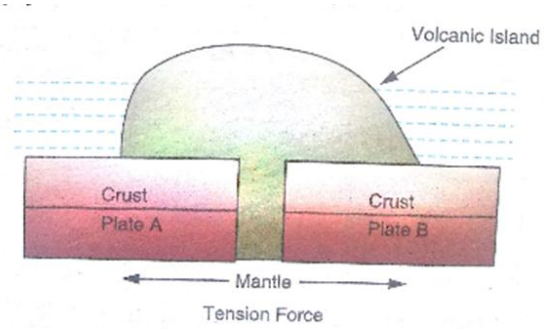


6. FORMATION OF VOLCANIC ISLANDS

These are formed under tensional forces that are created by diverging plate movements. When tensional forces operate on the earth's surface, a fault (vent) is created through which magma passes. When magma projects (protrudes) above the surface of the water and cools down and solidifies, a volcanic island is formed.

Formation of a Volcanic Island





THE MOUNTAIN BUILDING PROCESSES ASSOCIATED WITH PLATE TECTONICS

- There are many mountain building periods in the earth's history.

SOME OF THE MOST RECENT TIMES ARE AS FOLLOWS:

a. Caledonian

b. Hercynian
c. Alpine

SOME OF THEM ARE IN THE TABLE BELOW

PERIOD	AGE (MILLION YEARS)	OROGENESIS	EXAMPLES
Tertiary	30	Alpine	Rockies, Andes, Atlas, Alps, Himalayas.
Permian	240	Hercynian	Urals, Appalachians, Harz, Pennines, Welsh highlands, Siberian plateau.
Devonian	320	Caledonian	Scandinavian and Scottish highlands, Brazilian highlands.
Cambrian Archaeozoic	600-3500	Hudsonian	Ancient Shields (Brazilian, Lauresian, African, Siberian, Indian, Chinese, Australian).

- ❖ All the mountains formed during the **Tertiary Period** are commonly called **Young Fold Mountains**.
- ❖ All the mountains formed during the **Permian Period** are called the **Old Fold Mountains**.

THE EARTH'S MOVEMENTS

OROGENESIS

- This is the process of mountain building.
- These are movements caused within the earth's crust.

THE MAIN CRUSTAL MOVEMENTS

1. **Epeirogenic movements (vertical movements)**
2. **Orogenic movements (horizontal movements)**

EPEIROGENIC MOVEMENTS (VERTICAL MOVEMENTS)

- These elevate or depress the land masses.
- When the land rises due to these movements, the process is called ***positive epeirogenic movements***.
- When the land sinks, the process is called ***negative epeirogenic movements***.

RESULTS OF EPEIROGENI (VERTICAL) MOVEMENTS

1. They form rift valleys
2. They form block mountains

RESULTS OF OROGENIC (HORIZONTAL) MOVEMENTS

1. Formation of fold mountains
2. Formation of volcanic mountains
3. Formation of marine ridges
4. Formation of trenches

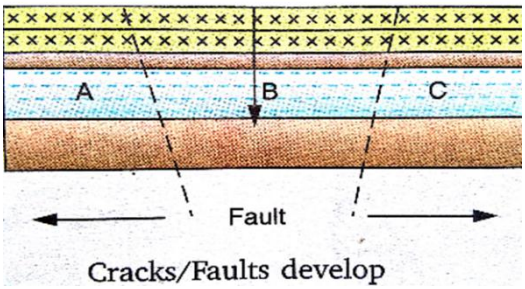
EXAMPLES OF RIFT VALLEYS IN THE WORLD

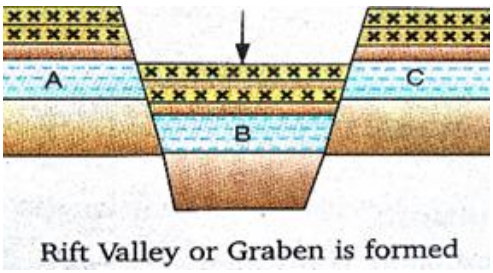
a. The central lowlands of Scotland
b. The Great East African Valley
c. The Rhine valley between Vosges and Black Forest mountains.

FORMATION OF RIFT VALLEYS

When tensional or compressional forces operate on the crust, two almost parallel faults are created in the rock strata. The central block subsides to form rift valleys, while the adjacent blocks are uplifted.

Formation of a Rift Valley





CHARACTERISTICS OF RIFT VALLEYS

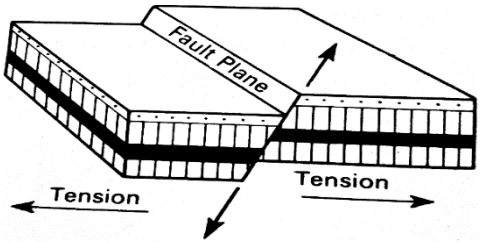
1) The edges of rift valleys are very steep.
2) The valley floor is almost flat.
3) The valleys are long and deep.
   → For example, the Great East African Rift Valley is 7200 kilometres long and its width varies from 30 kilometres to 100 kilometres.

FAULTS

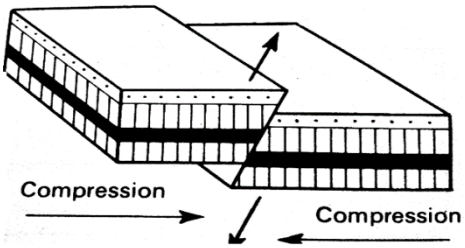
- A fault is a break in the rocks.
- Faulting is accompanied by the displacement of rocks along the fault line.

TYPES OF FAULTS

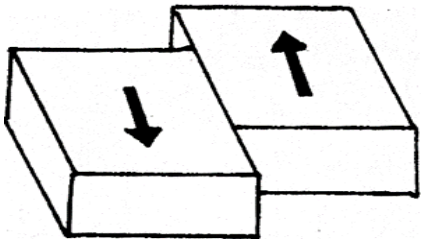
1. NORMAL (DIP-SLIP) FAULT



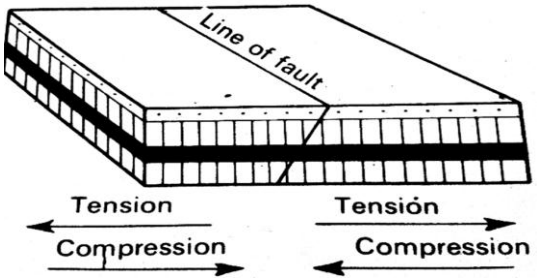
2. REVERSE (THRUST) FAULT



3. SHEARING (TRANSCURRENT OR STRIKE-SLIP) FAULT



4. OVERTHRUST FAULT



FOLDING

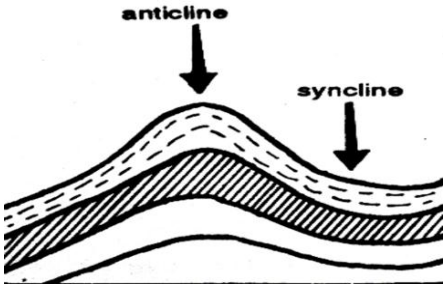
A fold is a bend in the earth's crust caused by compressional forces exerted by the earth's movements.

1) SIMPLE FOLD (FORMATION)

When compressional forces operate on the earth's strata, folding takes place that gives rise to a simple fold. The rock layers that bend up due to compressional forces form an ***anticyclone or an up fold***, and those that bend downwards form a ***syncline or a down fold***.

- The sides of a fold are called **limbs.**

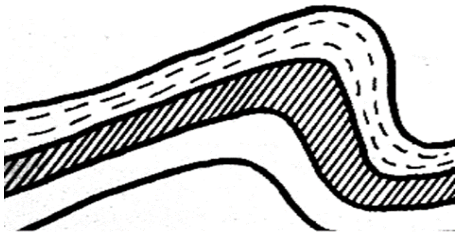
A Simple Fold



2) OVER FOLD (FORMATION)

If compressional forces continue, a simple fold is changed into an over fold where one limb is steeper than the other.

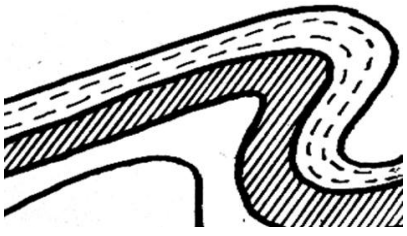
An Over Fold



3) RECUMBENT FOLD (FORMATION)

As compressional forces continue to act on the section of the earth, an over fold changes to a recumbent fold where one limb is pushed over the other.

A Recumbent Fold



4) OVERTHRUST (NAPE) FOLD (FORMATION)

If pressure continues, the rocks fracture and the limb of the fold is thrust forward over the other limb.

An Over thrust (Nape) Fold

TYPES OF MOUNTAINS

1. Fold mountains
2. Residual mountains
3. Block mountains
4. Volcanic mountains

FOLD MOUNTAINS

- These consist of masses of folded sedimentary rocks.
- Large scale earth's orogenic movements cause these mountains when stresses are set up in the earth's crust.

CAUSES OF MOVEMENTS THAT LEAD TO THE FORMATION OF FOLD MOUNTAINS

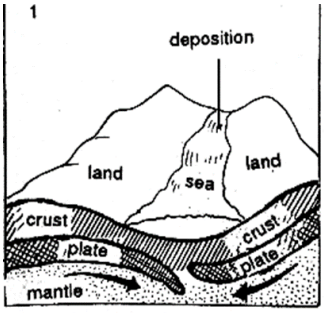
i. Increased load of the overlying rocks.
ii. Flow movements in the mantle.
iii. Magmatic intrusions into the lithosphere.
iv. The expansion and contraction of some parts of the earth.

- **NOTE:** When such movements take place, rocks are subjected to compressional forces that produce folding along fault lines.

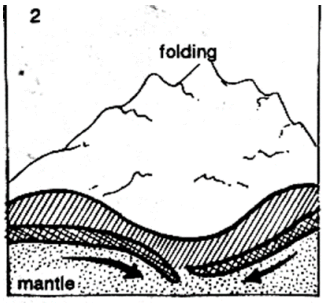
FORMATION OF FOLD MOUNTAINS

Deposition of sediments takes place in a depression such as a sea. Later, sedimentary rocks are formed. Due to crustal compression caused by converging plate movements, the rocks are folded to form folds. As compressional forces continue to act on the section of the earth, intense folding takes place. The plate that dips into the mantle melts to form magma which may come out to form volcanoes on the earth's surface.

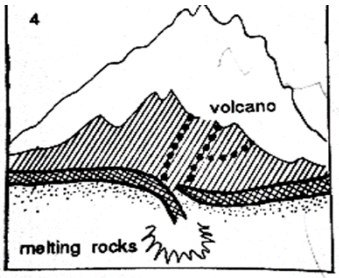
Formation of Fold Mountains



Deposition takes place in a depression (sea) and later sedimentary rocks are formed



Due to crustal compression the rocks are folded to form fold mountains in 3



The plate that dips into the mantle melts to form magma which may come out to form volcanoes on the earth's surface

CHARACTRISTICS OF YOUNG FOLD MOUNTAINS

- ✓ They are long and high.
- ✓ They are associated with volcanoes especially in the circum-pacific fold mountain system.
- ✓ They contain rich minerals such as tin, gold, copper and petroleum.
- ✓ They are generally found on the western continental margins and their interiors are badly folded.
- ✓ They are characterized by volcanic intrusions.
- ☞ **NOTE:** Most fold mountains are found on the western continental margins because that is where most plate boundaries are found.

INFLUENCES (EFFECTS) OF YOUNG FOLD MOUNTAINS ON HUMAN ACTIVITIES

a) Some fold mountains contain rich minerals.
☞ For example, gold in Nevada, and tin in Bolivia.
b) The valleys have fertile alluvial soils which are used for agriculture.
c) They act as communication barriers.
☞ This happens since they make construction of communication lines such as roads to be difficult.
d) They act as climate barriers.
☞ One side of the mountain may have a different climate from the other.
e) Some mountains or mountain ranges have valuable timber resources.
☞ For example, the western side of Rockies Mountain has coniferous soft woods and the foot hills of Himalaya have teak.
f) They receive heavy rainfall and snow that may give rise to big rivers.

- ☞ For example, Indus and Ganges from Himalaya Mountain and Colorado ad Columbia from Andes Mountain. These rivers are used for production of Hydro-Electric Power and irrigation.
- ☞ **SYSTEMS OF YOUNG FOLD MOUNTAINS**

1. THE ALPINE SYSTEM

Examples of Fold Mountains

i. Alps (in North Africa)
ii. Atlas (in Europe)
iii. Ararat
iv. Jura
v. Kigezi Mountain (in Uganda)
vi. Chimanimani Mountain (in Zimbabwe)
vii. Himalaya (in West Europe)
viii. Caucasus

2. THE CIRCUM-PACIFIC SYSTEM

Examples of Mountains

i. Rockies (in North America)
ii. Andes (in)
iii. Kolyama
iv. Anadyr
v. Cherskiy

EXAPLES OF OLD FOLD MOUNTAINS

- ☞ Urals mountain (in Russia)
- ☞ Appalachian mountain (in Canada)
- ☞ Welsh Highlands (Wales in Britain)
- ☞ Pennines mountain (in the U)
- ☞ Siberian Plateau (in Russia)
- ☞ Akwapim Hills (in Ghana)
- ☞ Ben Nevis Mountains (in Scotland)

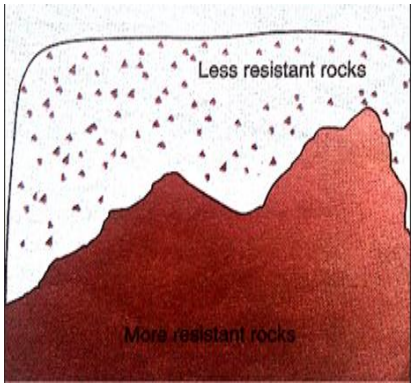
RESIDUAL MOUNTAINS (EROSIONAL OR DENUDATIONAL MOUNTAINS)

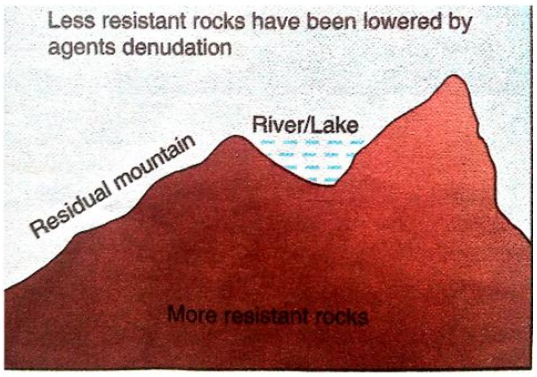
- ☞ These are mountains evolved by denudation.

FORMATION OF RESIDUAL MOUNTAINS

As denudation proceeds, the less resistant rocks are eroded away to form valleys. But the more resistant rocks or areas remain and stand out as residual mountains.

Residual Mountain





CHARACTERISTICS OF RESIDUAL MOUNTAINS

- ❖ They have accordant and irregular summits.
- ❖ Those that are formed from volcanic mountains have sculptured domes.
- ❖ Most of them exist as mountain ranges.
- ❖ The layers of rocks are wrapped and develop more faults.
- ❖ They are highly dissected with narrow valleys.
- ❖ They have rich deposits of bauxite from which aluminum is obtained.
- ❖ They have bare and very rocky walls due to erosion of loose materials.

EXAMPLES OF RESIDUAL MOUNTAINS

- ✓ Monadnock (in USA)
- ✓ Scottish highlands (in the UK, Europe)
- ✓ Scandinavian highlands
- ✓ Aravalli and Parasnath (in Bihar)
- ✓ Mulanje mountain (in Malawi)

SOME OTHER EROSIONAL FEATURES IN MALAWI

a. Nyika plateau
b. Viphya plateau
c. Dowa hills
d. Dedza mountain
e. Zomba mountain

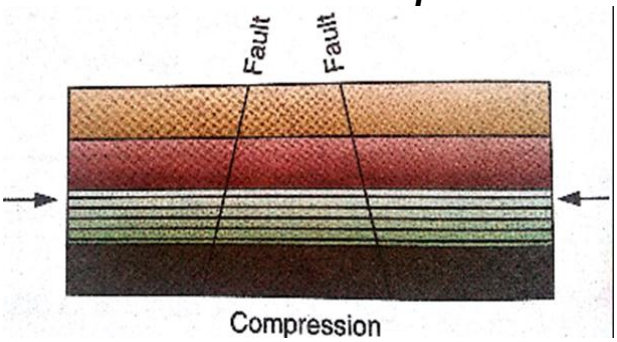
BLOCK MOUNTAINS

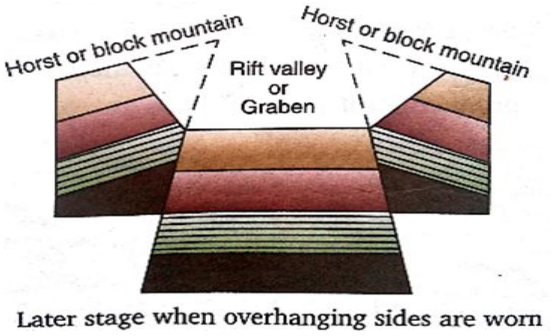
- ▪ Suffice to mention that Block Mountains are formed due to both compressional and tensional forces.

a) FORMATION OF BLOCK MOUNTAINS BY COMPRESSIONAL FORCES

When compressional forces operate on the section of the crust, two almost parallel faults are created in the rock strata. The central block subsides to form rift valleys, while the adjacent blocks are uplifted and stand out as Block Mountains or hosts.

Formation of Block Mountains by Compressional Forces



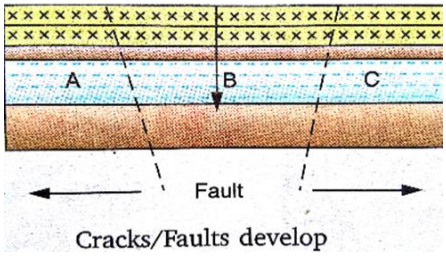


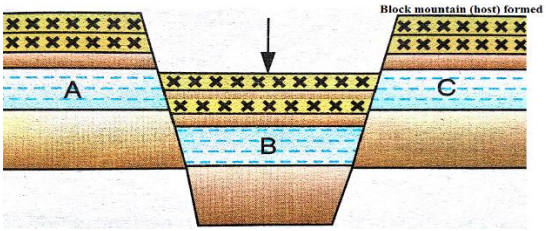
Later stage when overhanging sides are worn

FORMATION OF BLOCK MOUNTAINS BY TENSIONAL FORCES

When tensional forces operate on the section of the crust, two almost parallel faults are created in the rock strata. The central block subsides to form rift valleys, while the adjacent blocks are uplifted and stand out as Block Mountains or hosts.

Formation of Block Mountains by Tensional Forces





EXAMPLES OF BLOCK MOUNTAINS

1. Vosges mountain
2. Hunstruck mountain
3. Black forest mountain
4. Khana Mountain (in Namibia)
5. Ethiopian Highlands (in Ethiopia)
6. Congo Host (in DRC)
7. Ruwenzori mountain (in Uganda, Africa)
8. Shire Highlands (in Malawi)

CHARACTERISTICS OF BLOCK MOUNTAINS

- The faulted side is very steep.
- They are long especially when formed along rift valleys.
- The side facing away from the faulted side is generally less steep.

ENVIRONMENTAL AND RESOURCE INFLUENCES OF FAULTS AND BLOCK MOUNTAINS

i. Petroleum is formed along fault planes where rocks have been made permeable by crushing. It is also trapped in porous rocks that have been faulted against impervious rocks.
ii. Faulting allows ore-forming chemical solutions to rise along fault planes.
iii. Fault line scraps may form imposing topographic barriers which restrict communication.

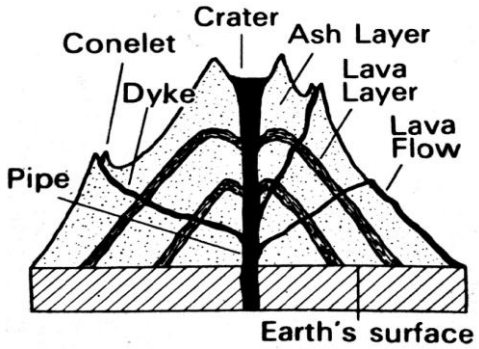
iv. Rift valley floors are used for cultivation and in some cases they contain lakes which are used for fishing.
v. Hot springs are generally common on rift valley floors. These are used for tourist attraction.

VOLCANIC MOUNTAINS

FORMATION OF VOLCANIC MOUNTAINS

These are mountains which are formed after the materials ejected from the inside of the earth solidify on the earth's surface. These materials include molten lava, volcanic bombs, cinder, ashes, dust and liquid mud. These mountains are also called mountains of accumulation.

A Volcanic Mountain and a Crater



CHARACTERISTICS OF VOLCANIC MOUNTAINS

i. They are high.
ii. They are symmetrical in nature.
iii. They are steep sided.
iv. They occur in isolated peaks.

MATERIALS EJECTED WHEN A VOLCANO ERUPTS

- ✓ Molten lava
- ✓ Volcanic bombs
- ✓ Cinder
- ✓ Ashes
- ✓ Dust
- ✓ Liquid mud

EXAMPLES OF VOLVCANIC MOINTAINS

- ➢ Hood (in USA)
- ➢ Mount Merapi (in Sumatra)
- ➢ Mount Fujiyama (in Japan)
- ➢ Mount Aconcagua (in Chile)
- ➢ Mount Agang (in Bali)
- ➢ Mount Cartopax (in Ecuador)
- ➢ Mount Mayon (in Philippines)

FORMATION OF A VOLCANO

- ▪ The rocks below the crust are semi-solid due to high pressure and temperatures. Friction along plate boundaries raises temperature, plus a reduction in pressure created by faulting and folding cause the rocks to become molten and semi-fluid (magma).

- The magma rises through the faults (cracks). Sometimes it solidifies before reaching the earth's surface and form internal features such as batholiths, sills, laccoliths and dykes. Sometimes it reaches the earth's surface quietly of violently, in a volcanic eruption.
- When magma reaches the earth's surface, it loses its gases and is called **lava**.

TYPES OF VOLCANOES

1) ACTIVE VOLCANO

➢ This is the type of volcano that erupts frequently.

2) DORMANT VOLCANO

➢ These are volcanoes that erupted in historical times, and are likely to erupt in future.

➢ (Or these are volcanoes that do not erupt frequently). For example, those that erupted on mount Kenya and Kilimanjaro.

3) EXTINCT VOLCANO

SHIELD VOLCANOES

❖ These are volcanoes whose lava flows quickly. For example, Mauna Loa on the Hawaii Islands.

ENVIRONMENTAL ASPECTS (EFFECTS) OF VOLCANOES

a) DESTRUCTIVE (NAGATIVE) EFFECTS

1. Loss of life. For example, the eruption of Pelee in Martinique killed 30 000 people in St. Pierre town, only two people survived.
2. Loss of property.
3. The land surface may remain barren and become rugged to cross.

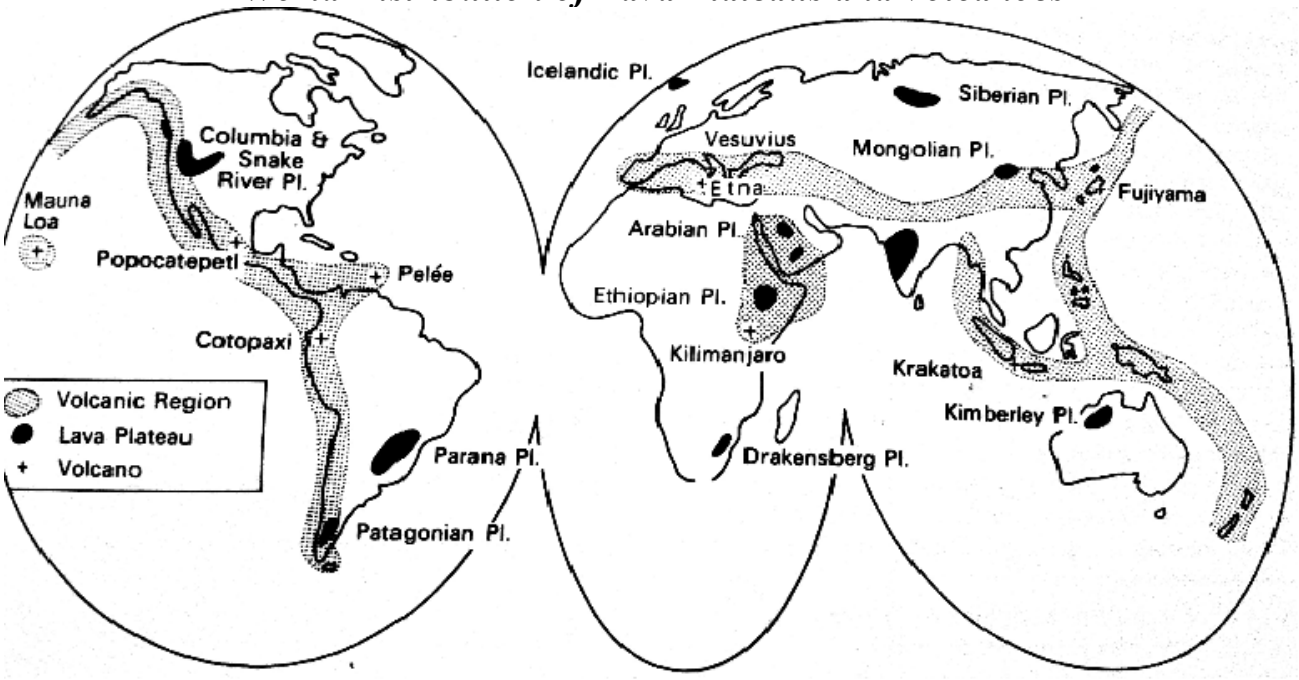
POSITIVE (CONSTRUCTIVE) EFFECTS

1. For tourist attraction since volcanoes give rise to scenic features of great beauty, such as Hawaii, Iceland and Azores islands.
2. Volcanic mountains contain important natural resources such as timber.
3. They are source of crushed rocks for construction.
4. Lava plains are fertile and used for agriculture.
5. They are source of geo-thermal power.
6. It leads to the formation of precious rocks that contain minerals such as diamond in Kimberly Mountain in Australia.
7. They are sources of hot springs and geysers which are used for heating in homes.

LOCATION OF THE MAJOR AREAS OF VOLCANIC ACTIVITY AND LAVA PLATEAUX

- Most of these are found in the circum-pacific region which is also called the circum-pacific ring of fire.

World Distribution of Lava Plateaus and Volcanoes



EXTRUSIVE VOLCANIC FEATURES

- These are features that are formed when magma solidifies after reaching the earth's surface.

i. Lava cones
ii. Lava plateaus
iii. Hot and cold springs
iv. Geysers
v. Lava
vi. Pyroclastic materials
vii. Lava plains
viii. Crater lakes (or calderas)
ix. Fumaroles
x. Volcanic mountains
xi. Lava plains

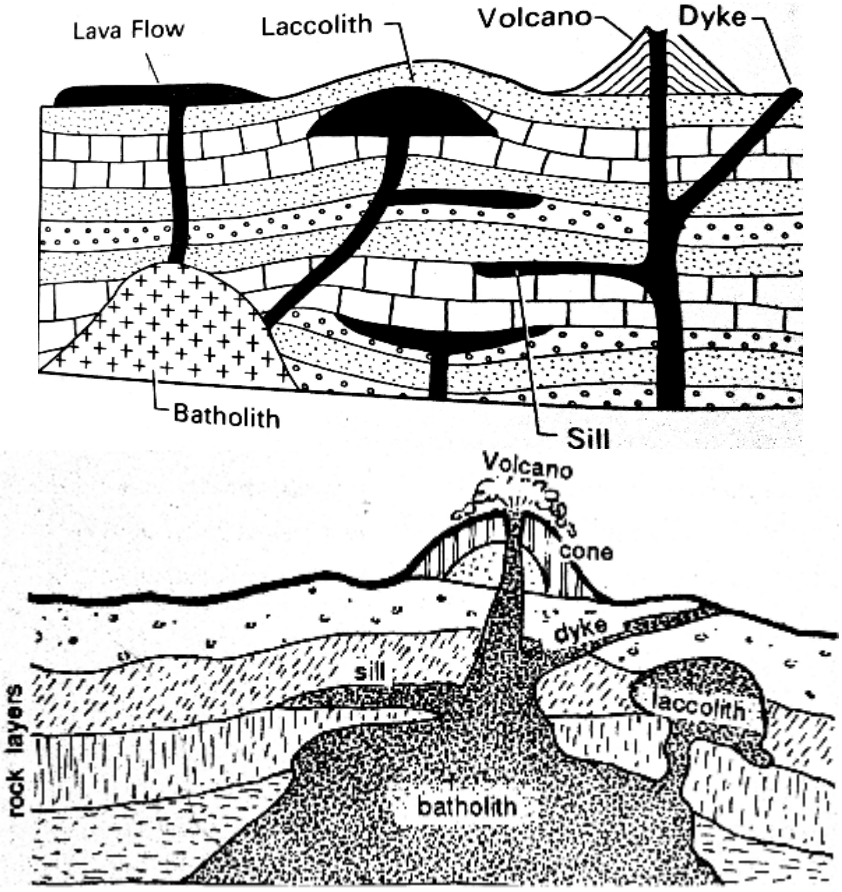
- **Fumaroles (emission of gas/steam from fissures around a dormant volcano)**

INTRUSIVE VOLCANIC FEATURES

- These are features that are formed when magma solidifies before reaching the earth's surface

i. Sill
ii. Batholiths
iii. Dykes
iv. Laccoliths

FEATURES FORMED WHEN MAGMA REACHES THE EARTH'S SURFACE OR FAILS TO REACH THE EARTH'S SURFACE



EXAMPLES OF VOLCANIC MOUNTAINS

i. Hood in USA
ii. Fujiyama in Japan
iii. Mayon in Philippines
iv. Merapi mountain in Sumatra
v. Agung mountain in Bali

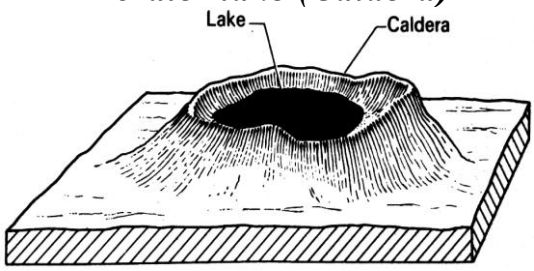
FORMATION OF A CRATER LAKE

When a volcano erupts, magma solidifies on the earth's surface. When another volcanic eruption takes place, the top part of the cone may be blown off. When this hollow is filled with water, a crater lake is formed.

FORMATION OF A CALDERA LAKE

A caldera lake is formed from a crater. When further subsidence takes place on a crater, an enlarged hollow is formed. When this hollow is filled with rain, a caldera lake is formed.

A crater lake (Caldera)



VOLCANISM

❖ This means all the various ways by which molten rocks and gases are forced into the earth's crust and out onto the surface.

VOLCANICITY

❖ This refers to volcanic eruptions and the features formed in the process, such as volcanic mountains.

LAVA

❖ Lava refers to magma that is ejected onto the earth's surface and loses gases.

TYPES OF LAVA

1) BASIC LAVA

- This is the type of lava which is very hot and highly fluid and flows quietly affecting extensive areas.

CHARACTERISTICS OF BASIC LAVA

➢ They are very hot (about 1000°C).
➢ They are very hot and highly fluid and flows quietly affecting extensive areas.
➢ They are dark in colour.
➢ They are rich in iron and magnesium but poor in silica.
➢ They flow quietly and are not very explosive.

EFFECTS OF BASIC LAVA

a) It leads to the formation of lava plains.
b) It leads to the formation of lava plateaus.
c) It leads to the formation of flattered shields or dome.

2) ACID LAVA

- This type of lava is very viscous and flows slowly.

CHARACTERISTICS OF ACID LAVA

➢ They are very viscous with a high melting point.
➢ They are light-coloured.
➢ They are very explosive.
➢ They have low density.
➢ They are rich in silica.
➢ They flow slowly and do not travel far before solidifying.
➢ The resultant cone is steep-sided.

EFFECTS OF ACID LAVA

a) It leads to the formation of cones.
b) It results in a loud explosion because the accumulation of lave in the vent obstructs the flow of the out pouring lava.
c) It throws out volcanic bombs or pyroclasts (rock fragments).

EARTHQUAKES

❖ An earthquake is a sudden movement of the earth

OR

❖ An earthquake refers to vibrations in the lithosphere.

CAUSES OF EARTHQUAKES

1) Plate collision

❖ Colliding plates cause vibrations that result in earthquakes.

2) Plate shearing

❖ Shearing plates rub against each other. These cause vibrations that give rise to earthquakes.

3) Volcanic eruption

❖ The eruption of a volcano is accompanied by a lot of force that makes the crust to shake and cause an earthquake.

4) Plate subduction

❖ When plates collide against each other at a destructive margin, the heavier plate deeps into the mantle where it melts to increase the volume of magma and pressure. This increases the odds of earthquakes.

FACTORS THAT INFLUENCE THE INTENSITY OF EARTHQUAKES

✓ Magnitude of the earthquake
✓ Depth of the focus
✓ Types of seismic (shock) waves
✓ Material of the transmitting body (shockwaves travel faster in the crust than in liquids)

AREAS WHERE MOST EARTHQUAKES OCCUR

➢ Generally, earthquakes occur along plate boundaries. They are common in the following:

a) Ocean deeps
b) The mid-oceanic ridges
c) A belt across Southern Europe and Southern Asia.
d) West Coast margins of North America and South America.
e) A belt in the Pacific Ocean which includes Japan, Philippines and most of the East Indies.
f) Ridges of crustal compression
g) Circum-pacific regions
h) In east Africa along the Great East African rift valley

TSUNAMI

- Tsunamis are huge waves set in motion by a deep sea earthquake.

SEISMIC WAVES

- This is the energy that travel through the earth in the form of vibrations created by violent breaking of rocks as the earthquake occurs.

❖ Seismic waves move out from the focus to the epicenter, spreading to all directions.

❖ The shock waves are strongest near the epicentre and get weaker in strength as it moves away from the epicenter. As a result, the ground near the epicentre shakes more than the area away from the epicentre.

❖ This means that there is a lot of damage near the epicentre than away from the epicentre.

NOTE: ***Shockwaves are used to study the behavior of an earthquake and this enables experts to provide necessary advice on how to reduce the damage caused by an earthquake.***

ISOSEISMS

- These are lines that connect all places that experience the same strength of an earthquake.

NATURE OF EARTHQUAKES

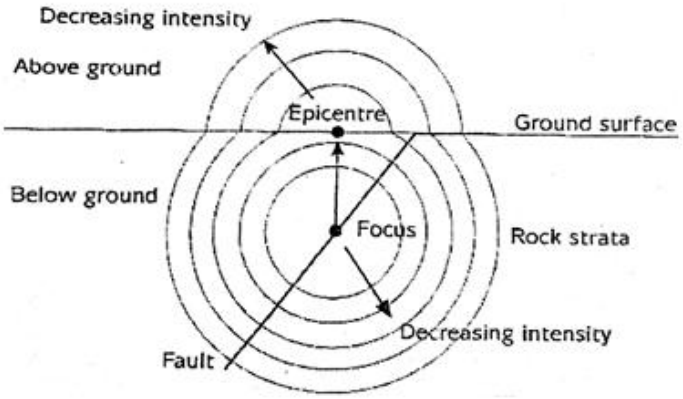
i. FOCUS

- This is the point of origin of an earthquake.

ii. EPICENTRE

- This is the point directly above the focus on the earth's surface.
- The epicentre is where shockwaves hit the earth's surface.
- Shockwaves give rise to earthquakes.

Section through an Earthquake



MEASUREMENT OF EARTHQUAKES

a) MAGNITUDE

- This is the amount of energy released by an earthquake.

b) SEISMOGRAPH

- This is an instrument that is used to measure the intensity of an earthquake.

c) RICHTER SCALE

- This is an instrument that is used to measure the magnitude of an earthquake.
- ✓ It has a range from 0-9.
- ✓ The bigger the number on the richter scale, the greater the damage an earthquake makes.

MAGNITUDE	EFFECTS
0 **1** **2**	No effect, normally detected by instruments.
3 **4**	Faint tremor (shake) causing little damage.
5 **6**	Structural damage seen.
7	Distinct shaking, poorly constructed buildings collapse.
8	Large buildings destroyed.
9	Ground seen shaking.

ENVIRONMENTAL EFFECTS OF EARTHQUAKES

i. They cause landslides.
ii. Can lower or raise coastal rocks or parts of the seafloor.

iii. Can displace the lithosphere vertically or horizontally.
iv. They cause fires in the cities and huge waves called ***Tsunamis***.

EXAMPLES OF DESTRUCTIVE ERTHQUAKES IN THE WORLD

a) Shanshi Province in China in the year 1556 in which 830 000 people died.
b) Calcutta in India in the year 1737 in which 300 000 people were killed.
c) Kansu Province in China in the year 1920 in which 180 000 people were killed.
d) Tokyo in Japan in the year 1923 in which 100 000 people died.
e) In Indian Ocean in the year 2004 a Tsunami (huge waves set in motion by a deep sea earthquake) killed 300 000 people. The affected countries were Indonesia (where the earthquake originated), Thailand, Malaysia, Maldives, Mynamar in Burma, Bangladesh, India, Sri Lanka and Somalia.

PRECAUTIONARY MEASURES FOR PEOPLE LIVING IN AREAS FREQUENTLY AFFECTED BY EARTHQUAKES

- ✓ Avoiding construction of houses in areas that are subjected to earthquakes.
- ✓ Constructing houses that can resist the impact of earthquakes. Such materials include steel rods and shock absorbers.
- ✓ Putting the foodstuffs, medicine and tents in store to be ready for any damage caused by earthquakes.
- ✓ Observing the earthquake maps to know the areas frequently affected by earthquakes.

REASONS WHY VOLCANOES, EARTHQUAKES AND FOLD MOUNTAINS OCCUR IN THE SAME REGIONS (OR RELATIONSHIP OF EARTHQUAKES, FOLD MOUNTAINS AND VOLCANIC REGIONS)

a) They all result from the movement of the earth's crust.
b) They all occur in the boundaries of tectonic plates.
c) They have close connection with each other in their formation in the sense that they all occur along plate boundaries. During the collision of plates, friction takes place which increases temperatures. This, plus the dipping of the denser plate into the mantle increases the volume of magma and hence, pressure. When magma squeezes itself through the faults into the crust, vibrations occur which give rise to earthquakes. The magma can get cooled and solidify before or after reaching the earth's surface. This may yield volcanic activities. Collision of plates also leads to the folding of the earth's crust which gives rise to fold mountains.

SHIELDS

☞ These are the most stable parts of the earth.

- These are parts of the continent made up of very ancient rocks, and were formed more than one billion years ago.

REASON WHY SHIELDS ARE THE MOST STABLE PARTS OF THE WORLD

✓ They are located far away from plate boundaries.

CHARACTERISTICS OF SHIELDS

- They are the most stable parts of the world. (not subjected to earthquakes or volcanoes)
- They are associated with plains.
- They are associated with low plateaus.

ECONOMIC IMPORTANCE OF SHIELDS

a) They contain valuable minerals such as gold and copper.
b) They are used for agriculture since they contain fertile alluvial soils.
c) They are used for settlements since they are located far away from earthquakes and volcanic eruptions.

Major Shields of the World

Laurentian is also known as Canadian, Siberian is also known as Russian, Baltic and Siberian shields together are known as Fannoscandian shields.

ROCKS

- Rocks are naturally formed aggregates of a mineral particle.

TYPES OF ROCKS

- Sedimentary rocks
- Igneous rocks
- Metamorphic rocks

A) SEDIMENTARY ROCKS

- These rocks are products of weathering.
- Weathering is the process in which rocks are broken down into small particles.
- These rocks form 75% of the earth's surface but make up only 5% of the volume of the lithosphere.

TYPES OF SEDIMENTARY ROCKS

i. Mechanically formed sedimentary rocks
ii. Organically formed sedimentary rocks
iii. Chemically formed sedimentary rocks

1) MECHANICALLY FORMED SEDIMENTARY ROCKS

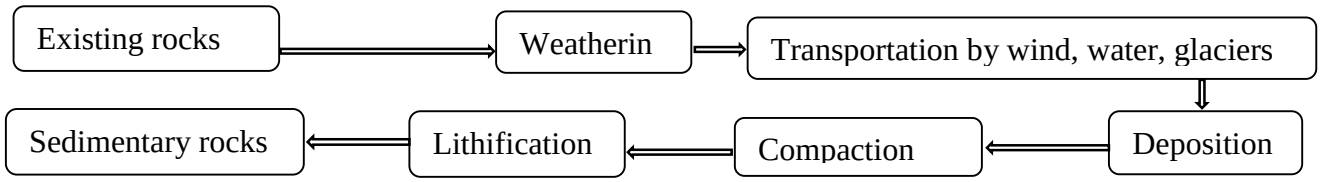
- These rocks have been formed from the accumulation of materials derived from other rocks which have been cemented.

EXAMPLES OF MECHANICALLY FORMED SEDIMENTARY ROCKS

- Sandstone
- Conglomerate

- ☞ Breccia
- ☞ Clay
- ☞ Shale or mudstone

FORMATION OF CLASTIC SEDIMENTARY ROCKS



EXPLANATION

- The existing rock is broken into small particles called sediments or clastics. These sediments are transported either by wind or water and deposited in a geosyncline (sea and oceans bordering the continents). The sediments are then compacted and lithified to form sedimentary rocks.

✓ Clastic rocks are named according to the size and shape of their sediments.

CLASTIC SEDIMENTARY ROCKS

NAME	TEXTURE	COMPOSITION	REMARKS
Conglomerate	Round pebbles	Any kind of rock	Gobbles held together
Breccia	Angular pebbles	Any kind of rock	Sand, clay and cement
Sandstone	Sand-sized grains	Quartz	Grains may be calcite
Siltstone	Very fine grains	Mostly quartz and clay	Gritty feel
Shale	Microscopic grains	Mostly clay and mica	Occurs in layers

2) ORGANICALLY FORMED SEDIMENTARY ROCKS

- These are formed from the remains of living organisms (thus plants and animals).

EXAMPLES OF ORGANICALLY FORMED SEDIMENTARY ROCKS

i. Chalk (formed from animals)
ii. Coral (formed from animals)
iii. Peat (formed from plants)
iv. Coal (formed from plants)
v. Lignite (formed from plants)

3) CHEMICALLY FORMED SEDIMENTARY ROCKS

- These rocks are precipitated chemically from solutions of one kind or another, and also through evaporation in saline lakes, forming sedimentary rocks.

EXAMPLES OF CHEMICALLY FORMED SEDIMENTARY ROCKS

a) Borax
b) Potash
c) Gypsum
d) Nitrates
e) Certain limestones
f) Rock salt

NON-CLASTIC SEDIMENTARY

- These are sedimentary rocks that are formed by chemical or organic processes.

HYDROGENIC SEDIMENTARY ROCKS

- These are chemical rocks when they are formed in water.

NON-CLASTIC SEDIMENTARY ROCKS

NAME	TEXTURE	COMPOSITION	REMARKS
Limestone	Coarse to small crystals	Calcite, small shell	Fine texture
Chert (flirt)	Microscopic crystals	Chalcedomy	Cement in rocks
Alabaster	Microscopic to coarse	Gypsum	Evaporate
Rock salt	Cubic crystals	Halite	Evaporate
Peat, lignite	Coarse to microscopic plant fragments	Products of plant decay without oxygen.	Fragments of plants

CHARACTERISTICS OF SEDIMENTARY ROCKS

- ☞ They are stratified or layered (especially clastic rocks).
- ☞ They are fossilized (they contain fossils).
- ☞ They are non-crystalline (particularly clastic rocks).

B) IGNEOUS ROCKS

- ➢ The name igneous comes from a Latin word ***ignis***, which means ***fire***.

FORMATION OF IGNEOUS ROCKS

- ✓ These rocks are formed by the cooling and solidification of molten rocks (magma) from beneath the earth's crust.

LAVA, VOLCANIC OR EXTRUSIVE ROCKS.

- ➢ These are rocks formed when magma solidifies after reaching the earth's surface.

HYPABYSAL ROCKS

- ➢ These rocks are formed when magma solidifies in channels connecting the molten magma reservoirs with the exterior.

INTRUSIVE OR ABYSSAL ROCKS

- ➢ These are rocks formed when magma solidifies well below the surface under the influence of pressure

CLASSES OF IGNEOUS ROCKS INTERMS OF THEIR ORIGIN

a) Plutonic igneous rocks
b) Volcanic igneous rocks

PLUTONIC IGNEOUS ROCKS

- These are rocks that are formed when magma cools beneath the surface and hardens slowly because of high temperatures.
- They have large and easily recognized crystals.
- They are exposed to the surface by the process of denudation and erosion.

EXAMPLES OF PLUTONIC IGNEOUS ROCKS

a) Granite
b) Diorite
c) Gabbro

VOLCANIC IGNEOUS ROCKS

- These are rocks which are formed when magma cools on the earth's surface, so the atoms do not have time to rearrange themselves; hence the rocks have fine texture.

EXAMPLES OF VOLCANIC IGNEOUS ROCKS

i. Obsidian
ii. Pumice
iii. Scoria
iv. Basalt
v. Andersite
vi. Rhyorite

THE CRYSTALLISATION ORDER FROM MAGMA

	ROCK NAME	**MINERALS DOMINANT**
Last to crystallize ⇧ First to crystallize	Granite	biotite
	Diorite	Biotite, amphibole
	Gabbro	Pyroxene
	Peridotite	Pyroxene, olivine

SOME IGNEOUS ROCKS

EXTRUSIVE ROCKS

TEXTURE	**ROCK NAME**	**DOMINANT MINERALS**
Glassy	Obsidian	Orthoclase, amphibole, quartiz
	Pumice	Orthoclase, amphibole, quartz
	Scoria	Plagioclase, olivine, pyroxene
Fine-grained	Rhyolite	Orthoclase, mica
	Andersite	Plagioclase
	basalt	Plagioclase, olivine, mica, pyroxene

INTRUSIVE ROCKS

TEXTURE	**ROCK NAME**	**DOMINANT MINERALS**
Coarse-grained	Granite	Orthoclase, amphibole, mica, quartz
	Diorite	Plagioclase, pyroxene, amphibole, mica
	Gabbro	Plagioclase, pyroxene
	Peridotite	Olivine, pyroxene

CHARACTERISTICS OF IGNEOUS ROCKS

- ✓ They are crystalline (contain crystals).
- ✓ They are non-stratified (do not have layers).
- ✓ They are non-fossiliferous (do not contain fossils).

- ✓ They contain squeezed and elongated vesicles.
- ✓ Rocks become hard and dense than before.

C) METAMORPHIC ROCKS

- These are rocks which were originally igneous or sedimentary but may be changed in character and appearance due to the following:

a) Heat

- Heat causes minerals to recrystallize sometimes.

b) Pressure

- This alters (changes) the rock structure.

c) Water

- Water dissolves some rock materials and deposits some other materials thus changing the composition of the rock.

d) Air

- Air moves through the rock pores and comes into contact with different rock elements, which leads to changing its composition.

DYNAMIC METAMORPHISM

☞ These are metamorphic changes which are due to **pressure**.

✓ The first sign of metamorphism (change) is the rearrangement of minerals in bands or layers. This structure is called **foliation**.

THERMAL (CONTACT) METAMORPHISM

✓ This is the type of metamorphism which takes place when **heat** determines the changes that take place.

REGIONAL METAMORPHISM

✓ This is the type of metamorphism which takes place when both **pressure and heat** operate together over a large area.

METASOMATISM

✓ This is the type of metamorphism which takes place when **gases** move through the rock pores and come into contact with different rock elements, such that chemical reactions take place so that new minerals are formed.

METASEDIMENTS

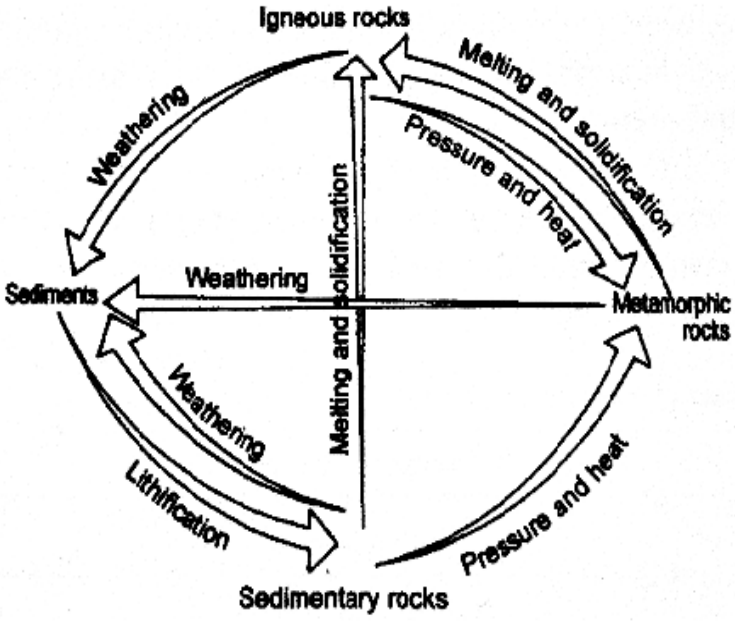
✓ These are all the metamorphic rocks which are formed from sedimentary rocks.

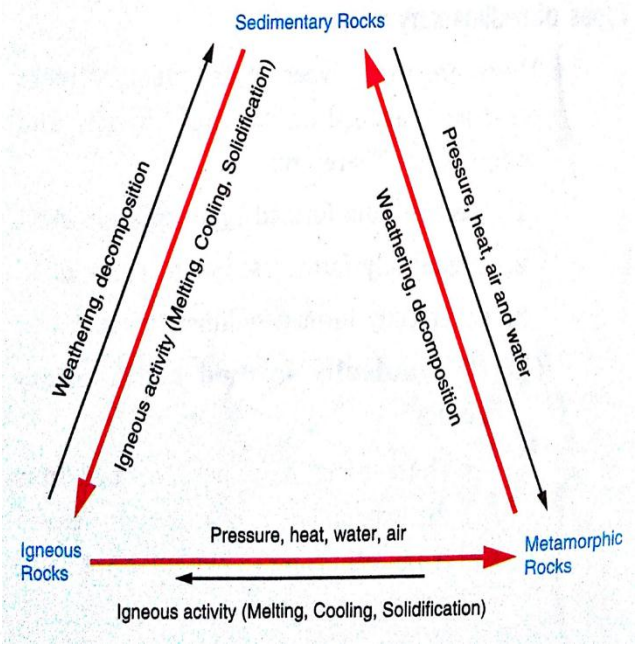
EXAMPLES OF METAMORPHIC ROCKS

- ☞ Slate
- ☞ Phyllite
- ☞ Schist
- ☞ Gneiss
- ☞ Marble
- ☞ Quartzite
- ☞ Serpentine

NAME	ORIGINAL ROCK	ARRANGEMENT OF GRAINS
Slate	Shale, siltstone	Layers almost invisible
Phyllite	Shale, siltstone	Layers almost invisible
Schist	Impure limestone, shale, siltstone	Layers from 1 cm to 1m apart
Gneiss	Granite, slate, conglomerate, siltstone	Layers from 1 cm to 1 m apart
Marble	Pure limestone	No layer
Quartzite	Pure sandstone	No layer
Serpentine	Basalt, peridotite	No layer

THE ROCK CYCLE (LITHOLOGICAL CYCLE)





INTERPRETATION OF THE ROCK CYCLE

- **Sedimentary** or **metamorphic rocks** may change to **igneous rocks** when exposed to high temperatures present inside the earth such that melting occurs. The molten materials cool and solidify to form igneous rocks.
- **Metamorphic** or **igneous rocks** may change to **sedimentary rocks** when they undergo weathering, and the sediments transported to geosynclines where deposition, compaction and lithification may take place to give rise to **sedimentary rocks.**
- **Igneous** or **sedimentary rocks** may change to **metamorphic rocks when the former are subjected to heat, air, pressure or water.** These may change the physical and chemical composition of the rocks to produce **metamorphic rocks.**

IMPORTANCE OF ROCKS

- For making machines and tools.
- Source of quarry for construction.
- Source of energy such as coal.
- Formation of soils after weathering.

- They are a source of minerals such as gold and diamond.

WEATHRING

- This is the process by which the rocks are broken down into small particles due to the exposure to the atmosphere.
- Weathering is one of the processes of denudation.

DENUDATION

- It refers to the breaking away of rocks by various agents and the removal of the broken down materials.

TYPES OF WEATHERING

- ✓ **Physical weathering**
- ✓ **Chemical weathering**

1) PHYSICAL WEATHERING

☞ This is where the rocks are broken down into smaller particles without changing the chemical composition of the rocks.

WAYS IN WHICH PHYSICAL WEATHERING OCCURS

- ✓ Frost action (freeze thaw or gelifraction)
- ✓ Repeated temperature changes
- ✓ Biotic agencies
- ✓ Repeated wetting and drying
- ✓ Pressure release (sheeting)

FROST ACTION (FREEZE THAW)

❖ Rain water fills the cracks (pores) of rocks. When temperature decreases, the water in cracks freeze at 0ºC, this exerts pressure and makes the rocks to expand. When the temperature increases, the ice melts and makes the rock to contract. The alternating freezing and melting may lead to rock disintegration.

REPEATED TEMPERATURE CHANGES

❖ When rocks are heated they expand, and when they are subjected to low temperatures they contact. The alternating expansion and contraction may lead to rock disintegration.

- This is very common in deserts where repeated temperature changes occur. This leads to the formation of **screes**.
- **Screes** are small rock particles heaped around a rock.
- Sometimes a thin layer or rocks may peel off. This is called **exfoliation**.

BIOTIC AGENCIES

❖ This can be done by the action of living organisms such as plants and animals.

☞ Plants growing in the rocks may have their roots extended into the cracks of rocks and this may lead to rock disintegration.

☞ Animal hooves may also promote physical weathering since haves may break rock into small particles as animals move about.

☞ People also working in mining, farming and construction may also contribute to physical weathering since rocks are broken down in the process.

REPEATED WETTING AND DRYING

❖ When rocks are wet, the outer layer absorbs water, and expands. When temperature increases, the moisture evaporates, making the rock to shrink. When this happens repeatedly, the outer layer may split off.

PRESSURE RELEASE

❖ This results from the removal of the overlying rocks by erosion. This makes the underlying rocks to expand and fracture, leading to rock disintegration.

CHEMICAL WEATHERING

❖ This involves the breaking down of rocks into smaller particles and changing the chemical composition of the rocks in the process.

WAYS IN WHICH CHEMICAL WEATHERING OCCURS

a) Solution (carbonation)
b) Oxidation
c) Hydration
d) Hydrolysis

SOLUTION (CARBONATION)

➢ Rainwater combines with carbondioxide in the atmosphere and forms a weak carbonic acid. This acid dissolves some minerals in rocks such as calcium carbonate from limestone.

OXIDATION

➢ Rainwater contains oxygen. This oxygen may react with iron in rocks and produce ferrous oxides (iron oxides), and this leads to rock disintegration.

HYDRATION

➢ This happens as water enters rocks through the cracks and get in contact with rock minerals to form new compounds. This leads to rock disintegration. For example, calcium sulphate reacts with water to form gypsum which promotes rock disintegration.

HYDROLYSIS

- This involves the reaction of Hydrogen (H^+) and Hydroxyl (OH^-) in water with metallic ions in rocks. This produces weak, unstable mineral compounds which promotes rock disintegration.
- For example, rocks containing orthoclase, feldspar, such as granite. When water containing acids enters a rock through its cracks, orthoclase reacts with acids in the water to form kaolin, silicic acid and potassium hydroxyl. This leads to rock disintegration.

FACTORS THAT AFFECT THE RATE AND TYPE OF WEATHERING

1) Rock structure

☞This is about both the physical and chemical characteristics of the rock, such as joints, faults etc. The minerals found in a rock also determine the type and speed at which weathering takes place.

2) Climate

☞Humidity also affects the type of weathering to dominate. Dry climates encourage physical weathering while hot and humid conditions promote chemical weathering.

3) Vegetation

☞The abundance and type of weathering determines the extent of rock exposure to the atmosphere. This in turn, determines the type and rate of weathering.

4) Topography

☞ This also determines the extent of rock exposure to the atmosphere. This in turn, determines the type and rate of weathering. Rocks are more exposed on steep slopes due to rapid soil erosion than they are on gentle slopes or flat lands.

5) Age of the rock

☞ Older rocks are more likely to break since the cohesion of particles is weaker than it is for younger rocks.

IMPORTANCE OF WEATHERING

- It leads to the formation of soil which supports life on earth.
- I creates and modifies landforms.
- It helps in the formation of sedimentary rocks.
- It lowers land surfaces.
- It promotes tourism by leading to the formation of beautiful residual mountains.
- It prepares rock particles for transportation by making the particles small.

NEGATIVE EFFECTS OF WEATHERING

- It encourages leaching and makes the soil lose its fertility.
- It exposes the rocks to agents of erosion.

- It promotes siltation of water bodies when the weathered sediments have been transported to water bodies.
- It promotes the process by which rock particles and soil move down slopes in bulk under the influence of gravity (mass wasting).

RELATIONSHIP BETWEEN PHYSICAL WEATHERING AND CHEMICAL WEATHERING

a) Physical weathering breaks down the rocks into smaller particles, this increases the surface area on which chemical weathering takes place.
b) Chemical weathering makes the rocks weak, making them to be easily broken down by physical weathering.

RIVERINE LAND FORMS

DEFINITIONS OF TERMS

RIVER SOURCES

☞ These are areas where rivers start from.
- Usually, these are uplands such as mountains.

MOUTHS OF RIVERS

☞ These are places where rivers finally drain into.
- Usually these are big water bodies such as oceans, lakes or seas.

RIVER COURSES (STAGES OF RIVERS)

☞ These are paths taken by rivers as they flow from their sources to their mouths.

TRIBUTARIES

☞ These are small rivers that join the main rivers.

CONFLUENCE

☞ This is a point where tributaries join the main river.

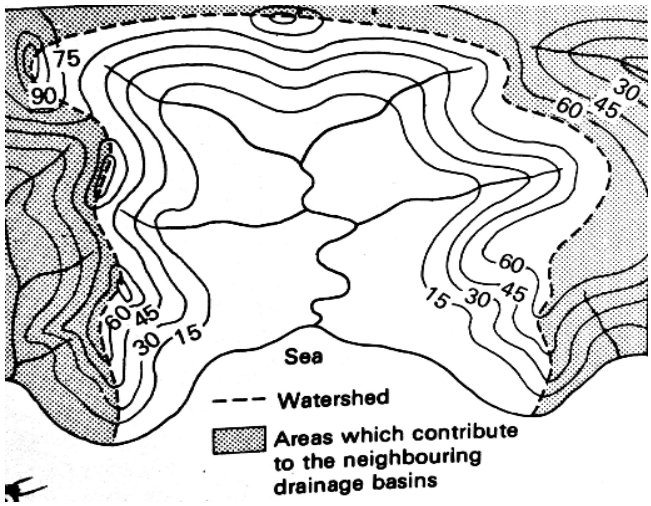
CATCHMENT AREAS (DRAINAGE BASINS)

☞ This is the land that supplies a river and its tributaries with water.

WATERSHED

☞ This is the division that separates one drainage area from the other.
- Usually these are highlands, such as hilltops.

A watershed



Some riverine features

- ✓ Meanders
- ✓ Ox-bow lakes
- ✓ Braids
- ✓ Levees
- ✓ Deltas
- ✓ Estuaries
- ✓ Flood plains
- ✓ Rapids
- ✓ Waterfalls
- ✓ Gorges
- ✓ V-shaped valleys
- ✓ Cliffs

Main courses of a river

a) Upper course (youthful stage)
b) Middle course (maturity stage)
c) Lower course (old stage)

1) Upper course (Youthful stage)

(Characteristics of this stage)

- This is found near the source of the river (hills, mountains).
- The water flows at high speed due to the presence of steep slopes.
- The main activity of the river here is **vertical erosion**.

Features formed in the upper course of the river

- ✓ Rapids
- ✓ Waterfalls
- ✓ Gorges
- ✓ V-shaped valleys

Economic importance of the upper course of the river

- Production of Hydro-Electric Power (HEP)
- Tourism
- Recreation

2) Middle course (Maturity stage)

Characteristics of this stage)

- The river flows in gentle slopes or flat areas.

- River banks get wide and deep.
- The river is joined by many tributaries.
- The river begins to meander.
- The main activity of the river is **(horizontal) lateral erosion**.

Features formed in the middle course of the river

✓ Meanders
✓ Ox-bow lakes
✓ Cliffs

Economic importance of the middle course of the river

- Irrigation farming
- Fishing
- Transportation

3) Lower course (Old stage)

Characteristics of this stage)

- It is found near the mouth of the river.
- The river passes through a flood plain.

Features formed in the lower course of the river

✓ Meanders
✓ Ox-bow lakes
✓ Braids
✓ Levees
✓ Deltas
✓ Estuaries
✓ Flood plains

Economic importance of the lower course of the river

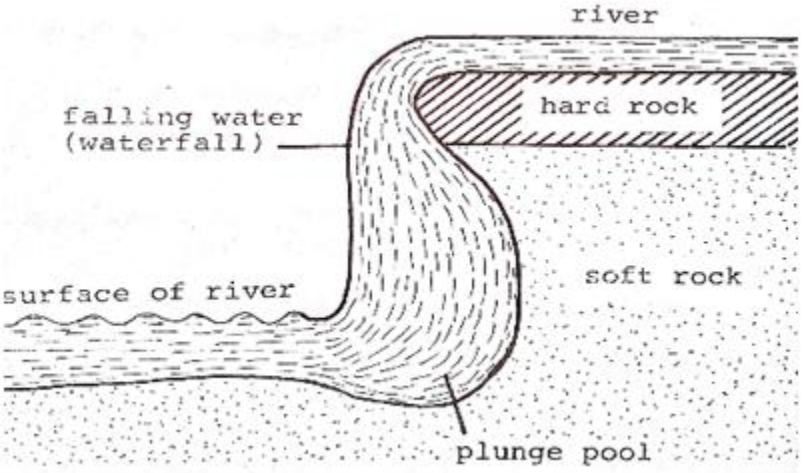
- Farming
- Tourism
- Oil drilling
- Transportation
- Recreation
- Fishing

Definitions of some riverine features

a) Waterfall

- It is a place where the riverbed suddenly becomes steep.

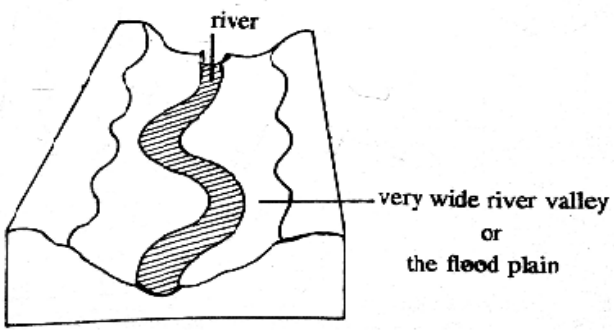
A Waterfall



b) Flood plain

- This is a belt of low flat ground on one or both sides of a river.

A Flood Plain



c) Gorge

- It is a steep-sided river valley.

☞ The valley floor is very narrow and almost flat.

d) Valley

- It is a low lying area.

☞ When a river passes through it, it is called a river valley.

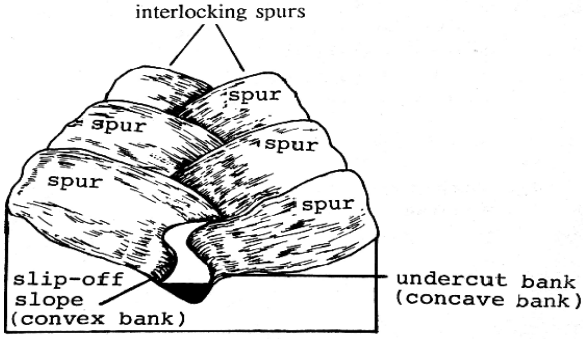
☞ In a river valley, contour lines point towards the higher ground.

e) Spur

- It is an area of high ground extending outwards from a larger mass of high ground.

☞ In a spur, contour lines point towards the low ground.

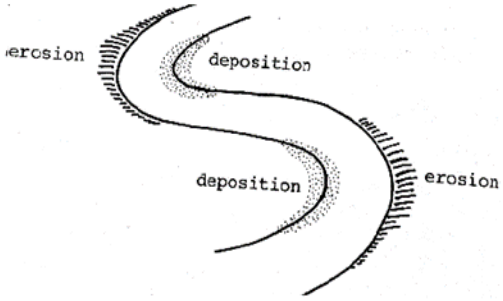
Interlocking spurs



f) Meanders

- These are bends of a river.

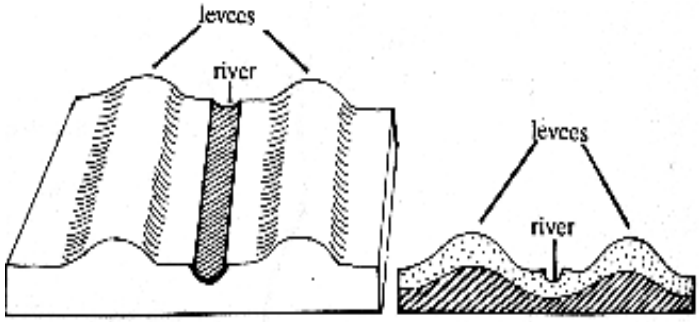
Meanders of a river



g) Levees (embankment)

- These are long piles of sediments (levees) or long and high piles of soil (embankment) built up on each side of a river.

Levees



h) Ox-bow lake

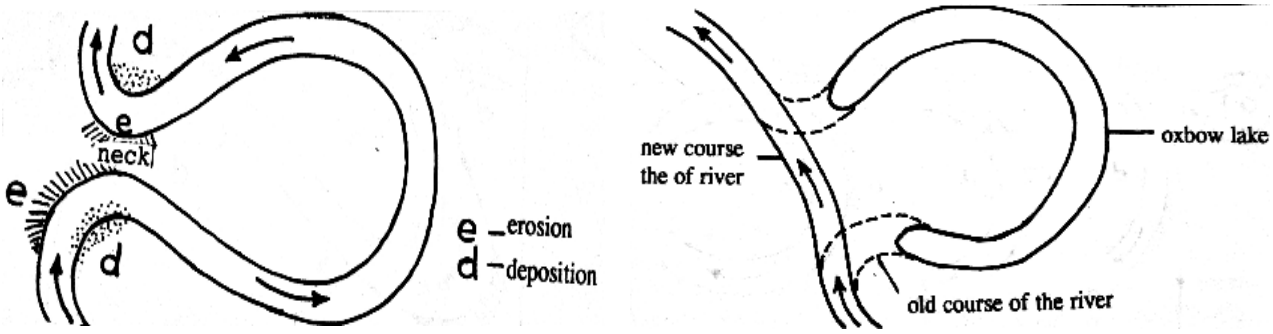
- This is a lake with the shape of a bow that results from meanders.

☞ Ox-bow lakes span from erosion and deposition.

FORMATION OF AN OX-BOW LAKE

When a river starts to bend, the curve becomes sharper as more deposition takes place. Sometimes the meanders become so sharp that a very narrow neck of the land develops. When the river floods, it erodes the narrow neck and the meander is cut-off; forming an ox-bow lake.

Stages in the formation of An Ox-bow lake



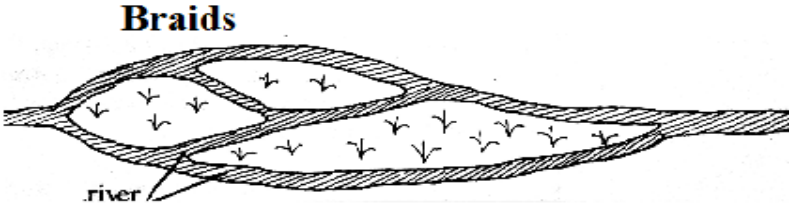
BRAIDS

❖ These are divided river channels.

FORMATION OF BRAIDS

These are formed when the speed of the river decreases greatly due to a very low gradient of the valley floor. As a result, deposition occurs across the full width of the valley floor, making the river to divide into several channels.

Braids



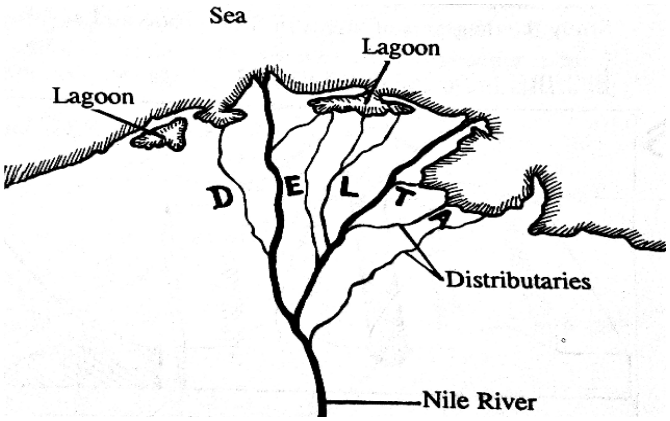
DELTA

☞ A delta is a fan-shaped alluvial area at the mouth of a river.

FORMATION OF DELTAS

- ☞ It is formed when a river joins a large body of water, such as a sea at its mouth. The sediments (materials) the river carries are deposited at its mouth. Due to obstruction caused by the deposited alluvium, the river may empty its water through several channels called ***distributaries***.
- ☞ The distributaries divide and subdivide, forcing the deposits to grow outwards in the shape of a fan or triangle. Deltas are associated with lagoons.

A delta



CONDITIONS NECESSARY FOR THE FORMATION OF DELTAS

- ➢ Large load (sediments) in rivers due to active erosion in the upper course of the river.
- ➢ Gentle or flat gradient.
- ➢ There should be no obstacle along the channel to prevent filtering thee materials.
- ➢ The speed of water in the river should be low.
- ➢ Faster deposition of the load than the rate at which it is removed by the action of tides or ocean currents.

TYPES OF DELTAS

1. **Estuarine Delta**

- ➢ The river is submerged or drowned.

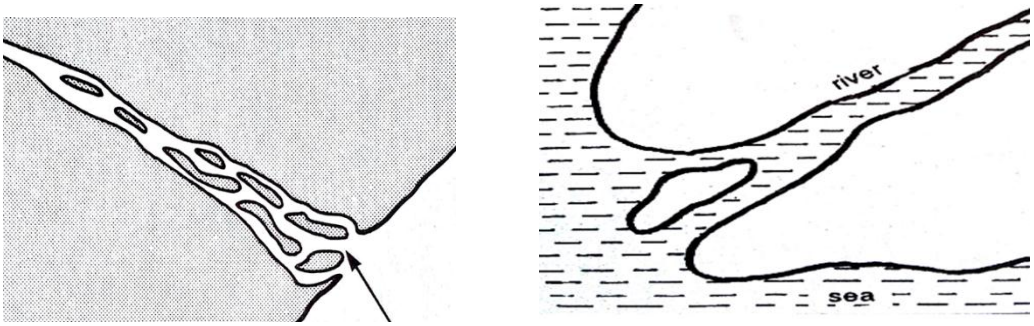
CHARACTERISTICS OF ESTUARINE DELTA

- ➢ It develops at the mouth of the submerged river.
- ➢ It is formed when the river deposits its load at a coast where strong waves and currents sweep sediment along the shoreline.
- ➢ It takes the shape of an estuary.

Examples of estuarine deltas

i. Seine
ii. Ob
iii. Elbe in Germany
iv. Vistula in Polland
v. Zambezi

Estuarine Delta



2. Cuspate Delta

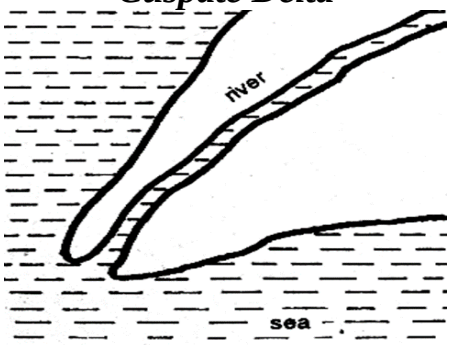
CHARACTERISTICS OF CUSPATE DELTA

- It is pointed like a tooth.

Examples of Cuspate Delta

- The mouth of Tiber River.

Cuspate Delta



3. Bird's Foot Delta

- It is made up of silt.

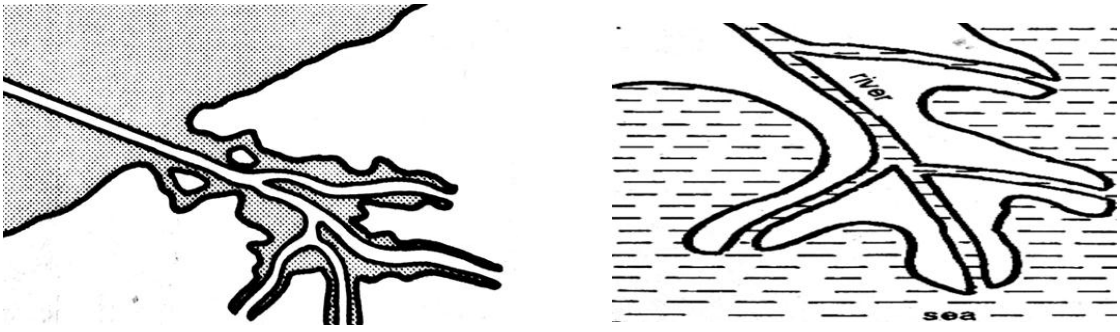
CHARACTERISTICS OF BIRD'S FOOT DELTA

- It is composed of very fine sediments called silt.
- The river is divided into few distributaries which form long finger-like projections of sediments out into the sea.
- It is formed when less dense water in a river carries large volumes of fine materials like silt, flowing into denser sea water.
- It occurs in areas which have few currents and tides to disturb the sediments.

Examples of Bird's Foots Delta

i. Omo
ii. Varda
iii. Mississippi

Bird's Foot Delta



4. **Arcuate Delta**

- This type of delta is triangular in shape, with many distributaries.

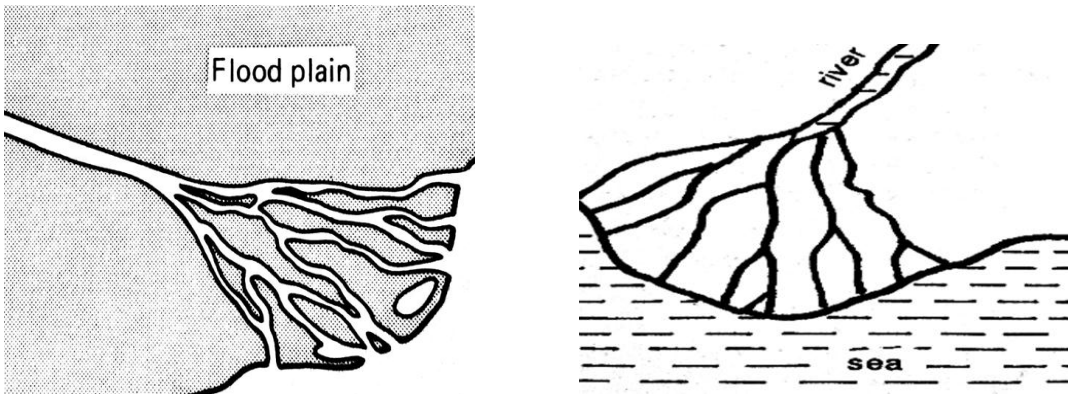
Characteristics of Arcuate Delta

- It is composed of coarse sediments such as gravel and sand.
- It is triangular in shape resembling an inverted pyramid.
- It has many distributaries.
- It is formed when the density of water in the river and sea are similar hence sediment deposition.

Examples of Arcuate Deltas

i. Indus
ii. Ganges
iii. Niger
iv. Nile
v. Mekong

Arcuate Delta



IMPORTANCE OF DELTAS

- Deltas are mainly used for agriculture (farming). For example, the Nile Delta where cotton and rice are grown, and Ganges Delta where Jute is grown.
- For tourism.
- They are habitats for different plant and animal species.

COASTAL FEATURES AND COASTAL LAND FORMS

- These are features that are formed next to the sea or lake as a result of activities such as erosion and deposition.

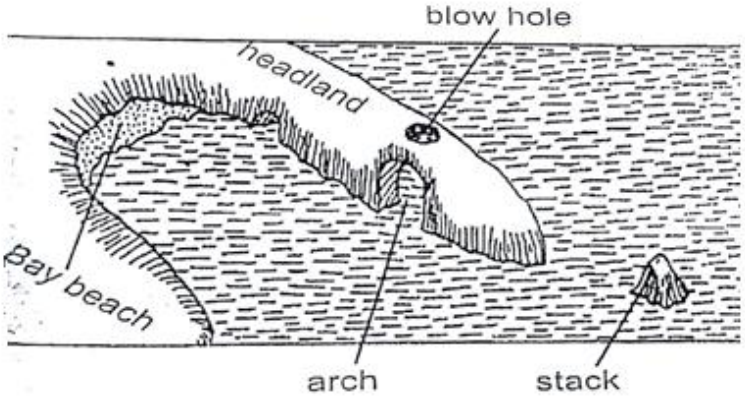
SOME COMMON COASTAL FEATURES

1) Headland (point)
2) Lagoons
3) Spit
4) Estuary
5) Bay
6) Cape
7) Peninsula
8) Fjord
9) Gulf
10) Strait
11) Sand bar
12) Caves
13) Arches
14) Stacks
15) Stumps

a) Headland

- A headland is a piece of land jutting out into the sea from the mainland, usually with steep high cliffs.

Headland



b) Cave

- It is a hollow opening in the base of a sea cliff, usually at sea level.

Formation of a cave

☞ It is formed by waves acting on weak parts of the weathered rock.

❖ It slowly enlarges into an **arch**.

c) An arch

- It is an opening through a headland, which leaves a bridge of rocks over the water.

d) Stacks

- Stacks are steep-sided pillars of rocks that have been isolated from nearby cliffs at the shoreline by erosion caused by waves.

e) Stumps

- These are low outcrops of rock left after the coastal stacks have been removed.

f) Promontories

- It is a long, narrow and high headland.

g) Lagoon

- It is a body of water that is partly or completely surrounded by land.

Formation of a lagoon

☞ It is formed when a ridge of sand develops across the entrance of a bay or concave coastline. The partly or completely cut off body of water is called a lagoon.

Example of a lagoon in Malawi is ***Chia Lagoon***.

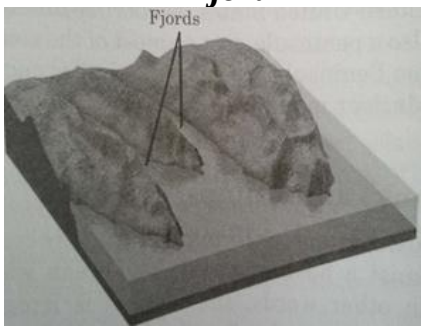
h) Fjord

- It is a long. Narrow sea inlet that is bordered by a steep cliff.

Formation of a Fjord

☞ Fjords are formed by heavy glaciers that erode the bottoms of river valleys.

A Fjord



i) Spit

- It is a sandy extension of a beach, stretching pathway across the mouth of a bay.

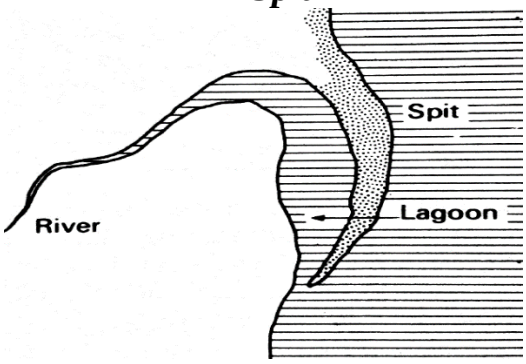
Formation of a spit

☞ It is formed where a long shore drift moves across the mouth of a river in a large body of water. The long-shore drift makes the sediments brought by the river to be curved like a hook, forming a spit.

Conditions necessary for the formation of a spit

- A constant supply of sand from erosion in the upper course of the river.
- A long shore drift must operate most of the time.
- The sea or lake must be shallow.

A Spit



j) Peninsula

- It is a piece of land that is almost surrounded by water but connected to the mainland by an isthmus.
- An isthmus is a narrow strip of land connecting a peninsula to the mainland.

Examples of peninsulas in Malawi

✓ Lulomo peninsula
✓ Nankumba peninsula

k) Bay

- It is a body of water that is partly enclosed by land.

Formation of bays

☞ They are areas where soft rocks have been eroded forming sheltered bays from strong winds and water waves.

➢ They are commonly used as ports.

Examples of bays in Malawi

a. Senga bay
b. Monkey bay

c. Koko bay
d. Nkhatabay

l) Cape

- It is a big headland extending into a water body.
- A cape is flat-topped and connected to mainland with a thicker neck.

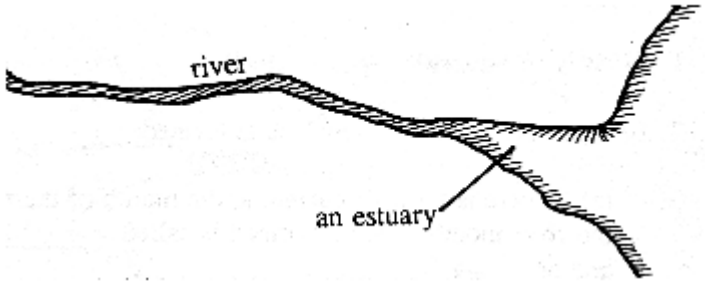
Examples of capes

a. Cape of Good Hope in South Africa
b. Cape Maclear

m) Estuary

- It is a drowned and V-shaped opening at the mouth of a river.

An Estuary



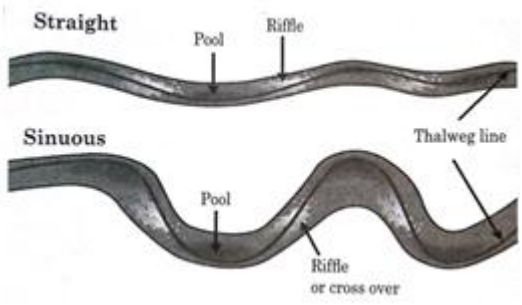
n) Gulf

- It is an arm of a sea or ocean that extends into the land.
- It is larger than a bay and connected with the sea with one or more straits.
- An example is the Gulf of Mexico.

o) Straight

- It is a narrow body of water that connects two larger bodies of water. For example, The Strait of Gibraltar.
- If the passage is long and wide, it is called a **channel** or **sound**. For example, The English Channel.

A straight

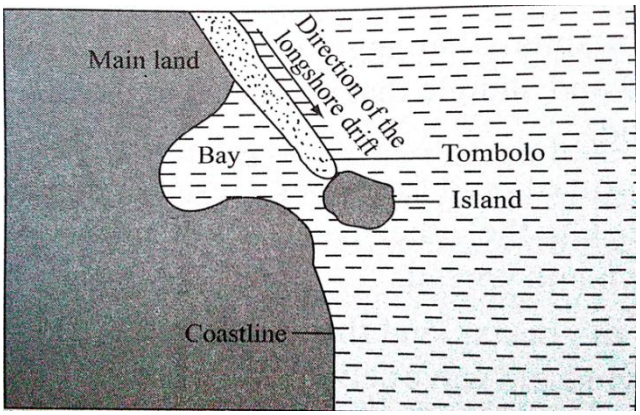


p) Tombolo

- It is a sand bar that connects an island to the mainland.

☞ Once connected, an island is called a tied island.

A Tombolo



IMPORTANCE OF COASTAL LANDFORMS

1) For tourist attraction because of their scenic beauty.
2) For transportation such as bays, channels etc.
3) For fishing
   - For example estuaries have plentiful planktons on which the fish feed.
4) For settlement
   - Such as on peninsulas and bays which are fertile for farming.
5) Habitat for wild and aquatic species.
   - These may include frogs, fish, birds etc.
6) Production of Hydro-Electric Power (HEP)
   - Tidal energy can be harnessed in lagoons and estuaries after damming the water.

RELIEF FEATURES OF THE OCEAN BASINS

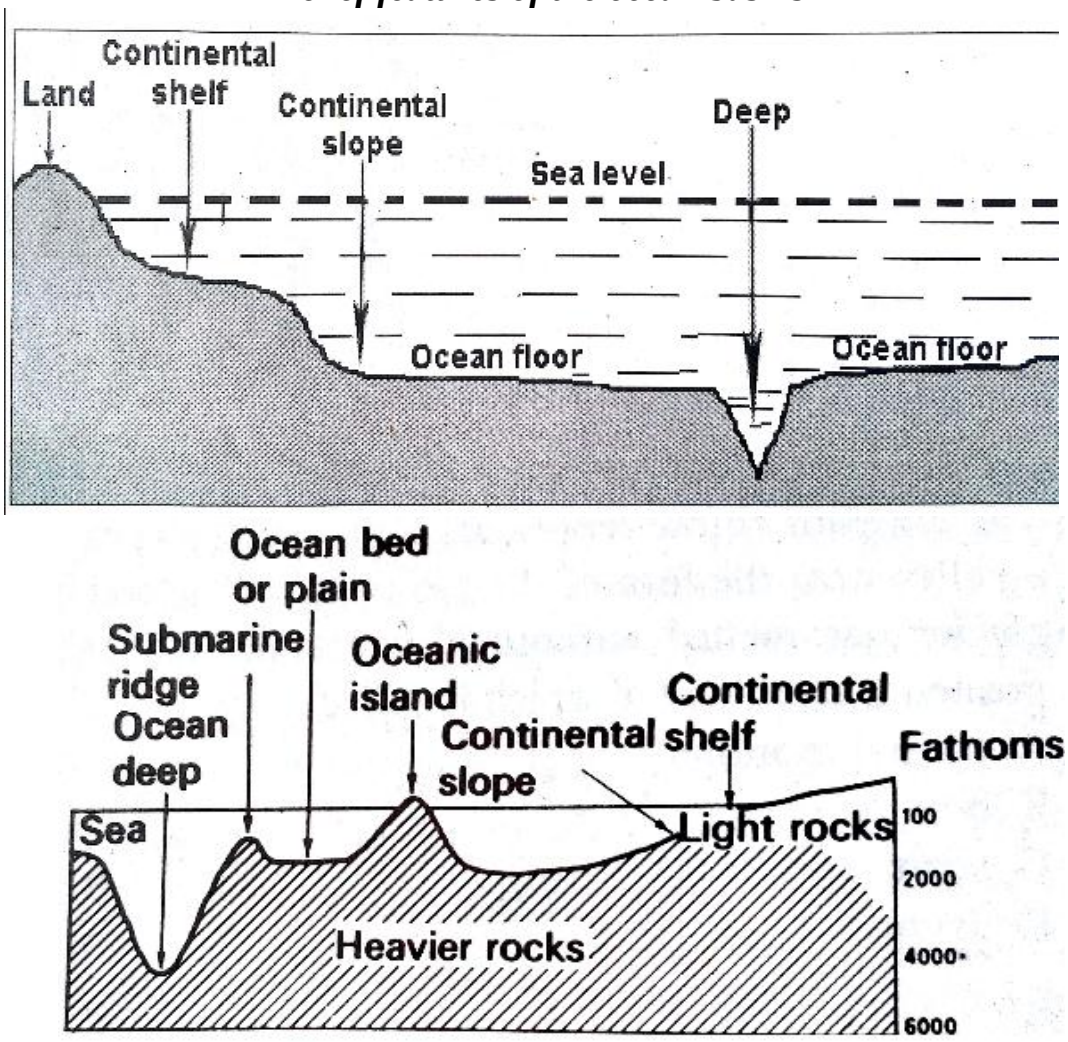
- An ocean basin refers to a depression of the earth's surface in which an ocean lies.

EXAMPLES OF OCEAN BASINS

i. Continental shelves
ii. Continental plains
iii. Continental rise
iv. Continental slopes
v. Abyssal plains
vi. Oceanic ridges
vii. Trenches
viii. Seamounts
ix. Guyots

NOTE: Continental shelves, slopes and rise are collectively called ***continental margins.***

Relief features of the ocean basins



1) **Continental shelves**

- These are narrow, relatively flat and submerged part of the continent that stretches from the continent into an ocean basin.

Importance of continental shelves

- ✓ **Fishing**

This is so since they are shallow, a condition promoting the growth of planktons on which the fish feed. Rivers also discharge into these zones, thereby bringing nutrients needed by fish and planktons.

- ✓ **Petroleum drilling**

Most oil reserves are found on the seabed.

2) **Continental slopes**

- These are formed of land-derived sediments which pile up at the foot of the continental crust.

3) **Continental rise**

- These are formed from sediments which move down from the continental shelves and pile up at the base of the slope.

4) **Abyssal plain**

- These form the second deepest regions of the ocean basin after subduction trenches.
- They are extensively flat, cold and dark terrains.

5) Oceanic ridges

- These are narrow, continuous ranges of underwater mountains found in the major water bodies of the world. For example, the Mid-Atlantic ridge.
- They are formed in water bodies after the eruption and solidification of molten magma from beneath the earth's surface.

6) Trenches

- These are formed in the zones of subduction after the collision of a continental plate and an oceanic plate. Since an oceanic plate has high density, it deeps into the mantle.
- Examples of trenches in the world include Tonga, Java, Mariana, etc.

7) Seamounts and guyots

- **A seamount** is an isolated undersea mountain formed due to volcanic eruptions on the sea bed.
- **A guyot** is a flat-topped underwater mountain and are commonly found in the Pacific Ocean. They are believed to be a result of an extinct volcano.

TOPIC 2: THE HYDROSPHERE

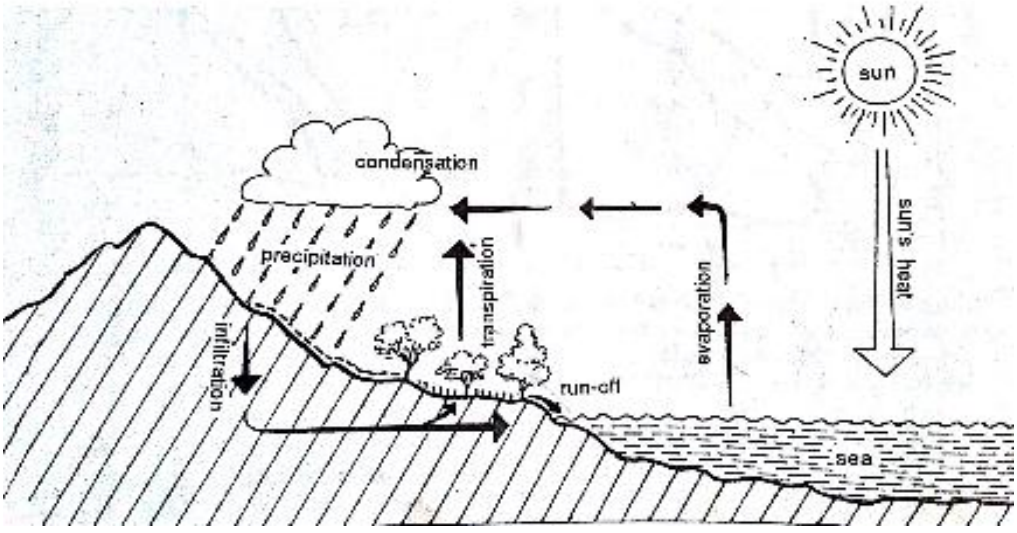
"***Hydro***" means water, so, hydrosphere refers to the part of the earth which is composed of water masses, such as rivers, lakes, dams, oceans etc.

- The hydrosphere comprises 70% of the earth's surface, and the remaining 30% is covered by the lithosphere (landmasses).

THE HYDROLOGICAL CYCLE

It means the circulation of water from the earth's surface to the atmosphere, from there to the land and back to the water bodies. It is a closed system, with inputs, processes and outputs. Water is neither lost nor created; it only changes from one state to the other. For example, from liquid to gas.

The Hydrological Cycle



THE MAIN FEATURES AND PROCESSES IN THE HYDROLOGICAL CYCLE

- The hydrological cycle being a system, it is made up of inputs, processes and outputs. The following table presents some of the major features and processes of the hydrological (water cycle).
- The **input** is the ***sun (solar) energy*** that breaks water molecules into hydrogen and oxygen gases which combine to form vapour. Solar energy promotes evaporation and transpiration.
- **Outputs** include all different forms of precipitation: ***rain, hail, sleet, fog, snow etc.***

MAIN FEATURES OF THE HYDROLOGICAL CYCLE	**PROCESSES IN THE HYDROLOGICAL CYCLE**
➢ Ground water ➢ Oceans ➢ Clouds ➢ Vegetation ➢ sun ➢ Rivers ➢ Land ➢ Ice blocks (snow)	➢ Evaporation ➢ Solar radiation ➢ Transpiration ➢ Condensation ➢ Precipitation ➢ Ice sheet melting ➢ Sublimation ➢ Infiltration ➢ Percolation ➢ Capillary attraction

IMPORTANCE OF THE HYDROLOGICAL CYCLE

It helps to maintain water supply which is used in the following ways:

- ➢ Water is used for sporting activities, such as swimming.
- ➢ It is a means of transport and communication by ship or boat.
- ➢ It is used for hydro-electric power generation.
- ➢ For domestic use (cooking, drinking etc) and industrial purposes.
- ➢ It serves as a habitat (home) for aquatic animals such as fish, frogs, hippos etc.
- ➢ For tourist attraction since rivers and lakes provide scenic features of great beauty.

EFFECTS OF DISTURBING THE HYDROLOGICAL CYCLE

- ✓ Land turns unproductive (desertification). This leads to low crop yields or complete crop failure.
- ✓ Prolonged droughts and/or heavy rainfall
- ✓ Climate change

- ✓ Flooding (the destroys fields, homes and causes erosion)
- ✓ Increase in water-borne diseases
- ✓ Water pollution, making it difficult for use.

NOTE: *Holistic approaches (measures) need to be taken to conserve water.*

FACTORS THAT CAN DISTURB THE HYDROLOGICAL CYCLE

1. Global warming
2. Acidic rain
3. Poor agricultural practices
4. Deforestation

A. Global warming

Generally, this is when the earth experiences high temperatures, this warms up the globe.

- It has to be noted that there is an ozone layer in the atmosphere. This ozone layer absorbs a certain amount of heat from the sun.

Causes of global warming

1) Chlorofluorocarbons (CFCs)

→ These are harmful gases emitted (released) into the atmosphere by cars, air conditioners, refrigerators, power stations, production of agricultural fertilizers, etc.

→ They include methane, nitrous oxides, carbon dioxide.

→ These are called ***greenhouse gases.***

❖ All these greenhouse gases absorb terrestrial radiation and send the heat back to the earth's surface.

❖ They also destroy the ozone layer, making it fail to absorb heat from the sun. As a result, the heat passes through directly, making the globe to be warm. This is called ***greenhouse effect***.

HOW GLOBAL WARMING DISTURBS THE HYDROLOGICAL CYCLE

- It affects rainfall distribution pattern, resulting in heavy, little or no rainfall at all. This happens as high temperatures disturb condensation processes in the atmosphere, resulting in little rains. High temperatures also increase evaporation and transpiration rates, these result in heavy rainfall.

B. Acidic rain

❖ Rain water (H_2O) reacts with various gases in the atmosphere such as oxygen (O_2) to form Hydronium (H_3O^+) ions, and when it reacts with carbon dioxide (CO_2), a weak carbonic acid is formed. These are acidic in nature**,** resulting in ***acidic rain.***

HOW ACIDIC RAIN DISTURBS THE HYDROLOGICAL CYCLE

❖ It leads to reduction in the number of water molecules as more of these react with gases in the atmosphere (as discussed above). This leads to little rains.

❖ Acidic rain also destroys the leaves of vegetation. This reduces the rate of transpiration which is a crucial process in the hydrological cycle.

C. Poor agricultural practices

➢ These would include, but not limited to; cultivating along steep slopes, overstocking, overgrazing, setting bush fires, shifting etc.

HOW POOR AGRICULTURAL PRACTICES DISTURB THE HYDROLOGICAL CYCLE

- ✓ Cultivation of steep slopes and river banks leads to siltation of water bodies (rivers, dams, lakes etc). This reduces the rate of evaporation from these water bodies as most of them dry up. This leads to little rainfall.
- ✓ Shifting cultivation and bush fires overgrazing depletes vegetation. This reduces the rate of transpiration. This leads to little rainfall.

D. Deforestation

This means the wanton (careless) cutting down of trees, without replacing them.

HOW DEFORESTATION DISTURBS THE HYDROLOGICAL CYCLE

- ✓ Depletion of vegetation reduces the rate of transpiration, this leads to tiny water droplets that form small clouds. Eventually, this yields little rainfall.
- ✓ It also leads to global warming since greenhouse gases keep accumulating in the atmosphere. This results in too much or very little or no rainfall at all as discussed above.

WAYS OF MAINTAINING THE HYDROLOGICAL CYCLE

1. Afforestation (planting trees where there were no trees) and re-afforestation (replacing depleted forests). This increases the rate of transpiration, leading to good rains.
2. Avoiding the use of machines that release harmful gases (chlorofluorocarbons) into the atmosphere. This ensures that the holes created in the ozone layer are sealed. When this happens, green house effects of global warming will stop. This eventually restores the normal rainfall distribution.
3. Use of good farming practices, such as bush furrowing, making ridges across the slopes etc. This prevents depletion of vegetation, and increases rainfall.
4. Conservation of water catchment areas. This is done by planting trees in catchment areas. This conserves vegetation that contributes vapour needed in cloud formation in the hydrological cycle.
5. Weather forecasting. People know in advance about the looming problem, and take relevant steps.
6. Proper disposal of industrial wastes so that water bodies do not become polluted.

DEFINITION OF TERMS

i. Evaporation

It is the process whereby water changes from liquid to state to gas (vapour). It takes place on both water and land masses.

Factors that influence the rate of evaporation

- Heat: high temperatures encourage it.
- Wind: higher (strong) winds encourage evaporation.
- Dryness of air: dry air absorbs moisture more than wet or humid air.

ii. Transpiration

It is the loss of water vapour from leaves of vegetation through ***stomata.***

iii. Sublimation

This is the changing of water from solid form directly to vapour. It happens when solar radiation abruptly becomes high in cold regions or high altitude areas where frozen water is common.

iv. Evapotranspiration

It is the combined loss of vapour from both vegetation *(transpiration),* and land and water masses *(evaporation).*

v. Adiabatical cooling

It is when the water vapour cools below its due point. This happens as the vapour starts losing its temperature to the air that surrounds it following since temperature decreases with increasing altitude.

vi. Condensation

This is when tiny water droplets start forming, which eventually enlarge as more and more water droplets join. This results from adiabatical cooling.

- These water droplets later form clouds.
- When the diameter of water droplets enlarges, the cloud can no longer be held in the atmosphere, but fall on to the ground in the form of **precipitation**.

vii. Precipitation

- It refers to the falling of liquid or solid water from the atmosphere.

viii. Infiltration

It refers to the socking of water into the soil.

ix. Run-off/overland flow

It is the moving of water on the earth's surface. This water joins water masses (sea, lakes, oceans, etc.)

x. Percolation

It is the movement of water into the soil. It can either be vertical (to join underground water) or horizontal (to join water masses).

xi. Capillary attraction

It is the process by which underground water rises until it is absorbed by roots of vegetation.

- Eventually, this water will also transpire again, thus completing and restarting the hydrological cycle.
- The water that percolates joins water masses.

xii. Cloud

A cloud is a mass of small water drops or ice crystals that is formed by condensation of water vapour in the atmosphere.

xiii. Dew-point

It is the temperature at which the atmosphere becomes saturated with water.

FACTORS THAT INFLUENCE OVERLAND FLOW (RUN-OFF)

1) The amount of precipitation
- The higher the amount of precipitation the higher the amount of water that will flow downstream.

2) Intensity and persistence of rainfall
- The high intense and persistent rainfall promotes run-off since water easily becomes saturated.

3) The initial soil moisture content
- When the soil already contains a lot of moisture, water easily fills the soil pores and runs off.

4) The texture and structure of soil
- Porous soils promote infiltration while fine textured soils such as clay promote run-off.

5) Slope of the land
- Steep slopes (gradients) promotes the rate of run-off while gentle slopes reduce it, and promote infiltration of water into the soil.

6) Vegetation
- Bare grounds promote run-off, but presence of vegetation promotes the infiltration of water into the ground.

PRECIPITATION

Precipitation is any form of liquid or solid water falling from the atmosphere.

LIQUID FORMS OF PRECIPITATION

1. **Rain**
2. **Freeze rain**
   - These are rain droplets which fall in super-cooled liquid form, but freeze on impact with the ground or another object to form clear ice.
   - It develops as falling snow encounters a layer of warm air deep enough for the snow to completely melt and become rain.
   - It causes a great deal of damage by coating roads, sidewalks and rails ways, making them impassable.
3. **Drizzle**
   - This means to rain lightly

SOLID FORMS OF PRECIPITATION

1) Hail

➢ These are balls or pieces of ice falling, often in connection with thunderstorm- ***(matalala)***

2) Sleet

➢ This is a mixture of rain and snow.

3) Snow

➢ This is a frozen state of water (tiny ice crystals stuck together).

CONDITIONS NECESSARY FOR PRECIPITATION

a) Air must be saturated.

✓ This means the air is full of water vapour (has high humidity).

b) Air must contain small dust particles (nuclei), around which the droplets form.

c) Air must be cooled below its dew-point.

✓ Dew point means the temperature at which the atmosphere becomes saturated with water.

d) Wind blowing from water masses (lakes, oceans etc.) carrying water vapour towards mountains. This yields relief rainfall upon rising.

e) Warm moist air must meet cold air mass along a line (front). This brings cyclonic rainfall.

f) Sufficient amount of evaporation from the water bodies to supply water vapour into the atmosphere.

NOTE: *Dew or morning mist is not a form of precipitation since it forms on the earth's surface following a decrease in temperature.*

VIRGA

✓ These are grey streaks that appear below a cloud. They are formed when rainfall evaporates before reaching the ground.

- Take note that rain may also not reach the ground because of updrafts. This is when the wind is blowing upward more than the rain is falling.

Conditions necessary for air to be cooled

✓ Air must be made to rise by convectional currents and mountains.

✓ When warm air passes over cold air.

✓ When air passes over cold surfaces such as cold ocean currents or land.

TYPES OF RAINFALL AND THEIR FORMATION

TYPES OF RAINFALL

a. Convectional rainfall

b. Cyclonic/frontal/depression

c. Orographic/relief rainfall

A. Formation of Convectional rainfall

❖ When the earth's surface is greatly heated, air rises and expands, leading to its cooling. Continued cooling makes the air to become saturated and then condensed to form clouds from which heavy rain falls.

NOTE! The colder air in the atmosphere slowly sinks to take the place of warm rising air. This creates a convectional circulatory movement.

☞This type of rainfall is common in equatorial regions and in summer as in the temperate interiors. It often comes in the afternoon after great heating of land surfaces.

Characteristics of convectional rainfall

i. It is associated with thunder and lightning

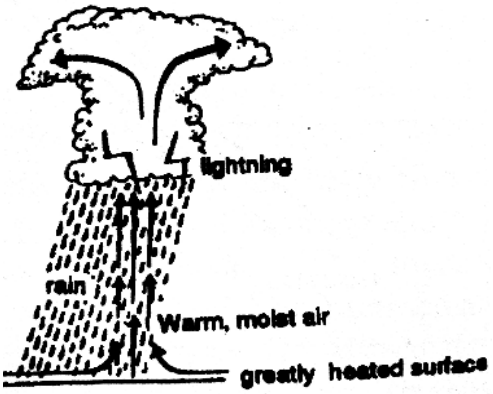
ii. It covers a small area

iii. It falls heavily but for a short period of time.

iv. It has anvil-shaped clouds.

v. It often comes in the afternoon after great heating of lad surfaces.

Formation of Convectional Rainfall



B. Formation of Frontal/Cyclonic rainfall (depression)

❖ This rainfall is formed when a warm air mass and a cold air mass meet at a front. After meeting, the warm air mass rises over the cold air mass. Upon rising, it cools and condenses to form clouds which eventually bring rainfall.

Characteristics of cyclonic rainfall

i. Heavy rainfall that lasts for a short time.

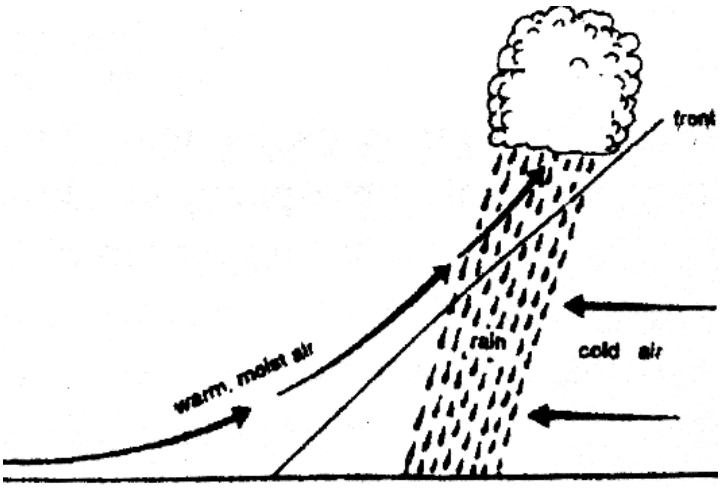
ii. It produces cumulonimbus clouds.

iii. It is associated with storms (cyclones)

iv. Lighter rainfall that lasts for a long time.

v. Commonest throughout the doldrums where the trade winds meet.

Formation of Cyclonic Rainfall



C. Formation of Relief/Orographic rainfall

❖ This rainfall is formed when a mountain stands in the path of moisture laden air. The air is forced to rise and is then cooled. If sufficient water vapour is present, rain falls on the high ground on the ***windward side.*** The other side of the mountain the ***leeward side*** or ***rain shadow*** is always dry (or little or no rainfall at all).

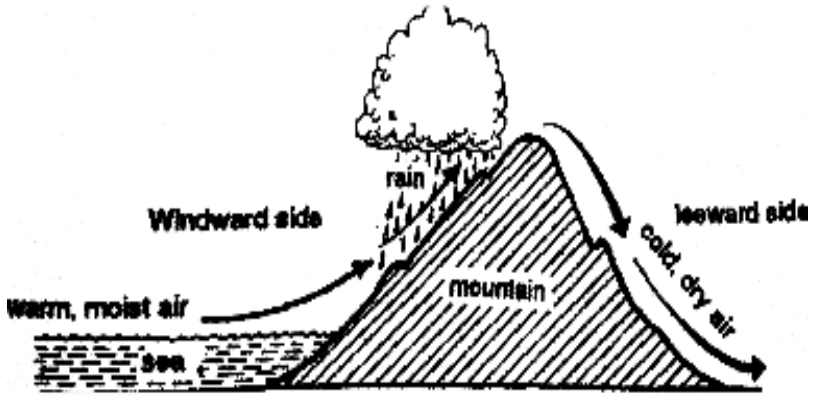
Reasons why there is little or no rainfall on the leeward side of the mountain

This is so because on descending the leeward side, a decrease in altitude leads to an increase in pressure and temperature. The air is compressed and warmed hence relative humidity drops. Instead there is evaporation.

Characteristics of Relief/Orographic rainfall

- ☞ It is widespread.
- ☞ It falls for a long time.
- ☞ It occurs in the mountain on the side that faces the direction of wind (windward side)

Formation of Relief (Orographic) Rainfall



SIMILARITIES AMONG THE THREE TYPES OF RAINFALL

1) They all involve warm moist air rising.
2) They all involve warm air cooling.
3) In all cases water vapour condenses to form clouds.
4) They all involve further cooling that leads to precipitation.

DIFFERENCES AMONG THE THREE TYPES OF RAINFALL

➢ Differences are seen in the way air rises, as discussed below.

a) In convectional rainfall, air rises because it is being heated.
b) In relief rainfall, air is forced to rise over mountains.
c) In frontal rainfall, warm air is rising over cold air.

MEASUREMENT OF RAINFALL

☞ Rainfall is measured using a rain gauge.

COMPONENTS OF A RAIN QAUGE

a) Funnel

☞ This directs water into the collecting glass bottle or bucket.

b) Collecting bucket

☞ This is put underground to avoid the evaporation of water from the jar, which may result in giving wrong readings.

☞ Using this, the water is poured into the measuring cylinder where readings are taken.

c) Measuring cylinder

REASONS FOR PLACING THE GAUGE AT LEAST 30CM ABOVE THE GROUND

☞ To avoid splashing of water into the funnel.

☞ To prevent evaporation of water from the funnel due to the reflected heat from the ground.

▪ The instrument should be sited well away from tall buildings, high trees and other objects ***to avoid sheltering it.***

☞ This helps to avoid wrong readings due to in-splashing of rain drops from tree leaves or roofs of buildings.

HOW TO MEASURE RAINFALL USING A RAIN GAUGE

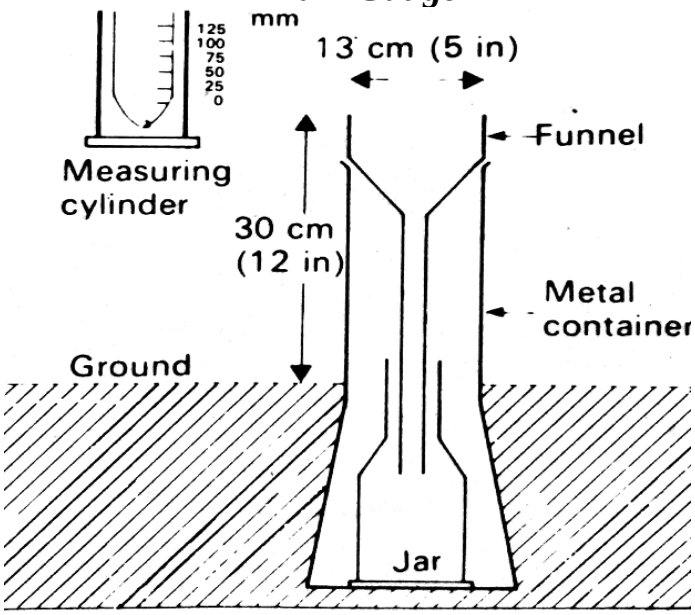
▪ It is done by removing the funnel, emptying the rain water from the container into a graduated cylinder with a 3.8cm.

▪ The readings should be done at eye level and to an accuracy of 0.25mm. For greater accuracy, a special kind of tape measure which tapers at the bottom is used.

▪ The rain gauge must be examined every day.

▪ Snow is melted by warming the funnel and then measured in temperate cold regions.

A Rain Gauge



INTERPRETATION OF RAINFALL DATA FROM GRAPHS

➢ Interpreting rainfall data from graphs helps to compare the rainfall patterns of different locations.

GUIDELINES TO FOLLOW WHEN INTERPRETING RAINFALL DATA

i. Look at the overall **shape** of the graph. That is; is the temperature line steep or gentle? Does it change throughout the year and/or look almost flat?

ii. Look for **extremes**, quote the highest and lowest temperature and rainfall and the month in which it occurs. Remember to quote units, for instance Celsius (°) or millimetres (mm).

iii. Can you identify the **seasons** when most rain and least rain falls? Or when the highest and lowest temperatures are experienced?

iv. Work out the **temperature range** by subtracting the lowest figure from the highest figure.

v. Add the **rainfall totals** for each month together to work out the total annual rainfall.

CLOUDS

➢ A cloud is a mass of small water drops of ice crystals, formed by condensation of water vapour in the atmosphere.

❖ Clouds made up of ice crystals are white and those that are full of water are dark, grey or black in colour.

FORMATION OF CLOUDS

✓ Clouds are formed when water vapour condenses into water droplets of ice crystals. There are tiny solid particles of dust and soot in the atmosphere, called the **aerosols**. The water vapour and these aerosols bump into each other. When the air is cooled at its dew point, some water vapour turns into liquid water droplets and stick to the aerosols when they condense to form clouds.

✓ Clouds form when the air is saturated and cannot hold any more water vapour.

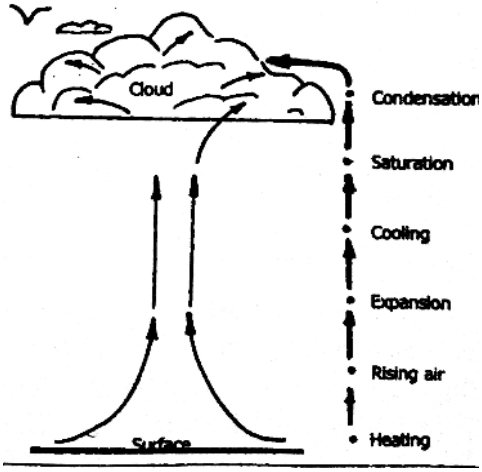
CONDITIONS NECESSARY FOR CLOUD FORMATION

1) Increased amount of water vapour in the atmosphere.
   - This can result from transpiration and evaporation.

2) Low atmospheric temperature.
- The air should be cooled below its dew point to promote condensation.

3) Soot and dust particles (aerosols or condensation nuclei)
- These act as nuclei around which water vapour condenses.

Illustration of cloud formation process



BASIS FOR THE CLASSIFICATION OF CLOUDS

1) General form (shape) or appearance
2) Altitude

ON THE BASIS OF SHAPE (APPEARANCE)

☞Stratiform or layered

☞Cumuliform or heaped (massive globular) type

CLASSIFICATION OF CLOUDS

LATIN WORD	TRANLATION	EXAMPLE
Cumulus	Heap	Fai weather cumulus
Stratus	Layer	Altostratus
Cirrus	Curl of hair	Cirrus
nimbus	Rain-bearing	Cumulonimbus

CLOUD HEIGHT, APPEARANCE AND ITS ASSOCIATED WEATHER

HEIGHT	CLOUD	APPEARANCE	WEATHER
Very high (6000-12000 metres)	Cirrus	Delicate, wispy, feathery, sometimes it forms streaks across the sky	Fair
	Cirrocumulus	White-heaped or globular masses, forming ripples in "mackerel sky"	Fair
	Cirrostratus	Thin white sheet or veil, milky sun forms a "halo"	Fair
Intermediate (2000-6000 metres)	Altocumulus	Wooly, bumpy, layered and looks like waves in the blue sky	Fine
	Altostratus	Denser, greyish with "watery" look	Fine
	Stratus	Grey and thick, appears like low ceiling of highland fog	Dull and light drizzle
	Nimbostratus	Dark, full, grey, white sheets and clearly layered rain-cloud	Continuous rain or sleet
Low clouds (below 2000 metres)	Stratocumulus	Rough, bumpy, wavy, (but more than altocumulus)	Fair
	Cumulus	Rounded top, horizontal base	Fair
Great vertical height	Nimbocumulus	Black, anvil-shaped thunder cloud	Torrential, convectional thunderous rain

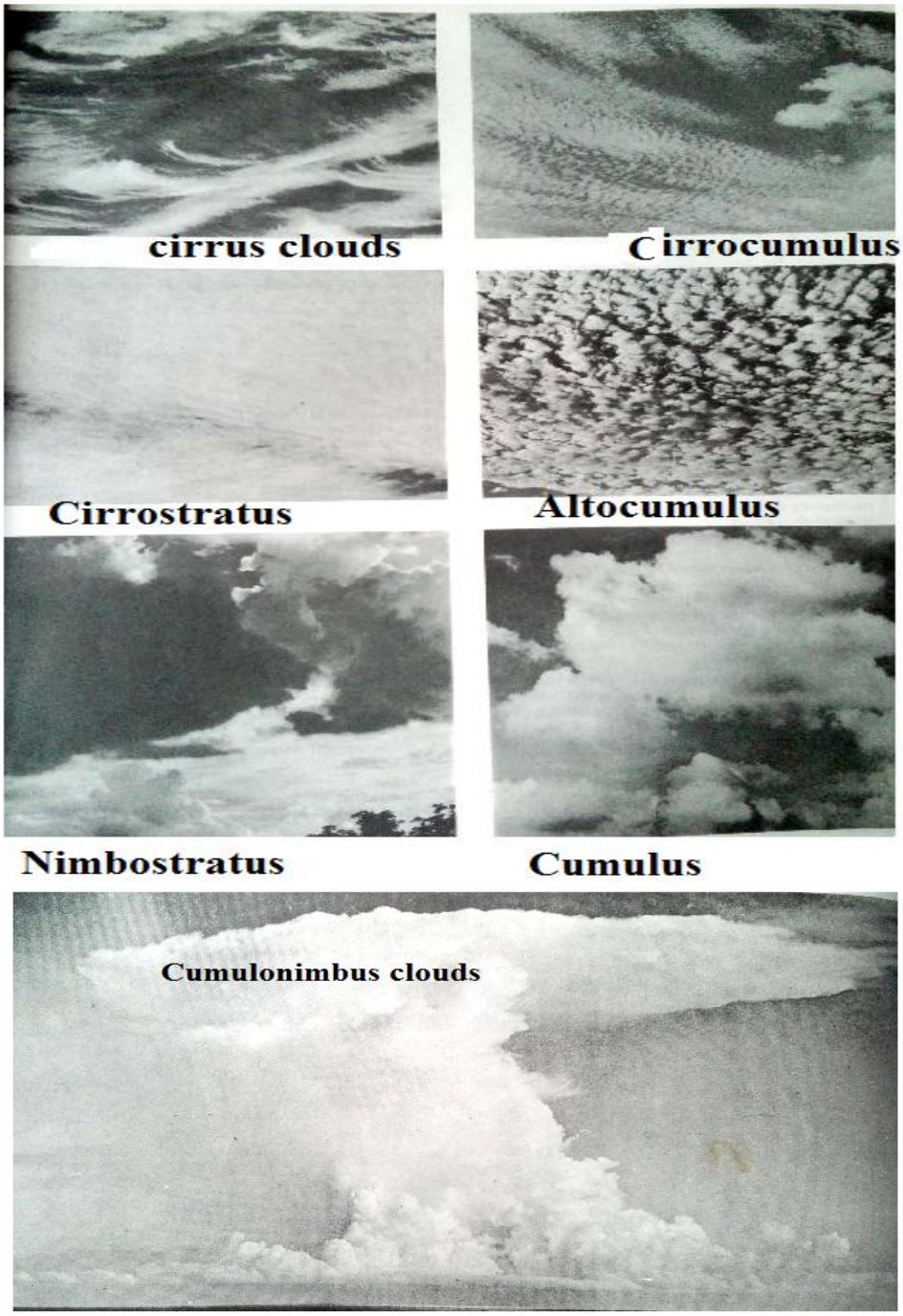
CHARACTERISTICS OF STRATIFORM CLOUDS

- ✓ They are blanket-like.
- ✓ They often cover large areas.
- ✓ They are fairly thin in comparison to horizontal distance.
- ✓ They are composed office crystals.

NOTE: Strati-form clouds are subdivided according to altitude.

- ➢ The **middle** clouds are altostratus and altocumulus. **Alto** means **middle**.
- ➢ If rain or snow is failing from a **stratus cloud**, the name changes to **nimbostratus** or **stratonimbus**.
  - **Nimbus** means **"rain-bearing"**.

Appearance of some clouds



MEASUREMENT OF CLOUD COVER

☞ Cloud cover refers to the fraction of the sky covered by the clouds when observed from a particular location.

☞ An okta is a unit of measurement used to describe the amount of cloud cover at a given location such as a weather station.

☞ 0 oktas means the sky is completely clear, and 8 oktas indicates that the sky is completely covered by clouds. 9 indicates that the sky is totally covered due to fog or heavy snow.

Table indicating cloud-cover measurement

Symbol	Scale	Cloud Cover
	0 Oktas	Clear sky
	1 Oktas	12.5% (sky almost clear)
	2 Oktas	25% cloud cover (scattered clouds)
	3 Oktas	37.5% (sky partly cloudy)
	4 Oktas	50% (sky half cloudy)
	5 Oktas	62.5% cloud cover
	6 Oktas	75% (sky mostly cloudy)
	7 Oktas	87.5% cloud cover
	8 Oktas	100% (sky completely cloudy)
	9 Oktas	Sky obscured from view

IMPORTANCE OF CLOUDS

1) They regulate temperature by reflecting and scattering solar radiation, absorbing and distributing heat.

2) They are a necessary condition for precipitation.

3) (They indicate the type of atmospheric processes. For example, cumulus clouds indicate surface heating.

OCEAN CURRENTS

- Ocean currents are large bodies of surface water that circulate in regular patterns around the oceans.

OR

- An ocean current is a continuous flow of ocean water in a directed and regular pattern.

DRIFT (OCEAN DRIFT)

- It is a wide, and slow-moving ocean current mainly caused by wind.

STREAM

- It is a continuous flow of the current in a specified direction.
- Stream currents occur where an ocean current flows through a constriction (narrow area) between two land masses.
- The velocity of the current increases greatly as it leaves the constriction area.
- An example of a stream is found between Florida and Cuba in America and the Gulf Stream.

Take note that:

- The circulation of the main ocean currents in equatorial and temperate regions is clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere. This is by Ferrel's Law of Deflection.

- They form rings in their circulation called gyros.

TYPES OF OCEAN CURRENTS BASED ON DEPTH

a) Surface ocean currents
b) Deep ocean currents

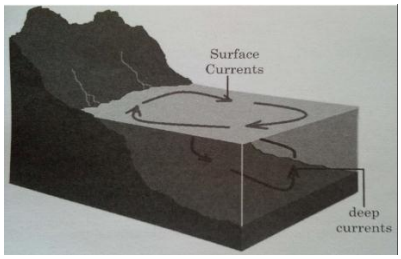
SURFACE OCEAN CURRENTS

- These are horizontal surface circulations of water to a depth of about 400 metres from the surface of the ocean.
- They travel over a very long distance.

DEEP OCEAN CURRENTS

- These are ocean currents that flow beneath the surface below 400 metres.
- They are mainly caused by differences in temperatures and salinity.
- They flow for a short distance.

Surface currents and deep currents



TYPES OF OCEAN CURRENTS BASED ON TEMPERATURE

a) Warm ocean currents
b) Cold ocean currents

Warm ocean currents

- These flow from the equatorial regions pole wards, having high surface temperatures.

EXAMPLES OF WARM OCEAN CURRENTS

IN THE NORTHERN HEMISPHERE	IN THE SOUTHERN HEMISPHERE
☞ North Pacific Drift ☞ Gulf stream current ☞ North Atlantic Drift ☞ Kurosiwo current	i. Brazilian current ii. Mozambique current iii. East Australian current

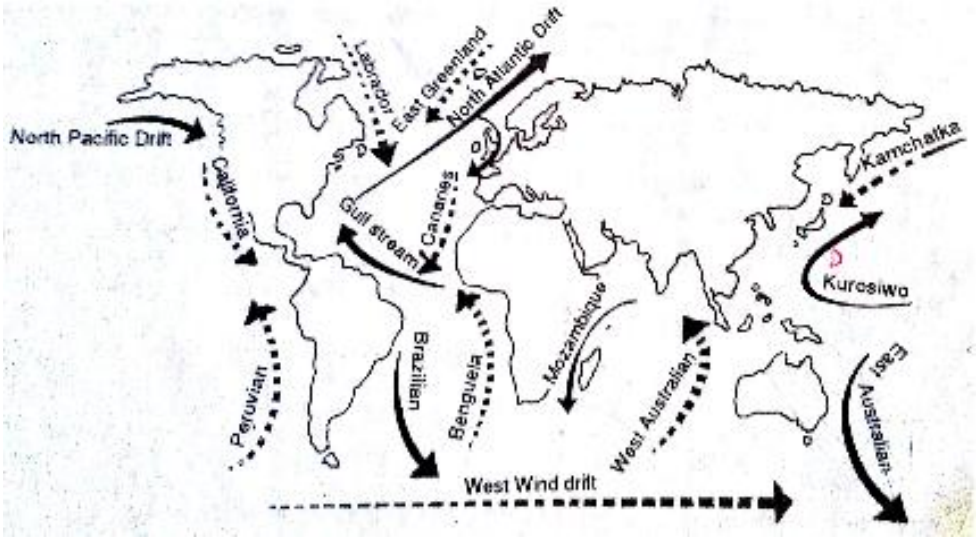
COLD OCEAN CURRENTS

These currents flow from the Polar Regions equator wards, having low surface temperature.

EXAMPLES OF COLD OCEAN CURRENTS

IN THE NORTHERN HEMISPHERE	IN THE SOUTHERN HEMISPHERE
i. Californian current ii. Labrador current iii. East Greenland current (also called Irminger current) iv. Canaries current Kamchatka current	i. Peruvian current (also called Humboldt current) ii. Benguela current iii. West Australian current iv. West Wind Drift

Location of Ocean Currents of the World



CAUSES OF OCEAN CURRENTS

- ✓ Temperature
- ✓ Rotation of the earth
- ✓ Planetary winds (prevailing winds)
- ✓ Salinity

1. Temperature

- ➢ On the one hand, equatorial waters are warmer than polar waters. Warm water is light (less dense), hence, rises. On the other hand, cold water is dense, and sinks and flows equator wards, this creates a current.
- ➢ Ocean currents caused by temperature are called ***convectional currents***.

2. Rotation of the earth

- ➢ Freely moving substances, such as ocean currents are deflected to the right in the northern hemisphere and to the left in the southern hemisphere.
- ➢ This happens due to the Coriolis (geostrophic) force, which is generated as the earth rotates on its axis. This is by ***Ferrel's Law of deflection***.

3. Planetary winds (prevailing winds)

- When prevailing winds blow over the ocean, surface water is pushed in one direction, creating a regular pattern of movement of large masses of water round the ocean. This creates ocean currents.
- Ocean currents caused by planetary (prevailing) winds are called ***drifts***.

4. Salinity

- Water of high salinity (high concentration of salts) is denser than water of low salinity. This makes water of low density to flow on the surface of the denser water, with high salinity.
- This movement creates friction which eventually triggers (causes/starts) an ocean current.

Factors that affect the salinity of ocean water

1) Mixing of ocean water

- Ocean currents that flow from areas of high salinity will tend to increase salinity of water in areas they go and vice versa.

2) Temperature

- Temperatures increase evaporation of water in oceans with high concentration of salts. This means a lot of salts will be left behind. Therefore, the higher the temperatures, the higher the salinity and vice versa.

FACTORS THAT DETERMINE THE DIRECTION OF OCEAN CURRENTS

- ✓ Shape of continents
- ✓ Rotation of the earth
- ✓ Wind direction (prevailing winds)
- ✓ Temperature

1. Shape of continents

- ❖ Ocean currents flow along the coasts of the continents.
- ❖ Land masses obstruct and divert a current.

2. Rotation of the earth

- ❖ Earth's rotation deflects ocean currents to the right in the northern hemisphere and to the left in the southern hemisphere *(Ferrel's Law of Deflection)*. For example, Kurosiwo current deflects to the right in the northern hemisphere, and Brazilian current deflects to the left in the southern hemisphere.

3. Wind direction (prevailing winds)

- ❖ These force the ocean currents to flow towards where the winds are blowing.

4. Temperature

- ❖ Water of high temperature is less dense while water of low temperature is denser. As a result, warm ocean currents (with high temperature) flow from the equator towards the Polar Regions while cold ocean currents (with low temperature) flow from the Polar Regions equator-wards.

EFFECTS OF OCEAN CURRENTS

a) On Climate

- As warm ocean currents move polar wards, they distribute heat from the tropics (equatorial region) to the poles. In this way the climate of those affected Polar Regions is influenced. For example, North Pacific Drift warms the west coast of Alaska and British Columbia, thereby melting the winter ice and this makes Vancouver port ice-free. In addition, the Mozambique current modifies the climate of eastern coast of Africa by raising temperatures.
- Cold ocean currents from Polar Regions distribute coldness to the tropics, influencing climatic conditions of the affected areas in the process. For instance, Banguela current lowers temperatures off the coast of Namibia (Kalahari), where fogs are common.

b) On Fishing

- Major fishing grounds of the world are located where ocean currents meet. For instance:

i. ***The Western Pacific fishing ground***: The cold Kamchatka current meets the warm Kurosiwo current.

ii. ***North Western Atlantic fishing ground:*** The cold Labrador Current meets the warm North Atlantic Drift current.

iii. ***Brazilian warm current:*** Encourages fishing along the coast of Uruguay and Argentina.

iv. Furthermore, when cold and warm ocean currents meet, there is precipitation of minerals which facilitate the growth of microscopic plants (planktons) which are food for fish. This promotes fish breeding.

c) On temperature

- Ocean currents raise or lower temperatures or the regions towards which they flow depending on whether they are warm or cold.

d) On shipping

i. Positive effects

- ❖ Ships will sail following the direction of ocean currents. This eases movement; it leads to less fuel consumption which reduces expenses and transit time (time spent on the way sailing).

ii. Negative effects

- ❖ Currents increase the height of tides and can make ship loading and offloading difficult.
- ❖ The meeting of cold and warm ocean currents creates fogs which impede (obstruct) visibility. This can cause capsizing of ships which results in loss of life and property.

e) Alternative energy

- ❖ Ocean currents carry a lot of energy that is captured and converted into a usable form through the use of water turbines.

IMPACTS (EFFECTS) OF SELECTED OCEAN CURRENTS

a. Brazilian Current

- ✓ It encourages fishing along the coast of Uruguay and Argentina.

b. North Pacific Drift

✓ This warms the west coast of Alaska and British Columbia. This helps melt the winter ice, hence Vancouver Port is ice-free in winter and winters are very mild (moderately warm).

c. Benguela current

✓ It lowers temperatures off the coast of Namibia (Kalahari) where fogs are common.

d. The Mozambique Current

✓ It modifies the climate of eastern coast of Africa by raising temperatures.

e. The meeting of Gulf Stream and Labrador

✓ This leads to formation of dense fogs off Newfoundland.

✓ It also leads to precipitation of minerals for the growth of planktons.

EFFECTS OF OCEAN CURRENTS TO THE COAST THEY BLOW

a) Warm Ocean Currents

- They bring rainfall to the coastal areas.
- They raise temperatures to the coastal regions.
- They provide warmth for the growth of planktons.

b) Cold Ocean Currents

- They lower temperatures of the coastal areas.
- They bring little or no rainfall to the coastal areas.

LAND AND SEA BREEZES

INTRODUCTION

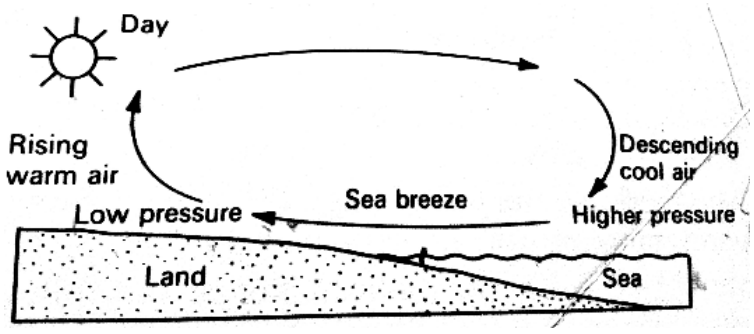
- Generally, air flows from an area of higher pressure to an area of low pressure.
- Land and sea breezes are caused by differential heating of land and water masses.

OCCURRENCE SEA BREEZES

EXPLANATION OF A SEA BREEZE

During the day, land heats up faster than the sea and air molecules above it expands to occupy a large space, and thus exerting a low outward pressure. As a result, air pressure decreases over land. The water in the sea will heat up at a slower rate than the land, making temperature to be lower above the sea than the land. This causes the air above the sea to contract, leading to high pressure. As a result, this causes air to move from the area of high pressure (sea), to the area of low pressure (land), creating a ***sea breeze***.

Sea Breeze

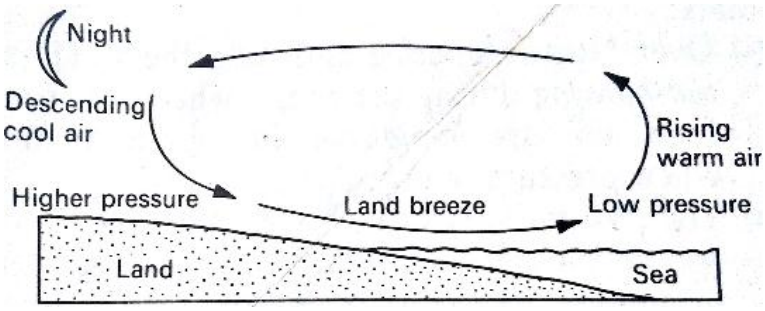


OCCURRENCE OF LAND BREEZES

EXPLANATION OF A LAND BREEZE

During the night, the land cools more quickly than the sea. This makes the air over the land to have a lower temperature and high pressure while the sea cools more slowly than the land. This results in the air above it to have a high temperature and low pressure. This makes the air to move from the area of high pressure (land), to the area of low pressure (sea), creating a land breeze.

A Land Breeze



SUMMARY OF THE OCCURRENCE OF LAND AND SEA BREEZES

During the day, land becomes warmer than the sea. This creates high pressure on the sea than the land. So, air moves from the sea to the land. This is called a ***Sea breeze****.*

During the night, the land loses heat faster and cooled than the sea. This creates high pressure on the land than the sea. So, air moves from the land to the sea. This is called a ***Land breeze.***

INFLUENCE (EFFECTS) OF LAND AND SEA BREEZES

✓ In summer, sea breezes lower the temperatures on the coastal areas. This promotes recreation by adding to the attraction of the shore zones.

Fishermen take advantage of the land breezes and sail out with them. They return the following morning with the sea breezes after fishing.

TOPIC 3: THE ATMOSPHERE

☞ The word atmosphere comes from Greek words **"atmos"** which means *vapour* and **"sphaira"** which means *sphere*.

➢ It is made up a several gases such as Nitrogen (78%), Oxygen (21%), Argon (0.93%), Carbon dioxide (0.03%) and other gases such as neon, Helium, Krypton, Xenon, Hydrogen, Methane, Nitrous oxides form a total of 0.01%.

LAYERS IN THE ATMOSPHERE

❖ It has two main parts as follows:

a) The **lower part**, which is also called the **Homosphere**.

- This extends from the earth's surface to a height of 80 kilometres.
- The chemical composition of the atmosphere is uniform in terms of the ratio of its gases.

b) The **upper part** which is called the **Heterosphere**.

- It is non-uniform in terms of its chemical composition.

THE HOMOSPHERE (LOWER PART) IS DIVIDED INTO:

1) Troposphere
2) Stratosphere
3) Mesosphere

THE TROPOSPHERE

- ☞ It extends from the earth's surface to a height of 13 kilometres.
- ☞ Temperatures decrease almost uniformly with increasing altitude (at a rate of 6.4^{o} per 100 metres). This rate in temperature decrease is called the "Environmental Temperature Lapse Rate".

THE STRATOSPHERE

- ☞ It lies above the troposphere.
- ☞ It extends from 13 kilometres to 50 kilometres.
- ☞ The temperature increases with increasing altitude.
- ☞ This is where the ozone layer that protects the earth's surface from sun's ultraviolet rays is found. Some radiant energy that is reflected back into space due to the ozone layer is called ***Albedo***.

THE MESOSPHERE

- ☞ It is found above the stratosphere.
- ☞ It extends from 50 kilometres to a height of 80 kilometres.
- ☞ Temperature decreases with increasing altitude.

IN THE HETEROSPHERE (UPPER PART) THERE IS:

THE THERMOSPHERE

- ☞ This is the uppermost layer of the atmosphere.
- ☞ It extends from 80 kilometres to a height of about 1000 kilometres above the sea level.
- ☞ Temperatures increase sharply with increasing altitude, hence the name ***"thermo".***

THE THERMOSPHERE IS FURTHER DIVIDED INTO:

a) Ionosphere
b) Exosphere

THE IONOSPHERE

- ☞ In this layer the particles are electrically charged.
- ☞ It begins from 80 kilometres of the earth's surface.
- ☞ The particles of the atmosphere are bombarded by energy from space and form ions and free electrons. These particles help in communications since at night they reflect radio waves.

THE EXOSPHERE

- ☞ It starts from 500 kilometres and extend to about 800 kilometres above the sea level; and extends out into interplanetary space.
- ☞ At these altitudes atoms and ions are far apart.

IMPORTANCE (SIGNIFICANCE) OF THE TROPOSPHERE

1. It regulates (controls) temperatures of the earth's crust. It has gases that absorb long wave radiations which help maintain the optimum temperatures.
2. It helps in diluting and eliminating pollutants suspended in the air.
3. It contains a mixture of gases which are very important for life on earth.
4. It contains necessary features such as water vapour, dust particles and ashes which help in the bringing of rainfall.
5. It contains the ozone layer which filters and prevents the harmful ultra-violet rays from reaching the earth's surface.

TWO MAIN MOVEMENTS OF THE EARTH AND SEASONS

a) Rotation

b) Revolution

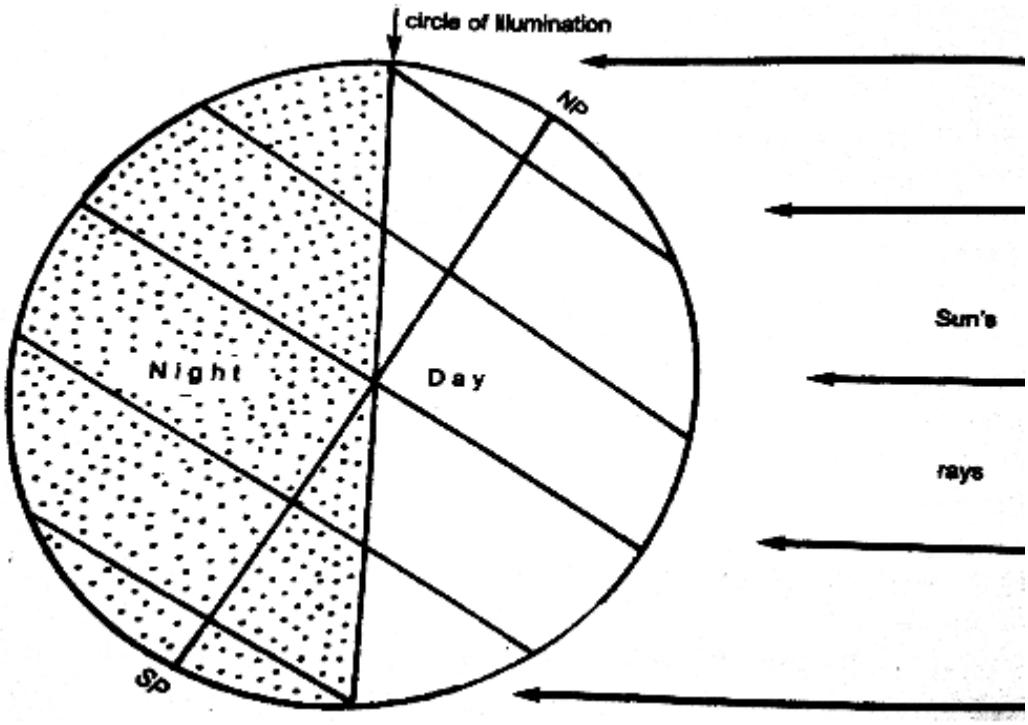
ROTATION OF THE EARTH

- It is the turning of the earth on its axis from west to east once in every 24 hours.
- It causes only one half of the earth's surface to face the sun, making that side to experience daylight, while the side facing away from the sun experiences darkness *(during the night).*
- The earth is tilted at an angle of 23½° on its vertical position.

The Circle of Illumination or Twilight Circle

- This is an imaginary line that separates day from night.

The Circle of Illumination



- The direction of the earth's movement is opposite the apparent movement of the heavenly bodies that seem to be moving from westwards across the sky (this is proof that the earth rotates eastwards).
- Recall that, mathematically, *Speed*$= \frac{Distance\ covered\ (D)}{Time\ taken\ (T)}$, based on this understanding,

- The speed of rotation is calculated as follows:

Speed of rotation= $\frac{\textbf{\textit{Length of a latitude}}}{\textbf{\textit{24 hours}}}$

❖ For example, latitude equator is 40 000 kilometres long, therefore, speed will be:

$= \frac{40\,000km}{24\ hours}$

=1667km/h

RESULTS OF THE ROTATION OF THE EARTH

✓ It causes day and night.
✓ A difference of 1 hour between longitudes that are 15° apart.
✓ Substances are deflected to the right in the northern hemisphere and to the left in the southern hemisphere *(Ferrel's Law of Deflection).*
✓ Daily rising and falling of tides.

REVOLUTION OF THE EARTH

- This is the movement of the earth along its elliptical orbit around the sun in an anti-clockwise direction in 366 or 365¼ days.
- It revolves around the sun at a speed of 30 kilometres per second or 106560 km/hr.
- Since the earth is not perfectly round, there are times when it appears to be close to the sun while sometimes it seems to be far away from the sun.

PERIHELION

- This is the time when the earth appears to be very close to the sun.
- This is when the earth experiences the greatest speed of revolution.
- It is very close to the sun on 31st January every year.

APHELION

- This is when the earth is very far away from the sun.
- The earth experiences the least speed of revolution at this time.
- The earth appears to be far away from the sun on 4th July every year.

ORBITAL PLANE

☞ This is the position at which the earth's orbit meets the centre of the earth.

The earth's orbit is tilted at an angle of 66½° on its orbital plane.

RESULTS OF REVOLUTION OF THE EARTH

1. It causes seasons.
2. It leads to varying lengths of days and nights at different times of the year.
3. It leads to changes in the midday sun's altitude at different times of the year.

SEASONS

☞ Seasons are periods of the year which changes in temperature, weather and lengths of the days.

OR

☞ Seasons are periods of the year that are characterized by some distinct weather and climatic conditions which are experienced for some months.

TYPES OF SEASONS IN THE WORLD

1) Summer
2) Winter
3) Spring

4) Autumn

MAIN CHARACTERISTICS OF SEASONS

SUMMER

i. It has high temperatures.
ii. It receives heavy rainfall.
iii. It has long days and short nights.

(it ends in autumn)

AUTUMN

i. Temperatures start decreasing.
ii. Rainfall starts decreasing.
iii. Day lengths start decreasing and night lengths start increasing.

(it ends in winter)

WINTER

i. It has low temperatures.
ii. It has little rainfall.
iii. It has short days and long nights.

(it ends in spring)

SPRING

i. Temperature starts increasing.
ii. Rainfall starts increasing.
iii. Day hours start increasing and night hours start decreasing.

(it ends in summer)

SOLSTICES

- This means the time when the sun appears to be temporarily over the tropic of cancer or Capricorn.
- This happens as the sun moves in its apparent northward or southward directions.

SUMMER SOLSTICE IN THE NORTHERN HEMISPHERE

- ✓ This happens on the **21st of June** when the sun is overhead on the tropic of cancer.
- ✓ At this time, it is **WINTER SOLSTICE** in the Southern Hemisphere.

SUMMER SOLSTICE IN THE SOUTHERN HEMISPHERE

- ✓ This occurs on the **22nd of December** when the sun is overhead on the tropic of Capricorn.
- ✓ At this time it is **WINTER SOLSTICE** in the Northern Hemisphere.

CAUSES OF SEASONS

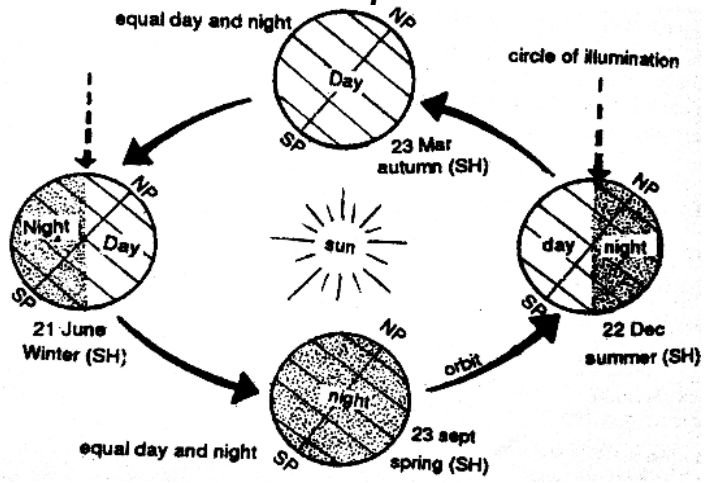
a) The tilting of the earth's axis at an angle of 66½°
b) The apparent movement of the sun

THE TILTING OF THE EARTH'S AXIS AT AN ANGLE OF 66½°

✓ From 21st to 23rd September, the northern hemisphere is tilted towards the sun and it is summer because heat from the sun reaches the ground as it is nearly overhead.
✓ This results in warm and long days.
✓ At this time, the southern hemisphere experiences winter since it is tilted away from the sun.
✓ From 22nd December to 21st March, the northern hemisphere is tilted away from the sun and it is winter season.

✓ At this time, the southern hemisphere has summer because the sun is nearly overhead there and the days are warmer and longer.

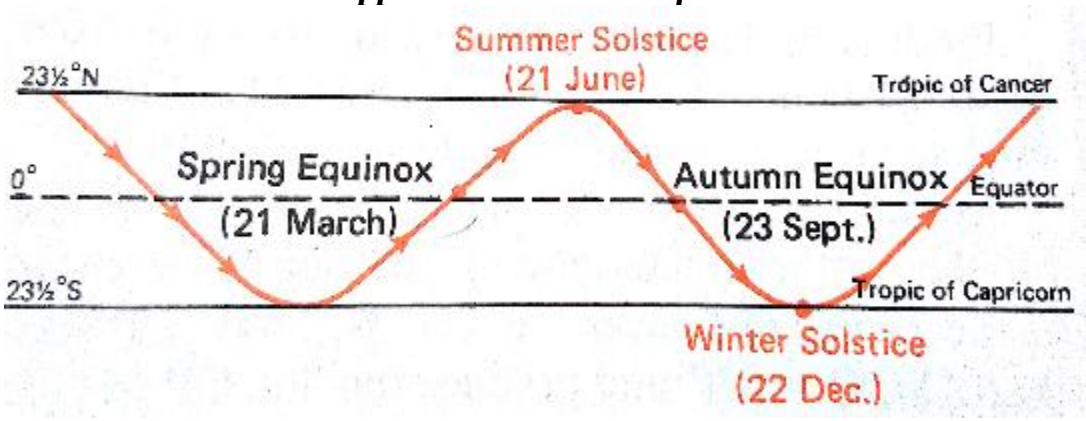
Revolution of the earth



THE APPARENT MOVEMENT OF THE SUN

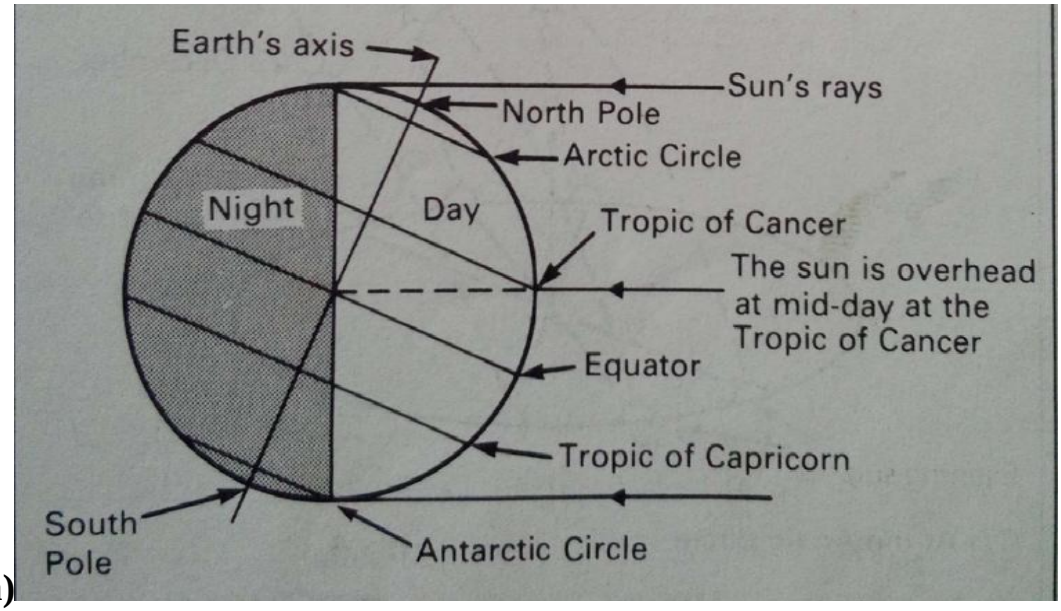
- The sun is overhead on the equator on 21st March and 23rd September every year.
- During this time, the length of days and nights are equal all over the world, thus why these two dates are called ***Equinoxes***, which means "*Equal Days and Nights*".

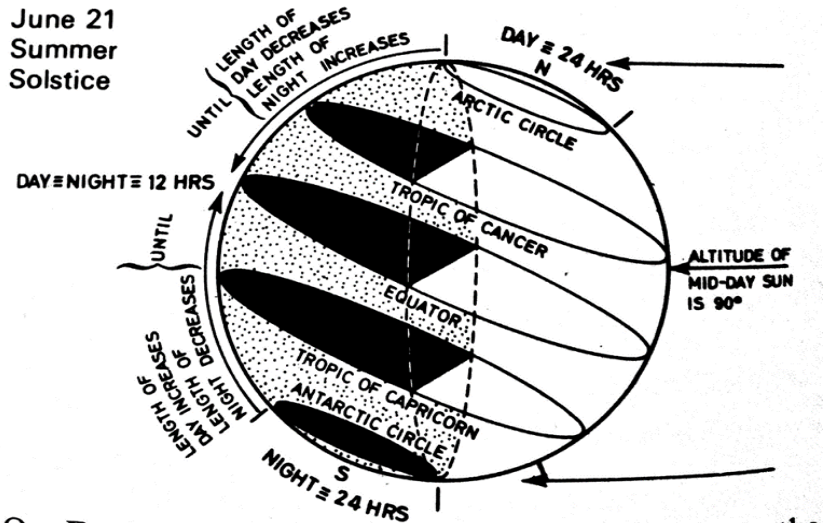
The Apparent Movement of the Sum



Position of the earth in relation to the sun on 21st June

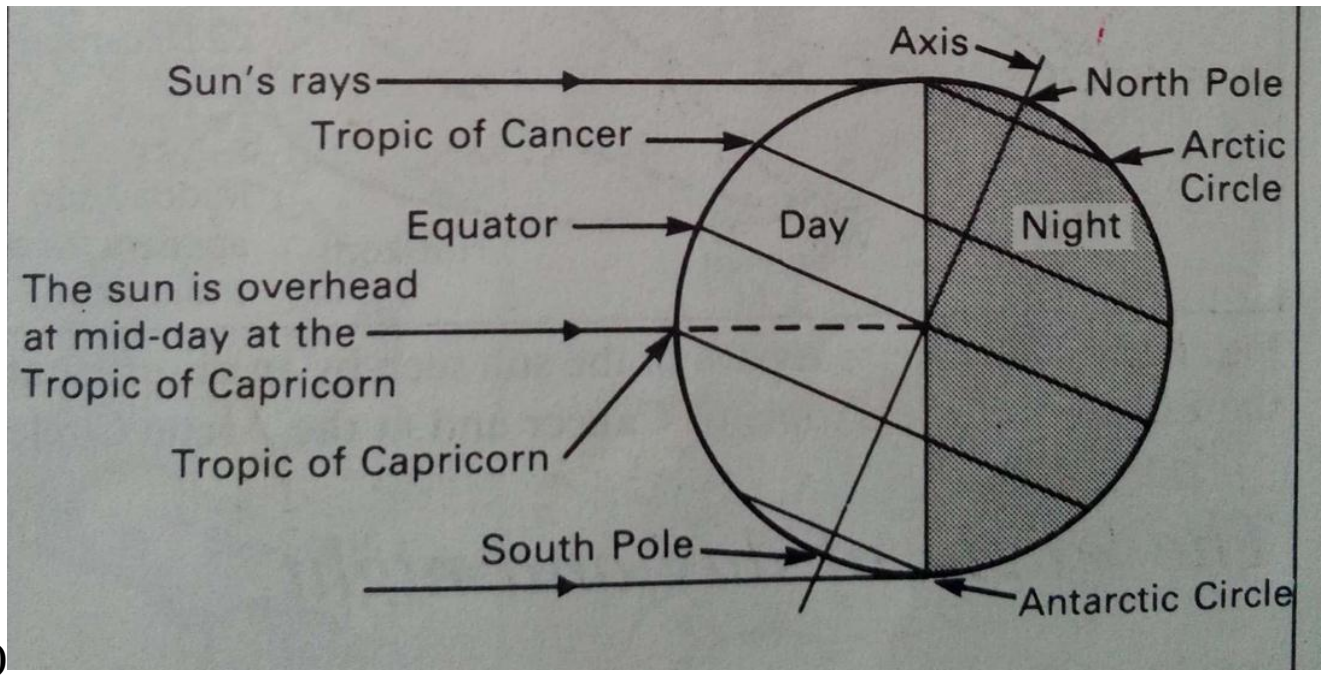
(a)



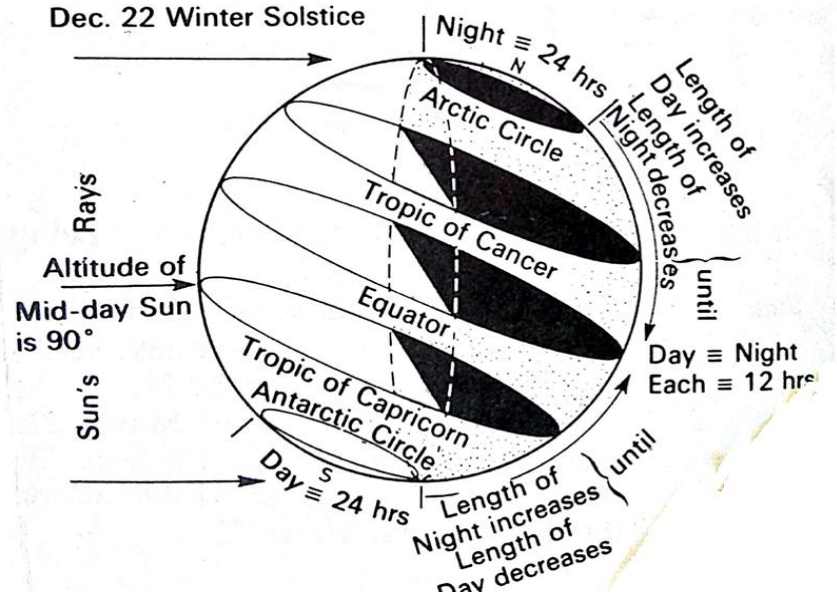


(b)

Position of the earth in relation to the sun on 22nd December



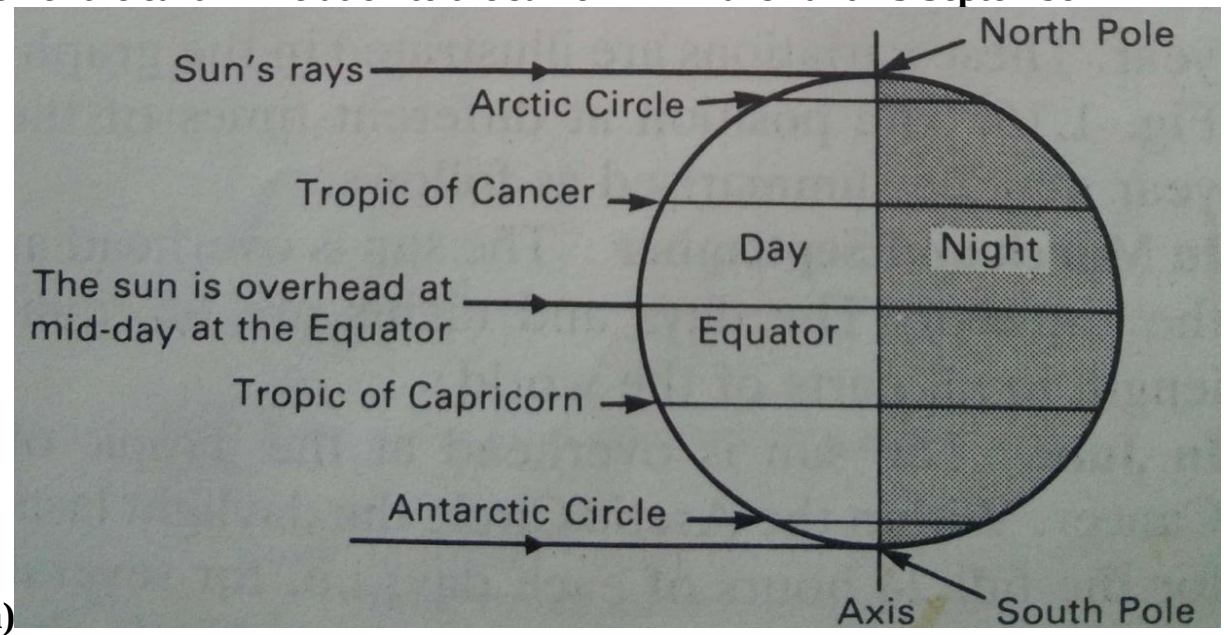
(a)



(b)

Position of the earth in relation to the sun on 21st March and 23 September

(a)



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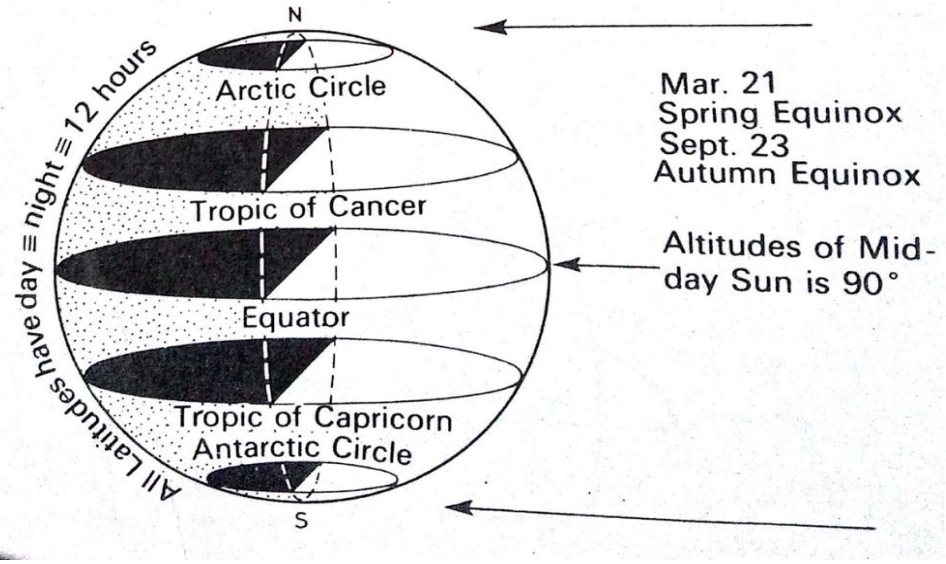


NOTE: *Remember, the two diagrams (a & b) in each case above convey the same information.*

SUMMARY OF WHEN THE FOUR SEASONS ARE EXPERIENCED IN THE TWO HEMISPHERES

NORTHERN HEMISPHERE

SEASONS	MONTHS AND DATES
Summer	21st June
Autumn	23rd September
Winter	22nd December
Spring	21st March

SOUTHERN HEMISPHERE

SEASONS	MONTHS AND DATES
Winter	21st June
Spring	23rd September
Summer	22nd December
Autumn	21st March

From the two tables above, it has been indicated that the two hemispheres experience alternating seasons as follows:

PERIOD	IN THE NORTHERN HEMISPHERE	IN THE SOUTHERN HEMISPHERE
June, July, August	Summer	Winter
September, October, November	Autumn	Spring
December, January, February	Winter	Summer
March, April, May	Spring	Autumn

SEASONS IN MALAWI

- Malawi is located within the tropics where the midday sun varies very little from its vertical position every day.
- As a result, days and nights are almost equal the whole year.

SEASONS IN MALAWI

PERIOD	SEASON
November to April	Hot, wet season
May to July	Cool, dry season
August to October	Hot dry season

CHARACTERISTICS OF SEASONS IN MALAWI

1) Hot wet season

- High temperatures.
- Heavy rainfall.
- Main growing season.
- Vegetation is evergreen.

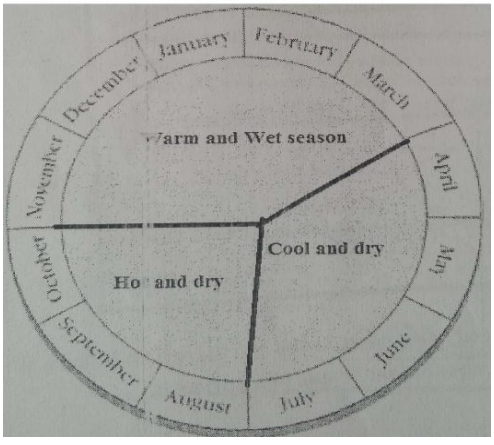
2) Cool dry season

- Low temperatures.
- There is little or no rainfall.
- Trees start to lose their leaves.
- Most organisms hibernate.
- Chiperoni winds are common especially in the southern and central regions of Malawi.

3) Hot dry season

- It has high temperature.
- There are no rains.
- Most vegetation have no leaves to reduce the loss of water through transpiration.
- Organisms start to reappear from hibernation.

Pie Chart Showing Seasons in Malawi



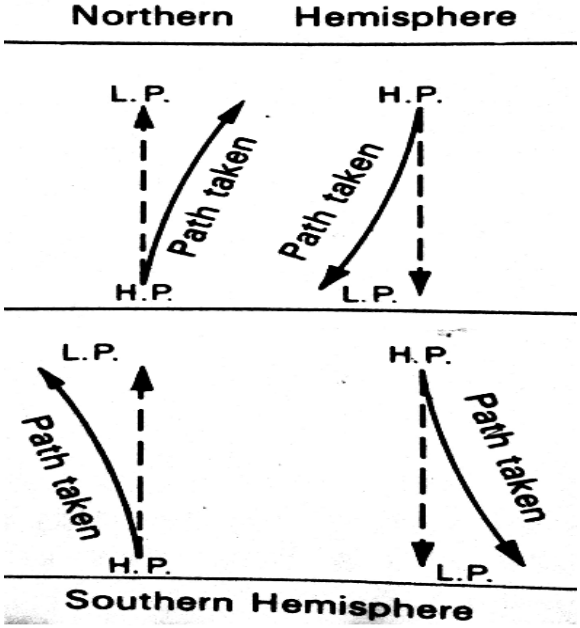
Assignment 1: Pair and Share!!

Draw two pie charts to show the seasons experienced in the world, one for the seasons in the northern hemisphere, and the other for the seasons experienced in the southern hemisphere. The pie chart for seasons in Malawi (above), may guide you. Hint: Each pie chart should have four seasons (thus four parts), and the related months for each season.

PREVAILING WINDS (WORLD WINDS)

- These are winds that blow more frequently in a certain direction in an area.
- The direction taken by these winds is influenced by pressure belts since air or wind moves from the region of high pressure to the region of low pressure.
- Wind direction is also influenced by earth's rotation as discussed earlier on (Ferrel's Law of Deflection).

Direction of Winds in the Northern Hemisphere and in the Southern Hemisphere



THE COMMON PREVAILING WINDS

a) Westerly winds
b) Trade winds
c) Polar winds

WESTERLIES

CHARACTERISTICS OF WESTERLIES

- ✓ They blow from the subtropical high pressure belts polewards to the 60° latitude, both north and south of the equator.
- ✓ In winter they blow southwards in the northern hemisphere affecting the Mediterranean regions.
- ✓ In both hemispheres, they blow from the westerly direction.
- ✓ They are variable in strength (force) and direction.
- ✓ They contain depressions or cyclones that move eastwards.
- ✓ In the southern hemisphere, they are strong and regular all year round over the oceans and they are called ***roaring forties*** *or* ***furious fifties*** *or* ***screaming sixties.***

IMPORTANCE OR EFFECTS OF WESTERLIES

1) They are good in long distance flying. When aeroplanes fly in an easterly direction, the transit time and fuel costs are reduced.

2) They reduce speed and increase fuel consumption when aeroplanes fly westwards (moving against them).

3) They negatively affect shipping by causing accidents, increasing the transit time and increasing fuel consumption when sailing in opposite direction of tides and strong tides created by westerlies.

TRADE WINDS

CHARACTERISTICS OF TRADE WINDS

- They follow regular paths since the ***word*** trade comes from a Saxon word ***tredan*** which means ***tread*** or ***to follow a regular path.***
- They blow from the Horse Latitude to the Doldrums (equatorial low pressure belts).
- They are deflected to the right to become the North East Trade Winds in the Northern Hemisphere and to the left to become the South East Trade Winds in the Southern Hemisphere.
- They are constant in strength and direction.
- They sometimes contain depressions or cyclones.

IMPORTANCE OR EFFECTS OF TRADE WINDS

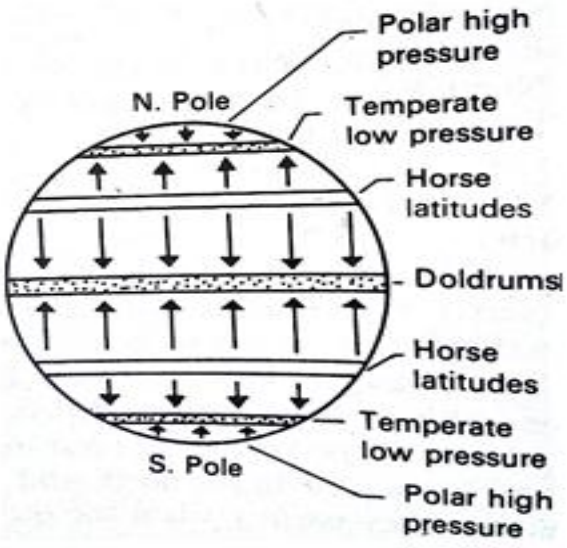
- ✓ They are good belts for westward sailing (on ships).
- ✓ They are associated with steady winds and clear weather which is ideal for mariners.
- ✓ They are sometimes associated with hurricanes or typhoons (tropical storms).

POLAR WINDS

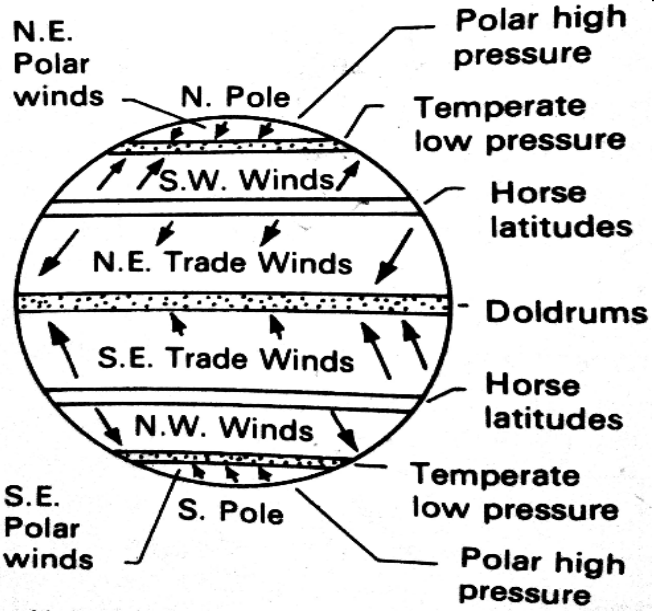
CHARACTERISTICS OF POLAR WINDS

- ❖ They blow from the polar high pressure belts to temperate low pressure belts.
- ❖ They are better developed in the southern hemisphere than in the northern hemisphere.
- ❖ They are deflected to the right to become the North-East Polar winds in the Northern Hemisphere and to the left to become the South-East Polar winds in the Southern Hemisphere.
- ❖ They are irregular in the northern hemisphere.

Pressure Belts and Prevailing Winds on a Non-rotating Globe



Pressure Belts and Prevailing Winds on a Rotating Globe



GENERAL CHARACTERISTICS OF PREVAILING WINDS

i. They blow from the high pressure belts towards the low pressure belts.
ii. They deflect to the right in the northern hemisphere and to the left in the southern hemisphere.
iii. Some of them are irregular in strength and direction.
iv. Some of the contain depressions or cyclones, such as trades and westerlies while others are not such as polar winds.

GENERAL IMPORTANCE OF PREVAILING WINDS

ii. They are good for air and water transport when flying or sailing in the same direction of prevailing winds. They help to reduce the transit time and fuel consumption.
iii. They help to bring about rainfall. For example, the trades bring convectional rainfall in tropics while westerlies and polar winds bring frontal rainfall to temperate low pressure areas.

GENERAL PROBLEMS OF PREVAILING WINDS

i. They are very destructive since they are associated with depressions or cyclones (strong storms).
ii. They slow down the movement of ships when sailing against them, increasing fuel consumption and transit time.
iii. They slow down air transport when flying against them.

LOCAL WINDS

- These are winds that are caused by the immediate influences of the surrounding topography (relief), rather than large scale pressure systems that produce global winds such as westerlies or trades.

SOME LOCAL WINDS

LOCAL WINDS	COUNTRIES WHERE THEY BLOW
1) Chiperoni winds	From Mozambique to Malawi
2) Chinook winds	North America (Canada and USA, from Pacific Ocean)
3) Harmattan winds	North Africa (Niger, Mali, Guinea)

4) Fohn winds	Europe (Italy, Switzerland, Germany)
5) Sirocco winds	North Africa
6) Pampero winds	South America
7) Zonda winds	South America
8) Santa Ana winds	North America
9) Bora	Europe
10) Mistral	Europe
11) Leveche	North Africa
12) Brick fielder	Australia
13) Khamsin	North Africa
14) Southerly Buster	Australia
15) Berg winds	South Africa

CHARACTERISTICS AND EFFECTS OF SOME LOCAL WINDS

a) CHIPERONI

- It originates from Mozambique (Indian Ocean), and mostly it affects the shire highlands in Malawi.
- It is caused by the movement of the inter-tropical convergence zone (ITCZ) to the northern hemisphere.

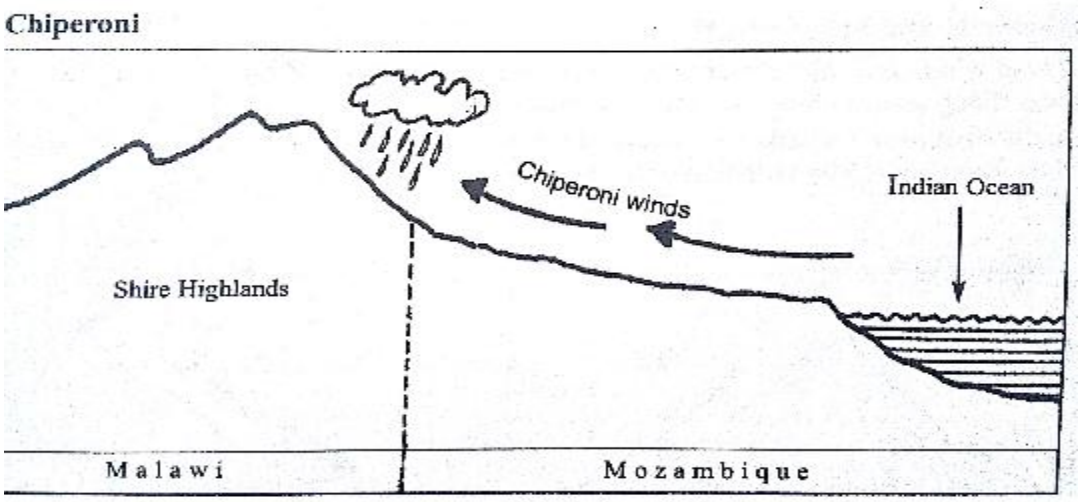
CHARACTERISTICS OF CHIPERONI WINDS

- ✓ It is warm.
- ✓ It is moist.
- ✓ It is common from May to August.

EFFECTS OF CHIPERONI WINDS

- It brings about persistent low clouds (stratus) which can sometimes bring drizzles in the southern part of Malawi, especially in Mulanje, Thyolo and Blantyre.
- It also brings "Mwera" on Lake Malawi.

Chiperoni Winds



b) CHINOOK WINDS

- Chinook means **"Snow-Eater"**.
- It originates from the Pacific Ocean and it blows across the Rockies Mountains in Canada and U.S.A.

CHARACTERISTICS OF CHINOOK WINDS

- ✓ They descend over Rockies Mountains.
- ✓ They are warm.
- ✓ They are dry
- ✓ They bring orographic (relief) rainfall to the western side of Rockies Mountains.
- ✓ It is commonest in spring and winter.

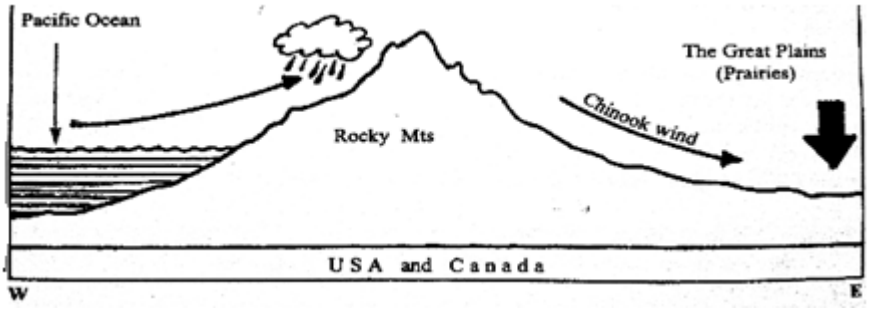
EFFECTS OF CHINOOK WINDS

- They bring relief rains to the western side of Rockies Mountains, and little or no rains to the eastern side of Rockies Mountain.
- Since it is warm, it raises temperature. ***It is therefore capable of melting and drying winter snow***. This is why it is called the **Snow Eater**.

ECONOMIC IMPORTANCE OF CHINOOK WINDS

- ❖ It promotes animal keeping in regions from Southern Colorado in USA to North of Mackenzie River in Canada since it makes pastures available.

Chinook Winds



c) HARMATTAN WINDS

- It blows from the Sahara Desert to the Western Coast of Africa.

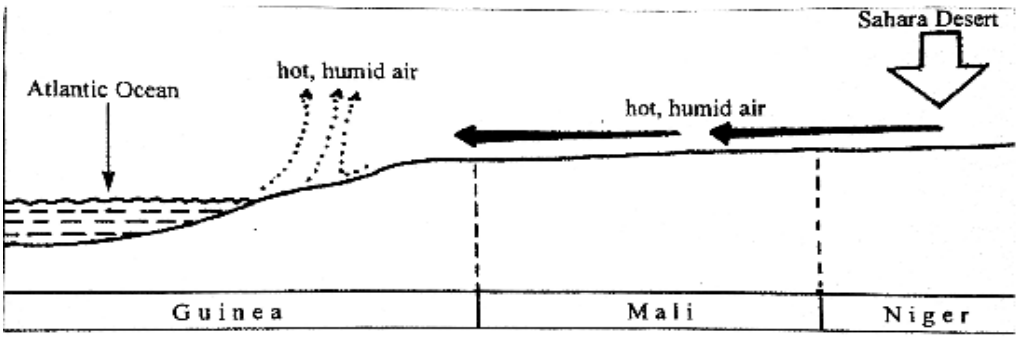
CHARACTERISTICS OF HARMATTAN WINDS

- ✓ It is hot.
- ✓ It is dry.
- ✓ It is dusty.
- ✓ It is capable of splitting trunks of trees and it also damages crops.

EFFECTS OF HARMATTAN WINDS

- ***They bring hot air to the area they blow***. For example, Guinea receives a lot of rainfall since the incoming of hot air encourages evaporation. This is why **Harmattan Wind** is also called **The Doctor wind.**
- It damages crops in the far inland.

The Harmattan Wind



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d) FOHN WINDS

- It blows down the leeward slope of Northern Alps Mountains (a fold mountain in Switzerland).

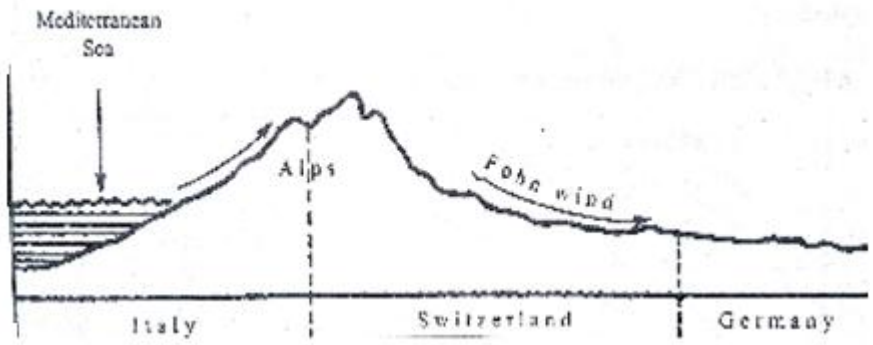
CHARACTERISTICS OF FOHN WINDS

✓ It is warm.
✓ It is dry.

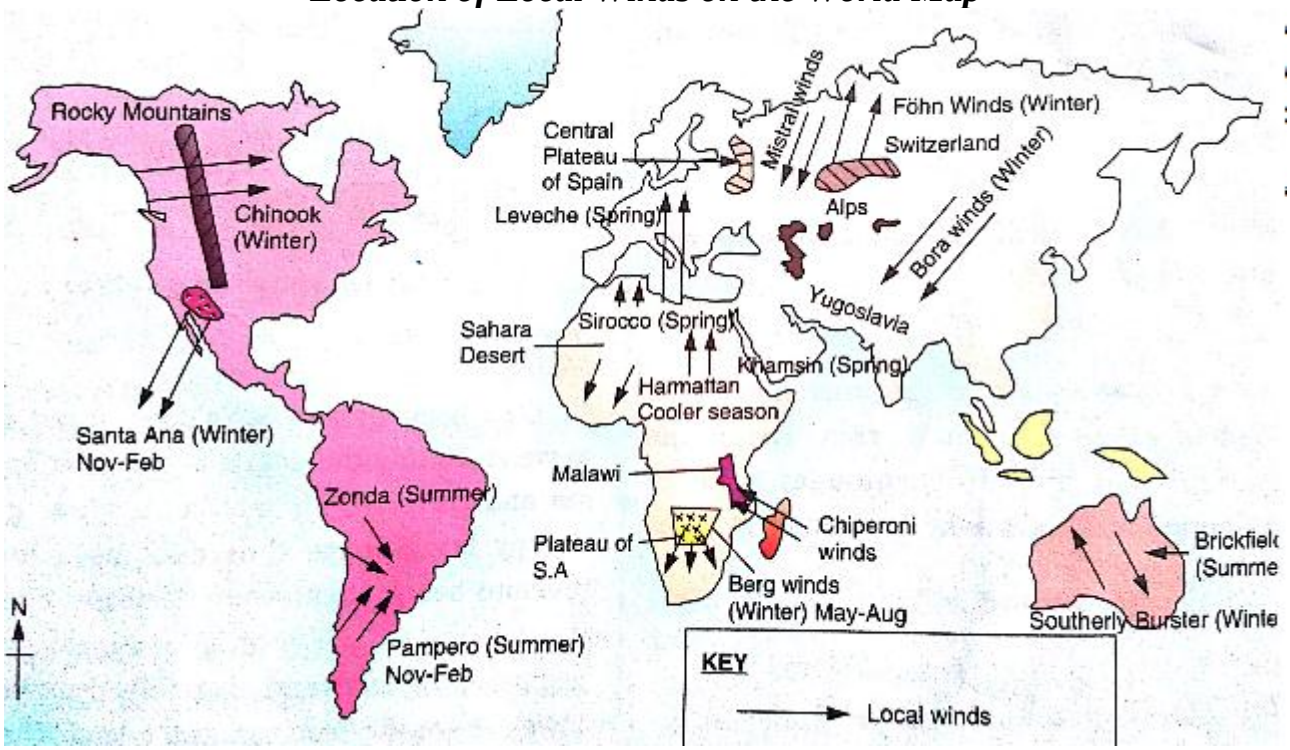
EFFECTS OF FOHN WINDS

- It capable of melting snow because it raises temperatures from 8°C to 11°C.
- Trees and houses become excessively dry, avalanches may occur.
- In Northern Switzerland in spring, it is useful in melting winter snow from the pastures.
- In autumn in northern Switzerland, it is useful in ripening crops especially grapes.

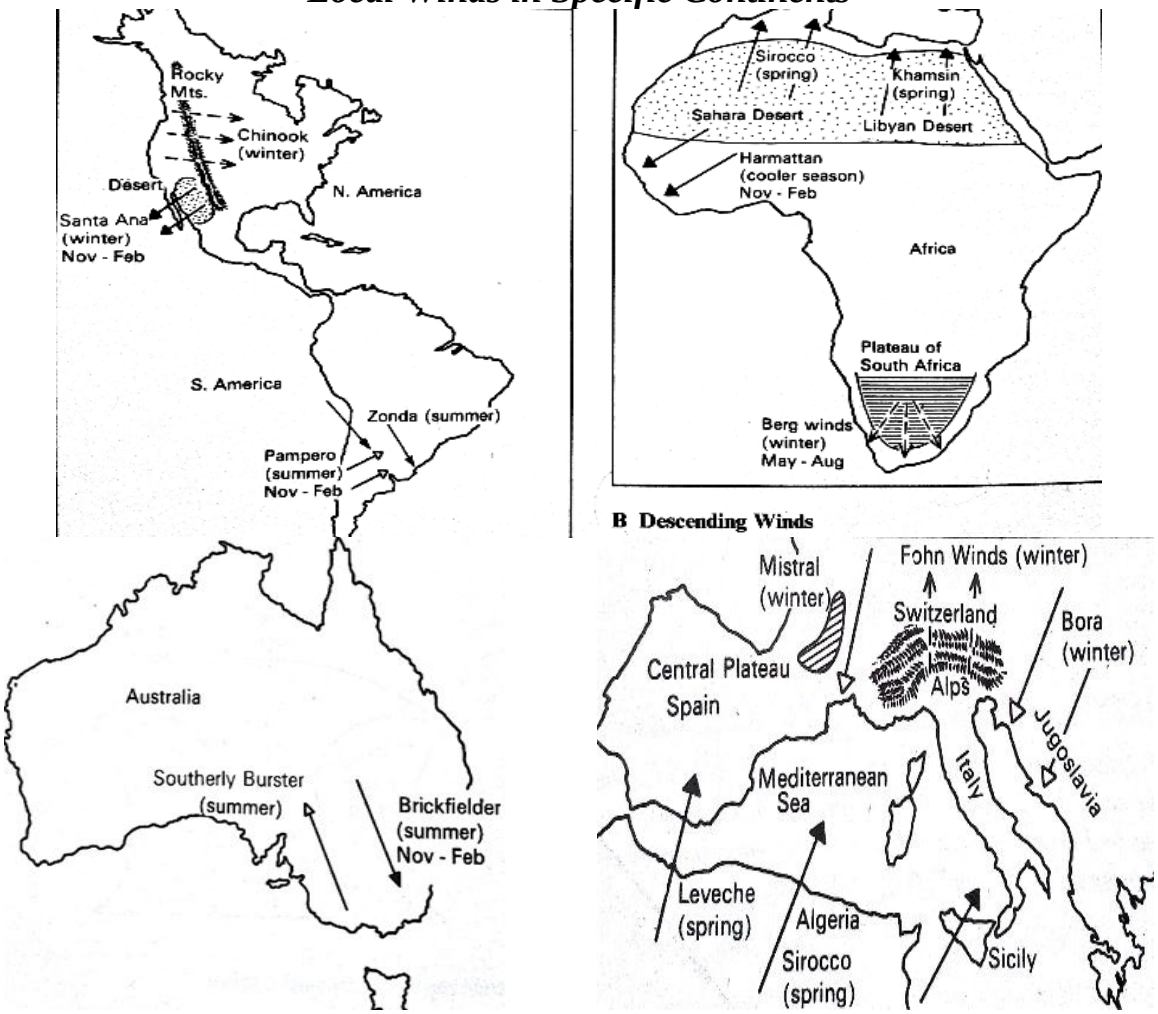
The Fohn Winds



Location of Local Winds on the World Map



Local Winds in Specific Continents



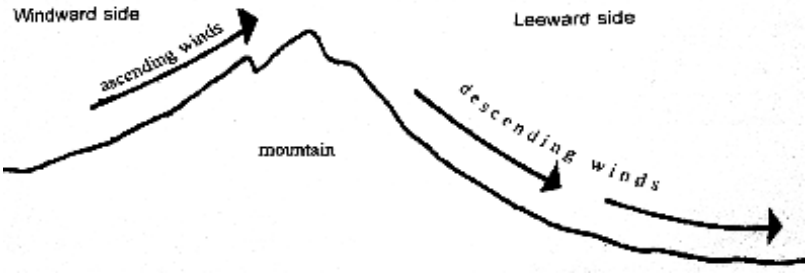
DRAINAGE WINDS

- These are winds that blow from higher to lower regions under the influence of gravity (mostly, cold air).
- They are called "katabatic" winds.
- They are common in many mountains of the world, being known by many different names as follows: **Bora** in Northern Adriatic Sea Coast and ***Mistral*** in Southern France.

DESCENDING WINDS

- These are winds caused when strong regional winds pass over a mountain range descend on the leeward side.
- This happens since when the air is heated, it expands and rises.
- Examples of descending winds include **Chinook** and **Fohn**.

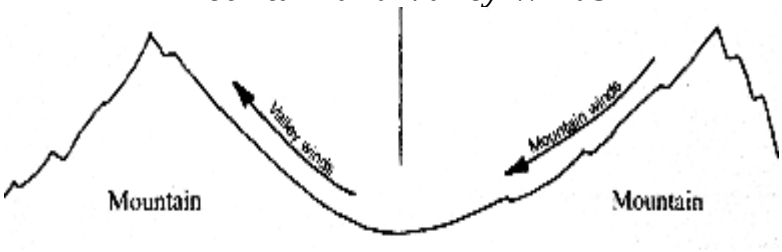
Descending Winds



MOUNTAIN AND VALLEY WINDS

- These are called "**anabatic**".
- During the day, air moves from the valley upwards over rising mountain slopes when the slopes are greatly heated.
- At night, air moves towards the valley, down the slopes when the slopes have been cooled by radiation of the heat from the ground to the air.

Mountain and Valley Winds



ENVIRONMENTAL IMPORTANCE OF LOCAL WINDS (OR EFFECTS OF LOCAL WINDS)

i. They negatively put a stress on plants and animals since they can be extremely dry, hot or cold.
ii. They affect the movement of pollutants such as pollution fumes far from their sources.
iii. Some local winds lower the temperatures of the coast they blow to.
iv. They have a moderating effect on the environment (the doctor winds), such as Chinook, Fohn and the land and sea breezes in summer.

DIFFERENCES BETWEEN LOCAL WINDS AND PREVAILING WINDS

i. Local winds are caused by the immediate influence of the surrounding topography while prevailing winds are caused by pressure belts.
ii. Local winds affect small areas while prevailing winds affect very large areas.
iii. Local winds have local names from the areas where they exist while prevailing winds have global names.

AIR MASSES AND FRONTS

An air mass is a large body of having uniform temperature and humidity throughout its surface layers.

- Air masses form over cover areas of the earth's surface where conditions remain the same fir long periods time.

FACTORS THAT AFFECT THE CHARACTERISTICTS OF AIR MASSES

1. The nature of the underlying surface: this determines the moisture content of the air mass e.g.

- Overland
- Over sea

2. Latitudinal position of the source area: this determines the temperature characteristics

❖ **Contrast** –Tropical air masses from polar air masses.

CLASSIFICATION OF AIR MASSES

Air masses are classified according to the following:

1. Latitudinal position of the source region. According to this, air masses are classified as:

1) **Polar air mass (p):** These originating from near the Polar Regions. Such air masses are cold or very cold.
2) **Arctic (A) or Antarctic (AA) air mass:** These air masses originate over the cold Arctic and Antarctic regions.
3) **Tropical air masses:** These originate from lower latitudes near the equator and warm.

2. These nature of the underlying surface: This, air masses are classified

1) **Continental (C) air mass**

☞ These originate from land masses and are generally dry.

2) **Maritime (M) air mass**

☞ These originate from over water (see and oceans) and are generally moist.

THE MAIN TYPES OF AIR MASSES AND THEIR ASSOCIATED WEATHER

Continental Polar (cP) or Continental Arctic (cA)

- ✓ These originate from polar landmasses such as Siberia, northern Canada, Alaska and Antarctica.
- ✓ The air masses are cold and dry.
- ✓ They have high pressures and the air is stable.
- ✓ There are few clouds and the weather is dry, sunny and mild.
- ✓ The air masses may become unstable when they blow towards the tropics.

Maritime Polar (mP)

- These originate from cold polar seas.
- As they pass over the ocean, they pick up moisture.
- They tend to be cold, not as cold as continental polar.
- They are moist.
- As they blow towards lower latitudes, they become unstable and can cause precipitation to occur.

Arctic (A) or tropical (AA):

- ✓ These originate in the arctic and Antarctic regions.
- ✓ The air masses are similar to continental polar air masses. The only difference is that they originate over the permanent ice cap near the north or south poles.
- ✓ They are bitterly cold making the weather very cold.

Continental Tropical (cT)

- ✓ These originate from tropical land masses in lower latitudes.
- ✓ The areas experience intense heart but there is little water to draw from to make the air more humid.
- ✓ The weather is hot, dry with clear skies.
- ✓ These air masses usually originate from tropical deserts and high plains.

Maritime Tropical (mT)

- ✓ These originate from the tropical oceans.
- ✓ The air tends to be warm, moist and usually unstable.
- ✓ Summer weather may be hot and muggy with hazy sunlight and scattered thunderstorms in afternoon.
- ✓ Winter weather may be warmer and damper.

Maritime Equatorial (mE)

- ✓ These originate over the equatorial oceans or water bodies.
- ✓ The air moist and hot and therefore very unstable.
- ✓ This results in heavy rainfall.

NB: Air masses do not remain permanently in its area of origin. They move from one area to another.

As they move, they are exposed to new surface conditions which modify their temperature, humidity and stability.

STABLE AND UNSTABILLE AIR MASSES

STABLE AIR MASSES

- ✓ A stable air mass is one which relatively cool and denser than the air surrounding it.
- ✓ This air resists rising and remains in place.
- ✓ There is poor surface visibility due to smoke, dust and other particle trapped near the surface.
- ✓ The weather also has low stratus clouds which settle on the ground as fog.

UNSTABLE AIR MASSES

- ✓ As unstable air mass is air that is warmer than its surrounding air and so rises easily.
- ✓ The rising air encourages convection currents to rises to great height. This may cause large quantities of vapour to condense to give shower or thunderstorms.

Unstable air masses creates the following weather conditions:

- ➢ Vertical cumulonimbus clouds that product heavy showers or thunderstorms.
- ➢ Severe turbulence or convection activity.
- ➢ Good surface visibility.

Airmasses and their properties

AIRMASS	*SYMBOL*	*PROPERTIES*	*TEMP (°C)*	*SOURCE*
Continental Arctic	cA	Very cold, very dry	-46	Arctic ocean nearby lands
Continental Antarctic	cAA	Very cold, very dry	-46	Antarctic ocean
Continental polar	cP	Cold, dry (winter)	-11	Continents (50-60° N,S)

Maritime polar	mP	Cool, moist (winter)	4	Oceans (50-60 ° N,S)
Continental tropical	cT	Warm, dry	24	Continents (20-35°N,S)
Maritime tropical	mT	Warm, moist	24	Oceans (20-35°N,S)
Maritime equatorial	mE	Warm, very moist	27	Oceans close to equator

FRONTS

- A front is a zone or a boundary in the atmosphere that separates two masses of air of different characteristics in terms of temperature or moisture content.

TYPES OF FRONTS

The classification of fronts depends no:

1) **The direction in which the air mass in moving and**
2) **The characteristics of the air mass.**

COLD FRONT: This is a zone separating two air masses where the cold air mass is pushing into a warmer air mass.

- ✓ The air behind the cold front is colder and drier than the air a head of it, which warm and moist.

CHARACTERISTICS OF COLD FRONTS AND THE WEATHER

a) They have steep slopes.
b) They move faster than all other fronts.
c) They have extremely tall clouds of great vertical extent.
d) They have the most violent weather of thunder and lighting. They also from squall lines.
e) They have heavy rainfall which only lasts for short periods of time.

NOTE: On a weather map, a cold front is drawn as a line with triangles.

A cold front

WARM FRONT

- It is a zone where a warm air mass is pushing into a cold air mass.

✓ The warm air slides up over the cold air.
✓ The air behind a warm front is warm and moist while that ahead of it is cooler and less moist.

CHARACTERISTICS OF WARM FRONTS AND THE WEATHER

- ✓ They have gentle slope.
- ✓ They tend to move slowly.
- ✓ They are less violent than cold front.
- ✓ They have widespread and continuous precipitation.
- ✓ The cold range from low stratus to middle level and high level clouds.

NOTE: On a map, a warm front is drawn as a line with semi-circles.

A warm front

OCCLUDED FRONT

- These front occur when a fast moving cold front catches up and overtakes slow moving warm front.
- It is formed when a cold surrounds the cold air and eventually lifts is up completely from the ground, on a weather map , an occluded front is indicated as a line with alternating semi circles and triangles.

Occluded fronts are of two types:

- **Cold occluded front.**
- **Warm occluded front.**

An occluded front

STATIONARY FRONT

- This is a zone where air masses air not moving against each other. Neither of the air masses is strong enough to push into the other.

- ✓ The air masses may move parallel to the boundary producing weak winds and prolonged rainfall.
- ✓ Neither of the air masses is strong enough to push into the other.

NOTE: On a weather map, the stationary front is represented by a line with alternating triangles and semi-circles facing opposite directions.

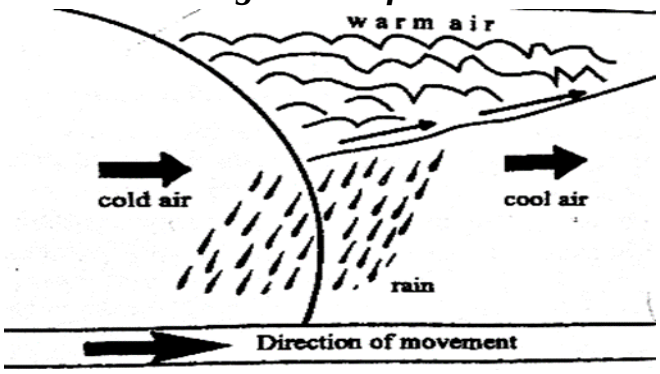
A stationary front

DRYLINE

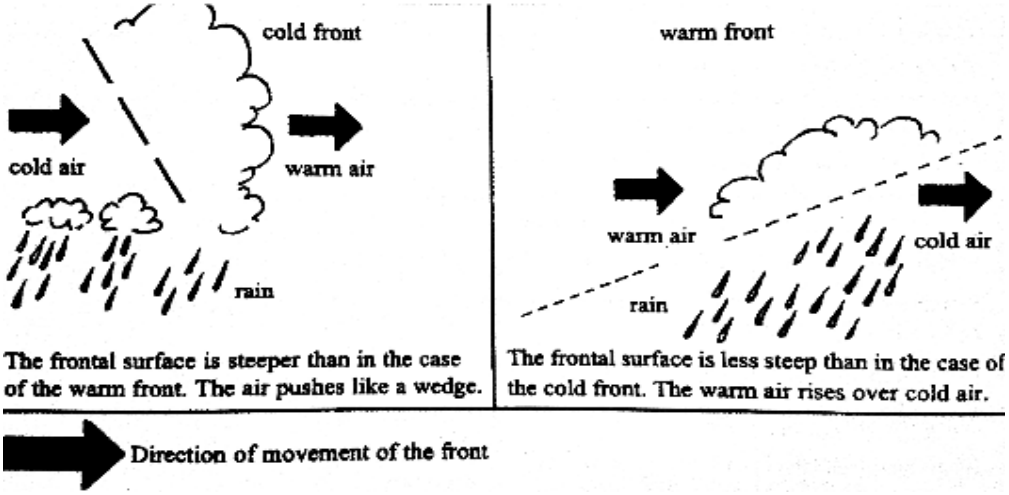
- This is a boundary that separates a warm moist air from a hot dry air.

✓ It is common in areas where dry continental tropical air meets maritime tropical air.
✓ There boundaries have intense thunderstorms, rain and tornadoes.
NOTE: On a weather map, it is represented by a dashed line.

Section through a cold front occlusion



Cold and warm fronts



IMPORTANT FRONTS IN GLOBAL WEATHER

1) POLAR FRONT

- This lies between polar air masses and tropical air masses.

2) INTER TROPICAL FRONT (ITCZ)

- This lies between N.E trades and S.E. trade wind belts.

THE INTER-TROPICAL CONVERGENCE ZONE (ITCZ)

- It is also called the meteorogical equator or the equatorial trough.

➢ This is an area where air masses meet and is indicated by the apparent movement of the sun.
➢ It is a zone of low pressure which is created because of high temperatures. Due to the low pressure, a conducive environment is created where air of different characteristics meet.

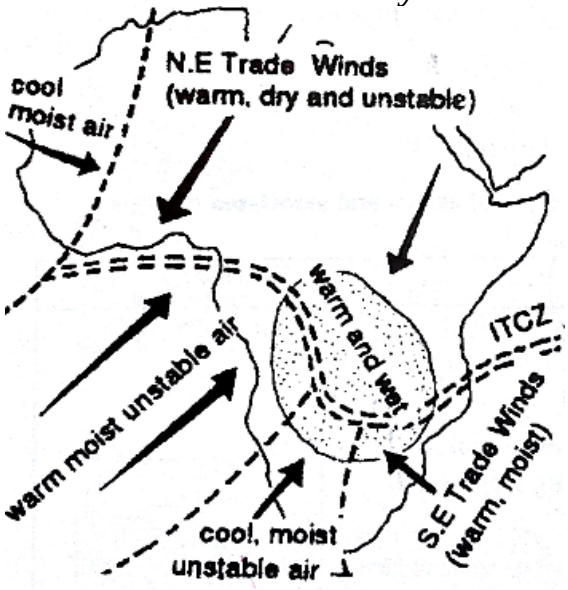
FORMATION OF THE ITCZ IN AFRICA

2) IN JANUARY

- The warm dry stable air from the land, north of the low pressure zone (North East trade winds) and the moist unstable maritime air from the Atlantic and Indian Ocean (South East trades) and the Zaire air meet.

- Such meeting makes the moist air to rise over the warm stable one, resulting in rainfall.

ITCZ in January



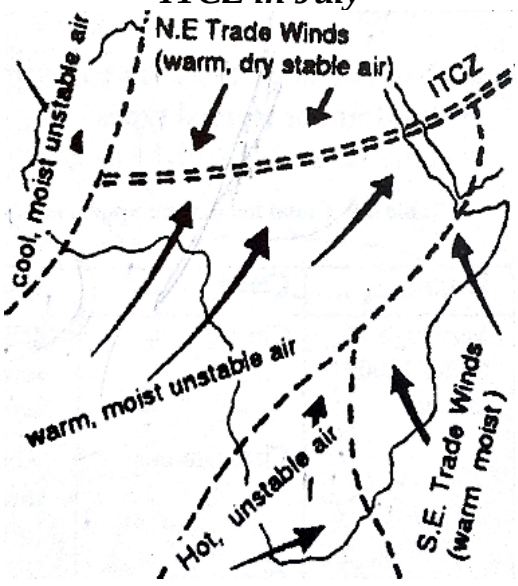
3) IN JULY

- The ITCZ shifts to the North.
- The warm moist air from the Atlantic (west coast), meet the warm dry stable air from the land North of Africa, including Sahara.
- This leads to rainfall.

TYPES OF RAIN EXPERIENCED IN THE CONVERGENCE ZONE

- Cyclonic rainfall
- Convectional rainfall.

ITCZ in July



NOTE:

- The type of rainfall experienced in Central Africa is largely influenced by the ITCZ, and if it fails to form in the area, droughts may occur.

ITCZ AND RAINFALL

✓ Rainfall can be predicted by studying the position of the ITCZ, especially in Central Africa.

✓ In Africa, rains are expected to be good if the ITCZ is positioned between Mid-Tanzania and Southern Zimbabwe.

✓ Any disturbing conditions that would increase pressure would lead to poor distribution of rainfall.

EFFECTS OF THE ITCZ

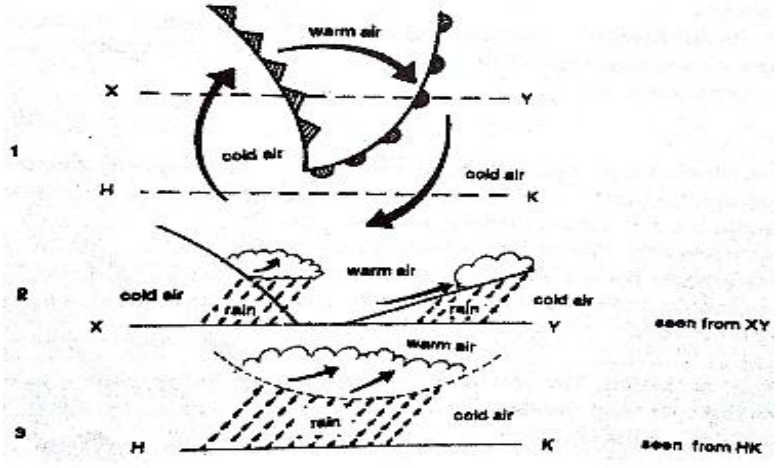
i. The affected areas are marked by line squalls which produce drier hot air that forces it to rise.

ii. The skies are filled with small white cumulus clouds, temperatures slightly drop and warm moistness replaces dry conditions.

iii. Winds veer (change direction) from north-east to south-west and gusty winds bring rain showers.

❖ Gradually cumulonimbus clouds accompanied with lightning, thunder and heavy rains develop.

Influence of fronts on weather

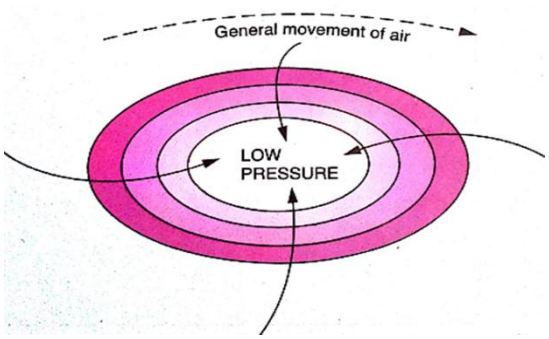


CYCLONE AND ANTICYCLONES

CYCLONES

- It is a region in which the atmospheric pressure is high at the Centre.

A Cyclone



TYPES OF CYCLONES

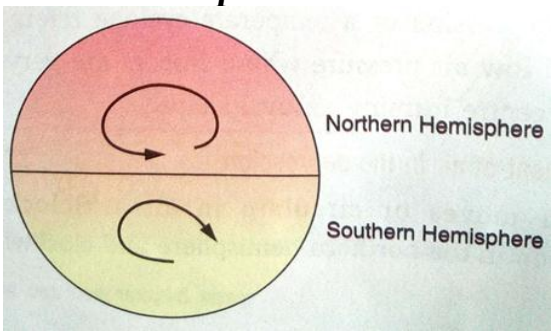
1. Temperate cyclones (depressions)

2. Tropical cyclones

TROPICAL CYCLONES

- A tropical cyclone is a storm generated by a low atmospheric pressure system in which isobars are closely spaced and they form a circular shape.

Cyclone in the Northern Hemisphere and in the Southern Hemisphere



AREAS WHERE CYCLONES DEVELOP

- In tropics between 5° to 30° North and South of the equator (in the westerly winds belt), where north east trade winds and the south east trade winds meet, ***along the inter-tropical front***.
- In the temperate latitudes of 60° North and South of the equator (in the trade winds belt).

NOTE: In these areas, humid tropical air meets cold polar air.

GENERAL CHARACTERISTICS OF A CYCLONE

i. It originates over oceans in tropic in summer.
ii. Once formed it moves westwards.
iii. Its rotation is clockwise in the southern hemisphere and anti-clockwise in the northern hemisphere (Buys Ballots Law).
iv. It does not occur in the regions within about 5° of the equator because of the weak coriolis force. It develops between 5° and 20° north and south of the equator.
v. It is smaller than a temperate depression and is centered around an area of extremely low air pressure.
vi. It is accompanied by heavy rainfall and showers which cause a lot of damage due to strong winds and floods.
vii. Its source of energy is the large amount of latent heat freed as moist tropical air condenses.
viii. Warm moist air is drawn into the low pressure centre from a large area over the ocean.
ix. Air spirals upwards, with great low pressure in the centre.

REASONS WHY A CYCLONE ROTATES

- Air at the centre is light (has low pressure) and it rises.
- The surrounding air is heavier (has high pressure), so it flows inwards.
- As the heavier air flows inwards, the rotation of the earth makes it swirl.

LIFE CYCLE OF A CYCLONE

- The development of cyclones goes through four main stages as follows:
  a) Formative stage
  b) Immature
  c) Mature stage } *Growth stage*
  d) Degenerative stage

1) FORMATIVE STAGE

- This is the birth of a cyclone.
- Two air masses meet at an inter-tropical front, one a warm air mass (in an easterly direction) and the other a cold air mass (in a westerly direction). The air pressure falls greatly at the centre to less than 1000kp.
- One air mass is lifted upon the other. Upon rising, the air expands and cools, and its moisture condenses to produce heavy rainfall.
- Condensation frees latent heat which makes the cyclone to rotate.

2) GROWTH STAGE

a) Immaturity Stage

- Air pressure in the centre continues to fall (below 1000kp).
- The winds reach hurricane strength.
- The area affected is small (30-50km in diameter).

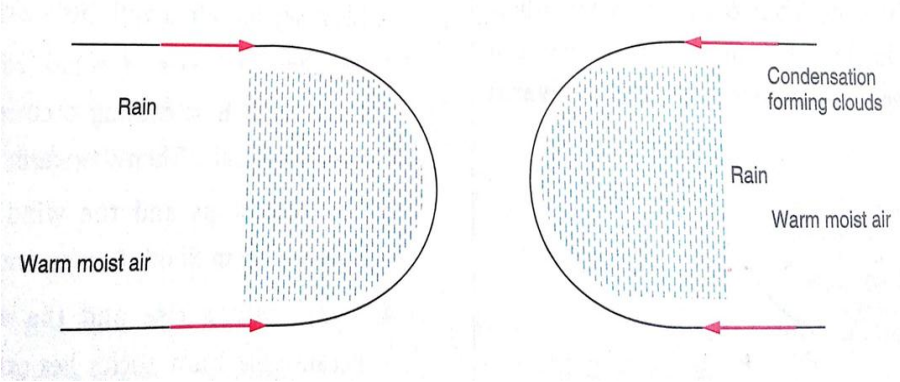
b) Maturity Stage

- The air pressure has stopped to drop.
- The area affected increases sharply.

3) DEGENERATIVE STAGE

- This is the dying out of a cyclone.
- It happens when the cyclone reaches the land.
- Air pressure in the centre rises and the area affected is reduced.
- The system dies out completely because their supply of moist air is cut off.

Development of a Tropical Cyclone



CONDITIONS NECESSARY FOR THE DEVELOPMET OF A TROPICAL CYCLONE

i. An abundant source of warm moist air of temperature of about 27°C near to sea surface.
ii. Air must be blowing inwards towards the centre and rising rapidly and nimbocumulus clouds must form to give heavy rainfall.
iii. There must be an inward flow of air in the upper level of the atmosphere.

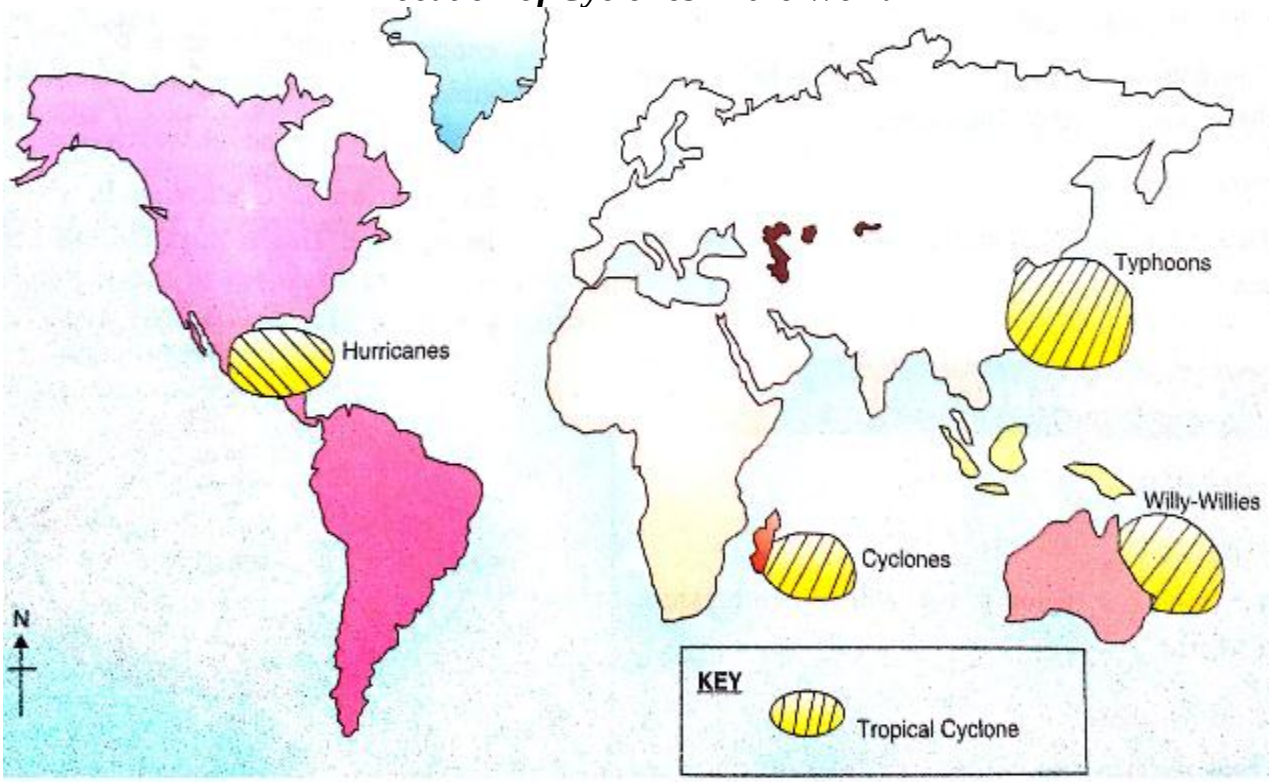
WEATHER ASSOCIATED WITH TROPICAL CYCLONES

i. As the front of the vortex arrives, gusty winds develop and thick clouds appear.
ii. When the vortex arrives, the winds become violent, and heavy rainfall comes.
iii. Calm conditions return when the "***eye"*** arrives.
iv. The arrival of the rear of the vortex brings violent winds and heavy rainfall.

EFFECTS (CONSEQUENCES) OF TROPICAL CYCLONES

- ✓ Great winds cause waves in the sea that cause a lot of damage to property and lead to loss of life.
- ✓ As the cyclone moves over land, the increased friction of moving air over land surface reduces the flow of air to the low pressure centre.
- ✓ It decreases the availability of moisture since the land becomes dry.

Location of Cyclones in the World



NAMES OF TROPICAL CYCLONES IN DIFFERENT PARTS OF THE WORLD

NAME OF CYCLONE	REGION
Typhoons	Asia (China Sea, around Japan)
Tropical Cyclones	Indian Ocean (around Madagascar)
Hurricanes	West Indies (Caribbean)
Tornadoes	Guinea, Southern USA
Australia	Willy-willies

DEPRESSIONS OR TEMPERATE CYCLONES

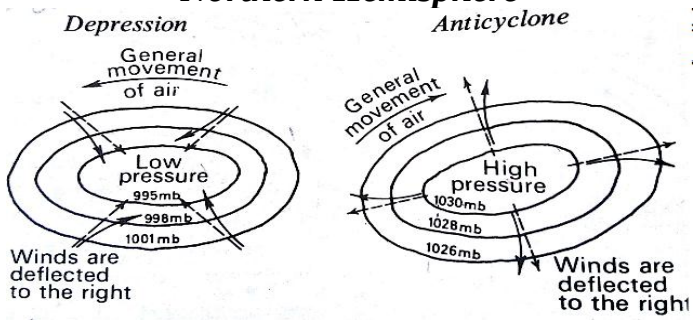
- ➢ These are areas with low air pressure whose isobars are very close at the centre, forming an oval shape.

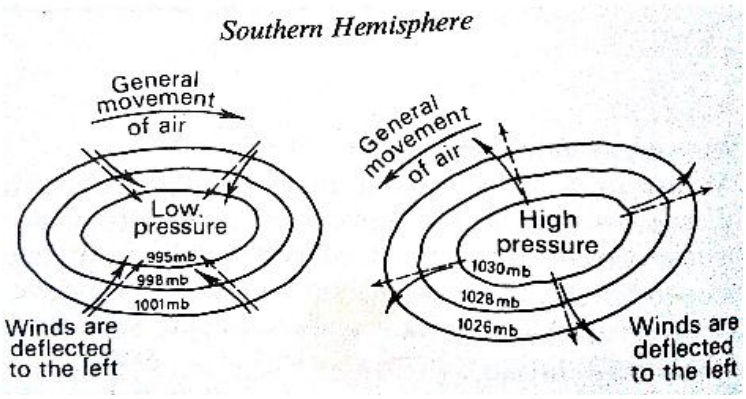
MOVEMENT OF AIR IN THE DEPRESSION

- ➢ Air moves in an anticlockwise direction in the northern hemisphere and clockwise direction in the southern hemisphere (Buys Ballot's Law).
- ➢ Depressions are rarely stationary, but generally move in an eastward direction.

A Depression in the Northern Hemisphere and in the Southern Hemisphere

Northern Hemisphere





AREAS WHERE DEPRESSIONS DEVELOP

- They occur in the temperate latitude of 60° north and south of the equator, where westerly winds meet polar winds.
- Humid air from the tropics meet cold air from Polar Regions along a boundary called ***polar front***.

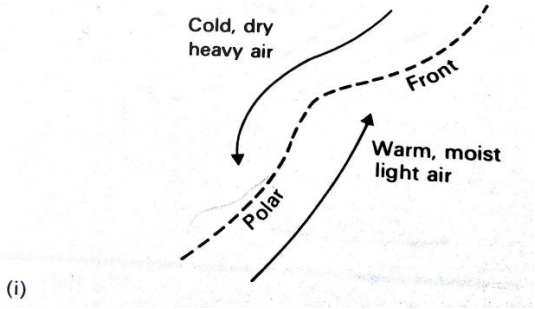
CHARACTERISTICS OF A DEPRESSION

- ❖ Changing weather with continuous rainfall caused by the uplifting of warm, moist tropical air by the cold polar air which is a bit drier.
- ❖ They vary in their sizes.

DEVELOPMENT OF A DEPRESSION

STAGE 1

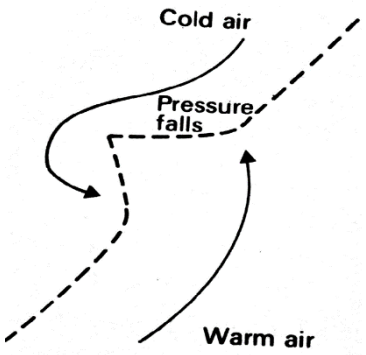
- ✓ This is the birth of a cyclone.
- ✓ Two air masses meet at a polar front, one a warm air mass (moving in an easterly direction) and the other a cold air mass (in a westerly direction).
- ✓ The frictional effects of the two air masses cause a wave to develop.

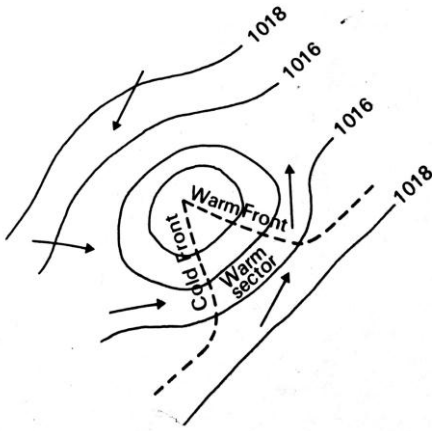


(i)

STAGE 2

- ✓ The wave bulges into the colder air and gets larger
- ✓ Pressure falls at the tip of the wave and an anti-clockwise circulation of winds blows around this low pressure point in the northern hemisphere, but the circulation is clockwise in the southern hemisphere.

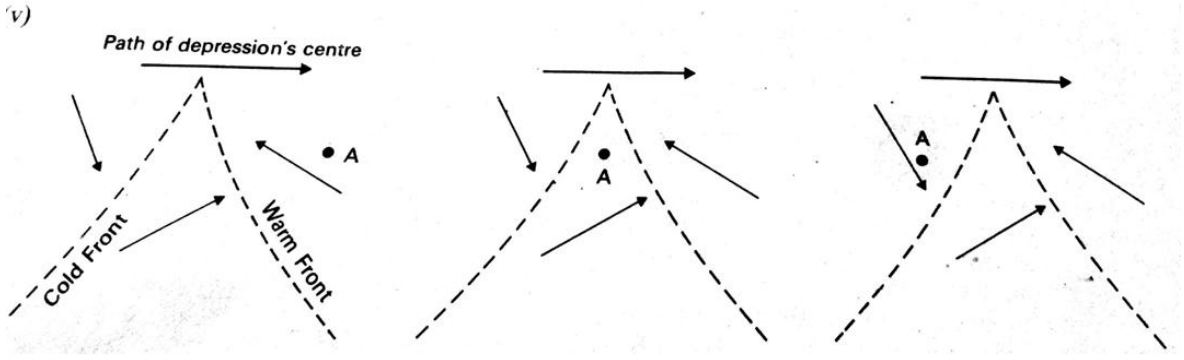




(iii)

STAGE 3

- ✓ As the bulge develops, the warm air rises up over the colder air at the front of the bulge. This front is called the ***warm front***.
- ✓ At the rear of the bulge, colder air forces its way under the warm air. The rear is called the ***cold front***.
- ✓ The warm air between the two is called the ***warm sector***.
- ✓ The warm front is much more gently sloping than the cold front.
- ✓ Eventually, the cold front catches up with the warm front and lifts it off the ground. This then becomes an ***occluded front*** and it soon dies out.



(a) **(b)** **(c)**

WEATHER ASSOCIATED WITH A DEPRESSION AT A PLACE (MARKED A ABOVE)

a) ***In a, this happens before the warm front reaches a place***.
   i. The skies are clear but with little cirrus clouds.
   ii. The wind blows from south to east.

b) ***This happens when the warm front passes over a place. This is the warm sector, thus in diagramb***.
   i. Heavy rainfall is experienced.

ii. Rain stops when wind changes direction from south east to south west.
iii. Temperature rises and the air becomes humid because the warm sector lies over point **A**.

c) ***In c, the cold front has finally passed over the place.***

i. The skies are clear and the weather is cool.
ii. The weather changes rapidly as the wind blows from North West, temperature drops and showers may be experienced.

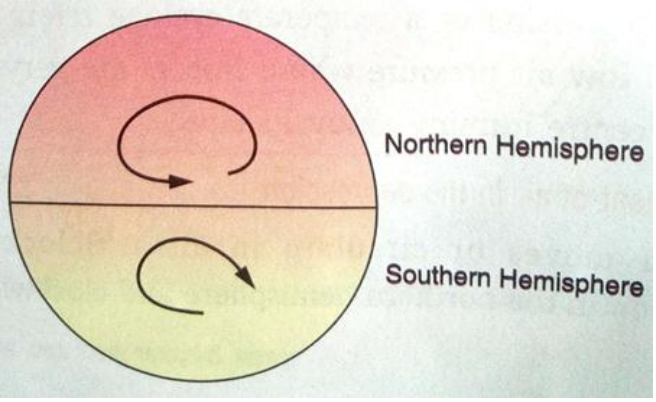
NOTE: Unfavourable conditions can bring a tropical cyclone to an end at any stage.

DIFFERENCES AND SIMILARITIES BETWEEN TEMPERATE AND TROPICAL CYCLONES

SIMILARITY

✓ They both circulate in an anti-clockwise direction in the Northern Hemisphere and in a clockwise direction in the Southern Hemisphere. ***This is according to Buys Ballot's Law***.

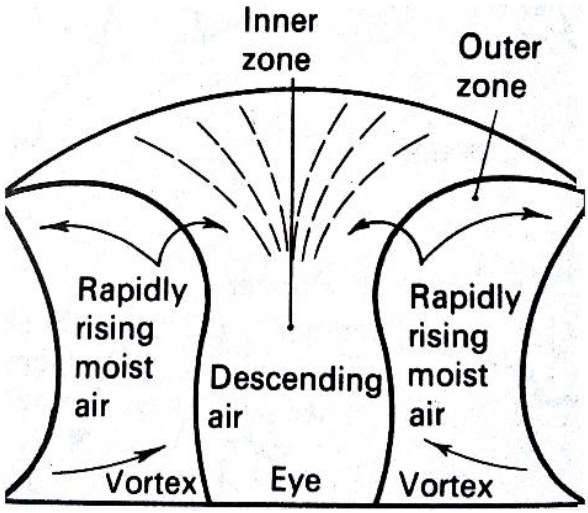
Circulation of Temperate and Tropical Cyclones

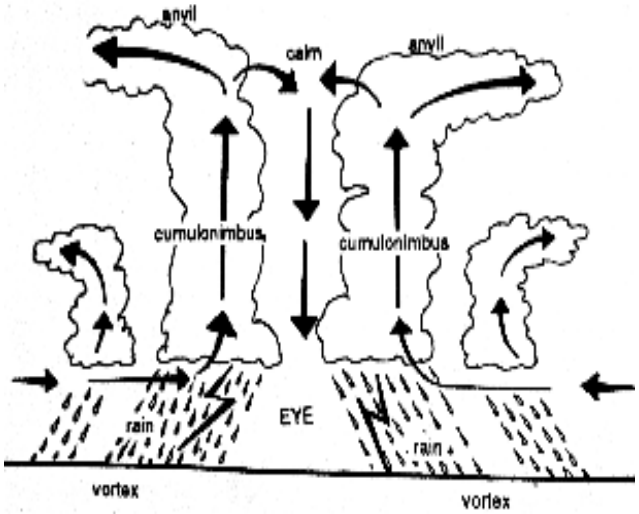


DIFFERENCES

i. A tropical cyclone is smaller in size than a depression.
ii. A tropical cyclone is also more violent than a depression.

zSection through a Cyclone





MEANINGS OF TERMS

a) VORTEX

- This is where air rises and is a very turbulent part where the air swirls around an eye.
- It is found on both sides of the eye.

b) EYE

- This is the central part of a tropical cyclone which is very calm.

ANTICYCLONES

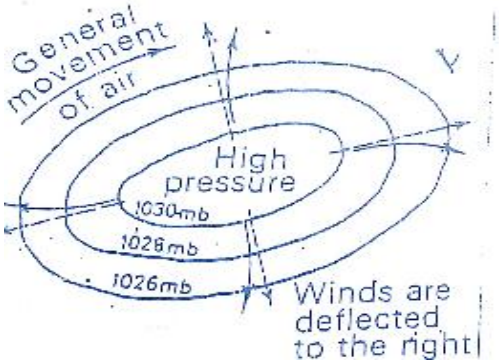
- These are regions in which the atmospheric pressure is high at the centre and decreases outwards.
- The pressure gradient is gentle and winds are light.

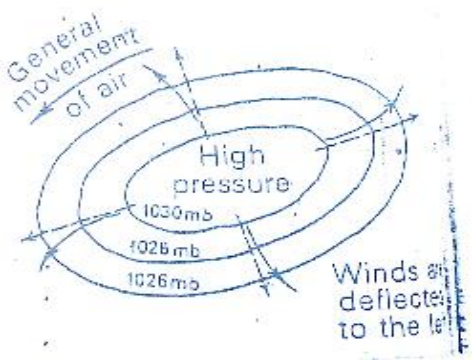
An Anticyclone

- **CHARACTERISTICS OF ANTICYCLONES**

- They bring about fine weather.
- Skies are clear, the air is calm.
- Temperatures are high in summer but low in winter.
- In winter, great cooling of the lower atmosphere may result into thick fogs.
- Winds blow outwards as opposed to inwards in a cyclone.
- The wind blows in a clockwise direction in the northern hemisphere and anticlockwise direction in the southern hemisphere.

Anticyclone in the Northern Hemisphere ***Anticyclone in the Southern Hemisphere***





THE MAIN ANTICYCLONES OF THE WORLD

1. The South Atlantic High
2. The Indian Ocean High

WIND

- Wind is air in motion.
- Wind direction is indicated by a **windvane**, or a **windsock**, or a **weather-cock**.
- Wind speed is measured by an **anemometer**.

- Winds are named after the direction from which they blow. For example, a south-east wind is from south-east.

BEAUFORT WIND SCALE

- Is used where an anemometer is not available.

A Beaufort Wind Scale

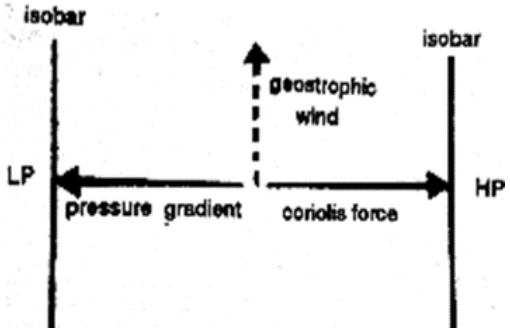
Scale No	Symbol	Description	Speed (kmh^{-1})	Observed effects
0		Calm	Less than 1.6	Smoke rises vertically
1		Slight breeze	1.6-5	Smoke-drift, not shown by vane
2		Slight breeze	7-11	Leaves rustle, vane moved
3		Gentle breeze	13-19	Wind extends light flags
4		Moderate breeze	21-29	Raises dust, paper
5		Fresh breeze	31-39	Small leaves sway
6		Strong breeze	41-50	Whistling in telephone wire
7		Moderate gale	51-61	Whole tree in motion
8		Fresh gale	63-74	Twigs broken off trees
9		Strong gale	75-86	Slight structural damage occurs
10		Whole gale	88-101	Trees uprooted, considerable damage
11		Storm	103-120	Widespread damage
12		Hurricane	more than 120	Widespread devastation (tropical areas)

- It has to be noted that wind blows from high to low pressure. At high levels, it follows isobars while at the earth's surface if blows across the isobars.

GEOSTROPHIC WIND

- This is the wind that tends to blow parallel to isobars when the pressure gradient force balances with the coriolis force.

Formation of Geographic Wind

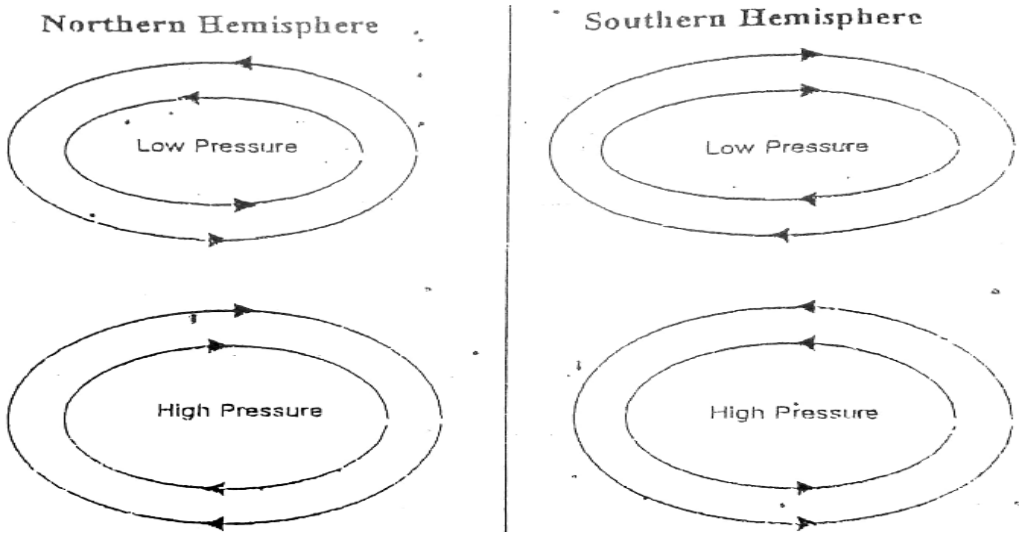


NOTE: Wind direction is influenced by the rotation of the earth. Its direction is the left in the southern hemisphere while in the northern hemisphere it is deflected to the right.

BUYS BALLOT'S LAW

- This law states that in the northern hemisphere the winds move clockwise around the centre of high pressure and anticlockwise around the centre of low pressure.
- In the southern hemisphere, the winds move clockwise around the centre of low pressure and anticlockwise around the centre of high pressure.

Buys Ballot's Law and Wind Patterns



WEATHER

❖ Weather refers to the current state of the atmosphere in a small area for a short period of time.

OR

❖ It is the daily condition of the atmosphere for a short period of time.

➢ It should be noted that climate is not the same as weather.

CLIMATE

- It means the average weather condition for a large area for a long period of time.

IMPORTANCE OF WEATHER

a) It influences the activities of farmers and their crops.

- Activities such as planting and harvesting controlled by the rainfall and temperature patterns of an area.

b) Temperature, humidity and rainfall promote or discourage diseases which may destroy both crops and animals.

c) It influences fishing and navigation.

- Stormy and rainy weather does not favour these activities.

d) Temperature controls the multiplication and transmission of germs and pathogens.

e) It determines the type of crops and animals to be grown and raised in an area since different crops and animals require different climatic conditions.

f) It promotes the safety of modern air travel through accurate weather conditions and records from the ground stations.

- Bad weather conditions discourage air travel and promotes accidents.

ELEMENTS OF WEATHER AND THEIR INSTRUMENTS FOR RECORDING

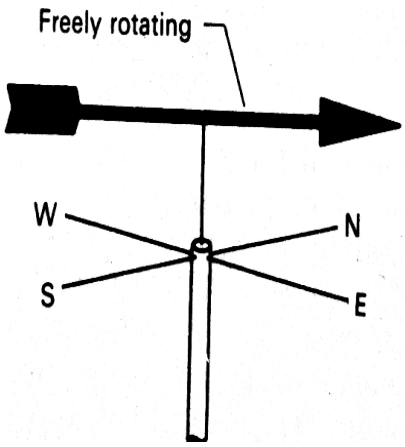
WEATHER ELEMENT	MEASURING INSTRUMEN
Temperature	Thermometer
Humidity	Hygrometer

Air pressure	Barometer
Rainfall	Raingauge
Evaporation	Evaporation basin
Wind direction	Windwane, windsock or windcock
Wind speed	Anemometer
Sunshine	Sunshine recorder

1. WIND VANE

- Is used to record the direction of wind.
- It is made of a metal and it attaches to the top of the building where there is free flow of wind.
- Winds are named after the direction from which they blow.
- The arrow of the wind vane points where the wind is blowing from.

The Wind Vane



2. WIND ROSE

- A wind rose is used for recording the direction of prevailing winds a place over a period of one month.
- It consists of eight compass directions as shown in the diagram above. Each number in the small square represents the date in the month when wind blew from a certain direction. For example, on date 12th of the month, the wind was from south west.
- ***The number at the centre represents the number of days in the month when it was calm.***

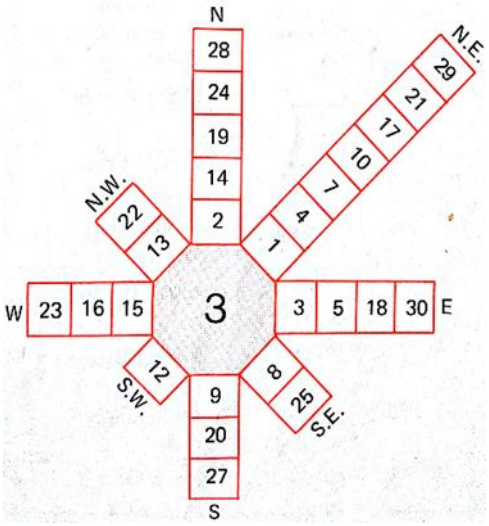
- Each day, there are three things that can take place, these are:

a) One can shade in the arm of the rose that shows wind direction, or write the date in the appropriate square.

b) The number of calm days is indicated in the centre of the rose.

c) One can just write the date in the arm against the direction from which the wind blew on that day.

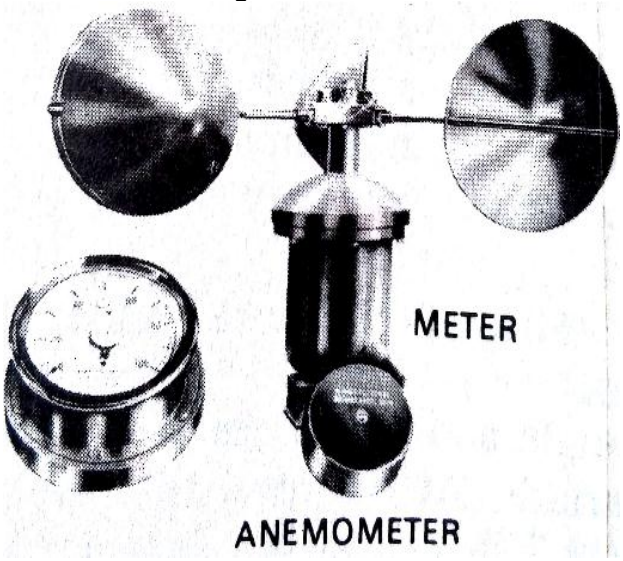
A Wind Rose



3. CUP ANEMOMETER

- The speed of the wind is measured using an anemometer.
- It consists of three or four semi-circular cups attached to the ends a spindle. When there is wind blowing, the cups rotate.
- The faster the wind speed, the faster the arms and cups of the anemometer will spin around.
- The number of rotations is recorded on a meter to give the speed of the wind in kilometres per hour or metres per minute.
- Note that wind speed can also be estimated using the Beaufort scale.

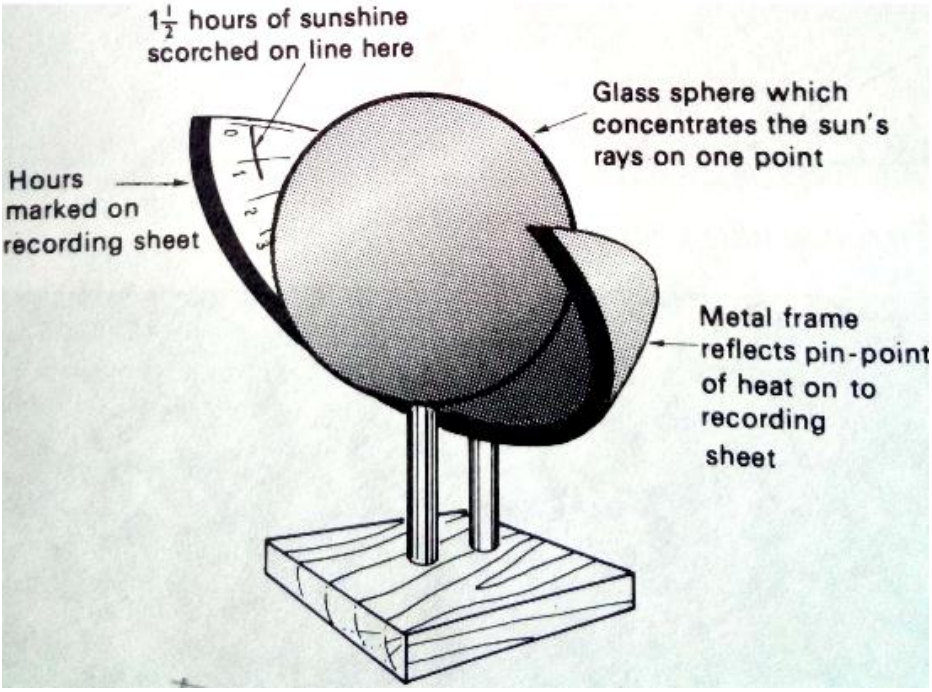
A Cup Anemometer



4. SUNSHINE RECORDER

- Is used to measure the amount of sunshine a place receives.
- The amount of sunshine a place receives depends on seasons, a factor determined by altitude and by the earth in its revolution around the sun.
- The sun rays are focused on the sensitive card on the recorder which is graduated in hours.
- All places that receive equal sunshine duration are joined by lines called **isohels**.

Sunshine Recorder



5. HYGROMETER (WET AND DRY BULB THERMOMETER)

- ➢ It is used to measure humidity.
- ❖ Humidity is the amount of water vapour in the atmosphere.

RELATIVE HUMUDITY

- ✓ This refers to the measure of the amount of water vapour in a given volume of air compared to the total amount of moisture that the volume of air can hold at a given temperature. For example, at $40^{o}C$, $2m^3$ of air can hold a total of 12 grams of water vapour.

ABSOLUTE HUMIDITY

☞ It refers to the actual amount of water vapour in the atmosphere expressed in grams per cubic metre.

- ➢ The hygrometer is made up of two thermometers.
- ➢ One is called ***Dry Bulb thermometer*** and it measures ***dry air temperatures*** within the Stevenson screen.
- ➢ The other is called the ***Wet Bulb*** thermometer because it is covered by a wet muslin cloth which is wrapped around its base.

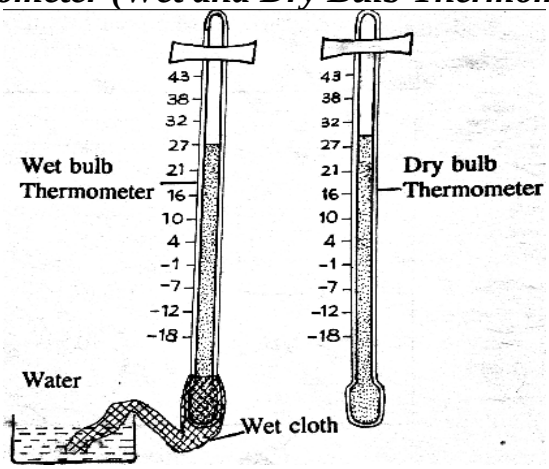
HOW THE HYGROMETER WORKS

- When the air is saturated or 100% full of moisture, there is no evaporation taking place from the muslin cloth.
- The two thermometers will then show the same readings.
- But, when the air is not saturated (not 100% full of moisture), moisture evaporates from the muslin cloth. Mercury contracts when evaporation is taking place.
- Temperature is therefore lowered in the wet bulb by this evaporation. But the temperature in the dry bulb remains the same.
- The difference between the two readings shows the humidity of the air.

Summary of how it works

THERMOMETER READING	MEANING
No difference	Air is saturated
Small difference	Humidity is high
Large difference	Humidity is low

Hygrometer (Wet and Dry Bulb Thermometer)



6. RAIN QAUGE

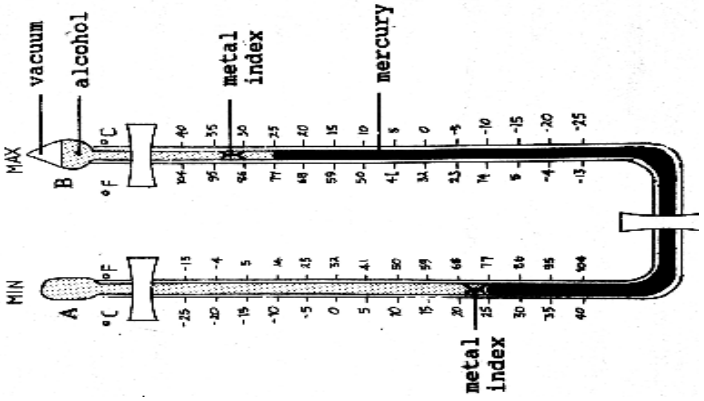
- It is used for measuring rainfall.
  NOTE: For details, revisit the topic of hydrosphere on how a rain gauge works.

☞ On maps, all places that receive equal amount or rainfall are joined by lines called **isohyets**.

7. MAXIMUM AND MINIMUM THERMOMETER

- These used for measuring temperature.
- Maximum and minimum temperatures are measured by maximum and minimum thermometers. These are either separated or joined in a U-shape.
- The maximum thermometer records the highest temperatures reached during the day. The mercury in the closed glass tube expands when the temperature rises. The metal indicator is pushed up the tube and this stays at the maximum level when the temperature drops.
- The thermometer is reset by pulling down the metal indicators to the meniscus (the curved surface of any liquid caused by surface tension) of the mercury.

Maximum and Minimum Thermometer



FACTORS THAT INFLUENCE TEMPERATURES OF A PLACE

ii) Latitude

☞Equatorial regions are warmer since the sun is often times overhead at the equator than polar regions.

iii) Altitude

☞ Temperatures are high on the earth's surface and decrease with increasing altitude.

iv) Continentality

☞ Land masses become heated more quickly than water masses. This makes landmasses to have higher temperatures as compared to water masses. However, landmasses lose heat faster than do water masses. This has reverse effects on temperatures.

v) Ocean currents and winds

☞ Ocean currents distribute heat or coldness in the water from one place to the other.

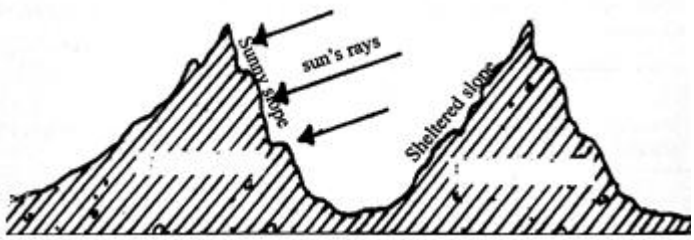
vi) Slope and aspect

☞ The facing of a surface in a particular direction is called **aspect**.

☞ Steep slopes experience higher temperatures than gentle slopes.

☞ In the southern hemisphere, the "north facing" experiences higher temperatures than the "south-facing"

How aspect affects temperatures of a given place



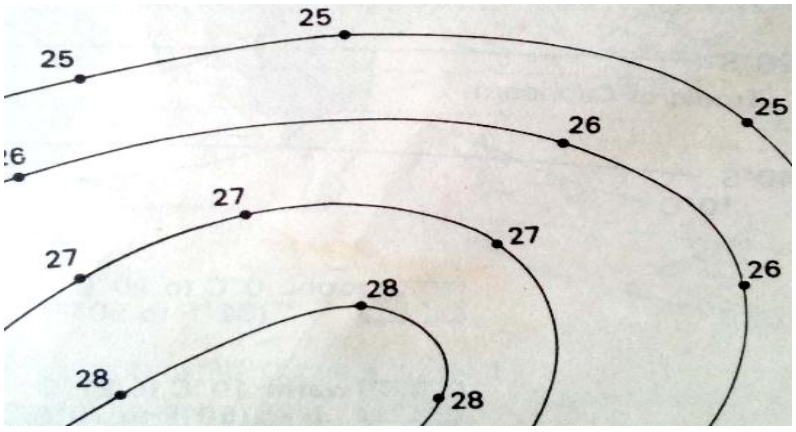
8. AIR PRESSURE

- It is the force exerted by air at a place due to its weight.
- It is also called atmospheric pressure or barometric pressure.
- Air pressure is expressed in millibars (mb).
- A pressure of 1000mb is equivalent to 75cm of mercury. The SI unit of pressure is the Pascal (Pa). One Pascal is equivalent to one newton per square metre.

ISOBARS

- These are lines joining places of the same pressure.

Isobars



IMPORTANCE OF ISOBARS

i. They are used to calculate the pressure gradient.
ii. They help to know the direction and strength of wind. (Closely-spaced isobars mean the winds blow strongly).
iii. They help to determine the position of high pressure and low pressure on the map.

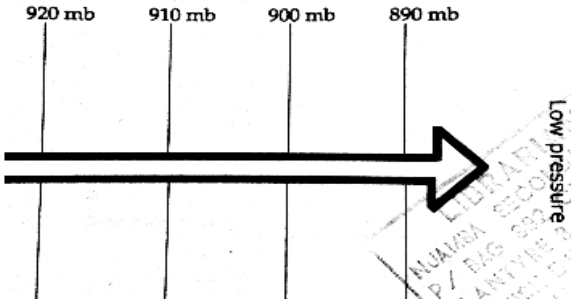
PRESSURE GRADIENT

- This is the rate at which the atmospheric pressure changes horizontally in a certain direction on the earth's surface.
- When the isobars are close together, it indicates that the movement of wind or air is great. Where they are far from each other, it shows that the winds blow lightly.

CALCULATION OF PRESSURE GRADIENT

✓ Is done by subtracting the isobar numbers for the adjacent isobars. For example, if the adjacent isobar numbers are **1002** and **998**, the pressure gradient will be **1002-998**, which gives **4**.

Isobars and pressure gradient



MEASUREMENT OF AIR PRESSURE

❖ There are two ways of measuring air pressure.

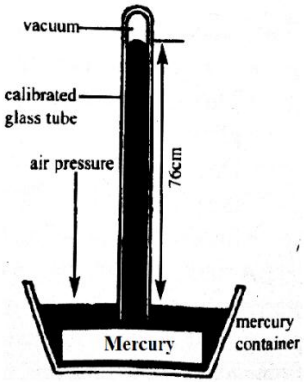
a) Mercury barometer
b) Aneroid barometer

MERCURY BAROMETER

HOW A MERCURY BAROMETER WORKS

❖ When air pressure increases, the air pressing on the surface of the mercury forces it to rise up the mercury column. This makes the barometer to register high pressure.
When the air pressure decreases, the mercury column drops to register low air pressure. The pressure readings are taken on the scale on the glass tube.

The Mercury Barometer



ADVANTAGE OF THE MERCURY BAROMETER

- It is an accurate instrument for measuring air pressure.

DISADVANTAGE OF THE MERCURY BAROMETER

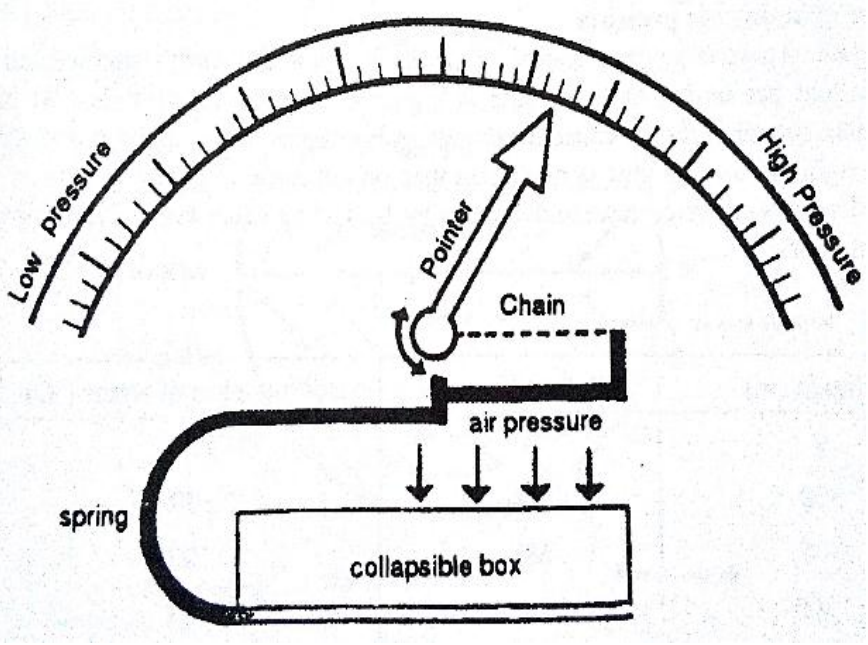
- The mercury barometer is not good for outdoor measurement.

AN ANEROID BAROMETER

HOW AN ANEROID BAROMETER WORKS

❖ It consists of a metal box with very little air inside. Any increase in air pressure on the outside of the box makes the lid to move inwards. This makes the chin to be pulled to the right, making the pointer to move to the right as well to register high air pressure.
When pressure decreases; the lid of the box moves outwards. This makes the pointer to move to the left to register low air pressure.

An Aneroid Barometer



DISADVANTAGE OF AN ANEROID BAROMETER

- It is less accurate than a mercury barometer.

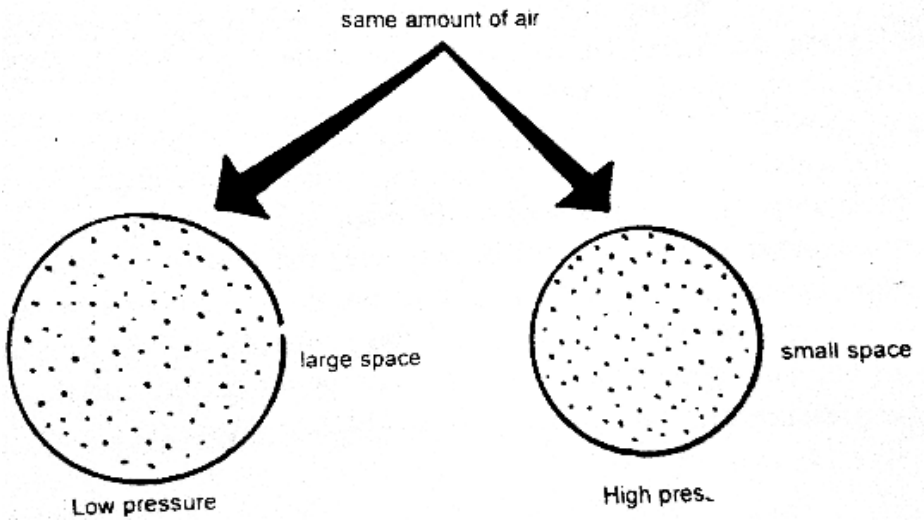
USES OF BAROMETERS

i. For weather forecasting by using it to determine the sea level pressure and how it changes. Any change in pressure entails a change in weather. For instance, high pressure is associated with clear skies and fine weather while low pressure is associated with cloudy atmosphere and heavy rainfall.
ii. It is used for determining the strength and direction of wind.
iii. It is used for determining the altitude. ***Altimeter barometer*** is used by pilots to know the altitude of their flight.

FACTORS THAT CAN CHANGE AIR PRESSURE

✓ Removing air from a given space reduces pressure.
✓ Adding air to a given space increases air pressure.
✓ Decreasing the volume of a given amount of air. This makes the air to be compressed and this increases air pressure.
✓ Increasing the volume of a given amount of air. This enables the air to expand and occupy a larger space. This reduces air pressure.

Effects of the Volume of Air on Pressure



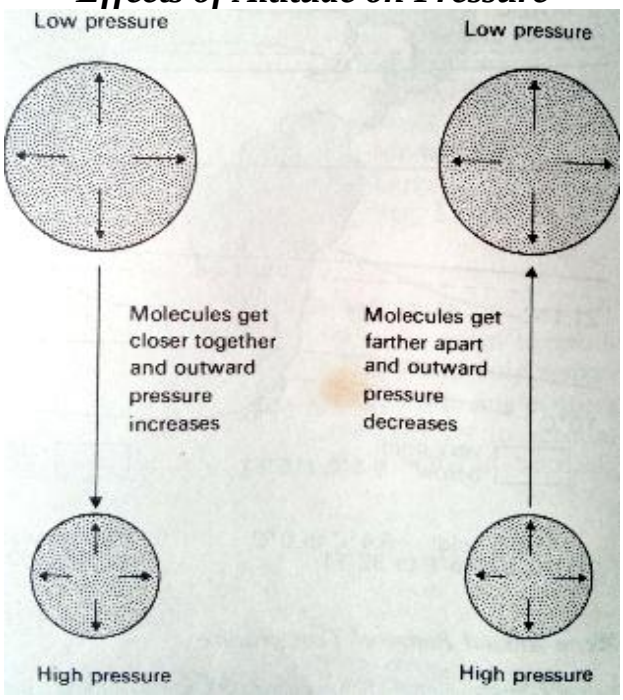
FACTORS THAT AFFECT AIR PRESSURE

i. Altitude
ii. Temperature
iii. Rotation of the earth
iv. Amount of water in the air (humidity)
v. Speed of the wind

1) ALTITUDE

- More air molecules are concentrated at the earth's surface that at higher altitudes. This increases its weight per unit area, and this increases air pressure.
- At higher altitudes, the air is thin, since it expands to occupy a larger space. This makes its weight per unit volume to be less than on the earth's surface. This leads to low air pressure.
- **NOTE:** The atmospheric pressure decreases by $^{1}/_{30}$ of its value every 275 metres are one goes upwards into the air.

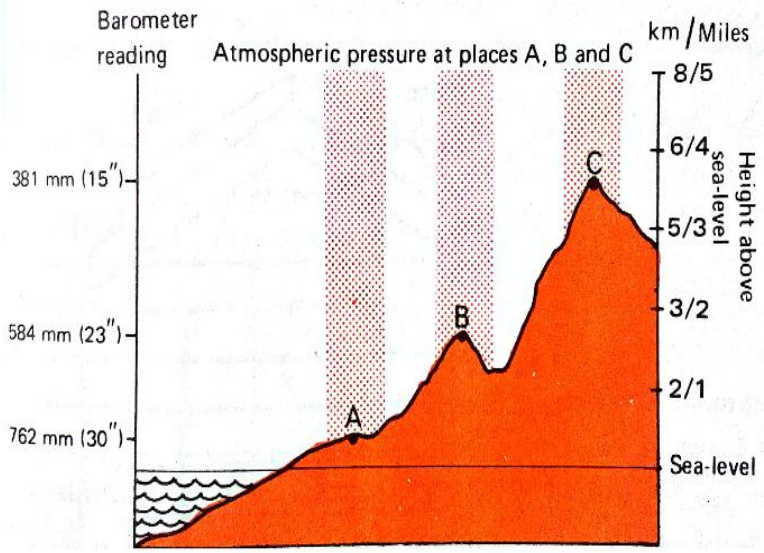
Effects of Altitude on Pressure



Altitude and Air Pressure

ALTITUDE (M)	PRESSURE (CM)	BOILING POINT OF WATER (°C)
0	76	100
300	73	99
900	68	97
1500	63	95
3000	53	90

Illustration of how pressure decreases with increasing altitude



TEMPERATURE

- When air is heated, it becomes less dense (lighter) and rises. This reduces air pressure.
- But when air is cooled, it becomes heavier and sinks back to the earth's surface. This increases air pressure.

2) ROTATION OF THE EARTH

- When air is thrown away from the poles as the earth rotates, it is spread and occupies larger latitudes (space). This reduces air pressure.
- The air that goes back to the poles from the equator occupies shorter latitudes and gets concentrated on a small space. This increases air pressure.

3) AMOUNT OF WATER IN THE AIR (HUMIDITY)

- Water vapour is lighter than air. This means that on the one hand, a large amount of water vapour in the air (high humidity) reduces air pressure.
- On the other hand, low humidity increases air pressure.

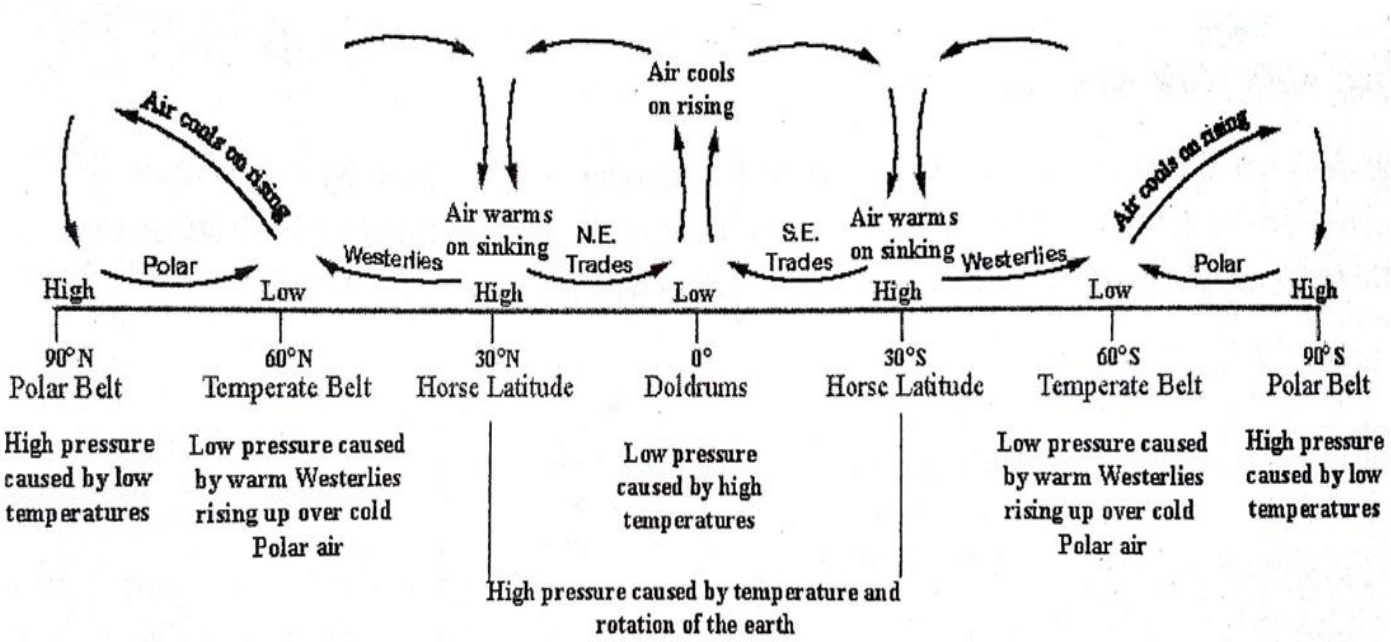
4) WIND SPEED

- Removing air molecules from a given space reduces air pressure.
- Strong winds lower air pressure.

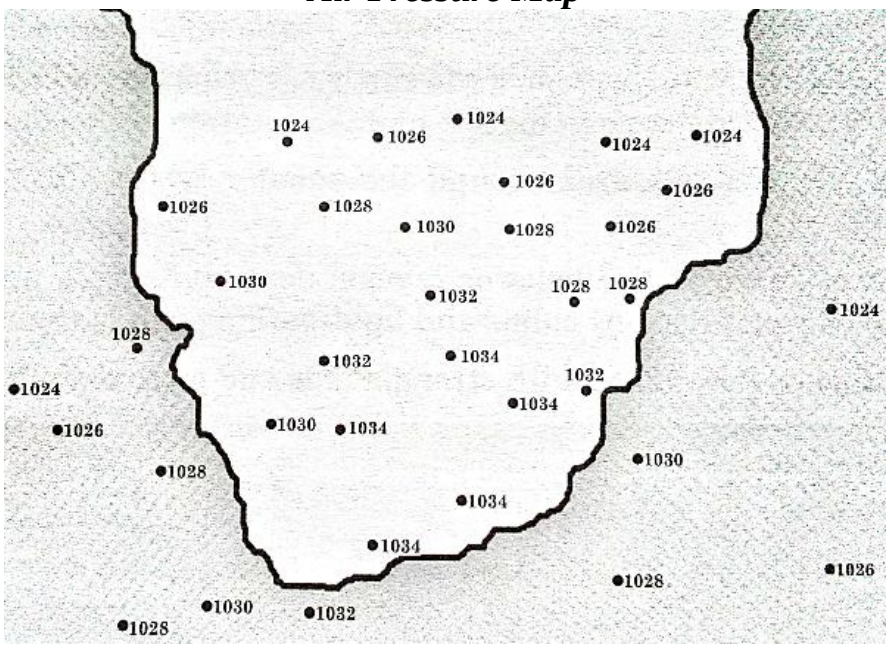
❖ **NOTE:** The pressure belts are influenced by the distribution of temperature. For instance, in January when it is summer in the southern hemisphere, temperatures are high which make low pressure to develop. However, there is high pressure on the oceans since temperatures are low on the oceans.

❖ In July, when it is summer in the northern hemisphere, temperatures there are higher on the land than on the oceans sea. This results in low pressure on land and high pressure on sea.

Pressure Belts and Air Movement



Air Pressure Map

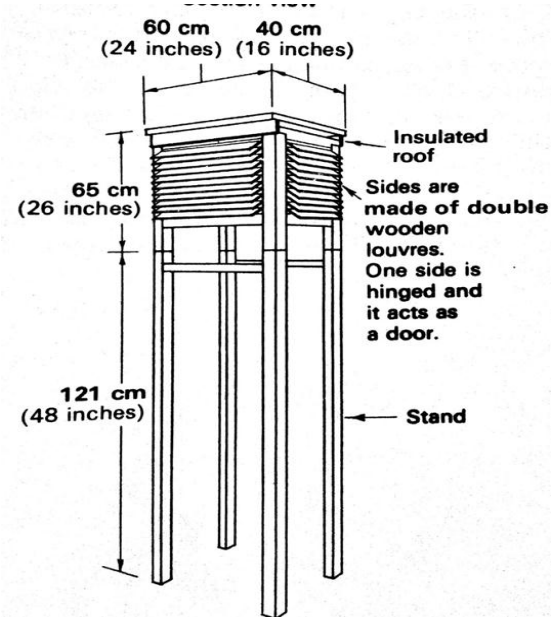


9. THE STEVENSON SCREEN

- This is a box which has louvered (slatted) sides to allow the air to flow through the box easily.
- This box is used to hold thermometers and other sensitive weather instruments.
- It is placed at least 1-2 metres above the ground ***to avoid ground temperatures which are often higher than air temperature from affecting the readings*** of the instruments.
- The box is painted white ***to reflect direct sunshine which can affect the readings of the instruments.***
- Examples of such instruments include the maximum and minimum thermometer and the wet and dry bulb thermometer.

- This box is used to provide shade for the instruments, to protect the instruments and to regulate air flow.

A Stevenson Screen



WORLD CLIMATES AND ITS ASSOCIATED VEGETATION

- Climate refers to the average weather condition of an area over a long period of time.

IMPORTANT ELEMENTS OF CLIMATE

a) Temperature
b) Rainfall

CLIMATOLOGY

- This is the study of climate.

ZONES (CLIMATIC REGIONS) OF THE WORLD

☞ A climatic region is an area experiencing a uniform pattern of temperature and precipitation over a long period of time.

ZONES (CLIMATIC REGIONS) OF THE WORLD

1. Hot zone (tropical)
2. Warm zone (subtropical)
3. Cool zone (temperate)
4. Cold zone (frigid)
5. Very cold zone

MAIN DIVISIONS OF THE WORLD

a) Tropical climates
b) Temperate climates

BIOME

- It is a division of the world's vegetation that corresponds to a defined climate, characterized by specific types of plants and animals.

MAIN TYPES OF CLIMATES

i. Equatorial Climate
ii. Tropical Continental Climate (Sudan Climate)
iii. Tropical Monsoon Climate
iv. Tropical Desert Climate
v. Mediterranean Climate (Warm, Temperate Western Margin Climate)
vi. Tundra Climate

TROPICAL CLIMATES

1. EQUATORIAL CLIMATE

Location

Between latitudes 5° and 5° north and south of the equator.

Examples of Equatorial Climate

i. Amazon Basin (South America)
ii. Zaire Basins
iii. Southern Ivory Coast
iv. South Western Ghana
v. Malaysia
vi. Coastal Burma
vii. Cambodia
viii. Vietnam
ix. Indonesia
x. New Guinea
xi. Central Ghana
xii. Western Coast of Nigeria

CHARACTERISTICS OF EQUATORIAL CLIMATE

- There are no definite seasons (i.e. winter and summer). This happens because the pressure is low throughout the year.
- High temperatures throughout the year, and an annual temperature range is 3°C on average.
- Heavy rainfall throughout the year.
- Annual rainfall is about 2000mm.
- Humidity is always high.

Equatorial Climate in the Southern Hemisphere

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	26	26	25	25	25	23	23	24	24	26	26	26
RAIN (mm)	380	240	280	340	300	310	300	310	380	550	600	560

HEMISPHERE: Southern hemisphere

REASON: The temperature is low in June and July when it is winter in the southern hemisphere**.**

ANNUAL TEMPERATURE RANGE=26°C-23°C

=3°C

Equatorial Climate in the Northern Hemisphere

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
TEMP (°C)	24	24	24	25	25	26	27	25	25	24	24	24
RAIN (mm)	221	240	280	340	300	310	300	310	323	200	229	212

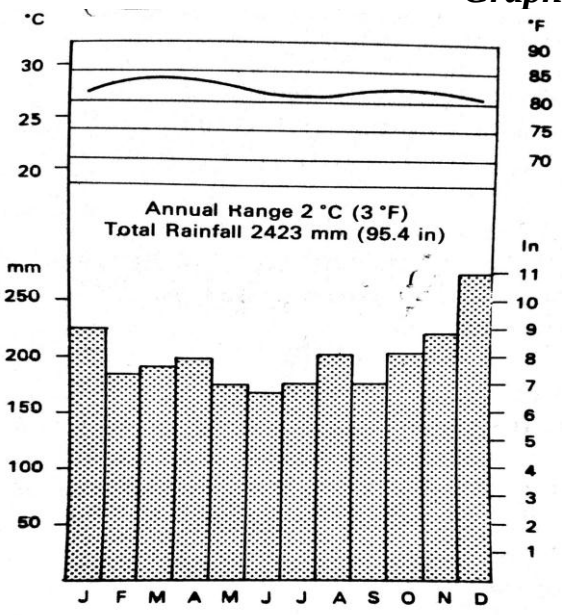
HEMISPHERE: Northern hemisphere

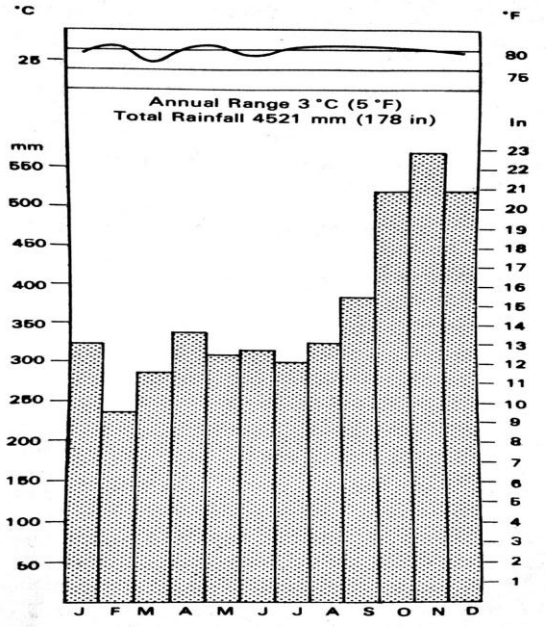
REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

ANNUAL TEMPERATURE RANGE=27°C-24°C

=3°C

Graphs for Equatorial Climate





AGRICULTURAL DEVELOPMENT

a) Shifting cultivation is done.

b) Plantation agriculture is practiced.

☞ For example, palm oil is planted in Malaysia and Zaire, sugarcane in Cuba and cocoa in Ghana.

c) Timber production (lumbering).

☞Trees used include mahogany, ebony and green heart.

d) Some people earn a living through hunting and food gathering since population is sparse.

THINGS THAT RETARD DEVELOPMENT IN THESE AREAS

- ❖ Diseases, insects and pests that attack people, crops and animals.
- ❖ Poor communication since roads are difficult to construct due to thick forests.
- ❖ Loss of soil fertility due to leaching.
- ❖ People are subjected to serious physical and mental hazards due to high temperatures.

TYPE OF VEGETATION IN AREAS EXPERIENCING EQUATORIAL CLIMATE

<u>TROPICAL RAIN FOREST (EQUATORIAL FOREST)</u>

CHARACTERISTICS OF TROPICAL RAIN FOREST (EQUATORIAL FORESTS)

i. Contains a great variety of plants and animals.
ii. The forests consist of three layers; upper layer, middle layer and bottom layer.
iii. The trees grow closely.
iv. Growth is continuous.
☞ This means that flowering, fruiting and shedding take place throughout the year.
v. Most trees have broad leaves
vi. Thin and smooth barks because there is no need to store extra water in barks.
vii. Most trees have long and strong roots. ***This ensures strong support***.
viii. Trees are tall, forming a canopy. ***This results into little undergrowth*.**

TREES FOUND IN TROPICAL VEGETATIONS

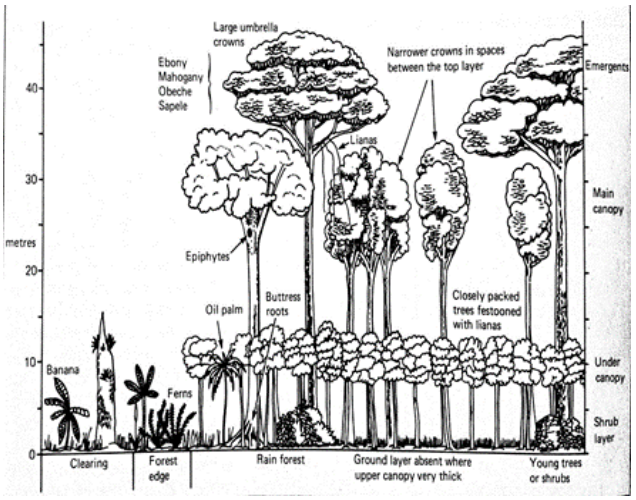
- Mahogany
- Ebony
- Orchids
- Rosewood
- Iron wood
- Green heart
- Lianas
- Palm trees

ECONOMIC IMPORTANCE OF TROPICAL EVERGREEN FOREST

a) It is used for lumbering (timber making, such as mahogany).
b) Used for sculpture (art of shaping figures), from trees such as ebony.
c) Used for poles.
d) Pharmaceuticals since there is a variety of vegetation which is used for medication.
e) For fishing since there are many reliable rivers.
f) Tourism due to evergreen scenery and a variety of animal species.
g) Production of hydroelectric power in the big rivers.
h) Hunting and gathering.
i) Shifting cultivation is done.
j) Plantation agriculture is also done on a large scale. Crops grown include cocoa.

Equatorial forest

Three distinct layers in equatorial forest



2. TROPICAL CONTINENTAL CLIMATE (SUDAN CLIMATE)

- In Africa it is called ***Savanna Climate***.

Location

- It occurs between latitudes 5° and 15° north and south of the equator.
- Most African countries experience this type of climate.

Countries experiencing this climate are as follows:

- Malawi
- Sudan
- Zambia
- Mozambique
- East Central South America
- Tanzania
- Kenya
- Zimbabwe
- Brazil
- Australia

CHARACTERISTICS OF TROPICAL CONTINENTAL (SUDAN) CLIMATE

1) There are definite wet and dry seasons.
   ☞These coincide respectively with hot and cooler seasons.
2) Summers are hot with temperature of about 32°C and winter temperature of about 21°C. *Annual temperature range is about 11°C.*
3) Annual rainfall is often about 762mm.
   ☞But it may be more in coastal regions and less near hot deserts.
4) Heavy convectional rain falls in summer and winters are dry.
5) Humidity is high in summer.
6) Highest temperatures occur just before the rainy season begins.
   ☞That is April in the northern hemisphere and October in the southern hemisphere.

AGRICULTURAL DEVELOPMENT

- Agriculture is not well developed in Africa because some people still follow primitive methods of farming. *For instance, the Masai of Kenya.*
- Commercial plantation is done. For example, tea is grown in Kenya and Malawi.
- In some areas such as Nigeria, people grow millet, maize, bananas, groundnuts and beans. Cattle and goats are also kept.

FACTORS PREVENTING FURTHER EXPANSION OF AGRICULTURE

- Unreliable rainfall (droughts are common).
- Diseases and insects.
- Loss of soil fertility.
- Poor communication.

Tropical Continental Climate

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	22	21	21	19	16	14	15	16	20	22	23	22
RAIN (mm)	205	220	154	36	8	0	0	4	5	9	85	131

HEMISPHERE: Southern hemisphere

REASON: The temperature is low in June and July when it is winter in the southern hemisphere**.**

ANNUAL TEMPERATURE RANGE=23°C-14°C

=9°C

Tropical Continental Climate

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
TEMP (°C)	15	16	17	19	19	24	25	18	17	17	16	16
RAIN (mm)	0	2	54	36	181	205	220	174	95	9	5	1

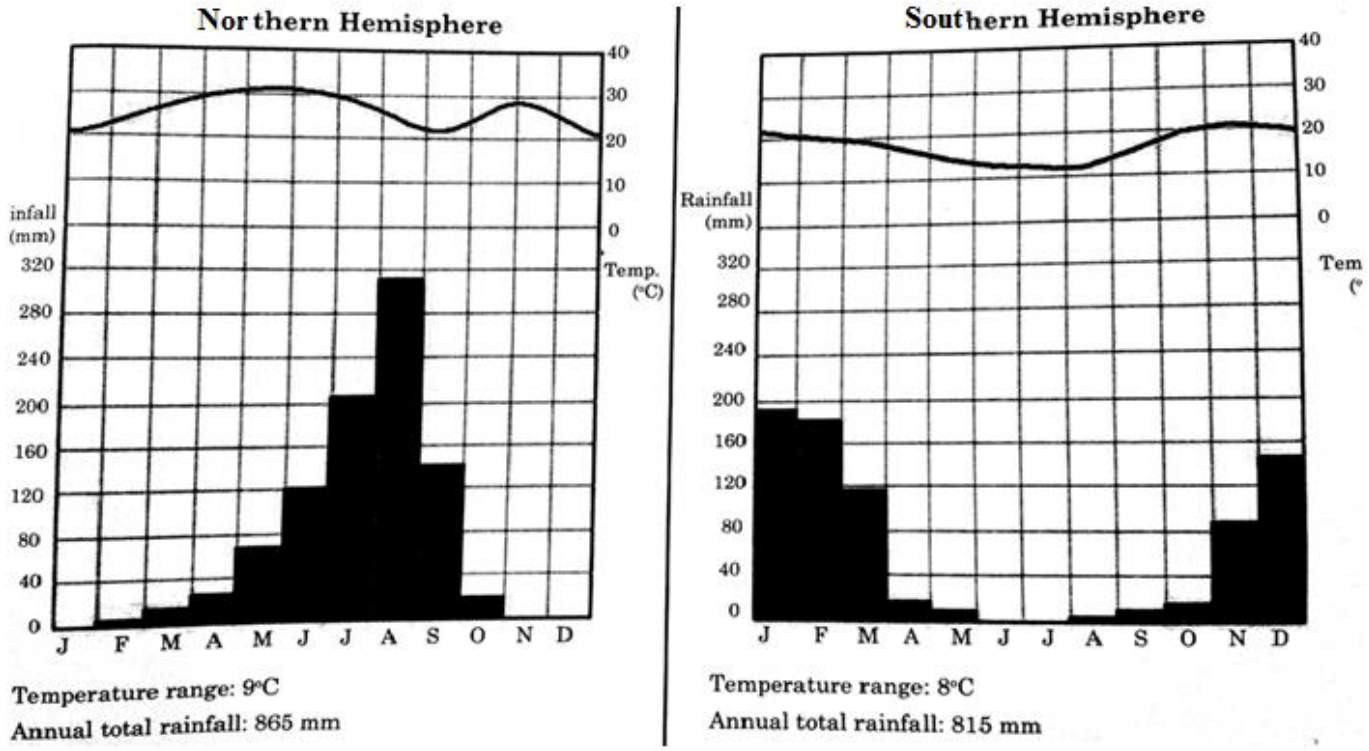
HEMISPHERE: Northern hemisphere

REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

ANNUAL TEMPERATURE RANGE=25°C-15°C

=10°C

Graphs for tropical continental climate



TYPES OF VEGETATION

TROPICAL GRASSLAND

TREES FOUND IN TROPICAL GRASSLANDS

i. Baobabs (it is umbrella-shaped to shield their roots from intense heat)
ii. Palm trees
iii. Acacias
iv. Gum trees
v. Elephant grass
vi. Scrub
vii. Thorny bushes

CHARACTERISTICS OF VEGETATION FOUND INTROPICAL GRASSLANDS

- It has tall grass with scattered trees.
- Grass dries up in the hot dry season.
- Luxuriant growth of both trees and grass is only evident during the hot wet season.
- Trees are deciduous (shed their leaves) ***to reduce the loss of water through transpiration***.
- Trees have long roots ***to reach deep down in search of water.***
- Trees such as baobab are umbrella-shaped to ***shield their roots from intense (scorching) heat***, and ***to expose only a narrow edge to the strong trade winds that blow all year round***.

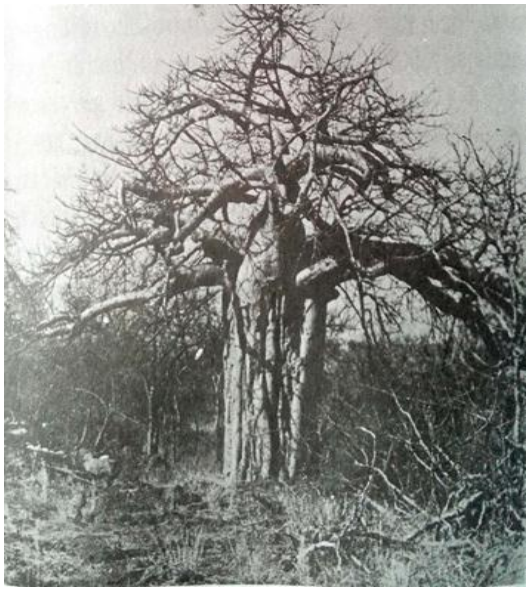
NAMES OF DIFFERENT TROPICAL GLASSLANDS IN DIFFERENT PARTS OF THE WORLD

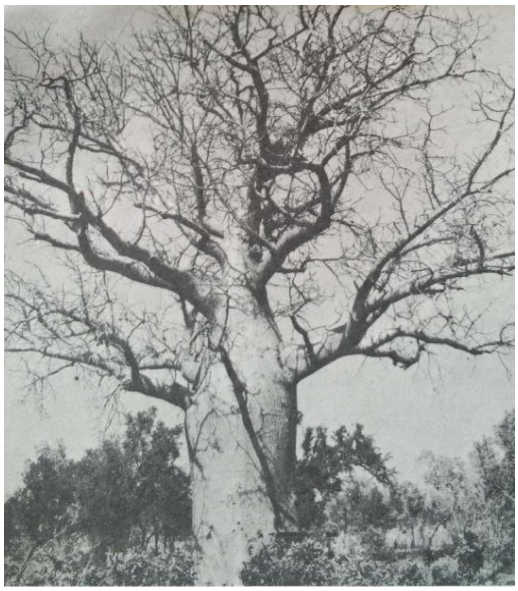
I. Campos (in Brazil)
II. Llanos (in Guinea Highlands)
III. Savanna (in Africa and Australia)

DIFFERENCES BETWEEN VEGETATION IN THE EQUATORIAL CLIMATE AND SAVANNA CLIMATE

i. Equatorial vegetation is dominated by trees while the savanna type is dominated by grass.
ii. Equatorial vegetation has a continuous canopy while savanna vegetation does not because in most cases it is spiced by grass.
iii. Growth, flowering and fruiting of trees is there all year round in equatorial vegetation while in savanna it is seasonal.
iv. There are most species in equatorial vegetation than in savanna type of vegetation.
v. Trees in equatorial vegetation are evergreen while in savanna it is deciduous (it sheds leaves).

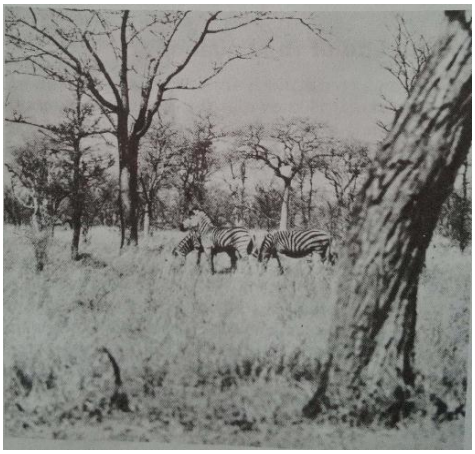
Baobab trees in savanna climate





Savanna vegetation

Savanna vegetation



3. TROPICAL MONSOON CLIMATE

Location

i. India
ii. China
iii. Bangladesh
iv. Indonesia
v. Sri Lanka
vi. Burma
vii. Northern Australia

CHARACTERISTICS OF TROPICAL MONSOON CLIMATE

i. Seasonal reversal of winds.
ii. Annual rainfall varies greatly depending on relief.
iii. Temperature ranges from 32°C in hot seasons to about 15°C in cool seasons.
iv. A typical tropical monsoon climate consists of three seasons:
   a) *Cool dry season (November to January)*
   b) *Hot dry season (March to May)*
   c) *Hot wet season (June to October)*

AGRICULTURAL DEVELOPMENT

- There is intensive cultivation of food crops, such as padi.
- Extensive cultivation of non-food crops such as sugarcane and tea in estates.

OBSTACLES (PROBLEMS/CHALLENGES) TO AGRICULTURAL DEVELOPMENT

- Farmers' ignorance on the on modern methods of farming.
- Practice of land division on the death of the owner.
- Poverty.
- Overdependence on on-shore monsoon winds.

TYPE OF VEGETATION

TROPICAL MONSOON FOREST

CHARACTERISTICS OF TROPICAL MONSOON FOREST

- There is a small number of species.
- Most of the trees are deciduous.
- Tall trees.
- Trees are sparsely spread.
- Undergrowth is denser.

TREES FOUND INTROPICAL MONSOON FORESTS

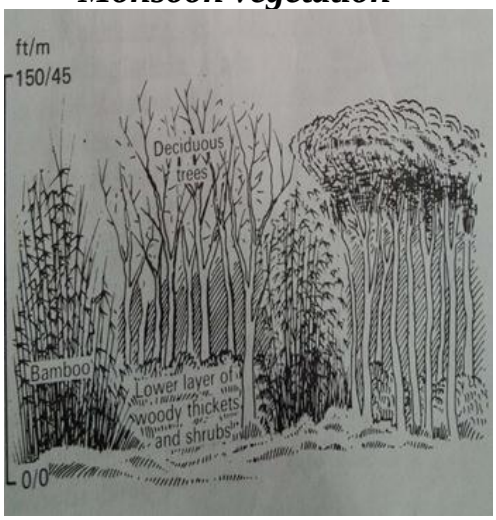
i. Eucalyptus
ii. Teak
iii. Bamboo
iv. Sal
v. Sandalwood
vi. Acacia

ECONOMIC IMPORTANCE OF TROPICAL MONSOON FORESTS

- Trees are used for lumbering, such as teak.
- Trees are used for poles, such as eucalyptus.
- Shifting cultivation.
- Rubber production.
- Wet pad cultivation.

Bamboos in monsoon forest

Monsoon vegetation



Tropical Monsoon Climate

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
TEMP (°C)	22	21	21	19	16	15	15	16	20	22	23	22
RAIN (mm)	225	223	154	36	18	0	0	4	15	29	85	131

HEMISPHERE: Southern hemisphere

REASON: The temperature is low in June and July when it is winter in the southern hemisphere**.**

ANNUAL TEMPERATURE RANGE=23°C-15°C

=8°C

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
TEMP (°C)	14	15	17	19	19	24	25	18	18	16	16	15
RAIN (mm)	5	20	54	196	208	230	210	94	75	9	5	0

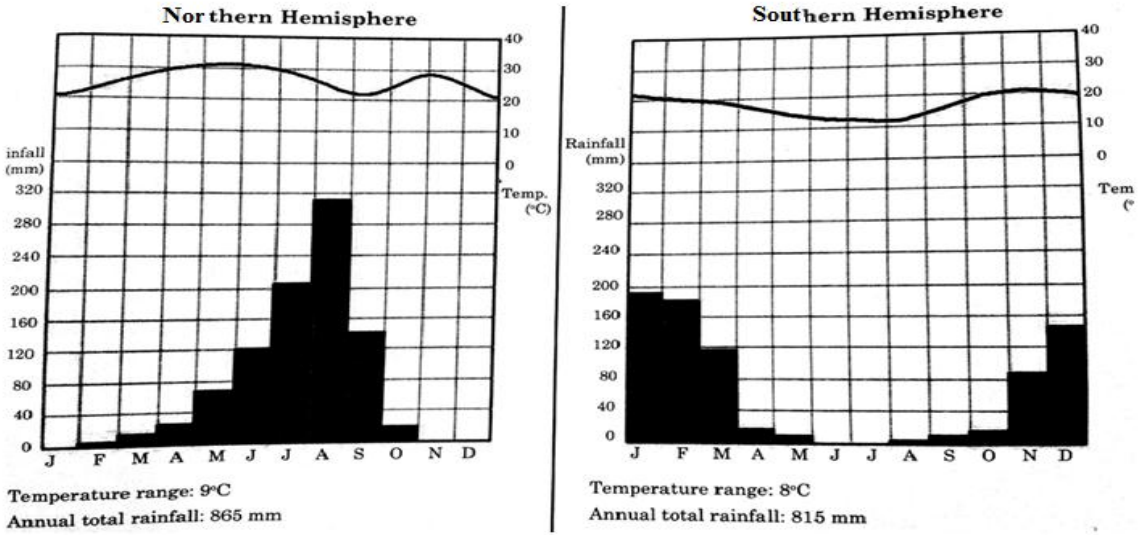
HEMISPHERE: Northern hemisphere

REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

ANNUAL TEMPERATURE RANGE=25°C-14°C

=11°C

Graphs for tropical Monsoon Climate



SIMILARITY BETWEEN SUDAN CLIMATE AND TROPICAL MONSOON CLIMATE

☞ In both cases there is seasonality of rainfall.

DIFFERENCES BETWEEN SUDAN CLIMATE AND TROPICAL MONSOON CLIMATE

☞ Tropical continental (Sudan/Savanna) climate rainfall is received for a short period of time while in tropical monsoon climate rain comes for a long period of time.

Sudan climate receives less rainfall as compared to tropical monsoon climate.

SIMILARITIES BETWEEN TROPICAL GRASSLANDS AND TROPICAL FORESTS

- In both cases the trees are deciduous.
- In both cases the trees are scattrered.
- Both vegetations contain a small number species of plants.

4..TROPICAL DESERT CLIMATE

Location

❖ It is well developed in the following regions: Sahara desert, Arabian Desert, Iranian desert, Namib Desert, Atacama Desert, Californian desert and Mexican desert.

Desert Climate

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	19	18	17	16	16	15	14	16	16	16	17	18
RAIN (mm)	-	0.1	0.2	-	-	-	-	-	-	-	-	0.2

HEMISPHERE: Southern hemisphere

REASON: The temperature is low in June and July when it is winter in the southern hemisphere**.**

ANNUAL TEMPERATURE RANGE=19°C-14°C

=5°C

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	14	16	17	17	18	18	19	18	16	16	15	15
RAIN (mm)	-	0.1	0.2	-	-	-	-	-	-	-	-	0.2

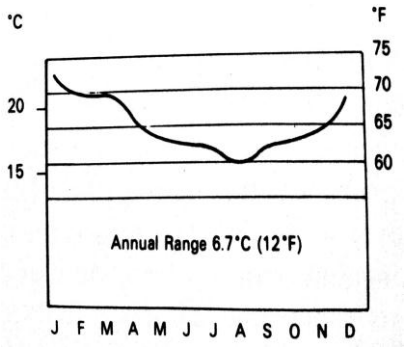
HEMISPHERE: Northern hemisphere

REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

ANNUAL TEMPERATURE RANGE=19°C-14°C

=5°C

Graph for Desert Climate



CHARACTERISTICS OF TROPICAL DESERT CLIMATE

- Dryness.
- No cold season in the hot desert.
- Rain rarely falls. Average annual rainfall is usually 120mm.
- It occurs in tropical high pressure belts.
- Temperatures are high throughout the year.
- Day temperatures often go over 38°C because of no clouds. At night due to no clouds, temperatures fall to 15°C in cool season.

AGRICULTURAL DEVELOPMENT

i. Irrigation agriculture can take place. Crops grown are wheat, date palms, vegetables and fruits.
ii. Nomadic herding takes place in Sahara and Arabian deserts.
iii. Rearing of camels for transportation.

ECONOMIC IMPORTANCE OF TROPICAL DESERT CLIMATE

- Hunting and fruit gathering, for example the Fulani of North West Africa.
- Mining
- Tourism
- Solar power generation

FACTORS PREVENTING FURTHER DEVELOPMENT OF AGRICULTURE

- Intense dusty winds make people not to like the places.
- Droughts and extreme.
- High rates of evapotranspiration.
- Poor soils which do not support farming.
- Very limited quantities and distribution of available fresh water.

SOLUTION TO THE ABOVE PROBLEM

- Ice towing from the Antarctic to hot desert areas.

TYPE OF VEGETATION

DESERT VEGETATION

CHARACTERISTICS OF DESERT VEGETATION

i. They grow long and well-spaced out roots ***to gather moisture, and search for ground water***.
ii. They have very thick stems and leaves ***to store water***. Such as **cacti**.

iii. They have no or few waxy, tiny, hairy or needle-shaped leaves ***to reduce the loss of water through transpiration***.

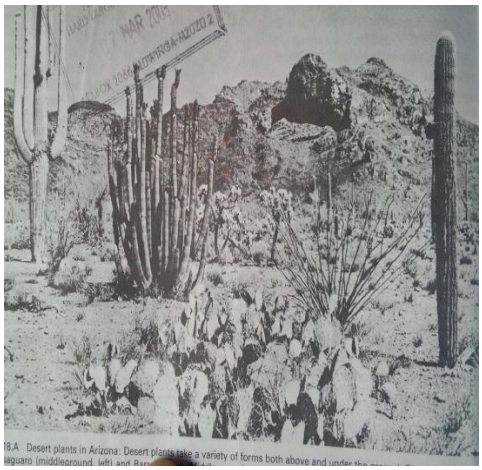
iv. They produce sleepy seeds (that become dormant when it is dry) and germinate when water is available.

v. Have scattered vegetation of drought resistant species.

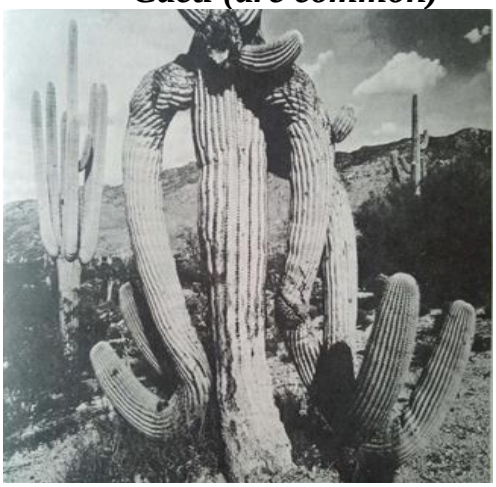
TREES FOUND IN DESERT VEGETATION

a) Cacti
b) Thorny bushes
c) Date palms
d) Shrubs
e) Wiry grasses
f) Dwarf acacias

Desert plants



Cacti (are common)



More desert plants

5..MEDITERRANEAN CLIMATE (WARM, TEMPERATE WESTERN MARGIN CLIMATE)

Location

- It occurs 30°C north and 45° north and 30° south and 40° south on the western side of continents.
- It is best developed around
    a) The shores of the Mediterranean sea such as:

    - ☞ *France*
    - ☞ *Italy*
    - ☞ *Spain*
    - ☞ *Israel*

b) Cape Town (South Africa)
c) Central Chile (south America)
d) Central California (North America)
e) South West Australia
f) South Australia (Adelaide)

CHARACTERISTICS OF MEDITERRANEAN CLIMATE

i. It receives rainfall in winter. This is a ***unique characteristic***.
ii. Annual rainfall is between 500mm-900mm. It receives both cyclonic and convectional rain.
iii. Temperature ranges from 21°C in summer to 10°C or below in winter.
iv. Off-shore trade winds blow in summer. These are dry and give no rains.
v. On-shore westerly winds blow in winter, bringing cyclonic rainfall.
vi. It receives local winds like sirocco in summer and mistral in winter.

Mediterranean Climate

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	18	18	17	16	16	15	14	15	16	16	17	18
RAIN (mm)	9	18	61	95	95	100	150	99	65	41	8	0

HEMISPHERE: Southern hemisphere

REASON: The temperature is low in June and July when it is winter in the southern hemisphere**.**

ANNUAL TEMPERATURE RANGE=18°C-14°C

=4°C

Mediterranean Climate

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	15	16	17	18	19	25	24	16	16	16	15	14
RAIN (mm)	99	81	81	49	35	10	-	-	5	11	80	98

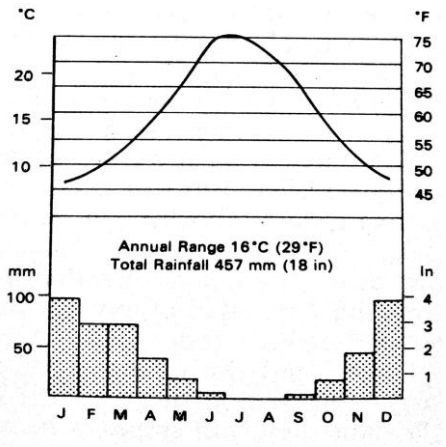
HEMISPHERE: Northern hemisphere

REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

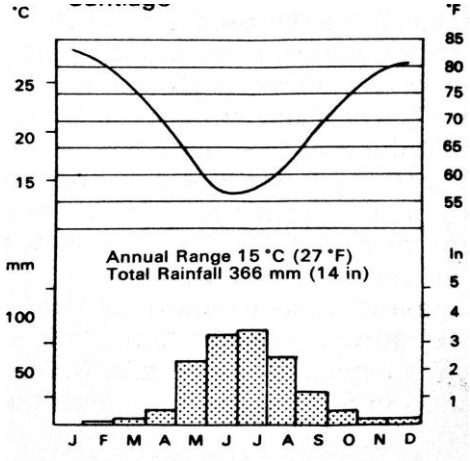
ANNUAL TEMPERATURE RANGE=25°C-14°C

=11°C

Northern Hemisphere Graph



Southern Hemisphere Graph



AGRICULTURAL DEVELOPMENT

- This climate is suitable for many crops such as fruits and cereals.
- Citrus fruits such as oranges and lemons are grown extensively through irrigation.

IMPORTANT AGRICULTURAL ACTIVITIES

- Olive trees for making cooking oil.
- Growing of grapes for making wine.
- Wheat and barley for making baking flour.

COMMON INDUSTRIES

i. Wine making.
ii. Flour milling.
iii. Fruit canning.
iv. Food processing.

ECONOMIC IMPORTANCE OF MEDITERRANEAN CLIMATE

- Mining (gold, diamond, platinum and coal are common in these areas).
- Tourism (long hot, dry summers attract tourists from cold regions).
- Farming (vines, citrus fruits, olives etc.)

MAIN PROBLEM IN THIS CLIMATE

- The regions are prone to wild fires due to hot, dry summers. The fire destroys property.
- Soils are low in humus.
- Excessive heat and lack of moisture do not support farming.

TYPE OF VEGETATION

TEMPERATE (MEDITERRANEAN) VEGETATION

CHARACTERISTICS OF MEDITERRANEAN VEGETATION

i. Evergreen trees most of which are not naturally growing.
ii. Trees have needle-shaped leaves.
iii. There are shrubs, grasses scattered all over.

iv. Very little natural vegetation.

SPECIES OF PLANTS FOUND

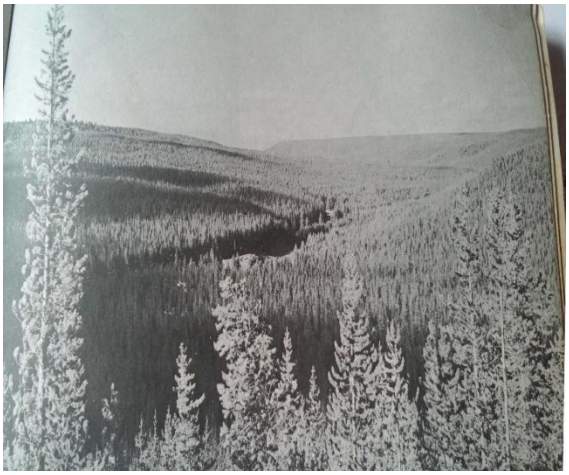
i. Cedars
ii. Conifers
iii. Eucalyptus
vii. Oaks
viii. Lavender
iv. Maquis
v. Chaparral
vi. Malle
ix. Cypres

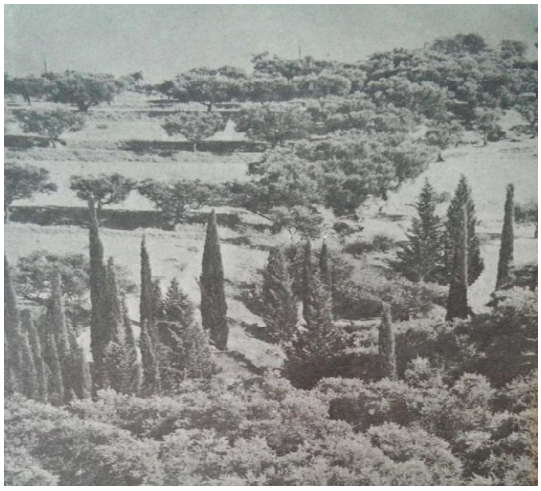
NOTE: These trees are well adapted to the summer drought.

WAYS IN WHICH THE MEDITERRANEAN VEGETATION WITHSTANDS THE DRY SUMMER

- They have thick barks for storing water ***to be used during dry season***.
- The plants have spreading and deep roots ***that easily trap water from deep soil layers***.
- They have needle-shaped leaves ***to reduce the loss of water through transpiration***.
- Most trees have a conical shape ***to reduce the surface area for transpiration.***

Mediterranean Vegetation





6.. TUNDRA CLIMATE

Location

- Northern continents north of the cold temperate continental climate.

BEST DEVELOPED IN:

- Northern Canada
- Northern Asia

CHARACTERISTICS OF TUNDRA CLIMATE

i. Winter temperatures range from -29°C to -40°C and summer temperatures is about 10°C.
ii. Annual temperature range varies from 39°C to 50°C.
iii. Winter nights are long with hardly any day light and summer days are long with hardly any nights.
iv. Total annual rainfall is about 250mm. Snow falls in winter.
v. Humidity is always low because of low temperature.

SALIFLUCTION

- It is when soil water melts under a protective network of roots of small plants, producing a thick mud which may flow down slope to create bulges without breaking through the surface.

AGRICULTURAL DEVELOPMENT

❖ Sub-soils are permanently frozen (perma-frost) and there is no agriculture of any type.

Tundra Climate

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	-20	-23	-20	-15	-4	2	5	5	0	-5	-10	-18
RAIN (mm)	10	10	15	15	15	15	25	28	25	28	28	13

HEMISPHERE: Northern hemisphere

REASON: The temperature is high in June and July when it is summer in the northern hemisphere**.**

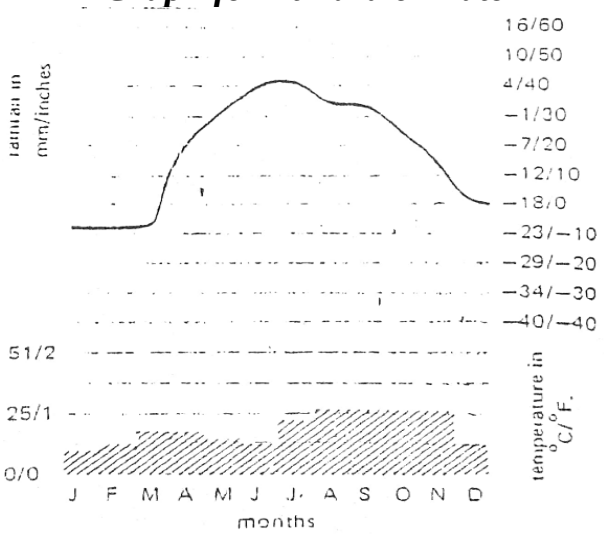
ANNUAL TEMPERATURE RANGE=5°C--23°C

=5°C(-×-)23°C

=5°C+23°C

=28°C

Graph for Tundra climate



TYPE OF VEGETATION

TUNDRA GRASSLANDS

CHARACTERISTICS OF TUNDRA GRASSLANDS

i. A variety of grass grows together with mosses and lichens.
ii. The grasses are short due to slow growth because of the very cold climate.
iii. The grass is punctured by very stunted growth of bushes.

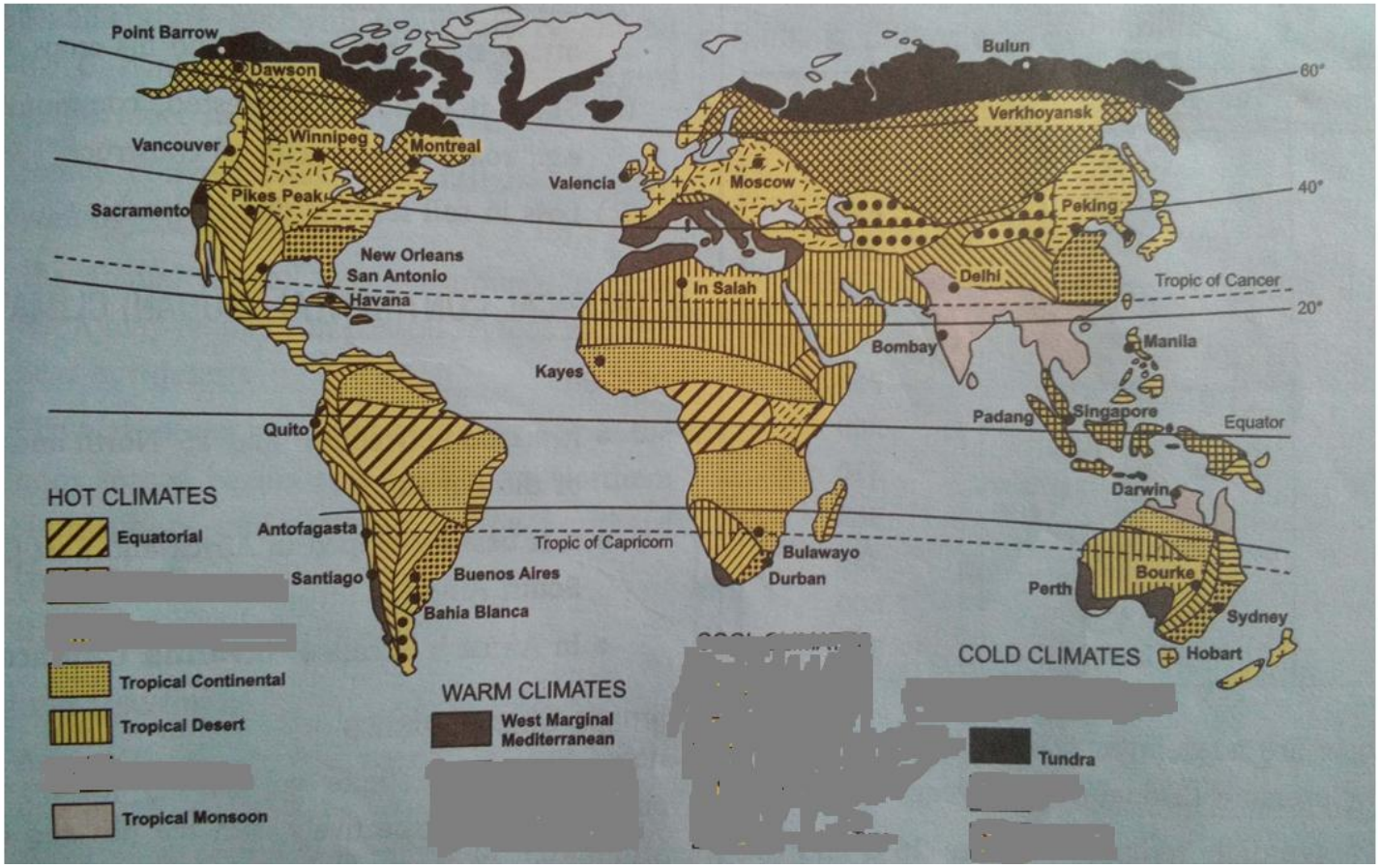
TREES/VEGETATION FOUND

i. Mosses
ii. Lichens
iii. Bilberry
iv. Bearberry

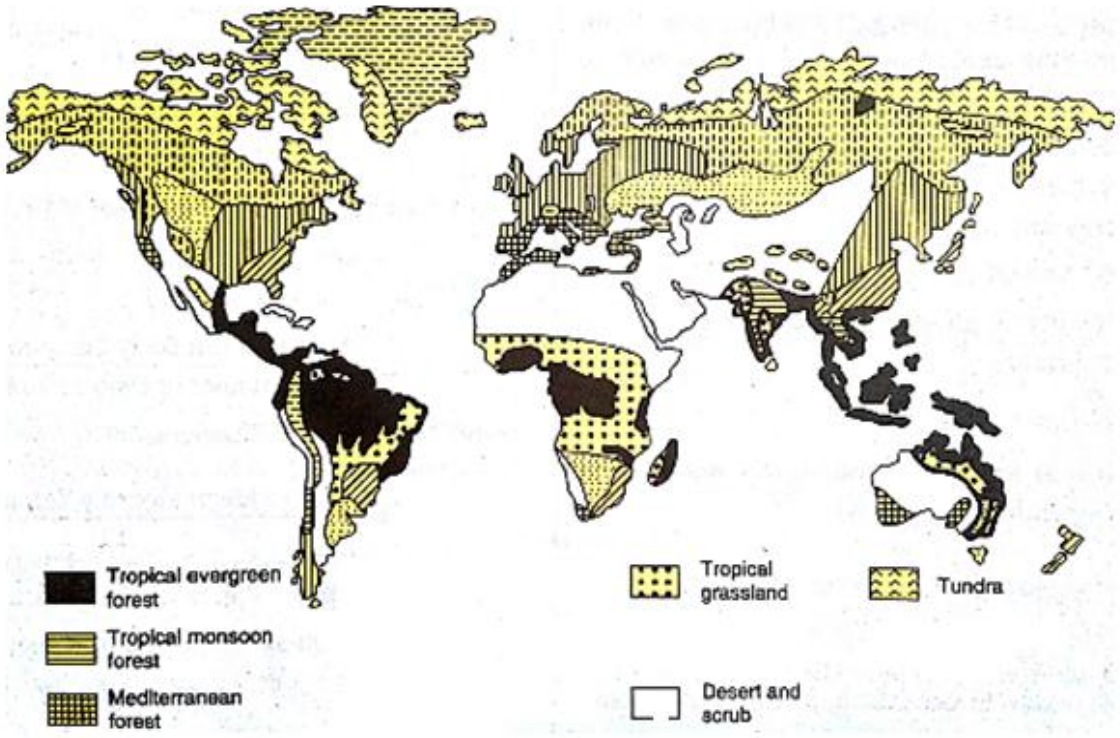
IMPORTANCE OF GLASSLANDS

a) They are habitats for a variety of wildlife. For example **in tropical grasslands**, there are ***antelopes***, ***gazelles***, **in temperate grasslands** there are ***horses***, ***antelopes;*** **in tundra vegetation** there are ***mosquitoes, musk-ox, arctic hares, arctic white fox*** and ***birds***.
b) They are used for farming.
c) Some grasslands are turned into National Parks and Game Reserves.
d) They beautify the country. This promotes the tourism industry.

World Map Showing Types of Climate



Natural Vegetation of the World



IMPORTANT FORMULAE FOR SOLVING WORLD CLIMATE-RELATED PROBLEMS

1. Annual Temperature Range $Maximum\ Temperature - Minimum\ Temperature$

Example 1

Calculate the annual temperature range for the station below.

MONTHS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
TEMP (°C)	22	21	21	19	16	14	15	16	20	22	23	22
RAIN (mm)	205	220	154	36	8	0	0	4	5	9	85	131

Annual Temperature Range$= Maximum\ Temperature - Minimum\ Temperature$

$= 23°C - 14°C$

$\underline{= 9°C}$

2. Average (Mean) Annual Temperature$= \frac{Sum\ of\ Monthly\ Temperatures}{Number\ of\ Months\ in\ a\ Year}$

Example 2

Calculate the average (mean) annual temperature for the station above.

Average (Mean) Annual Temperature$= \frac{Sum\ of\ Monthly\ Temperatures}{Number\ of\ Months\ in\ a\ Year}$

$= \frac{22+21+21+19+16+14+15+16+20+22+23+22}{12}$

$= \frac{231}{12}$

$\underline{= 19.25°C}$

3. Total Annual Rainfall$= Sum\ of\ Monthly\ rainfall\ for\ the\ station$

Example 3

Calculate the total annual rainfall for the station above.

Total Annual Rainfall= $Sum\ of\ Monthly\ rainfall\ for\ the\ station$

=205+220+154+36+8+0+0+4+5+9+85+131

$= 857mm$

TOPIC 4: THE ENVIRONMENT

WETLANDS

- These refer to swamps, marshes and begs.

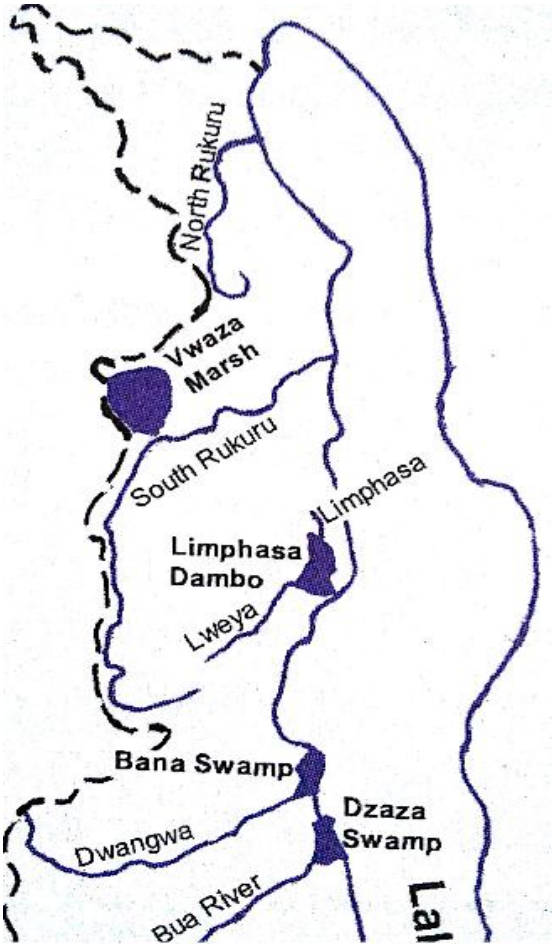
EXAMPLES OF WETLANDS IN MALAWI

- Ndindi marsh
- Elephant marsh
- Lake Chirwa marsh
- Vwaza marsh

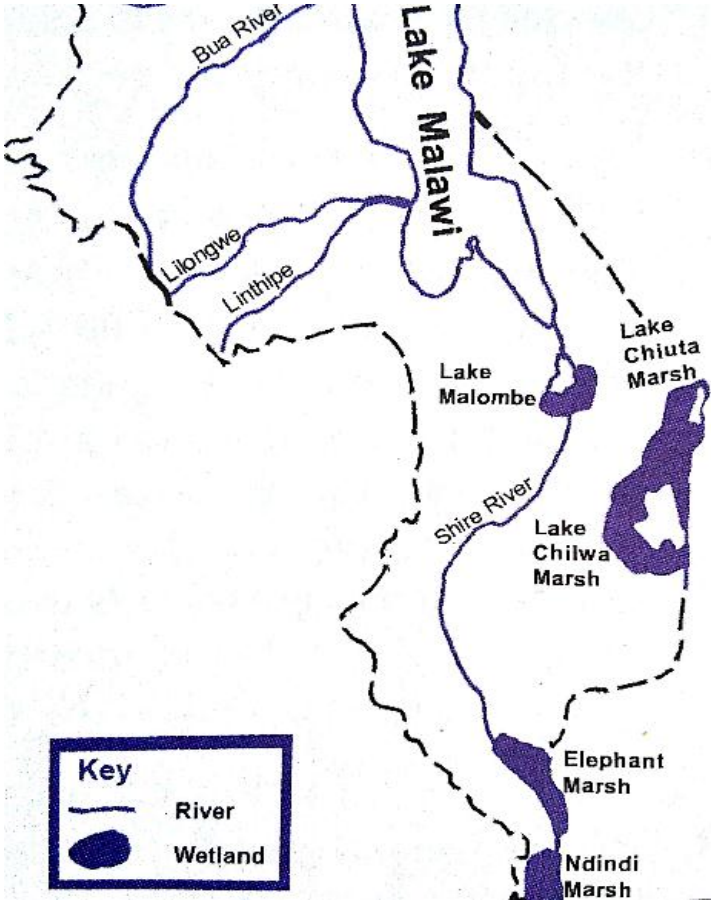
NB: *Some dambos are also regarded as wetlands.*

Location of wetlands in Northern and Southern regions of Malawi

(a) In Northern Malawi



(b) In Southern Malawi



NOTE: On the maps above, only focus on the location of the main wetlands as listed above, thus Vwaza Marsh, Lake Chilwa Marsh, Elephant Marsh and Ndindi Marsh.

IMPORTANCE OF WETLANDS

- ❖ They stabilize shore lines. This is done by reducing the impact of waves and tides.
- ❖ They provide feeding, spawning and nursery for fish.
- ❖ They are habitats for birds, endangered and threatened plant and fish species.
- ❖ They beautify the environment, promoting the tourism industry.
- ❖ They provide grounds where biological studies and recreational observations occur.
- ❖ They lock up carbon in the form of peat. This preventsit from escaping into the atmosphere as carbon dioxide (one of the green-house gases). This prevents global warming.
- ❖ They absorb and filter pollutants that would degrade rivers and lakes. They thus, help provide clean water.
- ❖ They absorb and hold back runoff. This prevents flooding.

HUMAN ACTIVITIES THAT THREATEN WETLANDS

i. Encroachment

- ➢ This is where people drain wetlands for farming.
- ➢ This results from scarcity of land for farming due to rapid population growth.

ii. Bushfires

- ➢ These destroy vegetation that conserves moisture and water I wetlands.

MANAGEMENT OF WETLANDS

A. By the Government

- ➢ Civic education to people who live near and around wetlands on the importance of conserving wetlands.
- ➢ Civic education to people to control rapid population growth through radios, newspapers etc. Rapid population growth is the major cause of encroachment as people need land for farming and settlement.

B. By Individuals

- ➢ Individuals should avoid encroachment into wetlands.

C. By Communities

- ➢ Community members should report to relevant authorities anyone found encroaching into wetlands. When this happens, necessary action can be taken.

ENVIRONMENTAL ISSUES (PROBLEMS)

☞ These are aspects of human activity that have negative effects on the quality of the environment necessary for the wellbeing of the organisms living in it.

MAJOR ENVIRONMENTAL ISSUES (PROBLEMS) AFFECTING THE WORLD

1) Pollution
2) Climate change
3) Global warming
4) Desertification
5) Resource depletion
6) Ozone depletion
7) Overpopulation
8) Hazardous (poisonous) wastes
9) Deforestation

HUMAN ACTIVITIES THAT ENDANGER THE ENVIRONMENT

- **Deforestation**

✓ This is when large areas of vegetation are cleared for either farming, settlement etc.

- **Poor agricultural practices**

✓ These include shifting cultivation, cultivating along river banks, making ridges along the slopes.

✓ These promote soil erosion which leads to silting of rivers.

- **Pollution**

✓ This can take the form of air, land and water pollution.

- **Poor waste disposal**

✓ These mainly come from industries, and partly individuals.

GLOBAL WARMING

Generally, this is when the earth experiences high temperatures, this warms up the globe.

- It has to be noted that there is an ozone layer in the atmosphere. This ozone layer absorbs a certain amount of heat from the sun.

Causes of global warming

Chlorofluorocarbons (CFCs)

→ These are harmful gases emitted (released) into the atmosphere by cars, air conditioners, refrigerators, power stations, production of agricultural fertilizers, etc.

→ They include methane, nitrous oxides, carbon dioxide.

→ These are called ***greenhouse gases.***

❖ All these greenhouse gases absorb terrestrial radiation and send the heat back to the earth's surface.

❖ They also destroy the ozone layer, making it fail to absorb heat from the sun. As a result, the heat passes through directly, making the globe to be warm. This is called ***greenhouse effect***.

EFFECTS OF GLOBAL WARMING

1) Floods due to the melting of ice caps.
2) Skin diseases such as skin cancer.
3) Desertification
4) Unreliable rainfall

DESERTIFICATION

- This means a steady process of down-grading land surface to produce desert conditions. Good and fertile land is turned into a barren and unproductive scrub.
- This process of desertification is promoted by careless cutting down of trees and overstocking livestock. This leads to overgrazing, where valuable ground cover is removed, leaving the land bare and susceptible to erosion.

DESERT

- A desert is almost a barren land in which the absence of precipitation (such as rainfall) does not support plant life.

CAUSES OF DESERTIFICATION

Removal of vegetation

- ☞ When forests are cleared, the land is left bare. This results into deforestation, which leads to desertification.
- ☞ Some of the primary factors promoting the removal of vegetation include droughts, climate shifts, tillage for farming, overgrazing and deforestation for fuel or construction materials.

❖ Suffice to mention that these problems are promoted by rapid population growth, which increases the pressure and demand for the forest resources.

TYPES OF DESERTS AND THEIR FORMATION

I. POLAR DESERTS (PHYSIOLOGICAL DESERTS)

FORMATION OF POLAR DESERTS

- These are areas of great ice sheets since they are located in Polar Regions with very low temperatures.
- Although moisture is available in the ice sheets, it is not available for plant growth because it is frozen.

II. MIDDLE LATITUDE DESERTS

- These deserts are also called Topographic Deserts because they exist due to their location in the deep interiors of continents or the presence of high mountains across the path of prevailing winds.

FORMATION OF MIDDLE LATITUDE DESERTS

- These are formed when a mountain or highland stands in the path of prevailing winds. When the winds get to the mountain, the air is forced to rise. Upon rising, the air gets condensed, leading to the formation of relief rainfall on the windward side of the mountain. There is little or no rainfall on the leeward side of the mountain. When this happens for a long time, a desert is formed on the leeward side of the mountain.
- In addition, these winds bring no rains because they have lost a lot of moisture after travelling over a long dry land or over mountains. This again reduces the odds of bringing rains.

EXAMPLES OF DESERTS FORMED AS A RESULT OF BLOCKED WINDS (TOPOGRAPHIC DESERTS OR MIDDLE LATITUDE DESERTS)

i. Patagonian Desert in Argentina
ii. Great Basin Region in USA
iii. Gobi Desert of Mongolia
iv. Turkestan Desert (formed due to its continental location)

III. LOW LATITUDE DESERTS (TROPICAL DESERTS)

FORMATION OF LOW LATITUDE DESERTS (TROPICAL DESERTS)

- These deserts are located around $15\text{-}25^0$ north or south of the equator, latitudes of subtropical high pressure belts or horse latitudes and trade winds. The horse latitudes are generally calm, with subsiding air. Subsiding air gets heated, a condition not favourable for precipitation. As this air moves to the equator, it gets heated further; this decreases chances of precipitation, leading to desert formation; except where mountains lie across the paths of the winds.

EXAMPLES OF LOW LATITUDE DESERTS (TROPICAL DESERTS)

i. Sahara Desert
ii. Kalahari Desert
iii. Arabian Desert
iv. Thar Desert
v. Sonora Desert
vi. Atacama Desert

vii. The Great Australian (Victoria) Desert

CHARACTERISTICS OF LOW LATITUDE DESERTS (TROPICAL DESERTS)

- They are rocky
- They are stony
- They are sandy

THE INFLUENCE OF OCEAN CURRENTS IN THE FORMATION OF DESERTS

Cold ocean currents do not bring rainfall to the areas they blow. This happens because cold ocean currents cool the air of the on-shore winds which blow across them. As they get cooled, humidity drops. This results into fogs, and later become warm and dry when they reach the land.

REASON WHY COLD OCEAN CURRENTS DO NOT BRING RAINFALL TO THE AREAS THEY BLOW

- Cold ocean currents are dry winds which do not absorb moisture. This discourages rain formation, leading to desert formation.

EXAMPLES OF DESERTS THAT WERE FORMED DUE TO THE INFLUENCE OF COLD OCEAN CURRENTS

1) Namib desert (influence of Benguela cold ocean current).
2) Atacama desert (influence of Peruvian cold ocean current).

☞ Atacama desert was also formed due to the influence of Andes mountain Range in the east which blocks the movement of moist air from the Atlantic ocean.

3) Californian desert (due to the influence of Atacama cold ocean current).
4) Western Sahara desert (influence of Benguela cold ocean current).
5) Western Australian desert (influence of west Australian cold ocean current).

❖ Take note that some deserts were formed due to the influence of many factors.

FEATURES (LANDFORMS) FORMED IN DESERTS

☞ Sand dunes
☞ Plains
☞ Basins
☞ Rock pedestals

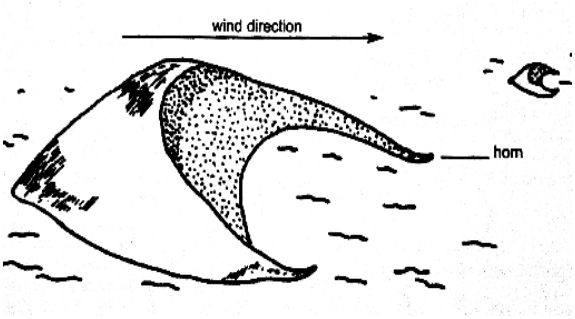
A. SAND DUNES

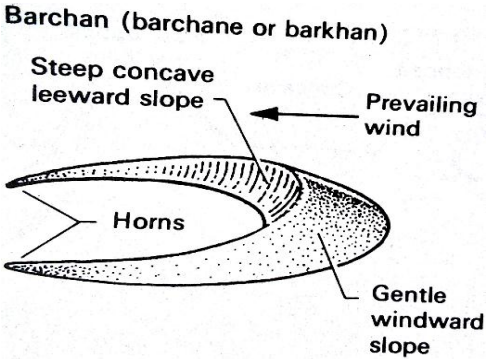
❖ This is a ridge of piles of sand. It usually forms where there is an obstacles and sand is heaped against it.

Types of Sand Dunes

i. Long, narrow, ridge-like dune (seif dune). This extends in the direction of prevailing winds.
ii. Crescent-shaped dune or barkhan.

A Barkhan





PLAINS

- A plain is an extensive flat land.

Types/examples of Desert Plains

i. Playa

- This is land that fills with water when it rains. It becomes a shallow muddy lake. It dries up again in hot weather.

ii. Bajada or Bahada

- It is an alluvial pain found at the foot of a mountain due to deposition of sediments.

iii. Alkali flat

- It forms where one or more desert streams lead.

iv. Pediment

- It is a gently sloping plain bordered by mountains.

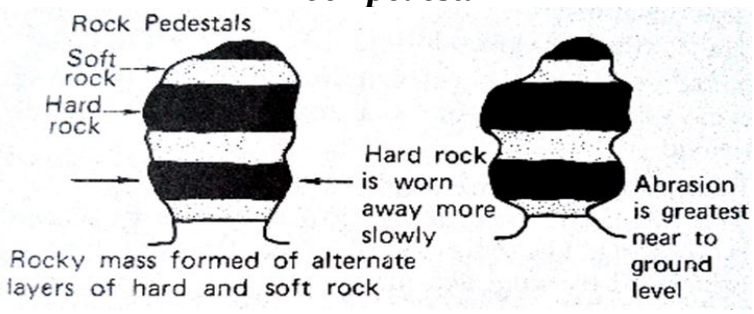
B. BASINS

- A basin is more or less surrounded by mountains whose floors tend to be filled by sediments laid down by fast flowing streams.
- The deposition of sediments laid in this way is called an ***alluvial fan***.

C. ROCK PEDESTALS

- These are rock masses formed of alternate layers of hard and soft rocks.

A rock pedestal



EFFECTS (PROBLEMS) OF DESERTIFICATION

1) It leads to climate change.
2) It leads to poor crop yield since soil fertility is lost.
3) It encourages soil erosion. This promotes siltation of rivers and this leads to flooding.

4) It leads to depletion of water resources. This results from tampering with the rate of evaporation and transpiration since river silt and vegetation is cleared. This leads to droughts and famine conditions.
5) It leads to soil degradation.
6) It causes landslides.

MEASURES FOR CONTROLLING DESERTIFICATION

a) Afforestation
- ❖ This means planting trees where there were no trees.

b) Re-afforestation
- ❖ This is the planting of trees where they have been cut down.

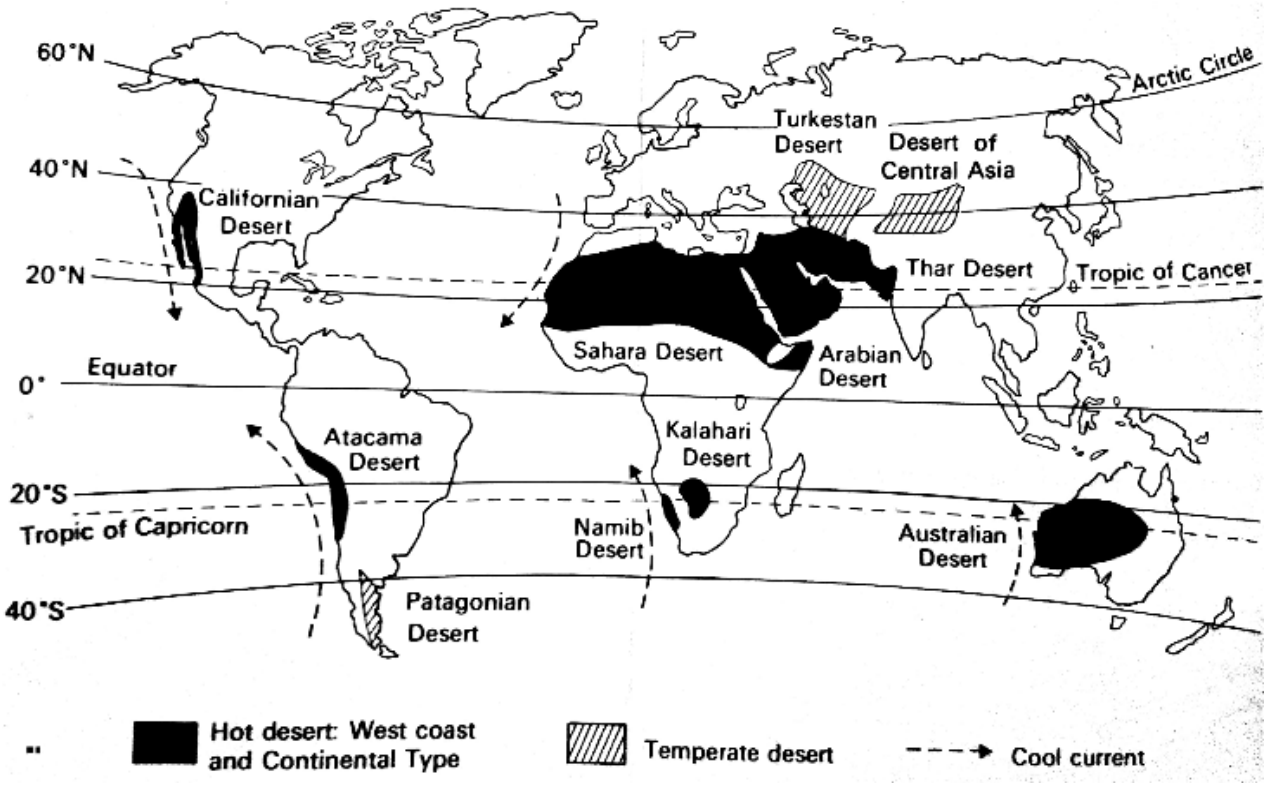
c) Proper/appropriate land husbandry
- ❖ This involves the use of good agricultural practices.
- ❖ These include contour ploughing, avoiding overgrazing, avoiding overstocking and bush furrowing.

d) Environmental education (Civic Education)
- ❖ Teach people about the dangers of deforestation and desertification. Also teach people about the importance of vegetation.

e) Controlling rapid population growth
- ❖ This will reduce pressure on vegetation, thus controlling desertification.

f) Provision of alternative sources of energy
- ❖ These include solar power, hydro-electric power etc.
- ❖ Doing so would reduce pressure on vegetation since there will be less or no demand for firewood or charcoal for cooking, heating etc.

Major Deserts of the World



REASONS WHY DESERTS ARE DRY (ARID)

a) They lie astride the horse latitudes where air is descending, a condition not good for precipitation.
b) The rain-bearing trade winds blow off-shore, and the westerly winds that are on-shore blow outside the desert limit. This discourages rain formation.
c) Winds that reach the deserts blow from cooler to warmer regions, and their relative humidity is lowered. This makes precipitation almost impossible.

POLLUTION

☞ It means the introduction of waste materials into the natural environment that make part of the environment not to be fit for desired use.
☞ It has to be noted that on the one hand, pollution can result from natural causes, such as acid rainfall, on the other hand, a great part of pollution is attributed to human causes.

TYPES OF POLLUTION

a) Air pollution
b) Water pollution
c) Land pollution

AIR POLLUTION

- It refers to the accumulation of substances in the atmosphere that endanger human health and other organisms.
- It is a common problem in industrial urban areas because these areas produce a lot of waste products from transportation, industrial processes and general combustion.
- **CAUSES OF AIR POLLUTION**

1) COMBUSTION OF FOSSIL FUELS

☞ The burning of fossil fuels in factories and automobiles in big cities release a lot of gases such as carbon dioxide, nitrogen and sulphur oxides into the air.

2) DEFORESTATION

☞ The clearing of forests means that carbon dioxide will no longer be absorbed by vegetation, making it to escape into the atmosphere to cause air pollution.

3) VOLCANIC ERRUPTIONS

☞ These release harmful gases and substances into the atmosphere, such as ash.

4) INCREASED URBANISATION

☞ This leads to expanding construction, transport and industrial activities, which cause dust to escape into the atmosphere.

NEGATIVE (HARMFUL OR DESTRUCTIVE) EFFECTS OF AIR POLLUTION

i. DISEASES

☞ Air pollution promotes the respiratory diseases such as bronchitis, lung cancer and some heart diseases.

ii. ACID RAINFALL

☞ This refers to precipitation that contains harmful nitric and sulphuric acids. These acids are formed when nitrogen and sulphur oxides are released into the atmosphere after the burning of fossil fuels.

EFFECTS OF ACID RAINFALL

- ✓ It damages trees.
- ✓ It causes soil and water bodies to be acidic.
- ✓ It speeds up the decay of buildings.
- ✓ It leads to less rainfall since the trees that help in the hydrological cycle through transpiration are damaged.

iii. POOR VISIBILITY (HAZE)

- Haze means mist, clouds or smoke suspended in the atmosphere and obscuring or obstructing the view.
- This happens when sunlight faces tiny dust particles in the air.
- Haze hinders the clarity, colour, texture and form of what we see. This leads to accidents in the transportation industry such as shipping and aviation (aeroplanes).

iv. DEPLETION OF THE OZONE LAYER

- Greenhouse gases lead to the depletion of the ozone layer. This increases the amount of ultra-violet radiation to reach the earth. This may lead to skin cancer and reduced crop yield.

v. GLOBAL CLIMATE CHANGE

- Increased production of greenhouse gases such as methane makes the earth to trap more heat from the sun. This leads to global warming.

WATER POLLUTION

☞ This results from introduction of chemicals, physical and other materials into water bodies that degrades the quality of water.

CAUSES OF WATER POLLUTION

1) DUMPING OF INDUSTRIAL WASTES

☞ Wastes containing sharp metals, harmful chemicals, by-products, organic toxins and oils into water bodies lead to water pollution.

2) OIL SPILLS

☞ This can result from breakage of oil pipes or tankers, leading to the spread of harmful substances into water bodies.

3) IMPROPER DISPOSAL OF WASTES

☞ This results from the discharge of home and industrial wastes into water bodies.

4) RESIDUES OF AGRICULTURAL PRACTICES

☞ These may include fertilisers, pesticides, herbicides and insecticides. These may enter groundwater systems through rainwater, leading to water pollution.

5) NATURAL DISASTERS

☞ Hurricanes and tornadoes can destroy nuclear power plants and automobiles. This may cause a lot of damage to marine life.

HARMFUL EFFECTS OF WATER POLLUTION

1. **SPREAD OF WATER BORNE DISEASES**

➢ Diseases such as cholera, dysentery and diarrhoea are caused by pathogens that are found in polluted (contaminated) water. These negatively affect animals and people.

2. **SCARCITY OF SAFE AND PORTABLE WATER**

➢ Polluted water is harmful for animal, people and plant use.

3. **DEATH OF AQUATIC SPECIES**

- Polluted water reduces the availability of oxygen in water bodies. This leads to the death of aquatic species.

4. **THE DISPOSAL OF NON-BIODEGRADABLE WASTES**

- Non-biodegradable wastes are those that do not easily rot or decompose. These may include nuclear wastes, containers, bottles and cans made of plastics, used cars and electric goods. These lead to land pollution.

5. **BURNING OF FOSSIL FUELS**

- This leads to the formation of ashes, which again leads to land pollution.

6. **MINING**

- This leads to the formation of piles of coal and slag. When these are not properly disposed of, they accumulate and contaminate the land.

HARMFUL EFFECTS OF LAND POLLUTION

- ✓ It leads to ecological imbalances since vegetation which provides food and shelter is destroyed.
- ✓ It leaves places dirty and unhealthy. This leads to many healthy problems such as skin diseases.
- ✓ Leached poisonous chemicals into the soil may cause long-term harmful environmental problems.
- ✓ Land pollution releases airborne chemicals and smell, which endanger health of people, plants and animals.

POSSIBLE SOLUTIONS TO (CONTROL MEASURES) TO THE PROBLEM OF POLLUTION

i. Using recycled products.
ii. Reusing things such as paper and plastic bags.
iii. Using renewable and clean sources of energy such as solar and wind.
iv. Public awareness campaigns (civic education) on the causes and dangers of various forms of pollution.
v. Legislation and enforcement of laws that protect the environment against all forms of pollution.
vi. Planting more trees to trap and store carbon dioxide.

Encouraging the use of public transport to reduce the number of vehicles on the roads. This may help lower the levels of gases from automobiles.

CLIMATE CHANGE

CLIMATE

- ❖ It is the average weather condition of an area over a long period of time.

CLIMATE CHANGE

- ❖ It is the gradual change of climate from one type to the other, caused by changes in weather patterns.

OR

❖ Climate change is a shift in long-term patterns of climatic factors such as temperature and precipitation.

CAUSES OF CLIMATE CHANGE

a) Deforestation

- This is the careless cutting down of trees, leaving the land bare. It should be recalled that plants withdraw huge quantities of carbon dioxide from the atmosphere during photosynthesis (the process of food making in plants), and release oxygen in return.
- This means that when plants are cleared, this balance is upset. It implies that carbon dioxide and other greenhouse gasses will be accumulating in the atmosphere without being replaced. These greenhouse gasses destroy the ozone layer, making direct rays from the sun to reach the earth surface. This leads to global warming, and consequently to climate change.

b) Burning of fossil fuels

- Such fuels include petroleum, coal and natural gas. When these are burnt, they withdraw oxygen from the atmosphere and replace it with carbon dioxide. Continued accumulation of carbon dioxide in the atmosphere leads to climate change (as discussed above).

c) Pollution

- Pollution changes the interaction patterns between the surface of the earth and the atmosphere. Such disruptions cause changes in weather which gradually leads to climate change.

d) Desertification

- This results from careless clearing of forests and other plants. This leads to climate change by bringing arid conditions.

e) Other causes

- Some crops that people grow lead to changes in the climatic conditions of the world.
- One of such crops is **rice**.
- Rice fields release methane into the atmosphere.
- **Cattle-rearing**, just like rice growing release methane (from dung) into the atmosphere.
- Methane is one of the green-house gases (just like carbon dioxide), that destroy the ozone layer, making direct rays from the sun to reach the earth surface. This leads to global warming, and consequently to climate change.

EFFECTS OF CLIMATE CHANGE

i. Global warming

❖ This is the warming up of the earth due to the inability of heat to escape from the earth's surface into the atmosphere.

❖ This happens due to the destruction of the ozone layer in the atmosphere by green-house gases such as carbon dioxide, methane, water vapour, fluorine and chlorine. This makes direct rays from the sun to reach the earth's surface.

❖ The green-house gases also form their own layer in the atmosphere. This layer makes the heat to fail to escape from the earth's surface into the atmosphere.

Effects of global warming

❖ It promotes desertification

❖ It shifts climatic belts and vegetation types, making some plants and animals to become extinct.

- ❖ It raises sea temperatures, causing water to expand and raise sea level.
- ❖ It promotes flooding by melting glaciers, which raise sea levels.

ii. Pollution which causes acid rains which destroy valuable forests

iii. Spread of the existing diseases

- ➢ These include diseases such as diarrhoea and invasion of the temperate regions by tropical diseases.

iv. Changing ocean currents

v. Collapse of the fishing industry

- ➢ This happens as sea temperature rises, bringing new fish species into major fishing grounds of the world.

vi. Increased frequency of storms

- ➢ This may include floods.

vii. Severe droughts and flooding

- ➢ This may increase migration of people and declining food production.

viii. Shrinking of the Antarctic ice cap and melting glaciers

ix. Damage to coral reefs

- ➢ This makes the tourism industry to suffer greatly.

Effects of climate change on selected regions

- ✓ Rising temperatures have melted glaciers of Kilimanjaro Mountain.
- ✓ Maldives Islands are threatened by rising sea levels. (Maldives Islands are 1.5 metres above the sea level).
- ✓ Pacific Island states of Tuvalu and Samoa face danger from rising sea level and increased frequency of hurricanes.
- ✓ In Netherlands, the rising sea level is threatening the dykes of the western region. The Dutch have now started constructing floating houses in readiness for any flooding of the reclaimed lands.

MITIGATION MEASURES TO CLIMATE CHANGE (POSSIBLE SOLUTIONS TO CLIMATE CHANGE)

- ☞ Mitigation means actions that aim at reducing the magnitude of climate change by reducing the emission of greenhouse gases. These factors may include but not limited to the following:

a. Recycling and reusing some products.

b. Afforestation and reforestation

- ❖ This means planting of trees in areas where there were no trees (afforestation), and replacing trees where they have been cut down (reforestation).
- ❖ Afforestation and reforestation can reduce the amount of carbon dioxide in the atmosphere by absorbing, and using it during photosynthesis. Photosynthesis in turn increases the levels of oxygen in the atmosphere. This reduces the possibilities of global warming.

c. Reducing the use of fossil fuels

- ➢ This can be done by introducing other sources of energy (such as solar energy, Hydro-Electricity, wind energy etc)

d. Reducing emission of green-house gases into the atmosphere

- ➢ This can be done by international agreements such as the protocols of Kyoto and Montreal.

- The Kyoto protocol was implemented in February, 2005.
- Its aim is to reduce emission of carbon dioxide and other green-house gases by 5% by the year 2012.

e. Proper waste disposal and no use of some farming inputs such as nitrate fertilizers.

- These have devastating effects on the environment if not properly handled.

f. Awareness campaigns (civic education) on causes of climate change.

This can help to change people's mind-sets (or attitude) on how they use and manage natural.

g. Establishment of strict laws and heavy penalties for non-environmental friendly actions by companies and industries through international agreements.

h. Integrating climate change into education systems of all parties to the convention.

ADAPTATION MEASURES TO CLIMATE CHANGE

☞ Adaptation involves efforts to reduce the impacts of climate change on vulnerable communities and their livelihoods through various measures, while not necessarily dealing with the underlying causes of those impacts. Some of these measures include the following:

1) Promotion of irrigation farming to reduce relying on rain-fed agriculture.
2) Promoting production of drought-tolerant crops such as cassava, millet, sorghum and sweet potatoes to ensure food security on family, community and national levels.
3) Improving weather and flood forecasting and communications to assist in evacuation, relief and rehabilitation.
4) Creating functional linkages with development partners for technology enterprise initiatives.
5) Diversifying rural economies by value addition to agricultural products and bee keeping to reduce relying on climate-sensitive agricultural practices.
6) Addressing land degradation by practicing proper farming methods such as making ridges across the slopes to promote infiltration of water.

EXAMPLES OF INTERNATIONAL AGREEMENTS ON CLIMATE CHANGE

- The Kyoto and Montreal protocols.

☞ The Kyoto protocol was implemented in February, 2005.

☞ Its aim was to reduce emission of carbon dioxide and other green-house gases by 5% by the year 2012.

TOPIC 5: GEOGRAPHICAL INFORMATION SYSTEMS (GIS) AND REMOTE SENSING

GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

☞ This refers to a system of capturing, storing, manipulating, retrieving, and comparing spatial or geographical data to support some analytic process.

☞ GIS stands for Geographical Information System (Science) or Geographical Information Studies.

☞ It is a computerised system that promotes the phases of data entry, data analysis and presentation of data especially when dealing with geo-referenced data.

☞ GIS is a computer-based tool for mapping and analysing feature events on earth.

☞ Geographically referenced information means the data that is identified by their location.

THINGS THAT MAKE THE INFORMATION SYSTEM GEOGRAPHIC

a) Spatial data:

- This means the data with a location.
- It contains information about the location and shape of, and relationship among geographic features usually stored as coordinates.

TYPES OF SPACIAL DATA

1) Vector data

☞ This is made of points, lines or polygons.

2) Raster data

☞ These are groups of grid cells with each cell having a value to represent what lies where the box is.

COMPONENTS OF GIS

1) Hardware

☞ These are computers on which GIS operates the software.

2) Data

☞ These are facts and statistics collected together for reference or analysis.

3) People

☞ These operate the system and decide on the methods of capturing, manipulating and analysis of data.

FUNCTIONS OF GIS

- For assembling data, for example by typing directly into the computer using GPS, digital scanning.
- For storing data using database.
- Spatial data analysis and manipulation.
- Spatial data output such as tables.

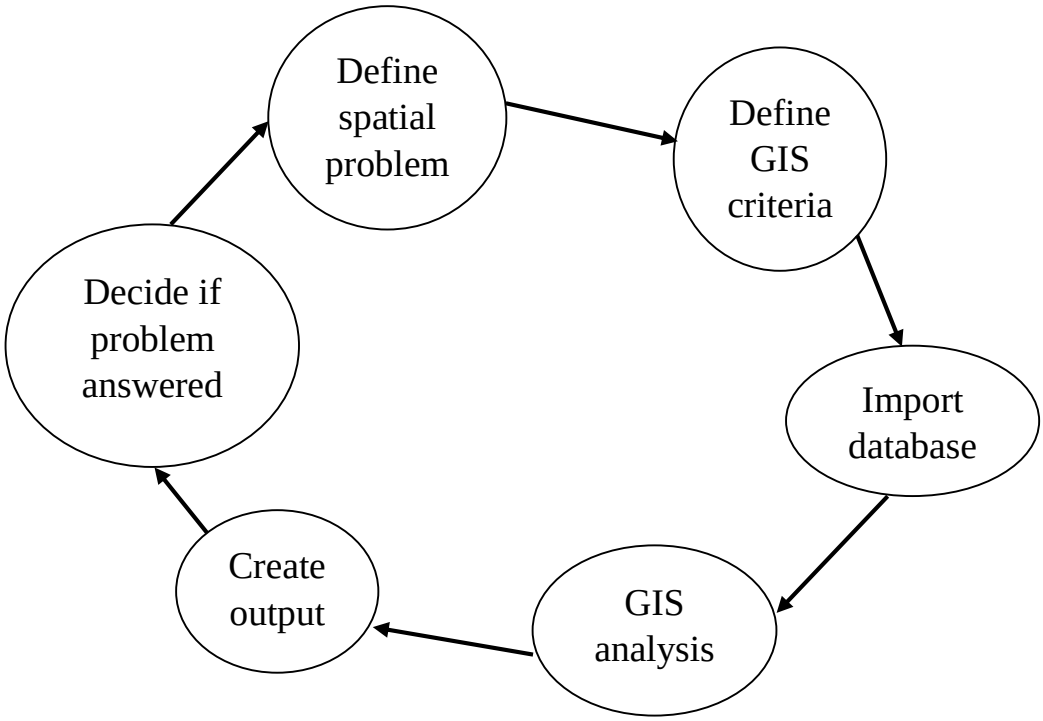
THE GIS PROCESS

➢ The process in GIS involves six steps which are common to the end-to-end map-making process.

The steps are:

a) Define the spatial problem or question.
b) Define the GIS criteria.
c) Import or create the data sets.
d) Perform the GIS analysis.
e) Create the output.
f) Decide whether or not the output solves or answers the spatial problem. If it does not, then redefine the problem or question and start the process again.

The GIS Process



APPLICATIONS OF GIS

a) Land use planning
b) Movie production
c) Environmental studies
d) Surveillance
e) Commercial advertising
f) Disease surveillance
g) Population and demographic studies
h) Power line inspection.
i) Engineering analysis
j) Urban planning and regional planning.
k) Infrastructure assessment and development.
l) Cartography, for producing topographic maps
m) Mapping archaeological sites to identify features.

REMOTE SENSING

- ☞ It is the science of obtaining information about objects or areas from a distance, typically from aircrafts of satellites.

OR

- ☞ It refers to the collection of information about an object without being in direct physical contact with an object.
- ☞ Remote sensing is the art and science of making measurements of the earth using sensors on airplanes or satellites.

- ☞ There sensors collect data in the form of images and provide specialized capabilities for manipulating, analysing, and visualizing those images.
- ☞ Remote sensed imagery is integrated within a GIS.
- ☞ Remotely sensed data may come from cameras on board satellites, air plane, space shuttles, remote controlled air plane and balloons.
- ☞ It is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area.

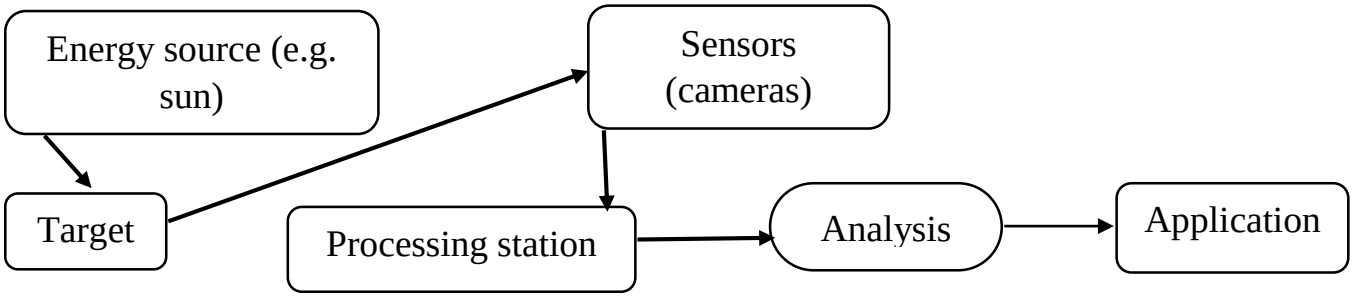
FEATURES OF REMOTE SENSING

1) Sun (energy source)
2) Energy features (target)
3) Sensors (cameras mounted on aeroplanes or satellites)
4) Processing stations (computes)

PROCESSES OF REMOTE SENSING

1) Radiation (from the sun)
2) Energy reflection and scattering (from target)
3) Energy (image) transmission (from sensors to computers)
4) Analysing and interpretation (on computers)
5) Application (on people and the environment)

THE REMOTE SENSING PROCESS



Applications of remote sensing

- ✓ General mapping
- ✓ Vegetation production
- ✓ Marine processes
- ✓ Geological processes

TYPES OF REMOTE SENSORS

a) **Active remote sensors**
b) **Passive remote sensors**

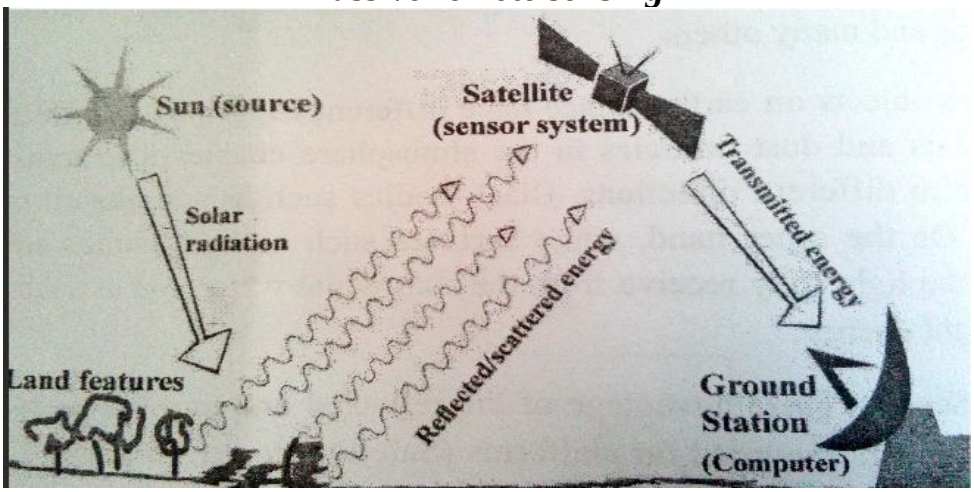
ACTIVE REMOTE SENSING

- ➢ In active remote sensing, active instruments provide their own energy to illuminate (provide light) the object or scene they observe.
- ➢ They send a pulse of energy from the sensor to the object and then receive the radiation that is reflected from the object.

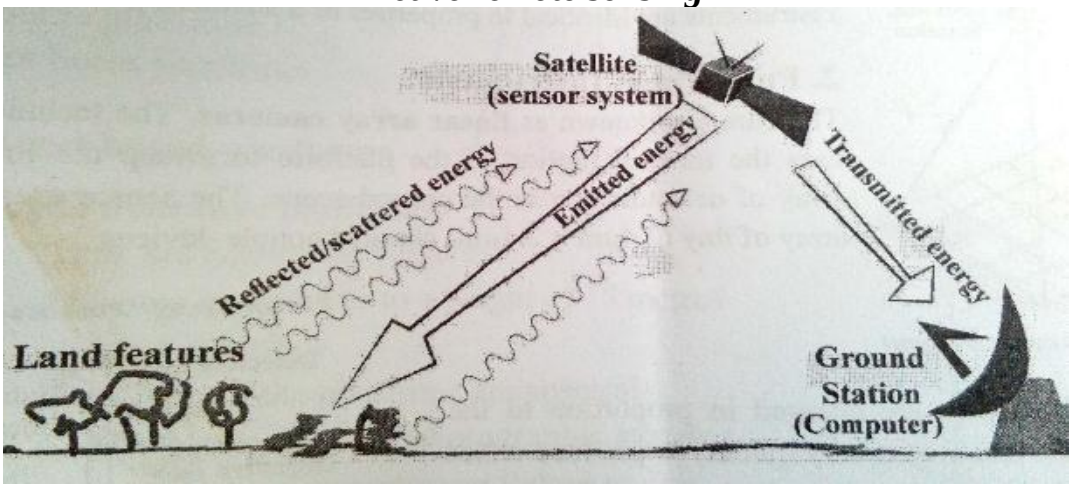
PASSIVE REMOTE SENSING

- ➢ In passive remote sensing, instruments detect natural energy (sunlight) that is reflected or emitted from the observed scene. They sense only radiation emitted by the object from the source.

Passive remote sensing



Active remote sensing



SATELLITE IMAGES

❖ These are images taken by satellites and aircraft cameras.

☞ **Google earth**

- It is a computer software programme used to view satellite images where people can explore anywhere in the world.

TYPES OF SATELLITE IMAGERY

1. Visible imagery
2. Infrared imagery
3. Water vapour imagery

Visible imagery

- Visible satellite images can only be viewed during the day, since clouds reflect the light from the sun.
- On these images clouds show up as white, the ground looks grey and water has a dark colour.

Infrared imagery

- These show clouds in both day and night.

Water vapour imagery

- These images indicate how much moisture is present in the upper atmosphere.
- The highest humidity will be the whitest areas while dark regions will be dark.

- They are useful in indicating whether heavy rains will be possible.

SATELLITE IMAGERY

ADVANTAGES OF SATELLITE IMAGES

- ✓ Large amount of data is collected within a short time. The size of pictures is very large covering an extensive area hence less expensive.
- ✓ Satellite information collection does not recognize international boundaries hence there are no delays in collection data.
- ✓ Data can be taken from hard to reach areas.
- ✓ Promote human security.
- ✓ The data collected promote research.

DISADVANTEGES OF SETELLITE IMAGES

- ✓ Being higher in the atmosphere satellites by weather conditions like clouds.
- ✓ Satellites are located far above the ground.

AERIAL PHOTOGRAPHS

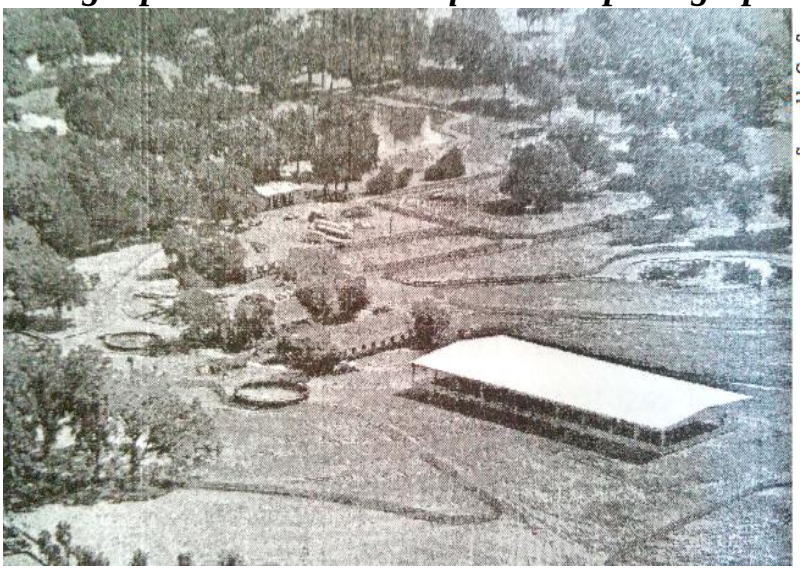
- ✓ This is the taking of photographs of the ground from an elevated or direct down position with cameras not supported by ground based structure.
- ✓ Aerials photography is another form of remotely sensed data.
- ✓ It has better resolution than satellite imagery yet covers smaller areas.
- ✓ Used to delineate roads, vegetation and many other physical features.

TYPES OF AERIAL PHOTOGRAPHS

(1) Oblique aerial photographs

- ✓ These are photographs taken at an angle. When they are taken from a low angle earth surface aircraft they are called low oblique aerial photographs.
- ✓ When they are taken from a high angle they are called high or steep oblique photographs.

Images produced in an oblique aerial photograph



(2) Vertical Photographs

- ➢ These are taken straight down. They are mainly used in photogrammetry.

Images produced in vertical aerial photograph

APPLICATION OF AERIAL PHOTOGRAPHS AND SATELLITE IMAGES

- ✓ In cartography
- ✓ In Archaeology
- ✓ In urban studies
- ✓ In climate change
- ✓ Other earth sciences

DIFFERENCES BETWEEN AERIAL PHOTOGRAPHS AND A MAP

AERIAL PHOTOGRAPHS	MAPS
☞ Show everything as viewed by the camera including unnecessary details.	☞ Show only features that are important for the purpose of the map.
☞ Have no uniform scale.	☞ Have a stated scale which is uniform throughout the map.
☞ Can be taken within a short period of time.	☞ Need a long time to be taken.
☞ Clearly show real images of features in an area.	☞ Use symbols to show features and land.

DIFFERENCES BETWEEN AERIAL PHOTOGRAPHS AND SATELLITE IMAGES

AERIAL PHOTOGRAPHS	SATELLITE IMAGES
▪ Images are taken at lower altitudes.	▪ Images are taken high above the atmosphere by satellites orbiting around the earth**.**
▪ Images are taken by a camera in an aeroplane.	▪ Images are taken and recorded by electronic scanners mounted to satellites in space.

LONGITUDES, LATITUDES, GREAT CIRCLES AND CALCULATION OF LOCAL TIME

PRIME MERIDIAN

- It is the zero degree line of longitude.

- It is also called the Greenwich Meridian because it passes through the city of Greenwich in England.
- It was officially established as zero degrees longitude at an international conference in 1884.

NOTE: Local time is also called **solar time.**

STANDARD TIME

- It is local time a country selects from a central meridian or any other convenient meridian as its standard meridian.
- The local time at Greenwich is called Greenwich Mean Time (GMT).

THE INTERNATIONAL DATELINE

- It is an imaginary line on the earth's surface that runs along and close to the 180^{o} longitude through the Pacific Ocean

LATITUDES AND LONGITUDES

LATITUDES

- A latitude is the angular distance of a point on the earth's surface, measured in degrees from the centre of the earth.

CHARACTERISTICS OF LATITUDES

i. They are always parallel to each other.
ii. Many of them can be drawn on the globe.
iii. They run from east to west.
iv. They intersect longitudes at right angles.
v. They are small circles except the equator which is a great circle.

USES OF LATITUDES

✓ To find positions on the maps.
✓ They are also used to calculate distances on the globe from the equator.

NOTE: On average, **1°=111 kilometres**. This is used to calculate distances between places.

EXAMPLE:

i. Mr. Jere is at a Shoprite which is 32° south of the equator. How far is he from the equator?

SOLUTION

Since 1°= 111km,

Therefore, 32°= more

Thus $\frac{32^{\circ} \times 111}{1^{\circ}}$

=3552km

ii. Chisomo is in town C which is located 22º North, while Mwayi is in town D which is found 48º South of the Equator. How far apart are they?

SOLUTION

Since 1^{o}=111km,

Therefore, 22^{o}=more

$= \frac{22^{\circ} \times 111\text{km}}{1^{\circ}}$

=2442km

It means town C is 244km from the equator.

For town D,

Since 1°=111km,

Therefore 48°=more

$$= \frac{48° \times 111km}{1°}$$

=5328km

It means town D is 5328km from the equator.

Therefore, the total distance between town C and D will be 2442km+5328km

=7770km.

The two girls are 7770 km apart.

PRACTICE QUESTION

iii. Mr. Jere visits a game reserve at latitude 54° 30’ (seconds). How far is the game reserve from the equator? **Hint:** 1° equals 60´ (seconds).

Pair and share

LONGITUDES

- A longitude is an angular distance measured in degrees along the equator, west or east of the prime meridian.
- They run from north to south on the globe.
- All longitudes are great circles because they cut the globe into two equal halves.

CHARACTERISTICS OF LONGITUDES

i. They run from north to south.
ii. They are halves of great circles.
iii. For suitability and convenience, they are selected at equal distances apart.
iv. They are spaced furthest apart at the equator and converge at the poles.
iv. All longitudes are great circles because they cut the globe into two equal halves.

IMPORTANCE OF LONGITUDES

- ✓ They determine local time in relation to Greenwich Mean Time (GMT).
- ✓ To calculate distance of places of the globe.
- ✓ To locate places on the earth’s surface.

TAKE NOTE OF THE FOLLOWING:

- The earth makes one complete rotation of **360°** in **24 hours**.

- Therefore, **15°** is completed in **1 hour**.
- And that, **1°** requires **4 minutes**.

❖ All areas to the right of the prime meridian (Greenwich Meridian) have their local time ahead. For every additional **15°**, **1 hour is added**.

❖ All areas to the left of the prime meridian (Greenwich Meridian) have their local time behind. For every additional **15°**, **1 hour is subtracted**.

▪ There are 12 hours and 180 longitude lines to the right of the Greenwich Meridian (Prime Meridian), and there are also 12 hours and 180 longitude lines to the left of the Greenwich Meridian (Prime Meridian).

STEPS TO CONSIDER WHEN CALCULATING LOCAL TIME

i) Find the difference in degrees between the two points. When doing so, follow these:

☞ When one place is to the west (W) of the prime meridian and the other along the prime meridian (0°), subtract the two. For example, It is 4pm in London (0°). What is the time in New York (74°W)? In this case, difference in degrees will be 74°-0°=74°.

☞ When one place is to the east (E) of the prime meridian and the other along the prime meridian (0°), subtract the two. For instance, Find the time in Malawi (30°E) when it is 19:24hours in London (0°). In this case, difference in degrees will be 30°-0°=30°.

☞ When one place is to the west (W) of the prime meridian and the other place is to the east (E) of the prime meridian, add the two. For example, It is 4pm in Town Q (45°E). What is the time in New York (74°W)? In this case, difference in degrees will be 74°+45°=119°.

EXAMPLES

i. It is 4pm in London **(0°)**. What is the time in New York **(74°W)**?

SOLUTION

Difference in degrees

74°-0°

=74°

Difference in time

Since 1°=4 minutes,

74° =more

$=\frac{74°\times 4minutes}{1°}$

=296minutes

Since 60min=1hour,

4 hours

60 296

-240

56 minutes

=4hours 56 minutes.

✓ Therefore, since New York is to the west of London **(0°)**, its time is behind that of London by 4 hours 56 minutes.

✓ Time will be: 4:00pm or 16:00 hours minus 4 hours 56 minutes (4:56).

=16:00

-04:56

11:04 AM

ii. A football match is expected to take place in London **(0°)**. If the match will start at **4pm**, at what time should the people in Yokohama **(140°E)** switch on their televisions to watch the match?

SOLUTION

Difference in degrees

140°-0°

=140°

Difference in time

Since 1°=4minutes,

140° =more

$=\frac{140° \times 4 minutes}{1°}$

=560 minutes

Since 60minutes=1hour,

9 hours

60|**560**

- 540

20 minutes

=9hours 20 minutes.

- ✓ Therefore, since Yokohama is to the east of London **(0°),** its time is ahead that of London by 9hours minutes.
- ✓ Time will be: 4:00pm or 16:00 hoursplus9 hours 20 minutes (9:20).

=16:00

+09:20

25:20 PM

But, there are only 24hours in a day, so time will be

25:20

-24:00

1:20AM the other day.

THE GREAT CIRCLE

- ☞ This is the circle on the earth's surface whose plane passes through the centre and therefore bisects it into two hemispheres.
- ☞ The equator is the only latitude which is a great circle because it cuts the earth into two equal halves (hemispheres).
- ☞ All longitudes are great circles.
- ☞ Most great distance routes for aircrafts and ships follow great circle routes because they give the shortest distances between the two points on the earth's surface.

CHARACTERISTICS OF GREAT CIRCLES

- Their planes pass through the centre of the globe.
- They are the largest possible circles that cab be drawn on the surface of the globe.
- Only one great circle can pass through any two points on the surface of the globe.
- Intersecting great circles bisect each other.